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A

DICTIONARY

OF

SCIENCE, LITERATURE, & ART.

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A

DICTIONARY

OF

SCIENCE, LITERATURE, & ART:

COMPRISING THE

HISTORY, DESCRIPTION, AND SCIENTIFIC PRINCIPLES

OF EVERY BRANCH OF

Human Knowledge;

WITH THE

DERIVATION AND DEFINITION OF ALL THE TERMS IN GENERAL USE.

EDITED BY

W. T. BRANDE, F.R.S. L. & E.

Of Her Majesty's Mint;

PROFESSOR OF CHEMISTRY IN THE ROYAL INSTITUTION OF GREAT BRITAIN;
PROFESSOR OF CHEMISTRY AND MATERIA MEDICA TO THE APOTHECARIES' COMPANY;
ETC. ETC. ETC.

Assisted by

JOSEPH CAUVIN, ESQ.

THE VARIOUS DEPARTMENTS BY EMINENT LITERARY AND SCIENTIFIC GENTLEMEN.

ILLUSTRATED BY NUMEROUS ENGRAVINGS ON WOOD.

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PREFACE.

THE advantages of Encyclopædias are now so universally acknowledged, that it would be wholly superfluous to endeavour to recommend the present work by dwelling on their peculiar merits. But though the utility of such works be no longer in dispute, it may, notwithstanding, be reasonably supposed that at a period when so many voluminous Encyclopædias, and special Dictionaries, have recently issued, and are still daily issuing from the press, this department of literature must be fully occupied, and that there can be no well-founded call for any farther addition to the number.

It will be found, however, on a little consideration that this is by no means the case. By far the greater number, or rather, perhaps we might say, all the Encyclopædias and Dictionaries of modern times, are either too voluminous or too special for ready reference and general use. The *Encyclopédie Française*, *Rees's Cyclopædia*, the *Encyclopædia Britannica*, the *Encyclopædia Metropolitana*, and the *Penny Cyclopædia*, are all works of vast extent, comprising many volumes, and embracing an infinite variety of articles, or rather treatises, which, if published separately, would each make a considerable work. Now it is obvious that such voluminous publications, whatever may be their merits in other respects, want that facility of reference and precision of statement which ought to be the distinguishing features of a useful Dictionary. No man can carry about with him any of the great modern Encyclopædias; while the extensive plan on which they are compiled renders them at once far too expensive for general circulation, and wholly unsuitable for ready consultation. The supply, indeed, of that concise and authentic information on the various subjects of science, literature, and art, which a book of reference should furnish with the utmost facility to all classes of readers, has been but a secondary object with the compilers of our great Encyclopædias; and though it had been otherwise, the length, theoretical character, and frequent obscurity of the articles in such works, must have effectually precluded their ever being used for mere purposes of reference. They are valuable as substitutes for libraries, as repositories of the various knowledge connected with the different departments of which they treat; and being so, they cannot be convenient manuals.

Special Dictionaries, on the other hand, though they may exhaust some one branch or department of science, literature, or art, and be invaluable to those engaged in its cultivation, and to those who wish to become acquainted with its details, are not intended to supply information on other branches. A work therefore like that now offered to the public, possessing the comprehensive character of a general encyclopædia without its amplitude, and

affording in a convenient form an abstract of the principles of every branch of knowledge, and a definition and explanation of the various terms in science, literature, and art which occur in reading and conversation, appears to be still wanting.

May we hope that this desideratum which has been long felt to exist in encyclopedical literature, has been at length supplied! Such at least will be the case, should the present work answer the expectations of its authors and publishers. They have endeavoured to produce a condensed and compendious Dictionary, of a convenient size, and adapted to the wants and means of all classes, that may be advantageously used as a manual or reference book in every department of science, literature, and art: and they flatter themselves that by rejecting all discussion and details not indispensable to the proper elucidation of the different topics, the work will be found, notwithstanding its comparatively narrow limits, to furnish, in the readiest possible manner, precise and accurate information on the all but infinite variety of subjects which it embraces. Great pains have been taken to make the definitions and explanations correct, clear, and concise. The principles of the most popular and important departments of science, literature, and art are also distinctly though briefly explained; and notices are given of their rise, progress, and present state.

Neither must it be supposed that because these articles are for the most part brief and compendious, they are either flimsy or superficial. On the contrary, they have been compiled throughout with the greatest care. Popularity has not been sought for at the expense of science, nor brevity by the sacrifice of useful facts or appropriate illustrations. The work contains not a few new and original views; and it is confidently believed that in every department it will be found to embody the latest information, and to be on a level with the most advanced state to which knowledge has attained, not merely in this but also in other countries. No statement has been made as to any unusual or doubtful matter, without referring to the authority whence it has been derived; and when subjects of general interest and importance are noticed, the reader is referred to the works relating to them in which they are handled with the greatest ability. Not only, therefore, will those who may consult this work have a guarantee for the authenticity of its information, but they will learn the sources to which they may resort with the greatest advantage, should they wish to make farther inquiries.

Such, in a few words, is the design of this work; and, unless its publishers be greatly deceived as to its execution, it can hardly fail to be useful to individuals of all ranks and conditions — to the man of business, and the man of pleasure, the student and the superficial reader, the busy and the idle. Every one who takes any share in conversation, or who dips, how cursorily soever, into any newspaper or other publication, will every now and then find the advantage of having access to the Dictionary of Science, Literature, and Art.

In finally submitting the work to the judgment of the public, the publishers may, perhaps, be allowed to say that they have left no means untried that appeared likely to insure the accuracy and excellence of the work. It was distributed into divisions or departments, each embracing a single subject,

or a class of closely allied subjects; and these were respectively assigned to gentlemen distinguished by their attention to, and proficiency in, the topics to be treated of. This seemed the most likely means to avoid mere compilation; to insure accuracy and adequate information; and to make the work not only a comprehensive and correct, but in some measure also an original, digest and synopsis of human knowledge.

List of the principal Authors of the work, with the departments for which they are respectively responsible.

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A

DICTIONARY

OF

SCIENCE, LITERATURE, AND ART.

A. The first letter of the Alphabet, in all known languages, with the exception of the Amaric, a dialect of the Ethiopian, in which it is the 13th, and of the Runic, in which it is the 10th. It was called *Alpha* by the Greeks, and *Aleph* by the Hebrews.

ABACI'SCUS (*see* ABACUS). In Architecture, any flat member. The square compartment of a mosaic pavement.

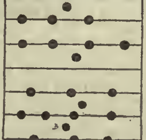
ABA'CK, in sea language, denotes the position of the sails when flatted against the mast by the force of the wind. This may happen either by a sudden change of the wind, or an alteration of the ship's course; or the sails may be *laid aback* for the purpose of avoiding some imminent danger.

A'BACOT. A cap of state worn by the old English kings.

A'BACUS. (Gr. αϐαξ, *a slab.*) In Architecture, the upper part or crowning member of the capital of a column. This member alone seems to have constituted the primitive capital. It is an essential and constituent part of the capital. In the Tuscan, Doric, and Ionic orders it is square, and in the Corinthian and composite curved inwards on its plane and truncated at the quoins or angles at 45 degrees with the face of the entablature. The use of the abacus is to give breadth to the top of the column, and present a larger surface of level bed for the reception of the architrave.

ABACUS. An ancient instrument used for assisting numerical calculations. This term has been variously derived; from the Greek word, *abax*, signifying a table; a Phœnician word, *abak*, signifying sand (because when covered with sand it served for the purposes of writing); but its derivation is most probably to be referred to the three first letters of the Greek alphabet.

The use of the abacus will be readily understood from the annexed figure. A parallelogram is divided by parallel bars, on which small pebbles or counters are placed. The counters on the lowest bar denote units, those on the second tens, those on the third hundreds, and so on; one counter on a superior bar being equal to ten on the bar immediately below it. By means of nine counters for each bar, it is obvious that any number may be thus expressed. But the number of counters may be diminished by placing a counter on the intermediate space between two bars, giving it the value of five on the bar below. When seven bars are used, any number may be expressed under ten millions. The number represented in the figure is 845,398. It will be observed that the artificial value given to the counters, according to the positions which they occupy, is entirely analogous to our numerical system of digits. The form of the instrument admitted of considerable variety. The Grecian abacus was an oblong frame, having wires stretched across it, strung with perforated beads or little ivory balls. In the Roman abacus the counters were slid along grooves. Its use formed an essential part of the education of every noble Roman youth: —



> Nec qui *abaco numeros, et secto in pulvere metas,*
> Scit risisse vafer —— *Pers. Sat.* I. 132.

The Chinese, like the Greeks, employ wires with beads; and with them the abacus or Swan-pan is in universal use, as it conveniently adapts itself to their decimal divisions of weights and measures. The abacus continued to be used in European countries during the middle ages. Instead of a board, however, with bars or wires, it became the practice to cover a bench or *bank* with chequered cloth, on which the counters were disposed. Hence our terms exchequer, bankrupt, &c. A chequered board, such as is still sometimes seen as a sign at the doors of public houses, was formerly used in this country as an abacus. For an excellent account of the abacus, and of palpable arithmetic generally, see the article on Arithmetic, in the Supplement to the Encyclopædia Britannica, by Sir John Leslie.

ABA'FT, or AFT, in sea language, signifies towards the stern, or hinder part of the vessel. Thus a thing is abaft the foremast when it is between the foremast and the stern.

ABA'NDONMENT. A term used in insurances, where, before compensation can be demanded, the insurer must abandon his interest in any portion of the rescued property. It is also used in the language of the customs, to signify the abandonment of an article by the importer to avoid payment of the duty.

ABA'TEMENT, Plea of, in Law, is pleaded to a declaration, writ, &c., on account of some defect in form. (*See* PLEADING.)

ABATEMENT. In Heraldry, symbols of disgrace introduced into arms: mentioned for the most part only by English heraldic writers. A *delf*, or *quadrant* spot, is the sign of a revoked challenge: an *escutcheon reversed*, belongs to an ungallant person or deserter: a *point dexter parted*, to a boaster: a *point in point*, to a coward: a *point champain*, to one who kills a prisoner of war: a *gore sinister*, to effeminate persons: a *gusset dexter* denotes voluptuousness, a *gusset sinister* intoxication. The only abatement now used in practice is the *baston*, which belongs to bastards; it is in the form of the bend sinister, contains one fourth of its dimensions, but does not reach quite to the circumference of the escutcheon.

A'BATIS. (Fr. abattre, *to knock down.*) A military term, signifying trees cut down, and laid with their branches towards the enemy, so as to form a defence for troops stationed behind them. *Abatis*, among the writers of the barbarous ages, denotes an officer in the stables, who had the care and distribution of the provender.

A'BATON. (Gr. αϐατον, *an inaccessible place.*) An edifice at Rhodes so called by Vitruvius, lib. 2., the

entrance whereof was forbidden to all persons, because it contained a trophy and two bronze statues erected by Artemisia in memory of her triumph on surprising the city.

ABATTOIR. (Fr. abattre, *to knock down.*) A building appropriated to the slaughtering of cattle. In Great Britain we have no example of such a structure, our slaughter-houses not deserving the appellation as applied by the French. Paris possesses some fine specimens of this sort of architecture, constructed in 1809; the most magnificent is that in the neighbourhood of Montmartre.

ABBE′. The French term for the superior of an abbey. Before the Revolution the title was assumed also by a class of persons who had not in all cases received the tonsure, or undertaken to connect themselves with the church. They held a conspicuous place in society, and generally attached themselves to fashionable or literary patrons. This anomalous class seems to have taken its rise from the great number of abbeys, the revenues of which were allowed to be bestowed upon laymen, upon condition of their taking orders within a year after their preferment, which latter clause was frequently evaded.

A′BBESS. (Fr. *Abbesse.*) The governess or superior of a monastery or abbey for females. By a decree of the Council of Trent she must be of the age of forty years, and have professed eight years at least.

A′BBEY. (Fr. *Abbaïe.*) In Architecture, properly, the building adjoining or near a convent or monastery, for the residence of the head of the house, abbot or abbess. It is often used for the church attached to the establishment. In ecclesiastical history an Abbey was a monastery under the superintendence cf on abbot, maintaining in later times the highest rank among religious houses, and enjoying some superior privileges.

A′BBOT. The superior of a monastery for men. Monastic societies, being originally composed of laymen, were obliged to have recourse to the assistance of a neighbouring priest to administer the sacraments and perform other clerical functions among them. Afterwards the superior of the society in many cases entered into orders, and exercised the ministerial office for the convenience of his community, under the title of abbot. (Heb. abba, *father.*) From the beginning of the sixth century this practice became universal, the abbot having absolute power within his own monastery, but being himself subject to the authority of his diocesan. This subjection, however, the abbots gradually threw off to a great extent, and in many places themselves assumed the titles and authority of bishops. Such were the mitred abbots, and the crosiered abbots; the former of whom, to the number of 26, sat in the English parliament with the bishops and two priors in the reign of Henry VIII.

Abbots are properly superior in rank to Priors; the latter being often appointed by the abbot to superintend a dependent foundation. But the distinction does not appear to have been regularly observed, and there are certain orders whose superiors are always called priors; —as the monks of Vallombrosa, the Cistercians, Bernardists, Feuillants, Trappists, Grandmontanists, and Præmonstratenses.

ABBREVIA′TION. (Lat. brevis, *short.*) In Arithmetic. The process by which a fraction is reduced to lower terms; thus the division of the numerator and denominator of $\frac{16}{24}$ by 8 reduces or abbreviates the fraction to $\frac{2}{3}$.

ABBREVIATION. In Music. A stroke which, placed over or under a note, divides it into quavers if there be only one; if two, into semiquavers; if three, into demisemiquavers.

ABBREVIATION. In Writing. Before the invention of printing, a variety of abbreviations were used, most of which have gradually fallen into disuse: they generally consisted in substituting the initials for the words. Of the abbreviations at present in use, the following are those which most commonly occur:—in Titles,

A. M., Master of Arts.	K. C. H., Knight Commander of Hanover.
A. B., Bachelor of Arts.	K. G., Knight of the Garter.
B. C. L., Bachelor of Civil Law.	LL. D., Doctor of Laws.
B. D., Bachelor of Divinity.	M. A., Master of Arts.
Clk., Clerk or Clergyman.	M. D., Doctor of Medicine
C. B., Companion of the Bath.	M. P., Member of Parliament.
D. C. L., Doctor of Civil Law.	M. R. I. A., Member of the Royal Irish Academy.
D. D., Doctor of Divinity.	R. A., Royal Academy.
F. R. S., Fellow of the Royal Society.	R. E., Royal Engineers.
	R. M., Royal Marines.
G. C. B., Grand Cross of the Bath.	R. N., Royal Navy.
G. C. H., Grand Cross of Hanover.	S. T. P., Doctor of Divinity, or Sanctæ Theologiæ Professor.
K. B., Knight of the Bath.	E. I. C., East India Company.
K. C. B., Knight Commander of the Bath.	W. S., Writer to the Signet.

Miscellaneous, Diplomatical, &c.

A. D., the year of our Lord.	A. C. or B. C., the year before Christ.
A. H., the year of the Hegira.	A. U. C., the year from the building of Rome.
A. M., the year of the world.	
i. e., that is to say.	Nem. con., no one contradicting.
ib., in the same place.	
id., the same.	Nem. dis., no one dissenting.
N. B., observe.	M. S., manuscript.
viz., for videlicet, to wit.	A. M., morning.
L. S., (in a deed) the place of the seal.	P. M., afternoon.
	H.M.S., His Majesty's ship, or service.
R. S. and L. S., right and left side.	D. G., by the grace of God.
N. S., new style, (since 1752.)	F.D., Defender of the Faith.
	H. R. E., Holy Roman Empire.
O. S., old style, (before 1752, and in the Greek calendar.)	U. S., United States of America.

ABDICA′TION. (Lat. abdico, *I abdicate.*) In Politics, the renunciation of an office or dignity by its holder; but it is commonly meant to express the voluntary renunciation of supreme power. The most famous examples of this on record, are the abdication of the dictatorship by Sylla, 75 years B. C.; of the imperial throne, by Dioclesian, anno 305; of the emperor Charles V., in 1556; and of Christina, queen of Sweden, in 1654.— Of all the sovereigns who have made voluntary abdications, Dioclesian, is, perhaps, the only one who did not regret the step. Examples of forced or involuntary abdication are too numerous to require to be pointed out. The modern history of France and England furnish some very striking instances with which every one is familiar. The convention parliament of 1688 used the word abdication to express the act of James II. in abandoning the government and kingdom. The word "desertion" was rejected, as implying the possibility of a return. The Scottish convention of estates declared that James had "forfeited" the kingdom. Abdication is said to differ from resignation, the former being unconditional, the latter done in favour of some other person.

ABDO′MEN. (Lat. abdo, *I conceal.*) The great cavity of the animal body, which is liable to temporary changes in its dimensions, independently of respiration. In entomology it forms, in insects the third, in arachnidans the second, in both classes the most posterior, of the sections into which the body is externally divided, and contains the principal digestive and respiratory, and the whole of the generative organs. The enlargements of the abdomen, in relation to the activity of the generative functions, is most remarkable in insects; in some of which, as the white ant, or termite, it constitutes at the full development of the ova an immense proportion of the entire body of the female. In vertebrates the abdomen is not divided externally from the thorax; and only in one class, the mammalia, by an internal partition, or diaphragm.

The abdomen is the first-formed cavity in the development of the animal body, and is the most constant in its existence throughout the animal series. (*See* CRANIUM and THORAX.)

ABDO′MINALS. *Abdominales.* An order of malacopterygious fishes, including those which have the ventral fins situated under the abdomen, behind the pectorals.

ABDU′CTION. (Lat. ab, *from,* and duco, *I lead.*) In Law, the forcible carrying away of a woman, for the purpose of marriage or defilement. Where the female has property, or is presumptively entitled to it, such abduction is felony: and in all cases the taking of a girl under sixteen from under the protection of her parents is a misdemeanour. The crime of abduction, according to Sir W. Scott (see his Notes and Introduction to Rob Roy), was at one period extremely common on the border of the Scottish Highlands; it is now an ordinary offence in Ireland: the number of convictions in the last 7 years amounts to 61; executions, 5.

ABDU′CTOR. Abductor muscles are those which pull back or separate the limbs to which they are affixed.

A′BELITES, or *Abelians,* in ecclesiastical history, a sect mentioned by St. Augustine, in Africa. They are said to have enjoined marriage and virginity, after the pretended example of Abel. (*See* Mosheim, *Eng. Trans.* i.233.)

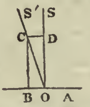
A′BER. A Celtic term, implying the mouth of a river; as Aberdeen, the mouth of the Dee; Aberystwith, the mouth of the Ystwith, &c.

ABE′RDEVINE, or European Siskin; (*Carduelis spinus,* Cuv.) A small green and yellow finch, belonging to the same sub-genus as the goldfinch of this country. Its song is similar to that of the goldfinch, but is not so sweet, and ends with a harsh jarring note. Its flight is a series of successive undulating courses, accompanied by a chirp, at each propelling motion of the wings, as in other species of *Carduelis.* The Aberdevine winters in the south of England, and flies northward in the month of March, to breed in the pine forests of Scotland. The

nest is built among the higher branches of the pine: the eggs are four or five in number; of a bluish-white colour, speckled with purplish-red. They begin to re-appear in the south in the month of September. The Aberdevine resembles in the markings of its plumage the common redpole, (*Linaria pusilla*, Cuv.) but the colours are different.

ABERRA'TION. (Lat. ab, *from*, and erro, *I wander.*) A term used in astronomy, to denote a change in the positions of the celestial bodies arising from the combined effects of the motion of light and the motion of the earth in its orbit.

To explain the cause of this remarkable phenomenon, conceive a ray of light to proceed from a star S to an observer at O. If the station of the observer were at rest, or if the motion of light were instantaneous, the star would be seen in its true place at S. But neither of these circumstances has place; the observer is carried rapidly forward by the motion of the earth in its orbit, and light occupies a certain time in coming from any of the heavenly bodies to the earth.



Suppose, then, that while a particle of light advances from D to O, the observer has been carried forward by the earth's orbital motion from A to O. At O the particles of light will strike the eye with a velocity proportional to D O, and the eye will impinge against the particle with a velocity proportional to A O. Thus a double effect will be produced: first, that of the motion of light proportional to D O, and, secondly, that arising from the motion of the observer proportional to A O. But it is obvious that the question will in no way be affected if we suppose that, instead of the observer having been carried forward from A to O, he had remained at rest in O, and the light had advanced to him in the opposite direction, and with a velocity B O = A O. Thus the eye would receive two simultaneous impressions in the directions D O and B O of the parallelogram B C D O; and by the theory of the composition of velocities the effect would be exactly the same as if the eye had received a single impression from a particle proceeding in the direction of the diagonal C O, and with a velocity proportional to C O. Hence the apparent place of the star will be at S′, in advance of its true place at S.

The angle C O D is the *aberration*, and its magnitude can easily be determined when we know the relative magnitudes of D O and B O, and the inclination of those lines; that is, when we know the relative velocities of light and of the earth, and the relative direction of their motions. It is obvious that the aberration will be greatest when those lines are perpendicular to each other; when they are parallel it vanishes altogether.

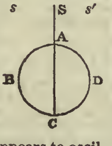
From the eclipses of Jupiter's satellites, and other phenomena, it has been ascertained that light is transmitted through space with a velocity of 192,000 miles per second. The mean velocity of the earth in its orbit is about 19 miles per second; we have, therefore, when B O and D O are at right angles, the proportion

$$192{,}000 : 19 = \mathrm{D\,O} : \mathrm{B\,O} = \text{rad.} : \text{tan. } \mathrm{C\,O\,D};$$

hence the tangent of C O D, or the aberration (or in so small an angle the tangent is equal to the arc), is found by the Trigonometrical Tables = 20″·5. This being the greatest value of the angle, is called the *Constant of Aberration.*

From Bradley's observations the Constant of Aberration was determined by Bessel (*Fundamenta Astronomiæ*) to be 20″·25. Dr. Brinkley found it = 20″·37. Mr. Richardson, from a series of 2000 observations made with the two mural circles in the Greenwich Observatory, found the value of this important element = 20″·307. (*Memoirs Royal Astr. Society*, vol. iv.)

The effect of aberration on any particular star depends on the position of the star with reference to the ecliptic. Let A B C D be the orbit of the earth, and S a star in the plane of the ecliptic. When the earth is at A the star will be thrown forward by the effect of aberration to *s*. When the earth arrives at the opposite point of its orbit C, the star will be thrown back to *s′*. At B and D the earth is moving in a direction parallel to the ray of light proceeding from the star, and there is, consequently, no aberration.



Hence a star situated in the plane of the ecliptic appears to oscillate backwards and forwards in a straight line, always returning to its former position at the end of a year.

A ray of light proceeding from a star situated in the pole of the ecliptic, is always at right angles to the direction of the earth's motion; consequently, a star having this position will appear to describe annually, about the pole of the ecliptic, a circle of which the radius = 20″·3.

In any other position the apparent path of a star, so far as depends on aberration, is an ellipse whose major axis = 40″·6, and its minor axis = 40″·6, multiplied by the sine of the star's latitude.

The apparent places of the planets are also affected by aberration; but in this case, as the body from which the light emanates is also in motion, we must consider that the ray of light which enters the eye has proceeded, not from the place which the planet occupies at the instant of the observation, but from that which it did occupy at as long an interval previously as light requires to traverse the distance between the planet and the earth. To this small variation in the place of the planet must be added the space described by the earth in the same interval; and it is easy to see that the sum is the apparent or relative motion of the planet during the time which light takes to pass from it to the earth.

The aberration was discovered, and its physical cause first explained, by Dr. Bradley. It is the most direct proof which astronomy furnishes of the motion of the earth round the sun.

ABERRATION. In *Optics*, denotes the deviation of the rays of light from the true focus of a curved lens or speculum; in consequence of which they do not unite in a single point, but are spread over on a small surface, and form a somewhat confused image of the object. This arises from two causes: 1st, the figures of the lenses or specula; and, 2dly, from a difference in the physical nature of the rays of light.

The surfaces of the lenses or mirrors of optical instruments are worked into a spherical form, because there is no practical means of accurately obtaining the parabolic curvature which theory shows to be necessary to collect parallel rays into a single point or focus. Hence the rays meet the axis of the lens at different points, the amount of deviation depending on the magnitude and curvature of the lens. This is called the *Aberration of Sphericity.* The second cause of aberration arises from the different degrees of refraction which the rays composing a beam of light undergo in passing from one medium into another. On account of this difference of refrangibility, the rays of light are separated, and the colours of the spectrum appear. It was long believed, and even by Newton himself, that it was impossible to refract, without decomposing, light; and hence the attempts that have been made to perfect reflecting telescopes, and adapt them to circular instruments. But it has since been discovered that the refractive and dispersive powers of different diaphanous substances are in different proportions, and that the decomposition of the light may be prevented by combining substances of different refractive powers; for example, crown and flint glass, in the same lens. (*See* ACHROMATISM.)

ABE'TTOR. (Sax. abedan, *to incite*,) In *law.* An instigator or incitor; a person who promotes or procures the commission of an offence or felony, by his advice or encouragement. If an abettor, or as he is then termed, an aider and abettor, be present at the commission of the crime, he is treated as a principal; if absent, he becomes an *accessory* before the fact. But in almost all cases of felony the abettor is considered as much a principal as the actual felon, especially in the case of murder; and the abettors of offences punishable summarily by justices of the peace, are subjected to the same penalties as the principals.

ABE'YANCE. (Norm. Fr. beyer, *to expect.*) In *law.* The fee simple, or inheritance of lands is said to be in abeyance, when there is no person *in esse* in whom it can vest and abide, although limited and ready to vest whenever the proper heir appears. Thus, in a grant to A for life, and afterwards to the heirs of B, the inheritance remains in abeyance until the death of B, as there can be no heir to a living person. A peerage descending to coheiresses is said to be in abeyance.

A'BIB. The first month of the Hebrew year, more generally known by the Chaldean name of *Nisan.* It is first mentioned in the 4th verse of the 13th chapter of Exodus.

A'BIES. (Lat. abies, *a fir tree.*) The name of all those fir trees which, like the spruce, the larch, the cedar of Lebanon, have their leaves growing singly upon the stem, and the scales of the cones round and thin. The wood called by timber-merchants "white deal" is produced by Abies excelsa, and a resinous, or terebintaceous substance by others; as Canadian balsam by A. balsamea, the balm of Gilead; Strasburgh turpentine by A. pectinata, the silver fir; Venetian turpentine by A. larix, the larch. Besides these, the substance called extract of spruce is furnished partly by A. canadensis, and partly by A. nigra. All the species are hardy, and, with the exception of larches, are evergreen, and in cultivation in this country. The most valuable for the timber are, A. Douglasii, A. excelsa, and A. larix; the most ornamental are, A. cedrus, the cedar of Lebanon, deodara, and larix. The most worthless in Great Britain are, A. canadensis, picea, balsamea, and pectinata; the three latter form, however, fine trees in favourable situations. The wood of the fir is in very extensive use, and it is, perhaps, the most serviceable of all trees.

ABIETI'NÆ. A division in the natural order of coniferous plants, comprehending the true firs, pines, and

araucaria-like pines, all which have cones with many rows of scales in which the seeds are formed.

ABJURA'TION, *Oath of.* (Lat. ab. *from*, and juro, *I swear.*) Introduced by stat. 13 W. III., and regulated by 6 G. III. An oath asserting the title of the present royal family to the crown of England. By this oath the juror recognises the right of the king under the Act of Settlement; engages to support him to the utmost of his power; promises to disclose all traitorous conspiracies against him; and expressly disclaims any right to the crown of England in the descendants of the Pretender.

Abjuration *of the Realm* (in law) signifies a sworn banishment; or the taking of an oath to renounce and depart from the realm for ever.

Abjuration also signifies a solemn recantation of opinion: as, the abjuration of heresy required by the Romish Church. Henry IV. abjured Protestantism at Saint Denis in 1593. Galileo was compelled to abjure his philosophical opinions by the Inquisition at Rome, in 1633.

A'BLATIVE *case.* (Lat. ablatus, *taken away.*) The sixth case of the Latin nouns implied in English by the preposition *from.* (See Grammar.)

A'BLU'TION. (Lat. ablutio, *washing.*) A religious ceremony, consisting in bathing the body, or part of it. It constituted a part of the Mosaic ceremonial, and was afterwards practised among the Jews, both by the priests and people. But ablutions are most rigidly enforced by the Mahometans. The term is also applied to the cup given, without consecration, to the laity in the popish churches.

ABNO'RMAL. (Lat. ab, *from*, and norma, *a rule.*) Any thing without, or contrary to, system or rule. Thus Horace calls a well-informed sagacious countryman, —

Rusticus, abnormis sapiens, crassâque Minervâ.

In *botany*, if a flower has five petals, the rule is that it should have the same number of stamens, or some regular multiple of that number; if it has only four or six stamens, then, in such a case, the flower would be abnormal.

ABOA'RD, within the ship; also one vessel is said to get aboard of another when she gets foul of her.

ABORI'GINES. The first, or original (*a prima origine*) inhabitants of a country, that is, those who occupied it at the period when it began to be known, and who either were indigenous to the soil or had immigrated thither before the dawn of history. Some of the ancients supposed they had always inhabited the same soil, and were created from it, as the Athenians, who thence called themselves *autochthones*, coeval with and sprung from the land. But the Romans and modern nations use the word Aborigines to designate those inhabitants of a country of whose origin nothing certain is known. Thus the Indians of America are properly called Aborigines, because they were found there at its discovery, and we have no accounts of their having immigrated from any other quarter.

ABO'RTION. (Lat. abortus, *miscarriage.*) This term is usually applied to the morbid or unnatural expulsion of the fœtus in the human subject after the sixth week, and before the sixth month, of pregnancy. Before the sixth week it is called a *miscarriage*, and after the sixth month, *premature labour.*

ABO'RTIVE. Is said of parts in plants that do not acquire their usual state of perfection; a flower only partially formed, a stamen whose filament has no anther, a seed which contains no embryo, or which consists only of skin, are cases of abortion. The term is also applied to parts which, although perfect in the beginning, cease to grow, and so end in being imperfect; thus ovules, which are not impregnated, and which shrivel up instead of growing into seed, are called abortive.

ABO'UHANNES. An African bird, supposed to be the Ibis of the ancients.

ABRACADA'BRA. A celebrated term of incantation: especially used as a spell against fevers. The manner in which it was written and carried for that purpose may be seen in Defoe's History of the Plague at London. The word seems to be connected with *Abrasax* or *Abraxas*; a name found inscribed on certain stones or amulets, in such characters, together with the figure of a human body, with the head of a cat and feet of a reptile. Various explanations have been attempted of the object of these curiosities: some from the cabalistic and an Egyptian derivation. Bellermann (Berlin, 1817,) and Neander, have written on the subject of the Abraxas stones.

ABRA'DING. In Agr. (Lat. ab, *from*, and rado, *I scrape or rub off.*) Applied to the sloping surface of banks of earth, which crumbles down from the effects of frost, or the alternate action of drought and moisture.

ABRA'MIS. (*Abramis*, Cuv.) The name of a subgenus of Malacopterygious or soft-finned abdominal fishes, characterized by the absence of spines and barbels; by the dorsal fin being short and placed behind the ventrals, and the anal fin being long. The common bream is a species of this genus.

ABRA'NCHIANS. *Abranchia*, Cuv. (Gr. α, *without*, βραγχια, *gills.*) An order (the third in Cuvier's arrangement) of anellidans, so called because the species composing it have no external organs of respiration; they are divided into the setigerous abranchians, or worms, and the non-setigerous abranchians, or leeches.

ABRA'SION. (Lat. abrado, *I rub off.*) In Numismatology, implies the waste of coins, or the loss by wear and tear in the pocket. This forms a considerable item in the expense of a metallic currency; and various means have been employed to lessen it, by alloying the coins so as to render them harder, by raising the borders so as to lessen the surface exposed to be rubbed, &c.

ABRA'XAS. A genus of Lepidopterous insects, of the family Geometridæ; founded by Dr. Leach for the common magpie moth (*Abraxas glossulariata*) and other allied species. It is the larvæ of the *Abr. glossulariata* which commit the well-known ravages upon the gooseberry trees of our gardens; consuming the leaves almost as soon as they appear. They feed early in the morning, before the dew is off or the sun has much power; and it is at this time that they should be sought for and removed.

ABRI'DGEMENT. In Literature. (Lat. abbrevio, *I shorten.*) A compendious arrangement of the matter contained in a larger work. Before the invention of printing, when manuscripts were valuable, and the labour of writing them great, the compiling abridgements of considerable works was an important branch of authorship; and it has been doubted whether we have lost or gained more by the practice: since, on the one hand, the contents of many lost authors are thus partially preserved to us: and, on the other, the abridgement becoming popular may, in some cases, have caused the loss of the original. Among the best known abridgements of antiquity are the History of Justin, being an abridgement of the lost History of Trogus Pompeius: the Natural History of Solinus, chiefly abridged from that of Pliny, &c. Few modern abridgements, taking the phrase in its strict sense, merit peculiar notice, or have been compiled with any other view than that of assisting education. This, however, is not the case with some of those works called abridgements, intended to exhibit a summary view of some science or department of literature. The *Abrégé Chronologique de l'Histoire de France*, by the president Henault, is a work of this kind. It has, perhaps, been praised beyond its deserts, but still it possesses uncommon merit. Its success led to the publication of various works of the same kind, of which the *Abrégé Chronologique de l'Histoire de l'Allemagne*, by Pfeffel, is probably the best. Dr. Robertson drew from it most of his knowledge of the constitution of the German empire. To abridge well requires a thorough knowledge of the subject, with tact to seize upon the prominent points, and ability to state them clearly and succinctly. Tacitus, says Montesquieu, "*abridged all because he knew all*," but Tacitus's are rare.

ABROGA'TION. The annulment of a law by competent authority. (From the Latin ab, *from*, and rogo, *I ask.*) A phrase derived from the practice of the Roman popular assemblies, in which the several tribes, curiæ, &c. were said rogare suffragia, to demand the suffrage: whence also the modern word *prerogative.* (*See* Comitia.)

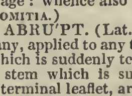
ABRU'PT. (Lat. abrumpo, *I break off.*) A term in Botany, applied to any thing which happens suddenly. A leaf which is suddenly terminated without tapering to a point, a stem which is suddenly bent, a pinnated leaf without a terminal leaflet, are all abrupt.

Abrupt. In Ichthyology is applied to the lateral line when divided into two or more parts not contiguous.

A'BRUS. (Gr. ἁβρὸς, *delicate*, or *elegant.*) A West Indian tree with papilionaceous flowers, and pods containing bright red seeds with a broad black scar on one side of them. The seeds are often strung into necklaces for children.

A'BSCESS. (Lat. abscedo, *I separate.*) Inflammation in the membranous or fleshy parts of the body, attended by the formation of *pus*, and the consequent separation or distension of the parts affected; thus the integuments separate from the parts beneath, and form a tumour.

A'BSCISS, or ABSCISSA. (Lat. ab scindo, *I cut off.*) A term used in geometry to denote a segment cut off from a straight line, by an ordinate to a curve. The position of a point on a plane is perfectly determined when its distances, measured in given directions, from two straight lines given by position, are known; and as curve lines may be regarded as formed by the continuous motion of a point, their various properties may be investigated by means of the relation common to all points of the same curve between the two distances so measured. Thus, let A B and A C be two straight lines given by position, and P any point in a curve X Y. Draw P Q parallel to A C, and meeting A B in Q, then P Q is called the ordinate of the point P, and A Q is the *absciss.* The absciss and ordinate, considered together, are called the co-ordinates



of the curve, and the point A, where they intersect, is called the origin of the co-ordinates. For every point of the same curve a certain unavoidable relation exists between A Q and P Q, which is called the equation of the curve. In order to represent this equation algebraically, the absciss A Q is represented by x, and the ordinate P Q by y. The co-ordinates may be inclined to each other at any angle, but in general the investigations are much simplified by assuming them at right angles. The origin of the co-ordinates, or the point from which the absciss is reckoned, may be taken any where in the plane of the curve. When a particular curve, however, is to be investigated, it is often convenient to place the origin at some point which is related to the other parts of the curve. Thus, if the curve is a circle, the co-ordinates are conveniently reckoned from the centre.

ABSENTE'E. In Politics, a word which has received, from usage, a peculiar signification: a landed proprietor who habitually resides at a distance from the district in which his property is situate: especially applied to Irish landlords and clergy. In 1715 a tax was imposed on absentees from Ireland, in all cases where their residence within it was for less than six months in the year; power of dispensation being secured to the crown. But it ceased to be levied in 1753, and has not since been renewed. Whether or not the absence of a landed proprietor be injurious to a country, in an economical sense, is a question which has been much debated of late years. See the evidence of Mr. J. R. M'Culloch before the Committees of the Lords and Commons, to inquire into the state of Ireland, 1825; and the controversy occasioned by that evidence, in the Edinburgh Review, No. 85., and Quarterly Review, Vol. 33. See also Mr. M'C.'s evidence before the Committee on the state of Ireland in 1830, and Mr. Senior's Outline of Political Economy, Encyclopædia Metropolitana.

A'BSIS, or APSIS. (Gr. ἁψις, *an arch.*) In Architecture, a word used by ecclesiastical authors to signify that part of the church wherein the clergy were seated, or the altar was placed. This part of the church was so called from its usually being domed or vaulted, and not, as Isidorus imagines, from its being the lightest part, from *apta*. The apsis was either circular or polygonal on the plan, and domed over at top as a covering. It consisted of two parts, the altar and the presbytery, or sanctuary; at the middle of the semicircle was the throne of the bishop; and at the centre of the diameter was placed the altar, towards the nave, from which it was separated by an open balustrade, or railing. On the altar was placed the cibarium and cup. The throne of the bishop having been anciently called by this name (apsis), some have thought that thence this part of the edifice derived its name, but the converse is the real truth.

A'BSOLUTE. ABSOLUTISM. In Politics, a government is strictly said to be absolute when the supreme head is above the control of law, and has unrestricted power of legislation. "El rey assoluto," is the common watchword of the anti-constitutional party in Spain. Yet in that country, as in almost every other, the theory of absolute sovereignty has some limit: since we find the same party denying the king the right of altering by his single will the fundamental laws of succession to the throne. (*See* DESPOTISM.)

ABSOLU'TION. (Lat. ab, *from*, solvo, *I loose.*) A ceremony practised in various Christian churches. In the Roman Catholic, the priest not only declares absolution to the repentant sinner, but is believed to have the power of actually releasing him from his sins: and this authority is declared by the council of Trent to belong to him in its full extent. The Church of England, in the Order for the Visitation of the Sick, has retained nearly the same words; but her authorities seem not to be exactly agreed as to the force and effect of the absolution so conferred. In the daily service, the words of the absolution are merely declaratory.

ABSO'RBED. (Lat. absorbeo, *I suck up.*) In Painting. Sucked up, imbibed. A term applied by the French connoisseurs to a picture in which the oil has sunk into the canvass or ground whereon it is painted, leaving the colour flat, and the touches indistinct. Our picture dealers used the term *chilled* to express the same thing. It may be remedied by rubbing the picture over with oil, and varnishing, after it has been well cleaned.

ABSO'RBENT *Ground*. In Painting. A ground prepared for a picture, either on board or canvass, chiefly with distemper or water-colour mixture, by which expedient the oil is immediately taken or sucked in from the colours, expedition gained, and a brilliancy imparted to the colours.

ABSORBENTS. In Medicine, substances which remove acid at the stomach, such as magnesia and chalk.

ABSO'RPTION. In Physiology, is one of the vital organic functions, the object of which is primarily to convey to the circulating organs the due supply of the materials for the growth and support of the system; and, secondarily, to remove and carry to the same organs the decayed and useless parts of the body. *See* LACTEALS.

A'BSTRACT (Lat. abstraho, *I take away*), signifies a general view or analysis of a whole work, or part of a work. It differs from *abridgment* chiefly in this, that while in the latter it is often necessary to enter into somewhat minute details, the former is always confined to a notice only of the leading particulars. *See* ABRIDGMENT.

A'BSTRACT MATHEMATICS, or PURE MATHEMATICS. That branch of science which treats of the relations or properties of magnitudes or quantities, considered generally, and without restriction to any individual magnitude. Thus, the proposition that the three angles of a triangle are, together, equal to two right angles, is an abstract truth, not confined to an individual triangle, or to a particular species of triangles, but belonging to all triangles whatever. Abstract mathematics is opposed to *mixed mathematics*, wherein abstract properties or relations are applied to sensible objects.

ABSTRACT NUMBERS. Numbers considered in themselves, and without reference to any particular thing. The operations of common arithmetic are performed on abstract numbers.

ABSTRA'CTION. (Lat. abstraho, *I draw off.*) In Metaphysics and Logic, the faculty by which, in contemplating any object, we can attend exclusively to some circumstances or qualities belonging to it, and withhold our attention from the rest. It is by the means of this faculty that we generalise, and arrive at the common terms or predicables (*see* PREDICABLES) which belong to a number of objects. Thus, in considering a horse, by abstracting mentally the qualities which belong to that particular animal, we arrive at the notion of a quadruped, thence at that of an animal, &c. &c.; which notions constitute, in logical language, the successive genera and species of the individual horse.

ABSU'RDUM, or REDUCTIO AD ABSURDUM. A term used in geometry to denote a mode of demonstration in which the truth of a proposition is established, not by a direct proof, but by proving that the contrary is *absurd*, or impossible. There are many examples of this mode of demonstration in the Elements of Euclid.

ABU'NDANT NUMBER (Arithmetic) is a number such that the sum of its divisors is greater than the number itself. Thus, 12 is an abundant number, because its divisors being 1, 2, 3, 4, and 6, their sum, which is 16, is greater than 12. An abundant number is opposed to a *deficient* number, of which the sum of the divisors is less than the number itself; and to a *perfect* number, of which the sum of the divisors is equal to itself.

ABU'TMENT. (According to some, from the French, aboutir, *to abut*, among whom the learned Spelman; but according to others, with more probability, from the Saxon abutan, *about.*) In Architecture, the solid part of a pier from which the arch immediately springs. Abutments are either artificial or natural. The former are usually formed of masonry or brickwork, and the latter are the rock or other solid materials on the banks of a river, in the case of a bridge, which receive the foot of the arch. It is obvious that they must be of sufficient solidity and strength to resist the arch's thrust.

ABU'TTALS. The buttings or boundings of land, showing by what other lands, highways, rivers, &c. they are bounded.

ACA'CIA. (Gr. ακακια.) A genus of spiny leguminous trees, with pinnated leaves, and small flowers collected in balls or spikes, of a white, red, or yellow colour. They are all inhabitants of the warmer parts of the world; some of them, as A. vera, arabica, &c., yield gum arabic; others gum senegal: the bark of A. catechu furnishes the astringent substance called catechu, or terra japonica. The flowers of A. farnesiana are exceedingly fragrant, and form one of the principal ingredients in Italian perfumery. The bark of many species abounds in tanning principles. New Holland, and some other countries, produce great number of species in which true leaves are not formed, but in their stead the branches are furnished with broad dilated petioles looking like leaves.

ACADE'MICS. A name given to a series of philosophers, who taught in the Athenian Academy, the scene of Plato's discourses. They are commonly divided into three sects, which go under the names of the Old, the Middle, and the New Academy. 1. The Old Academy, of which Plato was the immediate founder, was represented successively by Speusippus, Xenocrates, and Polemo. These philosophers, as far as the scanty notices remaining of them allow us to form a judgment, seem to have confined themselves to the task of elucidating and defending the doctrines of their great master. (*See* PLATONISM.) A list of their works is given us by Diogenes Laertius, b. iv. To them succeeded Arcesilaus, the founder of (2) the Middle Academy. Under his hands, the Platonic method assumes an almost exclusively polemical character. Whatever may have been his belief regarding the positive part of Plato's doctrines, he confined himself in public to the support of the negative portion; that, namely, which relates to the uncertainty

of the impressions on the senses, and, consequently, of the judgments founded on them. His main object was to refute the Stoics, who maintained a doctrine of perception identical with that promulgated by Dr. Reid in the last century. (*See* PERCEPTION.) Socrates is said to have professed, that all he knew was, that he knew nothing. Arcesilaus denied that he knew even this. Wisdom he made to consist in absolute suspension of assent; virtue, in the probable estimate of consequences; in the latter doctrine combating the ethical dogmatism of the stoics, as in the former the intellectual. He was succeeded by Lacydes, Telecles and Evander, and Hegesinus. 3. The New Academy claims Carneades as its founder. It is not easy to define the limits between this and the Middle Academy. Like Arcesilaus, Carneades appears to have taken up a negative and polemical position. His system is a species of mitigated scepticism. He considers probability to be the sole legitimate object, alike in speculation and in practice. The doctrines of this school were adopted by Cicero, more, probably, in consequence of the advantage which, as an orator, he would derive from the practice of discussing both sides of a question, than from any solid conviction. Carneades was succeeded by his disciple, Clitomachus. Charmides, the third and last of the New Academicians, appears to have been little more than a teacher of rhetoric: an accusation, indeed, to which the whole school is in no small degree liable. To these three academies a fourth and fifth are added, by some writers: of which Philon and Antiochus are produced as the representatives. The latter was the friend of Cicero and other distinguished Romans. Neither of them can in any justice be named academics, their doctrines being, in fact, in most points, of a diametrically opposite nature.

ACA′DEMY. (Gr. ἀκαδημια.) A society of learned men, associated for the advancement of the arts or sciences. The name is derived from that of a place near Athens, where there was a famous school for gymnastic exercises (*see* GYMNASIUM), at which also philosophy was taught, and the sophists gave their lectures. But the first institution of which we read, at all resembling our modern academy, was the society of scholars established at Alexandria by Ptolemy Soter. The Jews in various cities, the Constantinopolitan emperors, and the Arab caliphs, founded societies of the same description. Charlemagne, among his various efforts for the propagation of literature, collected an association of learned men, who read and compared the works of antiquity, and gave themselves, in their academic intercourse, the assumed names of different ancient authors. But this institution was dissolved at the death of Alcuin; nor do we find any memorial of a similar society, except a few among artists, chiefly in France, until after the taking of Constantinople by the Turks, when the Greek scholars driven into Italy held literary meetings, which gradually assumed a more regular form. About 1560 a society, called the Academia Secretorum Naturæ, was founded at Naples, in the house of Baptista Porta, but was abolished by a papal interdict. It was, however, succeeded by the Academia Lyncei at Rome, of which Galileo was a member, the objects of which, like those of the former, were chiefly connected with the pursuit of natural history. From the beginning of the 17th century academies multiplied in Italy. Among the most eminent of those which bore a philosophical character, was the A. del Cimento, at Rome, in that century; the Academy of Orossano, in the kingdom of Naples, &c.: and, in more recent times, the Academy of Sciences at Bologna deserves to be mentioned with honour. But Italy has been most prolific in academies of literature and philology, which form by far the greatest number in the catalogue of 550 such institutions which have been enumerated as existing or having existed in that country. A general and somewhat ridiculous fashion prevailed in the 17th and 18th centuries among literary men of that country, of forming themselves into societies for the promotion of literary objects, to which they gave fanciful symbolic names, every member assuming in his own person some analogous appellation. Some of these societies have done real service to literature, but by far the greatest number have contented themselves with multiplying insipid addresses and sonnets. Among the most celebrated was the A. degli Arcadj, at Rome, of which the meetings were held in a meadow, and the members enacted shepherds and shepherdesses: it was founded about 1690, and still subsists, having various affiliated societies in other places. The A. degl'i Umidi, one of the oldest of these associations, became afterwards the Florentine Academy. The A. degli Intronati (of the Deaf), degli Umoristi (of the Humourists), and many others with similar quaint appellations, have acquired celebrity in Italy. Of her philological academies, the most illustrious is that della Crusca (of the Sieve), at Florence, which, by the publication of its dictionary, established the Tuscan dialect as the standard of the national language; it is now incorporated with the A. Florentina. In France, the Académie Française was founded in 1635 by cardinal Richelieu. It was an association formed for the purpose of refining the French language and style; and, although in its first period it was chiefly remarkable for the adulation which it bestowed on its vain though able founder, it became, in process of time, by far the most celebrated and influential of all European literary societies. It consisted of 40 members, and a place among them was eagerly sought after, for a long period, as one of the highest honours which could be attained by an author. Like that of Crusca, it published a dictionary of the French language, in 1694. The Royal Academy of Sciences was founded by Louis XIV., in 1666, and published 130 volumes of memoirs, up to the year 1793, when it was abolished by the Convention. The Academies of Painting and Sculpture, and that of Inscriptions and Belles Lettres, were the other two principal academies of Paris. The latter was founded by Colbert in 1663, and remodelled in 1701. At the Revolution all four were abolished: and, in 1795, at the suggestion of Condorcet, the National Institute of France was established in their stead. It consisted of four classes, arising out of the four academies of which it was composed. According to its re-organisation by Napoleon, in 1806, these classes were remodelled, and each of them consisted of a certain number of sections, each furnished with a specified number of acting and corresponding members. The first class, or that of sciences, had sixty-three members, and 100 correspondents; that of languages, forty, and 60 correspondents; that of history and antiquities, forty, and 60 correspondents; that of the arts, twenty-eight, and 36 correspondents. The first, third, and fourth, named each eight foreign associates. In 1816, the Institute was again remodelled by Louis XVIII. The four classes again took the name of academies, and became more independent of each other, their joint property being managed by a commission of eight members, two from each, under the superintendence of the minister of the interior. The first academy (that of sciences) retained the same number of members. The second and third were reduced to thirty-eight and thirty-seven respectively; the fourth, increased to forty. The Academy of Inscriptions and Belles Lettres, and that of Sciences, had added to them a class of free academicians, of the number of ten, with no privilege except that of attendance; the Academy of Arts had the right to choose its own number of free members.

Of similar institutions in Germany, the oldest was the Academia Naturæ Curiosorum, a scientific association, founded in 1652, in Franconia; afterwards taken under imperial protection, when it received the name of the A. Cæsareo Leopoldina. The Royal A. of Sciences, at Berlin, was founded in 1700, by Frederic I. of Prussia: Leibnitz was its first director. The Imperial Academy of Sciences at St. Petersburgh was founded by Catharine I., and endowed by Catharine II. with great munificence, but established on the French model: she separated from it the Academy of Arts.

In England, the name academy has been chiefly confined to associations for promoting the arts. The Royal Academy of Arts was founded in 1768, and consists of forty members: it has separate professors of painting, architecture, anatomy, and perspective; and a council of nine is elected annually. The Academy of Ancient Music was founded by private association, in 1710: the Royal Academy of Music, under the patronage of George III., but dissolved shortly after. Our principal literary and philosophical societies, answering in character to the branches of the French Institute, are, 1. The Royal Society of London, which is confined to objects of a scientific character. It had its origin as early as 1645, but was established by royal charter in 1662. Its acts have been published, under the name of Philosophical Transactions, from 1665 to the present day. 2. Those of the Antiquarian Society, which was established in 1751, are published under the title of Archæologia. 3. The Royal Society of Arts originated in 1718. 4. That of Literature, in 1823. Besides these, there are numerous societies which bear the name of the peculiar branch of science to which their exertions are confined. The Royal Society of Edinburgh obtained a charter in 1783, and another, with more liberal provisions, in 1811. Among the most valuable published transactions of academies and similar societies, besides those already mentioned, are those of Colbert's A. des Inscriptions et Belles Lettres (50 vols. 4to. from 1701 to 1793): those of the Institute, being continuations of the memoirs of the former academies of which it was composed: those of the A. Royale des Sciences and Belles Lettres at Berlin; at first in Latin, then in French (from its remodelling in 1744 by Frederick the Great), now in German. The "Acta" of the Imperial Academy of St. Petersburgh. The "Commentarii" of the A. of Bologna. The Antichita d'Ercolano, published by the Herculanean Academy of Naples.

ACADEMY. In the sense of a place of instruction, is now in this country a term chiefly appropriated to schools for students in the fine arts. The fourth division of the Institute at Paris consists of the Académie

des Beaux Arts. In London, an Academy of Painting seems to have been established in 1712, under the presidency of Sir G. Kneller, but to have shortly after fallen into decay. The present Royal Academy of Arts, founded in 1768, has been already mentioned. In France the old universities were suppressed at the Revolution; but most of them, with some recent ones, have since been restored under the title of *Académies Universitaires.* Their collective body, represented by the re-union of their rectors, inspectors, deans, &c., constitutes the University of France, at the head of which is the Minister of Public Instruction. Colleges in France are equivalent to high schools in this country.

ACADEMY FIGURE. In Painting. A drawing usually made with black and white chalk, on tinted paper, after the living model.

ACALE′PHANS, Acalephæ. (Gr. ακαληφη, *a nettle.*) A class of radiate invertebrate animals, so called on account of the singular property possessed by most of the species therein comprehended, of irritating and inflaming the skin when touched. The class includes the animals called 'medusæ,' 'sea-nettles,' 'jelly-fish, 'Portuguese men-of-war,' &c.; these are divided by Cuvier dichotomously into those which have air-bladders for swimming, or the 'hydrostatic acalephans,' and those which have not, or the 'simple acalephans,' and which swim by means of external cilia, or by the contractions and dilatations of their gelatinous body. All the species are aquatic and marine.

ACA′MPTOSO′MES. (Gr. α, *without*, καμπτω, *I bend*, σωμα, *the body.*) An order of cirripeds including all those in which the body is entirely enveloped in a calcareous compound shell, and so attached that it cannot be unfolded and protruded.

ACANTHA′CEÆ. (*See* Acanthus.) A natural order of monopetalous exogenous plants, in which the genus acanthus is stationed. They have irregular didynamous flowers, and are particularly known by their calyx being imbricated in two broken whorls, and by their seed growing from hooks on the placenta. Many of this species have beautiful flowers, others are mere weeds. They are found wild only in hot or temperate climates.

ACA′NTHIA. (*See* Acanthus.) The name of a genus of hemipterous insects of the tribe *Geocorisæ*, characterised by a long and straight rostrum, sheathed at its base, or through its entire length; labrum very prominent; eyes of large size; and the head presenting, at its junction with the thorax, neither a neck nor a sudden constriction. In some of the species (subgenus *Syrtis*) the anterior pair of legs terminate in a monodactyle chela, or forceps claw, like that of the crustacea, adapted for seizing a living prey.

ACA′NTHOCE′PHALANS, Acanthocephala. (Gr. ακανθος, *a thorn*, and κεφαλη, *a head, spiny-headed.*) An order of intestinal worms, or entozoons, which attach themselves to the mucous coat of the intestines by means of a proboscis surrounded with minute recurved spines.

ACA′NTHOPHIS. (Gr. ακανθος, *spine*, and οφις, *serpent.*) A genus of venomous serpents, allied to the viper, peculiar to Australia, and characterised by a horny spine, simulating a sting, at the end of the tail.

ACA′NTHOPODS, Acanthopoda. (Gr. ακανθος, and πους, *a foot, spine-footed.*) This name is applied to a tribe of clavicorn coleopterous insects, including those species which have spiny legs.

ACA′NTHOPTERY′GIANS, Acanthopterygii. (Gr. ακανθος, and πτερυξ, *a wing or fin, spiny-finned.*) Cuvier's first order of fishes, characterised by the bony spines which form the first rays of their dorsal and anal fins, and generally, also, the first ray of the two ventral fins.

ACA′NTHU′RUS. (Gr. ακανθος, *a spine*, and ουρα, *a tail.*) A genus of spiny-finned fishes, characterised by trenchant and serrate teeth, and by having a strong movable spine, sharp as a lancet, on each side of the tail, by means of which these fishes have the power of inflicting very severe wounds.

ACA′NTHUS. (Gr. ακανθος, *a spine.*) A spiny herbaceous plant with pinnatifid leaves, and large whitish flowers enveloped in spiny bracts, found in various parts of the Levant. Its leaf is said by Vitruvius to have been the model on which the architects of Greece formed the leaves of the Corinthian capital, and that the idea of so applying it was derived from the following circumstance: — The leaves of acanthus grow in a tuft close to the ground, and sprout annually. It happened that a basket covered with a tile was left upon the crown of the root of an acanthus plant, which, when it began to grow in the spring, finding itself unable to arrange its leaves in the usual manner, turned them up round the sides of the basket, till encountering the edges of the tile, they gradually curved back in a kind of volute. Other leaves, besides those of the acanthus, are employed in the decoration of capitals; those, for instance, in the composite order of the arches of Titus and Septimius Severus, at Rome, have, from their strong indentations, more resemblance to parsley than to acanthus leaves, whilst those to the Temple of Vesta, at Rome, have a resemblance to laurel leaves. In Egyptian architecture, the palm leaf frequently occurs.

ACA′RDIA. (Gr. α, *without*, and Lat. cardo, *hinge.*) A term applied to a genus of fossil ostracean bivalves, in which the hinge is wanting, and the flat valve is applied to the convex valve, like a lid to a vessel; the two having been connected only by the adductor muscle.

A′CARI. (Gr. ακαρι, *a mite.*) In Entomology the term is restricted to the tracheary arachnidans which have, either a single-jointed chelicer, or pincer representing an antenna, or a suctorious mouth. All the species are extremely minute, or even microscopic, as the cheese-mite (*Acarus domesticus*), and many of them parasitic; of the latter, the itch-insect (*Sarcoptes scabici*) is a remarkable example. The mites are active insects, and possess great powers of life, resisting for a time the application of boiling water, and living long in alcohol.

ACCE′DAS AD CU′RIAM. In Law, the title of a writ which removes a plaint from an inferior court, generally the county court, as the issuing of which is a preliminary to trying a question of right upon a distress of goods by the proceeding called Replevin (which see).

ACCELERA′TION. (Lat. acceleratio, *hastening.*) In Mechanics, an increase in the velocity of bodies in motion. Acceleration is uniform or variable, according as the force by which the motion is produced acts regularly or irregularly.

The most familiar instances of uniformly accelerated motion, are those which are occasioned by the earth's attraction, and are exhibited in the falling of heavy bodies, or their descent along inclined planes. In both these instances, the observer cannot fail to perceive that the velocity becomes greater as the body falls from a greater height, or continues a longer time in motion. In order to explain the theory of acceleration from the action of gravity, it is necessary to recollect that, in virtue of the inertia of matter, a body always perseveres in its state of rest, or of uniform motion in a straight line, till, by some external influence, it is made to change its state. This is Newton's first law of motion, which is admitted as a principle or axiom in mechanics, and from which it follows, that as a body cannot accelerate its own motion, any change in the rate of velocity of a moving body must arise from the action of an extraneous force. Now, suppose a body to be carried to a considerable height above the earth, and abandoned to the action of gravity; and let us examine the circumstances which take place. In this supposition, gravity may be regarded as a force acting uniformly; for, though its intensity diminishes as the distance from the centre of the earth increases, yet any height to which we can reach is so small, compared with the radius of the earth, that the variation in the intensity of gravity depending on it may be disregarded. Let the time which the body takes to fall to the earth be divided into equal and small intervals. During the first interval an impulse is given to the body, and a certain motion is communicated. If gravity now ceased to act, the body would continue to descend uniformly with the velocity it had acquired; but the impulse is renewed with exactly equal vigour during the second interval, and, consequently, the velocity of the body is exactly doubled. The same thing is repeated in the third interval, and, consequently, the velocity of the body is then tripled. In the fourth interval it is quadrupled, and so on; the body continually receiving, during equal and successive intervals of time, equal increments of velocity from the action of the accelerating force, and preserving its acquired velocity in consequence of its inertia. Hence we infer the first great law of uniformly accelerated motion, namely, the velocity at any given moment is proportional to the number of impulses that have been received, or to the number of intervals that have elapsed since the commencement of the motion; in other words, *the velocity is proportional to the time.*

Let us now consider the spaces passed over by the falling body. Suppose the space through which the body falls during the first interval, or second of time, to be one pole. As the velocity is supposed, at the commencement of the motion, to be nothing, and to increase uniformly during the interval, it is evident that the space passed over will be the same as if the body had continued during the interval to move uniformly with the mean velocity, or the velocity it had at the middle of the interval. But the velocity has been shown to be proportional to the time. Hence, at the end of the first second the velocity is the double of what it was at the middle of the second; and, therefore, if gravity ceased to act, the body, during the second interval or second, would descend through two poles. In consequence, however, of the renewed action of gravity, the body receives a fresh impulse during the second interval equal to that which it received during the first, and is, consequently, carried through a space equal to one pole, in addition to that

through which it is carried by its previously acquired velocity. Hence, during the second interval the body falls through three poles. At the end of this time the velocity is the double of what it was at the end of the first interval, and, consequently, during the next second would carry the body through four poles. Add, again, the effect of the renewed impulse, and the space passed over by the body in the third second is five poles. In the same manner, we find the space passed over in the fourth second to be seven poles; in the fifth, nine poles, and so on; the spaces described in the successive seconds being proportional to the series of odd numbers, 1, 3, 5, 7, 9, 11, &c. Adding, therefore, these numbers successively, we shall have the spaces passed over, since the commencement of the motion, represented by the series of square numbers, 1, 4, 9, 16, 25, 36, &c. Whence the second great law of uniform acceleration, namely, *the spaces described are proportional to the squares of the times.*

Galileo was the first who discovered the laws of acceleration of falling bodies. He supposed the acceleration to take place by equal degrees, or to be uniform; and experiment has confirmed his hypothesis. (*See* GRAVITY, GRAVITATION.)

What has now been said, with respect to motion uniformly accelerated, applies equally (*mutatis mutandis*) to motion uniformly retarded. It will also be perceived that the effect of the resistance of the air has been neglected.

ACCELERA'TION OF THE FIXED STARS denotes the apparent greater diurnal motion of the fixed stars than of the sun; in consequence of which they daily come to the meridian of any place at an earlier hour of the solar day than they did on the day preceding. Thus, a star which to-day passes the meridian at six o'clock, mean time, will pass the meridian to-morrow three minutes and fifty-six seconds before six o'clock. The reason of this is, that the sun, which appears to make a complete revolution of the heavens, from west to east, in the course of a year, advances daily nearly a degree eastward among the stars; and the apparent diurnal motion, being from east to west, the sun's passage over the meridian is retarded daily about three minutes and fifty-six seconds of time, in respect of the stars. But our clocks are regulated by the sun; consequently, in reference to them, the daily transit of the stars over the meridian is accelerated. (*See* SIDEREAL TIME.)

ACCELERA'TION OF THE MOON. An increase of the mean angular velocity of the moon about the earth; in consequence of which, the time of her mean periodic revolution is somewhat shorter than it was many centuries ago. This acceleration is exceedingly small, amounting only to about ten or eleven seconds of a degree in a century. It was discovered by Dr. Halley, from a comparison of very ancient with modern observations, and was confirmed by an examination of the observations of the Arabians in the 9th and 10th centuries. Its physical cause long occasioned great perplexity to mathematicians, and was at length detected by the genius of Laplace. It depends on a very slow secular diminution of the eccentricity of the earth's orbit. One of the greatest discoveries in physical astronomy is, that all variations in the elements of the planetary system are periodic. Some centuries after the present time, the eccentricity of the earth's orbit will arrive at its minimum value, and then begin to increase. When this period arrives, the mean motion of the moon, which for many centuries has been accelerated, will begin to be retarded. (*See* PLANETARY SYSTEM, and PERTURBATION.)

ACCELERA'TION OF THE PLANETS. The motion of a planet in its orbit is variable, being quicker or slower, according as the planet is at a less or a greater distance from the sun. Hence, in moving from the apogee to the perigee of the orbit, the motion of a planet is accelerated; and, on the contrary, in moving from the perigee to the apogee, the motion is retarded.

A'CCENT. (Lat. ad, *to*, and cano, *I sing.*) In ordinary language, the greater or less stress laid in pronouncing on each syllable of a word is termed the accent of that syllable. But the accent of a Greek syllable is a species of tone, respecting which very contradictory notions prevail among modern commentators, and of which it is indeed difficult to form any accurate conception. The history of the employment of accentual marks in writing the Greek language, is extremely obscure. They are found in manuscripts of considerable antiquity. In our pronunciation of Greek, they are wholly neglected, quantity being our only guide in the stress which we lay on the syllable of each word. But the modern Greeks pronounce their language, in general, laying the stress on the accented syllables, and neglecting the quantity. The mark of the acute accent is ʹ; of the grave ˋ; of the circumflex, which is a compound of the other two, ^, or ~. But every syllable which has no accentual mark is said to have the grave accent; the grave being only marked on final syllables of words which have no acute accent on any syllable. These three accentual marks are also employed in the French language; but in it they are only employed, for convenience, to mark a difference in the pronunciation, not in the accent; the modifications of the vowel sounds not being all of them expressed by distinct letters.

ACCENT. In Music, a certain stress or forced expression laid on certain parts of a bar or measure.

ACCE'NTOR. A genus of seed and insect-eating passerine birds, of which the hedge-chanter, or as it is commonly called, the hedge-sparrow (*Accentor modularis*), is a well known example.

ACCE'PTANCE. *See* BILL OF EXCHANGE.

ACCE'PTOR. (Law.) *See* BILL OF EXCHANGE.

A'CCESSARY. (Lat. accedo, *I approach.*) In Law, an accessary to an offence is one who is not the chief actor, or present at its performance, but is concerned therein, either before or after the fact. An accessary before the fact, is one "who, being absent at the time of the crime committed, doth yet procure, counsel, or command another to commit a crime." An accessary after the fact, is one who, knowing that a felony has been committed by another, receives, relieves, comforts, or assists the felon. (*See* LAW, CRIMINAL.)

ACCESSARY, or ACCESSORY. (Fr. *accessoire*). In Painting, and the fine arts, is a term which extends to every thing introduced into a work that is not absolutely necessary. In an historical picture, for instance, the figures which are in action are the principal objects; by them the story is told, all the rest are accessories. Especial care is to be taken, that they be so selected and disposed, as not to interfere with the principal group; hence the ancient painters and sculptors were very shy of using them, lest the eye should be drawn away from the principal group, and its interest be thus lessened or destroyed.

ACCE'SSION. In international law, the act by which one power enters into engagements originally contracted between other powers. The accession of a sovereign is the period at which he assumes the sovereignty, and in hereditary monarchies takes place immediately on the decease of his predecessor.

ACCIA'CCATU'RA. (It. acciaccare, *to squeeze.*) In Music, a grace note, one semitone below that to which it is prefixed or, as it were, squeezed in.

A'CCIDENS, *per accidens*. A term used by the older philosophers to denote an effect not following from the nature or essence of the thing, but from some accidental quality. It is opposed to *per se.* Thus, fire burns *per se;* heated iron burns *per accidens.*

A'CCIDENT. In Logic, one of the predicables: in its strictest logical sense, it is that which may be absent from or present in the subject, the essence of the species to which the subject belongs remaining the same. Thus, it may be predicated of a man, that he is "walking," or that he is "a native of Paris:" the first of which examples expresses what is termed a separable accident; the latter, an inseparable; i. e. the individual may cease to walk, but cannot cease to be a native of Paris: but neither of these alter the species, man, to which the individual belongs. But it is to be observed, with regard to the accident, as well as the other predicables, that they exist only relatively to each other; so that the same quality may be accidental when predicated of the species, which is a property when predicated of the individual. Thus, "malleability" is an accident of the subject "metal," because many metals are not malleable. But it is one of the properties of gold, iron, &c., as distinguishing these from the non-malleable metal. (*See* PREDICABLE.)

ACCIDE'NTAL COLOURS. Colours depending on some affection of the eye, and not belonging to light itself, or any quality of the luminous object. If we look for a short time steadily with one eye upon any bright-coloured spot, as a wafer on a sheet of paper, and immediately after turn the same eye to another part of the paper, a similar spot will be seen, but of a different colour. If the wafer be red, the imaginary spot will be green; if black, it will be changed into white; the colour thus appearing being always what is termed the complementary colour of that on which the eye was fixed.

ACCIDE'NTAL POINT. Perspective. The point in which a straight line drawn from the eye, parallel to another straight line, cuts the perspective plane. It is the point in which the representations of all straight lines parallel to the original straight line concur when produced. It is called the accidental point, to distinguish it from the principal point, or point of view.

ACCIDE'NTALS. (Lat. accidentalis, *happening by chance*). In Painting, are those fortuitous or chance effects, occurring from luminous rays falling on certain objects, by which they are brought into stronger light than they otherwise would be, and their shadows are consequently of greater intensity. This sort of effect is to be seen in almost every picture by Rembrandt, who used them to a very great extent. There are some fine instances of accidentals in Raphael's Transfiguration, and particularly in the celebrated picture, the *Notte* of Coreggio, in which the light emanates from the infant Christ. With these effects may be classed such acci-

dental lights as those from a forge or a candle, or some such object, of which the use is extremely important to the painter of still life.

ACCIDENTALS. In Music, are those flats and sharps which are prefixed to the notes in a movement, and which would not be considered so by the flats and sharps in the signature.

ACCI′PITRES. (Lat. accipiter, *a hawk*) The name of the Linnæan order, including the birds of prey.

ACCLI′MATISE. (Lat. ad, *to*, and clima, *a climate*.) The art of cultivating exotic plants so as to inure them to a climate different to that which is natural to them. An acclimatised plant or animal differs from a naturalised one, in always requiring the assistance of art for its continuance in the adopted climate; the naturalised plant or animal continuing its kind without any care from man. The capacities of different plants and animals for being acclimatised, or naturalised, vary, but not to the extent that at first sight may be imagined; what passes under these terms being frequently nothing more than the fortunate discovery that some plant or animal, which had hitherto been found in a warm climate, would thrive equally well in a cold one.

ACCOLA′DE. (Lat. ad, *to*, and collum, *the neck*.) The slight blow given to the neck or shoulder, on dubbing a knight.

ACCO′MPANIMENT. In Music. The instrumental part of a composition which moves with the voice, to which it is to be kept subordinate. Also, the parts which in a concerted piece move with a particular instrument, whose powers it is the object of the composition to exhibit.

ACCOMPANIMENT. In Painting. Any object accessary to the principal subject, and serving to its ornament or illustration.

ACCO′MPLICE. In Law, is defined to be one of many concerned in a felony. (*See* ACCESSARY, APPROVER.)

ACCO′RD. (*See* CONCORD.)

ACCOU′NTANT-GENERAL. The principal or responsible accountant in the offices of Excise and Customs, India House, Bank of England, &c. The accountant-general of Chancery is an officer appointed by act of parliament to receive all the money lodged in court. He keeps his account with the Bank of England, which is responsible for all the sums lodged there by him.

ACCRE′SCIME′NTO. (It. accrescere, *to increase*.) In Music, the increase, by one half of its original duration, which a note gains by having a dot appended to the right of it.

ACCU′MBENT. (Lat. accumbere, *to lie down*.) Is a term applied, in botany, to cases where one part of an organ is applied to another by its edge; it is chiefly used in contradistinction to *incumbent*, where one part is applied to another by its back or face. These terms are principally employed among brassicaceous (cruciferous) plants.

ACCU′SATIVE CASE. That inflexion of the noun which expresses the passing over of an action from one substance to another: it consequently follows verbs active in all languages. In English it survives only in pronouns; and is used after all prepositions without distinction. (*See* GRAMMAR.)

ACE′PHALANS, Acephala. (Gr. ακεφαλος, *headless*.) A term applied to a class of molluscous animals, comprehending those which are without a head. The class is subdivided, according to the modifications of the respiratory organs, into the 'Lamelli-branchiate,' 'Pallio-branchiate,' and 'Hetero-branchiate,' or tunicate orders. (*See* those words.) The oyster, lamp-cockle, and squirter, or ascidia, are their several representatives. In the system of Cuvier it includes only the lamelli-branchiate and hetero-branchiate orders, or the acephala testacea, and the acephala nuda.

ACE′PHALOPHO′RES, Acephalophora. (Gr. ακεφαλος, and φερω, *I bear*.) The name given by Blainville to a class of molluscous animals corresponding to the acephala and brachiopoda of Cuvier.

ACE′PHALOUS. A botanical term, occasionally employed to designate ovaries, the style of which springs from their base, instead of their apex, as in lamiaceæ.

ACEPHALOUS. In Anatomy, is applied to those malformed fœtuses which are without a head.

A′CER. (Celt. ac, *a point*; Lat. acer, *sharp*. Pikes were made from the wood.) A genus of hardy trees, comprehending the common maple, the sycamore, and various kinds of American maples. Their wood is not of much value, being usually light and perishable; but the knotted parts of Acer campestre furnish the pretty bird's-eye maple of cabinet makers. The sap of Acer saccharinum is so sweet that sugar, of good quality, is prepared from it in North America. Acer platanoides, the Norway maple, is one of the best trees for planting in places exposed to the sea air.

ACERA′CEÆ (*see* ACER), or ACERINEÆ. A small natural order of polypetalous exogenous plants, comprehending the genus acer, and three others. It consists of trees, or at least of woody plants, inhabiting the temperate parts of the world; their most essential character consists in their samaroid dicarpellary fruit, connected with a broken whorled calyx, and unsymmetrical flowers without scales at the base of the petals. The uses of the order are the same as those of acer.

A′CERANS, Acera. (Gr. ἀ, *without*, and κερας, *a horn*.) A name applied to a family of apterous insects, characterised by the absence of antennæ: and to a family of gastropodous mollusks, including those species which have no tentacles.

A′CERIC ACID. (Lat. acer, *the maple*.) An acid obtained from the sap of that tree.

ACERO′SE. This word literally means chaffy (Lat. panis acerosus, *chaffy* or *brown bread*). Botanists apply the term to leaves of a narrow, stiff, and pungent nature, like those of fir trees.

ACETA′BULUM. (Lat. *a little cup*, or *dish*.) A term applied to the suckers on the arms of the cuttle-fish, and other dibranchiate cephalopods, which have been, hence, recently termed *acetabulifera*. These suckers were called by Aristotle *kotuloi*, which Taylor has erroneously rendered 'joints,' in the English translation of the History of Animals. In anatomy, *acetabulum* signifies the cavity of the hip-joint. In entomology it is the socket on the trunk in which the leg is planted.

ACETA′RIOUS PLANTS. (Lat. acetaria, *a salad*.) Plants used in salading; such as lettuce, mustard and cress, endive, &c.

ACE′TATES. Salts containing acetic acid. (*See* VINEGAR.)

ACE′TIC ACID. The pure acid contained in vinegar. It is a pungent acrid liquid; its odour, when diluted, is agreeable and refreshing; when perfumed, it is known under the name of *aromatic vinegar*.

ACHÆ′AN LEAGUE. A confederacy which existed from very early times among the twelve states of the province of Achaia, in the north of the Peloponnesus. It was broken up after the death of Alexander the Great, but was set on foot again by some of the original cities, B. C. 280, the epoch of its rise into great historical importance; for from this time it gained strength, and finally spread over the whole Peloponnesus, though not without much opposition, principally on the part of Lacedæmon. It was finally dissolved by the Romans, on the event of the capture of Corinth by Mummius, B. C. 147. The two most celebrated leaders of this league were, Aratus, the principal instrument of its early aggrandisement; and Philopæmen, the contemporary and rival, in military reputation, of Scipio and Hannibal. (*See* Polybius, i. ii. Pausanias, l. vii. Schlosser's Universal History. Clinton's Fasti Hellenici.)

ACHÆ′NIUM, or ACHENIUM. (Gr. ἀ, *without*, and χαινω, *I gape*.) A small bony fruit, containing a single seed, which does not adhere to the shell or pericarp, nor open when ripe.

ACHA′TMA. A genus of terrestrial gastropods, known by the trivial name of agate-snails: characterised by an oval oblong ventricose shell, striated longitudinally; with the aperture ovate and never thickened or reflected, and a smooth, straight columella, truncated at the base. All the species are oviparous, and one, the *Achatma zebra*, produces eggs with a hard, white, calcareous shell, and as large as those of the sparrow.

A′CHERON. (Gr. αχος, *grief*.) The river of sorrow which flowed round the infernal realms of Hades, according to the mythology of the ancients. There was a river of Thesprotia, in Epirus, of the same name, and also one in Italy, near which Alexander, king of the Molossi, was slain; both of which, from the unwholesome and foul nature of their waters, were supposed to communicate with the infernal stream.

ACHIE′VEMENT. (Fr. achever, *to accomplish*.) In Heraldry, denotes generally a shield of armorial bearings; but is more particularly applied to the funeral shield, commonly called hatchment, affixed to the dwelling-house of a recently-deceased person. The achievement is various, according not only to the rank of the deceased party, but to his situation as single, married, or widower.

ACHLAMY′DEOUS. (Gr. ἀ, *without*, and chlamys, *a tunic*.) Plants which have neither calyx nor corolla, and whose flowers are consequently destitute of a covering, or naked.

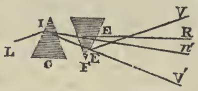
ACHROMA′TIC. (Gr. ἀ, *without*, χρωμα, *colour*.) Free from colour.

ACHRO′MATISM. The destruction of the primary colours which accompany the image of an object seen through a prism or lens. Light is not homogeneous, but compounded of rays unequally refrangible, and differing from one another in other physical properties. In passing into a refracting medium, some of the rays are more refracted, or bent out of their course, than others; whence the image of an object, seen through a lens, is rendered confused and indistinct, and appears encircled by a coloured ring. This circumstance presented a formidable obstacle to the use of the telescope; and, accordingly, soon after the invention of that admirable instrument, the utmost efforts

of mathematicians and artists were exerted to remove the imperfection. The compound nature of light, and, consequently, the theory of unequal refrangibility, were, however, not known till the time of Newton; and after the true source of the difficulty had been made known, it continued for a long time to be believed that achromatism was impossible, or that light could not be deflected without being decomposed. Newton himself was conducted to this conclusion by imperfect experiments. Subsequent discoveries have proved that the conclusion was erroneous, and that the rays of light may be bent without being separated; but, after all, the progress that has been made in the arts, as well as in the theory of colours and light, the subject of achromatism continues to be one of the most delicate and embarrassing, both in regard to theory and practice.

The principles on which achromatism is effected, may be briefly explained, as follows. On observing the spectra formed by prisms of different substances, it is soon perceived that the different colours, though always ranged in the same order, do not occupy the same relative lengths. A prism of flint glass, for example, exhibits proportionally less red, and more violet, than a prism of crown glass; and, in some other substances, the difference is still more remarkable. Hence it follows, that the primary coloured rays, in passing through different substances, do not undergo the same relative refractions; that is to say, the angle formed by two rays, the red and the violet, for example, is greater when the light is refracted by some substances than when it is refracted by others, though in all substances the violet is more refracted than the blue, the blue more than the green, and so on. The angle formed between the extreme rays of the spectrum measures the *dispersion* of the rays; and it is found by experiment that the dispersive power of common flint glass is to that of crown glass in the ratio of about 3 to 2; so that if a prism of flint glass give a spectrum three inches long, a similar prism of crown glass will give a spectrum of only two inches.

Now, suppose a prism of crown glass, C, the faces of which make an angle of 25°, and a prism of flint glass, F, of 20° 21′ 43″, to be placed behind it, and that a ray of direct or white light, L I, falling on the first prism at I, emerges from the second between the points E and E′. It is known by experience, that when the angles of the two prisms



are as above stated, the violet ray E V, on emerging from the second prism, is parallel to the incident ray L I; and that the red ray E′ R must fall below E V, because the red ray only emerges parallel to the incident ray when the angle of the prism of flint glass is 20° 56′ 28″. But if the prism of flint glass were removed, or, which would be the same thing, if its sides became parallel, and, consequently, its angle = 0, the red ray E′ R would fall above the violet ray E V, the violet being more refrangible than the red. While the angle F, therefore, increases from 0° to 20° 56′ 28″, the emerging rays E′ R and E V change their relative positions; whence it follows, that at some intermediate angle of the prism F they will be parallel, and this is the angle of achromatism. It is found by experience to be 11° 58′ 3″; varying, however, between narrow limits according to the peculiar constitution of the two refracting substances; and, therefore, in determining the ratio of the angles of the two prisms, recourse must generally be had to particular experiments on the individual substances of which the prisms are composed.

The achromatism of lenses depends on the same principles, and is determined in the same manner, as that of prisms; but in the case of lenses, the compensation is attended with great practical difficulties, on account of its being necessary to have regard to the spherical aberration.

If the ratios of the dispersion of the different spectral colours were all equal, the achromatism would be perfect when the extreme rays, or, indeed, any two rays, emerge parallel. This, however, is not generally the case; these ratios are in general variable, and, therefore, the angle which renders the red and violet rays parallel is not that which is required for the intermediate colours. It is possible, however, to remedy this defect, by combining a greater number of prisms or lenses. Theoretically speaking, indeed, the number of rays united or rendered parallel is the same as the number of prisms. The achromatic object-glasses of telescopes formerly made in this country, were generally triple; that is to say, consisted of three lenses, namely, a concave lens of flint glass placed between two lenses of crown glass: but almost all the large object-glasses lately constructed consist of only two lenses; the achromatism produced by this combination, though not rigorously exact, being sufficient for optical purposes.

The possibility of refracting light without producing colour was discovered and experimentally proved by Mr. Hall, a country gentleman of Worcestershire, under whose directions an achromatic telescope was made by a London artist in 1733. But, from whatever cause, no notice was taken of Hall's discovery; indeed, it appears to have been entirely forgotten, and contributed nothing whatever to advance subsequent researches. The merit of the discovery of achromatic compensation belongs to John Dollond, who arrived at it through a long course of skilful and systematic experiments undertaken for the express purpose. Its possibility had, indeed, been previously asserted by the celebrated Euler, who, reasoning from the construction of the eye, which, indeed, is a perfect achromatic instrument, proposed various hypotheses for destroying the coloured images. After Dollond's discovery, the subject was examined theoretically by Euler, Clairaut, and D'Alembert, but their profound mathematical investigations led to no practical improvement. The object-glasses made by Peter Dollond (a son of the inventor) were long celebrated throughout Europe as the best that were manufactured. Of late years, however, the science of light has been vastly extended; and the discoveries of Fraunhofer, in particular, have opened up an entirely new view of the composition of the spectrum. The largest and best achromatic glasses have recently been made in Bavaria and Switzerland. (*See* CHROMATICS, REFRACTION.)

ACI′CULAR. (Lat. acicula, *a needle*.) Any thing that is slender, sharp-pointed, and rather stiff; as many kinds of prickles on the leaves of plants, &c.

A′CID. In common language, any *sour* substance; in chemistry the term is less restricted, and often applied to all substances which saturate and neutralise the alcalis and other salifiable bases, without other obvious acid properties.

ACIDIFI′ABLE. Convertible into an acid.

ACI′DULOUS. *Dim.* of acid. Subacid; a term frequently applied to mineral waters containing carbonic acid.

ACI′NACIFORM. (Lat. acinaces, *a scimitar*, and forma, *shape*.) A name applied to certain succulent leaves and fruits, which resemble the blade of a curved sword or Turkish scimitar.

A′CINUS. (Gr. *ακινος*, *the stone of a grape*.) The separate carpels of a succulent fruit consisting of many carpels; as the raspberry. This term is also applied in anatomy to a cluster of the ultimate secerning follicles of certain conglomerate glands; as the liver.

ACIPE′NSER. (Lat. acipenser, *a sturgeon*.) The name of a Linnæan genus of the amphibia nantes, characterised by solitary, lateral, linear gill-openings; the mouth, situated beneath the head, retractile and edentulous; feelers under the snout, in front of the mouth. The sturgeon (acipenser sturio), and most of the other amphibia nantes of Linnæus, form the order chrondropterygii, or cartilaginous fishes of Cuvier. The genus acipenser is separated by Agassiz from the other cartilaginous fishes. It forms a link between the osseous and cartilaginous fishes, having its gills protected by an operculum, and only a single issue, or gill-opening, on each side for the respiratory currents; but at the same time having no rays to the branchiostegal membrane, and having the whole of its true internal skeleton in a cartilaginous state. By Cuvier, therefore, the genus acipenser is placed in the cartilaginous division of fishes, but separated from the rays, sharks, and lampreys, which have five or more gill-openings on each side, to form, along with the genera spatularia and chimæra, the order eleuthero-branchiata, or those which have the branchiæ free at their outer circumference. In the system of Agassiz the sturgeons are joined with the sauroid fishes, siluri, polypterus, and some other genera, to form the order Ganoides. (*See* that word.) And it is worthy of observation, that the polypterus (a ganoid fish of the Nile) has a spiral valve in the intestine like that of the sturgeon.

There are several distinct species of acipenser in the Danube, and other great rivers of Europe; but that which is occasionally caught on our east coast, and is commonly brought to the London market, is the Acipenser Sturio of Linnæus, or the common sturgeon.

The largest specimen ever caught in this country is, probably, that which is recorded by Pennant as having been taken in the Esk, and which weighed four hundred and sixty pounds.

In England the sturgeon is considered a royal fish, and its use is exclusively as an article of luxury for the table; its flesh, like that of most cartilaginous fishes, is firmer than is usual among osseous fishes, and having little peculiar flavour of its own, affords ample scope for the skill of the cook in imparting to it an extrinsic zest.

In the northern parts of Europe this fish is much more numerous than in the British rivers, and extensive fisheries are established for its capture. The best isinglass is manufactured from the sound, or air-bladder; and caviare is prepared from the roe of the female.

ACKNOW′LEDGEMENT-MONEY, in Law, paid according to the custom of some manors by copyhold tenants, on the death of a lord.

A′CME. (Gr. *ἀκμη*, *a point*.) In Rhetoric, the extreme

height, or farthest point of pathos, or sentiment, to which the mind is judiciously conducted by a series of impressions gradually rising in intensity. (*See* CLIMAX.)

ACO'LOGY, or AKOLOGY. (Gr. ἀκος, *a remedy*, and λογος, *a discourse*.) The doctrine of remedies, or of the materia medica.

A'COLYTE. (Gr. ακολουθος, *disciple*.) The second of the inferior orders of clergy in the primitive church, according to the Roman Catholic authorities. The Council of Trent declares the inferior orders to be five—subdeacons, acolytes, exorcists, readers, and doorkeepers; considering them all to be of apostolical institution. By the Protestants they are supposed to be merely occasional or local officers. The office of the acolytes, according to the Roman Catholic Catechismus ad Parochos, is to follow and serve the superior orders, the subdeacons and deacons, in the ministry of the altar. Besides this, they carry lights when the sacrifice of the mass is celebrated, whence they are called also ceroferarii (waxbearers).

ACONI'TA, ACONITINA. A poisonous vegetable principle or alkaloid extracted from the aconite.

A'CONITE. (Acone, a place in the Crimea famous for its poisonous herbs.) A genus of exogenous plants belonging to the natural order ranunculaceæ, with showy purple or yellow helmet-shaped flowers, growing in panicles, deeply cut leaves, and perennial roots of a highly poisonous nature. Those of Aconitum lycoctonum are used for the destruction of wolves, and of A. napellus for certain medicinal purposes; they are exceedingly acrid, and act as violent drastic purgatives. The bish root, with which the natives of Nepal poisoned their wells, during the advance of the British army into their territory, during the last war, was furnished by Aconitum ferox. The name aconite has also been given to another plant related to the original genus, namely, eranthis hyemalis, or winter aconite.

ACO'NTIA. (Gr. ἀκων, *a dart*.) A genus of non-venomous ophidian reptiles, allied to the snakes proper (anguis), but destitute of the bony rudiments of the scapular and pelvic arches. They are known by the trivial name of "Dart-snakes;" are numerous in species, and distributed over the warmer and more arid parts of the old world. They were the subjects of fabulous accounts by the ancient naturalists and poets, who attributed to them the power of projecting themselves with so much force and velocity as to transfix the object aimed at, like a hurled javelin, or arrow shot from a bow. This is as untrue as the assertion that they are venomous. The Dart-snakes are amongst the most harmless of their order; their food consists of small worms, insects, and larvæ.

ACORA'CEÆ, or ACOROIDEÆ. The natural order of plants which includes the genus acorus. It is distinguished from araceæ only by having its carpels separate, and its leaves in the bud state arranged in an equitant manner.

A'CORN. (Accorn, Sax. of aac, *an oak*, and cern, *grain*.) The well-known fruit of the oak, and therefore not a term of art, though belonging to architecture from its use as an ornament. In the early ages acorns constituted a principal part of the food of man. (Ovid. Metamorph. i. 106.; Virgil, Georg. i. 8. &c.) At present they are occasionally used in different parts of the Continent during scarcities; but in England they are never used, except for the feeding of pigs, poultry, &c.

A'CORUS. (Gr. ἀκορος.) A plant with sword-shaped leaves and aromatic stems, found abundantly in the meadows of some parts of England. It bears, but very rarely, its flowers in a little greenish yellow spadix, which appears at a short distance below the end of a leaf-like scape. The leaves, when crushed, exhale a pleasant odour, and are still used for strewing the floors of churches upon the occasion of certain ancient ceremonies. Its stem, or rhizoma, is like that of an iris, and is the calamus aromaticus of the druggists.

A'COTYLE'DONS. (Gr. ἀ, *without*, and κοτυληδων, literally, a hollow or concave part, but applied by botanists to the seed-lobe.) Plants whose seeds have no distinct cotyledons. The term is usually applied to what are more commonly named cryptogamic plants, such as ferns, mosses, lichens, &c., in which there are no seeds, properly so called, but which are propagated by undivided spherical bodies called spores. The word acotyledon is occasionally used for such plants as cuscuta, cactus, &c., whose seeds, although really of the same nature as those in which cotyledons are usually present, have no obvious division; this mode of applying the term is, however, seldom employed.

ACOU'STICS. (Gr. ἀκουω, *I hear*.) The science of hearing, or of sound. (*See* SOUND.)

ACQUI'TTAL. In Law. (Lat. acquietare, *to render tranquil*.) Freedom from services to a superior lord. Also, deliverance from a criminal charge by the verdict of not guilty. This verdict may always be pleaded in answer to a second charge on the same offence: the plea is termed "autrefois acquit"

ACQUI'TTANCE. In Law, the discharge in writing of a sum of money due. An acquittance not under seal is admissible only in evidence, and is not pleadable. An acquittance in full of all demands, is an answer to all debts, except such as are on specialty, which can only be discharged by an instrument of equal force.

A'CRE. A measure of land, that formerly varied in different parts of the United Kingdom. The magnitude of the imperial or statute acre may be referred to that of the square yard, by recollecting that a square, whose side is 22 yards long, is the *tenth* part of an acre; whence the latter contains $22 \times 22 \times 10$, or 4,840 square yards. The *chain* with which land is measured is 22 yards long, so that ten square chains are one acre. The acre is divided into 4 roods, and each rood into 40 perches; so that each perch contains $30\frac{1}{4}$ square yards.

Acre.		*Rood.*		*Perch.*		*Square yards.*		*Side of equivalent squares in yards.*
1	=	4	=	160	=	4840	=	69·5701
		1	=	40	=	1210	=	34·7851
				1	=	$30\frac{1}{4}$	=	5·5

121 Irish acres are equivalent to 196 English acres.
48 Scotch acres are equal to 61 English acres.
The French are is a square, whose side is 10 metres: and 1000 English acres are equivalent to 40·466 ares.

ACRI'DIANS, ACRIDIA. (Gr. ἀκρις, *a locust*.) A family of orthopterous insects, having the genus acridium for the type.

A'CRITES, ACRITA. (Gr. ἀκριτος, *indiscernible*.) The lowest division of the animal kingdom, in which there is no distinct discernible nervous system; and in which the alimentary canal is not separated from the parietes of the body, or contained in a distinct abdominal cavity. It is composed of the classes spongiæ, polypi, polygastrica, sterelmintha, acalepha. (*See* those words.)

ACRODA'CTYLUM. (Gr. ἀκρος, *highest* or *extreme*, and δακτυλος, *a digit*.) In Zoology, the upper surface of each digit.

A'CRODUS. (Gr. ἀκρος, *extreme*, οδους, *tooth*.) The name of a genus of sharks, characterised by the presence of large polygonal obtuse enamelled teeth; aggregated at the extremity of the jaws. The fishes of this genus are found exclusively in the fossil state.

A'CROGENS. (Gr. ἀκρος, and γιγνω, *I grow*.) Plants, otherwise called cryptogamous and acotyledonous. They correspond to ferns, mosses, lichens, &c.; have no sexes; are multiplied by spores instead of seeds; and are remarkable for increasing chiefly in length, by additions to their end, and not in diameter, by the addition of fresh matter to their outside, as in exogens, or to their inside, as in endogens.

ACRO'LITHOS. (Gr. ἀκρος, and λιθος, *stone*.) In Sculpture, a statue whose extremities are of stone, the body being made of wood. According to Vitruvius, there was a temple at Halicarnassus dedicated to Mars, and built by Mausolus, king of Caria, wherein was an acrolithan statue of the god. And from Trebellius Pollio we learn that Calpurnia set up an acrolithan statue of Venus, which was gilt.

ACRO'NYCAL, or ACHRONYCHAL. (Gr. ἀκρος, and νυξ, *night*.) A star or planet is said to be acronycal when it is opposite to the sun, or passes the meridian at midnight. It rises acronycally, when it rises as the sun sets; and sets acronycally, when it sets as the sun rises. The Greek poets designated these different positions of a star, at its rising or setting, with respect to the sun, by the terms *acronycal*, *cosmical*, and *heliacal*; and thereby indicated, in a rude way, the position of the sun in the ecliptic, or the season of the year.

ACROPO'DIUM. (Gr. ἀκρος, and πους, *foot*.) In Zoology, the upper surface of the whole foot.

ACRO'POLIS. (Gr. ἀκρος, and πολις, *city*.) The upper town or citadel of a Grecian city. It was usually the site of the original settlement, and was chosen by the colonists for its natural strength. The most celebrated were those of Athens, Corinth, and Ithome; the two latter of which were termed the horns of the Peloponnesus, as if their possession was enough to insure the submission of the whole peninsula.

A'CROSPIRE. (Gr. ἀκρος, and σπειρα, *a curved line*.) When seeds begin to grow, the part of the germ which afterwards produces the stem shoots forth in the form of a delicate curved fibre, and, gradually bursting the outer covering, makes its appearance at the end of the seed. Maltsters, especially, call this the acrospire of barley.

ACRO'STIC, or ACROSTICH. (Gr. ἀκρος, and στιχος, *line*, or *rank*.) A composition in verse or prose, in which the first or last letter of every line, or of every word, read collectively, form a name or a sentence. Great labour and ingenuity have been exercised in inventing varieties of this and similar curious trifles. Such, for example, is the pentacrostic, in which the initial letter of each verse is repeated five times in every verse, so as to form five repetitions of the same acrostic, as it were, in different columns.

ACROTA'RSIUM. (Gr. ἀκρος, and ταρσος, *tarsus*.)

In Zoology, the upper surface of the tarsus. (*See* that word.)

ACROTE'RIA. (Gr. ἀκρωτηριον, *the extremity of any thing.*) In Architecture, the pedestals, often without base or cornice, which are placed on the centre and sides of pediments, and which are so placed for the reception of figures. Vitruvius gives the rules for their dimensions. The same word is applicable to the ridge of a building. Some have used the word acroterion to signify the statues on the pedestals, but it is strictly the pedestals themselves only to which it is applicable. The word acroteria is also used to denote the small pieces of wall in balustrades between the pedestal and the balusters.

ACRY'DIUM. (Gr. ἀκρις, *a locust.*) The name applied by Fabricius to a genus of locusts, characterised by a carinate thorax; filiform antennæ, shorter than the thorax; and equal palps or feelers.

ACT. In Dramatic literature, a division of a drama, subdivided into scenes. The Greek dramas of the old model were naturally divided into separate portions by the stasima, or choric odes, which occur at intervals, during which the stage was left to the sole occupation of the chorus. Nevertheless, the Grecian writers do not notice this division in express terms; nor do we know the origin of the famous rule of Horace, that every dramatic piece should be restrained within the limits of five acts, neither more nor less. The division into acts must be in great measure arbitrary, although rules have been laid down, by various writers, to define the portion of the story or plot which should be contained in each of them. Thus, Vossius lays it down as a rule, that the first act presents the intrigue, the second develops it, the third is filled with incidents forming its knot or complication, the fourth prepares the means of unravelling it, which is finally accomplished in the fifth. (*See* DRAMA.)

ACT. In the Universities, an exercise performed by students before they are admitted to degrees. The student proposes certain questions to the presiding officer of the schools, who then nominates other students to oppose him. The discussion is syllogistical and in Latin, and terminates by the presiding officer questioning the respondent, or person who is said to keep the act, and his opponents, and dismissing them with some remarks upon their respective merits.

ACT OF PARLIAMENT. *See* STATUTE.

A'CTA DIURNA, *daily proceedings.* Among the various important improvements effected by Julius Cæsar may be ranked that of his furnishing the Romans with a species of newspaper. He was the first to order that the *acta diurna* of the senate and the people should be drawn up in a regular form and published. This publication must consequently have, in many important respects, closely resembled a modern newspaper. — (Sueton. in Cæs. cap. 20.)

A'CTA ERUDITORUM. The title of a celebrated literary and scientific journal, which was commenced at Leipzig, in 1682, by professor Mencke, of that university. The last volume was that for 1776.

A'CTIAN GAMES. (Lat. *Ludi Actiaci.*) Games celebrated in antiquity at Actium in honour of Apollo, hence surnamed *Actius.* The temple of the god was repaired, and the games restored and celebrated with increased splendour by Augustus, in memory of his victory over Mark Antony off Actium.

ACTI'NIA. (Gr. ἀκτιν, *a ray.*) A genus of polypi with very numerous tentacles, which extend, like rays, from the circumference of the mouth. They are amongst the most highly organised of the class, having the alimentary sac distinct from the parietes of the body; feeding on shellfish and other marine animals, which they draw into their mouth with their tentaculæ, and in a short time rejecting, through the same aperture, the shells and indigestible parts. They are of a soft gelatinous texture, and they assume various forms when the tentacles are all expanded, having the appearance of full-blown many-petalled flowers; whence they are called "sea anemones," "sea sunflowers," &c. (*Phil. Trans.* lxiii. p. 361.)

ACTI'NOCA'MAX. (Gr. ἀκτιν, *a ray*, καμαξ, *a pale.*) A name applied by Miller to the fossil shells of an extinct genus of Cephalopodous Molluscs, apparently connecting the *Belemnites* with the existing *Sepiæ*. The remains of the *Actinocamax* appear, as yet, to be peculiar to the chalk formations of England and Normandy.

ACTI'NOCRI'NITES. (Gr. ἀκτιν, *a ray*, κρινον, *a lily.*) The name of a subgenus of extinct Crinoidean radiated animals, or Encrinites, characterized by the numerous rows of angular plates, which, being articulated by their margins, constitute the body.

ACTI'NOLITE. (Gr. ἀκτιν, *a ray*, and λιθος, *stone.*) A variety of hornblende, which usually occurs in fascicular crystals.

ACTINO'METER. (Gr. ἀκτιν, and μετρον, *measure.*) An instrument invented by Sir John Herschel for measuring the intensity of the sun's rays. *See* PHOTOMETER.

A'CTION. (Lat. ago, *I act.*) In Painting and Sculpture, the state of the subject as imagined in the artist's mind at the moment chosen for representation. It must not be confounded with motion, which relates to the mobility of a single figure. Action must be true, simple, natural, and connected; and its unity must be preserved, or the action is weakened.

ACTION. In the Military Art, an engagement or battle between opposing forces; hence *partial* actions, *general* actions, &c.

ACTION. In Oratory, the accommodating or suiting of the countenance, voice, and gesture of the speaker to the matter to be spoken or delivered. This *sermo corporis*, as Cicero calls it, has always been regarded as a most important part of oratory. The ancient masters laid the greatest stress upon it. Demosthenes said that action was "the beginning, the middle, and the end of the orator's office;" and Cicero admits, that "*what* an orator says is not of so much importance as *how* he says it." Hamlet's advice to the players should be kept in mind by those who desire to excel in this art.

ACTION. In Poetry, an event either real or imaginary, forming the subject of an epic poem or play, &c. Thus the wrath of Achilles forms the action or subject of the Iliad, the wanderings of Æneas the action or subject of the Æneid, &c.

ACTION. In the Stock Market in Paris, and other places in France, *action* is the name given to a share of the capital stock of a joint stock company.

ACTION. In Mechanics, denotes sometimes the effort which a body or power exerts against another body, sometimes the effect or motion resulting from such effort. Mechanical action is exerted either by percussion or by pressure; in the former case the effect is instantaneous, in the latter it is continued. In all cases of mechanical action, the effect of the acting body is resisted in an equal degree by the inertia of the body acted upon, which resistance is termed reaction; and it is an axiom in mechanics, that action and reaction are always equal, and exerted in opposite directions. Thus, in driving a nail with a hammer, the stroke acts against the face of the hammer exactly with the same energy as against the head of the nail; and in pressing the hand against a stone, the pressure on the hand and on the stone is precisely the same.

A'CTIONS, in Law, are real, personal, or mixed. Actions, real or mixed, for the recovery of real property, are very numerous, but so prolix and difficult that they are almost wholly abandoned as a means of obtaining justice, and questions relating to title to land are now tried by the simple form of ejectment. The only case in which they have been resorted to, of late years, has been when, from the shorter period to which the action of ejectment was limited (*see* LIMITATIONS), a right survived for the purpose of the former, which was barred as to the latter. But the recent acts on this subject have much reduced the distinction. Actions in common use, *i. e.* personal actions, are also divided into actions of contract and actions of tort, and into local and transitory, in the former of which the place or county where the cause of the action arose must be accurately alleged, for the purpose of the trial taking place there. This allegation is termed the *Venue* of the action, from the Norman-French *visne*, vicinetum, neighbourhood, because the jury impanelled to try an action came originally from the neighbourhood. In the latter it is immaterial. Actions of tort to the person, and all actions of contract, are generally transitory, but under certain circumstances the latter may be local.

ACTI'VITY. The virtue or faculty of acting. The term is used in physics to denote the promptitude of the action of one body on another. Thus we speak of the activity of an acid, of poisons, of the electric fluid, &c.

Sphere of activity, the space within which the action of a body (of a magnet, for example) produces any sensible effect.

A'CTOR, ACTRESS. In the flourishing period of the early Greek drama, so long as a certain remnant of religious solemnity was attached to it, there was no degradation in the character of an actor: in fact, the parts of the chorus were often filled by volunteer performers of birth and station. But when the dramatic performers began to form a profession apart, they appear soon to have been regarded with disrespect. In Rome, the first actors were buffoons (known by the Tuscan name of *histriones*), who enacted the grotesque farces imported from Etruria, and the qualification of actor was among the most dishonourable in the period of the republic; and no circumstance was considered to indicate more decisively the intention of Nero to degrade and subject all classes in the state, than his having persuaded a Roman knight, Laborius, to appear on the stage in the performance of one of his own mimi. Under the dissolute reigns of the first emperors, especially Nero, much favour and countenance was shown to actors. Nero was, however, obliged at last to banish the *pantomimi*, the most popular species of actors, entirely from Italy, together with their performances, in consequence of the strong party spirit which was excited about them. (Sueton. Nero. c. 16.) It seems from Tacitus, that they were soon afterwards restored: again banished

by Domitian; restored by Nerva, and finally expelled by Trajan; but, by the time of the reign of the last-mentioned emperor, the dramatic stage was nearly abandoned, and its place wholly occupied, by gladiatorial shows and other pageants. In England, the first actors were the servants of great nobles, who performed for their diversion; and when regular theatrical companies were formed, they were long in the habit of putting themselves under the protection of distinguished personages: the companies of the greater theatres, as is well known, retain the custom of calling themselves servants of His Majesty. Actresses were not known on the English stage until some time after the Restoration: although ladies of quality had frequently, under James and Charles I., performed parts in masques, &c. Kynaston was the last celebrated male performer of female parts. A singular notice of him will be found in Pepys's Memoirs. In Roman Catholic countries, actors, even to this time, are under the ecclesiastical restriction of excommunication. (*See* DRAMA.)

ACTIVE MOLECULES. (*See* MOLECULES.)

ACTS OF SEDERUNT. (Scotch law.) Statutes made by the Lords of Session sitting in judgment, by virtue of a Scottish act of parliament, passed in 1540, empowering them to make such constitutions as they may think expedient for ordering the procedure and forms of administering justice.

A'CTUARY. Originally a public officer in the Roman courts of justice, who drew up writings, contracts, &c., in the presence of the magistrate; whence his name, from actus, *an instrument.* The clerk who registered the acts and constitutions of the convocation, in the assemblies of that body, was termed actuary. The managing officer of an insurance company is usually termed in England an actuary. (*See* INSURANCE.)

ACU'LEATE. (Lat. aculeus, *a prickle.*) In Botany, any thing covered with prickles; that is, with sharp prominences which originate in the cellular system and have no connection with wood.

ACU'LEATES. In Zoology, a tribe of hymenopterous insects, in which the females and neuters are provided with a sting, generally concealed within the last segment of the abdomen.

ACU'MINATE. (Lat. acumen, *the point of any thing.*) When a leaf or any other body is very much tapered to a point; it is thus distinguished from acute, which means sharp-pointed without any tapering.

ACUPU'NCTURA'TION. (Lat. acus, *a needle*, and punctura, *a puncture.*) Pricking with a needle. In the East this is a common remedy for painful affections of different parts of the body. It has lately been extensively practised here for the cure of chronic rheumatism, a long and sharp needle being thrust into the affected muscles.

ACU'TE. The opposite of obtuse. An acute angle is that which is less than a right angle; an acute-angled triangle is one of which each of the angles is acute; an acute-angled cone is one whose opposite sides form an acute angle at the vertex.

ACUTE. (Lat. acutus, *sharp.*) In Music, the height or pitch of a sound or tone, in respect of another. It is opposed to grave.

AD LI'BITUM. In Music (*at pleasure*), a term applied to an accompaniment which is not essential, and may or may not be performed without interfering with the composition.

AD QUOD DAMNUM. (Lat. *to what damage.*) A writ sued before the grant of certain liberties and franchises, as a fair, market, &c., which may be prejudicial to the king who grants, or the public; by it the sheriff is directed to inquire what damage may accrue from the grant in question.

ADA'CTYLE. (Gr. ἀ, priv. and δακτυλος, *a digit.*) In Zoology, signifies a locomotive extremity without digits.

A'DAGE. (Lat. adagium, *a proverb.*) (See PROVERB.) The proverbs of antiquity are collected by Erasmus in a work entitled *Erasmi Adagia.*

ADA'GIO. (Ital. adagio, *leisurely.*) In Music, the slowest of musical time, grave only excepted. (*See* ALLEGRO.)

ADAMA'NTINE SPAR. (Gr. ἀ, *without*, and δαμαω, *I break*, or *conquer.*) A variety of crystallised alumina, nearly resembling the sapphire in composition, and of extreme hardness. The finest specimens come from India and China. At Bombay it is called corundum.

A'DAMITES. (Theology.) A sect in the early ages of the Christian church who are said to have professed an exact imitation of the primitive state of innocence. They re-appeared in the 15th century in Bohemia. (*Mosheim*, I. p. 233, &c.)

ADANSO'NIA. A remarkable African tree, named after Adanson, a celebrated French botanist and traveller. It is called by the negroes *Baobab.*

A'DAPIS. A name originally applied by Gesner to the Hyrax or coney of Scripture, and adopted by Cuvier to designate another small pachydermatous quadruped, now extinct, but the existence and nature of which that great naturalist detected and deduced from three fragments of the head, which were discovered in that immense depository of fossil bones, the gypsum quarries of Montmartre. The dentition of the Adapis is as follows:— each jaw has four trenchant incisors; two conical canine teeth, the upper ones straight, the lower inclined obliquely forwards; and apparently fourteen molar teeth, of which the first is trenchant, and the three or four posterior ones, on each side, like the posterior molars of the Anoplotherium. Cuvier supposes the animal to have been about the size of a rabbit, and to have closely approximated the Anoplotheria.

A'DDER. (*See* VIPER.)

ADDI'TION. In Arithmetic. The operation by which a number is found equal to several others taken together. It is the first of the four fundamental rules. Addition, in algebra, is the uniting or incorporating of several algebraic quantities into a simple or contracted expression.

A'DDITIVE. Something to be added, in contradistinction to subtractive, which denotes something to be taken away. The terms additive and subtractive are sometimes applied to algebraic quantities, to denote those relations to other quantities which are more commonly, though less correctly, expressed by positive and negative.

ADDU'CTOR. (Lat. adduco, *I draw towards.*) The adductor muscles are opposed to the abductors: they draw the parts to which they are attached, together.

ADE'LPHIA. (Gr. ἀδελφος, *a brother.*) A collection of stamens into a bundle. Linnæus employed this term for those plants in which the stamens, instead of growing singly, combine into one or more parcels, or brotherhoods; thus, monadelphia signified stamens all connected into one parcel, diadelphia into two parcels, and so on.

ADE'NOSTY'LEÆ. (Gr. ἀδην, *a gland*, and στυλος, *a column*, or *style.*) A subdivision of composite plants, comprehending tussilago, liatris, eupatorium, and some other genera, in which the branches of the style are covered with long glandular hairs.

ADE'PHAGANS, ADEPHAGA. (Gr. ἀδηφαγος, *voracious.*) A family of carnivorous and very voracious coleopterous insects.

A'DEPT. (Lat. adipiscor, *I obtain.*) A distinctive term applied to those alchemists who were supposed to have attained the great object of their researches, or to have discovered the philosopher's stone.

ADFE'CTED, or AFFECTED. (*See* the latter term.)

ADHE'SION, (Lat. adhæreo, *I adhere*,) is a property of vegetable matter by which contiguous parts grow together; and is one of the causes of the great diversity of appearance in the organs of plants. Two opposite leaves grow together and form apparently one, through which the stem passes; several in a whorl adhere, and form an involucre; a number of petals adhere, and thus constitute a monopetalous corolla; several stamens adhere, and an adelphia is the result; some carpels contract an adhesion with one another, and form a compound fruit; finally, the calyx adheres to the sides of the ovary, and then seems as if it grew from the apex of it. Irregularity in flowers and fruit is also in many cases produced by the unequal manner in which adhesion takes place between similar parts; of the calyx, two of the sepals adhere into one parcel, and three into another; the result of which is a two-lipped calyx; the same thing occurs in the corolla, and elsewhere.

ADHESION. (Physics.) A term used to denote the force with which different bodies remain attached to each other, when they are brought into contact. Adhesion has often been confounded with cohesion; but the two terms are essentially distinct. Adhesion is the force with which two bodies of different kinds cling to each other when united; cohesion is that which unites the particles of a homogeneous body with each other. Thus, the particles which form a drop of water or quicksilver are united by cohesion; the particles of water which wet the surface of any body are united to it by adhesion.

Adhesion may exist between two solid bodies, between a solid and a fluid, or between two fluid bodies. The adhesion of solid bodies is exemplified in the force required to separate two pieces of marble, whose polished surfaces have been brought into contact. The suspension of water above its level in capillary tubes, or between two plates of glass very nearly in contact, shows the adhesion of a fluid to a solid body; and an instance of the adhesion of two liquids is obtained by covering a plate of glass with oil, and bringing it into contact with the surface of water; a very sensible force is required to raise it perpendicularly from the water.

Dr. Brook Taylor appears to have been the first who undertook to estimate experimentally the force of adhesion; and the method which he employed, was to determine the weight necessary to separate fir-boards from the surface of water. This method, however, unless proper precautions are taken, is apt to give inaccurate results. On separating a fir-board from water, the whole

surface of the board may be observed to be wetted; that is to say, a thin film of water remains attached to the wood, so that the force by which the separation was effected is not the force necessary to overcome the adhesion of the water to the board, but the cohesion of the particles of water to each other. This is fully established by the experimental fact, that, when discs of different substances are applied to a liquid, by which they are perfectly wetted, their adhesion to it is the same, whatever may be their nature, and exactly equal to the cohesive force of the fluid. Discs of glass and discs of copper of the same diameter adhere to water with precisely the same force.

The adhesion of discs to the surfaces of liquids is demonstrated by Laplace to be a capillary phenomenon, arising from the action of attractive forces which are sensible only at very small distances. Supposing the diameter of the disc to be known, and the height to which the same liquid rises in a capillary tube of the same matter, and of a given diameter, Laplace determined from theory the force necessary to detach the disc. The results of his determination, applied to different liquids, as water, oil of turpentine, and alcohol, at different densities, agreed exactly with the numbers found by M. Gay-Lussac, in a series of very accurate experiments on this subject. The perfect identity of the forces producing adhesion and capillary attraction, is also proved by the following experiment: — It is well known that the height to which fluids rise in capillary tubes depends on the angle which the fluid makes with the sides of the tube. But the surface of mercury covered with water in a capillary tube is exactly spherical; consequently, the angle which the mercury makes with the sides of the tube vanishes, and the force is reduced to zero. If, therefore, adhesion depends on a force of the same nature, it follows that, on applying a disc of glass to the surface of mercury, and covering them both with water, no force should be required to separate the disc, excepting what is necessary to overcome its weight. Now, this was found by Gay-Lussac to be exactly what takes place. When the mercury and disc were covered with water, no resistance was offered to their separation; without the interposition of the water, a weight of 296 or even 400 grammes was required to overcome the adhesion. (Laplace, *Mécanique Céleste*, tome iv. Biot, *Traité de Physique*, tome iv. p. 464.)

The adhesion of the polished surfaces of solid bodies is proportional to the extent of the surface, or to the number of points brought into contact. It was formerly believed that the resistance to separation in this case arises solely from the pressure of the atmosphere; but the difference of its amount in different substances proves this opinion to be erroneous; besides, it is found to be the same in a vacuum. (*See* CAPILLARY ATTRACTION.)

ADIA'NTUM. (Gr. ἀδιαντος, *dry.*) A genus of thin-leaved ferns, having their fructification in short marginal lines. The leaflets are usually wedge-shaped and placed upon slender shining petioles. One of the species (A. capillus veneris) was formerly employed in the manufacture of syrup of capillaire.

ADIA'PHORITES. (Gr. ἀδιαφορος, *indifferent.*) A name given to Melancthon, and the party that agreed with him, in submitting, in things indifferent, to an imperial edict. The controversy which gave rise to this name had its origin in the imposition by Charles V., in 1548, of an edict, styled the Interim, because it proposed to accommodate for a time the differences of the papists and protestants, until the whole matter could be set at rest by the authority of a council. The opposite side was maintained by Flavius and the primitive Lutherans; and in the debate which followed there were two principal questions: first, whether it is lawful to yield to the enemies of truth, even in matters which are not of themselves essential; and, secondly, whether, granting the affirmative, the points in which the Interim required compliance, and in which Melancthon yielded it, are properly indifferent. Those points related chiefly to the doctrine of justification by faith, in which Luther and his genuine followers went to a great extreme; while Melancthon, although ostensibly the head of the Lutheran church, after the death of the great Reformer, adopted much more moderate views. Out of this controversy a great variety of other debates were engendered, and from these quarrels many schisms and divisions among protestants derived their origin.

A'DIPOCE'RE. (Lat. adeps and cera, *fat* and *wax.*) A fatty substance produced by the decomposition of the flesh of animals in moist situations, or under water, resembling, in some of its properties, a mixture of fat and wax.

A'DIPOSE. (Lat. adeps, *fat.*) Unctuous, or containing fat. Adipose membrane is the cellular membrane in which fat is deposited.

A'DIT. (Lat. adeo, *I approach.*) A horizontal shaft or passage in a mine, either for access, or carrying off water.

ADJA'CENT ANGLE. In Geometry, an angle immediately contiguous to another, so that one side is common to both angles. It is more particularly used when the two angles, besides having a common side, have their other sides in the same straight line. In this case, the adjacent angle is the same as the supplemental angle.

A'DJECTIVE. (Lat. ad, *to*, and jaceo, *I lie.*) In Grammar, that part of speech which is annexed to substantives, to define more accurately the conceptions intended to be denoted by them. *See* GRAMMAR.

ADJECTIVE COLOURS. Colours which require to be fixed by some base or mordant, in order to be applied as permanent dye-stuffs.

ADJOURNMENT, in Parliamentary language, means a postponement of the sittings or proceedings of either House of Parliament from one time to another specified for its re-assembling. Adjournment differs from prorogation in this, that the latter is an act of royal authority, whereas the power of adjournment is vested in each house respectively, no definite limits being prescribed to it by the constitution. *See* PROROGATION.

ADJU'DICATION. In Scottish Law, the diligence (*i. e.* process) by which land is attached as security for payment of debt. Adjudication for debt is a species of mortgage, redeemable, except in the cases of what are termed general adjudications, or adjudications contra hæreditatem jacentem.

ADJU'STMENT. In Marine Insurance, the settlement of a loss incurred by the insured.

A'DJUTANT. A military officer, attached to every regiment, who relieves the major of part of his duty, and performs it in his absence.

A'DJUTANT-GENERAL. A staff officer, who is to the army what the adjutant is to a regiment. He assists the general, and distributes his orders.

A'DJUTANT-GENERAL OF THE JESUITS. A title given to certain fathers who resided with the general of the order.

A'DJUVANT. (Lat. adjuvare, *to help.*) In Medicine, a substance which assists and promotes the operation of others.

ADMINISTRA'TION. (In Law.) If a person die intestate as to his personalty, letters of administration are granted by the ordinary (*see* LAW, tit. ECCLESIASTICAL COURTS) to such person as is pointed out by the statutes 31 E. 3., and 21 H. 8. These empower the ordinary to grant these letters to the widow, if there be one, or next of kin, at his discretion. Of persons equally near in degree the ordinary may grant to which he please. If none of the kindred take out administration, a creditor may do it. When the will is made without the nomination of any executor, the ordinary grants administration cum testamento annexo. Where a person dies intestate, his personal property descends (subject to his debts) as directed by the statute of Distributions, 22 & 23 C. 2. c. 10., explained by 29 C. 2. c. 30. One-third goes to the widow; the residue in equal proportions to the children, or, if they are dead, to their representatives, i. e. their lineal descendants. If there are none of these, then the widow takes a moiety, and the next of kin in equal degree, and their representatives take the other; if there be no widow, they take the whole. But of representatives none are admitted among collaterals farther than the children of the intestate's brothers and sisters. The order of nearness of kin, with reference to the distribution of intestates' estates, is thus arranged according to the rules of the civil law — children, parents, brothers, grandfathers, uncles or nephews (and the females of each class respectively), and, lastly, cousins.

ADMINISTRATION. (Lat. administratio, *care of an affair.*) In its general sense means the conduct or management of any affair; but in this country the term is usually applied to the management of the public or national affairs by the government, which is thence called *the Administration.*

A'DMIRAL. A great naval officer, who has the same power and authority over the maritime forces of a state that a general has over its land forces; and who also tries himself, or appoints officers to try, maritime cases. There are three ranks of Admirals, the Admiral (or full Admiral), Vice Admiral, and Rear Admiral. Each of these again has three gradations, of red, white, and blue, the colours of the flags they bear. —The Admiral carries his flag at the main, the Vice at the fore, and the Rear at the mizen mast.

ADMIRAL, *Lord High.* The ninth great officer of state in England. The office has been usually given, at least since the reign of Henry IV., to some of the king's youngest sons, near kinsmen, or of the higher nobility. Since the reign of Charles II. it has been, with occasional exceptions, always in commission, and the commissioners are styled 'Lords of the Admiralty.' It was held by the late sovereign William IV., when Duke of Clarence, from 1827 to the following year.

A'DMIRALTY, the Board of Commissioners for executing the Office of Lord High Admiral, and having authority over naval affairs generally.

ADMIRALTY, *Court of.* In Law, is a court of record,

of which the proceedings are carried on, at least to a certain extent, according to the course of the civil law; although, as the judge may have in some cases the assistance of a jury, it has also a resemblance to the courts of common law. It has jurisdiction principally for the determination of private injuries to private rights arising at sea, or intimately connected with maritime subjects; and in most cases, to which its authority extends, it has concurrent jurisdiction, either with the common law courts, or those of equity. Suits may be instituted in this court for assault and battery at sea; for collision of ships; for the restitution of goods piratically taken not under colour of war. It has also an equitable jurisdiction between part owners of a ship, It adjudicates in suits for mariners' wages, and for pilotage. It has a peculiar jurisdiction in cases of bottomry bonds, and other deeds in the nature of a mortgage of the ship; having an exclusive power to grant warrants to arrest the ship itself. It has also jurisdiction in cases of salvage, and incidentally of wreck.

The prize court, which decides prize causes in time of war, is a separate tribunal, although usually presided over by the same judge as that of admiralty. To that able and philosophical jurist, Sir W. Scott (Lord Stowell), who sat in these courts (as well as the ecclesiastical) for many years during the late war, and after its close, the country is indebted, not only for the high character and value of these tribunals, but also for the light thrown on the difficult and important questions of national law, by the most profound and lucid decisions ever applied to that subject.

A'DNATE. (Lat. adnascor, *I grow to any thing.*) Is said when one organ grows to the face of another, and not to its apex, in which case it would be innate. This term is chiefly employed in speaking of anthers.

ADO'NIS. In Mythology. A beautiful youth, son of Cinyras, king of Cyprus, beloved by Venus, and killed by a wild boar, to the great regret of the goddess. It is, also, the name of a river of Phœnicia, on the banks of which Adonis, or Thammuz, as he is called in the East, was supposed to have been killed. At certain seasons of the year this river acquires a high red colour, by the rains washing up particles of red earth. The ancient poets ascribed this to a sympathy in the river for the death of Adonis. This season was observed as a festival in the adjacent country. Facciolati, *Lexicon;* Calmet, *Dictionnaire de la Bible*, art. *Thammuz.*) Milton has beautifully alluded to these circumstances: —

> "——— Thammuz came next behind,
> Whose annual wound in Lebanon allured
> The Syrian damsels to lament his fate
> In am'rous ditties all a summer's day:
> While smooth *Adonis* from his native rock
> Ran purple to the sea; supposed with blood
> Of Thammuz yearly wounded."
> *Parad. Lost*, I. v. 445.

ADO'NIC. (Gr. 'Ἄδωνις, *Adonis.*) A species of verse consisting of a dactyle and a spondee; as in Horace, lib. I. Od. ii. v. 5. *Terruit urbem, visere montes*, &c. It was invented by Sappho, and derived its name from being principally sung at the festivals in memory of Adonis. (Facciolati, *Lexicon.*)

ADO'PTER. A vessel with two necks placed between a retort and a receiver, serving to increase the length of the neck of the former.

ADO'PTION. (Lat. adopto, *I adopt.*) In the Civil Law, signifies the admission of a stranger to the rights and privileges of a son. Adoption was a common custom among the Romans, by whose law a relation, nearly resembling that of master and slave, was constituted between father and son; so that a child, adopted from one family into another, passed, in effect, from the power of his parent to that of his adopter. Adoption is said, in Justinian's institutes, to be of two sorts: the one, also called arrogation, where a person, independent of parental control, is adopted into a family by virtue of an imperial rescript; the other, where, by the authority of a magistrate, a child passes from one family to another. But unless the adopter possessed a certain right by blood over the person adopted (as a grandfather), the parental power of the father was not extinguished. Adoption exists in the jurisprudence of various countries, where derived from the civil law; as in the German states and in France: in the latter country, the person adopting must be one having neither children nor other legitimate descendants.

A'DRAGANT. Gum Tragacanth.

ADRI'FT. Not fastened; as a ship that has parted from her anchor, a boat that has broke from her ship, a gun from the ship's side, &c.

A'DVENT. (Lat. advenio, *I approach.*) The holy season, comprising four Sundays before Christmas. It begins on St. Andrew's day, the 30th of November, or on the Sunday next before or after it, according to the day of the week on which the 25th of December falls.

ADVENTI'TIOUS. (Lat. adventitius, *extraordinary.*) In Botany, when any thing appears out of the ordinary course of nature: if a bud appears where buds do not usually appear, it is adventitious. This term must not be confounded with abnormal, which is used when any thing is *constructed* out of the ordinary course.

A'DVERB. A word annexed to an adjective or verb, to define more closely the modifications of the quality or action denoted. *See* GRAMMAR.

ADVE'RSA. A medallic term, applied to two heads facing each other.

A'DVERSE. (Lat. ad, *to*, and verto, *I turn.*) In Botany, leaves are so called when they present their under surface to the sun.

ADVE'RTISEMENT. (Lat. adverto, *I attend to.*) In its general sense, means any information as to any fact or circumstance. But it is more particularly used to designate notices made by competent authority in the daily papers, and otherwise, of events of local or general interest, as the publication of new books, sales of estates and produce, meetings of creditors, formation and dissolution of partnerships, &c. Such notices, when inserted in the gazette, or in newspapers and literary works published in numbers, pay a duty of 1*s.* 6*d.* each for each time of insertion.

ADULA'RIA. A resplendent crystallised felspar, of a pearly lustre. The finest specimens came from Adula, at the summit of St. Gothard.

ADU'LT. (Lat. adultus, *grown up.*) In its general sense it means any thing grown up, or arrived at maturity. It is that period of human life that extends from youth to old age.

ADU'LTERY. (Lat. adulterium, a word of very uncertain derivation.) The sin of incontinence committed by a married person: adultery between two married persons is termed *double* by some jurists. By the law of Moses, adultery was punished by death, Lev. xx. 10., Deut. xxii. 22.; and passages in Proverbs (c. vi.) and Ezekiel (xvi. 38. 40.) prove that the law was observed in this respect down to the overthrow of the Jewish monarchy, as we know it to have been in the time of our Saviour. The mode of punishment was by stoning; but it is observable that this mode is not ordained in Deuteronomy, as it is for various other offences. The test or ordeal of adultery is detailed in Numbers v. 11—31. Under the Grecian and Roman republics adultery was variously treated; but the celebrated Lex Julia de Adulterio, under Augustus, punished it with banishment (deportatio vel relegatio), Tacit. lib. ii. Annal. It was not until the reign of Constantine, when some tincture of Judaism had been introduced into the state along with the establishment of Christianity, that the punishment of death was formally enacted for it. This penalty was again mitigated under Leo and Mareian; and by the laws of Justinian the adulterer was punishable with death, the adultress with flagellation, imprisonment, &c. But about the same period, the gradual increase of episcopal authority in civil cases seems to have drawn crimes of incontinence almost wholly within the cognizance of the ecclesiastical courts; and the canons contain a variety of directions on the subject of adultery. On the other hand, the jurisprudence of the Northern nations, which visited this as well as other crimes of freemen with very little severity, as mere offences against individuals, reduced the penalty in most of the Western kingdoms to a mere pecuniary one, sometimes attended with public disgrace or corporal punishment. The customs of the several French provinces contain a great variety of penalties and fines; at Castelnaudari, in the fourteenth century, the fine for adultery was fixed at "five sous only!" Such penalties, of course, fell rapidly into disuse; and in the sixteenth century we find it observed by a French civilian (quoted by Thuanus), that "it was never heard that any body had been punished for adultery in France." This observation is quoted by the historian when relating an event which created great sensation at the time, namely, the capital punishment at Orleans of two offenders by St. Cyr, the governor, a rigid Calvinist. The protestants of that sect, in France as well as in Scotland and England, made it their endeavour to introduce primitive severity of manners by severity of punishment. De Thou, the father, appears also to have made some efforts toward putting in force the laws against adultery: but from the time of the religious wars, penal cognizance of adultery may be said to have nearly ceased in France, although, by various arrêts (1637, 1701, &c.), besides the civil consequences of an action of adultery by husband against wife, the latter might be condemned to seclusion in a house of correction for two years, or more. In Geneva, Strasbourg, and other places where the reformed religion prevailed, a temporary strictness of law was introduced about the same period, but with little permanent effect. In England, by the old common law, mutilation was the punishment of this as well as other offences; but under the Plantagenets it became matter of ecclesiastical cognizance (except so far as civil consequences were concerned), and visited

only by the spiritual censure of the church. "The rules of the canon law," says a recent writer, "have manifested an indulgence towards this offence which is chiefly to be accounted for by reference to the constrained celibacy of its early compilers." But in 1650 the puritans, under Cromwell, succeeded in obtaining an ordinance by which adultery, as well as simple fornication, was made felony, without benefit of clergy; an absurd decree, which was soon repealed. In 1694, and again in 1801, the subject of adultery and divorce was discussed at length in parliament, but without producing any enactment. (See Tebbs's Essay on the Scriptural Doctrines of Adultery and Divorce, and on the Criminal Character and Punishment of Adultery, 8vo. Lond. 1822.) For the civil consequences of Adultery, *see* MARRIAGE, LAW OF.

A'DVOCATE. (Lat. advocatus, *he who is called in to plead in a court of law the cause of another.*) The original pleaders of causes at Rome were the patricians, who defended gratuitously their clients; but even before the downfal of the republic, the class had degenerated into a profession, its members receiving rewards for their services, although still among the most honourable of employments. But from the original gratuitous character of advocates arose the peculiar custom by which, among ourselves, the fees of barristers are still regarded as honorary, and cannot be recovered at law. In the later ages of the empire the advocati appear to have formed a distinct class from the jurisconsulti, or chamber-counsel, and to have much declined in reputation. In France the avocats, or counsel, form a separate order, of which each member is attached to a particular local court. The lord advocate, in Scotland, is a public officer, who prosecutes crimes before the court of justiciary.

ADVOW'SON. (Lat. advocatio, *a calling.*) Properly, the relation in which a patron (advocatus) stands towards the living to which he presents, i. e. the patronage of a church. The earliest provision for divine worship, in England and in other countries, was derived from the offerings of the laity, which were distributed by the bishop of each diocese among his clergy, whom he sent from place to place to preach and administer the sacraments. By degrees he was enabled, by the bequests of the faithful, and the customary offering of tithes, to subdivide his diocese, or parochia, as it was originally called, into various districts, and to build churches and establish permanent ministers in each. At the same time it became a common practice among the nobles to build and endow churches for the benefit of themselves and their own dependants; in which case they were allowed to present to the benefice, subject to the licensing power of the bishop and the canons of the church. Advowsons, in legal phraseology are either appendant, where immemorially annexed to a manor; or in gross, where they form separate subjects of property. If the patron of a rectory fails to present within six months after the vacancy happens, the right falls to the bishop; and by similar neglect on his part, to the archbishop, and thence to the king. The presentation is by letter to the bishop; institution, by an instrument registered in the bishop's court; and induction, which completes the incumbent's title, is performed by the archdeacon.

A'DYTUM. (Gr. ἄδυτον, *a recess.*) In Architecture, the secret dark chamber in a temple, to which none but the priests had access. It was from this part that the oracles were delivered. Seneca, in his tragedy of Thyestes, says,

> "Hinc orantibus
> Responsa dantur certa, dum ingenti sono
> Laxantur Adyto fata."

Among the Egyptians, the Secos was the same thing of which Strabo has given a description. The only well preserved adytum of the ancients is in the little temple at Pompeii. It is raised some steps above the level of the temple itself, and is without light.

Æ'DES. (Lat.) In architecture. A small temple consecrated to a god which was not afterwards dedicated by the augurs, from which circumstance, according to Varro, it was different from the templum. This distinction among the Romans in the early ages was afterwards lost, and the words were used indiscriminately.

ÆDI'CULA. (Lat.) A diminutive of the preceding.

Æ'DILE. The title of certain Roman magistrates, so called from their care of buildings (ædes). They were divided into two classes, distinguished by the epithets plebeian and curule. The two plebeian ædiles were, as their name imports, elected from the commonalty (plebs), and were subordinate to the tribunes of the commons, having jurisdiction over lesser causes, submitted to them by those magistrates. The two curule ædiles, so called from their privilege of giving judgment on ivory seats (sellæ curules), were originally elected from the patricians, but afterwards from both plebeians and patricians promiscuously. This magistracy was one of the most dignified in the state, and was allowed the use of the robe of honour (toga prætexta), and a certain precedence in the senate. The peculiar office of the ædiles was the superintendence of public works, markets, &c., in the city. They had also, particularly the curule ædiles, to exhibit public games, which they often did at a vast expense, in order to court popularity. Julius Cæsar added two other plebeian ædiles, called cereal, to inspect the public stores of provisions.

ÆGICE'REÆ. (Gr. αἲξ, *goat*, κερας, *horn.*) A division of myrsinaceous plants, the type of which is the genus ægiceras. It is distinguished by the absence of albumen; the species grow in maritime swamps in tropical countries, and have the embryo germinating within the pericarp, after the manner of mangroves.

Æ'GIS. (Gr. αἲξ, *a goat.*) The mythological shield of Jupiter, which was covered with the skin of the goat Amalthæa, and given by him to Minerva, who, by fixing on it the head of Medusa, gave it the power of petrifying all persons who looked at it. The word is also used sometimes for the breast-piece of a god.

Æ'GYLOPS. (Gr. αἲξ, *a goat*, and ὤψ, *an eye.*) A sore in the inner angle of the eye, frequently terminating in fistula lachrymalis. Goats were supposed to be very subject to an analogous affection. — Also the name of a kind of grass.

Æ'NEID. The epic poem of Virgil, relating the wanderings of Æneas after the capture of Troy, and his settlement in Italy.

Æ'OLIPILE. (Lat. Æolus, *the god of the winds*, and pila, *a ball.*) An hydraulic instrument, contrived for the purpose of exhibiting the convertibility of water into steam. It consists of a hollow ball of metal, having a slender neck or pipe, with a very small orifice inserted into it. The ball, having been filled with water, is placed over the fire; and the heat gradually converts the water into vapour, which rushes out of the pipe with great violence till the whole is discharged. The experiment is not unattended by danger; for should the small orifice by any accident be stopped, the steam would burst the ball. The æolipile was known to the ancients, being mentioned by Vitruvius. Descartes and others have used it to account for the natural cause and production of the wind; hence its name, Æolipile, that is, pila Æoli, the ball of Æolus, the god of the winds. The æolipile is sometimes filed with alcohol, and the jet of its vapour being inflamed, it serves the purpose of a blowpipe.

Æ'OLUS. The god of the winds, who was fabled by the early poets to have his seat in the floating island of Æolia; but the Latin and later Greek poets placed him in the Lipari isles. Here the winds were pent up in vast caves, it being the duty of Æolus to let them loose, and to restrain their violence at the pleasure of Jupiter. Virgil has described the power and functions of Æolus, in one of the finest passages of the Æneid: —

> —— "Hic vasto rex Æolus antro,
> Luctantes ventos tempestatesque sonoras
> Imperio premit, ac vinclis et carcere frænat.
> Illi indignantes magno cum murmure montis
> Circum claustra fremunt. Celsâ sedet Æolus arce
> Sceptra tenens, mollitque animos, et temperat iras:
> Ni faciat, maria ac terras cœlumque profundum
> Quippe ferant rapidi secum, verrantque per auras."
> *Æneid*, I. l. 52.

ÆOLUS' HARP, or ÆOLIAN HARP. A well-known instrument, which produces a pleasing combination of sounds, by the action of the wind. Its construction is very simple, consisting of merely a number of catgut or wire strings, stretched in parallel lines over a box of thin deal, with sounding holes cut in the top. The strings being tuned in unison, the effect is produced by placing the instrument in a current of air. The invention of the Æolian harp is generally given to Kircher, by whom it was first described.

Æ'ON. *See* GNOSTICS.

Æ'RA, or ERA. (A word of doubtful derivation.) In Chronology, the term æra, as now understood, is the period that has elapsed from some fixed point of time, or epoch, called the commencement of the æra. — Thus the Christian æra began at the birth of Christ, the Mohammedan æra at the flight of Mohammed from Mecca to Medina, the æra of Diocletian at the coronation of that emperor, &c.; and the period of the occurrence of any event is ascertained by reckoning from one or other of these epochs. When, for example, it is said that Queen Victoria ascended the throne of Great Britain in 1837, it means that this event took place in the 1837th year of the Christian æra, or of that æra which began with the birth of Christ. It is plain from the above statement that the period of time selected for an æra, or point whence to begin the computation of time, is necessarily arbitrary; and different nations have adopted different periods coincident with some important event in their civil or religious history. Some have adopted the year of the creation of the world, and this, were its date well ascertained, would be one of the best that could be selected. But the sacred writings are not explicit on this point, and there are great discre-

pancies in the estimates, as to the period of its occurrence. The Greeks used to reckon by the æra of the Olympiad (*see* the word), which began at the summer solstice, anno 776, B. C. The Romans reckoned from the building of the city, generally held to be the 24th of April, B.C. 753. The Julian æra dates from the reformation of the calendar by Julius Cæsar, B. C. 45. All Christian nations now adopt for their æra the birth of Christ, which took place on the 1st of January, in the middle of the 4th year of the 194th Olympiad, and the 753d year of the building of Rome. The æra of most Mohammedan nations is that of the Hegira, or flight of Mohammed to Medina, corresponding with the 16th July, A. D. 622. The æra of Sulwanah, in common use in a great part of India, corresponds to A. D. 78. The æra of Yezdegird, used in Persia, began 16th June, A. D. 632.

Subjoined are the names of some of the principal æras, with the year of the Christian æra in which they began, and the abbreviations by which they are commonly distinguished.

Æras.	Commenced	Abbreviations
Year of the World (Constantinopolitan account) -	B. C. 5,509	A.M. Const.
— (Alexandrian account)	— 5,492	A.M. Alex.
— (Jewish account) -	— 3,760	A.M.
Æra of Nabonassar - - -	— 747	Ær. Nab.
Olympiads - - -	— 776	Olymp.
Year of Rome - - -	— 753	A. U. C.
Julian Æra - - -	— 45	Jul. Ær.
Christian Æra - - -	— —	A. D.
Æra of Sulwanah - -	A. D. 78	Saca.
Æra of Dioclesian - - -	— 284	Ær. Dioc.
The Hegira - - -	— 622	A. H.
Æra of Yezdegird - - -	— 632	A. Pers.

It is easy to deduce from this the year of the Christian æra corresponding with that of any greater æra. (*See further* Chronology of History by Sir H. Nicholas, p. 22, &c.)

ÆRA'RIAN. The term applied to a Roman citizen who had been degraded to the lowest rank compatible with personal freedom. He, however, still paid taxes, but enjoyed no privileges, and could not serve in the army, or, consequently, participate in the distribution of land granted to such classes as did.

ÆRA'RIUM. (Lat.) The public treasury of the Roman people, the care of which was vested in the quæstors. After the fall of the republic the ærarium was kept distinct from the treasury of the emperor, which was called fiscus. The ærarium sanctius, or more sacred treasury, was appointed to provide for cases of extreme emergency, and might not be opened on other occasions.

AE'RIAL. (Gr. ἀηρ, *air.*) In Painting, a term applied to the diminishing intensity of colour on objects receding from the eye. Aerial perspective is the relative apparent recession of objects from the foreground, owing to the quantity of air interposed between them and the spectator, and must accompany the recession of the perspective lines.

AERIAL ACID, *Carbonic acid.*

A'ERO-DYNA'MICS. (Gr. ἀηρ, and δυναμις, *power.*) The science which treats of the motion of the air, and of the mechanical effects of air in motion. This is an experimental science, and there are two ways in which it may be investigated. The first is, by ascertaining the effects which air, moving with a certain velocity, that is, wind, produces on a body against which it strikes; and the second, by ascertaining the resistance which air at rest offers to a solid body rapidly passing through it. The problem is exactly the same, whether the body is considered as moving against the air at rest, or the air is supposed to move against the body with the same velocity.

Conceive a body to be moved forward in a straight line, displacing successively the particles of air opposed to it; the effect which it produces is proportional to the number of particles against which it strikes, and to the quantity of motion communicated to each. Suppose now the velocity of the body to be doubled, the motion communicated to each particle of air displaced will be twice as great as before, and twice as many particles will receive the impulsion in the same time. Hence we infer that the effect will be four times as great, or that the effect is proportional to the square of the velocity. This result of theory agrees tolerably well with experiments made to determine the resistance of the air when the velocity is not very great, or not exceeding eight or nine hundred feet in a second. When the velocity is much greater than this, the effect is modified by circumstances which require further explanation.

When a solid body is moved out of its position, the space which it occupied is not filled with air instantaneously, but only after a sensible, though very short time. Theory, confirmed to a certain degree by experience, shows that air, under the ordinary atmospheric pressure, rushes into a vacuum with a velocity of between 1300 and 1400 feet in a second of time. But this velocity is very speedily checked; for the instant that any portion of air is admitted, or the vacuum ceases to be perfect, that portion resists the entrance of more with a force proportional to its density. Suppose, for example, the air in a receiver to be reduced to one-fourth of its natural density; the effort of the exterior air to enter the receiver will be reduced to three-fourths of its amount when the receiver was perfectly exhausted; and consequently the velocity, which is proportional to the square root of the effort or the resistance, will be reduced in the proportion of 1 to $\sqrt{\frac{3}{4}}$; or of 100 to 87, very nearly. In this manner, as the air continues to enter, the velocity will rapidly diminish.

Now, conceive a body, for example a cannon ball, to be moving rapidly through the air, but with a less velocity than 1300 feet per second. The air in front of the ball will remain in its natural state, because the condensation produced every instant by the contact of the ball, is propagated more quickly than the ball moves (the velocity of the propagation being equal to that with which air enters a vacuum). But there is a certain space behind the ball in which the air has not entirely recovered its equilibrium, but remains more or less rarefied, the ball having passed through it in less time than is required for the surrounding air entirely to fill it. In addition, therefore, to the resistance which arises from the communication of motion to the particles of air, there is a pressure on the front part of the ball, not counterbalanced from behind; in consequence of which, we may infer that the resistance will increase in a quicker ratio than the square of the velocity. This deduction is also confirmed by experience; for it is found that the resistance continues to increase with the square of the velocity only while the velocity is less than 900 or 1000 feet per second. Above this velocity the ratio begins to fail; and when the velocity exceeds that with which air enters a vacuum, the ratio is entirely altered. At a velocity of 1600 feet per second, the resistance is found to be more than twice that given by theory. The reason is obvious: the density of the air before the body is increased by the rapid motion, and, consequently, presses more on the fore part of the body than air in its natural state.

The resistance of the air on the motion of projectiles, was first examined experimentally by M. Robins (see his Principles of Gunnery), and afterwards by Dr. Hutton, of Woolwich (see his Tracts, vol. 3., and Math. Dictionary), whose experiments were carried on to a greater extent, and varied in a greater number of ways. The following are the principal results deduced by Dr. Hutton, from his experiments on bodies moving very slowly, not more than 20 feet per second:—

1st, " That the resistance is nearly in the same proportion as the surfaces; a small increase only taking place in the greater surfaces and for the greater velocities.

2d. " The resistance of the air to the same surface with different velocities, is, in these slow motions, nearly as the square of the velocity, but gradually increases more and more above that proportion as the velocity increases.

3d. " The round ends and sharp ends of solids suffer less resistance than the flat or plane ends of the same diameter; but the sharper end has not always the less resistance.

4th. " When the hinder parts of bodies are of different forms the resistances are different, though the fore parts be exactly alike and equal; owing, probably, to the different pressures of the air on the hinder parts."

Dr. Hutton likewise found, that although in slow motions the experimental resistance is nearly equal to that computed by theory, yet, " as the velocity increases, the experimental resistance gradually exceeds the other more and more, till, at the velocity of 1300 feet, the former becomes double the latter; after which, the difference increases a little further, till, at the velocity of 1600 or 1700 feet, when that excess is the greatest, and is rather less than 2 and 1-10th; and, after this the difference decreases gradually, as the velocity increases; and at the velocity of 2000 the former resistance again becomes just double the latter." For further information on this subject, *see* PROJECTILES, WIND.

AERO'GRAPHY. (Gr. ἀηρ, *the air*, and γραφω, *I write.*) The description of the atmosphere, its nature, properties, limits, &c. (*See* ATMOSPHERE.)

A'EROLI'TE. (Gr. ἀηρ, *the air*, and λιθος, *a stone*, *stones of the air.*) The origin of these singular substances is involved in the greatest mystery. Some philosophers, among whom is Laplace, the illustrious author of the " Mécanique Céleste," suppose them to be ejected from volcanos in the moon; others suppose them to exist ready formed in the celestial space, circulating about the sun with great velocity, like planets, and falling to the earth when its attraction upon them preponderates; others regard them as fragments of rocks which have been propelled by terrestrial volcanos to an immense height above the limits of the atmosphere, and again descend after having described several revolutions about the earth.

On examining and comparing the aerolites, the first circumstance that strikes us as remarkable is their perfect resemblance to one another in their composition, whatever be their form or magnitude. Their exterior surface is black, as if they had been exposed to the heat of a furnace. Internally they are of a greyish white. Their specific gravity, which is very nearly the same in all of them, varies between 3·352 and 4·281, that of water being taken as unit. Their chemical analysis gives, in almost every instance, the same substances, combined in very nearly the same proportions. They are composed of silex, magnesia, sulphur, iron in the metallic state, nickel, and some traces of chrome. Sometimes they are formed of a spongy or cellular texture, the cavities being filled with a stony substance. They have occasionally been found without nickel. These common and constant characters indicate with the greatest evidence a common origin, and their composition renders it probable that it is to be sought elsewhere than in the earth. Iron is scarcely ever found (if, indeed, it is found at all) in the metallic state in terrestrial substances; volcanic matter contains it only in the state of an oxide. Nickel is also very rare, and never found on the surface of the earth; and chrome is still more rare.

The fall of the aerolites is accompanied by meteors, named bolides, or fire balls. They are, in fact, inflamed globes, which appear instantaneously in the atmosphere, and move through it with extreme velocity, sometimes even equal to that of the earth in its orbit. The direction of their motion is inclined to the horizon. After shining with great splendour for a few instants, they explode with a loud noise, and often at a great height, 30 or 40 miles above the surface of the earth. They do not affect any peculiar direction with respect to the motion of the earth, but seem to come from all points of the heavens indifferently.

With regard to the hypothesis which explains the origin of the aerolites, by supposing them to be propelled from lunar volcanos, it may be remarked, that no improbable amount of mechanical force would be required. As there is no atmosphere about the moon sufficient to offer a sensible resistance to the motion of a solid body, the force required is only that which would be sufficient to overcome the moon's attraction, which is found by calculation to be about four times the force with which a ball is expelled from a cannon with the ordinary charge of gunpowder. A body projected with a velocity of about 7770 feet per second from the lunar surface, would be detached from the moon, and be brought to the earth by terrestrial gravitation. But philosophers seem now disposed to assign the aerolites a different origin. From the phenomena of comets there is reason to believe that portions of chaotic matter are dispersed in the planetary regions in detached parcels, or perhaps in considerable masses. The earth in describing its orbit may meet with such masses directly, or pass so near to them as to carry them along with it by virtue of its attraction. On plunging into the atmosphere with the velocity due to the height from which they have fallen, which is that of their distance from the earth, when they begin to obey its attractive force, an enormous heat is evolved by the rapid and powerful condensation of the air; the matter becomes inflamed, and the aerolite is the product of the combustion. In the same manner shooting stars, and other igneous meteors of frequent occurrence, are explained. The chaotic matter may be entirely consumed long before it reaches the earth, in which case the appearance of the bolide will not be accompanied with the fall of an aerolite. (*See* METEOR.)

Philosophers were long inclined to disbelieve in the fall of stones through the atmosphere. The fact, however, is now placed beyond all doubt by numerous and well authenticated instances which have occurred in almost all quarters of the world, even within the present century. A very complete list of the falls of stony or earthy matters, with the times and places of their occurrence, and the appearances they exhibited, is published in the Edinburgh Philosophical Journal, from a work by Chladni, in German, in which the whole subject of meteoric stones is ably and fully treated.

AERO'LOGY. (Gr. ἀηρ, *air*, and λογος, *a discourse.*) The doctrine of air, generally applied to medical discussions respecting its salubrity.

AERO'METER. (Gr. ἀηρ, *air*, and μετρον, *a measure.*) An instrument for making the necessary corrections in pneumatic experiments, to ascertain the mean bulk of gases

A'ERONAUT. (Gr. ἀηρ, *air*, and ναυτης, *a sailor.*) One who travels in a balloon.

A'ERONAUTICS. (Gr. ἀηρ, *air*, and ναυτικος, *of or belonging to ships.*) The art of sailing in and navigating the air. From the earliest ages men have been actuated by a wish to be able to participate in the advantages conferred on the lower animals, and having succeeded in navigating the sea, to be able also to mount, like the eagle, into the air. The story of Dædalus, who is said to have escaped from Crete to Sardinia, by means of wings contrived to assist him, is known to every classical reader, and proves, at least, the antiquity of attempts of this sort. But the fate of his companion Icarus, seems to have had a greater influence in deterring from similar attempts, than the reported success of the artificial dove, constructed by the geometer Archytas, which is said to have wafted itself through the air by means of internal springs. During the middle ages, when the nature of the atmosphere and the sound principles of mechanical philosophy were alike unknown, many rude and necessarily unsuccessful attempts were made to realize this difficult problem. But it was not till the composition of the atmosphere had begun to be ascertained, and that means had been devised of filling vessels with heated air, or other air lighter than atmospheric air, and consequently capable of floating on it, that there came to be a rational prospect of succeeding in the "audacious attempt" of riding in the air. At length, in 1782, the brothers Montgolfier succeeded in constructing a balloon; and on the 21st of October, 1783, Pilatre de Rozier, a young naturalist, and the Marquis d'Arlandes, ascended from Paris to an elevation of more than 3000 feet, and alighted safely from their "ærial tour," after describing a circuit of about six miles. Since that time ascents in balloons have become comparatively common. (*See* BALLOON, and the article Æronautics in the *Encyclopædia Britannica*, 7th edit.)

A'EROPHY'TES. (Gr. ἀηρ, *air*, and φυτον, *a plant.*) Plants which live exclusively in air; in distinction to hydrophytes, which live as constantly under water.

A'EROSTA'TICS. A term sometimes used to denote the science which treats of the equilibrium of elastic fluids. (*See* PNEUMATICS.)

A'EROSTA'TION. (Gr. ἀηρ, *air*, and σταω, *I stand.*) Means simply the weighing of the air; but it has been employed, though incorrectly, in the science of æronautics, or as the art of raising substances into the atmosphere by the buoyancy of heated air, or of very light gases enclosed in a bag of a spheroidical form; hence called a balloon, which see.

ÆSCULA'CEÆ. A natural order of exogenous plants, consisting of the horse-chesnut, Æsculus hippocastanum, and other nearly allied species. They are all either shrubs or trees inhabiting temperate regions, and nearly correspond with Æsculus hippocastanum in the structure of the flowers. Their seeds contain starch, and their bark is in some cases bitter and astringent.

ÆSCULA'PIUS, or ASCLE'PIUS, as he was called by the Greeks, was a mythological deity of the Greeks and Romans, according to whom he was the son of Apollo and the nymph Coronis. He was worshipped as the god of surgery and medicine; but the older poets, as Homer and Pindar, mention him only as a hero well skilled in these arts. The chief seat of his worship was Epidaurus, where he was represented as an old man, with a mantle and staff, round which a serpent is twined.

AESTHE'TICS. (Gr. αισθητικος, *having the power of perception by means of the senses.*) In the fine arts, that science which derives the first principles in all the arts from the effect which certain combinations have on the mind, as connected with nature and right reason. It is intimately related to sentiment, which links together with feeling the different parts of a composition. All art, considered as imitation of nature, is affected by the same relations, and subject to the same laws, which govern nature herself; and if it could be satisfactorily proved that those rules of art which are the result of reason were necessarily connected with sensation, it might be possible to lay down laws from which the principles of art might be satisfactorily deduced. As an illustration of this, in architecture we might take the rule which forbids the position of a heavy mass over a void, when it may appear to have no ostensible and immediate support; in which case it might almost seem possible to connect the unpleasant sensation produced on the mind with the rules of reason; but in architecture it is difficult to conceive how this could be effected, without recurring to primitive types, and on them pursuing the reasoning into all its details. In the other arts it might not, perhaps, be so difficult to establish a set of rules, inasmuch as the immediate type is nature herself. The Germans have written much on the doctrine of aesthetics; it would, however, seem, that the fundamental principles of taste in all the arts depend on the laws of gravitation, and their balances, equipoise and counterpoise; the necessary resultants whereof are symmetry and proportion. We shall here lay before the reader a synoptical view of this science: to do more would occupy a space much more than would fill this volume; for, under other names, it is a subject which has much engaged the attention of writers on the philosophy of the arts. The essence of the polite arts lies in expression, or the power of representation, whether by lines, words, or other media, and that expression arises from an exercise of the inventive faculty; their end being the production of pleasurable sensations; thus being distinguished from the end sought in the sciences, whose object is to produce instruction and utility. And here we are to observe, that though

in some of the polite arts, such as eloquence, poetry, and architecture, the end may be to instruct, or to be applicable to useful objects, yet that the expression on which they depend brings them within the laws which govern the fine arts. The object of the fine arts is beauty, which is the result of all the various perfections whereof an object is susceptible: such perfections arising, first, from the agreeable proportions between the several parts of the same object; and, second, from the proportions between each part and the object taken as a whole. Genius, or the power to invent, is the faculty of the mind by which it is enabled to conceive and express its conceptions, and is, consequently, necessary to the production of beauty; while taste, or the natural sensation of a mind refined by art, is the guide to genius in discerning, embracing, and producing beauty. Hence a general theory of the polite arts must be founded on a knowledge of all that they contain truly agreeable and beautiful. They are usually said to include eloquence, poetry, music, painting, sculpture, and architecture. By some, dancing has been added to the number; but, for reasons too long to be advanced here, we cannot include it. The rules have been reduced to six, for the guidance of the artist, who is to recollect that, in every art, what is low, indecent, or disagreeable, must be banished from his work. First, he must consult his genius —

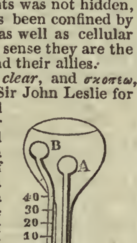
Quid ferre recusent,
Quid valeant humeri;

second, he must constantly labour to improve his taste; third, nature must be the constant object of his imitation; fourth, he must attain perspicuity, so that his end may be free from ambiguity and obscurity; fifth, he must elevate his sentiments above all common or commonplace objects, by which an expansion of the imagination supervenes and stamps his works with an air of sublimity, which, sixthly, results from a concurrent observance of the fourth and fifth rules. We close this with the following observation of Menzel: "Art is not the result of understanding alone; the inspiration of the artist has been, and ever must be, the source of that which gives æsthetic value to his productions."

ÆSTHNA. A name applied by Fabricius to a genus of dragon-flies, characterised by having the wings expanded when at rest, and the divisions of the lip equal.

AE'THEO'GAMOUS. (Gr. ἀηθης, *unusual*, and γαμος, *marriage.*) A name contrived to express more clearly the nature of what are called cryptogamic plants; it being the opinion of the author of the name that the mode of propagation among such plants was not hidden, but only of an unusual nature. It has been confined by De Candolle to such as have vessels, as well as cellular tissue, in their organisation. In this sense they are the same as ferns, lycopodiums, mosses, and their allies.

Æ'THRIOSCO'PE. (Gr. αιθριος, *clear*, and σκοπεω, *I view.*) An instrument invented by Sir John Leslie for measuring the relative degrees of cold produced by the pulsations from a clear sky. It consists merely of a differential thermometer, adapted to the cavity of a spehroidal cup of metal, the interior of which is highly polished, in such a manner that one of the balls occupies a focus of the spheroid; while the orifice of the cup is formed by a plane passing through the other focus, perpendicular to the axis. A lid of the same metal is fitted to the mouth of the cup, and only removed when an observation is to be made. Suppose the cup exposed to a clear sky: the cold pulses darted from the upper regions of the atmosphere, which enter the orifice of the cup, are reflected from polished surface upon the ball A in the focus, while the ball B, lodged at the side of the cup in its widest part, is nearly screened from them, or receives only the small number which fall obliquely upon it. The two balls are thus exposed to different degrees of cold, the effect of which is immediately apparent, by the rise of the liquor in the stem of the thermometer, in consequence of the contraction of the air in the ball A. The effect may be augmented by covering the ball B, which is out of the focus, with a coat of gold or silver leaf. It is evident that the instrument is equally adapted to measure the effects of the radiation of heat, which will be manifested by the descent of the liquor in the stem. When applied to this purpose, however, the metallic cup becomes unnecessary; the hot pulses being mostly thrown back from the bright surface of the gilt ball, while they produce their full effect on the naked or sentient one. The æthrioscope is thus converted into a pyroscope. (See *Encyc. Brit.* article Climate.)



ÆSTIVA'TION. (Lat. æstivus, *of or belonging to summer.*) A figurative expression, employed to indicate the manner in which the parts of a flower are arranged before they unfold. Botanists speak of the æstivation of the calyx, of the corolla, of the stamens.

Æ'STUARY. (Lat. *Æstuarium.*) In Geography, was anciently understood to be any creek, frith, or arm of the sea, in which the tide ebbs and flows (Plin. Epist. lib. 9. ep. 33.); but it is now applied to designate those parts of the channels of certain rivers contiguous to the sea in which the water is either salt or brackish, and in which the ebb and flow of the sea is distinctly perceptible, and there is little or no current.

Æ'THER. *See* ETHER.

A'ETIA'IOI. (Gr. αετος, *an eagle.*) In Architecture, the name given by the Greek architects to the slabs forming the face of the tympanum of a pediment. This word occurs in the Athenian inscription now in the British Museum, brought to England by Dr. Chandler, and relating to the survey of some temple at Athens.

ÆTIO'LOGY. (Gr. αιτια, *a cause*, and λογος, *discourse.*) The doctrine of the causes of disease.

AETO'MA, or A'ETOS. (Gr. αετος, *an eagle.*) In Architecture, the name given by the Greek architects to the tympanum of a pediment. It seems to have derived its name from the custom of decorating the apex or ridge of the roof with figures of eagles, and that the name thence first given to the ridge was afterwards transferred to the pediment itself.

AFFECTA'TION. (Lat. affectare, *to seek for overmuch.*) In the fine arts, an artificial show arising from the want of simplicity either in colouring, drawing, or action. Also, the overcharging any part of a composition with an artificial or deceitful appearance.

AFFE'CTED, or ADFECTED. A term of algebra. When applied to an equation, it signifies that two or more several powers of the unknown quantity enter into the equation: thus, $x^3 - ax^2 + bx - c = o$, in which there are three different powers of x, namely, x^3, x^2, and x. When the term is applied to a quantity, it implies that the quantity has a coefficient, or a proper sign: thus, in the quantity $+ 2x$, x is said to be affected with the coefficient 2, and with the sign $+$. Dr. Hutton thinks the term affected was introduced into algebra by Vieta.

AFFE'TTO, or AFFETTUOSO. (It. affetto, *affection.*) In Music, a term prefixed to a movement, showing that it is to be performed in a smooth, tender and affecting manner, and, therefore, rather inclining to slowness than the reverse.

AFFIDA'VIT. (Lat. affido, *I confirm by oath.*) In Law, is an oath in writing, sworn before some person who has authority to administer it.

AFFILIA'TION. (Lat. ad, *to*, filius, *a son.*) In Law, the assignment of a child to a parent by legal authority; as where the father of a bastard child is designated on the testimony of the woman, and the expenses of maintaining it cast upon him. By the Poor Law Amendment Act, s. 72., this can now only be done, after sufficient notice to the party intended to be charged, by an order of the court of quarter sessions, on the testimony of the woman, corroborated as to some material fact by other evidence. (See BASTARD.) *Affiliated societies*, in politics, are local societies, depending on a central society with which they correspond, and from which they receive directions. Such were the provincial jacobin clubs, founded on the model of the jacobin club of Paris. Such, also, were the corresponding societies in England, for the suppression of which the statute 39 G. 3. c. 79. was chiefly passed.

AFFI'NITY. (Lat. affinis, *related.*) A relation of animals to one another, in the similarity of a greater proportion of their organisation: thus, a porpoise is said to have an affinity to man, because of its resemblance to him in the respiratory, circulating, and generative systems, in the brain, eye, and ear, &c.; while it is said to have an analogy to a fish, because the resemblance is confined to external form. In short, affinity is that degree of relationship by which, in forming a concatenated series of animals, we pass from one to another by the closest gradations.

AFFINITY, CHEMICAL. The attractive force by which dissimilar substances combine with each other to produce chemical compounds. All natural and artificial substances are either simple or compound. The metals, for instance, are simple substances, — no one of them having been as yet decomposed: water is a compound; it may be resolved into oxygen and hydrogen gases, which are therefore called its component parts. To enable substances to exert their mutual affinities, or to act chemically upon each other, the opposing powers of matter must be overcome, and they must be placed under circumstances favourable to the exertion of their mutual chemical attractions. Two solid bodies seldom combine, in consequence of their imperfect contact, and the immobility of their particles; hence the old axiom, *corpora non agunt, nisi fluida.* But to this there are exceptions: ice and salt, for instance, run down into liquid brine; oxalic acid and dry lime unite; and when sulphur and chlorate of potash are rubbed together, they act violently on each other. Even when one or both substances are fluid, heat is often requisite to diminish cohesion, and promote affinity: thus, mercury and iron combine with melted sulphur; and oxygen and hydro-

gen, and oxygen and carbon, require heat to effect their union. In some cases the action of the solar rays excites and increases affinity, as in the combination of hydrogen and chlorine.

The investigation of the relative proportions in which bodies combine, forms the basis of the atomic theory, or doctrine of chemical equivalents.

Many substances seem to unite in all proportions; but these are not strict cases of chemical combination: thus, water and sulphuric acid, and alcohol and ether, mix together in any quantities. Others unite indefinitely, up to a certain point: water, for instance, dissolves salt, in variable quantity, till the solution is saturated: we thus find that a given quantity of water is only able to retain a certain weight of salt in permanent solution. In these cases of indefinite combination, the affinities of the combining substances are usually feeble; but where their affinities or attractive powers are energetic, there is a remarkable tendency to combine in certain proportions only. Thus, sulphuric acid and lime unite in the proportions of 40 of the acid to 28 of the lime, and in no other or intermediate quantity: in such cases the acid and the base are said to neutralise each other; and such compounds are often called neutral salts, that is, salts in which the leading characters of the component parts are no longer perceptible, which are neither acid nor alkaline. When such bodies combine in more than one proportion, which is often the case, the second, third, &c. proportions are simple multiples of the first: thus, 16 parts of sulphur combine respectively with 8, 16, and 24 of oxygen; in these compounds the relative proportions being as 1, 2, and 3. Again, 14 parts of nitrogen combine with 8, 16, 24, 32, and 40 of oxygen, forming five distinct compounds, in which the relative proportions of the oxygen are as 1, 2, 3, 4, and 5.

Where the combining substances are either naturally gaseous, or where they may be hypothetically so considered, it is obvious that, as their weights bear these simple relations to each other, their bulks or volumes will do so likewise: thus, in the case of the compounds just noticed, 1 volume of nitrogen will combine respectively with ½, 1, 1½, 2, and 2½ volumes of oxygen; or, what amounts to the same thing, 2 volumes of nitrogen will combine with 1, 2, 3, 4, and 5 volumes of oxygen.

As bodies thus combine with each other in definite proportions, it is obvious, that if we select any one substance as unity, or $=1$, all other substances may be represented by numbers equal to the weights in which they respectively combine with each other, and with the unit. Upon this principle of numeric representation, hydrogen, which is the lightest known substance, is assumed as unity; the compound of hydrogen with oxygen is water, in which 1 part by weight of hydrogen is combined with 8 of oxygen, to form 9 of water: hence, in a table of atomic numbers, definite proportionals, or chemical equivalents, (for all these terms have been applied to such numbers,) we have —

Hydrogen	represented by	1
Oxygen	. .	8
Water	. .	9

And in the above series of nitric compounds we have, in the first of them, 14 of nitrogen combined with 8 of oxygen; and, accordingly, calling 14 the equivalent of nitrogen, and 8 the equivalent of oxygen, we have the following equivalents of their compounds; and it may be presumed that these numbers represent the weights of the combining atoms of those bodies: —

Atoms *of nitrogen.*		*of oxygen.*	*Equivalents, or combining weights,* *of nitrogen.*		*of oxygen.*		*Equivalents of the compounds.*
1	+	1	14	+	8	=	22 nitrous oxide.
1	+	2	14	+	16	=	30 nitric oxide.
1	+	3	14	+	24	=	38 hyponitrous acid.
1	+	4	14	+	32	=	46 nitrous acid.
1	+	5	14	+	40	=	54 nitric acid.

This table also shows the nomenclature commonly applied to the compounds; the termination *ous* indicating the minimum of oxygen, the termination *ic* the maximum; the term oxide implying generally all those combinations of oxygen which are not sour, such being called acids. More frequently the relative proportions of oxygen in the oxides are designated by the first syllable of the Greek ordinal numerals: thus we have protoxides, deutoxides, tritoxides, &c.; and when the base is saturated with oxygen, the compound is termed a peroxide. When the same substance forms three or four acids, the term hypo is conveniently introduced with the termination *ous* or *ic*, as shown in the following table of the acids of sulphur: —

Atoms of *sulphur.*		*oxygen.*	*Equivalents of* *sulphur.*		*oxygen.*		*Equivalents of the acids.*
1	+	1	16	+	8	=	24 hyposulphurous.
1	+	2	16	+	16	=	32 sulphurous.
1	+	3	16	+	24	=	40 sulphuric.

There is also an acid of sulphur intermediate between sulphurous and sulphuric, composed of 1 atom of hyposulphurous acid and 1 of sulphurous acid; $(24+32=56)$ or of 2 atoms of sulphur and 3 of oxygen: this is appropriately called the hyposulphuric acid. The terms *sesqui* and *bi* are sometimes used to designate intermediate and double compounds of acids, or other bodies with bases: thus, we have three compounds of carbonic acid with ammonia, in which 1 proportional or atom of ammonia is respectively combined with 1, 1½, and 2 of carbonic acid, and these we call the carbonate, sesquicarbonate, and bicarbonate of ammonia. For a table of the equivalent numbers of the simple substances, *see* Equivalents.

Change of form and change of properties are the common consequences of chemical affinity. We observe, 1. Solids forming liquids (ice and salt). 2. Solids forming gases (explosion of gunpowder). 3. A solid and a liquid producing a solid (lime and water). 4. A solid and a liquid producing a liquid (all common cases of solution; as of salt and sugar in water). 5. Liquids producing solids (solution of carbonate of potassa mixed with muriate of lime). 6. Liquids producing gases (alcohol and nitric acid). 7. Gases producing solids (ammonia and muriatic acid). 8. Gases producing liquids (chlorine and olefiant gas).

The density of bodies is also materially affected by chemical combination; the density of a compound is very rarely the mean of its components, but generally increased: thus, almost all gaseous compounds occupy less bulk than their elementary gases in a separate state; there are, however, cases in which 1 volume of one gas, combined with 1 volume of another, produce exactly 2 volumes of a compound gas, the density of which is, of course, the mean of that of its components; and again, in the combinations of some of the metals with each other, and with sulphur, the density of the compound is below the mean of its elements. When certain liquids are mixed, great and immediate increase of density ensues, and much heat is evolved (sulphuric acid and water). Change of form and of density are often attended by remarkable changes in other qualities: thus, tasteless bodies produce active compounds (oil of vitriol is composed of oxygen, sulphur, and water), and active substances produce inert compounds (sulphuric acid and caustic potash produce the inert salt, sulphate of potash); so that it is utterly impossible, by any *à priori* reasoning, to determine what will be the consequence of chemical combination: useless elements produce useful compounds, and useless compounds yield useful elements.

Another important and curious consequence of chemical action is change of colour: the vegetable blues are generally reddened by acids, and rendered green by alcalis; the alcalis render many of the reds purple; and of the yellows, brown: chlorine destroys most colours; so does the joint action of light, air, and moisture (bleaching, &c.).

AFFI'RMATIVE. In Logic, denotes the quality of a proposition which asserts the agreement of the predicate with the subject.

AFFIRMATIVE QUANTITY. In Algebra, denotes a quantity to be added, in contradistinction to one to be taken away.

AFFIRMATIVE SIGN, or POSITIVE SIGN. The sign of addition, marked +, meaning plus, or more. Dr. Hutton observes, that the early writers on algebra used the word plus in Latin, or piu in Italian, for addition, and afterwards the initial *p* only as a contraction; like as they used minus or meno, or the initial *m* only, for subtraction; and thus their operations were denoted in Italy by Lucas de Burgo, Tartalea, and Cardan, while the signs + and — were employed much about the same time in Germany by Stifelius, Scheubelius, and others, to denote the same operations.

A'FFIX. In Grammar, a syllable attached to the end of a class of words, determining their meaning. Thus, a class of adverbs in English are determined by the affix *ly*; strongly, weakly, &c. Prefix is a syllable so attached at the beginning.

AFRA'NCESADOS. In Modern History, a denomination given in Spain to the party which attached itself to the cause of the French, or of the intrusive King Joseph, during the war of independence, 1808—1814.

AFT. *See* Abaft.

A'FTERMATH. In Agr. Grass which is mown, after the first crop of hay has been taken away, instead of being eaten off by stock.

A'GA. A title of dignity among the Turks and Persians, given to various officers: as, the aga of the janissaries, while that corps subsisted; the capi-aga, or chief eunuch of the seraglio, &c. It is also a common epithet of respect in addressing a distinguished person.

AGA'LMATOLI'TE. (Gr. ἀγαλμα, *image*, and λιθος, *a stone*.) The mineral which the Chinese carve into images.

AGA'MA. (Gr. ἀγαμαι, *I wonder at*.) The name of a lizard, employed by Cuvier to designate the

first section of the Iguanian sauria, or *Agamidæ;* which section is characterised by the absence of palatal teeth. The Agamoid lizards include several genera, which are numerous in species, and they are distributed over the warmer parts of America, Africa, Asia, and Australia. They have all the power of inflating the body, and of producing, but in a less degree than in the chamæleon, changes of colour, whence, probably, the origin of the name.

A'GAMOUS. (Gr. ἀ, *without*, and γαμος, *nuptials.*) A term substituted by some writers for cryptogamic, because such plants have in reality no organs analogous to sexes: it is, however, usually limited to such groups as confervæ, lichens, and fungi, because they have in reality nothing either analogous or similar to the sexes of more perfect plants; while, on the contrary, ferns and mosses, although they have not any real sexes, nevertheless are considered by some writers to possess parts of an analogous nature.

A'GAPÆ. (Gr. ἀγαπη, *love.*) Love feasts, in use among the primitive Christians. After the celebration of the communion, the oblations which had been made in the temple, consisting of meat and bread which the rich had brought from their houses, were consumed at a common feast. There is some dispute whether in the apostolic times this feast did not take place before the communion, in more exact accordance with the circumstances attending the institution of the sacrament. The agapæ or feasts in churches, were prohibited by the Council of Laodicea, A. D. 361, and the third of Carthage, A. D. 397.

A'GAPHITE. *See* TURQUOISE.

A'GARIC. (Agaria, *a kingdom in Sarmalia.*) A genus of fungi comprehending many hundred species, among which are, A. campestris, the common mushroom, and some others, which are delicate articles of food; A. muscarius and others that are dangerous poisons; many of the disgusting deliquescent fungi called toadstools; and numerous beautiful little ephemeral species, which appear to be harmless: A. olearius is remarkable for being phosphorescent. These plants uniformly grow in decaying animal or vegetable matter, among which their stem, or spawn, as it is commonly called, ramifies. After the spawn has arrived at the proper age, it ceases to branch, collects into parcels, and generates from those parcels the fructification, which forces its way into the light under the form of the agaric. The cap is the part where the spores or seeds for reproducing the species are generated; they are formed within the plates or gills that lie on the under side of the cap, and are little grey round bodies, which, when they are collected in great quantities upon a sheet of white paper, have the appearance of exceedingly fine dust. "Fairy rings" are caused by the underground stems of agarics which branch from a common centre, and only protrude their fructification at the circumference.

AGARIC MINERAL. A very soft mealy variety of carbonate of lime.

AGA'STRICS, AGASTRIA, AGASTRICA. (Gr. ἀ, *without*, γαστης, *a stomach; stomachless.*) A term which has been applied to certain animalcules, on the erroneous supposition that they were devoid of internal digestive cavities. (*See* POLYGASTRICS.) The term is still applied to a family of medusæ.

A'GATE. An aggregate of certain siliceous minerals, possessing hardness, and variety of colour and mixture, and admitting of a good polish. Chalcedony generally appears to be the base of agate; carnelian, jasper, amethyst, and other similar minerals, often enter into their composition.

A'GATHODÆ'MON. (Gr. ἀγαθος, *good*, and δαιμων.) A good spirit. (*See* DÆMON.)

AGA'VE. (Gr. ἀγαυος, *admirable.*) A genus of plants found in the temperate parts of America, resembling aloes in their mode of growth and general appearance, but differing in having an inferior ovary, and in their sensible properties. The best known species is Agave americana, called the American aloe, which has been naturalised on the coasts of the Mediterranean, where it assists, with Cactus opuntia, the palmetto, and date palms, to give a tropical air to European scenery. It is many years preparing the materials for its gigantic pyramid of flowers, and is so exhausted by the effort, that it quickly afterwards perishes. A sweet sap flows from its inward stem, and upon fermentation becomes an intoxicating beverage, yielding by distillation a powerful ardent spirit. Hemp of considerable strength is manufactured from its leaves. The genus agave is the type of one of the subdivisions of amaryllidaceous plants.

AGE. (Fr. *age.*) Means, generally, a definite period or length of time.

AGE. As applied to man, age may either mean the whole of his life, or a portion of it. It is usual to divide the whole period of human life into four parts or ages. The first, or infancy, extending to the fourteenth year; the next, or youth, from the fourteenth to about the twenty-fifth; manhood, from the twenty-fifth to the fiftieth or sixtieth; and the last, or old age, filling up the remainder. Ovid ingeniously compares these four ages to the four different seasons of the year. — (Metamorph. xv. ver. 200.) These divisions are, however, in a great degree arbitrary; and very frequently they have been extended to six, the first being divided into infancy and childhood, and the last into old age and extreme old age. Sometimes, also, the life of man is supposed to be divided into seven ages, the leading characteristics of which have been most admirably depicted by Shakespeare: —

> "His acts being seven ages. At first, the infant,
> Mewling and puking in the nurse's arms:
> And then, the whining schoolboy, with his satchel,
> And shining morning face, creeping like snail
> Unwillingly to school: And then the lover;
> Sighing like furnace, with a woeful ballad
> Made to his mistress' eyebrow: then a soldier,
> Full of strange oaths, and bearded like the pard,
> Jealous in honour, sudden and quick in quarrel,
> Seeking the bubble reputation
> Even in the cannon's mouth: and then, the justice;
> In fair round belly, with good capon lin'd,
> With eyes severe, and beard of formal cut,
> Full of wise saws and modern instances,
> And so he plays his part: The sixth age shifts
> Into the lean and slipper'd pantaloon;
> With spectacles on nose, and pouch on side;
> His youthful hose well sav'd, a world too wide
> For his shrunk shank; and his big manly voice,
> Turning again toward childish treble, pipes
> And whistles in his sound: Last scene of all,
> That ends this strange eventful history,
> Is second childishness, and mere oblivion;
> Sans teeth, sans eyes, sans taste, sans every thing."

For a scientific discussion of this subject, *see* MORTALITY.

AGE. In Law, is the period at which individuals are qualified to undertake certain duties and offices. By the common law of England, a man at fourteen is at the age of discretion, and may then appoint guardians, and marry with their consent: at twenty-one he is of full age, and may, consequently, exercise any civil privilege to which he may otherwise be entitled, that is, he may elect or be elected to parliament, be appointed a judge, alienate lands, &c. But no person can be admitted in England to deacon's orders till he be twenty-three years of age, nor to priest's till he be twenty-four. At twelve years a woman may marry, provided she have the consent of her parents or guardians; and at twenty-one she is her own mistress, and may dispose of herself and her estates.

Infants under seven years are held by the law of England to be incapable of committing felony. If persons above that age, and under fourteen, commit felony, they are *prima facie* entitled to an acquittal; but if it appear to the court and the jury that the accused was *doli capax*, or clearly understood the nature of the crime he was committing, they may proceed on the principle that *malitia supplet ætatem*, and subject the offender, as, in point of fact, has been repeatedly done, to the extremest penalty of the law. Persons above fourteen are treated in this respect as if they had arrived at full age. — (*Blackstone*, book iv. cap. 2.)

At Rome, the *consular age*, or the age at which a person became capable of holding the consular dignity, was fixed at forty-three, though in extraordinary cases this rule might be set aside. In France, at this moment, a man is not allowed to exercise the elective franchise till he be twenty-five years of age; nor to be elected a deputy till he be thirty. In some of the American states judges are obliged to retire when they have attained to a certain age, which is sometimes so early as sixty.

AGE. In Mythology, age means one or other of the four ages as described by the ancient poets. The first or golden age, *aurea ætas*, when there was an eternal spring, and when the earth spontaneously poured forth her harvests, and man

> —— "vindice nullo,
> Sponte suâ sine lege fidem rectumque colebat,"

was coeval with the reign of Saturn on earth. The next, or silver age, *argentea ætas*, was marked by the change of seasons, and the division and cultivation of lands. The third, or brazen age, *aenea ætas*, is described as

> "Sævior ingeniis, et ad horrida promptior arma:
> Nec scelerata tamen."

And then came the last, or iron age, *ferrea ætas*, full of all sorts of hardships and wickedness, which still continues. (*Ovidii Metamorph.*, i. lin. 89., &c.)

AGE. In Literature, age is a period distinguished by great improvements and eminence in arts and sciences, usually bearing the name of some powerful sovereign, or other prominent person, who flourished during that period. Of these ages, the most memorable are the age of Pericles, the Augustan age, the age of Leo X., the age of Louis XIV., &c.

AGE. In Chronology and History, age is sometimes used as synonymous with a century, and sometimes also with a generation. Writers differ in respect to the period included under what is called the *middle ages;* but they are commonly understood to begin with the reign of Constantine, and to extend to the fifteenth or the early part of the sixteenth century. The æra of the invention

of printing, 1450—1455, might, we think, be advantageously adopted as the termination of the middle ages.

AGE'NDA. (Lat. *things to be done.*) Small books are now published under this title, in which individuals may set down, under their proper heads, the things to be daily attended to.

AGENDA. In Divinity, articles of moral practice, in opposition to *credenda*, articles of faith. Also, the ritual of a church, and the books containing it.

A'GENT. In Law, is a person authorised to do some act or acts in the name of another, who is called his principal. An agent may, in general, be appointed by bare words, or his appointment will be inferred from circumstances; but, for some purposes specified by the statute of frauds, his appointment must be in writing. The agent of a corporation must, in general, be appointed by deed. If an agent has engaged to perform certain duties for a consideration, the performance may be enforced in law. But against an unremunerated agent, the principal can only recover damages for misconduct in the performance, and cannot compel him to proceed. With respect to the dealings of third parties with an agent, some general rules of law are, that the extent of an agent's authority is, as between his principal and third parties, to be measured by the extent of his usual employment; that the representation of an agent about the subject-matter of a contract which he is negotiating for his principal, will, if made during the course of the negotiation, bind the latter; that payment to an agent, in the course of his employment, is payment to the principal; that the principal is, under many circumstances, responsible in civil actions for the negligence or fraud of his agent, but not criminally liable for his acts, unless done under an express command.

AGENT. In Diplomacy, a general name, comprising several ranks:—as, 1. Ambassadors. 2. Envoys extraordinary and ministers plenipotentiary. 3. Ministers resident. 4. Chargés d'affaires. 5. Secretaries of legation, &c. In common language, however, the highest officer employed by one power at the court of another, is usually termed the agent of that power at the court in question. (*See* DIPLOMACY.)

A'GGREGATE ANIMALS. This term is applied to those animals which are collected together in a common enveloping organised substance containing numerous compartments, from each of which a distinct occupant sends forth a circle of organs to collect food, which, after assimilation, is carried by a common and continuous system of vessels for the support and enlargement of the common dwelling. Examples of animals so associated or aggregated occur in the class polypi, where they form most of the orders; also in the class acalephæ, forming the polytoma; and in the acephalous mollusca, forming the genera botryllus, pyrotoma, and polyclinum.

AGI'LIA. (Lat. agilis, *swift.*) A family of rodents in the system of Illiger, including the squirrels and dormice.

A'GIO. A mercantile term, denoting the percentage difference existing between the values of the current and standard moneys of any place. Also, the rate of premium which is given, when a person having a claim which can only be legally demanded in one metal, chooses to be paid in another. Thus, in countries where silver is the only legal standard, a large payment in silver is so inconvenient, that the receiver will often pay a small premium for the convenience of receiving gold: this premium constitutes the agio on gold.

A'GIOTAGE. A term employed to designate the sort of manœuvres by which speculators in the public funds contrive, by disseminating false rumours, or otherwise, to lower or enhance their price. It is sometimes also, though less commonly, applied to the machinations of those who endeavour, by similar artifices, to raise or depress the prices of commodities.

AGI'STMENT. In Law. From the old French word, *agister*, which signifies a licence granted for cattle, viz. to be harboured, or, in legal phrase, levant and couchant, on the land. A contract by which A.'s cattle are taken into B.'s ground, to remain there at a stipulated sum, paid periodically. Agistment is also used for the profits of such feeding. The "Tithe of Agistment," or of cattle and other produce of grass lands, demanded by the Irish clergy, was resisted, in 1720, by the landlords, and in effect abolished by a resolution of the Irish house of commons (1735). By the act of union, this resolution was passed into law; and thus the tithes of Ireland have, in effect, been thrown on the poorest part of the agricultural population, the owners and cultivators of arable land. (See *Ed. Rev.*, vol. xxxiv.: Wakefield's *Ireland*, vol. ii.)

A'GNATE. (Lat. agnatus.) In Roman Law, *agnates* are those who descend through males from a common ancestor; in opposition to *cognates*, i. e. all the descendants of a common ancestor, whether through males or females. Thus, in France, the hereditary crown passes by right of *agnation*, females being excluded.

AGNO'MEN. Besides the prænomen, nomen, and cognomen, the Romans sometimes had a fourth name (agnomen), which was derived from some illustrious action or remarkable event. Thus, two Scipios had the name Africanus given them, on account of their victories over the Carthaginians in Africa. The younger of these celebrated generals had a second agnomen, viz. Æmilianus, because he was the son of L. Paulus Æmilius, and adopted into the family of the Scipios.

A'GNON. A name applied by Fabricius to a genus of dragon-flies, having the wings erect when at rest, the eyes distinct, and the outer divisions of the lip bifid.

AGNO'STUS. (Gr. ἀγνωστος, *unknown.*) A name devised to express the obscure nature of a genus of trilobites (fossil crustaceans), to which it is attached; the genus is characterised by the semicircular or reniform shape of the body, which in all other trilobites is ovate or elliptical.

A'GNUS DEI. (Lat. *Lamb of God.*) 1. A prayer of the Roman Catholic church, which begins with the words, "Agnus Dei qui tollis peccata mundi." 2. An image of wax, impressed with the figure of the Lamb, consecrated by the pope, and distributed to the faithful.

AGO'MPHIANS, AGOMPHIA. (Gr. ἀ, *without*, and γομφιος, *a tooth.*) A term applied by Ehrenberg to those rotifers of which the jaws are deprived of teeth.

A'GONY. (Gr. ἀγωνια, *contest.*) In Divinity, the suffering of our Saviour in the garden on the night preceding his crucifixion. Luke, xxii. 24.

A'GORA. The market place of a Greek town, which was generally used also as the place where the assemblies of the people met. It answers to the Latin term forum. From the verb ἀγειρειν, *to collect*, or *assemble*. From agora is derived

AGORA'NOMUS. The title of an Athenian magistrate, forming one of a body of ten, or, as some say, fifteen, persons whose duty it was to superintend the markets, and collect the customs imposed on certain articles.

AGOU'TI. The Indian name of some South American herbivorous rodent quadrupeds, now included in the genus *Dasyprocta*.

AGRA'RIAN LAWS. (Lat. ager, *field.*) Under this term are comprehended the enactments which were carried or attempted to be carried at Rome by the plebeians and their partisans, in opposition to the patricians, touching the distribution made of the public lands accruing to the state by conquest. These were leased out to the patricians by the state at a moderate or nominal rent, while the plebeians gained nothing by them. The object of the agrarian laws, which did not interfere with private freehold property, was to obtain for the plebeians a share in these lands, to restrict the quantity occupied by individuals, and to cause a real rent to be paid from them for the support of the army. The most celebrated movers of these laws were, Sp. Cassius, Licinius, and the two Gracchi, whose reputation has suffered with posterity, from being intrusted to the hands of writers who favoured the party whose unjust encroachments were sought to be moderated by these laws. For a more impartial investigation of them than can be found in ancient writers, (for Cicero, from his aristocratic partisanship, has much misrepresented the objects of these reformers, and the character of the laws they sought to introduce,) see Niebuhr's *Roman History*. In consequence of the misrepresentations here alluded to, an "Agrarian law" now generally serves to denote a law for the spoliation of individuals, by reducing landed property in private hands to a fixed amount. The law of partibility of real estates, as it obtained in the Roman jurisprudence, and still more in countries where it cannot be controlled by testamentary disposition, has, in some measure, the effect of an Agrarian law, although free from its injustice.

AGREE'MENT. (Fr. agrément, *agreeableness.*) In the fine arts, a certain degree of resemblance between the parts, in style and character, so that they may seem to belong to each other.

AGREEMENT. In Law, that which is consented to by two or more parties. Agreements are divided into executed and executory. By the statute of frauds, 29 Car. 2. c. 3. no action can be brought to charge a defendant on any agreement upon consideration of marriage, or on any contract or sale of lands, &c., or any interest therein, or any agreement not to be performed within one year, unless such agreement or some memorandum or note of it be in writing, signed by the party to be charged therewith, or some other person by him thereunto lawfully authorised.

The remedy which law affords for the breach of an agreement is only by way of damages. But equity will in general compel the specific performance of any contract or agreement for the non-performance or breach of which a court of law could have awarded damages. The principal exception to this rule is, where the agreement is of such a nature that its breach can be or was intended to be compensated by damages.

A'GRICULTURE. (Lat. ager, *a field*, and colo, *I till.*) This art may be defined as that of cultivating land in fields, or in large quantities; as opposed to horticulture, which is the art of cultivating land in gardens, or in

small quantities: or, agriculture may be defined as the art of cultivating land with the plough; and horticulture that of cultivating it with the spade. The restricted meaning of the word agriculture, therefore, is simply the art of cultivating fields; but its more extensive and general meaning includes the whole business of the farmer, which comprehends, in addition to raising corn, and other crops, the management of live stock. As a general term, the word agriculture is also frequently considered as including every description of territorial improvement; thus it is made to comprehend embanking, road-making, draining, planting, and sometimes even horticulture. In this sense the word agriculture is used by the French writers on the subject.

We shall here consider the term agriculture in its general acceptation in Britain, and in other countries where the English language prevails, as only including the culture of field crops, and the rearing and managing of domestic animals, on a large scale; and we shall give a very concise outline of its origin, history, theory, and practice.

The origin of Agriculture must doubtless have been coeval with that of fixed property. In the pri-næval state of society, the sole riches of the husbandman consisted of flocks and herds, which were kept in a state of movement from one point to another, in search of pasturage and water; but as population increased, mankind adopted a fixed abode; this could only be done by bestowing on the site a certain degree of labour and care, which became, as it were, the price paid for constituting it private property. At this point in the progress of civilisation agriculture may be said to have commenced. Previously, the natural products of the soil were merely consumed where they were found; but now man sought to increase them by culture.

History of Agriculture.—The culture of the land will be found to have depended, in every country, principally on its climate, and its civilisation; though partly, also, on its government and population. In the warmer climates, where nature produces fruits in the greatest abundance for the food both of men and animals, and where very little care is required to procure shelter or clothing, agriculture has made little progress; because it is comparatively unnecessary for the prosperity of the inhabitants. In climates of a directly opposite character, agriculture has made equally slight progress, from the natural obstacles opposed to it. In such countries, for example, as Greenland and Kamschatka, only one or two kinds of corn crops can be cultivated, and perennial grasses can scarcely exist; because the ground is covered with snow for eight months in the year: and in these countries agriculture is but little practised, as the chief resources of the inhabitants for food are found in the sea and the forest. In intermediate climates, such as those of the south of Britain, the middle of France, and the north of Italy, the soil may be laboured by man throughout the whole year; and there is scarcely any limit to the kind of crops that may be raised on it. In such climates, agriculture is calculated to attain the highest degree of perfection; and comparing the different parts of the zones of this description of climate in both hemispheres, perhaps it may be asserted, that the best agriculture in the world is to be found in Britain and in the north of Italy; viz. in East Lothian and Norfolk, in the vale of Arno, and on the banks of the Po. The kind of agriculture practised in different countries is also of course adapted to the difference of climate. Thus, towards the north, the great art of the cultivator would consist in supplying heat; or, rather, in adopting such measures as would best guard plants and animals against cold, rains, and the vicissitudes of the weather. Towards the south, on the other hand, the art of the cultivator would be chiefly directed to moderating extreme heat, and supplying moisture. It thus appears that the agriculture of any country necessarily depends on its latitude; and that in high and low latitudes, where there are greater extremes of temperature and climate to contend with, agriculture must be of a more difficult and hazardous description than in intermediate or temperate climates: such as that of Syria, where the art is supposed to have originated, or in Europe, where it may be considered as having attained its highest degree of perfection.

In tracing the progress of this art in civilised countries, we have only to follow the chronology of general history. As the Greeks and Romans appear to have arrived at as great a degree of perfection in legislation as the moderns, so they appear to have attained nearly equal excellence in the practice of agriculture. Till within the present century, very little difference existed between the most approved agriculture of climates analogous to that of Italy, and the agriculture of the Romans as described by Cato, Columella, and other ancient writers. The chief superiority of the moderns consists in their machinery, and in their knowledge of the science of the art; the last being of very recent date, and by no means general among practitioners. By science, improved breeds, both of plants and animals, have been originated; and by improved machinery, a more perfect tillage has been produced, and also a more complete separation of the produce from the soil, from the refuse of the plants which bore it, and from all impurities.

The history of agriculture in Britain begins with that of the Roman conquest. Julius Cæsar found the inhabitants in a state of semi-barbarism; but Agricola left them in possession of all the arts of civilisation then known. Agriculture declined with the invasion of the Saxons; but was preserved through the dark ages after the establishment of Christianity, by the intelligence of the religious establishments, who gradually became possessed of the greater part of the landed property of the country. Agriculture revived in the reign of Henry VIII., and in that of Elizabeth, during the long period of peace which then prevailed, and the consequent security of property; and it afterwards declined during the civil wars: it again revived during the reigns of William and Mary, Queen Anne, and George I., in consequence of the introduction of the Flemish husbandry, which included the culture of turnips and clover. A still greater stimulus to the art was given during the reign of George III. by the introduction of ploughs drawn by two horses, instead of four or six; of the drill system, and its application to the culture of turnips and potatoes; and by the improvement made in the breeding and rearing of live stock by Bakewell and Culley. Early in the present century, the threshing machine was an important addition to agricultural machinery; the reaping machine, the frequent drain system, and the subsoil plough, are improvements just coming into use; and the next grand attempt will probably be the general application of steam, instead of horses or cattle, in tillage and other field operations.

The literature of agriculture commences with the works of the Romans, of which Columella's work, "*De Re rustica*," may be considered the most comprehensive. In the dawn of modern agriculture, the principal writers were, Crescentius in Italy, Herrera in Spain, Olivier de Serres in France, Hereshbachius in Germany, and Fitzherbert in England. At the beginning of the present century the most comprehensive author on agriculture in Italy, was Filippo Re; in France, Tessier; in Germany, Thayer; and in England, Marshall. The best work from which a general idea may be obtained of the agriculture of France and corresponding climates, is "*Maison Rustique du xix^e siècle; ou, Encyclopédie d'Agriculture pratique*," complete in one thick volume, 8vo.; and the corresponding work in Britain is Loudon's "*Encyclopedia of Agriculture.*"

The principles of Agriculture are derived from a knowledge of the nature of plants and of animals, of soils and manures; and of the climate, the seasons, and the weather. Plants are organised beings, which take up their food, by means of roots, from the interior of the soil; animals are organised beings which select their food from vegetables growing on the surface of the soil, or from other animals, and this food is prepared before being absorbed into the system, by means of a stomach. The climate of a country determines both the plants and the animals which can be produced in it; and the seasons and the weather, the time when the plants and animals of the given climate are in particular states of vigour or torpidity; and when certain operations of culture can be performed on them, or on the soil.

The nature of these elementary materials being understood, even though imperfectly, certain improvements can be effected in them by art, which are greatly conducive to the increase of agricultural produce. The kinds of plants and animals suitable to any given climate, soil, or season, are determined by the laws of nature; but from among these kinds it is in the power of man to make a selection; and with the plants and animals so selected to originate others, adapted to his purposes in a superior degree. Hence the importance of selecting certain breeds of animals rather than others; and of making choice, not merely of one kind of bread-corn rather than another, but of particular varieties of that corn. Thus, in the case of wheat, there are some kinds the grains of which, under no circumstances, weigh more than from 50 to 55 pounds a bushel; while there are others which never weigh less than 60 pounds a bushel. The nourishment of plants has been found to depend chiefly on organised matters contained in the soil, and produced chiefly by the decay of other plants. This is a law of nature, which, followed up by man, has led to the use of manures; as the fact, every where observed, that no plant can live without water, has led to irrigation; and, as the observation that the excess of water is injurious, has led to surface and under draining. The influence of temperature and shelter over the growth of plants, and the thriving of animals, is every where observable in wild nature; and though the temperature of a climate cannot be changed, yet that of most localities may be improved by shelter from cold winds, and by diminishing the evaporation from the surface, by means of surface and under draining, to draw off the superfluous water. The most important principles in the theory of agriculture are those which relate

to the improvement of plants and animals, and of the soil.

The improvement of the soil may be comprised under two heads — the improvement of its earthy part, and the increase of the organised matter added to the earths. The improvement of the soil, considered as a mixture of different earths, consists in rendering it more or less retentive of water, by diminishing or increasing the size of the particles of which it is composed : for example, by the addition of clay in some cases, and sand in others ; and by improving the earthy composition of the soil by the addition of such earths as may be in too small quantities, or wanting altogether. It has been found, from experience, that those soils which are composed of several primitive earths are naturally more productive than such as consist of only one earth, all other circumstances being the same ; and it has also been found that no soil will maintain its fertility for any length of time that does not contain a certain portion of calcareous earth in its composition. Hence one of the most common means of improving all soils not calcareous is, by the addition of lime ; and of all other soils, by mixing them with such as are of an opposite description.

All soils whatever are rendered more productive by the addition of organised matter, or what are called manures. Manures may either be composed of animal or of vegetable matter ; and these may either be applied separately or together, and in a fresh state, or in a state of decay. It has been found from experience, and explained by chemical experiments, that every description of manure is rendered more effective by being made to undergo putrefactive fermentation before it is applied ; and this process is carried on with solid manure in heaps or dunghills, and with liquid manure in tanks or wells. In the application of manure to soils, the great object of the cultivator is to apply enough for the ensuing crop, and as little more as possible ; because all that is applied and not immediately used, is liable, to a certain extent, to have its particles carried off by evaporation into the atmosphere, or by rains into rivers or the sea. But, even if this were not the case, to apply manure to a soil where it would not be immediately turned into a crop, would be an expenditure of capital without interest.

The operation of freeing a soil from superfluous water is of equal or perhaps more importance than supplying it with manure ; because, though without manure plants will not grow with great luxuriance and vigour, yet with too much water they will not grow at all, or will become sickly. The excess of water may proceed from three causes : an extremely moist climate, the only alleviation to which is arranging the surface with frequent furrows, and short slopes between them, so as to carry off the rain as soon as it falls ; a soil very retentive of moisture, so as to hold it like a sponge, in which frequent under drains, as near together as the surface furrows, are required ; and, lastly, a soil lying over a subsoil which abounds in springs, or, in other words, which has the substrata charged with water, which is continually oozing out through the surface soil. The remedy for this last evil is by under drains of considerable depth, so directed as to collect the water from the substrata, and carry it off before allowing it to reach the surface soil.

A soil, after being drained and rendered of a proper texture and composition by the admixture of such earthy ingredients as may be wanting, requires, to render it fit for being penetrated by the roots of plants, to be frequently stirred and comminuted. This is done by the mechanical operations of ploughing, harrowing, &c. ; which, aided by the alternate action of droughts and rains, frosts and thaws, and summer and winter, have the effect of pulverizing the soil. To maintain a soil in a fertile state, it is not only necessary to supply it with manure in proportion to the crops which have been carried from it, but to vary the crops which it is made to produce. It has been found from experience that crops of plants belonging to the same natural family do not succeed so well after each other, as when crops of a different family are made to intervene. Thus, the several grasses alternate better with root or herbage crops than with one another ; or, one of those grasses of which the seed is ripened will alternate better with another in which the herbage only constitutes the crop, than with one of the same kind as itself. Something analogous to the succession of crops takes place also with regard to the pasturage of animals, and it is found advantageous to put cattle in a field that has been grazed by horses, rather than to put horses after horses, and cattle after cattle.

Thus, the principles of agriculture may be comprised under the selection of breeds of plants and animals ; the improvement of the soil and subsoil ; the culture or movement of the soil ; the improvement of the local climate by shelter and drying ; and the succession of crops. All these principles have been derived from experience ; and they are only in part accounted for by chemistry or natural philosophy. They are not, however, on that account, the less true and useful. It is singular that they should all have been known to the Romans, and, to all appearance, as fully so as they are to modern cultivators.

The practice of Agriculture in Britain may be included under the heads of the choice, hiring, and stocking of a farm ; and its general culture and management. In the choice of a farm in any given country, the object of greatest importance is the nature of the soil ; because, though this may be improved by art and expense to such a degree as almost to render a bad soil equal to a good one, yet in practice this would be so expensive as by no means to answer the purpose of the farmer. It may be thought that the vicinity of good roads, of a canal, a river, or a market-town, are objects of more importance than the nature of the soil ; but this is not the case, because, supposing the roads to be bad, and the market at a distance, it is only necessary to change the system of cultivation and management, and to turn the produce of the farm into some description of live stock which may be driven to any distance, even over a country without roads. If it be alleged that the nature of the climate is of paramount importance to the soil in the choice of a farm, we allow that in an extended sense it is ; for example, if a cultivator had the choice of any part of Europe, there are doubtless many districts where the climate is far more favourable for all the operations and products of agriculture than others ; and even if he had the choice of every part of Britain, he might find some localities much more favourable than others. In general, however, the actual choice of any cultivator lies within a given locality, where the climate, in a practical point of view, is every where the same. Next to soil and climate in the choice of a farm, the state of the buildings and fences on it, the state of the roads, and the distance from a market-town, a canal, or a sea-port, are of importance. Without buildings of a sufficient extent, properly situated, and of the proper kinds, the business of a farm cannot be carried on ; and though some farms, and some kinds of farming, may be conducted without fences, yet, in general, fences are as necessary as roads. The last circumstance which we shall mention in this cursory glance is, the nature of the tenure by which the farm is to be held, and the covenants and conditions of the lease. No cultivator, who calculates on the employment of a considerable capital, will risk it on the lands of another without some security for having it returned ; and this security is a lease for a fixed number of years. On the other hand, no proprietor of lands will delegate the possession of them to another for a fixed number of years, without a valuable consideration ; and this he reserves to himself in the lease, under the denomination of rent. As lands in a state of cultivation, and buildings and fences in a state of repair, are liable to be injured and deteriorated in value by bad management or neglect, the proprietor guards against these accidents by certain conditions in the lease.

The kind of culture and management adopted in any farm depends jointly on the soil and climate ; and on the kind of produce most in demand, or reckoned most profitable. In the mountainous districts of Great Britain, where the climate is cold, almost the only kind of farming practised is that of breeding and rearing different kinds of live stock ; such as sheep or cattle, which are sold for being fattened in more favourable districts ; or horses, in order to supply the demand for these animals for the purposes of draught, or the saddle. The mountainous districts of Scotland and Wales are chiefly devoted to the breeding and rearing of sheep and black cattle ; which are sold to the farmers of the low country in both kingdoms, in order to be fattened for the shambles. The hilly districts of Yorkshire and Lancashire are chiefly employed in the breeding and rearing of horses. In the low country of the east coast of Great Britain, the climate being dry, is favourable for the culture of corn ; while on the west coast, and in Ireland generally, the climate being moist, is more favourable for pasture. The farm products most universally in demand are, corn and butcher's meat ; and these may be produced on every farm the fields of which admit of being kept alternately in tillage and in grass. The butcher's meat may, however, be produced in much greater abundance, on such soils as admit of the culture of root and herbage crops, such as turnips, potatoes, clover, &c. ; while corn may be produced most abundantly in strong loamy soils, within reach of extensive sources of manure. The most profitable description of crop will frequently be found to be different from that which is most generally in demand : for example, in the neighbourhood of a large town, the culture of culinary vegetables, on a large scale, in what are called farm-gardens, is generally far more profitable than the raising of corn or butcher's meat. Even the raising of food for cattle, in such situations, is found to yield more profit than common farming. There are also particular crops which may be occasionally cultivated which yield extraordinary profits ; such as plants used in dying, or in some manufacture not common ; plants of some new and improved variety of the kinds in general cultivation for their seed, &c.

A farm being fixed on, all preliminary matters settled,

and the farmer in possession, his first business will be to fix on the general system of cultivation that he means to adopt. In this, as already observed, he will be guided by what the farm is capable of producing, and what he can dispose of. One of the first points that he will determine after this, will be the quantity of land that he can have under each particular kind of crop that he intends to grow; and next, the order in which these crops are to succeed one another. No point, indeed, in the whole system of farm management, is of more importance than the succession, or, as it is usually called, the rotation, of crops. The principle on which the succession of crops is founded has been already hinted at; and in here treating it practically, it may be sufficient to state, that all agricultural crops whatever may be reduced to three kinds — exhausting crops, restoring crops, and cleaning crops; and that the perfection of a rotation consists in always having an exhausting crop followed by a restoring or a cleaning crop; or, what is best, by both combined. All crops which are allowed to ripen their seeds, or which are carried wholly off the ground, are considered exhausting, though in different degrees. Thus, the most exhausting crops in general cultivation are those of corn; but clover, tares, or even hay cut green, are also exhausting, though in a much less degree. Restoring crops are those where the produce is suffered to decay on the ground, or is consumed on it; as in the case of pasture, crops of tares, turnips, &c. Cleaning crops are such as are grown in drills, sufficiently wide to admit of hoeing and other operations of cleaning between. Some of these are at once cleaning and exhausting, as where corn is sown in drills; while others are cleaning and restorative, such as where herbage plants, as clover and lucerne, or roots, as turnips, are drilled, and the plants are to be eaten off on the spot. Other principles which enter into consideration in fixing on a rotation of crops are, that plants which are nearly allied should not succeed each other; because, whether from exhausting the soil of one particular kind of nutriment, or by depositing in it one injurious kind of secretion, certain it is, that the same kind of plants cultivated without intermission on the same soil soon become sickly. Thus three or four crops of any kind of corn in succession will not only unfit the soil for that variety or species of corn, but in a great measure for every other.

The farmer having determined on the crops which he is to grow, and the order of their succession, his next business is to calculate the quantity of stocking which will be required for his farm. By stocking is to be understood the number of horses, cattle, and other live stock; and the kind and number of machines, implements, and tools that will be required. In addition to these, he must take into calculation the number of male and female servants which it will be necessary for him to keep, either permanently by the year, or to hire occasionally by the week. Lastly, he will have to take into consideration the sum of money which he will require to lay out for servants' wages, housekeeping, rent, and all other expenses, before he receives any return from his farm produce. The sum total is the amount required for what is called stocking a farm; and it amounts, in different parts of the country, to from 5*l.* to 10*l.* per acre. Poor soil under pasture requires the smallest sum per acre; and rich soil under tillage the largest sum.

The farm being entered on, and the system of culture determined, the future business during the lease is one uniform routine of preparing, sowing, reaping, threshing, and marketing; including, where the breeding or fattening of live stock enters into the system, their purchase, fattening, and sale; or, their rearing, breeding, and sale.

The agriculture of Britain, and especially of the low country of Scotland, excels that of most other countries having similar climates, from the superior skill, intelligence, and capital of the farmer; the considerable length of lease which is granted by the landlord; the superiority of the machines and implements employed; and the improved breeds of animals and plants which are reared or cultivated. Perhaps the nearest approach to perfection in the culture of arable land in any part of Britain, is made in some parts of East Lothian; where, in consequence of deep ploughing, substituting under drains for furrows; regularly supplying manure, and alternating cleaning and restoring crops with exhausting crops, as great an amount of produce is obtained as can stand on the surface at one time. The agriculture of Britain is most defective in the southern districts of the island; in consequence of the farmers being the very opposite of those in the northern districts, the want or the shortness of leases, and the restrictive clauses in those leases, by which the tenant is prevented from exercising his own judgment, and is obliged to follow in the routine prescribed in the leases of a former age.

A'GRIMONY. A wild plant with sawed pinnated leaves, and a long spike of yellow flowers, followed by burlike fruit. It has had the reputation of keeping old age away from those ladies who persevere in the use of it in decoction. At least, it has the merit of being harmless, and from its slightly tonic qualities it would probably form a good kind of diet drink.

AGRIO'NIDÆ. (Gr. ἀγϱος, *a field.*) The name of a family of neuropterous insects, including the various kinds of dragon-flies (*Libellula*, Linn.; *see* that word). The blue dragon-fly (*Agrion puella*) frequents the rushy sides of ditches, and is one of the commonest of the British species of this family.

AGRO'NOMY. (Gr. ἀγϱος, *a field*, and νομος, *a rule.*) The art of cultivating the ground: sometimes used, particularly by the French, as synonymous with agriculture.

AGROSTO'LOGY. (Gr. ἀγϱωστις, *a grass*, and λογος, *a speech or writing.*) That part of botany which comprehends what relates to the grasses.

AGRY'PNIA. (Gr. ἀγϱυπνος, *sleepless.*) Watchfulness or restlessness.

A'GUE. An intermittent fever, which comes on at certain intervals, leaving the person in the intermediate periods in apparent health. The febrile attacks are often remarkably regular, whence the division of agues into quotidians, which are daily attacks; tertians, which appear every third day, having an intermission of forty-eight hours; and quartans, the intermission of which is about every seventy-two hours. The period during which the fever continues is called the paroxysm or pyrexial period; and the intermission, the apyrexial period. The febrile paroxysm consists of three stages, which follow each other in regular succession; namely, the cold, the hot, and the sweating stage: during the latter, the febrile symptoms abate and disappear.

AGUE CAKE. An enlargement of the liver or of the spleen produced by the ague.

AGY'RATE. (Gr. ἀ, *without*, and γυϱος, *a circle.*) A name given to osmundaceous plants by Swartz, in consequence of their having no true elastic annulus.

A'HRIMAN, or ARIMANIUS. (East. theology.) One of the chief deities of the ancient Persians. Their philosophers entertained the opinion subsequently held by the Manicheans, that there were two principles, one of good and one of evil. To the latter they gave the name of Ahriman, and ascribed to his agency all the evils existing in the world. The two principles were not, however, supposed to be co-eternal or alike powerful, at least such was not the orthodox belief; but it was supposed that in the end, the principle of good, Oromasdes, would finally prevail over and utterly destroy the principle of evil. — (*Bayle*, arts. ARIMAN, MANICHE'ENS, and ZOROASTER.)

AI. A word which is a pretty close imitation of the plaintive cry of the three-toed sloth (*Acheus tridactylus*, F. Cuv.). of which it is the trivial name. *See* BRADYPODÆ.

AID. A pecuniary tribute paid by feudal vassals to their lords in certain cases of emergency. (*See* FEUDAL SYSTEM.)

AIDE-DE-CAMP. An officer appointed to attend a general officer in the field, in winter-quarters, and in garrison, to receive and carry orders. A field-marshal is entitled to four, a lieutenant-general to two, and a major-general to one. The king appoints as many as he pleases, and this situation gives the rank of colonel.

AIGRETTE, in Botany. *See* PAPPUS.

AIR, *Atmospheric.* (Gr. ἀηϱ, *air.*) The air which surrounds our globe to a height of about forty miles, and which is essential to all living beings, was one of the elements of the ancient philosophers: its weight and several of its mechanical properties were discovered by Galileo and Torricelli about the middle of the seventeenth century; but its composition was not accurately determined till more than a century afterwards.

The air is transparent, colourless, inodorous, and tasteless, essential to the respiration of animals and vegetables, and to the support of combustion. It is 816 times lighter than its bulk of water; 1000 cubic inches, at mean temperature and pressure, weighing about 305 grains.

The air is a mixture of nitrogen and oxygen gases, with a small portion of carbonic acid gas and of the vapour of water: in particular situations, other substances exist in it; as, over marshes, miasmata; over sulphureous springs, sulphuretted hydrogen; over and near the sea, in dry weather, muriatic acid, either free or combined; and a substance, probably of organic origin, which, aided by light, reddens solution of silver; peculiar organic combinations, sometimes infectious, where people, especially the sick, are confined; sulphurous acid and ammonia, in London and other places where large quantities of coal are burned; and traces of nitric acid during severe thunder-storms.

The leading constituents of the air are nitrogen and oxygen, which are to each other in the relative bulks of about 79 and 21, or 80 and 20; and these proportions are probably not liable to any appreciable change, either dependent on season, wind, weather, situation, or height from the surface. Berthollet found 21 per cent. of oxygen in Cairo and in Paris; Saussure, the same in Geneva; De Martyr, in Catalonia, and in all winds, weather, seasons, and states of the barometer; in wet and dry, and in

inhabited and uninhabited places; Davy, in Bristol and other places in England and upon the coast; also in air brought from the coast of Guinea; Brande, in air from Behring's Straits and from Otaheite: Berger, in the Jura, and in the mountains and valleys of Savoy: Configliachi, on the Simplon and Mont Cenis (20·8 of oxygen over rice-fields); Gay Lussac and Humboldt, in Paris, and in all seasons and weathers, and at 6,636 mètres above the surface, from 20·9 to 21·5.; Dalton, in England, from 20·7 to 20·8.: Selden, 21.: on the 8th of January, 1835, the barometer being 30·9 inches and a north-east wind, 21·15. In crowded and confined places, the relative proportion of oxygen may be a little below the proper standard, but is soon again restored. Air collected at the back of the upper gallery in Covent Garden Theatre, on a full night, gave 20 oxygen, and rendered lime-water more than usually turbid.

The relative proportion of carbonic acid is more variable; yet this gas is found in air from the most elevated regions and purest sources. Saussure and Beauvais found it on the top of Mont Blanc, and in the same proportion in the streets of Paris, and at 650 toises above the city. At sea, carbonic acid has sometimes not been discoverable. Saussure found it vary with the seasons, and no doubt vegetation may affect it. In August, over a meadow, the air contained 0·000,713, in January, 0·000,425. Dalton estimates the mean proportion of carbonic acid at 1 in 1000; Configliachi, the maximum at 8, and Humboldt at from 5 to 18: this is probably in excess.

The aqueous vapour is the most variable constituent of the atmosphere. It is more abundant with a south and west wind in summer and in warm weather, than with a north and east wind in winter and cold weather. In this climate it usually fluctuates between 1 and 1·5 per cent.

Dr. Prout, in his Bridgewater Treatise (p. 350.), has suggested the possibility of the occasional existence of extremely minute portions of foreign and poisonous matters in the air during the prevalence of epidemic disorders; and, in reference to this subject, a remarkable observation occurred during the prevalence of the cholera. For more than six weeks previous to the appearance of cholera in London, he had been almost every day engaged in accurately determining the weight of a given quantity of air under precisely the same circumstances of temperature and pressure. On the 9th of February, 1832, the weight of the air suddenly rose above the usual standard, and it continued so for six weeks. On the 9th of February, the wind, which had been west, veered round to the east, and the first cases of epidemic cholera made their appearance.

Without reference to the occasional presence of foreign matters, the average ordinary constitution of the atmosphere may be stated as follows:—

	By measure.	*By weight.*
Nitrogen	77·50	75·55
Oxygen	21·00	23·32
Aqueous vapour	1·42	1·03
Carbonic acid	0·08	0·10
	100·00	100·00

Air. In Music, signifies the *melody*, or treble part of a musical composition.

The word is also used for a tune, or song itself, that is, for a series of sounds whose movement is regular and graceful.

Air. In Painting, the medium in nature through which every object is viewed, and hence to be transferred to the imitation on canvass. The effects which it produces are an indispensable part of the knowledge of every artist. It affects the sizes and colour of objects according to their distance.

AIR-BLADDER, called also *Air-bag*, sound, swim, &c. An organ situated in the abdomen of most osseous fishes, which, by altering its dimensions, and the quantity or density of its contents, regulates their relative position to the surface of the water, and is supposed to represent the rudimental condition of the lungs of the higher vertebrates.

AIR-CELLS. Are cavities in the stems and leaves of plants, constructed of cellular tissue, and intended to render the part in which they reside buoyant in water.

Air-Cells. In birds, are membranous receptacles communicating with the lungs, eight of which, of large size, occupy the interspaces of the thoracic and abdominal viscera; the smaller ones extend around the principal joints of the four extremities, penetrate the substance of the bones, insinuate themselves between the skin and subjacent muscles, and enter the quills of the feathers, so that the whole body of the bird is permeated by the atmosphere; whereby its specific gravity is diminished, its respiration extended, its circulation accelerated, and its muscular energies increased, and thus it is finally adapted to wing its way through aërial space. In the flying insects the air-vessels are more or less dilated into air-cells at different parts of their course, in order to diminish the specific gravity of the general mass of the body.

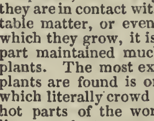
AIR-GUN. An instrument for projecting bullets or other missiles, the moving power being the elastic force of condensed air. A strong vessel of metal is constructed, into which air is forced by means of a condensing syringe, through a small hole with a valve opening inwards, and the greater the quantity of air thrown into the vessel, the greater will be the effect, the elastic force of air being nearly in proportion to its condensation. The magazine of condensed air is then detached from the syringe, and screwed to the breech of the barrel; and a trigger, adapted to the stock of the gun in the usual way, is constructed so as to be capable of opening the valve. The bullet is placed near the breech, and should fit the barrel very exactly, so as to leave no windage. On pulling the trigger the condensed air escapes through the valve, and rushes with violence into the barrel, propelling the bullet before it; and the instant the finger is withdrawn from the trigger the valve is closed by the pressure of the air in the magazine, which remains in a somewhat less condensed state for the next discharge. Thus the same supply of air in the magazine will serve for several successive discharges, but the force becomes weaker and weaker after each.

The air vessel may be of any form, but it is most conveniently disposed of by placing it within the stock; and this circumstance usually determines its shape and dimensions. Sometimes, also, a reservoir of bullets is placed in a channel under the barrel; and by a simple mechanism these are successively transferred into the barrel, whereby the gun is quickly loaded after each discharge. The instrument thus constructed is called the magazine air-gun.

The elastic force of inflamed gunpowder is from 1000 to 2000 times greater than that of common air. It would seem, therefore, that air would require to be condensed upwards of 1000 times beyond its natural state, in order to exert the same propulsive force as gunpowder. Now the velocities communicated are as the square roots of the forces; therefore, if the air in the magazine be condensed only ten times, it consequently exerts a force only equal to 1-100th of that of inflamed gun-powder, and communicates a velocity of 1-10th. There is a circumstance, however, which adds considerably to the effect of the air-gun, namely, that as the magazine is large in proportion to the cavity of the barrel, and the valve remains open a sensible portion of time, the ball is urged all the way through the barrel with nearly the same force as at the first instant; whereas, in the case of gunpowder, the gas produced by the inflammation occupies a small space in proportion to the capacity of the barrel, and the force ceases to act before the ball has quitted the barrel. On this account it happens that air condensed only ten times in a magazine of considerable size, projects a ball with a velocity not greatly inferior to that given by gunpowder. The time and labour necessary for effecting the condensation of the air prevents the instrument from being employed as an engine of war; but, as it produces its effect with less noise than the ordinary gun, it has sometimes been made subservient to the purpose of the assassin.

AIR-PLANTS. A name given to plants of any kind which grow without their roots penetrating the earth. They have been so called, from its being supposed that they derive their nourishment exclusively from the atmosphere; but as they are usually found in places where they are in contact with at least minute quantities of vegetable matter, or even with the juices of the plants upon which they grow, it is probable that their existence is in part maintained much in the same way as that of other plants. The most extensive natural order in which air-plants are found is orchidaceæ, thousands of species of which literally crowd the forests of some of the damp and hot parts of the world. Next to these range bromeliaceous plants, some of which will live for months suspended freely in the air, or tied to iron or stone balconies. Various species of ficus, and some Gesneraceæ, have similar habits. The only real air-plant that grows wild in Great Britain is cuscuta.

AIR-PUMP. A pneumatic machine for removing the air out of a vessel. The principle of this important philosophical instrument is very simple, and may be easily comprehended from a brief explanation. The essential



part of the machine consists of an exhausting syringe (a), formed of a tube or barrel of brass, closed at one end with the exception of a small orifice, to which a valve (b), opening inwards, is attached. An air-tight piston is worked up and down in the barrel by a rack and pinion turned by a winch. The piston has also an orifice with a valve (c) which opens upwards, or in the same direction as the valve of the tube. The syringe communicates, by means of a small pipe (d) fitted into the opening at its lower extremity, with a vessel (e) called the receiver, from which the air is to be extracted.

The receiver is placed on a brass plate (f, g,) over a

small hole, into which the other end of the pipe is inserted; and in order that the contact may be air-tight, the edge of the glass is previously rubbed with lard or some unctuous matter.

Suppose the piston at the bottom of the tube. As it begins to be drawn up, the valve *c* of the piston is immediately shut by the pressure of the exterior atmosphere, so that no air can enter the barrel, and a perfect vacuum would be left under it, were it not that the valve at the bottom of the barrel is forced open by the pressure of the air in the receiver, which rushes into the barrel till its density becomes the same both in the receiver and barrel. When the piston has been drawn to the top of the barrel, the whole of the air which occupied the barrel has been removed, and the receiver and barrel are now both filled with the air which was previously contained in the receiver alone.

Suppose the capacity of the receiver to be six times that of the barrel, the air which at first occupied six measures now occupies seven, and is consequently reduced to 6-7ths of its former density. Let the piston now be returned to its first position. The instant it begins to descend, the valve *b* shuts, so that no air can enter the receiver. As soon as the piston has descended through one-seventh of the barrel, the air in the barrel is restored to the density of the exterior atmosphere; and as it descends further, the air in the interior of the barrel is condensed, till it acquires an elasticity sufficient to open the valve *c* in the piston, when it rushes out, and continues to do so till the piston has quite returned to the bottom of the barrel. Thus by one stroke of the piston the density of the air in the interior of the receiver is reduced to 6-7ths of its previous density; and it is evident that each succeeding stroke will produce the same effect, or remove 1-7th part of the remaining air. Consequently, after the second stroke, the density of the air in the vessel will be reduced to 6-7ths of 6-7ths = 36-49ths of the exterior air; after the third stroke it will be reduced to 6-7ths of 36-49ths = 216-343ds, and so on. After twenty-one strokes, it will be reduced to about 1-25th of its first density; after one hundred strokes, to 1-5,000,000th part. But so high a degree of rarefaction cannot in practice be obtained; for as soon as the elasticity of the air in the receiver is reduced so far that it has not sufficient force to lift the valves, no more air can escape from the receiver into the tube, and the exhaustion cannot be carried further.

What has now been said applies to all air-pumps, though the form of construction admits of great variety. The better sorts have two exhausting barrels, and the pistons are worked by a rack and pinion, so that when the one piston is ascending in the barrel, the other is descending, by which means an uninterrupted discharge of the air is kept up. The receiver is placed on a smooth plate of brass, having a small hole in the middle to receive the end of a pipe communicating with the syringe. Various contrivances have been employed to continue the exhaustion after the air has been rarefied to that degree that it does not retain sufficient elasticity to lift the valves. In order to determine the degree to which the rarefaction is carried, a barometric tube is adapted to the machine, the upper end of which communicates with the receiver, while the lower end is plunged into an open basin of quicksilver. As the receiver is exhausted, the air is withdrawn from the tube at the same time, and the external air presses up the mercury in the tube to a height proportional to the degree of rarefaction.

This is called a *gauge*; but the following form is more frequently employed. A tube six or eight inches in length, sealed at one end and filled with mercury, is inserted in a basin of the same liquid. The mercury is of course supported by the pressure of the atmosphere, and continues to fill the tube. This apparatus is placed beneath a second receiver, communicating with the pipe *d*. During the first stages of the exhaustion, the mercury still remains supported; but so soon as the tension of the contained air becomes less than is sufficient to support the column of mercury, the liquid begins to fall, and the height at which it stands above the level of that in the basin is the measure of the tension of the remaining air. This is called the short Barometer Gauge.

Otto Guericke, a magistrate of Magdeburg, was the first who conceived the idea of rarefying the air in a vessel by means of a pump, about the year 1654. The machine which he constructed was of a very rude kind, but it enabled him to exhibit experiments which at that time were regarded as astonishing. The air-pump was afterwards greatly improved by Hooke and Boyle; and has attained its present state of perfection through the successive inventions of Hauksbee, Smeaton, Cuthbertson, and others.

AIR-VESSELS. Are minute tubes composed of an exceedingly fine transparent membrane, closed at each end, and furnished internally with a delicate elastic thread twisted spirally, whence they are now commonly called spiral vessels. They occur in the medullary sheath, the veins of leaves and of flowers, in the stamens, the ovary, and the seed: their office is to convey oxygenated air.

AIR-VESSELS. In insects, the atmospheric air is conveyed through all parts of the body, for the purposes of respiration, chiefly by means of air-vessels, or *tracheæ*. (*See* that word.)

AISLE, or ALA (Lat. ala, *a wing*.) In Architecture, a term used by the English, more especially, to signify the side subdivisions in a church, usually separated from the nave, or centre division, by pillars or columns; but among different nations it bears different significations as applied to architecture. Strabo informs us, that among the Egyptians, the alæ of the temple were the two walls that inclosed the two sides of the pronaos, and which were of the same height as the temple itself. The walls, he observes, from above ground, were a little farther apart than the foundations of the temple, but, as they rose were built with an inclination towards each other. The right understanding, however, of this passage is attended with difficulty, and seems to have puzzled Pocock no less than ourselves. The Greek alæ, called ptera, were the colonnades which surrounded the cell of the temple, the monopteros temple being the only species which had columns without an interior (to them) wall. The peripteral had one tier of columns round the cell, the dipteral two, and the pseudo or false dipteral, which Hermogenes invented, was that in which the ala was single, but occupied the same space on the sides of the cell as the dipteral, though one of the tiers of columns was left out; thus, by metaphor, the columns were called the alæ, or wings, of the temple. This term is also applied to the sides of a building which are subordinate to the principal, and central division, and are vulgarly called wings.

AITS. Islets, or little islands, commonly planted with osiers, and which are then called willow aits.

AKE'NIUM. *See* ACHÆNIUM.

A LA MIRE. In Music, the name of one of the notes in the modern scale of Guido. (*See* MUSIC.)

A'LA. (Lat. ala, *a wing*.) In Ornithology, the pectoral extremity, the bones of which support broad folds of skin, covered with feathers, and are modified for flight. The under part of the base of the wing, where it joins the body, is termed the *axilla*; the joint between the antibrachium and carpus is termed the flexure or *plica*. The wing is said to be armed (ala calcarata) when the carpus bears one or two horny spurs; to be impennate (ala impennata) when provided with equal, lax plumes, unfit for flight; to be elongate (ala elongata) when, in the folded state, it equals or exceeds in length the body from the base of the bill to the root of the tail; to be middle-sized (ala mediocris) when, in the folded state, the extremity covers the base of the tail; to be short (ala brevis) when, in the folded state, the extremity reaches the sides of the coccyx.

In Entomology, the wings, or organs of aërial progression, are tegumentary productions simply, and consist of a double membrane of a tender and generally transparent consistence, inclosing numerous nervures, or branched tubes of a firmer substance.

These organs present considerable differences of form and structure in the different orders of insects, and also vary in number from two to four.

A'LABASTER. A white semitransparent variety of gypsum or sulphate of lime. It is a mineral of common occurrence, and is manufactured into ornamental vases, and occasionally into small statues. The ancients used it for ointment and perfume boxes. Perhaps the term is derived from ἀ, privative, and λαβὸν, *a handle*, as opposed to vessels with handles. This stone is not slippery, and therefore the derivation is incorrectly referred to ἀ and λαμβανω, as if it were difficult to grasp.

ALANGIA'CEÆ. (Alangi, *the Malabar name of one species*.) A natural order of plants closely akin to myrtaceæ. It consists of Indian species, with aromatic roots and eatable fruit. Their long strap-shaped petals afford one of the principal distinctions between them and myrtaceæ.

ALA'NTINE. An amylaceous substance extracted from the root of the Angelica archangelica.

ALA'RMISTS. In a general point of view, means all those individuals who are particularly prone to take alarm at, and to circulate and exaggerate, any sort of bad news; but the designation is more peculiarly applied to those who take alarm at political innovations or changes.

ALA'TE. (Lat. ala, *a wing*.) When any solid body is bordered by a membranous or leafy expansion.

ALAU'DA. (Lat. alauda, *a lark*.) The name of a Linnæan genus of passerine birds, characterised by the claw of their hinder toe, which is straight, strong, and longer than the others. The birds of this genus are granivorous, and nidificate on the ground. The field-lark Alauda arvensis, L., is a well-known example: they appertain to the conirostral division of the passerine order of Cuvier.

ALB. (Lat. albus, *white*.) A vestment worn by priests in the Roman Catholic church, which differs from the surplice in fitting more closely to the body, and being tied with a girdle: it is also commonly embroidered on the breast with crosses.

ALBA'RIUM OPUS. (Lat.) In ancient Roman architecture, a term imagined by some to have been nothing more than a species of whitewash applied to walls, but not, as we think, correctly. In the passage of the tenth chapter of the fifth book of Vitruvius where he recommends the use of the albarium opus, for the ceilings of baths, he allows tectorium opus as a substitute, so that it was clearly a species of stucco. Its employment at the baths of Agrippa, knowing, as we do, the extent to which luxury was carried in the baths of the ancients, seems to prove that it was a superior sort of stucco, and it is by no means improbable that it was susceptible of taking a polish.

A'LBATROSS. (*See* DIOMEDEA.)

A'LBIGENSES. A sect which arose in the south of France in the latter half of the twelfth century. They have been confounded with the Waldenses, with whom, however, they do not appear to have had any real connection. Their tenets have been very differently described, and probably misrepresented, by their opponents; and great obscurity is thrown upon the subject, by the fact of the appearance of various dissenters from the church of Rome in England and elsewhere, about the same time, whose respective views have not been very accurately discriminated. It is probable that the reformers of the south of France opposed themselves originally to the corruptions in discipline, which began first at that period to draw general attention and animadversion upon the clerical order. Hence a very easy step would lead them to think slightingly of many ecclesiastical ordinances, and the ceremonial observances of religion would seduce them into the adoption of mystical notions about an internal light and assurance, and finally betray them into the wildest extravagancies. Thus they are charged with perpetuating the Manichean doctrines: but Bossuet, who accuses them of inclining to that system on certain points, acquits them of holding what is, after all, the distinguishing tenet of the Oriental heresy—the monstrous doctrine of the two principles.

The origin of the name is doubtful. The Latin name by which Narbonnese Gaul was known in the twelfth century, was Albigesium, which seems to put forth a better claim to the derivation than the town of Albi in Languedoc. In the year 1163, Alexander III. published a decree against these sectarians in a council held at Tours, and another in 1179. On neither occasion, however, did he invoke the assistance of the secular arm. At the close of the century, when the sect was still flourishing, and seemed to be more particularly under the protection of Raymond, count of Thoulouse, Innocent III. commenced the work of its extirpation. He appointed two legates to go through the country and excite the zeal of the clergy and laity against the innovators: he instituted the Dominican order of friars, purposely to preach them down; and finally, in 1207, he addressed himself to Philip Augustus, king of France, exhorting him to eradicate the heresy with the sword. The chief leader of the expedition, which soon assumed the character and name of a crusade, was Simon de Montfort, earl of Leicester, to whom the earldom of Thoulouse was promised by the pope as a stimulus to his exertions. In the siege of that city, however, he was killed. The contest, which was carried on with more or less vigour for many years, and which furnishes the first evidence of the disposition of the church of Rome to employ the extreme of violence against those who dissent from its doctrines, ended in the entire destruction of the Albigenses, about the middle of the thirteenth century. (*See especially* Sismondi, *Hist. des Français*, tom. vi.)

ALBI'NISM. A state in which the skin is white, the hair flaxen, and the iris pink. (*See* ALBINO.)

ALBI'NO. A term originally applied by the Portuguese to negroes who were born mottled or discoloured with white spots. It is now generally applied to persons of a preternatural whiteness of the skin and hair, and a peculiar redness of the pupil of the eye, which is so weak as to be of little use in broad daylight, so that albinos sleep in the daytime, and are only capable of seeing distinctly in the twilight or by moonlight. The disease appears to depend upon a deficiency or morbid state of the rete mucosum over the whole body.

A'LBUM. Literally means any thing white. The term is now generally applied to a book in which persons collect autographs, literary essays, &c. The prætor's album was a white board, on which the edicts of that functionary were inscribed.

ALBUM GRÆCUM. When dogs are fed upon bones, they digest the animal portion, and the earthy parts (chiefly phosphate of lime) are voided in the form of white excrement. This inert matter was formerly used in medicine under the above title.

ALBU'MEN. A peculiar animal matter entering largely into the composition of animal bodies, such as the blood, muscles, bones, &c.; also the chief component of white of egg, to which the term albumen was originally applied, and which well and familiarly illustrates its leading peculiarity, namely, that at a certain temperature it coagulates into a soft white solid, no longer soluble in water. It may be obtained pure by coagulating the white of egg by alcohol, washing it thoroughly with that fluid, and then carefully drying it at 120°. It then appears as a yellow, shining, transparent and brittle substance composed of—

Nitrogen	- -	1 atom	= 14	15·05
Carbon	- -	8	= 48	51·61
Hydrogen	- -	7	= 7	7·53
Oxygen	- -	3	= 24	25·81
		1	93	100·00

The albumen of birds' eggs coagulates at a temperature of 145° to 165°; and when dried, shrinks and becomes brittle and semitransparent, in all respects resembling horn. One hundred parts of the albumen of the hen's egg lose, upon careful drying, about 86 of water, and leave 34 of solid residue. Alcohol, most of the acids, and several metallic salts, also coagulate albumen, and some of the latter are very delicate tests of its presence in animal fluids: subacetate of lead, for instance, renders a solution of 1 part of fresh white of egg in 2000 of water turbid, so that it detects 1 part of dry albumen in 10,000 of water. Corrosive sublimate is also an excellent test of albumen, forming with it a white insoluble compound; hence white of egg has been proposed as an antidote in cases of poisoning by corrosive sublimate.

ALBUMEN. A solid fleshy, bony, or horny substance, secreted in some seeds between the embryo and the seed-skin. It is supposed to be intended for the nutriment of the young embryo when it first springs into life. The part that furnishes the flour of corn, the flesh of the cocoa-nut, the great mass of the seeds of coffee, are albumen. Botanists have remarked that this substance is never deleterious, however poisonous the plant may be by which it is borne.

ALBUMEN OF VEGETABLES. Is a proximate principle, having some of the leading chemical characters of animal albumen.

ALBU'RNUM. (Lat. alburnum, *sap-wood.*) The newly formed and soft part of the wood of exogenous trees, consisting of empty or nearly empty tubes and cells, the sides of which are thin and not indurated; however durable the timber of a plant may be, this part of it is in all cases perishable, the vegetable matter of which it consists having but little power of adhesion, and readily yielding up its carbon to the oxygen of the atmosphere, the consequence of which is speedy decomposition. It is only when the tissue of this part becomes consolidated by the addition of resins, tannin, and various other products, which change its colour from a pale yellow to various other deeper colours, that timber really becomes valuable. In some species this is effected rapidly, as in oak, teak, lignum vitæ, &c.; in others very slowly, or not at all, as in the poplar and willow. Hence the wood of the latter class of trees never acquires any durability. By some writers the alburnum is defined to be "wood only one year old;" this is, however, erroneous. It is through the alburnum principally that the ascending sap of a plant moves; the course of the sap is not, however, confined to the alburnum, but is effected wherever the woody tubes are sufficiently open for it to pass.

A'LCA. The name of a Linnæan genus of anserine birds, characterised by a short, compressed, vertically extended, convex beak, edged along the upper surface, and generally transversely furrowed; feet toti-palmate, and wanting the hinder toe. Recent ornithologists have divided the Linnæan awks or penguins into the subgenera fratercula and alca.

ALCABA'LA, or ALCAVA'LA. A tax formerly imposed in Spain and her colonies, consisting originally of 10, and subsequently of 14 per cent. ad valorem, on all property sold, and payable as often as it changed hands. This monstrous impost, by preventing the sale and transfer of property, necessarily proved in the highest degree injurious. (*See* Ulloa, *Rétablissement des Manufactures d'Espagne*, cap. 3.)

ALCA'LDE. A Spanish officer of justice; from the Arabic kadi, *judge*. In Portugal, Alcayde.

ALCALI'METER. A graduated glass tube employed in determining the quantity of real alkali in commercial potash and soda, by the quantity of dilute sulphuric acid of a known strength which a certain weight of these saturates.

ALCA'MPHORA. A Brazilian herb, the croton perdicipes, whose leaves are used in decoction against syphilis, and as a diuretic.

ALCANTA'RA, Order of: otherwise called of Saint Julian, or of the Pear-tree. An order of knighthood, instituted in 1156 at Alcantara, a town of Estramadura, by Hadrian II. king of Leon. The king of Spain is sovereign of this order

ALCARA'ZZA. A porous vessel used in Spain for cooling water by its transudation and consequent superficial evaporation.

ALCE'DO. (Lat. alcedo, *supposed to be the king fisher.*) The name of a Linnæan genus of picæ, charac

terised by a long, straight, angular and pointed beak; the tongue and tail very short. The feet have the structure which is the basis of Temminck's order Syndactyli, viz. the external toe is nearly as long as the middle one, and is united thereto as far as the penultimate articulation. The kingfisher, Alcedo ispida, is a familiar example of that genus. The Alcedo tridactyla, and some others, are remarkable for the absence of the inner toe; these have accordingly been separated from the Linnæan genus under the subgeneric term ceyx. A third subgenus, dacelo, receives the great laughing kingfisher of New Holland.

A'LCHEMY. An imaginary art, once much practised among modern nations, and even now perhaps not wholly exploded. The name is a mixture of Greek and Arabic; the last syllables being from the same root with *chemistry*, *chemist*, Fr. *chimie:* probably the verb cheein, *to pour*, although the intermediate stages of its derivation are disputed: the prefix being the Arabic article al, *the*. Whether alchemy was followed as an art among the classical ancients, seems questionable: some suppose it to have originated among the Arabs of the Califate. Its object was the production of gold and silver. The principle of the alchemists was, that the baser metals were all convertible into these two precious substances by a long series of processes. To this fundamental notion the common followers of the art added an infinity of fantastic imaginations respecting the influence of the planets, &c. in hastening or retarding the work. The instrument by which it was supposed that this mighty change was to be effected, was a certain mineral to be produced by these processes, which, being mixed with the base metal, would transmute it; and this was called the lapis philosophorum or philosopher's stone. Hence the term *adept*, adeptus, for him who was supposed to have attained the secret of alchemy; who had, in the Latin force of the word, gained or discovered the philosopher's stone. Innumerable instances are on record of persons who practised on the credulity of former times by professing to possess this stone, and who actually wrought the transmutation required; and it is supposed that the philosopher's stone employed by these personages was nothing more than an amalgam of gold, which, if projected into tin and cupellated, would leave a portion of the precious metal. Dr. Price, of Guildford, is said to have been the last person in this country who professed himself able to turn mercury into gold: he destroyed himself in 1782, to avoid, it was supposed, the detection of his deceptions. The alchemists, in the course of their endless experiments, are said to have served the cause of true science in many ways. To various adepts is ascribed the discovery of the concentrated acids and of phosphorus. Another object of the adepts, often pursued by them, together with their research after transmutation, was the discovery of the elixir vitæ, or supposed universal medicine. Alchemy is also denominated the Hermetic Art, from the imaginary sage, Hermes Trismegistus.

A'LCOHOL. A term of Arabic origin, implying the spirit, or essence, and originally applied to several chemical preparations. It is retained in modern chemistry to signify pure spirit of wine.

Fermented liquors were known in the earliest ages. The northern nations were probably acquainted with the art of obtaining spirits before the Greeks or Romans. Albucasis, in the twelfth century, taught the method of procuring spirit from wine; and Raymond Lully, in the thirteenth century, concentrated spirit of wine by carbonate of potash. The composition of alcohol was first accurately demonstrated by Lavoisier, and its analysis was perfected by Saussure.

Alcohol is exclusively produced by the process of fermentation: it is obtained in combination with water by distilling fermented liquors, such as wine, beer, wash, &c.; the liquor thus obtained (brandy, for instance, if from wine,) is redistilled, and the spirituous portion, being most volatile, first passes over; in this state it is called ardent or rectified spirit, and often contains acetic acid and a peculiar flavouring principle, probably of an oily nature: these are got rid of by redistillation with alkaline substances, charcoal, chloride of lime, &c.

Pure or absolute alcohol is obtained by distilling the purest rectified spirit off dry and warm carbonate of potash, or dry quicklime. The specific gravity of rectified spirit is 820 to 828; that of alcohol, 792, at the temperature of 60°.

Pure alcohol has an agreeable odour, a strong pungent taste, and is eminently intoxicating. It consists of

Carbon	- 2 atoms	= 12	52·18
Hydrogen	- 3	= 3	13·04
Oxygen	- 1	= 8	34·78
	1	23	100·00

Alcohol burns with a pale flame, and produces carbonic acid and water; the weight of the water thus formed to that of the alcohol consumed, is as 27 to 23. It produces no smoke or soot, and hence forms a cleanly lamp, giving much heat with little light. Mixed with water and certain vegetable substances, especially gluten, and exposed to air and a due temperature, alcohol becomes vinegar. It is the intoxicating principle of wine and of fermented and spirituous liquors, and of important use in medicine and in some of the arts, being the solvent of various resins for varnishes, &c. When alcohol and water are mixed, heat is evolved, and condensation ensues, and it is some hours before the two liquids perfectly unite. So that the bulk of a pint of alcohol and a pint of water falls far short of two pints. A series of tables by Mr. Gilpin will be found in the Philos. Trans. for 1797, exhibiting much information upon the subject of the specific gravities and composition of various mixtures of alcohol and water,—a subject of great importance, as bearing upon the levying of duties upon spirituous liquors.

Alcohol has never been frozen; hence its use in the construction of thermometers for measuring low temperatures. It boils at the temperature of 176°, and is converted into a vapour, the specific gravity of which is to that of air as 16 to 10.

A'LCOHOLATES. Salts in which alcohol appears to replace the water of crystallisation.

A'LCORAN, or ALKORAN. (Al Koran, or *the Book*, Arabic.) The sacred book of the Mohammedans; which, according to their belief, was dictated to their prophet by the angel Gabriel. The Koran consists of 114 chapters; which are distinguished, not by their numerical order, but by certain titles, under which they are respectively known. Every chapter is divided into smaller portions, analogous to the verses of our Scriptures. There are, however, seven principal ancient copies of the Koran; and in all of these the number of verses is not the same. The Koran is written in what may be termed a species of chiming or jingling prose. It is regarded among the Mohammedans as in itself a standing miracle, and a proof of the truth of their religion; and hence the division between those who believe the Koran to be eternal and uncreated (the Sonnites or orthodox), and various sects of heretics.

ALCO'VE. (Alcoba, Sp., Elcaut, Arab., *a sleeping chamber.*) In Architecture, that part of a sleeping chamber where the bed is placed. The use of alcoves, though not by that name, is ancient. They were frequently designed in the form of a niche; such, for instance, as those that Winckelman notices at Hadrian's villa at Tivoli, of which species some are also to be seen at Pompeii. They were often formed by an enclosure or balustrade, sometimes high and sometimes low, through which, by means of draperies, this part was separated from the large chamber, whereof it was a part. A notion of it may be obtained from many of the ancient bassi rilievi, especially from the celebrated one known by the name of the Nozze Aldobrandine. In modern architecture, this part of a room differs according to the rank and taste of the proprietor; in England it is rarely used, but in France and Italy it forms frequently a beautiful feature in the apartments of their palaces.

A'LCYONITES. A collective term for the fruit-like spongiform flint fossils common in chalk formations.

ALCYO'NIUM. A Linnæan term for an aggregate genus of marine polypes, having a fleshy, coriaceous, spicular axis, beset with stellate cells, containing each a polype with eight radiate denticulate arms. The axis is fixed to foreign bodies, and in some species rises in short branches or lobes, as in that commonly known by the name of "Dead Man's Hand" (Alcyonium digitatum, *Lin.*; Lobularia digitata, *Lam.*)

A'LCYONS. (Gr. ἀλκυων, *a kingfisher.*) The name given by Temminck to an order of birds of which the kingfisher (alcedo) is the type.

A'LDER. (Ellarn in Anglo-Saxon.) A native tree belonging to the natural order Betulaceæ. It is chiefly found in damp situations, and is of little value except for hurdle wood, and for the manufacture of charcoal.

A'LDERMAN. Originally written ealdor-man, meaning elder-man, which was used in the earlier parts of the Saxon period as a name of dignity unconnected with office; it was also the original title of the officer who was subsequently styled earl, whence counties were sometimes called alderman-shires. It seems also to have been the designation of the chief magistrate or judicial functionary of minor districts, in which sense it first appears in connection with boroughs. Its application is now confined to the class of municipal officers in a borough next in order to the mayor. By 5 & 6 W. 4. c. 76., the aldermen are to be in number one-third of the councillors in every borough (London alone being excepted from the provisions of the act), one part to be elected triennially, on the 9th of November, from among councillors or persons qualified to be such; and to form, with the mayor and councillors, the council of the borough.

A'LDINE EDITIONS. In Bibliography, those which proceeded from the press of the family of Aldus Manutius. The first of that name established his press at Venice, not

long after the year 1490; and to his industry and zeal we owe several of the first editions of Greek authors, and many other valuable works. The Italic characters used in Roman printing by Aldus and his family, first appear in his Virgil of 1501; and from that period a series of works, chiefly classical, both Greek and Latin, proceeded from his press in a duodecimo form: these are the best known and most common Aldine editions. The family press is said to have been broken up in 1597, after producing 908 editions. There are, however, Venetian publications of the beginning of the 17th century which bear the impress of the Aldine family (an anchor and dolphin engraved on the last page). A branch of the Aldine press was for a short period established in Rome. (*See* Raynouard, *Annales de l'Imprimerie des Aldes.*)

ALE. *See* Beer.

ALEATO'RIUM. (Lat.) In ancient Roman architecture, an apartment appropriated to the use of players with dice or aleæ.

ALECTO'RIDES. (Gr. ἀλεκτωρ, *a cock.*) A tribe of rasorial or gallinaceous birds, including the curassow, and the species which, like it, resemble the common fowl in the form of the beak.

ALE'MBIC. (From the Arabic particle al, *the*, and ambeeq, corrupted from the Greek word ἀμβιξ, *a cup or vessel.*) An obsolete form of still. Constructed upon a small scale in glass, it is sometimes used in the laboratory.

ALE'MBROTH, or Salt of Wisdom. A term applied by the old chemists to a salt composed of ammonia, muriatic acid, and oxide of mercury. It is poisonous.

ALEXA'NDRIAN SCHOOL. An academy for literature and learning of all kinds, instituted at Alexandria by Ptolemy, son of Lagus, and supported by his successors. The grammarians and mathematicians of this school were particularly celebrated. In the former class occur the noted names of Aristarchus, Harpocration, and Aristophanes; and among the latter were numbered the astronomer Ptolemy, and geometer Euclid. The grammarians of Alexandria exercised a universal literary jurisdiction, publishing canons of those who were to be considered standard authors, and revised editions of ancient writers. For some account of the famous collection of books at Alexandria, *see* Library.

ALEXA'NDRINE. The French heroic verse of twelve syllables or six Iambic feet. In English poetry it is occasionally used: by Dryden, sometimes as a second line in a heroic couplet, more frequently as a third line in a triplet; and the Spenserian stanza necessarily concludes with an Alexandrine. The lines of Pope, defining the Alexandrine by an example, are well known:

"A needless Alexandrine ends the song,
Which, like a wounded snake, drags its slow length along."

ALEXIPHA'RMIC. (Gr. ἀλεξω, *I avert*, and φαρμακον, *a poison.*) Antidotes to poisons.

ALEXITE'RICS. (Gr. ἀλεξω, *I avert.*) Preservatives against contagious and infectious diseases and the effects of poisons in general.

A'LGÆ. (Lat. alga, *sea-weed.*) Plants which are destitute of all signs of sexual organs, and which vegetate exclusively under water. When they grow in salt water they are called sea-weeds, when in fresh water they are named confervæ. They comprehend in the division Zoospermeæ some of the lowest known forms of vegetable life, plants consisting of simple cells adhering in different degrees, and emitting at maturity spores or seeds having a distinct animal motion. In the case of Oscillatorias, the whole mass of the plant writhes and twists spontaneously; and Zysmenas actually copulate. It is in this part of the vegetable kingdom that plants approximate to animals in the most striking degree. An excellent account of the salt-water species is given in Greville's Algæ Britannicæ; the fresh-water kinds may be studied in the third volume of the English Flora.

ALGARO'BA. (Arab. al, *the*, and garoba, *a bean-tree.*) A tree found in the southern parts of Europe, and in Palestine, having pods filled with a sweetish nutritious powder: they are supposed to have been the locusts on which St. John fed in the wilderness. It is the ceratonia siliqua of botanists.

A'LGAROTH, POWDER OF. The white powder which falls when chloride of antimony is dropped into water: it is a submuriate of antimony, virulently purgative and emetic.

A'LGEBRA. An important branch of the mathematical sciences, and may be defined to be the method of calculating indeterminate quantities. It is a sort of universal arithmetic, founded on the same principles as common arithmetic, and proceeding by rules and operations precisely similar. But it is not confined merely to questions relating to numbers, being applied generally to investigate the relations that subsist among quantities of all kinds, whether arithmetical or geometrical. The reasoning is carried on by general symbols; and it is to the complete system of notation, which has been introduced by its successive cultivators and improvers, that it owes its immense superiority over the ancient analysis.

The symbols employed in algebra are of two kinds: those which denote quantities; and those which denote the affections or relations, or properties of quantities, and operations to be performed on them. For representing quantities or magnitudes, the letters of the alphabet are employed. Thus, in the solution of an arithmetical problem, a number may be represented by the letter a; in geometry, a may represent a line or an angle; in mechanics, a force. The relations of quantities are expressed by other conventional symbols. The relation of equality is expressed by the sign $=$; thus, to express that the quantity represented by a is equal to the quantity represented by b, we write $a = b$. The symbol $>$ or $<$ coming between two quantities denotes inequality; thus, $a > b$ signifies that a is greater than b, and $a < b$ denotes that a is less than b. The two primary operations of which quantities are susceptible, are addition and subtraction, and these are respectively indicated by the symbols $+$ plus, and $-$ minus. For example, $a + b$ denotes the sum of the two quantities a and b, or that a is to be increased by b; and $a - b$ denotes the difference between a and b, or that a is to be diminished by b. Multiplication is indicated by the symbol $\times$, or by simply placing the letters beside each other without an intervening symbol. Thus, in numbers, $a \times b$ or $a\,b$ denote the same thing, namely, the product arising from the multiplication of the number a into b. In geometry, two letters joined together, as $a\,b$, denote a rectangular parallelogram, one of the sides of which is represented by a, and the other by b. Division is indicated by $\div$; or more frequently by placing one of the numbers above the other in the form of a fraction; thus:

$$30 \div 10, \text{ or } \tfrac{30}{10}.$$

In addition and subtraction, the quantities connected by the appropriate symbols must be homogeneous, or of the same kind; for it is only such quantities that admit of addition or subtraction. Of two quantities connected by the symbol of multiplication, one must necessarily be an abstract number, for a quantity can only be multiplied by a number, or, which is the same thing, added to itself once or twice, or some other number of times. When division is to be performed, the divisor may either be a quantity of the same kind as the dividend, or it may be an abstract number; in the former case, the quotient is an abstract number; in the latter, it is a quantity of the same kind as the dividend.

In the multiplication of quantities, the frequent repetition of the same symbol would become inconvenient; it is usual, therefore, to write the root only once, and to place over it, on the right, the exponent or number indicating the power: thus, a^2 denotes the same thing as $a\,a$, or the square of a; a^3 is the same as $a\,a\,a$, or the cube of a, and a^n denotes the nth power of a, or a multiplied by n times into itself. By analogy, $a^{\frac{1}{2}}$ denotes the square root of a; $a^{\frac{1}{3}}$ the cube root of a, and so on. (*See* Notation, Symbol.)

Algebra is in its nature essentially distinct from arithmetic. In arithmetic absolute numbers are given, from which other absolute numbers are required to be determined. But in algebra the symbols that are employed are perfectly general, and may represent any numbers whatever; and the expressions which result from combining them according to the conditions of the problem, indicate the solution not of a particular question, but of all questions whatever, in which numbers are subjected to the same series of operations. In this manner the general properties of numbers are discovered. For example, the expression $(a + b)\,(a - b)$, which signifies that the sum of the two numbers a and b is to be multiplied by their difference, becomes, on performing the multiplication, $a^2 - b^2$; whence we infer this general or universal truth, namely, that the product of the sum and the difference of any two numbers, is equal to the difference of the squares of those numbers. Arithmetic could only prove the property to be true in respect of particular numbers. The systematic notation, to which algebra owes nearly the whole of its power as an instrument of research, is only of recent introduction. Indeed, the science itself, if known at all to the ancient Greek mathematicians, was known only as a higher species of arithmetic. The first writer on the subject, with whose works we are acquainted, is Diophantus, who lived about the middle of the fourth century of our era, and his work relates only to a peculiar class of arithmetical questions, in the solution of which he displayed considerable address, but the symbols which he used were only abbreviations (such as the initial or terminating letters) of the ordinary words. The treatise of Diophantus passed into the hands of the Arabians; but algebra received from them no improvement or extension. From the Arabians, it was transplanted into Italy, in the beginning of the 13th century, by Leonardo Bonacci, a merchant of Pisa, who had travelled frequently in the East, and become acquainted with the science of those countries. A treatise on arithmetic, comprehending algebra as it was then

known, was written by him in the year 1202, and from that time the science appears to have been cultivated with some assiduity in Italy. The earliest printed book on the subject was composed by Lucas Paciolus, or Lucas de Burgo, a minorite friar, and appeared in 1494. It contains a pretty complete treatise on algebra for the time; but exhibits the science in nearly the same state in which it was left by Diophantus. Its application was confined to questions relating to numbers of no great interest, and its power extended only to the solution of equations of the first and second degrees. But after this epoch it began to be cultivated extensively, and to undergo rapid improvement. Scipio Ferreus, a professor of mathematics at Bononia, about the year 1505, first broke through the boundary within which it had so long been confined, and accomplished the solution of a problem of the third degree. A general method of solving cubic equations was soon after discovered by Tartalea, who communicated it, under an oath of strict secrecy, to the celebrated Cardan. Presuming on some improvements he had made in the rules given to him by Tartalea, and on the demonstrations which he certainly had the merit of inventing, Cardan, with a remarkable (though, unfortunately, in the history of science not singular) instance of bad faith, published the whole as a supplement to a treatise which he had composed several years before. Cardan, however, considerably extended the methods given to him by Tartalea, and, besides, contributed to improve the notation, by frequently employing the letters of the alphabet. Lewis Ferrari, a disciple of Cardan, had the honour of making the next important improvement in the science, by the discovery of a method of solving biquadratic equations, or equations of the fourth degree; and it is remarkable that all the efforts of modern mathematicians have not yet been able to pass this barrier, or effect the general solution of equations of a higher order than the fourth.

The first great step to the improvement of algebra, by the introduction of a concise and systematic notation, was made in Germany, by Stifel, or Stifelius, a protestant minister, whose work, "Arithmetica Integra," was published in 1544. Stifel adopted the symbols $+$ and $-$ for plus and minus, to represent addition and subtraction, and also $\surd$ (the contraction of r) for radix, or root: he likewise introduced the numeral exponents of the powers, $-3, -2, -1, 0, +1, +2, +3$, &c. The symbol $=$, denoting equality, was first used by our countryman, Robert Recorde.

In following the chain of the principal discoveries, our attention is next arrested by Vieta, a native of France, who first applied algebra to the improvement of geometry, and thereby laid the foundation of the modern analysis. He was also the first who employed general symbols to represent known, as well as unknown, quantities, and thus introduced what has been called the specious algebra, in contradistinction to the literal, where known quantities are represented by numbers. This improvement, simple as it may appear, was attended by important consequences, as it rendered the methods quite general, and enabled the algebraist to comprehend whole classes of problems in a single formula. Vieta likewise gave a method of solving algebraic equations by approximation; and from his doctrine of angular sections have been derived the arithmetic of sines, and some of the most valuable processes of trigonometry.

Vieta was followed by Albert Girard, who first showed the use of the negative sign in the solution of equations; and by Harriot, to whom the science is indebted for the very important discovery, that every algebraic equation may be regarded as the product of as many simple equations as there are units in the number expressing its order. An equation, for instance, of the fifth degree may be regarded as the product of five simple equations. Descartes followed soon after, and opened up vast fields of discovery, by the application of the algebraic analysis to define the nature and investigate the properties of curve lines. By referring every point of a curve to co-ordinate or perpendicular axes, he expressed the relation between its different points by means of an equation, which served as a characteristic to distinguish the curve, and from which its different properties could be investigated by the ordinary operations of algebra. Descartes also pointed out the method of constructing or representing geometrically, equations of the higher orders; gave a rule for solving a biquadratic equation by means of a cubic and two quadratics; and improved the methods of reducing and treating equations which had been adopted by Cardan, Girard, Harriot, and others who had preceded him.

Algebra, as a science, has undergone no revolution since the time of Harriot and Descartes; but it has been improved in all its details, and greatly varied and extended in its applications. During the last century, and the latter part of the preceding, the method of infinite series, so useful in many applications of mathematics, particularly in the calculation of probabilities, was successfully cultivated by Wallis, Newton, the Bernoullis, Euler, De Moivre, Stirling, Simpson, and others. The nature and composition of algebraic equations has been fully investigated, and the methods of approximating to their roots reduced to order and system. The investigation of the relations of angular sections, begun by Vieta, conducted Euler to the arithmetic of sines and a complete theory of plane and spherical trigonometry. Applied to problems concerning the motion of bodies or points, algebra has given rise to the doctrine of fluxions, and the refined methods of the differential and integral calculus. It has completely superseded the use of the elegant, but comparatively feeble, ancient analysis, and may be now regarded as forming the basis of the whole edifice of mathematical science. (*See* BINOMIAL THEOREM, EQUATION, NOTATION.)

ALGEBRA'IC CURVE. A curve of which the relation between the abscissa and the ordinates is expressed by an equation which contains only algebraic quantities. The term algebraic is here used in contradistinction to transcendental, under which is comprehended infinite series and quantities of the following kind: log. x, a^x, sin. x, cos. x, tan. x, &c.

ALGEBRAIC EQUATION. An equation of which the terms contain only algebraic quantities. (*See* EQUATION.)

A'LGORITHM, signifies the art of computing in reference to some particular subject, or in some particular way; as the algorithm of numbers; the algorithm of the differential calculus.

A'LGUAZIL. A Spanish officer corresponding with the English bailiff, having power to place persons in custody, and apprehend criminals.

A'LIAS. (Lat. *otherwise*.) In Law, when a defendant sued on a specialty, or a prisoner, had more than one common appellation, he was designated in the Latin forms of instruments, as "A. alias dictus B." When it is necessary for a second writ of the same description with a former one to issue, it is headed "alias," as, an alias capias, &c.

A'LIBI. (Lat. *elsewhere*.) A cant law phrase, used to express the species of defence set up by one charged with a criminal offence, who offers evidence to prove that he was elsewhere at the time of the act committed.

A'LIDADE. An Arabic name given to the index or ruler which moves about the centre of an astrolabe or quadrant, carrying the sights or telescope, and showing on the limb of the instrument the number of degrees and minutes the object observed is elevated above the horizon.

A'LIEN, generally speaking, is one born in a country out of the allegiance of the sovereign, unless his father were a natural born subject, in which case he will himself be deemed a natural born subject, to all intents and purposes. An alien in England cannot hold landed property, but he may hold and dispose of, by will or otherwise, goods, money, or other personal estate, and may take a lease of a house for habitation or trade. An alien may, by letters patent, become a denizen, and take lands by purchase; or he may be naturalised by act of parliament, and so take by inheritance. In either case he becomes an English subject, but, nevertheless, cannot be a member of the privy council or parliament. (*See* DENIZEN.)

ALIEN WATERS. Any stream of water carried across an irrigated field or meadow, but which is not employed in the process of irrigation.

ALIENA'TION. In Law, the act of parting with property: more especially real property. The alienation of real property takes place by deed, or in pais. (*See* REAL PROPERTY.)

ALIME'NTARY CANAL. A cavity in the interior of an animal body in which the nutriment is taken to be digested, before it is conveyed by the nutritive vessels to the system: it affords the best organical characteristic of an animal, but presents various modifications of structure. Sometimes it is a simple cavity with one opening; sometimes a true canal, with an outlet or anus, distinct from the inlet or mouth; this canal may be divided into stomach and intestine, as in the oyster; or a mouth, pharynx, and œsophagus may precede the stomach; the œsophagus, again, may have one or two sacculi appended to it, called crops. The stomach may be subdivided into four bags, as in the ruminants, or into seven, as in the bottle-nose whale; and the intestines into small, blind, and large, forming, with their subdivisions, what are termed duodenum, jejunum, ileum, cæcum, colon, and rectum. The cæcum, again, may be single, or double as in most birds; or a single cæcum may exist in addition to a double one, as in the hyrax, a small pachydermatous quadruped. Lastly, the various glandular organs which communicate with the alimentary canal are to be regarded as cæcal processes of that tube, since these are developed from it, and in this condition they are permanently retained by one or other of the lower animals: thus, in the sea-mouse, the liver is represented by long, branched, lateral processes of the intestine; in the cod fish, &c. the pancreas is similarly represented by numerous cæcal processes of the duodenum.

A'LIMONY. In Law. The allowance for which a

married woman is entitled to sue on separation from her husband. (*See* MARRIAGE.)

A'LIQUOT PART of a number. A number which divides the given number without leaving a remainder. Thus 2, 3, 4, and 6, are aliquot parts of 12. To find the aliquot parts of any number, divide the given number by its least divisor; divide the quotient also by its least divisor, and so on, always dividing the last quotient by its least divisor till the quotient is 1. The divisors thus used are the prime aliquot parts of the given number; and the products of every two, every three, every four, &c. of the prime aliquot parts, give the compound aliquot parts of the given number. Suppose the given number 30; divide 30 by its least divisor, which is 2, and the quotient is 15; divide 15 by its least divisor 3, and the quotient is 5; divide 5 by itself (it has no smaller divisor) and the quotient is 1. Therefore, 2, 3, and 5, are the prime aliquot parts of 30. The compound aliquot parts are, $2\times3=6$, $2\times5=10$, $3\times5=15$.

ALISMA'CEÆ. (Alisma, from alis, *water*, in Celtic.) A small natural order of endogenous plants, marked by the presence of numerous distinct carpels in a tripetaloideous flower. They form a near approach to ranunculaceæ among exogens. Alisma and sagittaria are common genera.

ALI-TRUNCK, ALITRUNCUS. In Entomology, the posterior segment of the thorax of an insect to which the abdomen is affixed, and which bears the legs, properly so called, or the two posterior pairs, and the wings.

ALIZARINE. From Ali-zari the commercial name of madder in the Levant; a peculiar colouring principle obtained from madder.

A'LKAHEST. A term of obscure Arabic origin, applied by the alchemists to a supposed universal solvent.

A'LKALI, or ALCALI, derived from the Arabic article al, and kali, the name of a plant in the same language. A term originally applied to the ashes of plants; now generally used to designate potash, soda, and ammonia, which are also termed vegetable, mineral, and volatile alcali. These substances have certain properties in common, such as neutralising and forming salts with the acids, reddening several vegetable yellows, and changing some blues to green, and ready solubility in water. Lime, baryta, strontia, and magnesia, have been called alcaline earths, from their analogous action on vegetable colours. Lithia is also one of the alcalis. A singular class of bodies have been discovered in vegetables which have been termed alcalis, or alkaloids, chiefly in consequence of their power of saturating and forming definite salts with the acids. Morphia, quinia, &c. are substances of this description.

ALKALI, FOSSIL or MINERAL. Soda.

ALKALI, PHLOGISTICATED. Ferrocyanuret of potassium.

ALKALI, VEGETABLE. Potash.

ALKALI, VOLATILE. Ammonia.

A'LKALOI'DS. Substances analogous to alcaline bases of vegetable origin, and generally possessed of great medicinal activity. Their ultimate elements are carbon, hydrogen, oxygen, and nitrogen. The principal substances of this class, together with the plants from which they are obtained, are the following:—

Aconita - -	Aconitum napellus.
Aricina - -	A bark from Arica.
Atropia - -	Atropa belladonna.
Brucia - -	Strychnos nux vomica.
Cinchonia - -	Cinchona lancifolia.
Codeia - -	Opium.
Conia - -	Conium maculatum.
Corydalia - -	Corydalis tuberosa.
Cynapia - -	Æthusa cynapium.
Daturia - -	Datura stramonium.
Delphia - -	Delphinium staphisagria.
Digitalia - -	Digitalis purpurea.
Emetina - - -	Cephaelis ipecacuanha.
Hyoscyamia - -	Hyoscyamus niger.
Meconia - -	Opium.
Morphia - -	Opium.
Narcotina - -	Opium.
Nicotina - -	Nicotiana tabacum.
Picrotoxia - -	Menispermum cocculus.
Quinia - - -	Cinchona cordifolia.
Sanguinaria - -	Sanguinaria canadensis.
Solania - -	Solanum nigrum.
Thebaia and Narceia	Opium.
Veretria - -	Veratrum sabadilla.

A'LKANET. (A corruption of the French *orcanette; orca, a rouge pot.*) A kind of reddish purple dye, obtained from the roots of Anchusa tinctoria: it was formerly used for staining the face.

ALKANET. The Anchusa tinctoria. The root of this plant, which is a native of the warmer parts of Europe, contains a red resinous colouring matter which it imparts to alcohol and oils: it is used to tinge some ointments, especially lip-salves, of a red colour.

ALKOO'L. A preparation of antimony used by the women of eastern nations, to tinge the eyelids and lashes of a black colour. Dr. Shaw, speaking of the women in Barbary, says, " None of these consider themselves dressed, till they have tinged the edges of their eyelids with alkoohl. "

A'LLA BREVE. (Ital. according to the breve.) In Music, the name of a movement whose bars or measures consist of the note called a breve, equal therefore to two semibreves or four minims. It is denoted at the beginning of a staff by a C with a bar drawn through it vertically.

A'LLA CAPELLA. (Ital. according to the chapel.) In Music, the same as alla breve. The name originates in the circumstance of this time being principally employed for movements used in the church or chapel.

A'LLAH. The Arabic name of the Supreme Being. It signifies the True God, as opposed to the deities of idolaters.

A'LLANITE. A silico ferriferous oxide of cerium from Greenland; named after the late Mr. Allan of Edinburgh.

ALLA'NTOIC ACID. A white crystallisable acid, obtained by evaporating the allantoic liquid of the fœtal calf.

ALLA'NTOIS. (Gr. *αλλας, a sausage* and *ἑιδος, form.*) A thin membranous sac developed from the termination of the alimentary canal of the embryo, situated between the amnion and chorion, and organised by the hypogastric arteries and umbilical vein. Its function, as a temporary respiratory organ, is of most importance in those oviparous vertebrates where the embryo has no branchiæ; in the mammalia, its use is more or less superseded by the chorion and placenta. In some quadrupeds the allantois has the form of a sausage; whence its name.

ALLE'GIANCE. (Fr. ligence, from the Latin ligare and allegare, *to bind.*) The obedience which a citizen owes to his prince or country. The allegiance of a born subject of the English Crown is inseparable, and follows him every where: nor can he by any act of his own free himself from it. There is also a temporary allegiance, which foreigners incur so long as they reside within the king's dominions. By common law, all persons above the age of twelve years were required to take the oath of allegiance at the court leet; and the oaths of allegiance and supremacy have since been imposed by many statutes. The present form of the oath of allegiance was introduced by the Convention Parliament of 1688. In the United States, it appears to be regarded as a doubtful point, whether the allegiance of the citizen is necessarily perpetual, as with us. The American laws also require a foreigner to have renounced (as far as possible by his own act) allegiance to his former government, two years before he takes the oath of allegiance to that of his acquired country.

A'LLEGORY. In Rhetoric and Literature (from the Greek words *ἀλλο, another thing*, and *ἠγορεω, I declare.*) has been defined, " a figurative representation, in which the signs (words or forms) signify something beyond their literal or direct meaning. In this sense allegory may be addressed to the eye, in painting and sculpture, by means of forms, intended to convey, besides the notion of those sensible objects which they represent, certain abstract ideas to which these objects are supposed to bear analogy. Allegory differs, 1. from symbolical writing or representation; because in the first, the type and antitype, or thing exhibited and thing intended, have some real or natural resemblance, relation, or analogy: in the latter, the resemblance is merely conventional. Thus, to take an instance from modern literature: if it be true, as is now alleged, that the earlier Italian poets of the middle ages, and Dante in particular, attached a conventional meaning to certain ideas frequently recurring in their poems; as, for example, that Satan signified the papal power,—the three beasts mentioned in the commencement of Dante's poem three States — love, loyalty to the emperor, &c. &c.; then their poems, considered with reference to this occult sense, must be regarded as specimens not of allegory but of symbolical writing. But if, as in the more ordinary interpretation of Dante's poem, Satan represents the abstract idea of eternal misery, the beasts particular vices, &c., which in common acceptation are supposed to have some natural analogy with their representatives, the poem is in this respect to be regarded as an allegory. Thus, also, critics have endeavoured to give a symbolical sense to the sixth book of Virgil's Æneid; while, independently of that sense, if it really exist, there is an obvious allegorical meaning running through the whole. (In ancient criticism, however, the words allegory and symbol were not so accurately distinguished; and in our translation of the Bible, St. Paul is made to use the word allegory in the clear sense of type. Gal. iv. 24.) Allegory differs, 2. from parable, only inasmuch as the latter is a species of the former: a parable being a short, sententious, allegorical narration. And, 3. it is different from metaphor, being in effect a chain of metaphors, or a single metaphor continued and wrought out into a lengthened discourse.

4. Fables may also be mentioned as a species of allegory. (*See* FABLE.) An allegory, or allegorical tale, in the somewhat narrower sense in which the term is used in literature, is generally a tale in which abstract ideas are personified: such (to cite one of the earliest instances of this species of composition) as the Choice of Hercules, or human youth, between virtue and vice, in the shape of two females: an allegory which descends to us from Greek antiquity. Entire poems are sometimes strictly allegorical, as that of Spenser; or entire narratives, as Bunyan's Pilgrim's Progress; in which case it requires consummate art to keep up the propriety of the allegory, which is in fact a compound of two opposite, and sometimes scarcely compatible, qualities—consistency running through its several incidents, when considered merely as a narrative and without reference to the ulterior meaning, and consistency of analogy between the thing represented and the thing answered.

ALLEGR'ETTO, and ALLEGRO. (Ital. *a little merry*, and *merry*.) In Music. The first term is a diminutive of the second, which, prefixed to a movement, signifies that it is to be performed in a brisk and lively manner; not, however, with hurry or precipitation, but quicker than any other time in music, except that marked presto. The different times used in music are arranged as follows: proceeding from slow to quick, namely grave, adagio, allegretto, allegro, and presto. The word più, *more*, added to any of these, and the word poco, *little*, strengthen the significations in their various kinds.

A'LLEMAND. (Fr.) In Music. A species of slow grave music or movement in common time and performed slow. From its name it would seem to belong to Germany, but it is now altogether disused.

ALL-HA'LLOWS. The old English name for All Saints' day (the 1st of November).

ALLIA'CEOUS. (Lat. allium, *garlic*.) Any thing having the smell of onions or garlic.

ALLIACEOUS PLANTS. Plants which partake more or less of the qualities of garlic and onions; such as onions, shallots, rocambole, chives, leeks, garlic, &c.

ALLI'ANCE. In Politics and International Law, a league between two or more friendly powers; which may be either offensive and defensive, or defensive only. Of the former species is the alliance of 1813 against Napoleon, subsequently called the Holy Alliance. Of the latter, the Quadruple Alliance, concluded in 1833 between England, France, Spain, and Portugal. Alliances are divided by publicists into three classes. 1. Those in which the allied parties agree to prosecute a war with their whole force. 2. Alliances in which auxiliary states pledge themselves to grant to a principal state a fixed contingent of men, money, &c. 3. Treaties to furnish troops for stated subsidies, to make advances of money, &c.

ALLIGA'TION. (Lat. alligo, *I bind*, or *tie together*.) A rule of Arithmetic, for the solution of questions concerning the compounding or mixing together of different ingredients, or ingredients of different qualities. There are two cases, one of which is alligation medial, and the other alligation alternate. To the first case belongs a question of this sort: Suppose 4 gallons of wine at 12 shillings per gallon, to be mixed with 6 gallons at 17 shillings per gallon, what is the worth of a gallon of the mixture. But if it were asked, how many gallons of wine, at 17 shillings per gallon, must be mixed with 4 gallons at 12 shillings per gallon, in order that the worth of a gallon of the mixture may be 15 shillings, the question would belong to alligation alternate. Questions of this kind are, however, most easily resolved by elementary algebra; of which they form an easy class of indeterminate problems, admitting in general of an indefinite number of solutions.

A'LLIGATOR. (A corruption of the Portuguese word 'lagarto,' which is derived from lacerta, *a lizard*.) In modern Zoology, the term is limited to those species of crocodile which have a wide obtuse muzzle, unequal teeth, the fourth pair of which, counting backwards in the lower jaw, pass into corresponding cavities in the upper jaw, where their points are concealed when the mouth is closed. In the true crocodiles, the corresponding teeth pass into open grooves in the margin of the upper jaw, and are consequently exposed. In the alligators the head is less oblong, its length being generally as to its breadth as 3 to 2: the teeth are more numerous than in the crocodiles, sometimes amounting to twenty-two in the lower jaw, and to twenty in the upper. The hind legs and feet are rounded, and have neither crests nor dentations; the interspaces of the toes are only occupied for half their extent by a short membrane. The alligators, so far as is yet known, are peculiar to the New World.

ALLITERA'TION. In Composition. The frequent recurrence of the same letter, chiefly at the commencement of different words. This is sometimes resorted to, especially in poetry, for the production of effect. In the Celtic languages, alliteration was a recognised ornament in versification: it was so likewise in the early Gothic tongues; and in old English there are entire poems composed in alliterative metre, of which the celebrated Vision of Piers Ploughman is the most remarkable.

ALLOCA'TION. In Law. The allowance of an account in the Exchequer. The writ *de allocatione facienda* is for allowing an accountant sums expended by him in his office. The certificate of allowance of costs of taxation granted by the master, prothonotary, or other officer of court, is termed in practice an *allocatur*.

ALLO'CHROITE. A massive mineral allied to the garnet. Melted with phosphate of soda before the blowpipe, it exhibits several changes of colour, hence its name, from ἀλλος, *another*, and χροια, *colour*.

ALLO'DIUM. In feudal Law. A word of uncertain derivation (deduced by some writers from the old Teutonic "aloud," denoting the antiquity of the tenure). Land held by an individual in his own absolute right, discharged of all feudal obligation: opposed, therefore, to fee, fief, or feud. No allodial property can exist in England, where the king, in the eye of the law, is lord paramount of all lands and hereditaments. In ancient France the rule was, "nulle terre sans seigneur," and the presumption was in some parts of that country always in favour of a fief, unless the land were shown to be allodial. In Germany, on the contrary, the legal presumption was in favour of the allodium.

ALLO'TMENT OF LANDS. Any piece of land, set apart or allotted for any particular purpose. When more land is laid to a cottage than suffices for a garden, it is commonly called a cottage allotment.

ALLOY', or ALLAY. (From the French verb alloyer, *to mix one metal with another, in order to coinage;* derived perhaps from *à la loi*, the proportions of the metals being regulated by law; perhaps from allier, *to unite;* or allocare, *to put together*.) A term applied to compounds of the precious metals with others of less value, or to the least valuable of the metals in such compounds: thus, gold is said to be alloyed with silver, and silver with copper. Chemists generally apply the term to all combinations obtained by fusing metals with each other: thus, brass is an alloy of copper and zinc; and bronze, of copper and tin; except when mercury is one of the combining metals, in which case they call the compound an amalgam. Many of the alloys are importantly useful in the arts: thus, gold and silver, which in their pure state are too soft and flexible for the manufacture of plate, coin, trinkets, &c., are hardened by the addition of a certain portion of copper; while their colour and other valuable qualities are not materially impaired. The standard gold in circulation in this country, is an alloy of 11 parts of pure gold, and one of copper. Sometimes the alloy consists partly of silver, especially in the older coins; and it is to the preponderance of one or other of these alloys that the different colour of gold coin is owing; the paler containing silver, the deeper coloured, copper. A little palladium is sometimes present, which gives the gold a disagreeable brownish hue, as seen occasionally in some sovereigns. Our standard silver, used for coin, consists in 12 parts, of $11\frac{2}{20}$ silver, and $\frac{18}{20}$ copper: in these alloys it is necessary to employ copper of the utmost purity; for a very minute portion of some of the other metals, especially of lead, renders the precious metal brittle. The silver alloy used for plate is the same as that for coin, and the purity is guaranteed by the stamp of the Goldsmiths' Company. The subject of alloy for coin underwent an elaborate investigation at the beginning of the present century by order of government; the inquiry was intrusted to Mr. Cavendish and Mr. Hatchett, and the latter gentleman has published a valuable account of his experiments in the "Philosophical Transactions" for 1803, to which the reader is referred.

Some curious circumstances ensue in the combination of metals, as affecting their densities; the specific gravity of an alloy being sometimes greater and sometimes less than the mean of its components,—showing that in some cases expansion has taken place, and in others contraction.

Alloys generally melt at a lower temperature than that required for the fusion of their component metals separately; and in some cases the most refractory metals form very fusible alloys. There are some alloys which are crystallisable, and probably of definite composition; but the atomic doctrine applies only in a few cases to the alloys, and it is often difficult to get a mass of alloy of similar composition throughout; thus, gold made standard with copper, and then cast into bars in upright moulds, does not yield an uniform compound except under due precautions; for the upper end of the bar, containing the metal from the bottom of the crucible, will be the purest.

A'LLSPICE. The dried immature berry of the Myrtus Pimenta; called also Jamaica Pepper. It is supposed to possess the mixed flavour of several spices, amongst which that of the clove predominates.

ALLU'SION, in Rhetoric. (Lat. ad, *to*, and ludo, *I*

play.) Strictly, a covert indication, as by means of a metaphor, a play of words, &c. of something not openly mentioned and extrinsic to the principal meaning of the sentence. In common language, to allude to any thing merely means to mention it indirectly or incidentally.

ALLU'VIUM. (Lat. alluo, *I wash upon.*) Gravel, sand, and other transported matter washed down by rivers and floods, upon land not permanently submerged beneath water.

ALMACA'NTAR. (From the Arabic.) A term used by the old astronomers to denote a small circle of the sphere parallel to the horizon.

ALMAGE'ST. A name given by the Arabs to the celebrated work of Ptolemy, the astronomer of Alexandria: it signifies the greatest work. The best edition of this work is that of Paris, 1813-15, two vols. 4to., Greek and French, by M. Halma.

A'LMANACK. (Probably from the Arabic particle *al* and manach, *to commit;* whence Al Manach, *The Diary.*) An annual publication containing a calendar of the days and months of the year, the ecclesiastical feasts, the time of the sun's rising and setting, the age of the moon, the solar and lunar eclipses. To these (the most essential matters) are frequently added information on various subjects of astronomy, chronology, meteorology, the tides, statistics, lists of posts, offices, public institutions, &c., according to the views or fancy of their respective authors. Almanacks correspond in some respects to the Fasti of the Romans, and are of very ancient date. The first printed almanack appeared in 1474, and was drawn up by Regiomontanus, nearly, at least so far as regards the calendar, in the form now used. Till within a few years, the numerous almanacks published in England were little creditable to the taste or morals of the country. They had for a long time been monopolised by the Stationers' Company. This monopoly was at length broken through by the publication of a new almanack under the superintendence of the Society for the diffusion of Useful Knowledge; and since that time the more exceptionable ones have entirely disappeared, and their place been supplied by others which abound in useful and valuable information. The removal of the heavy stamp duty of fifteen pence per copy, to which they were subjected till 1834, has been attended with all the advantages which usually result from the exercise of free competition.

The Nautical Almanack is published by order of the board of the admiralty for the use of seamen, and contains a copious list of astronomical phenomena at sea, and of the elements which are used in finding the longitude. This work is also a very complete astronomical ephemeris, showing the instants of time at which the planets and principal stars daily pass the meridian of Greenwich; the sun's right ascension, and the logarithms of his distances; the moon's place at intervals of three hours, &c. &c. For a more particular account of works of this kind, *see* CALENDAR, EPHEMERIS.

A'LMOND. (Gr. ἀμυγδαλον. Fr. amande.) The seed or kernel of the Amygdalus communis. Sweet almonds afford, in the 100 parts, 54 of fixed oil, 24 of albuminous matter, 9 gum and sugar, 4 woody fibre, 5 husk, and 4 water and loss. Bitter almonds contain less fixed oil, and a peculiar principle termed *Amygdalin.* When bitter almonds are cold pressed, the oil which exudes contains no trace of prussic acid; when hot pressed, its flavour may be perceived: the cake remaining after pressure yields a volatile oil by distillation, the quantity and strength of which in prussic acid is variable. The oil of bitter almonds is about the specific gravity of water; that which passes first over is most poisonous. It changes when exposed to air, and forms benzoic acid: in close vessels it may be long kept without deterioration. When used in medicine, great care is requisite on account of its varying strength. Half an ounce of oil of bitter almonds was put into the mouth of a Newfoundland dog (in a diseased state and moaning with pain), with the intention of immediately killing it; but after some slight convulsions the animal became tranquil, appeared easier, and recovered the effect: about a drachm of recently and carefully prepared oil was then administered, when the animal fell upon its side, became convulsed, and died in three minutes. The distilled oil of peach leaves and of the cherry laurel also contain prussic acid, and the water distilled from them is poisonous. By digesting these oils with finely powdered peroxide of mercury, crystals of cyanuret of mercury are formed.

A'LMONER. An officer in a religious house, to whom the distribution of alms was committed. The term is still retained by officers in some of our hospitals.

ALMS. Charitable offerings; from the Greek ἐλεημοσυνη, *pity;* which came in the early ages of the church to be used in the plural number in the peculiar sense which is represented in our language by the word Alms.

A'LOE. (Arabic, alloch.) A small tree with endogenous stems, and stiff, fleshy, hard pointed leaves, abounding in a purgative principle which is obtained by simple pressure of the bruised leaves, or by boiling. The juice when inspissated becomes the medicinal drug of the shops. It varies much in quality. (See the following article.)

A'LOES. The inspissated juice or extract of several species of aloe. This article is largely imported for medical use from Bombay. It is of a brown colour, a peculiar and somewhat aromatic odour, and a nauseous and intensely bitter flavour: it consists of extractive and resin, and is nearly soluble in boiling water, but the solution as it cools deposits flakes of resin. The best aloes was formerly brought from the island of Socotorah, in the Indian Sea, and hence all the finer aloes of commerce is frequently termed Socotorine aloes. Another variety of this drug comes from Barbadoes, in large gourd-shells containing upwards of half a hundred weight each; it is deep coloured, opaque, and has a nauseous and peculiar odour, especially when breathed upon. Aloes is a warm stimulating purgative, operating as such in the dose of four to eight grains. It stimulates the large intestines, and should be administered with caution in habits where there is tendency to piles, and in cases in females in which uterine stimulants are improper.

ALO'NSINE, or ALPHONSINE TABLES. An astronomical work, which appeared in the year 1252, under the patronage of Alonso X., in the first year of his reign.

ALO'PECU'RUS. (Gr. ἀλωπηξ, *a fox*, and οὐρα, *a tail.*) A genus of grasses, called by the farmer *foxtail;* the flowers are arranged in compact tail-like stalks. It is very like Phleum or *catstail*, from which it differs in its glumes being acute, not truncate, and its lower pales awned. *Alopecurus pratensis* forms a part of all the richest pastures in this country.

ALO'SA. The name of a genus of Clupeoid fishes, including the alose, or shad; separated from the herring and pilchard, with which it was classed by Linnæus. The shad ascends large rivers to the fresh water, where it spawns. The white-bait used to be regarded as the young of the shad, but is now ascertained to be a distinct species of the present genus.

A'LPHABET. (From the Gr. ἀλφα, βῆτα, the two first Greek letters.) The letters of a written language, disposed in their regular order. An alphabetical language is one possessing an alphabet.

1. The first and most obvious mode by which thought can be expressed and conveyed to the eye, is by the representation of actual objects. Hence the species of writing which the learned have termed *ideographic*, i. e. in which knowledge is conveyed, first, by representations of the objects of thought; secondly, by symbols. The origin of designing is coeval with that of mankind; and men early availed themselves of this art to make their thoughts visible. To make it be understood, for example, that one man had killed another, they drew the figure of a dead man stretched on the ground, and of another standing by him upright, with some deadly weapon in his hand. To let it be known that some one had arrived by sea, they drew the figure of a man disembarking from a ship; and so on. This kind of writing, if we may so employ the word, was very early used in Egypt, and most probably, also, in most of the ancient nations. In Greek, the word γραφειν signifies indifferently either to write or to paint. In Mexico, when the Spaniards landed, the inhabitants of the sea coast conveyed intelligence of the event to Montezuma by sending him a large cloth, on which they carefully painted what they had seen. It is unnecessary to insist on the difficulty and inconvenience of this method of writing; and to lessen these, recourse was had to the *symbolic* or *emblematic* variety of ideographic writing. In this method abbreviations or characteristic parts were introduced instead of the entire object. Thus, the ancient Egyptians are said to have represented a siege by a scaling-ladder; a battle, by two hands holding a buckler and a bow, &c. Abstract ideas were, also, represented by symbols, or sensible objects, supposed to have a certain analogy to them: as, ingratitude by a viper, providence by an eye, the head of a hawk, &c.

2. From ideographic was derived syllabic writing. It must have been early remarked that the sounds formed by the voice in speaking are articulate and well-defined; and the idea occurred of endeavouring to represent such sounds by appropriate signs. Thus the word *republic*, in the writing of which we use eight letters, would be written with three syllabic characters. The President de Goguet suspects that originally all the Asiatic nations, known to the ancients under the names of Syrians and Assyrians, used the syllabic mode of writing. We may, he thinks, discern the vestiges of this in an ancient tradition which ascribes the invention of writing to the Syrians; but acknowledges that the Phœnicians improved, made it more simple, and brought the characters to perfection. But this mode of writing, though a vast improvement on what is purely ideographic, is still very imperfect and cumbersome. The vast number of characters required in it overburdens the memory, and occasions the greatest confusion. The existing language of the Chinese, which is partly ideographic and partly syllabic, is an example of

this. In it there are a certain number of *elementary signs* or *keys* (two hundred and fourteen), which are strictly hieroglyphic or symbolical; that is, they are abridged representations of visible objects. From these 214 elements, all the characters of the language (80,000, it is said) are formed by varying and combining their figures; every compound character representing one or more syllables having a distinct meaning. 3. The defects incident to ideographic and syllabic writing being thus obvious, ingenious individuals would early endeavour to find out some more simple and precise method of communicating their ideas. And at length the method of Alphabetic writing, the greatest of all the inventions made by man, and which has been the great instrument of his civilisation, was introduced and perfected. In this method syllables are decomposed into their elements; and the few simple sounds emitted by the voice being represented each by its appropriate mark or letter, syllables and words are formed by their combination; the latter serving not only to describe external objects, but to depict the workings of the mind, and every shade and variety of thought. Before entering into the much disputed question respecting the origin of this mode of writing, it is necessary to indicate the new light thrown upon the subject by the recent discoveries of Dr. Young, and more especially of M. Champollion, as to the phonetic writing of the Egyptians. We have already seen that the hieroglyphical characters of that people denoted, in the first place, *objects* either of sense or thought; i. e. they were ideographic. But, according to the new theory, they came in the course of time to denote sounds; and those not syllabic merely, but alphabetical. For example, the Egyptian word Ahom signified an eagle; the figure of an eagle, therefore, stood for the letter A, with which that word begins. B was represented by a censer (Berbe). R sometimes by a mouth (Ro), sometimes by a tear (Rimé). According to the views of these recent discoverers, a great proportion of the inscriptions on Egyptian monuments and papyri are partly ideographic, partly alphabetical; i. e. some characters represent objects or ideas; and these are intermingled with others which merely stand for letters. Dr. Young, who first conceived the notion of the phonetic alphabet, imagined that it was only employed when foreign words or names (as those of Greek kings) were introduced. M. Champollion carried the discovery further, and applied it to the deciphering of words and names in the language of the country. The name of the ancient king Sabaco, among others, being found by this mode of interpretation, would appear to show that the phonetic writing was used as early as 700 years B. C. (See Dr. Young's writings, especially the article EGYPT in the Appendix to the *Encyclopædia Britannica*; those of Champollion; M. Klaproth's *Examen Critique des Travaux de Champollion*; *Quarterly Review*, vol. liii. p. 110.; Salt's *Essay on the Phonetic System of Hieroglyphics*, 8vo. London, 1825, &c.) It is not within our present province to discuss the question, upon what ground of probability this theory rests. But if a complete phonetic alphabet should be discovered, in the language of that country in which the earliest germs of knowledge and civilisation seem to have been developed, it is probable that we shall have made a considerable step towards tracing the origin of pure alphabetical writing in other languages. As it is, although various attempts have been made to show the symbolical origin of the letters in the most ancient alphabets, it cannot be said that any very satisfactory result has been obtained. And, from the total want of all recorded knowledge concerning the invention of alphabetical writing, and the difficulty of accounting for it on any known principle of mental association, the hypothesis of divine revelation has obtained considerable currency; but it need hardly be observed, how ill such a doctrine agrees with all that we know by analogy of the dealings of Providence with man.

It is clear that writing was known to the Hebrews at the period when the Mosaic books were composed, from many allusions contained in them. Exodus, xxxii. 15, 16. Numbers, xvii. 18., xxxi. 9. 19., xxxiii. 1., &c. And although it cannot be positively asserted, that the writing there alluded to may not have been of the symbolical description in use among the Egyptians, there seems, on the other hand, little reason for supposing that the Hebrew alphabet was not in use even at that remote period. And the question of superior antiquity seems to lie entirely between that alphabet and the Phœnician. The claims of the latter are supported by Mr. Astle (*Essay on the Origin of Writing*, 4to. London, 1803); but apparently on little better authority than what may be derived from the traditions of the Greeks respecting Cadmus and his alphabet; and the extreme antiquity of Hebrew civilisation and literature seems to give probability to the supposition, that the Phœnician alphabet may have been derived from theirs. The belief, however, was all but universal among the Greeks and Romans, that the Phœnicians were the inventors of letters According to Lucan,

> "Phœnices primi (famæ si credimus) ausi
> Mansuram rudibus vocem signare figuris."

And Pliny says (lib. v. cap. 12.), "Ipsa gens Phœnicum in gloria magna est literarum inventionis." But whether the Phœnicians were or were not the inventors of alphabetic writing, there can be little or no doubt that the knowledge of it was brought by Cadmus, from Phœnicia, into Greece, about 1500 years B. C. From the Phœnician, therefore, or the Hebrew, are incontestably derived, 1. The Oriental alphabets used in Asia, West of the Indus; written, like Hebrew, from right to left; the principal being the Syriac, Arabic, and Persian. 2. The Pelasgic, or original Greek alphabet. Were there nothing else by which to establish the fact, the eastern origin of the Pelasgic language would be obvious from its being originally written, like the Phœnician and other eastern languages, from right to left. It was afterwards written consecutively from right to left, and left to right, in the manner that land is ploughed. This procured for it the name of *βουστροφηδὸν*, or furrowed writing. This species of writing maintained its ground for a lengthened period. The laws of Solon, promulgated about 594 years B. C., were written in it; and it was used till the 5th century B. C. But writing from left to right was introduced for a considerable period before the alternate or furrowed method was abandoned. Inscriptions dated 742 years B. C. have been found written from left to right, or in the way now practised. (Goguet, *Origin of Laws*, Eng. trans. ii. p. 32. &c.) From the Pelasgic alphabet were derived the Etruscan and Oscan. From the Ionic, a later variety of the Greek, came the Arcadian, the Coptic, and Ethiopic, the Mæso-Gothic and Runic; and, in comparatively modern times, the Armenian, Illyrian, Sclavonic, Bulgarian, and Russian. With regard to Greek writing, it is to be observed that the most ancient mode was in capitals. The small letters now in use seem to have been introduced gradually; for, in our oldest Greek MSS., even as early as the fifth century, they appear intermixed with capitals. But the latter were principally employed, until the seventh or eighth century. 3. The Latin alphabet is also derived from the Ionic Greek; it is said to have been introduced about the time of Tarquinius Priscus. In the earliest inscriptions which we possess, the forms of the letters scarcely differ from those in use at the present day; but, great varieties have been in subsequent times introduced: first, in the ordinary method of writing it; as, the Uncial, Semi-Uncial, Lombard, Italic, &c. (*See* CHARACTER.) Secondly, in the number and form of the letters contained in the numerous alphabets derived from it. 4. A fourth class of alphabetical languages consists of the Sanscrit and its derivatives. These are very numerous, and are spoken in the continent and islands of India. The antiquity of the Sanscrit alphabet is undoubtedly great; but those who assign to it a separate origin are probably in error. Its derivation from the Hebrew, or some of its cognate alphabets, admits of little doubt. Indeed, the great regularity of the Devanagaree, or most elegant form of the Sanscrit alphabet, and its copiousness (it contains 100 letters), seem to afford strong presumption that it was compiled by some learned individual, or body, (like the Russian and other modern Western alphabets,) from other forms of writing then in use, and imported into India from the West. The Sanscrit and its derivative languages are written, like European, from left to right. These four classes comprehend all the alphabetical languages in existence. The following table exhibits the number of letters in some of the principal.

- Class 1. Hebrew, Samaritan, Syriac, and Chaldean, 22 each. Phœnician (known), 17. Arabic, 28. Persian, 32.
- Class 2. Greek, 24. Armenian, 38. Ethiopic, or Abyssinian, 202. Modern Russian, 41.
- Class 3. (which is only a subdivision of Class 2.) Latin, 22. English, 26. French, 28. Italian, 20. German, 26.
- Class 4. Sanscrit (Devanagaree), 100.

Various learned persons have proposed the adoption of an universal alphabet; and have shown that the elementary sounds are reducible to a still smaller number than those employed in our western alphabets. Harris (*Hermes*, book iii. c. 2.) estimates them at twenty. Wachter (*Naturæ et Scripturæ Concordia*) conceives that the number may be diminished to ten. But the celebrated Bishop Wilkins, in his *Essay towards a real Character and Philosophical Language*, fol., London, 1668, estimates the necessary number at thirty-four.

The following Table contains specimens of the principal alphabets.

ARABIC.

Final.		Medial.	Initial.	
ا	ـا	ـا	ا	Elif.
ب	ـب	ـبـ	بـ	Be.
ج	ـج	ـجـ	جـ	Jim.
د	ـد	ـد	د	Dal.
ذ	ـذ	ـذ	ذ	Dsal.
ه	ـه	ـهـ	هـ	He.
و	ـو	ـو	و	Wau.
ز	ـز	ـز	ز	Ze.
ح	ـح	ـحـ	حـ	Ha.
خ	ـخ	ـخـ	خـ	Kha.
ط	ـط	ـطـ	طـ	Ta.
ظ	ـظ	ـظـ	ظـ	Tza.
ي	ـي	ـيـ	يـ	Ye.
ك ک	ـك ـک	ـكـ کـ	كـ کـ	Kef.
ل	ـل	ـلـ	لـ	Lam.
م	ـم	ـمـ	مـ	Mim.
ن	ـن	ـنـ	نـ	Nun.
ع	ـع	ـعـ	عـ	Ain.
غ	ـغ	ـغـ	غـ	Gain.
ف	ـف	ـفـ	فـ	Fe.
ص	ـص	ـصـ	صـ	Tsad.
ض	ـض	ـضـ	ضـ	Dhad.
ق	ـق	ـقـ	قـ	Kaf.
ر	ـر	ـر	ر	Re.
س	ـس	ـسـ	سـ	Sin.
ش	ـش	ـشـ	شـ	Shin.
ت	ـت	ـتـ	تـ	Te.
ث	ـث	ـثـ	ثـ	The.

SANSCRIT.

Vowels.

अ	a short.	ऊ	u long.
आ	a long.	ऋ	ri short.
इ	i short.	ॠ	ri long.
ई	i long.	ऌ	lri short.
उ	u short.	ॡ	lri long.

Compound Vowels.

ए	e short.	ओ	o short.
ऐ	ai.	औ	au.

Consonants.

क	ka.	झ	jha.
ख	kha.	ड	da.
च	cha.	ढ	dha.
छ	ch'ha.	द	da.
ट	ta.	ध	dha.
ठ	tha.	ब	ba.
त	ta.	भ	bha.
थ	tha.	ल	la.
प	pa.	व	va.
फ	pha.	स	sa.
य	ya.	ह	ha.
र	ra.	क्ष	ksha.
श	sa.	ङ	nga.
ष	sha.	ञ	nya.
ग	ga.	ण	na.
घ	gha.	न	na.
ज	ja.	म	ma.

GERMAN.

Characters.	Significations.	Name.
𝔄 𝔞	A a	Au.
𝔅 𝔟	B b	Bey.
ℭ 𝔠	C c	Tsey.
𝔇 𝔡	D d	Dey.
𝔈 𝔢	E e	Ey.
𝔉 𝔣; 𝔣𝔣	F f; ff	Ef; Ef-ef.
𝔊 𝔤	G g	Gey, or Gay.
ℌ 𝔥; 𝔠𝔥	H h; ch	Hau; Tsey-hau.
ℑ 𝔦	I i	E.
𝔍 𝔧	J j	Yot.
𝔎 𝔨; 𝔠𝔨	K k; ck	Kau; Tsey-Kau.
𝔏 𝔩	L l	El.
𝔐 𝔪	M m	Em.
𝔑 𝔫	N n	En.
𝔒 𝔬	O o	O.
𝔓 𝔭	P p	Pey.
𝔔 𝔮	Q q	Koo.
ℜ 𝔯	R r	Err.
𝔖 ſ 𝔰; ſſ	S ſ s; ſſ	Ess; Ess-ess.
ß; ſt	sz; st	Ess-tset; Ess-tey.
𝔗 𝔱	T t	Tey.
𝔘 𝔲	U u	Oo.
𝔙 𝔳	V v	Fou.
𝔚 𝔴	W w	Vey.
𝔛 𝔵	X x	Iks.
𝔜 𝔶	Y y	Ypsilon.
ℨ 𝔷; 𝔱𝔷	Z z; tz	Tset; Tey-tset.
𝔞̊ 𝔬̊ 𝔲̊ or 𝔞̈ 𝔬̈ 𝔲̈	ae oe ue	

HEBREW AND CHALDEE.

א	Aleph.	ם מ	Mem.
בּ ב	Beth.	ן נ	Nun.
גּ ג	Gimel.	ס	Samech.
דּ ד	Daleth.	ע	Ain.
ה	He.	ף פ	Phe.
ו	Vau.	ץ צ	Tzaddi.
ז	Zain.	ק	Koph.
ח	Cheth.	ר	Resch.
ט	Teth.	שׂ	Sin.
י	Yod.	שׁ	Shin.
ך כ	Caph.	ת	Thau.
ל	Lamed.		

GREEK.

Α α	Alpha.	Ν ν	Nu.
Β β ϐ	Beta.	Ξ ξ	Xi.
Γ γ	Gamma.	Ο ο	Omicron.
Δ δ	Delta.	Π ϖ π	Pi.
Ε ε	Epsilon.	Ρ ρ ϱ	Rho.
Ζ ζ	Zeta.	Σ σ ς	Sigma.
Η η	Eta.	Τ τ	Tau.
Θ ϑ θ	Theta.	Υ υ	Upsilon.
Ι ι	Iota.	Φ φ	Phi.
Κ κ	Kappa.	Χ χ	Chi.
Λ λ	Lambda.	Ψ ψ	Psi.
Μ μ	Mu.	Ω ω	Omega.

SAXON.

A	a	P	p
B	b	Q	ꝗ
C	c	R	ꞃ
D	ꝺ	S	ꞅ
Є	e	T	ꞇ
F	ꝼ	U	u
Ᵹ	ᵹ	Ƿ	ƿ
Ƕ	h	X	x
I	ı	Y	ẏ
K	k	Z	z
L	l		Ð and.
M	m		ð th.
N	n		Ꝥ that.
O	o		

ALPHO'NSIN. An instrument for extracting balls: so called from the name of its inventor, Alphonso Ferrim, a Neapolitan surgeon.

A'LPINE PLANTS. Low plants which grow naturally in hilly or mountainous situations, where they are covered with snow during great part of the winter; and for which reason, in gardens, they require the protection of frames and glass during winter. In this respect alpine plants differ from rock plants; which, in gardens, only require to be grown among rocks or stones, without the protection of a frame and glass.

ALPINIA'CEÆ. One of the names of the natural order of plants called Zingiberaceæ.

ALRU'NÆ. (Germ. Alraun, Alraun-bilder.) Small images carved out of the roots of trees, exhibiting rude representations of the human figure, generally female. The veneration paid to these figures formed a peculiar feature in the superstition of the northern nations. They were looked on as the Penates, or household gods, of families; laid in boxes, and presented with meat and drink. They are supposed by some to represent female magicians or druidesses.

ALSEGNO. (It. *To the mark.*) In Music, a notice to the performer that he must recommence from that part of the movement to which the sign or mark 𝄋 is prefixed.

ALSINA'CEÆ. A rather extensive order of weedy plants, allied to the much more beautiful Silenaceæ, from which they are known by their calyx consisting of distinct sepals. The order derives its name from Alsine (aloos, *a sacred gem*, in which places it is found), the common chickweed.

ALT. (Lat. altus, *high.*) In Music. A term applied to the high notes of the scale.

A'LTAR. (From alta ara, Lat.; or, according to some, from אל, *God*, and ראה, *described*, or *appointed.*) In Architecture, a sort of pedestal whereon sacrifice was offered. Servius tells us that among the ancients there was a difference between the ara and altare, the latter being raised on a substruction, and used in the service only of the celestial and superior divinities, whilst the former was merely on the ground, and appropriated to the service of the terrestrial gods. To the infernal gods the altars were made by excavations, which were termed scrobiculi. Some authors have maintained that the ara was the altar before which prayers were uttered, whilst the altare was used for sacrifices. It does not, however, appear that ancient authors made these distinctions, but that the words were used by them indiscriminately. The earliest altars were square polished stones, on which were placed the offerings to the gods. Whilst sacrifices were confined to libations, perfumes, and offerings of that sort, the altar was not of large dimensions, and was even portable; but as soon as man thought he was doing honour to the Divinity by an offering of blood, the altar necessarily expanded in dimensions. Different forms were contrived, according to the nature of the sacrifice, on which the throat of the victim was cut and the flesh burnt. Of this sort is the circular altar of the villa Pamphili at Rome, one of the largest and most elegant of existing remains of that class. Upon it is to be seen the cavity for holding the fire, and the grooves for carrying off the blood. The varieties of altars follow the service to which they were assigned by difference in their forms, ornaments, and situations. Some, as we have already observed, served for burning incense and receiving libations. Some were for the sacrifices of blood, and others for receiving offerings and sacred vases. Many were erected merely as monuments of the piety of the devotee, whilst others were constructed to perpetuate some great event. They served for adjuration, as well as for an asylum to the unfortunate and evil-doer. The forms varied from square to oblong, from triangular to circular. Those of metal were usually tripodial. When of brick or stone, they were generally square on the plan. According to Pausanias, wood was occasionally a material of which they were composed. They do not seem to have been of any standard height, inasmuch as we sometimes see them on bassi relievi reaching little above a man's knee, whilst in others they appear to reach his middle, though it would seem that the circular altar was generally the highest in proportion to its diameter. Vitruvius says they should be kept down in height, so that they may not intercept the statues of the gods; and he gives the relative height of those used for the different divinities. Those of Jupiter and the celestial gods the highest; next, those of Vesta and the terrestrial gods; then the sea gods were to have theirs a little lower, and so on. On festivals they were decorated for the occasion with such flowers and leaves as were sacred to the particular divinity. But besides this casual decoration, the ancient altars furnish us with some of the most elegant bassi relievi and foliage ornaments that are extant, still serving as models of taste, which have escaped the hands of the barbarian destroyer. According to Vitruvius, their fronts were turned towards the east, though often little regard seems to have been paid to their position, as they were occasionally deposited under the peristyle of a temple, and not unfrequently in the open air. In the larger temples there were often three different altars: the first was in the most sacred part, in front of the statue of the god; the second was before the door of the temple; and the third was portable, called anclabris, on which the offerings and sacred vases were placed. Amongst Christians, the altar is a square or oblong table or tablet, placed at the east end of the church, for the celebration of the mass, or, in Protestant churches, for the celebration of the sacrament. These are varied in their form almost as much as those we have already described.

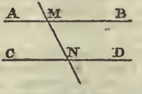
The word *Altar* was adopted by the early Christians, together with the corresponding Greek term θυσιαστηριον, (but not, unless, perhaps, in a single instance, βωμος,) to express the table of the Lord (1 Cor. x. 21.). But the word altar is stated to have been used by the fathers in four different senses (v. Suicer, in voc. θυσιαστηριον): for, 1. Christ himself, from Hebr. xiii. 10. 2. The church of Christ in general. 3. Individual members of the church. 4. The Lord's table. It is observed that the fathers of the first three centuries universally speak of the altar, and not of the table, although constantly admitting the charge which the heathens made against them of their having no altars, conceiving the term as used by the heathens to imply the offering of a sacrifice upon the altar, and the presence of the statue of the deity to whom the offering is made. From the fourth century the word table is frequently adopted, as by St. Chrysostom, St. Augustin, &c.

In King Edward I.'s Book of Common Prayer, the word altar was retained in the communion service: but great opposition being raised against it, especially by Bishop Hooper, on account of the ambiguity of its meaning, and the colour it might seem to lend to the Romish notions of the eucharist, it was abandoned, and table substituted throughout. This, however, did not satisfy the more violent party; and on the restoration of the reformed worship at the accession of Elizabeth, the people proceeded to take the first step towards a real and not a verbal substitution, by pulling down the altars in many churches. Hereupon the queen issued an injunction, wherein she declares that "it is no matter of great moment whether there be altars or tables, so that the sacrament be duly and reverentially administered;" and directs that where the altars had been pulled down, tables should be erected in the same place.

A'LTERATIVES. (Lat. altero, *I change.*) Medicines which cure diseases by slow and imperceptible degrees, without producing sensible evacuations.

ALTE'RNATE. (Lat. alternatus, *changed by turns.*) In Botany, parts are said to be alternate with each other when one is placed upon the stem a little higher or a little lower than the other; the word is chiefly applied to leaves, and is used in distinction to opposite, in which parts arise from the same plant on opposite sides of the stem.

ALTERNATE. (Geometry.) When two straight lines are intersected by a third, the interior angles on the opposite sides of the intersecting line are said to be alternate. Thus A M N and M N D are alternate angles; and so also are B M N and M N C.



If the two straight lines A B and C D be parallel, the alternate angles are equal. In proportion, the alternate terms are the first and third, and also the second and fourth, and the terms of a proportion are said to be taken alternately, or by alternation, when the second and third are made to change places: and it is a well-known theorem, that a proportion subsisting among four quantities of the same kind is not disturbed by this change. Thus, if $a : b :: c : d$, then, alternately, $a : c :: b : d$.

A'LTICA. A name applied by Fabricius to a subdivision of the Linnæan Chrysomelæ, characterised by the oblong body, bifid lip, and thickened hind legs.

A'LTITUDE. (Lat. altus, *high*, altitudo, *height.*) In Astronomy, denotes the angle of elevation of a celestial object, or the angle of the visual ray with the horizon. The altitude of a star is apparent or true. The apparent altitude is the angle ascertained immediately from observation; the true altitude is found by correcting the apparent altitude for refraction, parallax, &c. Altitude is frequently used in Elementary Geometry instead of height. The altitude of a triangle is measured by a straight line drawn from the vertex perpendicular to the base; and the altitude of a cone by the straight line drawn from the vertex perpendicular to the plane of the base.

ALTO. (Lat. altus, *high.*) In Music, the counter-tenor part, or that immediately below the treble or highest. It is a word also used to denote the tenor violin.

ALTO RILIEVO. *See* RILIEVO.

A'LUDEL. A piece of chemical apparatus used in the process of sublimation, and much resembling the ancient alembic.

A'LULA. (Lat. ala, *a wing.*) In Ornithology, the group of ill-feathers, attached to the joint of the carpus; as in the snipe. These are also called the 'bastard wings' (*ala spuria*).

A'LUM. A salt composed of alumina, potash, and sulphuric acid, and in its usual form containing a large quantity of water of crystallisation. Its octohedral crystals consist of

Alumina	3 atoms	=	54	10·76
Potassa	1	=	48	9·95
Sulphuric acid	4	=	160	33·74
Water	24	=	216	45·55
Crystallised alum	1	=	478	100·00

Alum dissolves in about five parts of water at 60°. The solution has a sweet and astringent taste, and is a powerful styptic. When crystallised alum is heated, it melts, and, gradually losing water of crystallisation, becomes a white spongy mass, called burned alum.

Alum is largely manufactured for the uses of the arts, especially dying and calico printing. What is termed alum ore, is an aluminous slate containing sulphuret of iron; it is calcined, exposed to air, lixiviated, and the solution so obtained mixed with sulphate of potash, and crystallised. The alum-works near Paisley, and at Whitby, in Yorkshire, are the largest in this country.

Milk, curdled by stirring it with a lump of alum, furnishes alum whey, which is sometimes taken as a remedy for relaxed bowels. Alum curd is made by beating the white of egg with a piece of alum till it coagulates.

ALU'MINA. Aluminous earth; earth of alum; argil. When a solution of ammonia is dropped into a solution of alum, a white precipitate falls, which, thoroughly washed, dried, and heated, is pure aluminous earth. There are two properties of this earth which render it of great importance in the arts: one is, that it forms a plastic mixture with water, and, though it is not the predominant ingredient in, yet it confers the valuable property of plasticity upon, all natural clays, which enables them to be moulded into the various forms of pottery and earthenware; the other is the remarkable affinity of alumina for colouring and extractive matter, whence its use in the arts of dyeing and calico printing.

In a pure and crystalline form, alumina constitutes the sapphire, one of the hardest and most valuable of the gems. In its common state, aluminous earth is a soft white powder, strongly attractive of moisture; hence, aluminous fossils are often recognised by adhering to the tongue, and many of them exhale an earthy smell when breathed upon, as we observe in common slate. Alumina consists of 52·94 aluminum, and 47·06 oxygen; like the other earths, as they are usually called, alumina, therefore, is a metallic oxide. Aluminum is with difficulty obtained, and in small quantities, by heating chloride of aluminum with potassium; it is a grey, difficultly fusible metal, not easily acted on by water, and which, when heated in the air, burns with great brilliancy, and forms alumina by the absorption of oxygen.

Alumina has but a feeble attraction for acids, and does not fully neutralise them; and when it has been heated red hot, or is in an indurated state, as it exists in the sapphire, in corundum, and some other minerals, it is absolutely insoluble.

The aluminous salts are mostly colourless, soluble in water, and of a sweetish astringent taste. Exclusive of alum, the acetate of alumina is the most important of these salts, being used as a base or mordant by the dyers. (*See* DYEING.) It is usually prepared by mixing a solution of 190 parts of acetate of lead with one of 487 parts of alum: a white precipitate of sulphate of lead falls, and acetate of alumina remains in solution.

ALU'MINITE. Native subsulphate of alumina.

ALU'MINUM. The metallic base of alumina.

A'LUMSTONE. A silicious subsulphate of alumina.

ALU'RNUS. A genus of coleopterous insects, characterised by having short filiform antennæ; palpi four to six, very short; maxillæ horny and short.

ALUTA'CEOUS. (Lat. aluta, *tanned leather.*) A pale brown colour.

ALVE'OLAR. (Lat. alveolus, diminutive of alveus, *a cavity.*) Belonging to the alveoli, or sockets of the teeth.

ALVE'OLATE. In Botany. When the surface is covered with numerous deep hollows, as in the receptacle of some Compositæ.

ALVEO'LITES. A genus of fossil zoophytes, allied to the corallines; one species of which (*Alv. suborbicularis*) occurs in the Portland stone.

A'LVINE. (Lat. alvus, *the belly.*) A term generally used as relating to the intestinal excretions.

A'MADOU. German tinder; a fungus found chiefly in old oaks and ash trees. It is boiled in water, dried, beaten, soaked in a solution of nitre, and again dried for use.

AMA'IN. A sea term, signifying *to yield, to let go.* Thus, to strike amain is to lower or let fall the topsails, in token of surrender. To wave amain is to make a signal to a vessel to strike its topsails. Amain is also a term used in letting down a thing into the hold or elsewhere, or in lowering a yard, or the like, to denote that the sailors are to let go that part of the rope which they held before, and let down the thing easily and by degrees.

AMA'LGAM. A combination of mercury with other metals. Medallists apply the term to soft alloys generally.

AMALTHÆ'A. In Mythology. The name of a goat in Crete, alleged to have suckled Jupiter: or of the nymph who tended the goat. The *cornu Amalthææ*, or horn of the goat in question, was the magic *cornu copiæ*, or horn of plenty.

A'MARANTH. (Gr. ἀ, priv., μαραινω, *I wither,* and ἀνθος, *a flower.*) Plants with richly coloured flowers, whose parts are of a thin dry texture, so that they are a long while before they wither. They give their name to the natural order of Amaranthaceæ. Amaranthus melancholicus, hypochondriacus, caudatus, &c., are the annuals known in gardens by the names of Love lies bleeding, Prince's feather, &c. The name, in composition with other words, is used to designate plants not belonging to the same genus, but to the same natural order. Globe-amaranth is Gomphrena globosa.

AMARANTHA'CEÆ. The order which comprehends the amaranthus, and other similar dry-flowered genera. Some of the species are objects of ornament, as cockscombs (*Celosia coccinea*), globes (*Gomphrena globosa*), various species of amaranthus, trichinium, &c.; but the principal part consists of tropical kinds. The order participates in the harmless qualities of Chenopodiaceæ, from which it is not very different.

AMARYLLIDA'CEÆ. (Amaryllis, one of its genera.) A natural order of beautiful Endogens, with inferior fruit, six stamens, and six nearly equal segments of the flower. The greater part consists of bulbous species inhabiting the Cape of Good Hope, and the tropical parts of both hemispheres. Snowdrops are the most northern form. A few, such as agave and doryanthes, are trees in stature, although only herbaceous plants in duration.

A'MATEUR. (Fr.) A person familiar with, and who encourages any particular art or pursuit, without being professionally engaged in it, is said to be an amateur. But the term is usually restricted to those who are skilled in and patronize the fine arts.

AMAURO'SIS. (Gr. ἀμαυρος, *dark.*) A loss of sight dependent upon defective action of the nerve of vision, and independent of visible injury. It is also called gutta serena: drop serene of Milton.

AMAZO'NIAN STONE. A beautiful green felspar, found in rolled masses near the Amazon river.

A'MAZONS. (Gr. ἀ, *without,* and μαζος, *breast.*) Female warriors. Tribes, either real or imaginary, belonging to Africa and Asia, among which the custom prevailed for the females to go to war; preparing themselves for that purpose by destroying the right breast, in order to use the bow with greater ease. According to Greek tradition, an Amazon tribe invaded Africa, and was repulsed by Theseus, who afterwards married their queen. Hence, all female warriors have been called Amazons; and the river of that name owes its appellation to one of the early Spanish navigators, who fancied he beheld armed women on its banks. The wars of the Athenians and Amazons formed favourite subjects for Attic art: they were depicted in the Pœcile or painted chamber of the Parthenon. See Justin, Diod. Siculus, Strabo, &c.

AMBARVA'LIA. (Lat. ambire arva, *to go round the fields.*) In Roman Mythology, religious fêtes to propitiate Ceres; so called from the victims being carried round the fields (*ter circum ibat hostia fruges,* Virg. G. i. 345.). These sacred rites were performed by an order of priests, *Fratres Ambarvales,* twelve in number. They were celebrated in the end of May, when the blessing of the goddess was invoked on the coming harvest. The victims were accompanied by crowds of country people, having their temples bound with oak leaves, dancing, and singing the praises of Ceres, to whom libations were made of honey and wine. (*Facciolati; Adam's Antiq.*)

AMBA'SSADOR, or EMBASSADOR. In Politics, the name of the highest order of foreign ministers. An ambassador is not only the agent of the country which sends him, but also represents personally the dignity of its sovereign. The greater powers of Europe send ambassadors to each other, with the exception of Prussia, which never employs ministers of this class. The word ambassador is of very uncertain derivation, but is supposed to be derived from the Italian word ambasciare, *to solicit.* In charters and diplomas of later date than the ninth century, the names of those who had solicited the grants are frequently signed at the foot with the designation of "ambasciatores," or solicitors; and it may hence be presumed that the title was originally given to envoys who attended at a court to solicit some favour for another party. As to the rights and privileges of ambas-

sadors in England; if an ambassador commit any act which is a crime against the law of all countries, as treason, felony, &c., he is punishable as a private alien. But an ambassador is not criminally liable for such acts as are only mala prohibita against statute or custom; as, infringements of the laws of the exchequer. By 7 Anne, c. 12., an ambassador or public minister, and his domestic servants, *bonâ fide* registered according to the act, are privileged from arrest; and the goods of an ambassador cannot be taken in distress. This statute was passed in consequence of the arrest and ill treatment of Count Matuschef, the Russian ambassador. As to the rights and duties of ambassadors in modern international usages, see the elaborate work of M. de Wicquefort, *L'Ambassadeur et ses Fonctions*, 2 tomes, 4to, 1746; F. von Moshamon (*Law of European Embassies*, Landshut, 1806); and the valuable *Manuel Diplomatique* of Von Martens (Leipzig, 1822), may also be consulted.

A'MBER. A yellow resin-like substance, found occasionally in detached pieces on the sea-coast, but most generally dug up in diluvial soils: it is probably an antediluvial resin, and often contains leaves and insects. Its specific gravity is about 1070. It is hard, and becomes strongly electro-negative by friction. It contains a trace of odorous volatile oil, a resin easily soluble in alcohol, a resin difficultly soluble in alcohol, and an insoluble resin, which is its chief constituent (80 to 90 per cent.). When burned, it exhales a fragrant odour. Distilled per se, it yields inflammable gases, water holding succinic and acetic acids, and empyreumatic oil in solution (the spirit of amber of old Pharmacy), sublimed succinic acid (salt of amber), and an empyreumatic oil (oil of amber). The acid, when purified, amounts to from 3 to 5 per cent. The residual charcoal amounts to 12 or 13 per cent., and, when strongly heated, yields a little volatile matter resembling camphor.

A substance resembling amber, called fossil copal, sometimes occurs with it; it is less soluble in alcohol, and yields no succinic acid.

The largest known mass of amber was found near the surface of the ground in Lithuania, about twelve miles from the Baltic; it weighs eighteen pounds, and is in the royal cabinet at Berlin.

The chief use of amber is as an article of ornament, cut into beads for necklaces, and in the manufacture of varnish.

A'MBERGRIS. (From ambre, and gris, *grey amber.*) This substance has been found in the intestines of the spermaceti whale: it is probably a product of disease; perhaps a kind of gallstone. It has also been found upon the coasts of various tropical countries, in masses of various sizes, of a grey, speckled appearance, and interspersed throughout its substance with the beaks of the sepia octopoda, which is the common food of the whale. When genuine, ambergris has a peculiar odour, not easily described or imitated, and which is exceedingly diffusive, especially in solution, so that a very minute quantity of ambergris is perceptible in perfumes, and is thought to exalt their odour. A grain or two, when rubbed down with sugar, and added to a hogshead of claret, is very perceptible in the wine and gives it a flavour, by some considered as an improvement. The best ambergris is softish and somewhat waxy when cut; its specific gravity varies from 780 to 896: it fuses at 140° or 150°, and at a higher temperature gives out a white smoke, which condenses into a crystalline fatty matter. Its chief component (about 80 per cent.) is a peculiar fatty matter (ambreine), which may be obtained by boiling it in alcohol; as the solution cools, it deposits crystals, which may be purified by pressure in folds of blotting paper. Ambreine fuses at 100°; its odour is agreeable, and it rises in vapour at 220°.

AMBIDE'XTER. (Lat. ambo, *both*, and dexter, *right hand.*) One who uses both hands alike, the left as well as the right. Numerous theories have been advanced to explain the preference so generally given to the right over the left hand; but, generally, they seem to be more specious than solid.

A'MBITUS. (Lat. ambio, *I encompass*, or *circumvent.*) The circumference or extreme edge of any thing; the encompassing border of a leaf.

Ambitus. n Politics. A term used by the ancient Romans to designate the soliciting and canvassing for offices and honours. It was of two kinds, the one, *ambitus popularis*, laudable; as, where a candidate openly avowed his pretensions, publicly stated the grounds on which he solicited the suffrages of the electors, and left them to form their opinion upon his claims without privately soliciting their votes. The other, and more common kind of *ambitus*, was either disreputable or unlawful. It consisted in using artful solicitations, cajolery, offers of money and preferment, and all those resources for corrupting the free choice of electors, so well understood, and successfully practised, in our own times. The bribery of electors was forbidden, although to very little purpose, by repeated acts of the Roman legislature. (Facciolati *Lexicon*, Adam's *Antiquities*, &c.)

A'MBLE, AMBLING. (In Horsemanship, Terme du Manège.) A peculiar kind of a pace in which a horse's two legs of the same side move at the same time.

AMBLO'TIS. (Gr. ἀμβλωσις, *abortion.*) The generic name, in the system of Illiger, of the Marsupial genus, including the wombat.

AMBLYO'PIA. (Gr. ἀμβλυς, *dull*, and ὢψ, *the sight.*) Imperfect vision.

AMBLY'PTERUS. (Gr. ἀμβλυς, *obtuse*, and πτερον, *a fin.*) The name of a fossil genus of fishes, with obtuse and rounded pectoral and ventral fins, and characterised by having small and numerous teeth, set close together like a brush, which shows the habit of these fishes to have been to feed on decayed sea-weed and soft animal substances at the bottom of the water.

A'MBO. (Gr. ἀμβον, *a boss*, or *knob.*) In Architecture. The elevated place, or pulpit, in the early Christian churches, from whence it was usual to address the congregation, and on which certain parts of the service were chanted.

A'MBREIN. The fatty matter of ambergris; convertible by nitric acid into ambreic acid.

AMBRO'SIA. (Gr. signifying, *immortal.*) The food of the gods, as nectar was their drink, the use of which conferred immortality.

AMBROSIAN CHANT. In Music. So called from St. Ambrose, archbishop of Milan, who composed it for the church there in the fourth century: it is distinguished from the Gregorian chant by a great monotony and want of beauty in its melody.

A'MBUBAIÆ. A Syrian or Arabic term, meaning musical girls from Syria, who prostituted themselves at Rome. See Hor. *Sat.* lib. 1. sat. 2. v. 1. and Facciolati *Lexicon.*

AMBULA'CRA. (Lat. ambulacrum, *an alley.*) The narrow longitudinal portions of the shell of the sea-urchin (*Echinus*), which are perforated with a number of small orifices, giving passage to tentacular suckers, and alternate with the broad tuberculate spine-bearing portions.

AMBULATO'RES. (Lat. ambulo, *I walk.*) The name of an order of birds in the system of Illiger, corresponding nearly with the *Passeres* of Linnæus.

A'MBULATORY. Formed for walking. In Ornithology, the term is applied to the feet of birds where the toes are placed three before and one behind.

AMBU'SCADE. A military term derived from the Italian imboscata, concealed in a wood. It is also applied to any snare laid for an enemy.

AMBU'STION. (Lat. amburo, *I burn.*) A medical term for a burn or scald.

A'MEN. (Heb. אמן, signifying, *let it be*, or rather, *let it be irrevocably fixed.*) It is understood to express belief and assent at the end of a prayer. It is sometimes translated, verily, as when used at the beginning of a discourse.

AME'NDE HONORABLE. In French Law, a species of infamous punishment, to which criminals guilty of an offence against public decency or morality were condemned under the ancient system, and are so still in some instances. Such were, sedition, forgery, sacrilege, fraudulent bankruptcy, &c. The *simple* or *dry* amende honorable consisted merely of an acknowledgment by the criminal of his offence in open court, bare-headed and kneeling. The *amende honorable in figuris* was made by an offender, kneeling in his shirt, a torch in the hand, a rope round the neck, and conducted by the executioner. It was, and still is, usually conjoined with some other punishment; sometimes capital, as in the case of parricides, &c.

AME'NDMENT. In a general sense, is any change made in any thing for the better. In Parliamentary Proceedings, it is an alteration in the words of any bill or motion, which it is competent for any member to move when the bill or motion has been read. (*See* Parliament.)

Amendment. In Law. The correction of an error committed in any process: as the amendment of a declaration, plea, &c. The deficiency of means of amendment in pleading at common law, led to the statutes of amendments and jeofails, beginning with that of 14 E. 3. All amendments are held to be within the discretion of the court, and allowed in furtherance of justice according to the particular circumstances of each case.

AME'NORRHŒA. (Gr. ἀ, *without*, μην, *a month*, and ῥέω, *I flow.*) Morbid irregularity or deficiency of the menstrual discharge.

AMENTA'CEOUS. Having amenta; a name formerly applied in Systematic Botany to such plants as have their flowers arranged in amenta. But as very different kinds of structure were combined by this character, the order Amentaceæ of Jussieu is broken up in several others, and the term is but little used.

AME'NTHES. in Eastern Mythology. the kingdom of the dead, or Tartarus of the ancient Egyptians.

AMENTIA. (Lat. amens, *deprived of mind.*) Idiotism.

AME'NTUM. (Lat. amentum, *a thong*, or *loop.*) A kind of inflorescence such as is found on willows and poplars: it differs from a spike only in being deciduous.

AME′RCIAMENT. (From the French *merci.*) The pecuniary punishment of an offender against the king or other lord in his court, when by his offence he is said to stand at the mercy of the king or lord.

AMETABO′LIANS, AMETABOLIA. (Gr. ἀ, *without*, and μεταβολη, *change.*) A sub-class of insects which do not undergo any metamorphosis.

A′METHYST. Purple rock crystal. The finer varieties are in great request for cutting into seals and brooch stones. Some of the ancient vases and cups are composed of this mineral, and it was an opinion among the Persians that wine drank out of an amethystine cup would not intoxicate: hence its name, from the Greek ἀμεθυστος.

A′MIA. The name of a Linnæan genus of abdominal fishes founded on a single species (*Amia calva*, Linn.) a native of the freshwater streams of Carolina, North America; and which is still its sole representative. It is an example of the Sauroid fishes of Agassiz, and is remarkable for the cellular structure of its air-bladder, which, as Cuvier remarks, is similar to the lung of a reptile.

AMIA′NTHUS. (Gr. ἀμιαντος.) A term applied to asbestus, in consequence of the resistance which it affords to the action of fire.

A′MIDES. Compounds containing a base apparently composed of 1 atom of nitrogen, and 2 of hydrogen. The term Ammonide, from their resemblance to ammonia, would perhaps be more correct.

A′MIDINE. The soluble part of starch.

AMID-SHIPS. A nautical term, denoting the middle of the ship, either with respect to her length or breadth.

A′MMOCŒ′TES. (Gr. ἀμμος, *sand*, and κοιτη, *a bed.*) The name of a genus of Cyclostomous fishes, of which the 'pride,' or 'stone grig' (*Amm. branchialis*), is a well-known example. This fish buries itself in the sand or clay of the banks of rivers; has many of the habits of a worm; possesses a skeleton reduced to membraneous consistence; and ranks among the lowest of organised vertebral animals.

A′MMODYTES. (Gr. ἀμμος, *sand.*) The name of a Linnæan genus of apodal fishes, characterised by a compressed head, narrower than the body; and both elongated. Gill-openings large, with seven branchiostegal rays; dorsal fin extending nearly the whole length of the back; anal fin of considerable length; dorsal and anal fins separated from the caudal fin. The sand-eel (*Ammodytes tobianus* Lin.) and the sand-launce (*Ammodytes lancea* Cuv.) are examples of this genus.

A′MMON. In Mythology, apparently a Libyan divinity, adopted by the Greeks, and by them identified with their Jupiter.

> ——— "stat corniger illic
> Jupiter, ut memorant, sed non aut fulmina vibrans,
> Aut similis nostro, sed tortis cornibus Ammon."

The name appears to be derived from ἀμμος, *sand;* and the situation of his celebrated temple in an oasis, surrounded by African deserts, indicates his origin. Alexander visited the temple, and assumed the title of son of this divinity, in order to impose on oriental imagination. It possessed a celebrated oracle. The lines of Lucan, partly quoted above (*Pharsal.* lib. ix. lin. 510. &c.), describing the temple, and the refusal of Cato to visit it, and consult the Fates respecting an enterprise, of the justice of which he was convinced, are among the finest and best known portions of his poem.

AMMO′NIA. Volatile alcali. This important compound is chiefly produced artificially. It exists, combined with acids, in some of the saline products of volcanos, and, in very small quantities, it is discoverable in sea-water. It is found in putrid urine and in the salts produced by the decomposition of animal matter; it exists occasionally in very minute quantities in the air, especially in large towns where pit-coal is burned; and the small stellated crystals which are sometimes observed on dirty windows in London. consist of sulphate of ammonia.

Ammonia was originally obtained (in the form of muriate of ammonia) by burning the dung of camels, which was collected for the purpose in Egypt, especially about the temple of Jupiter Ammon (whence the term sal ammoniac). It was afterwards procured by the distillation of putrid urine: at present, the demand for ammonia in its various states and combinations is in this country chiefly supplied from two sources; the distillation of pit-coal, and that of refuse animal substances, such as bone, clippings and shavings of horn, hoof, &c.

When coal is distilled (*see* GAS), a large quantity of ammoniacal liquor, as it is called, is formed, to which sulphuric or muriatic acids are added so as to form a sulphate or a muriate of ammonia. When the animal substances just mentioned are distilled, a quantity of impure ammonia passes off with the other products, which is also converted into sulphate or muriate of ammonia.

Pure ammonia is obtained in the form of a gas, by heating a mixture of quicklime and muriate of ammonia. It is very pungent and acrid; and so soluble, that one measure of water absorbs nearly 500 of gaseous ammonia: this solution is known under the name of liquid ammonia, and is used in medicine. Ammonia is a compound of nitrogen and hydrogen; it consists of

Nitrogen	1 atom	=	14	82·35
Hydrogen	3 . .	=	3	17·65
	1		17	100·00

It is decomposed when passed through a red-hot tube, and every 100 volumes of ammonia are resolved into 200 volumes of a mixture of 3 volumes of hydrogen and 1 of nitrogen.

Carbonate of ammonia is used in medicine as a stimulant, and frequently employed, under the name of smelling salt, as a restorative in faintness. It is obtained by sublimation from a mixture of muriate of ammonia and carbonate of lime. Muriate of ammonia has been above referred to as the common source of pure ammonia. Sulphate of ammonia is also manufactured for the same purposes.

Ammonia is recognised by its pungent smell, by its transient alcaline effect upon vegetable colours, and by producing white fumes when approached by muriatic acid. Thus, if we burn a piece of quill, and hold a glass rod dipped in muriatic acid near the smoke of it, dense white fumes appear, announcing the presence of ammonia, formed by the action of heat upon the animal matter.

AMMONI′ACUM. A gum resin used in medicine: it is imported in drops and cakes from Africa and the East Indies, and is said to be the produce of the Dorema ammoniacum. It is of a pale buff colour, and stands in the materia medica among the mildly stimulating but uncertain expectorants. It is sometimes applied externally in the form of a plaster.

A′MMONITE, AMMONITES. An extinct genus of molluscous animals which inhabited convoluted chambered siphoniferous shells, sometimes called Cornua ammonis, and vulgarly snake-stones. From their affinity to the nautilites, and the known organisation of the animal of the pearly nautilus, fossil shells of this genus are referred to the Tetrabranchiate order of Cephalopods, and constitute the typical genus of the second family of that order (*Ammonitidæ*). They are characterised by their conspicuous whorls, and the marginal-external position of the siphon. They abound in the strata of the secondary formation, varying from the size of a bean to the dimensions of a coach-wheel. Their name is derived from their resemblance to the horns upon the statue of Jupiter Ammon.

AMMONI′TIDÆ. A family of Cephalopods, with chambered syphoniferous shells, characterised by the septa being sinuous, with lobated margins.

AMMO′NIUM. A name given by Davy to the hypothetical base (supposed to be metallic) of ammonia. According to the hypothesis of Berzelius, ammonium is a compound of 1 volume of nitrogen with 4 volumes of hydrogen.

AMMO′PHILA. (Gr. ἀμμος, *sand*, and φιλεω, *I love.*) The name of a genus of hymenopterous insects, called sand-wasps. The generic characters are, proboscis conic, inflected, concealing a bifid, retractile, tubular tongue; jaws forcipated, 3-toothed at the tip; antennæ filiform in each sex, with about 14 articulations; eyes oval; wings plane; sting pungent, concealed within the abdomen.

AMMUNI′TION. In Military Language, signifies all sorts of warlike stores and provisions, but more especially powder and ball.

A′MNESTY. (Gr. ἀμνηστια, *oblivion.*) In Politics, freedom from penalty, granted by a solemn act to those guilty of some crime. Usually, by an act of amnesty is meant one passed to comprehend a number of individuals guilty of offences of a political nature, as rebellion, &c. Among remarkable amnesties in modern European history, may be cited, that granted on the restoration of Charles II., from which were excepted those concerned in the death of Charles I.; that granted on the second restoration of the Bourbons, in January, 1816, from which, besides the regicides, several others were excepted by name; and the law of amnesty for political offences in France, in 1836.

A′MNION. (Gr. ἀμνος, *a lamb.*) The membrane which surrounds the fœtus in utero: it includes a thin watery fluid, the liquor amnii.

A′MNIOS. In Botany, a thin, semitransparent, gelatinous substance in which the embryo of a seed is suspended when it first appears, and on which the embryo appears to feed in its early stages. Sometimes it is wholly absorbed; sometimes a portion of it is solidified in the form of albumen; occasionally, as in the cocoa-nut, a portion is consolidated into albumen, and a portion remains always in a fluid state.

AMNIO′TIC ACID. An acid supposed to be peculiar to the liquor amnii of the cow, but now known to belong to the liquor of the allantois.

AMO′MEÆ. (*See* AMOMUM.) One of the names of the plants more commonly called Zingiberaceæ.

AMO'MUM. (hhamâmâ, Arabic; ἄμωμον, of the Greeks.) A Zingiberaceous plant, with aromatic seeds, much employed under the name of cardamoms, grains of Paradise, &c. The species occur exclusively in the hottest parts of India and Africa.

AMO'RPHOUS. (Gr. ἀ, without, and μορφη, *form.*) Bodies devoid of regular forms.

AMPELI'DEÆ. Botany. (Gr. ἀμπελος, *a vine.*) One of the names of the natural order Vitaceæ.

A'MPELIS. The name of a Linnæan genus of Passerine birds, characterised by a straight convex beak, of which the upper mandible is the longer, and is subincurved, and emarginate on both sides. The Bohemian chatterer, or wax-wing (*Ampelis garrulus*), Linn., is a well known species of this genus; but is referred in the recent systems of Ornithology to a distinct section or subgenus, retaining the name of Bombycilla, originally applied to it by Brisson.

AMPHI'BIANS, AMPHI'BIA. (Gr. ἀμφι, *both*, and βιος, *life;* having the faculty of existing both in water and on land.) In modern Zoology, this term is restricted in its application to those animals which possess organs for breathing water, and organs for breathing air, or gills and lungs conjointly. Many cold-blooded animals, from the slowness of their circulation and the great capacity of their lungs in proportion to the vascular surface which alters the chemical state of the contained air, can remain a long time under water without being necessitated to seek the surface for a fresh supply: such are all the Vertebrata called Reptilia by modern zoologists, and which Linnæus, from the above mentioned faculty, included under the term Amphibia: yet if these animals were kept submersed longer than the period necessary for renewing the air in their lungs, they would inevitably be drowned; they are, therefore, not strictly amphibious. Not so, however, with that small portion of the order which retain their branchiæ throughout life;—these perennibranchiate reptiles suffer nothing from a prolonged aquatic existence, but, on the contrary, are most affected by a too long continuance on dry land; a desiccation of their external fringed gills, according to some recent experiments on the Siren lacertina, occasioning their death. Those warm-blooded mammalia which have their general form and locomotive instruments adapted for aquatic life, as whales, porpoises, walrusses, and seals, are, from the rapidity of their circulation and the prodigious extent of the vascular and respiratory membrane of the lungs, still more dependent upon a fresh supply of air for their existence than the pulmonated reptiles, and are consequently further removed from a true amphibious organisation. This is, in fact, enjoyed by a very small proportion of the animal kingdom; besides the perennibranchiate reptiles, a few species of mollusca, as the Ampullaria, and some insects and crustaceans, are the only examples.

AMPHI'BIOLI'TE. (Gr. ἀμφιβια, and λιθος, *a stone.*) The name given by Linnæus to the parts of reptiles, or amphibia, which were changed to a fossil substance.

AM'PHIBOLE. (Gr. ἀμφιβολος, *equivocal.*) A name which some mineralogists apply to hornblende, because it may be mistaken for augite.

AMPHIBO'LI. In Ornithology, the name of a family of scansorial birds, in the system of Illiger, including those in which the external posterior toe is versatile.

AMPHIBO'LOGY. (Gr. ἀμφι, *about*, and λογος, *discourse.*) In Rhetoric, an equivocal phrase or sentence, of which the sense may bear more than one interpretation.

AMPHI'CTYO'NIC COUNCIL. This was a congress of the deputies of twelve northern Greek tribes, viz. Thessalians, Bœotians, Dorians, Ionians, Perrhæbians, Magnetes, Locrians, Œnianians, Achæans of Phthia, Malians, Phocians, and Dolopians, or Delphians. In the Dorians and Ionians were included the Lacedæmonians and Athenians, who each sent one deputy. Each of these tribes had two representatives in the council called the Hieromnemon (*ιερομνημων*) and Pylagoras (*πυλαγορας*). The congress met twice every year; in the spring at Delphi, and at Thermopylæ in the autumn. Its functions do not seem to have been of a political nature, further than to see that no member of the union was destroyed; but were chiefly directed to religious matters, and more especially the protection of the temple of the Delphian Apollo. The principal ancient authorities which we possess respecting the objects and constitution of the amphictyonic council, are to be found in the orations of Æschines and Demosthenes: the 16th book of Diodorus Siculus; 9th of Strabo; and 10th of Pausanias. See also Ant. Van. Dale's *Dissertationes*, Amst. 1702; Paper by Valois, in the *Mém. de l'Ac. des Inscripions*, *&c.*, iii. 191. v. 405.; St. Croix, *Des Gouvernemens Féderatifs;* Tittmann's *Prize Essay on the Amphictyons;* and Muller's *Hist. of the Dorians.*

AMPHIGA'MOUS. (Gr. ἀμφι, in the sense of *doubtful*, and γαμος, *marriage.*) The most imperfect of all plants, having no trace whatever of sexual organs They form one of the classes in De Candolle's Natural System. (See BOTANY.)

AMPHI'PNEUSTS. (Gr. ἀμφις, *on both sides*, and πνεω, *I breathe.*) Merrem so calls a tribe of reptiles comprehending those which have both lungs and gills at the same time, as the true amphibia or perennibranchiates.

AMPHIPODS. (Gr. ἀμφις, *on both sides*, and πους, *a foot; feet diversely conformed.*) The third order of crustaceans in Latreille's arrangement, and the only one in which subcaudal natatory feet co-exist with sessile eyes.

AMPHI'PROSTYLE. (Gr. ἀμφι, *both or double*, προ, *before*, στυλος, *a column.*) In Architecture, a term applied to a temple having a portico or porch in the rear as well as the front, but without columns at the sides. This species of temple never exceeded the number of four columns in front and four in the rear. It differed from the temple in antis, in having columns instead of antæ at the angles of the portico.

A'MPHISBÆ'NA. (Gr. ἀμφι, *both*, βαινειν, *to walk.*) A genus of serpents or Ophidian reptiles, in which the tail and head are equally obtuse, and the scales of the head so similar to those on the back, as to render it difficult, on a cursory inspection, to distinguish one extremity of the body from the other. Hence these reptiles have been supposed to have the power of creeping backwards or forwards with equal facility.

AMPHI'SCII, or AMPHI'SCIANS. (Gr. ἀμφι, *about*, and σκια, *shadow.*) A term used by the ancient geographers, to denote the inhabitants of those climates in which the shadows, at noon-day, fall in opposite directions at different times of the year; that is to say, towards the north when the sun at noon is to the south of their zenith, and towards the south when the sun is to the north of their zenith. The term consequently applies to the people who live between the tropics.

AMPHITHE'ATRE. (Gr. ἀμφι, *about*, and θεατρον, *a theatre.*) In Architecture, a double theatre, or one of an elliptical figure; being, as its name imports, two theatres joined at the line of the proscenium; by which contrivance all the spectators, being ranged round on seats rising the one above the other, saw equally well what was passing in the arena, or space inclosed by the lowest range of seats. The origin of the amphitheatre was among the Etruscans, to whom also are attributed the first exhibitions of gladiatorial fights. From these the Romans acquired the taste for such shows, which they communicated to every nation subject to their dominion. Athenæus says, "Romani, ubi primum ludos facere cœperunt, huic asciti artifices ab Etruscis civitatibus fuerunt, sero autem ludi omnes qui nunc a Romanis celebrari solent, sunt instituti." (L. iv. cap. 17.) The most extraordinary edifice remaining in Rome is the amphitheatre, generally called the Coliseum, begun by Vespasian and finished by his son Titus. Words are inadequate to convey a satisfactory idea of its stupendous and gigantic dimensions.

> "Omnis Cesareo cedat labor amphitheatro,
> Unum pro cunctis fama loquatur opus,"

says Martial. It covers five English acres and a quarter of ground; the walls are of the height of 166 feet; it had seats for 87,000 spectators, with standing room for 22,000 others; and a vast arena, where thousands of gladiators and wild beasts contended at once—

> "Butcher'd to make a Roman holiday!"

This magnificent ruin has suffered much from earthquakes, and the destroying influence of time; and to the disgrace of the Papal government, it was allowed to be used, in comparatively recent times, as a convenient quarry, whence the materials of many modern edifices have been derived.—Still, however, its remains are such as to astonish the spectator;—

> A ruin – yet what ruin! From its mass,
> Walls, palaces, half-cities, have been rear'd;
> Yet oft the enormous skeleton ye pass,
> And marvel where the spoil could have appear'd.

Latterly, more attention has been paid to the preservation of this noblest monument of Imperial Rome. The walls have been propped up in some places, and sentinels have been placed for its protection.—Besides this amphitheatre, there were three others in Rome, namely, the Amphitheatrum Castrense, probably built by Tiberius, on the Esquiline; that of Statilius Taurus; and that built by Trajan, in the Campus Martius. The other principal amphitheatres were those of Otricoli, on the Garigliano, of brick, Puzzuoli, Capua, Verona, the foot of Monte Casino, Pæstum, Syracuse, Agrigentum, Catanea, Argos, Corinth, Pola in Istria, Hipella in Spain, Nismes, Arles, Fréjus, Saintes, and Autun. This last has four stories, similar in that respect to the Coliseum. But that in the most perfect state is the amphitheatre of Verona, which, with the exception of the exterior wall, is still perfect. The first that were erected, were, as we learn from Pliny, constructed of wood, and usually seated in the Campus Martius, or in some place out of the city. Accidents occurring from their insecurity, they were abandoned for the more substantial species of fabric whereof we have been speaking. The first person

who is said to have erected an amphitheatre in Rome, was Caius Scribonius Curio, in the games he gave to the people on the occasion of his father's funeral obsequies. Determined to surpass, in the way of games, all that had hitherto been seen, he constructed two theatres of wood, back to back, which, after the theatrical representations had been finished, were turned round with the spectators still in them, leaving the stages and scenery behind, and, by their opposite junction, forming a perfect amphitheatre, in which the people were gratified with a show of gladiators. The part in which the gladiators fought was called the arena, from being usually covered with sand to absorb the blood spilt in the conflicts for which it was used. The arena was encompassed by a wall, called the podium, fifteen or sixteen feet in height, immediately round which sate the senators and ambassadors. As in the theatres, the seats rose at the back of each other; fourteen rows in the rear of the podium being allotted to the equites, and the remainder for the public generally, who sate on the bare stone, cushions being provided for the senators and equites. Though generally open to the sky, there were contrivances for covering the whole space with a sort of awning. The avenues by which the public entered were many in number, and bore the name of vomitoria. See the work of Maffei, *Degli Amfiteatri;* and the section on Amphitheatres in his learned and excellent work, Verona Illustrata. The modern history of the Coliseum is given at considerable length in Hobhouse's Illustrations to Childe Harold.

AMPHITRI'TE. The name of a genus of cephalobranchiate or tubicular Annelides, characterised by golden-coloured short bristles, arranged like a crown, in one or two rows, on the anterior part of the head. One species inhabits the south coast of England, and forms for its habitation a very delicate, straight, conical tube of grains of sand, agglutinated together by the mucus exuded from the skin: this is the *Amphitrite auricoma.*

AMPHI'TROPAL. (Gr. ἀμφι, *round*, and τρεπω, *I turn.*) In Botany. This is said of an embryo which is turned round albumen, or curved upon itself in such a manner that both its ends are presented to the same point.

AMPHIU'ME, AMPHIU'MA. A genus of true amphibious reptiles, with a persistent branchial orifice on each side of the neck; palatal teeth in two longitudinal rows; a lengthened body, and four rudimental extremities, each divided either into three or two toes according to the species.

A'M'PHORA. (Gr. ἀμφορεος, *two-handled.*) In Sculpture and ornamental Architecture, a vase or measure having two handles, used as a measure for liquids by the Greeks and Romans: they are frequently applied as ornaments on sarcophagi, &c.

AMPHORA. A kind of earthenware vase with two handles, used by the Romans to hold wine and other liquids. Also a liquid measure, containing probably about nine gallons; but its exact size is not satisfactorily made out.

AMPLE'XICAUL. (Lat. amplecto, *I embrace*, and caulis, *a stem.*) A leaf or bract whose base projects on each side, so as to clasp the stem with its lobes.

AMPLIFICA'TION. In Rhetoric, the lengthening a discourse or a passage by the enumeration of minute circumstances, the employment of epithets, particularity of description, &c., with a view to produce a deeper impression. *Exaggeration* is properly a species of amplification, in which circumstances and facts are not merely dwelt upon, but represented beyond their true dimensions.

AM'PLITUDE. In Astronomy, denotes the angular distance of a celestial body, at the time it rises or sets, from the east or west points of the horizon. The amplitude of a fixed star remains the same all the year round; that of the sun or moon is constantly changing. At a given latitude, it depends on the declination of the object. Amplitude is sometimes used to denote the horizontal distance to which a projectile is expelled from a gun, or what is more frequently termed the range of the gun.

A'MULET. A substance worn about the person, and supposed to have the effect of protecting the wearer against some real or imaginary evils. Those of the Persians and Egyptians are said to have been small cylinders ornamented with figures and hieroglyphics. The Greeks and Romans employed for the same purpose a great variety of gems and small figures of deities, heroes, or animals, the bulla, and various other articles. Some of these were hung around the necks of children, to defend them from the evil eye. In more modern times, scraps of paper or parchment inscribed with verses of the Bible, or with magical characters and jargon, have often been used for the same purposes. The celebrated Arabian talismanic medals are called by the Arabs Ain, from the first letter of the inscription always beginning with that character.

AMYGDA'LEÆ. (Gr. ἀμυγδαλον, *an almond.*) A division of Rosaceous plants, comprehending the peach, the plum, the apricot, and similar objects. The species have all a fleshy or succulent fruit, gum in their bark, and hydrocyanic acid in their leaves. They occur principally in cold and temperate latitudes.

AMY'GDALOI'D. (Gr. ἀμυγδαλον, *an almond*, and εἶδος, *a form.*) Almond-shaped. The term is applied to certain rocks in which other minerals are occasionally imbedded like almonds in a cake.

AMYRI'DA'CEÆ. Balsamic exogenous plants, consisting of shrubs or trees, found almost exclusively in the Tropics. Bdellium, balsam of copaiva, gum elemi, and balsam of Tolu, are all produced by species of this order, the type of which is the genus amyris (myrrha, *myrrh*).

ANA. A termination of the neuter plural form in Latin, used in English and French to denote anecdotes of eminent persons, or selections from their works. The first of the French collections termed "Ana," and from which that denomination originated, is the Valesiana; containing detached observations on passages of classical antiquity by the celebrated scholar Valois, or Valesius: it appeared at Paris in 1695. The Menagiana (Paris, 1715) is a more amusing work, consisting of anecdotes, criticisms, and miscellaneous observations on all possible subjects, attributed to the academician Ménage. The popularity of this work produced a multitude of other "Ana:" among which may be mentioned the Huetiana, 1723; the Scaligerana, Thuana, Poggiana, and a variety of similar books, consisting of extracts from the works of distinguished writers, or of thoughts or sayings attributed to them.

ANA, or AA (contracted from ana). In Medical prescriptions, implies "of each."

ANABA'PTISTS. Properly, all sects are so called, that insist upon the repetition of baptism upon admission into their communion, from a notion of the invalidity of the religious ceremonies of other denominations. There were several such in the early period of the church, as the Cataphrygians and Novatians: but they are to be distinguished from the sects which arose in the 15th and the beginning of the 16th centuries, under the papal dominion, especially in Germany; and adopted, in their ignorance and fanaticism, preposterous notions of the qualifications requisite for admission into the visible church. Their idea of primitive society consisted in the rejection of all the customs and decencies of life; in the community of goods and of women; in uncompromising hostility to all modes of artificial life, and to government generally, as the foundation and sanction of social distinctions. They had, of course, no indulgence for the ordinances of any church but their own, and required baptism for themselves as the essential preliminary for admission within their pale. Early in the progress of the Reformation, finding their numbers daily increasing under the licentiousness of opinion which the unrestricted abuse of private judgment produced among a rude and uneducated people, they united in a hostile league against all existing institutions, and declared open war against the governments of Lower Germany. After committing the greatest atrocities, and causing an universal panic throughout Europe, their progress was arrested by a complete defeat in Saxony, in which their leader, Muncer, perished. The remnant, however, escaping, established their opinions with more or less moderation of tone in Holland and elsewhere. Some of the party seized, soon after, upon the town of Munster, overthrew the magistracy, and established society upon their own principles; but eventually were put down with great slaughter. (See, as to the Munster Anabaptists, Mosheim's *Ecclesiastical History*, sect. ii. part ii. c. 3., where reference is made to the best works on the subject.) It should be observed, that the anabaptists were not dependent upon religious views only for their support, but that the war soon assumed the character of a struggle between the lower and upper classes; and the enormities committed by the insurgents must be attributed as much to revenge for oppression as to religious fanaticism. (*See* BAPTISTS.)

A'NABAS. A genus of Acanthopterygious fishes, in which the surface of the pharynx is broken into numerous little branched appendages and cells, capable of retaining water, and of gradually dropping it into the branchial cavity, so as to moisten the gills; whereby these fishes have the curious faculty of voluntarily quitting the water, creeping about on land, and even, it is said, of climbing trees. The only known species (*Anabas testudineus*) is the *Perca scandens*, or climbing perch, of the older naturalists.

A'NABLEPS. (Gr. ἀναβλεπω, *I raise the eyes.*) A name applied to a genus of malacopterygian viviparous fishes, characterised by a remarkable projection of the eyes from the sides of the head, and a still more singular structure of the cornea and iris, from which there result two pupils, and the eyes appear to be double on each side, although they have but one crystalline lens, one vitreous humour, and one retina.

ANACLA'STICS. (Gr. ἀνα, *up*, and κλαω, *I break.*) That part of Optics in which the refraction of light is considered, commonly called Dioptrics. The term was

applied by Desmairau to the apparent curves formed by the bottom of a vessel when looked at through a body of water.

ANACA'RDIA'CEÆ. A natural order of exogens, founded upon the *Anacardium occidentale*, or cashew nut. It consists of tropical trees, often abounding in a fluid resin of extreme acridity, but forming a valuable varnish in some cases. Marking nuts, the fruit of Semicarpas anacardium, black Burmen varnish from Melanorhœa usitatissima, mastich, Scio turpentine, pistacia nuts, sumach, are all produced by various species of this extensive natural order.

ANA'CHORITE. See ANCHORITE.

ANA'CHRONISM. (Gr. ἀνα, *backward*, and χρονος, *time.*) An inversion or disturbance in the order of time: as where, in Shakspeare's King John, cannon are introduced, which were not in reality employed until a hundred years afterwards.

A'NACOLU'THON. (Gr. ἀνακολουθον, *not following.*) A Grammatical term, denoting the want of sequence in a sentence, one of whose members corresponds not with the remainder. This figure recurs more frequently in the Greek than in any other language.

ANA'CREO'NTIC. In Poetry, a species of ode devoted chiefly to the praises of love and wine; —

> "Quid nisi cum multo venerem confundere vino,
> Præcipit lyrici Teia musa Senis?"

The name is derived from Anacreon of Teos, who flourished in the sixth century B.C. The genuineness of the Odes which pass under his name, has, however, been questioned by some critics; but some of them are, at all events, very ancient; and they have been universally admired for their simplicity and sprightliness; —

> "All thy verse is softer far
> Than the downy feathers are,
> Of my wings, or of my arrows,
> Of my mother's doves and sparrows;
> Graceful, cleanly, smooth, and round,
> All with Venus' girdle bound."

The poems of Anacreon have been rendered familiar to the English reader by the translations of Cowley and Moore. The best editions of the original are those of Fischer and Brunck.

ANÆSTHE'SIA. (Gr. ἀ, *without*, and αἰσθανομαι, *I feel.*) Diminution or loss of the sense of touch.

ANAGLY'PHIC. (Gr. ἀνα, *upon*, and γλυφω, *I carve.*) In antique Sculpture, chased or embossed work on metal, or any thing worked in relief. When raised on stone, the production is a cameo. When sunk or indented, it is a diaglyphic or an intaglio.

ANAGNO'STA. (Gr. ἀναγινωσκω, *I read.*) A domestic servant employed by wealthy Romans to read to them at their meals and on other occasions. The ancient monks and clergy preserved the same custom, and name.

A'NAGRAM. (Gr. ἀνα, *back*, and γραφω, *I write.*) The most proper, and most difficult, species of anagram is that which is formed by the reading of the letters of a word or words backwards: as "evil," "live."

> "Live, vile, and evil, have the self-same letters;
> He lives but vile, whom evil holds in fetters."

A less perfect anagram is that which is made by transposition of letters ad libitum: and an anagram in which the transposition is helped out by the admission of letters not in the original word, or the rejection of some of those which it contains, is termed impure. The manufacture of anagrams, particularly out of proper names, formed a favourite exercise of ingenuity in the 16th and 17th centuries; when a common mode of flattery was by inventing some complimentary transposition of the letters of the name of the person addressed. But none of the anagrams of that period exceed, in felicity, Dr. Burney's on Lord Nelson: "Horatio Nelson," "Honor est a Nilo." Of all the extravagances occasioned by the anagrammatic fever, when at its height, none probably equals what is recorded of an eccentric Frenchman in the 17th century, André Pujom. He read in his own name the anagram "pendu à Riom" (the seat of criminal justice in the province of Auvergne), felt impelled to fulfil his destiny, committed a capital offence in Auvergne, and was actually hung in the place to which the omen pointed.

ANAL. In Ichthyology, the fin which is placed between the vent and tail, and expands perpendicularly.

ANAL GLANDS. Comp. Anat. Organs for secreting substances, sometimes attractive, but generally repulsive in their properties, and applied to purposes of defence; they present every grade of the glandular structure, from the simple cæcum, or tube, to the conglomerate mass; developed from, and consequently always opening into, the termination of the intestine, near the anus. In insects, the sweet fluid ejected by the aphides, and of which the ants are fond, is, at least in some species, the product of secerning tubules opening near the anus. Odorous substances, — sometimes fragrant, sometimes fetid, — are in different species of insects respectively emitted from the same part; and the singular defensive acrid vapours discharged explosively by the insects called "bombardiers," are the products of anal glands. In the mollusks, the most remarkable example of the anal glands is presented by the higher organised cephalopods, where they are represented generally by a single, sometimes by a bilobed or trilobed, cyst, with part of its parietes spongy and glandular, and which secretes the inky fluid which these animals eject to blacken the water around them for the purpose of concealment in time of danger. Among fishes, an anal bag opens by a single narrow duct, as in cephalopods, into the termination of the rectum, in rays and sharks; but it no longer exercises the function of a secerner of colouring matter. In reptiles, the anal bags are either single, double, or triple; and in many species, as in frogs and tortoises, are developed to a great size, and serve for aquatic respiration. In crocodiles they are two in number, and emit into the cloaca a muco-caseous secretion, without any strong odour. In birds, the anal follicles have a similar function, but they are aggregated into a single cavity, which is called the "bursa Fabricii." In quadrupeds, the anal follicles are generally collected into two sacciform groups, each having an opening near the verge of the anus. The insupportably disgusting odour of the secretion of these glands has rendered some of the viverrine quadrupeds, as the skunk, &c., proverbial; in others, the odour is not stronger than serves to attract the individuals of the same species to one another, which is the common function of the anal glands in this class of animals.

ANAL VALVES. A mechanical structure for defending the terminal orifice of the intestines in some of the cephalopods, which swim forwards, from the retrograde entrance of foreign or noxious substances. This mechanism is required from the position and direction of the anal opening, which is turned forwards towards the base of the funnel or respiratory channel.

ANA'LCIME. A variety of zeolite, which by friction becomes weakly electric: from ἀναλκις, *weak*.

ANALE'CTA. A servant in great Roman houses, whose duty it was to collect the scraps after a meal; whence he derived his name, from the Greek ἀναλεγω, *I pick up*.

ANALE'MMA. (Gr. ἀναλαμβανω, *I take up.*) In Geometry. An orthographic projection of the sphere on the plane of the meridian. In this projection the eye is supposed to be placed at an infinite distance. Every great circle whose plane is perpendicular to the plane of projection, — the horizon, for example, — is represented by its diameter; every small circle perpendicular to the same plane is represented by the chord which forms its diameter. A small circle parallel to the plane of projection, is represented by a circle. Every circle, great or small, of which the plane when produced does not pass through te eye, or is not perpendicular to the plane of projection, will be seen obliquely and under the form of an ellipse. — Analemma also denotes an instrument of brass or wood on which the projection is made, (the plane of projection being the solstitial colure,) with a moveable horizon attached to it, by means of which some of the common astronomical problems may be solved, though not very exactly. Ptolemy wrote a treatise on the Analemma, of which there is a Latin translation from an Arabic version, with a commentary by Commandine. According to Delambre, it contains only some complicated rules for computing the true values of the arcs of the sphere from the straight lines by which they are represented on the analemma. Since the invention of trigonometry, contrivances of this sort have become useless.

A'NALE'PSY. (Gr. ἀναλαμβανω.) A species of epileptic attack of sudden and frequent recurrence.

ANALE'PTIC. A restorative medicine.

A'NALOGUE. A body that resembles another. A fossil shell of the same species as a recent one, is its analogue.

ANA'LOGY. (Gr. ἀναλογος, *according to rule or proportion.*) In Geometry, signifies the same thing as proportion, or the equality or similitude of ratios. (*See* PROPORTION, and RATIO.)

ANALOGY. In modern Zoology, this term is restricted to the relation which animals bear to one another in the similarity of a smaller proportion of their organisation: thus, the Ascalaphus italicus, in the length and knobbed extremities of its antennæ, the colouring of its wings, and its general aspect, exhibits a striking resemblance to a butterfly; but in all the essential parts of its organisation it adheres to the neuropterous type of structure; its relation to the Lepidoptera is therefore said to be one of analogy, while it is connected to the ant-lions by the order of affinity. As it has been found in some instances, that two series of animals, arranged according to the greater amount of resemblances, or the relation of affinity, are connected to one another by analogical resemblances at given points of the series, the relation of analogy has been regarded as differing from that of affinity not only in degree, but in kind. If a zoologist, for example, were led, by a too superficial glance at the external resemblances of two animals, to

place them in the same series contiguous to one another, and it were discovered that the resemblance was but skin-deep or limited to a temporary state of being, as a stage of metamorphosis, but contradicted by a dissimilarity of a greater proportion of the internal organisation, then it would be said that he had mistaken a relation of analogy for one of affinity; a phrase which the reader, however, will readily perceive, merely expresses the fact, that a false judgment had been formed, from not taking into consideration the whole of the points of comparison necessary for determining the mutual relation of animals to each other.

Analogy. In its Rhetorical sense, signifies a similarity of two things in their relation to a third, though there may be the greatest difference in their structure, form, colour, &c.: thus, a hat is analogous to a turban, and both are analogous to a bonnet, having a similar relation to the head of the wearer. In this sense, a porpoise is analogous not only to a fish, but to every other animal which habitually moves and seeks its food in the water. It often happens, however, in Zoology, that a similarity of relationship to a medium of locomotion, a kind of food, &c., is accompanied with a certain amount of corporeal and organic resemblance; and this is necessary to constitute an analogy in the zoological sense, though by no means in the strictly logical application of the word.

Analogy. In ordinary Language, denotes a relation or similarity between different things in certain respects. The conclusions to which we are led concerning one thing, by reasoning from our experience concerning another similar thing, form what is termed analogical knowledge. The word analogy is generally employed to designate an imperfect degree of similarity. Thus, a physician, arguing, from the effects which he had seen produced by a drug on one man, to its probable effects on another man, would be said to reason from experience: but reasoning from the effects produced on an inferior animal, to the probable effects on man, would be, more properly, reasoning by analogy.—In Rhetoric, the word analogy is employed in a somewhat stricter sense; it designates, not the specific resemblance between two objects, but a resemblance between the relations in which they stand to other objects. Thus, to term youth "the dawn of life," is said to be a metaphor by analogy; not because of any actual resemblance between youth and morning, but because the one is to life, what the other is to the day.—In Mathematics, analogy signifies the similitude of certain proportions.—In Grammar, it means a conformity in the principles of organisation of different words or collections of words.

ANA'LYSIS. (Gr. ἀναλυω, *I dissolve.*) A Greek word, which signifies the resolution of a thing into its component parts.—In Logic, analysis is used in opposition to synthesis, as a method of arriving at adequate definitions. In the synthetical method, we begin by assuming some quality which the subject is known to possess. Finding this to be common to other subjects than the one we wish to define, we add on some further property and so on, until we have adequately distinguished it from all other things. Thus, man is an animal, man is a hot-blooded animal, man is a hot-blooded viviparous animal, &c. &c., may be taken as a specimen of a synthetical process. In analysis we should reverse the method; assuming the most distinguishing characteristic, and descending, through successive gradations, to that which is least so. Correspondently with this distinction, an analytical proposition is one in which the subject is implied in the predicate: e. g. "matter is extended." A synthetical proposition, on the contrary, is that in which the terms have no necessary connection: e. g. "John is tall:" "the world is round." As applied to mental phenomena, analysis is the referring them to the acts or faculties of the mind which they necessarily imply, either as contemporaneously contributing to their production, or as rendering their production possible by their past operation.

The distinction frequently made between analytic and synthetic reasoning, rests on a somewhat vague use of language. Strictly speaking, all reasoning can be but of one kind. A process of ratiocination admits, however, of being reversed: i. e. we may make certain assumptions, and from them form certain legitimate deductions; and we may then proceed to take the truths thus deduced for granted, and by a counter-process arrive, as inferences, at what, in the former case, were the grounds from which we started. Here it is evident that the distinction lies not in the reasoning, but in the subject-matter concerning which we reason.

Analysis. In Chemistry, this term is applied to the resolution of compound bodies into their elements. It is either qualitative or quantitative. Qualitative analysis consists in the determination of the component parts, merely as respects their nature, and without reference to their relative proportions: it is an imperfect, and often a very easy, operation, as compared with quantitative analysis, by which we determine not merely the components of a compound, but their relative proportions: to effect this, much scientific skill and practical dexterity are required, more especially in the identification of new substances. The theory of definite proportionals, or the Atomic Theory, as it is usually called, has materially facilitated many analytical processes, and is especially valuable as furnishing an unerring test or criterion of the general accuracy of the results.

In reference to chemical analysis generally, but more especially as regards organic products, we often employ the terms proximate and ultimate analysis: the former referring to the immediate combinations which form the subject of experiment; the latter, to their final resolution into elementary principles. Thus, in regard to sulphate of lime, it is resolved by proximate analysis into sulphuric acid and lime, and these are called its proximate elements; but sulphuric acid is itself a compound of oxygen and sulphur; and lime, of oxygen and calcium; oxygen, sulphur, and calcium, therefore, are the results of the ultimate analysis of sulphate of lime; and there are many theoretical points in chemistry dependent upon the views which are taken of the various groupings of these ultimate principles. Wheat flour is a compound of starch and gluten; starch is compounded of oxygen, hydrogen, and carbon; and gluten, of the same elements with the addition of nitrogen; so that the ultimate components of wheat, are oxygen, hydrogen, carbon, and nitrogen.

Analysis. In Geometry, a method of conducting geometrical inquiries, invented by the philosophers of the school of Plato, or, according to Theon of Alexandria, by Plato himself, and one of the most ingenious and beautiful contrivances in the Mathematics. The essence of the analytic method of establishing the truth of a proposition consists in assuming the proposition enunciated to be true, and deducing consequences from that supposition till a conclusion is arrived at manifestly true or manifestly false; or at least known to be true or false by its agreement or disagreement with some proposition which has already been demonstrated. Analysis is thus the converse of synthesis, or composition,—a form of reasoning by which we ascend, through a series of propositions, from some known truth to the conclusion we are in search of. The distinction between analysis and synthesis, as well as the definition of the two terms in the sense in which they were understood by the ancient geometers, is concisely given by Pappus, in the Preface to the Seventh Book of his Mathematical Collections. "Analysis," says Pappus, "is the course which, setting out from the thing sought, and which for the moment is taken for granted, conducts by a series of consequences to something already known, or placed among the number of principles admitted to be true. By this method, therefore, we ascend from a truth or a proposition to its antecedents; and we call it analysis, or resolution, as if indicating an inverted solution. In synthesis, on the contrary, we set out from the proposition which is the last in the analysis; and proceed by arranging, according to their nature, the antecedents which present themselves as consequents in the analytic method, and combining them together till we arrive at the conclusion sought. Analysis may be distinguished into two kinds: in the first, which may be called contemplative analysis, we propose to discover the truth or falsehood of an affirmed proposition; the other belongs to the solution of problems, or the investigaton of unknown truths. In the first we assume the subject of the proposition advanced to be true, and proceed through the consequences of the hypothesis till we arrive at something known. If this result is true, the proposition is true also, and the direct demonstration is obtained by stating in an inverse order the different parts of the analysis. If the ultimate consequence at which we arrive is false, the proposition was also false. In the case of a problem, we first suppose it to be resolved, and deduce the consequences resulting from that proposition till we arrive at something known. If the last consequence involves only something which can be executed, or is comprised among what geometers called data, the proposed problem can be solved; and the demonstration, or rather in this case the construction, is obtained, as in the former case, by taking the different parts of the analysis in an inverse order. If the last result is impossible, the thing demanded is also impossible."

The names of the ancient writers on the geometrical analysis have been preserved by Pappus in the preface before referred to: they are, Euclid, in his Data and Porismata; Apollonius, in his treatise De Sectione Rationis, and in his Conic Sections; Aristæus, De Locis Solidis; and Eratosthenes, De Mediis Proportionalibus; but of these only the Data of Euclid, and some fragments of Apollonius, have come down to our times. The subject has, however, been fully investigated by the moderns, and a complete system of the ancient geometrical analysis may be found in the works of Dr. Simson of Glasgow. (See also Leslie's Geometrical Analysis.)

By the term analysis the ancient geometers understood

a certain mode of reasoning altogether independent of signs or symbols, and which might be carried on by ordinary language. In its modern acceptation, analysis is synonymous with algebra, or the calculus, and is opposed, not to synthesis, but to geometry. In this sense the original meaning of the word is entirely lost sight of; and, instead of being used to denote a particular mode of reasoning, it rather indicates the instrument by which the reasoning is carried on. Algebra may be employed with advantage, whether the method of demonstration be analytical or synthetical.

One great advantage arising from the use of algebra in the solution of geometrical questions, consists in this, —that the demonstration is reduced to certain rules, and carried on by systematic processes; in consequence of which, the analyst, having reduced his problem to equations, can generally determine at a glance, whether the solution is possible or not. It must be admitted, that the demonstrations of many of the propositions of elementary geometry by the ancient methods have a peculiar elegance which the algebraic methods cannot always reach; but, in point of power and applicability, the modern analysis is vastly superior to the ancient. "The geometrical synthesis," says Laplace, "has the advantage of never losing sight of its object, and of illuminating the whole path which leads from the first axioms to their last consequences; whereas the algebraic analysis soon causes us to forget the principal object in order to occupy us with abstract combinations. But in thus isolating the objects, after having abstracted from them what is indispensable to arrive at the result he is in search of, in abandoning himself to the operations of analysis, and reserving all his forces to overcome the difficulties which it presents, the analyst is conducted to results inaccessible to synthesis. Such is the fecundity of analysis, that it is sufficient to translate particular truths into this universal language, in order to perceive a series of other new and unexpected truths arise from their mere expressions. No language is equally susceptible of the elegance which results from the development of a long series of expressions intimately connected with one another, and all flowing from the same fundamental idea. Analysis also unites with these advantages that of being always capable of leading to the simplest methods; for this purpose it is only required to apply it suitably, by a skilful choice of indeterminate quantities, and to give the results the form the most convenient for geometrical construction or numerical calculation. Modern geometers, convinced of the superiority of analysis, have especially applied themselves to extend its domain, and enlarge its limits."—(*Exposition du Système du Monde*, 4to. p. 423.)

Analysis is in general the instrument of invention; and it is supposed, not without reason, that the greater part of the discoveries, for which the mathematicians of the 17th century were distinguished, were made by its means, though they were given to the world in a synthetical form. It is evident, from the posthumous works of Pascal and Roberval, that they first obtained the solution of many of their problems by the method of indivisibles, and afterwards demonstrated the truth of their results in the manner of the ancients. Newton himself thought that a mathematical proposition ought not to be made public, or was not fit to be seen, till invested in a synthetic dress. Synthetic demonstration is now rarely met with in any other than the most elementary works; the algebraic analysis has become the ordinary intrument of mathematical investigation. "Nevertheless," says Laplace, "geometrical considerations ought not to be entirely abandoned; they are of great utility in the arts. Besides, it is interesting to figure to one's self in space the divers results of analysis; and reciprocally to read the affections of lines and surfaces, and all the variations of the motion of bodies, in the equations which express them. This connection of geometry and analysis throws a new light over both sciences; the intellectual operations of the latter, rendered sensible by the former, are more easily apprehended, and more interesting to follow; and when the imagination realises these images, and transforms geometrical results into laws of nature; when those laws, while they embrace the universe, unveil to our eyes its past and future conditions; the sight of this sublime spectacle affords the noblest of the pleasures reserved for the human race."—(*Exposition du Système du Monde*, p. 424.)

ANAMORPHO'SIS. (Gr. ἀνα, *backward*, and μορφη, *form.*) A term employed in Perspective, to denote a drawing executed in such a manner that, when viewed in the common way, it presents a confused or distorted image of the thing represented, or an image of something entirely different; but when viewed from a particular point, or as reflected by a curved mirror, or through a polyhedron, it recovers its proportions, and presents a distinct representation of the object.

ANAMORPHOSIS. In Botany, when any part assumes an appearance unusual with it. The calyx of the rose assuming the appearance of a fruit, the stipule of a prosopis become spiny, the stem of a cactus when succulent and tube-like, are cases of anamorphosis.

ANA'NAS. (Ananas, *Brazilian.*) The plant that produces the delicious pineapples of the gardens. It is of South American origin, but has been gradually dispersed through similar climates till it has become apparently wild in Africa and many parts of Asia, especially the Malayan Archipelago, where it arrives at a greater degree of excellence than in its native woods.

ANA'NDROUS. (Gr. ἀ, *without*, and ἀνηρ (genitive ἀνδρος), *a male or stamen.*) When flowers are destitute of stamens, they are usually called female flowers.

A'NAPÆST. (Gr. ἀναπαιστος.) A foot in Greek and Latin metre, consisting of two short syllables followed by a long being the name of the dactyle.

ANA'PHORA. (Gr. ἀναφορα, *raising up.*) In Rhetoric, a repetition of words or phrases at the commencement of sentences or verses. Thus in Cicero, Verr. iv. c. 10., *Verres calumniatores apponebat, Verres adesse jubebat Verres cognoscebat, Verres judicabat.*

ANAPLOTHE'RIUM. *See* ANOPLOTHERIUM.

A'NARCHY. (Gr. ἀ, *without*, ἀρχω, *I govern.*) In Politics, the constitution of a country in which not only lawful government, but regular government *de facto*, is superseded by force. Hence Milton metaphorically terms his personified Chaos an "Anarch."

ANARRHI'CHAS. A name conceived by Gesner and applied by Linnæus to a genus of spiny-finned osseous fishes, characterised by having their mandibular, palatine, and vomerine bones armed with large osseous tubercles, bearing on their summits small enamelled teeth; anteriorly the jaws support longer and more conical teeth: by means of this powerful dental apparatus the species of this genus, which inhabits the northern seas, called the "wolf-fish," is enabled to break and bruise the testaceous defensive coverings of shellfish, the soft parts of which form its ordinary food.

A'NAS. (Lat. anas, *a duck.*) The name of a Linnæan genus of Anserine birds, characterised by a large, broad, obtuse bill, furnished at the margin with numerous thin, transverse, projecting plates, and an obtuse papillose or ciliate tongue. The subdivisions of this extensive group of web-footed birds, which were indicated by Linnæus, have since been raised to the rank of genera (*see* ANATIDÆ), and the term Anas is now restricted to the species which present a flattened bill, the base of which is always of greater breadth than depth, as wide (or wider) at the extremity as at the beginning; with nostrils placed nearer the upper margin and base of the bill. The legs are shorter and placed farther back than in the geese (*Anser*); they have a shorter neck, and the windpipe is dilated at its lower end into two osseous capsules, of which the left is usually the larger. The ducks, thus characterised, are subdivided into those which have the hind toe provided with a membrane, and those in which it is naked. Both divisions are again broken up into numerous minor groups, which are distinguished by generic terms.

ANASA'RCA. (Gr. ἀνα, *through*, and σαρξ, *flesh.*) A diffusion of water through the cellular membrane of the limbs, as in dropsy.

ANA'STOMO'SING. When two parts, growing in different directions, meet and grow together, as the veins in leaves.

ANA'STOMO'SIS. (Gr. ἀνα, *through*, and στομα, *a mouth.*) The communications of the vessels of the body with each other.

ANA'STROPHE. A name given in Classical Philology to some species of inversion (*see* INVERSION) or departure from the usual order of succession in words. From the Greek ἀναστρεφω, *I overturn or invert.* Such phrases as mecum, vobiscum, &c., in which the preposition follows the word governed by it, or in which it is placed between two words governed by it, &c., are instances of anastrophe.

ANA'THEMA. (Gr. ἀναθεμα.) Properly, a thing laid by, consecrated, or devoted: hence a person upon whom the ban of the church is laid, is said to be anathematised, or in the Jewish phrase, to be "anathema." St. Paul says, "If we or an angel from heaven preach any other gospel to you than that which we have preached, let him be anathema:" and upon the authority of this and similar passages, the church assumed from the first the power of anathematising or excommunicating evildoers and heretics.

ANA'TIDÆ. The name of a family of web-footed birds, of the swan, goose, and duck kind, of which the genus Anas is the type.

ANA'TOMY. (From ἀνα, *through*, and τεμνω, *I cut.*) This term literally means *dissection*, but is generally understood to signify a knowledge of the internal structure of the human body, in the acquisition of which dissection is essentially necessary. The anatomy of other animals is usually designated Comparative Anatomy; and that of plants, Vegetable Anatomy; which see.

Although some anatomical knowledge must have been accidentally acquired by the earliest inhabitants of the

globe, and although there are several allusions in the early books of the Old Testament to the subject, no dissections of the human body were performed with a view to ascertain the position and structure of its internal organs, or to elucidate their functions, till a much later period.

Homer has, it is true, been complimented, and in some respects justly so, for the precision with which he describes the wounds of his heroes; and the ancient Egyptians are said to have acquired great anatomical skill by their practice in the art of embalming; but these, and similar statements, have no bearing upon the pursuit of anatomy as a science, or in connection with surgery, medicine, and physiology. Thales, Socrates, Xenophon, and Plato, are each quoted by anatomical historians, as having acquired no inconsiderable anatomical knowledge; Plato is even said to have anticipated the celebrated discovery of the circulation of the blood. "The heart," he says, "is the centre of the blood-vessels, the spring of the blood, whence it flows rapidly round: blood is the pabulum of the flesh, in order to the nutriment of which the body is intersected by canals, like those of gardens, to convey the blood like water from a fountain, to the remote parts."

The first author who is supposed to have written on human anatomy is Hippocrates; and the first recorded dissection was, probably, made by his contemporary Democritus of Abdera. This carries us back to about 400 years before the Christian era, from which period, to that of Galen, (that is, in the space of 600 years,) little progress seems to have been made in the knowledge even of the structure and position of the viscera of the body, much less in their uses and diseases.

It would appear from Galen that the most eminent anatomists of antiquity were Erasistratus and Herophilus, who taught anatomy in the celebrated school of Alexandria, and are said to have been the first who were authorised to dissect human bodies: hence, probably, the high rank which the school, founded by the Ptolemies, acquired, and maintained for several hundred years. The works of the above-mentioned anatomical professors have been lost, but they are abundantly quoted by their more immediate successors.

Among the Romans the first anatomist was, probably, Asclepiades, who flourished in the time of Pompey; and soon afterwards Rome became a celebrated seat of medical science. Celsus, Aretæus, and Galen, are the ornaments of this period; especially the latter, as an anatomist; though it appears probable that his descriptions were often taken from dissections of inferior animals, and applied to the corresponding organs of the human body: it is, however, said, that he anticipated many subsequent discoveries, and that a great part of his writings were for a long time unintelligible, till cleared up and explained by the labours of his successors.

During the dark ages anatomy sustained the fate of other branches of knowledge; and, with few exceptions, little progress was made in it, till the revival of learning in Europe. the prejudice, too, against the dissection of the human body was not only maintained, but sanctioned by the highest existing authorities. In the year 1315, a System of Anatomy was drawn up by Mundinus, chiefly, it is said, founded upon such parts of Galen's doctrines as had been preserved by the Arabians. This work deserves notice, as having been the anatomical text-book of the schools of Italy for a period of nearly 200 years. Mundinus is, indeed, celebrated by his contemporaries as the restorer of anatomy. Early in the fifteenth century, when learning began to revive in Europe, in consequence chiefly of the introduction of the writings of the Greek authors, numerous treatises on the Sciences made their appearance, amongst which anatomy formed a prominent subject; and among its most successful followers, the name of the celebrated Leonardo da Vinci may be recorded, although he apparently only pursued it in reference to his own art. (See the sketches annexed to Memorie Storiche di L. da Vinci, by C. Amoretti, Milano, 1804.) In reference to some of the drawings and their descriptions, preserved in the library of George III., and which he had access to, Dr. Hunter observes, that he saw with astonishment that Leonardo had been a deep student, "and was at that time the best anatomist in the world." We must give the fifteenth century the credit of Leonardo's anatomical studies, as he was fifty-five years of age at its close. At the beginning of the sixteenth century Berengarius and Massa wrote upon human anatomy; but such was the authority of Galen, even at that time, that few dared publish any statement or opinions contradicting those of their infallible master. About the middle, however, of the sixteenth century, this spell was broken by the celebrated Vesalius of Brussels, who taught anatomy at Paris and Louvain, and afterwards in Italy. He boldly demonstrated the errors of Galen; described accurately the dissections of the body, corrected and improved anatomical nomenclature, and insisted upon the necessity of diligence and actual observation in dissection, as the only solid foundation of successful medical and surgical practice. He had many opponents, and is said to have been detected in the very mischievous error for which he blames Galen; namely, that of describing the human viscera from dissections made upon quadrupeds.

Among the most remarkable contemporaries or immediate successors of Vesalius, were Fallopius and Eustachius,— the former of Padua, the latter of Venice; whose names, as annexed to their discoveries, have been handed down to posterity. Indeed, the schools of Italy seem to have been the only accessible sources of practical anatomy at that period: in France and England an antipathy to dissection prevailed, which was fatal to all anatomical improvement. Cortesius, who wrote at the beginning of the seventeenth century, and who, after having been professor of anatomy at Bologna, filled the chair of medicine at Massana, complains that he was prevented finishing a treatise on Practical Anatomy, in consequence of having only been able twice to dissect a human body in the course of twenty-four years, "whereas in the academies of Italy there is that opportunity once every year."

About this time the name of the renowned Harvey becomes conspicuous in the annals of anatomy: he, like his most eminent contemporaries, studied medicine in Italy. Fabricius ab Aquapendente, who was his master, had just made the highly important discovery of the valves of the veins; and it was this which, probably, more especially directed Harvey's attention to the use of the heart, and the vascular system: for at that time the liver was considered as its great centre, and the veins were supposed to convey the blood from it to the remote parts of the body. Harvey's great discovery of the circulation of the blood was taught by him in his lectures as early as 1616, though not published till 1628, in consequence of his desire to demonstrate the subject in detail, and to collect proofs and illustrations of the correctness of his doctrines. This discovery was not only of vast intrinsic importance, but, as is the case in all similar instances, it led to others; and the route of the blood had no sooner been traced and described, than the manner in which the nutritious part of the food is conveyed into the circulation became an object of research: this was successfully developed by Asellius, an Italian physician, in the year 1627. He was so fortunate as to see the lacteals filled with chyle, and to trace them to their common trunk, the thoracic duct, and thence into the blood-vessels. The lymphatic system was also soon afterwards detected, and first described by T. Bartoline, a Danish anatomist; and this was followed by important details bearing upon the anatomy of the gravid uterus and of the generative system, in which nearly all the celebrated anatomists of Europe had a share; and among them Harvey was conspicuous, though Dr. Hunter attributes, with apparent injustice, his knowledge upon this subject, and even the merit of detecting the use of the arteries, to his master Fabricius. The physiology of generation was more especially followed up by Swammerdam, Malpighi, and Leuenhoek, who were enabled greatly to extend the bounds of anatomical knowledge by their ingenious use of the microscope.

Although this country has produced many celebrated anatomists, there is no one to whom we are so deeply indebted as Dr. William Hunter, who was born in 1718, at Kilbride, in Lanarkshire, and was contemporary with the celebrated Cullen. Dr. Hunter came to London in 1741, bringing with him an introduction to Dr. Douglas, who was then engaged in a work upon the bones, and was in search of a young man who might assist in his dissections. He found in William Hunter a person so exactly suited to his purpose, that he not only engaged him as an assistant, but received him into his family and made him his son's tutor. As our object here is to give a brief historical Outline of Anatomy, rather than the biography of its successful cultivators, we must pass over many interesting points in Dr. Hunter's early history, till he came before the public as an anatomist, which was in the year 1743, when he communicated to the Royal Society an Essay "On the Structure and Diseases of Articulating Cartilages;" and was remarked for his diligence, ingenuity, and skill in the arrangement of anatomical preparations, of which he had accumulated a considerable collection, with a view of pursuing his favourite object, namely, that of publicly teaching anatomy. He commenced this arduous task in 1746, under the auspices of Mr. Sharpe, of Covent Garden, in whose theatre he made his first appearance as a public lecturer. In 1747 he became a member of the Corporation of Surgeons; and in the spring of the following year, having concluded his course of lectures, he accompanied his pupil, Mr. James Douglas, into Holland and France. He returned in time to begin his winter course, during which he not only acquired a high character as an anatomist, but commenced the practice of midwifery, in which he soon attained eminence, founded not merely upon his person and address, both of which were agreeable and well suited to that line of the profession, but upon his anatomical skill; so that in all cases of danger and difficulty it soon became customary to call in his aid. In this respect his celebrity became so extended, that he afterwards acquired great

and merited reputation as a general anatomical physician. In 1762 Dr. Hunter entered into a spirited vindication of his claims to certain anatomical discoveries, in a work entitled "Medical Commentaries;" and in the same year he was appointed physician to the queen of George III. His professional avocations now became so numerous and urgent, that he was obliged to take a partner in his lectures, and for that purpose selected his pupil, William Hewson, who afterwards joined Mr. Cruickshank, two gentlemen whose names occupy no unimportant place in the history of practical and structural anatomy.

In 1754 Dr. Hunter began his great and splendid work on the "Anatomy of the Gravid Uterus," which was not completed till 1775. This gave him a high rank among European anatomists, and foreign and domestic honours were abundantly conferred upon him in consequence; but it is to the establishment of his Museum, and School, that we are principally to look for the new impulse which was given to the study of anatomy in London, and for the celebrity which this metropolis has since maintained. The account of the origin and progress of this Museum, therefore, deserves to be briefly recorded here. When Dr. Hunter had acquired a competent fortune, the result entirely of his high professional merit and unwearied diligence, he found wealth still pouring in upon him, and became desirous of applying this surplus to some great national purpose of public utility; and what more important or useful than "A Metropolitan School of Anatomy?" He accordingly, in the year 1765, during the administration of Mr. Grenville, presented a memorial to that minister, in which he requested the grant of an unemployed piece of ground near the King's Mews, at Charing Cross, for the site of his intended building; upon which he undertook to expend 7000*l.* and to endow a professorship of anatomy in perpetuity. After waiting for some time without a reply, he renewed his request, or rather repeated his proposal; and his second application, which was even in more liberal terms than the former, shared the same supercilious treatment. Although disgusted, as he well might be, at this unaccountable neglect, he determined that the town in which he had acquired his wealth and reputation should not be without some useful and honourable memorial of his labours: he accordingly purchased a piece of ground in Great Windmill Street, near the Haymarket, where he erected a spacious dwelling-house, behind which was a magnificent fire-proof room, fitted up as a museum and library, and communicating with a good anatomical theatre, and an extensive series of apartments for dissection and for the preparation of anatomical specimens. This building was completed in 1770.

Dr. Hunter expended upon this Museum a sum exceeding 20,000*l.*: it included, besides its unrivalled anatomical treasures, a splendid and valuable collection of books, coins, medals, and antiquities; of minerals, shells, and other articles of natural history. By his will, the use of this Museum, under the direction of trustees, devolved upon his nephew, Dr. Matthew Baillie; and in case of his death, to Mr. Cruickshank, for the term of thirty years; at the end of which period the entire collection was bequeathed to the University of Glasgow, together ith a sum of 8000*l.* for its preservation. Dr. Hunter died on the 20th of March, 1783; so that his will, in regard to his Museum, has long since been carried into effect, and it is now in Glasgow. To say nothing of the books, antiquities, and objects of natural history, it contained, when sent to its final destination, the finest series of anatomical specimens in Europe. Thus, through the apathy of the administration of that day, was this unrivalled collection lost to this metropolis. Dr. Hunter's munificent intentions must, however, never be forgotten: he furnishes a noble and rare example of a man who, as soon as he had rendered himself independent by his own exertion, in a laborious and difficult profession, applied the whole of his large income to a great public object; and, though thwarted in his original desire, that it should remain in the metropolis in which the fortune expended upon it had been amassed, as a monument of his gratitude, and an example to his successors, he was, nevertheless, sufficiently liberal and patriotic to devote it to the use of the public, by bequeathing it to the university which had granted him his degree.

Dr. Hunter not only gave a new impulse to anatomical science, the effects of which have been transmitted to the present time, but his zeal in behalf of his favourite pursuit tended to make many converts. Among these, the celebrated John Hunter stands foremost. Hearing of his brother's reputation, he offered his services as an assistant in his inquiries, and his proposal was kindly accepted. Accordingly, in September, 1748, he left Lanarkshire, being then twenty years of age. His disposition to excel in anatomical pursuits soon became evident. In the course of the succeeding year he had rendered himself sufficiently master of the subject to instruct his brother's pupils in the dissecting-room; and in 1755 was admitted to a partnership in the lectures. His ardour and enthusiasm as an anatomist were most extraordinary, and he became as eminent in surgery as his brother was in physic; yet his more lucrative professional avocations were never allowed to supersede his scientific zeal; and the result was, the formation of a Museum of Comparative Anatomy, which is at once a memorial of a scientific mind and a skilful hand. Mr. Hunter died suddenly on the 16th of October, 1793, at the age of 65. He directed by his will that his Museum, upon which he had expended nearly the whole of his large professional income, should be offered to the purchase of government; and, fortunately for the credit of our country, the proposal met with a very different reception to that which we have above recorded in reference to his brother. It was purchased for the sum of 15,000*l.*, and made over, under certain conditions, which have been not only faithfully, but liberally, fulfilled, to the Royal College of Surgeons, in London. It is one of the most splendid collections in the world, and in many respects unrivalled; it is open, under proper regulations, to public inspection, in the magnificent building erected by the College for its reception, on the south side of Lincoln's Inn Fields.

Another convert to anatomical pursuits, educated in the school of William Hunter, was his nephew, the late Matthew Baillie. His virtues and his talents placed him high in public estimation; his anatomical knowledge was the foundation of his professional eminence; and the excellence of his lectures, both as regards matter and manner, tended to exalt the reputation of his uncle's school, and to establish the importance of anatomy as the basis of medical, no less than of surgical practice.

We have dwelt upon the Hunterian School, from the conviction that it gave a character to anatomical pursuits, which has materially and beneficially influenced their subsequent progress, not only in London, but throughout the kingdom. Their importance and their necessity as the basis of the sciences of medicine and surgery are now publicly felt and acknowledged; the aversion to the dissection of the human body is on the wane; and the degrading and disgraceful practice of allowing the schools of anatomy to be supplied with subjects for dissection, by the revolting process of exhumation, has been superseded.

Human anatomy is usually subdivided into *descriptive*, and *morbid*, or, more correctly, *pathological.*

Descriptive Anatomy embraces a description of the different organs of the body, together with their relative situations and connections; it examines the textures of which they are formed, enumerates the nerves and vessels by which they are supplied, and gives all general and particular details concerning their organisation. Having done this, it proceeds to the analogies that subsist among the materials of which different organs are composed; and is thus led to specify the proximate constituent parts of the living body.

Morbid or *Pathological Anatomy* comprehends all that relates to the effects of disease upon healthy structures; and carefully traces and describes the changes of texture and of composition which they thus suffer, in reference to the entire organ, as well as to its individual parts.

We shall now proceed to give a short description of the parts of which the human body is constructed, referring for the account of individual organs to the separate terms under which they are enumerated.

Anatomical teachers generally first direct the student's attention to that branch of the subject which is termed *Osteology;* in other words, to the bones or skeleton, constituting the hardest and most durable part of the whole structure, and that which gives it its stability and general form. At the period of birth, the bones, for obvious reasons, could not exist with the degree of induration and firmness which they possess in the adult; we accordingly find that, at that period, they are mostly soft and flexible, resembling cartilage, with certain specks of osseous matter, which gradually extend and increase, as the process of ossification advances during the growth of the young animal. In contemplating this bony skeleton when it has thus become perfect, we are struck with the admirable adaptation and mutual connection of the various parts of which it consists; the separate bones being extremely numerous, (including the teeth, amounting to about 250,) and attached to each other by unequal surfaces, the cavities and eminences of which mutually correspond. These connections, termed *articulations*, are extremely various; some admitting of every variety of motion, others of limited motion, and others, as it were, continuously united. In the former case the evils of friction are perfectly provided against by the peculiarity of the articulating surfaces, which are covered with an extremely smooth and elastic substance, called *cartilage;* and lubricated, or as it were oiled, by a slippery fluid termed *synovia*, which here performs precisely the same office as that of the various anti-attritions which are used in machinery. But as the bones must be more or less restricted in their range of motion, there are peculiar means by which that end is attained: some being prevented from changing their relative situations by certain

modes of articulation; others, where a slight motion is required, being united by cartilage; and others, where extensive and varied motions are wanted, being connected by ligaments, membranes, or flesh.—*Ligaments* are white, fibrous, glistening, and flexible substances, occurring in an infinite variety of forms and situations. They are, for the most part, exterior to the joint, and, by their great strength and trifling elasticity, preserve the relative position or connection of the bones in their various movements. — *Membranes* are thin, whitish webs or textures, more flexible and elastic than ligament. They not only assist in the security and motion of joints, but fulfil a variety of other offices. They surround or line the cavities and the organs of the body, and contribute to unite and combine the whole; and, at the same time, interpose, and preserve a distinction, enabling separate parts either to co-operate or to act independently of each other. They vary in strength and texture, and different terms are applied to them in different parts of the body: two within the skull are called *matres;* those which envelope muscular fibres are called *aponeuroses;* that which covers the lungs and lines the cavity of the chest is termed *pleura;* that which lines the cavity of the abdomen and its included viscera is named *peritoneum;* those which inclose articular surfaces are termed *capsules;* that which covers bone, *periosteum;* and, in other cases, they are called *coats*, or *tunics*. The remaining substance concerned in the connection of the bones is *flesh:* it is thus, that the upper extremities are connected with the body, and that many of the joints are rendered secure. But flesh performs another and more important office, inasmuch as it constitutes a principal part of the organs termed *muscles*, through the medium of which the various movements of the body are effected. Many of the muscles contain, besides flesh, a substance analogous to ligament, through the medium of which they are attached to the bones, and to which the term *tendon* is applied: muscles and tendons are composed of bundles of fibres, which may be unravelled to extreme minuteness; and when what appears to be a single fibre is viewed under the microscope, it resembles a chain of infinitely small globular particles. But though the muscles are the immediate organs of motion, they are dependent for their powers of contraction and relaxation upon the *nerves* with which they are supplied. These, when separately examined, appear in the form of white cords or threads; and, when traced to their origin, are found to issue as it were from the brain, and from its elongation, termed the *spinal marrow*. The trunks of the nerves are subdivided into branches, and these again into filaments, which enter into, and are, as it were, lost in the substance of the muscles and other organs of the body. Their functions are in some cases obedient to, and in others independent of the will: to the former belong the nerves of the locomotive muscles; to the latter, those of the heart, viscera, &c. When they are divided, the peculiar functions of the organs which they supply are impaired or impeded: thus, the muscles may be deprived of the power of contracting, the glands of secretion, the eye of sight, the ear of hearing, and the skin of feeling. The nervous trunks, which issue in pairs from the brain or spinal marrow, amount to about forty; and in tracing them and their branches, they are found in certain different places to swell into knots, which are termed *gangliæ*, or they are reticularly aggregated into *plexuses*.

Having thus shown how the bones are connected and put into motion, and from what sources their motion is derived, it may next be inquired how they and the other organs of the body grow and are nourished. This brings us to consider the blood and its vessels.

The composition and properties of the blood, and the extraordinary changes which it suffers in its passage through the pulmonary vessels, are elsewhere defined. (*See* Blood, and Respiration.) Without this exposure to the action of the air in the lungs, the blood is unfit for the support of life. We accordingly find that the heart is so constructed as to propel the blood which it receives through the structure of the lungs, and after it has there been aërated, to transmit it over the body: in fact, the heart is a hollow muscle: when it relaxes, its two principal cavities, or ventricles, are enlarged, and the blood flows in; when it contracts, they are diminished, and the blood is propelled into two large tubes or arteries, one leading to the lungs, and called the pulmonary artery, and the other to the system generally, and called the aorta: these arteries are not only elastic, but also muscular, so that they drive the blood onwards from the heart, its retrograde motion being effectually prevented by valves placed at their origin.

The arteries are divided and subdivided into an infinite number of ramifications; and the branches from the same trunk are frequently observed to unite or anastomose in their course; so that when, by any accident, some are obstructed, an adequate supply of blood may be kept up by the others. As, however, the blood cannot return to the heart by these vessels or arteries, we find that they inosculate, or communicate at their extremities with another series of tubes or vessels, which are called veins. These are more numerous than the arteries, and generally accompany them in their course. They have a less muscular power; and as they are not assisted by the heart in propelling the blood, they open to it larger and larger channels as it advances, and are supplied with valves by which its reflux is prevented. This is, in fact, the circulation of the blood (first made out by Harvey, as before mentioned); the veins ultimately terminating in two large trunks which pour the blood into the right auricle of the heart; whence it is propelled into the right ventricle, from which arises the pulmonary artery, transmitting it through the lungs; from the lungs the blood (having been aërated) returns by the pulmonary vein into the left auricle of the heart, which contracting, propels it into the left ventricle, from which arises the aorta. Such, then is the extraordinary mechanism by which the circulation of the blood is effected; but it must not be supposed that the whole of the blood is thus directly returned from the arterial into the venous system: a part of it is transmitted by minute arterial ramifications into the different structures and organs of which the body is composed, each of which is gifted with the power of assimilation, that is, of converting the blood, or a part of it, into a substance of its own kind. Some of these minute or capillary vessels also terminate upon the surface of the body, where they exhale perspirable matter; others, upon the membranes lining the cavities of the body, where they secrete the fluids which lubricate and moisten the interior surfaces; and others again go to the glands, —those peculiar organs or structures, which have not only the power of separating certain parts of the blood, but of converting it into new forms, which are called secretions, some of which are ejected, others retained, for the purposes of the animal economy.

Thus, then, it appears that the blood nourishes and preserves the body and all its parts, and that it is continually tending to the renovation and reproduction of the different organs; but this very process implies another, and no less extraordinary, function, which is performed by a distinct system; namely, that of absorption. There are, in short, a series of vessels which are continually carrying away the useless and worn-out materials; removing them in a state of solution; furnished, like the veins, with valves; terminating in a common trunk, called the thoracic duct; and pouring its contents into the veins, just before they enter the right auricle of the heart.

It appears, therefore, that a continual system of deposition and removal is carrying on within the living body; that the ramifications of the arterial system are constantly renovating the different organs, whilst the absorbents are as constantly removing the materials of which they consist. Nothing, therefore, is stationary or permanent; and as the blood, on the one hand, conveys the materials required, so, on the other, it receives those which are removed: and such as are useless, or would be hurtful if retained, are thrown off either by the intestines, the kidneys, the lungs, or the skin. It now only remains to show how this waste is compensated for, and by what means those materials which are thrown off in one form are replaced in another: this leads us to the functions of another branch of the animal machinery, called the organs of digestion; those organs, namely, by which the food is converted into blood.

Different animals require different kinds and quantities of food; some living almost exclusively upon animal, others upon vegetable substances; hence their division into carnivorous and graminivorous tribes. Man partakes of both; and, accordingly, the structure of his digestive organs is intermediate between the comparative simplicity of the truly carnivorous, and the complexity of the graminivorous classes. In all the higher orders of animals, however, the mechanism of digestion is of a complicated character.

The first change which the food undergoes is in the mouth, where it is torn, ground, and moistened by machinery expressly adapted to those operations. The teeth are admirably contrived for this purpose; some of them cutting, and as it were mincing, others rubbing and grinding, whilst a fluid is supplied by the salivary glands so as to render the mixture of a proper consistency to be swallowed: this is effected by the organs of deglutition: the food is propelled from the mouth into the tube which conveys it to the stomach, and which is called the œsophagus; and is, at the same time, prevented, by an extraordinary and complicated arrangement of the parts concerned, from passing in any other direction, and, more especially from entering the trachea or air-passage into the lungs. In the stomach the food is subjected to the secretions of that organ, called gastric juice, which is acid, and by which it is gradually converted into a greyish homogeneous semi-fluid substance, termed chyme; so that by the time the food has reached the right end of the stomach, or the pylorus, its original characters are entirely changed; its separate materials are no longer discernible, and it has acquired distinct properties; it is, in short,

digested. How these changes are effected we know not, though many attempts have been made to explain them upon chemical and mechanical principles. Dr. Hunter, in his Introductory Lecture, has the following apposite remarks, in reference to this and similar phenomena, "I must therefore expect," he says, "that you will not hereafter be surprised, when you find me avowing great ignorance in many of the most considerable questions relating to animal operations, such as sensation, motion, respiration, digestion, generation, &c. In my opinion, all these subjects are much less understood than most people think them. Our vanity deceives us, and persuades us that we have got the whole as soon as we have acquired a smattering of natural knowledge. Hence it is that the different sects of physiologists have endeavoured to explain animal functions upon such different principles. Hence, for example, to account for digestion, some have made the stomach a mill; some would have it to be a stewing-pot, and some a wort-trough; yet, all the while, one would have thought that it must have been very evident that the stomach was neither a mill, nor a stewing-pot, nor a wort-trough, nor any thing but a *stomach.*"

When the food has been thus far digested in the stomach, it passes into the duodenum, or upper end of the intestinal canal; a tube, the whole length of which is about six times that of the body, and which, therefore, is variously and strangely convoluted to enable it to be packed into the abdominal cavity. Into this portion of the intestines, various vessels and glands deliver their secretions, partly for the purpose of lubricating its surface, and partly to assist in the further changes which are to be brought about in the chyme. Of these fluids, two are especially remarkable, from the importance and size of the glands by which they are secreted, and of the ducts by which they are conveyed; namely, the *bile*, which is of a green colour and bitter taste, and is secreted in the liver; and the *pancreatic juice*, which appears to resemble saliva, and which is secreted by a gland called the pancreas. The influence of these fluids upon the chyme is direct and important: the pancreatic secretion probably acts as a diluent merely; but the effect of the bile is more complicated; and it appears to be essential to the further change of the chyme into *chyle*, which is a white milk-like fluid, formed in the upper part of the intestine, and absorbed by a distinct set of vessels which, from the colour of their contents, have been called lacteals, and which convey the chyle, that is, the portion of the products of digestion fitted for nutrition, into the above-mentioned trunk of the lymphatics, whence it is transmitted into the veins, which open through the medium of the right auricle into the right ventricle of the heart. The bitter principle of the bile, and its colouring matter, are obviously not absorbed by the lacteals, but remain with the residue of the food, which is slowly propelled along the whole of the intestinal tube, and, having undergone certain changes in its passage, is ultimately voided as excrementitious.

Having now enumerated the various classes of organs in the human body, and adverted to their leading functions; having seen how the bones are united by articulations, and connected by ligaments, flesh, and membranes, forming a variety of levers adapted to the motions of the limbs, and supporting and protecting the soft parts, as in the skull and spine; how the brain and nerves are concerned in the sentient energies, and in presiding over and directing muscular motion, and influencing the functions of the viscera; having likewise seen how each part of the body is nourished by the blood, which is sent from the heart by the arteries, and conveyed back to it by the veins; how the useless and decayed parts are removed by the lymphatics; how the nutritious part of the food is carried into the blood by the lacteals; and how venous is changed into arterial blood in the course of its passage through the pulmonary vessels; it only remains to observe, that the whole fabric is as it were protected from external injuries by its *integuments.* Of these the most exterior is a covering, varying in thickness and induration on different parts of the body, but every where without feeling, and called the *epidermis;* immediately beneath it is a soft mucous substance termed *rete mucosum;* and under it the *cutis*, or true skin. These external coverings of the body are attached to and connected with the parts beneath, by cellular membrane. But though the animal owes much of its general security to these textures, it owes more to the senses, instincts, and appetites, with which it is so miraculously endowed. "By these it is led to pursue what is useful, and to guard against danger, inconvenience, and want. Nor is this all; there has likewise been conferred, to a certain extent, upon all living bodies, the power of reproduction, by which they are frequently able to repair the slighter injuries to which the different organs are exposed; and if this power be exceedingly languid in the latter periods of old age, it is because the author of nature never intended that the animal structure should be immortal. He has fixed its bounds, which it cannot pass; and has measured out the time when the fairest fabric must crumble into dust, and its animating spirit return unto Him, the great Almighty Incomprehensible Being, who first bestowed it." (See Dr. Barclay's Introductory Lectures to a Course of Anatomy; and Dr. William Hunter's Two Introductory Lectures, for details respecting the history, uses, and importance of the study of Anatomy.)

Anatomy, Comparative. So called because the organisation of the lower animals was first principally studied with immediate reference to that of the human subject. Galen, who visited the schools of Alexandria at a period when the dissection of the human body was no longer permitted, sought in the anatomy of the ape to acquire a vicarious knowledge of the anatomy of man. Vesalius, after the revival of literature, dissected various quadrupeds, and compared their organisation with that of man, in order to correct the errors of Galen, and to establish the true knowledge of the peculiarities of the human structure.

Succeeding anatomists have investigated the structure of the lower animals, to acquire the knowledge necessary for experimenting upon them with success; and still more important discoveries in physiological science have resulted from tracing the modification and disappearance of different organs in the descending series of animals, as the only means by which we can obtain just notions of the uses and relative importance of the different organs in the animal economy, and a perception of the laws which regulate their co-existence in the same individual.

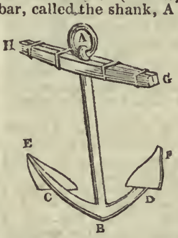
Aristotle, Harvey, and Hunter combined the investigation of the mature animals of different classes with observations of the different stages of development of the embryo, and their example has been assiduously and successfully followed by the ablest comparative anatomists of the present day, whereby some of the general laws of animal organisation, of development, and of the analogies which apparently different parts bear to one another throughout the great scheme, have been discovered.

A very important application of comparative anatomy is to the determination of the relative degrees of complexity in the organisation of different animals, and of the number and value of the points of resemblance which different species manifest to each other in the totality of their organisation. A study of the anatomy of animals, guided by these views, is essential to the determination of their natural affinities, which is the highest aim of the philosophic naturalist.

Lastly, the labours of the comparative anatomist continually tend to bring to light examples of structures, designed with reference to especial purposes, of the most striking and forcible description; and thus provide for the moralist and divine a storehouse of facts peculiarly adapted to the illustration of the doctrine of final causes.

ANA'TROPOUS. (Gr. ἀνατρέπω, *I invert.*) A very common kind of embryo, produced by one side of the ovule growing upon itself, while the other remains immoveable, till, at last, that part of the ovule which was originally next the apex, is brought down to the hilum, the base of the nucleus in such cases being at the apex of the ovule. The common apple, and the greater part of plants, offer an example of this.

A'NCHOR. (Gr. ἀγκυρα.) Consists of a straight bar, called the shank, A B, which ends in two arms, B C, B D, on which are placed the triangular plates called flukes, or palms; the extremity E or F is called the pea (peak) or bill; the point B is called the crown. At the end A is placed the stock G H, which, when of wood, consists of two pieces of oak, hooped together. When the stock is of iron, it passes through a hole in the end of the shank. The stock is at right angles to the plane of the flukes, and is a little longer than the shank. At A is the ring, which is of iron, to which the cable is attached, and by which the anchor is lifted or hung.



When a hemp cable is used, the ring to which it is bent (fastened in a particular way) is covered first with tarred canvas, and then with pieces of rope secured firmly round it; this is called a puddening, and protects the hemp from the iron. When a chain cable is used, it is shackled to the ring, which is not then puddened.

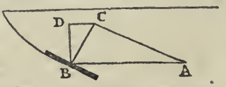
Men of war and large ships carry two large anchors of equal size, at the bows, called, thence, bower anchors; and two others, of the same size, called the sheet and the spare anchors; besides two or three others, which are much smaller, for temporary occasions.

The anchor, after being let go from the ship's bow or side, whether the shank be vertical or horizontal when it enters the water, arrives upright at the bottom, in consequence of the resistance of the water on the stock,

when it falls over, and rests on the crown, one corner of a fluke, and the end of the stock. From this position of stable equilibrium on three points, forming a long narrow triangle, a small force disturbs it, when the stock, falling flat, one of the bills must pierce the ground, penetrating deeper as the cable pulls, until the arm is partly or entirely buried.

Since the security of the vessel depends on the hold the anchor has of the ground, it is evident that the direction of the fluke should be such that the reaction of the soil against it, from the pull of the cable, may tend most effectually to keep it down.

The pressure on the fluke being perpendicular to the surface, take AB to represent the pull of the cable, then the resolved portion of this perpendicular to the fluke is BC or $AB \cos. ABC$; and the effect of this in keeping the fluke down is $BD = BC \cos. CBD = BC \sin. ABC$, because AB is horizontal, and CBD is $90^\circ - CBA$, vertical; hence $BD = AB \sin. ABC \cos. ABC$, which is maximum when $ABC = 45^\circ$. The flukes of anchors in general make the angle with the shank much greater than this; but Lieut. Rodger, R. N., has, among other improvements, adopted this angle in his patent anchor, having established the above conclusion by experiment.



Anchors are made of broad flat bars forged together. As the greatest strain upon the shank takes place during the act of weighing, the diameters of the shank are made unequal, the longest being placed vertical. This improvement is, we believe, due to Mr. Pering, on whose plan anchors have of late years chiefly been made.

The weight of an anchor in men of war is estimated roughly at about 1 cwt. to a gun; in merchantmen, about 1 cwt. for each 15 tons. The weight of the anchor is not strictly proportional to the size of the vessel, as large vessels are less affected by sudden or violent motions than smaller ones are. Large anchors are thicker in proportion to their length than smaller ones are; that is, the weight increases faster than the cubes of the dimensions.

When an anchor is left behind, it is recovered either by lifting it by the buoy rope, or, where that is not possible, by sweeping for it; which is dragging a hawser, hung between two boats, slowly over the bottom till it catches the upper fluke, by which the anchor is then weighed.

When one anchor is down the ship is said to be at single anchor, when two are down, the ship is generally moored. (*See* Moored; Cable; Buoy.) Ships rarely ride by more than two anchors; in bad weather a third is often let go under foot, as a precaution in case of one of the cables parting.

When the anchor is dragged by the pulling of the cable, it is said to come home. When the cable gets twisted round the anchor or stock, the anchor is said to be foul. The anchor is sometimes hove up without one of the flukes, which has either been fixed in a cleft of the rock and wrenched off by the force of weighing, or been snapped off, as some think, by striking against a point of rock in its rapid descent.

When the ship is at single anchor, the wind or tide may carry her over the anchor; if the water is deep, she may so drag the cable as to foul the anchor, in which case it may not hold again; if the water is very shallow, she may get upon the anchor, the fluke entering the ship's bottom, or she may break the shank by striking upon it. Keeping the ship clear of her anchor is, therefore, an important, as it is also a nice point of seamanship.

When the anchor is lifted out of the ground, it is said to be aweigh; when hove up to the surface of the water, it is awash. The anchor being hove up by the cable only to the hause holes, is lifted by the ring to the cathead; this is called catting it. The fluke next the ship's side is then lifted up to its resting-place, called the bill board; it is now said to be fished. When the ship is fairly at sea, the ring is lashed close up to the cathead, and the fluke brought close to the ship's side, or inside the bulwark, and the cable and buoy rope unbent; the anchor is then secured.

Anchor. In Architecture, an ornament applied to mouldings somewhat resembling an anchor intermixed with eggs, and by some called a tongue, from the resemblance it bears to the forked tongue of a serpent. It is found in the mouldings of all the orders, but is only applied to that called the echinus or quarter round.

A'NCHORAGE. Ground fit to hold a ship's anchor, so that she may ride safely. The ground best suited for this purpose is hard sand, or stiff clay; and the best position is that which is land-locked, or out of the tide.

AN'CHORITE. (Lat. anachoreta. Gr. ἀναχωρεω, *I retreat*, or *withdraw*.) More properly, anachoret, a hermit, or person who has retired from the world with the purpose of devoting himself entirely to meditation and prayer. Such was the case with many of the early Christians, beginning, perhaps, with such as fled from the persecutions of Decius and Diocletian, and retired into forests and deserts, at first with a view to security merely, and afterwards continued, from religious motives, the mode of life they had there adopted. The adoption of perfect solitude was essential to the character of an anchorite: but they were not necessarily bound by vows. The origin of this class of religionists preceded that of the Cœnobites, or monks living in societies; but in later times the monks used frequently to leave their monasteries, with the permission of their superior, and devote themselves for a time, or for their whole lives, to the solitude of anchorites.

ANCHO'VY. *See* Engraulis.

ANCHYLO'SIS. (Gr. ἀγκυλοω, *I bend.*) A stiff, immoveable, or bent joint.

A'NCIENT DEMESNE. In Law, all lands which, having been in possession of Edward the Confessor, and from him having passed to William the Conqueror, are named in Doomsday Book as Terra Regis, are said to be held in ancient demesne. The tenure is peculiar, resembling copyhold in some respects.

A'NCIENTS. (Fr. anciens.) In the more general sense of the term, Ancients means those who lived long ago, or before the *moderns*. But the term is now usually employed to designate the Greeks and Romans; and if any other people be meant, it is customary to specify them, as the ancient Germans, the ancient Jews, &c.

Ancients, Council of. In French History, one of the two assemblies composing the legislative body in 1795. It consisted of 250 members; and derived its name from each of them being at least forty years of age. It was put an end to by the Revolution of the 18th *Brumaire*.

ANCI'LE. The shield of Mars, which, according to tradition, fell from heaven in the reign of Numa, and was accompanied by an oracle, which declared that, while it remained in Rome, the city could never be taken. Its figure was that of an oval compressed in the middle, so as to be widest near the two extremities. Numa had it preserved in the temple of Mars, to whose priests, the Salii, its care was committed; and at the same time had eleven more shields made to exactly the same pattern, in order to prevent the genuine one from being distinguished and stolen.

Every year, in the month of March, these ancilia were carried round the city by the Salii, with solemn dances and music, for thirty consecutive days, during which time no business connected with war was allowed to be carried on in the city.

ANCI'PITAL. Having two opposite edges or angles.

ANCI'PITOUS. (Lat. anceps, *two-edged*.) When any thing is compressed, with the two opposite edges thin. It is chiefly applied in Botany to leaves and stems.

ANCO'NES. (Gr. ἀγκων, *the point of the elbow*.) In Architecture, the consoles or ornaments cut on the keystones of arches, or on the side of door-cases. They are sometimes used to support busts or other figures.

ANDALU'SITE. A mineral composed of 52 alumina, 58 silica, 8 potass, 2 oxide of iron. It is very hard and infusible, by which characters it is distinguished from felspar. It was first observed in Andalusia in Spain.

ANDA'NTE. (Ital. *going*.) In Music, signifies that the notes are to be played distinctly.

ANDRÆA'CEÆ. (Andræa, one of the genera.) Little moss-like plants, differing from the mosses in the want of an operculum and peristome, and in having a four-valved theca.

A'NDREASBE'RGOLITE. From Andreasberg, in the Hartz. A mineralogical name of a species of Harmotome.

ANDRE'NA. The name of a Fabrician genus of bees, including those which have the tongue 3-cleft, and the labium cylindrical, with two membraneous bristles on each side.

ANDROCÆ'UM. (Gr. ἀνηρ, *a male*, and οἶκος, *a house*.) All that part of a flower to which the male organs appertain. The ring of stamens in a plant is an androcæum; so is the fringe at the mouth of the tube in the passion flower, taken together with the true stamens. The term may be literally translated the male apparatus.

ANDRO'GYNOUS. (Gr. ἀνηρ, *a man*, and γυνη, *a woman*.) An animal whch possesses the organs of both sexes, as the snail. An hermaphrodite.

In Physiology, the possession of the organs of both sexes in the same individual, either naturally, as in the snail; or preternaturally, as in the free martin and similar monsters. An hermaphrodite.

In Botany, a union of both males and females, either in the same flower, which is also called hermaphrodite; or upon the same plant, the sexes being in different flowers, as in the birch and similar trees. The latter is what Linnæus called monœcious.

A'NDRON. (Gr. ἀνηρ, *a man*.) In Grecian and Roman Architecture, the apartment appropriated to the reception of the male branches of the establishment, and always in the lower part of the house: the gynœcea, or women's apartments, being in the upper part.

ANDROPE'TALOUS. (Gr. ἀνηρ, *a man*, and πεταλον, *a petal.*) Is used in speaking of double flowers which are produced by the conversion of the stamens into petals, as the garden ranunculus. Most double flowers are of this nature.

ANDRO'PHORUM. (Gr. ἀνηρ, *a man*, or, in Botany, *a stamen*, and φερειν, *to bear.*) A columnar expansion of the centre of the flower, on which the stamens seem to grow, as in the passion flower. In reality, it is formed partly of the adhering filaments, and partly of an elevation of the growing point.

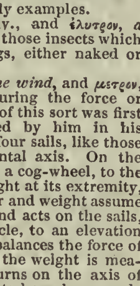
A'NECDOTE. (Gr. ἀνεκδοτον, *something inedited*, or *unpublished.*) In its original sense, some particular relative to a subject to which publicity had not been given in previous works on that subject. In its secondary sense, the narrative of a particular action or saying of an individual.

ANE'LLIDES, ANELLA'TA. (Lat. anellus, *a little ring.*) Generally, but improperly, written Annelidans or Annelides. A class of articulate animals with a long cylindrical body divided into ring-like segments, having red blood, and respiratory organs, but no jointed extremities. The class is divided, according to modifications of the respiratory system, into, Cephalobranchiates, Dorsibranchiates, and Abranchiates, of which the *Serpula*, or tube-worm, the *Aphrodita*, or sea-mouse and the *Lumbricus*, or earth-worm, are respectively examples.

ANELY'TROUS. (Gr. ἀ, priv., and ἐλυτρον, *a sheath.*) A name sometimes given to those insects which have two or four membranous wings, either naked or covered only with hairs or scales.

ANEMO'METER. (Gr. ἀνεμος, *the wind*, and μετρον, *measure.*) An instrument for measuring the force or velocity of the wind. An instrument of this sort was first invented by Wolfius, and described by him in his *Elementa Metheseos*. It consists of four sails, like those of a windmill, turning on a horizontal axis. On the axis is a perpetual screw, which turns a cog-wheel, to the axis of which a lever, carrying a weight at its extremity, is attached. When it is calm, the lever and weight assume the vertical position. When the wind acts on the sails, the lever is raised in a vertical circle, to an elevation at which the weight exactly counterbalances the force of the wind. The angle of elevation of the weight is measured on a dial, the index of which turns on the axis of the cog-wheel. Several improvements have been made on this form of the instrument. The sails have sometimes been placed horizontally; and Mr. Benjamin Martin gave the axis the form of the fusee of a watch, having a cord winding upon it with two weights at the ends, which answers the same purpose as the lever and weight.

Dr. Lind's anemometer consists of a glass tube, bent into the form of the letter U, and open at both extremities. One of the extremities, A, is also bent round to the horizontal direction, in order that the wind may blow into it. The tube being partially filled with water and exposed to a current of air, the water in the branch at which the wind enters is depressed, for example, to B, and consequently rises in the other branch to C, and the difference at C, of the levels at which it stands in the two branches, is the height of a column of water, the weight of which forms a counterpoise to the force of the wind. The relative velocities of the wind are thus ascertained, the variation of the velocity being nearly proportional to the square root of the resistance. The bore of the tube is diminished at the bottom to check the undulations of the water caused by a sudden gust of wind. Various other contrivances have been proposed, of which one of the simplest is to expose a flat board of given dimensions to a current of wind, and observe to what extent it will force back a spring attached to it, and resting against an immoveable obstacle.



ANEMO'NIN, or ANEMO'NIA. An acrid crystallisable substance obtained from some species of anemone. It burns like camphor.

A'NEMOSCO'PE. (Gr. ἀνεμος, *wind*, and σκοπεω, *I look.*) An instrument for indicating the direction of the wind. A common vane, or weathercock, is an instrument of this kind. Sometimes the vane turns a spindle which descends through the roof of the building into the chamber where the observation is to be made. An index fixed to the spindle points out the direction of the wind, on a compass card fixed to the ceiling. By means of wheel-work, the direction of the spindle, or the axis of the index, may easily be changed, so that the compass card may be placed on a wall of the chamber, or in any convenient position for observation.

A'NEURISM. (Gr. ἀνευρυνω, *I dilate.*) A tumour formed by the morbid dilatation of an artery, and which is therefore distinguished by its pulsatory motion.

ANFRA'CTUOUS. (Lat. anfractus, *a winding backward and forward.*) When the lobes of an anther, of the margin of any thing, is folded back upon itself, and doubled and bent till all trace of its normal character is lost. The anther of a cucumber is anfractuous.

A'NGEL. A coin of the value of about ten shillings. It was impressed with the figure of an angel, in commemoration of a saying of Pope Gregory, that the pagan Angli or English were so beautiful, that if they were Christians they would be angels.

ANGEL, GOLDEN, or ST. GEORGE, or ST. CONSTANTINE. An ancient order of knighthood, fabulously reported to have been instituted by Constantine, but probably by the imperial house of Comnenus at Constantinople, and revived by the Emperor Charles V. The grand mastership of this order was resigned by the last representation to the house of Comnenus to that of Farnese, dukes of Parma; and now belongs to the crown of Naples.

ANGEL-WATER. A mixture of rose, orange-flower, and myrtle water, perfumed by musk and ambergris. It is made in Portugal.

AN'GELS. Spiritual beings ministering to God. In the Scriptures they appear as messengers, which the word properly denotes (Gr. ἀγγελος), by whom God conveys his commands to men. The term seems also to be applied to the highest order of ministers in the Church of Christ, if we may so interpret the "Angel of the Church of Ephesus, of Pergamus," &c., and the passage in the Epistle to the Corinthians, "A woman ought to have power (a veil, as some interpret) on her head, for fear of the angels." We read also of the devil and his angels.

ANGI'NA. (Gr. ἀγχω, *I strangle.*) A disease attended with a sense of anxiety and suffocation: the term is applied to sorethroat, and to certain symptoms arising from organic disease of the heart; the latter gives rise to a distressing difficulty of respiration, and is hence termed Angina Pectoris.

A'NGIOCA'RPOUS. (Gr. ἀγγειον, *a case*, and καρπος, *fruit.*) When seed-vessels are inclosed within a covering that does not form a part of themselves; as the filbert, which is covered by its husk, the acorn seated in its capsule. The word is also applied sometimes to such fungi as have their spores included in a peridium, or hollow-shell, as Lycoperdon.

ANGIO'LOGY. (Gr. ἀγγειον, *a vessel*, and λογος, *a discourse.*) The doctrine of the vessels of the body.

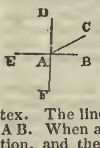
ANGIOSPE'RMOUS. (Gr. ἀγγειον, *a vessel*, and σπερμα, *seed.*) When seeds are inclosed within a pericarp, as in most plants. The word is now chiefly used in opposition to gymnospermous, when seeds are not included in a pericarp, as in fir-trees and others. Linnæus intended to apply it in the same sense; but he contrasted it with small-lobed seed-like fruits, which he mistook for naked seeds.

ANGIO'SPOROUS. (Gr. ἀγγειον, *a vessel*, and σπορα, *a seed.*) A term applied to such fungi as Lycoperdon, which have their spores inclosed in a hollow shell or bag.

ANGIO'TOMY. (Gr. ἀγγειον, *a vessel*, and τεμνω, *I cut.*) The dissection of vessels.

A'NGLE. (Lat. angulus, *corner.*) In Geometry, this term is employed in several senses, and to signify very different things. Euclid defines a plane angle to be "the inclination of two lines to one another, which meet together, but are not in the same direction;" a definition somewhat obscure, and also defective, inasmuch as in strictness it can apply only to acute angles, and gives no idea whatever of angular magnitude. The definition given by Apollonius, namely, "the collection of space about a point," is still more exceptionable. In fact, it is extremely difficult to form a correct idea of its nature from any description that can be given in the terms of a definition.

The simplest way, perhaps, of obtaining a clear conception of angular magnitude is by means of revolving motion. Suppose a straight line A B to revolve about the point A from right to left, and to occupy successively the different positions A B, A C, A D, A E, and A F. At A C it forms angle B A C with its first position A B, of which A B and A C are the sides, and the point A the summit or vertex. The line A C is then inclined to its first direction A B. When at A D, it is perpendicular to its first direction, and the angle formed by A B and A D is called right. At A E the separation is equal to two right angles, and the line lies in the same direction as at first, or A E and A B are in the same straight line. When it arrives at A F, three right angles have been described; and, on returning to A B, a whole circuit or four right angles. The right angle B A D is considered the unit of angular magnitude B A C, which is less than the right angle, is called acute; and E A C, which is greater than the right angle is called obtuse. The angle D A C, or the defect of B A C from the right angle, is called the complement of B A C; and E A C, or the defect of B A C, from two right angles, is called the supplement of B A C.



When an angle is considered in this manner as result-

ing from revolving motion, it is obvious that two straight lines meeting in a point, form not only one, but an indefinite number of angles. Thus, A B may pass into the position A C after describing merely the angle B A C, or after describing that angle together with one, two, three, or any number of revolutions. If we assume A to represent the measure of the angle B A C, and C that of the whole circuit, then the same angle B A C will be represented not only by A, but also by $A + C$, $A + 2C$, $A + 3C$, and so on. This extension of the signification of an angle is of very great importance in Trigonometry.

A solid angle is defined by Euclid to be "made by the meeting of two plane angles which are not in the same plane in one point." These magnitudes are of a very peculiar kind; and, unlike all other subjects of geometrical investigation, admit of no accurate comparison one with another. No multiple or submultiple of such angles can be taken, and we have no way of expounding, even in the simplest cases, the ratio which one of them bears to another. Hence all our reasoning concerning them must be chiefly confined to the plane angles by which they are contained.

Angle, Facial. In Zoology, signifies the angle made by the intersection of two lines drawn, the one from the most prominent part of the frontal bone over the anterior margin of the upper jaw, the other from the external orifice of the ear-passage along the floor of the nasal cavity.

Angle, Frontal. In Ornithology, signifies the angle which the culmen, or upper line of the beak, makes with the forehead.

Angle, Spherical. In Trigonometry, signifies the angle made on a sphere by the intersection of two great circles, or the inclination of the planes of these circles to each other. A spherical angle is measured by the arc of a great circle intercepted between those two points of its sides which are at the distance of a semicircle from the point of intersection, or the vertex of the angle.

Angle, Visual. (Optics.) The angle formed by two rays of light, or two straight lines drawn from the extreme points of an object to the centre of the eye. The apparent magnitude of objects depends on the magnitude of the angle under which they are seen; nevertheless, in observing distant objects, our ideas of their magnitude are greatly modified by the judgment which we form of their distances. (*See* Apparent Magnitude.)

A'NGULAR MOTION. The motion of a body moving circularly, or oscillating about a fixed point. The angular motion of a planet is measured by the angle described at the centre of the sun, by a straight line drawn from that point to the planet, called the radius vector; and its amount is reciprocally proportional to the periodic time of the planet.

A'NGULAR SECTION. The division of an angle into any number of equal parts. The bisection of an angle is accomplished by elementary geometry. The trisection requires the aid of the solid geometry, being equivalent to the solution of a cubic equation. The general division of an angle into any proposed number of equal parts, is a problem which Mathematicians have not yet been able to solve. In modern Mathematics, the term Angular Sections is used to denote that branch of analysis which is employed in the investigation of the properties of circular functions.

ANGUI'LLIFORM. (Lat. anguilla, *an eel*, forma, *shape*.) Eel-shaped fishes, or those belonging to the tribe of eels.

A'NGUIS. The name of a Linnæan genus of Amphibia serpentes, characterised by having subcaudal and abdominal imbricated scales; which scales consequently form a uniform covering over the whole body. The genus is now subdivided into the subgenera Pseudopus, Ophisaurus, Acontias, and Anguis, properly so called; the reptiles comprehended under the latter denomination have the tympanum concealed beneath the skin; the maxillary teeth compressed and hooked, and no teeth on the palate. The *Anguis fragilis*, or slow-worm, is a well-known example of this genus.

ANGUSTU'RA BARK. The bark of the Cusparia febrifuga, originally imported from Angustura in South America; it is occasionally used in medicine as a tonic, and in the case of diarrhœa. It was first described by Mr. Brande in the year 1791. A poisonous bark is occasionally found in commerce under the name of spurious Angustura, which appears to be the produce of a species of strychnos.

ANGU'STATE. (Lat. angustus, *narrow*.) When any part sensibly diminishes in breadth. (*See* Attenuated.)

ANHELA'TION. (Lat.) Difficulty of breathing.

A'NHYDRITE. An anhydrous sulphate of lime.

A'NHYDROUS. (Gr. ἀ, *without*, and ὕδωρ, *water*.) Without water. A term often applied to salts, and to certain acids when deprived of water.

A'NIL. One of the plants yielding indigo.

Anil. (Sanscr. nili, *indigo*.) A kind of indigo, said to be a native of America, although now cultivated in the East Indies. It is very like Indigofera tinctoria, the true indigo, from which it chiefly differs in having compressed legumes which are not torulose.

ANILLE'ROS. In Politics, the name given to the moderate party among the principal actors in the Spanish revolution from 1820 to 1823. They had the greatest influence, and directed the Cortes. Arguelles and Martinez de la Rosa were at their head.

A'NIMAL. (Lat. anima, *soul*, or *life*.) The name of the higher division or kingdom of organised beings, distinguished by endowments of sensation and voluntary motion, superadded to the organic functions which animals possess in common with plants.

It has been objected to this definition, that the so called sensitive plant is susceptible of impressions which cause action and motion of its parts, and that the embryos of Algæ and Confervæ have locomotion, while many of the lower animals are fixed as immoveably to the earth as plants. But these objections have no real value; and could only have arisen from confounding irritability with sensation, which are two very different phenomena. It is the property of all living organised beings, and essential to their existence as such, to be susceptible of the impressions of certain stimuli, which occasion a reaction of the part stimulated; and the main object of physiology is to determine the precise mode in which each organ of a plant or animal reacts when stimulated. But it is here only necessary to state, that the muscular fibre in animals reacts when stimulated by an angular puckering called contraction, and this property is termed irritability. It is independent of the nerves and of sensation, for a portion of muscle removed from an animal body manifests the same contraction when irritated, whether mechanically, galvanically, or chemically. In the living animal the most common stimulus of the muscular contraction is the operation of the nerves, excited by the will, and is commonly the consequence of an act of sensation; but this is by no means the only stimulus by which the irritable property of the muscle is or can be called into play. In plants, universally, there are also irritable parts, or parts which react when stimulated by producing motion of a part or the whole of the body. It is this property which occasions the motion of the cambium or sap; it is by the same endowment that growing plants incline to the light, and extend their roots to the most congenial soil; or entwine their tendrils around the bodies which serve as their support; or move the stamens in regular succession towards the female part or pistil (saxifrage), or incline the pistil successively to each stamen (lily). By a modification of the same irritable property some plants close their leaflets or flowers at sunset; while others, like the nocturnal animals, go to sleep, as it were, at the approach of day. By a higher degree of this irritability the leaflets of the fly-trap (*Dionæa*) approximate each other, and inclose the irritating insect which has alighted upon them; and the Mimosa pudica withdraws its leaves from the offending touch; — while the Desmodium exhibits during the day a constant alternate movement of the lesser folioles, analogous to the quicker vibration of the cilia which beset the respiratory organs of many molluscous animals, and which is equally independent of the nerves and of the will. The conditions of all these vegetable motions, which essentially distinguish them from the voluntary movements of animals, are, that they never proceed from an internal impulse, but are invariably the consequences of external stimulus, and take place, as it were, mechanically, and in the self-same manner; while in animals the motions arise out of an internal determination from parts not moving to the moving powers. There is also an essential difference in the nature of the motion itself, even when we compare the simplest animal with the plant. If we touch the feeler of a polype, it recedes from the irritant by a true contraction of the part within itself; but in the case of the sensitive plant, there is nothing like this contraction of the part touched, but only an articular plication of a contiguous part, without the dimensions of the irritated leaf being altered. Experiment has also shown that the intumescent parts of the mimosa, in which the irritable property is concentrated, move the leaf by an extension of cells, and not a contraction of fibres.

It is true that many of the lower aquatic animals are rooted to the bottom; and these are often aggregated, and grow in a branched or plant-like form, as the serpularia and other corallines; but, although voluntary motion of the whole is impossible, yet it is sufficiently conspicuous in the different parts, and the vital endowments of the individual polypus manifest a multiplied animal enjoyment, not the condition of a vegetable. The simplest monad of infusions exhibits the voluntary characteristics of the animal, by varying its movements to avoid obstacles or seize its food, while the locomotive embryo of the Conferva dilatata proceeds blindly onwards in an unvarying course, till its irritability is exhausted, and excites no idea of animality in the mind of an observer who has had any experience in the observation of animalcules. Ehrenberg has asserted that he can distin-

guish a moving embryo of the Algæ from a polygastric monad as easily as a tree from a bird.

The nerves are the organs on which spontaneous motion and sensation depend, and they chiefly distinguish the animal from the vegetable. Hence the nervous system has been termed the essence of an animal. All the other systems of organs appear in their plan of arrangement to be subject to the modification of the nervous system; and it is upon this system, therefore, that, in the classification of animals, their primary division is founded. Recent and more accurate researches have proved the existence of nerves in many of the lower organised animals, where their presence had been denied; and, as in every species in which the nerves have been detected, sensation has been found to depend exclusively upon them, we are hence led to assume that all animals in which sensation is observable must have it depending on nervous matter present in some condition or other in their tissue; even where, as in the freshwater polype, this is apparently homogeneous, and where, from the extreme divisibility of the individual without loss of vitality in the detached parts, we may reasonably conclude the nervous molecules to be dispersed throughout the corporeal mass.

The attributes of sensation and voluntary motion modify, as might be expected, all the other functions which animals possess in common with plants. For example, as regards nutrition: vegetables which are fixed to the soil absorb immediately by their root the nutritive parts of the surrounding fluid. These roots are indefinitely subdivided; they penetrate the smallest interspaces, and seek, as it were, at a distance, the nourishment of the plant to which they belong. Their action is tranquil, but unintermitting; being only interrupted when dryness has deprived them of the juices which are necessary for them.

Animals, on the contrary, which are rarely stationary, but which have the power of moving, not only parts of the body, but the entire body, from place to place, require the means of transporting the provision necessary for their subsistence; accordingly, they have received an internal cavity, appropriated for the reception of the nutriment, and upon the parietes of which open the pores of the absorbent vessels, which have been justly compared to internal roots.

An internal cavity is requisite for animals on another ground; — their food must first be digested. Plants are supported by water containing carbonic acid, or the already dissolved organised material of the soil. But nutrition in animals does not immediately commence by the absorption of such fluids as the soil or the atmosphere furnishes, but their food consists of substances already in organic combination, which must be prepared and submitted to instruments for dividing and comminuting it, and to the action of solvent fluids. Thus digestion, or the preparatory assimilation of the food, is entirely peculiar to animals. They alone are endowed with organs of sensation, which guide them in the choice of aliment. They alone possess labial and other prehensile organs for seizing the food; teeth and jaws for comminuting and destroying its vitality if living; muscular actions, by which it is swallowed, and a reservoir for its reception endowed with chemical and vital powers for dissolving and assimilating such parts as are proper for nourishment, and which are selected and taken into the system through the purely vital sensibilities of the absorbent internal surface, while such parts as are unfit for nourishment are expelled.

A still more important difference, in connection with the digestive functions, arises out of the limitation of the powers of assimilation in the animal kingdom. Animals can convert into their own substance only matter which has already been organised; while plants have the power of assimilating the inorganic binary compounds, carbonic acid and water. This property of plants is more important than perhaps at first sight might be suspected; for in the vital operations of animals a great quantity of organised matter is constantly decomposed, and is rendered, at all events, useless as nutriment for other animals; while, by means of combustion and other decomposing processes, an incalculable quantity of vegetable matter is continually resolved into binary compounds, or the ultimate elements of matter: hence, if the power of producing new ternary organised compounds out of carbonic acid and water had not been given to plants, both these and animals must, in process of time, inevitably have been annihilated, and successive creations of animals and vegetables would have been indispensable to maintain the present system of things. It is a beautiful instance of the harmony which pervades the relations of nature, that animals contribute as essentially to the support of vegetables, by a process of excretion, as these to the maintenance of animal life, by their powers of assimilation. The product of the respiratory interchange which takes place between the circulating fluids and the atmosphere in animals, is carbonic acid; which is the essential aliment of plants; and which, when in health, and exposed to the influence of the sun's rays, plants absorb from the atmosphere by their respiratory organs, the leaves, and exhale the superfluous oxygen which is extricated in their assimilative processes. Thus the constitution of the atmosphere is maintained by the different products which are evolved in the respiratory processes of plants and animals.

The circulation of the nutrient juices is much more independent of the external influences of light and heat in animals than in plants; and in most classes of the animal kingdom, the motion of the blood is principally determined by the contractions of an express muscular organ called the heart.

From a general review, therefore, of the nature and properties of living animals, their distinguishing characteristics may be summed up as follows: —

Animals are the only beings in nature which manifest sensation and spontaneous movements. They digest organised substances alone, and are always provided with a mouth, and an internal digestive cavity or canal.

Their nutrient fluids are received by an absorbent internal surface; while in plants they are taken up by an absorbent external surface.

Animals at all times, in respiration, exhale carbonic acid and absorb oxygen.

ANIMAL'CULES. *See* Infusores.

ANIMAL SUBSTANCES. The principal products of the animal kingdom are chemically characterised by the presence of nitrogen as one of their ultimate elements, which is generally in combination with carbon, hydrogen, and oxygen. When, therefore, they are subjected to destructive distillation, ammonia is a common product; it is also often evolved when they are triturated with caustic potash, or quicklime.

ANIMA'TION. (Lat. animare, *to enliven.*) In Painting, the expression given to a figure when indicating activity in its members. Thus a figure truly and vigorously executed, is said to be animated.

A'NIME. A resin which exudes from the Hymenæa Courbaril. It is brought from South America. It was formerly used in medicine, but is inert.

A'NIONS. (Gr. ἀνα, *upwards*, and ἰων, *going.*) Substances which in electro-chemical decompositions are evolved from their combinations at the surface by which the electricity enters the electrolyte. (*See* Electrode.)

A'NISE. (Arab. anisun. Gr. ἀνισον.) The aromatic fruit of an eastern annual umbelliferous plant called Pimpinella anisum. It is principally employed in the manufacture of liqueurs, and against flatulence. Star-anise is a very different thing, the produce of Illicium anisatum, a tree belonging to Winteraceæ.

ANISE'TTE. A French liqueur, made by distilling anise, fennel, and coriander seed with brandy, and sweetening the produce.

ANISO'BRYOUS. (Gr. ἀνισος, *unequal*, and βρυω, *I grow.*) A name given by some writers to monocotyledonous plants; having only one colytedon they grow at first with more force on one side of their axis than the other.

ANISODAC'TYLES, ANISODAC'TYLÆ. (Gr. ἀνισος, *unequal*, and δακτυλος, *a digit.*) The name given by Temminck to an order of birds, including those Insessorial species the toes of which are of unequal length, as in the nuthatch.

ANISODY'NAMOUS. (Gr. ἀνισος, *unequal*, and δυναμις, *power.*) A name given to monocotyledonous plants, for the same reason as anisobrious; which see.

ANISOSTE'MONOUS. (Gr. ἀνισος, *unequal*, and στημων, *a stamen.*) When the number of stamens in a flower neither corresponds with the calyx nor corolla in number or power; as, for instance, when a flower having five sepals has three or seven stamens; in such a case the stamens are neither equal to the number of sepals nor any power of their number.

ANISO'STOMOUS. (Gr. ἀνισος, *unequal*, and στομα, *a mouth.*) When the divisions of a calyx or a corolla are unequal. Seldom used; the term unequal or irregular is usually employed instead.

ANISOTO'MIDÆ. (Gr. ἀνισος, *unequal*, and τεμνω, *I cut.*) A family of Coleopterous insects, having moniliform, or beaded, antennæ, subelongate, slender at the base, gradually increasing towards the apex, with a terminal club-shaped multiarticulate joint; palpi various, generally filiform; head small and ovate; body convex, never linear. This family includes eight genera: *Tritoma*, of which we have one indigenous species, *Tr. bipustulatum*; *Phalacrus*, of which Stephens describes twenty-eight British species, remarkable for their brilliant colours, and faculty of rolling up the body into a ball; *Ephistemus*, of which only three species are known, which have been detected in the neighbourhood of London; *Leiodes*, abundant in species, of which twenty-six are British; *Agathidium*, of which we have twelve species, inhabiting putrid wood and fungi, also found near London; *Clambus*, of which various species, all extremely minute are known; *Clypeaster*, a term already appropriated to a genus of *Echinidæ*; lastly, *Sericoderus*; distinguishable from the rest of the family by its truncate elytra.

A'NKER. A measure of wine or spirits equal to 10 of the old gallons, or $8\frac{1}{3}$ imperial gallons, = 2310·6 cubic inches.

A'NNALS. A chronological history: derived from the Roman "Annales Pontificum," or "Annales Maximi," which were annual records of passing events connected with religious observances, kept by the Pontifex Maximus.

Annals are a species of historical writing; but they seem, notwithstanding, to differ materially from history, as the latter is now understood. Annals should comprise a succinct account of the events having reference to some peculiar subject, as they occur in successive years. Inquiries as to the remote causes and consequences of events seem to be misplaced in them; though they are the essence of history. Cicero, when speaking of annalists, says, "*Unam dicendi laudem putant esse brevitatem, non exornatores rerum, sed tantum narratores.*" Annals are, in fact, rather materials for history, than history. In the one, events only are narrated, in the other they are narrated and reasoned upon. The annalist may, no doubt, reason upon facts as well as the historian; but such reasonings are not so well or happily placed in a book divided into years, as in one that depicts the continuous stream of events, without breaking it into limited compartments. Hailes's "Annals of Scotland" is, perhaps, the best work of its class in English literature.

ANNA'TES, or FIRST FRUITS. A fine paid to the king, as head of the church, by one promoted to an ecclesiastical benefice, and supposed to amount to one year's value of that benefice. This, however, is evaded by assuming as the basis of the valuation that made in 1535, and contained in what is termed the "Liber Regis." In England, first fruits go to the augmentation of Queen Anne's bounty.

ANNEA'LING. (Anhelan, Sax.) There are many substances which, when rapidly cooled, after having been heated, become exceedingly brittle; an inconvenience often prevented by very slow cooling: this is especially the case with glass, which is therefore suffered to cool very gradually in an oven constructed for the purpose, and the process is called annealing. Many of the metals which have become harsh and hard in the process of manufacture, are softened in the same way; thus the blank pieces for coinage, several metallic wires, &c. are annealed.

ANNE (ST.), ORDER OF. An order of knighthood, originally established in Holstein, and carried with the princes of that country into Russia. It was made a Russian order in 1796; and is now widely diffused.

ANNO'TTA. Is the pulp of the seeds of the Bixa Orellana, an exogenous tree common in Cayenne and other parts of America: it is made into a pulp, which, after having fermented, is rolled into pieces of two or three pounds' weight: it is imported under the names annotto, Roucou, or Orleans, and is used occasionally as an orange dye and for colouring cheese. It imparts little colour to water, but dissolves in alcohol and in alkaline solutions; its colour is not materially altered by acids or alkalis.

ANNO'NA. In Roman writers, means, in a general sense, the year's increase, or the fruits of the year; and it also means the contribution or tax payable in corn, imposed on some of the more fertile provinces of the empire, as Sicily, Egypt, &c., for the use of the army and of the capital. The poorer class of citizens were entitled to a share of this tribute; and their habitual dependence on it was not only a fruitful source of idleness, but of all sorts of disorder. To grant an increased allowance of corn was one of the surest methods by which to attain popular favour.

> ——— *Summa favoris*
> *Annona momenta trahit.* Namque asserit urbes
> Sola fames, emiturque metus, cum segne potentes
> Vulgus alunt. Nescit plebes jejuna timere.

The office of Præfectus Annonæ was of great importance at Rome, and was generally, indeed, exercised by the emperors. (See, for further particulars, Contarenus, *De Re Frumentaria*, passim.)

A'NNUAL. (Lat. annus, *a year.*) A plant which arrives at perfection, passing from a seed into a perfect plant, yielding its fruit, and perishing, within the space of a year. The term also applies to all cases where duration is for one growing season only. Many plants have perennial roots and annual stems; that is, stems perishing and being renewed annually: such plants are usually denominated Herbaceous.

ANNUAI'RE. A name given by the French to publications on continuous or similar subjects, which appear in yearly parts or numbers. Of the existing *Annuaires*, that published by the *Bureau des Longitudes* is the most celebrated. There are also an *Annuaire Historique*, corresponding to our *Annual Register*, an *Annuaire de l'Etat Militaire*, an *Annuaire du Clergé de France*, &c.

ANNU'ITY. A rent or sum receivable yearly for a term of years.

An annuity may be receivable during a definite number of years, or during a period of uncertain length; for example, during the life of one or more individuals. In the former case it is called an *Annuity Certain*; in the latter, a *Contingent Annuity*.

An annuity which is not to be entered upon immediately, but after a certain number of years, is called a *Deferred Annuity*; if it is not to be entered upon till after the death of some person or persons now living, it is called a *Reversionary Annuity*. When limited by the duration of a given life or lives, it is called a *Life Annuity*; and when it is to continue only for a term of years, provided an individual or individuals now living shall survive that term, it is called a *Temporary Life Annuity*.

The practice of raising or investing money on annuities is attended with many advantages in the ordinary affairs of the world. A merchant or trader thus finds the means of clearing off his engagements gradually by the profits of his trade, and without losing possession of the capital necessary for carrying on his speculations; and one who possesses unemployed capital is thus enabled to convert it into an equivalent annual income for life, and thereby derive the utmost benefit from it while he lives, without risk of destitution from its failure. The accurate determination of the value of annuities in present money, is therefore a subject of very considerable importance. We propose to explain the principles on which the calculation is made, and to apply them to a few of the cases of most frequent occurrence.

Annuities Certain.—The values of annuities of this kind depend only on the rate of interest of money, and the number of years during which they are payable; and are easily calculated. Suppose it were required to determine the value, in present money, of an annuity of £100 per annum, to continue five years, or till five payments have been made, the interest of money being 5 per cent., we should reason as follows.—The first payment of £100 becomes due at the end of a year from the present time; but since £100 in hand is equal to £105 receivable at the end of a year, the present value of the first annual payment is £100 reduced in the proportion of 100 : 105, or of 1 to 1·05; that is, it is equal to £$\frac{100}{1·05}$. In like manner, the present value of £100, to be received at the end of two years, is less than if it were receivable at the end of one year, in the proportion of $\frac{1}{1·05}$; consequently, the present value of £100, to be received at the end of two years, is £$\frac{100}{(1·05)^2}$. Pursuing the same reasoning, the present value of £100, to be received at the end of three years, is £$\frac{100}{(1·05)^3}$; at the end of four years, it is £$\frac{100}{(1·05)^4}$; and so on till the end of the term. But it is evident that the present value of the whole annuity is the sum of the values of all the annual payments; hence the required value of the proposed annuity is—

$$\frac{100}{1·05} + \frac{100}{(1·05)^2} + \frac{100}{(1·05)^3} + \frac{100}{(1·05)^4} + \frac{100}{(1·05)^5}$$

This reasoning may be easily generalised. Let a denote the annual payment, r the rate of interest, n the number of years during which it continues, and S the present value of all the payments, we shall then have—

$$S = \frac{a}{1+r} + \frac{a}{(1+r)^2} + \frac{a}{(1+r)^3} + \ldots \frac{a}{(1+r)^n}$$

For the sake of abridging, put $v = \frac{1}{1+r}$, and the formula will become—

$$S = a\,(v + v^2 + v^3 \ldots\ldots\ldots + v^n)$$
$$\text{or } S = av\,(1 + v + v^2 + v^3 \ldots + v^{n-1})$$

The sum of the series within the parenthesis is $\frac{1}{1-v^n}(1-v^n)$; therefore, $S = \frac{av}{1-v}(1-v^n)$; or, writing $\frac{1}{r}$ for $\frac{v}{1-v}$ $S = \frac{a}{r}(1-v^n)$.

From this it is easy to see the method of proceeding in all other cases of annuities certain. For instance, let it be required to find the present value of an annuity deferred for three years, that is, not to be entered upon till after the end of three years; and to continue ten years from that time. It is evident that we have only to find the value of an annuity of the same amount for thirteen years, and also for three years, and to subtract the latter value from the former. The difference is the value of the deferred annuity. Again, suppose that the annuity, instead of being payable yearly, is to be paid half yearly, or quarterly. It is obvious that an annuity of £100 per annum for ten years, to be paid in half yearly payments, the interest of money being 5 per cent., is the same thing as an annuity of £50 per annum for twenty years, payable yearly, interest being $2\frac{1}{2}$ per cent.; or an annuity of £25 per annum, payable yearly for forty years, interest being $1\frac{1}{4}$ per cent. The principle of the calculation is the same in all the cases.

Life Annuities. — When the annuity is to cease with the life of an individual, or any number of individuals, the calculation of its value is a little more complicated, as it becomes necessary not only to find the present value of the payment to be made at the end of any given year, but also to take into account the probability of its being received, that is to say, the probability that the individual or individuals, on the duration of whose lives it depends, will be alive at that period. Let the annuity depend on the continuance of a single life, and let us denote the probability that the life will be in existence at the end of

	1,	2,	3,	4,	5, &c. years,
by	p_1,	p_2,	p_3,	p_4,	p_5, &c.;

and, as before, let $v = \frac{1}{1+r}$. The present value of £1, to be received certainly at the end of a year, is v; but the probability of receiving it is p_1; therefore, the value of £1 at the end of the year, subject to the chance of the given life being then in existence, is $p_1 v$. In like manner, the value of £1, to be received certainly at the end of two years, is v^2; and the chance of its being received is p_2; therefore, the value subject to the contingency is $p_2 v^2$, and so on. Let A denote the value of £1 to be received yearly during the whole continuance of the given life, and we have evidently

$$A = p_1 v + p_2 v^2 + p_3 v^3 + p_4 v^4 + \&c.$$

continued till p becomes nothing, or till the extremity of human life.

It is now necessary to consider the nature of the quantities represented by p_1, p_2, p_3, &c., and to show in what manner they are to be computed. By the doctrine of chances, the probability of the occurrence of any event is measured by the quotient that arises from dividing the number of chances favourable to its occurrence by the whole number of ways in which it can happen. Consequently, if n denote the number of individuals living at a given age, n_1, the number of the same individuals alive at the end of one year, n_2 the number living at the end of two years, n_3 the number living at the end of three years, and so on, we shall have $p_1 = \frac{n1}{n}, p_2 = \frac{n2}{n}, p_3 = \frac{n_3}{n}, p_4 = \frac{n4}{n}$, and so on. The numbers n, n_1, n_2, &c., are taken from a table of mortality, or a table constructed to show the ratio of the number of individuals who enter upon every given year of life to the number who survive that year, or who die in the course of it.

There is no other method of finding the value of the series represented by A than that of calculating the value of its different terms separately, and adding the whole into one sum. Nevertheless, as the object in general is not to determine merely the value of an annuity on a life at a particular age, but to construct a table showing its value for all the different ages of life, there is a method of deducing the value at one age from the value at another age, which greatly abridges the labour of calculation. Thus, suppose the age of the individual on whose life the annuity depends to be 40, and the probabilities of a life of 40 continuing 1, 2, 3, &c. years to be p_1, p_2, p_3, &c., we have, by what is already shown,

$$A = p_1 v + p_2 v^2 + p_3 v^3 + \ldots + p_x v^x.$$

Now, let A_1 be the annuity on a life of 41, that is, one year older than the former; and let the probabilities of a life of 41 living over 1, 2, 3, &c. years, be q_1, q_2, q_3, q_4, &c., we shall have

$$A_1 = q_1 v + q_2 v^2 + q_3 v^4 \ldots + q_4 v^{x-1}.$$

But the quantities q_1, q_2, q_3, &c. are not independent of p_1, p_2, p_3, &c.; the one set are evidently functions of the other. In fact, the probability that a life of 40 will live over 2 years, is equal to the probability that a life of 40 will live over 1 year, multiplied into the probability that a life of 41 will live over 1 year. This is evident from the manner in which the probabilities are obtained; for, n, n_1, n_2, being the numbers respectively alive at the ages of 40, 41, and 42, the probability that a life of 40 will live over 1 year, is $\frac{n_1}{n}$, and that it will continue 2 years, $\frac{n_2}{n}$ or $\frac{n_2}{n_1} \times \frac{n_1}{n}$. In like manner, the probability of a life of 40 living over 3 years, is equal to the probability of a life of 40 living over 1 year multiplied into the probability that a life of 41 will live over 2 years; and so on. Hence, $p_2 = p_1 q_1$, or $q_1 = \frac{p^2}{p_1}, q_2 = \frac{p_3}{p_1}, q^3 = \frac{p_4}{p_1}$, and so on. We have, therefore,

$$A_1 = \frac{p_1}{1} (p_2 v + p_3 v^2 + p_4 v^3 \ldots + p_x v^{x-1});$$

and, multiplying both sides by $p_1 v$,

$$p_1 v A_1 = p_2 v^2 + p_3 v^3 + p_4 v^4 \ldots + p_x v^x.$$

On subtracting this equation from

$$A = p_1 v + p_2 v^2 + p_3 v^3 + p_4 v^4 \ldots + p_x v^x$$

we get $A - p_1 v A_1 = p_1 v$, whence $A = p_1 v (1 + A_1)$. This formula, which was found by the celebrated Euler, gives the following rule for determining the value of an annuity on a life at any age from the value of the same annuity on a life one year older, and renders the computation of the whole table not much more laborious than the direct calculation of the annuity on the youngest life. "To the value of an annuity on a life one year older, add unit; multiply the sum by the probability that the given life will live over one year, and also by the present value of £1 to be received at the end of a year. The product is the value of the annuity on the given life."

The values of deferred and temporary annuities on single lives, are easily found from the table of the values for the whole of life. For example, let it be required to determine the present value of an annuity on the life of an individual now aged 40, but deferred 10 years, that is to say, not to commence till the expiration of 10 years. After the 10 years, if the individual be then alive, the value of the annuity on the remainder of his life is the annuity on a life of 50: let this be called B. The present value of £1 payable at the end of 10 years is v^{10}; and the probability of receiving it in the event of an individual now aged 40 being then alive, is p_{10}; therefore, the present value of B subject to the contingency, is $p_{10} v^{10}$ B. In general, the value of an annuity deferred n years, is $p_n v^n A_n$, where A_n represents the annuity on a life n years older than that corresponding to A.

A temporary annuity on a single life for n years, is found by adding together the first n terms of the series

$$p_1 v + p_2 v^2 + p_3 v^3, \&c.$$

But it is frequently more easy to find it by means of the deferred annuity on the same life for the same term of years; for it is obvious that the temporary annuity and deferred annuity are, together, equal to the whole annuity. Thus, let A be an annuity for the whole of life, A_{tn} a temporary annuity of the same amount for n years on the same life, and A_{dn} the same annuity deferred n years, we shall have $A_{tn} = A - A_{dn}$.

Annuities on Joint Lives. — The method of calculating annuities to be paid so long as two or more individuals shall continue to live together, is equally simple. Let the probabilities that A and B will live over

	1,	2,	3,	4, &c. years
be	p_1,	p_2,	p_3,	p_4, &c.
	q_1,	q_2,	q_3,	q_4, &c.

respectively, then the probability that both will live over

	1,	2,	3,	4, &c. years
will be	$p_1 q_1$,	$p_2 q_2$,	$p_3 q_3$,	$p_4 q_4$, &c.,

and the value of an annuity on their joint lives, which we may denote by Æ, becomes

$$Æ = p_1 q_1 v + p_2 q_2 v^2 + p_3 q_3 v^4 + p_4 q_4 v^4 + \&c.,$$

continued till p or q becomes nothing, or to the last age in the table. When more lives than two are involved, the method of proceeding is obvious.

Another question of this kind frequently occurs, namely, to determine the value of an annuity on the survivor of two or more lives. Let us suppose two lives only are concerned; and let A be the value of the annuity on the first life, B that on the second, and Æ that on the joint lives (*i. e.* to be paid till one of the lives shall drop). Let $p_x =$ the probability the first will live over x years, and $q_x =$ the probability the second will live over x years. We shall then have

$1 - p_x =$ probability 1st will die before the end of x years,
$1 - q_x =$ prob. 2d will die before the end of x years,
$(1 - p_x)(1 - q_x) =$ prob. both will die before end of x years;

and hence the probability that both will not die before the end of x years, is $1 - (1 - p_x)(1 - q_x)$, which is equal to $p_x + q_x - p_x q_x$. This expression, therefore, is the measure of the probability that a payment will be received at the end of the xth year; and supposing the annuity to be £1, the present value of that payment certain is v_x. Multiplying this into the above probability, we get the value in present money of the payment to be made at the xth year, if one or both of the lives survive, viz.

$$p_x v^x + q_x v^x - p_x q_x v^x.$$

Now, if we substitute successively the numbers 1, 2, 3, 4, &c. for x in this expression, we shall have the value of the 1st, 2d, 3d, 4th, &c. payment, and the sum will be the value of the annuity to continue during the life of the survivor. But it has been shown that

$$p_1 v^1 + p_2 v^2 + p_3 v^3 + p_4 v^4 + \&c. = A,$$
$$q_1 v^1 + q_2 v^2 + q_3 v^3 + q_4 v^4 + \&c. = B,$$
$$p_1 q_1 v^1 + p_2 q_2 v^2 + p_3 q_3 v^3 + p_4 q_4 v^4 + \&c. = Æ;$$

therefore, the value of the annuity is A + B — Æ; that is to say, *the value of an annuity on the survivor of two lives is equal to the sum of the annuities on each of the single lives diminished by the annuity on the joint lives.* (For applications of the doctrine of annuities, see the terms Assurance, Survivorship.)

Annuity Tables. — In consequence of the numerous and important application of the doctrine of life annuities to commercial purposes, great pains and labour have been bestowed in the formation of tables of their values at all

the different ages of human life. These tables differ very considerably, not from any difference in the methods of constructing them, but from the difficulty of estimating with numerical precision the probable duration of human life. The first table of the kind which we possess was given by Dr. Halley, in a paper inserted in the "Philosophical Transactions" for 1693, and founded on observations of mortality made at Breslaw. De Moivre, in a tract entitled "Annuities on Lives," published in 1724, gave a very elegant formula for determining the value of a life annuity at any age, founded on the hypothesis that the annual decrements of life are equal; or that out of a given number of individuals, equal numbers die every year, till the whole become extinct. In 1742, Thomas Simpson published tables of annuities on single and joint lives, calculated from observations of mortality made in London. These were extended in a supplementary work published in 1752. Deparcieux, in 1746, published his excellent "Essai sur les Probabilités de la Durée de la Vie Humaine," with tables of annuities on single lives, calculated from the probabilities deduced from the registers kept in different religious houses, and the lists of the nominees in the French Tontines. These tables were decidedly the best that had then appeared, and even now, when much more extensive observations have been obtained, are of great value. But the tables which acquired the most extensive reputation were the celebrated Northampton Tables, calculated by Dr. Price from registers kept in the city of Northampton. These, till a late period at least, have formed the guide of the transactions of all the assurance offices. They give the probabilities of life, and consequently the value of the annuities, considerably lower than all other good observations have subsequently proved them to be; but, in proportion as the annuities are too low, the premiums for assurance deduced from them are too high; and hence they were extremely safe for the offices, though proportionally unjust for the assured. In consequence of the competition resulting from the recent great increase in the number of assurance offices, they now transact their business on more equitable terms. An extensive set of annuity tables was given by Mr. Milne in his "Treatise on the Valuation of Annuities and Assurances on Lives and Survivorships," published in 1815. One of these tables, founded on observations made at Carlisle, has acquired considerable reputation, and perhaps gives a nearer representation of the value of life at present in England generally than any other which has yet been published. The annuities granted by government are now valued according to a table calculated by Mr. Finlaison from the mortality experienced among the different classes of annuitants. This table possesses a great advantage over most others, inasmuch as it is founded on observations of the actual numbers who entered upon and passed through the several years of age among a class of individuals none of which could be lost sight of, so that no uncertainty remains about the accuracy of the data. The values of the annuities are in general considerably higher than those given by the Northampton Table, at the same rate per cent., and approach to those of the Carlisle Table. The observations also indicate a considerable difference between the values of male and female life at the same ages; a fact which appears to be borne out by all the accurate registers of mortality which have been kept in this and other European countries. (*See* MORTALITY.)

The following table, extracted from Mr. Finlaison's Report to the Lords Commissioners of the Treasury (March, 1829), shows the value of a life annuity of £1 at all the different ages of male and female life to 90, according to the mortality among the government annuitants, the rate of interest being 4 per cent.

VALUE of a LIFE ANNUITY of £1, Interest being 4 per Cent.

Age.	Male.	Female.	Age.	Male.	Female.
1	19·0666	19·8135	26	16·8675	18·0175
2	19·1912	19·8981	27	16·7730	17·9043
3	19·2642	19·9512	28	16·6705	17·7878
4	19·2880	19·9795	29	16·5606	17·6683
5	19·2699	20·0008	30	16·4438	17·5456
6	19·2162	19·9902	31	16·3202	17·4172
7	19·1324	19·9549	32	16·1904	17·2861
8	19·0284	19·8923	33	16·0522	17·1526
9	18·9098	19·8070	34	15·9049	17·0171
10	18·7817	19·7014	35	15·7488	16·8795
11	18·6435	19·5794	36	15·5849	16·7439
12	18·4962	19·4485	37	15·4153	16·6047
13	18·3394	19·3159	38	15·2101	16·4607
14	18·1738	19·1848	39	15·0608	16·3113
15	18·0044	19·0594	40	14.8752	16·1560
16	17·8366	18·9587	41	14·6822	15·9927
17	17·6782	18·8663	42	14·4759	15·8229
18	17·5330	18·7797	43	14·2612	15·6461
19	17·4057	18·6962	44	14·0352	15·4615
20	17·2948	18·6130	45	13.7975	15·2686
21	17·1986	18·5230	46	13·5483	15·0661
22	17·1306	18·4298	47	13·2814	14·8543
23	17·0683	18·3329	48	13·0048	14·6331
24	17·0059	18·2320	49	12·7199	14·4022
25	16·9400	18·1273	50	12·4299	14·1610
51	12·1385	13·9061	71	6·5042	7·5256
52	11·8571	13·6409	72	6·2400	7·1980
53	11·5789	13·3656	73	5·9738	6·8762
54	11·3065	13·0816	74	5·6967	6·5655
55	11·0392	12·7904	75	5·4103	6·2640
56	10·7751	12·4952	76	5·1149	5·9590
57	10·5151	12·1946	77	4·7787	5·6707
58	10·2551	11·8888	78	4·4448	5·4058
59	9·9907	11·5778	79	4·1248	5·1617
60	9·7207	11·2609	80	3·8117	4·9358
61	9·4379	10·9328	81	3·5074	4·7307
62	9·1411	10·5983	82	3·2174	4·5213
63	8·8330	10·2597	83	2·9251	4·2922
61	8·5246	9·9186	84	2·6312	4·0372
65	8·2163	9·5765	85	2.3495	3·7511
66	7·9077	9·2328	86	2·0782	3·4410
67	7·6196	8·8903	87	1·8458	3·1139
68	7·3343	8·5476	88	1·6489	2·7743
69	7·0520	8·2022	89	1·4837	2·4371
70	6·7745	7·8580	90	1·3346	2·1133

ANNUITY. In Law. A sum of money paid yearly. and charged on the personal estate, or on the person, of the individual from whom it is due: thus differing from a rent-charge, which is charged on real estate. Annuities are commonly employed as a system of borrowing and lending; the borrower of the money being the grantor of the annuity, and the lender the grantee. An annuity is either for a term of years, for a life or lives, or in perpetuity; and the latter, although charged on personal property, may by the terms of the grant descend as real estate. A perpetual annuity is redeemable by the grantor, subject, however, to conditions in the grant, by which he may preclude himself from redeeming for a certain period of years. An annuity for life or years is only redeemable by consent of the parties, unless it has been rendered redeemable on specific conditions in the original grant. Annuities for life, on account of the risk to which the grantee is exposed, are not within the usury laws: they are, therefore, commonly resorted to as a mode of raising money by loan at high interest. By the stat. 53 G. 3. c. 141., a memorial of every instrument by which annuities for life are granted, must be enrolled in the Court of Chancery, containing the date, names of parties and witnesses, and conditions of contract, and the grantor may have the instrument cancelled, if the consideration money is not *bonâ fide* paid him. This act is intended to relate only to annuities, granted in return for loans. Annuities created by will are general legacies, and subject to abatement, in proportion with other legacies, on a deficiency of the funds of the testator. If a person on whose life an annuity is charged dies between two days of payment, the grantee has no claim pro rata, for the proportionate amount of the yearly or quarterly sum incurred since his death. This act is further explained by 3 G. 4. c. 92., 7 G. 4. c. 75.

AN'NULAR ECLIPSE. An eclipse of the sun, in which the moon conceals the whole of the sun's disk, excepting a bright ring all round the border. (*See* ECLIPSE.)

AN'NULATE. Formed or divided into distinct rings, or marked with differently coloured annulations.

AN'NULET, (Lat. annulus, *a little ring.*) In Architecture. A small square moulding which crowns or accompanies a larger. Also that fillet which separates the flutings of a column, though improperly used in that sense. It is sometimes called a list or listella; which see.

ANNULO'SA. (Lat. annulus, *a ring.*) A term used to designate, sometimes a part, sometimes the whole, of the Articulate division of Invertebrate animals.

A'NNULUS. (Lat. annulus, *a ring.*) This word is used in Botany in several different senses. In the mushroom and some other fungi it is applied to a collar which surrounds the stipes just below the hymenium; in mosses it signifies a rim external with respect to the peristome; in ferns it is an elastic rib which girds the theca nearly all round, and which by its contraction tears the theca open and disperses the spores.

ANNUN'CIA'TION, ORDER OF THE. Founded in Savoy by Amadeus VI., in 1335, as the order of the Collar: received its present name from Charles III. The reigning king of Sardinia is grand master of the order.

ANNUNCIATION, *Feast of the.* A festival of the Christian church, in commemoration of the announcement of the conception of our Saviour to the Blessed Virgin, by the angel Gabriel. (St. Luke i. 26. 38.) It is celebrated on the 25th of March, commonly called Lady-day.

ANO'BIUM. The name of a Fabrician genus of Coleopterous insects, characterised by antennæ filiform, the last joints larger; thorax nearly round, not margined, receiving the head; palpi clavate; labium entire.

A'NODE. (Gr. ἀνα, *upwards*, and ὁδος, *a way.*) The way by which electricity enters substances through which it passes: opposed to cathode, the road or way by which it goes out.

A'NODON. (Gr. ἀ, priv., ὀδους, *a tooth.*) The name of a genus of Lamellibranchiate Bivalves, including the common freshwater muscle, the shell of which has no

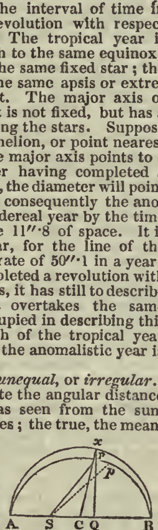
articular processes, or *teeth*, at the hinge. The name has also been applied to a genus of serpents, which have the teeth in the mouth very minute, or rudimental: the *Anodon*, *Typus* (*Coluber scaber* of Linnæus), a South African species of this genus, lives upon the eggs of birds, which, by the structure of the mouth above mentioned, it is enabled to swallow entire. The inferior spinous processes of the cervical vertebræ are prolonged into the gullet, and there receive a coating of enamel; thus serving the office of teeth where the breaking of the egg may take place without the loss of any of its nutritious contents.

A'NODYNE. (Gr. ἀ, *without*, and ὀδύνη, *pain.*) A term applied in Physic to medicines which relieve pain. Anodynes are chiefly of vegetable origin, and generally come under the head of sedatives or narcotics.

ANO'LIS. *Anoli*, *anoalli*, is the vernacular name, in the Antilles, of the lizard to which the generic term *Anolis* is applied. This term is restricted in Zoology to those Iguanoid species of lizard which have minute scales on the under part of the last joints of the toes, while the next joints are extended into soft pads transversely striated, but not organised to act as a sucker, as in the Geckos. All the species of Anolis are natives of the warmer parts of the American continent; all are remarkable for their power of inflating the skin of the throat; they are light and agile in their movements; and in the beauty and brilliancy of their colour exceed all others of the Saurian order.

ANO'MALI'STIC YEAR. The interval of time in which the earth completes a revolution with respect to any point in its elliptic orbit. The tropical year is measured by the return of the earth to the same equinox; the sidereal year by its return to the same fixed star; the anomalistic year by its return to the same apsis or extremity of the greater axis of its orbit. The major axis of the diameter of the earth's orbit is not fixed, but has a progressive motion eastward among the stars. Suppose that when the earth is at its perihelion, or point nearest the sun, the other extremity of the major axis points to a given star; when the earth, after having completed a revolution, returns to its perihelion, the diameter will point $11''\cdot8$ eastward of the same star; consequently the anomalistic year is longer than the sidereal year by the time which the earth takes to describe $11''\cdot8$ of space. It is still longer than the tropical year, for the line of the equinoxes goes backwards at the rate of $50''\cdot1$ in a year; therefore, after the earth has completed a revolution with respect to the line of the equinoxes, it has still to describe $50''\cdot1 + 11''\cdot8 = 61''\cdot9$, before it overtakes the same point of its ellipse. The time occupied in describing this arc is 25 minutes, and the length of the tropical year is 365 d. 5 h. 48 m. 45 s.; therefore the anomalistic year is 365 d. 6 h. 13 m. 45 sec.

ANO'MALY. (Gr. ἀνώμαλος, *unequal*, or *irregular.*) A term used in Astronomy to denote the angular distance of a planet from its perihelion, as seen from the sun. There are three different anomalies; the true, the mean, and the eccentric. Let A*p*B be the orbit of a planet, S the sun, A B the transverse diameter, and C the centre. Through *p* draw P Q perpendicular to A B, meeting the circle circumscribed about the orbit in *x*. On account of its unequal distances from the sun, the angular motion of a planet in its orbit is irregular: conceive, therefore, that while the real planet moves from A to *p*, another planet moving in the same orbit, with an equable motion, and performing a revolution in the same time, has moved from A to P. This being supposed, the angle A S *p* is the true anomaly; A S P is the mean anomaly; and A C *x* the eccentric anomaly. The mean anomaly is proportioned to the time of description; to find the true anomaly, is a problem of considerable difficulty, requiring the aid of the higher mathematics. From the circumstance of its having been first proposed by Kepler, it is usually called Kepler's problem.



ANOMALY. In Grammar, an exception from a general rule.

ANO'MIA. (Gr. ἀ, *without*, νόμος, *a law*; because not easily reduced to the ordinary laws of classification.) The name of a Linnæan genus of the Vermes Testacea, the characters of which, as given in the *Systema Naturæ*, apply to the organisation of the soft parts and shell of the modern Terebratulæ. In the system of Cuvier the term *Anomia* is limited to a genus of Acephalous Mollusca, having two unequal irregular thin valves, of which the flatter one is deeply notched at the cardinal margin. The greatest part of the central muscle traverses this opening to be inserted into a third piece, which is sometimes calcareous, and sometimes simply horny, but which is always attached to foreign bodies. The rest of the muscle serves to join one valve to the other. The animal has a small vestige of a foot, and is remarkable for the length of its labial tentacles.

AN'ONA. (Menona, the Malayan name of *the custard apple.*) A genus of trees found in hot latitudes, with large roundish pulpy fruit, which in some species is used as food. The custard apple, so named from its seeds lying in a whitish sweet cream like pulp, is produced by A. squamosa; the cherimoyer, the most esteemed of all the fruits in Peru, is yielded by another; and other kinds are known.

ANONA'CEÆ. (See ANONA.) An extensive natural order of Exogenous plants, comprehending evergreen trees or shrubs, whose fruit is sometimes eatable, as in Anona, more generally dry and aromatic, as in the genera Unona, Habzelia, &c., whose ripe carpels furnished the Piper æthiopicum of the old drug shops. The great mark of Anonaceæ is their having ternary (trimerous) flowers, and a ruminated albumen.

ANO'NYMOUS. (Gr. ἀνώνυμος, *nameless*, from ὄνομα, *a name.*) In Literature, works published without the name of the author. Those published under a false name are termed *Pseudonymous* (ψεῦδος, *falsehood*). The best catalogue of anonymous works is that of Barbier (*Dictionnaire des Œuvrages Anonymes et Pseudonymes*, 3 vols. Paris, 1822-1824). There is also the great work of Placcius, *Theatrum Anonymorum et Pseudonymorum*, t. fol. Hamburg, 1708.

ANOPLOTHE'RIUM. (Gr. ἄνοπλος, *unarmed*, and θηρίον, *beast.*) The name of a genus of extinct animals of the order Pachydermata, characterised by the shortness and feeble size of the canine teeth, which resemble the incisors, and are consequently unfitted for being used as weapons of offence. As the canines in this genus do not project beyond the level of the incisors and molar teeth, no vacant interspace is required in the dental series of the opposite jaw for the reception of their pointed extremities, and consequently the series of teeth is uninterrupted in both jaws, — a structure observable in no existing animal save man. The Anoplotherium has 6 incisors, 2 canines, and 14 molars in each jaw. The best known (*Anoplotherium commune*, Cuv.) is about the size of a wild boar, but longer in the body, with the head of an oblong form, and a tail of considerable thickness, and as long as the body. Its probable use was to assist the animal in swimming. Another species of Anoplotherium (*A. medium*) is of a size and form more nearly approaching to the light and graceful character of the gazelle; a third species was about the size of a hare. All the species, from the form of the teeth, and the absence of claws or horns, appear to have been singularly deficient in defensive organs.

ANORE'XY. (Gr. ἀ, *without*, and ὄρεξις, *appetite.*) Loss of appetite.

ANO'SMIA. (Gr. ἀ, *without*, and ὀσμή, *smell.*) Loss of the sense of smelling.

ANO'STOMA. (Gr. ἄνω, *upwards*, and στόμα, *mouth.*) A genus of Pulmonate, or air-breathing Gastropods, the adult shell of which presents the following peculiarity, — the last whorl turns upwards towards the spire of the shell.

ANOU'RANS, ANOU'RA. (Gr. ἀ, priv., and οὐρά, *tail.*) A name applied to a tribe of Batrachian reptiles, which lose the tail in arriving at maturity; as the toad and frog.

A'NSERES. (Lat. anser, *a goose.*) In the Linnæan arrangement, the name of the third order of birds, having the bill broad at the top, and covered with a soft skin; the feet webbed. (*See* NATATORES.)

ANT. *See* FORMICA.

A'NTA, Æ. plur. (Lat. ante, *before.*) In Architecture, a pilaster or square projection attached to a wall. When they are detached from the wall, Vitruvius calls them parastatæ. They are not usually diminished even when accompanying columns from whose capitals, in all Greek works, they vary.

ANTA'CIDS. Medicines which neutralise the acid of the stomach.

ANTA'LGIC. (Gr. ἀντί, *against*, and ἄλγος, *pain.*) That which relieves pain.

ANTANACLA'SIS. (A compound word from the Greek prepositions ἀντί and ἀνά, and the verb κλάω, *I break.*) In Rhetoric and Composition, a figure in which a word is repeated, but in a different sense or different inflection from the first; which gives a kind of antithetical force to the expression.

"Labitur, et labetur in omne volubilis ævum."

The return to the former series of thought and diction after the interruption of a parenthesis. is also termed Antanaclasis.

A'NTAPHRODI'SIACS. (Gr. ἀντί, *against*, and Ἀφροδίτη, *Venus.*) Medicines which quell amorous desires.

ANTA'RCTIC. (Gr. ἀντί, *against*, and ἄρκτος, *a bear.*) Opposite to Arctic. Antarctic circle, one of the small circles of the sphere, parallel to the equator, and distant 23° 27½′ from the South pole. Antarctic pole, the South pole, or southern extremity of the axis of the earth. (*See* ARCTIC.)

ANTECE'DENT. In Analysis, the name given to the first of the two terms composing a ratio. Thus in the ratio $a:b$, a is the antecedent, and b is denominated the consequent.

ANTECEDENT. In Logic, the first member of an hypothetical proposition; followed by the consequent; as in the following instance: —

If we say we have no sin (*antecedent*),
We deceive ourselves (*consequent*).

ANTEDILU'VIAN. (Lat. ante, *before*, and deluvium, *deluge*.) Something that existed before the deluge.

ANTELOPE. *See* ANTILOPE.

ANTE'NNA. (Lat. *a yard arm.*) A moveable, tubular, and jointed sensiferous organ situated on the head; and peculiar to the Condylope Articulata. Certain Annelides carry soft tentacles or filaments upon the head, which have been termed antennæ; but improperly, according to the above definition, which would restrict the phrase to the jointed antennæ of insects and crustaceans. In the latter class the antennæ are commonly four in number, consisting each of a 'scape,' a 'pedicel,' of two joints, and a 'clavolet'; the latter is setaceous, and divided into a vast number of minute joints. It is simple in the external antennæ, but in the internal pair is always composed of two and sometimes of three setaceous filaments. The internal pair of antennæ are situated before or between the eyes, the external behind, at the outer sides of the eyes. In insects the antennæ are always two in number, and situated in the space between or before the eyes; they consequently correspond to the internal antennæ of crustaceans. The cavity or socket in which the base of the antennæ is planted is called the 'torulus,' or bed. The first, and in many cases the most conspicuous, joint of the antennæ is termed the scape. The base of the scape, by which it is articulated with the torulus, is the bulb. It often looks like a distinct joint, and is the point upon which the antenna turns. The pedicellus, or second joint of the antenna, in some insects, also acts the part of a pivot in the bed of the scape, in order to give a separate motion to the clavola, or clavolet. This, which includes the remaining joints of the antenna taken together, is occasionally terminated by a capitulum or knob; a term applied to the last joints of the clavolet when suddenly larger than the rest. (For the varieties of antennæ with respect to situation, approximation, proportion, direction, figure, termination, and appendages, the reader is referred to the 4th vol. of Kirby and Spence's *Introduction to Entomology*.)

ANTE'NNULÆ. (Dim. of antenna.) A term sometimes applied to the articulated filaments attached to the jaws or lower lip of Mandibulate insects, and which seem to be endowed with a sensiferous faculty specially adapted to distinguish kinds of food, and applied by the animal to that use: these organs are more commonly called palps, palpi, or feelers.

A'NTEPAGME'NTA. (Lat.) In Architecture, the mouldings or architraves round doors; also the jambs of a door.

ANTEPE'CTUS. In Entomology, signifies the under side or breastplate of the manitrunk, and the bed of the first pair of extremities or arms.

A'NTEPENU'LT, or ANTEPENULTIMA. In Grammar and Prosody, the last syllable of a word but two.

ANTE'RIOR. (Lat. ante, *before*.) This is said either when of two lobes of a stigma, one, the anterior, is directed towards the front of a flower, and the other, the posterior, towards the back, or in any other similar case. It is also applied to certain stipules, which stand between the petiole and stem of a plant, adhering to the former, as in some Cinchonaceous plants.

ANTESIGNA'NI. A class of soldiers in the Roman army, who were drawn up in front of the standards (*ante signa*), whence they derived their name. As their post was one that demanded great courage and firmness, they were picked troops.

ANTHE'LA. (Gr. ἀνθήλιον, *a little flower*.) A name given by Meyer to the inflorescence of rushes.

ANTHE'LIX. (Gr. ἀντι, *against*, and ἡλιξ *the helix*, or *external involute margin of the auricle*.) In Anatomy, the outer or external ridge of the auricle ear, which runs nearly parallel with the helix.

ANTHELMI'NTICS. (Gr. ἀντι, *against*, and ἕλμινς, *a worm*.) Medicines which kill intestinal worms, or effect their expulsion.

A'NTHEM. (Gr. ἀντιφωνη, *alternate singing*.) A piece of music performed in cathedral service by choristers who sing alternately. This manner of singing is very ancient in the church; some suppose it to have descended from the practice of the earliest Christians, who, according to Pliny, were accustomed to sing their Hymn to Christ in parts or by turns (*secum invicem*).

A'NTHER. (Gr. ἀνθηρα, *a flowery herb*.) A hollow case, usually consisting of two parallel cells, and constituting the apparatus that contains the pollen, or male part of a flower. Theoretically considered, an anther is the blade of a leaf, in a contracted state, with its two sides hollowed out and its parenchyma converted into pollen, while the midrib in a fleshy state divides the two lobes, and is called the connective. This part is sometimes highly developed, when the lobes of the anther are often placed at a distance from each other, as in Nymphæa; or it is altogether absorbed, when the lobes run together, and there is but one cell, as in Epacris. Other modifications produce other striking appearances: one lobe, for instance, disappears, and the connective is expanded into the state of a petal, as in Canna; or it is simply lengthened and distorted, as in Salvia; or, the anther remaining in its normal state, it is converted into a fleshy mass, as in Penæa; and it undergoes many similar transformations, either from the same or other causes. What is most curious about the anther, is its property of opening to discharge its pollen just at the very time when the stigma is ready to receive the influence of the latter. The cause of this sympathy between two really independent parts is supposed to consist in an emptying and drying up of the cellules forming the lining of the anther by the absorbent action of the ovary, which is imagined thus by its own efforts to bring about an action which is necessary to its own complete operation. The cellules lining the anther, when thus dried up, contract, and pull against certain fissures or dehiscent lines in the valves of the anther, which give way, and so form openings by which the pollen escapes.

ANTHERI'FEROUS. (Lat. anthera, *an anther*, and fero, *I bear*.) Forming a support to an anther.

ANTHERO'GENOUS. (Lat. anthera, and Gr. γείνομαι, *I am produced*.) When, in double flowers, the anthers are converted into horn-like petals, as in the double columbine.

ANTHE'ROID. Resembling an anther.

ANTHE'SIS. (Gr. ἀνθησις, *the generation of flowers*.) The period when flowers expand. It is as that time that all the curious phenomena of fertilisation occur; the parts are all in their most perfect state, and consequently it is often necessary to speak of that period.

ANTHO'DIUM. (Gr. ἀνθος, *a flower*, or ἀνθωδης, *full of flowers*.) The head of flowers of a thistle or a daisy; it is the same thing as capitulum, and is applicable to all cases where a number of small flowers or florets are combined in a head, and surrounded by a common involucrum. An anthodium is nothing but a depressed spike.

ANTHO'LOGY. (Gr. ἀνθολογια.) Signifying "a garland of flowers," and metaphorically applied to a collection of short pieces of poetry, on amatory, convivial, moral, funereal, &c. subjects, called epigrams; not in the English sense of the word, which implies a pointed conceit, but in the more proper signification of "inscription." The first collection of epigrams known by the name of Anthology was made by Meleager, a Syrian Greek poet, who lived about a century before the birth of Christ; and to this several additions were made by different hands as low down as the times of the Byzantine empire. A selection from the Greek Anthology, translated into English verse by the late Mr. Bland and several friends, has gone through two editions.

ANTHO'LYSIS. (Gr. ἀνθος, *a flower*, and λυσις, *a breaking up*.) The changes of flowers from their usual to some other state, as leaves, branches, &c.

ANTHO'PHORUM. (Gr. ἀνθος, *a flower*, and φερειν, *to bear*.) A columnar process arising from the bottom of the calyx, and having at its apex the petals, stamens, and pistil. It is usually very short, and is in reality an internode between the whorls of sepals and petals.

ANTHOXA'NTHUM. (Gr. ἀνθος, *a flower*, and ξανθος, *yellow*.) A dwarf annual grass, found plentifully in pastures, and having sweet-scented leaves. It is thought that the fragrance of hay is owing to its presence. The flowers are in oval heads, which become dull yellow when ripe. Farmers call it the sweet vernal grass.

ANTHOZA'SIA. (Gr. ἀνθος, *a flower*, and ζαω, *I flourish*.) When the leaves of a plant assume the appearance of petals.

AN'THRACITE. (Gr ἀνθραξ, *charcoal*.) Mineral carbon. A difficultly combustible species of coal.

A'NTHRACOTHE'RIUM. (Gr. ἀνθραξ, *charcoal*, and θηριον, *a beast*.) A name indicative of the stratum in which the fossil genus of Pachyderms, to which it is applied, was found, viz. in the tertiary coal or lignite of Cadibona, in Liguria. The genus presents seven species, some of them approximating to the size and character of the hog; others approaching nearly to the dimensions of a hippopotamus.

A'NTHRAX. The name of a Fabrician genus of Dipterous insects, having the mouth provided with a very long straight setaceous sucker, formed of two unequal horizontal valves, and containing setaceous stings; palpi two, hairy; antennæ distant, the last joint setaceous. The genus is now raised to the rank of a family, *Anthracidæ*, characterised by a short body; wings spreading widely out; antennæ distant, two and sometimes three jointed;

the head as high as the thorax. Two of the genera (*Somatia*, and *Anthrax* proper) are British.

ANTHRE'NUS. The name of a Linnæan genus of Coleopterous insects, having the antennæ clavate, the club solid; palpi unequal, filiform; maxillæ membranaceous, linear, bifid; labium entire; head hid under the thorax.

A'NTHRIBUS. The name of a Fabrician genus of Coleopterous insects, applied to that section of the Linnæan Curculiones, which has the lip bifid, the jaw bifid and short, and the proboscis short.

ANTHROPO'GRAPHY. (Gr. ἀνθρωπος, *man*, and γραφειν, *to describe*.) A branch of Physical Geography which investigates the physical characteristics, local boundaries, and actually existing circumstances, of different races or families of men: differing from Ethnography, which examines their origin and affinities.

ANTHROPO'LOGY. (Gr. ἀνθρωπος, *man*, and λογος, *discourse*.) The science which treats of human nature, both physical and intellectual: any writing on the nature and attributes of man may be said to be anthropological. But the term is frequently used to denote the science of Anatomy in particular.

ANTHRO'POMO'RPHITES. Persons who conceive the Deity to have naturally the human shape. Such sensuous conceptions of the nature of God have been always common among heathens.

ANTHRO'POMO'RPHOUS. (Gr. ἀνθρωπος, *a man*, and μορφη, *form*.) A name applied to the labellum in some Orchidaceous plants, in consequence of the upper lobes having a fancied resemblance to human arms, and the lower to human legs.

ANTHROPO'PHAGI. (Gr. ἀνθρωπος, *man*, and φαγειν, *to eat*.) People who feed upon human flesh.

ANTHU'RUS. (Gr. ἀνθος, *a flower*, and οὐρα, *a tail*.) A spike of minute flowers arranged closely on a long axis, as in the genus Piper.

A'NTHUS. The name of a subgenus of Passerine birds, including the pipits.

A'NTI. (Gr. ἀντι, *against*.) This Greek preposition is constantly used as a prefix; thus, antidote, antibilious, antipathy, &c.

A'NTIAR. (*See* Upas.) A Javanese poison.

A'NTI-ATTRI'TION. A compound applied to machinery to prevent the effects of friction. It frequently consists of a mixture of plumbago with some greasy material.

ANTIBRA'CHIUM. (Gr. ἀντι, *against*, βραχιον, *arm*.) The fore-arm, or third segment of the anterior extremities, which is formed, in the skeleton, by the radius and ulna conjointly; or sometimes by the radius, either alone, or with the ulna partially developed. And the fore-arm articulates, above with the arm, below with the hand.

A'NTICHAMBER. (Fr. antichambre.) In Architecture. Any outward chamber adjoining or near a bed-chamber; also an apartment before any principal chamber; also a lobby or outer waiting room in a palace.

A'NTICHRIST. (Gr. ἀντιχριστος, *opponent of Christ*.) Mentioned by St. John, 1st Ep. ii. 18., and supposed to be the same with the "man of sin" whose coming is foretold by St. Paul, 2d Thess. ch. ii. The speculations in which theological writers have indulged respecting this great adversary of Christianity have been various and most fanciful; but the prevalent opinion among reformed divines has always connected him with the Romish church. At the council of Gap, in 1603, the reformed ministers there assembled, inserted an article in their Confession of Faith, in which the pope is pronounced Antichrist. Grotius, and most catholic divines, consider Antichrist as symbolical of Pagan Rome and her persecutions: Leclerc, Lightfoot, and others, of the Jewish Sanhedrim, or particular Jewish impostors. (See Dodsworth's *Advent Lectures*, London, 1837, for the opinion entertained by some High Church divines of the present day.)

ANTICLI'MAX. (Gr. ἀντι, and κλιμαξ, *gradation*.) In Rhetoric, when a sentence or discourse, instead of ascending from little to great, descends from great to little. Horace has given a famous example,

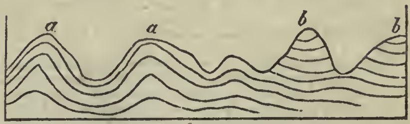
> "Parturiunt montes, nascetur ridiculus mus.'

There are also several striking examples of this figure in Pope, as in the verse,

> "Die, and endow a college or a cat."

But in this case the effect is heightened by the alliteration.

ANTICLI'NAL AXIS (Gr. ἀντι, *against*, and κλινειν, *to incline*.) If a range of hills or a valley be composed of strata which, on the two sides, dip in opposite directions, the imaginary line that lies between them, towards which the strata on each side rise, is called the anticlinal axis. In a row of houses with steep roofs facing the south, the slates represent inclined strata dipping north and south, and the ridge is an east and west anticlinal axis (Lyell). In the annexed diagram, *a a* are the anticlinal, and *b b* the synclinal lines.



ANTI'COUS. (Lat.) In Botany, is applied to an anther whose lobes are placed facing the style; or to a petal which is stationed on that side of a flower which is next the eye of an observer as it grows upon its stem.

ANTI'CUM. (Lat.) In ancient Architecture. The southern porch of a building; that which was towards the north being called the posticum. It is also used to signify that part of the temple between the cell and the columns of the portico.

A'NTIDOTE. (Gr. ἀντι, *against*, and διδωμι, *I give*.) A remedy or preservative against sickness.

A'NTIFI'XA, or ANTEFIXA. (Lat. ante, *before*, and figo, *I fix*.) In Architecture. The ornaments of lions' and other heads below the eaves of a temple, through perforations in which, usually by the mouth, the water is cast away from the eaves. By some this term is used to denote the upright ornaments above the eaves in ancient Architecture, which concealed the ends of the harmi, or joint tiles.

ANTILI'THICS. (Gr. ἀντι, *against*, and λιθος, *a stone*.) Medicines used in the treatment of stone in the bladder and urinary gravel.

A'NTILO'GARITHM. In its most common acceptation, denotes the number to a logarithm. Thus, in the common system of logarithms, 100 is the antilogarithm of 2, because 2 is the logarithm of 100. Sometimes the term is used to denote the complement of the logarithm, or the difference of the logarithm from the next higher term in the series, 1, 10, 100, &c.

ANTILOI'MIC. (Gr. ἀντι, *against*, and λοιμος, *contagion*, or *the plague*.) Remedies used in the prevention and cure of the plague.

A'NTILOPE. (Gr. ἀνθος, *ornament*, and ὠψ, *eye*.) Antelope; a term which, according to Cuvier, is a corruption of the word "antholops," applied by Eustathius, an ancient naturalist, to the gazelle, in allusion to its beautiful eyes. The name is now given to a division of the hollow-horned Ruminants (see Cavicornia), in which the bony axis of the horn is without cavities or sinuses. Antilopes are further distinguished by suborbital or maxillary glandular pouches, and their light and elegant figure. They are the natives, for the most part, of the wildest and least accessible places in the warmer latitudes of the globe; frequenting the cliffs and ledges of mountain rocks, or the verdure-clad banks of tropical streams, or the oases of the desert. They traverse the intervening wildernesses in pairs or in troops, with incredible fleetness, clearing obstacles, which would impede the course of other quadrupeds, by a succession of agile bounds.

The antilopes are now arranged under a number of subgeneric divisions, according to the form of the horns, which are peculiar to the male.

ANTIMO'NIC ACID. The peroxide of antimony. (*See* Antimony.)

AN'TIMONY. A brittle metal of a silver white colour; specific gravity, 6·7. Fuses at 810°, or just at a red heat. The principal properties of this metal were first described in the "Currus Triumphalis Antimonii" of Basil Valentine, published towards the end of the thirteenth century. When heated in an open vessel, it gradually combines with oxygen, and evaporates in a white vapour. There are three oxides of antimony. The protoxide consists of 65 antimony + 12 oxygen; it is a greyish white powder, eminently purgative, sudorific, and emetic; and as such, of much importance in medicine. It is the active base of emetic tartar and of James's powder. The other oxides of antimony, from combining with certain bases, have been called antimonious and antimonic acid; they consist respectively of 65 antimony + 16 oxygen, and 65 + 20. The combination of chlorine and antimony was known to the old chemists under the name of *butter of antimony*. The principal ore of antimony is the *sulphuret:* it is met with in commerce, melted into conical ingots, under the name of crude antimony. It is of a bluish grey colour, metallic lustre, and a striated texture; specific gravity 4·62; it is much more easily fusible than the pure metal. Antimony forms brittle alloys with some of the most malleable metals: when gold is alloyed with a two-hundredth part of antimony, the compound is brittle; and even the fumes of antimony in the vicinity of melted gold are sufficient to render it brittle. Alloyed with lead in the proportion of 1 to 16, and a small addition of copper it forms the metal used for printers' types: with lead only, a white and rather brittle compound is formed, used for the plates upon which music is engraved. With iron it

forms a hard whitish alloy, formerly called *martial regulus*: 12 parts of tin and 1 of antimony form hard pewter. The white metal spoons and teapots are formed of an alloy of 100 tin, 8 antimony, 2 bismuth, and 2 copper.

Antimony is the stimmi, or stibium, of the old chemists.

ANTINO'MIANS. (Gr. ἀντι, *against*, and νομος, *law*.) Oppugners of the law. In Theology, Antinomians are such as interpret the law, to which St. Paul refers more especially in the Epistle to the Romans, as including all moral ordinances whatsoever; and push the contrast which the Apostle maintains between faith and the works of the law to an extreme extent, asserting the entire uselessness of good works, in any case, and the sole efficacy of faith. Hence the term Solifidian is applied to the same class of religionists. The name of Antinomian was first given by Luther, as a term of reproach, to the followers of the opinions of John Agricola on this subject, who complained, however, that his notions had been unfairly represented. Similar doctrines appear to have been held in England by an ephemeral sect in the time of the commonwealth: but antinomianism may now be taken rather as expressing the extreme to which the Calvinistic scheme of theology has the tendency to lead men, than as denoting any distinct sect or congregation, either in this country or abroad.

ANTIPÆ'DOBA'PTISTS. In Theology. Those who object to the baptism of infants on the ground that they are not capable of understanding the nature of the rite, and of pledging themselves to such a course of life as is required of all such as come to be baptized. (*See* BAPTISTS.)

A'NTIPATHES. A genus of Corticiferous Polypes, or corals, in which the central axis is enveloped by so soft a cortex that it falls off when the specimen is removed from the water. From the colour of the axis, it is commonly called "black coral."

A'NTIPE'DES. (Lat. ante, *before*, pes, *foot*.) In Zoology, the anterior or pectoral extremities.

A'NTIPHLOGI'STICS. (Gr. ἀντι, *against*, and φλογισμος, *inflammation*.) Medicines which allay inflammatory action.

A'NTIPHLOGIS'TIC SYSTEM. In Chemistry, the system opposed to that of Phlogiston. (*See* PHLOGISTIC.)

A'NTIPHON. (Gr. ἀντιφωνειν, *to sing against*, or *mutually*.) In ancient Church Music, the short verse sung before the psalm and other portions of the Catholic service. (*See* ANTHEM.)

ANTI'PODES. (Gr. ἀντι, *against*, and πους, *the foot*.) Denotes, literally, those who stand feet to feet; that is, the inhabitants of opposite parts of the earth. They live under the same parallels of latitude, on opposite sides of the equator, consequently the seasons are reversed, or, when it is summer to the one, it is winter to the other. Their longitude differs by 180°, or 12 hours, consequently their days and nights are reversed, that is, when it is mid-day to the one, it is midnight to the other. They have the same climate, in so far, at least, as climate depends on latitude.

A'NTIPOPE. One that assumes the title and functions of pope without a valid election. The term more particularly refers to the popes who maintained themselves in opposition to each other, during part of the fourteenth and fifteenth centuries. The great western schism was caused by the rival jealousies of the French and Italian parties in the conclave; the French cardinals having been accustomed by their numbers, and the influence of the kings of France, to carry the election in favour of French candidates, while the popes resided at Avignon, a period of about 70 years, from 1305 to 1376. Accordingly, when the Italian party at last succeeded in the election of Urban VI., in 1389, the French cardinals retired from Rome, and there invested with the functions of pope one of their own body, under the title of Clement VII. They attempted, in the first instance, to maintain themselves in Italy, and war was proclaimed between the two rivals. After a short struggle, Clement retreated to Avignon; and there he, and his successor, Benedict XIII., held their court, while Urban, and after him, Boniface IX. and Gregory XII., reigned at Rome. They were supported respectively by different European states, of which France, Austria, Castile, Aragon, Savoy, Genoa, and Scotland sided with the party of the seceders. The schism, however, caused great scandal throughout Christendom, and measures were repeatedly taken, and baffled only by the artifices of the rival claimants, for an adjustment of the difference. There seemed to be three methods of proceeding to this end, and each liable to great difficulties:—1st. By the simultaneous resignation of both pontiffs, and a fresh election. 2d. By an arbitration between them. And, 3d. By the calling of a general council, to declare the holy see void, and recommend the conclave to fill the vacancy. This last method was finally adopted; though it has been constantly objected, that such a council could not be lawfully convened except by the summons of a reigning pope; which condition certainly was not fulfilled in the instance of the council of Pisa. However, in 1409, the rival parties were both declared guilty of heresy and schism, and thereby the validity of both claims greatly disproved. Alexander V. was then elected in due form; and the antipopes were unable long to maintain their pretensions against the authority of a general council.

A'NTIQUARY. Copiers of old books, especially in convents, were termed *Antiquarii* in the Latin of the middle ages. In modern phraseology, antiquary is defined "a person who studies and searches after monuments and remains of antiquity, as old medals, books, statues, inscriptions, &c.;" to which may be added those who make the manners and customs of ancient times an especial subject of inquiry. Henry VIII. gave Leland the title of his "Antiquary." The Royal Society of Antiquaries, in London, was founded under the reign of George II. (*See* ACADEMY.)

ANTI'QUE. In a restricted sense, pieces of ancient art, and by artists usually confined to such as were made by the Greeks and Romans of the classical age.

ANTI'QUITIES. Under this term, which has not a very definite meaning in modern European languages, we appear generally to comprehend all memorable things respecting Man in his social state in past time, except the political events, which form more properly the subject of History. Thus, manners and customs, language, literature, topographical details, the monuments of architecture, sculpture, &c. of ancient times, all fall under the general cognizance of the antiquary. His science is, as it were, subsidiary to the more general objects of the historian. In a more restricted sense, the study of antiquities is confined to the description and interpretation of the existing relics of former times, such as architectural remains, manuscripts, medals, and other objects of curious research. Among classical writers, there is, perhaps, only one who falls exactly within the definition of what in modern times we should term an antiquary; viz. Pausanias, whose work, written about the period of Marcus Antoninus, is entirely devoted to a description of the monuments of earlier periods then existing in Greece. But about the time of the revival of letters, when the study of classical writers became the main pursuit of literary men, classical antiquities became also a distinct and important branch of research. Besides the writers who employed their antiquarian knowledge in the shape of commentary on classical authors, a great number devoted their talents to the production of treatises exclusively illustrating particular points in ancient customs and usages. To enumerate the chief classical antiquaries of the 16th and 17th centuries would be impossible; but the following works may be named as among the most comprehensive and general which we possess, containing an immense repository of facts, which the more refined criticism of modern times has sifted and applied with better success: the treatises of *Signonius* and *Meursius*—the latter chiefly on Greek antiquities—are collected in 12 folio volumes, Florence, 1741; the vast *Thesaurus Antiquitatum Græcarum* of the Dutch commentator Grævius (Leyden, 12 vols. fol. 1697, &c.); and the still more extensive work of Gronovius (*Thesaurus Antiquitatum Romanarum*, Leyden, 13 vols. fol. 1697), together with its continuations and supplements, by Burmannus, extending in the whole to 45 volumes; The works of Polenus, Pitiscus, and Gruterus, on the same plan with those two vast collections; the *Antiquité Expliquée* of Bernard de Montfauçon, extending, with the supplements, to 15 vols. folio, Paris, 1719-24. From these great works our modern Compendia in common use (in English, the Grecian Antiquities of Archbishop Potter, the Roman Antiquities of Kennett, Adam, &c.) are chiefly compiled. The names of Boeck (*Public and Private Economy of Athens*), Heeren (*History of Ancient Commerce, &c.*), Müller, Niebuhr, Creuzer, Böttiger, Wachsmuth, &c., attest the equal industry and superior critical skill of the classical antiquaries of modern Germany, the only country in which this branch of knowledge is now successfully cultivated. In that more restricted branch of classical antiquities, the description of the monuments of ancient art, among many illustrious names we may mention those of Caylus (*Recueil d'Antiquités Egyptiennes, Grecques, et Romaines*, 7 vols. 4to. Paris, 1752, &c.) and the Abbé Winkelmann. In the peculiar study of Egyptian antiquities, the names of Young, Hamilton, and Champollion stand pre-eminent. In ecclesiastical antiquities, the huge collections of Ugolinus (*Thesaurus Antiquitatum Sacrarum*, 34 t. fol. Antv. 1744) and Canisius (*Lectiones Antiquæ*, edited by Basnage, 4 t. fol. v. Antv. 1725) may be mentioned among many others. Lastly, the antiquities of the middle ages have received much and accurate attention, especially in France and England, within the last century. Besides the works of Leland and Camden, the fathers of English antiquities, of Dugdale and Hearne, &c., we may name, in modern times, Fosbrooke (*British Monachism*, 2 vols. 4to. 1802, and *Encyclopædia of Antiquities*), Strutt (*Regal and Ecclesiastical Antiquities of England*, 4to.

1773, and many subsequent works), Brand, Lodge, Playfair, &c. &c., besides many who have devoted themselves to particular branches of the subject; and, among living authors, Sir Henry Ellis, Sir F. Palgrave, Sir H. Nicholas, Mr. Petre, &c. In French antiquities, the greatest name is that of Montfaucon (*Monumens de la Monarchie Française*, 5 vols. fol. Paris, 1725, &c.); while the Italians, among whom the study of national antiquities has been very sedulously cultivated, are peculiarly indebted to the indefatigable Muratori. His principal works are the *Antiquitates Italicæ Medii Ævi*, and *Rerum Italicarum Scriptores*: the whole are said to amount to 41 vols. in folio, besides 34 in 8vo.

ANTIRRHI'NEÆ. A small division of Scrophulariaceous plants, consisting of *Antirrhinum* (the snapdragon of the gardens), Linaria, and a few other genera.

ANTI'SCII, or ANTISCIANS. (Gr. ἀντι, *against*, and σκια, *shadow*.) An old term used in Geography to denote those inhabitants of the earth whose shadows fall in opposite directions. The inhabitants of the north and south temperate zones are always Antiscians; those living within the tropics may be Antiscians at one season of the year, and not at another.

ANTISCORBU'TICS. Medicines against the scurvy.

ANTISE'PTIC. (Gr. ἀντι, *against*, and σηπειν, *to putrefy*.) Antiputrefactive. Substances which prevent or check the putrefaction and decay of animal and vegetable matter, are called antiseptic.

ANTISPASMO'DICS. (Gr. ἀντι, *against*, and σπασμος, *a spasm*.) Medicines which alleviate or cure cramp and spasm.

ANTIS'TROPHE. See STROPHE.

ANTI'THESIS. (Gr. ἀντι, and τιθεναι, *to set*.) In Rhetoric, a figure in which two thoughts, words, or sentences are set in opposition to each other, in order to be more strikingly brought forward by the contrast; as in the following sentence from Cicero: "Quod scis, nihil prodest: quod nescis, multum obest." "Your knowledge avails you nothing: your ignorance hurts you much." Quintilian translates the Greek word ἀντιθεσις by the Latin *contrapositum*. The following well known passage of Spenser may be cited as an instance of mixed antithesis and accumulation.

> "Ah! little dost thou know, that hast not tried,
> What hell it is in suing long to bide;
> *To speed to-day, to be put off to-morrow:*
> *To feed on hope, to pine with care and sorrow:*
> *To have thy prince's grace, yet want her peer's:*
> *To have thine asking, yet wait many years:*
> To fawn, to crouch, to wait, to ride, to run,
> To spend, to give, to want, to be undone."

ANTI'TRAGUS. (Gr. ἀντι, *against*, τραγος, *the marginal process of the external ear which is immediately in front of the meatus*.) In Anatomy, the process of the external ear opposite the tragus, and behind the meatus auditorius, or ear-passage.

ANTI'TROPAL. (Gr. ἀντι, *opposite*, and τρεπειν, *to turn*.) When in a seed the radicle of the embryo is turned to the end farthest away from the hilum. This, although a comparatively unusual position of parts, is nevertheless the normal position, if the exact nature of the developement of an ovule is rightly understood.

A'NTLIA. The oral instrument of Lepidopterous insects, in which the ordinary trophi, or instruments for obtaining, are replaced by a spiral, bipartite, tubular machine for suction, with its appendages. It principally consists of the solenaria, or two lateral subcylindrical tubes, and the fistula, or intermediate subquadrangular pipe, formed by the union of the two solenaria, which intermediate canal conveys the nectar to the pharynx. Theoretically, the solenaria are the maxillæ inordinately elongated, and they support at their bases two minute palpi. Rudiments of the upper lip or labrum, and mandibles, exist above the maxillæ; and below these is the labrum, attached to the head, and distinguished by a pair of large palpi.

ANTLIA PNEUMATICA. A constellation of the southern hemisphere.

ANTŒ'CI. (Gr. ἀντι, *opposite*, and οἰκος, *a house*.) Those who live over against each other; a term used in Geography to denote the inhabitants of the globe who live under the same meridian, but on opposite parallels of latitude. The hours of the day or night are the same to each, but the seasons of the year are opposite; that is, when it is summer with the one, it is winter with the other.

A'NTONOMA'SIA. (Gr. ἀντι, *instead of*, and ὀνομα, *a name*.) In Rhetoric and Composition, a figure by which a proper name is put for an appellative noun; as where a tyrant is called a Nero, an usurper a Cromwell, &c.: or, vice versâ, a complimentary periphrasis, or an appellation derived from some attribute, is put for a proper name; as where a king is called "His Majesty," or Tacitus "the prince of political historians."

A'NTRUM. (Lat. antrum, *a cave*.) An old name applied to such hollow fruits as the apple; they are now called Pomes.

ANTRU'STIONS, otherwise styled Fideles (Faithful) and Leudes (Leute, Germ. *people*). A class of people among the Franks, who were the personal vassals or dependents of the kings and counts. They were not dependent on them by reason of holding lands by their grant: but rather, in consequence of being such dependents, were favoured with donations of land, or benefices; which, in process of time, becoming hereditary, assumed the character of Fiefs. (See FEUDAL SYSTEM.) The original word from which Antrustion is derived, was undoubtedly the same with that from which our word *trust*, confidence, has its descent.

ANU'BIS. In Mythology, an Egyptian deity. The seventh, according to the astronomical Theology, of their eight gods of the first class. The Greeks identified him with Mercury. In Egyptian painting and sculpture he is represented as a man with the head of a dog: whence the lines in the 6th book of Virgil's Æneid, describing the conflict of Egypt with Rome:—

> Omnigenûmque Deûm monstra, et latrator Anubis,
> Contra Neptunum et Venerem, contraque Minervam,
> Tela ferunt.

A'NUS. The excrementary orifice of the alimentary canal, which sometimes opens directly on the exterior surface of the animal, as in most Mammals; sometimes into a cavity common to it with the outlets of the urinary and genital organs, called the cloaca, as in most oviparous Vertebrates; sometimes into the respiratory cavity, as in most Mollusks. In Entomology, it signifies the two last segments of the abdomen, and includes the podex, hypopygium, culus, ovipositor, and appendices. In most of the Acrites there is but one orifice to the alimentary cavity, which thus combines the functions of mouth and anus.

A'ORIST. (Gr. ἀοριστος, *indefinite*.) That inflexion of the verb which leaves the time of the action denoted uncertain.

AO'RTA. (Gr. ἀηρ, *air*, and τηρειν, *to keep*.) The great arterial trunk which issues from the left ventricle of the heart. After death it is found empty; whence the older anatomists, supposing that it was for the conveyance of air, gave it the above name. It is single in Mammals and birds; double in most reptiles, and in the Cephalopods; triple in the Crustaceans.

APA'GYNOUS. (Gr. ἁπαξ, *once*, and γυνη, *a female*.) When a plant fructifies but once, perishing immediately after it flowers. It is the same as monocarpic, and nearly the same as annual; only that, like the latter term, it includes such plants as the American agave, which live many years before they fructify.

A'PALUS. A Linnæan genus of coleopterous insects, having the antennæ filiform; the palpi equal and filiform; the maxillæ horny and one-toothed; the labium membranaceous, truncate, and entire.

A'PANAGE. An allowance to younger branches of a sovereign house out of the revenues of the country; generally together with a grant of public domains. A district with the right of ruling it, when thus conferred, is termed paragium. An apanage, in ordinary cases, descends to the children of the prince who enjoys it.

A'PATITE. Native phosphate of lime (from ἀπαταω, *I deceive*), having been confounded with other minerals.

APATU'RIA. An Athenian festival, which came also to be observed by the rest of the Ionians except those of Colophon and Ephesus. Two accounts are given of its origin: one of which derives its name from the Greek word ἀπατη, *deceit*, because it was instituted in memory of a stratagem by which Melanthus the Athenian king overcame Icanthus king of Bœotia; the other from πατηρ, *father*, and the prefix ἁ, signifying *together*, because at this festival children accompanied their fathers that their names might be entered on the public register. The festival took place in October, and continued three days.

APE. In the Zoological sense, is restricted to those higher organised species of the Linnæan *Simiæ* which are destitute of a tail. They are included in the modern subgenera, *Pithecus*, *Troglodytes*, and *Hylobates*, or the ourangs, chimpanzees, and gibbons.

APE'LLOUS. (Gr. ἀ, priv. and pellis, *skin*.) Destitute of skin.

APE'TALOUS. (Gr. ἀ, priv., πεταλον, *a petal*.) When a flower has a calyx only, and no corolla. The term is sometimes extended to those cases in which there is neither calyx nor corolla; thus, the apetalous plants of Jussieu are either destitute of a corolla only, or of all floral envelopes of whatever kind.

A'PEX. The summit or highest point of any thing. Thus, the apex of a cone, of a pyramid, &c.

APHÆ'REUS. (Gr. ἀφαιρειν, *to take away*.) In Writing or Pronunciation, the removal of a vowel from the commencement of a word; as, in English, 'it is' is sometimes written ''t is,' abide is changed into ''bide,' &c.

APHANI'PTEROUS, APHANI'PTERA. (Gr. ἀφανης, *obscure*, πτερον, *wing*.) The name of an order of Apterous Haustellate insects, having rudimental elytra or wings in the perfect state, and undergoing a metamorphosis, resembling that of the *Tipulidæ*, or crane-flies. The common flea (*Pulex irritans*, Lin.) may be regarded as the type of this order. The female flea (*Pulex irritans*, Lin.) deposits a dozen eggs, of a white colour and rather

viscous texture, from which proceed little apodal maggots, which are very active in their motions, winding themselves in a serpentine manner through the substance in which they may be deposited: the head of the larva is protected by a firm skin, and bears two small antennæ, but no eyes; the body consists of thirteen segments, bearing little tufts of hair, and the last is armed with a pair of hooklets: the mouth presents some small moveable instruments with which the maggot hauls itself along. After having passed twelve days under this form, the larva spins itself a little silken cocoon, in which it passes into the pupa state, and in about twelve days more emerges a perfect flea; this metamorphosis distinguishes the flea and chigoe from other blood-sucking parasitic Apterous insects; and they are further distinguished by the number of segments into which their body is divided, and their pentamerous, or five-jointed, tarsi.

APHE'LION. (Gr. ἀπο, *from*, and ἡλιος, *the sun.*) In Astronomy, is that point of a planet's orbit which is at the greatest distance from the sun. It is opposed to perihelion, which signifies the point of the orbit nearest the sun. The aphelion and perihelion of an orbit are consequently the two extremities of its greater axis. In consequence of the mutual attractions of the planets, the positions and figures of their orbits are constantly undergoing a slow variation. The aphelia gradually shift their places on the planes of the orbits; and it is remarkable that these motions are direct, or eastward, in the case of all the planets excepting Venus, the aphelion of whose orbit, when referred to the fixed stars, moves westward at the rate of about 4 seconds annually. Of the old planets, Saturn is that whose aphelion undergoes the greatest annual variation; it amounts to about 18 seconds of a degree. (*See* PERIHELION, PLANET.)

APHE'LXIA. (Gr. ἀφελκειν, *to abstract.*) Absence of mind.

APHE'RESIS or APHÆ'RESIS. (Gr. ἀφαιρεσις, from ἀφαιρεω, *I take away.*) In Grammar, a figure by which a letter or a syllable is cut off from the beginning of a word; as in the common abbreviation, "'t is," for "it is."

A'PHIDES. (Gr. ἀφις, *a puceron*, or *vine-fretter.*) A family of Hemipterous insects, commonly called "plant-lice," inhabiting trees and plants, and living on their juices; remarkable for the anal saccharine secretion referred to in ANAL GLANDS, but more especially for a peculiarity of their generative economy, particularly described by Bonnet, and which consists in the first fecundation of the female influencing not merely the ova immediately developed thereafter, but those of the females resulting from that developement, even to the ninth generation, which are successively impregnated and productive without any intercourse with the male insects. Certain Coleopterous insects, which prey upon and keep in check the Aphides, are termed Aphidiphagi and Aphidivora (φαγω, *I eat*, voro, *I devour*).

APHLOGI'STIC. (Gr. ἀφλογιστος, *uninflammable.*) Without flame or fire.

APHLOGI'STIC LAMP. A lamp with a glowing wick, the combustion in which goes on without flame.

A'PHONY. (Gr. ἀ, priv., and φωνη, *voice.*) Loss of voice.

A'PHORISM. (From the Greek ἀφοριζειν, *to define*, or *limit.*) A term chiefly used in Law and Medicine, but occasionally also in Moral Philosophy, &c., to denote a comprehensive maxim or principle expressed in a few words.

APHRI'TE. (Gr. ἀφρος, *froth.*) A soft, friable carbonate of lime.

APHRODI'SIAC. (Gr. 'Αφροδιτη, *Venus.*) That which incites to venery.

APHRODI'TE. (Gr. 'Αφροδιτη, the name of *the Goddess of Love*, having reference to her supposed origin from the *foam of the sea*, ἀφρος.) This classical name was applied by Linnæus to a beautiful genus of Annelidans adorned with resplendent silky hairs and bristles, of which the sea-mouse (*Aphrodita aculeata*, Lin.) of our coasts is an example.

APHRODI'TIDÆ. The name of the family of Annelides of which the Aphrodita aculeata is the type.

APHYLLA'NTHEÆ. A small division of the Juncaceous order of Endogens, comprehending the genus Aphyllanthus from the South of Europe, with Calectasia and Dasypogon from New Holland.

APHY'LLOUS. (Gr. ἀ, priv., and φυλλον, *a leaf.*) Leafless. The term is, however, often applied to plants in which the leaves are present, but so small as not to look so much like leaves as mere scales. Plants are also called leafless, in which, although scales of considerable size are present, there are no true green leaves: of this description are Monotropa, Orobanche, Pyrolaaphylla, &c.

APIA'CEÆ. (Lat. apium, *parsley.*) A name recently proposed to replace that of Umbelliferæ, it being constructed with more resemblance to the plan upon which the names of other natural orders are formed in Botany, than that of Umbelliferæ.

A'PIARY. (Lat. apis, *a bee.*) A place for keeping beehives. Sometimes this is a small house, with openings for the bees in front, and a door behind, which is kept locked for security; and sometimes it is an area, in which each particular beehive is chained down to a post and padlocked.

API'CULATED. (Lat. apex, *a sharp point.*) When a leaf or any other part is suddenly terminated by a distinct point.

A'PIDÆ. (Lat. apis, *a bee.*) One of the varieties resulting from the modern division of the Linnæan genus *Apis*, including those species which are distinguished by the length of the terminal parts of the inferior organs of the mouth, which constitute a proboscis.

APIO'CRINITES. (Gr. ἀπιον, *a pear*, κρινον, *a lily.*) Pear Encrinite. (*See* ENCRINITE.) The name of a subgenus of fossil Encrinites, in which the body is formed of separate pieces articulated with the stem, and supporting the rays by similar articulations, in consequence of which the stem is rounded and dilated into a pyriform figure at its upper part.

A'PION. A genus of minute Coleopterous insects, of the weevil family (*Curculionidæ*); very numerous in species; distinguishable by their elegant pear-shaped form, protruded snout, and straight antennæ.

A'PIS. In Mythology, a bull, to which divine honours were paid by the Egyptians, especially at Memphis. He was required to be black, with peculiar spots and marks. One of this description was always maintained; but not suffered to live beyond twenty-five years. He was then buried with much solemnity; and Belzoni was of opinion that the bones discovered in one of the sarcophagi disinterred by him, belonged to such an animal. The outrage made by the Persian conqueror Cambyses on the bull Apis, and the disasters which were supposed to have befallen him in consequence of that act, are detailed in the history of Herodotus, book ii.

APIS. (Lat. apis, *a bee.*) The Linnæan genus, now subdivided into different families, is thus characterised: mouth horny; jaw and lip membranaceous at the tip; tongue inflected; feelers four, unequal, filiform; antennæ short, filiform, those of the female subclavate; wings flat; sting of the females and neuters pungent, and concealed in the abdomen.

The insects of this extensive genus live, some of them, in large societies, and some are solitary; their food is the nectar of flowers, honey, and ripe fruit; the larva is soft and without feet; the pupa resembles the perfect insect.

The characters of the Linnæan genus are applicable to a variety of forms, now the types of numerous subgenera, included by Latreille in a family of Aculeate Hymenopterous insects, under the term Anthophila, or Mellifera. The habits of each of the subgenera of this family are replete with interest, arising from their social economy, and the separation of the individuals into three sexual modifications, viz., the prolific females, or queens; the unprolific females, or workers; and the males, or drones. The policy of the hive-bee (*Apis mellifica*, Lin.) has been studied with so much diligence and detail, that we penetrate this mystery of nature with astonishment, and often feel inclined to regard what Huber relates, as fabulous. Nevertheless, the highly interesting observations of the writer, and those especially on which his reputation chiefly rests, have been confirmed by subsequent observers, both scientific entomologists as well as practical apiarians.

The hive-bee is distinguished from all other species of the modern genus Apis, by having the femora of the posterior pair of legs furnished with a smooth and concave plate on the outer surface, and fringed with hair, forming a basket adapted for the conveyance of pollen; and in being destitute of spines at the extremity; by the basal joint of the tarsi, in the workers, being of an oblong form, with its inner surface clothed with hairs disposed in transverse rows; by the trophi being of an elongated form, and the maxillary palpi being almost obsolete and consisting of a single joint.

The different individuals of the social Apis mellifica more nearly resemble each other in their grade of developement—as regards their locomotive powers, organs of sense, and instinctive endowments — than the ants. No individual among them is without wings; and the industry of the workers, or imperfect females, is less astonishing, at least their tasks are less arduous, than fall to the lot of the Apterous labourers of the ant tribes.

As bees, like most other winged insects, are annuals, or go through the whole essential economy of their existence within the year, the history of a year's existence includes the whole, and we have only to choose the point in the circle at which to commence it.

As some individuals, however, always survive the winter, and begin to breed early in spring, forming a colony which quits the parent stock, we shall begin with this colony, and trace their operations through the year.

The first young swarm in this country is generally sent off in June. The migration seems to depend on want of space in the mother-hive, not on an instinctive desire of change on the part of the brood; for if there be space for the operations of the increasing community, bees will not

naturally swarm; and skilful apiarians sometimes take advantage of this circumstance, and, by making successive additions to the hive, retain the whole year's increase in the same building. The swarm consists in general of about six or seven thousand individuals, of which about 1-30th part are males, the rest females; and of these, one only, for the most part, is prolific, and she is called the queen. Her body is longer than that of either the drone or worker; her colours are brighter and purer, and generally of a darker shade; the transverse bands across the abdomen are of a deeper and brighter yellow, and are sometimes orange; the head is smaller than that of the unprolific female, and the tongue is shorter and more slender; her mandibles are notched, and her sting is curved; but the most obvious distinctive character is the proportional length of the abdominal segment of the body, which lodges the generative apparatus, and which is of an elongate conical form, tapering rather sharply to the anus. The male bee is readily distinguished by the short and thick form of his body, which is obtuse at each extremity. He has no sting. The workers, like the queen, are armed with a sting, but it is straight, and proportionally larger and stronger. The workers are essentially females in their internal structure, but their growth is arrested before arriving at the period when the full development of the sexual system takes place, and they consequently are smaller than either the queen or the drones; and their colours are less bright. According to Huber, there are two varieties of labourers, one of a larger size, which he calls 'abeilles cirières,' or makers of wax; the other, or smaller variety, he terms 'abeilles nourrices,' or nurse-bees, whose crop, or first stomach, is not capable of the distention requisite for collecting honey, but whose office is to build the combs and cells after the foundation has been laid by the cirières, and to feed the larvæ.

It is also stated there are two kinds of drones; one not larger than the workers, the other as above described. And Huber has described another variety of the inmates of the hive, which he terms 'black bees,' and which are supposed to be the superannuated workers.

The swarm, thus composed, commonly leaves the hive in the heat of the day, and often immediately after a shower. It is supposed that the queen takes the lead; and she ever afterwards exercises an inscrutable influence over all their operations. Perhaps a stronger proof that instincts do not necessarily depend on physical conformation is not afforded by any phenomenon in natural history, than by the effects which the loss or death of the queen produces on the labourers: this event does not deprive them of any organ, or paralyse any limb; yet, the moment they are conscious of her loss, all their labours are interrupted and forsaken, and, unless another queen be provided, they join another hive, or perish from inanition.

The flight of the swarm is directed to some neighbouring fixed place, and wherever the stand is made they all forthwith repair to it. In the wild state, the cavity of an old tree is commonly chosen; and this, with a seeming prudence and foresight which cannot be sufficiently admired. The first care of the bees is to cleanse it from dust and rubbish, and to gnaw off with their mandibles any asperities or projections which might interfere with the future construction of the comb. In the state of domestication in which the hive-bee is usually preserved in this country, the practice of the above instinctive actions is rendered unnecessary, by the reception of the swarm into neat artificial hives. Yet this modification of their habits, and many other interferences to which they are subject, have had no effect in inducing any varieties in the organisation of the bee, nor any change in those instinctive actions which the care of man has not rendered indispensible. The consideration of this curious exception to the ordinary consequences of domestication, and of the conditions on which the circumscribed limits of variation in the bee depend, would lead us far beyond the extent allotted to the present subject; but it is an inquiry full of interest in relation to the recondite laws which govern the variation of animals from their specific standard.

In the wild state, the young colony at first return occasionally to the parent establishment for supplies of provision; and the domesticated bees always fill their crops with honey before they leave the hive. The wax is a peculiar secretion from the working bee; and having the materials, therefore, within themselves, they immediately begin to form the comb.

Before describing the many-chambered nursery and storehouse which our bees are about to prepare, a few words are necessary regarding the material of which it is constructed.

The formation of the wax is a very singular and complex operation. Huber says, "The wax-makers, having taken a due portion of honey or sugar, from either of which wax can be elaborated, suspend themselves to each other, the claws of the fore legs of the lowermost being attached to those of the hind pair of the uppermost, and form themselves into a cluster, the exterior layer of which looks like a kind of curtain. This cluster consists of a series of festoons or garlands, which cross each other in all directions, and in which most of the bees turn their back upon the observer: the curtain has no other motion than what it receives from the interior layers, the fluctuations of which are communicated to it. All this time the nurse-bees preserve their wonted activity, and pursue their usual employments. The wax-makers remain immoveable for about twenty-four hours, during which period the formation of wax takes place, and thin laminæ of this material may be generally perceived under their abdomen. One of these bees is now seen to detach itself from one of the central garlands of the cluster, to make a way amongst its companions to the middle of the vault or top of the hive, and by turning itself round to form a kind of void, in which it can move itself freely. It then suspends itself to the centre of the space which it has cleared, the diameter of which is about an inch. It next seizes one of the laminæ of wax with a pincer formed by the posterior metatarsus and tibia, and drawing it from beneath the abdominal segment, one of the anterior legs takes it with its claws and carries it to the mouth."

The wax has, perhaps, the nearest analogy to the sebaceous secretion of the integument, than to any other animal secretion: it is formed beneath the scales on the under side of the abdomen, and when accumulated there seems to irritate the part, for the bee may then be observed wagging her abdomen, and running round, or to and fro, as if endeavouring to shake out the little scales; and she is generally followed by one or two other bees, which have been attracted by her movements, and are ready to seize upon the plates of wax as they fall. How the bees mould the scales into the walls of the cells is not yet exactly understood. Some have supposed that they bite pieces off and join them together; but the smooth and uniform surface of the cell shows that some other operation must take place: besides, the wall of the cell is sometimes thicker than a scale of wax. We must, therefore, suppose that the bees have the power of applying some dissolving or softening menstruum to the wax-scales, by which they are enabled to knead and blend them into a ductile paste. And when we remember that the secretion of the salivary tubes of insects is generally alkaline, and that wax is best dissolved by alkali, it is reasonable to suppose that it is by this means that the wax-scales are brought into a workable state. Reaumur, indeed, observed a frothy substance exuding from the mouth of a bee while working at a cell, which was applied to the proper place by the nimble tongue, and then kneaded in by the mandibles; and Huber has described the process very circumstantially: he says that the bee holds the lamina of wax with its claws vertically, —the tongue rolled up serving for a support,—and by elevating or depressing it at will, causes the whole of its circumference to be exposed to the action of the mandibles, so that the margin is soon gnawed into pieces, which drop, as they are detached, into the double cavity, bordered with hairs, of the mandibles. These fragments, pressed by others newly separated, fall on one side of the mouth, and issue from it in the form of a very narrow riband. They are then presented to the tongue, which impregnates them with a frothy liquor. During this operation the tongue assumes all sorts of forms: sometimes it is flattened like a spatula; then like a trowel, which applies itself to the riband of wax; at other times it resembles a pencil, terminating in a point. After having moistened the whole of the riband, the tongue pushes it so as to make it re-enter the mandibles, but in an opposite direction, where it is worked up anew. The liquor mixed with the wax communicates to it a whiteness and opacity which it had not before, and doubtless gives it that ductility and tenacity which it possesses in its perfect state.

Bees commonly begin at the top or roof of their chamber, and build downwards, at first working irregularly, and as it were pasting over the surface; and then building horizontal cells of a more perfect form. These at length become so numerous, that they extend downwards in the form of a vertical wall; other congeries of cells are formed in succession, until the whole comb assumes the form of a series of perpendicular plates or partitions. Each plate consists of a double set of cells, the bottoms of which are applied to each other, and form the partition between each set. The plates are not always regular, and the irregularities which may be observed are not always necessary adaptations to a peculiar form of the cavity in which they are built. The cells are not all of the same size; but a sufficient number of a given depth are reserved for receiving the eggs, and which are necessarily adapted to the size of the future maggot: the smaller or shallower cells are those in which the honey is stored. The breeding and store cells are placed horizontally, but the mouth of the cell is sometimes a little raised—the better to retain the honey. The interspace between the vertical combs is generally about half an inch; these streets, as

they may be termed, in this city of industry, being just wide enough to allow two bees busied upon the opposite cells to pass without incommoding each other. In addition to these interspaces, the combs are perforated in various places, so as to allow a passage for the bees from one street to another, thus saving them much time.

The shape of each cell is not, as might have been expected, cylindrical, or that which seems best adapted to the form of the maggot, or even of the bee constructor; but it is hexagonal, — the only form which allows the cell to be of the largest size in proportion to the quantity of matter employed, and at the same time to be so disposed as to occupy in the hive the least possible space. The form of the base of each cell, which is in apposition with the one on the opposite side, is also such as to gain greater strength, and more capacity, with less expenditure of wax; the latter consideration being one of great importance to bees, which do not secrete a very large quantity of this material; and the most profound mathematicians and most skilful geometers have found the solution of the problem, relating to the attainment of the preceding objects, as derived from the infinitesimal calculus, to have a surprising agreement with the actual measure of the different angles formed by the walls of the cell.

There may generally be observed one or more cells, wider and shallower than the rest, placed either on the edge of a comb, or partition; or placed against the mouths of the cells, and projecting beyond the general surface of the comb. — These are called the royal cells; but as they are not adapted to the form of the queen, nor ever lined with the silken covering of the chrysalis, the supposition that the queen is bred in them seems improbable.

Having now generally described the comb, we return to the consideration of those instinctive operations by which its several compartments are furnished with their destined contents.

The comb seems at first to be formed entirely for propagation, and, indeed, to be essentially related to that function; for if the workers lose their queen, they make no combs; and the reception of honey is, therefore, its secondary use. Wasps and hornets make combs, although they collect no honey.

As soon as the young colony has prepared a few combs the female begins to exclude her eggs. The first that she lays produce the imperfect females, or workers; the subsequent ones produce the males, and, perhaps, the fertile females, or queens. The eggs are deposited at the bottom of the cells, often before these are half completed; they adhere generally by one end to the cell. In about five days the little maggot is hatched, and is seen lying at the bottom of the cell, coiled up in a transparent fluid.

Now begins the additional employment of the labourers, that of feeding and nursing the young maggots; for this purpose new materials must be collected abroad, and brought into the hive.

At first the bees of a young colony fly out singly, and afterwards collectively. They direct their flight generally in a straight line, or the nearest way to the destined object, and often travel to great distances from the hive. In summer time they may be seen almost every where where flowers bloom. In April and May they are abroad the whole day; but in the hot months they venture out less frequently, generally in the morning and evening, at which times it is more easy for them to form the pellets of the pollen, the grains of which adhere together less strongly during the heat of noon-day.

Bees do not like wet weather; yet it is, perhaps, less the presence of rain, than the changes in the degree of light, which deters them from venturing abroad at this time: for they possess large and complex organs of sight, and when clouds collect quickly over the clear sky, they are seen to hurry back in great numbers to the hive; while, if the sky be uniformly overcast, it is not merely a shower of rain that will drive them back: many of the actions of the bee prove, on the contrary, how essential moisture is for them. The bee does not take honey indiscriminately from every flower; in the meadows they may be seen generally upon the Orchideæ, Polygonia, Caryophylacea, but seldom, if ever, upon the Ranunculaceæ, perhaps on account of some poisonous quality. The oleander (*Nerium oleander*, L.), which yields poisonous honey fatal to thousands of flies, is carefully avoided by bees; and the crown imperial (*Fritillaria imperialis*, L.), the white nectaries of which are so conspicuous, tempts in vain the passing bee. They are, however, extraordinarily active in spring at the blossoming of the Amentaceæ, Rosaceæ (especially the dog-rose), and the balsamic lilies, Primulaceæ, &c.; and are, above all, allured by the innumerable flowers of the lime (especially *Tilia parvifolia*), and their hum may be heard among the branches at some distance. The finest flavoured and most delicate honey is collected from aromatic plants; and it is therefore always advisable to have large beds of borage, mignionette, lemon thyme, and sage in the neighbourhood of bee-hives. Those flowers which yield a nectar innocuous to the bees themselves, but possessing poisonous qualities when taken by man, are sometimes frequented by bees, and the honey derived from them acts like a poison. The description by Xenophon of the intoxicating or maddening honey, which so violently affected a number of the ten thousand Greek soldiers in his celebrated retreat, has been confirmed by the observations of Tournefort. And Dr. Barton, in his account of the poisonous honey collected from the Kalmia latifolia by the bees in Pennsylvania, justly observes, that there is more of poetry than philosophy in the following lines of Pope: —

> "In the nice bee what sense so subtly true,
> From poisonous herbs extracts the healing dew."

The honey which is swallowed by the bee passes into the crop, where it is accumulated as in a reservoir, and upon the return of the bee to the hive is regurgitated into a honey cell. If any honey had been previously accumulated there, the bee breaks through the firm cream-like crust which always forms upon the exposed surface of the honey; and it is this crust which maintains the honey in the horizontal cells.

The collection of the farina, or pollen, of flowers, is a great object of the industry of bees. In large flowers, as the tulip, the bee dives in; and if the pollen receptacle, or anther, be not burst, she bites it open, and comes out singularly disguised, being covered over entirely with the fertilising dust, which adheres readily to the fringed hairs of her body and legs.

Aristotle, who was well acquainted with much that is interesting in the economy of the bee, was the first to observe that a bee, during each single excursion from the hive, limits her visits to one species of flower. Modern naturalists have confirmed the general accuracy of this statement, and have noticed that the pollen with which a bee comes home laden is always of the same colour. The necessity of this instinct arises out of the operation which the pollen first undergoes when collected by the bee. She rakes it out with incredible quickness by means of the first pair of legs; then passes it to the middle pair, which transfer it to the hind legs, by which it is wrought up into little pellets. Now, if the pollen were taken indiscriminately from different flowers, it is probable that the grains, being heterogeneous, would not cohere so effectually. Certain it is, that bees enter the hive, some with yellow pellets, others with orange, pink, white, or even green coloured ones; but they are never observed to be party-coloured. Through this instinct, another important end is gained, in relation to the impregnation of flowers; the production of hybrid plants by the application of the pollen of one species to the stigma of another is avoided — while those flowers are more effectually fertilised, which require the aid of insects for that purpose.

When a pollen-laden bee arrives at the hive, she generally walks or stands upon the comb beating her wings, and three or four of her fellow citizens assist in lightening her of her load; or the laden bee puts her two hind legs into a cell, and with the intermediate pair, or the extremity of the abdomen, brushes off the pellets. These are then kneaded into a paste at the bottom of the cell; and several cells are thus filled with the packed and softened pollen, which is called bee-bread.

Besides the honey and farina, bees also collect a peculiar substance, like gum-resin, which was called 'propolis' by Pliny; and this they obtain principally from the balsamic buds of the horse-chestnut, birch, and poplar, especially the *Populus balsamifera*, L. The propolis is soft, red, will pull out in a thread, and is aromatic. It is employed in the hive, not only in finishing the combs, but also in stopping up every chink or orifice by which cold, wet, or any enemy can enter. Like the pellets of pollen, it is carried on the posterior tibiæ, but the masses are lenticular. Having thus traced the operations of the working bees relating to the collection of the substances required in the economy of the hive, we shall now return to the larvæ, which are the immediate objects of all this industry.

The bees may be readily detected feeding the young maggot, which opens its lateral jaws to receive the bee-bread, and swallows it. The well-fed maggot soon grows too large for its tough outer skin, and accordingly casts it; when its bulk has increased so that it fills its cell, it then requires no more food, and is ready to be inclosed for the chrysalis state. The last care of the foster-parents is to cover over the mouth of the cell with a substance of a light brown colour, apparently a mixture of wax and farina. This takes place generally four days after the larva was excluded from the egg. The inclosed larva now begins to line the cell, and covering of the aperture before mentioned, with a silk, which it spins from glandular tubes, similar to those of the silkworm. When the first three segments of the trunk, to which the locomotive organs of the perfect insect are attached, begin to be enlarged, the last larva-skin splits along the back, and is pushed off from the head backwards, and

deposited at the bottom of the cell, and it then becomes a chrysalis. Now the wonderful changes take place, partly by a formation of new organs, partly by a development of pre-existing ones, which end at last in the completion of the perfect bee.

Mr. Hunter ascertained the duration of the pupa state of the bee to be, in one instance, thirteen days and twelve hours, exactly; making the period of immature life, from the first deposition of the egg, to be twenty-two days and a half,—a remarkably brief time for the completion of the metamorphoses, as compared with that in which the corresponding changes are effected in other metabolian insects. When the bee first comes forth it is of a greyish colour, but soon assumes the ordinary brown tints.

When the season of oviposition and the rearing of the larvæ is over, then the business of collecting honey seriously begins; and when the last chrysalis of the season has disclosed its imago, the deserted cell is immediately filled with honey, and covered over with wax, to serve as a store for winter.

In the month of August it is supposed that the prolific female, which is to produce the swarms of the following year, is impregnated. This act takes place in the air. The queen, being preceded by the drones, traverses the exterior of the hive, and suddenly rises aloft in the air, wheeling upwards in large circles, until she is out of sight. The male, unable to extricate the intromitted parts, generally perishes. The rest of this unhappy sex share a similar fate, and meet a violent death from the jaws of the unprolific females. It would seem as if the drones were conscious of their danger at this season, for they do not loiter as usual at the mouth of the hive, but hurry in or out. However, they are attacked by one, two, or three workers at a time, who do not sting them, as Huber asserts, but pinch them and pull them about, as if to wear them out. From this instinctive and indiscriminate slaughter of the males, we may infer that the impregnation of the queen has taken place before the setting in of the winter season; and that the ova, the development of which is retarded during the indolent state in which bees pass through the cold months, are in a condition to be developed and produce the larvæ at the approach of spring. Yet, although on the setting in of the cold weather the bees remain very quiet, they are not torpid, as is the case with most other insects. They cluster as close together as the comb will permit, and have the faculty of generating a degree of heat superior to that of the external atmosphere.

Mr. Hunter found, during an evening in July, when the temperature of the atmosphere was 54°, that of the interior of a hive full of bees was 82°; and in December, the external atmosphere being 35°, the bees preserved a temperature of 73°; and, what is, at this season, extremely rare in the lower animals, they maintain their digestive powers, and subsist on the produce of the summer and autumn. Accordingly, they are ready to take advantage of any fine and mild day, and may be seen then flying abroad and appearing to enjoy it. They void their excrements at this time, for they are insects of singular cleanliness and propriety; and when purposely confined in the hive, with abundance of food, they have been known to fall a sacrifice to this instinctive repugnance to defile the hive.

The continuance of the digestive actions during the winter influences the condition of the oviducts in the queen, and the impregnated ova begin early to expand, and are ready for exclusion in the month of March. This makes the bee the earliest breeder amongst the insects of this country. The labourers now resume their accustomed duties, and, as the season is too early for collecting the provision of the maggot abroad, the store of bee-bread, laid up in the preceding year, comes into use, for the sustenance of the larvæ, which are about to form the first swarm. As soon, however, as the flowers begin to blow, the bees fly forth to gather fresh pollen, propolis, and honey, and the labours of the year recommence.

It appears to be the presence of the larvæ, which are destined to become perfect females, which stimulates the old queen to leave the hive. After repeated attempts to penetrate their cells, and destroy her royal progeny, she becomes infuriated, communicates her agitation to a portion of her subjects, which, together with her, rush out of the hive, and seek a new domicile. It is stated that in every instance the old queen leads the first swarm; the labourers that remain pay particular attention to the royal larvæ that remain; and these, as they are successively excluded, lead away fresh swarms, if the hive be not sufficiently enlarged. Each swarm contains, not only the recently hatched young bees, but also a portion of the old inhabitants. Some assert that the queen, which leads each swarm, is impregnated soon after the new colony is settled; and, as this may take place early in the summer, she begins to oviposit the same year. The number of ova which are fertilised by a single coupling is prodigious: Huber calculates that the queen lays 12,000 eggs in two months; while, according to Reaumur, she oviposits at the rate of 200 a day. The duration of life of the different individuals of the hive varies: that of the male bee is not more than two or three months; there is more doubt respecting the longevity of the workers, but it is probable that it does not extend much beyond a year. The term of the queen's existence has been stated to have been prolonged for five years; but this is rendered improbable by the fact that all insects of the same species have nearly the same duration of existence allotted to them.

The true honey-bee (*Apis mellifica* L.), was originally limited in its geographical range to the Old World, whence it has been transported to America, and other countries where European colonies have been established, and where it is now acclimated. The distinguished entomologist Latreille, on whose authority we state this fact (*Règne Animal*, tom. v. p. 365.), is even of opinion that the honey-bee of the south and east of Europe, as well as that of Egypt, differs specifically from the Apis mellifica of Western Europe.

API'STES. (Gr. *ἀπιστος, treacherous.*) A genus of Acanthopterygious fishes, notable for a strong suborbital spine, with which they are apt to inflict severe wounds when incautiously handled.

APLO'ME. (Gr. *ἁπλοος, simple.*) A mineralogical term for a variety of garnet crystallised in rhombic dodecahedra, derived by the simplest laws of decrement from the cube.

APLY'SIA. (Gr. *ἀπλυσια, uncleanness.*) A genus of Tectibranchiate Gastropods, well known to the ancients under the name of *Lepus marinus*, or sea hare, from a resemblance which the long tentacles of the Aplysia give it to the head of the hare. By Aristotle, the term Aplysia was applied to certain zoophytes, but was arbitrarily transferred by Linnæus to the molluscous animals now known under this denomination.

APO'CALYPSE. (Gr. *ἀποκαλυπτω, I reveal.*) The Book of Revelations, the last in the canon of the New Testament. Many conflicting opinions have been entertained as to the authenticity of this book; but, though rejected by Luther, and neither admitted nor rejected by Michaelis, the opinion of the great majority of critics and divines in modern times has been decidedly in favour of its genuineness. There have, also, been great varieties of opinion as to the person by whom, and the period when, the book was written: but the prevalent opinion is, that it is the work of St. John the Evangelist. Different commentators have differed widely in their interpretations of different parts of this book; and it is looked on by many as being still a "sealed book," admitting, in the present state of our knowledge, of no satisfactory explanation. The phrase apocalyptic writings is frequently used to designate those portions of the Scriptures which contain prophetic descriptions, under the form of visions, of the future state of the church: such as the book of Daniel; and, among the Apocrypha, the fourth book of Esdras.

APOCA'RPOUS. (Gr. *ἀπο, from,* and *καρπος, fruit.*) When the carpels of a flower either do not adhere to each other at all, as in the strawberry, or only by the ovaries, as in Aigella. When a carpel is altogether single in a flower, it is considered, for systematic purposes, apocarpous; the supposition being, that if another carpel were present, it would not adhere to the first.

APO'CRYPHA. (Gr. *ἀποκρυπτειν, to hide.*) Properly, things concealed or put out of sight; applied to certain books, in behalf of which a claim to inspiration has been put forth, but which are supposed to be spurious, and are therefore rejected from the canon of Scripture. One great distinction between the Roman and the Reformed churches is, that the latter reject certain books, admitted by the former on the same footing as those books about which there is no dispute, from the canon of the Old Testament; viz. the 3d and 4th of Esdras, the book of Tobias, that of Judith, the rest of the book of Esther, that of Wisdom, of Jesus the son of Sirach, Baruch the prophet, the Song of the Three Children, the story of Susanna, of Bel and the Dragon, the Prayer of Manasses, and the 1st and 2d Maccabees; reading them, as the sixth Article of the English church declares, for example of life and instruction of manners, but not applying them to establish any doctrine. The English church receives no books into the canon of the Old Testament which were not so received by the Jews; and it appears that the writings thus excluded are not quoted by the authors of the New Testament, nor are admitted into any of the earlier catalogues set forth by the Christian fathers. They are also found to contain some manifest inconsistencies, some obviously fanciful relations, and, in one or two passages, to countenance tenets at variance with the character, or even the express declarations, of revealed religion. There exist at the present day various writings purporting to be the Gospels or Epistles of Joseph, of James the Apostle, of St. Paul, an Epistle of Christ himself to king Abgamus, &c.; which are, for the most part, intrinsically absurd; and, having no external evidence or authority in their favour, have never obtained currency in the church. (*See* art. CANON.)

APOCYNA'CEÆ. An extensive natural order of plants, named after Apocynum, one of the more common of its genera. A few species are found in cold climates, but by far the larger part are natives of warm or tropical latitudes, in the form of shrubs or trees, or twining plants, some of which are remarkable for their beauty, as various species of Echites; others for their poisonous properties, as Cerbera, which furnishes the Tanghin poison of Madagascar, and Strychnos, from various species of which the poisons called tienté and woorary are procured in different countries; while a third set produce bark, having useful bitter and febrifugal properties; the inspissated milk that flows from these plants, when removed, constitutes their poison; the febrifugal bitter principle is an independent secretion, that becomes useful when it can be separated from the milk. Notwithstanding these dangerous properties, the fruits of some species are eatable, as that of Carissa, the cream fruit of Sierra Leone, and some others.

A'PODE. APODA. (Gr. ἀ, priv., and ποῦς, *a foot.*) Footless. A term applied by Latreille to a section of Saurians or lizards, by Mayer to a family of serpents, and by Oppel to a family of Batrachians; by Linnæus to his first order of fishes, which have no ventral fins; and by Cuvier a suborder of Malacopterygia, or soft-finned fishes, is thus designated, comprehending those which are devoid of the ventral fins, or the homologues of the posterior extremities. It is also indicative of those larvæ of insects which have only the soft tubercles or prolegs; and the skins of the bird of paradise, imported as an article of commerce, being always deprived of the legs, it was for some time believed that the species was naturally without feet, and it was consequently termed Paradisea apoda.

APODO'GYNOUS. (Gr. ἀ, priv., ποῦς, *a foot*, and γύνη, *a female.*) A name given by Richard to disks which do not adhere to the base of an ovary.

APO'DOSIS. (Gr. ἀποδιδωμι, *To give back.*) In Rhetoric, the second part of a period. (*See* PROTASIS.)

APODYTE'RIUM. (Gr. ἀποδυσθαι, *to strip one's self.*) In ancient Architecture, the apartment in the palæsta, or bath, in which a person divested himself of his dress, whether for bathing or for gymnastic exercises. In the baths of Nero, these apartments were small; but in those of Caracalla, the apodyterium was a magnificent room with columns and other decorations.

A'POGEE. (Gr. ἀπο, *from*, and γῆ, *the earth.*) Applied, in Astronomy, to the orbit of the moon and the apparent orbits of the sun or planets, to denote the points of those orbits most remote from the earth. It is opposed to perigee, which denotes the point nearest the earth. The apogee of the lunar orbit advances eastward among the stars, and completes a revolution in about nine years.

APOLLIN'ARIANS. In Ecclesiastical History, a sect who denied the humanity of Christ as far as regards the soul, believing its place to be supplied by the *Logos*, or Word of God. Apollinaris, their founder, was a bishop of Laodicea, in the latter part of the fourth century: his doctrine was condemned by the council of Constantinople, A. D. 381. (*See* Mosheim's Eccl. History, English translation, i. 423.)

APO'LLO, or PHŒBUS. A heathen divinity, son of Jupiter and Latona, in Homeric times the god of archery, prophecy, music, and medicine.

> Jupiter est genitor. Per me quod eritque, fuitque,
> Estque patet. Per me concordant carmina nervis,
> Certa quidem nostra, est nostra tamen una sagitta
> Certior in vacuo quæ vulnera pectore fecit;
> Inventum medicina meum est, opiferque per orbem
> Dicor, et herbarum est subjecta potentia nobis.

Later poets represent him also as the god of day and the sun. The statues of Apollo represent a young man in the perfection of manly strength and beauty, with unshorn curling locks, and a bow or lyre in his hand. The worship of this god was very general in Greece and Italy, especially in the former, where he uttered prophetic responses from many of his temples, the most celebrated of which were those of Delos and Delphi, in Phocis: in the latter of these his most esteemed oracles were delivered. The mythological tales about Apollo are very numerous. His birth took place in the island of Delos, whither his mother took refuge from the persecutions of the jealous Juno; and his first exploit was the slaughter of the dragon Python, for which, according to one tradition, he was subjected to servitude under Admetus, king of Pheræ, in Thessaly. Of his numerous amours, that with the nymph Daphne is most noted. She fled from his embraces, and, when no other means of escape from the arms of her pursuer were left, was turned by her father, the river-god Peneus, into a bay-tree, which in consequence became the peculiar emblem of Apollo.

APOLLO BELVIDERE. A beautiful statue of Apollo, found, towards the end of the fifteenth century, among the ruins of the ancient Antium. It was purchased by Pope Julius II., who placed it in the Belvidere of the Vatican, whence it takes its name. It is, perhaps, the noblest work of art. The god is standing, about seven feet high, and almost naked. His quiver hangs over his right shoulder; his pallium over his left arm, which is extended; and in his hand are the remains of a bow, out of which he is supposed to have just discharged the arrow that killed the serpent Python. The whole figure has about it an indescribable air of grace, beauty, and majesty.

> "Or view the Lord of the unerring bow,
> The God of life, and poesy, and light —
> The sun in human limbs array'd, and brow
> All radiant from his triumph in the fight;
> The shaft has just been shot — the arrow bright
> With an immortal's vengeance: in his eye
> And nostril beautiful disdain, and might,
> And majesty, flash their full lightnings by,
> Developing in that one glance the Deity."

This *chef-d'œuvre* of Greek sculpture has been supposed by some, but on very slight grounds, to be alluded to by Pliny (*Hist. Nat.* lib. xxxvi. § 4.). The best critics are of opinion that the artist is wholly unknown. This noble statue was conveyed to Paris by Napoleon; but, on the downfal of the latter, it was again restored to the Vatican.

A'POLOGUE. (Gr. ἀπόλογος.) In Literature, a fable or fiction, of which the object is moral. According to some definitions of the Apologue, it is a fable of which the interlocutors or subjects are animals: but this seems an unfounded limitation. (*See* FABLE.)

APO'LOGY. (Gr. ἀπολογία.) In Literature, a defence, or answer to an accusation. The two pieces of Xenophon and Plato, each commonly termed Apologia Socratis, differ in character: the first being a defence supposed to be pronounced by the philosopher himself; the last, a narration of his last hours and discourses. Treatises in defence of the Christian religion, in its early period, were denominated Apologies by their writers; as those of Justin Martyr, Tertullian, and others, both preserved and lost. The title has been retained by some writers in modern times: as by Robert Barclay, in his Apology of Quakerism, and by Bishop Watson, in his Apologies for the Bible and for Christianity.

A'POPHTHEGM. (Gr. ἀποφθεγμα, from φθεγγομαι, *I speak.*) A short and sententious speech or saying. The apophthegms of the ancients are generally sentences expressing some truth of universal application in philosophy, the conduct of life, &c. &c. Such are Plutarch's "Apophthegmata Laconica," a collection of the brief and pointed sayings for which the Lacedæmonians were famous.

A'POPHYGE. (Gr., signifying *flight*, or *refuge.*) In Architecture, that part of a column between the upper fillet which rests on the base and the cylindrical part of the shaft of a column, usually moulded into a hollow or cavetto, out of which the column seems as it were to fly or shoot upwards.

APOPHY'SIS. (Gr. ἀποφυω, *I proceed from.*) A protuberance, process, or projection. In Anatomy, restricted to processes of the osseous system.

A'POPLE'XY. (Gr. ἀποπλησσειν, *to strike down.*) A sudden suspension or loss of the powers of sense or motion; the heart continues to act, and respiration is continued, though often with some difficulty.

APOROBRA'NCHIANS, APOROBRANCHIATA. (Gr. ἀπορεω, *I want*, and βραγχια, *gills.*) A name applied by Latreille to an order of the class Arachnida, characterised by the absence of stigmata or respiratory pores on the surface of the body.

APOSE'PEDIN. (Gr. ἀπο, *from*, and σηπεδων, *product of putrefaction.*) A peculiar crystallised substance obtained from putrid cheese.

A'POSIOPE'SIS. (Gr. ἀποσιωπαω, *To leave off speaking suddenly.*) A figure in Rhetoric and Composition, by which a sentence is made to break off abruptly when unfinished either in sense or grammatical construction; so that the part which was to follow appears to be retained in the mind of the speaker or writer. In writing, the Aposiopesis is now often denoted by an horizontal line or break at the point where the sense is interrupted.

APO'STACY. (Gr. ἀφίστημι, *I desert.*) A deserting or abandoning of the true faith; but the word is now used to designate the renunciation of political as well as religious opinions.

APOSTASIA'CEÆ. A very small natural order of plants found in the tropics of India, closely allied to Orchidaceæ, from which they differ in having a three-celled ovary and diandrous flowers, the sexes of which are partly free. Apostasia is the principal genus.

APO'STILL. In Literature, a marginal note to a book.

APO'STLE. (Gr. ἀποστολος.) A person sent forth upon any business: hence applied, by way of eminence, to the twelve elect disciples of Christ, who were sent forth by him to convert and baptize all nations. In the first century, the apostles assumed the highest office in the church; and the term apostle during that period was equivalent to bishop in after times. According to Theodoret (v. Bingham, II. Q. 1.), the titles of bishop and

presbyter were originally applied promiscuously to the same, or second, order in the church.

APO'STLES' CREED. A confession of faith, supposed anciently to have been drawn up by the apostles themselves, and deriving the title "Creed" from the word with which it begins in Latin (credo, *I believe*). With respect to its antiquity, it may be affirmed, that the greater part of its clauses is quoted by the apostolic father Ignatius; and that the whole, as it now stands in our liturgy, is to be found in the works of St. Ambrose, in the fourth century.

APOSTO'LIC FATHERS. The writers of the Christian Church, who lived in the apostolic age, or were during any part of their lives contemporary with the apostles. They are five: Clement of Rome, Barnabas, Hermas, Ignatius, and Polycarp; of whom the last suffered martyrdom, A. D. 147. Of these the three first are supposed to be mentioned in the Epistles and Acts; the fourth, according to a prevalent tradition, was the child whom Christ took in his arms, whence he was called Theophorus; and the fifth, who suffered at a very advanced age, seems to be the angel or bishop of Smyrna whom St. John addresses in the Revelations.

APO'STROPHE. (Gr. ἀποστρέφειν, *to turn off.*) In Rhetoric, a figure of speech by which the orator or writer suddenly breaks off from the previous method of his discourse, and addresses himself in the second person to some person or thing, absent or present. It is not necessarily an address to the absent or dead, although often so defined. An orator, who should suddenly direct his speech to one of the audience, would be employing an apostrophe. It is, like other figures of speech, an imitation of one of the most natural effects of strong emotion. In oratory, the Apostrophe of Demosthenes to the gods, at the end of the *Oratio pro Coronâ* in narrative writing, that of Tacitus to the shade of Agricola, in his biography of that statesman, may be cited as splendid examples in ancient literature of the use of this figure.

APOTHE'CA. (Gr. ἀποθήκη, *a repository.*) In ancient Architecture, a storehouse for oil, wine, &c.

APO'THECARY. (Gr. ἀποθήκη, *a shop.*) Apothecaries were originally the venders and preparers of drugs and compounds used in medicine. The Apothecaries' Company, or the Society of Apothecaries for the City of London, was incorporated by James I. in 1606. Their last charter bears date 6th of December, 1617. (*See* COMPANIES.)

APOTHE'CIUM. (*See* APOTHECA.) A flat disk, consisting of a nucleus surrounded by a border, in which the asci of lichens are inclosed. It is commonly called a shield.

A'POTHEO'SIS. (Gr. ἀποθέωσις.) The change from a mortal to a divine nature, which the ancients supposed some men to undergo after death: as the old heroes among the Greeks; and the ancient kings of Italy, and Romulus, with the Romans, who also paid divine honours, in later times, to their deceased, and, in some cases, to their living, emperors.

AP'OTOME. (Gr. ἀποτομος, *cut off.*) In Music, the remaining part of an entire tone, after a major semitone has been abstracted from it; or it is the remainder of a whole tone when diminished by a limma, or smaller semitone. As the tone major cannot be rationally divided into two equal parts, the Greeks divided it into a greater and less semitone; the greater being the apotome, and the less the limma. The proportion of the apotome to the limma is 2187 to 2048.

APOTOME. In Geometry, a term employed by Euclid and some of the ancient mathematicians to denote the remainder or difference between two lines or quantities commensurable only in power. Thus, if from the diagonal of a square, a part equal to the side of the square is cut off, the remainder is the apotome, and is represented numerically by the expression $\sqrt{2}-1$. In the tenth book of his Elements, Euclid divides apotomes into six classes.

A'POZEM. (Gr. ἀπο, and ζειν, *to boil.*) An old Pharmaceutical term for a decoction.

APPA'RENT. A term used in Astronomy to denote things as they appear to the eye, in distinction to what they really are. Thus, the apparent altitude of a star denotes the angle which its line of vision makes with the horizon; but the real altitude is found by making a correction for the effects of parallax, which causes the star to appear a little higher than it would if there were no atmosphere. The apparent diameter of a planet is measured by the angle made by two straight lines drawn from the eye to opposite points of its disk; the real diameter is a straight line joining those points; while astronomers call the angle under which the diameter would be seen from the centre of the earth, the true diameter. The apparent or sensible horizon denotes the plane which is a tangent to the earth's surface at the place of the observer; the true horizon is a plane parallel to the former, and passing through the centre of the earth. Apparent motion is the velocity and direction in which a body appears to move to an observer who is himself in motion. For example: the apparent diurnal motion of the stars from east to west arises from the rotatory motion of the earth, which carries us along with it in an opposite direction. Apparent time is the same as true time, or the hour indicated by the sun's passage over a meridian; while mean time is that which would be indicated by the sun if its angular velocity in its orbit were uniform.

APPARI'TION. In a general sense, means the appearance or semblance of any thing; but the word is now commonly used to denote a spectre, or the preternatural appearance of some spirit. A belief in the reality of such preternatural appearances has been entertained by many eminent men; but it has chiefly prevailed in times of ignorance and superstition, and has either wholly disappeared, or had a comparatively limited influence in more enlightened times.

APPEA'L. In Law, 1. The removal of a cause from an inferior court to a superior. 2. An accusation of a criminal offence by one subject against another. The bringing decisions of the courts of Scotland and Ireland, or the court of chancery in England, before the house of lords, is peculiarly termed an appeal in the first sense. Criminal appeals are now obsolete: those on charges not capital have long been so. Appeals of treason and of felony subsisted for a much longer period: the latter had doubtless their origin in the early jurisprudence of the Gothic nations, by which acts of violence or injury were redeemable by a weregild or fine to the party injured or his near estrelative. They were put an end to by stat. 59 G. 3. c. 46. (*See* WAGER OF BATTLE.)

APPEA'RANCE. In Law, the act whereby a defendant in an action recognises the process by which that action is commenced against him: originally by appearing in person, or by attorney, in court; now, by filing common or special bail to a writ of capias, by delivering a memorandum in writing to an officer of the court, in answer to a writ of summons, &c.

APPE'LLANT. In Law, the party by whom an appeal is made; as against an order of magistrates to the quarter sessions, or against the decision of a court of equity to the house of lords. The opposite party is termed respondent.

APPE'NDAGE. In Botany, all parts which are regularly arranged round any other part are called appendages; leaves are appendages of the axis: so are all the parts of a flower theoretically; the supernumerary sepals in a strawberry are appendages of the calyx; the abortive stamens that arise from the calyx of a passion-flower are appendages of the calyx; and so on.

APPEND'ICULATE. Having appendages. The word is sometimes applied to all those plants which are furnished with leaves (appendages of the axis).

APPE'NDIX. In Literature, a supplement added at the end of a work, either to contain portions of the subject which had been omitted, or separate pieces and extracts from other works bearing on it: such as are termed in French *pièces justificatives.*

APPE'NSUS. (Lat. appendo, *I hang up.*) When an ovule is not exactly pendulous, but is attached to the placenta by some point intermediate between the apex and the middle.

A'PPIAN WAY. The most celebrated of the highways leading from ancient Rome. It was constructed by the censor Appius Claudius, A. U. C. 442; and commencing at the gate of Capena, now St. Sebastian, extended to Capua, the then limit of the empire. It was formed of stones squared and jointed, and was wide enough for two chariots to go abreast. On each side was a ditch for carrying off the water.

A'PPLE. (Gr. ἀπιος, *a wild pear.*) The cultivated fruit of *Pyrus malus*, the crab apple of our hedges. All the numerous varieties that are now so common are said to have originated slowly from improvements of this wild sort. At what period its amelioration commenced is unknown; but, as Pliny was acquainted with several kinds, it is reasonably to be supposed that its improvement is to be assigned to a high antiquity. If it could be true that pippins, that is, seedling improved apples, were introduced only at the end of the 16th century, we should have to give the southern nations of Europe the credit of having furnished us with the stock from which the valuable varieties we now possess have been derived. But there is no doubt that apples of some kind have been known in England from long before the Conquest, and although they may have been of bad quality, and fit for food only when roasted, yet they could hardly have failed to produce seedlings of valuable qualities. The term apple is employed in composition to designate any large fleshy fruit, as love-apple, thorn-apple, pine-apple, &c.

APPOGIATU'RA. (Ital. appogiare, *to lean upon.*) In Music, a small note preceding a larger one of greater duration, of which it borrows one half of its value: sometimes, however, it is only one quarter in duration of the note which it precedes.

APPO'RTIONMENT. In Law, the dividing of a rent, &c. into parts, according to the number and proportion of the parties between whom the land is divided.

APPRAI'SEMENT. The valuation of goods sold under distress for rent due, by sworn appraisers, under several statutes. (*See* DISTRESS.)

APPREHE'NSION, SIMPLE. In Logic, is that act or condition of the mind in which it receives a notion of any object, and is said to be either incomplex or complex: the former being the apprehension of one object, or of several without any relation between them, as "a man," "cattle;" complex, of several, with such a relation, as "a man on horseback," "a herd of cattle."

APPRE'NTICE. (Fr. apprendre, *to learn.*) A person bound by indenture, for a certain term, to perform services for a master, receiving, in return, instruction in a trade or occupation; and, in most instances, necessary food and clothing. Apprenticeship seems to have originated, together with guilds and fraternities, in the middle ages. Seven years is a common term of apprenticeship in Germany, as well as in England; but other periods, as three and eight, have been customary in different trades, places, and times. The former period was fixed in England by the statute 5 Eliz. c. 4., which regulated apprenticeship throughout the realm in general. By 54 G. 3. c. 96., the legal force of apprenticeship was finally destroyed; that is, persons were allowed to exercise their respective trades without having served; London, and a few other corporate towns, being excepted. Apprenticeship is, therefore, now only recognised by the law as the mode of learning a trade.

APPROA'CH. In Fortification, a term given to the trench or covered way by which a besieging army may advance from its camp to the wall of a fortress without being exposed to the fire of the defenders. Approaches sometimes consist of covering masses only, formed of earth in bags, fascines, stuffed gabions, woolpacks, bales of cotton, or other materials within reach.

APPROACH, CURVE OF. In Geometry, the name given to a curve which possesses this property, — that a heavy body descending along it by the force of gravity, makes equal approaches to the horizon in equal portions of time. It was proposed by Leibnitz, and its propertles investigated by Bernoulli and others.

APPROACH ROAD. In Landscape Gardening, is the road which leads from the public or main road, through a park or pleasure ground, to the mansion of a country residence. In the ancient or geometric style of gardening, this road was bounded by lines either straight or regularly curved, and was generally accompanied by one or more rows of trees on each side, at regular distances: but in the modern style, the approach road is led in graceful sweeps, which are made to appear as if they were determined by existing circumstances, either in the surface of the ground, or in the trees or other objects which are placed on it. There ought to be no bend in an approach road for which there is not an obvious and sufficient reason, either naturally existing, or created by art.

APPRO'PRIATION. In Landscape Gardening, is the art of so blending the scenery of one estate with that of the others that adjoin it, as to make the one subservient to the other, in a scenic point of view. This is effected by forming appropriate fore-grounds, in the estate at command, to the distant views, in the estates not at command; or in fields immediately adjoining, by imitating in our own field a part of what is contained in the field of our neighbour: thus, if the park of A. should be chiefly planted with pines and firs, and that of B. chiefly with oaks; A., in order to appropriate the scenery of B., must substitute oaks for a part of his pines and firs; more especially in the immediate vicinity of the grounds of B.

APPRO'VER. In Law, a person who being indicted of treason or felony, and not disabled from giving legal evidence, upon his arraignment, before any plea pleaded, confesses the indictment, and takes an oath to reveal all treasons and felonies that he knows of, and therefore prays a coroner to enter his appeal or accusation against those that are his partners in the crime contained in the indictment.

APPRO'XIMATE. In Zoology, when the teeth are so arranged in the jaws, that one passes on the side of the next, and there is no intervening vacancy.

APPROXIMA'TION. (Lat. proximus, *nearest, next to.*) A drawing near to. In Mathematics, quantities are said to be approximate which are nearly but not absolutely equal.

In a general sense, the term approximate may be applied to every result of natural philosophy or experimental science. For example, the magnitude of the earth, the distance of the sun, the masses of the planets, in fact, all the elements of astronomy, are only known nearly, or by approximation. In these cases, however, the want of absolute knowledge arises from the imperfections of our senses, or the errors of our instruments. In the language of Analysis, approximation is used to denote those methods of calculation by which we obtain near values of quantities which cannot be found accurately, either on account of the nature of their composition, or the imperfections of our methods of calculation.

The problem of finding the length of the circumference of a circle, by means of inscribed polygons, affords an instance of approximation to the values of geometrical quantities. It is a principle in Geometry, that any arc of a circle, however small, is greater than its chord. Now, suppose a regular polygon of 100 sides to be inscribed in a circle, and that we know the exact length of one of the sides; it is evident that the sum of all these lengths will give an approximation to the length of the circumference, though it would fall short of it by a very sensible quantity. But suppose that, instead of a polygon of 100 sides, one of 1000 sides were inscribed in the circle, the aggregate lengths of the sides would now approach much more nearly to the length of the circumference. By continuing to multiply the number of sides, we may obtain an approximation to any degree of nearness we please; but whatever the number of the sides of the polygon may be, their sum will never be exactly equal to the circumference, for they are only the chords of small arcs, which of necessity are smaller than the arcs to which they belong.

Numbers are formed by successive additions of unity, which is necessarily a finite quantity. In consequence of this finitude, it may be affirmed that no magnitudes which flow, or increase, by insensible degrees, can be expressed generally by numbers. For example, let a straight line be taken at random, and suppose that we wish to determine its length, our unit of linear measure being one foot. On applying successively a scale divided into feet to the different parts of the given line, the chances are infinity to one that the last division does not exactly coincide with the extremity of the line. We may diminish our unit by reducing it to an inch, or to the hundredth or the thousandth part of an inch; the chances of ultimate coincidence will not thereby be increased, though the difference between the last division of the scale and the extremity of the line may be diminished till it becomes smaller than any quantity we may be pleased to assign. Precisely similar to this is what takes place when we attempt to express by decimals a vulgar fraction whose denominator is not a measure of any power of ten. Thus, the fraction $\frac{1}{3}$, expressed decimally, is ·33333, &c. The first figure of the series gives the approximate value 3-tenths; the first two figures give 33-hundredths; the first three, 333-thousandths, and so on; the addition of every figure to the series making the difference of its value from 1-third ten times smaller. The difference may, therefore, be diminished till it becomes smaller than any assignable quantity, but it can never entirely disappear.

Another instance of the necessity of having recourse to approximation, is presented in seeking to find the roots of numbers. If a number is not an exact square, its square root cannot be expounded by rational numbers, whether integers or fractions. The same thing occurs with respect to numbers which are not cubes, and so on. In these cases, exact numerical values of the roots cannot be found. In other cases exact values may exist, though our methods of analysis are not sufficiently perfect to enable us to discover them. Notwithstanding the successive efforts of the greatest algebraists since the days of Lucas de Borgo, no general method has yet been discovered of solving equations of a higher degree than the fourth; consequently, the values of quantities involved in such equations can only be obtained approximately. It is to this subject that the attention of our best writers on analysis has chiefly been directed; in fact, the discussion of the different methods of approximating to the roots of equations of the higher degrees, forms one of the principal subjects of pure Algebra.

The method of exhaustion, by which the ancient mathematicians attempted to find the rectification and quadrature of the circle, was the first instance of a systematic method of approximation. The Indivisibles of Cavalleri effected the same object in a more rapid and general manner, and prepared the way for the differential calculus. The invention of the method of infinite series led immediately to general methods of approximating to the values of all radical quantities, and subsequently to the roots of all kinds of compound equations whatever. Vieta was the first who showed how to find successive values of the roots of equations, each approaching more nearly to the true value than the preceding; but his method was tedious and imperfect. Other methods, more easy and general, have been given by various mathematicians; among which, the best known are those of Newton, Halley, and Raphson, and those which have been proposed at a later period by Lagrange, Legendre, Budan, and others. These methods are in general drawn from the most abstruse parts of the theory of equations, and could not be explained in this place with the details necessary to render them of any use. For the best information on the subject, we may refer the reader to the excellent work of Lagrange, "Traité de la Résolution des Equations Numériques;" the "Nouvelle Méthode pour résoudre les Equations Numériques" of M. Budan; the "Supplément à l'Essai sur la Théorie des Nombres," by

Legendre; and the article *Equations*, in the Encyclopedia Britannica, by Mr. Ivory. (*See* Equations.)

A'PRICOT. (Lat. præcox, *early*, or Arab. berkhach, *butter fruit.*) The fruit of Armeniaca vulgaris, a native of Cachmere, and probably of the mountains of Caubul, and cultivated from Persia and the Oases of Egypt throughout the temperate parts of the world. In its wild state the apricot is a small round pale waxy yellow fruit, rosy on one side, and agreeably subacid; in that state it is dried in large quantities under the name of mishmish; in its most improved state it becomes three times as large and sweeter: but it is then apt to become insipid. For the confectioner's purpose, the Brussels and Breda apricots, which are near approaches to the wild fruit, are better adapted than the larger and sweeter kinds.

A'PRIL. The fourth month of the year. The name is probably derived from Lat. aperire, *to open*, either from the opening of the buds, or of the bosom of the earth, in producing vegetation.

A PRIO'RI. (The argument *à priori.*) In Philosophy and Rhetoric, is a phrase somewhat loosely applied to designate a class of reasonings. It is generally understood to apply to any argument in which a consequent conclusion is drawn from an antecedent fact, whether the consequence be in the order of time, or in the necessary relation of cause and effect; — e. g., "The mercury sinks, therefore it will rain." This is an argument drawn from an antecedent in time, not from a cause to an effect. A murder has been committed; a party falls under suspicion, as having had an interest in the death of the deceased, or a quarrel with him: this suspicion is founded on the argument *à priori*, from cause to effect; because the fact of his enmity or interest would afford a cause for his committing the murder. On the other hand, another party falls under suspicion, as having been seen to quit the house at a particular time, having marks of blood on his clothes: these are arguments *à posteriori*, in which we reason either from consequent in the order of time to antecedent, or from effect to antecedent cause. The famous *à priori* argument of Clarke and others in favour of the existence of a God, was an argument drawn from certain primary axioms in metaphysics; while the common course of reasoning to prove the same truth from the visible proofs of design in the works of nature, is an instance of the latter or *à posteriori* form.

A'PSIDES, or APSES. (Gr. ἁψις, *circle*, or *curvature.*) The two points of the orbit of a planet or satellite, at which it is moving at right angles to the straight line joining it with the primary. These two points of the orbit are the two extremities of the major axis, or the points at which a planet is at its greatest and least distance from the sun. The point at the greatest distance is called the higher apsis; that at the least is called the lower apsis; consequently, the higher apsis corresponds with the aphelion, and the lower apsis with the perihelion. The line joining these two points, which is the transverse axis of the orbit, is called the line of the apsides. It has a slow angular motion in the plane of the planet's orbit; and the time which the planet employs in completing a revolution with regard to its apsides is called the anomalistic period. (*See* Aphelion. Anomaly.)

APTENODY'TES. (Gr. ἀ, priv., πτηνος, *that can fly.*) A genus of diving web-footed birds, peculiar to the antarctic shores, having wings too short for flight, covered with short stiff feathers, resembling scales, and used as fins or paddles for swimming under water. The legs are short, thick, set far back, with four toes, all turned forwards, three of them long and webbed, the fourth very short. The bill is longer than the head, straight, and slightly curved at the tip: nostrils in the upper part of the bill, concealed in front by feathers. The Patagonian penguin is the representative of the genus.

A'PTERANS. APTERA. (Gr. ἀ, priv., πτερον, *a wing; wingless.*) A term including a proportion of the class of insects, the value of which varies in different systems of Entomology. In the Linnæan system it is the seventh order of insects, distinguished by their having no wings. Kirby makes his Aptera the twelfth order of the class of insects, but acknowledges that it is not a natural one, and limits the definition of it to those insects which are apterous, or never acquire organs of flight. In Latreille's last system, aptera is no longer applied to designate an order of insects.

A'PTEROUS. In Botany, denotes any part of a plant which is destitute of membranous expansions. The term is usually employed in distinction to alate, or winged.

A'PTERYX. (Gr. ἀ, priv., πτερυξ, *a wing.*) A genus of birds represented by an extremely rare species, a native of New Zealand, in which the wings are reduced to a single defensive spur.

A'PTHOUS. (Gr. ἅπτειν, *to inflame.*) Resembling Aphtha or Aptha, the disease called the *thrush*.

A'PUS. A name applied by Scopolo to a curious genus of Entomostracans; characterised by a flattened, semitransparent, membranous envelope, which protects the body like a shell, having a deep cleft posteriorly; and bearing in front two large eyes, placed close together, with a third smaller one behind. The first pair of legs are long, filamentary, and branched, representing antennæ; the remaining sixty pairs are short, compressed, and modified so as to form a respiratory organ; according to the structure which characterises the Branchiopodous, or gill-footed order, to which the Apus belongs. The species of Apus appear in immense numbers in our freshwater pools; they prey chiefly on tadpoles; and some attain the length of an inch and a half.

APYRE'XIA. (Gr. ἀ, priv., and πυρετος, *fever.*) The intermission of feverish disorders.

A'PYROUS. (Gr. ἀ, priv., and πυρ, *fire.*) A term formerly applied to substances which resisted a strong heat without change.

A'QUA. (A Latin word of uncertain derivation, but probably from æqua, *smooth*, or *level.*) Water. It is often almost Anglicised, as in the words aquavitæ, aquafortis, aquamarine.

AQUA FORTIS. Nitric acid.

A'QUAMARI'NE. See Beryl.

AQUA REGIA. A mixture of nitric and muriatic acids, so called from its power of dissolving gold, the king of the metals.

AQUA TOFFANA. See Aquetta.

AQUA'RIUM. (Lat. aqua, *water.*) In Horticulture. A place in gardens, in which only aquatic plants are grown. It is generally a small pond or cistern, containing shelves or benches at different depths from the surface, in which pots are placed containing the plants.

AQUA'RIUS. *The Waterbearer.* The eleventh sign of the zodiac, through which the sun moves in part of the months of January and February. Also, one of the twelve zodiacal constellations.

AQUA'TICS. AQUATILIA. (Lat. aquaticus.) A name applied by Nitzch to an order of birds; by Cuvier, to a family of Mollusks; by Latreille, to a division of Crustacea: by Lamarck to a family of bugs (*Cimicidæ*); each of which groups includes animals which live in, swim on, or frequent the margins of waters.

AQUA'TIC PLANTS. Plants which grow in water, which may be either running or stagnate. In the former case they are called river plants; in the latter, pond plants. Such as grow in the sea are called marine plants.

A'QUATINT. (Lat. aqua, *water*, tinta, *dyed.*) In Engraving, a species of execution resembling an Indian ink drawing in effect. (*See* Engraving.)

A'QUEDUCT. (Lat. aqua, *water*, and ductus, a *conduit.*) A conduit or channel for conveying water from one place to another; more particularly applied to structures erected for the purpose of conveying the water of distant springs across valleys, for the supply of large cities.

The largest and most magnificent aqueducts, with the existence of which we are acquainted, were the work of the Romans; and the ruins of several of them, both in Italy and other countries of Europe, remain to the present time monuments of the power and industry of that enterprising people. The aqueduct of Appius Claudius was the most ancient, and constructed in the 442d year of Rome. It conveyed the Aqua Appia to the city, from a distance of between 7 and 8 miles, by a deep subterranean channel of more than 11 miles in length. The aqueduct of Quintus Martius was a more extraordinary structure. It commenced at a spring 33 miles distant from Rome, made a circuit of three miles, and afterwards, forming a vault of 16 feet diameter, it ran 38 miles, along a series of arcades at an elevation of 70 English feet. It was formed of three distinct channels, placed one above the other, conveying water from three different sources. In the uppermost flowed the Aqua Julia; in the second, the Aqua Tepula; and in the undermost, the Aqua Martia. The Aqua Virginia, constructed by Agrippa, passed through a tunnel of 800 paces in length. The Aqua Claudia, begun by Nero and finished by Claudius, conveyed the water from a distance of 38 miles. This aqueduct formed a subterraneous stream of 30 miles in length, and was supported on arcades through the extent of 7 miles; and such was the solidity of its construction that it continues to supply the modern city with water to the present day. The waters of the river Anio were also conducted to Rome by two different channels; the first was carried through an extent of 43 miles, and the latter through upwards of 63 miles, of which $6\frac{1}{2}$ miles formed one continued series of arches, many of them upwards of 100 feet in height. Nine great aqueducts existed at Rome at the commencement of the reign of Nerva. Five others were constructed by that emperor, under the superintendence of Julius Frontinus; and it appears that at a later period the number amounted to twenty. The supply of water furnished by these different works was enormous. "According to the enumeration of Frontinus, the nine earlier aqueducts delivered every day 14,018 quinaria. This corresponds to 27,743,100 cubic feet. We may therefore extend the supply, when all the aqueducts were in action, to the enormous quantity of 50,000,000 cubic feet of water. Reckoning the po-

pulation of ancient Rome at a million, which it probably never exceeded, this would furnish no less than 50 cubic feet for the daily consumption of each inhabitant."—(*Leslie's Elements of Natural Philosophy.*)

The remains of some Roman aqueducts in other parts of Europe give evidence of the existence of works on a still more magnificent scale than those of Rome. Of these the aqueduct of Metz was one of the most remarkable. A number of its arcades still remain. It extended across the Moselle, a river of very considerable breadth at this place, and conveyed the water of the Gorse to the city of Metz. The water was received in a reservoir, whence it was conducted by subterraneous canals, formed of hewn stone, and so spacious that a man might walk in them upright. The arches appear to have been 50 in number, and 50 feet high at the deepest part. Some of the middle ones have been swept away by the descent of ice down the river; those at the extremities still remain entire.

The aqueduct of Segovia, in Spain, is in a still more perfect state than that of Metz. About 150 of its arcades remain, all formed of large stones without cement. There are two rows of arcades, the one above the other, and the height of the edifice is about 100 feet, passing over the greater part of the houses of the city.

Aqueducts have been constructed in modern times, particularly in France, which rival those of the ancient Romans. One of the most remarkable was constructed by Louis XIV., for conveying the waters of the river Eura to Versailles. It extends about 4400 feet in length, or nearly seven eighths of a mile, and is upwards of 200 feet in height. It contains 242 arcades, each divided into three rows, forming in all 726 arches of 50 feet span. The introduction of cast-iron pipes, which has only taken place within the last century, has superseded the use of such expensive structures.

A'QUEOUS SOIL. Agr. and Hort. Soil naturally abounding in water, the fluid being supplied by springs in the subsoil.

AQUE'TTA. (Ital. *little water.*) A celebrated poison used by the Romans under the pontificate of Alexander VII. It was probably a preparation of arsenic, and was also known under the name of *aqua Toffana*, from a woman of the name of Toffana, who prepared it at Naples.

AQUIFOLI'ACEÆ. (Lat. Aquifolium, *the holly.*) A natural order of Exogens, connecting the monopetalous with the polypetalous subclasses. The whole of the species are either shrubs or trees, and scattered over most parts of the world. Ilex, Prinos, and Cassia are the commonest genera.

A'QUILA. (Lat. aquila, *an eagle.*) The genus of Accipitrine or Raptorial birds, including the eagles proper, or those species of the Linnæan *Falco*, which have no trenchant tooth and corresponding notch in the beak.

A'QUILA ALBA. (Lat. *the white eagle.*) An alchemical name of *calomel*. The old chemists designated sal ammoniac and other sublimates by the term aquila.

AQUILARIA'CEÆ. (Aquilaria, *eagle wood, one of the genera.*) A very small order of Indian plants, secreting a fragrant resin, and nearly allied to Thymelaceæ. The species are but little known. The Aquillaria agallochum is the tree that produces the eagle or aggul wood, and which, in all probability, was the aloes wood of Scripture.

ARABE'SQUE. (French.) Painting and Sculpture, after the Arabian taste. This is a term applied to a species of ornament, capricious, fantastic, and imaginary, consisting of fruits, flowers, and other objects, to the exclusion, in pure Arabesques, of the figures of animals, which religion forbade. That the Arabians originated this sort of ornament is not the fact; it was known to and practised by the ancients at a very early period. Foliage and griffins, with ornaments not very dissimilar to those of the Arabians, were by no means unfrequent in the friezes of temples; and on many of the ancient Greek vases at Herculaneum, on the walls at the baths of Titus, at Pompeii, and many other places, elegant examples of this species of decoration are to be found. It is, however, to Raphael that we owe the most splendid specimens of the style, which he dignified, and left in it nothing to be desired. Since his time it has been practised with varying and inferior degrees of merit, especially by the French in the time of Louis XIV. Arabesques lose their character when applied to large objects, neither are they appropriate where gravity of style is required.

A'RABLE. (Lat. arare, *to plough.*) Land fit to be brought into a state of tillage, or of aration.

A'RABO-TEDE'SCO. (Ital. arabo, and tedescho, German.) In Painting and Sculpture, a style of art composed of Moorish, Roman, and German-Gothic.

ARA'CEÆ, or AROIDEÆ. (*Arum, one of the genera.*) Acrid Endogens, with the flowers arranged upon a spadix, inclosed within a spathe. In hot countries they sometimes become arborescent; in many cold countries they are unknown. Most commonly they arise from a fleshy underground tuber, from which an eatable fæcula is procured by washing away the acrid matter. Their flowers are almost destitute of floral envelopes; the sexes are mostly placed in different flowers, and their embryo has a slit on one side. *Caladium seguinum*, the dumb cane of the West Indies, derives its name from its juice paralysing the muscles of the mouth, if chewed; nevertheless, the leaves of certain caladiums are eaten by the negroes like spinach, but they are too acrid for an European palate.

ARA'CHNOID. (Gr. ἀραχνη, *a spider*, and ειδος, *form.*) Cobweb-like. It is an Anatomical term, applied to the tunic of the vitreous humour of the eye, and to the thin membrane placed between the dura and pia mater of the brain.

ARACHNI'DANS. ARACHNIDA. (Gr. ἀραχνη, *a spider.*) A class of Apterous, spider-like Condylopes, having the head confluent with the chest, and, the body, consequently, consisting of but two segments, with eight legs, smooth eyes, and the sexual orifices situated on the thorax, or anterior part of the abdomen.

ARÆO'STYLOS. (Gr. ἀραιος, *wide*, and στυλος, *a column.*) In Architecture, that style of building in which the distance between the columns used is four and sometimes five diameters; the former, however, is the distance to which the term is strictly applied. It is only suited to the Tuscan order.

AR'ÆOSY'STYLOS. (Gr. ἀραιος, *wide*, συν, *with*, and στυλος, *a column.*) In Architecture, that style of building in which four columns are placed in a space equal to eight diameters and a half. In this arrangement the central intercolumniation is equal to three diameters and a half, and the others on each side only half a diameter, by which coupled columns are introduced.

ARALIA'CEÆ. (Aralia, *one of the genera.*) An order of Exogens, differing in little from the Apiaceous or umbelliferous plants, except in having more than two parts in their fruit. They are commoner in hot than in cold latitudes, and form an unexpected transition from Apiaceæ to Vitaceæ. The only state of them in Europe is the diminutive Adoxa moschatellina.

ARANEI'DANS. ARANE'IDÆ. (Lat. aranea, *a spider.*) A tribe of the Pulmonary order of Arachnidans, with a coriaceous integument; modified antennæ, or chelicers, consisting of a single joint armed with a claw, perforated near the apex for the transmission of venom; breathing by pulmonary ones, which are either two or four in number, with the abdomen pedicellate, and the arms provided with four or six spinnarets.

ARANEO'SUS. (Lat. aranea, *a spider.*) Covered with hairs crossing each other like the rays in a spider's web.

A'RAR. The Barbary name of *Thuja articulata*, the tree whose wood is chiefly used by the Mahometans of Africa for the construction of their mosques, and whose resin is the sandarach of commerce.

ARA'TION. Agr. Lands are said to be in a state of aration, when they are under tillage.

ARA'TOR. Agr. Literally a ploughman, but commonly applied to an arable farmer.

ARAUCA'RIA. (Araucanos, *a tribe of Indians in the southern parts of Chili.*) Fir trees with very rigid branches, having leaves like scales, either small and sharp pointed, or stiff, spreading, and lanceolate. The cones consist of leaves something like those of the stem, only longer, and containing large seeds. Two species occur in South America, and two in New Holland.

A'RBALEST. (Lat. arcubalista, *a cross-bow.*) This weapon is supposed to have been introduced into European armies by the crusaders, although used long before in the chase (in England as early as the reign of William the Conqueror). The arrows used with the cross-bow were short and thick (quarrels, bolts). The weapon was used in the English armies after the reign of Richard I.; but the Italians, and especially the Genoese, were most expert in the use of it at one time. A large force of Genoese cross-bow men served in the French army at Cressy, where their weapon was found very inadequate to match the English long-bow. Yet so deadly a weapon was it at one time considered, that papal bulls were issued in the twelfth century, condemning and forbidding its use in combats between Christians. It was disused in England, as a weapon of war, in the reign of Henry VIII. Cross-bows were of several sizes: the large or stirrup cross-bow was bent by the foot.

A'RBITRARY. (Lat. arbitro, *I judge.*) In a general sense, means that which is not defined by any rule or law, but is left to the sole judgment and discretion of some one individual or body of individuals. It is commonly used in political discussions to designate despotical or irresponsible power. (*See* DESPOTISM.)

ARBITRA'TION. In Law, the investigation before an unofficial person of the matters in difference between contending parties. His judgment is called an award. The reference to him may be made, whether legal proceedings concerning the question referred have been instituted or not. The reference is made by writing under seal or otherwise, and even by parole agreements but in this latter case the submission cannot, as in the others be made a rule of court. (*See* AWARD.)

A'RBOR. The principal spindle or axis which communicates motion to the other parts of a machine.

ARBOR DIANÆ. *The tree of silver*, that metal having been called Diana by old chemists; it is made by putting quicksilver into a solution of nitrate of silver, which causes the separation of the silver in a beautiful arborescent and crystalline form.

ARBO'REOUS. Woody, or growing on wood. Herbaceous plants, the stems of which take a ligneous character, are called suffrutescent, or arboreous, according to the degree of woodiness which they exhibit. Plants which grow on trees are also called arboreous, such as the arboreous lichens, arboreous mosses, arboreous fungi, &c.

ARBORE'SCENT. Stems of plants which are at first herbaceous, and afterwards become somewhat woody and tree-like.

ARBORE'TUM. In Gardening, a place in a park or pleasure ground, or in a large garden or nursery, in which a collection of trees and shrubs, one of each kind, is cultivated. In such a scene there ought to be sufficient room for each species and variety to attain something like its natural size and shape; though, from the limited space generally allowed to collections of trees and shrubs in garden scenery, this is very seldom the case. The most complete arboretums in Europe, so far as respects the number of species collected together, are those of Messrs. Loddiges, at Hackney; and of the London Horticultural Society, at Chiswick.

ARBORICU'LTURE. (Lat. arbor, *a tree*, and colere, *to cultivate*.) The art of cultivating trees and shrubs, which are chiefly grown for timber or ornamental purposes. The culture of trees and shrubs grown for their fruits as food, is included under horticulture, and is sometimes called Pomology. The origin of arboriculture may be traced to the progress of agriculture; because, as population increased in any given country, it would become necessary to clear away the natural woods in order to grow corn, and other products of the field and garden. After this was done to a certain extent, a scarcity of wood, both for fuel and building purposes, would be found, and then recourse would be had to artificial plantations, or arboriculture. This art may be considered almost exclusively as one of modern times; because, though the Greeks and Romans planted both timber and ornamental trees, yet they did so only on a very limited scale, and near their houses, for the purposes of shade or ornament. They also planted the elm and the poplar, for supports to their vines; and they cultivated osier beds for the purposes of basket-making; but there is no instance on record of their having planted trees with a view of cutting them down either for timber or fuel. Wood for these purposes they procured from the native forests, to the management of which they paid particular attention. In Britain, the first plantations of barren timber on a large scale, with a view to profit, were made during the reign of Henry VIII.; and the kind of tree planted was chiefly the oak, which was raised from the acorn where it was finally to remain. Since that period, the formation of artificial plantations has been on the increase, more especially during the latter end of the last and the beginning of the present century, when the foreign supply of timber was comparatively limited by the war, and when there was a great demand for timber for ship-building. The discovery of coal mines, and more especially the increased facility of working them after the invention of the steam-engine, by providing fuel exclusively of wood, has rendered the necessity of preserving natural woods, and of forming artificial plantations, less in Britain than in any other country in the world. In consequence of this, there is no other country in which so small a portion of its surface is covered with forests; the woods being almost every where planted and maintained for ornamental purposes. On the continent of Europe, the practice of sowing or planting barren timber was little known before the time of Louis XIV., though the natural woods both of France and Germany were appropriated, and carefully preserved, for many generations before. At the present time, in consequence of the continental nations depending almost entirely on wood for their fuel, the care of the natural forests, and the formation of artificial plantations, form an important part of the duties of government. In North America, in the oldest cultivated parts of the country the formation of artificial plantations is barely commencing, while in the back settlements, or newest parts, the felling and clearing of timber is only now taking place.

The science of Arboriculture depends on a knowledge of the nature of trees, of the different agents in cultivation, and of the purposes to which trees are applied in the arts. The practice includes nursery culture: viz. propagation by seeds, by cuttings, layers, grafting, &c., and raising in beds and rows; transplanting, pruning, thinning, and, finally, felling, and the succession of kinds. The nursery culture is carried on in limited spots, called nursery grounds, or nursery gardens, by gardeners or nurserymen; and the other operations in woods, groves, rows, hedgerows, hedges, copses, osier holts, &c., by foresters, woodmen, or hedgers.

ARBU'STUM. The classical name for an orchard, hopyard, or vineyard.

A'RBUTUS. (Arbutus, Lat.; ar, *rough*, and boise, *bush*, in Celtic, according to Dr. Théis.) A genus of evergreen trees, with conical pallid flowers and a bullet-like succulent austere fruit, rough externally, and containing numerous minute seeds. Several species, all hardy, are known in gardens; the most common of which is Arbutus unedo, the most beautiful A. andrachne.

ARC. In Geometry, a portion of a circle or other curve line. The arc of a circle is the measure of the angle formed by two straight lines drawn from its extremities to the centre of the circle.

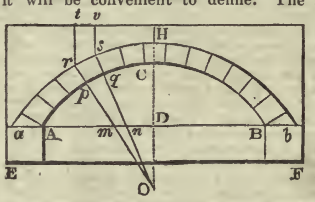
A'RCA. The name of a Linnæan genus of the Vermes Testacea, characterised by a bivalve and equivalve shell, having numerous sharp alternate teeth at the hinge. In modern systems the genus is placed among the Acephalous Lamellibranchiate mollusca, and is raised to the rank of a family (*Arcadæ*), subdivided into the subgenera Arca, Cucullæa, Pectunculus, and Nucula.

ARCA'DE. (Fr.) In Architecture, a series of arches crowned with a roof or ceiling, with a walk or passage thereunder. The piers of arcades may be decorated with columns, pilasters, niches, and apertures of different forms. The arches themselves are turned sometimes with rock-worked and sometimes with plain rustic arch-stones or voussoirs, or with a moulded archivolt, springing from an impost or platband, and sometimes,—though that is not to be recommended,—from columns. The key-stones are generally carved in the form of a console, or sculptured with some device. Scamozzi made the size of his piers less, and varied his imposts and archivolts in proportion to the delicacy of the orders he employed, but Vignola made his piers always of the same proportion.

ARCA'NUM. (Lat. *a secret*.) A term often applied to Chemical and Medical preparations by the old philosophers. Thus they called red oxide of mercury, obtained by the action of nitric acid, Arcanum corallanum; sulphate of potash, Arcanum duplicatum, &c.

ARCE'STHIDA. (Gr. ἄρκευθος, *a juniper berry*.) A small cone whose scales become succulent, and grow together into a fleshy ball.

ARCH. (Lat. arcus, *a bow*.) In Building, a structure of stones or bricks, or distinct blocks of any hard material, disposed in a bow-like form, and supporting one another by their mutual pressure. In describing arches some technical terms are made use of, which it will be convenient to define. The arch itself is formed by the voussoirs, or stones cut into the shape of a truncated wedge, the uppermost of which at C is called the keystone. The seams or planes in which two adjacent voussoirs are united, are called the joints; the solid masonry, A E and B F, against which the extremities of the arch abut or rest, are called the abutments; and the line from which the arch springs at A *a* B *b*, the impost. The lower line of the arch stones, A C B, is the intrados or soffit; the upper line, the extrados or back. The beginning of the arch is called the spring of the arch; the middle, the crown; the parts between the spring and the crown, the haunches. The distance A B between the upper extremities of the piers, or the springing lines, is called the span, and C D is the height of the arch.



There is considerable difficulty in determining the form which an arch ought to have, in order that its strength may be the greatest possible, when it sustains a load in addition to its own weight; in fact, the determination cannot be accurately made, unless we know not only the weight of the materials the arch has to support, but also the manner in which the pressure is connected; that is to say, unless we know the amount and direction of the pressure on every point of the arch. Supposing, however, that the arch has to sustain only its own weight, and supposing, further, that the friction of the arch-stones is reduced to nothing, a relation between the curve and the weight of the voussoirs may be found by comparing the pressures which are exerted on the different joints. Thus the pressure on any joint, *s q* for example, arises from the weight of that portion of the arch which is between *s q* and the summit C H. Now, the portion of the arch C *q s* H is sustained by three forces: the pressure on the joint *s q*, the pressure on C H, and its own weight. Let *s q* be prolonged till it meets C D in O, and let *n* be its intersection with A B. It is

a theorem in statics, that when a body is held in equilibrium by three forces balancing each other, these forces are proportional to the three sides of a triangle formed by lines respectively perpendicular to the directions of the forces. The three forces sustaining CqsH are, therefore, proportional to the sides of the triangle ODn; for the pressure on sq acts in the direction perpendicular to sq or On; the pressure on CH is perpendicular to DO, and nD is perpendicular to the direction of gravity. The pressure on sq is, therefore, to the pressure on CH as nD to DO. In like manner, the voussoir $prqs$ being so shaped, that rp, when produced, meets OH in the point O; the pressure on the joint rp is to that on CH, as mD to DO. Hence, the pressure on sq is to the pressure on rp as Dn to Dm. We are thus led to infer that the voussoirs ought to increase in length, from the key-stone to the piers, proportionally to the lines Dn, Dm, &c.; for in this case, the surfaces of the joints being increased in proportion to the pressure they sustain, the pressure on every point of the arch will be equal. It will also be observed that the angle nOD is equal to the angle made by a tangent to the curve at q, and the horizontal line parallel to AB; the angle mOD equal to that made by the tangent at p and the horizontal line; and the radius DO remaining constant, Dn is the tangent of the point of these angles, and Dm of the second; hence the pressures on the successive joints are proportional to the differences of the tangents of the arches reckoned from the crown. From this property, when the intrados is a circle given in position, and the depth of the key stone is given, the curve of the extrados may be found. When the weights of the voussoirs are all equal, the arch of equilibration is a catenarian curve, or a curve having the form which a flexible chain of uniform thickness would assume if hanging freely, the extremities being suspended from fixed points.

Such is the form which theory shows to be the best adapted to give strength to an arch, on the supposition that there is no superincumbent pressure. But it seldom if ever happens that this is the case, and therefore it is entirely unnecessary, in the actual construction of an arch, to adhere closely to the form determined on the above supposition. Indeed, on account of the friction of the materials and the adhesion of the cement, the form of the arch, within certain limits, is quite immaterial, for the deviation from the form of equilibration must be very considerable before any danger can arise from the slipping of the arch-stones. The Roman arches, which have resisted the attacks of time for so many centuries, are generally in the form of a semicircle. For bridges, it is better to employ a smaller segment of a circle; frequently the elliptic arch is preferred, on account of the beauty of its form.

It has not been satisfactorily ascertained in what country arches were first erected. They do not occur in any of the buildings of the Egyptians that can unquestionably be referred to an ancient date; and if they were not altogether unknown to the Greeks before the period of the Roman conquest, their principal uses appear to have been very little understood. They do not appear ever to have been employed in roofing the temples, or to have formed a part of ornamental architecture. By the Romans, however, the advantages of the arch were well understood at a very remote period. The Cloaca Maxima, which is an arched structure, is referred, with the greatest probability, to the age of the Tarquins; the arched dome is supposed to have originated with the Etruscans, and to have been employed for the convenience of the augurs, affording them a shelter from the weather, and permitting them at the same time to have a view of the whole range of the horizon. In the magnificent buildings erected under the empire the arch is of frequent occurrence; and it was by the Romans that it was first applied to its most useful purposes, namely, the construction of bridges and aqueducts. The Romans, however, appear to have given little attention to the graces of form in the erection of their arches, for they seldom deviated from the semicircle. It was in the middle ages that the pointed or Gothic arch was introduced, when Christians and Saracens vied with each other in giving beauty to their public buildings, by multiplying and combining arches in all possible manners. The associated architects of those ages, says Dr. Robison (*Ency. Brit.* art. *Arch*), having studied this branch of the art of building with so much attention, were able to erect the most magnificent buildings with materials which a Greek or Roman architect could have made little or no use of. There is infinitely more scientific skill displayed in a Gothic cathedral than in all the buildings of Greece and Rome; indeed, these last exhibit very little knowledge of the mutual balance of arches, and are full of gross blunders in this respect; nor could they have resisted the shock of time so long, had they not been almost solid masses of stone, with no more cavity than was indispensably necessary. It is somewhat remarkable that those architects do not appear ever to have studied or paid any regard to the theory of equilibrated arches. The form which they adopted was strong, and capable of resisting considerable inequalities of pressure, and hence the durability of their constructions. For further particulars on this subject, *see* Bridge. Dome.

ARCHÆO'LOGY. (Gr. ἀρχαιος, *ancient*, and λογος, *a description*.) The science or study of Antiquities, and chiefly, in ordinary language, of those minor branches of antiquities which are discarded from the contents of general history; as genealogies, national architecture, manners, customs, heraldic and similar subjects.

ARCHÆ'US. (Gr. ἀρχη, *principle*.) A term used by the old chemists and physicians to imply the occult cause of certain phenomena. Van Helmont and Stahl ascribe certain vital functions to the influence and superintendence of a spiritus archæus.

A'RCHAISM. (Gr. ἀρχαιος, *ancient*.) In Rhetoric and Literature, the use of an obsolete expression or phrase, giving an air of antiquity to the passage in which it occurs.

ARCHA'NGELS. A superior order of angels. The term occurs once in Scripture, being applied by St. Jude to Michael.

ARCHBI'SHOP, or METROPOLITAN. The primate of a province containing several dioceses. The term first came into use in the fourth century, and was then considered superior to that of metropolitan, and equivalent to patriarch, or bishop of an imperial diocese, such as Rome, Constantinople, Antioch, Alexandria, and Carthage.

ARCHDE'ACON. An Ecclesiastical officer, ranking next to the bishop. As deacons were originally attendants upon the bishop, so the archdeacon was one selected from among the deacons of several dioceses. His functions were confined to attending upon and assisting the bishop in the discharge of his spiritual duties and the management of his diocese, and had at first no jurisdiction. There are now more archdeacons than one in each diocese, the whole number in England being sixty; and they are employed by their bishops in visiting the clergy of the diocese, and in the dispatch of other matters relating to the episcopal superintendence.

ARCH-DUKE. A title originally assumed by various dukes, but in the sequel appropriated to those of the house of Austria by the Emperor Frederic III. in 1453. It is now strictly confined to the younger sons of an Emperor of Austria,

A'RCHER. (From the Latin arcus, *a bow*.) A bowman; one who uses a bow. The use of the bow in war may be traced to the earliest antiquity, and to the history of almost every people. The exact time when the English long-bow began to be used in war is not exactly ascertained: the Normans brought with them the arbalest or cross-bow; but from the reign of Edward II. the long-bow, the favourite national weapon, seems to have been fully established. When fire-arms began to come into use, various attempts were unsuccessfully made, by statute and proclamation, to prevent this ancient weapon becoming obsolete. In France the officers who attended the lieutenant of police were, before the Revolution, always called archers, although provided with carbines. Artillery is a French term, originally signifying archery, and the London artillery company were a fraternity of bowmen.

A'RCHETYPE. (Gr. ἀρχετυπος, from ἀρχη, *origin*, and τυπος, *type*.) The original of that which is represented in a picture or statue; and, figuratively, the reality which is shadowed out in prophecies or mysteries. Thus, in Theology, the death of our Saviour is said to be the archetype of the Jewish sacrifices, which were instituted as types of that event. (*See* Type.)

A'RCHIL. (A corruption of orseille, French.) A kind of purple dye obtained from the lichens, called *Rocella tinctoria* and *fuciformis*. It is chiefly procured in the Canaries.

ARCHIMA'NDRITE. A title of the Greek Church, equivalent to abbot; the word mandia signifying a *monastery* in the language of the Lower Empire.

A'RCHITECTURE. (Gr. ἀρχη, *beginning*, τεκτων, *artificer*.) The art of Building, according to certain proportions and rules determined and regulated by nature and taste. Architecture becomes an art at that period only in the history of nations when they have reached a certain degree of civilisation, of opulence, and of luxury. In an earlier state, it can only be reckoned among the trades or occupations necessary to the wants of mankind; its application is then very limited, its use little more than furnishing man with shelter from the waters of the heavens, and protection from the inclement vicissitudes of the seasons. At its birth, however, it assumes a character in all countries which in the sequel stamps it with such remarkable and distinguishing features, that in the summit of its grandeur the traces of its early origin are still discernible. Notwithstanding the interval of so many ages from its origin, we may even trace the general form of architecture to three distinct states of the human race, which necessarily influenced the nature of the

habitations suitable to each, and which ultimately became standard models of the art.

People whose dependence for their sustenance was on hunting the beasts of the field, as well as those who lived on the produce of the waters, from the natural indolence induced by those occupations and the little industry called for in such courses of life, would not be at an early period led to the construction of dwellings. They availed themselves of the natural caverns of the rock, or at most hollowed them out, for shelter and protection.

Nations occupied in a pastoral life, through a large portion of the year, obliged, for the sake of fresh pasturage, frequently to change their abode, and thus lead a wandering life, would find the most suitable dwelling one which they could remove with themselves; hence the use of tents.

Agriculture, which requires continued and active industry on the same spot, doubtless induced man to exert his energies in the erection of solid and durable dwellings. For his produce no less than for himself were they necessary, and the wooden hut with its sloping roof was the offspring of his wants.

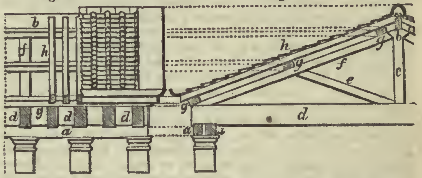
It is not, however, to be understood that in every country the art can be traced to a single principle, since among some nations, as will hereafter be seen in relation to Egyptian architecture, more than one will be found to enter into the combination. Causes, independent of the habits of the people, may have had their influence on the formation and taste of different species of architecture; yet will these in their turn be found dependent on the first named. In short, it is to the three states of mankind that we must refer to account for those striking peculiarities which prevent us from confounding the art of one people with that of another. In some of its details caprice may have had a share; but in every country the great leading forms spring from principles dependent on the different states of life we have just enumerated.

Those who have sought for the original types of this art in subterraneous temples and excavations exclusively, have fallen into error. These are found in almost every country. Many of them, such as the famous ear of Dionysius, and the quarries of Syracuse, had been the quarries that furnished stone for their neighbourhoods. By the help of history, and an acquaintance with the habits of the nation, by a knowledge of its origin and earliest mode of life, only, are we able to form a just opinion on its architecture. By the aid of these we recognise the origin of Egyptian architecture. A taste for subterraneous dwellings has existed among the Egyptians from the remotest period even to the present hour. The massive and colossal character of their edifices seems to bear a strong relation to hollow caves of rocks; and though the Egyptians grafted on this at a later period forms and details, whose types may be traced to carpentry, yet it is quite clear that the types of the masses must be found in a far different origin. The same passion for subterranean works appears in parts of Asia. The climate, and similar physical causes, would seem to have led to it. At Elephanta none of the parts appear to have been derived from imitation of any system of carpentry; the columns cut out of the rock, the short and massive proportions, the shape of the capitals, and their details throughout, point to an entirely different type for their invention.

In the architecture of China we have remarkable indications of timber construction. M. de Pauw justly observes, it is impossible to mistake the objects which served as models for the earliest Chinese buildings. In them the tent is the object of imitation, and this is quite in character with the primitive habits of the Chinese, who, like all the Tartars, were Nomades or Scenitæ, encamping with their flocks ages before they gathered into cities. Their cities of the present day exhibit the appearance of a vast encampment, and the great extent of them seems to indicate an insolidity of construction that will not allow of a number of stories above each other.

The wooden hut, then, which has been universally assumed as the model or type of all styles of architecture, and among all people, could not have been that of Chinese or Egyptian, though it unquestionably was that of Grecian architecture. The Greeks, working upon this, transferred to stone the forms of an assemblage of carpentry, a construction which gave birth to the members of the orders of architecture which are to this day the ornaments of our buildings. This style, be it remembered, belongs to a nation whose chief occupation is agriculture. In pursuing this theory, a few observations only will be needed. The first trees driven into the earth for the purpose of bearing a covering for shelter, were the origin of the insulated columns of the portico of a temple, and became one of the most splendid features of the art. As the trees were wider in diameter at the bottom than the top, so were the columns diminished in thickness as they rose. Scamozzi imagines that the mouldings at the bases and capitals of columns had their origin in cinctures of iron, to prevent the splitting of the timber; others, however, think that the use of the former was to elevate the shafts from the dampness of the earth, and thereby prevent rot. The architrave or chief beam speaks its origin. It was the great beam placed horizontally on the tops of the columns, and destined to receive the covering of the entire building. The joists of the ceiling lay upon the architrave, the space in height which they occupy being called the frieze, the ends of the joists in the Doric order bearing the name of triglyphs, from their being sculptured with two whole and two half glyphs or channels. Sometimes the ends of them are sculptured into consoles, as in the composite order of the Coliseum at Rome. The space between the triglyphs was for a long period left open, as we find from a passage in the Iphigenia of Euripides, where Pylades advises Orestes to slip through the metopes in order to get into the temple. These intervals were afterwards filled up solid; and in the other orders, the whole length of the frieze becomes one plain surface. The inclined rafters of the roof formed a projecture beyond the face of the building, which delivered the rain free of the walls. The ends of these rafters are the origin of mutules and modillions, the former whereof appeared in the cornice with their undersides inclined, as in the Parthenon at Athens. The form of the pediment followed from the inclined sides of the roof, which were regulated in respect of their inclination by the nature of the climate. (*See* art. ROOF.) Here, then, in the skeleton of the hut, may be traced the origin of the different members of architecture, which will be better understood by reference to the subjoined diagram. Figs. 1 and 2 exhibit the parts of

Fig. 2. Fig. 1.



a roof in section and elevation: *a a* are the architraves, or trabes; *b b* the ridge piece, or columen; *c* the king post, or columna of a roof; *d d* the tiebeam, or transtrum; *e* the strut, or capreolus; *f f* the rafters, or cantherii; *g g g g* the purlines, or templa; *h h* the common rafters, or asseres.

It has been suggested, but with less probability, that the main supports being by degrees placed at greater distances from each other than the strength of the architrave would safely admit, inclined struts were placed from the sides of the columns or supports to the underside of the architrave, to lessen its bearing, and that these gave the first notion of the use of arches in architecture. The subject has been pursued into many more details, on which our limits do not permit us to enter.

It is difficult, perhaps now impossible, to fix the exact period of the invention of architecture in Greece. Every art is perfected by slow degrees, and is the result of the labours of many. In the time of Homer, architecture does not seem to have been in so forward a state as to have been reduced to principles and proportions of a fixed nature. No mention is made by the poet of the use of the orders of architecture. The material seems with him of more importance than the form; and well selected and polished stones, more than fine proportions, are enumerated as the principal merit of the palace of Alcinous.

The Doric order, doubtless the earliest of the orders, remains without testimony which can satisfactorily assure us of the period of its invention. Its name is not alone sufficient proof that it was invented by Dorus, the son of Helen, and king of Achaia and Peloponnesus. It is possible it might have acquired its name from having been used at the celebrated temple which that prince built at Argos in honour of the goddess Juno; or it might have been, that, from the use of it by the Dorians, it obtained introduction into the other parts of Greece. Certain, however, it is that in the time of Alexander the Great the three original orders of architecture had been brought to perfection. Moral as well as physical causes had contributed to bring the arts to this state. Liberty, love of country, and ambition had made Athens the common centre of science and art. The defeat of the Persians at Marathon, with other victories, had restored peace to the country. In the period preceding the Peloponnesian war, there was a general burst of talent in Greece. In it the chisel of Phidias was employed; philosophy, eloquence, the military art, the arts and sciences, all conspired to give the epoch lustre. It was in this age that the Greeks commenced the rebuilding of the temples and edifices that had been destroyed in the Persian war, buildings whose ruins had been carefully preserved, perhaps, for the express purpose of keeping alive a remem-

brance of the danger that constantly menaced them as a nation. It was not, indeed, until after the flight of the general of Xerxes, and the victory of Themistocles, that a general restoration of their monuments was commenced, and the city of Athens rebuilt; a city whose edifices might be considered, as M. Quatremère de Quincy has well observed, as so many trophies of the victory at Salamis. This was the epoch of a pure and grand style of architecture, and, indeed, of art generally. The sculpture of that period is marked by the same character of purity, sublimity, and grandeur; and the Elgin marbles, fortunately now possessed by this country, exhibit a perfection which has never been approached by modern art, and which we scarcely conceive can be surpassed. It was in this age that the temple of Minerva, known by the name of the Parthenon (because that goddess preserved her virginity pure and inviolate), was erected; a building which displays, perhaps, the finest model of the Doric order.

The Ionic order seems, at this period, to have likewise received the finishing touches of that grace and elegance whereof it was susceptible. This order, passing from Greece to Asia Minor, seems, in that enervating climate, to have acquired elegance and finish at the expense almost of solidity. Whether we are indebted for its invention to the people whose name it bears, is of little importance. Upon the relation of Vitruvius no dependence can be placed. At the period, however, of the erection of the temple of Minerva Polias at Athens, which was about the time we have alluded to, it seems to have been brought to a state of perfection that leaves us nothing to desire. The capitals of this example are splendid specimens of decorated architecture.

By a substitution of acanthus leaves for the olive, laurel, and lotus leaves of the Egyptian capital, Callimachus is said to have invented the Corinthian capital, the feature which distinguishes the Corinthian from the Ionic order. The tale seems an idle one; but though almost threadbare, we cannot omit it, and will give it in the words of the author who has recorded it. "A Corinthian virgin, of marriageable years, fell a victim to a violent disorder. After her interment, her nurse, collecting in a basket those articles to which she had shown a partiality when alive, carried them to her tomb, and placed a tile on the basket, for the longer preservation of its contents. The basket was accidentally placed on the root of an acanthus plant, which, pressed by the weight, shot forth, towards spring, its stems and large foliage, and in the course of its growth reached the angles of the tile, and thus formed volutes at the extremities. Callimachus, who for his great ingenuity and taste was called Catatechnos by the Athenians, happening at this time to pass by the tomb, observed the basket, and the delicacy of the foliage which surrounded it. Pleased with the form and novelty of the combination, he constructed, from the hint thus afforded, columns of this species in the country about Corinth, and arranged its proportions, determining their proper measures by perfect rules."

The annexed diagram gives a representation of the circumstance, as usually found in architectural works: the reader, however is at liberty to make his own representation of it, which will most probably be as near the truth as that here given.

But few ancient examples of the Corinthian order are extant of so early a date as the age of Alexander. Its delicacy and slenderness render it very susceptible of the ravages of time; and it has been suggested, that the value of the material of which the columns and capitals of this order were made, excited the cupidity of the Romans to remove them.

The general opinion runs, that architecture, as well as the other arts, was carried into Etruria by the Pelasgi, at which period Doric was the only order in use in Greece, and was the only one, moreover, as far as can be judged of, adopted by the Pelasgi. But they changed its character, stripping it of triglyphs, and adding to it a base. — The Romans, who borrowed their earliest architecture from the Etruscans, adopted, under the name of Tuscan, this Doric order, thus cheated of its fair proportions, which is in truth but a species of Doric.

Rome appears to have been indebted to the people of Etruria for its earliest work of any note. It has always been supposed, that to an Etruscan architect was confided the construction of the immense sewer which drained the city, and in which might be discerned a presage of its future grandeur. The undecorated and simple art of Etruria suited the roughness and austerity of a warlike and then needy people. The art of architecture was long neglected among them. Their temples and palaces for a long period were protected from the seasons by a covering of nothing more than clay and straw. Marble and slavery entered Rome together, under the reign of Augustus. Effeminacy had been induced by the riches of the known world which centered in the city, whose inhabitants did not apprehend that slavery would follow in the train of the arts which were bound to the triumphal chariot.

Augustus, sensible that the only mode of tranquillising the people, when liberty was no more, would be by introducing the pleasures and luxuries attendant on the arts, exerted himself most zealously for their prosperity: his conduct on this point is sufficiently exemplified in the boast attributed to him, "That he found the city built of brick, and left it constructed with marble." Livy compliments him as the founder or restorer of temples, "Templorum omnium conditorem aut restitutorem." His patronage drew the most skilful Grecian artists to Rome, which now became the capital of the arts, and architecture reached all the perfection it could there attain. It was under Augustus that Vitruvius wrote his work on architecture, the only ancient text-book on the art that has reached us. It has been of late the fashion to decry the utility of this author. Those that have done so know little of the art. Though in matters relating to the history of architecture, our author deals somewhat in fable, the more important parts of his work are invaluable; and if one of the most profound architects that ever existed could dignify Vitruvius with the title of "our great master," it ill becomes the small fry of the present age to carp at him. Under Agrippa, the son-in-law of Augustus, the Pantheon was raised; one of the most magnificent examples of Roman grandeur. Amongst other superb structures he introduced baths, and constructed a considerable number of fountains, temples, &c. Under the successors of Augustus, the public buildings of the nation continued to increase; but the art began to degenerate in the reigns of Tiberius, Caligula, and Claudius. It could not be expected, that it would revive under such a personage as Nero, who deprived the finest statues of their heads to substitute his own portrait on their shoulders. He was, however, a great encourager of buildings on a highly decorated and colossal scale; witness the Domus Aurea, built for him by Severus and Celer, in which, from all accounts, richness and luxury themselves were exhausted. The wisdom and greatness of character of the emperor Trajan were infused into the buildings of his reign. The triumphal arches, but especially his column and forum, incontestably prove the rise of the art under his auspices, at which time his architect, Apollodorus, who raised the column to his memory, was highly patronised. Hadrian and the Antonines were also much devoted to the art, in which the former himself practised. Marcus Aurelius was so attached to the arts, that he became a pupil of Diognetus. Antoninus Pius, at ancient Lanuvium, built a country house, whose ruins at the present day astonish by their extent: as an index to its magnificence, it may be mentioned that a cock for regulating the supply of water, of the weight of forty pounds, and formed of silver, has been extracted from its ruins. The art, however, was then in its decline, and soon after disappeared under his successors. The arch of Septimus Severus is an extraordinary falling off from what it had been; and it is difficult, in such a short period, namely, since the reign of Marcus Aurelius, to conceive how the art of sculpture, more especially, could have become so debased. The details of what is called the goldsmiths' arch indicate the decay of good taste; its profiles are bad, and the ornaments overloaded.

For a short time architecture was prevented from entirely sinking, by the fostering hand of Alexander Severus; but the fall of the western empire completed its ruin: it is, however, from the reign of Gallienus, whose arch proves to what a state it was reduced, that we must reckon the total extinction of the arts. Architecture was indeed most likely to have survived the general wreck, and perhaps was not completely involved in the universal ruin. In an age when no sculptor existed, the baths erected by Diocletian exhibited a grandeur manifest even in their stupendous remains; it seems, however, that a bad taste must have reigned in the design of them, inasmuch as we learn from history, so overloaded with ornament was the edifice, that during the public games a great number of spectators lost their lives by the fall of some of the flowers from the ceilings and entablatures. Diocletian's palace at Spalatro is another proof of the enormous efforts made by that emperor, and of what the art could then do. About the same time, or in the time of Aurelian, were erected the extensive buildings in Cœlosyria, at Balbec, and Palmyra: vicious as they are in taste, one is astonished at the vastness of the plans, the boldness of the undertaking, and the funds lavished on their construction. There is nothing more instructive to a student on the rise, progress, and decline of Roman art, because the eye can almost cover it at one glance, than an examination of a series of Roman coins; and it is recommended, as likely to make an impression on the mind much stronger than the most elaborate treatises on the subject.

Though architecture, from various causes, was des-

tined to survive the other arts, its protracted existence could not extend beyond the period of the removal of the seat of empire to Byzantium. The endeavours of Constantine to erect his city into a metropolis that should rival Rome, which he spoiled of its treasures, were vain; all his efforts to embellish it with the most splendid monuments only proved how ineffectual are the attempts of kings to subject the arts to their power. That which Constantine left behind him in the eternal city and the rest of Italy fell a prey to the unrestrained fury of the Visigoths. The edifices which they afterwards reconstructed were from fragments of those they had destroyed; but their ignorance or forgetfulness of the stations and proportions in which they had originally been used, induced a sad confusion of the different members—entablatures inverted, and other grotesque arrangements, were to be seen in their buildings. The vast number of columns which the ruins supplied was used as piers for arcades, from which originated, beyond doubt, the plan of the Gothic cathedral, after its passage through various modifications. Quatremère de Quincy attributes (Enc. Method.) the use of the arch springing from columns to the ignorance of the builders of the period, who knew not, he assumes, the mode of connecting the different lengths of an architrave; but it seems scarcely probable that they, who so well knew the mode of connecting the voussoirs of an arch, should have been deficient in understanding the principle in question, which is either that of the arch itself or of the simplest joggling. From this period to the restoration of the arts at a late period, all sight of the original types seems to have been lost; and in the end arose a style under the name of Gothic, which will be separately treated of. Here occurs a considerable gap in the history of the art: all is dark on the subject, though the ancient taste does not seem to have passed away altogether. The first glimmer of returning light appears under Justinian, in the church of St. Sophia at Constantinople, in the sixth and seventh centuries. It was the chef-d'œuvre of the lower empire, and perhaps, indeed, the only specimen it has left us. The church of St. Mark at Venice rose in the tenth or eleventh century; it was the work of Greek architects. and is invaluable in tracing the history of architecture: its plan and its beautiful proportions remind the spectator of the magnificence of the ancients. Nearly about the same period other cities of Italy began to exhibit advances in the art. In 1013 the Florentines laid the foundations of the church of S. Miniato; but the most extraordinary monument of the period was the cathedral at Pisa, erected by Buschetto da Dulichio, a Greek architect, in 1016: this building is lined both inside and outside with marble, and the roof is borne on four ranks of columns of the same material. The commerce of the Pisans enabled them to explore the Levant, the islands on the coast of Asia Minor, Egypt, and Africa, for the most costly and precious marbles which were used in the work. Painters and sculptors were brought from Greece to embellish their buildings, and these contributed to introduce a better taste in the arts. Had Buschetto lived to form a school here, there can be little doubt that architecture would have been at once re-established; but such does not appear to have been the case, and the successful cultivation of it was, consequently, deferred for a time. The falling tower, as it is usually called, or campanile, at Pisa, was raised close to the cathedral in the twelfth century; its inclination evidently arises from a failure in the foundation; its style evinces but little progress as compared with the cathedral.

In the thirteenth century the church of the Virgin of Assisi was erected in Tuscany, and the castel del Ovo at Naples; the first by Lapo, and the last by Fucio, both Florentines. Nicolo da Pisa, their countryman and cotemporary, was employed on several edifices of consideration in Bologna, Padua, and Venice. His greatest work was the church at Padua, dedicated to St. Anthony, the sculpture in which is chiefly from his hand. The church, however, at Florence, della santissima Trinità, is his finest work, of which it is no small encomium to say that it was the admiration of so great a man as M. A. da Buonarotti. Arnolfo di Lapo built the church of St. Croce, and designed the cathedral also at Florence of Santa Maria de' Fiori. All the cities of Italy, indeed, at this epoch seemed to be emulous of outvying each other. Paolo Barbetta was engaged at Venice on the church of Santa Maria Formosa; many works were in progress at Bologna; the marble chapel of the church of Santa Maria Maggiore at Rome, about the year 1216, was executed by Marchione: every effort indicated the speedy restoration of pure art. These scintillations, however, of good taste were confined to Italy; in the other parts of Europe the Gothic style,—one, indeed, in some of its monuments, of stupendous grandeur, of which we shall treat in another article,—was prevalent, and soon afterwards in Germany carried to the utmost pitch of perfection. It was in the thirteenth and fourteenth centuries that the cathedral at Strasbourg was erected, under the designs of Irwin Steinbeck. The fourteenth century produced also in France and England some extraordinary Gothic structures.

In Italy architecture was fast approaching to a perfect restoration. John of Pisa son of the Nicholas whom we have just mentioned, was employed by his townsmen on the Campo Santo. This public cemetery was in the Gothic style, and is remarkable for the elegant simplicity of its plan and the beauty of its details. It is a singular link of the chain of history of this art: there is no difficulty in discerning the struggle in the mind of the architect to free himself from those Gothic shackles which seemed to hang on it as an impediment to an immediate return to the classic taste of the land, which became completely restored in Italy in the fifteenth century. The troubles throughout Europe were stilled at the time that Brunelleschi appeared as the restorer of genuine art, to which title he has a just and honourable claim. By a diligent investigation of the remains of ancient Rome, with the scale and compasses in his hand, he succeeded in reviving the ancient rules of art, the just use of the orders, and was himself the first to make a practical application of his discoveries. He well knew how to unite theory with practice, and from a profound acquaintance with the monuments of antiquity was led to the principles of sound construction, without which all other knowledge in architecture is useless.

The cathedral at Florence, begun in the Gothic style by Arnolpho, was reserved for Brunelleschi to finish, which he effected with a boldness worthy his genius. He surmounted the church with the tambour dome, which had, though projected by the original designer, been considered by the artists of the age more as a phantom of the imagination than a subject for reality. We have not room here to record the strange schemes that were proposed for carrying the project into execution; the facility with which the architect effected his object marks him as an artist, in that age, of surprising resources and ability.

The erection of the dome and cupola of Santa Maria de' Fiori opened the road for some of the grandest examples of human skill applied to the art: it was the subject of eulogy from Michael Angelo, and is still the astonishment of those who know how to appreciate the difficulties by which it was surrounded. The school formed by Brunelleschi spread by means of his disciples through Italy, and propagated the art in that revived state, which acquired liberal and enlightened protectors in the Medicis, the dukes of Milan, and many nobles of Italy, who opened their palaces to its professors, and the learned generally. These latter, who had after the arrival of cardinal Bessarion and other Greeks rendered Italy illustrious by their labours, soon opened the works of Vitruvius to the architect, in which they were considerably aided by Leo Battista Alberti, of the noble and ancient family of the Albertis of Florence, who himself did not disdain to practise architecture, as an art. Bold and ingenious as Brunelleschi his predecessor, his designs have the further charms of a grace and elegance which the former did not exhibit; and his work on the art, the only one at that period which could be put in competition with the ancient master Vitruvius, whose obscurity in many parts left much for experience to dissipate, displayed such vast stores of erudition, such a profound knowledge of construction, and so accurate an acquaintance with the works of the ancients, that it not only contributed to its firm establishment, but left little to desire on the theory and practice of architecture.

About the period that Alberti was thus engaged, an extraordinary work in the history of the art appeared from the pen of Francesco Colonna (in 1467), under the title of "Poliphili Hypnerotomachia," and published in folio by Aldus. This book is now extremely rare; it is replete with plates, some of great beauty, from wood blocks, and in it the author, in a supposed dream, promulgates sound precepts, noble ideas, and principles valuable to the amateur and architect. Felibien recommends to the artist its perusal, which he considers almost as necessary as that of Vitruvius. Indeed the poetic descriptions in it of pyramids, mausolea, colossal statues, circi, amphitheatres, temples, and palaces, seem to have made more impression at the time than the dry doctrines of Vitruvius, and Italy soon saw realised the poetic dreams of the author. In the period of a century and a half the cities of Italy were embellished with the works of Bramante, M. A. da Buonarotti, Raphael, Julio Romano, San Gallo, Baltazar Peruzzi, Giocondo, San Micheli, Sansovino, Serlio, Pirro Ligorio, Vignola, Palladio, Scamozzi, and a long list of others whose names are an honour to their country.

It was late before pure art reached this country. In it Inigo Jones is the father of architecture, and we, fortunately, still possess some of his beautiful designs. He can scarcely be said to have completely emancipated himself from the trammels of the debased Elizabethan style, as it is called, till the beginning of the reign of Charles I., which was a splendid epoch of the arts in this country. From many concurrent causes, the French

school of architecture has exhibited and still exhibits a very high degree of excellence, and may perhaps be fairly considered as holding the highest rank in the present day.

ARCHITECTURE, *Chinese*. As a description of the buildings of China would be out of place in a work of this nature, the subject of the present article is confined to a general view of the principles, the character, and the taste of Chinese architecture. To describe its general forms, for the purpose of identifying them, is unnecessary; they are universally known.

When we reflect on the limits to which in China the arts of imitation have for so long a period been confined, we are led to the conclusion, whatever be the cause, that the Chinese are deficient in that activity of mind which conducts other nations by degrees to perfection. In China the rise of the arts seems to have been constantly repressed by the state of mechanical drudgery and servitude in which the people are restricted. In their painting, for example, the most exact imitation of plants, fruits, and trees, is thought indispensable. A Chinese painter would think it necessary to count the scales between the head and tail of a carp he was about to represent; in other words, he is more of a naturalist than an artist. In China every matter relating to building is the subject of regulation by the police, which, rather than theory, governs its architecture. The laws of the empire detail and enforce with the greatest precision the mode of constructing a lou or palace for a prince of the first, second, or third rank, of a grandee, of a mandarin, &c. A man, unless he hold some office, who acquires a fortune by his own exertions is not allowed to build a house above his rank in society; his condition has nothing to do with it. According to the ancient law of the kingdom, the number and height of the apartments, the length and height of a building, are all regulated with precision, from the plain citizen to the mandarin, and from the latter up to the emperor himself. Herein alone we have sufficient to account for the poverty and want of invention in Chinese art.

In speaking of the principles of Chinese architecture, the word is not applicable in the same way as when we speak of classic architecture, but is meant to apply to those primitive causes which gave birth to it. Character and taste in every species of architecture are the necessary results of these elements. M. de Pauw has well described it, in respect of its principles and elements. It is impossible, he says, to be mistaken in the objects which were the models of imitation of their first buildings: they are imitations of tents, and that is in consonance with all our knowledge of the primitive state of the Chinese, who were, like all the Tartar tribes, nomadic. This, beyond doubt, is the true origin of their dwellings. However the missionaries of Pekin may have refuted M. de Pauw upon some inaccuracies, there canbe little hesitation in agreeing with him on this head. One of its strongest proofs is the form of the Chinese roof. Nothing but the form of a tent or pavilion could have given the idea of it; and though carpentry was for a long period made subservient to this form, reasoning from the progress of all inventions, it would be impossible to believe, where carpentry supplied the architecture, it should all at once have adopted combinations and coverings so light and at the same time so complex. There is another point of analogy with the tent construction, which is, that there is nothing like the appearance of a member of wood, similar to our architrave, destined to lie on the tops of the columns, and receive and support the remainder of the carpentry. The Chinese roofs, on the contrary, jut out beyond the columns, whose upper extremity is hidden by the eaves: hence the omission of the use of capitals. It is easy to perceive that extreme lightness must result from the imitation whereof we are speaking. The spirit and character of tents carried into the construction of cities might, at least in reality, be lost and altered by a change of materials. The semblance of lightness might be found in union with essential solidity of construction; the character would have been intellectually the same. Here, however, identity of material has contributed to the identity of the copy with the original. The Greeks, whose model was carpentry, copied in, as it were, a figurative manner, and the change from wood to stone soon removed the appearance of weakness and lightness that was found in the model. In China the material remains the same, and its architecture of wood still copies the model of wood; hence, the lightness of the original is transferred to the copy.

Lightness is the essential character of Chinese architecture; but there is another characteristic quality, both of the model and the copy, that is observable in the edifices of China, which is its gayness of appearance. In this respect scarcely any style presents a more pleasing effect. Its roofs, single and double, brilliantly painted, its gaily diapered porticos, the gloss over the whole surface, the harmony of this species of decoration, with the light and flowing forms of the buildings themselves, produce a sense of pleasure to eyes constantly accustomed to their contemplation, which would doubtless be disgusted with our cold and monotonous mode of decoration.

It is particularly in ornament and decoration that we are accustomed to investigate taste, which is the result of a combination of all the physical and moral causes that influence art. Yet, as every thing in architecture is connected by a sort of mutual relationship, it is difficult to fix the exact proportion that exists between construction and decoration, and especially in Chinese architecture. In speaking of ornament in architecture, one naturally recurs to sculpture for the purpose; but this is not found in Chinese architecture. With the Chinese ornament consists in varnishing columns, colouring roofs, coating walls with porcelain, and the like expedients. The figures painted on their buildings are connected with their religion, and the merit of the art is secondary. The art of ornamenting in China is a sort of patchwork, yet the parts of Chinese architecture are in unity with each other. A foreign style could never be made to amalgamate with it; it has been developed in a mode conformable to the wants of the country, and its duration for such a number of ages leads us to conclude that it will not lightly be abandoned by the people that have adopted it.

ARCHITECTURE, *Egyptian*. The preservation of the Egyptian monuments of architecture, in many instances so perfect as they still appear, is highly calculated to excite our surprise and admiration, inasmuch as ancient Egypt ceased to exist in its splendour long before the period of the earliest histories that have come down to us. Almost, as it were, separated from the rest of the world, by seas of sand as well as water, and bordering on the most savage tribes, it seems indebted to those circumstances for the protection its edifices have received. Had the country received as successors to its early inhabitants a powerful people, if rich and industrious cities had risen on the sites of the old ones, the temples of Egypt would doubtless have been used as quarries admirably suited to the purpose. Arabian hordes, and the almost barbarous and wretched inhabitants of the present day, have indeed built their villages on some of the ancient sites. The terraces of some of the temples serve as floors to modern habitations; and at Thebes, a town of two stories, or rather two stories of towns built on the ceilings of these everlasting ruins, indicate that the means of destruction have not been equal to the natural resistance of works of such solidity. No people ever existed whose whole feelings were so much a passion for ever-enduring monuments. Religion, a genius formed by that religion, government, habits, climate, materials, all united to confer on their buildings a durability as great as the power of man can confer; and the efforts resulting from such causes were successful.

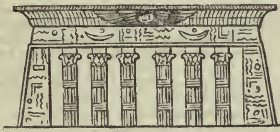
In a preceding article we have adverted to the three classes of mankind, whose different wants had an influence on their styles of architecture. It is not a forced supposition that the primitive inhabitants of Egypt used the excavations with which nature furnished them for protection against the heat of a sultry climate. As the inhabitants of Tyre, Sidon, and Palestine were indebted to their forests of cedar for becoming great workers in wood, so the Egyptians, from their earliest mode of life, from their quarries and the facility they acquired in hollowing them out, gained that aptitnde for working stone, and that high degree of perfection, so manifest in their works. It is true that their country is not the only one in which excavations abound; but in most other places these excavations have been caused by working them as quarries, and no trace of architecture or human abode can be perceived in them. In Egypt, on the contrary, where the caverns still furnish dwellings for the inhabitants, immemorial custom has assigned them to the use of mankind. The immense subterraneous apartments of Egypt must not be placed to the account of luxury in sepulture. Herodotus tells us, that the priests would not allow him to visit the subterranean apartments of the labyrinth in which they dwelt, and which were considered the most beautiful. Now, if this species of dwelling was used in the refined times of Egypt, à fortiori would it have been so in the earlier ages. Throughout Egyptian architecture its origin appears. A simplicity bordering on monotony; extreme solidity, amounting to heaviness; are its principal characters. There is entire absence of every thing that can be traced to a type of carpentry, as in the Grecian orders; hence it appears certain, that at least its type was different, and that type was cavern excavation. The exception that seems to arise from the use of columns does not militate against the theory; for decoration invariably refers to nature for objects of imitation; and nothing would sooner occur in decorating pillars in every style than the imitation of trees and plants, without referring to them as a type.

The honours of sepulture seem to have been the cause of the most stupendous of the Egyptian monuments Diodorus Siculus tells us, that the kings of Egypt ex-

pended sums upon their tombs more immense than other kings did upon their palaces. They were of opinion, he observes, that the frailty of the body during life was not worthy of a substantial and solid abode. They considered a palace like an inn, which is occupied by many in succession, and in which one stops but for a day. Their tombs, however, they considered as the real palace in which the abode was to be perpetual; hence, they spared no expense in rendering them worthy of such an object. Some have supposed that the pyramids were but immense cenotaphs, and that the bodies of the kings were interred in some neighbouring subterranean spot; in short, that these masses of stone were erected to mislead one from the spot which the body occupied. This, however, would not make them the less monuments of sepulture. Some have attributed to the pyramids a mystic, others an astronomical, purpose.

From Egypt were derived the principal mysteries that passed into other religions, and it was in the darkness of subterranean apartments that those initiations had birth, in which secrecy was the first law. Secrecy was there deified under the figure of Harpocrates. According to Plutarch, the sphinxes with which the entrances of their temples were decorated, signified that Egyptian mythology was mysterious and emblematic. The number of vestibules enclosed with a series of doors, prevented the temple itself from being seen. This, which none were allowed to approach, was small in extent, and in it the sacred animal or its image was preserved. It was in the galleries, porticos, and dwellings of the priests, that the large area which the temples covered was occupied.

Excepting some varieties in the plans of their temples, a sameness of character and uniformity is observable in them, which pervade their fronts, their general forms, and the details of their decoration; which latter are mostly of the hieroglyphic species, certainly the most monotonous of all decorations. To give the reader a general idea of the temples of the country, a diagram of that at Esneh is subjoined. With the Egyptians, heaviness seemed to be



ESNEH.

synonymous with strength, height with grandeur, and size or mass with power. Uniformity of plan is universal. The right line and square was never abandoned, and, as M. de Caylus observes, there exists no circular monument in this style. In the elevations the uniformity is still more striking, no division of parts, no contrast, no effect. It would seem that the ideas we have for judging of art, were no guide with the architecture of that country. Uniformity of decoration was an almost necessary result of the institutions of the country: the edifices were destined to receive certain inscriptions in symbolic characters, and were not allowed to be left in that respect to the caprice of the architect.

As respects the materials for building which the country afforded, we shall speak as concisely as possible. Though palm trees are found about the deserts of Lybia, and near Dendera, timber of every sort is scarce; indeed the soil is not suitable to the growth of trees. The most common next to the palm tree is the acacia; but, with the exception of the palm tree, most of the trees of Egypt are unfit for building purposes. The oak does not grow in Egypt, and the modern inhabitants import that from Arabia, as well as the fir which they use in their buildings. Brick seems to have been a material used from the earliest date; it was unburnt, being merely dried in the sun. Pocock says it is made of the mud deposited by the Nile, which is of a black colour, sandy, and mixed with flints and shells. One of the pyramids described by Pocock, was constructed with this species of brick, and unconnected by any cement. Bricks, however, were used after undergoing the heat of the fire at a very early period, as we learn from Scripture, Exod. v. 6., where we find the Israelites condemned to the labour of making bricks without straw to burn them. Stone of almost every description, marbles, and granite, were to be had in profusion; and these, as we have before observed, the Egyptians were very expert in working.

In construction there must have been considerable mechanical knowledge employed, for some of the blocks of stone were of enormous dimensions; and to form an idea of the quantity used, it is only necessary to mention that the walls of some of their temples extend to the extraordinary thickness of twenty-four feet. Indeed, the walls to the principal entrance of the gate at Thebes are no less at their base than fifty feet in thickness. The stones are all squared inside as well as on the external face; no rubble-work is to be seen; another cause of the surprising durability of their monuments. The roofs are all formed of single blocks of stone from pier to pier; no trace of the arch is any where discoverable. In the pyramids the passages are covered with stones inclined to each other, terminating in a point, one stone lapping over the other.

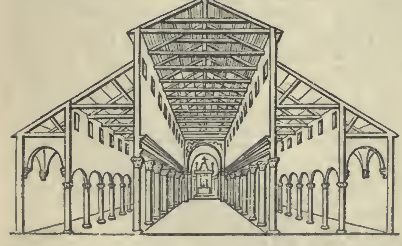
The Egyptian temple, unlike that of the Greeks, which may be almost all taken in at one view both interiorly and exteriorly, consists of an assemblage of porticos, courts, vestibules, galleries, and other apartments communicating with one another, each of which in size had little relation to the rest of the edifice. They were usually in a spot surrounded with walls; and those which were not so surrounded were inclosed in front by a wall engaged to the columns, and extending in height about a half or a third of the shaft. Strabo says that at the entrance of temples was a large paved court three or four times or even more of its width in length, which the Greeks called the dromos. This was ornamented with sphinxes in rows. Through the dromos was the propylum or fore portico; thence to another, and from that to a third, the number of them not being fixed. Beyond the propyla was situated the temple itself (or naos), which consisted of two parts, the pronaos or fore temple, and the secos or sanctuary, which in Egyptian temples was very small, and contained a figure of the divinity, usually represented under the form of some animal. Some of these temples were of very large dimensions; that of Jupiter at Thebes was more than 1400 feet long and 300 feet wide, exclusive of the porticos that led to it. The forms of all the plans are either square or rectangular. The art of designing a plan in modern architecture becomes difficult from the necessity of keeping the apartments within such bounds that they may be covered or roofed, and of arranging the decorations, and of counterpoising thrusts; but the Egyptian architect had no such difficulties to contend with. Columns were brought to the spot and covered at once with masses of stone, all combining without much contrivance with the exterior walls: hence, the abundant use of columns in the interior of their buildings. Great regularity appears in their plans. The temple at Philæ, evidently from its being suited to the form of the island on which it was built, is the only exception to the observation. Their intercolumniations are narrow, rarely exceeding twice and a half the width of the column, and usually not more than a diameter and a half. The elevation is always uniform and monotonous, always of one story, and without columns above columns. The pyramidal form seems to pervade every edifice, and the result must be great solidity. Their columns may be considered as of two sorts, circular on the plan, and polygonal; the former differ only among each other by their being sculptured or not with hieroglyphics. Those representing as it were bundles of rods or trunks, are generally encircled at different heights with bands like the hoops of a cask, generally in two or three ranges of three, four, or five each. This part of the arrangement seems to have been quite arbitrary. The polygonal column frequently occurs, but more generally where the edifice has been formed out of a rock or quarry. All the columns rise from their bases in right lines, diminishing to the top, without any appearance of entasis or swelling. One can hardly say that any precise proportion is preserved between their height and their thickness. In describing them, we can only say that they were short, thick, and of enormous diameter, the latter in some cases extending to as much as eleven feet. What are understood by pilasters are not found in Egyptian buildings, though some quadrangular columns might give that idea, excepting only in the small sepulchral chamber of the great pyramid. Bases are also rarely found; but the capitals of their columns exhibit great variety. In general form they are either square, vase-formed, or swelled; some of them are very elegantly shaped and decorated with the lotus, the palm branch, and other kinds of vegetation, and occasionally with the human head. They are usually without abacus, and are connected to the architrave by a small die or square block out of the same piece of stone as the capital. The entablature rarely, if ever, consisted of more than an architrave surmounted by a huge cavetto, which finished upward with a bead or fillet. This cavetto was frequently ornamented with glyphs and other indentations of the surface, and the wings of the vulture in the centre. The covering of the temple was a flat terrace, though there are no proofs, by the remains of steps to ascend to it, that it was so used.

Some years ago a question was proposed by the French Academy of Inscriptions and Belles-Lettres, whether the Greeks borrowed their architecture from the Egyptians; that question has been well answered by M. Quatremère de Quincy, in the Encyc. Method., to whom we are indebted for much in this article, and the substance of his answer is as follows: — There is no such thing as general human architecture, because the wants of mankind must vary in different countries. The only one in which the different species of architecture can approach each

other is intellectual: it is that of impressions which the qualities whose effects the building art accomplishes can produce upon the mind of every man, of whatever country he may be. Some of these impressions result from every species of architecture. Architecture sprung as well from the huts of Greece, as from the subterraneous excavations of Egypt and the tents of Asia, and from several mixed principles to us unknown: thus the use of the word architecture is absurd. We ought to name the species; for between the idea of architecture as a genus and as a species, there is the same difference as between language and tongue; and to seek for a simple origin of architecture, is as absurd as a search would be after the primitive language. If so, the hut of Vitruvius would not be an ingenious fable, as some have said, but it would be a ridiculous falsehood if he had pretended that it was the type of all architecture. Vitruvius, however, spoke only of Grecian architecture; and if in Egypt there exists another type, that only proves that the hut was not the type of Egyptian art, but that it was that of Greek art, and that theory would be fabulous which pretended to be universal. We will conclude this article by adding that similarity between certain forms of ornament, certain details borrowed by the one from another, prove nothing more than that between the people by whom they were used there was some interchange of commerce or other intercourse, which could not long subsist without some sort of necessary transfusion of the inventions and habits of one of those countries into the habits, manners, and customs of the other.

Architecture, *Gothic.*—To form a correct idea of the Gothic style of architecture, it will be necessary to trace its progress through one very different in its details, though not exactly so in its plan and arrangements. Its type is of a mixed character, and not, as we have seen in the two foregoing articles, founded on the habits of a people. Though a search into the origin of the pointed arch is an idle and useless inquiry, it will be necessary in the end to glance at that as incidental to the style under consideration.

The ancient basilica, which derived its name from basileus, king, and oikos, house, was the part of the king's palace in which justice was administered to the subjects. The building for this purpose retained its name long after the extinction of the kingly office, and was in use with the Romans as well as with the Grecians. Vitruvius does not, however, give us any specific difference between those erected by one or the other of those people. He has (ch. i. l. 5.) given the details of its form and arrangement, and we refer the reader to his work for the particulars of it. The name was afterwards transferred to the first monuments of Christian worship, not because, as some have supposed, the first Christian emperors used the ancient basilicæ for the celebration of their religion, but more probably with reference to the idea of sovereignty which the religion exercised, though no assertion is here advanced that such a conclusion is necessarily to be drawn. There is no doubt that the most ancient Christian basilicæ were constructed expressly for the purpose of that religion, and their architectural details sufficiently point to the epoch in which they were erected. Nevertheless these new temples of religion, both in the whole and in the details, borrowed so much of those of the ancient basilicæ, that even on this account it is not surprising that they should have retained the name. A general notion of one may be formed from the annexed diagram, which will immediately



show how admirably it was suited to the reception of an extremely numerous congregation. The numberless columns which were at hand, the remains and ruins of ancient edifices, were put in requisition for the construction of these basilicæ, of which, adopting the former buildings of that name as the type, they proportioned the elevation to the extent of the plans, and in some cases decorated it with the richest ornaments. Instead of connecting the columns together by architraves on their top, which were not at hand as were the former, arches were thrown over, not only to connect them, but that thereon walls might be carried up to bear the roofing. On this sort of substruction, vaults could not with safety have been borne. From these the obvious and natural step was to piers, connected by arches and ornamented with pilasters or columns. The piers underwent a change by being made circular on the plan; these again, for the purpose of giving the interior a lighter appearance, were made polystylic or in ribs, and ultimately received a vaulting and cross vaultings in character with their plan below. Though the practice of vaulting large areas, and the pointed arch, did not appear till a considerable time after the building of the first Christian basilicæ, it is to be observed that the Temple of Peace at Rome had previously to that period exhibited a specimen of the profound knowledge of the Romans in the practice of vaulting; in that example groined vaults of very large dimensions were borne on entablatures and columns. Nor does this knowledge appear to have been lost in almost the last stage of decline of Roman architecture under the emperor Diocletian. In the baths of this emperor are to be seen not only groined vaults in three divisions, whose span is nearly seventy feet, but at the back of each springer a buttress, precisely of the nature of a flying buttress, is contrived to counteract the thrusts of the vaulting. If a comparison be made between this large hall (now used as a church), of the baths of Diocletian, with the nave of a Gothic church, the difference will be found to be more such as must result from the nature and employment of the materials, than from difference of style. From the age of Constantine down to the ninth century, the edifices within the limits of the Roman empire are but degraded specimens of Roman architecture; and there is no evidence from their remains (few indeed they are) that the Goths and other barbarians who devastated Italy had any other influence on the arts than hastening, perhaps, that fall from which it would seem nothing could have saved them. We quite coincide in the opinion of Möller, who in the text to his Deukmaehler der Deutschen Baukunst says, " I cannot possibly agree to the opinion of those connoisseurs who ascribe an individual and peculiar style of architecture to the Goths and Lombards in Italy and Spain, to the Franks in Gaul, and to the Saxons in England." The Roman architecture of the fifth and sixth centuries was the model, and the constant correspondence from every part with Rome kept up an influence from thence over the arts and sciences. Fine proportions were lost, and the art completely degenerated into a servile imitation of earlier forms. The art of construction and the preparation of materials did not, however, fall away from solid building. The basement of the palace built, it is supposed, at Terracina, by Theodoric, the Gothic king, who reigned in Italy from A.D. 493 to 525, is in the Roman style. So also is the church of St. Apollinaris at Ravenna; and the circumstance mentioned by the writer above named, who up to the period at which we are writing, D'Agincourt excepted, is the only writer of any value on the subject, of the employment by Theodoric as architects of one Aloysius, an architect called Daniel, and the well known Boetius, a native and senator of Rome, is a strong corroborative proof that the edifices of the Goths were built by Romans and in the Roman style. Neither does it appear likely that upon the irruption of the Lombards in the year 568, after the sway of the Goths had lasted so long, they should have established a style of their own. They were a rude people, whereas the Goths, we know, had become quite a civilised nation, whose style was suited to the wants and habits of the country. It is true that D'Agincourt ascribes to the Lombards the church of St. Julian, near Bergamo, and some others; but it has not been proved that the churches in question were really erected by the Lombards. The appellation of Lombardic to the style of church building which existed in France and

9th to 12th century. After the 12th century.

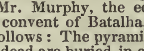
Germany stands on too slender an assumption to be admitted; indeed it has been demonstrated by Maffei, Muratori, and Tiraboschi, that neither the Goths nor the Lombards introduced any style in particular, but employed the architects whom they found in Italy. The late learned Mr. Dallaway says, in his Discourses upon Architecture in England, that "at the beginning of the eighth century all Europe formed but one Gothic kingdom;" and it is certain that anterior to A.D. 800, there are very few Gothic remains. From that period to the general introduction and use of the pointed arch in the twelfth century, the leading form of the churches was a

parallelogram, consisting of a nave, side aisles, a transept on each side forming the arms of a cross, and beyond the intersection of the transept with the nave was placed a choir, terminated by a semicircular added building called the apsis. The whole of these buildings were constructed with very thick walls, pierced with comparatively small openings. In the vaulting of the nave and aisles, and over all windows and doors, the covering was semicircular. The nave was lofty, and was mostly constructed with groins. The section A shows the general appearance of the arrangement. The gables were not much inclined, and in the upper part of the building rows of small pillars appear in the walls. The profiles of the different members are all of Roman origin: many are correctly copied in their forms. In this country endeavours have been made to subdivide this style into Saxon and Norman. The subdivision is useless. Speaking of architecture as an art, they are of the same school, and the style has been by Möller called the Christian or Roman style; by others, the Romanesque style; either of which are appellations suitable, and would sufficiently carry their meaning with them.

Towards the latter end of the twelfth century and in the beginning of the thirteenth, very considerable deviations were introduced. For the flat southern gable, says Möller, was substituted the high northern roof, which brought with it the pointed arch in place of the semicircular one, being a consequence necessary for the harmony of the parts among each other. With the elevation of the roof and vaulting came a slender proportion of towers, columns, capitals, &c.; and at the latter end of the century the flat pilaster spreads outwards, and is converted into a flying buttress. At this period the edifices were in several respects anomalous, inasmuch as we have a mixture of circular and pointed arches, pillars, and vaults intersected by horizontal cornices and the like. The duration of this heterogeneous style was very limited, being immediately succeeded by the universal prevalence of the high pitched gable and the pointed arch. The plans of the edifices were not materially changed except in the omission of the apsis, and a general idea may be formed of the whole by an inspection of the section marked B in the preceding cut. It appears incontrovertible that the Germans were the first to carry this style to its highest perfection. As early as A. D. 1248, the cathedral of Cologne was begun upon its present plan, a building which, if finished, would have been the grandest and most beautiful in the world. Erwin von Steinbach, soon after 1276, built the porch of the minster of Strasburg; a building more, perhaps, esteemed than the last, because nearly brought to a state of completion. The style which we have just been describing wants no other distinctive appellation than the pointed. Imagination seems after its establishment to have been tortured to invent new combinations of ornaments and tracery. It overstepped at length the true bounds of architecture, and was abandoned in the sixteenth century for the introduction and restoration of Roman, or, more properly speaking, Italian architecture. The author above quoted says that the architects of these times were adapted to their age, and that their works are the result of the time in which they lived; and that, however we admire and imitate these works, we are not able to reproduce them, on account of the circumstances under which the style arose not being the same.

The powers of mechanical construction exhibited in the pointed style are such as to excite our admiration and astonishment; the exact calculated proportion between strength and burthen, the counteraction of thrusts of vaulting, and the consequent lightness and boldness resulting from those calculations, evince an intimate acquaintance with the most important and useful qualification which an architect can possess, namely, the production of the greatest possible effect with the most limited means. This qualification was possessed by the architects of the thirteenth century in the highest degree, and to an extent quite unknown to the Greeks and Romans.

The name Gothic, which has been given to the styles of architecture just described, is, from what has been advanced, very inappropriate. It is, however, now no longer used in its application as a term of reproach. That the Goths had no share in its invention or perfection is quite clear, and, as Mr. Dallaway justly observes, "it is not worth the dispute whether the Gothic power was ever annihilated in Europe, or whether they subsisted in the conquered countries as a separate people." We subjoin an enumeration of the different hypotheses upon which endeavours have been made to account for the invention of the pointed arch. 1st. Warburton (notes to Pope) asserts that Gothic architecture originated in Spain under Moorish architects; its type being an avenue of lofty trees, the intersecting branches at top forming the sharply pointed arch, and the stems of a clump of trees being represented by columns split into distinct shafts. Warburton, however, not only lost sight of accurate chronology in his hypothesis, but is wanting in originality. Stukely had made a similar remark. Spence (Anecdotes of Pope) puts in his claim before Warburton, and Sir Christopher Wren had a notion that the invention belonged to the Saracens; so also had Thomas Warton. 2d. The hypothesis of Sir James Hall, ingenious but far from satisfactory. He first assumes that the first English churches were made of wicker work, and then states them to have been the prototypes of those built with stone, furnishing, that is, the wicker work, from its sprouts, the original examples of every ornament or particle that was introduced. 3d. That it is founded upon the structure of framing in wooden buildings. 4th. That of Mr. Murphy, the editor of the celebrated work on the convent of Batalha, in Portugal. His reasoning is as follows: The pyramids of the Egyptians are tombs; the dead are buried in churches, and on their towers are pyramidal forms; consequently, the pyramids of the towers indicate that there are graves in the churches; and as the pyramidal form constitutes the essence of the pointed arch style, and the pyramids of the towers are imitations of the Egyptian pyramids, the pointed arch is derived from the latter. We cannot suppose the reader can require any refutation of such a set of syllogisms as this. 5th and last is that of the late Dr. Milner, who, whatever may be the opinion on his theory of its origin, was well informed upon and intimately conversant with the general subject. Dr. Milner says that it arose from the imitation of pointed arches, generated by the intersection of semicircles, thus:



There are, however, many reasons why this account is not satisfactory, though it must be admitted that in the Romanesque style this combination is frequently to be found. Dr. Milner seems entirely in his hypothesis to have lost sight of a circumstance that is quite familiar to every artist, namely, that it is a principle in all art that the details of every style are subordinate to and dependent on the masses, and not the converse; how then could it have been probable that the leading features of a style so generally used should have had its origin in an accidental and even unessential decoration like that of the learned doctor's theory. In short, none of the hypotheses mentioned can be considered satisfactory; and, as Möller observes, the solution of the question, whether the pointed style belongs to one nation exclusively, is attended with greater difficulties. After all, the problem for solution is not who invented the pointed arch, but in what way is its prevalence in the thirteenth century to be accounted for.

ARCHITECTURE, *Grecian*.—Grecian architecture, which was transplanted after its perfection to an Italian soil, where it assumed almost another form, will not require an extended notice in this place. The particular detail of the changes it underwent will be found in the articles DORIC, IONIC, and CORINTHIAN orders. The architecture of the Greeks, adopted afterwards by the Romans, has, indeed, with certain modifications, long been the architecture of the world. Its origin and types have already been considered in the article Architecture, and an explanation of its terms will be found under their several heads in this work. We shall, however, present a cursory sketch of its rise and progress.

Cadmus, about 1519 B.C., is reported to have introduced into Greece the worship of the Egyptian deities, and also the practice of quarrying stone; to him also is attributed the instruction of the Greeks in the art of fusing and working metals, from which period it is said the Greeks rapidly advanced in civilisation. According to Pausanias the Greeks at an early period had raised some extraordinary structures, such as the treasury of Minyas, king of Orchomenus, and the walls of Tiryns, which that author describes as a work worthy the admiration of every age. From the Homeric writings we find that the form of government was patriarchal, that the chief buildings were the palaces of the princes, and that the altar was the only structure for sacred use, and that even this was little more than a hearth, on which the victim was prepared for the meal; for, until after Homer's time, no regular priesthood existed in Greece. It seems probable that the temple was not used until the kingly and sacerdotal offices were separated. It would be difficult, perhaps now impossible, to trace the degrees from the use of the simple altar to the establishment of the regular temple, or when the latter became a necessary appendage to the religion of the country. Eusebius and others have conjectured that the early temples were but stately monuments, raised in honour of the primitive heroes who had conferred benefits on mankind. In respect of the houses of the Greeks, they appear to have been simple in plan, and at an early age consisted of two stories, as was indeed the case with the dwellings of the East mentioned in the Scriptures.

Between the period commonly assigned to the siege of Troy to the time of Solon and Pisistratus, we have few means of investigating the progress of Grecian art. Goguet (*Origine des Loix*) says that Asia Minor was the cradle in which architecture was nursed, and thinks that

to this country we are indebted for the invention of the Doric and Ionic orders. All authors seem to admit that the Corinthian did not appear till some time afterwards, and that it had birth in the mother country, and not in the colonies. Perhaps the earliest temple recorded is that of Jupiter, at Olympia, which, according to Pausanias, must have been built 630 years before the Christian era. If Livy be right, that of Diana at Ephesus was of a period little less remote, and at this time the science of mechanics was in its infancy; for even in the time of Thucydides, though the powers of the crane were known, they were not compendiously applied for the purpose of raising weights.

Admitting that the system of imitation in the Doric order was founded on the elementary forms and parts of the hut, it was in that case guided by the principles that nature herself adopts in her operations, otherwise no bounds would have limited the caprice and imagination of its improvers. In the copy, no part is precisely similar to the model; but an analogy, and that very strong, is observable. The proportions and parts of the Doric order, in different examples, plainly indicate that the Grecian artists considered themselves restricted only by general rules, inasmuch as we find them varying the height of the Doric column from four diameters to six and a half in height (*see* Doric Order), while the height of the entablature varies in terms of the diameter from 1·72 to 1·97. Lord Aberdeen, in his Inquiry into the Principles of Beauty in Grecian Architecture, has suggested that the height of the capital of this order, in terms of the upper diameter of the shaft, will afford some indication of the comparative antiquity of an example; but there is no ground for the suggestion, as the author of this article has pointed out in a treatise on Grecian Architecture prefixed to his edition of Chambers's Civil Architecture. The intercolumniations used in the Doric order at Pæstum, Corinth, and Segesta, and the Parthenon, are equal to about one diameter of the column. They are about a quarter of a diameter more at the Temple of Theseus, whilst in an example at Syracuse they are somewhat less than a diameter.

The age of Pericles exhibited almost all that art could be imagined to accomplish; the Peloponnesians and their colonies had erected the temples at Corinth, Nemea, Pæstum, Syracuse, and other places in Sicily: thus, in a space of little more than three hundred years from its introduction, it appears that the art was raised to the summit of perfection. It is probable that the Ionic order is not far behind the Doric in antiquity. In the former, the different examples exhibit a variety not less to be noticed than that we have observed in the latter order. The height of the Ionic column varies in the three examples of the temples on the Ilyssus, Minerva Polias, and Erectheus, from eight diameters and a quarter to nine and a half in height; but in the heights of the entablatures there is not so much variance. The cornice of the Grecian Ionic may be considered as bearing a constant ratio to the whole height of the entablature, as two to nine; while the whole height of the latter seems nearly constant at two diameters in height. This order received the addition of a base to its shaft, which was wanting in the Doric order; but, for the varieties, the reader will refer to that article in this work. The volutes, which are its distinguishing features, are found with many varieties. In the temple on the Ilyssus, that of Minerva Polias at Priene, and that of Apollo Didymæus, the volute contains only one channel between the revolutions of the spiral; whereas in those of Erectheus and Minerva Polias, at Athens, each volute has two distinct spirals with channels between them. In the former of these two the column terminates with an astragal and fillet, just below the eye of the volute; in that of Minerva Polias, with a single fillet. In each, the neck of the capital is ornamented with honeysuckles. The shafts are usually cut with flutes of an elliptical form, to the number of twenty-four. These flutes vary from those of the Doric order, in their separation from each other, through the intervention of fillets.

The distinguishing feature of the Corinthian as of the Ionic order is the capital. In a preceding article the elegant story by Vitruvius of its invention has been told, because that has been rendered almost sacred by tradition; but it must be observed, that long before the age of Callimachus, its reputed inventor, perhaps even before capitals or columns themselves were known to the Greeks, the leaves of the palm tree, the flowers of the lotus, and even volutes, were applied as ornaments to the capitals of Egyptian architecture; and, be it observed, the form of the bell itself in no small degree resembles the contour of the lotus flower. The Greek Corinthian and the Egyptian capitals of this class, are more distinguishable by their respective heights than by peculiarity of other features. The former, however, has a lightness and elegance which the Egyptian, perhaps from moral and political causes, never attained; but if even a slight intercourse between the two countries existed, there would appear considerable proof of the identity of the primitive inventors.

Our knowledge of the Greek Corinthian order is unfortunately circumscribed, from the destruction and decay to which from its extreme delicacy it was exposed; nevertheless, under even these circumstances, the few examples that remain induce a supposition that it was not in such high estimation as those we have already named, inasmuch as the only examples that have come down to us are those of what is called the Tower of the Winds, and the Choragic Monument of Lysicrates, both at Athens. But the former of these is scarcely to be classed among examples of Corinthian, and the latter (as we now understand the Corinthian order) is in some respects a little outré in the species. In the Choragic Monument the height of the entablature is somewhat less than a fifth of the total height of the order. The base varies little from that of the Ionic order, excepting in the non-appearance of the horizontal fluting in the upper torus.

To the orders enumerated may be added one scarcely to be named here, because apparently under no rules which regulated its proportions, namely, the figures called Caryatides, which were employed for the support of an entablature. For the supposed account of their origin, the reader is referred to the article Caryatides.

The only subject remaining for notice, under this head, is that of the roofs of the Grecian temples. Their roofs consisted, of course, of two inclined sides, which at the ends formed a pediment. From experience it was soon found that the angle at which the sides of a roof should be inclined to the horizon, should be such as effectually to shelter the interior of the building from the inclemencies of the seasons. Hence greatly inclined roofs are indispensable in northern climates; the reverse as the climate approaches the equator: but this will be more fully explained under the article Roof. Here we shall merely state that, according to the hypothesis, the inclination of the sides of a roof should, for the latitude of Athens, be 16¾ degrees. The actual inclination of the roof of the temple of Erectheus is 15¼ degrees, temple of Theseus 15 degrees, the Parthenon 16 degrees, and that of the Propylea 14½. Comparing the law with the Roman examples, the climate would require an inclination of the sides of the roof with the horizon of 22 degrees, and the variation between the examples remaining is from 22 to 24 degrees.

The invention of the arch does not at present appear to belong to Greek architecture. It was one of the most important inventions in the history of architecture; but so disputed a point is not to be touched upon in a work of this nature. We incline to the opinion that its invention does not belong to the Greeks, for this simple reason, that they have left us no examples of it that have come to our knowledge.

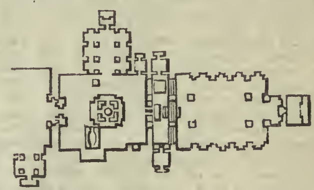
Architecture, *Indian*.—It is very properly observed by M. Quatremère de Quincy, that, in spite of all theories, an infallible mode of estimating the state of the architecture and other arts of any people is by their representations of the human form. Every people, he says, who during a number of ages have persevered in falsely representing the figure void of all proportion, and according to a certain barbarous and ignorant routine, must be convicted of a want of that sentiment which leads to a knowledge of truth, and of that intelligence which knows how to find in nature rules for the choice of forms and arrangements applicable to the art of building. Every people who do not manifest in their works this conformity to nature must be ignorant of the arts of imitation, and all their productions must be the result of an irregular taste. These observations particularly apply to Indian architecture, whose exact antiquity is still a problematical question. In a country abounding with deserted monuments, where are found the traces of an ancient language now no longer spoken, books no longer understood, the vestiges of a religion whose creed and allegories seem to have had some resemblance to those of Greece, one is naturally led to surmise that civilisation existed at a very early period. These opinions would seem corroborated by the extraordinary chronologies which the modern Indians have produced as incontestable authorities for their remote antiquity. The chronology, however, of the Hindoos will not bear the test of strict investigation; neither has any inscription or historic monument been discovered, nor annals found, which give us an idea of the changes, revolutions, or prosperity which the country may have experienced. It is, however, certain, that India has been possessed and successively invaded by several people, and that its creeds, as well as its religious allegories, indicate such great diversity and mixture of opinions as might lead us into every species of error in matters of historical research.

It is natural to suppose, that the subterraneous or excavated monuments of India are prior in date to raised or constructed works; and yet, in point of fact, there are in the former neither less details, less caprice in form, nor less profusion of fantastic ornament, than in the latter. Hence the monuments themselves afford us no

clue to their respective antiquities. M. Meiners contends that none of them are more ancient than the vulgar era, whilst M. Langles, a critic of no ordinary sagacity, is of an opinion rather different, namely, that Indian art was brought from Egypt, and that traces of such an importation are very distinctly marked, as well as that Greek art is strongly indicated in them. If, however, those monuments, whose date we have good reason for believing is recent, exhibit the same taste as that manifest in those monuments whose date is unknown, we may fairly assume that the same style of architecture existed in this country at a period preceding the conquest of Alexander and the epoch in which this early civilised country had intercourse with the Grecians. Though we have no historical nor chronological guides to enlighten us on the subject of Indian architecture, it is to be recollected that there is some analogy between the irregular taste that prevailed in India, and that of the rest of Asia. Southern India abounds with excavated monuments of art; these are equally found in the centre as well as the sides of the vast peninsula. Throughout the region nature seems to have supplied the first associated inhabitants with excavations, either ready formed or easily converted to the purposes wanted. It therefore appears probable that the originating principal of the building art in India is found in the subterranean dwelling; and as we find constructed edifices so similar in proportion, form, and details to those that are, as it were, quarried out, it is fair to conclude that the former are the type of the latter, which are, consequently, of a later date.

Construction scarcely seems a term applicable to the greater number of works of Indian architecture. It means the raising of a work composed of divers materials, or of pieces joined together to form a mass; hence it cannot be properly applied to an excavated structure. The edifices of India may be divided into two classes, the quarried and constructed; the last are mostly those towers improperly called pagodas. Of the unconstructed class may be ranked the seven large pagodas of Mavalipouram, which consist of large masses of stone more or less engaged to the earth, and contiguous to similar masses. These masses were shaped and sculptured exteriorly in accordance with their general form, partly pyramidally and partly by irregular zones, in the same style as the pyramidal tower of the constructed pagoda. No order is apparent in the respective dispositions of the masses, neither is regularity in the plan and exterior form to be detected. These edifices are extremely small in the interior, being hollowed out of the mass, and remind us of the monolythic temples of Egypt, which were cut out of immense blocks of granite, and, as Herodotus tells us, removed to very considerable distances. In other respects, there was clearly some resemblance between the art of India and Egypt; it is found in the excavations of monuments, and in working large natural masses of stone in their original situation. But to infer from this similarity of taste that there was communication between the two nations, seems too much; and still more hypothetical would it be to infer a resemblance of style in architecture from a similarity of practice; for nothing is more unlike the Egyptian than the Indian style of architecture; and in the end it will be seen that, except in the practice of excavation, there is no similarity at all. The dimensions of the pagodas, as they have been called, compared with those of the Egyptian pyramids, no less than their excavated temples, have been much overrated by travellers. Of the latter, the dimensions are generally but moderate, and the difficulty of their execution could not have been very considerable. If the description that comes to us be correct, the latter are hollowed out from quarries of calcareous stone, and the dimensions are on so moderate a scale, that even the celebrated temple at Elephanta is only 130 feet long, 110 feet wide, and but 14 feet 6 inches high. The operation of hollowing out a cavern of this sort can scarcely be dignified with the name of art; but in the pagoda construction we must admit some display of that which at least approaches it. The pagodas are, in many instances, of considerable height; but to compare them with the pyramids of Egypt is out of the question: these, the only buildings of much height, are pyramidal in general form. Sonnerat, vol. i. p. 217., gives us some idea of them: he says, "Around the most celebrated temples the surrounding walls are thick and much raised. On each side is a gate surmounted by a pyramidal tower, with a curved mass of enormous size. The tower is loaded with figures," &c. &c. If we may trust to the representation of the pagoda of Chillambaram by M. Durocher de la Perigne, given by Caylus in the 31st vol. of the Mémoires de l'Académie, the pyramidal form is therein strongly marked. In it the height of the whole is but 120 feet, and at its base it is but 80 feet wide. The termination is not in a point, but is truncated at a height which makes the plan of its summit about 36 feet wide. The pyramid is unequal sided, the flanks being much narrower than the faces. But the largest of these monuments is that described by Lord Valentia, namely, the pagoda of Tanjore, which he considers the finest specimen of this species of building. This is 200 feet high, placed on a basement of 40 feet in height. The pyramidal mass rises by twelve sets off, or bands, sculptured in various ways. Such samples of masonry, however, required no great display of constructive skill for their execution, either in working or transport of the materials. At Chillambaram, for instance, the pyramidal part is constructed to the height of 30 feet only in masonry, the remainder being of brick. The mass is coated with ornaments of stone and of a species of white cement of the country. As in Egypt, none of the monuments of this country exhibit any trace of the arch: the coverings of the apartments are all horizontal, and the dimensions in all are necessarily limited by the want of that expedient which, in modern architecture, has been the parent of the most stupendous monuments whereof art was capable. The ceilings in Indian architecture are of enormous blocks of stone, laid on the supports wherewith the buildings are constructed, being the simplest and most inartificial mode of contriving a covering to an apartment. It must be apparent to every one, that the art of India was many degrees below that of Egypt. Though, in the last-named country, art was limited by the habits of the people, yet it is equally certain that their knowledge in the use of materials was of a high character, and that their skill in masonry was carried to great perfection.

That which is known to the architect by the term ordonnance, which means, in its most extended sense, the composition of a building and the due arrangement of its several parts, and which the Greeks and Romans practised in their architecture with so much success, is not perceptible in Indian architecture, as far as we are acquainted with it. It seems easy to account for this, for, notwithstanding some of the existing monuments have received the name of palaces, there is little doubt of their being all destined originally for religious purposes. Hence the architects, confined to certain established routines, were not at liberty to exercise their invention and ingenuity; and even had they been so, the system of castes, in perpetuating uniformity of practice, had a tendency to repress them. Again: scarce any system could be conceived less likely to develope talent in ordonnance than the use of subterranean edifices, which admit of no variety of plan, no extent of elevation, nor lead to any of those conceptions, which the taste of the architect generates when he has length, breadth, and materials at his command. In the caves at Ellora, a plan of the Indra Subba whereof is here subjoined, if we examine what



may be called the columns, we find some of them hexagonal, without base, capital, or ornament; some square, with a long cap, like carpentry. The greater number are composed of three parts: a square pedestal, running up more than one half of the total height; a small portion of shaft, if we may so term it, crowned with a capital of strange form, whereof words cannot give any definite idea. The reader who is desirous of acquaintance with the temples at Ellora, may advantageously refer to Daniel's plates of these curious objects. Decoration, in architecture, consists of large and small details, which receive the name of ornaments. The larger parts are columns and similar masses. In the system of Indian decoration there is no trace of what may be called an order; but among the larger masses of decorations for support, sculptured elephants very frequently occur. In one of the temples at Ellora, for instance, there are three masses of building, on the same line, whose bases are sculptured with elephants, seen in face. Lions are also much used as objects for decoration.

From information which Sir C. W. Malet obtained, the works at Ellora were said to be executed about the year 900, by Elloo, the rajah of Ellichpour, who at that period is said to have founded the town: and the late Dr. Heber, bishop of Calcutta, observing that no mention was made of these excavations, even incidentally, in any Sanscrit manuscript, and that the idols were the same as those still worshipped in India, dates them in the 13th century. But all this is conjecture, unsupported by any historical document that entitles it to any weight, and a wide field is open to the traveller and antiquary, in investigating these curious and fantastic monuments, as illustrative of the early history of the art.

Architecture, *Moorish or Saracenic.* When the victories of the Arabians had extended their empire from

Constantinople to the confines of Spain, the magnanimity of their leaders, and the brilliant talents of their caliphs, raised the nation to a pitch of glory and power which exhibited itself in some very extraordinary productions in the architectural art. In Africa and in Spain, where their empire became firmly established, the edifices they erected sufficiently prove with what success they cultivated the arts and sciences. For the notice here given of some of the most extraordinary edifices for which Spain is indebted to its ancient conquerors, we are assisted from the celebrated work by Murphy, published in 1816, to which the reader who seeks further information may refer.

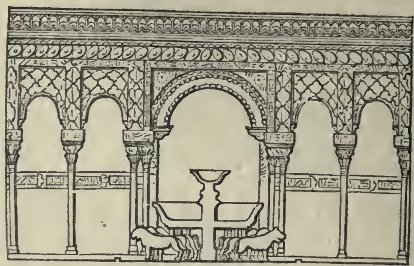
We do not, in the limited space of such an article as this, think it necessary to extend any inquiry into the earliest works of the Saracens, such as the original Mosque of Omar, built in 640. Neither of that nor other of their works (few indeed in number) have we sufficient historical evidence to compare them with the architecture of the period in other countries; but we proceed at once to that period when some of its most distinguishing features were such arches as are here exhibited.

The mosque at Cordova was begun by Abdelrahmen, the second king of Cordova, and finished by his son towards the end of the eighth century. Its plan is a parallelogram of 600 feet by 400, formed by an embattled wall with counterforts also embattled; the height of this wall varies from 35 to 60 feet, and its thickness is 8 feet. This large quadrangular space is divided internally into two parts; viz. a court, 200 feet long by the length of the edifice, and the mosque itself, which is about 400 feet square. The mosque consists of 19 naves, formed by 17 rows of columns, from south to north, and 32 narrower naves, from east to west. Each of these naves is 16 feet wide, from north to south, by 400 feet long; the width of them in the opposite direction is less. Thus the intersection of the naves with each other produce 850 columns, which, added to the 52 columns of the court, form a total of near a thousand columns. Their diameter is about a foot and a half, and their mean height about 15 feet, and they are crowned by capitals of a Corinthian or composite species. These columns, which have neither socle nor base, are surmounted by arches from column to column. The ceilings are of wood painted, each range forming on the outside a small roof, separated from those adjoining by a gutter. One of the most striking effects of the edifice is produced by the beautiful marbles whereof the columns are composed. It seems probable that the larger portion of these columns might have been procured from the Roman ruins in the city; an opinion which is strengthened by their being without bases, or such as ill suited the style of the columns or capitals. In the commencement of the sixteenth century great changes were made in this mosque, for the purpose of converting it into a Christian church; these, it is said, ruined the original effect, but enough is left to indicate what it anciently must have been. It is always considered as one of the earliest Moorish buildings in Spain. The decorations throughout are in stucco, painted of different colours, and occasionally gilt, in imitation of the churches of the lower empire. One cannot doubt that its architects were well acquainted with the Byzantine architecture, in which the walls, the arcades, the pavements, in short all the parts were covered with paintings: and it is clear that the Arabians, who really had invented no architecture of their own, spreading themselves in those countries wherein the arts had been established, were thus led to a trial of imitating the old masters.

The Alhambra, at Granada, is perhaps the most curious and interesting Moorish edifice in Spain. It served the double purpose of palace and fortress, and is situate on the summit of a rock that commands the town. According to travellers who have visited and described this edifice, you may here fancy yourself in a fairy-built dwelling. After passing the principal entrance, you arrive at two oblong courts, one of which is called the court of the lions, and is celebrated in Arabian history. A portion of the section of this court is given below. Round these two courts, on the ground floor, are disposed all the apartments of the palace; those for state look out towards the country; the rest, cooler and more retired, have small openings for light under the interior porticos, the whole of which are decorated with painted stucco, porcelain, and the most valuable marbles.

There is on a neighbouring hill another palace, called the Generaliffe, now in a state of ruin; but its ruins show that it was inferior to the Alhambra neither in size nor splendour. It is precisely in the same taste, and the details are similar, proving that the two edifices are contemporaneous.

Surprising as the works we have just named must be considered we do not discover in them that real grandeur which exists in the works of the Egyptians, the Etrurians, the Grecians, or the Romans. The mode of construction, though sufficiently durable, is not scientific, as respects the working of the materials. Brick was the material



most in use; the masonry, where employed, is covered with a coating of stucco, the painting whereof, in different colours, is a great source of the admiration these buildings excite. In the combinations of the building art in these edifices, there is nothing to surprise, from the supposition of extraordinary means used in their erection. The domes which crown their apartments are neither lofty nor large in diameter, neither do they exhibit great mechanical skill. The Moorish architects seem to have had no notion of raising vaults from lofty piers. In the mosque at Cordova, the span from pier to pier would have been less than 20 feet, which to vault would not have required very extraordinary skill; yet herein we find timber ceilings throughout. The use of orders seems to have been unknown to them; they employed the antique columns which they found ready to their hands, or rude imitations of them, without any apparent acquaintance with the types from which they were derived, their principles or proportions. Hence their columns may be more appropriately termed posts. In the forms of Moorish architecture one does not discover a character of originality arising out of local causes. The Arabians had wandered far from their country, in which they had never cultivated the arts; their architecture was, therefore, necessarily formed upon models which were before them, such as the degenerated Roman and Byzantine. Such elements as these, with the materials which the lower empire afforded, formed their taste and monuments. The form of their arcades, whereof we have given some examples above, is confined to this style of architecture. They may be divided into two classes, both of them vicious in construction, from not affording the necessary resistance to thrust near the abutments. In masonry, failure would follow such forms, if practised on a large scale; but where arches are formed of brick, the large surface of cement used, if it be good and the centres not struck until the cement is set hard, allows great caprice in their forms. If the pleasure—we might almost use the word sensuality—of the eye be the sole object, it cannot be denied that success attended the efforts of the Arabian architects of Spain. The details of their decoration, and the fantasticness of their forms, cannot fail to please the eye; and though they may not satisfy the spectator, they are capable of producing on his mind some of the most seductive charms of which the art is capable. The embroidery and painted draperies of the East appear to have been transposed to their architecture. The variety and profusion with which they used their ornaments, moreover, give their masses the appearance of a congeries of painting, incrustation, mosaic, gilding, and foliage: much, perhaps, of this was induced by the law of their religion, which forbade the representation of animals or the human figure. If taste be not required to produce a reason for the admission of ornament, nothing can be more splendid and brilliant than the effects that resulted from their combinations. It cannot be denied that in this profusion of ornament we find the details beautifully executed, and some of their forms extremely fine; and the mode of piercing domes for light, which they practised by means of star-like formed openings, is attended with an almost magical effect.

Architecture, *Mexican*. From the historian Robertson we collect, that the cities of Mexico, large and populous as they are described, were rather the asylums of men just emerged from barbarism, than the peaceable dwellings of a civilised people. Tlascala, according to its description, nearly resembles that of an Indian village. It was but a heap of low straggling huts; according to the caprice of each proprietor, built of turf and stone, and thatched with reeds, the light being received by a door so low that it could not be entered upright. In Mexico, from its peculiar situation, the disposition of the houses was more orderly, but their structure was equally mean. The Mexican temples, and other public edifices, do not appear to have deserved the high praises which Spanish

authors have bestowed upon them. The great temple of Mexico, the most celebrated in New Spain, as far as can be gathered from the obscure and inadequate descriptions of it, has been represented as a magnificent building, raised to such a height that the ascent to it was by a flight of 114 steps, yet it was but a solid square mass of earth, faced partly with stone. Its base on each side extended 90 feet: it decreased gradually as it advanced in height, terminating at top in a quadrangle of about 30 feet, whereon was placed a shrine of the deity, and two altars on which the victims were sacrificed. All the other celebrated temples of New Spain resembled that of Mexico. The temple of Cholula, which was considered the most sacred in the country, was also the most considerable; yet, according to Torquemada, it was but a solid mound of earth, about a quarter of a league in circuit.

The Spanish historians lead us to suppose that the palace of the emperor and the houses of the nobles exhibited some elegance of design and convenient arrangement: we have, however, no vestiges of these remaining, and, from the mode in which Cortes conducted the siege of Mexico, it seems likely that all the monuments of any importance were destroyed. Still, as at the period when Robertson wrote his history only two centuries and a half had elapsed, it seems impossible that in so short a time edifices of importance should have left no trace of their existence.

The great hillock at Cholula, to which the Spaniards have given the name of temple, is without any steps to ascend it, and without any appearance of stone. Perhaps it has never been more than a natural eminence of the ground. In several accounts, though under different names of places, we find descriptions of monuments pyramidal, as well as in steps, of which the ruins are sufficient to furnish a clue to the whole design. The attempt to restore them in drawing was made in 1804, and published at Rome by D. Pietro Marquez, entitled "Due Antichi Monumenti di Architettura." His restoration was founded, we believe, on descriptions published in the Literary Gazette of Mexico, in 1785 and 1791, by D. Gius. Ant. Abzate. The first monument is at a place called Papantla. Its form is pyramidal, (that is, in general effect,) being built in steps or stories, of six ranks, one above the other. The lower step is 100 feet long, on the four faces. The other dimensions of the steps are not given, but each had in its height a certain number of square niches, each 3 feet every way; the lowest contained 24 on every side, the second 20, the third 16, the fourth 12, the fifth 10, and the sixth 8. It is presumed there was a seventh step, which had 6 of these niches on every side. Upon one of the faces of this pyramid there were smaller steps, serving as a staircase to mount to the top, whereon, it is supposed, there was a small chapel enclosing the idols to which the sacrifices were made. The author (Marquez) above mentioned gathered from the same documents some ideas upon another Mexican monument, if in architecture may be so called a hill surrounded by five or six enclosures of stone, whose object was to retain the earth in its place. This also terminates by a platform at top, which is supposed to have been occupied by a small temple, after the manner of the country. Some writers have thought this last was merely a fortification, but it seems more probable that it was a religious edifice, inasmuch as the basement of it is sculptured with figures supposed to be the hieroglyphics of the country. The name (Xochicalco) of this hill, interpreted by those who possess a knowledge of the Mexican language, bears out the conjecture that it was used for the last named purpose.

Architecture, *Roman*. It can scarcely be said that the Romans had an architecture peculiar to themselves. That which we understand by the name is a modification, some call it a debasement (we disagree with them), of the architecture of the Grecians. We are ready to admit that the Romans gave to their art the lasciviousness of the courtesan, whilst the Greeks preserved in theirs the modest demeanour of the staid matron; but our senses may be charmed by the one, though the other may make a stronger appeal to the understanding. In strictness, Roman and Grecian architecture are identical. Wherever the Greeks penetrated, their genius, not less than their arms, extended and founded their influence. The religion, the language, the habits, and the arts of the Greeks, appear to have been carried into Italy at a period of very high antiquity. Numerous colonies of that nation established themselves on the shores of that country, and even in the interior of the peninsula, where they erected cities long before the existence of Rome. Italy, as far as we can trace, had no original arts of its own, nor can any thing be found in it whose origin was not Grecian. Hence, as has been observed, there is, strictly, no such thing as Roman architecture. But as every nation which cultivates the arts, impresses them with a character peculiar to itself, so when we speak of Roman architecture, we mean that peculiar character with which Greek art was invested under the Roman empire,—that character which was manifest in a greater exuberance of ornament in all the parts of the orders, and which changed the sections of the mouldings of an order from profiles formed by the sections of a cone, to those formed by the horizontal sections of a cylinder. An intercourse of very ancient date existed between Etruria and Greece; in the former of which, at the period in question, the language and mythology of Greece prevailed to a considerable extent. From what is known on this subject, we may safely state that Etrurian architecture was identical with that of Greece. History tells that Rome, from its origin, borrowed from Etruria artists to execute their great works, though, afterwards, the city possessed a large number of native architects, which was not the case with the professors of the other arts. That the Romans at this period were not barbarous and ignorant of the arts, more than one memorial of their skill in architecture still attests. Livy records a circus, traced by Tarquin, between the Aventine and Palatine hills, for the celebration of feasts and games to commemorate the victory over the Latins. Tarquinius Superbus soon afterwards encompassed this circus with covered porticos. This was at the epoch of the construction of the great sewer or cloaca. Perhaps in no age were two more splendid undertakings carried on at the same time. This Tarquin, as Dionysius Halicarnassensis asserts, ornamented the Forum, and had centred in it all that could tend to its beauty as well as to its utility. The first Tarquin was a native of the city of Tarquinium in Etruria, and brought to Rome that taste for grandeur and solidity which were the distinguishing features of the arts in the country he had left. He constructed the immense walls of the city in regular masonry, and laid the foundations of the temple of Jupiter Capitolinus, which, in levelling the hill on which it stood, was attended with prodigious labour and expense. The temple mentioned, according to Tacitus, was continued by Servius Tullius and Tarquinius Superbus, the latter engaging workmen from Etruria; but it was not finished till after the expulsion of the kings. Such was its magnificence, says Tacitus, that all the victories of the Romans added to its wealth and decoration more than to its extent. His words are, "Horatius Pulvillus dedicavit, eâ magnificentiâ, quam immensæ postea populi Romani opes ornarent potius, quam augerent." The description of it by Dionysius brings to mind the Grecian temple, with its two interior ranks of columns, its peristyle and pediment, eulogised by Cicero. It was twice destroyed, and twice rebuilt, on the same foundations. These notices suffice to show that the Romans at an early period were inferior to no nation in those matters of architecture which were necessary and useful to a people. Such was the opinion of Strabo, who adds, that in some respects, such as paving their great roads, constructing aqueducts and sewers, the Romans far excelled the Greeks. Usefulness in their enterprises, and solidity in carrying them into execution, were the characteristics of the art among the Romans at a period when magnificence of a high degree was confined to the temple.

The necessary materials are wanting to enable us to follow up historically the taste of the art during the ages of the republic. There is scarcely the vestige of a ruin of the period; it is, however, easy to form, either from the political state of the times, or from the encouragement given to the other arts, and especially to literature, some idea of the extent to which the architecture of the Romans flourished. The conquest of Greece by the Romans produced to their city not only an importation of works of art, but the artists themselves, who, be it observed, can be created only where opulence reigns. In architecture, however, the Romans at this time had erected monuments of such dimensions as were beyond the means of the little and separated states of Greece. The new state of things brought to its aid all that it needed. The great use which at this period was made of the Corinthian order, is one of the proofs of the public and private wealth. From the time of Augustus we see the extent to which richness of detail was carried. A small portion of the Baths of Agrippa, known to us under the name of the Pantheon, one of the most splendid examples of the art, enables us to appreciate the art of this period, though now despoiled of the bronzes of its pediment, its gilt caissons, and the profusion of sculptures that adorned it. In the time of Augustus, Rome was not only the capital of the world, but the world itself; it possessed within itself all the food that was necessary for the nourishment of the art. Private individuals in the city possessed the wealth of kings, military glory created a necessity for monuments, and the amusements of the theatre, the races and fights of the circus and amphitheatre, required accommodation for such multitudes of spectators, that art expanded from the calls to which it was subject. Rome now began to raise monuments of a description unknown to the Grecians—triumphal arches, baths as large as cities, immense porticos, amphitheatres, and naumachia. The marbles of all the quarries of the then known world were almost exhausted in supplies, and even Egypt furnished the city

with means of adding to the general magnificence. Applied to such new species of edifices, it would have been indeed surprising if architecture had preserved its original Greek purity. It was the medium for satisfying a vanity which knew no bounds, and was ultimately obliged to gain its end more by effect than purity, by richness and exuberance of ornament rather than by harmony, and by grandeur of lines rather than by beauty of forms. Architecture was at all periods a favourite art among the Romans. Not a single name of a Roman sculptor has reached us, and Pliny mentions only two or three painters. From Vitruvius we learn, that before his time several had written on the art. The names of Fussitius, Terentius Varro, Publius Septimius, Cossutius, and C. Mutius are mentioned by him.

The luxury in art induced by the sculptor, aided the number of different combinations in the Corinthian capital, which we have above stated to have been a favourite with the Romans; this was carried to an excess which in the end produced a new order, known by the name of the composite. Thus, Roman architecture having, says Quatremère de Quincy, exhausted all the resources of richness guided by taste in the use of ornaments, throws aside all sobriety, sacrifices the whole to details and accessaries, covers all parts of the surface without distinction, loads the different members with ornaments and sculptures, like a person who, to decorate a piece of cloth, covers it entirely with embroidery.

We close this article with a few observations on the Doric order. This, in Greece itself, at the time of her subjugation, had begun to be affected by change. It had lost much of the primitive simplicity of its character and the severity of its principles. The various wants in edifices less simple in plan, a taste for elegance and richness which was found in the other two orders, contributed to diminish the severity of its forms and profiles. Thus, in the portico of Augustus at Athens it was strangely changed in appearance. In Rome it was adopted with proportions still more slender, and an aspect infinitely less severe. (For remarks on English Architecture, *see* the word ENGLISH.)

A'RCHITRAVE. (Gr. ἀρχειν, *to govern*, and Lat. trabs, *a beam.*) In Architecture, the lower of the three members of the entablature of an order, being, as its name imports, the chief beam that is employed, and resting immediately on the columns. Its origin is given under the article ARCHITECTURE. A French writer has called it the foundation of the head of an edifice. The architrave sometimes receives the name Epistylium, from the Greek words ἐπι, *upon*, and στυλος, *column*.

A'RCHIVES. The repositories of the public records of a state or community: sometimes the records themselves are so called. The word is supposed to be derived from the Greek ἀρχεια, used for public registers by Josephus.

The following table presents a summary of the principal metropolitan repositories of English archives, and the character of their contents. It is extracted from the Law Magazine, No. 35. and is professedly compiled from the information furnished by the Record Commission.

Name of Repository.	Situation.	Species of Record.
1. Tower	Thames Street	Chancery & Parliamentary
2. Chapter House	Poet's Corner, Westminster.	King's Bench, Common Pleas, Parliamentary, Miscellaneous
3. Duchy of Lancaster	Waterloo Bridge	Relating to the Duchy
4. Duchy of Cornwall	Somerset House	Relating to the Duchy
5. Roll's Chapel	Chancery Lane	Chancery & Parliamentary
6. Common Pleas	Carlton Ride Stables	Belonging to the Court
7. King's Bench	Rolls' House, Chancery-lane	Belonging to the Court
8. King's Remembrancer's Record	Carlton Ride Stables, Temple, Tower of Westminster Hall	Chiefly Exchequer
9. Augmentation Office.	Palace Yard, Westminster	Ecclesiastical Record respecting dissolution of Monasteries
10. Pipe Office	Somerset House	Exchequer Records
11. Lord Treasurer's Remembrancer's Office	Somerset House	The same
12. Land Revenue	Carlton Ride, and Spring Gardens	Its own department, and Exchequer Records, &c.
13. First Fruits	Temple	Its own department.
14. Exchequer of Pleas	Lincoln's Inn	Exchequer.

A'RCHIVOLT. (Lat. arcus volutus, *a turned arch.*) In Architecture, the ornamented band of mouldings round the voussoirs or arch stones of an arch, which terminates horizontally upon the impost. The archivolt is decorated analogously with the architrave, which it may in arcades be said to represent.

A'RCHON. (Gr. ἀρχων, *ruler.*) The title of the chief magistrate of Athens. The office was originally instituted after the death of Codrus, the last king of Athens, and was vested in one person who enjoyed it for life, and was succeeded by his son. Its duties were those of a limited monarchy, accountable to the assembly of the people; its duration was afterwards limited to ten, six, and, finally, one year, when its functions were divided among nine persons, taken at first by suffrage, and afterwards by lot, from the nobles. One was chief among them, and was called Eponymus, or, naming Archon, because the year was distinguished by his name. The second, or king Archon, exercised the functions of high priest. The third, or Polemarch (polemarchos,) was originally the chief military commander. The other six were called Thesmothetæ, or setters forth of the law; they presided as judges in the courts, and the six formed a tribunal which had a peculiar jurisdiction. The nine together formed the council of state, on which the whole administration rested; but this was transferred by Solon to the senate. The exclusive right of the nobles to this office was taken away by the measures of Cleisthenes, who threw it open to the people at large. *See* especially *Boeckh's Public Economy of Athens*.

A'RCTIC. (Gr. ἀρκτος, *the bear.*) An epithet given to that part of the heavens, in which are situated the constellations of the Great and the Little Bear. *Arctic Pole*, the north pole of the heavens, or the northern extremity of the axis of the diurnal motion. *Arctic Circle*, in geography, denotes a small circle of the sphere parallel to the equator, and 23½ degrees from the north pole. At this latitude, the sun, at the summer solstice, comes exactly to the horizon at midnight, without descending below it. The corresponding circle in the southern hemisphere is called the *Antarctic*. The arctic and antarctic circles separate the frigid from the temperate zones.

A'RCTOMYS. (Gr. ἀρκτος, *bear*, μυς, *mouse.*) The name of the subgenus of *Rodentia*, or gnawers, including the marmot.

ARCTU'RUS. A star of the first magnitude in the constellation of Bootes, designated in the catalogues as α Bootes. It has a sensible proper motion.

A'RCUATE. (Lat. arcus, *a bow.*) A part of an animal so called which is linear and bent like a bow.

ARCUA'TION. (Lat. arcus, *a bow.*) An obsolete term for the mode of propagating trees by layers, the shoots being bent.

A'RDEA. The name of a Linnæan genus of *Grallæ*, or wading birds, characterised by a straight, sharp, long, subcompressed bill, with a furrow extending on each side, from the nostrils to the apex of the bill. The genus was subdivided by Linnæus into the *Cristatæ*, corresponding to the modern genus *Anthropoides;* the *Grues*, or cranes; the *Ciconiæ*, or storks; and the *Ardeæ*, or herons; which latter have been subsequently subdivided into *Ardeæ*, or herons proper; *Nycticoraces*, or night-herons; and *Botauri*, or bitterns.

ARDISIA'CEÆ. (Ardisia, *one of the genera.*) Exogens, which might, without much inaccuracy, be termed woody primulaceous plants. They form herbs and trees in warm countries, and have a succulent fruit; but they really differ in scarcely any positive point of structure from primula and its co-ordinates. (*See* MYRSINACEÆ.)

A'RE. *See* A LA MI RE.

A'REÆ. In Entomology, the larger longitudinal species into which the wing may be divided: they are termed cretal, intermediate, and anal, according to their relative position.

ARE'CA. (Areec, *the Malabar name.*) An East Indian palm tree, whose nuts are folded in the leaf of the piper betel, and, mixed with a little lime, are chewed by the natives of the country bordering on the Indian Archipelago, as a stimulating narcotic.

ARE'NA. A Latin word signifying, in its original meaning, sand, but applied in a secondary sense to that part of the amphitheatre in which the gladiators fought, which was covered with sand. The word is sometimes applied to the whole amphitheatre.

ARENA'CEOUS. (Lat. arena, *sand.*) Sandy.

ARENA'RIA. (Lat. arena, *sand.*) A genus of wading birds, wanting the hinder toe: of this genus there is but one British species — the Sanderling.

ARENA'RIOUS SOIL. (Lat. arena, *sand.*) In Agr. and Hort., soil in which sand is the prevailing ingredient.

ARENA'TION. (Lat. arena, *sand.*) The cure of diseases by sprinkling hot sand upon the body.

ARE'OLA. (Dim. of *area.*) The ring or margin which surrounds the pustule of small and cow pox.

ARE'OLÆ, in Entomology, are smaller spaces into which the wing is divided by the nervures: they are termed vasal, middle, and apical, according to their relative position.

ARE'OLATE. In Entomology, divided into small spaces, or areolations.

AREOLATE. In Botany, in composite plants, when the florets are placed so completely upon the surface of the

receptacle, that many a pentagonal area, or space, is left when the ovaries drop off.

AREOLA'TION (Lat. *area*) means any small space, distinctly bounded by something different in colour, texture, &c. The spaces of parenchyma, which in leaves are bounded by veins, are areolations.

AREO'METER. (Gr. ἀραιος, *rare*, and μετρον, *measure*.) An instrument for measuring the density or specific gravity of fluids. (*See* HYDROMETER.)

AREO'METRY. The science of measuring the density or specific gravity of fluids.

AREO'PAGUS. The chief court of judicature at Athens: so called because it met in a hall on an eminence, called the hill of Mars (Ἀρειος παγος.) This court, which was of very early origin, was raised to the high character it afterwards enjoyed, by Solon, who appointed that it should consist of the archons who had undergone, with credit, the scrutiny they were subject to at the expiration of their office. The areopagus had cognizance of capital crimes, and from it was no appeal to the people, whose decisions it was sometimes known to annul. It controlled all issues from the public treasury, and exercised a censorship over the citizens. Its powers were much reduced by the measures of Pericles and his partizans. On the subject of this celebrated institution, our best ancient authority is the *Oratio Areopagitica* of Socrates. See also Meursius, *De Areopago*; Du Canaye, *Recherches sur l'A.*, in the *Mém. de l'Acad. Des Inscr.*, *&c.* vol. vii. p. 174.: and Petitus, *Ad Leges Atticas*. See also Boeckh's excellent work on Athens and her Institutions.

A'RGEL. The Egyptian name of the leaves of the *Cynanchum oleafolium*, which are mixed with senna leaves.

A'RGENT, in Heraldry. (French, argent, *silver*.) One of the metals employed in blazonry: it is equivalent to pearl among precious stones, diamond among planets. In engraving it is represented by a plain surface.

ARGENTI'NA. A Linnæan genus of abdominal fishes, belonging to the salmon family; characterised by a small mouth, without maxillary teeth; the tongue armed with curved teeth; and a transverse row of small teeth on the vomer; banchiostegal rays, six. The argentines rank in the order *Malacopterygia*, or soft-finned fishes of Cuvier. The name is derived from the silvery glistening appearance in the scales of these fishes.

A'RGENTINE. In Mineralogy, nacreous carbonate of lime, so called from its silvery lustre.

ARGILLA'CEOUS SOIL. (Lat. argilla, *clay*.) Soil in which clay is the prevailing earthy ingredient.

ARGOL. The tartar of wine.

A'RGONAUT, ARGONAUTA. Applied by Linnæus, in the singular number, to the testaceous cephalopod, designated by Aristotle and the ancients, nautilus, and commonly called at the present day the paper nautilus, from the fragile nature of the boat-like shell in which the inhabiting cephalopod occasionally floats on the still seas of the warmer latitudes. Many modern naturalists limit the application of the term argonauta to the shell, supposing that its true constructor is yet to be discovered, and that the cephalopod which has hitherto been exclusively found in it, is a parasite. (*See* OCYTHOË.)

A'RGONAUTS. The name given to the chieftains "who accompanied Jason in the ship Argo on his fabled expedition" to Colchis, after the golden fleece of Phryxus. The original facts on which this mythological story is founded cannot now be recalled; but it is generally supposed to represent the result of some bold commercial expedition that overstepped the previous discoveries of its age, or more probably still, the series of enterprises by which "Greek maritime knowledge was extended to the furthest shores of the Euxine." We have a poem on the subject, which falsely goes under the name of Orpheus, who is said to have been one of the Argonauts himself, and an epic by Apollonius Rhodius, a Greek poet of Alexandria, and likewise one in Latin, by Valerius Flaccus, who flourished in the age of Vespasian.

A'RGUMENT. In Astronomy, denotes the angle or quantity on which a series of numbers in a table depends. For example, suppose a table were formed showing the amount of horizontal refraction at every degree, &c., of altitude; then the altitude would be termed the argument of the refraction; and the table is said to be entered with the argument.

ARGUMENT. In Logic, an expression in which, from something laid down as granted, (*i. e.* the premises,) something else (*i. e.* the conclusion,) is to be deduced. In ordinary discourse, argument is very often used for the premises alone, in contradistinction to the conclusion; *e. g.* "the conclusion which this argument is intended to establish, is, &c. &c." This word is also sometimes employed to denote what is, strictly speaking, a *course* or *series* of arguments: it is in this sense that we speak of "Warburton's argument to prove the divine legation of Moses." The word argument is frequently used to express what may be properly called a disputation: *i. e.* two trains of argument opposed to each other, as when it is said that A and B had a long argument on any subject, and that A had the best of the argument. (Vide *Whately's Logic*, p. 300.)

A'RIANS. The followers of the theological opinions of Arius, a presbyter of the church of Alexandria in the fourth century, who denied the equality of the Father and Son, and is generally considered as the author of a system which continued, under various modifications, to exercise the most extensive influence upon the Christian world of any heresy of ancient times. It was in the year 319, that these views were first promulgated at a meeting of the clergy of Alexandria; and their author, after some delay, excommunicated by the patriarch Alexander. The progress, however, which the opinions continued to make, excited, after a few years, the notice of the emperor Constantine, who addressed a letter to Alexander and Arius jointly, in which he attempted to attain the object for which on other occasions he resorted to more violent methods, that of reconciling the conflicting parties upon whatever basis, and securing harmony at all events. At the earnest desire, however, of the orthodox party at Alexandria, he convened the general council of Nicæa, which assembled in the year 325, and proceeded to institute a full investigation into the matter in dispute. On this occasion the Nicene creed was drawn up, in which the clause which principally affects this subject is the assertion of the consubstantiality of the Son with the Father, or the Omoousion. This the Arians would not concede. A middle party arose under Eusebius of Nicomedia, who proposed, but without effect, the term Omoiousios, asserting, not the identity, but the similarity of substance. This, which is generally denominated the Semi-arian scheme, satisfied neither the Catholics nor the Arians, who from their rejection of it acquired the title of Anomoioi. The Catholics triumphed, and their opponents submitted to the decree of the emperor which required them to acknowledge the creed propounded for their acceptance. From this time, according to some writers, the Eusebians became a mere political party, who endeavoured to preserve the favour of the prince, for which they had already made the greatest of sacrifices, by a repetition of similar unworthy arts. At this period another Eusebius, the courtly bishop of Cæsarea, and celebrated historian of the Christian church, became one of the leaders of this branch of Arianism. His talents and ingenuity are represented as being of singular service to the cause of the heretics, by inducing the emperor, after some delay, to command the restoration of Arius to the church of Alexandria, and the banishment of Athanasius. A day was appointed, upon which Alexander, the aged bishop, should admit the still suspected heretic to the holy communion: his protestations of orthodoxy were such as to satisfy the prelate that God only could discover his real sentiments, and he solemnly declared that in His hands he left the matter. In the midst of the fears and scruples of the one party, and the anticipated triumph of the other, the proceeding was suddenly terminated by the death of Arius: a deliverance of the church, in which the Catholics discovered a signal interposition of God, but which the heretics confidently ascribed to assassination by poison.

Under Constantius, the successor of Constantine, in the East, the Arian party was taken into favour, and the orthodox persecuted and proscribed: and when on the death of Constans, the whole empire fell into his single hands, the cause of heresy began to flourish in the West also, and the "whole world," says St. Jerome, "groaned to find itself Arian." It was at this period, also, that many northern nations, who were just preparing to pour themselves upon the western empire, were converted to the Christian faith, in which they were instructed, according to the Arian interpretation. This circumstance contributed materially to the permanence of these opinions; for after the orthodox emperor Theodosius had re-established the doctrine of the Nicene creed throughout his dominions, the West was subjected to a second inundation of heresy in the preceding century. The conversion of Clovis to the Catholic faith at the end of the fifth, and of Theodelinda, queen of the Lombards, in the sixth century, combined with the successes of the generals of Justinian, in Italy and Africa, restored the orthodox opinions throughout the greater part of these regions; and from that period Arianism dwindled away, and all traces of it seem to have been lost for many centuries.

In modern times these opinions have been revived. The inferiority of the Son to the Father was proclaimed by Servetus, in 1531: and in Geneva, the very place in which he suffered death, these opinions took root, and have since become very prevalent among the disciples of the church which Calvin founded. The immediate followers of Servetus removed, upon his death, to Poland. In England, the principal revivers of Arianism, were Whiston and Samuel Clarke, who flourished at the be-

ginning of the 18th century. Their doctrines were embraced by great numbers of the Presbyterian and Independent preachers, and gave rise to a great deal of controversy among the members of those communities, and of the church also. It is remarkable that the congregations which in modern times have embraced any form of Arianism, whether at Geneva, in Poland, or in our own country, have in almost all cases degenerated into Unitarianism. At the present day, there exist few, if any, churches of professed Arians.

It should be remarked, that the term Arian, which is vulgarly attributed to those who conceive of the second and third persons, that though inferior to the first, they are, nevertheless, divine, admits of many distinctions and qualifications. Questions arise among sects generally denominated Arian, 1st, As to the similarity of substance between the Father and Son: 2d, As to the existence of the Son; whether he was created before the world;—whether that creation was from eternity: 3d, As to the relation of the Son and Spirit, concerning whose rank among the Divine personages there are many conflicting opinions. Dr. Clarke, though generally considered to hold Arian sentiments, professed himself a believer in the Trinity, and continued a member of the established church. He distinguished the Son from the Father, considering the latter as the primary author of all good, to whom all honour and worship is due: the power which was original in the Father being derivative in the Son, who derives also from him his Divinity and other attributes. The Holy Spirit, he considered to hold a similar subordination to the Son. When the question, whether the Father can annihilate the Son, was propounded to Dr. Clarke, he confessed that he had not reflected upon this imputed consequence of his scheme, and declined to give any answer.

ARICI'NA. An alkaloid discovered in 1829, by Pelletier and Coriol, in a bark from Arica, resembling a species of chinchona.

A'RIEL. Arilla (*in low Latin*), *a piece of red cloth.* A membrane, either fleshy or otherwise, originating from the placenta, and growing on a seed either partially or entirely. Instances of it occur in the nutmeg, where it constitutes mace; and in the Euonymus Europæus, where it is a red succulent membrane. It is remarkable that this part, the use of which is unknown, never appears till after the young seed is fertilised.

A'RIES. (Lat. *the Ram.*) The first constellation of the ancient zodiac. Aries also denotes the first sign or the first 30 degrees of the zodiac; the first point of Aries being the point in which the equator intersects the ecliptic, and from which the longitudes are reckoned. In ancient times the signs and constellations of the zodiac coincided; but owing to the precession of the equinoxes, the twelve signs go backward among the constellations, at the rate of about 50″ annually, and the first point of Aries is now situate in the constellation Pisces.

ARIES. In ancient Military Science, the Latin name of the battering ram, an instrument with an iron head used to batter and beat down the walls of besieged places.

ARIOSO. *See* LEGATO.

ARISTO'CRACY. (Gr. ἄριστος, *the best*, and κράτειν, *to govern.*) According to the acceptation in which the word is used by ancient writers, a government in which all the *best* citizens of the state, *i.e.* those excelling either in hereditary distinction or in wealth, ruled their fellow-citizens. When the power was in the hands of a small class of these, who had acquired it by chance or usurpation, such a government was said to be an oligarchy. Thus aristocracy is enumerated by Aristotle among the distinct forms of government; oligarchy is only mentioned as a perversion of aristocracy: and the distinction as taken by him is, that in an aristocracy the governors rule for the public good, and in an oligarchy for their own. In modern times, those governments have usually been termed aristocratic in which a small privileged class of noble or wealthy persons either governed absolutely, or shared the government in various proportions with the sovereign or with the people. Thus the Republic of Venice presented the purest example of an aristocracy among the older governments of Europe: while the government of the United Provinces, before the French Revolution, might also be cited as an instance of an aristocratic commonwealth; and Great Britain of a monarchy tempered by aristocracy. In a stricter sense, however, the word has been used by modern speculative politicians to signify any government in which "a minority of adult males" constitute the ruling class. In this sense, the government of France, that of England both in respect of the House of Commons and of the House of Lords, and, in short, almost every state in which a census is adopted as the qualification of those who elect representatives in the national assembly, must be cited as aristocratic. The word aristocracy is also frequently used to signify a class of persons in the state: the wealthy and noble classes in a body, or the latter class by itself.

ARISTOLO'CHIA. (Gr. ἄριστος, *best*, and λοχεια, *childbirth.*) A genus of exogenous plants, usually having twining stems and one-sided bent, yellow or purple variegated flowers, the odour of which is often very offensive. They are reputed to be powerful stimulants and aromatics. One species, but not a twining one, is occasionally met with wild in England (A. clematitis, common birthwort): a few are natives of the South of Europe, but the principal part of the genus is tropical.

ARI'STOLO'CHIA'CEÆ. The natural order of which Aristolochia is the type. Asarum (*see* ASARABACCA) is the only other common genus associated with Aristolochia; but there are several tropical forms. The wood of this order is remarkable for growing without forming concentric zones, although undoubtedly exogenous.

ARISTOTE'LIAN PHILOSOPHY. In attempting to give an account of the doctrines of Aristotle of Stagira, we feel embarrassed by peculiar difficulties. The prejudices under which, until lately, the name of this philosopher has laboured, and still, perhaps, continues in a great measure to labour, would seem to render a more than usually detailed account of his writings necessary, in order to justify what, in the view we shall take of their nature and value, may contradict the ordinary opinion. At the same time, there is perhaps no ancient philosopher, the full comprehension of whose system requires so extensive a knowledge of the works of his predecessors in scientific research, and so careful a collation of detached passages in his own writings, which are composed for the most part in a fragmentary and unmethodical manner, and an obscure and concise diction. The latter difficulty will be the more apparent, when we state the now unanimous opinion of the learned, that the works of Aristotle which remain to us are entirely of the *esoteric* or *acromatic* class, intended, not for publication, but to serve as notes to the oral lectures which he delivered to the more instructed of his pupils. It requires no more than a cursory glance at the titles and the bulk of Aristotle's writings, to be convinced of the comprehensiveness of his views, and the daringness of his design. He divides the whole circle of knowledge into three great provinces, Metaphysics, or the Philosophia prima, including, as its instrument, Logic; Physics, or the Second Philosophy, under which term, in addition to the sciences ordinarily falling under that denomination, he embraces a great portion of the philosophy of the human mind, as the phenomena of sensation, memory, and fancy; and, thirdly, Ethics, or the science which treats of the conduct and duties of man, regarded both as an individual and as a citizen. His Logic is contained in his Categories, his treatise on Interpretation or the Nature of Propositions, his former and latter Analytics, and his eight books of Topics; to which may be added his work on the exposure of Sophisms. These form together what has been called the Organism of Aristotle; and seem intended as a preparatory discipline to the study of his Metaphysics. (See *Arist. Metaph.* iv. 3.) The common opinion, which attributes to Aristotle the discovery of the science of Logic, is, we doubt not, substantially correct. The flippant objection of Locke, that this notion would represent God as having made men mere animals, and having left it to Aristotle to make them rational, hardly needs a serious refutation. Natural philosophers might with equal justice be accused of asserting, that Sir Isaac Newton changed the motion of the heavenly bodies, or that Locke himself created the human understanding. The logic of Aristotle is, what it professes to be, an enumeration of the leading classes, or genera, to which all our notions may be referred; an account of the various methods by which we arrive at general propositions, and reason from these when formed; and a body of rules for the conduct of the understanding in going through these processes. (*See* LOGIC, CATEGORY, &c.) Metaphysics is the science of being, as such; and herein is distinguished from physics, which considers only the modifications of being, and the changes to which they are subject. Each of the physical sciences has its own fundamental axioms, the truth of which it is compelled to assume: it is the province of metaphysics to verify these assumptions, and to discover their unity and connection. Aristotle's metaphysical system, though it may be said to owe its origin and many of its peculiarities to that of his great predecessor, Plato, yet deviates from it in many important respects. Both the one and the other admit the existence of a faculty, the sphere of which transcends the objects of sense: they differ as to the method by which this faculty is to arrive at its determinations. Plato doubtless conceived, that in virtue of the necessary connection in which all conceptions stand to each other, we are able, so soon as we have awakened one idea in our consciousness, to arrive at the knowledge of all the rest. Aristotle, on the contrary, conceived all deductive science to be illusive which does not rest, for the truth of its fundamental principles, on a previous induction from particulars. Agreeably to this conviction, he begins his Ontological speculations with the consideration of the individual, as it presents itself in the world of sense. To the production of each separate existence, four causes are

necessary: the material cause, the formal, the final, and the moving cause. The three latter, he seems to admit, are substantially identical, inasmuch as in Nature the end of a thing is that very thing itself in its completeness: while the moving cause may be conceived as the type pre-existing in the mind of the artificer, which is the same with the form which he communicates to the material. We should greatly misconceive Aristotle's meaning, if, as has sometimes been done, we identified his forms of things with their outward figure, or even with the notion of them apprehended by the understanding. The form of a thing may be differently expressed, as the law of its being, the principle of life within it, which animates and gives an individual existence to the matter; which, on the other hand, without its presence, would remain a mere blank potentiality, destitute of all qualities, and therefore unintelligible and imperceptible. This distinction between matter and form re-appears, under different names, in various portions of the Aristotelian philosophy, and is with him a solution of most of the difficulties in ontology and physics. He conceives it to be the only mode of explaining the possibility of a thing coming into existence, the difficulty of comprehending which had led the electic philosophers to deny any reality to outward phenomena. He himself conceives the universe to be eternal. With Plato, however, he strenuously asserts the existence of reason, as something immutable and universal: co-eternal with but unaffected by the shifting phenomena of the world. He differs from that philosopher, in making the universal reason identical with God, instead of being, with its correlative being, a creation of the Divine energy.

Of Aristotle's strictly physical researches we shall say little. He does not himself seem to conceive that great certainty can be attained in this department of human science. When, however, we remember, that his History of Animals has received very high praise from no less a naturalist than Cuvier, and when we reflect that this was perhaps the only branch of natural science in which he was furnished with experimental data, we shall be inclined to attribute the errors and deficiences of his physical theories rather to the deficiencies of the Greeks in the necessary mechanical apparatus, than to any disqualification in the philosopher himself. In his treatises on the Soul, on Memory and Recollection, and on the Nature of Dreams, he has earned the perhaps still higher praise of having created the science of Psychology, and of having discovered the guiding clue to the explanation of our mental phenomena, in the principle of association.

The third great division of the Aristotelian philosophy, that which regards the relations of man as a "social and political animal," is comprised in the Politics, the Œconomics, the Nicomachean and Eudemian Ethics, and those books entitled the Magna Moralia. In the true spirit of an ancient Greek, Aristotle regards the science of ethics as most intimately connected with that of politics. He repeatedly expresses his aversion from all speculations on merely ideal perfection; and his conviction that the practicable, under the existing circumstances of humanity, is the true object of ethical enquiry. Among the most influential of these circumstances on the conduct of an individual, is the constitution of the state to which he may belong; in the spirit, and according to the maxims of which he must act, if he would earn the praise of a good citizen. Not indeed that a good citizen and a good man are necessarily identical terms: they can only become so in the case of one who is a dutiful member of a rightly constituted commonwealth. The question necessarily arises, "How is this perfect form of polity to be determined?" The answer is, that form of government is the best, which affords scope for the developement of the best part of our nature; in other words, which produces the best men. Out of this circle, Aristotle cannot be said to have fairly extricated himself. He has in some measure approximated to a definite rule of morality in the doctrine, that every virtue lies between two opposite excesses. It must however be confessed, that a certain degree of vagueness prevails in his ethical speculations: a vagueness of which he was himself conscious, and apparently despaired of satisfactorily removing. Perhaps the most valuable part of his moral writings, is that in which he discusses the much vexed question of the relation of happiness to morality. Pleasure, he determines, can never be taken as a measure of actions, inasmuch as it is the uniform concomitant of all natural action whatsoever. (*Eth. Nic.* l. x.) His politics comprise a most careful review of the most celebrated Grecian constitutions, and a generalization of the leading possible forms of government, with their various merits and defects, built on a careful induction from the great mass of varied facts and instances with which the history of his country supplied him. They are consequently invaluable, alike to the curious in Grecian history, and to the political theorist; and traces of their effects are sufficiently visible in the writings of perhaps all who have arrived at eminence in the latter department.

The best edition of Aristotle's complete works is that of Bekker, 3 vols. 4to. Berlin, 1831. Of the Ethics, that of Michelet, with a commentary, 2 vols. 8vo. Berlin, 1835. Of the Politics, those of Schneider and Göttling. Of the Treatise de Animâ, with copious notes, that of Trendelenburg. Numerous editions of the Rhetoric have been published in Oxford. Of his Ancient Commentators, the best are Ammonius, Alexander Aphrodisiensis, Simplicius, and Thomas Aquinas.

ARI'THMETIC. (Gr. ἀϱιθμος, *number.*) The science of numbers, or that part of mathematics which is concerned with the properties of numbers. The elementary operations of arithmetic, being necessary in transacting the ordinary affairs of life, are perhaps as commonly known as the art of reading and writing, and therefore require no explanation; the principles, however, on which they depend are of a very general and highly refined nature.

Every number, according to the definition of Newton, is, properly speaking, only a ratio, or relation. In order to explain this, it may be remarked, that every magnitude which we compare with another magnitude is either equal, or greater, or less, and, consequently, has a certain relation to that with which it is compared; that is to say, it either contains it or is contained in it, in a certain manner. This relation, or manner of containing or being contained, is what we call number: thus the number 3 expresses the ratio which one magnitude has to another smaller than itself, which is taken for unit, and which the greater contains three times. On the contrary, the fraction ⅓ expresses the ratio of one magnitude to another greater than itself, which is taken as unit, and which contains the smaller three times.

Having distinguished the numbers or relations of magnitudes, which we have conceived in our minds by particular signs, arithmetic becomes the art of combining these relations with one another; employing for this purpose the signs themselves by which the numbers are distinguished. Hence, the four operations of addition, subtraction, multiplication, and division, include the whole science: for all the different combinations that can be formed of ratios are reduced ultimately to an examination of the excess of some above others, or of the way in which they contain one another. For the purpose, indeed, of facilitating commercial accounts, astronomical calculations, &c., many other very useful rules have been invented, such as the rules of proportion, interest, discount, alligation, position, extraction of roots, progression, &c.; but, on attending to the operations prescribed by these rules, it is easy to see that they are only different applications of the four principal rules.

The particular operations of arithmetic depend in their details on the system of characters by which numbers are represented. Our arithmetic, which is constructed on the denary system of notation, would be entirely changed if more or fewer characters than ten were employed. The Romans used a different notation, and their rules of arithmetic were entirely different from ours. But all arithmetic, in whatever manner numbers may be represented, is ultimately reduced to the four operations or rules already mentioned. Strictly speaking, indeed, the fundamental rules may be reduced to two, addition and subtraction; for multiplication is only an abridged method of repeatedly adding the same number to itself, and division only an abridged method of repeatedly subtracting one number from another.

The numeral system of the Romans was very ill adapted to the purposes of arithmetical calculation; and, hence, in keeping their accounts, and in all their commercial transactions, they made use of the abacus. The astronomers of Greece contrived an ingenious system, by means of which they were able to perform the most complex arithmetical operations. (*See* NOTATION.) The Indian numerals, on which the modern system of practical arithmetic is founded, were received from the Saracens of Spain, and appear to have been partially introduced into the other countries of Europe in the fourteenth century; but there is no evidence of their having come into general use before the invention of printing. The facility afforded by the Indian numerals in the performance of all numerical calculations has been one of the main causes of the great and rapid advancement of modern mathematical science.

The first complete treatise on practical arithmetic, in which the numerals now in universal use were employed, was written by Tartalea, and published in the year 1556. It consists of two books, the first containing the application of arithmetic to the purposes of civil life; and the second the foundations of the principles of algebra. A less perfect treatise had been published by Tunstall in 1526, and another by Stifel or Stifelius, 1544: since that time works on the science have been almost infinite.

Arithmetic acquires several distinctive appellations, from the particular manner in which it is used, or the purpose to which it is applied: thus,

Binary Arithmetic. The art of expressing and combining numbers by pairs, and by means of two cha-

racters only. A system of arithmetic of this sort was invented by Leibnitz, and also by De Lagni, and traces of it have been found in the early monuments of China. Suppose the two characters to be 1 and 0; the zero multiplying any number after which it is placed by 2, as in the denary scale, it multiplies the preceding number by 10, the first ten numbers on the binary scale would be represented thus: 1=one, 10=two, 11=three, 100=four, 101=five, 110=six, 111=seven, 1000=eight, 1001=nine, 1010=ten.

Decimal Arithmetic, which requires a series of ten characters, the progression proceeding according to the powers of ten. It is this which is universally employed by modern nations; the term, however, is generally applied to those operations in which fractions occur, the fractions proceeding according to the descending powers of ten; that is, the unit is considered as divided into tenths, the tenths into hundredths, and so on. It is very remarkable that the Hindoos, who have so long been acquainted with the denary notation, are still ignorant of its application to fractions. The Moors, from whom it was transplanted into Europe, were equally unacquainted with this application. The invention of decimal fractions, which has doubled the efficiency of our arithmetical system, is generally ascribed to Regëomontanus.

Duodecimal Arithmetic, in which the multiples and divisors of unity proceed according to the powers of 12. This is adapted to our system of lineal and superficial measures, in which the foot is divided into 12 inches, the inch into 12 lines, &c., and is accordingly generally used by artificers.

Sexagesimal or *Sexagenary Arithmetic*, which descends by the powers of 60. The system of subdivision was introduced into the Alexandrian school by Ptolemy, for the purposes of astronomical calculation. The partition of the circumference of the circle into 360 degrees, was probably founded on the property that the chord of one-sixth of the circumference is equal to the radius. Having divided the radius into 60 equal parts or primes, the angle of the hexagon naturally followed the same division; hence, one part or prime was equivalent to the 360th part of the whole circumference. The degree was by analogy subdivided into 60 minutes, the minute into 60 seconds, and so on. Ptolemy ascribes the reason of adopting this method of division to the facility which it affords in calculation; and his commentator Theon adds that 60 is the most convenient of all numbers, inasmuch as being sufficiently small it has a considerable number of divisors.

Political Arithmetic. The application of arithmetic to researches connected with civil government, such as the number of inhabitants of a country, the quantity of food necessary for their consumption, the labour they can accomplish, the mean duration of life, the produce of the soil, the frequency of fires or shipwrecks, &c. In applying arithmetic to inquiries of this sort, we have three principal objects in view; the first is to procure precise facts; the second to deduce from the observed facts the consequences to which they lead, and the third to determine the probability both of the facts and the consequences. (*See* STATISTICS.)

Universal Arithmetic. The name given by Newton to algebra, or the calculation of magnitudes in general. The operations of ordinary arithmetic are founded on two distinct classes of principles; the first are independent of the particular signs by which numbers are expressed, the second depend on those signs. The general properties of numbers, which are independent of any particular system of notation, form the subject of universal arithmetic.

ARITHME'TICAL COMPLEMENT — of a number is what it wants of the next higher decimal denomination. Thus 4 is the arithmetical complement of 6, because it is what 6 wants of 10. In like manner 43 is the arithmetical complement of 57, and 432 of 568: the number and its complement, when added together, always producing a sum which is expressed by 1, followed by as many ciphers as there are digits in the number. It is used in logarithmic calculation to avoid the trouble of subtraction: for example, if two logarithms are given, and a third is to be subtracted from their sum, the whole operation may be performed at once, by writing the reciprocal of the logarithm to be subtracted, and adding the three together.

Arithmetical Mean between two numbers is a number such that its excess above the first is equal to its defect from the second, or it is a number equal to half their sum: thus 10 is an arithmetical mean between 7 and 13. An arithmetical mean among any number of quantities is found by adding all the quantities together, and dividing by the number. Thus, let there be six numbers, 1, 3, 4, 6, 7, 9; a mean among them is 5, for their sum is equal to 30, and 30 divided by 6 gives 5.

Arithmetical Progression. A series of three or more numbers, such that each differs from that which precedes or follows it by the same number: thus, 3, 5, 7, 9, 11, form an arithmetical progression, in which the common difference of the terms is 2. The general expression of this progression is a, $a+d$, $a+2d$, $a+3d$, &c.

Arithmetical Proportion. Four numbers are said to be in arithmetical proportion, when the difference between the first and second is the same as the difference between the third and fourth: for example, 2, 5, 6, 9.

Arithmetical Ratio. The difference between any two terms of an arithmetical progression.

ARMA'DA. (Spanish military or naval force.) This name is peculiarly applied in English history to the fleet assembled by Philip II. in 1588, for the conquest of England. The Spaniards, with their usual inflation of language, termed it "Invincible." It consisted of 150 ships, carrying 2650 guns, and having on board 20,000 soldiers, besides volunteers, and 3000 seamen. The account of its misadventures and dispersion is well known. The reader who is curious to consult a new and careful relation of this celebrated passage in history, will find it in Southey's *Naval History of Great Britain*, forming a part of the *Cabinet Cyclopædia*. The best Spanish account of the transaction will be found in Herrera.

ARMADI'LLO. A Spanish epithet, applied to a genus of small South American macronykous or edentate quadrupeds, characterised by a defensive armour of small polygonal bony plates, which covers the head, trunk, and sometimes the tail. Linnæus applied to this genus the term Dasypus, by which the Greeks, with more propriety, designated the hare and rabbit.

AR'MAMENT. (Lat. *Armamentum*.) A force equipped for war, naval or military. In Roman antiquities, armamenta comprehended the rigging and tackling of a ship, its sails, sailyards, oars, ropes, &c. Hence "Arma" denotes the sails (Virg. Æn. v. l. 55.) and the rudder (ib. vi. l. 353.) of a vessel.

ARMI'LLA. (Lat. armilla, *a bracelet*.) In Ornithology, the coloured circle of the distal naked end of the tibia, above the tarsal joint.

ARMI'LLARY SPHERE. (Lat. armilla, *a bracelet*.) An ancient astronomical machine, composed of an assemblage of hoops or circles, representing the different circles of the system of the world, as the equator, the ecliptic, the colures, &c. put together in their natural order, and occupying their proper relative positions.

ARMI'NIAN CHURCH. The Arminians are Christians of the Eutychian or Monophysite doctrine, which recognises only one nature in the Saviour, viz. the Divine; and the procession of the Holy Ghost from the Father only. They hold the seven sacraments of the Romish Church, and the doctrine of transubstantiation: their clergy is also divided into secular and regular. From the wide dispersion of the Arminians over the commercial regions of the east, their form of Christianity is also considerably diffused, although it appears to be strictly a national church of which none but Arminians are members. Since the last war between Russia and Turkey (1829), the place where the principal of their four patriarchs resides (Etchmiadzine), has been transferred from the latter to the former government. There is also at Constantinople, and in other parts of the Levant, an Arminian Roman Catholic Church, owning the supremacy of the Pope. There is a well known congregation of Arminian monks on the island of San Lazaro, near Venice, who have published a variety of useful works in the language of their country.

ARMI'NIANS. Those who hold the tenets of Arminius, a Protestant divine, born in Holland in the year 1560. They are thus summed up: —

1st. God from all eternity determined to save all who he foresaw would persevere in the faith, and to condemn all who should continue in unbelief.

2d. Christ atoned for the sins of all mankind, but those only who believe partake of the benefit of that atonement.

3d. Man is of himself incapable of true faith; therefore regeneration by the Holy Spirit, given of God through Christ, is necessary.

4th. All good works are to be attributed to the grace of the Holy Spirit, which, however, does not force a man against his own inclination.

5th. God gives to the truly faithful the means of continuing such. With respect to the possibility of a defection from this state of grace, Arminius and his immediate followers expressed themselves undecidedly; but it came afterwards to be considered a part of the character of Arminianism to affirm the possibility.

The assertors of these opinions in Holland were vehemently attacked by the Calvinistic party, which was prevalent at the time; and in 1610 the Arminians addressed a petition to the States of Holland for protection, from which they derived the name of Remonstrants. In the year 1618, nine years after the death of Arminius, the synod of Dort was convened by the States General, and a hearing given to both parties. The Arminian opinions were defended by Episcopius, divinity professor at Leyden; but his side complained that they were unfairly treated, and the conditions of the discussion violated to their prejudice. They were condemned by the Synod,

and treated in consequence with great severity, being forbidden to exercise the ministry in public: many of them fled to Antwerp, France, and other quarters.

From this period their opinions underwent a considerable change; and the articles above stated, which seem little different from the tenets of the Lutherans, began to be so explained as almost to do away entirely with the idea of the necessity of succour from the Holy Spirit. From hence they proceeded to reject many matters of faith, and to simplify materially the articles requisite for salvation. They proposed to draw up such a comprehensive and liberal scheme as should embrace all Christians, with the exclusion of the Romanists. They considered it sufficient that a man should receive the Holy Scriptures as the rule of faith, and allowed each individual to interpret them for himself, only adding thereunto the necessity of moral duties and good works. The Papists were excluded on the score of morality, as admitting the lawfulness of persecution.

There is no longer any particular sect to which the name Arminian is exclusively applied; but the opinions above stated are adopted in England by one branch of the Methodists, who follow therein the views of their founder Wesley, and by many individuals of the church of England, and other denominations. The articles of the English church have been represented by different parties as inclining both to Arminianism and Calvinism; and Whitby, and Taylor, bishop of Norwich, are among the most famous of her friends who have maintained the Arminian tenets.

A'RMISTICE. (Lat. armistitium.) In National Law, a truce or suspension of hostilities.

A'RMOUR. (Lat. armatura.) A term applied to those artificial means by which man is wont either to protect himself or to annoy his enemy, hence called defensive and offensive. *Defensive* armour includes those arms specially used for the defence or protection of the body, as cuirasses, helmets, &c. The materials used in their construction are exceedingly multifarious, varying in many instances according to the products of the country in which they are fabricated, but depending in general on the judgment and experience of the inhabitants. *Offensive* arms, or those used in attack, are of different kinds; 1. For cutting, such as the sabre; 2. For thrusting, such as the straight sword, the bayonet, pike, lance, &c.; 3. For throwing, such as the mortar, rocket, howitzer, &c.; and lastly, for shooting, such as guns, pistols, carabines, rifles, and cannons. Lucretius traces the progress of offensive arms very minutely: —

> "Arma antiqua manus, ungues dentesque fuere,
> Et lapides et item sylvarum fragmina, rami
> Et flammæ, atque ignes postquam sunt cognita primum;
> Posterius ferri vis est, ærisque reperta;
> Et prior æris erat quam ferri cognitus usus."

The history of armour is identified with that of every nation; and an elaborate discussion of this subject would throw great light upon questions of mythology, poetry, jurisprudence and civil polity, and strikingly display the progress of civilisation. Into such details, however, our limits necessarily preclude us from entering, and we can only refer the reader to Meyrick's work upon this subject (3 vols. 4to. London, 1824), which the student of the politics, arts, manners, and wars of antiquity and the middle ages, may consult with great benefit.

ARMS, or ARMORIAL BEARINGS. In Heraldry, the name given to the devices borne on shields or coat armour. Family coats of arms are divided by heralds into perfect and imperfect. Perfect are, 1. Abstract, or warranted by regular descent. 2. Terminal, belonging to the brethren of the right line. 3. Collateral, borne by brethren of the heir male. 4. Fixal, in third degree by right line of male heirs. Imperfect are, 1. Granted by the king, with a lordship. 2. The gift of a king, derived by a herald. 3. The ensign of a Saracen won in the field. 4. Heir female of close branch. 5. Arms of bastardy.

A'RMY. (Fr.) Lit. men in arms. A body of men organised and disciplined for military service, commanded by a chief or leader, with subordinate officers in regular gradation, and supported both in time of peace and war for the preservation of internal quiet and defence against foreign aggression. An army is generally divided into a certain number of corps, each consisting of brigades, regiments, battalions, and squadrons. When in the field it is formed into lines: the first is called the vanguard, the second, the main body; the third, the rear-guard or body of reserve. The middle of each line is occupied by the foot; the cavalry forms the right and left wing of each line, and sometimes squadrons of horse are placed in the intervals between the battalions. In the history of armies we may distinguish those of three different periods: 1. The ancient armies, which, from the time of Sesostris downwards, underwent a series of progressive improvements under the Persians, Greeks, and Carthaginians, till they finally reached a high degree of perfection under the Romans. 2. Those of the middle ages, the offspring of the feudal system, which, however well calculated to keep alive a spirit of ferocity, opposed a fomidable barrier to the revival of the military art, from their contempt of discipline and utter lawlessness. 3. Those that have existed since the invention of gunpowder and the establishment of standing armies. Since the use of gunpowder there have been seven principal periods in the history of the military art. The first extends from the early part of the fourteenth to the end of the fifteenth century. The second begins with the campaign of Charles VIII. in Italy, and extends to the commencement of the wars in the Netherlands, comprising the wars of the French, Germans, and Spaniards in Italy. The third period comprehends the great war of independence, waged by the Netherlands, in order to shake off the yoke of Spain, and extends from 1568 to the general suspension of hostilities in 1609. The fourth period comprises the celebrated Thirty Years' War, and extends from 1618 to 1648. The fifth period comprehends the wars of the French in Italy, Germany, and the Netherlands, as well as the Northern and Turkish wars, and embraces the space of 90 years, viz. from 1648 to 1738. The sixth period includes the three Silesian wars, viz. from the beginning of the first Silesian war in 1740, to the breaking out of the French Revolution in 1792. During these several periods many improvements took place in the composition and discipline of armies; but these were destined to be far surpassed in the seventh and last period, which embraces the military systems and establishments of our own times. In the organisation of the Continental armies great uniformity prevails; but as these are inseparably connected with the political condition of the people, a consideration of their character belongs to the history of these various nations, to which we must refer the reader. The British army, like those of the Continent, is divided into cavalry, infantry, and artillery, and these again into regiments and battalions; but in its composition and organisation an entirely different principle is adopted. While the Continental armies are recruited by conscription, and every officer must have served as a private or a cadet, or have acquired some knowledge of the military art in a preparatory establishment, the ranks of the British army are supplied by voluntary enlistment, and commissions are, with rare exceptions, only attainable, with or without purchase, as a favour from the commander-in-chief. In addition to the officers attached to each separate regiment, the superintendence of the whole army in its various departments and ramifications is entrusted to a commander-in-chief, a secretary at war, a master-general of the ordnance, a paymaster-general of the forces, an adjutant-general, and a quartermaster-general. There are, besides, a board of general officers for the clothing of the army, an inspector of army colours, commissioners of the military college, and commissioners of the military asylum. (For an account of armies in general, vide *Encyc. Brit.* art. *Army*; of the British army, *M'Culloch's British Statistics*; of the Russian, Italian, and French armies, Tanski, Oudinot, and Daniel.)

A'RNOLDISTS. The followers, or rather partisans, of Arnold of Bresica, who in the twelfth century was the first to raise his voice against the abuses and vices of the papacy. He acquired for a time considerable influence among the lower orders, and the tumults which were raised by his supporters caused great uneasiness in Rome, which was the chief scene of his proceedings. He was finally put down by an armed force, made prisoner, and burnt by Pope Adrian IV. Certain heretical notions on the nature of the Eucharist were charged against him; but the insurrection which arose under his auspices was clearly a political disturbance, and his harangues seem to have been directed rather against the morals than the tenets of the church which he attempted to overturn.

ARNO'TTO. *See* ANNOTTA.

ARO'MA. The characteristic odour of substances, especially the strong and peculiar odours of certain plants, whence the term *aromatic*.

ARPE'GGIO and ARPEGGIA'TO. (It. arpeggiare, *to play on the harp.*) In Music, the striking or bowing, if on an instrument of the violin species, the notes of a chord in quick and repeated succession, so as to imitate the harp.

ARQUEBUSA'DE. (From arquebus, *a hand gun.*) An aromatic spirituous lotion, applied to strains and bruises, but originally invented as an application to wounds inflicted by an arquebus.

A'RQUEBUSE, or HARQUEBUSE. A sort of hand gun, used by infantry before the invention of the musquet. The word is of uncertain derivation: the Italian archibuso is said to come from arco, *a bow*, and busio, or bugio, but the meaning of this last seems unsettled. The word is used very loosely in old writers for every sort of fire-arms used by infantry. Gunsmiths are still called arquebusiers in France. In the German, Spanish, and Gascon infantry of the earlier part of

the sixteenth century, the pike and arquebuse-men were intermixed in the same ranks. The barbarous English words hackbut, hackbutteer, which we find in military language in the reign of Elizabeth, are derived from arquebuse, arquebusier. The arquebuse is said to occur first in the descriptions of the battle of Morat in 1476. Arquebusiers on horseback are mentioned in that of the battle of Fornosa, 1494.

ARRACA'CHA. The South American name for an umbelliferous plant, the arracacia esculenta of botanists; whose fleshy sweet roots are cultivated in Columbia and Jamaica, in the mountainous parts of those countries, in the same way as parsnips and carrots in Europe. The roots are of large size, and in quality are when cooked between a sweet chestnut and a parsnip. Attempts to introduce it into common European cultivation have uniformly failed.

ARRA'CK. A spirituous liquor, obtained by distilling the fermented produce of rice; but other spirituous liquors are called by the same name. Arrack has a very strong and somewhat nauseous flavour and odour, derived from a peculiar volatile oil which it contains, and which corresponds with that which gives a sickly and disagreeable taste to our corn spirit.

ARRAI'GNMENT. In Law, the arraignment of a prisoner on a criminal charge consists in calling him to the bar, and (in treason and felony) making him hold up his hand, or otherwise own himself to be the party charged, reading the indictment to him in English, and demanding of him his plea (guilty or not guilty), and entering it accordingly.

ARRE'ST. In Law, in execution of the command of some court of record or officer of justice, may take place either in criminal or civil cases. 1. For treason, felony, or breach of the peace, any person may arrest without warrant or precept. Arrests by public officers may be made either with or without process. Any constable, or even private person, who has a warrant directed to him from a justice of the peace to that effect, may arrest for felony or misdemeanor; and, if the warrant was given without sufficient ground, the justice is responsible. Every warrant should be under the hand and seal of a justice of peace, and specify the day on which it was made out: it seems to be rather discretionary than necessary, although it is usual to specify the cause of arrest in the warrant. 2. Arrest in a civil cause is by process, in execution of the command of some court or officer of justice. On affidavit of a cause of action to the amount of 20*l.* (such cause of action importing a contract or liability, express or implied, and a breach of such contract, and a present debt overdue, unless in some rare cases, in which special orders to hold to bail are given for the causes of action), the plaintiff obtains a writ of capias, which is the proper process for the arrest of one or more defendants who are at large. When a defendant is already in custody in one of the prisons of the superior courts, a writ of detainer to continue such imprisonment at the suit of the new plaintiff is the proper proceeding. The form and effect of the writ of capias (*see* Capias), on which arrest on mesne process takes place, are now regulated by the Uniformity of Process Act, 2 W. 4. c. 39. The sum specified in the affidavit, the sum bonâ fide claimed for debt and costs, and various other particularities, must be indorsed on the capias. A writ of capias may, like a writ of summons, be merely served on the defendant; but when it is intended to arrest, a sheriff's warrant is obtained, on which the defendant is arrested, and a copy of the writ then delivered to him. Arrest must be made within the county, and at any time within four months after the date of the capias, except Sundays, Christmas-day, and Good Friday. If the writ or warrant is so defective as to be absolutely void, the party arrested might legally resist; but if the process were only irregular, such resistance would be an indictable offence. On arrest, the defendant and two sureties usually execute what is termed a bail-bond, conditioned for causing special bail to be put in. (*See* Bail.) But instead of giving bail, he may put into court the sum indorsed on the writ, together with a further sum for costs.

Arrest on a writ of execution (*see* Capias ad Satisfaciendum) is an absolute and perfect execution of the highest nature against the defendant, under which the debtor is imprisoned until satisfaction is made, unless discharged under the Insolvent Act.

A'RRIS. (Probably abbreviated or corrupted from a risega, Ital. *at the projection*, or from the Saxon ariſan, *to arise.*) In architecture, the edge of two surfaces meeting each other, or line of concourse of two planes.

A'RROW ROOT. The commercial name of the starch obtained by washing the grated root of the masanta arundinacea, which it yields to the amount of twenty-five to thirty per cent. It is sometimes adulterated with potato starch, and the fraud is not easily detected; it, however, gives a disagreeable flavour and smell, like that of the raw potato, and forms a less firm jelly with hot water than when the arrow root is genuine.

A'RSENAL. (It. arsenale, from arx, *a citadel.*) A magazine of military stores, or public establishment where naval and military engines are manufactured or stored.

A'RSENIC. (Gr. *ἀρσενικός, strong.*) A very soft, brittle, and eminently poisonous metal, of a steel grey colour: its sp. gr. 5·7. It volatilizes, exhaling a strong odour of garlic, before it fuses, at a temperature of 365° F., and is easily inflammable. It combines with oxygen in two proportions; and as both compounds are sour, and form salts with bases, they have been termed arsenious and arsenic acids: the former is composed of 38 arsenic and 12 oxygen, and the latter of 38 arsenic and 20 oxygen. Arsenious acid is more commonly known under the name of *white arsenic*, and is the usual state in which this poison occurs in commerce; it is obtained during the extraction of several of the metals from their ores, and is a white brittle semitransparent substance, having little taste, but is virulently poisonous. Its sp. gr. is 3·7. It forms a dull white powder, and it is in this form that it is usually sold. When heated in the flame of a candle, it rises in the form of a white poisonous vapour, and exhales, in consequence of its partial reduction, a strong garlicky smell: 1000 parts of cold water dissolve about $2\frac{1}{2}$ of white arsenic; but when the water is boiled with the arsenic, 1000 parts take up between 77 and 78; and this solution, after standing a few days, deposits rather more than half of the white arsenic, in the form of small crystals, retaining about 30 grains in permanent solution. White arsenic dissolves in the alkalies, and combines with the metallic oxides, forming a class of salts called *arsenites:* they are all poisonous. Of these the arsenite of potash is used in medicine, under the name of Fowler's mineral solution: it is employed in very small doses in the cure of agues, and is an effective remedy, but requires much care in its administration.

When white arsenic is taken as a poison, that is, in large doses, it produces violent spasmodic pains of the stomach and bowels, attended by a sense of heat, and constriction in the mouth and throat, an increased flow of saliva, tightness about the head, itching of the face and neck, and nausea. These symptoms are succeeded by vomiting and purging and excruciating pains; the pulse, at first full, hard, and frequent, sinks and becomes irregularly feeble, and clamminess of the skin, cold sweats, purple spots, and convulsions precede death; or if the patient escape this catastrophe, it often happens that hectic fever, paralysis, and mental and bodily debility attend him for the remainder of his days. It is often said that the bodies of persons poisoned by arsenic are very prone to putrefaction; but this does not appear to be always the case. After death the stomach and bowels are usually found inflamed, but often only slightly so; and it appears from Sir B. Brodie's observations, that this poison kills by some peculiar action upon the heart and nervous system. The treatment of persons thus poisoned consists in promoting the vomiting by an emetic, composed of a solution of 20 grains of sulphate of zinc in two ounces of water, aided by copious draughts of warm barley-water or gruel; but the most effective means of getting rid of the arsenic, is by the use of the stomach-pump, which, when immediately resorted to, has often saved the patient. The after treatment requires much circumspection.

The only ready means of ascertaining the presence of white arsenic is by heating the suspected substance upon a red-hot coal, or in the flame of a condle or spirit lamp, when it will exhale the peculiar arsenical odour resembling that of garlic; but the treatment of persons poisoned by arsenic, and its detection in doubtful cases, must be left to the medical man and the chemist. It is impossible too strongly to represent the evil which results from the unfettered sale of arsenic, and from the unwarrantable use of it as a poison for rats, and as a veterinary remedy, for it is thus that it finds its way into culinary vessels, gets accidentally mixed with articles of food, and that bottles which have contained it are used for beer, wine, vinegar, or medicine: its sale should be rigidly prohibited.

Arsenic acid is more soluble and sour, but equally poisonous with the arsenious acid. Its salts are called *arseniates*, and the arseniate of potash obtained by deflagrating a mixture of white arsenic and nitrate of potash is occasionally used in medicine: it is the active ingredient in the tasteless ague drop.

A'RSIS and THESIS. (Gr. *ἄρσις, lifting up, θέσις, laying down.*) In Music, terms used in composition, as when a point is inverted or turned, it is said to move *per arsin et thesin*, that is, when it rises in one point and falls in another; properly speaking, it is the rise and fall of the hand in beating time.

A'RSON. (Lat. ardeo, *I burn.*) At Common Law, signifies the maliciously and voluntarily burning the house of another. This offence is now defined and regulated in its various degrees by the stat. 7 & 8 G. 4. c. 30. The subjects of arson are defined in two sections of this statute: the first, relating to buildings of every descrip-

tion, the latter to stacks of vegetable productions, (both these classes of offences being capitally punishable), and to crops of corn, &c. standing or cut down, plantations, heath, &c., the firing of which is punishable with transportation for seven years.

ART. (Lat. ars.) The application of knowledge or power to effect a desired purpose. The ancients divided the arts into "artes ingenuæ, bonæ" or "liberales," and "artes serviles." Under the latter were comprehended the mechanical arts, because these were practised only by slaves. The former were summed up in the Latin verse,

"Lingua, Tropus, Ratio, Numerus, Tonus, Angulus, Astra;"

and the latter in the pentameter,

"Rus, Nemus, Arma, Faber, Vulnera, Lana, Rates."

In modern times arts are divided into fine and useful, comprising under the former those which have not utility for their direct or immediate object; such as music, poetry, sculpture, &c. (For the history and description of the fine and useful arts, see the respective articles.)

ARTEMI'SIA. (Artemis, *one of the names of the goddess Diana.*) A composite genus consisting of bitter or stimulating plants, of which wormwood, southernwood, and tarragon form a part.

ARTERIO'TOMY. (Gr. ἀρτηρία, *an artery*, and τέμνω, *I cut.*) The opening of an artery: this operation is occasionally performed upon the temporal artery, with a view of relieving inflammatory symptoms about the head.

A'RTERY. (*See* AORTA.) These vessels are usually found empty in the dead body, and were supposed by the old anatomists to be air tubes; they are ramifications of the aorta, and convey the florid blood with a pulsating motion to the different organs and parts of the body.

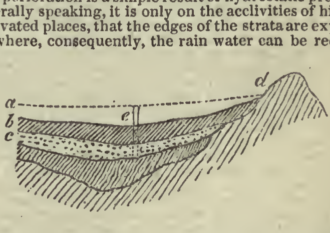
ARTE'SIAN FOUNTAINS, or ARTESIAN WELLS. (Fr. Puits Artésiens.) Vertical perforations of the exterior crust of the earth, of small diameter, and frequently of great depth, through which subterraneous water arises to the surface, often forming abundant and elevated jets. The name Artesian is derived from Artois, a province of France, where especial attention has been given to this means of obtaining water; but it appears, from sufficient historical evidence, that wells of this kind were perfectly well known to the ancients. Niebuhr cites a passage from Olympiadorus, who flourished at Alexandria about the middle of the sixth century, in which it is stated that when wells are dug in the Oasis to the depth of two hundred, three hundred, or sometimes five hundred yards, rivers of water gush out from their orifices of which the agriculturists take advantage to irrigate their fields. The oldest Artesian well known to exist in France is in the ancient convent of the Chartreux, at Lillers in Artois. It is said to have been made in 1126. Others exist at Stuttgard, of great antiquity, though their dates cannot be fixed with precision. The inhabitants of the great desert of Sahara appear also to have been long acquainted with this mode of obtaining water, and the Chinese are said (but the truth of the statement is questionable) to have practised it for thousands of years.

Various conjectures have been made as to the source of the water which comes from the Artesian wells. It was long believed that the water of the sea must necessarily penetrate by way of infiltration into the interior of the continents, and at length form large bodies of subterraneous waters, which, excepting for capillary influences, would not rise above the general level of the ocean. Another opinion, maintained by Aristotle, Seneca, Cardan, and even Descartes, was, that the subterraneous water, from which the sources of rivers and springs are supplied, is the product of the condensation of aqueous vapours ascending from the interior parts of the earth in consequence of the central heat. But these hypotheses are founded on mere conjecture, unsupported by the slightest evidence, and consequently merit no attention. The simplest and most natural explanation is, that the water of ordinary wells, of Artesian fountains and rivers, is supplied by the rain which falls on the surface at a higher elevation, and which penetrates through the pores and fissures of the ground till it meets with some impermeable stratum, or is collected in subterranean reservoirs. It has been objected that springs are sometimes situated on or near the summits of mountains, which could not be supplied in this way; but on an attentive examination of all the circumstances, that is to say, on measuring accurately the extent of surface at a greater elevation than the spring, and comparing it with the quantity of rain that falls annually in the same climate, it has been found, in every instance, that the aqueous deposition from the atmosphere greatly exceeds the supply from the spring. It is computed that not more than a third part of the rain which falls in the valley of the Seine is conveyed to the sea by the river; the remaining two-thirds support vegetation, supply fountains and springs, or are returned to the atmosphere by evaporation. The immense bodies of water which some continental rivers roll towards the ocean are but a small part of the rain which falls in the surrounding countries.

Assuming, then, that the subterraneous water is supplied from atmospherical deposition, it remains to be explained how it arrives at the situation it occupies in the interior of the earth, and by what forces it is raised from great depths to the surface.

All persons who have paid the slightest attention to geology are aware that in stratified countries (and it is in such only that Artesian wells exist) different beds of rocks are superposed on one another, and ranged in a certain constant order. The strata sometimes follow a horizontal direction for a considerable extent of country; at other places they are inclined, and even placed perpendicularly to the horizon, having the appearance of having been bent and burst through by the action of a powerful force from beneath. In those cases the edges of the strata are often exposed, especially on the summits and flanks of hills, to the action of the atmosphere. Between the strata are frequently found beds of permeable sand, through which water, coming in contact with them, must necessarily pass, first, through the inclined part by virtue of its specific gravity, and then in the horizontal branches, by virtue of the pressure of the water remaining in the elevated portions of the strata. In this manner the water insinuates itself between the different strata; and hence we may expect that in localities where the tertiary stratification prevails, as many distinct sources of subterraneous water will be met with in penetrating perpendicularly through the surface, as there are distinct layers of a sandy or gravelly nature reposing on impermeable strata. This consequence of the theory is perfectly confirmed by experience. M. Arago mentions, that in digging for coal near St. Nicholas d'Aliermont, a short distance from Dieppe, seven distinct and copious sources of water were found, the respective depths of which were: 1st, between 80 and 100 feet; 2d, 328 feet; 3d, from 570 to 590 feet; 4th, from 690 to 710 feet; 5th, 820 feet; 6th, 940 feet; 7th, 1090 feet; and the occasional force of each source was very great. Similar occurrences are frequent in the neighbourhood of London, and are familiar to all miners. But it is not enough that the structure of the country is such that water can percolate between the different strata; the phenomena of Artesian fountains could not be explained without supposing it to be collected in large quantities, and forming subterraneous reservoirs of immense extent. That such reservoirs exist, no doubt can be entertained. The celebrated fountain of Vaucluse sends forth at all times a stream of water sufficient to form a considerable river. Even in the driest seasons, when the water is least plentiful, it produces 4780 cubic feet per minute. After great rains, its product is thrice as great. The mean quantity emitted is 9360 cubic feet per minute, or about 5030 millions of cubic feet in a year. Many other examples of the same kind might be cited; showing that water must not only be collected in subterraneous cavities in immense quantities, but that it also passes freely from one place to another. In fact the disposition of the rocks in strata permits the water to be collected under the surface, and to be conveyed without waste, as if in close pipes.

According to the view which has now been taken of the manner in which subterraneous water is collected, its elevation to the surface through a natural fissure or artificial perforation is a simple result of hydrostatic pressure. Generally speaking, it is only on the acclivities of hills, or in elevated places, that the edges of the strata are exposed, and where, consequently, the rain water can be received



under beds of impermeable materials. Conceive two strata of clay or rocks as *a* and *b*, having a bed of sand or other matter permeable to water interposed, and suppose that *d* is the place where the edges of the strata crop out, or where a fissure allows a free entrance of the water to the permeable stratum. The water at first descends through the effect of gravity; it then passes along towards *b* in consequence of the pressure exercised by the superior part of the column near *d*. Now suppose a perforation to be made at *e*, and continued till it reaches through the stratum *a*, the water will naturally continue to rise till it gains the same altitude as *d*, or at least till it reaches the surface if below that altitude. The water in fact between the two impermeable strata is in the same circumstances as in an artificial pipe; and if the surface

of the ground at *e* is considerably lower than *d*, the ascensional force may be sufficient to cause a considerable jet.

Some Artesian fountains, for example that at Lillers in Artois, are situated in the middle of immense plains, where not the most insignificant hill is to be seen on any side. In such cases it may be inquired where we are to look for those hydrostatic columns whose pressure causes the rise of the subterraneous water to the level of the lowest points? The answer is obvious: we must suppose them placed beyond the limits of view; at the distance of 50, 100, or 200 miles, or even at a greater distance. The necessity of supposing the existence of a subterraneous liquid column of two or three hundred miles of extent cannot appear a serious objection, when it is considered that the same geological structure has been found to prevail sometimes over even a much greater extent of country. An interesting paper on this subject is given by Arago, in the "Annuaire du Bureau des Longitudes," for 1835.

ARTHRI'TIC. (Gr. ἀρθρῖτις, *the gout*, or from ἄρθρον, *a joint.*) Gouty pains, chiefly affecting the joints.

ARTHRO'DIC. (Gr. ἀρθρώσις, *articulation.*) A connection of bones in which the head of one is received into a very superficial cavity in another, so as to admit of motion in almost all directions; as in the joint between the *lumeras* and *scapula.*

ARTHRO'DIEÆ. (Gr. ἄρθρον, *a joint.*) A name given to those algæ which, like conferva and oscillatorias, have an articulated structure.

ARTHRODY'NIC. (Gr. ἄρθρον, *a joint*, and ὀδύνη, *pain.*) Rheumatic and other painful affections of the joints.

A'RTICHOKE. (Kharciof, *the Arabic name of the plant.*) A thistle-like plant, called by botanists cynara scolymus, a native of the south of Europe, and now cultivated for its "bottom," that is, for the sake of the fleshy sweet receptacle of its flowers; the harsh hairy substance that is pulled away consists both of the hairy paleæ of the receptacle, and of the feathery pappus of the ovaries. The dried artichokes, called by the French "culs d'artichaut," are the receptacles deprived of the choke and the spiny hard hairs of the involucre, blanched by immersion in boiling water and dried in the sun. Jerusalem artichokes are quite different; they are the tubers of helianthus tuberosus, and derive their name, not from the Holy City, but from a corruption of the Italian *girasole*, a sunflower.

A'RTICLE. A part of speech prefixed to substantives in order to render their signification more or less definite. (*See* GRAMMAR.)

A'RTICLES OF FAITH are the particular points of doctrine which together make up the sum of the Christian belief. The various churches of Christendom, not being agreed upon all these points, have for the most part set forth their own expositions of the whole; and it is to these creeds, symbols, or confessions, that the term articles is most commonly applied. The articles of the English church are 39 in number; the substance of which was first promulgated in 42 articles by Edward VI., in 1553. Under Henry VIII. a committee had been appointed for the formation of ecclesiastical laws, which was renewed under his successor; and in 1551, according to Style, "the archbishop (Cranmer) was directed to draw up a book of articles for preserving and maintaining peace and unity of doctrine in the church, that, being finished, they might be set forth by public authority." From this and the details that follow, it seems that Cranmer composed the articles in their original form, with the assistance of Ridley and others. A great similarity in thought and expression may be traced between many of the articles and the language of the Augsburg Confession: the XIth Article (on justification) corresponds with what Cranmer had previously written on the subject in private memoranda. There has been considerable question raised as to the authorities from which the XVIIth Article (on predestination) is derived; for while some persons have interpreted expressions in it according to the Calvinistic system, others have denied the justice of such interpretation, and have undertaken to show that Cranmer must have referred in the composition of the article to the writings and sentiments of Luther and Melancthon.

On the accession of Elizabeth these articles were remodelled by archbishop Parker, who omitted four of them, introducing four new ones, and altering seventeen. These were again revised by convocation in 1563, some alterations made, and the number reduced to thirty-eight.

The XXXIXth was restored in a final review by Parker in 1571, and then imposed on the clergy for subscription. It is remarkable that in the manuscripts and earliest editions there is one important variation in the admission or rejection of the first clause of the XXth Article, the authority of which may be considered as virtually recognising and establishing it.

ARTICLES OF WAR, the code of military law embodied in the Mutiny Act, which is passed each year.

ARTI'CULATED. (Lat. articulus, *a joint.*) Literally connected by an articulation or moveable joint; but in plants applied to cases where parts are so slightly connected that they finally fall asunder. Thus a leaf is said to be articulated with its stalk when the two finally fall asunder. A flowerstalk is articulated in the middle when it is contracted, and finally separates there into two parts. This separation is called disarticulating. It is a curious fact that the articulation of plants uniformly takes effect across the longitudinal or woody tissue, and never parallel with it; as in the petiole, in a stem at its nodes, in the middle of legumes and other kinds of seed vessels.

ARTI'CULATES, ARTICULA'TA. A term applied by Cuvier to a primary division of the animal kingdom, characterised by an external skeleton in the form of a series of rings articulated together and surrounding the body; by an internal gangliated nervous system; the ganglinus being arranged symmetrically along the middle line of the body (*see* HOMOGANGLIATA), and by having distinct respiratory organs.

ARTICULA'TION. The connection of the bones of the skeleton by joints.

ARTICULA'TION. In Painting and Sculpture, the moveable connection of the bones, in the representation of which by the artist the greatest skill and knowledge of anatomy is required.

ARTI'CULATE or HOMOGA'NGLIATE. Division of the animal kingdom. See those words.

ARTI'FICER. (Lat. ars, *art*, and facio, *I make.*) Lit. one who makes according to art. Among the Romans, artificers had peculiar privileges. They possessed their own temples, and enjoyed an exemption from personal service. An artificer is one who requires intellectual refinement in the exercise of his profession, in contradistinction to artisan, who may practise either the fine or useful arts, but whose knowledge is limited to the general rules of his trade.

ARTI'LLERY. (Fr. artiller, *to fortify.*) In a general sense, denotes all kinds of missiles used in warfare, with the machines by which they are propelled. Since the invention of gunpowder, however, the term has been chiefly confined to large ordnance, namely, cannon, howitzers, mortars, rockets, &c., with their carriages, ammunition, and apparatus of all kinds, including also the troops especially appointed for their management.

The principal military engines of the Romans, which can be properly classed under the term artillery, were the balista and catapulta; the former for throwing stones, the latter for propelling darts and arrows. The invention of the balista is ascribed by Pliny to the Phœnicians; but other authors, among whom are Diodorus and Plutarch, say that both instruments were invented in Sicily. Ælian ascribes them to Dionysius the elder. They were very extensively employed in the later periods of the republic, and under the empire. In the middle ages, engines for assaulting and defending fortified towns or castles were greatly multiplied. Among these inventions are enumerated the espringal, trebuchet, mangona, mangonel, bricolla, petrary, metafunda, berfrey, war-wolf, &c. It is stated in the chronicle of Peter Langtoft, that Richard I. in his wars against the Saracens, had mills in his barges and galleys which were turned by the wind, and threw fire and stones upon the enemy. If the accounts given of the effects of some of these machines may be credited, they must have been of great power, and well adapted to the purpose of battering down walls and fortifications. It is related by Hemingford, that the engines used by Edward I. at the siege of the castle of Stirling, threw stones of 300 pounds weight.

Though the explosive force of gunpowder was known to Roger Bacon in the twelfth century, it was at a considerably later period that fire-arms began to supersede the ancient artillery. Barbour, in his "Metrical Life of Robert Bruce," says that cannon were used by Edward III. in his first campaign against the Scots, A. D. 1327. Du Cange says they were employed by the French at the siege of Puy Guillaume in 1338; but they must have been at that time very uncommon, for Rapin relates that the four cannon employed by Edward III. at the battle of Cressy, in 1346, contributed as much by the surprise they occasioned to the French troops as by their execution to the success of the day. A few years later they seem to have been no longer rare. The most ancient cannon were formed of bars or pieces of iron, soldered to each other lengthwise, and bound together by iron hoops; occasionally lead, or even leather, protected in the same manner, appears to have been employed; and the cannon balls were made of stone. About the middle of the fifteenth century, cannon began to be cast; and it was about the end of the same century that font metal, or bronze, was first used for this purpose. In 1477, when Louis XI. was about to attack the cities of Flanders and Picardy, he ordered bombards or cannon of prodigious length and weight to be cast at Paris, Tours, Orleans, and Amiens. He also ordered iron bullets to be cast at the foundries of Creil, though stone bullets were still in use. Brass cannon appear to have been first cast in England by John Owen, in 1535. A foundery was also established about the same time in Edinburgh, by Robert Borthwick, an artist in the service of James IV. of Scotland. Mortars were

made in England under the reign of Henry VIII. and cast-iron cannon under that of Edward VI. About the beginning of the 15th century, the custom of applying to cannon the names of birds or beasts, from some fanciful analogies respecting their cruelty or swiftness, began to prevail; thence the names falconet, falcon, sacker, culverin, basilisk, dragon, syren, &c. At present cannon take their names simply from the weight of the ball they carry. Thus a piece which discharges a cast-iron ball of 24 pounds, is called a 24-pounder; one that carries a ball of 12 pounds, is called a 12-pounder; and so on. The size of the gun is determined by the service to which it is appropriated; and frequently by the means of transport, or facility of manœuvring. Ship guns and garrison guns, not requiring to be moved from place to place, admit of large sizes, and are frequently made to carry balls of 32, 36, or even 42 pounds. The largest cannon known to exist is a brass one at Beejapoor, which was cast in commemoration of the capture of that place, by Alum Geer in 1685. Its extreme length is 14 feet 1 inch, the diameter of its bore 2 feet 4 inches. An iron shot of the proper size to fill this bore would weigh 1600 pounds.

Mortars are probably as ancient as cannon, and were employed to throw red-hot iron and stones long before the invention of shells. The first account of shells used for military purposes is in 1435, when Naples was besieged by Charles VIII. The howitzer is a species of ordnance of a medium length between the cannon and the mortar, and is used for discharging either shells or large balls at point-blanc, or at a small elevation. It is said to have been invented by Belidor, and was used at the siege of Ath in 1697. It is chiefly made of brass. The carronade, a very short howitzer, was first cast at the Carron Iron Works; from which it takes its name. It began to be employed about the year 1779. Iron-rockets, the invention of Sir William Congreve, were first used at the bombardment of Copenhagen.

ARTILLERY PARK. The place in a camp, or the rear of an army, where the artillery is placed. The artillery is drawn up in lines, one of which is formed by the guns, the others by the ammunition waggons, pontoons, &c.; and the whole is surrounded by a rope, which forms the park.

ARTILLERY TRAIN. A number of pieces of ordnance mounted on carriages, and ready for service.

ARTISAN. *See* ARTIFICER.

ARTOCA'RPEÆ. (Gr. ἄρτος *bread*, καρπὸς, *fruit; bread-fruit tree.*) A considerable division among urticaceous plants, having the fruit composed of flowers combined in fleshy heads, and the stem flowing with an acrid milk. The bread-fruit tree of the South Seas, and the jackfruit, are among the most conspicuous species. With them are associated the upas tree, and the fig, in different genera. The bread-fruit tree itself (artocarpus incisa) is a small tree with broad lobed leaves and large globular heads of fruit; the jack (artocarpus integrifolia) has oblong undivided leaves, and a larger, coarser, and oblong fruit. In all the species of artocarpeæ the flowers are unisexual.

ARTS, FINE. (Lat. artes.) Works imagined and executed by the mind and ingenuity of man. They include painting, architecture, sculpture, poetry, music, rhetoric, and, according to some, dancing. Their history, as respects the three first, will be found under several heads in this work, and a concise account of the philosophy of them under the article *Æsthetics*. They are distinct from the arts simply so called, commonly called the useful arts from their general utility to mankind, because their end is pleasure. The fine arts are the offspring of genius, their model nature, and their master taste. Characterised by simplicity, they should never wander into luxury nor degenerate into extravagance.

ARUNDINA'CEOUS. (Lat. arundo, *a reed.*) Any thing having the general appearance of a reed. The term is confined to glumaceous plants.

ARU'SPICES. Roman soothsayers, who foretold future events from the inspection of the entrails of the victims offered at the altars of the gods.

Their college was not held in the same respect as that of the augurs, and did not consist, like the latter, of men of high distinction; so much so, that Cicero mentions the admission of one of their order to the senate, as an indignity to that body. Like that of the augurs, their art was brought from Etruria.

ARVI'COLA. (Lat. arvum, *a field;* colere, *to inhabit.*) A genus of rodent, or gnawing mammals, of the numerous family of the rat and mouse (*Muridæ*), distinguished by the prismatic form and fangless structure of the molar teeth, and of which the field campagnol (*Arvicola agrestis*) and the bank campagnol (*Arvicola riparia*) are indigenous species; these are commonly confounded with other *muridæ*, under the name of field mice.

AS. A Roman weight nearly answering to one pound, being accurately equal to 10 oz. 18 dwt. $13\frac{5}{7}$ grs. troy weight. It was divided into 12 ounces (unciæ).

It was also the name of a brass coin, which originally weighed one pound; but was subsequently reduced by various degrees at different periods to half an ounce, in consequence of the gradual increase of the value of meta as compared with that of provisions and other necessaries, as civilisation advanced. Its value was a little more than three farthings of English money.

A'SAPHUS. (Gr. ἀσαφὴς, *obscure.*) A name devised to express the obscure nature of the genus of trilobites, fossil crustaceans, to which it is attached; and which is characterised by a tail-like appendage terminating the posterior extremity of the body, sometimes of a semicircular form, sometimes in the shape of a short triangle, and by tuberculate eyes, which have a granular surface arising from the number of compartments (at least 400) on the surface of the cornea, containing each a separate spherical lens.

ASARABA'CCA. (Asarum, *a kind of plant*, and bacca, *berry.*) A small, round, hard, stemless, hardy European herbaceous plant, with chocolate-coloured three-lobed flowers, belonging to the natural order Aristolochiaceæ. It is reputed to be a sternutatory. The French call it cabaret, the public-house plant, as it is said, because it was formerly used as an emetic to relieve the stomachs of people who had been drinking too hard.

A'SARIN. A crystallisable substance, somewhat resembling camphor, extracted from the roots of the Asarum Europæum.

ASBE'STUS. (Gr. ἄσβεστος, *unconsumable.*) A fibrous soft mineral, composed of easily separable filaments of a silky lustre. It consists essentially of silica, magnesia, and lime. It is sometimes woven into cloth, which is incombustible, and may therefore be purified by fire: hence the term *amianthus*, from ἀμίαντος, *undefiled.* This cloth was used in antiquity to wrap the bodies of the dead when about to be burned, to prevent their ashes being mixed with those of the funeral pile.

ASCA'LAPHUS. A Fabrician genus of insects separated from the ant-lions (*myrmeleon*) of Linnæus, and characterised by having nearly equal palpi; maxilla ciliate; labium horny, rounded, and entire.

ASCA'RIDES. (Gr. ἀσκαρὶς, a term applied by Hippocrates to certain intestinal worms.) In modern Zoology restricted to a genus of round worms, or cælelminthans, with a trilobate or trivalvular head, and a double spiculum for the intromittent organ. Two species of this genus infest the human body; one large, found in the small intestines, called Ascaris lumbricoides; the other of very small size, found in the rectum called Ascaris vermicularis.

ASCE'NDING. (Lat. ascendo, *I climb up.*) Is said of any part which, being horizontal at its base, gradually curves upwards, as is the case in many stems. If applied to ovules, it means that they are attached to the placenta by a point intermediate between the lower end and the middle.

ASCENDING NODE. In Astronomy, is that point of a planet's orbit in which it crosses the ecliptic, proceeding northward. (*See* NODE.)

ASCENDING SIGNS. The signs are said to be ascending when they are eastward from the meridian, and consequently approaching the meridian through the effect of the diurnal rotation.

ASCE'NSION. In Astronomy, is either right or oblique: the RIGHT ASCENSION of a star denotes the arc of the equator intercepted between the first point of Aries and that point of the equator which comes to the meridian at the same instant with the star. The most convenient way of defining the place of a star is to refer it to the equator, and to a certain fixed point in the equator from which the degrees are begun to be reckoned. For this purpose astronomers choose the point of the equator at which the sun's path crosses it when he ascends into the northern hemisphere, which is the first point of Aries, or the vernal equinox, and reckon the degrees along the equator eastward, all round the circle. Now, to determine the plane of any star, a great circle is conceived to pass through it, intersecting the equator at right angles. The distance of the star from the equator, measured on this circle, is called its declination; and the distance of the point of intersection of the equator and the circle from the vernal equinox is called the right ascension of the star. The right ascension and declination are thus the two co-ordinates by means of which the plane of any star is determined. The right ascension is reckoned in time, because it is found by observing the time on the sidereal clock which elapses between the passage of the first point of Aries and that of the star over the meridian. When the first point of Aries passes the meridian the astronomical day begins; astronomers then reckon 0 hours 0 min. 0 sec. Suppose a star to come on the meridian 5 hours 35 min. 26 sec. after this; then 5 hours 35 min. 26 sec. is the star's right ascension in time, and is equivalent to an arc of the equator of 83° 51′ 30″, because an hour in time corresponds to 15° in space, and a minute or second in time to 15 minutes or seconds in space. If the clock, therefore, is regulated to keep time with the

heavens, the time indicated by the clock at which any star passes the meridian is the right ascension of the star in time.

The Oblique Ascension of a star is the arc of the equator intercepted between the vernal equinox and that point of the equator which comes to the horizon at the same time with the star. This varies with the latitude of the place of observation. At the equator it coincides with the right ascension. This term is now seldom used in astronomy.

Ascensional Difference is the difference between the oblique and the right ascension. This term is chiefly used in respect of the sun, because when the arc which it denotes is turned into time it shows the time before or after six o'clock of sunrise. The sine of the ascensional difference is equal to the tangent of the latitude multiplied into the tangent of the star's declination; hence, when the declination of a star is north, its oblique ascension is found by subtracting the ascensional difference from the right ascension, and when the declination is south, by adding the ascensional difference to the right ascension.

On account of the greater precision with which observations are made with fixed meridional instruments, all astronomical elements are now computed from observations of right ascension and declination; but in ancient times the positions of the celestial bodies were chiefly referred to the horizon, and hence the *oblique ascensions* and *ascensional differences* entered constantly into the solutions of astronomical problems.

Asce'nsion. The reception of our Saviour into glory, after his last appearance on earth: celebrated in the Christian church, from time immemorial, on the last Thursday but one before Whit-Sunday. Rogation week, that in which the ascension is celebrated, is so termed from the rogations (petitions or litanies) which were used in the perambulation of the bounds of the parish, which, according to ancient usage, took place in this week.

ASCE'TICS. (Gr. ἀσκεω, *I exercise.*) Persons who, in the early ages of Christianity, devoted themselves to a solitary and contemplative life, following the system of the Essenes and Therepeutæ among the Jews, and practising great austerities, with a view to mortify the flesh and abstract the mind from worldly objects. They had their origin in Egypt and Syria, and appear to have suggested the first idea of monachism.

A'SCI. (Gr. ἀσκὸς, *a bottle.*) Little membranous bags or bladders, in which the seed-like reproductive particles or spores of lichens, fungi, &c. are enclosed.

A'SCIANS, or ASCII. (Gr. α, *without*, and σκιὰ, *shadow.*) A term found in the older works on geography, and used to denote those inhabitants of the globe who at certain times of the year have no shadow. This can only happen with respect to the inhabitants of the torrid zone, who, twice a year, have the sun in the zenith.

ASCI'DIAN, ASCIDIA. (Gr. ἀσκὸς, *a bottle* or *pouch.*) A genus of heterobranchiate acephalous molluscs, or tunicaries, characterised by a body having the form and commonly the consistence of a tough leather pouch, attached to some foreign substance, and with two openings, one branchial, and the other anal, from which streams of water are forcibly ejected when the animal is touched or irritated.

AS'CIDIUM. (Gr. ἀσκὸς, *a bottle.*) A hollow pitcher-shaped body found upon the stems of certain plants, as nepenthes, sarracennia, &c. It usually contains water, and is sometimes clothed with reflexed hairs, which prevent the escape of insects which fall into it; its use is unknown. In nepenthes, sarracennia, cephalotus, and dischidia, it is in reality a leaf rolled up till its edges touch, when they grow together; in marcgraavia, it is a bract in the same state.

ASCI'TES. (Gr. ἀσκὸς.) Dropsy of the belly.

ASCLEPIADA'CEÆ. (Asclepias, *one of the genera.*) Monopetalous exogenous plants, with bifollicular fruit, the stamens adhering to the stigma, which is large and pentagonal, and an acrid milk in their stems. They are exceedingly different in appearance, some being trees with showy flowers, others obscure twiners with very inconspicuous herbaceous corollas, others herbaceous plants with clusters of gaily coloured flowers, and others leafless decumbent shrubs with angular stems and brown putrescent flowers. The latter are stapelias. Hoya, with its delicate waxen flowers running with honey, is a genus of the order; and another is the curious climbing water carrier called dischidia, which mounts to the tops of lofty trees with its fleshy bags filled with a constant supply of water. Some of the species are valuable for the toughness of the fibre extracted from their stems. The milky secretion of these plants contains caoutchouc, or Indian rubber; it is of an emetic nature, and in some cases it is dangerous. Asclepias tuberosa, the butterfly weed of North America, is the handsomest of the hardy species. This order only exists in temperate climates, and is most copious in the tropics.

ASH. (Celt. ac, *a point;* its wood being used for pikes.) The fraxinus of botanists, consists of several species of hardy trees, usually valuable for their timber. The tough ash wood of carpenters is yielded by Fraxinus excelsior, and the sweet substance called manna by Raxinus ornus. They mostly bear flowers without petals; but the latter species having those organs is called, in distinction, the flowering ash.

A'SHLAR. (Ital. asciare, *to chip.*) In Architecture, common freestones, as they are brought rough and chipped or detached from the quarry, of different lengths and thicknesses. Their usual thickness is nine inches.

ASHLERING. (From same as last.) In Architecture, the upright timber or quarters towards the rooms or inwards in garrets by which the slope of the roof is concealed — sometimes it is only two or three feet high, and sometimes the whole height of the room.

ASH-WEDNESDAY. The first day in Lent, called in the Latin church dies cinerum, *the day of ashes;* it being customary on that day for penitents to appear in church clothed in sackloth, upon which occasion ashes were sprinkled upon them.

ASI'LUS. A Linnæan genus of dipterous insects, in which the mouth is furnished with a horny, projecting, straight, two-valved sucker, and gibbous at the base: antennæ filiform, approximate, of two articulations; body, oblong and conical in shape. The insects of this genus prey on other insects, especially those of the dipterous and lepidopterous orders.

ASP. (Gr. ἀσπὶς, *an asp.*) A species of poisonous serpent frequently mentioned by ancient authors, some of whom describe its bite as being inevitably mortal, and say that the bitten die within three hours, and without pain, being thrown into a deep sleep; whence it was selected by Cleopatra as the instrument with which at once to terminate her existence, and bereave her conqueror of the chief feature of his triumph. There is always much difficulty in identifying the precise species mentioned in the classical writings of antiquity, from the vague manner in which they are there alluded to. Some naturalists are of opinion that the species of hooded viper, called by the modern Arabs 'El Haje' [Vipera (Naja) Haje, Cuvier] is the 'Aspis' of the ancients; and as it possesses the power of distending the skin of the neck, like the Indian Cobra di Capello, it agrees with one of the characters assigned by Pliny to the Aspis — "Colla aspidum intumescere," lib. viii. The size, however, of the Haje, which varies from three to five feet, is greater than that which is usually attributed to Cleopatra's asp.

ASPA'RAGIN. A white crystallisable substance obtained from the expressed juice of asparagus. It has been proposed as a diuretic in medicine.

ASPA'RAGUS. (Gr. σπαράσσω, *I tear.*) A genus of spiny plants, many of which are shrubs, and climb upon other plants. They all have minute scale-like leaves, small white or greenish flowers, and berried fruit; very often they produce short leafless branches, in room of leaves. Asparagus officinalis, one of the few species which neither climb nor bear spines, is found wild occasionally on the seashore near Weymouth. The succulent shoots which it throws up from its underground eyes are the asparagus of the market gardeners. It is not a little singular, that although this plant has been an object of careful cultivation for so many years, it should never yet have produced a well-marked permanent variety; the sorts, as they are called in the shops, are produced by casual differences of soil or cultivation, and are not distinct varieties.

ASPARA'GINOUS PLANTS. In Hort. In a strict sense, this term ought to be applied only to such plants as belong to asparagineæ; but in horticulture it is used to signify all those culinary vegetables the points of the tender shoots of which in spring, when they nearly emerge from the soil, are eaten, in the same manner as those of asparagus: such, for example, as the points of the common hop, of the sea-kale, &c.

ASPA'RTIC ACID. When asparagin is boiled with magnesia it is resolved into ammonia and a peculiar acid called as above.

A'SPECT. In Architecture, the direction towards the point of the compass in which a building is placed. The aspectus is also used by Vitruvius to denote the external distribution of a temple. Thus he describes seven sorts of aspects of temples: that in Antis, the Prostyle, Amphiprostyle, Peripteral, Dipteral, Pseudodipteral, and Hypæthral; under which words they are severally described.

Aspect. In Astrology, the angle formed by the rays of light proceeding from two planets, and meeting at the earth, and which are supposed to possess some natural influence. (*See* Astrology.)

Aspect. In Hort. In speaking of the inclination of the surface of the ground, the word aspect is used with reference to the sun, as the word exposure is with reference to the wind. Hence, a garden, the surface of which slopes to the east, has an eastern aspect, and also an eastern exposure; but a garden on a flat surface, sheltered by plantations on the east, west, and north, cannot be said to have any aspect, while it has a southern

exposure, being open to the winds of the south, though sheltered from those blowing from the other cardinal points of the compass.

ASPERGI'LLIFORM. (Lat. aspergillus, *the brush with which holy water is scattered about in Roman Catholic places of worship.*) Any thing shaped like that instrument; it is chiefly used in speaking of the stigmas of grasses.

ASPERGI'LLUM. A genus of tubicolar Bivalves, characterised by the soldering of both valves to the inner surface of the calcareous sheath; which is dilated or club-shaped at the lower end, and perforated there by many small holes, whence it has obtained the trivial name of the "Watering-pot Shell." In the system of Cuvier, this rare and remarkable genus ranks among the Family *Clausa*, of the Class *Acephala testacea*.

ASPERIFO'LIÆ. (Lat. asper, *rough*, folium, *a leaf.*) The name given by Linnæus to the plants now called Boraginaceous.

ASPE'RMOUS. (Gr. ἀ, *without*, σπέρμα, *seed.*) Destitute of seed.

ASPHA'LTUM. (Gr. ἀ, priv. and σφαλλω, *I slip*, from its use as a cement in ancient building.) A black brittle bitumen, very fusible and inflammable; it is soluble in naphtha, and forms a good varnish. It is found upon the surface and banks of the Dead Sea (hence called Asphaltic Lake), and in large quantity in Trinidad and Barbadoes; the ancients employed it in some of their cements, and it was used also in the art of embalming.

ASPHODE'LEÆ. (Asphodelus, *the principal genus.*) Subdivision of the natural order Liliaceæ, comprehending the onion, the squill, the ornithogalum, anthericum, asparagus, and similar genera. They differ from true liliaceæ in little beyond their flowers being usually smaller. (*See* Liliaceæ.)

ASPHY'XIA. (Gr. ἀ, *without*, and σφύξις, *pulsation.*) A fainting fit: a state of body in which the pulse cannot be felt, and in which the powers of mind and body are suspended.

ASPIDORTRY'NCHUS. (Gr. ἀσπὶς, *a shield*, ῥύγχος, *a beak.*) The name of a fossil extinct genus of sauroid fishes characterised by the length and bony covering of the upper jaw.

ASSAFŒ'TIDA. A fetid gum resin obtained from the root of the *ferula assafœtida*, whence it exudes by incision in the form of a milky juice, which, when dried by exposure to the sun, acquires a mottled appearance and pink colour. It is a native of the south of Persia, and is used in medicine as a stimulant and antispasmodic in hysteric and nervous disorders, and in spasmodic cough, asthma, and flatulent colic.

ASSA'I. (Ital. *enough.*) In Music, an adverb of quantity prefixed to such words as allegro, adagio, &c., signifying that the motion of the bars or measures should be kept at a mean rate of quickness or slowness, quick or slow enough, but not too much so in one or the other case.

ASSA'SSINS. Those who attack and kill by treachery and violence persons unprepared for defence. The word is derived from a military and religious order, formed in Persia by Hassan Ben Sabah, about the middle of the eleventh century, and called Assassins from their immoderate use of Haschischah (henbane), which produced an excitement amounting to fury. Hammer, in his History of the Assassins, has opened some new and striking views of the origin, proceedings, and doctrines of this sect. Their principal seat was in the mountains; and they were subject to the control of a prince, or, according to Hammer, a grand master, who possessed such an ascendency over his fanatical subjects that they paid the most implicit deference to his commands, esteemed assassination meritorious when sanctified by his mandate, and courted danger, and even certain death, in the execution of his orders. Nor did they stoop to humble prey; for the more lofty the object of their hatred, the more sure and deadly was their aim. In the time of the crusades, they mustered to the number of 50,000, and presented a formidable obstacle to the arms of the Christians. Among the victims of their swords, at this period, may be mentioned Conrad, Marquis of Montferrat, who was murdered in the market-place of Tyre, in the year 1192. Several historians have charged upon Richard I. the instigation to this crime; but it is a point which none have succeeded in elucidating. Long after this period the Assassins continued to levy contributions in return for the safety which they afforded to distinguised individuals; but they were at length, after an obstinate resistance, effectually crushed by the sultan Bibars. Scattered abroad, however, hated and despised, the order of the Assassins, like that of the Jesuits, endured long after its nominal suppression, and the mountainous regions of Kuhistan offered for a time a secure asylum to those who still lingered in their faith. Remnants of the Assassins still exist both in Persia and Syria, but merely as one of the many sects and heresies of Ismalism, and utter strangers to the murderous tactics of their predecessors.

The numerous battles and enterprises of the Assassins, their valorous defence against the armies of the crusaders and the great sultan Bibars, and the adventurous character of their whole history, opened a fertile source to the Syrian romance writers, of which, according to Hammer, they have freely and skilfully availed themselves.

ASSAU'LT. (Lat. assilio, *I leap upon.*) In Law, generally speaking, a violent kind of injury offered to a man's person. The nature of an assault has never been precisely defined; some lawyers being of opinion that a blow or an attempt to strike alone constitutes the offence, others including under this category irritating or abusive language.

Assault. In War, an effort made to carry a fortified post, camp, or fortress, wherein the assailants do not screen themselves by any works. During an assault, to avoid endangering their own party, the batteries of the assailants cease to play.

Assault. In Fencing, a mock engagement with foils, in imitation of a real single combat.

ASSA'Y. (Fr. essayer, *to try.*) This term is sometimes employed as synonymous with analysis, but more generally restricted to the determination of the composition and consequent value of alloys of gold and silver. From the quantity of coin, plate, and trinkets constantly fabricated, the art of assaying is of much importance, and requires considerable practical skill in its performance. At the mint there are two assay masters, the master's assayer and the king's assayer: the business of the former is to receive the gold and silver ingots brought for coinage, to cut one or more pieces from each ingot, and to make written reports of each assay. The king's assayer examines the melted bars previous to their passing into the moneyers' hands for coinage, and is responsible for their standard purity: and when the money is coined it is not allowed to go out of the mint until pixed; that is, until it has been ascertained, by the assay of one piece taken out of each journeyweight of coin, that it is of standard purity: the king's assayer therefore is a check officer upon the melter and upon the moneyers, and is responsible for the standard purity of all gold and silver coin issued from the mint. About twelve grains of gold, and twenty grains of silver, are usually employed for the assay.

ASSE'MBLY. In French history, the four great legislative bodies which succeeded each other during the period of the Revolution, are usually termed, 1. The *National* or *Constituent Assembly;* commenced 17th of June, 1789, by the resolution of the deputies of the communes in the States-General, constituting themselves a national assembly, to which the deputies of the nobles and clergy afterwards adhered; termed Constituent Assembly, from having framed a constitution: dissolved on the acceptance of the constitution by the King, 30th of September, 1791. 2. The *Legislative Assembly:* it commenced its sittings October 1. 1791; suspended the royal authority by its decree of the 10th of August, 1792; and was dissolved September 21. 1792. 3. The *Convention* (*see* Convention): it commenced its sittings September 21. 1792, with a proclamation of the Republic; was dissolved 4 Brumaire, 4th year of the Republic (Oct. 26. 1795). 4. Two-thirds of this assembly were then included in the new body of the "Corps Legislatif," which commenced its sittings Oct. 27. 1795, forming two councils, 1. of 500 (des Cinq-cens); 2. of the Ancients (des Anciens), 250 in number. The latter body named the Directory. This assembly subsisted until the dissolution of the Directory by Bonaparte, 19 Brum. 8th year of the Republic (Nov. 10. 1799). (*See* Directory.)

Assembly, the General, of the Kirk of Scotland, is the highest ecclesiastical court of that establishment. It meets annually in May, and sits for ten successive days, with power to appoint a commission to take cognizance of any cases undecided within that period; the commission being in fact a continuation of the assembly, with one additional minister named by the moderator. The assembly consists of representatives from the presbyteries, royal burghs, and universities of Scotland, and from the churches in the East Indies connected with the Kirk: in all about 380 members. The meeting of the assembly is attended by a nobleman as representative of the king, with the title of Lord High Commissioner; who, however, takes no part in the proceedings. The moderator, or president, is chosen by the assembly yearly. The General Assembly is a court of appeal from the Presbytery and Synod.

ASSE'SSMENT OF DAMAGES. *See* Damages.

ASSE'SSOR. In Law, a person possessed of knowledge of the law, appointed to advise and direct the decision of the judge. In various inferior courts assessors are appointed by statute. Assessors were employed, previously to the Reform Act, to assist the returning officer in deciding on the cases submitted to his cognizance at the period of an election. By the Municipal Corporation Reform Act (5 & 6 W. 4. c. 76. s. 37.) the burgesses of every borough are directed to elect two assessors, for the purpose of assisting the mayor in his duty of revising the burgess lists and presiding at the

elections. And, by sect. 43. the burgesses of each ward are to elect two assessors for the purpose of assisting the alderman at the ward elections.

A'SSETS. In Law, are the fund out of which a deceased person's debts are to be paid. Assets by descent are liable to those debts only which are secured by specialty, as bond or covenant binding the party's heirs; but assets in the hand of executors or administrators are liable to all debts.

ASSIE'NTO TREATIES. In History, the contracts entered into by Spain with several European nations (first Portugal, then France, and after the peace of Utrecht in 1713, England), to supply her South American colonies with negro slaves from Africa, were so termed.

ASSI'GNATS. Paper-money issued by the French government at various periods during the Revolution, based on the security of the unsold lands of the clergy, emigrated nobles, &c., which had become forfeit to the nation.

ASSI'GNMENT. In Law, is the total alienation of a chattel interest: which, by the third section of the Statute of Frauds, must be, if of a term of years in land, by writing and signature. *Assignee* is the party to whom an assignment is made.

ASSIMILA'TION. (Lat. assimilatio.) The act by which organised bodies incorporate foreign molecules and convert them into their own proper substance.

ASSI'ZE. (From the Norman French assise, *session.*) 1. In a sense now obsolete, an ordinance or constitution of the sovereign: thus, the code of feudal law framed for the kingdom of Jerusalem is termed the Assizes de Jerusalem. 2. The ordinances regulating the price of bread and other necessaries, were also called Assizes. 3. The peculiar jury by which a writ of right was tried, was termed the Grand Assize. 4. In the only sense in which the word is now an existing law term, the assize signifies the periodical session held by the judges of the superior courts in the counties of England, for the purpose of trying issues at nisi prius and delivering the gaols. (*See* COURTS, SUPERIOR.)

ASSO'CIA'TION. In Psychology, a name given to that property of our minds, by which any object or state of consciousness (whether image, thought, or emotion) has a tendency to recal other states or objects of consciousness with which it has been previously in some way connected. The conditions under which this tendency exists were first stated by Aristotle, in his "Treatise on Memory and Recollection." According to him they are threefold, consisting of Resemblance, Contrast, and Contiguity. If by the last word we understand connexion in space and time, and that of cause and effect, this division is the same with that given by Hume, and adopted by modern philosophers. The principle of association has been applied by Hartley, Sir J. Mackintosh, and other writers on ethics, to explain the origin of our more complex emotions, and in particular of our moral sentiments.

ASSOCIATION. In Politics, a society formed of a number of individuals acting under common rules and an elective government, for the accomplishment of some definite object. The principle of association is so obvious as to need no comment or explanation. But its practical developement in politics and ethics in modern times, owing in great measure to the facility of communication and diffusion of intelligence, is a feature in society of vast and daily increasing importance. The value of a combination of means and wills is plain and undeniable,—Firstly, in cases where the object pursued is pecuniary advantage. Undertakings which it would be impossible for individuals to embark in, either from the great actual outlay required, or the great amount of pecuniary responsibility imposed (such as the establishment of banks, great public works, distant commercial enterprises, &c.), are every day carried into effect with success and profit by companies. Secondly, in cases where the object is to raise and direct the disposal of a large amount of funds, with a view to the accomplishment of certain ends. Such are associations for purposes of education, for the distribution of Bibles, charitable institutions, &c. &c. And thirdly, we may mention a class of associations, common in all times, but which have far more frequently failed with actual loss than accomplished their object; associations, namely, for the purpose of controlling the rate of profit or of labour. (*See* COMBINATION.) But besides these ordinary instances of association, the present times appear more peculiarly favourable to the formation of societies having in view the accomplishment of political or moral objects, by controlling the action of governments or individuals. These are wholly distinct from those which we have before enumerated. Their purposes do not generally require a large outlay, nor (except in some occasional contingencies) much actual and definite co-operation. Their main object generally is to overrule by a display of associated numbers; occasionally also to bring combined energies to bear upon particular points. They serve to concentrate the action of the wills of many separate individuals, by inducing every man to abandon a portion of his own particular views, and take up instead of them the views of the majority of his co-associates. Of this character were, in France, the clubs which exercised so great a power during the Revolution; and those which, in calm times, are said to have contributed materially towards bringing about the second revolution of 1830: the society "Aide toi et le ciel t'aidera" more especially. In our own country, the history of political unions and associations of late years is abundantly well known. The most powerful that we have hitherto seen was the famous Catholic Association, formed in May, 1823, dissolved in March, 1829, when its great object, the passing of the Catholic Relief Bill, was attained. Of associations having moral instead of political objects, and falling within the category last described, perhaps (if we exclude the Freemasons, from the want of any definite purpose which appears to distinguish them) the Temperance Societies of late years afford the most singular examples; the more remarkable, because their great end is one which (except in a very few instances, such as the exclusion of spirits from ships, &c.) cannot be attained by combined action, unless in so far as it may influence the action and will of individual men.

It is impossible to deny the power of political associations; and it cannot be wondered at that they are regarded favourably by the state in such countries as America, where the principle of democratic associations pervades everything; with distrust by aristocratic governments, in which the power of a ruling class is exposed to danger from their attacks; and altogether suppressed as far as possible under arbitrary governments. Yet it may be questioned whether the tendency of modern opinion is not greatly to overrate that power. It is essentially of a temporary character. At the moment of a doubtful crisis in politics, the expression of the will of an associated multitude will often turn the scale through the mere weight of intimidation. But even with the best organisation, they seem to be radically unfit for the accomplishment of objects requiring untired zeal and perseverance. In the first place, by fettering the individual will of their members, they destroy a great portion of the collective energy in the attempt to concentrate what remains. No mind capable of achieving great objects ever voluntarily works in the trammels of an association. They become therefore, for the most part, passive bodies, guided solely by the will and management of a few individuals among them, who are flattered by the exercise of a power resembling sovereignty, but who are themselves, perhaps, rather fettered than aided in their activity, by the necessity of managing the large masses which they drag along with them. Perhaps no history affords so remarkable an example of the apparent splendour and real weakness of political associations on a large scale, as that of the Jesuits. Their company was formed on an admirable organisation; it had one precise object, the spread of the Roman Catholic faith; one definite principle of union, implicit obedience: the means put within its reach were enormous. It spread and flourished amazingly, exerted the most boundless activity, and excited naturally the most exaggerated fears among its opponents. And yet it would be difficult to say in what it has contributed to the objects it had in view. It has made no conquests over Protestantism; for in Bohemia, France under Louis XIV. &c., where it made the greatest show of effectiveness, its operations merely followed in the train of military oppression or state persecution. It has effected no permanent conversions among the heathen. It has done little or nothing, notwithstanding great show and immense expense, in the way of national education on Roman Catholic principles. Its learned men, with few exceptions, have done still less toward advancing the cause of true knowledge. Nor has a single mind of great originality and power been developed within the boundaries of the institution.

Nor is it possible to speak without great doubt of the moral good produced by the extension of the spirit of association. Some valuable remarks on this subject will be found in an article of Dr. Channing, reprinted from the North American Review, with the title "Remarks on Associations." "One of the most remarkable features of our age," he says, "is the energy with which the principle of combination, or of acting by joint forces in associated numbers, is now manifesting itself. Men have learned what wonders can be accomplished in certain cases by union, and seem to think that union is competent to anything. You can scarcely name an object for which some institution has not been formed. Would men spread one set of opinions and crush another? they make a society. Would they improve the penal code, or relieve poor debtors? they make societies. Would they encourage agriculture, or manufacturers, or science? they make societies. Would one class encourage horse-racing, and another discourage travelling on a Sunday? they make societies. We have immense institutions spreading over the country, combining hosts for parti-

cular objects. We have minute ramifications of those societies, penetrating everywhere, and conveying resources from the domestic, the labourer, and even the child, to the central treasury." — "Associations often injure free action by a very plain and obvious operation. They accumulate power in a few hands, and this takes place just in proportion to the surface over which they spread. In a large institution a few men rule, a few do everything; and, if the institution happens to be directed to objects about which controversy exists, a few are able to excite in the mass strong and bitter passions, and by these to obtain an immense ascendency. Public opinion may be so combined, and inflamed, and brought to bear on odious individuals or opinions, that it will be as perilous to think or speak with manly freedom as if an inquisition were open before us. It is now discovered that the way to rule in this country is by an array of numbers, which no prudent man will like to face. Of consequence, all associations aiming or tending to establish sway by numbers ought to be opposed. They create tyrants as effectually as standing armies. Let them be withstood from the beginning. No matter whether the opinion they intend to put down be true or false, let no opinion be put down by such means: let not error be suppressed by an instrument which will be equally powerful against truth, and which must subvert that freedom of thought on which all truth depends."

A'SSONANCE. In Rhetoric and Poetical Composition, a jingle or imperfect rhyme, formed by separate words, or members of a sentence.

ASSU'MPSIT, or trespass on the case on promises, in law, is an action of an anomalous character, having the form of tort and the substance of contract. It is, properly, a claim of damages sustained through the breach of a simple contract (*i. e.* a promise not under seal), and alleges that the defendant assumpsit promised or undertook to perform the acts specified. It has become the most ordinary remedy, not only where unliquidated damages, but also where debts are sued for; the law implying a promise to pay or do whatever the defendant is legally liable to pay or do.

ASSU'MPTION. A festival of the Romish church, kept on the 15th of August, in celebration of the alleged miraculous ascent of the Virgin into heaven.

ASSU'MPTIVE ARMS. In Heraldry, such as may be assumed with the approbation of the sovereign, or grant from the proper officers of arms: also, in another sense, armorial bearings improperly assumed.

ASSU'RANCE, or INSU'RANCE. A contract for the payment of a certain sum on the occurrence of a certain event. The term assurance is generally confined to those contracts under which a certain sum is to be paid on the death of an individual or individuals now living; while insurance is applied to those which provide for the payment of a sum on the occurrence of events not depending on the duration of human life, and which may never happen, such as the loss of ships at sea, the destruction of houses by fire, &c.

Assurances on Lives, are contracts which stipulate for the payment of a certain sum of money on the death of one or more individuals, in consideration of an immediate payment, or, more frequently, of an annuity or annual contribution, to be continued during the existence of the lives assured. Contracts of this kind are of immense importance to society. Every man whose income depends on his own life or exertions, and on whom others are dependent for support, must be sensible of the advantages of arrangements by means of which, at a small sacrifice of immediate comfort, he is enabled effectually to provide against the casualties of life. They are of a totally different nature from gambling. Though nothing can be more uncertain than the continuance of an individual life, yet nothing is more invariable than the duration of life in the mass; consequently, the exact value of life assurances can be calculated without any uncertainty whatever, and a man, by effecting an assurance, secures to his representatives, against the risk of accident, the advantages they would have from his enjoying his exact proportion of the average duration of life. Such transactions provide against destitution, and tend directly to the accumulation of capital; they will, therefore, be encouraged and protected in all well-governed communities.

Method of computing the Value of Assurances. The value of assurances on lives are computed in nearly the same manner as those of annuities, the principles being the same in both cases. A table of mortality must first be selected, from which we deduce the probabilities of living over the different years of life. Having obtained these, and assumed a rate of interest, we proceed as follows: let the probabilities that an individual of a given age will live over

$$1,\ 2,\ 3,\ 4,\ 5,\ \&c.\ \text{years}$$
$$\text{be } p_1,\ p_2,\ p_3,\ p_4,\ p_5,\ \&c.\ \text{respectively;}$$

also, let r be the rate of interest, and $v = \frac{1}{1+r}$, and suppose that the sum assured is to be paid at the end of the year in which the life fails. Now, the value of 1*l.* to be received at the end of the first year is v, but it will not be received if the life continues to the end of the year; and, as the probability that the individual will live over the year is p_1, the probability that he will not live over it is $1-p_1$, therefore the value of 1*l.* to be received at the end of the year, subject to the contingency of the life failing in the first year, is $(1-p_1,)\ v$. The probability that the life will continue to the end of the second year is p_2, and that it will continue one year only, p_1, therefore $p_1 - p_2$ is the chance it will drop in the second year; and the value of 1*l.* to be received at the end of the second year is v^2, therefore the present value of 1*l.* to be received if the life fails in the second year is $(p_1 - p_2)\ v^2$. In like manner, the probability that the life will fail in the third year is $p_2 - p_3$; and the value of 1*l.* to be received at the end of three years is v^3, therefore the present value of 1*l.* to be received at the end of three years, if the given life fails in the third year, is $(p_2 - p_3)\ v^3$. The same process is continued from year to year, till the probability of living over a year becomes nothing. Now, the whole value of the assurance is manifestly equal to the sum of all its partial values for the different years; therefore, denoting the value by I, we get

$$I = (1-p_1)\ v + (p_1 - p_2)\ v^2 + (p_2 - p_3)\ v^3 + \&c.$$

or, separating this into two series,

$$I = v\ (1 + p_1 v + p^2 v^2 + p_3\ v^3 + \&c.)$$
$$- (p_1 v + p_2 v^2 + p^3 v^3 + \&c.)$$

But it is shown in the article ANNUITY that the series $p_1 v + p_2 v^2 + p_3 v^3 + \&c.$ denotes the value of an annuity of 1*l.* on a life, the probabilities of the continuance of which are represented as above; therefore, calling this annuity A, we have $I = v\ (1 + A) - A$.

Since $v = \frac{1}{1+r}$, this formula becomes by substitution

$$I = \frac{1}{1+r}\ (1 - r\,A).$$

The sum now found is what ought to be paid down, in order to receive 1*l.* on the failure of the given life; but by far the most usual practice is to pay for the assurance by means of an annual premium, the first payment being immediate, and the others at the end of each successive year. Let π be the annual premium; then the value of all the premiums after the first is obviously the same thing as the value of an annuity of the same amount, and is, consequently, equal to πA. Hence, the value of all the premiums is $\pi + \pi A$, or $\pi\ (1 + A)$, which is necessarily equivalent to the assurance. We have therefore the equation $\pi\ (1 + A) = v\ (1 + A) - A$, whence $\pi = v - \frac{A}{1+A}$

This formula is very easily computed when we are in possession of a table of annuities, and it shows at once the annual sum which an individual of any age ought to pay, in order to secure to his representatives 1*l.* (and, consequently, any other sum) at his death.

Temporary Assurances. The values of temporary assurances, or engagements to pay a certain sum in case a given individual dies within a given number of years, are easily found from those on the whole of life. For example, let it be required to find what sum ought to be paid for 1*l.*, to be received if an individual now aged 40 shall die within seven years. Let I be the value of 1*l.* to be paid on the death of a person aged 40, and I_7 the present value of the same sum, to be paid on the death of a person aged 47. Seven years after this the value of an assurance of 1*l.* on the death of the person now aged 40 will be I_7; but the present value of 1*l.*, to be received certainly at the end of seven years is v^7, and the probability that the life will continue seven years is p_7; therefore the present value of I_7, on the contingency that the life will not fail within seven years, is $p_7\ v^7\ I_7$; subtracting this from I, the value of 1*l.* to be received certainly at his death, there remains $I - p_7\ v^7\ I_7$, to denote the value of the temporary assurance. This may be expressed by the following rule. Multiply the assurance on a life seven years older than the given life by the present value of 1*l.*, payable seven years hence, and also by the probability that the given life will survive seven years; subtract the product from the assurance on the given life, and the remainder is the value of a temporary assurance for seven years in a single payment.

In order to find the equivalent annual payment, it must be recollected that the first payment is made immediately, and that seven payments are to be made in all; consequently, all the payments after the first are equal to a temporary annuity of the same amount for six years, or one year less than the given term; consequently, if π represent the annual premium, and A′, a temporary annuity of 1*l.* for one year less than the given term, the value of all the premiums to be received is $\pi + \pi A'$ or $\pi\ (1 + A')$, which by hypothesis is equal to the assurance; consequently, to find the annual premium, we have to divide the value of the temporary assurance in a single payment by $1 + A'$.

In the same manner, the value of an assurance on any number of joint lives is found: it is only necessary to substitute for A in the above formulas, the value of an annuity on the joint lives. Thus, let M be the value of an annuity, to continue while A and B both live, then $v(1 + M) - M$ is the value of an assurance to be paid at the end of the year in which the first of the two lives shall fail, and the equivalent annual payment is $v - \frac{M}{1 + M}$.

A very important class of assurances comprehends those in which the contract is to pay a sum on the death of one party, provided that another party shall be then alive. The computation of the values of such contracts is somewhat more intricate, and cannot be explained without entering into details respecting the manner of combining the probabilities of life, which our limits will not permit.

For assurances on ships and goods, *see* INSURANCE.

ASSU'RGENT. (Lat. assurgere, *to rise up.*) Rising in a curve from a decurved base.

A'STACUS. (Lat. astacus, *a lobster.*) The name of a Fabrician genus of insects, and now the type of a family (*Astacidæ*) of Decapod, Macrourous, or long-tailed Crustaceans; including the lobsters (*Astacus* Leach), the craw-fish (*Potamobius* Leach,) and the cray-fish or spiny lobsters (*Palinurius* Leach). The distinguishing character is derived from the antennæ, the two pairs of which are inserted in the same horizontal line; the mesial ones having moderate or long footstalks, terminated by two filaments; the outer ones naked, or furnished with a scale, which never entirely conceals the base.

A'STERISK. In Diplomatics, a sign in the figure of a star, frequently met with in ancient Latin manuscripts, and seeming to serve various purposes; sometimes to denote an omission, sometimes an addition, sometimes a passage which appeared remarkable on any account to the copyist.

A'STERISM, in Astronomy, denotes a collection of stars. It was formerly used in the same sense as constellation, but is now generally appropriated to any small cluster of stars, whether forming part of a particular constellation, or otherwise.

A'STEROI'DS. A fantastical name by which the four small and recently discovered planets, namely, Juno, Vesta, Ceres, and Pallas, have been sometimes designated.

ASTE'RN. (A, and stern.) A sea term, denoting, in the hinder part of the ship, or behind the ship.

ASTHE'NIC. (Gr. ἀ, *without*, and σθένος, *strength.*) Asthenic diseases are those which are prominently marked by great and direct debility.

A'STHMA. (Gr. ἀσθμαίνω, *I breathe hard.*) A disease, the leading symptoms of which are difficulty of breathing, coming on at intervals, accompanied with cough, and more or less expectoration. The fit most frequently occurs in the night during the first sleep, suddenly awaking the patient, and lasting for three or four hours or more. It is a terrible, but in itself rarely a fatal, disease, though it often lays the foundation of organic mischief. Its proximate cause has not been very clearly ascertained.

A'STOMOUS. (Gr. ἀ, *without*, and στόμα, *a mouth.*) Certain mosses whose theca has no aperture.

A'STRAGAL (Gr. ἀστράγαλος, *a die or huckle bone.*) In architecture, a small moulding whose profile is semicircular. Some have said that the French call it talon, and the Italians tondine; but this is a mistake, and the word is only properly applied to the ring which separates the capital from the column. The astragal is sometimes cut into representations of beads and berries, and a similar sort of moulding is used to separate the faces of the architrave.

ASTRA'GALUS. (Gr. ἀστράγαλος, *a die.*) The ancle bone. The ancients used the corresponding bones of animals as substitutes for dice.

ASTRÆ'A. (Gr. ἄστρον, *a star.*) A genus of lithophytous Polypes; the polypiary or calcareous skeleton of which is characterised by sessile, star-shaped lammellate cells, crowded upon the upper surface. The species are divided into rayed Astreæ (*Ast. radiatæ*), with the stars separated from the base; and toothed Astreæ, (*Astreæ denticulatæ*), with the stars contiguous.

A'STROLABE. (Gr. ἄστρον, *a star*, and λαμβάνω, *I take.*) A circular instrument used for taking or observing the stars. The ancient astrolabe consisted of two or more circles, having a common centre, and so inclined to each other as to enable the astronomer to observe in the planes of different circles of the sphere at the same time. For example, if the circles were at right angles, the instrument would give both longitude and latitude, or the right ascension and declination of star. The equatorial, the altitude and azimuth instrument, and the theodolite, are instruments which answer the same purpose as the ancient astrolabe. Ptolemy changed the form of the ancient instrument, and reduced it to a plane surface, to which he gave the name of planisphere; and, from this circumstance the term astrolabe has been used in modern times to denote a planisphere, or stereographic projection of the sphere on the plane of one of its great circles.

ASTRO'LOGY. (Gr. ἄστρον, *a star*, and λόγος, *discourse.*) According to its derivation, this term should signify the science or knowledge of the stars. Originally, the terms astrology and astronomy were used indifferently in the same sense; but for a long time the former has been employed to denote the vain and superstitious study of predictions and horoscopes; while the latter has been reserved to denote the true science of the celestial motions. According to Lalande, this distinction began to be observed in the time of Clement of Alexandria, that is, in the second century. Astrology is generally coupled with the epithet judicial, from the judgments drawn from it relative to future events.

Judicial astrology is supposed to have had its origin in Chaldea, whence it passed into Egypt, Greece, and Italy. The desire of penetrating into futurity is so congenial to the human mind, that this pretended science has found favour in all ages and countries; and it is a remarkable fact, that astronomy, which demonstrates the frivolity and absurdity of its predictions, was long indebted to it for the principal part of its own progress. Kepler, in the preface to the Rudolphine Tables, observes, that astrology, though a fool, was the daughter of a wise mother, to whose support and life the foolish daughter was indispensable. At the present day it is only among the most ignorant vulgar, or the unenlightened tribes of Asia and Africa, that astrology is held in esteem; but the triumph of sound science and the spirit of philosophy has been slow and difficult. So late as the year 1705 the conductor of "The Connaissance des Tems" thought it necessary to apologise for the absence of all predictions in that astronomical work, by stating, that the Academy had never recognised the solidity of the rules which were given by the ancients for discovering the future by the configurations of the stars; and, what is still more surprising, the first lunar tables calculated according to the Newtonian theory were intended to be subservient to the calculation of nativities.

Astrological predictions are founded on the positions or aspects which the sun, moon, and planets have relatively to each other at the moment of birth, or some other critical period of a person's life, and certain arbitrary influences supposed to belong to each of those bodies. For the purpose of facilitating the determination of the aspects, the whole heaven, visible and invisible, is divided into twelve equal parts by the horizon, the meridian, and four other circles passing through the north and south points of the horizon, and the points of the equator (or rather the prime vertical, or sometimes the ecliptic, for the practice was not uniform), which are at the distance of 30 and 60 degrees from the meridian. These equal spaces are called the twelve houses of the heavens, and the circles by which they are circumscribed are called circles of position. The circles of position are supposed to remain fixed, so that a celestial body is carried through each of the twelve houses in the course of a day by the diurnal rotation. The first house is contained between the eastern horizon and the next circle of position, going to the eastward; consequently the seventh will commence with the western horizon, and the tenth with the meridian or culminating point of the ecliptic. The beginning of the first house, or the point of the ecliptic just rising, is called the horoscope. The first house is the house of life; the second, of riches; the third, of brothers; the fourth, of parents; the fifth, of children; the sixth, of health; the seventh, of marriage; the eighth, of death; the ninth, of religion; the tenth, of dignities; the eleventh, of friends; and the twelfth, of enemies. Each of the houses has one of the heavenly bodies as its peculiar lord. They have also different powers, the strongest of all being the first, and the next in power the tenth; so that if two planets are equally powerful, ceteris paribus, that will prevail which is in the stronger house.

Having made the preliminary arrangement of the heavens, the next object is to consider the aspects or configurations of the influential bodies. Aspect, as defined by Kepler, is the angle formed by the rays proceeding from two planets, and meeting at the earth, and which have the property of producing some natural influence. The ancients reckoned five aspects, namely, the conjunction denoted by the character ☌, the opposition by ☍, the trine by △, the quadrile by □, and the sextile by ⚹. These names and characters, besides several others added in more recent times, are retained in our almanacks to the present day. In the aspect of conjunction the angle made by the two planets is 0; in the opposition it is 180°. The trine is the third part of a circle, or 120°; the quadrile is 90°, and the sextile 60°. With regard to the influences of the aspects, they are benignant, malignant, or indifferent. The quadrile and opposition are considered as malignant or adverse; the trine and the sextile as benignant or propitious; and the conjunction an indifferent aspect.

It now remains only to ascribe certain influences to each of the planets, and to suppose all animals, plants, countries, &c. subject to their control, in order to obtain an idea of the nature of the astrological art. The influences ascribed to the planets were of course as arbitrary as those ascribed to the aspects. Saturn being at the greatest distance from the sun was supposed to be of a cold nature; Jupiter, Venus, and the Moon, temperate and benignant. Saturn and Mars were the most dangerous. The Sun and Mercury participated in the properties of the one and the other, according to circumstances. But these influences were exerted in an infinite number of ways, according to the houses which the planets happened for the time to occupy.

It would be superfluous at the present day to adduce any serious argument against a system of imaginary influences and arbitrary rules, having no other foundation than the ignorance and superstition of mankind, and contradicted by every result of true science, and every dictate of common sense. The celestial bodies pursue their courses in obedience to unalterable laws; and the legitimate business of the philosopher is to discover those laws, to trace out their consequences, and to apply the results of his discoveries to alleviate the wants or multiply the comforts of humanity.

ASTRONOMY. (Gr. ἀστρον, *a star*, and νόμος, *a law.*) The science which treats of the motions, distances, arrangement, and magnitudes of the celestial bodies; of their constitution and physical condition, and, in general, of whatever can be known respecting them.

There is no branch of human knowledge of which the results appear at first sight more at variance with the impressions of our senses. The first aspect of the heavens leads us almost irresistibly to imagine ourselves placed in the centre of a starry sphere; which, in its diurnal revolution, carries along with it all the heavenly bodies. But the changes of relative position which some of the most remarkable among them continually undergo, soon make it evident that they do not all belong to the same sphere. Further observation and reflection lead us to conclude that the apparent daily revolution of the firmament is merely an illusion occasioned by the diurnal rotation of our own earth, which, instead of remaining fixed at the centre, is carried forward about the sun with a velocity of about 19,000,000 of miles in a second of time, or four times that of a cannon-ball when it leaves the mouth of a cannon. The sun, which appears to be of very moderate dimensions, is a body whose volume is 1,384,470 times greater than that of the earth, and placed at a distance of 95,000,000 of miles; and the stars, which even in the best telescopes appear only as luminous points, are bodies of the same nature as the sun; many of them, probably, far surpassing it in magnitude.

Different Classes of Heavenly Bodies. By far the greater part of the celestial bodies appear to be fixed in the firmament, and to preserve invariably the same relative positions. These are the *fixed stars.* A second class comprehends a small number which are continually shifting their positions among the stars, and are perceived to accomplish a complete revolution of the sphere in stated intervals of time. Hence they were called *Planets,* that is, *wandering stars,* from a Greek word signifying to wander. They describe orbits, very nearly circular, about the sun. Some of them are accompanied by smaller bodies revolving round them, as the moon revolves round the earth, and which are called *Satellites,* or attendants. A third class comprehends bodies differing greatly from those now mentioned, and which sometimes exhibit very extraordinary appearances. These are the *Comets.* Like the planets they are obedient to the attractive force of the sun; but the orbits which they describe are exceedingly elongated, and they are only visible when near the sun. Hence they appear at distant or uncertain intervals, and only for a short time; and consequently their physical nature is very imperfectly known. The sun, planets, satellites, and comets form a system of which all the members are connected with and act upon one another in obedience to the law of universal gravitation. (*See* PLANETS, SATELLITES, SUN, and the other terms, in their respective places.)

Uses of Astronomy. Mere curiosity, without reference to practical utility, would prompt mankind to study the movements of the vast machine which rolls over our heads; but the applications of astronomy to the affairs of life are so numerous and important, that an accurate knowledge of its principles is almost indispensable to society. 1st, It is by means of the celestial bodies that we are enabled to determine the relative positions of points on the surface of the earth; to fix geographical latitudes and longitudes, and ascertain the form and dimensions of our planet. 2d, It is to astronomy that we are indebted for all the advantages resulting from navigation. Without an accurate knowledge of the positions and motions of the heavenly bodies, it would be impossible for the mariner to traverse the ocean, or to venture in safety beyond the sight of the shore. With this knowledge he can direct his course with unerring certainty to any given coast; and the ocean, which, without this science, would present an insuperable barrier to the intercourse of distant countries, is rendered "the highway of nations." 3d, Astronomy also presents us with the means of establishing the divisions of time necessary for the regulation of civil affairs, and of fixing chronological epochs. The diurnal revolution of the sphere gives the smaller divisions of time; the revolution of the moon gives the month; that of the sun, the year; and the various configurations of the planets mark out periods of all magnitudes, from a few months or years to millions of ages.

Divisions of Astronomy. The first object of the astronomer is to ascertain, with all possible precision, the apparent places of the stars, or their projections on the sphere, in order to obtain an accurate knowledge of their apparent motions and periods. But it is not enough to have ascertained their positions and motions; the results of observations made at different places and distant times must be compared, in order that we may be enabled to distinguish the movements which are real from those which are only apparent, and depend on our own position with regard to objects observed. And when the real paths described by the different bodies have thus been determined, we are next led to investigate the causes of the phenomena, and the expressions of the mechanical forces necessary to produce them. Hence, the science of astronomy may be divided into *practical, rational,* and *physical:* the first embracing all that is necessary for determining the apparent motions; the second being devoted to the real motions; and the third to the physical causes by which the different motions are regulated and perpetuated.

Practical Astronomy. In order to determine the positions and motions of the celestial bodies, it is necessary to have the means of measuring time and space with the utmost precision. But neither time nor space can be measured without the aid of very refined instruments and contrivances. Hence, the theory of instruments, the method of using them, and the determination of the different corrections that must be applied in order to free the observed positions from the various instrumental and physical errors by which they are affected, belong to this division of the science. A complete knowledge of the sphere and its various circles, as also of the methods of spherical trigonometry, is requisite to the practical astronomer. Observation gives him the place of a star only with reference to his own zenith, or horizon, or to another star whose place is already determined. But their positions must be reduced; that is, referred to invariable planes or circles, in order that the observations made in different places may be capable of comparison with one another. Without such reductions, the observations are of no use.

Rational Astronomy. This division includes the determination of the real orbits, and the laws of motion which the different bodies observe, and the construction of hypotheses by the aid of which we may calculate the positions in advance. In the infancy of astronomy, and before observations became very numerous, or were made with precision, various hypotheses were invented to explain the apparent motions. Thus Ptolemy explained the inequalities of the planetary motions, by supposing each of the planets to describe a circle about a centre moving uniformly round the earth in the circumference of another circle. Tycho Brahe supposed the planets to revolve in circular orbits about the sun; and the sun, accompanied by the planets, to revolve round the earth. Copernicus supposed the earth, as well as all the other planets, to revolve in circular orbits around the sun. All these hypotheses served to explain the phenomena that were known at the time they were respectively invented; and have been successively exploded by more accurate observations, which have proved that the planetary orbits are not circles but ellipses, having the sun in the focus which is common to all of them.

Physical Astronomy. By this term is generally understood the application of mathematical science to the investigation of the laws by which the motions of the celestial bodies are regulated, the nature of the forces by which their motions are maintained, and the effects of their action on one another. By comparing the momentary deflection of the moon's orbit from a straight line with the effects of terrestrial gravity, as manifested in the descent of falling bodies near the surface of the earth, Newton found that both the phenomena were produced by one and the same cause, and that the moon is retained in her orbit by the attraction of the earth. Subsequent investigations, founded on the general laws of the planetary motions, discovered by Kepler, led him to the conclusion, that a force of the same nature extends through the universe; and that all bodies in the heavens and on the earth gravitate towards each other with forces directly as their quantities of matter and inversely as the squares of their distances. By this single principle he explained the elliptic motions of all the planets and satellites; the facts which concern their figures, rotation, and the position of

their axis; and the oscillations of the fluids with which they are surrounded. The quantity of matter in the sun is vastly greater than in the largest of the planets; hence all the planets are principally controlled by the sun, and circulate about him in elliptic orbits, nearly in the same manner as if they were independent of the attractions of one another. Still their mutual influences are sufficiently perceptible; though, from being comparatively small, they are regarded merely as disturbing the sun's action. The calculation of the disturbing forces, or of the effects produced by the mutual attraction of all the bodies in the solar system, forms the most difficult and the most important problem ever submitted to mathematical analysis. Its solution has occupied the most eminent mathematicians of the last and the present century; and the successive advances made towards it by Newton, Clairaut, D'Alembert, Euler, Lagrange, and Laplace, have surrounded their names with a halo of glory.

History of Astronomy. The study of the heavens has occupied the attention of mankind in all ages of the world. At the remotest epochs of historical record, the Chaldean shepherds and the Egyptian priests had found a near approximation to the length of the solar year, and determined, by the comparison of a long series of recorded or traditional observations, periods of time after which the eclipses of the sun and moon return in nearly the same order, and were consequently able to predict these phenomena. The early philosophers of Greece exhausted their imagination in idle speculations about the formation and nature of the universe; but the names of the constellations which they have transmitted to us with their theogonies prove that they had paid considerable attention to the arrangement of the principal stars. Pythagoras appears to have had a distinct notion of the true system of the world; affirming that the earth was not placed in the centre, but revolved about the sun. But the first recorded observations which contributed in any way to the real progress of astronomy were made at Alexandria, under the Ptolemies, about 300 years before our era, by Aristillus and Timocharis, who determined the positions of some of the principal zodiacal stars, and thereby afforded Hipparchus the means of arriving at his important discovery of the precession of the equinoxes.

Hipparchus, the founder of Grecian astronomy, observed at Rhodes about 140 years B. C. This illustrious man appears to have paid little regard to the theoretical speculations of his contemporaries, but adopted the only method by which a correct knowledge of nature can be obtained, namely, assiduous and accurate observation. Among his important discoveries are the precession already mentioned; the length of the solar year; the eccentricity of the sun's orbit; the periodic time of the moon's revolution with respect to the stars, to the sun, to her nodes, and her apogee; the eccentricity and inclination of the lunar orbit. He invented the planisphere, determined the places of 1080 stars, and was the first who introduced into geography the method of fixing the positions of places on the surface of the earth by means of their latitudes and longitudes.

The name of Ptolemy is still more celebrated than that of Hipparchus; though, as an astronomer, he occupies a far inferior rank. His principal astronomical discovery is the inequality of the moon's motion, technically called the evection; but his fame chiefly rests on his great work called Syntax, or Composition; in which he explains the apparent motions of the sun, moon, and planets, according to a hypothesis invented by Apollonius of Perga, some centuries before, and which consists in supposing each of these bodies to be carried by a uniform motion round the circumference of a circle called the epicycle, the centre of which is carried uniformly forward in the circumference of another circle called the deferent. This second circle may be the epicycle of a third, and so on as long as inequalities remain to be explained; the earth occupying a position near, but not at, the centre of the last circle. This hypothesis is utterly demolished by a few accurate observations of the present day; but in the time of Ptolemy it served to explain all the deviations from circular motion then known, particularly the phenomena of the stations and retrogradations of the planets; and it was even of service to astronomy, by offering a means of reducing the apparent irregularities of the planetary motions to arithmetical calculation. Ptolemy's share of the merit belonging to the invention of this ingenious hypothesis consists in the determination of the proportion between the radius of the epicycle and that of its deferent circle, and between the velocity of the planet and the velocity of the centre of its epicycle. The Ptolemaic system continued in vogue till the revival of astronomy and the other sciences in the fifteenth century, when it gave place to theories founded on more enlarged views and more accurate observations.

Fourteen centuries elapsed between Ptolemy and Copernicus; and during this long interval, astronomy continued nearly in the same state. The elements of the solar and lunar tables had indeed received many corrections; and various improvements in the methods of observing and calculating had been introduced, principally by the Arabs; but in respect of theory, no change had taken place. But an epoch had now arrived when men's minds could no longer be held in thraldom by reverence for ancient authority; and a spirit of investigation and inquiry had arisen, which produced the happiest results in all the departments of natural science. Copernicus, guided perhaps in some measure by the opinions of Pythagoras, but more by his own meditations on the planetary phenomena, and the comparison of the numerous observations accumulated by Purbach, Regiomontanus, and Walther, in the latter half of the fifteenth century, had the glory of establishing the system of the world on its true basis. In his great work, "De Revolutionibus Orbium Cœlestium," published in 1543, he showed that all the apparent motions are easily explained by simply attributing a double motion to the earth; a diurnal rotation about its axis, and an annual motion about the sun. The doctrine of the earth's motion was opposed to the religious dogmas of the age, and accordingly the theory of Copernicus met with great resistance; but as observations now began to be greatly multiplied, and to be performed with greater accuracy, the evidences in favour of it daily acquired strength, and in a short time commanded universal assent among astronomers. Tycho Brahe, indeed, an excellent observer, and one to whom astronomy is under the greatest obligations, made an attempt to save the ancient prejudices; while he explained the phenomena by supposing the sun, accompanied by the planets, to perform a diurnal revolution about the earth. This system, however, on account of its physical improbability, never obtained many followers.

The next important step in astronomy was made by Kepler. By means of a laborious comparison and calculation of observations, Kepler discovered that the orbits of the planets are not circles but ellipses, having the sun in one of the foci. He also found that the motion of any planet in its elliptic orbit is so regulated, that the spaces passed over by a straight line drawn from the planet to the sun are equal in equal times; and that the periodic times of the different planets are in a certain given ratio to their distances from the sun. It is difficult to estimate the importance of these discoveries; either with reference to the amount of prejudice they overthrow, or their influence on astronomical theory. The circular and uniform motion of the celestial bodies was an axiom that had never been disputed. It was even admitted by Copernicus; who was obliged, in order to reconcile it with the observations, to suppose the sun placed at a little distance from the centre of each of the planetary circles. The elliptic motion was a proposition as bold as original; and, combined with the equal description of areas in equal times, led to the discovery of universal gravitation, and all the sublime results of physical astronomy.

About this time, or a little earlier, two discoveries were made which gave an immense impulse to astronomy. These were the logarithms, invented by Napier, and the telescope. Without the aid afforded by the logarithms, it would have been impossible to accomplish the calculations which Kepler's discoveries rendered necessary; and to the telescope we are indebted not only for the enlargement of the visible boundaries of the universe, and the knowledge of numerous bodies whose existence would otherwise never have been suspected, but also for all the precision of modern observation.

From the time of these great discoveries, the progress of astronomy has been uninterrupted. By combining the laws of the planetary motions discovered by Kepler, with the theory of central forces established by Huygens, Newton completed the theory; and proved that all the motions of the universe, from the fall of a body on the surface of the earth, to the oscillations of the celestial sphere, are the necessary consequences of a single, invariable, and simple law. This is the law of universal gravitation; which not only affords a physical explanation of all the phenomena that have been observed, but which, in the hands of mathematicians, has led to the discovery of many important facts which observation subsequently confirmed, though it could not have detected them. The progress of the practical parts of the science has, also, since the same epoch, been commensurate with the improvements of the theory. Observatories were established in different countries, where a continued series of observations has been kept up. Academies and societies were founded for the purpose of effecting, by combined efforts, what surpassed individual exertion; voyages and expeditions have been undertaken to distant parts of the world for the purpose of measuring the earth, and determining other elements necessary to a complete knowledge of the planetary system.

The state of perfection to which astronomy is now brought, may be regarded as the greatest triumph of human exertion and reason. The motions of the moon and the planets are known with the utmost accuracy; and the tables have all the precision which the navigator or practical astronomer can desire. Our knowledge of the planetary system may be regarded as complete. That

of the sidereal heavens must always be limited by the optical powers of the human eye and the telescope. In this department of astronomy, a boundless field has of late years been thrown open for future research and speculation. Stars are observed revolving about one another in elliptic orbits. Are they then connected with each other by forces of the same nature, and observing the same laws, as solar attraction? The periodic times, and consequently the mean distances of one or two comets, are observed to be diminished. Are we then to infer that the regions of space are filled with matter of sufficient density to resist the motions of comets? Are the comets themselves permanent bodies; or are they merely formed by the occasional collapse, as it were, of nebulous matter, and again dissipated after a few revolutions? The resistance of the ether, the nature of comets, the constitution of the nebulæ, the laws which regulate the formation and motions of sidereal systems: such are the questions (questions remote indeed from any practical application to the affairs of mankind) which astronomers now aspire to solve.

For further information on this extensive and very important science, we must refer the reader to the particular terms which belong to it, and also the general terms, COMET, MOON, PLANET, SATELLITE, STAR, SUN. The physical theory of the planetary motions will be found explained under GRAVITATION; and astronomical instruments described under their respective names. Works on astronomy are so abundant in every European language, that it could serve no purpose to make any references to them in this place. The best popular treatise is that of Sir John Herschel in Lardner's Cabinet Cyclopedia.

ASTA'RTE — the queen of heaven — a Phœnician goddess called in the Scripture Ashtaroth. There is some obscurity with respect to her worship, and the attributes assigned to her, which were held by different of the ancients, to correspond with those of the Grecian divinities Juno, Diana, or Venus, but most generally the latter. Indeed it is probable that the worship of this latter goddess was borrowed by the Greeks from that of Astarte, which prevailed to a great extent in the island of Cyprus, the fabled residence of Venus.

ASY'LUM. (Gr. ἀ, *not*, and συλάω, *I rob.*) A place of refuge to which criminals might fly, and from which it was considered the greatest impiety to move them by force. This privilege was given to many of the temples, altars, and statues of the gods, and its violation subjected the perpetrator, and all his posterity, to the vengeance of the tutelary deity, and consequently they were driven from their native country as accursed. The sacredness of the asylums was preserved till the reign of Tiberius Cæsar, who, on account of their inconvenience, abolished many, and restricted the privileges of the rest.

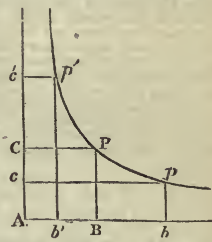
Thebes and Athens each claimed the establishment of the first asylum. Romulus set apart a particular spot on the descent from the Capitoline hill for this purpose, and thereby materially augmented the population of his infant city. Hence Juvenal satirically refers all the aristocracy of Rome to this ignoble stock:

> "Et tamen ut longe repetas, longeque revolvas
> Nomen ab infami gentem deducis asylo."

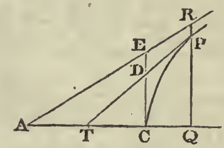
ASYLUM. The modern signification of this word differs widely from its ancient acceptation, and the purposes for which it is now employed will be best inferred from the epithets with which it is connected. The most prominent of these are asylums for the blind, deaf and dumb, lunatics, and the destitute. There is no feature, perhaps, which distinguishes a civilised from a savage state of society more than the establishment of institutions which tend to alleviate the condition of those whom moral or physical defects incapacitate for the purposes of self-exertion or competition with their fellow-citizens. In this view England has a right to claim a place in the foremost ranks of civilisation, whether we regard the number, the principles, or the internal management of its asylums. It would be out of place here to enter into detail upon so wide and comprehensive a question as the word asylum involves, but the reader will find in the parliamentary papers both of France and England, and in the reports published from time to time by the managers of asylums, a mass of information, on this subject, at once amusing and instructive.

ASY'MPTOTE. The name given to a straight line or curve which continually approaches nearer and nearer to the infinite branch of a given curve, in such a manner that when they are both indefinitely produced the distance between them, though it never entirely vanishes, becomes less than any assignable finite distance. The term, which was first employed by Apollonius, is derived from the Greek ἀ, priv., σύν, *with*, and πίπτω, *I fall*, and therefore signifies literally, *not coincident*, or that which does not meet.

Beginners feel some difficulty in assenting to the truth of the proposition that lines may continue to approach each other without meeting. It is, in fact, a proposition which cannot be made evident to the senses, but this arises from our inability to effect the division of magnitude beyond certain limits. A familiar instance of continual approach to equality is afforded by a repeating decimal; for instance, ·99999, &c.; the difference of which from unity is made ten times smaller by the addition of every successive digit; but it does not become equal to unity till the number of digits is supposed infinitely great. The nature and properties of an asymptote may be illustrated geometrically by the common hyperbola, the equation of which is $x\,y = a^2$. Let A B be the absciss, and A C the ordinate of any point P, and the parallelogram A P is equal to a constant quantity a^2. In like manner, the parallelograms made by the co-ordinates of any other points, p, p' will be each equal to a^2. It is evident, therefore, that the more the absciss A B is increased, the more the corresponding ordinate A C is diminished. If A b is equal to twice A B, then $p\,b$ is only half of P B, and so on. The curve, therefore, continually approaches to the axis of the abscissa, but never meets it; for supposing the point p to be taken at such a distance that A b would be a million of times greater than A B, $p\,b$ would be a millionth part of P B, — a small quantity, indeed, but still not zero. However great A p may be supposed, $p\,b$ must always have some value, otherwise a straight line would become equal to a parallelogram, which is impossible. It is obvious that all that has now been said of the axis A B applies equally to A C; therefore the two lines A B and A C are asymptotes to the curve.



The asymptotes of curve lines are most readily determined from the properties of their algebraic equations. Let us take, for example, the equation $B^2x^2 - A^2y^2 = A^2B^2$, which is that of the common hyperbola referred to its diameters. We easily deduce $y^2 = \frac{B^2x^2}{A^2}\left(1 - \frac{A^2}{x^2}\right)$ whence the absolute value of y is found, namely, $y = \frac{B}{A}x\sqrt{1 - \frac{A^2}{x^2}}$. But the quantity under the radical sign in this expression is always less than unity while x retains a finite value (for x cannot be less than A); the value of the ordinate y is therefore always less than $\frac{B}{A}x$. Now let a straight line A R be drawn through the centre A (the origin of the co-ordinates) making



with the axis an angle R A Q, whose tangent is equal to $\frac{B}{A}$; and let the ordinate P Q be produced to meet it in R, and let R Q be denoted by Y. We shall then have the two equations $Y = \frac{B}{A}x$, $y = \frac{B}{A}x\sqrt{1 - \frac{A^2}{x^2}}$; whence it is easy to see that the more x is increased, the more the difference between Y and y, that is R P, is diminished; and that it vanishes altogether when x is infinite.

The trigonometrical value of the cotangent of the angle P T Q, which a tangent at P makes with the axis, is $= \frac{A^2}{B^2}\frac{y}{x}$; or, substituting for y its value in terms of x, $= \frac{A}{B}\sqrt{1 - \frac{A^2}{x^2}}$ When the value of x is supposed infinite, this expression is reduced to $\frac{A}{B}$; consequently, the tangent of the same angle is $\frac{B}{A}$. But this is the tangent of the angle made by the asymptote; and hence the asymptote to a curve is frequently defined and considered as a tangent at an infinite distance.

In order to discover whether a curve has an asymptote, draw C E, meeting the tangent in D. In proportion as the point P is taken at a greater distance, the point T

approaches to A, and D to E. But the asymptote is the limiting position of the tangents; therefore we have only to find whether the expressions of C T and C D, relative to the given curve, are susceptible of finite limits, and when this is the case the construction of those limits will give the points A and E, and consequently the asymptote.

An algebraic curve cannot have more asymptotes than there are units in the exponent of its order. Of the curves of the second order, the hyperbola alone has asymptotes, and they are two in number. All curves of the third order, or which are defined by a cubic equation, have some infinite branches, but these branches have not always asymptotes. With respect to curves of the fourth order, there are an infinity of them which, so far from having four asymptotes, have none at all, and which have not even infinite branches; for instance, the curve of Cassini. The conchoid, cissoid, and logarithmic, though not classed among algebraic curves, have each an asymptote.

It may appear a sort of paradox that the areas bounded by curves and their asymptotes, though indefinitely extended, have sometimes finite limits which they cannot exceed. This is the case with the logarithmic curve, and with hyperbolas of all kinds, except the common or Apollonian.

In what precedes we have regarded an asymptote always as a straight line; but two curves are sometimes said to be asymptotes of each other when they are such that on being produced they continually approach without ever meeting. Thus two parabolas, having the same parameter, and their axes in the same straight line, fulfil the conditions of asymptotism.

ASYNARTE'TA. (Gr. ἀ, priv., and συναρτάω, *to connect.*) In Grammar, sentences which follow each other immediately, without the intervention of any connecting particle; as, "I came, I saw, I conquered."

ASY'NDETON. (Gr. ἀ, *without*, συνδέω, *I connect.*) A figure by which the conjunctions in a sentence are omitted: as in the famous phrase of Cæsar, "Veni, vidi, vici."

A'TE. (Gr. ἄτη.) In Greek Mythology, the personification of Revenge, Punishment, or Fatality. See Hom. Il. lib. xix.

A'TELES. (Gr. ἀτελής, *imperfect.*) A genus of South American monkeys, characterized by the absence or rudimental condition of the thumb of the anterior hands. The deterioration of these members as prehensile organs is compensated by a very efficient prehensile tail.

ATELLA'NÆ FA'BULÆ. A species of comedy which had its origin among the Oscan inhabitants of Campania, from a town of which country, Atella, it derived its name. It was much in vogue at Rome, and it was not thought disgraceful for persons of gentle blood to take parts in its exhibitions, as was the case in the other species of drama. The language used in the attellanæ fabulæ was Oscan, and the plots and style of the dialogue, unrestrained by any fixed rules, partook of the nature of comedy, farce, and burlesque, but was not stained by licentiousness, till the degenerate morals of the empire drew them too into the general vortex of corruption.

A TEMPO GIUSTO. (Ital. *in correct time.*) In music, a direction to the performer, generally after a recitative, to keep the measure true and correct, which, during the recitative, was performed to suit the action and passion of the scene.

ATHA'LAMOUS. (Gr. ἀ, *without*, and θάλαμος, *a bed.*) Lichens whose thallus is not furnished with shields or beds for the spores; in these the reproductive matter is supposed to be dispersed through the substance of the crust, as in lépraria.

ATHANA'SIAN CREED. A confession of faith, which is described in the rubric of the Common Prayer Book, which appoints it to be read on certain days, as commonly called the Creed of St. Athanasius. That it was really composed by that father is more than doubtful: modern divines seem generally to assent to the judgment of Waterland, who considers it to have been written by Hilary.

A'THEIST. (Gr. ἀ, *without*, and θεός, *God; without God.*) One who denies the existence of a God, or a Providence.

ATHENÆ'UM. (Greek.) In Antiquity, a public place where the professors of the liberal arts held their assemblies, the rhetoricians declaimed, and the poets rehearsed their performances. There were various places of this kind at Athens. The emperor Adrian established a famous Athenæum on the Capitoline hill at Rome, and at a later period there was another of nearly equal celebrity at Lyons. In modern times the name has been frequently bestowed upon establishments connected with learning, and upon public clubs or libraries frequented for convivial or literary purposes.

ATHERI'CERA. (Gr. ἀθὴρ, *a point*, κέρας, *a horn.*) The name given by Cuvier and Latreille to one of the primary divisions of the Dipterous order of insects. It comprehends the modern families *Syrphidæ*, *Astridæ*, *Conopidæ*, and *Muscidæ*, in all of which the antennæ have only two or three joints, the last being furnished with a bristle.

ATHERI'NA. A Linnæan genus of abdominal fishes, having an elongated body, two widely-separated dorsal fins, and a very protractile mouth armed with very small teeth. All the known species have a broad silvery band along each side, six branchiostegal rays. It was to the fishes of this genus that the ancients attributed an origin by equivocal generation; and the inhabitants of the shores of France, which are washed by the Mediterranean, still call them "nonnats."

ATHEROSPERMA'CEÆ. (Atherosperma, *one of the genera.*) Incomplete aromatic exogenous shrubs found in New Holland and South America, remarkable for having their flowers in a cup-shaped involucre, and the peculiar anthers of lauraceæ.

ATHLE'TES. (Gr. ἆθλον, *a prize.*) Men who contended at the public games of the Greeks and Romans, in boxing, wrestling, running, leaping, and throwing the quoit. The name was more particularly applied in the two former cases. Their dress consisted merely of a linen bandage round the loins, the rest of the body being left naked, and anointed with an unctuous mixture called ceroma. The boxers used a kind of glove called cæstus, which consisted of leather thongs wrapped round the hand with pieces of lead and iron sewed into them, to give greater weight to the blows.

Among the Greeks these contests were considered highly honourable, and the victors at their national games at Olympia, and elsewhere, were received in their native states with great distinction, and were rewarded with valuable privileges; indeed, one of their most popular divinities, Pollox, was celebrated for his skill in boxing. Among the Romans they were slaves, or hired persons of lower rank, or foreigners.

ATLA'NTES. (Gr. τλάω, *I bear.*) In Architecture, the statues of men used instead of columns to support an entablature. The word is used by Vitruvius.

ATLA'NTIDES. In astronomy, a name given to the Pleiades, because they were supposed to be daughters of Atlas, or his brother Hesperus, who were translated to heaven.

ATLA'NTIS. (Greek.) An island mentioned in Plato's Dialogue entitled Limæus, as having once existed in the Atlantic Ocean opposite to the Pillars of Hercules. It was said to have exceeded Europe and Africa jointly in magnitude; and after existing for 9000 years, during which period its inhabitants extended their conquests throughout the known quarters of the globe, to have been uprooted by prodigious earthquakes and inundations, and submerged in the ocean. The question of the reality and site of this island has been frequently discussed by modern geographers, who have displayed much critical perspicacity in its elucidation. M. Bailly supported the Platonic view of the existence and site of the island on the authority of the ancients, and cited Homer and Diodorus Siculus in corroboration of his opinion. Rudbeck, Kircher, Beckman, and others, concur in opinion respecting its reality, but each assigns to it a different locality. According to the conjectures of Buffon and Whitehurst, who regarded the Canaries and the Peak of Teneriffe as the summits of mountains belonging to some submerged continent, Atlantis was the land which, at a former period, united Ireland to the Azores and the Azores to America. On the other hand, D'Anville and Heeren regard Plato's account of the Atlantis as altogether a fanciful speculation; while there are not wanting many who discover in it proofs that the American continent was known at some remote period to the people of the Eastern hemisphere, but that the knowledge was subsequently lost.

A'TLAS, in Anatomy, is the term applied to the uppermost of the cervical vertebræ; so named from its supporting the head, as Atlas was supposed to support the globe.

ATLAS. In Literature, a name given to collections of geographical maps and charts; so called from the mythological giant who was said to support the globe. The name was first applied in this sense by Gerard Mercator, the geographer, in the 16th century. It is now used also for works in which other subjects are displayed in a tabular form: as, genealogy, chronology, ethnography, &c.

ATLAS. In Geography and Mythology, the name of an extensive chain of lofty mountains, some of their summits having an elevation of above 13,000 feet, in the N.W. of Africa. The early Phœnician and Greek navigators, who saw this vast chain from a distance, and were unacquainted with the intervening country, naturally formed the most extravagant notions of its height. This gave rise to a number of fables. The summits of the mountains were believed to pierce the skies; and the poets represented Atlas as an old man of gigantic stature who supported the heavens on his shoulders. Virgil has described Atlas, consistently with

the popular belief, in some of the finest lines of the Æneid : —

> ——— Jamque volans apicem et latera ardua cernit
> Atlantis duri, cœlum qui vertice fulcit ;
> Atlantis, cinctum assiduè cui nubibus atris
> Piniferum caput et vento pulsatur et imbri ;
> Nix humeros infusa tegit ; tum flumina mento
> Præcipitant senis, et glacie riget horrida barba. — IV. 246—252.

ATMO'METER. (Gr. ἀτμὸς, *vapour*, and μέτρον, *measure.*) An instrument for determining the rate of evaporation from a humid surface.

A'TMOSPHERE. (Gr. ἀτμὸς, *vapour*, and σφαῖρα, *a sphere.*) The assemblage of aeriform vapours which form the invisible medium which surrounds the earth. For an account of the different gases which enter into the composition of atmospheric air, see AIR. We shall here confine ourselves to an account of the mechanical properties of the atmosphere.

Weight of the Atmosphere. The first circumstance connected with the atmosphere which attracts our attention is its weight, or the pressure which it exerts on solid bodies at the surface of the earth. It is well known that the rise of water in the sucking pump, and the suspension of the column of mercury in the barometric tube, are caused by the pressure of the atmosphere ; we have therefore, in either of these phenomena, the means of exactly measuring its weight. The column of mercury in the tube of a barometer is exactly equal in weight to a cylinder of air of equal diameter reaching to the top of the atmosphere. Now, the mean height of the barometer at the level of the sea is about 28·6 inches ; and a cubic inch of mercury weighs 3425·92 grains, or 0·48956 lbs. avoirdupois. It follows, therefore, that a column of mercury whose base is a square inch, and height the mean height of the barometer, weighs $0·48956 \times 28·6 = 14·6$ lbs. avoirdupois nearly, or that the atmosphere exerts a pressure equal to 14·6 lbs. on every square inch at the surface of the earth.

This pressure of the atmosphere plays a very important part in the animal and vegetable economy. Like that of all other fluids, it is exerted equally in all directions ; thus the air in a tube presses not only on the bottom but also on the sides of the tube, with a force equal to 14·6 lbs. for every square inch. The surface of a man of ordinary stature is about 15 square feet, or 2160 square inches, whence the whole atmospheric pressure which his body sustains amounts to the enormous sum of 31,536 lbs. This great pressure is not sensible, because it is balanced by the reaction of the elastic fluids in the interior of our bodies ; but if the equilibrium were to be suddenly destroyed, the consequences might be fatal. Under the exhausted receiver of an air pump, animal life is soon destroyed : on the summit of a very high mountain a man experiences extreme fatigue, respiration becomes difficult, the pulse is accelerated, and it has happened that the blood has started from the eyes and ears, and other tender parts of the body, in consequence of the diminished pressure.

Density of the Atmosphere. The density of the atmosphere is not the same at different distances from the surface of the earth, but diminishes in the duplicate ratio of the altitude : that is to say, if at a certain altitude above the earth's surface it be one half what it is at the surface, then at twice that altitude the density will be only one fourth of what it is at the surface. This may be proved as follows. Conceive a vertical tube filled with air, reaching from the surface of the earth to the limits of the atmosphere ; it is evident that each particle of the inclosed air will sustain the pressure of all those above it ; and as the air, in consequence of its elasticity, is condensed proportionally to the pressure, it is easy to see that the density will go on diminishing from below upwards. To discover the law of this diminution, let x be the height of any point of this column above the surface of the earth, u = the density and p = the pressure of the air at x ; and in order to simplify the problem, we shall suppose the temperature to be the same throughout the column, and neglect the difference of pressure arising from the diminution of gravity. Supposing the area of the column = 1 the volume of an infinitely thin stratum is the differential of the height, or $d\,x$, and therefore the weight of all the strata or the whole column above the point x expressed by the integral $\int - u\,d\,x$ ($d\,x$ being taken with the negative sign, because when x increases the weight diminishes). But it is evident that the weight of the column above x must make an equilibrium with the pressure at x, therefore we have the equation $p = \int - u\,d\,x$. But the density is proportional to the pressure, therefore, A being a constant quantity, $p = A\,u$ and consequently $A\,u = \int - u\,d\,x$. Hence $A\,d\,u = - u\,d\,x$ and $d\,x = - A\frac{d\,u}{u.}$ Integrating this equation we get $x = C - A \log u$. Let U be the density at the surface, where $x = o$; the equation then becomes $o = C - A \log U$; whence eliminating C, $x = A \log U - A \log u$; or $x = A \log \frac{U}{u.}$ It follows therefore that as the altitude x increases, the logarithm of the density u diminishes ; whence we derive this important conclusion, that if the altitudes above the surface of the earth be taken in arithmetical progression, the densities of the air at these altitudes will be a geometrical progression decreasing.

By means of this theorem we can easily find the density of the atmosphere at different altitudes, with the help of a common table of logarithms. Suppose that at the height of one mile above the surface the density is represented by unity, the densities at other altitudes will be represented as follows : —

Height in miles	1,	2,	3,	4,	5,	6,	7.
Corresponding densities	1	0·739,	0·6309,	0·5011,	0·3981,	0·3163,	0.2511

So that at an elevation of seven miles the density is reduced to one-fourth, and at 14 miles to one-sixteenth, and so on. Conversely, when the variation of the density or pressure at different points is ascertained, the difference of altitude becomes known ; hence by means of the barometer we are enabled to ascertain the elevations of the different countries or mountains of the earth above the level of the sea.

Height of the Atmosphere. If the air were of the same density throughout, it would be very easy to determine the limits of the atmosphere. It has been found by accurate experiments, that at the temperature of 60° and under a pressure measured by 29·82 inches of mercury, a cubic inch of atmospheric air weighs 9·311446 grains. Comparing this with the weight of a cubic inch of mercury, it is found that if the density continued the same, the height of the atmosphere would be 328,021 inches, or 5·17 miles. But on account of the rapid diminution of the density, it is very evident that the height of the atmosphere must greatly exceed 5 miles, though we have no means of directly determining how much. There are, however, various methods of obtaining an approximate estimate. One of them, proposed by Kepler, is derived from observations on the twilight, which is occasioned by the power the atmosphere possesses of refracting and reflecting light. It is generally assumed that twilight ceases when the sun has descended 18° below the horizon. Now it may be considered that this takes place when a ray of light proceeding from the sun, and passing by the surface of the earth, just reaches the highest stratum of the atmosphere, and is reflected back to the earth in the direction of a tangent to its surface at the place of observation. On this principle it is calculated that reflection cannot take place at a greater altitude than 45 miles. There are other considerations which lead us to infer that the height of the atmosphere cannot be much less than this sum. With a good air pump, air may be rarefied 300 times ; supposing this to be the utmost limit to which rarefaction can be carried, the atmosphere would still extend to an altitude of about 40 miles.

Limits of the Atmosphere. Though we are unable to assign the precise boundaries of the atmosphere, there are phenomena which prove that it has a limit ; that it does not extend indefinitely into the celestial spaces, but belongs exclusively to our earth. If matter, or rather if atmospheric air, were infinitely divisible, the extent of the atmosphere would also be infinite ; but in this case the fluid could not be in equilibrio unless the sun and all the planets as well as the earth had respectively portions of it condensed around them proportional to their respective attractions. But it is known, from the phenomena of the eclipses of Jupiter's satellites, that the atmosphere of that planet does not by any means exceed that of the earth in proportion to the great superiority of his mass and attractive power ; hence there can be no communication between the atmosphere of the earth and that of Jupiter. It has also been shown by Dr. Wollaston, from phenomena attending the passage of Venus near the sun, that the sun has no sensible atmosphere. We are therefore warranted in concluding that the atoms of air are not infinitely divisible, and consequently that the atmosphere has a limit ; and the limit must be situated at that height above the earth where the gravitation of the atoms is just equal to the force of their repulsion.

Effects of the Atmosphere on Light. Like all other diaphanous substances, the atmosphere attracts the molecules of light, and deflects them from their rectilinear course. This phenomenon is called refraction. It increases the apparent elevation of all the celestial bodies above the horizon ; but, fortunately for astronomy, its effects can be rigorously calculated. The atmosphere also, notwithstanding its transparency, intercepts and reflects the rays of light, and multiplies and propagates them by an infinity of repercussions. If the atmosphere did not exist, objects would not be illuminated unless exposed to the direct light of the sun. As soon as we ceased to look at the sun, or objects illuminated by his rays, we should be left in total darkness. The solar rays reflected from the earth would be lost in the regions of space, and an excessive cold continually prevail. The

sun would continue to shine with unabated intensity, till it reached the horizon, and the transition from the glare of meridian splendour to absolute darkness would be almost instantaneous. All these effects may be judged of by what is experienced on the summits of very high mountains, where the air is greatly rarefied. The cold is insupportable. Scarcely any other light is received by the eye, than that which comes direct from the sun and the stars. The illuminating power of the atmosphere is so feeble, that to an eye placed in the shade the stars are visible in broad day.

Colour of the Atmosphere. The general blue colour of the atmosphere, and the brilliant and glowing tints of the morning and evening, arise from the different modifications which the different rays of light receive in passing through the air. When the sun is near the horizon, the stratum of air through which the light must pass before it reaches us is greatly thicker than when he is at a considerable altitude. Now the red rays possess a greater momentum than those of the upper portion of the spectrum, whence they force their way in greater abundance through the resisting mass of air, and penetrate to the earth, while the violet and blue are reflected or absorbed. Hence the ruddy colour of the morning and evening skies. The prevailing blue colour of the atmosphere is to be ascribed to the greater facility with which the blue and violet rays are reflected, or from possessing less power to penetrate through the aerial strata. At a great height in the atmosphere, the blue tinge disappears, and the sky becomes a deep black.

The atmosphere is a region of clouds and vapours through the agency of which the earth is fertilised and rendered fit for the support of animal and vegetable life. The various phenomena of which it is the theatre, and the effect of the changes which are continually taking place in its physical condition, form one of the most important branches of natural philosophy. (*See* CLIMATE, METEOROLOGY, VAPOUR, WIND, &c.)

Atmosphere, in Electricity, denotes a medium conceived to be diffused over the surface of electric bodies, and to extend to some distance from them. It is not proved that any such fluid medium exists, at least of a peculiar kind, though it figured greatly in the language of the early writers on electricity. Phenomena that were explained by the agency of a peculiar fluid, are now known to depend on the modification which common air receives from electric substances. *See* ELECTRICITY.

ATMOSPHE'RIC STONES. *See* AEROLITES.

ATMOSPHERIC TIDES. Certain changes in the barometric pressure of the atmosphere, depending on the attraction of the sun and moon. Laplace ascribes the lunar influence indicated by the observations on the diurnal variations of the barometer to the elevation and depression of the waters of the ocean, instead of the direct effect of the moon's attraction. The solar action he attributes wholly to the expansion caused by the heat of the sun. It is extremely doubtful if, in our latitudes, the attraction of the sun and moon produces any perceptible oscillation of the atmosphere.

A'TOM. (Gr. ἀ, *not*, and τέμνω, *I cut.*) A part so small as not to be divisible.

ATO'MIC THEORY. (In Chemistry.) When substances combine chemically, they are found to unite in certain weights; thus, water is constituted of one part by weight of hydrogen and eight of oxygen, and the gases only combine in those proportions to form it. It is assumed that water is a compound of an atom of hydrogen and an atom of oxygen, and that the relative weight of the atom of hydrogen to the atom of oxygen is as $1:8$; hence the atomic weight of water is $1+8$, or $=9$. The same theoretical views are applicable to all other simple and compound bodies, and the numbers which represent their combining weights are hence called their atomic or equivalent numbers. (*See* EQUIVALENTS, and AFFINITY.)

ATOMOGY'NIA. (Gr. ἄτομος, *uncut*, and γυνή, *a female.*) A word proposed to be substituted for angiospermia, the name of the second order of the sixth class of Linnæus, signifying that the ovary is not cleft into distinct parts.

ATO'NEMENT. (From the old English verb to atone, or reconcile: the phrase is still used adverbially, as where we say that two persons are "at one," i. e. agreed.) In Theology, the reconcilement of God with man by virtue of the death of our Saviour. The sacrifices of Jewish and patriarchal antiquity were types of this great event, and were in themselves offered for the purpose of atoning for sin; and the idea attached to the practice of sacrifice by the numerous heathen nations of antiquity, and of the present time, has always been the same. (*See* SACRIFICE.)

A'TRIUM. (According to Scaliger, from the Greek αἴθριος, *exposed to the air.*) In ancient Architecture, the atrium is by some considered the same as the vestibule, and Aulus Gellius intimates that in his time these two words were frequently confounded. There is reason for supposing that the vestibule was not properly a part of the house, but merely a portion of the entrance; for Cicero, in a letter to Atticus, describing the attack made on him in the via sacra, says, he took refuge to defend himself in the vestibule of Tatius. "Secessi in vestibulum Caii Tatii Domionis." If, however, in the time of Aulus Gellius these words were used ambiguously, it is not probable that at this period the question will be settled; and that this was the case is quite certain, for, in describing the spot where the colossal statue of Nero stood, Martial places it in the atrium, and Suetonius in the vestibulum. That the atrium was in an inner part the verse of Virgil, "Apparet domus intus et atria longa patescunt." According to the description of Vitruvius, it seems to have been a sort of covered portico, composed of two ranks of columns, forming a centre and two side aisles, and to have been beyond the cavædium or court, and before the tablinium or cabinet. The atrium was decorated with the statues of the proprietor's ancestors. Festus derives its name from its first use at Atria in Etruria. "Dictum atrium quia id genus edificii primum Atriæ in Etruria sit institutum."

A'TROPHY. (Gr. ἀ, priv., and τρέφω, *I nourish.*) A wasting away of the flesh.

ATRO'PIA. (Gr. ἄτροπος, *one of the Fates.*) A highly poisonous alkaline substance, extracted from the atropa belladonna, or deadly nightshade.

A'TTA. The name of a Fabrician genus of Hymenopterous insects belonging to the ant-tribe (*Formicidæ*), characterized by their very minute palpi, and the large size of the heads of the neuters. Some of the largest species of ant, as the visiting ant of South America, (*Formica cephalotes* L.), are included in this genus.

ATTA'CHMENT. In Law, a process issuing in a summary manner from a court of record against the person of any one guilty of a contempt of its rules. Attachment is most commonly granted against attorneys for malpractice, against sheriffs for making a false or no return to a writ, and against any parties neglecting to pay costs when ruled to do so.

Foreign Attachment. Under the custom of the city of London, whenever process for debt from the mayor or sheriffs' court is returned nihil, the plaintiff may, upon its appearing that a third person is indebted to the defendant, obtain satisfaction of his claim by attaching the debt. This is called foreign attachment.

ATTA'INDER, BILL OF. A species of extraordinary proceeding against parties accused of treasons or felonies which cannot be reached by the ordinary course of justice. During the reigns of the Tudors the more constitutional process of impeachment was entirely laid aside, and attainders were generally adopted in the case of state criminals. These bills usually commenced in the Lords. They have been very unusual in later times: the last recorded in Mr. Hatsell's Precedents of Parliament was directed against some persons concerned in the Scotch rebellion in 1746. Parliament is now bound, in passing these acts, to adhere to the rules of evidence which are followed in ordinary courts of justice.

Attainder is the supposed stain or corruption of the blood of a criminal legally condemned, which, by the common law of England, immediately follows the pronouncing sentence of death. The attainder of a criminal follows upon judgment, and not upon conviction. Attainder is either on appearance (by confession or by verdict) or by process, otherwise termed by default or outlawry, in case of non-appearance. For the effect of attainder on the lands, &c. of the criminal, *see* FORFEITURE. It is enacted by 54 G. 3. c. 145. that no attainder for felony, except in cases of high treason, petty treason, or murder, or abetting and counselling the same, shall extend to the prejudice of the rights of any persons except the offender during his life.

ATTE'LABUS. The name of a Linnæan genus of Coleopterous insects, characterised by moniliform antennæ, thicker towards the tip, and situated on the rostrum: the head pointed behind, and inclined. The species thus heterogeneously grouped together are now divided into the genera Attelabus proper, Apoderus, and Rhynchites. The latter includes some of the most beautiful weevils in this country, amongst which is the rare and splendid Carculio auratus.

ATTE'NTION. (Lat. *attentio.*) In Metaphysics, a steady exertion or application of the mind to any object of sense or intellect, in order to its being thoroughly understood, and afterwards retained. Attention is regarded by Stewart as a distinct faculty of the mind; and though this arrangement does not coincide with the views of many philosophers, his illustrations of the results or effects of attention are universally considered as a masterpiece of metaphysical disquisition. (Vide *Inquiry into the Human Mind*, ch. 2.)

ATTE'NUANTS. Remedies which dilute the blood.

ATTENUA'TUS. (Lat. *made thinner.*) When the thickness of any part diminishes in some particular direction, it is often used in the sense of narrowed, or angustate.

A'TTIC. (Gr. ἀττικὸς, *Athenian;* derived, in the seventh edition of "Ency. Brit.," art. "Architecture," from ἄτειχον, *without a wall*, which, if true, would make every thing attic

that was detached from a wall.) In Architecture, a low order of architecture, commonly used over a principal order, never with columns in it, but always antæ, or pilasters. It is employed to decorate the façade of a floor of small height, terminating the upper part of a building, and is doubtless called attic from its resemblance in proportional height and concealed roof to some of the buildings of Greece. Pliny describes it, after speaking of the other orders, thus: "Præter has sunt quæ vocantur atticæ columnæ quaternis angulis pari laterum intervallo." We, however, find no examples of square pillars in the remains of ancient art, though almost all the triumphal arches exhibit specimens of pilastral attics, having no capitals save the cornice breaking round them. In modern architecture the proportions of the attic order have never been subject to fixed rules, and their good effect is entirely dependent on the taste of the architect.

ATTIC BASE. *See* BASE.

A'TTICISM. (Gr.) An elegant or concise form of expression. Milton, in his Apology for Smectymnuus, thus uses it: "They made sport, and I laughed: they mispronounced, and I misliked; and, to make up the atticism, they were out, and I hissed." The term *Sal Atticum* was employed by the Romans at once to characterise the poignancy of wit and brilliancy of style peculiar to the Athenian writers, and to designate the liveliness, spirituality, and refined taste of the inhabitants of that city, which formed the focus and central point of all the eloquence and refinement of the Greeks.

A'TTITUDE. (Fr.) In Painting and Sculpture, the gesture and position of a figure, in which the action or sentiment of the person is represented. It should be natural and unconstrained, expressive, varied. Where more than one figure occurs there should be contrast in the limbs, and at the same time a balancing of each other.

ATTO'RNEY. (From the modern Latin torno, whence attorno, attornatus, signifying one who serves the *turn*, or is set in the place of another to do his business.) An attorney is either private or public. A private attorney is a person who acts for another in the conduct of his affairs out of court; for which purpose a verbal authority is in general sufficient; but for the performance of some acts, as, to deliver seisin of land, to transfer bank stock, or to execute a deed for another, he must be authorised by a formal power of attorney. He is not necessarily of the profession of the law; and the above, and all other the various matters unconnected with actual litigation in which he may be employed, such as the preparation of legal instruments, and the giving of advice and assistance in the transfer and management of property, may be undertaken by any other person. A public attorney, or an attorney at law, has been defined to be an officer of a court of record, legally qualified to prosecute and defend actions in courts of law on the retainer of clients. The circumstance of his being an officer of the court in which he may practise is important, as bringing him immediately within its summary jurisdiction, and thereby giving rise to his peculiar privileges and disabilities. A solicitor differs from an attorney in practising in courts of equity instead of common law.

Anciently parties were not allowed to appear in court by attorney without the king's special warrant by writ or letters patent, and if this could not be obtained were compelled every day during the pendency of their suit to be present in their own proper persons. The power of suing and being sued by attorney was first given by statute in the time of Edward I. All persons may now appear in court by an attorney of their own appointment, except infants, who must appear by next friend or guardian; married women, for whom, unless when proceeding in chancery in respect of their separate estate against their husbands, the attorney must be appointed by their husbands; idiots, and persons charged with any criminal offence, must appear in person; lunatics, if of full age, and corporations, cannot appear otherwise than by attorney.

The admission and practice of attorneys is now chiefly regulated by the 2 G. 2. c. 23., and other statutes made in the same and succeeding reign. The first requisite to be complied with in order to become an attorney is to enter into a contract in writing, called articles of clerkship, on which a heavy stamp duty is payable, with an attorney or solicitor actually practising, or other officer of court specified by statute to serve him in the capacity of clerk for five years. No attorney or solicitor can take more than two articled clerks at the same time, but some of the officers above referred to are allowed to take three persons who have taken the degree of B. A. or B. C. L. at Oxford, Cambridge, or Dublin, within a certain fixed period after matriculation at the university, and before execution of their articles may be admitted as attorneys after a clerkship of three years. Clerks also who are bound for five years are allowed to reckon as part of their term a year passed as bonâ fide pupils to a barrister or special pleader. After the expiration of the service, and notice given of his intention to apply for admission, the clerk must go before a board of examiners recently established by the judges under rule of court, and his fitness and capacity having been approved, be sworn in open court to demean himself honestly in his practice. His name is then entered on one of the records of the court, called the roll of attorneys, and he is duly admitted an attorney of that particular court. He may, however, when admitted of any one court at Westminster, practise in any one of the other courts there, in the name of an attorney of such other court, with his consent in writing. He may, at a trifling expense, be admitted a solicitor in any of the courts of equity, as a solicitor in equity may in like manner be admitted an attorney of any of the courts of common law. After admission he must, before the 16th December in every year, pay a certain duty, and obtain his certificate. Should he for one whole year neglect to take out his certificate, he would, besides incurring a penalty for practising without one, be thenceforth incapable of acting in court in any professional character; but upon payment of all arrears of duty since the expiration of his last certificate, and of a further sum by way of penalty, may be readmitted.

An attorney actually practising is supposed to be always present in court, and has for that reason many privileges in common with its other officers. He is accordingly exempted from serving on juries and inquests, and generally from filling all offices which require personal service; he has the privilege in all personal actions of suing in his own court, and of retaining the venue in Middlesex, and as defendant is not liable to be arrested on mesne process. He is in general privileged from giving evidence of any confidential communication made to him by his client: this, however, is the privilege not of the profession but of the client, who may waive it if he please. An attorney cannot fill the office of justice of the peace, sheriff, and many other offices, and cannot be bail for another unless in criminal cases. He is not permitted to deal with his clients in the same unrestrained manner in which ordinary men may deal with each other; and when a purchaser of his client's property, is sometimes required to show affirmatively in the first instance that he has given for it its full value. To restrain him from extortionate and vexatious conduct, he is required, one month at least before bringing an action to recover fees for business done in court, to deliver to his client a bill of costs, which, upon application of the client and his undertaking to pay what shall appear due, will be taxed by an officer of the court, and if exorbitant be reduced to a fair and reasonable amount. Where an attorney has been guilty of gross ignorance, neglect, or misbehaviour, in the management of his client's business, the court will frequently interpose in a summary manner, and compel the attorney to pay the costs, or make reparation for any loss occasioned by his default; and in cases of fraudulent malpractice grant an attachment against him, or even strike him off the roll. He is besides liable to an action for any gross and culpable negligence, by which the interests of his client may have been prejudiced. In matters of difficulty, not lying within his own department of the profession, he is protected from responsibility by acting on the opinion of counsel; but in matters of simple and ordinary practice, where the law will presume him to have the requisite knowledge himself, he cannot avoid his responsibility by consulting another.

ATTORNEY-GENERAL. An officer made by letters patent. He is the public prosecutor on behalf of the crown, his duty being to exhibit informations in criminal matters which concern the crown, ex officio, or by virtue of his office. (*See* INFORMATION.) He also files bills in the exchequer for any thing concerning the king's inheritance and profits, and bills are filed against him by others. The attorney-general has precedence of all other counsel. As chief legal adviser of the crown, in all matters falling within the purview of his office, his place is one of great importance, and is usually entrusted to new hands whenever an extensive change is made in the cabinet. It is generally understood that the attorney-general for the time being has a priority of claim for preferment to any of the high law offices which may fall vacant, if he is willing to accept it; but this rule has by no means been uniformly acted on.

ATTRA'CTION. (Lat. ad, *to*, and traho, *I draw*.) Used in physics to denote the tendency which we observe in certain bodies to approach one another, and to resist separation. The meaning of this term has been greatly obscured by metaphysical disputations. When a body A, is connected with another body B, by a rod, or chain, or in general by the intervention of any mechanical means, we see, or fancy we see, the reason why B attracts A, or A is compelled to follow the motions of B. But when two distinct bodies not connected by any visible bond of union are observed to aproach one another, the phenomenon seems to assume a greater degree of mystery, from our being no longer able to perceive any mode by which the one body can act on the other. On reflecting, however, on the constitution of material substances, and considering that they are composed of

distinct particles, which there are many reasons for believing are not in contact with each other, we may soon satisfy ourselves that there is, in reality, as much difficulty in conceiving how the different particles of a body cohere, or act on each other by impulse, as in conceiving how one body can be the cause of motion in another placed at a distance.

It is well remarked by Maupertuis, that the manner in which the different properties reside in a subject is always inconceivable to us. The vulgar are not astonished when they see a body in motion communicate its motion to other bodies; we are accustomed to the phenomenon, which prevents our perceiving in it any thing marvellous. But philosophers will not readily believe that an impulsive force is more conceivable than an attractive one. What, in fact, is this impulsive force? How does it reside in bodies? Who could have predicted its existence before seeing the bodies impinge on each other? The existence of other properties in bodies is not more clear. In what way does impenetrability and the other properties become joined to extension? In these things there will always be mysteries for us.

Before the time of Sir Isaac Newton, the term attraction was used to denote a species of quality inherent in certain bodies; at the present time, however, philosophers use the word not to express any particular mode or species of action, or any physical cause of such action, but simply the fact, that the different parts of matter tend to approach each other, without any reference to the question whether the power which produces that tendency is inherent in the bodies, or consists in the expulsion of an external agent. They regard it as one of the ultimate phenomena to which the analysis of matter leads. Newton himself particularly cautions his readers against supposing that there is really an attractive force residing in the centre towards which bodies tend, the centres being only mathematical points. He takes care to mention that he uses the term to denote a fact, and not a cause; that he used it only for the purpose of avoiding systems and explications; that this tendency might be caused by some subtle matter proceeding from bodies, and be the effect of a real impulsion; but whatever its cause might be, it was clearly a primary fact from which we might set out in explaining other facts depending on it. At present, objections of the sort which Newton here attempts to avoid, carry little weight with them, but in the time of Newton they were considered of the greatest importance. Leibnitz called attraction an occult quality, a term then held in horror; and the fact is certain, that the physical or metaphysical difficulties of explaining the nature of attraction contributed not a little to retard, on the Continent, the adoption of the Newtonian theory of the universe.

Attraction, with reference to the laws which it observes, may be divided into two kinds; one, taking place among bodies, placed at measurable distances from each other; the other among the small particles of matter, where the effect is only sensible at insensible or inappreciable distances. Among the instances of attraction at sensible distances, even at the greatest distances, the most remarkable is that of the attraction of gravitation, which belongs to all matter; which determines the motions and the figures of the planets and comets, and causes the descent of heavy bodies to the ground. For an account of the law which this species of attraction observes, and the astronomical phenomena which it produces, *see* GRAVITATION. The attraction of magnetism, of electricity, &c., are also instances of the action of bodies on each other, at sensible distances. *See* MAGNETISM; ELECTRICITY.

The second species of attraction exists only among the molecules or small particles of matter, and is hence called molecular attraction. The distances to which it extends are extremely small, or insensible. This species of attraction is the cause of the coherence of solids; of crystallisation; the refraction of light; the ascent of fluids in capillary tubes; the roundness of a drop of water; and in general, of all chemical actions. (*See* CAPILLARITY, COHESION, AFFINITY, &c.) It is to Newton that we owe the first distinct announcement of this last species of attraction, as it is to him that we owe the discovery of the law of the attraction of gravitation, and that it pervades celestial as well as terrestrial matter. The law of molecular attraction is not known; all that can be positively affirmed of it is, that it decreases in a much quicker ratio than the inverse square of the distance, and in many instances becomes prodigiously great, when the distance between the particles is diminished to its utmost limit.

It would not be possible to explain the constitution of matter, or account for the different forms under which it presents itself, by molecular attraction alone, without calling to aid the antagonist principle of repulsion. If the particles of matter only attracted each other, they would continue to advance nearer and nearer to each other, till further approach was rendered impossible by their impenetrability. But this does not take place; for all bodies are capable of contraction and dilatation, and in fact do dilate and contract, by the application of heat and cold. Thus, the particles of matter being solicited at the same time by two kinds of opposite forces, naturally assume that state of equilibrium which results from the compensated energies, and approach or recede, according as the attractive or the repulsive force predominates. All terrestrial phenomena depend on forces of this kind, as the celestial phenomena depend on universal gravitation. The repulsive force appears to be produced by the principle of heat: the attraction cannot be referred to any principle with which we are more familiar than we are with itself. Some philosophers have attempted to confound molecular attraction with the general attraction of gravity, or at least to regard the former as a modification of the other; but in the laws which they obey they are totally different.

Most of the disputes which have taken place about the nature of attraction have proceeded from the indistinct ideas which we attach to the term force. By force is meant the cause of motion; but we know not in general what that cause is; we only judge of its degree by the effect which we see produced. We have no means of measuring or comparing forces directly; what we do measure and compare are the changes of motion; and when we see bodies in motion, we immediately conclude that it is occasioned by the action of a force. Attraction and repulsion are principles of action; and if they are more difficult to be conceived than any other causes of action or motion, the obscurity arises merely from their implying action at a distance.

Of all the different kinds of attraction mentioned above, there is only one of which the laws have been fully investigated, namely, the attraction of gravitation. The electric and magnetic attractions are rather terms employed in physics for the purpose of giving a name to what we imperfectly understand, than used as principles from which to deduce the phenomena to which they give rise. The laws of capillary attraction have been investigated to a considerable extent by Laplace; but molecular attractions in general, which play so important a part in the economy of the world, have seldom been made the subject of mathematical investigation.

ATTRACTION OF MOUNTAINS. That power or force by which all the celestial motions are regulated, and to which we give the name of gravitation, does not act merely on the large masses of the universe; the smallest molecules of matter equally partake of its influence, and have an inherent and natural tendency to approach one another. This mutual action, in the case of small bodies, is insensible; because the attraction resulting from the whole mass of the earth absorbs, as it were, altogether, that which they exercise on one another; and renders their mutual approach infinitely small or imperceptible. But though the attractive force of matter is insensible in regard to small masses, it may become quite appreciable in the case of large mountains acting on the plummet of a delicate astronomical instrument. Newton himself was the first who deduced this consequence from his theory of universal gravitation. In his tract "De Mundi Systemate," § 22., he computes that a plummet, at the foot of a hemispherical mountain three miles high, and six broad (at the base), would be drawn about one minute and eighteen seconds out of the perpendicular. Some time elapsed, however, before any attempt was made to investigate the subject experimentally.

Those who are unaccustomed to consider the intimate relation that subsists among the different parts of physical science, and the light which the accurate solution of one question frequently throws on a multitude of others, will naturally inquire what useful purpose is to be gained by determining the attraction of a mountain, — a determination, moreover, of an extremely nice and delicate kind, and by no means easily executed. Nevertheless, the subject is one of very great importance in astronomy, and its investigation necessary, in order to ascertain the figure of the earth, and determine its interior density. The magnitude and figure of the earth are found by comparing the lengths of lines measured at different places on its surface with the corresponding celestial arcs, the extremities of which are the zenith points of the extremities of the terrestrial line. Now if, by the attraction of a mountain, or any other local cause, the plumbline is drawn aside from the perpendicular, or the direction of gravity is not perpendicular to the general surface, the position of the apparent zenith will be altered; and a very small deviation of this kind will produce a great error, for every second of the celestial arc corresponds to about 100 feet on the ground. It is necessary, therefore, to possess the means of making a correct allowance for such causes of local irregularity where they cannot be avoided. Again, the attraction of a mountain gives the means of determining the mean density of the earth. For suppose this attraction to be known by its effect on the plumbline, as the dimen-

sions of the mountain can be determined by measurement, and the density of its materials can in general be ascertained with tolerable accuracy, the quantity of matter which it contains becomes known. But the dimensions of the earth, and the amount of its attraction, are also known; therefore we are in possession of all the data necessary to enable us to compute its mean density.

There are various ways by which the quantity of the attraction of a mountain may be ascertained. One of the most obvious is to take two stations, one on the south and the other on the north side of the mountain, and as nearly as possible in the same meridian. From the zenith distances of the same stars observed at each station, the difference of their apparent latitudes may be accurately determined. But the real difference of the latitudes can also be determined by a trigonometrical measurement on the ground of the distance between the same stations. The difference of these determinations gives the sum of the deviations of the plumbline on the opposite sides of the mountain; and when divided in the inverse ratio of the squares of the distances of the stations from the centre of gravity of the mass, will give the deflection of the plummet at each station. Another method supposes one observer to be placed at the eastern foot of the mountain, and another at the western, having the means of accurately determining astronomically the difference of their meridians. This difference, compared with the measured distance by which the one station is east or west of the other, will show the effect of the attraction of the mountain; but as there is greater difficulty in determining accurately the difference of longitude than of latitude, this method cannot be so easily applied as the former. But it is not absolutely necessary, indeed it may be impracticable, to make observations on the opposite sides of the mountain. Let the meridian altitudes of the same stars be observed first on north or south sides of it, and then at a station on the same parallel of latitude, but at such a distance from the mountain as to be out of the reach of its action. The difference of the altitudes in the two cases will show the amount of the attraction of the mountain.

The first attempt to ascertain the attraction of a mountain by actual observation was made by the French academicians, Bouguer, Godin, and Condamine, who, about the year 1738, were dispatched to Peru for the purpose of measuring the length of an arc of the terrestrial meridian. Their experiments were made on the mountain Chimbaraço, the highest of the Cordilleras, and the result seemed to show that the zenith point was altered by the attraction of the mountain to the extent of about 7½ seconds of a degree. But this quantity was much too small to determine, with certain evidence, whether the mountain had or had not a sensible effect on the plumbline, for their instruments were not so perfect but that inconsistencies, amounting sometimes to upwards of 20 seconds, entered into their observations. From that time no farther attempt was made to determine this interesting fact in physical astronomy to the year 1774, when Dr. Maskelyne, the astronomer-royal at Greenwich, made an experiment of the same kind on the mountain Schehallien in Perthshire, with instruments capable of measuring the minute quantities in question. The difference of latitude of two stations on the north and south side of the mountain, compared with that which was inferred from the measurement of the distance on the ground, gave decidedly 5·8 seconds on each side, for the action of the mountain on the plummet of the zenith sector. The magnitude of the mountain was accurately measured at the same time; and with the data thus obtained a laborious calculation was made by Dr. Hutton, from which it resulted that the mean density of the earth is about five times that of water, or twice that of the ordinary rockstone near its surface. A third experiment of the same kind was made in 1810 by Baron Zach on the mountain Mimet, at a little distance from the shore of the Mediterranean near Marseilles. The instrument which he employed for determining the latitudes, a repeating circle of 12 inches radius, was much less to be depended on for accurate results than the zenith sector of Dr. Maskelyne; but in other respects his operations, particularly those connected with the terrestrial measurements, appear to have been conducted with far greater science and practical skill. The result was, that the deviation of the plumbline from the true vertical, caused by the attraction of the mountain, amounted to two seconds of a degree. Baron Zach did not attempt the further researches required for comparing the density on the mountain with that of the earth; such comparison, indeed, can only be made with respect to an insulated mountain, which Mimet is not.

Though the experiments hitherto made on this subject are few and imperfect, they are quite sufficient to establish the fact, that mountains are capable of producing sensible deflections of the plumblines of astronomical instruments. It is, therefore, of very great importance, in the measurement of degrees of the terrestrial meridian, to select for the station where the astronomical latitudes are observed, places remote from large mountains, and where the local irregularities of the surface are not very considerable. After every precaution of this sort has been taken, some uncertainty will still remain on account of local attraction; for it is obvious that a sudden and considerable variation of density in the strata under the surface will produce the same effect on the plumbline as a mass of matter elevated above it. To this cause is attributed, with much probability, a great part of the discrepancies among the results of the operations made to determine the figure of the earth, particularly among those for ascertaining the variations of density by means of the pendulum. See *Zach's Attraction des Montagnes*, Avignon, 1814. *Playfair's Works*, vol. iii. *Hutton's Tracts*, vol. ii. *Phil. Trans.* vol. lxviii.; also *Bouguer's Figure de la Terre.*

ATTRACTION, CHEMICAL. *See* AFFINITY.

A'TTRIBUTES. (Lat. ad, *to*, and tribuo, *I give.*) In the Fine Arts, certain symbols which are used to distinguish and characterise certain figures. Thus the eagle and thunderbolt are the attributes of Jupiter; the trident, that of Neptune; the caduceus, of Mercury; the bow and quiver attend Love; the balance and sword accompany Justice, &c. &c.

AUBAINE, DROIT D'. In French Jurisprudence, the right of the sovereign to the succession of a foreigner not naturalised, or of a naturalised foreigner dying intestate without heirs resident within the realm. The word is derived from the old French aubain, *foreigner:* said to come from the Latin alibi natus, *born elsewhere.* The droit d'aubaine still exists in various countries; and, although abolished at the Revolution, was restored by the Code Civil of Napoleon.

AUCHE'NIA. (Gr. αὐχήν, *the neck.*) In Mammalogy this term is restricted to the region of the neck, below the micha, or nape. Also, the name of a genus of Camelidæ, in which the above region of the neck is remarkably elongated.

AU'DITOR. One who examines and verifies the accounts of officers and others entrusted with money. The term is derived from the Latin audio, *I hear:* probably from the ancient practice of delivering accounts vivâ voce. Receivers-general of fee-farm rents, &c. are termed auditors. Officers with the same title are assigned by courts of law to settle accounts in actions of account, &c. The auditors of the exchequer were officers appointed to take the accounts of receivers of public revenues. The present board of commissioners for auditing the public accounts, exercising the duties formerly divided between various officers of the exchequer, was constituted in the year 1806. In Germany the junior legal functionaries are termed auditors. Its most usual sense seems to have been originally given to the word in France, where the members of the Chambres des Comptes were divided into conseillers-maîtres, and conseillers-auditeurs.

AU'GER. An instrument for boring the soil for the purpose of ascertaining the nature of the subsoil, the mineral, and, in agriculture more especially, the existence of water. There are various kinds of augers, according to the purposes to which they are to be applied; but they all consist of three parts, viz. the bit, mouth, or cutting piece; the handle; and the connecting rods. The handle is for the purpose of working the instrument by the means of two or more men: the rods for connecting the handle with the bit, or cutting piece; and the bit for penetrating the soil. When it is necessary to pass through stony soil or rocks, a chisel is substituted for the bit; and after the rock is broken in small pieces, the chisel is removed, and replaced by the common auger, by which the loose matters are drawn up.

AUGMENTA'TION, ARMS OF. In Heraldry, coats given by sovereigns to subjects as a mark of honour, to be quartered with their own; or charges, such as ordinances charged with some device, to be borne in their family shield. Such coats or devices are in general either significant, i. e. bearing some relation to the nature of the achievement for which the honour is bestowed; or they are portions of the royal arms.

AUGMENTATION OF STIPENDS. (Church of Scotland.) The stipends of ministers are under the control of the Court of Session. That court has the power to entertain applications for augmentation from clergymen, and either to grant or dismiss them. But twenty years must elapse before such application can be renewed.

AU'GSBURG, CONFESSION OF. A formulary drawn up by Luther and Melancthon, and presented to Charles V. at the diet held at Augsburg in 1530. It is adopted by the Lutheran church, but did not at the time succeed in comprehending all the reformers, and was the occasion of a separation between the followers of Luther and the party who called themselves the Evangelical Reformed Church, which has continued ever since.

AU'GURS. (Lat. augures.) Roman soothsayers, who professed to foretel events by the flying, singing, or feeding of birds. Their office was one of great importance in the state, as no enterprises or ceremonies were

performed unless they declared the omens favourable. Accordingly the members of their college were always elected from the most honourable citizens.

Their divinations were called auguries or auspices, between which there is sometimes a distinction made; the latter meaning such as were derived from the inspection of birds, the former being extended to all omens or prodigies whatever.

The Romans derived their knowledge of augury from the Tuscans, who were celebrated for their skill in this and other religious ceremonies.

AU'GUST. The eighth month of the year. The ancient Roman year commenced with March, and the sixth month was called Sextilis. The name was changed to August in compliment of Augustus Cæsar. In the calendar of Julius Cæsar, the distribution of the days through the several months was more commodious than the present arrangement. The first, third, fifth, seventh, ninth, and eleventh months consisted of thirty-one days each, and the other months of thirty, excepting February, which in common years contained twenty-nine days, but in leap years thirty. In order to gratify the frivolous vanity of Augustus, who thought it a disparagement that the month bearing his name should contain fewer days than July, which was named after the first Cæsar, a day was taken from February and given to August. Such was the origin of the capricious distribution of the days among the different months which now prevails over the whole Christian world; and which, being founded on no principle, requires some pains to be remembered.

AUGUSTA'LES. The epithet given to the priests or flamens of Augustus Cæsar. *See* FLAMEN.

AUGUSTA'LIS PRÆFE'CTUS. The præfect or governor of Egypt when it became a Roman province. This officer was a military viceroy appointed immediately by the emperor, and not selected from the senate, but from the order of knights; and he enjoyed greater power than the proconsuls and proprætors, under whose care the other provinces fell. The epithet Augustalis was derived from the circumstance of Augustus having appointed the first præfect of Egypt.

AUGUSTA'LIA. A festival instituted in honour of Augustus Cæsar on the occasion of his pacifying Sicily, Greece, Syria, Asia Minor, and Parthia.

AUGU'STAN HISTORY. A series of history of the Roman empire from the year 157 A. D. to 285 A. D., written by the following six authors: Æl. Spartianus, J. Capitolinus, Æl. Lampridius, Vulcatius Gallianus, Trebellius Pollio, and Flavius Vopiscus.

AUGU'STINE AGE. A term used to designate the reign of Augustus, the most brilliant period in the literary history of Rome. The civil wars that had long distracted the Roman empire had stifled the cultivation of literature and the arts; and when the battle of Actium had terminated internal commotion, nothing, it was supposed, could so effectually celebrate and adorn the restoration of peace and the happy reign of Augustus, as the appearance of great national poets, who might supply the chief defect in the literature of their country, and create a body of classical works, in which the ancient Roman traditions might be transmitted to posterity. To accomplish this object, men of genius were flattered, courted, and enriched, in an unexampled manner, by the liberality of Augustus; and after a brief interval, the verses of Virgil, Horace, Propertius, Ovid, and Tibullus resounded throughout the empire in their respective epic, lyric, and elegiac strains. But it was not merely for ornamental literature that the age in question was distinguished. The science of jurisprudence, the only original intellectual possession of great value to which the Romans can lay undisputed claim, then received its full development: the immense and nearly inexplicable masses of Roman statutes were perspicuously arranged; and the boundaries of strict law on the one hand, and equity on the other, were respectively ascertained. In this age, too, Rome became the seat of universal government and wealth; and so numerous and splendid were the architectural decorations with which it was embellished, as to justify the saying of Augustus — that he found Rome of brick, and left it of marble.

AUGU'STINE. In Ecclesiastical History, an order of monks and nuns established in the eleventh century, apparently in commemoration of the monastic societies assembled by Saint Augustine in the fourth, but which had long ceased to exist. *See* ORDERS, ECCLESIASTICAL.

AU'LIC COUNCIL, or REICHSHOFRATH. A council of high powers and dignity in the German empire. The Aulic Council and Imperial Chamber (reichskammergericht) were the two supreme courts in that empire. The former consisted of a president, vice-president, and eighteen councillors, six of whom were Protestants, with the peculiar privilege that, if unanimous, their votes could not be overruled by those of the Catholics. This court had exclusive jurisdiction in various affairs, principally those which concerned the imperial government.

AULO'STOMA. (Gr. *αὐλὸς, a pipe, στόμα, a mouth.*) A genus of Acanthopterygians belonging to the family called by Cuvier *Bouches en flute;* including the pipe-fishes, or those species which are characterised by a mouth which is lengthened into a kind of tube or pipe.

AU'RA. (Lat. *the air.*) The subtle essence which is contained within the grains of pollen, and in which is supposed to reside the power of fertilising the ovules. It is now generally considered that this essence is imaginary, and that fertilisation is produced by the descent of minute organic particles through the stigma to the ovules.

AURA. A sensation resembling a wind, or being breathed upon. *Aura epileptica* is a sensation often experienced by epileptic patients, resembling the ascent of a blast of cold air from the extremities upwards.

AURANTIA'CEÆ. (Lat. aurantium, *an orange.*) A considerable natural order of Exogens, with polypetalous flowers, confined to the warmer parts of Asia, or the nearest parts of Africa. They have dotted leaves filled with a fragrant oil, and succulent eatable fruit, covered by an aromatic skin. The orange, the shaddock, the lime, the lemon, are all species of the genus Citrus, and the best known in Europe. In the woods of India, there are some species that climb; and in the Himalaya exists a species, Limonia laureola, which would probably be a hardy evergreen if introduced into this country.

AURE'LIA. In Entomology, the name given to the nymph, or quiescent stage of transformation of an insect, on account of the metallic golden lustre which is reflected from the case of the nymphs of some diurnal Lepidoptera.

AURE'OLA. (Lat. *of the colour of gold.*) In Painting, the glory with which the ancient painters decorated the heads of the saints, martyrs, and confessors which they executed.

AU'REUS. A Roman gold coin worth a little more than sixteen shillings, according to the proportion given by Tacitus. But it varied, as appears from the different values assigned to it, from 1*l.* 4*s.* to 12*s.* Its weight was about 2½ oz. avoirdupois.

AU'RICLE. (Lat. auricula, *a little ear.*) Signifies, in Mammalogy, the external ears, which are said to be 'marginate' (*auriculæ marginatæ*) when bordered by a helix, or involute margin; — to be 'operculate' (*auriculæ operculatæ*) when provided with a largely developed tragus, which stands out like a subsidiary auricle; — to be 'concealed' (*auriculæ absconditæ*) when covered by the hair. In Ornithology, the circle of feathers surrounding the entry to the ear-passage are called auriculars. In Anatomy, the venous chambers of the heart are termed auricles.

AURI'CULAR CONFESSION. Confession of sins to a priest in private, distinguished from the public confession which was enjoined as a duty by the primitive church, but was early allowed to drop into disuse. It was on occasion of the scandal which the original practice produced, that Leo the Great, in the fifth century, first recommended private confession to a priest in certain cases. It was not till the fourth council of Lateran in 1215, that the doctrine of the necessity of this practice was formally established.

AURI'CULATE. (Lat. auricula, *a little ear.*) When the base of a leaf or similar part projects on each side of the axis in the form of a little round lobe.

AURO'RA. In the ancient Mythology, the goddess of the morning. She was the daughter of Titan and Terra, and was deified as the light which precedes the rising of the sun above our hemisphere. So lovely a being as she was represented to be could not fail to attract a host of admirers; and, accordingly, we find her engaged in numerous amours. But the object of her peculiar favour was Tithonus, son of Laomedon, king of Troy, for whom she cherished so permanent an attachment as to obtain for him the gift of immortality. She unfortunately neglected, however, to combine this privilege with an immunity from age; and in the course of time Tithonus became so decrepid that Aurora out of pity transformed him into a grasshopper, in which shape he still retained the garrulity of old age. She is supposed generally to rise from the couch of Tithonus: —

> Et jam prima novo spargebat lumine terras,
> Tithoni croceum linquens Aurora cubile. — VIRG.

Milton, in a passage teeming with poetic imagery and truth, thus opens the fifth book of Paradise Lost: —

> Now Morn, her rosy steps in th' eastern clime
> Advancing, sowed the earth with orient pearl;
> When Adam waked, so customed, for his sleep
> Was aëry, light, from pure digestion bred
> And temperate vapours bland, which th' only sound
> Of leaves and fuming rills, Aurora's fan,
> Lightly dispersed, and the shrill matin song
> Of birds on every bough.

AURO'RA BOREALIS. *Northern lights, Polar lights,* or *Streamers.* A luminous meteor, generally appearing in the northern part of the sky, and presenting a light somewhat resembling the dawn or break of day. The appearances which it exhibits and the forms it

assumes are so proverbially unsteady, that it is not possible to comprehend them under any general description. Most frequently the phenomenon appears to proceed from a sort of horizontal cloud or haze in the northern part of the sky, rising a few degrees above the horizon, and stretching from the north towards the east and west, so as to form an arc, which in some instances has been observed to extend upwards of 100°. The upper edge of the cloud is whitish and luminous, the lower part often dark or thick, and sometimes the clear sky may be seen between it and the horizon. From the upper part of the cloud streams of light shoot up in columnar forms, reaching sometimes only a few degrees, sometimes to the zenith, or even beyond it. Instances occur in which the whole hemisphere is covered with coruscations; but the brilliancy is greatest, and the light strongest, in the north near the main body of the meteor. The streamers have in general a tremulous motion, and, when close together, present the appearance of waves or sheets of light following each other in rapid succession. When several columns, issuing from different points, meet at the zenith, a small meteor is formed of greater brilliancy than the separate columns. The phenomenon sometimes continues a few hours, occasionally the whole night, and even for several nights in succession. It generally commences at most two or three hours after sunset, and very rarely in the morning or much after midnight. Auroras have been observed even before the evening twilight has disappeared. In the Shetland Islands, and other countries in high latitudes, the northern lights are the constant attendants of clear and frosty evenings in winter. They are most frequent in autumn.

In Captain Franklin's Narrative, the Auroras observed at Fort Enterprise, in North America, are described by Lieut. Wood as follows:—

"They rise with their centres sometimes in the magnetic meridian, and sometimes several degrees to the eastward or westward of it. The number visible seldom exceeds five, and is seldom limited to one. The altitude of the lowest, when first seen, is never less than 4°. As they advance towards the zenith, their centres (or the parts most elevated) preserve a course in the magnetic meridian, or near to it. But the eastern and western extremities vary their respective distances, and the arches become irregularly broad streams in the zenith, each dividing the sky into two unequal parts, but never crossing one another till they separate into parts. Those arches which were bright at the horizon increase their brilliancy in the zenith, and discover the beams of which they are composed, when the interior motion is rapid. This interior motion is a sudden glow, not proceeding from any visible concentration of matter, but bursting out in several parts of the arch, as if an ignition of combustible matter had taken place, and spreading itself rapidly towards each extremity. In this motion the beams are formed. They have two motions; one at right angles to their length, or sideways; and the other a tremulous and short vibration, in which they do not exactly preserve their parallelism to each other. The wreaths, when in the zenith, present the appearance of coronæ boreales. The second motion is always accompanied by colours; for it must be observed, that beams are often formed without any exhibition of colours, and I have not in that case perceived the vibratory motion."

The northern lights are sometimes seen tinged with the various prismatic colours, among which orange and green, but more frequently the different shades of red, predominate. Maupertius describes one seen by him in Lapland, by which an extensive region of the heavens towards the south appeared tinged of so lively a red that the whole constellation of Orion seemed as if dyed in blood. Some observers of this meteor have affirmed that they have heard a rustling or crackling sound proceed from it. Doubts have, however, been entertained on this point, from the circumstance that no such noises were heard by Scoresby, Richardson, Franklin, Parry, and Hood, who observed the polar lights with great care, under the most favourable circumstances, in very high latitudes. But the testimony of other observers is of so positive a kind as to leave no reasonable doubt that the phenomenon has, at least in particular instances, been accompanied by sounds.

From the accounts which have been collected of the polar lights, it would seem that the phenomenon was less frequent in former ages than it is now; but it must be kept in mind that meteoric observations have not always been so much attended to as at present. Aristotle describes the phenomenon with sufficient accuracy in his book of Meteors. Allusions are also made to it by Pliny, Cicero, and Seneca; so that it must have been often witnessed by the ancients, even in the climates of Greece and Italy. The descriptions of armies fighting in the air, and similar prodigies observed in the dark ages, doubtless owed their origin to the striking and fantastic appearances of the Northern Lights. It is remarkable, however, that no mention is made by any English writer of an Aurora Borealis having been observed in England from the year 1621 to 1707. Celsius says expressly that the oldest inhabitants of Upsala considered the phenomenon a great rarity before 1716. In the month of March in that year a very splendid one appeared in England, and by reason of its brilliancy attracted universal attention. It has been described by Dr. Hally in the Phil. Trans., No. 347. Since then, the meteor has been much more common. A complete account of all the appearances of Auroras recorded previous to 1754 may be found in the work of Mairan, "Traité de l'Aurore Boreale."

The Aurora is not confined to the Northern hemisphere, similar appearances being observed in high southern latitudes. An Aurora was witnessed by Don Antonio d'Ulloa at Cape Horn in 1745; one appeared at Cuzco in 1744; and another is described by Mr. Forster (who accompanied Captain Cook in his last voyage round the world), which was seen by him in 1773, in latitude 58° south, and resembled, entirely, those of the northern hemisphere, excepting that the light exhibited no tints, but was of a clear white. Similar testimony is given by subsequent navigators.

There is great difficulty in determining the exact height of the Aurora Borealis above the earth, and accordingly the opinions given on this subject by different observers are widely discordant. Mairan supposed the mean height to be 175 French leagues. Bergman says 460 miles, and Euler several thousand miles. From the comparison of a number of observations of an Aurora that appeared in March 1826, made at different places in the north of England and south of Scotland, Dr. Dalton, in a paper presented to the Royal Society, computed its height to be about 100 miles. But a calculation of this sort, in which it is of necessity supposed that the meteor is seen in exactly the same place by the different observers, is subject to very great uncertainty. The observations of Dr. Richardson, Franklin, Hood, Parry, and others seem to prove that the place of the Aurora is far within the limits of the atmosphere, and scarcely above the region of the clouds; in fact, as the diurnal rotation of the earth produces no change in its apparent position, it must necessarily partake of that motion, and consequently be regarded as an atmospherical phenomenon.

No satisfactory theory has yet been given of the cause of the polar lights. Mairan ascribed the phenomenon to the sun's atmosphere; Euler, to particles of the earth's atmosphere driven beyond its limits by the impulse of solar light. Beccaria, Canton, Franklin, and others refer it to electricity, an agent to whose mysterious influence all the inexplicable phenomena of meteorology are conveniently ascribed. An absurd theory proposed by M. Libes (Dictionnaire de Physique) formerly met with considerable favour. He had observed that on passing an electric spark through a compound of oxygen and nitrogen, nitrous vapours of a reddish colour are produced. He therefore supposed that the higher regions of the atmosphere near the pole contain little or no hydrogen; and that consequently the discharges of electricity, which, by producing a combination of oxygen and hydrogen, form water in the lower strata, in the more elevated strata produce nitrous vapours, which constitute the polar lights. That some connexion subsists between the Aurora and magnetism, or rather electricity, which is now regarded as the primary cause of magnetism, is made certain by the fact that during the continuance of brilliant Auroras the magnetic needle is generally disturbed, sometimes violently agitated. The air at the same time is often observed to be highly charged with electric matter. An experiment contrived by M. Canton also seems to indicate an electric origin. If a glass tube be partially exhausted of air, hermetically sealed, and applied to the conductor of an electric machine, the whole tube is illuminated from end to end, and continues luminous for a considerable time after it has been removed from the conductor. If, after this, the tube be drawn through the hand, the light will be remarkably intense through its whole length; and if it is grasped in both hands, near the extremities, strong flashes of light will dart from one end to the other, and continue many hours without fresh excitation. The only conclusion which, in the present state of our knowledge, we are warranted in deducing, is, that the Aurora Borealis must be ascribed to the agency of electricity in the upper regions of the atmosphere: in what way the excitement is produced, it remains for future discoveries to make known.

The most systematic series of observations which we possess on the subject, was made by the Rev. James Farquharson, of Aberdeenshire, in 1829, with an apparatus furnished by the Royal Society, and of which an account is published in the Transactions for 1830.

AU'RUM MUSIVUM. An obsolete chemical name of the bisulphuret of tin.

AU'SPICES, AUSPICIA. *See* AUGURS.

AUSCULTA'TION. (Lat. auscultare, *to listen.*) A method of distinguishing healthy and diseased states of the body by the study of the sounds produced by the movements of the different organs, and which differ more

or less when the parts are diseased from those which belong to their healthy functions. *See* STETHOSCOPE.

AUTHE'NTIC, AUTHENTICATED. A word of Greek origin. In Diplomatics, ancient MSS. were formerly termed authentica when originals, in opposition to copies. In the modern acceptation of the word, it is only applied to instruments bearing marks of having been executed by the proper authority.

AUTHENTIC MELODIES. In Music, such as have their principal notes contained between the key note and its octave. This term is applied by the Italians to four of the church modes or tones in music which rise a fourth above their dominants, which are always fifths above their finals, that is, rise to complete their octaves, thus distinguished from plagal melodies, which fall a fourth below their finals.

AUTO-DA-FE, properly AUTO-DE-FE. (Span. *act of faith.*) A public solemnity held by the Court of the Inquisition in Spain and Portugal. It was a gaol-delivery, at which extracts from the trials of offenders, and the sentences pronounced by the judges, were read; after which, absolution was conferred on those who were penitent, and discharged: after which, those condemned to death (relajados) were transferred to the secular authority: and here the auto, properly so called, ended; the execution of the victims taking place immediately afterwards, under the authority of the civil judge, a secretary to the inquisition attending. The ceremonial of the autos, processions, horrible executions, &c., are amply described by many writers. See especially *Llorente's History of the Inquisition; A Relation of the Inquisition in Portugal*, published by Bishop Burnet; and *Olmo's Account of the Senual Auto-da-Fe at Madrid* in 1680, from which the account in the Penny Cyclopædia is abridged. Autos were of several sorts: the public general act (auto publico general), to which the above descriptions apply; the particular act, at which only the officials of the inquisition were present; autillo, or little act; and auto singular, the condemnation of a single individual. *See* INQUISITION.

AUTOBIO'GRAPHY. (This word is of Greek origin, and signifies literally *the life of a person written by himself.*) One of the most fascinating, and, if properly understood, one of the most instructive, species of composition. But none is more calculated to mislead the incautious reader, or to give more false impressions, both of men and events. These memoirs may be divided into two classes: those in which the chief object of the writer is to illustrate the history of his own mind and heart, and the manner in which these were swayed by the destinies of his life; and those in which his purpose is merely to give a sketch of the scenes and events which have occurred within his own experience, and of characters with which he has been brought in contact. Of the first class of writings, from the Confession of Saint Augustine down to the Confessions of Rousseau, and the many works which have since been produced in imitation of the latter, it may be said that the general defect is a morbid spirit of exaggeration. The mind dwells with intense recollection on its own pains and pleasures, errors and victories; it magnifies contrasts, paints every thing in extrêmes, and leaves out of the portrait all neutral and moderate features, because the recollection of ordinary feelings and actions passes away, while that of strong excitement is indelible. Of the more narrative class of memoirs, it is sufficient to say, that where the writer was himself a prominent actor in passing events, they are usually little better than apologies or self-justifications, such as the famous Memoirs of the Cardinal de Retz, and, in our own times, the various fragments of autobiography which have been published from the hand of Napoleon.

AUTOCA'RPIOUS. (Gr. αὐτὸς, *himself*, and καρπὸς, *fruit.*) A name given to such fruit as consists of nothing but pericarp, without any additional organ, such as the calyx adhering to the outside.

AUTO'CHTHONS. (Gr. αὐτὸς, *self*, and χθὼν, *earth.*) The Greek term for the aboriginal inhabitants of a country, implying that they were sprung from the soil. The Athenians, whose territory had been held by the same race from time immemorial, chiefly on account of its sterility, which offered no incitement to foreign aggression, particularly laid claim to this title, in memorial of which they wore the emblematic grasshopper as part of their head-dress.

AU'TOCRAT. In Politics, a word derived from the Greek αὐτοκράτωρ, *sole* or *independent governor.* This title of Autocrator was given to Athenian generals invested with full command by the republic; also to envoys, in which case it corresponded in meaning with the barbarous Latin word plenipotentiaries. In modern political phraseology, the term autocrat, signifying a sovereign possessed of absolute power, is usually confined to the emperor of Russia.

AU'TOGRAPH. (Gr. αὐτὸς, *self*, and γράφω, *I write.*) The autograph of an individual is a piece of writing in his hand.

AUTO'MATON. (Gr. αὐτὸς, *self*, and ματῆν, *easily.*) A name applied to pieces of mechanism so constructed as to imitate the actions of living animals. The term Android (from the Gr. ἀνὴρ, *man*) is sometimes applied to such machines as resemble the figures and imitate the actions of mankind.

The extent to which these useless but ingenious contrivances has been sometimes carried is very surprising. Archytas of Tarentum, about 400 years before our era, is said to have made a wooden pigeon that could fly. Friar Bacon's speaking head is a well-known tradition. Albertus Magnus constructed an automaton to open his door when any one knocked; the celebrated Regiomontanus, a wooden eagle that flew forth from the city, saluted the emperor, and returned; and likewise an iron fly which flew out of his hand, and returned after flying about the room. These instances may perhaps have been exaggerated in the description; but there are some of recent date, and not less remarkable, respecting which the testimony is clear and strong. The following are a few of the best authenticated: — The flute-player of Vaucauson, described by D'Alembert in the *Encyclopedie Methodique*, was exhibited in Paris in 1738. It played on the flute exactly in the same manner as a living performer, and commanded three octaves, the fullest scale of the instrument. Its height was nearly six feet. In Hutton's *Mathematical Recreations*, a description is given of an automaton group, constructed by M. Camus for the amusement of Louis XIV., consisting of a coach and horses, with coachman and page, and lady inside, &c., by which the action of driving up, alighting, presenting a petition to the king, and setting off again, were mimicked with wonderful accuracy. In 1741, Vaucauson produced a flagelet-player, which played the flagelet with the left hand, while it beat a tambourine with the right. He also produced a duck, which dabbled in the water, swam, drank, and quacked like a real duck; raised and moved its wings, dressed its feathers with its bill, took barley from the hand and swallowed it, and even digested its food by means of materials for its solution placed in the stomach. (Montucla, *Histoire des Math.*, tome iii. p. 802.)

Automaton flute-players have likewise been exhibited in this country, of the size of real life, which performed ten or twelve duets. Maelzel, the inventor of the metronome, exhibited an automaton trumpeter at Vienna, of which a description is given in the *Journal des Modes* for 1809. It was a martial figure, in the uniform of a trumpeter of an Austrian dragoon regiment, which played not only the Austrian and French cavalry marches, and all the signals of those armies, but also a march and an allegro, by Weigl, accompanied by the whole orchestra, &c. (*Dictionary of Musicians*, London, 1827.)

Automata have also been constructed which wrote, drew likenesses, played on the pianoforte, &c. The celebrated chess-playing automaton is now considered as a solved mystery, it being supposed (and not denied) that a boy was concealed inside the figure. The machinery, however, which produced such motions must have been highly ingenious. See *Penny Cyclopædia; Hutton's Math. Dictionary; Encyc. Brit.*, article "Androides."

AU'TOPSY. (Gr. αὐτὸς, *self*, and ὄψις, *sight.*) Ocular evidence.

AU'TUMN. The third of the four seasons of the year. In a popular sense it denotes that period of the year in which the fruits of the earth are gathered in. Astronomically speaking, it is the time during which the sun is passing from the autumnal equinox to the winter solstice. Owing to the elliptic form of the earth's orbit, the seasons are not all of the same length; and owing to the precession of the equinoxes, their lengths vary a little from age to age. In the present century, the time which elapses between the sun's passage through the autumnal equinox and his reaching the winter solstice, or while he passes through the three signs of Libra, Scorpio, and Sagitárius, is 89 days 16 hours and 47 minutes. The autumn of the northern hemisphere corresponds to the spring of the southern.

AUTU'MNAL EQUINOX. The day on which the sun passes through the equator, going southward, or on which his declination changes from north to south. When the sun is in the equator, the day is equal in length to the night all over the world. *See* EQUINOX. The autumnal equinox falls generally on the 22d or 23d of September.

AUTU'MNAL POINT. One of the two points in which the ecliptic intersects the equator. It is the same as the first point of the sign Libra.

AVALA'NCHES. Masses of snow which collect upon the heights of mountains, and gradually sliding down their sides, acquire enormous bulk by fresh accumulations: when they ultimately reach the valleys below, they often cause great destruction.

AVA'ST. A sea term, signifying, enough; stop; cease. The etymology of this word is doubtful.

AVELLA'NA. (Abella or Avella, *a town of Campania, celebrated for its fine filberts.*) One of the names of the common hazel nut. The Spaniards in Chili apply

the name to the fruit of Quadria heterophylla, because of its resemblance to filberts.

AVENA SATIVA. (Diandria trigynia *Lin.*, Gramineæ *Juss.*) The Linnean name of the common oat. A gramineous plant characterised by a loose compound equal panicle and two-flowered spikelet. The oat is very extensively cultivated in most of the northern countries of Europe as a bread corn. It has long occupied the same place in Scotland that rye occupies in Germany and the potatoe in Ireland. In England it is chiefly used in the feeding of horses; but there, also, it is used to a considerable extent as food for man, particularly in the northern counties. There are three leading varieties of the common oat cultivated in England — black; grey, dun-brown, or red; and white. The first two varieties being comparatively hardy, may be raised on very inferior soils, and in situations unsuitable for the other. The black oat is now, however, hardly known in England; but it is still cultivated to a considerable extent in some parts of the Highlands of Scotland, and in the Western Islands. The dun or red oat is principally confined to the moors of Cheshire, Derbyshire, and Staffordshire. White oats are, speaking generally, less hardy than either of the other varieties, and require a better soil; but they are also earlier, heavier, and yield a greater quantity of meal. There are numberless, and some widely different, sub-varieties of the white oat. That which is called the potatoe oat has long enjoyed the highest reputation in this country, and is almost the only variety that is at present raised on good land in most parts of England and the south of Scotland. The produce of oats varies very greatly. When the ground is foul or exhausted, not more than 20 bushels an acre are obtained; but in a rich soil well managed and in favourable years, 60, 70, and sometimes even 80 bushels and upwards have been reaped, weighing from 35 lbs. to 45 lbs. a bushel, and yielding 7 lbs. meal for 14 lbs. oats; but the proportion of meal increases as the oats become heavier. The price of oats amounted at an average of the 7 years ending with the 31st December, 1835, to 22*s*. per. Imp. quarter.

A′VENUE. (Lat. ad, *to*, and venio, *I come*.) In Landscape Gardening, is a road leading from some other road, and forming the main approach to a house; but it is also applied to any broad walk or road of grass or gravel, bordered on each side by lines of trees. When the modern style of gardening began to take the place of the ancient style, the term avenue gave way to that of approach road, which subsequently became shortened into that of approach.

A′VERAGE, GENERAL. In Mercantile Law, whatever damage or loss is incurred by any part of the ship or cargo for the preservation of the rest. When such damage accrues, the several persons interested in the ship, freight, and cargo, contribute their respective proportions to indemnify the owner of the part in question against the damage or necessary expense which has been incurred for the good of all. General average, therefore, cannot be unless the whole adventure has been in jeopardy. Every species of loss incurred on any part of the cargo in the course of the voyage, is somewhat loosely denominated average, or particular average. *See* Insurance.

AVE′RNUS. (Lat.) A lake of Italy 10 miles west of Naples, celebrated in antiquity as the entrance to the infernal regions. Strabo's description of this lake was well fitted to impress the minds of the "*profanum vulgus*" with superstitious awe. "Its steep and perilous banks were studded with mighty oaks that stretched their boughs over the watery abyss and excluded every ray of wholesome light; mephitic vapours ascending from the hot bowels of the earth floated along the surface of the lake in poisonous mist, while the dark and savage practices of the neighbouring people enhanced the horrors of the gloomy scene." A cave adjoining the lake is represented by Virgil as the habitation of the Cumæan sybil: —

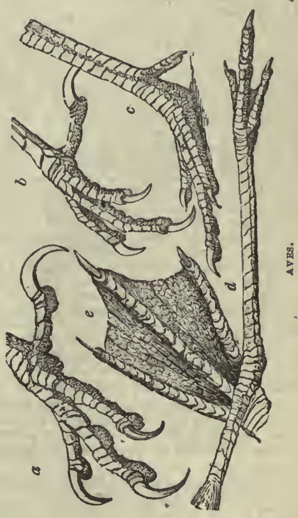
"Spelunca alta fuit, vastoque immanis hiatu,
Scrupea, tuta lacu nigro nemorumque tenebris;
Quam super haud ullæ poterant impune volantes
Tendere iter pennis: talis sese halitus atris
Faucibus effundens supera ad convexa ferebat; [out birds.
Unde locum Graii dixerunt nomine Avernum." (ἄορνος, with-

This place continued to be the favourite haunt of superstition till the time of Augustus, who violated its sanctity, and dispelled the impenetrable darkness in which it had hitherto been enshrouded, by cutting down the surrounding wood, and connecting it with the Lucrine lake, then an arm of the sea. This lake still exists under the name Lago d'Averno; it is about a mile and a half in circumference, and in many places 190 feet deep. Averni is a generic name for certain lakes or other places that infect the atmosphere with pestilential vapours, called also Mephites.

AVERRUNCA′TOR. (Lat. averrunco, *I dress* or *weed*.) In Arboriculture, is an instrument for cutting off the branches of trees, consisting of two blades fixed on the end of a rod; one of which has a moveable joint, which, by means of a line fixed to it, operates like a pair of scissors. In the improved forms of this instrument, the point on which the moving or cutting blade turns, instead of being confined to a circular opening, works in a longitudinal one; in consequence of which, instead of a crushing cut, like that produced by common hedge shears, a draw cut is formed, which leaves the section from which the branch or shoot has been amputated as clean as that produced by a pruning knife.

AVE′RSE. (Lat aversus, *turned back*.) In Ornithology, when the posterior extremities are attached to the trunk near the anus, so that the body is supported erect, as in the penguin, they are termed "pedes aversi."

A′VES. (Lat. avis, *a bird*.) The name of a class of warm-blooded vertebrated animals, characterised by a double circulation and respiration, oviparous generation, a covering of feathers, and by their anterior extremities being organised for flight. The posterior extremities present five principal modifications, affording characters which distinguish five primary orders. In the first order the foot (*a* fig.) has three toes before and one behind, all armed with long, strong, crooked, and more or less retractile talons, adapted to seize and lacerate a living prey; this structure is associated with a strong, curved, sharp-edged and sharp-pointed beak, often armed with a lateral tooth; a very muscular body, and capability of rapid and long-continued flight. The order is termed Raptores or Accipitres. The second type of foot presents three toes before and one behind, and placed on the same level; slender, flexible, of moderate length, and provided with long, pointed, and slightly curved claws. The two external toes are united by a very short membrane. A foot so constructed (*b* fig.) is especially adapted for the delicate operations of nest building, and for grasping and perching among the slender branches of trees; hence



AVES.

the order so characterised has been termed Insessores, and, from including the smaller tribes of birds, Passeres. In the third type of foot (*c* fig.) the hinder toe is raised above the level of the three anterior ones; this deteriorates the power of perching; but the other toes are strong, straight, and terminated by robust obtuse claws, adapted for scratching up the soil, and for running along the ground; the legs are for this purpose very strong and muscular, and the order so characterised is termed Rasores, or Gallinæ. The modification by which birds are enabled to wade and seek their food in water along the margins of rivers, lakes, and estuaries, is gained simply by elongating the bones of the leg (tibia and metatarsus), which are covered with a naked scaly skin. The three anterior toes are sometimes very long and slender, as in the Parra jacana, by which the bird can support itself upon the broad floating leaves of aquatic plants; sometimes they are of moderate length. The hind toe is elevated, short, and sometimes wanting (*d* fig.). The order of birds characterised by this form of leg and foot is termed Grallatores, from the resemblance of the pos-

terior extremities to stilts. In the last form of foot (*e* fig.) the toes are united by intervening webs; the legs are placed behind the centre of equilibrium; the body is protected by a dense covering of feathers, and a thick down next the skin; and the whole organisation is especially adapted for aquatic life. Hence the order is termed Natatores.

A'VIARY. (Lat. avis, *a bird.*) A place for keeping birds. In gardens, aviaries for singing birds are generally limited spaces attached to summer-houses or hot-houses, in which a temperature is kept up during winter suitable to the kind of bird or birds in the aviary. When an aviary contains only birds which live in climates analogous to that of Britain, it is formed in the open garden or pleasure ground, each kind of bird having a separate house; or, instead of a house, a small enclosure covered with netting to prevent it from flying away. The most common exotic singing birds kept in aviaries are canaries; and the most common exotic ornamental birds are turtle doves, and birds of the parrot tribe. The ornamental and curious birds which live in climates similar to that of Britain may be divided into two classes, the terrestrial and the aquatic. Of the former, the most ornamental are the gold and silver pheasants, and the common pigeon, including its numerous varieties; and among the latter, the white and black swans, the Muscovy duck, &c. The most complete aviaries in the neighbourhood of London, exclusive of those in the Zoological Gardens, are those at Woburn Abbey, and at Knowsley.

AVI'CULA. A name applied to a genus of bivalves, in some of the species of which the shell, when expanded, offers a slight resemblance to a bird flying. The shell is equivalve, with a rectilinear hinge, notched at the anterior edge for the passage of a hyssus: the anterior adductor muscle very small. To this genus belongs the celebrated pearl oyster, *Avicula margaritifera*.

AVOI'DANCE. In Ecclesiastical Law, signifies the condition of a benefice when void of an incumbent, and is opposed to plenarty.

A'VOIRDUPO'IS, or AVERDUPOIS. (Fr. avoir du pois, *to have weight;* or perhaps from an old French verb, averer, *to verify.*) The name given to the common system of weights in England, by which goods in general, excepting the precious stones and medicines, are weighed. The standard weight of this country is the grain, which is ordered by act of parliament, 5 Geo. IV. c. 74., to be such that "a cubic inch of distilled water, weighed in air by brass weights, at the temperature of 62 degrees of Fahrenheit's thermometer, the barometer being at 30 inches, is equal to two hundred and fifty-two grains, and four hundred and fifty-eight thousandth parts of a grain. A pound avoirdupois contains 7000 grains. The pound is subdivided into 16 ounces, and the ounce into 16 drams. The higher denominations are the quarter-hundred, the hundredweight, and the ton; 28 pounds making a quarter, 112 pounds a hundredweight, and 20 hundredweights a ton. The pound avoirdupois is greater than the pound troy; the latter containing only 5760 grains. But the troy ounce, which contains the twelfth part of 5760, or 480 grains, is greater than the ounce avoirdupois, which contains the sixteenth part of 7000, or 437½ grains. The avoirdupois ounce is considered as being the Roman uncia, which, according to Dr. Arbuthnot, contains $437\frac{1}{7}$ grains, though other authorities make it several grains less. The term averdupois occurs in some orders of Henry VIII., A.D. 1532; and Queen Elizabeth, in 1588, ordered a pound of this weight to be deposited in the Exchequer as a standard. *See* WEIGHTS.

AVOSE'T. A native wading bird, characterised by a long recurved bill. *See* RECURVIROSTRA.

AVOW'RY. In Law, the justification advanced in pleading by one who has taken a distress in his own right when sued in replevin. The avowry must contain a sufficient averment of right to have return. One who justifies as having taken in the right of another, is said to make cognizance. *See* REPLEVIN.

AWA'RD. In Law, the judgment pronounced by one or more arbitrators, at the request of two parties who are at variance, for ending the matter in dispute without the decision of a public tribunal. The act of reference to an arbitrator is termed a submission.

By the stat. 9 & 10 W. 3. c. 15. it is provided that parties desirous to end a controversy may agree that their submission of the suit to arbitration shall be made a rule of any court of record; and, after such rule the party disobeying the award is liable to be punished for a contempt of the court. But the award may be set aside for various causes, as corruption, informality, &c., by motion in court within one term after the award is made. When submission to arbitration has been made a rule of court, it is, by 3 & 4 W. 4. c. 42. s. 39., not revocable by either party without leave of the court. The arbitrators have a jurisdiction over the costs of the action as well as over the matter in controversy; and, in case of a reference at nisi prius, they may refer the costs to be taxed by the proper officer of the court. An award must be made in writing, signed and sealed by the arbitrators.

AWN. (Derivation unknown.) A stiff, usually rough, bristle, proceeding from the end or some other part of a leaf, or of a leafy organ; it is the beard of grasses, and often proceeds in those plants from the base of either glumes or paleæ. An awn is in reality either a vein separating from its parenchyma, or a rigid sharp-pointed barren branch of inflorescence. A part is said to be awned, or aristate, when furnished with this organ.

AW'NING. In Hort., a temporary covering for plants, generally consisting of cloth of some kind, stretched by means of ropes, cords, or wooden rods, so as to protect fruit trees against a wall, or flowers in a bed. An awning for a tulip bed is the most complete structure of this description, and is so constructed, by means of lines and pullies, that the sheeting can be either pulled up or let down over a bed of considerable length in two or three minutes.

A'XESTONE. A tough silico-magnesian stone, sometimes shaped into cutting instruments. *See* NEPHRITE.

AXI'FEROUS. (Lat. axis, *a centre*, and fero, *I bear.*) A name given to those plants which, like lichens, fungi, &c., consist exclusively of an axis, without any leaves or appendages of it.

A'XIL. (Lat. axilla, *the armpit.*) That part of a plant where a leaf fits on a branch, forming an angle with it: or where two branches diverge from each other.

A'XILE. (Axis.) Lying in the axis of any thing; as an embryo, which lies in the axis of a seed, that is from the base to the end diametrically opposite.

AXI'LLA. (Lat. axilla, *the armpit.*) In Anatomy, the hollow below the base of the arm, at its insertion into the chest. An interesting region in topographical anatomy, containing important arteries, veins, nerves, glands, &c. which are termed 'axillary.'

AXI'LLARY. Growing in an axil. The term is modified by the prefixing different Latin prepositions: thus, infra axillary, signifies growing from below the axil; extra axillary, on one side of it; and supra axillary, from above it.

A'XINITE. (Gr. ἀξίνη, *an axe.*) A mineral usually occurring in axeshaped crystals; it is an alumino-silicate of lime and iron.

A'XIOM. (Gr. ἀξιόω, *I demand.*) In Geometry, a proposition which it is necessary to take for granted, and which therefore admits of no demonstration. The following are among the propositions of this kind enunciated by Euclid: "Things that are equal to the same thing are equal to one another." "The whole is greater than its part." "If equals be added to equals, the sums will be equal." "If two figures when placed the one on the other entirely coincide, they are equal in every respect." The formal statement of such propositions is totally useless, or rather tends only to produce obscurity.

AXIOM. In Philosophy, properly that which is demanded, or postulate. It is used, in the mathematical and physical sciences, in the sense of a proposition, to which the assent of the student is demanded without proof, as a foundation for farther argument.

A'XIS. (Lat. *an axletree.*) That part in plants about which particular organs are arranged. Thus, the stem is an axis for the branches; a branch, an axis for leaves; the rachis, an axis for the divisions of inflorescence; and the receptacle, gynobase, or columella, is the axis of the fruit. The term is also applied to the imaginary point round which parts of any sort are arranged.

AXIS. (Lat. axis.) In Architecture, a real or imaginary straight line passing through any body on which it may revolve; the axis of a column, for instance, is a straight line drawn down through its centre; the axis of the Ionic volute is a line drawn through the two eyes, front and rear.

AXIS. (Lat. axis.) In Mechanics, signifies in general the straight line, real or imaginary, about which a body turns. In this sense it is called the axis of rotation, of oscillation, &c., according to the motion of the body. In Geometry, the axis of a figure is a straight line about which the parts of the figure are symmetrically disposed. Thus, the axis of a cone is the line drawn from the vertex to the centre of the base; and the axis of a cylinder, the line drawn through the centre of its two ends. In the ellipse and hyperbola, the transverse axis is the straight line drawn through the two foci; and the conjugate axis, that drawn through the centre, perpendicular to the transverse. In general, by the axis of a curve line is meant that diameter which has its ordinates at right angles to it. We also speak of the axes of the co-ordinates of a curve, meaning the line on which the abscissa are taken.

AXIS IN PERITROCHIO. One of the five mechanical powers, consisting of a peritrochium or wheel fixed immovably to an axle, so that both turn together round the axis of motion. The power is applied at the cir-

cumference of the wheel, and the weight raised by a rope wound round the axle. The power gained is the same as that gained by a lever, the longer arm of which is equal to the radius of the wheel, and the shorter equal to the radius of the axle; so that if we suppose the radius of the wheel to be 30 inches, and the radius of the axle 6 inches, a weight of one pound suspended by a rope passing round the wheel would raise a weight of five pounds similarly suspended from the axle.

A'XOLOTL. (Axolotes, is, em, ibus.) A term derived from the Mexican language, and applied to a genus of Perennibranchiate Amphibians, found in the lake of Mexico.

AYE-AYE. The name of a singular nocturnal quadruped of Madagascar, indicative of its peculiar cry; it is placed by Cuvier in the Rodent order, under the generic name Cheiromys, from the hand-like structure of the hinder feet; a structure which approximates the genus to the monkey tribe, or Quadrumana, in which other naturalists have placed it.

AZA'LEA. (Gr. ἀζαλεος, *dry.*) A genus of beautiful plants inhabiting North America and China. They have trumpet-shaped or bell-shaped richly coloured flowers, which are in some species fragrant. The name has apparently been derived from the dry brittle nature of their branches. They differ from rhododendron chiefly in being deciduous.

A'ZIMUTH. (From the Arabic.) A term used in astronomy, to denote the arc of the horizon intercepted between the meridian and the vertical circle passing through a star or other celestial body; or the angle made at the zenith by the meridian and the vertical circle in which the body is situated. The azimuth may be counted either from the north or the south point of the horizon: modern astronomers seem to prefer beginning at the north point, and counting eastward and westward to 180°; but it is not one of those elements usually observed in astronomy, being easily deduced from the declination, which can be measured much more conveniently and accurately. In trigonometrical surveys, however, on the earth's surface, the accurate determination of the azimuth of an object is an operation of very great importance. It is usually made with the theodolite.

AZIMUTH CIRCLES, or VERTICAL CIRCLES, are great circles of the sphere passing through the zenith, and intersecting the horizon at right angles.

AZIMUTH COMPASS. A compass used at sea for finding the horizontal distance of the sun or a star from the magnetic meridian.

AZIMUTH DIAL. A dial of which the stile or gnomon is perpendicular to the plane of the horizon. It is so called because the shadow marks the sun's azimuth.

A'ZOTANE. Sir H. Davy proposed to designate the compounds of chlorine by the termination *ane*, and consequently distinguished the compound of chlorine and azote, or chloride of azote, by the above name.

A'ZOTE. (Gr. ἀ, *not*, and ζωη, *life*.) A simple gaseous body, unfit for respiration; it forms four-fifths of our atmosphere. *See* NITROGEN.

A'ZURE. (Fr. azur.) In Painting, a sky-coloured blue. That made of lapis lazuli, called ultramarine, is of great value to the painter.

A'ZURE. (Fr. azur, *blue*.) In Heraldry, one of the colours, or tinctures, employed in blazonry. It is equivalent to sapphire among precious stones, and Jupiter among planets. In engraving it is represented by horizontal lines.

A'ZURITE. *See* LAZULITE.

A'ZYGOS. (Gr. ἀ, *without*, and ζυγον, *a yoke*, because it has no fellow.) In Anatomy, some single muscles, bones, veins, &c., are so called.

B.

B. The second letter in all European alphabets, and in that of most other languages. B is one of those letters which the Eastern grammarians call labial, because the principal organs employed in its pronunciation are the lips. It has a close affinity to the other labial letters P and V; and by the Saxons it is confounded with the former, and with the latter by the modern Greeks, Spaniards, and Gascons. Hence the sarcastic remark, that in Gascony "vivere" and "bibere" are the same thing. Among the Greeks and Hebrews, B signified 2; among the Romans 300 (et B tricentum per se retinere videtur); with a dash over it it denoted 3000, and with a kind of accent below it 200. The Romans also used it in inscriptions as an abbreviation for Baccho, Beleno, Benemerenti, &c.; B. B. for bene bene (i.e. Optime), B. L. for lector benevole, B. F. (affixed to decrees or senatus consulta) for bonum factum. In modern times also it is used as an abbreviation for *before*, as B.C. (before Christ); and for *bachelor*, as, B.A., B.LL., B.D. (bachelor of arts, of laws, of divinity). In music, B is the note on the second line in the bass, and the third in the treble; and in the chemical alphabet, according to Raymond Lully, it denotes mercury.

B MOLLE. (Lat. molle, *soft*.) In Music, one of the notes in the musical scale, usually called soft or flat ♭, to distinguish it from B quadro (square), ♮.

BAAL, or BEL. (Heb.) A god of the Phœnicians and Carthaginians, worshipped chiefly at Tyre. The term Baal, common to all the Eastern languages, signifies lord or master; and this circumstance has probably given rise to the various contradictory opinions that prevail respecting this divinity. Servius (in Am. I.), who is followed by Vossius (*Theol. Gent.* b. xi. c. 4.), observes that Baal in the Runic language had two significations: the one denoting Saturn, the other equivalent to the Greek Ζευς. Accordingly, if Baal and Ζευς be words of similar import in different languages, we may apply to the former what Varro relates of the latter, that the number of divinities worshipped under this title amounted to three hundred. This opinion, it would appear, was held also by Milton,

> With these came they who, from the bordering flood
> Of old Euphrates, to the brook that parts
> Egypt from Syrian ground, had general names
> Of *Baalim* and Astaroth, &c. &c.

It is probable that the Baal of the Phœnicians, and the Belus of the Babylonians, whose worship was so assiduously cultivated (*Herod.* i.), were one and the same divinity. The priests of Baal amounted to 450; and, among other sacrifices offered upon his shrine, the Bible mentions human victims. To the zealous devotion paid by the Eastern nations to this divinity, and the wide circulation of his worship, the adoption of his name in the appellation of distinguished individuals, such as Hannibal, Belshazar, Asdrubal, &c., bears ample testimony. (Selden, *de Diis Syris*; *Shuckford's Connection*, b. v.)

BA'BEL. (Heb.) A tower undertaken to be built shortly after the flood by the posterity of Noah, and remarkable for the frustration of the attempt by the confusion of languages. About 1700 years after the erection of the tower of Babel, Herodotus saw at Babylon a structure consisting of eight towers, raised one above another, and each 75 feet high (*Herod.* b. i.); but whether this structure was the famed tower of Babel or not, it is impossible to ascertain. It is generally supposed, however, both by ancient and modern writers, that the city of Babylon afterwards occupied the site of Babel, and that the famous temple of Belus was built from its ruins. A great difference of tradition prevails as to the height of the tower of Babel. While the orientalists maintain that it was 10,000 fathoms, or about 12 miles high, St. Jerome asserts, on the authority of eyewitnesses who had examined the ruins of a tower at Babylon, that it was 4 miles high, and there are other statements still more extravagant. With regard to modern travellers who pretend to identify the ruins found on or near the site of ancient Babylon with the tower of Babel, their accounts are so discrepant and indefinite, as to render it doubtful if any of them have seen the genuine ruins of this celebrated tower. (*Rich's Travels; Buckingham's Travels in Mesopotamia; Rennel's Remarks on Herodotus.*)

BABIA'NA. A genus of Cape plants belonging to the natural order *Iridaceæ*. The name is derived from *Babianer*, a term given by the Dutch colonists to these plants in consequence of the avidity with which their roots are devoured by the baboons.

BA'BILLARD. The name of a small frugivorous Passerine bird, the *Curruca gurrula:* also called the white-breasted or babbling fauvette, lesser white throat, and nettle-creeper.

BABOO'N. The monkeys, or quadrumana, which have projecting ridges above the eyes, long and truncate muzzles, cheek-pouches, ischiatic callosities, and generally short tails.

BABYROU'SSA. The name of an animal of the hog kind (*Sus babirussa* Cuv.) inhabiting the forests of the Indian Archipelago, with longer legs and longer tusks than the other species of hog; both the upper and the lower tusks curve upwards and backwards, and serve as a defence to the eyes while the animal forces its passage through the entangled jungles.

BA'CCA. A berry; usually a succulent fruit containing several seeds. In its most exact application it is a succulent fruit filled with pulp, in which the seeds lie loosely, as in the gooseberry.

BACCALAU'REAT. (Lat.) The first or lowest academical degree in the English and French universities. The mode by which this degree is attainable is different in different universities. Oxford and Cambridge have two ways of conferring it: 1. By examination, to which those students alone are admissible who have pursued the prescribed course of study for the space of three years. 2. By extraordinary diploma, granted to individuals wholly unconnected with the university. The former class are styled Baccalaurei Formati, the latter Baccalaurei Currentes. In France, the degree of

Baccalaureat (Baccalaureus Literarum) is conferred indiscriminately upon such natives or foreigners as, after a strict examination in the classics, mathematics, and philosophy, are declared to be qualified. In the German universities, the title "Doctor Philosophiæ," has long been substituted for Baccalaureus Artium or Literarum. In the middle ages, the term Baccalaureus was applied to an inferior order of knights, who came into the field unattended by vassals: from them it was transferred to the lowest class of ecclesiastics; and thence again, by Pope Gregory IX., to the universities. There are few words whose origin has been more controverted than that of Baccalaureat; and both the military and literary classes have asserted their claims to this honour with equal zeal and ingenuity. While the former maintain that it is either derived from the *baculus* or staff with which knights were usually invested, or from *bas chevalier* (an inferior kind of knight), the latter, perhaps with more plausibility, trace its origin to the custom which prevailed universally among the Greeks and Romans, and which was followed even in Italy till the thirteenth century, of crowning distinguished individuals with laurel: hence the recipient of this honour was styled Baccalaureus (quasi *baccis laureis* donatus).

BACCAULA'RIS. A fruit consisting of several distinct carpels, having a succulent coating, and seated upon a short receptacle.

BA'CCHA. In Entomology, a genus of the order *Diptera*, and family *Syrphidæ*. The two basal joints of the abdomen are long and slender, with the remaining joints depressed and broad; they are bronze colour marked with yellow, and are found upon flowers in the neighbourhood of London.

BACCHANA'LIA. (Lat.) Festivals in honour of Bacchus. In the mythology of the Greeks and Romans, allusion is constantly made to the conquest which Bacchus achieved over India, and it is generally supposed that these festivals were instituted to commemorate that event. They consisted originally of a grand procession, in which the priests and priestesses of Bacchus bore the principal part, and were accompanied with games, spectacles, and theatrical representations. But, at a later period of Grecian history, they assumed a totally different character: vice, debauchery, and licentiousness became their distinguishing characteristics; and Plato (*de Leg.* l. i.) asserts that during the celebration of these festivals he has seen the whole Athenian populace in a state of drunkenness. At Athens, there were two principal Bacchanalia held annually: viz. Bacchanalia Dionysia or Majora, celebrated in the city about spring time; and Bacchanalia Lenæa or Minora (so called from ληνος, a wine press), celebrated in the country during autumn. On these occasions, the Bacchæ or priestesses of the god ran up and down the mountains in a frantic manner (*Stat. Theb.* vi. 92.), clad in doe-skins, with spears in their hands, bound at the points with ivy-leaves (thyrsi), and using the wildest gestures and exclamations. (See the *Bacchæ of Euripides*.)

These festivals were introduced from Greece into Etruria, and thence by an easy transfer into Rome, where they were at first celebrated chiefly by young men on their laying aside the toga prætexta for the toga virilis. But they soon after extended among all classes of the community; and in the course of time such were the enormities practised at their celebration, that the senate (A. U. C. 566) came to the resolution of abolishing them entirely. Virgil, in the 7th book of the *Æneid*, gives a graphic description of these festivals, and says that the priestesses

> —— tremulis ululatibus æthera complent,
> Pampineasque gerunt, incinctæ pellibus, hastas.

And Juvenal uses the term Bacchanalia to express a dissolute and licentious life:

> Qui Curios simulant, et Bacchanalia vivunt.

BA'CCHUS, or DIONY'SUS (Διόνυσος). The god of wine, and son of Jupiter and Semele daughter of Cadmus. His mother perished in the burning embraces of the god, whom she persuaded to visit her with his attribute of royalty, the thunderbolt; the embryo child was sewn up in Jupiter's thigh, whence in due time he was produced to light. Mythology abounds with the adventures of Bacchus, the most noted of which are, the transformation of the Tyrrhenian pirates, who carried him off to sell for a slave, into dolphins; his revenge on the scoffing Pentheus; and his invasion and conquest of India. Bacchus was generally represented as a young man of effeminate appearance, with a garland of ivy binding his long hair; in his hand he bore a thyrsus or rod wreathed with ivy, and at his feet lay his attendant panther.

BACCI'FEROUS. Bearing berries.

BA'CHELOR. In the English Universities, the lowest degree in arts, law, divinity, medicine, and music. It is, like other university honours, of French origin. For the various derivations that have been suggested for this word, *see* BACCALAUREAT.

BACHELOR. In Heraldry, the lowest order of knighthood. *See* KNIGHT.

BACHELOR. In the Livery Companies of London, is one who is not yet admitted of the livery; also called *yeoman*.

BACILLA'REÆ. A small group of Algaceous plants, having an extremely simple structure, and in part the same as what are called Cymbelleæ. They stand on the limits of the animal and vegetable kingdoms, and are said to have a power of spontaneous motion.

BACI'LLUS. A name given to the cotyledon of the hyacinth by Link.

BACK (from the Saxon bæc) OF A HIP. In Architecture, the upper faces of the hip-rafter between the two sides of a hipped roof, so formed to an angle as to be in the same plane with the rafters on each side of it.

BA'CKER. In Architecture, a term used to denote a narrow slate laid on the back of a broad square-headed slate where the slates begin to diminish in width.

BACKGA'MMON. A game played with dice by two persons on a table divided into two parts, upon which there are 12 black and as many white spaces, called *points*. Each player has 15 men, black and white, to distinguish them. This game is of Welch origin, and is said to have been invented in the period preceding the Conquest. (*Gloss. ad Leges Wallic.*, cited by Henry, vol. iv. p. 404.) Backgammon can only be learned by observation and practice; and though much depends on chance, still great skill may be displayed in the course of the game. Hoyle, the received oracle in these matters, has evinced great accuracy in calculating the odds of backgammon, and has embodied a variety of rules and instructions respecting it, which must prove of great service to every player.

BACK THE OARS. To row the oars backwards.

BACK AND FILL. To keep a ship in the middle of the stream of a narrow river, by alternately advancing ahead from one shore and moving backwards from the opposite shore, while the stream carries her along, the wind being contrary to the direction of the stream.

BACK-STAFF. An instrument used before the invention of the quadrant and sextant, for taking the sun's altitude at sea. In using it the observer turned his back to the sun, whence the instrument had its name. It was invented by Captain John Davis, about the year 1590.

BACK-STAYS. In Sea language, ropes stretched from the top-mast heads to the starboard and larboard sides of the ship, their use being to support the top-masts, and second the efforts of the shrouds. They are distinguished into *breast back-stays* and *after back-stays*, according as the strain on the mast is caused by a side-wind, or a wind further aft. *See* RIGGING.

BACO'NIAN PHILOSOPHY. The system propounded by Francis Bacon, Lord Verulam. It is usual to speak of this philosophy as if it were a new invention of its illustrious founder—as if the method of induction were a mode of philosophising unknown before his time, and in direct opposition to preceding systems, especially that of Aristotle: this opinion, we conceive, is entirely erroneous. Aristotle has in many parts of his works clearly and satisfactorily explained the inductive method, and has himself, in his physical writings, given examples of its application. Lord Bacon's distinguishing merit consists, we believe, rather in the attention which, by his splendid eloquence, his wonderful power of illustration, his comprehensive views of the relations of the sciences to each other, and his unhesitating faith in the boundless progressiveness of human knowledge, he succeeded in awakening in the minds of his countrymen, than in any philosophical discoveries properly so called. No man, we admit, ever obtained a clearer insight into the nature and province of inductive research; no man, certainly, has laid down with such rigour and accuracy the rules for its successful prosecution. The various modes of experimenting and observing (in the language of Bacon *instances*) are classed under twenty-seven heads; and the circumstances under which each kind is applicable are stated with great fulness and accuracy. This is done in the second book of his *Novum Organon;* the former book of which consists of aphorisms on the errors of the human intellect generally, and in particular of preceding philosophical systems. These delusions, under the name of idols, he reduces to four classes: the *idols of the tribe*, or those common to human nature generally; the *idols of the cave*, or those generated by individual peculiarities; the *idols of the market-place*, produced by the incorrect use of words in ordinary discourse; and lastly, the superstitions introduced by false and visionary systems of philosophy, to which the name is assigned of the *idols of the theatre*. His own method he designates as holding an intermediate place between the merely empirical and the dogmatical schools. "While the one," says he, "like ants, content themselves with heaping up materials for immediate use, the latter, after the manner of spiders, spin webs out of their own

train: there is a middle and a better way — that of the bee, which derives, indeed, its material from the flowers of the garden and the field, but converts and digests it by its own proper virtue." These two books of the Organon form the second great division of his projected undertaking, the *Instauratio Magna*, or *Reform of Philosophy*, and relate to the interpretation of nature. The treatise *De Augmentis Scientiarum* (*of the Advancement of Learning*) constitutes the first division: the third was to consist of a history of the phenomena of the universe: the fourth (*Scala Intellectus*) was to comprise an account of the processes of the human understanding, with examples from various sciences: in the fifth was to be contained the introduction to the *Philosophia Secunda*, or *Active Philosophy*, which, as the combined result of history and experience, was itself to constitute the sixth and last division. (See his *Distributio Operis; Bacon's Works*, 4to ed. vol. iv.) Of this mighty work Bacon only completed the first two divisions. For a comprehensive and impartial estimate of the value of the Baconian philosophy, the German scholar may consult Tennemann's *Geschichte der Philosophie*, 10ter band. (Leipzig, 1817.) An account of the *Novum Organon* has been published by the Society for the Diffusion of Useful Knowledge.

BA'CTRIS. (Gr. βακτρον, *a cane*.) A genus of palms with spiny slender stems and pinnated leaves. Their fruit is succulent, and manufactured into a kind of wine; walking sticks are made from their stems.

BA'CULITES. (Lat. baculum, *a stick*.) A genus of fossil Tetrabranchiate Cephalopods, the chambered shells of which are quite straight, but differ from those of the Orthoceratites in having sinuous or undulated partitions with lobated margins: in this structure they are allied to the Ammonites.

BA'DGER. *See* MELES.

BA'DISTER. In Entomology, a genus of the order *Coleoptera*, and family *Harpalidæ*. This genus, with some others, forms a leading group among the carnivorous beetles.

BA'GGAGE. (Fr. bagage.) In the art Military, the clothes, tents, provisions, and other necessaries belonging to an army. In regard to the conveyance of baggage, a striking contrast is presented between the military systems of ancient and modern times. The Roman soldiers had four kinds of baggage (bucellatum or corn, utensils of various kinds, valli, and arms), termed by a felicity of language *impedimenta*; and were so heavily laden, that they were called by way of jest *muli Mariani*, and *ærumnæ*. In modern times, the plan is every where adopted of ridding the soldier of all unnecessary encumbrance; and with this view waggons attached to each battalion are employed for the conveyance of baggage, and guarded and regulated by a body of men set apart for the purpose, called the waggon-train.

BA'GGING. A mode of reaping corn or pulse with a hook, in which the operator effects his object by striking the straw or haulm, instead of drawing the hook through it. In other words, it is separating the straw or haulm from the root by chopping, instead of by a drawing cut.

BA'GPIPE. This instrument appears to be of ancient origin, and is very similar to the *tibia utricularis* described by Blanchinus. A representation of it is given by Luscinius in his *Musurgia* (1536), whence it appears that at that time the instrument was similar to that now in use. It consists of a leather bag, inflated through a valved tube by the mouth (or a bellows), and of three pipes; two of which give only one note each, and are called the great and little drone; and the third, somewhat like the oboe, has eight finger holes. The bagpipe is peculiar to the Scotch and Irish nations.

BA'IKALITE. A manganesian epidote from lake Baikal in Siberia.

BAIL (Old Fr. bailler, *to deliver or give up*), in Law, is the liberation of one in custody, whether for a civil or criminal cause, on surety taken for his appearance at a day and place certain. In civil cases bail is chiefly of two kinds, called bail to the sheriff, and bail to the action; or, in other terms, bail above and bail below. When a person is arrested upon an affidavit made that he is indebted to the plaintiff in the sum of 20*l*. or upwards (which, since the recent act for abolishing arrest on mesne process, 1 & 2 Vict. c. 10., must also state that there is probable cause for believing that the defendant is about to quit England), he has then, in order to regain his liberty (unless previously discharged under a judge's order), to execute a bail bond to the sheriff, the condition of which is, that he will at the proper period put in special bail, which amounts to an appearance in court: at this period he either puts in special bail, who are two or more persons, who undertake generally that if the defendant lose the verdict he shall pay the amount awarded against him, or render himself to custody, or that they will do it for him. In default of special bail he returns again into custody.

Bail, in cases of felony, is taken by two magistrates in cases where the evidence against the prisoner is not such as to raise a strong presumption of his guilt.

BAIL-BOND, in Law, is a deed executed by a party arrested on mesne process (*see* ARREST), and two persons as his sureties, to the sheriff, conditioned for his causing special bail to be put in. If the defendant neglect afterwards to put in and perfect such bail, the plaintiff usually takes from the sheriff an assignment of the bail-bond, and proceeds against the defendant in a separate action.

BAI'LIE. The name by which the municipal magistrates of Scotland are designated. The term is synonymous with *alderman*.

BAI'LIFF. (Fr. bailler, *to deliver*.) The term properly meant "lessee:" whence it came to signify more generally deputy, and was applied to those officers who, by virtue of deputation either from the sheriff or the lords of private jurisdictions, exercised within the hundred, or whatever might be the limits of their bailiwick, certain judicial and ministerial functions. With the disuse of private and local jurisdictions, the meaning of the term became commonly restricted to such persons as were deputed by the sheriff to assist him in the merely ministerial portion of his duty, such as the summoning of juries and the execution of writs. These persons are called bound bailiffs, so termed from the obligation which they enter into to indemnify the sheriff against the consequences of his responsibility for their right conduct in the discharge of their duty.

BAI'LIWICK. (Fr. bailli, *bailiff*, and Lat. vicus, *a village*.) The dwelling-place or district of the bailiff: it also signifies a county, which is the bailiwick of the sheriff, or the particular franchise of some lord who has exclusive authority within its limits.

BAI'LMENT. In Law, is a delivery of goods in trust, upon a contract, express or implied, that the trust shall be faithfully executed on the part of the bailee, or receiver. Transactions with carriers, agents, pawnbrokers, and many other mercantile proceedings, are affected by the law of bailment.

BA'IRAM. A Mohammedan feast, instituted in imitation of the Easter of the Christian church, and following the Rhamaan, or month of fasting, which answers to our Lent. In consequence of the Turkish mode of reckoning by lunar months, these periods fall successively in all the seasons during a cycle of thirty-three years. Sixty days after the greater follows a second feast, termed the lesser Bairam.

BA'JADERES. The name given by the Portuguese to the Indian dancing girls, who, under various appellations, are partly employed as priestesses, and instructed in music and dancing by the priests of Schiva and Vishnu, partly employed by the grandees of India to cheer their festivities and minister to their pleasure. Their dress consists of costly materials, tastefully arranged; and their movements are most dexterous, graceful, and fascinating, at least if we may judge of them from the Bajaderes that appeared at the *Adelphi* theatre in the autumn of 1838. In their whole character and proceedings, they bear a strong resemblance to the *Hierodouloi* of the Greeks.

BA'JULUS. (Lat. *porter*.) In the Lower Greek Empire, the title of the officer to whom the education of a prince was entrusted. The name was borrowed by various Western courts which imitated the etiquette of Constantinople, and from it some have erroneously derived that of bailiff.

BALÆ'NA. (Gr. φαλαινα.) The Greenland whale; also a generic term, comprehending the species which agree with it in the presence of whalebone in the mouth and the absence of a dorsal fin.

It is to this genus that the whale, properly so called, or large-walebone whale (*Balæna mysticetus*, Linn.), belongs, the value of which to man is such that large fleets are annually fitted out expressly for its capture. The food of the whale consists exclusively of small molluscous and crustaceous animals, but chiefly the *Clio borealis*; and as these animals abound only in the Arctic seas, the whale cannot be expected to frequent for any length of time those latitudes in which its food is scarce or altogether wanting. The long-continued annual destruction of the *Balæna mysticetus* has greatly diminished the numbers of this species, and driven those which remain to the extremest limits of the northern seas where their means of subsistence can be obtained.

The large-whalebone whale is often spoken of as the largest of existing animals, but it is inferior in magnitude to the small-whalebone whale (*Balænoptera*). The latter attains the length of from 90 to 100 feet; while the ordinary dimensions of the true whale are from 50 to 60 feet in length, and from 30 to 40 feet in circumference. The terms "large-whalebone" and "small-whalebone" relate to the size of the whalebone or baleen-plates, which is always much greater in the genus *Balæna* than in *Balænoptera*; and it is this structure, combined with the greater amount of blubber in the true whale, which renders it an object of so much more value to the whale catchers; while its less courageous habits, and less violent

efforts to escape when wounded, make it a more sure and safe prey than the small-whalebone whale.

The true whale is chiefly remarkable for the immense size of its head, white constitutes a full third of the entire length of the animal: it is narrow above, but very broad below, where it consists chiefly of a large under lip, which rises five or six feet, and completely overlaps the upper lip. The eyes are very small, and are placed just above the angles of the mouth. The external opening of the ears is scarcely perceptible. The pectoral fins are of moderate size, and placed about two feet behind the angles of the mouth. The neck is indicated by some furrowing of the skin, but there is no constriction. The greatest circumference of the cylindrical body is a little behind the pectoral fins. The tail-fin consists of two lobes of great breadth, measuring 20 feet across from tip to tip in a full-grown specimen; and wielded by muscles of enormous power. It is this part which constitutes the sole organ of offence and defence in the whale, for it has no teeth wherewith to bite or lacerate; a single blow of the tail well delivered suffices to cut a stout boat in two, or to send it whirling through the air.

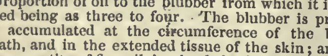
The plates of whalebone are the substitutes for teeth in the mouth; they have a similar mode of development from a pulp and external membrane, and differ only in form, and in a less proportion of earthy matter in their composition. They are arranged vertically and transversely, in two series, consisting each of 300 plates, descending from the palatal surface of the upper jaw, and terminating in a fringe of coarse hairs on their oblique lower and inner margins, which hairs are in contact with the upper surface of the bulky tongue when the mouth is closed. It is thus that the mechanism of the sieve is realised on an enormous scale; and while the water gulped at each successive mouthful is drained off through the interstices of the baleen plates, the molluscous and crustaceous animals are retained, bruised into a pulp between the muscular tongue and coarse fibres of the whalebone, and swallowed. The area of the gullet corresponds with the minute character of the food, and is relatively smaller in the whale than in any other animal. The stomach is divided into four cavities; the intestinal canal is long and narrow, and provided with a short and simple cœcum.

The whale has usually but one young at a birth, and brings forth in the early spring. The period of gestation is unknown, that of suckling lasts a year. In this stage of their growth the young are called *short heads* by the whale-fishers; at two years old, and until they are able to find their appropriate food in due abundance, they are termed *stunts;* when they begin to get fat, and until they have arrived at their full size, they are called *skull-fish*.

The interesting details of the profitable but perilous occupation of whale-fishing, will be found most amply and correctly given in *Scoresby's Account of the Arctic Regions*, from which many popular narratives have been compiled. The baleen and the blubber are the only parts of the animal of any commercial value, and the quantity of both yielded by these enormous animals is of course considerable. The length of the largest whalebone plates in a whale of 60 feet is as much as 12 feet; and the blubber of such a one will yield more than 20 tuns of pure oil, the proportion of oil to the blubber from which it is extracted being as three to four. The blubber is principally accumulated at the circumference of the body, beneath, and in the extended tissue of the skin; an immense quantity of fine oil is also lodged in the cellular substance of the tongue; and the coarse and porous bones, particularly the lower jaw, are full of pure oil.

BA'LANCE. (Lat. balanx or bilanx, probably a corruption of valentia, denoting, in low Latin, *price* or *value.*) A machine for weighing substances. The process of weighing may be performed in various ways, and accordingly there are several kinds of balances; as the common balance or scales, the bent lever balance, the spring balance, the steel-yard, the hydrostatic balance, &c. (for which see the respective words). The term is also applied to any apparatus employed for comparing the intensities of very small forces, as the electric balance, the balance of torsion, &c. We shall here confine our remarks to the philosophical balance, the instrument used when great accuracy is necessary; for instance in assaying, and in the more delicate investigations of physics and chemistry.

Neglecting the mere circumstance of construction, and the particular methods of suspension, the balance may be represented thus:—



A and B are the points from which the scales are suspended at the extremities of the beam, C the point of support, G the centre of gravity of the beam, D the point in which the straight line C G intersects the straight line joining A and B.

The properties required in a good balance are *sensibility* and *stability*. The balance must be sensible; that is to say, when it is properly poised a very small addition of weight to either scale should disturb the equilibrium, and cause the beam to turn; and it must be stable, that is to say, when the equilibrium has been disturbed it should quickly return, and oscillate about the position of rest. These two properties are in some degree opposed to each other; in order to attain them both, as far as possible, it is necessary to attend to certain mechanical principles, as well as to the physical circumstances of construction. Let us suppose

W = the weight of the beam.

L = the load, *i. e.* the weight of the scales and whatever is in them when the beam is poised.

P = the preponderating weight, or that which causes the beam to turn.

Suppose now the beam to be poised, or that the scales being loaded the position of the line A B is perfectly horizontal. The sensibility will evidently be measured by the angular space through which the beam turns when a small weight P is added to either scale; but the force which acts in turning the beam is proportional to $P \times DB$, that is, proportional to the weight multiplied into the length of the lever at the extremity of which it acts; therefore for a given weight P, the sensibility of the balance, all other circumstances being equal, is proportional to the length of the beam. Let us next consider the force which tends to restore the beam when the equilibrium is disturbed. This is made up of two parts; the first of which is proportional to $W \times CG$, that is to say, proportional to the weight of the beam (which may be regarded as concentrated at the centre of gravity) multiplied into the length of the lever on which it acts; and the second proportional to $L \times CD$, that is, to the load also multiplied into its length of lever. The whole restoring force is therefore proportional to $W \times CG + L \times CD$. Now this force is precisely that which the preponderating weight P has to overcome in turning the scale; consequently any circumstance which tends to increase it, increases the stability and diminishes the sensibility of the balance; and anything which tends to diminish it, diminishes the stability and increases the sensibility. By bending the arms of the balance, or altering the points of suspension of the scales, the points G and D may acquire different positions relatively to C. Supposing G to be above C in the vertical line joining those points; the term $W \times CG$ would become negative, and the restoring force proportional to $L \times CD - W \times CG$. In this case, if the load L, or the distance C D, were diminished till $L \times CD$ became less than $W \times CG$, the balance would be useless; because if moved ever so little from the position of rest, it would have no tendency whatever to return. The best construction is to make $CD = 0$, that is, to place the three points of action A, C, B, in the same straight line, and to construct the beam so that G, the centre of gravity, shall fall a little below the line A B. The sensibility is then independent of the load, and is simply in the inverse proportion of $W \times CG$; so that by diminishing the weight of the beam, or the distance C G, it may be increased to any required degree. It is supposed that the two arms are precisely of the same length, or that C is placed exactly in the middle between A and B, and also that they are perfectly inflexible.

The conditions now determined from theory must be the guide of the artist in the construction of a good balance. It is of importance that the beam be as light as possible consistent with inflexibility; for not only the inertia, but also the friction, is increased in proportion to the weight, and the sensibility consequently diminished. In order to give lightness and strength at the same time, the beam should be formed of two hollow cones of brass, joined together at the broad ends. A cylinder of steel, passing through the middle of the beam at right angles, forms the axis; and its extremities, ground into sharp edges on the lower side, serve as the points of support. The two edges must be accurately in the same straight line, and turn on smooth planes of agate or polished steel carefully levelled. The scales should likewise be suspended from the extremities of the beam on knife edges, crossing each other at right angles; those in the beam being sharp upwards, and those to which the scales are attached sharp downwards. A needle, or tongue, is usually attached to the beam, pointing directly upwards or downwards when the beam is horizontal, for the purpose of indicating the deviations of the beam from the horizontal position on a graduated scale. It is better, however, to bring the arms to terminate in sharp points, and to place a scale behind each; in this way the slightest flexure of the beam will be rendered evident, if the zeros of the scales are placed exactly in the same level. The scale is indispensably necessary, because the balance, if very sensible, would require a long time to come to rest; but it is known to be poised, when the excursions of the needle

on both sides of the zero of the scale are equal. In order to preserve the knife edges, the beam, when not in use, is supported on rests. Props should also be placed under the scales while loading or unloading the balance. The whole apparatus must be placed under a glass case, to protect it from the disturbing influence of currents of air.

The sensibility of a balance constructed with due care, according to the principles now explained, may be carried to an almost inconceivable extent. There is one in the possession of the Royal Society, made by Ramsden, which weighs ten pounds, and is said to turn with the ten-millionth part of that load, or the thousandth part of a grain. Nevertheless, whatever skill may be employed in the construction, it is plain that the conditions necessary to mathematical accuracy can never be entirely fulfilled. It is impossible to make the two arms of the beam exactly similar, or exactly equal in length. Absolute precision is unattainable in practice. This difficulty, however, may be overcome by the following simple method, imagined by Borda, by which accurate results are obtained independently of extreme precision in the construction of the balance: it is only necessary that it be very sensible. Let P, the substance to be weighed, be placed in the scale A; instead of placing known weights in the scale B, put into it some other substance, for instance bits of iron, chips of wire, or sand, added in minute quantities till the substance P is exactly counterpoised, or the beam becomes exactly horizontal. This being done, let the substance P be gently removed out of the scale A, and let known weights, as grains, be put into it till the substance in the scale B is again exactly counterpoised. It is now of no consequence whether the balance was accurate or not, or whether the body P was exactly equal in weight to the substance against which it was weighed in B. The weight of P must be precisely equal to that of the grain weights; because, under exactly the same circumstances, they both formed a counterpoise to the substance placed in B.

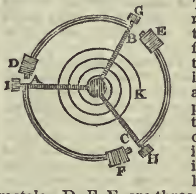
Chinese Balance. This is formed of a slender tapering rod of wood or ivory, about a foot in length. A silk thread passed through a hole perforated nearer one of its extremities than the other serves as the point of suspension. The balance has thus two unequal arms. From the extremity of the shorter a small scale is suspended to hold the substance to be weighed. A sliding weight passes along the other arm, on which divisions are marked; and when the counterpoise is made, the distance of the standard weight from the fulcrum indicates the weight of the substance. In order to procure a greater range, the rod has generally four holes or points of support, at different distances from the extremity, and a corresponding set of divisions is marked on each of its four sides. The principle of this machine is exactly the same as that of the common steel-yard.

The *Danish Balance*, much used in the north of Europe for weighing coarse commodities, is usually formed of an iron bar or a batten of hard wood, having a lump of lead at one of its extremities. The goods are fixed in a hook in the other end; and the whole is suspended through a loop of cord, which is passed backwards and forwards under the rod till equilibrium is obtained. The weight of the goods is then to the weight of the lead reciprocally as their respective distances from the loop.

Roman Balance or *Steel-yard.* *See* STEEL-YARD.

BALANCE OF TORSION. A machine invented by Coulomb for measuring the intensities of electric or magnetic forces, by establishing an equilibrium between them and the force of torsion. Conceive a metallic wire suspended from a fixed point, and kept stretched by a small weight attached to its lower extremity; where also a horizontal needle or lever is fixed, which may be rendered magnetic, or is so formed that one of its ends is a conductor and the other a non-conductor of electricity. The force is brought to act on the extremity of this lever, and its intensity measured by the length of the arc which the needle passes over, reckoning from the point of repose; or an index may be attached to the upper extremity of the wire, and the force measured by the number of degrees through which it can be turned before the lower lever begins to move. The force of torsion is inversely proportional to the length of the wire, and directly to the fourth power of its diameter. The wire must therefore be of considerable length (two or three feet for example), and very fine; and also formed of a substance possessing considerable elasticity. Brass wire is greatly preferable to iron wire; and in some instruments recently constructed a fine thread of spun glass has been used instead of metallic wires, at the suggestion of the late Professor Ritchie. One of the most interesting applications of the torsion-balance was that made by Cavendish to measure the force of attraction of two leaden spheres, in his celebrated experiment to determine the mean density of the earth.

BALANCE OF A WATCH. That part of the machine which, by its inertia, regulates the beat and produces equable motion. It is formed of a wheel or ring, having its weight principally accumulated in its rim, and connected with a spiral spring in such a manner that when drawn aside from the position of rest it acquires an oscillatory motion from the alternate contraction and expansion of the spring. The balance answers the same purpose in watch-work as the pendulum in clock-work, and is affected in a similar manner by variations of temperature. Supposing the length of the spring to remain constant, the time of vibration is directly proportional to the distance of the centre of gyration from the axis of the balance; consequently the duration of the vibration is increased by heat and diminished by cold. To remedy this inconvenience, various contrivances have been applied; but that which is most generally adopted is the *expansion* or *compensation balance*, the principle of which depends on the unequal expansion of two different metals. It may be constructed in the following manner:



The rim consists of two laminæ, the inner of steel and the outer of brass, united by fusion. After being turned to the proper size, the rim is cut in three places, A, B, and C; and one end of each of the parts thus formed being fixed to an arm of the balance, the other is left at liberty to move inwards or outwards according to the variation of the relative lengths of the two metals. D, E, F, are three equal weights placed near the free ends, and which, when adjusted at the proper distances, are fixed in their places by means of screws. Three heavy-headed screws, G, H, I, enter the arms of the balance, and serve to adjust its centre of gravity to the axis of vibration, and also to increase or diminish the mean rate of motion. Now, suppose the balance to receive an increase of temperature, this will tend to lengthen the arms, and consequently to throw the centre of gyration further from the axis, and thereby diminish the velocity of vibration; but as the brass expands more than the steel, the compound bars will at the same time be bent inwards, and the weights D, E, F, thereby thrown nearer the axis, by which the velocity will be increased. When the temperature is diminished, the arms are shortened; but the weights are now thrown to a greater distance from the axis by reason of the contraction of the brass being greater than that of the steel, and the consequent tendency of the compound bars to assume a less curved form. It is easy to see that in so small a machine the adjustment of the parts to procure exact compensation is a matter of great nicety, and requiring much practical skill; in fact, it is only possible to obtain a tolerable compensation by repeated trials.

BALANCE OF POWER. In Politics, a system by which the relative power of different states and alliances is so maintained as to render any extensive derangement improbable. The idea of preserving a balance of power naturally suggested itself to statesmen in ancient Greece, where so large a number of independent states with opposing interests existed on a narrow territory. In Europe, this portion of political science scarcely began to be understood until the 16th century; since which time the maintenance of the balance of power has formed a favourite object, often pursued with unreasonable avidity, by those who have controlled the international relations of Christendom. The great aim of neutral politicians during that century was to establish a balance between the power of France and that of Austria: the latter united with that of Spain became so enormously powerful in the course of it, as to render this an object of great anxiety. But after the commencement of the 17th century the power of France steadily increased, and that of Austria abated. Cromwell's alliance with Mazarin was the last result of the ancient system: for the alliances of Charles II. with the French were for personal objects, and strongly reprobated by all European statesmen. At the end of the 17th century France stood predominant, and it became the great problem of European politics to find a counterpoise to her influence. This was the aim of William III., Eugene, and the Whigs under Queen Anne; and the treaty of Utrecht in 1713, which acknowledged the French supremacy in Spain, was condemned as one of the severest blows ever struck at the balance of power. Nevertheless, this fear, like so many others sedulously cherished by speculative statesmen, proved to have little foundation. The power of France remained stationary during the 18th century, while the forces of Austria, Russia, and Britain increased; and Prussia suddenly arose from a third-rate power to the lowest, but still a respectable position, among the first-rates. During that century the alliances were formed with no very steady regard to the balance of power: France and Austria were usually, but not uniformly, rivals. In 1756, the three great Continental powers were united in a fruitless endeavour to crush the new state of Prussia. The wars of the French revolution entirely altered the ancient

equilibrium; it was restored by the congress of Vienna and the long maintenance of that peaceful arrangement certainly speaks in favour of the sagacity of its constructors. At present Europe is divided, singularly enough, by two different sets of causes, producing different alliances, or rather tendencies towards alliances, for mutual defence. In the first place, the opposition between constitutional and monarchical principles has ranged on the one side Austria, Russia, and Prussia, with their dependent states: on the other, Britain and France, with the Western kingdoms which have liberal governments. In the next place, the interests engendered by purely external politics cause a different line of division. The enormous increase of Russian dominion, particularly towards the East, renders Austria necessarily distrustful, and hostile to the former power. England may be expected to take part with Austria in this quarrel; Prussia, which has no direct interest in the result, will be ranged by position against Austria; while the ultimate decision of France is doubtful, and will in effect determine the struggle.

BALANCE OF TRADE. The term commonly used to express the difference between the value of the exports from and the imports into a country. The balance is said to be favourable when the value of the exports exceeds that of the imports, and unfavourable when the value of the imports exceeds that of the exports. The notion was once entertained that the prosperity of a country depended on exporting merchandise exceeding the value of the imports, and receiving the balance in the precious metals. This mode of estimating the balance of trade, which is evidently founded on the assumption that the precious metals constitute the wealth of a country, has been proved to be completely fallacious, and it is now conceded on all hands that gold and silver are nothing but commodities, whose exportation or importation it is necessary neither to prevent nor encourage by any legislative enactments. But the theory of the balance of trade is not erroneous merely from the false notions which its advocates entertain with respect to money: it proceeds on radically mistaken views as to the nature of commerce. For it will be found that so far from an excess of exports over imports being any criterion of an advantageous commerce, it is directly the reverse; since, were the value of the exports greater than the value of the imports, merchants would lose on every transaction with foreigners, and the trade with them would be speedily abandoned. For a succinct statement and exposition of the errors which were till lately generally prevalent upon this subject, see *M'Culloch's Commercial Dictionary*.

BALANI'NUS. In Entomology, the name applied by Germar to the subgenus of Weevils (*Curculionidæ*), of which the nut grub, or nut weevil (*Balaninus nucum*), is a species. In the perfect insect the rostrum or borer is nearly as long as the body. It is by means of this instrument that the parent weevil drills a hole through the soft shell of the immature filbert, into which she introduces a single brown egg: this is hatched in about a fortnight; and by the time the nut is full ripe, the grub has attained its full growth; it then proceeds to bore a hole with its jaws through the shell, and emerges from the cavity of the nut: falling to the ground it burrows into the earth, and there remains all winter, changing to the proper state, and appearing as a perfect insect in August.

BA'LANITES. (Lat. balanus, *an acorn.*) In Botany, acorn-barnacles, an order of Cirripeds, comprehending those which have a shelly tube, adherent by its base to foreign substances, and closed at its apex by four opercular valves.

BA'LANOPHORA'CEÆ. (Balanophora, one of the genera.) A natural order of Rhiganths, consisting of fungus-like parasitical plants, with small monœcious flowers collected in dense heads arranged upon fleshy receptacles.

BA'LAS RUBY. A term applied by lapidaries to the bright red varieties of the spinel. It is much less rare and valuable than the oriental ruby or red sapphire.

BALAU'STA. In Botany, a kind of fruit having a leathery rind, a superior calyx, and several cells irregularly disposed, with many drupaceous seeds in each.

BALCO'NY. (It. balcone.) In Architecture, a projection from the external wall of a house, borne by columns or consoles, usually placed before windows or openings.

BALDACHI'NO. (It. *a canopy.*) In Architecture, a species of canopy over the principal altar of a church, similar to that at St. Peter's, where it is supported by columns; or that of St. Sulpice at Paris, where it is suspended from above. It succeeded to the ancient *ciborium* (see that word), which was a cupola supported on four columns, still to be seen at many of the altars in Rome. Bernini may claim the merit of its invention. The height of that which he erected in St. Peter's is 128 feet, and being entirely of bronze weighs near 90 tons. It was built by order of the Pope Barberini, from the robbery of the Pantheon, and occasioned the bitter sarcasm — "Quod non fecerunt Barbari, fecerunt Barberini."

BA'LDRIC. (Lat. baldrellus.) A girdle used by the warriors of feudal times: it was often splendidly ornamented, and marked the rank of the wearer.

BA'LDWIN'S PHOSPHORUS. Fused nitrate of lime.

BALEA'RIC CRANE. *See* CRANE.

BALL. (Ger. bal.) Literally, any thing made in a globular form. The word signifies also at once a well-known *divertissement*, and a game familiar in Europe and America. Ball-playing was a favourite amusement among the ancients, who practised it in various ways. They had their hand-ball (*pila trigonalis*), their football (*follis* or *pila paganica*, because played by the rustics), and some other kinds not used by the moderns. In country villas a tennis-court or place for playing ball, called *Sphæristerium*, was usually to be found. (*Sue. Vesp.* 20.) In the middle ages, there were houses appropriated to ball-playing; and in Italy there are still public places where this amusement is practised, and great dexterity displayed.

BALL. In the art Military, any round substance of lead or iron which is discharged from fire-arms, as musket-balls, cannon-balls, &c. The word Ball, with a prefix more or less expressive of its purposes, such as fire-balls, chain-balls, denotes a composition of various ingredients generally combustible. (For an account of these terms see separate articles.) Cannon-balls are made of iron, balls for pistols and fusees of lead. The experiment has been tried of employing iron balls for pistols or fusees, but without effect; as their lightness prevents their flying straight, and they are apt to furrow the barrel of the pistol. As was remarked, cannon-balls are made of cast-iron, and are distinguished as follows by their respective diameters: — Thus the diameter of a

42 lbs. ball is	6·684 inches.			9 lbs. ball is	4·000 inches.		
32	—	6·105	—	6	—	3·493	—
24	—	5·547	—	3	—	2·775	—
18	—	5·040	—	2	—	2·423	—
12	—	4·403	—	1	—	1·923	—

BA'LLAD. (It. ballata.) A species of narrative poetry, founded either in history or fiction, displaying the condition and the habits, the tastes and the sentiments of the various nations among whom it is found. The term Ballad is very indefinite in its general acceptation, including classes of composition wholly different in themselves, of which the only common characteristics are brevity of metre and simplicity and perspicuity of style. The opinion entertained by Schlegel of the ballad is, that it is not an original species of composition; but that in general poems of this kind are to be found in the greatest abundance among nations possessed of truly poetical feelings, whose legends, traditions, and national recollections have been interrupted or mutilated by long-protracted civil wars, or by some universal revolution or concussion of opinions. While some authors have assigned the ballad an Arabian, some an Armorican origin, and others have claimed this distinction for the Normans and Provencials, Percy, Bouterweck, and Schlegel concur in awarding to it a Teutonic descent. Be this as it may, it is agreed that the Scandinavian nations delighted, at a very early period, to celebrate in song the deeds of heroes, lovers, knights, &c.; and the three great divisions of the Teutonic poetry of the middle ages — the stories of the Niebelungen, those of Charlemagne (particularly such as relate to his wars against the Arabians, and the battle of Roncesvalles), and the tales of King Arthur's Round Table, consist of what at a later period were called Ballads. Though the name Ballad is Italian, the spirit of chivalry had at no period during the middle ages much dominion or influence on the other side of the Alps; a circumstance that sufficiently accounts for the meagreness of the Italians in this department of poetry. The French too never attained any perfection in the ballad, as their fabliaux, legends, &c. soon degenerated into long prose romances, which were quite destitute of the spirit of the ancient minstrelsy. The Spaniards, on the other hand, are rich in ballads of a highly chivalrous character. These, however, along with some Portuguese ballads which bear infallible marks of a Spanish origin, may with more propriety be classified under the denomination of Romantic Poetry. Among the Welsh, even so early as the 12th century, music and this species of poetry seem to have attained a high degree of excellence; but the ruthless hand of Edward I., by his massacre of the bards, doomed both the one and the other to an almost total annihilation. Of all the species of ballad, the Irish, among other characteristics, appears to be pre-eminently fitted for adaptation to music, as is witnessed in the universally admired "National Melodies" of Thomas Moore. While a variety of opinion exists among the learned as to the nature and requisites of the ballad, it is admitted on all sides that England and Scotland have the honour of possessing a collection of ballads superior to that of every other nation. There

can be little doubt, too, that the home of the English and Scottish ballads is either in the north of England, or in the southern counties of Scotland, as there the influence of the Normans was less than in the south of England. To the proximity, also, of those parts of the two countries where the ballad was cultivated, and the small circle which they embraced, may be attributed the difficulty that exists in assigning to each country its proper share in the collection of ballads. In modern times, if we except the romantic legends of Sir Walter Scott (which can scarcely be denominated ballads), the Germans have cultivated this species of poetry with more success than any other nation; and they can boast of Schiller, Göethe, and Bürger, not only as distinguished poets, but as the revivers of that chivalrous spirit which formed the grand characteristic of our British ancestors. For remarks on the Ballad, vide *Aikin's History of Song; Warton's History of English Poetry; Burney's History of Music; Motherwell's Ancient and Modern Minstrelsy; Jones's Musical and Poetical Relics; Schlegel's Kritische Schriften* (article on Bürger); *Sir W. Scott's Minstrelsy of the Scottish Border; Bishop of Dromore's Collection of Ballads.* (See also the *Conversations Lexicon.*)

BA'LLAST. Is a mass of weighty material placed in the bottom of a ship or vessel to give her *stiffness;* that is, to increase her tendency to return to the upright position when inclined or *heeled over* by the force of the wind or other cause. Ballast consists of shingle (the coarse gravel of the sea-beach), stones, &c. In the royal navy iron ballast alone is used, in pigs of nearly 3 cwt. This has the advantage of lying in small compass; but in consequence of its great weight it tends to give excess of stability, which renders the vessel *uneasy* from the suddenness of the motion: this defect is remedied by *winging* up the ballast, whereby its centre of gravity is raised. For the like reason in stowing the ballast it is tapered to a point at the fore and after extremities. Iron ballast, from its greater cleanliness, is more healthy for the crew than that of other materials. When a ship has no other loading she is said to be *in ballast.*

The quantity of ballast and the mode of its stowage differ greatly in different vessels; and the connection between the motions of a ship and her stowage has not yet been analysed sufficiently to lead to the discovery of direct rules on these important points.

BALL-COCK. A hollow sphere or ball of metal attached to the end of a lever, which turns the stop-cock of a cistern pipe, and regulates the supply of water. As the surface of the water rises in the cistern, the ball is raised by its buoyancy; and as the water descends, it falls by its own weight. The cock is thus closed when the water rises to a certain height, and the supply stopped; but when a part of the water is drawn off from the cistern, the cock is again opened, and the water admitted through the pipe.

BA'LLET. (Fr.) A theatrical representation of actions, characters, sentiments, and passions, by means of mimic movements and dances, accompanied by music. The ballet is divided into three kinds — historical, mythological, and allegorical; and consists of three parts — the entry, the figure, and the retreat. (*Noverre, Lettres sur les Arts imitateurs, et sur la Danse en particulier.*) The chief merit of the ballet lies in an ingenious adaptation of music to the sentiments of the mind as developed in the dance, and in its power of representing every variety of human conduct and emotion, whether of a tragic or comic nature. It has been frequently asserted that the ballet was unknown to the ancients; and yet if the meaning of the Greek term "ὀρχησις" and the Latin term "saltatio" be duly considered, it will be found that both these nations indulged in pantomimic dances of a peculiar kind; the province of gesticulation or of dancing being assigned to one individual, that of declamation to another. (*Xen. Symposion* and *Anab.* vi. 1. 3. 8.) Hence it would appear that the only merit which the moderns can claim in reference to the ballet consists in the substitution of music and scenery in the room of declamation. Be this as it may, it is generally admitted that the ingenious artist Baltazarini, director of music to the princess Catherine de Medicis, first gave its present form to the regular ballet, and that after a considerable interval it was introduced into France. There it continues to flourish like an indigenous plant: while Germany and England, whither it was afterwards transplanted, have not been remiss in fostering its growth. There are many persons who object to the incorporation of the ballet with the opera; and in a few instances, such as the opera "Der Gott und die Bajadere," their objections may be well founded. But assuredly every one who has witnessed the dances introduced into the opera of Guillaume Tell, Robert le Diable, La Tentation de St. Antoine, and Masaniello, must be of opinion that in these cases at least the adoption of the ballet produces a peculiar charm, by enhancing the power and beauty of the representation. (*Conversations Lexicon*).

BALLI'STA. (Gr. βαλλω, *I throw.*) A military engine, used by the ancients for throwing stones, darts, arrows, &c. The Ballista is sometimes confounded with the Catapulta; but a distinction is made by Polybius, who confines the latter term to those machines which throw stones only. The particular mechanism of these engines is not very certainly understood. According to Vitruvius they were made in divers manners; but the principle of all seems to have been the same. A beam of wood or plate of metal is firmly fixed at one extremity; the other extremity is drawn back by means of cords and pulleys; and being suddenly set free, the elastic force with which it seeks to recover itself propels the missiles.

BALLISTIC PENDULUM. An instrument, invented by Benjamin Robins, for measuring the force or velocity of cannon and musket balls. To one extremity of an iron bar is fixed a heavy cubical block of wood, lined at the back with iron. A transverse bar of iron at the other extremity of the first bar serves as an axis of suspension, in which the pendulum swings freely backwards and forwards. The instrument being thus fitted, if the weight of the pendulum be known, and likewise the respective distances of its centres of gravity and oscillation from the axis of suspension, it is easy to determine the quantity of motion that will be communicated to the pendulum by the percussion of a body of a given weight moving with a given velocity and striking it at a given point. Conversely, if the pendulum, when at rest, is struck by a body of a known weight, and the vibration which the pendulum makes after the blow is known, the velocity of the striking body may thence be determined. In order to measure the extent of the vibration, a riband is attached to the lower end of the pendulum, passing loosely through an orifice in a horizontal bar in the frame-work; when the pendulum is raised it draws the riband along with it, and the quantity which thus passes through the orifice measures the chord of the arc of vibration. (See *Robins's New Principles of Gunnery*, vol. i. Prop. 8.; also *Hutton's Mathematical Tracts*, vol. ii.)

BA'LLIUM. In the Architecture of the Middle Ages, the open space or court of a fortified castle. This has acquired in English the appellation Bailey; thus St. Peter's in the Bailey at Oxford, and the Old Bailey in London, are so named from their connection with the sites of castles.

BALLOO'N. (Fr. ballon, *a little ball.*) The name of a machine, which, consisting of an envelope containing a gas specifically lighter than common air, rises into the atmosphere with a greater or less degree of ascensional force. A car, supported by a net-work which extends over the balloon, supports the aëronaut; and a valve, usually placed at the top, to which a string is attached reaching to the car, gives him the power of allowing the gas to escape, and of descending at pleasure.

During the dark ages, and for some time after the revival of science, numerous projects were entertained for navigating the air; but it is only in very recent times, since 1783, that any of them have been realized. The first idea was to employ some mechanical contrivance resembling the wings of birds; but Borelli demonstrated that all attempts on the part of man to fly must necessarily fail, from the utter disproportion of his muscular power to the force that would be necessary to give impulsion to wings of such enormous magnitude as would be required to sustain his weight in the air.

The principle by which a balloon rises in the atmosphere is exactly the same as that which causes the ascent of a cork from the bottom of a vessel filled with water. The weight of the volume of air which it displaces must exceed the weight of the balloon and all that it carries with it. That bodies must rise and remain suspended in a fluid denser than themselves was proved by Archimedes; but the weight of the air is a modern discovery; and it was only in the latter half of the last century that chemistry detected the nature and differences of specific gravities of aëriform fluids. Mr. Cavendish, in 1766, by some ingenious experiments, recorded in the *Philosophical Transactions*, vol. lvi., found hydrogen gas to be from about seven to eleven times lighter than common air, according to the mode of its preparation. In its pure state state it is found to be nearly sixteen times lighter than common air. This substance, therefore, if prevented from diffusing itself, and allowed to obey the force by which it is impelled upwards, will continue to mount till it arrives at a stratum of the atmosphere sixteen times more attenuated than at the surface of the earth. Accordingly, no sooner had Cavendish announced his discovery, than it occurred to Dr. Black that a very thin bag filled with hydrogen gas would mount to the ceiling of a room. Through some imperfection, the experiment when he attempted to execute it failed; and it was several years later before an envelope was thought of sufficiently light, and at the same time impermeable to the gas. Cavallo made a series of experiments on this subject in 1782, but did not succeed in raising any thing heavier than a soap bubble. The expense attending the preparation of the gas probably prevented the experiment from being made on a great scale.

Knowing the specific gravities of atmospheric air, of

the gas with which the balloon is to be filled, and the weight of the envelope in which it is confined, it is not difficult to compute the size the balloon must have in order to rise from the ground, or carry a given weight to a given height in the atmosphere. A globe of air, one foot in diameter, at the level of the sea and under the ordinary pressure, weighs about 1-25th of a pound avoirdupois. An equal globe of hydrogen gas, obtained in the usual way by dissolving iron filings in dilute sulphuric acid, may be assumed (making every allowance for imperfect preparation) to be about six times lighter than atmospheric air; consequently 5-6ths of its whole buoyant force will act in impelling it upwards; that is to say, the force with which a sphere of such gas, one foot in diameter, will tend to rise in the atmosphere will be $\frac{5}{6} \times \frac{1}{25} = \frac{1}{30}$ of a pound avoirdupois. The ascensional forces of different spheres will be proportional to their magnitudes, that is, to the cubes of their diameters; therefore a sphere 12 feet in diameter would rise with a force of 57 pounds, and one of 24 feet in diameter with a force of $8 \times 57 = 456$ pounds. But these determinations must be diminished by the weight of the envelope. The best material for the purpose at present known is thin silk varnished with elastic gum, or Indian rubber. The quantity of this material required to cover a globe one foot in diameter weighs about 1-20th of a pound. Now, for a globe of a greater size, the quantity required will increase with the square of the diameter; hence the covering of a balloon 12 feet in diameter must weigh about 7 pounds, and of one 24 feet in diameter 28 pounds. It follows, therefore, that a balloon of 12 feet diameter will only raise from the ground a weight of 50 pounds, and one of 24 feet 428 pounds. Computing in the same manner, it is found that a balloon 60 feet in diameter would raise a weight equal to about 6950 pounds; and that one of a foot and a half would barely float, the weight of the bag being just equal to that of the imprisoned gas.

The height to which a balloon will rise is determined from the law according to which the density of the atmospheric strata diminishes as the distance from the earth is increased. The buoyant force diminishes with the density; and when it is reduced to a quantity only equal to the weight of the balloon and its appendages, no further ascension can take place. Another circumstance also confines the possible elevation within moderate limits. As the pressure of the external air is diminished, the expansive force of the confined gas becomes greater, and would ultimately overcome the resistance of any material of which a balloon can be made. A balloon quite filled at the surface of the earth would inevitably be torn to shreds at the height of a few miles in the atmosphere, unless a portion of the gas were allowed to escape. For this purpose the balloon is furnished with a safety valve, which can be opened and shut at pleasure; but to prevent unnecessary waste of gas, it ought to be made of such a size that it requires only to be partly filled. A balloon half filled at the surface of the earth would become fully distended at the height of 3½ miles.

We have hitherto spoken only of balloons filled with hydrogen gas; but it is evident that any other substance specifically lighter than air would answer the purpose; in fact, the first balloons by which any one was raised into the atmosphere were not filled with hydrogen, but simply with rarefied air, the rarefaction being produced by kindling a fire under them; and as they thus became filled with smoke, they were called smoke-balloons. The ascensional force, however, which can be gained in this way is not great; besides, the aëronaut must carry a portion of fuel with him for the purpose of maintaining the fire, which adds sensibly to the weight to be raised. The keeping up of the fire is also attended with inconvenience, and even danger.

Two brothers, Stephen and Joseph Montgolfier, proprietors of a paper manufactory at Annonay in France, have the honour of first preparing and sending up a balloon into the air. After one or two previous trials, they announced a public ascent on the 5th of June, 1783. The balloon was prepared of linen cloth; a fire was kindled under it, and fed with bundles of chopped straw. This substance was used with a view to produce a large quantity of smoke. It would seem that they attributed the elevation of the balloon to the ascending power of the smoke, instead of its true cause, the rarefaction of the heated air. In the space of five minutes it was completely distended; and on being let slip, ascended rapidly. It reached an elevation of about a mile, remained suspended ten minutes, and fell at the distance of a mile and half from the place of its ascension. When the news of this experiment was carried to Paris, the surprise was general, and the virtuosi began immediately to consider how it could be repeated. It was determined to apply hydrogen gas on this occasion; and Charles, a celebrated lecturer on natural philosophy, undertook the superintendence of the process. On the 26th of August, 1783, the preparations were complete, and the balloon was transported with much ceremony to the Champ-de-Mars. On the following day, at five o'clock in the afternoon, the report of a cannon announced to the assembled multitude that every thing was ready. "The globe, liberated from its stays, shot upwards, to the great surprise of the spectators, with such rapidity that in two minutes it reached the height of 3000 feet. It traversed successively several clouds, by which it was repeatedly obscured. The violent rain which began to fall at the moment of its ascent did not retard its rapid progress, and the experiment was attended with complete success. The satisfaction was so great that even elegantly dressed ladies remained with their eyes intently fixed on the balloon, regardless of the rain, which fell on them in torrents." (*Libes, Dictionnaire de Physique.*) This balloon remained in the atmosphere only three quarters of an hour; it fell at a distance of about fifteen miles, when it was discovered that a rent was made in its upper part, through which the gas had escaped.

The first adventurers who had courage to undertake an aërial ascent in a balloon, were Pilatre de Rosier, a young naturalist, and the Marquis d'Arlandes. On the 21st of November, 1783, they took their seats in the basket of a smoke balloon; and after rising to an elevation of upwards of 3000 feet, descended safely to the earth. The next ascent was made by MM. Charles and Robert in a balloon filled with hydrogen gas, on the 1st of January, 1784. After a flight of a hour and a half they alighted on the meadow of Nesle, about twenty-five miles from Paris, without the slightest accident. As the balloon still retained a considerable buoyant force, M. Charles resolved on another ascent alone. It rose to the height of near two miles in about ten minutes; and the aëronaut had the satisfaction of seeing the sun, which had set when he left the earth, again rise above the horizon. After remaining about thirty-five minutes in the air he descended safely, at a distance of about nine miles from the spot from which he had risen.

So many aërial voyages executed with safety encouraged other attempts; and no accident occurred till the accomplished Pilatre de Rosier, with his companion Romain, was killed in an attempt to cross the channel from France to England. On the 13th of June, 1785, they ascended from Boulogne. Under the principal balloon, which was of hydrogen gas, they had suspended, for the purpose of increasing or diminishing the ascensional power at pleasure, a smoke balloon, which occasioned the disastrous issue. Scarcely a quarter of an hour had elapsed when the whole apparatus, at the height of 3000 feet, was perceived to be on fire; and the unfortunate voyagers were precipitated to the ground. This calamitous occurrence, however, did not damp the courage of aëronauts. It was obvious that it had been occasioned by the want of proper precautions; accordingly ascents continued to be multiplied, and have since become so common as to be an ordinary spectacle in the principal cities of Europe.

When balloons first began to be constructed, it was expected that they would be found applicable to many important purposes. These expectations have been disappointed, chiefly because it has been found impossible to guide or controul their course. The only power the aëronaut possesses over his balloon is to regulate its elevation within certain limits. In one or two instances they have been successfully used for military reconnoissance. The victory which Jourdan obtained over the Austrians at Fleurus, in 1794, was ascribed to the knowledge obtained of the enemy's movements by means of a balloon. A very interesting ascent was made by Biot and Gay Lussac, in August 1804, and by Gay Lussac alone in September of the same year, with a view to make meteorological observations in the upper strata of the atmosphere. In the first voyage, the two philosophers, at an elevation of between 9,500 and 13,000 English feet, found the oscillations of the magnetic needle to be performed in the same time as at the surface of the earth. At 12,800 feet the thermometer, which stood at 63½° at the observatory, had sunk to 51° of Fahrenheit, being only a decrease of 1° for every thousand feet. The hygroscope indicated increased dryness in proportion to the elevation. In the second ascent, performed by Gay Lussac alone, the variation of the compass, at the height of 12,680, was found to remain unaltered. At 14,480 feet a key held in the magnetic direction attracted with one end and repelled with the other the north pole of the magnetic needle. The same was the case at 20,150 feet. At 18,000 feet the thermometer fell to the freezing point, and at 22,912 feet to 14·9° of Fahr. Two flasks, which had been previously emptied of air, were opened and filled at an elevation exceeding 21,400 feet; and the air brought down from this region was found, on being analysed, to contain exactly the same proportions of the constituent elements as at the surface. The utmost elevation which he reached was 23,040 feet, or four miles and a quarter above the level of the sea, considerably higher than the loftiest peak of the Andes.

Excepting in these two memorable ascents of Gay Lussac, nothing has been gained to science by the use of balloons. The numerous other ascents undertaken, both

before and since, have as yet served no other purpose than to gratify idle curiosity; and from the total failure of every scheme that has been proposed for directing their course through the air, there is little reason to anticipate any great advantages from them to society. Nevertheless, the comparative cheapness and facility with which they can be filled by coal gas, now so generally used for the purposes of illumination, have been the cause of directing public attention again to the subject; and the recent feat of Mr. Green and two companions, who, with a stupendous balloon, and carrying with them a ton of ballast, ascended from Vauxhall in November, 1836, crossed the channel, and, after a journey through the air of eighteen hours, safely descended in the territory of Nassau in Germany, has contributed to revive the hope of rendering balloons available to useful purposes.

BA'LLOT. (Fr. balloter.) A method of voting at elections, &c., by means of little balls, of different colours, which are put secretly into a box, and, when counted, disclose the result of the poll without any discovery by whom each vote is given. The origin of the ballot may be traced to the commonwealth of the Israelites, from whom it was adopted by many eastern nations. The voting by tablets began with the earliest operations of Athenian polity. But it appears questionable whether the ballot at Athens, at least in its more flourishing times, was anything more than a contrivance for securing rapidity of voting, and whether any secrecy was necessarily attached to it. It was employed in judicial proceedings. Secret voting was, however, the custom of the Areopagus. (*Scott on the Athenian Ballot*, 1838.) The same system of voting prevailed also at Carthage, and to this is attributed by Ray (*Travels through Germany and Italy*) the cause of the grandeur and independence of its inhabitants. In the early periods of Roman history, the people voted by word of mouth; and, in creating magistrates, used the form — Consules, &c. nomino, or dico; and it was not until the 614th year of the city, that the Gabinian law, Lex Tabellaria, was introduced, for the purpose, as Cicero alleges (*De Off.* 2. 7.), of giving to the people more liberty in voting. But from this period, as is universally admitted, the practice of bribery made rapid strides; and notwithstanding every effort was made for its suppression by the enactment of penal statutes, such was its success that Julius Cæsar saw himself necessitated to deprive the people not only of the ballot, but even of the right of suffrage. Since the Christian era, the ballot was adopted at a very early period by the Maltese and the Venetians. At Venice, in particular, a most curious and intricate system of voting, consisting of ten previous ballotations, prevailed for the space of 1300 years; and Postellus (in a work *De Magistratibus Atheniensium*) pointedly asserts that the abolition of this practice, combined with other causes, led to the decline of this once flourishing state. Another author, after an elaborate dissertation on the advantages of the Venetian ballot, sums up his account of an election of which he had been an eyewitness in the following words: — "All was easily performed in a short time, without tumult, without noise, without animosities, and the most deserving always elected." In our own times, as is well known, the system of voting by ballot in the election of representatives, magistrates, &c. is adopted in France and America; and, among ourselves, in cases of application for admission into private clubs and societies. Of all controvertible subjects, perhaps there is none which has excited the attention of all political parties so vividly, and formed so large an arena for the display of argumentative skill, as the ballot. While its opponents foresee in its introduction into the public business of this country a tissue of hypocrisy and falsehood, and ultimately danger and ruin to the state, it seems to its supporters to contain the germ of all that is admirable in government and advantageous to the community. Our limits necessarily preclude us from doing more than merely noticing the principal arguments on both sides. The advocates of the ballot, on whom the onus probandi naturally rests, assume as an axiom that the great body of the electors are dependent, and consequently in an unfit condition to give a free and unbiassed vote. On this assumption is hinged not merely the validity, but even the necessity of all their demonstrations in favour of the ballot. The ballot, it is maintained, will not only place the elector on a footing of independence, but will remove all inducement to bribery, as no candidate will choose to offer a bribe when the elector is at liberty to deceive him by giving a secret vote: in a word, that it will annihilate the two species of corrupt influence by which electors are liable to be swayed, — the influence of threats, and the influence of bribes. Nor, as they allege, are their opinions upon this head merely speculative; for they point with triumph to the example of France and America, where the ballot is practised, and where it has long been regarded as the safeguard of the people's liberty. The opponents of the ballot, on the other hand, maintain that, even under the ballot, the canvassing of constituents by candidates would still be practised; in which case, the ballot would prove serviceable only to the dishonest elector, who promises his suffrage to one candidate and votes for another. Moreover, that even here secrecy would be impracticable, as the elector would not only be subjected to a process of the most searching curiosity, but that the landlord would be inclined to visit with more signal marks of his displeasure that tenant on whom his suspicions of deceit should rest, than him who came boldly forward, and voted in the face of day for the candidate of his choice. Again, that even were secrecy practicable (vide *Burke's Reflections*, p. 370.), it would not be desirable. For, as every elector holds his vote for the benefit of the community at large, he is bound to show by an open vote his opinion of the fitness of the candidate for his suffrage: that a secret vote is eminently calculated to counteract the legitimate influence of public opinion, and to lower the standard of political and moral principle, inasmuch as it removes from a public act that responsibility from which no public act ought to be exempted. And lastly, that the argument derived from the practice of France and America can have but little weight, unless it can at the same time be demonstrated that the condition of these countries in other respects is precisely analogous to that of our own: that, as far as America is concerned, vote by ballot was not ingrafted upon its peculiar form of government, but, as in the case of Athens, was coeval with its existence: and that, as regards France, only 200,000 in a population of 33 millions enjoy the elective franchise; and these, from their rank and condition in society, are least likely either to be influenced by intimidation or seduced by bribery. Whether the opponents or the advocates of the ballot have the best of the argument, it is not for us to determine; but one thing is certain, that whether we regard the Athenian or the Roman, the French or the American form of government, it will be found that the people either stipulated for the adoption of the ballot in the original framing of their several constitutions, or, as soon as they ascertained the nature of their rights, insisted on its introduction, from some fancied security it afforded them in the exercise of their privileges. For some apposite remarks on the ballot, see *West. Review* for July 1830; and a Treatise entitled *Reflections on the Ballot*, 1831, Hatchard and Son: see also Montesquieu, *Esprit des Lois*, ii. cap. 20.; and *Ferguson's Roman History*, p. 81.

BA'LSAM OF SULPHUR. Solution of sulphur in olive oil. A brown fetid liquid.

BALSAMA'CEÆ. A natural order of imperfect exogenous balsamiferous trees, related to the Platanaceæ; a species of the only genus, Liquidambar, yields the fragrant resin called storax.

BALSAMINA'CEÆ. (Balsamina, one of the genera.) A natural order of polypetalous Exogens allied to Geraniaceæ. They have irregular flowers, with a spur to one of the sepals, and are chiefly annual-stemmed plants, with a succulent foliage and showy flowers. The common Impatiens nolitangere is a species of this order.

BALSAMODE'NDRON. *See* MYRRH.

BA'LSAMS. Exudations from certain plants, which are liquid or soft solid, and consist of a substance resembling a resin, either combined with benzoic acid or with an essential oil, or both.

BA'LTEUS. (Lat. *a girdle.*) In Architecture, the wide step in theatres and amphitheatres which afforded a passage round them without disturbing the sitters. Nobody sat on it, but it served as a landing or resting place. In the Greek and Roman theatres every eighth step was a balteus. Vitruvius gives the rules for constructing it in the third chapter of his fifth book. The same term is also used by that author to denote the strap which seems to bind the coussinet or cushion of the Ionic capital.

BA'LUSTER. (Said to be from balaustrum, or *βαλαυστιον*, the flower of the wild pomegranate, to the form of which a resemblance is pretended.) In Architecture, a species of small short column, used between piers on the upper parts of buildings, under windows, in balconies, &c. It is quite of modern introduction, that is to say, soon after the revival of architecture. The form of the most ancient that are met with in Florence and other cities of Italy is that of a column, a puerility which has even in these days found admission into some of what are called Greek buildings in this metropolis. Blondel gives rules for proportioning the baluster in its use where the orders are employed.

BALUSTRA'DE. A parapet or protecting fence formed with balusters.

BAMBO'O. An Asiatic genus of arborescent grasses, with hollow jointed stems, and a hardy woody texture. They are externally coated with silex, and sometimes secrete the same substance in the hollows of their stems, when it is called tabasheer. Bamboos grow with great rapidity, and their shoots are cut when young, and boiled like asparagus. They vary in size, according to the

species, from 6 feet to 150 feet in length. When small, they form handles to umbrellas and parasols or walking sticks; when sufficiently large, they are used for the frame-work of Indian cottages, bedsteads, floors, and a variety of domestic purposes. If split into slips, they form bow-strings, and sometimes the arrows discharged from the blow-tubes of the Malays. A few species inhabit the tropical parts of America.

BAMBUSA'CEÆ. A section of the natural order of grasses, comprehending the bamboo as its type.

BAN. A word bearing a variety of significations in the Teutonic jurisprudence and usages, but all apparently connected with the original meaning of "to proclaim, or give public notice." Hence, 1. Ban, the proclamation against an outlaw: *e.g.* the ban of the German Empire, equivalent to ecclesiastical excommunication or declaration of outlawry; whence the words banish, bandits, banditti, and to "ban" or curse; in German bannen, verbannen. 2. The *ban*, in the sense of the national army of a Teutonic people levied by proclamation: hence the French "lever le ban et l'arrière ban" (the latter word being a corruption of *heribannum*, from *heer*, an army). The French ban and arrière ban was levied for the last time in 1672, and commanded by Turenne, but behaved so ill that this feudal armament was thenceforth discontinued. 3. The *banns* of marriage, being notice given by public proclamation to the parish of the intended solemnization. In the Sclavonic tongues ban means master: the lords of some of the frontier provinces of Turkey were so styled; hence the *bannat* or lordship of Temeswar, now belonging to Austria.

BANA'NA. A tall herbaceous endogenous plant, the *Musa sapientum* of botanists, having broad convex leaves with fine oblique veins, and growing in a tuft from the top of a stem formed by the union of the broad bases of the leaves. The fruit ripens in succession in large clusters weighing many pounds; it is of the same nature as the plantain (*quod vide*). It is a native of the West Indies, where it contributes essentially to the food of the better classes.

BA'NCHUS. A Fabrician genus of Hymenopterous insects, of the tribe *Pupivora*, and family *Ichneumonidæ*; characterised by long threadlike antennæ, abdomen compressed at the extremity, ovipositor not extended. Of this genus there are five British species, which, like the rest of the family, are parasitic in the larva state, feeding on the bodies of other insects.

BA'NCO. In commerce, a word of Italian origin, signifying a bank, and commonly employed to describe the bank of Venice. Banco is also used to distinguish banco money from current money at Hamburg, &c. *See* EXCHANGE.

BA'NCO. In Law, superior courts of common law are said to sit in banco during term, the judges occupying the bench of their respective courts. *See* COURTS OF LAW.

BAND. (Fr. bande.) In Architecture, a term used to denote what is generally called a face or fascia. To speak correctly, it signifies a flat, low, square, profiled member, without respect to its place. That member in a cornice on which modillions or dentils are cut is called the modillion band in the former, and the dentil band in the latter case.

BA'NDED. (Lat. fasciatus.) When any body is striated across with coloured bands.

BANDI'TTI. (It.) Persons *declared* to be banished, exiled, or outlawed. (Horne Tooke.) At the present time, bandit and robber are nearly synonymous terms. The Italian bandits formed a peculiar class, and were frequently employed by the petty princes and grandees in executing their projects either of love or ambition. As late as the year 1820, they were frequently employed as escorts; and in their case the proverb "honour among thieves" was amply verified, for, on the payment of a stipulated sum, travellers might repose in them unlimited confidence.

BANDOLE'ER. In ancient Military History, a large leathern belt worn over the right shoulder, and hanging under the left arm, to carry military weapons. The term is also applied to small leather cases, of which each musketeer wore twelve, hanging upon a shoulder-belt: each of these contained the charge of powder for a musket. They are disused, but may be seen in the armoury in the Tower.

BA'NIANS. A peculiar class among the Hindus, whose office or profession is trade and merchandise. In this sense Banians stand contradistinguished from Brahmins, Cuttery (Eschatryá), and Wyse (Vaisyá), the three other castes into which the Indians are divided. (See Gemelli Carreri, and Sir W. Jones.) They are scattered over the whole of Asia, and have appropriated to themselves the sole management of traffic in the East. They retain every where their native language and religion (the doctrine of the Metempsychosis); and are distinguished by their honesty, fidelity, and goodnature.

BA'NISHMENT. "Expulsion from any country, province, or town, by the judgment of some court or competent authority." Banishment as a species of punishment has been practised by all governments, both ancient and modern. Among the Greeks two kinds of banishment were in use: φυγη, which involved confiscation of property, and was inflicted only upon those convicted of certain crimes; and, at Athens, *ostracism*, by which persons were banished on mere suspicion that their power or riches might prove subversive of liberty. The Romans made use of three kinds — *relegatio*, *exilium*, and *deportatio*, — which involved various grades of punishment; the last, however, being the most severe, as it subjected the delinquent to the confiscation of his property, and the loss of his rights as a Roman citizen. The *second* was introduced by the Emperor Augustus, and formed the kind of banishment to which, among others, Ovid was condemned. During the first French revolution, banishment (*deportation*) was substituted for the guillotine, and towards the end of Robespierre's administration became very general. It still forms part of the French code, where it is classed in the third degree of infamous punishments, and gives rise to civil death. As a criminal punishment banishment was unknown to the ancient unwritten law of England, although voluntary exile was often adopted in order to evade legal prosecution. It was first towards the end of Queen Elizabeth's reign that a statute was enacted which condemned persons convicted of certain delinquencies to leave the town or village where they lived; but it was at a much later period that the punishment of *transportation* (*quod vide*) was legalised by parliamentary statute. In Germany, numerous instances have recently occurred of persons convicted of treasonable practices having had their sentence commuted into perpetual banishment; and in the universities of the same country this punishment (*relegatio*) is inflicted upon those who are convicted of a gross infringement of the academical laws, and involves the forfeiture of all right to enter upon a professional career.

BANISTERIEÆ. (Banisteria, one of the genera.) That division of Malpighiaceous plants in which the fruit is samaroid, not baccate, and analogous to what is found in Aceraceæ.

BANK. In Natural History, an elevation of the ground. Banks at sea are indicated by a decrease of the soundings, and sometimes by the elevation of the land above low-water mark. Of these, one of the largest and best known is the great bank of Newfoundland, famous for the resort of cod-fish.

BANK. In Commerce, an establishment for the custody and issue of money. The individual who manages a bank, or who carries on the business of banking, is called a banker.

Banks are of various kinds; some confining themselves entirely to the custody and issue of the money deposited in their hands by their customers, while others issue notes or paper money of their own. They are sometimes conducted by private individuals, and sometimes by companies consisting of an indefinite number of persons.

Utility of Banks. — Notwithstanding the precious metals are, in many respects, admirably fitted to serve as a medium of exchange (*see* MONEY), they have two very serious drawbacks, — their cost, and the difficulty and expense of carrying them from place to place. If the currency of Great Britain consisted only of gold, it would amount to at least sixty millions of sovereigns; and the expense attending such a currency, allowing only ¼ per cent. for wear and tear and loss of coins, could not be reckoned at less than 3,250,000*l.* a year. The weight of 1000 sovereigns exceeds 21 lbs. troy; so that were there nothing but coins in circulation, the conveyance of large sums from place to place to discharge accounts would be a very laborious process, and even small sums could not be conveyed without considerable difficulty; hence it is that most commercial and highly civilised nations have endeavoured to fabricate a portion of their money of less costly and heavy materials, and have resorted to various devices for economising the use of coin. Of the substitutes for coin hitherto suggested, paper is, in all respects, the most eligible. Instead of discharging their debts by a payment of the precious metals, individuals, on whose solvency the public may rely, pay them by giving a bill or draft for the sum, payable in coin at sight, or at so many days after date; and as this bill or draft passes currently from hand to hand as cash, it performs all the functions of coin, while it saves its expense to the public. A sense of the advantages that might be derived from the circulation of such bills or drafts led to the institution of banks for their regular issue.

By a bank of this description, or a bank of circulation, is meant an establishment founded by one or more individuals, known or believed to be possessed of large property, for the accommodation of the public with loans. A banker, on being applied to for a loan, does not make the advance in gold or silver, or other valuable material, but in his own promissory notes or engagements, binding him to pay the sums specified in them at

sight, when presented at the bank, or at some specified period. When a bank is in good credit, its notes are deemed by the public equivalent to a corresponding amount of gold or silver; and, being freely accepted in payment of debts of all sorts, and easily carried about or conveyed by post, they are even more useful to those who originally borrowed them from the bank, and to their subsequent holder, than an equal sum in coin. The borrowers, therefore, do not scruple to pay the same interest for the loan of a promissory note of 100*l.* or 1,000*l.* that they would do for the loan of a hundred or a thousand sovereigns. But the note costs the issuer comparatively little. He, in fact, deals in credit, or in obligations to pay, and not in real values; his profits consisting in the excess of interest derived from the notes or obligations he has issued over and above the interest of the cash or unproductive stock he is obliged to keep in his coffers to meet the demands of the public for payment of his notes, and the expenses of his establishment.

Besides this sort of bank, there are also banks of deposit, or banks for keeping the money of individuals. A merchant, or other person, using a bank of this sort, makes all his considerable payments by drafts upon his bankers, and sends all the bills due to him to them to be presented, and noted, if not duly paid. By this means he saves the trouble and expense of keeping a quantity of unemployed money at home, of receiving coins or notes that are not genuine, and of making any mistakes with respect to the presentation of due bills; and in consequence of the saving of money that is thus effected, a much less quantity serves for the demand of the public.

If a bank of circulation, or an establishment for the issue of notes, fall into discredit, its notes must obviously cease to circulate. Unless when guaranteed by government, or made legal tender, no one ever takes promissory notes, except on the supposition that they will be paid when presented or when due, and that they are substantially equivalent to cash. The moment any suspicion (whether well or ill founded is so far of little consequence) arises that the issuers of notes are unable to meet their obligations, there is a run upon them for payment, and their notes are rejected by every one.

All banks of circulation are necessarily almost at the same time banks of deposit; but there are in all civilised and commercial countries a good many of the latter class of banks only. Banks of deposit derive their profit either from their paying no interest on the sums deposited in their hands, as is the case with most of the London banks; or from their paying a less rate of interest on deposits than that for which they lend them to the public, as is the case with the Scotch banks.

English Banks. — Banking establishments for the issue of notes, and for taking care of other people's money, have existed in this country since the latter part of the seventeenth century. The Bank of England was founded in 1694, and has long been the greatest bank of circulation and deposit in the world. It grew out of a loan of 1,200,000*l.* for the public service, for which (such was the low state of public credit at the time) the subscribers were to receive 8 per cent. interest, with 4,000*l.* a year as the expense of management, and be incorporated into a banking company, denominated the Governor and Company of the Bank of England. The charter was granted for ten years; and it has since been prolonged by various renewals till the 1st of August 1845. The loans made by the bank to government were gradually increased, till in 1800 they amounted to 14,686,000*l.* But at the last renewal of the charter in 1833, a fourth part of the standing debt due to the bank was paid off, making the sum now (1838) due by the public to that establishment, exclusive of advances on account of dead weight and other public securities, 11,047,750*l.*

From its foundation the bank has enjoyed several peculiar privileges. The principal of these was conferred upon it in 1708, by an act which prohibited any company from being established for the issue of notes payable on demand in England and Wales with more than *six* partners. This restriction continued till 1826, when it was abolished, in so far as respects all places more than 65 miles distant from London; but within that distance it still prevails.

The Bank of England is, and always has been, the goverment bank, transacting for it all the banking business of the nation, receiving the produce of the taxes, loans, &c.; and paying the interest of the public debt, the drafts of the treasury and other public departments, transferring stock, &c. For this the bank has received since 1834, exclusive of the use of the balances of the public money in her hands, about 130,000*l.* a year.

In consequence of its employment by the government, of the restriction confining the number of partners in other banks to *six*, and of its great capital and credit, Bank of England notes have always been held in the highest estimation; and no bank for the issue of promissory notes payable on demand has been established in or near London. In the provinces, however, numerous *private* banks (that is, banks with not more than *six* partners) of issue and deposit have always existed. In 1792, their number is supposed to have exceeded 350. Many were destroyed by the revulsion of that year; but subsequently to 1800 they began rapidly to increase. In 1809, they amounted to 782; and in 1814, when most numerous, to 940. Since the abolition of the restriction on the number of partners, in 1826, many banks have been established; some with very large bodies of proprietors. Except in the case of the Bank of England, all the holders of stock in the other English banks are liable not merely for the amount of of their share in the capital stock of the company, but for its whole debts, whatever may be their amount. All notes are made payable on demand; and since 1826 no notes for less than 5*l.* have been allowed to circulate.

From the first establishment of the Bank of England, down to 1797, it had always paid its notes regularly when presented. But in the course of 1796, and the early part of 1797, there was, owing to the prevalence of reports of invasion, a pretty severe run upon the Bank of England, and it was at length apprehended that she might be obliged to make a temporary stoppage. To avert a contingency of this sort, an order in council was issued in February, 1797, authorising the bank not to pay her notes in gold; and this order was subsequently confirmed by parliament, and prolonged till after the conclusion of a definite treaty of peace.

Contrary to what might have been and was anticipated by many, the order referred to did not stop the circulation of Bank of England notes, or diminish the confidence of the public in that establishment. The report of a committee of the House of Commons, published soon after the suspension, showed that the bank was not merely possessed of the most ample funds to meet all her engagements, but that she had a surplus stock, after all demands upon her were deducted, of no less than 15,513,000*l.* This report, and the fact that Bank of England notes became practically legal tender, secured their circulation.

The obligation on the issuers of paper to pay their notes on demand is necessary, not only to give them circulation, but to prevent their being issued in excess; for as soon as any considerable over-issue takes place, the currency becomes depreciated as compared with that of other countries, and notes are, in consequence, returned upon the banks for payment, in order to get gold and silver to send abroad, where their value is higher; and the banks, to obviate the drain, are obliged to narrow their issues. London being the centre where the exchanges with other countries are adjusted, the value of its currency determines the state of the exchange; and it ultimately also determines the value of the currency of the provinces, there being a constant demand upon the country banks for gold or bills on London. While the Bank of England was obliged to pay in specie the value of her notes could not, and in point of fact did not, differ materially from that of gold. But in 1799, or 1800, after the check of cash payments was removed, they began to be depreciated, partly in consequence of their own over-issue, but far more through the over-issue of the paper of the country banks. The latter were multiplied to an unprecedented extent. It is of importance, too, to observe that previously to 1797 neither the Bank of England nor any of the country banks issued notes for less than 5*l.*; but both parties having commenced their issue in the course of that year, a new outlet was opened for the emission of paper that was particularly accessible to the country bankers. And such was the eagerness of the greater number of the latter to get their paper afloat, that individuals who could barely afford to buy stamps for bills frequently succeeded in getting the command of immense sums; and, as they had nothing of their own to lose, boldly ventured on the most hazardous speculations. During the last half dozen years of the war the depreciation of paper resulting from the circumstances now glanced at was such, that the ounce of standard gold, which should be worth only 3*l.* 17*s.* 10½*d.*, was, in 1814, actually worth 5*l.* 4*s.*, being a depreciation of 25¼ per cent.

The difficulties which had been thrown during the latter years of the war in the way of importation from abroad, combined with deficient crops at home, caused an extraordinary rise in the price of corn. But no sooner had the northern ports been opened, in the autumn of 1814, than a large importation, accompanied by a heavy fall of prices, began to take place; which was still further increased after the general pacification in 1815. This fall proved ruinous to many farmers, who had been large borrowers from the country banks. In consequence of the losses arising from this and other causes that grew out of the altered situation of the country, a want of confidence was experienced; and the country banks being generally without the means of meeting any emergency, no fewer than 240 of these

establishments stopped payment. There is, in fact, believed to have been, in 1814, 1815, and 1816, a greater destruction of bank paper in this country, and a wider range of bankruptcy, than had ever previously taken place any where else, except perhaps in France at the breaking up of the Mississippi scheme. The contraction of the currency that had been thus violently brought about raised its value nearly to par, and paved the way for the act of 1819, the 59 G. 3. c. 78., commonly called "Peel's Act," from its being introduced by Sir Robert Peel, which provided for the return to cash payments by the Bank of England at the old standard. These were resumed in 1821.

The policy of the act of 1819 was much questioned at the time, and since; but it has been successfully vindicated over and over again. But admitting that when enacted it might, in some respects, be objectionable, that would add nothing to the plea of those who still continue to urge its repeal. The restored standard has now (1838) been maintained for nearly twenty years; and 99 out of every 100 of the existing contracts have been entered into with reference to it. To set it aside would not be to repair former injustice, if such were committed, but to commit it afresh — to perpetrate an abuse in 1838 for no better reason than that it is alleged that a similar abuse had been perpetrated in 1819! So long as there is either common sense or common honesty in parliament, we are pretty secure against an attempt of this sort succeeding.

Notwithstanding that the bankruptcy which overspread the country in 1814, 1815, and 1816, was mainly ascribable to the defective constitution of the country banks, and to the reckless and improvident manner in which they were managed, no steps were taken when the resumption of cash payments was decided upon in 1819 to obviate any one of these sources of mischief. The consequences were such as might have been anticipated. A peculiar combination of circumstances having conspired to produce an extraordinary rage for speculative undertakings in 1824 and 1825, the country bankers gave in to the infatuation, and made the most sudden and excessive additions to their issues. In consequence the currency became redundant; and this having occasioned a heavy drain for gold on the Bank of England, the latter was, in the end, obliged to contract her issues. The country banks, whose engagements had in many instances been carried to an extent quite incommensurate with their capital, began to give way the moment they experienced an increased difficulty of obtaining pecuniary accommodation in London; and so rapid and sweeping was the destruction, that in less than six weeks above seventy banking establishments were swept off, and a vacuum created in the currency that absorbed from *eight* to *ten* millions of additional issues by the Bank of England!

This catastrophe seems at length to have satisfied the parliament and people of England that the private banking system was weak and vicious, and that it was imperatively necessary it should be amended and strengthened. In this view the clause in the act of 1708 already referred to, prohibiting any private bank from having more than *six* partners, was repealed; and the issue of notes for less than 5*l*. was also forbidden.

The last measure has, no doubt, shut up one of the easiest channels through which the inferior order of country bankers used to get their paper into circulation, and has been in so far advantageous. But abundance of other channels are still open to them; and the fact that a third part of all the private banks existing in England and Wales in 1792 were destroyed during the revulsion of that year, though no notes for less than 5*l*. were then in circulation, shows how little the suppression of small notes can do to obviate the mischiefs complained of. Very important advantages were, however, expected to result from the other measure, or that repealing the act of 1708, and consequently allowing the formation of joint stock banks, or banks with any number of partners. But these anticipations have proved to be nearly, if not quite, fallacious. There cannot, in fact, be a greater error than to suppose that because a bank has a considerable number of partners it will necessarily be either rich or well managed. It may be neither the one nor the other. A single individual may possess more wealth than a number of individuals associated together; and the chances are, that if he engage in banking, or any other business, it will be better managed than by a company. Under our present system, and in fact it is impossible to prevent it under any system, the partners in joint stocks, or in other banks, may be men of straw, or persons without property, and unable to fulfil their engagements. It is of the essence of a secure and well established paper currency that the notes of which it consists should be of the exact value of the gold or silver they profess to represent, and that, consequently, they should be paid the moment they are presented. But it is not enough to order that this condition shall be uniformly complied with. Such order is obeyed only by the opulent, prudent, and conscientious banker, and forms little or no check on the proceedings of those of a contrary character. It is the latter class, however, that it is especially necessary to look after; and it is needless to say that any system that permits notes to be issued without let or hindrance by speculative, ignorant, or unprincipled adventurers, must be essentially vicious.

The progress of the system of joint stock banking, or of banks with more than *six* partners, since 1826, when it commenced, has been as follows: —

		Banks.			Banks.
In 1826 were registered		3	In 1833 were registered		9
1827	—	4	1834	—	10
1828	—	0	1835	—	9
1829	—	7	1836	—	45
1830	—	1			
1831	—	9			104
1832	—	7			

In point of fact, however, the joint stock banks have each at an average from five to six branches; and as these branches transact all sorts of banking business, and enjoy the same credit as the parent establishment, from which they are frequently at a great distance, they are to all intents and purposes so many distinct banks. Hence, instead of 104, there were really above 500 joint stock banks in England and Wales in 1836, of which no fewer than 200 were opened in the course of that year! Some private banks have latterly been converted into joint stock banks, and others have wound up their affairs and ceased to exist; still, however, their number amounts to about 550; so that, in all, there are at this moment nearly 1,100 joint stock and private banking establishments in England and Wales. From a half to two thirds of these establishments issue notes.

Previously to 1833, the notes of the country banks were made payable in gold; but it was then enacted that they might be paid either in gold or Bank of England notes, at the option of the issuers. Bank of England notes are now, in fact, legal tender everywhere except at the bank and her branches.

The dividends on Bank of England stock from 1767 to the present time have been—from 1767 to 1781, 5½ per cent. per annum; from 1781 to 1788, 6 per cent.; from 1788 to 1807, 7 per cent.; from 1807 to 1823, 10 per cent.; and from 1823 to 1838, 8 per cent. The dividends are exclusive of the sums occasionally advanced as *bonuses:* the latter amount since 1799 to 3,783,780*l*. over and above an increase in the capital of the bank in 1816, which amounted to 2,910,600*l*.

Defects in our present Banking System — Suggestions for its Improvement. — The issue of notes is of all businesses that which seems to hold out the greatest prospect of success to the schemes of those who attempt to get rich by preying on the public. The cost of engraving and issuing notes is but an inconsiderable item compared with the sums for which they are issued; and provided they get into any thing like extensive circulation, they become, at once, considerably productive. They are not issued, except on the deposit of bills or other securities yielding a considerable rate of interest; so that if an individual, or set of individuals, with little or no capital, contrive, by fair appearances, promises, and similar devices, to insinuate himself or themselves into the public confidence, and can maintain 20,000*l*., 50,000*l*., or 100,000*l*. in circulation, he or they secure a good income in the meantime; and when the bubble bursts, and the imposture is detected, they are no worse off than when they set up their bank. On the contrary, the presumption is that they are a great deal better off; and that they have taken care to provide, at the cost of the credulous and deceived public, a reserve stock for their future maintenance: hence, seeing the facilities for committing fraud are so very great, the propriety, or rather necessity, of providing against them.

It has sometimes been contended, in vindication of our present system, which allows any individual or set of individuals, how bankrupt soever in fortune and character, to issue notes without check or limitation of any kind other than the promise to pay them on demand, that they are essentially *private paper;* that the accepting of them in payment is optional; and that as they may be rejected by every one who either suspects or dislikes them, there is no room or ground for interfering with their issue! But every body knows that whatever notes may be in law, they are in most parts of the country *practically and in fact legal tender*. The bulk of the people are totally without power to refuse them. The currency of many extensive districts consists in great part of country notes; and such small farmers or tradesmen as should decline taking them would be exposed to the greatest inconveniences. Every one makes use of or is a dealer in money. It is not employed by men of business only, but by persons living on fixed incomes, —women, labourers, minors; and in short by every class of individuals, very many of whom are necessarily, from their situation in life, quite unable to form any estimate of the

solidity of the different banks whose paper is in circulation. Such parties are uniformly severe sufferers by the failure of banks. The paper that comes into their hands is a part of the currency or money of the country; and it is quite as much a part of the duty of government to take measures that this paper shall be truly and substantially what it professes to be, as that it should take measures to prevent the issue of spurious coins or the use of false or deficient weights and measures.

Now it will be found, should the circulation of provincial notes be allowed to continue, that there is but one means of making sure of the solvency of the issuers, and of providing for their being paid when presented; and that is, by compelling all issuers of such notes to give security for their payment. This, and this only, will hinder the circulation of spurious paper, and afford a sufficient guarantee that the notes the public are obliged to take are really and in fact what they profess to be. The measure, too, is one that might be easily enforced. To carry it into effect, it would merely be necessary to order that all individuals or companies, on applying for stamps, should be obliged, previously to their obtaining them, to lodge in the hands of the commissioners an assignment to government stock, mortgages, landed or other fixed property, equivalent to the amount of the stamps issued to them, to be held in security for their payment.

It has been objected to this plan, that it would be injurious, by locking up a portion of the capital of the banks; but this is plainly an error. Its only effect in this respect would be to force such banks as issued notes to provide a supplemental capital, as a security over and above the capital required for conducting their business. But this supplemental capital would not be unproductive. If it consisted of lands, the owners would receive the rents; and if it consisted of government securities, they would receive the dividends or interest due upon them, precisely in the same way that they are received by other persons; while the fact being known that they possessed this supplemental capital, or that they had lodged security for the payment of their notes, would, by giving the public perfect confidence in their stability, enable them to conduct their business with a less supply of floating or immediately available capital than would otherwise be necessary.

It is absurd to object to this plan on the ground of its interfering with the private pursuits of individuals. It is the duty of government to interfere to regulate every business or pursuit that might otherwise become publicly injurious. On this principle it interferes to prevent the circulation of spurious coins, and of notes under a certain sum and not payable on demand; and on the same principle it is called on to interfere to prevent the act ordering the payment of notes becoming again, as it has very frequently done already, a dead letter, by making sure that it shall be complied with. The interference that would take place under the proposed measure is not only highly expedient, but would be of the least vexatious kind imaginable. All that is required of the persons applying for stamps for notes is, that they should deposit in the hands of the commissioners a certain amount of exchequer bills, or other available securities, according to their demand for stamps. They are not asked to state how they mean to dispose of these stamps, — to whom or in what way they are to be issued. They are merely required to give a pledge that they shall be paid, or that they shall not be employed, as so many others have been, to deceive or defraud the public. It is little else than an abuse of language to call this an interference with private affairs.

The taking of security in the way now suggested, from the issuers of notes, would effectually provide for their payment when presented. Adventurers without capital, and sharpers anxious to get themselves indebted to the public, would find that banking was no longer a field on which they could advantageously enter. Notes would be made, in fact as well as in law, equivalent to the specie they profess to represent; and the paper currency would acquire a solidity of which it is at present wholly destitute.

But though the plan of taking security would completely obviate the risk of loss from the circulation of worthless paper, or of paper issued by parties without the means, and probably also the inclination to pay it on presentation, it would not touch another abuse inherent in the present system; that is, it would leave the currency exposed, as at present, to all those constantly recurring fluctuations in its amount, those alternations of glut and deficiency, by which it has been affected since provincial banks became considerably multiplied, and which are in the last degree injurious. A paper currency is not in a sound or wholesome state, unless, 1st, means be taken to insure that each particular note or parcel of such currency be paid immediately on demand; and unless, 2nd, *the whole currency vary in amount and value exactly as a metallic currency would do were the paper currency withdrawn and coins substituted in its stead.* The last condition is quite as indispensable to the existence of a well-established currency as the former; and it is one that cannot be realised otherwise than by confining the issue of paper to a single source.

It is supposed by many that there can be no greater fluctuations in a paper than in a metallic currency, provided the paper rest on an undoubted basis, and be regularly paid the moment it is presented. But this is an error. Wherever there are numerous issuers, there may be, and the chances are fifty to one there will be, perpetually recurring fluctuations in the amount and value of the currency. An over-issue of convertible paper is not, of course, indicated by any difference between the value of such paper and gold at home; but it is indicated by a fall of the exchange, and by an efflux of bullion to other countries. If paper were only issued by the Bank of England, or some one source in London, and then only in exchange for bullion, the currency would be in its most perfect state, and would fluctuate exactly as it would do were it wholly metallic. But at present it is quite otherwise. The currency is supplied by hundreds of individuals and associations, all actuated by different and frequently conflicting views and interests. The issues of the Bank of England, though not always are generally governed by the state of the exchange, or rather by the influx and efflux of bullion, increasing when it flows into and decreasing when it flows out of the country. But it is quite otherwise with the provincial bankers. Their issues are not regulated by any such standard, but by the state of credit and prices in the districts in which they happen to be situated. If their managers suppose that these are good or improving, they rarely hesitate about making additional issues. Hence, when the state of the exchange and the demand on the Bank of England for bullion show that the currency is redundant, and ought to be contracted, the efforts of the bank to effect its diminution are often impeded, and met by a contrary action on the part of the country banks. This is not owing to the ignorance of the latter. Under the supposed circumstances, the country bankers see, speaking generally, that they ought also to contract; but being a very numerous body, comprising several hundred establishments scattered over all parts of the country, each is impressed with the well-founded conviction that all that he could do in the way of contraction would be next to imperceptible; and no one ever thinks of attempting it, so long as he feels satisfied of the stability of those with whom he deals. On the contrary, every banker knows, were he to withdraw a portion of his notes, that some of his competitors would most likely embrace the opportunity of filling up the vacuum so created; and that consequently he should lose a portion of his business, without in any degree lessening the amount of paper afloat. Hence, in nineteen out of twenty instances, the country banks go on increasing their aggregate issues long after the exchange has been notoriously against the country, and the Bank of England has been striving to pull up.

The circumstances now stated were strikingly exemplified in the course of 1836 and the early part of 1837. The excessive multiplication of joint stock banks in 1836, the great additions they made to the number of notes afloat, and the still greater additions they made to the number of bills, checks, and other substitutes for money, occasioned a redundancy of the currency, a fall of the exchange, and a drain upon the Bank of England for gold. But while the latter was narrowing her issues, by supplying the exporters of bullion with gold in exchange for notes, the country banks went on increasing their issues! What the former did by contracting on the one hand, the latter more than undid by letting out on the other. The vacuum created by the withdrawal of Bank of England paper was immediately filled up, and made to overflow by the issue of a more than equal amount of provincial paper; so that had it not been for the rise in the rate of interest, and the other repressive measures adopted by the bank, the probability is that she might have gone on paying away bullion for notes till she was drained of her last sixpence, without in any degree affecting the exchange. But this is not all. Not only do the country banks almost universally increase their issues when they ought to be diminished, but the moment they are compelled to set about their reduction they run headlong into the opposite extreme, and unreasonable suspicion takes the place of blind unthinking confidence. The cry of *sauve qui peut* then becomes all but universal. It is seldom that a recoil takes place without destroying more or fewer of the provincial banks; and, provided the others succeed in securing themselves, little attention is usually paid to the interests of those they have taught to look to them for help.

We have previously noticed the bankruptcy and distress entailed on the country by the over-issue and consequent failure of the country banks in 1814, 1815, and 1816, and again in 1825—26. The influence of the revulsion in 1792 was similar, and equally disastrous; and though, owing to the assistance afforded by the Bank of England, the crisis of 1836 was very much mitigated, it

seriously affected the industry and commerce of the empire, and inflicted a blow upon them both from the effects of which they have not as yet (1838) recovered.

Although, therefore, the exacting of security for their payment from the issuers of notes would protect the holders from loss, and be in so far advantageous, it would not hinder that competition among the issuers that is so very injurious, nor prevent the supply of paper being at one time in excess and at another deficient. If we would provide for that unity of action on the part of the issuers, and that equality in the value of money, that are so indispensable, it must all emanate from one source. Were one body only entrusted with the issue of notes, it would be able immediately to narrow the currency when bullion began to be exported, and to expand it when it began to be imported; and it would be easy for the legislature to lay down and enforce such regulations as would effectually prevent the fluctuations in the amount and value of the currency ever exceeding those that would take place were it wholly metallic. But nothing of the sort need be expected so long as it is supplied by more than one source. Everything must then be left to the discretion of the parties. And it will certainly happen in time to come, as it has invariably happened in time past, that some of them will be increasing their issues when they should be diminished, and diminishing them when they should be increased; and that the country will continue to be exposed to the incessant recurrence of the most destructive revulsions.

Statement of the Affairs of the Bank of England, February 29. 1832.

Dr.		
To bank notes outstanding - -		L 18,051,710
To public deposits, viz.—		
Drawing accounts - -	2,034,790	
Balance of audit roll - -	550,550	
Life annuities unpaid - -	85,030	3,198,730
Annuities for terms of years unpaid - - -	38,360	
Exchequer bills deposited -	490,000	
To private deposits, viz.—		
Drawing accounts - -	5,683,870	5,738,430
Various other debts - -	54,560	
To the Bank of England for the capital		14,553,000
To balance of surplus in favour of the Bank of England - - -		2,637,760
		L 44,179,630

Cr.		
By advances on government securities, viz.—		
Exchequer bills on the growing produce of the consolidated fund in the quarter ending		
5th of April, 1832 - - -	3,428,340	
5th of July, 1832 - -	697,000	L 4,134,940
Exchequer bills on supplies 1825 - - -	7,600	
Ditto for 10,500,000*l.* for 1825	2,000	
By the advances to the trustees appointed by the Act 3 Geo. 4. c. 51. towards the purchase of an annuity of 585,740*l.* for 44 years, from 5th of April, 1823 - -		10,897,880
By other creditors, viz.—		
Exchequer bills purchased -	2,700,000	
Stock purchased - -	764,600	
City bonds - - -	500,000	
Bills and notes discounted -	2,951,970	9,166,860
Loans on mortgages -	1,452,100	
London Dock Company -	227,500	
Advances on security of various articles - - -	570,690	
By cash and bullion - - -		5,293,150
By the permanent debt due from government - - - - -		14,686,800
		L 44,179,630
Rest, or surplus brought down - -		2,637,760
Bank capital due to proprietors - -		14,553,000
		L 17,190,760

Account of the Amount of the Notes of the Bank of England in Circulation, of the Deposits in the Hands of the Bank, of all Securities held by the Bank, of Bullion in her Coffers, and of the Rest or Surplus Capital of the Bank, on the last Day of February in each of the following Years.

Years.	Notes in Circulation.	Deposits.	Public Securities.	Private Securities.	Bullion.	Rest, or Surplus Capital.
1778	7,440,330	4,662,150	7,898,292	3,322,228	2,010,690	1,128,730
1779	9,012,610	4,358,160	8,862,242	2,073,668	3,711,150	1,276,290
1780	8,410,790	4,723,890	9,145,659	1,755,371	3,581,060	1,347,410
1781	7,092,450	5,796,830	8,640,073	2,546,067	3,279,940	1,676,800
1782	8,028,880	6,130,300	10,346,055	3,448,015	2,157,860	1,792,750
1783	7,675,090	4,465,000	10,016,349	2,779,431	1,321,190	1,976,880
1784	6,202,760	3,903,920	7,789,291	3,829,929	655,840	2,168,380
1785	5,923,090	6,669,160	7,198,564	4,973,926	2,740,820	2,321,060
1786	7,581,960	6,151,660	6,836,459	3,516,781	5,979,090	2,598,710
1787	8,329,840	5,902,080	7,642,587	3,716,463	5,626,690	2,753,820
1788	9,561,120	5,177,050	7,833,857	4,030,653	5,743,440	2,869,780
1789	9,807,210	5,537,370	8,249,582	2,711,108	7,228,730	2,844,840
1790	10,040,540	6,223,270	8,347,387	1,984.733	8,633,000	2,701,310
1791	11,439,200	6,364,550	10,380,358	2,222,282	7,869,410	2,668,300
1792	11,307,380	5,523,370	9,938,799	3,129,761	6,468,060	2,705,870
1793	11,888,910	5,346,450	9,549,209	6,456,011	4,010,680	2,780,570
1794	10,744,020	7,891,810	9,950,756	4,573,794	6,987,110	2,875,830
1795	14,017,510	5,973,020	13,164,172	3,647,168	6,127,720	2,948,530
1796	10,729,520	5,702,360	12,951,812	4,188,028	2,539,630	3,247,590
1797	9,674,780	4,891,530	11,714,431	5,123,319	1,086,170	3,357,610
1798	13,095,830	6,148,900	11,241,333	5,558,167	5,828,940	3,383,710
1799	12,959,800	8,131,820	11,510,677	5,528,353	7,563,900	3,511,310
1800	16,844,470	7,062,680	13,975,663	7,448,387	6,144,250	3,661,150
1801	16,213,280	10,745,840	15,958,011	10,466,719	4,640,120	4,105,730
1802	15,186,880	6,858,210	14,199,094	7,760,726	4,152,950	4,067,680
1803	15,319,930	8,050,240	9,417,887	14,497,013	3,776,750	4,321,480
1804	17,077,830	8,676,830	14,684,686	12,314,284	3,372,140	4,616,450
1805	17,871,170	12,083,620	16,889,501	11,771,889	5,883,800	4,590,400
1806	17,730,120	9,980,790	14,813,599	11,777,471	5,987,190	4,867,350
1807	16,950,680	11,829,320	13,452,871	13,955,589	6,142,840	4,771,300
1808	18,188,860	11,961,960	14,149,501	13,234,579	7,855,470	5,088,730
1809	18,542,860	9,982,950	14,743,425	14,374,775	4,488,700	5,081,090
1810	21,019,600	12,457,310	14,322,634	21,055,946	3,501,410	5,403,080
1811	23,360,220	11,445,650	17,201,800	19,920,550	3,350,940	5,667,420
1812	23,408,320	11,595,200	22,127,253	15,899,037	2,983,190	6,005,960
1813	23,210,930	11,268,180	25,036,626	12,894,324	2,884,500	6,336,340
1814	24,801,080	12,455,460	23,630,317	18,359,593	2,204,430	6,937,800
1815	27,261,650	11,702,250	27,512,804	17,045,696	2,036,910	7,631,510
1816	27,013,620	12,388,890	19,425,780	23,975,530	4,640,880	8,639,680
1817	27,397,900	10,825,610	25,538,808	8,739,822	9,680,970	5,736,090
1818	27,770,970	7,997,550	26,913,360	3,991,970	10,055,460	5,192,270
1819	25,126,700	6,413,370	22,355,115	9,099,885	4,184,620	4,099,550
1820	23,484,110	4,093,550	21,715,168	4,472,322	4,911,050	3,520,880
1821	23,884,920	5,622,890	16,010,990	4,785,280	11,869.900	3,158,360
1822	18,665,350	4,689,940	12,478,133	3,494,947	11,057,150	3,674,940
1823	18,392,240	7,181,100	13,658,829	4,660,901	10,384,230	3,130,620
1824	19.736,990	10,097,850	14,541,127	4,530,873	13,810,060	2,847,220
1825	20,753,760	10,168,780	19,447,588	5,503,742	8,779,100	2,807,890
1826	25,467,910	6,935,940	20,573,258	12,345,322	2,459,510	2,974,240
1827	21,890,610	8,801,660	18,685,015	4,844,515	10,159,020	2,996,280
1828	21,980,710	9,198,140	19,818,777	3,762,493	10,347,290	2,749,710
1829	19,870,850	9,553,960	19,736,665	5,648,085	6,835,020	2,794,960
1830	20.050,730	10,763,150	20,038,890	4,165,500	9,171,000	2,561,510
1831	19,600,140	11,213,530	19,927,572	5,281,408	8,217,050	2,612,360
1832	18,051,710	8,937,170	18,497,448	5,836,012	5,293,150	2,637,760

Average Quarterly Account of the Liabilities, Assets, and Surplus or Rest, of the Bank of England, as ordered by the Act 3 & 4 Will. IV. cap. 98.

	Notes in Circulation.	Deposits.	Securities.	Bullion.	Rest, or Surplus Capital.
1834.	L.	L.	L.	L.	L.
January 1. - -	18,216,000	13,101,000	23,596,000	9,948,000	2,207,000
April 1. - - -	19,097,000	14,011,000	25,970,000	9,431,000	2,293,000
July 1. - - -	18,895,000	15,096,000	27,593,000	8,695,000	2,261,000
September 23. - -	19,126,000	14,754,000	28,691,000	7,695,000	2,506,000
December 18. - -	18,304,000	12,256,000	26,362,000	6,720,000	2,522,000
1835.					
January 15. - -	18,012,000	12,585,000	26,390,000	6,741,000	2,534,000
April 7. - - -	18,591,000	11,289,000	16,328,000	6,329,000	2,677,000
June 30. - -	18,315,000	10,954,000	25,678,000	6,219,000	2,628,000
September 22. - -	18,240,000	13,230,000	27,888,000	6,261,000	2,679,000
December 15. - -	17,821,000	17,729,000	31,048,000	6,626,000	2,624,000
1836.					
January 12. - -	17,262,000	19,169,000	31,954,000	7,076,600	2,599,000
April 5. - - -	18,063,000	14,751,000	27,927,000	7,801,000	2,914,000
July 1. - - -	17,899,000	13,810,000	27,153,000	7,362,000	2,806,000
September 22. - -	18,147,000	14,118,000	29,406,000	5,719,000	2,860,000
December 15. - -	17,361,000	13,330,000	28,971,000	4,545,000	2,825,000
1837.					
January 10. - -	17,422,000	14,354,000	30,365,000	4,287,000	2,876,000
April 4. - - -	18,432,000	11,192,000	28,813,000	4,071,000	3,263,000
June 27. - - -	18,202,000	10,424,000	26,932,000	4,750,000	3,056,000
September 19. - -	18,814,000	11,093,000	26,605,000	6,303,000	3,001,000
December 14. - -	17,998,000	10,195,000	22,727,000	8,172,000	2,706,000
1838.					
January 12. - -	17,900,000	10,992,000	22,606,000	8,895,000	2,609,000

N. B. — The rest is found by adding together the circulation and deposits, and deducting their amount from the amount of the securities and bullion.

An Account of the aggregate Number of Notes circulated in England and Wales by Priavte Banks, and by Joint-Stock Banks and their Branches, distinguishing Private from Joint Stock Banks. From Returns directed by 3 & 4 Will. IV. c. 83.

Quarters ended		Private Banks.	Joint Stock Banks.	Total.
1833. -	December 28. - -	8,836,803	1,315,301	10,152,104
1834. -	March 29. - - -	8,733,400	1,458,427	10,191,827
— -	June 28. - - -	8,875,795	1,642,887	10,518,682
— -	September 27. - - -	8,370,423	1,783,689	10,154,112
— -	December 28. - -	8,537,655	2,122,173	10,659,828
1835. -	March 28. - -	8,231,206	2,188,954	10,420,160
— -	June 27. - - -	8,455,114	2,484,687	10,939,801
— -	September 26. - -	7,912,587	2,508,036	10,420,623
— -	December 26. - - -	8,334,863	2,799,551	11,134,414
1836. -	March 26. - - -	8,353,894	3,094,025	11,447,919
— -	June 25. - - -	8,614,132	3,588,064	12,202,196
— -	September 24. - -	7,764,824	3,969,121	11,733,945
— -	December 31. - - -	7,753,500	4,258,197	12,011,697
1837. -	April 1. - - -	7,275,784	3,755,279	11,031,063
— -	July 1. - - -	7,187,673	3,684,764	10,872,437
— -	September 30. - -	6,701,996	3,440,053	10,142,049
— -	December 30. - -	7,043,470	3,826,665	0,870,135

Scotch Banks. — The act of 1708, preventing more than six individuals from entering into partnership for carrying on the business of banking, did not extend to Scotland. In consequence of this exemption, several banking companies, with numerous bodies of partners, have always existed in that part of the empire. The Bank of Scotland was established by act of parliament in 1695. By the terms of its charter it enjoyed, for twenty-one years, the exclusive privilege of issuing notes in Scotland. Its original capital was only 100,000*l.*; but it was increased to 200,000*l.* in 1744, and now amounts to 1,500,000*l.*, of which 1,000,000*l.* has been paid up.

The Royal Bank of Scotland was established in 1727. Its original capital was 151,000*l.*; at present it amounts to 2,000,000*l.*, which has been all paid up.

The British Linen Company was incorporated in 1746, for the purpose, as its name implies, of undertaking the manufacture of linen. But the views in which it originated were speedily abandoned, and it became a banking company only. Its paid up capital amounts to 500,000*l.*

Exclusively of the above, there are two other chartered banks in Scotland: the Commercial Bank, established in 1810; and the National Bank of Scotland, established in 1825. The former has paid up capital of 600,000*l.*, and the latter of 500,000*l.*

None of the other banking companies established in Scotland are chartered associations; and the partners are jointly and individually liable to the whole extent of their fortunes for the debts of the firms. Some of them, as the Aberdeen Town and Country Bank, the Dundee Commercial Bank, the Perth Banking Company, &c., have very numerous bodies of partners. Generally speaking, they have been eminently successful. An original share, 150*l.*, of the stock of the Aberdeen Banking Company, established in 1767, is now (1838) worth no less that 2,500*l.* Their affairs are uniformly conducted by a board of directors chosen by the shareholders.

There are very few banks with less than six partners in Scotland. Almost all the great joint stock banks have numerous branches; so that there is hardly a town or village of any consequence without two or more banks.

The Bank of Scotland began to issue one-pound notes as early as 1704, and their issue has since been continued without interruption. With only one exception, all the Scotch banks issue notes; and taking their aggregate circulation at from 3,500,000*l.* to 4,000,000*l.*, it is supposed that from 2,000,000*l.* to 2,500,000*l.* consists of notes for 1*l.* In 1826 it was proposed to suppress one-pound notes in Scotland as well as in England; but the measure having been strongly objected to by the people of Scotland, as being at once oppressive and unnecessary, was abandoned.

There have been very few bankruptcies amongst the Scotch banks. This superior stability is to be ascribed to a variety of causes; partly to the great wealth of the early established banks, which had a considerable influence in preventing an inferior class of banks acquiring any hold on the public confidence; partly to the comparatively little risk attending the business of banking in Scotland; partly to the facilities afforded by the Scotch law for attaching a debtor's property, whether it consist of land or moveables; and partly and principally, perhaps, to the fact of the Scotch banks being but indirectly and slightly affected by a depression of the exchange and an efflux of bullion.

The circumstances now mentioned render it unnecessary to enforce that suppression of local issues in Scotland which is so indispensable in England, where the system of provincial banking is of a very inferior description, the risk attending the business much greater, and where any excess in the amount of the currency necessarily occasions a fall of the exchange and a demand for bullion. The commerce and population of Scotland are too limited, and that country is too remote from the metropolis, or from the centre of the moneyed world, the pivot on which the exchanges turn, to make it of importance that her currency should be identical with that of England. We believe that the Scotch attach much more importance than it deserves to the issue of paper, and especially to the issue of one-pound notes; still, however, we do not think that the circumstances are at present such as to call for or to warrant any attempt to introduce any material changes in their banking system.

All the Scotch banks receive deposits, even of the low amount of 10*l*., and allow interest on them at from one to two per cent. below the market rate. But should a deposit be unusually large, as from 5,000*l*. to 10,000*l*., a special agreement is usually made with regard to it. This part of the system has been particularly advantageous. It, in fact, renders the Scotch banks a sort of savings' banks for all classes; and their readily receiving all sorts of deposits at a reasonable rate of interest, has tended to diffuse a spirit of economy and parsimony among the people that would not otherwise have existed. The total deposits in the hands of the Scotch banks are believed at present (1838) to exceed 25,000,000*l*., of which fully a half is understood to be in sums of from 10*l*. to 200*l*.

The Scotch banks make advances in the way of discounts and loans, and on what are called cash-credits or cash-accounts. By the latter are meant credits given by the banks for specified sums to individuals, each of whom gives a bond for the sum in his account, with two or more individuals as sureties for its payment. Persons having such accounts draw upon them for whatever sums within their amount they have occasion for, repaying these advances as they find opportunity, but generally within short periods. Interest is charged only on the average balance which may be found due to the bank. The total number of these accounts in Scotland in 1826 was estimated at about 12,000; and it may now, perhaps, be taken at about 14,000. They are believed to average about 500*l*.; few are for less than 100*l*., and fewer still above 5,000*l*.

It has been contended by no less an authority than Adam Smith, that this species of accommodation gives the Scotch merchants and traders a double command of capital. "They may discount their bills of exchange," says he, "as easily as the English merchants, and have, besides, the additional conveniency of their cash accounts." But this is an obvious error. The circulation will take off only a certain quantity of paper; and to whatever extent it may be issued by means of cash-accounts, so much the less can be issued in the way of discounts. The advantage of a cash account does not really consist in its enabling a banker to enlarge his advances to his customers, but in the extreme facility it affords of making them. An individual who has obtained such an account may operate upon it at any time he pleases, and by drafts for any amount; an advantage he could not enjoy to any thing like the same extent, without an infinite deal of trouble and expense, were the loans and advances made to him through the discounting of bills. The Scotch banks draw upon London at twenty days' date. This is denominated the par of exchange between London and Edinburgh.

Irish Banks.—The Bank of Ireland was established in 1783, and the same restriction as to the number of partners in other banks that formerly prevailed in England was enacted in its favour. Owing to that and other causes the bankruptcies of private banks have been more frequent in Ireland than in England. In 1821 this restriction was repealed, as respects all parts of the country more than 50 Irish miles from Dublin. Since that period several banking companies, with large bodies of partners, have been set on foot in different parts of the country: of these the Provincial Bank, founded on the Scotch model, is among the most flourishing. The charter of the Bank of Ireland expired in 1838; but it will continue to go on till it receive notice to that effect. The Irish as well as the Scotch banks issue notes for 1*l*.

For accounts as to Foreign Banks, see the art. "Paper Money and Banks," in the new ed. of the *Encyclopedia Brittanica*, and the authorities there referred to.

BANK FOR SAVINGS. A bank established for the receipt of small sums deposited by the poorer class of persons, and for their accumulation at compound interest.

Though not so well calculated as friendly societies to enable the labouring classes to provide against sickness and old age, savings' banks are very valuable institutions, and are eminently entitled to the public patronage and support. The want of a safe place of deposit for their savings, where they would yield them a reasonable interest, and whence they could withdraw them at pleasure, has formed one of the most serious obstacles to the formation of a habit of accumulation among labourers. Public banks do not generally receive a less deposit than 10*l*.; and there are but very few amongst the labouring classes who find themselves suddenly masters of so large a sum; while, to accumulate so much by the weekly or monthly saving of a few shillings, appears at first view almost a hopeless task; and should an individual have the resolution to attempt it, the temptation to break in upon his little stock at every call of necessity might be too strong to resist. At all events, the progressive addition of interest is lost during the period of accumulation; and it even frequently happens that the chest of the servant or labourer is not safe from the depredations of the dishonest; while the very feeling of insecurity which such a circumstance inspires must operate as a fatal check to habits of saving. A similar effect results from the instances that have often occurred, where those poor persons who had, in despite of every discouragement, accumulated a little capital, have been tempted, by the offer of a high rate of interest, to lend it to persons of doubtful characters and desperate fortunes, whose bankruptcy has involved them in irremediable ruin. It is plain, therefore, that nothing could be more advantageous with a view to the formation of those improved habits that must necessarily result from the diffusion of a spirit of frugality and forethought among the poor, than the institution of savings' banks, or places of safe, convenient, and advantageous deposit for their smallest savings. They are no longer tempted, from the want of facility of investment, to waste what little they can save from their expenditure in frivolous or idle gratifications. They now feel assured that their savings, and the interest accumulated upon them, will be faithfully preserved to meet their future wants; and as there are very few who are insensible of the blessings of independence, there is no reason to suppose that they will be slow to avail themselves of the means of accumulation now in their power.

All moneys paid into any savings' bank established according to the provisions of the act 9 Geo. 4. c. 92., are ordered to be paid into the banks of England and Ireland, and vested in bank annuities or exchequer bills. The interest payable to depositors is not to exceed 2¼*d*. per cent. per diem., or 3*l*. 8*s*. 5¼*d*. per cent. per annum. No depositor can contribute more than 30*l*., exclusive of compound interest, to a savings' bank in any one year; and the total deposits to be received from any one individual are not to exceed 150*l*.; and whenever the deposits, and compound interest accruing upon them, standing in the name of any one individual, shall amount to 200*l*., no farther interest shall be paid upon such deposit. The number of depositors in savings' banks, in England, Wales, and Ireland, on the 20th of November, 1834, amounted to 499,207, and the deposits to 15,369,844*l*. giving an average deposit of 30*l*. 16*s*. to each. As far as we are aware, no return of the Scotch savings' banks has been published.

BA'NKRUPTCY, in Law, is a peculiar condition, with reference to legal liabilities and disabilities, into which certain classes of persons only are liable to fall. The word is said to be of Italian origin, and derived from the ceremony usual in some towns in the middle ages of breaking the bench or counter (bancus) occupied in the public exchange by the merchant.

The statutes respecting bankruptcy begin at the 34 H. 8., and end with those of the 6 G. 4. and 1 W. 4., in which the principles of the law on this head are now contained.

All persons engaged in trade, if in other respects capable of making valid contracts, are liable to be made bankrupts. The proof of trading is, buying and selling with a view to profit by dealing generally with the public; and it is a question of fact for the decision of a jury, whether a party be a trader or no. Acts of bankruptcy are of two sorts. 1. Such as tend to defraud or delay creditors. Such as departing from the realm under suspicious circumstances; keeping house; making a fraudulent conveyance, gift, or delivery of goods and chattels (in which all conveyances without a consideration, or voluntary conveyances, are included, and also conveyances or gifts to creditors with a fraudulent preference). 2. Such as are evidence of insolvency: as, for instance, a declaration of insolvency in the Gazette, a petition of insolvency in the Insolvent Debtors' Court, lying in prison twenty-one days after being arrested for a *bonâ fide* debt, or compounding under certain circumstances with a petitioning creditor. An assignment of the whole of a trader's effects for the benefit of his creditors is also an act of bankruptcy, on which a commission may be supported either immediately, or, under certain circumstances, within six months after such assignment has been made. An act of bankruptcy, concerted between a trader and his creditor with fraudulent views, is a contempt of court, and also an indictable offence.

When an act of bankruptcy has been committed by a trader, a commission, or, as it is now termed, a *fiat* in the nature of a commission, may be sued out (with certain exceptions) immediately, by a creditor or creditors to a stated amount: such creditor is then termed a petitioning creditor. The bankruptcy will then be held to have commenced at the time when the act of bankruptcy on which the petition is supported was committed. The striking what is termed a docket in the bankrupt office gives priority of petitioning to a creditor. The fiat when issued is opened, and the circumstances necessary to constitute a bankruptcy proved before a commissioner of bankrupts. There are six commissioners, nominated according to the act of the 1st year of W. 4.; and of these three together form a subdivision court for the purpose of acting in concert on questions of difficulty. The assignees of the estate and effects of the bankrupt are then chosen by the creditors among themselves; and to these, in conjunction with an official assignee appointed

by the court, the whole property of the bankrupt is assigned by adjudication. From the decision of a commissioner or subdivision court there is an appeal to the court of review in bankruptcy, instituted by the same act; and from thence to the lord chancellor, and finally to the House of Lords. The jurisdiction in bankruptcy is both legal and equitable.

By the assignment, the whole property, real and personal, of the bankrupt, is vested in the assignees from the period of the act of bankruptcy, to the avoidance of all the bankrupt's subsequent transactions, except such as have been performed *bonâ fide* with parties having no notice of such act; the notice being understood according to ordinary rules in equity. Besides the bankrupt's own property, such property of third parties as shall have been in his use and disposition, or reputed ownership, by permission of the true owner, passes to his assignees. The bankrupt's right of action of contract, and of tort to property, but not personal torts, pass likewise to his assignees. But actions against him, except for the recovery of specific real property, do not lie against the assignees, the amount claimed being proveable as a debt under the commission; unless in some cases, where the right of action has accrued subsequently to the appointment of the assignees. The debts which may be proved by creditors against the bankrupt's estate are either certain or uncertain in their amount: the first class including such as are either specific sums of money lent or due, or such as are originally uncertain, but capable of being liquidated or reduced to a certain amount; the second, such as can only be estimated on general principles of equity. It is the business of the assignees to collect the estate of the bankrupt, as ascertained by his examination upon oath and by inspection of his books; but monies on account of the bankrupt's estate are received by the official assignee alone, and paid by him into the Bank of England in the name of the accountant-general of the Court of Chancery.

Not sooner than four months, nor later than twelve after the issuing of the fiat (unless ordered by the court of review), a public meeting of creditors is appointed for the purpose of making the first dividend of the net estate after certain necessary liabilities have been provided for out of it. A second dividend, if necessary, is made within eighteen months of the issuing of the fiat; after which a third or more may follow, according to circumstances. A bankrupt refusing to surrender his estate, or to make full discovery respecting it, is liable to transportation for life. While the proceedings are going on, he is entitled to maintenance out of his estate. The certificate of conformity is a testimony given to the bankrupt of his having, since his bankruptcy, complied with the requisitions of the law: it cannot, however, be obtained without the consent of a certain proportion of the creditors; and it is open for any creditor certain of misconduct on the part of the bankrupt, subsequent or even previous to the bankruptcy, to oppose the granting of this certificate. The effect of the certificate, besides entitling the bankrupt to an allowance, where a dividend of 10*s.* in the pound or upwards has been paid to the creditors (being a percentage on his estate, limited, according to circumstances, so as not to exceed in any case 600*l.* per annum), is to discharge his person and future estate from all claims and debts which might have been proved under the bankruptcy. But in case of a second bankruptcy, or a bankruptcy after discharge under the Insolvent Act or composition with creditors, unless 15*s.* in the pound has been paid, the effect of the certificate is only to discharge the person.

BA'NKSIA. (In honour of Sir Joseph Banks, Bart., the great patron of natural history, and one of the companions of Captain Cook in his second voyage.) A genus of Proteaceous plants forming a conspicuous feature in the landscape of Australia, where the species are called by the colonists wild honeysuckle, and reckoned a sign of bad land. They have flowers and fruit growing in close hard downy or woolly cones, and hard broad leaves on branches so close and rigid that the traveller, it is said, may literally walk without inconvenience upon the top of a wood formed of these trees.

BA'NLIEUE. (Fr.) The territory without the walls, but comprised within the legal limits of a city or town. The word is evidently derived from Ban (bannus, &c.), but the immediate origin is unknown.

BANN. A proclamation commanding or forbidding any thing. Hence the public notices of marriage given in church, derived from the civil law, are called Banns of Marriage. According to the law of England, the banns must be published three successive Sundays; and if the marriage be not performed within three months from the last publication, the same process must be repeated. Bishops have the power of appointing surrogates, who may grant a faculty or licence to parties applying to be married without banns. But this licence may only be given under certain conditions, and upon good caution and security taken, such as to supersede the necessity of public proclamation.

BA'NNER. (Swed. baner; Fr. banniere.) A flag or standard under which men are united or bound for some common purpose. This word, found in all the modern languages of Western Europe, is of very doubtful origin; it is a word of which our ancient English authors were exceedingly fond, and to which they invariably attach the same meaning. (Chaucer, *the Knight's Tale*, v. 978.; *Sir Thomas More's Works*, 207.; Drayton, *Battle of Agincourt; Yalden to Sir H. Mackworth*, &c.) Among the ancient Germans, the honour of bearing a banner was conferred by the emperor on that individual who could bring ten vassals into the field. In later times, petty princes assumed this privilege; and in the year 1424 Pope Eugene IV. created Count Sforza banneret (bannerherrn) of the Roman empire. In the free towns on the Continent, the banner was always carried by the chief magistrate ex officio, in cases of solemnities or of grand processions. In England, a knight banneret was created by the ceremony of cutting off the four corners of his standard and making it square. Some antiquarians trace the origin of this custom to Conan, the lieutenant of Maximus, who governed Britain in the year 383 (Gwillim, *Analogia Honorum*); while others maintain it took its rise from the Black Prince on the field of Cressy. A wonderful similarity seems to exist between the duties and privileges of the old knights bannerets of England and those of the primipili (the standard bearers) among the Romans. (*Tac. Histor.* iii. 22.) Several banners are famous in history; such as the Danish banner, taken from the Danes by Alfred the Great; and the oriflamme of the French, which, after passing through various hands, became eventually the great standard of France. (Lanzelot, *Memoires de l'Academie des Inscriptions.*)

BANNER. The ordnance flag, fixed on the forepart of the drum-major's kettle-drum carriage, formerly used by the royal artillery. At present, when such a flag is carried it is affixed to the carriage of the right-hand gun of the park — generally a twelve-pounder.

In the horse equipage the *banner* of the drums and trumpets must be of the colour of the facings of the regiment: it bears the royal cypher and crown, and the rank of the regiment.

BA'NNERET. A knight who in the feudal times possessed a certain amount of fiefs, and had the right of carrying a "banner." This honour was also very generally adopted among European nations, and was awarded on the field of battle to such as had there distinguished themselves. Knights bannerets were considered, in England, next to barons in precedence. The dignity has not been conferred for a long period. The banner of a banneret was oblong, that of a baron square. When a knight bachelor was made banneret on the field of battle, the ceremony was performed by cutting off the ends or tails of his pennon, and thus converting it into a banner. *See* KNIGHT.

BA'NYAN. A kind of Indian fig, the *Ficus indica* of Linnæus, forming a very large tree, which sends down roots from its branches, and those roots striking into the ground themselves become trunks, which serve as props to the extending branches; and as the tree is very long-lived, the quantity of ground an individual will thus cover is incredible. Dr. Roxburgh says, he has seen the tree 100 feet high, and full 500 yards in circumference round the extremities of the branches. It is found wild in the skirts of the Circar mountains; its leaves are used by the Brahmins as plates to eat off; a species of birdlime is obtained from its juice, and the fruit is eaten by birds.

BA'OBAB. The African name of *Adansonia digitata*, a tree inhabiting the western side of Africa, and cultivated in Egypt and Abyssinia. It increases more in proportion in diameter than in height; so that it may be seen with a trunk 10 yards in thickness and only 73 feet high, its appearance being lumpish and inelegant. It is supposed that the most remarkable cases of longevity in the vegetable kingdom are afforded by this tree. Adanson is quoted by De Candolle as asserting that he saw individuals which must have been 6000 years old; and other travellers declare that however ancient the individuals may be, the bark is always green and shining, and so full of life that an abundant discharge takes place at the least wound. It is probable that the data upon which these calculations are made will not bear strict investigation; nevertheless, there can be no reasonable doubt of the Baobab trees arriving at a most unusual age. The leaves are employed in powder as an ingredient in African cookery; and the fruit has a sub-acid juice, which makes it valuable in fevers.

BA'PHOMET. The imaginary idol, or rather symbol, which the Templars were accused of employing in their mysterious rites. (*See* TEMPLARS.) The distinguished orientalist Hammer has published a dissertation on this subject, in which he endeavours to revive the ancient accusations against that military order. These images, which he calls Baphomet, are to be found in some of the museums of continental cities; they are small human figures with two heads, and covered with emblems, to which Hammer attaches a very horrible signifi-

cation. He derives the name (very improbably) from the Greek words βαφη, dipping or baptism, and μητις, counsel or wisdom: as if they represented the admission of the initiated to the secret mysteries of the sect. It is proper to observe, that other writers have treated all this discovery as a mere fancy of the learned orientalist, and maintain that the figures which he terms Baphomets are in reality relics of the art magic: while the word itself is supposed to be a corruption (arising from the negligence of some transcriber) of the name Mahomet, occurring in the depositions of witnesses against those unfortunate knights.

BA'PTISM. (Gr. βάπτω, *I dip.*) The rite of initiation into the community of Christians, ordained by Christ himself, when he commissioned his apostles to go and baptize all nations in the name of the Father, the Son, and the Holy Ghost.

It is recorded by the Evangelists, that our Saviour himself received baptism from John; and the ceremony which the Baptist performed is allowed generally to have been an imitation of a rite in common practice among the Jews, who appear to have admitted proselytes by circumcision and baptism. Lustration, however, by water, as an initiatory rite, is of great antiquity and general practice, especially in the East; and Christian baptism may be considered as an adaptation of a form which was generally understood to have a symbolical meaning. Accordingly, it has been recognised by all Christian communities as a sacrament, although they have differed in their explanation of its nature and meaning. It is upon this point that the question of the validity of infant baptism principally depends; the words of Scripture in that particular not being allowed on all hands to be decisive, nor even the practice of the early church universally admitted. Those, therefore, who consider baptism to be a symbol of a covenant thereupon entered into between God and the person baptized, require the understanding of the person to accompany the act, and reject the notion of sponsors undertaking to promise on the part of infants: the more common notion, however, conceives this sacrament to have in itself a regenerative virtue, by which an infant may be received into participation in the promises made to the church, and be really and truly from that time forth put into the way of salvation.

Baptism was originally administered by immersion, which act is thought by some to be necessary to the sacrament. It is not clear, however, even in the Scripture history, that this ceremony was always adhered to. At present sprinkling is generally substituted for dipping, at least in northern climates.

BA'PTISTERY. (Gr. βαπτιζω, *I baptize.*) In Architecture, a building destined for the purpose of administering the rite of baptism. Some authors have contended that the baptistery was anciently placed in the interior vestibules of the early churches, as are in our days baptismal fonts. But this is not so: the baptistery was entirely separated from the basilica, and even placed at some distance from it. Up to the end of the sixth century, after which period the interior vestibule of the church received it, the baptistery was distinct from the church; and excepting in a few churches, such as that at Florence, and those of all the episcopal cities of Tuscany, Ravenna, and San Giovanni Laterano, and perhaps of a few other places. the practice was general. The last mentioned is perhaps the most ancient remaining. One at Constantinople was so large that on one occasion it held a very numerous council. The baptistery of Florence is nearly 90 feet in diameter, octagonal, and covered with a dome. The celebrated bronze gates by Lorenzo Ghiberi, which Buonarroti said were fit to be the gates of Paradise, enclose it. The baptistery at Pisa, designed by Diotisalvi, was finished about 1160. It is octagonal, about 129 feet in diameter, and 179 feet high. We are not aware of any building of this sort having been erected in England.

BA'PTISTS. A denomination of Christians, who deny the validity of infant baptism, and maintain the necessity of immersion. These were also the principal tenets of the Anabaptists, or Rebaptizers, with whom, however, the modern Baptists ought not to be confounded. They are subdivided into two classes, the Particular (Calvinist) and the General (Arminian) Baptists. The mode of church government is similar with both, acknowledging three orders of ministers; of whom the messengers correspond to bishops, the elders to priests, and ministering brethren to deacons. Their churches are congregational, and in respect to the election of their own ministers independent. Each denomination has, however, its general assembly, possessing some kind of authority over the whole community. The Baptists are numerous in Holland, where they are known by the title of Mennonites; and in England they form one of the principal Dissenting bodies.

BAR. A shoal often found lying across the mouth of rivers, and also of harbours; thence called bar harbours. As the sea breaks on these places, in bad weather the passage of a bar is generally dangerous.

BAR, CONFEDERATION OF. In Politics, was an association of a few influential Polish nobles, formed at Bar, a small town of Podolia, in the year 1767, for the purpose of freeing their country from foreign influence. Their efforts, however, were eminently unsucccessful: the small bands of the patriots were annihilated one by one; and their defeat gave rise to an event almost unprecedented in history, — the partitien of Poland by the three neighbouring powers.

BAR. The bar or place in the courts of law where barristers or advocates plead: also where prisoners accused of felony are stationed for arraignment and trial.

BAR. In Heraldry, a kind of ordinary, resembling the *fess*, but containing only the fifth part of the field. Where two bars are borne in an escutcheon, they are so arranged that the whole field appears divided into five parts. A field divided by horizontal lines into four, six, eight, ten, or twelve equal parts, with alternate tinctures, is termed *barry* of four, six, eight, &c.

BAR. (Sax. Beorgan, *to bar.*) In Music, a line drawn vertically across the lines of the staff, including a certain quantity or measure of time, varying as the music is either triple or common.

BAR, ELOQUENCE OF. *See* ELOQUENCE.

BA'RBA. (Lat. barba, *a beard.*) In Mammalogy, signifies the long tuft of hair dependent from the under jaw. In Ornithology, the same term is applied to the setiform or simple feathers, which in some species of birds depend from the skin covering the gullet or crop. In Ichthyology, a kind of spine, with the teeth pointing backwards.

BARBA. A beard; a term used in Botany to denote any collection of long loose hairs into a tuft or crest, as on the petals of the iris.

BARBA'DOES LEG. A disease indigenous to Barbadoes, in which the limb becomes tumid, hard, and misshapen.

BA'RBARISM. (Gr.) In Rhetoric, an offence against purity of style or language, which consists in employing uncouth or antiquated expressions, or in assigning to terms a different signification from that which usage has conferred on them.

BA'RBASTELLE. A small indigenous bat; *Plecotus barbastellus*, Lisson.

BA'RBEL. An indigenous fresh-water fish (*Cyprinus barbus*, Linn.) which takes its name from the processes termed Barbels.

BA'RBELLATE. (Lat. barba.) When the pappus of composite plants is bearded by short, stiff, straight bristles, as in Centaurea. Barbellulate is used when the roughness of the pappus is caused by extremely short points, as in Aster.

BA'RBELS. Small cylindrical vermiform processes appended to the mouth of certain fishes, and subservient to the sense of touch.

BA'RBER. (Lat. barba.) A person who makes a trade of shaving and dressing the hair of other people for money. It would seem that it is only where a state has made considerable progress in civilisation that this art begins to flourish. If we believe Varro, for instance (*Plin.* 7. 56.), it was not until the 454th year of the city that Ticinius Mena first imported barbers into Rome from Sicily. Their shops (Tonstrinæ) soon became the resort of fashionable loungers and idlers; and Horace, to indicate the extreme notoriety of a story, says that it was "omnibus et lippis notum et tonsoribus." Even the poorest citizens, according to the same author, sought refuge from their ennui in making a round of the barbers' shops:—

> Mutat cœnacula, lectos,
> Balnea, tonsores.

That the Romans paid great attention to this department of the toilet, is obvious from the ridicule that was excited against any citizen whose hair bore marks of being cut "inæquali tonsore" (by a bungling barber).

But besides shaving the beard, to the barbers of the Romans was assigned the delicate task of trimming the nails. Hence Plautus, *Aulul.* ii. 4. 33.—"Quin ipsi pridem tonsor ungues dempserat;" and Tibullus, I. 9. 11. —

> Quid ungues
> Artificis doctâ subsecuisse manu.

As early as the time of Hippocrates, some surgical operations were considered as degrading to physicians, and consequently fell to be performed by barbers. In France the council of Tours, in the year 1163, prohibited the clergy, who then shared with the Jews the practice of medicine in Christian Europe, from performing any bloody operation; and from that time the barbers remained for some centuries in uninterrupted possession of the practice of surgery. In England also, early in the 16th century, the barbers were incorporated with the surgeons of London (32 Hen. 8. c. 42.); but at the commencement of last century, when a new impulse was given to the science of surgery by the attainments and ability of many practitioners throughout Europe, the

barbers were degraded from their honourable association with surgeons. (18 Geo. 2. c. 15.) In Holland and Germany to this day the barbers are wont to wield the lancet and the razor alternately. Nowhere, however, in these countries is the business of haircutting carried on by the barbers, but by a distinct and superior class, the friseurs. The barber's pole has given rise to many speculations and ingenious absurdities. The fact is, that the pole was the distinguishing characteristic of a few only, being a mark of superior skill, and indicated on the part of him who possessed it surgical as well as tonsorial ability. (For some curious remarks on the barbers of Edinburgh, vide *Creech's Statistical Account of Edinburgh.*)

BA'RBERRY. *See* BERBERRY.

BA'RBICAN. A watch tower for the purpose of descrying the enemy: also the outer work or defence of a castle, or the fort at the entrance of a bridge. Apertures in the walls of a fortress for firing through upon the enemy are also called barbicans. Authors have ascribed to this word a French, Italian, Spanish, Saxon, and Arabic origin.

BA'RBITON. An ancient musical instrument, somewhat resembling the lyre.

BAR'BULA. (Lat. barba, *a beard.*) A finely divided beard-like apex to the peristome of some mosses, as in the genus Tortula.

BA'RCAROLLE. A song sung by the Venetian gondoliers. A boat song (from the Italian *barcarola*).

BARDS. The ancient poets of the Celtic tribes are so termed by the Roman writers. The etymology of the word is uncertain. According to the ancients, they appear to have been the priests as well as the instructors of these tribes, and regarded with peculiar veneration. Lucan expressly mentions the doctrine of the immortality of the soul as one of their most characteristic tenets. After the introduction of Christianity the importance of the bards in society diminished; but in Wales, Ireland, and other Celtic districts, they continued to be held in much honour. The most ancient compositions of Welsh bards which we possess (those of Taliessin, Aneurin, and Lywarch) are supposed to be of the sixth century.

BARE POLES. The masts without any sails upon them, the ship being at sea. Under bare poles, in general, implies that the wind is so high that no sail can be exposed to it.

BA'RGAIN. *See* CONTRACT.

BARGE. (Gr. *βάρις, a kind of ship.*) A general name given to flat-bottomed craft of a certain size employed on rivers and canals. Also one of the larger boats of a man of war, between 30 and 40 feet long. Barge is also a general term for boats of state or pleasure.

BARGE BOARDS. (Sax. pÿpgan, *to bar.*) In Architecture, the inclined projecting boards placed at the gable of a building, which hide the ends of the horizontal timbers of a roof, and are frequently carved with trefoils, quatrefoils, flowers, and other ornaments.

BARGE COURSE. In Architecture, that part of the tiling of a roof which projects beyond the external face of the gable of a building.

BARI'LLA. The name given in commerce to the impure carbonate of soda, imported from Spain and the Levant. It is made by burning certain plants that grow upon the sea shore, especially the salsola soda, to ashes, which are fused into grey porous masses. (For an account of the places where it is produced, the quantities shipped from them, and the uses to which it is applied, see *M'Culloch's Commercial Dictionary.*)

BA'RITONE. (Gr. *βαρυς, heavy,* and *τονος, a tone.*) In Music, a high bass, which, in the ancient church music, is written with the F clef on the third line of the staff. By the French it is called basse-taille.

BA'RIUM. The metallic base of baryta; it is of a grey colour, more than twice as heavy as water, and is instantly oxidized by air and by water.

BARK. (Ger. bergen, *to cover.*) The exterior covering of the trunk of a tree. It is composed of cellular tissue, traversed by woody tissue passing down it longitudinally, and connected with the medullary processes of the wood. It is increased in trees by annual layers formed on its inner face, and gradually perishes on the outside as it is distended by the growth of the interior. It seldom, however, shows any very distinct trace of concentric circles, because the latter are continually displaced and disturbed by its distention. Its inner face is named liber. At the commencement of the annual growth of a tree, it separates spontaneously from the wood, in order to make room for the new matter forming beneath it. It is the depositary of many of the secretions of plants, and seems to act as a living filter of a curious kind, separating certain secretions from others, and allowing a part only to pass off horizontally in the medullary processes on their way to the centre of the tree. Its use is to act as a protector to the wood, and as the channel of the sap in its descent from the leaves. Its fibre is often tenacious, and manufactured into linen or cordage. True bark only exists in Exogens and Gymnosperms; in Endogens its place is supplied by a cortical integument, which cannot be separated from the subjacent wood without violence.

BARK, PERUVIAN. *See* CINCHONA.

BARK. Originally a general term for a vessel, is now restricted to a particular form of rig; namely, that of a ship, but having a gaff topsail instead of the square mizen topsail.

BARK, USE OF IN TANNING. *See* TANNING.

BA'RKING IRONS. Instruments for removing the bark of oak and other trees which is used for tanning. They consist of a blade or knife for cutting the bark, while yet on the trunk, across at regular distances, and of chisels or spatulæ, of different lengths and breadths, for separating the bark from the wood.

BARK STOVE. A glazed structure for tropical plants, in which there is a bed of tanner's bark, or of some other fermentable material, which will produce a moist heat.

BA'RLEY. (Hordeum, *L.*; Triandria monogynia, *L.*; Gramineæ, *Juss.*; characterised by an imbricated-spiked inflorescence, consisting of one-flowered spikelets in twos or threes.) A bread corn of considerable importance. Its native country is unknown, some ascribing it to Tartary, others to Siberia, and a few to Scotland. In Spain and Sicily it produces two crops in the year; but in countries as far north as Britain it produces only one, and is rather a delicate species of grain. In England it is second in importance to wheat. It is a most valuable crop in the rotation best adapted to light or turnip soils, which, from that circumstance, are sometimes called barley lands. Where its culture is best understood, as in Norfolk, it is generally preceded by turnips or other green crop. There are two leading species of this grain in cultivation, — the *Hordeum distichon*, two-rowed or common barley; and the *Hordeum hexastichon*, or six-rowed barley. One of the best known varieties of the latter, and the only one in common cultivation in Scotland, is called bear or bigg. It is not now very extensively used as a bread corn; but it is used very extensively in malting, and in the fatting of black cattle, hogs, and poultry. The crops differ very widely, according to the land and the season, varying from 28 to 64 bushels an acre; but the most usual crop is from 28 to 40 bushels. The common weight of barley is 50 or 51 lbs. per Winchester bushel; but the best Norfolk barley weighs 53 or 54 lbs. The price of barley in 1837 was **30*s.* 4*d.*** a quarter.

BA'RNACLES. *See* CIRRIPEDS.

BARO'METER. (Gr. *βαρος, weight,* and *μετρον, measure.*) A well-known instrument for measuring the weight or pressure of the atmosphere. The invention of the barometer was in some degree owing to an accident. Some workmen employed by the Duke of Florence to prepare a sucking-pump for a deep well, found to their surprise that notwithstanding their utmost care in forming and fitting the valves and piston, the water would not rise higher than 18 palms, or about 32 English feet. For an explanation of this unexpected difficulty they applied to the illustrious Galileo, then passing the evening of his life at his villa near Arcetri; but the philosopher was not yet prepared with the true answer. In that age the doctrine of a *plenum* was an axiom in philosophy; and the ascent of water in the barrel of the pump was universally ascribed to nature's horror of *a vacuum*. Galileo, either fearing to encounter further persecutions by propounding opinions at variance with the prejudices of the times, or preoccupied by the prevailing metaphorical modes of expression, evaded the difficulty by saying that the power of nature to overcome a vacuum was limited, and did not exceed the pressure of a column of water 32 feet in height. That he was himself little satisfied with this explanation. is evident from the circumstance that previously to his death, which happened soon after, in 1642, he earnestly recommended to his pupil Torricelli to undertake the investigation of the subject, which the infirmities of advanced age no longer permitted him to prosecute. Torricelli, suspecting the true cause of the suspension of the water, namely, the weight of the atmosphere, happily conceived the idea of trying the experiment with mercury. He perceived that if the weight of the atmosphere forms a counterpoise to a column of water of 32 feet, it must also counterpoise a column of mercury of about 28 inches in height, the weight of mercury being about 14 times greater than that of water. Having accordingly procured a glass tube of about 3 feet in length and a quarter of an inch in diameter, hermetically sealed at one end, he filled it with mercury; and covering the open end with the finger, he immerged it in an open vessel containing mercury. On bringing the tube to the vertical position, and removing the finger, the mercury instantly sunk, leaving a vacuum at the top of the tube, and, after making several oscillations, stood in the tube at the height of about 28 inches above the surface of that in the vessel. On covering the mercury in the vessel with a portion of water, and raising the tube till the lower end came into contact with the water, the mercury all ran out, and the water rushed up to the top of the tube. This experiment,

called after its author the *Torricellian experiment*, demonstrated that the mercury was sustained in the tube, and the water in the barrel of the pump, by exactly the same counterpoise, whatever the nature of it might be. Torricelli died shortly after, in the flower of his age, without completing his great discovery; but the fame of his experiment was soon carried into other countries, and the subject engaged the attention of the most eminent philosophers; among others the celebrated Pascal. After a variety of ingenious experiments on the subject, all of which tended to establish the pressure of the atmosphere, it at length occurred to Pascal that if the mercurial column was really supported by atmospheric pressure, it must be affected by the weight of the superincumbent mass of air, and consequently be diminished at considerable elevations. In order to verify this conjecture, he requested his brother-in-law, Perier, to try the experiment on the *Puy de Dome*, a lofty conical mountain in the province of Auvergne, which rises to the height of 500 toises. At the foot of the mountain Perier filled two tubes, and observed the mercury in each to stand at precisely the same height, nearly 28 English inches. Leaving one of them under the care of a person to watch its rise or fall, he carried the other to the top of the mountain; and on repeating the experiment there, the mercury stood at the height of only 24·7 English inches. At two intermediate stations in his descent, the mercury was observed successively to rise, and at the foot of the mountain it stood at exactly the same height in the tube as at first. This experiment was decisive; the result of it was communicated to Pascal at Paris, who, after confirming it by similar observations made successively on the ground, and at the top of a glass-house and the belfry of a church, proposed the barometer as an instrument for measuring the height of mountains, or the relative altitudes of places above the surface of the earth.

The barometer had been but a short time invented, before it was observed that the height of the mercurial column is subject to variations connected in some way with the changes of weather. But the variations are confined within a limited range, scarcely exceeding 3 inches in all, and often, for many days together, do not exceed a few hundredths of an inch. It therefore was considered desirable to render these minute oscillations more apparent by increasing their range; and accordingly, of the numerous forms which the barometer has received, or which have been suggested, the greater part have been proposed with a view to this purpose. The most remarkable or useful constructions are the following, the descriptions of which will be readily understood with the assistance of the diagrams:—

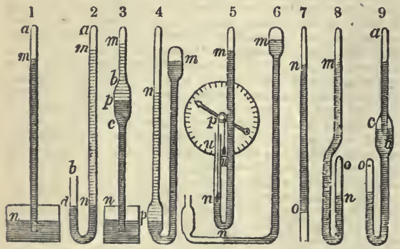


Fig. 1. is the *Cistern Barometer*, and is merely the inverted tube of Torricelli already described. The tube must be about 34 inches long. When placed in the cistern, the mercury sinks till the column between the two surfaces *m* and *n* just counterbalances the pressure of the air. The space above the mercury, *a m*, is or ought to be a perfect vacuum, or only filled with the vapour of mercury. In this barometer, as the diameter of the cistern is generally very much greater than that of the tube, almost the whole effect of the rise or fall is perceived in the variation of the upper surface at *m*. For supposing the section of the cistern 20 times greater than that of the tube, and that the height of the column *m n* suffers a diminution of one inch; it is evident that, as all the mercury which goes out of the tube passes into the cistern, when it falls at *m* it must rise at *n*, but less in proportion as the section of the cistern exceeds that of the tube. In the case supposed, therefore, the alteration of the level at *m* will be 20 times greater than at *n*; that is to say, there will be a fall of $\frac{20}{21}$ of an inch at *m*, and a rise of $\frac{1}{21}$ of an inch at *n*.

Fig. 2. is the *Siphon Barometer*, which was also proposed by Torricelli, as being more convenient than the former. It is merely a tube hermetically sealed at the upper end, having the lower or open end bent upwards in the form of a siphon. The variations in this are only half as great as in the cistern barometer; for the tube being of the same width throughout, a diminution of the column *m n* amounting to one inch will be marked by a fall of half an inch at *m* and a rise of half an inch at *n*. This inconvenience may, however, be remedied by having the lower branch blown into a wide bulb; but as it is very difficult to procure the bulb to be blown into a perfectly regular shape, this enlargement of the bulb is found to give rise to inaccuracies.

Fig. 3. is a barometer suggested by Descartes, and executed by Huygens, in which the sensibility is greatly increased. Two tubes are cemented to the opposite ends of a pretty wide cylinder, *b c*. The lower tube and a portion of the cylinder, *c p*, are filled with mercury; above which water or spirit of wine is introduced, reaching to the top of the upper tube, which is hermetically sealed. The vacuum is made, as in the Torricellian barometer, by inverting the compound tube in a basin of mercury. The enlargement of the scale obtained by this construction is found thus: Suppose the horizontal section of the cylinder, *b c*, to be 10 times that of the tube, and the specific gravity of mercury 14 times that of water. Let *x* be the fall of the mercury in the cylinder at *p*, corresponding to a fall of one inch of the common Torricellian barometer. The descent of the water *x* inches at *p* will be marked by a descent of 10 *x* inches in the tube at *m*. But the diminution of the height of the column of water must correspond to a diminution of $(1-x)$ inches in the height of the column of mercury of equal weight with the water; therefore, the diminution of the column of water is 14 $(1-x)$ inches. Hence $10\,x=14\ (1-x)$, or $x=\frac{7}{12}$, and the descent of the water at $m=\frac{70}{12}=5\frac{5}{6}$; that is to say, when the Torricellian barometer falls one inch, the barometer of Descartes falls $5\frac{5}{6}$ inches. The defect of this construction is, that the air contained in the water escapes into the vacuum above, and destroys the accuracy of the instrument.

Fig. 4. is a form proposed by Huygens, to obviate the defect of the former. The siphon barometer terminates in two equal cisterns, or enlarged tubes; that at the open end communicating with a narrow tube containing water. In this case we may neglect the weight of the water between *n* and *p*, or consider it as a small addition to the weight of the atmosphere; the variations at *n* will be then as much greater than in the common siphon barometer as the horizontal section of the cisterns exceeds that of the tube at *n*. Thus, suppose the section of the cistern 10 times that of the tube; a variation of atmospheric pressure causing a fall of one inch in the Torricellian barometer will cause the mercury at *p* in this barometer to rise half an inch, and the water at *n* to rise 10 times as much, or 5 inches. The defects of this barometer are these: first, as the water descends at *n*, a portion of it adheres to the sides of the tube, and consequently diminishes the length of the column; secondly, the volume of the fluid in the reservoir is considerably affected by the influence of heat and cold; and, thirdly, the instrument is subject to constant derangement from the evaporation of the water.

Fig. 5. is the *Wheel Barometer*, proposed by Hooke. A small weight floats on the surface of the mercury in a siphon barometer, which is very nearly counterpoised by another weight, *w*, connected with the former by a string passing over a pulley, *p*. When the mercury rises at *n*, the weight *w* descends, and turns the pulley. An index attached to the axle of the pulley shows on a dial the quantity of revolution. This barometer, though very commonly met with, is a mere toy; and indicates neither the absolute height of the mercurial column, nor its variations, with sufficient accuracy to be of the slightest use for any philosophical purpose whatever. Even as a weather glass, it is the worst of all the common forms of the barometer.

Sir Samuel Moreland proposed to enlarge the scale, by inclining the upper part of the tube so as to form a considerable angle with the perpendicular. By this contrivance the scale is increased in the proportion of radius to the cosine of the angle of inclination; but the friction on the sides of the tube is greatly increased, and it is very difficult to determine the exact plane of the top of the column which requires to be read off on a vertical scale. This construction is easily conceived without a diagram.

Fig. 6. is a form proposed by John Bernoulli. The tube terminates in a horizontal branch of considerable length and small diameter: the pressure of air on the column of mercury is exerted horizontally, and by making the vacuum in a cistern at the top, the range becomes very great; but the mercury moves along the horizontal branch with difficulty, and by starts. No reliance can be placed on its indications.

Fig. 7. represents an extremely elegant and ingenious form of the barometer proposed by Amintons. A conical tube about 4 feet long, closed at the top, is partly filled with mercury, and inverted. The diameter of the tube must be small, scarcely exceeding 3-20ths of an inch at

the wide end, and tapering away to about 1-10th near the top. The pressure of the atmosphere from beneath prevents the mercury from falling out, but it descends in the tube till it comes into such a position that the height of the vertical column forms an exact counterpoise to the atmospheric pressure. If the pressure is diminished, the mercury sinks a little at *n*; but as it there fills a tube of larger diameter, its vertical height undergoes a corresponding diminution. The height of the upper surface at *m* therefore marks the absolute height of the vertical column, supposing the tube to taper equally; but the difficulty, or rather the impossibility, of fulfilling this condition practically, prevents this kind of barometer from being used.

We shall notice only one or two other forms of the barometer, proposed with a different view from that of enlarging the scale. Fig. 8. is a modification of the siphon barometer proposed by Gay Lussac. It differs from the common form in this respect, that, after the tube has been filled, the short branch is hermetically closed at the top, and the communication with the atmosphere takes place through a small capillary hole drilled laterally through the tube at *o*, so fine that though it admits the air to pass freely, it prevents the passage of the mercury. The barometer is thus rendered very convenient for carriage; but notwithstanding the promising appearance of this barometer, it has been found, particularly in travelling, that a portion of air will frequently insinuate itself through the mercury. In order to prevent the possibility of this accident, an ingenious modification has been made by M. Bunten, a Parisian artist. It consists in causing the part of the tube *a b* to terminate in a very fine point, and to penetrate to some depth into the other part *c o*, to which it is joined at *c*, in the manner represented in fig. 9. Now if an air bubble from the end *o*, which communicates with the atmosphere, should find its way through the bent capillary tube, it will pass along the sides of the bulging part, and instead of penetrating to the vacuum at *a*, will be arrested at *c*, whence it is easily expelled by reversing the barometer.

None of the contrivances which have been described for increasing the range of the oscillations have been found to succeed well in practice. It is found to be decidedly better to apply minute divisions, than to attempt to enlarge the scale; accordingly, experimenters now adhere to one or other of the two ancient forms, the cistern barometer and the siphon barometer. The height of the column in the siphon barometer is conveniently measured by means of a moveable scale attached to the frame which supports the tube; by means of a tangent screw, the scale is raised or lowered till its zero coincides exactly with the surface of the mercury in the lower branch; and with the assistance of a vernier, the height can be read off to the hundredth or two-hundredth of an inch with sufficient precision. The scale of the cistern barometer is usually fixed, and the bottom of the cistern is raised or lowered by a screw till the surface of the mercury in it coincides with the zero of the scale; but the scale may be moveable, and its zero brought to coincide with the surface of the mercury in the basin, as in the former case. In order to determine when this coincidence takes place, various expedients may be had recourse to. The most usual is to place on the surface of the mercury a float carrying a vertical needle, some point on which answers to a fixed point on the scale, and the coincidence obtains when the two points are brought into the same level. Another contrivance to effect the same purpose was employed by Fortin, a celebrated French artist. An ivory needle is attached to the scale, pointing downwards, and having its point exactly in the same level with the zero of the scale. The image of the needle is clearly reflected from the surface of the mercury in the cistern, and the cistern is raised or lowered till the point of the needle and its image precisely coincide.

In order to construct a good barometer, it is indispensably necessary that the mercury be perfectly free from impurities, and carefully purged of air; this is obtained by boiling it. The particles of air and moisture which cling obstinately to the sides of the tube must also be expelled by heat; the mercury must then be introduced slowly and continuously in a hot state, and while the tube continues hot. Since the time of Deluc it has been usual to boil the mercury in the tube before inverting it and forming the vacuum; but doubts now begin to be entertained among the most skilful makers of the expediency of this very troublesome process. The mercury is partially oxydated by boiling, and a thin crust formed, which keeps the column suspended at a greater height, and obstructs the freedom of the motion. It is important that the diameter of the tube be not very small; for it is found that the mercury moves with more freedom in a tube of considerable width, the oscillations following the atmospheric changes with more promptitude than in one of smaller dimensions; besides which, there is less disturbance from capillary attraction. The interior diameter should in every case exceed one fourth of an inch.

The value of the barometer as a scientific instrument depends on the purity of the mercury, and the total exclusion of atmospheric air. By proper care in the construction, it is, perhaps, possible to expel every particle of air from the mercury and the interior of the tube when the barometer is made; but it seems doubtful if, by any means whatever, it can be preserved for a considerable length of time in this state. The most carefully constructed barometers are liable to a slow and gradual deterioration by the intrusion of air, which has been supposed to insinuate itself between the metal and the tube, and not through the mercury. To obviate this inconvenience Professor Daniell conceived the ingenious idea of fixing to the open end of the tube of the cistern barometer a substance having a greater affinity than glass for mercury. "I caused," says he, "a small thin piece of platinum tube to be made, about the third of an inch in length, and of the diameter of the glass tube; this was carefully welded to its open end, so that the barometer tube terminated in a ring of platinum. The tube was filled and boiled as usual, and the infiltration of air was completely prevented by the adhesion of the mercury both to the interior and exterior surface of the platinum guard. I have no doubt that a mere ring of wire welded, or even cemented, upon the exterior surface of the glass, which would be a much easier and less expensive operation, would be a sufficient protection, as the slightest line of perfect contact must effectually arrest the passage of the air." — *Meteorological Essays*, p. 577. He farther states, that though time alone can fully confirm the efficacy of the platinum guard, the experiments, as far as they have gone, have been completely satisfactory.

Corrections necessary. — In all barometic observations there are, in general, two essential corrections to be made; one for the capillarity or depression of the mercury in the tube, and the other for temperature. Pure mercury in a glass tube always assumes a convex surface. The following are the corrections for tubes of different diameters, according to the theory of Mr. Ivory. (*Encyc. Brit.*, art. "Capillary Action.")

Diam. of Tube.		Depression.	Diam. of Tube.		Depression.
Inches.		*Inches.*	*Inches.*		*Inches.*
·10	-	·1403.	·40	-	·0153.
·15	-	·0863.	·45	-	·0112.
·20	-	·0581.	·50	-	·0083.
·25	-	·0407.	·60	-	·0044.
·30	-	·0292.	·70	-	·0023.
·35	-	·0211.	·80	-	·0012.

These corrections, which must always be applied to cistern barometers, show that wide tubes ought to be preferred; in fact, when the diameter of the tube exceeds half an inch, they may be safely omitted. In siphon barometers having both branches of the same diameter, the depression is equal at both ends; consequently the effect is destroyed, and no correction is required. This is a considerable advantage; for notwithstanding the most elaborate calculations, some uncertainty must always remain with regard to the exact amount of the capillary repulsion.

The correction for the temperature, which is the most important, depends on the expansion of the mercury, and the expansion of the scale on which the divisions are marked. If we make $a =$ the height of the thermometer in degrees above the freezing-point, $x =$ the fractional part of its bulk which mercury expands for one degree of heat on Fahrenheit's scale, $y =$ the fractional part of its length by which the scale increases, $h =$ the observed height of the barometer; then the height which would have been observed had the thermometer stood at the freezing point is

$$h - h\,a\,(x - y).$$

The expansion of mercury in part of its bulk is ·0001001. The scale is generally of some mixed metal of which the expansion is not very well ascertained: supposing it to be equal to that of copper, the expansion would be ·0000096; therefore it will be sufficiently accurate to neglect the temperature of the scale, and assume that of the mercury to be ·0001. Hence the following practical rule for reducing an observed height to the corresponding height at the temperature of the freezing point: "Subtract the ten-thousandth part of the observed altitude for every degree of Fahrenheit above 32." Suppose the thermometer 54° and the barometer 30 inches, the correction will be $(54-32) \times 30 \times {\cdot}0001 = {\cdot}066$, to be subtracted from 30 inches. In order to find the value of this correction a thermometer must be attached to the barometer, and observed at the same time. A table, showing the correction for temperature for every degree of Fahrenheit from 30° to 90°, and for every difference of half an inch in the height of the mercury from 28 to 30·5 inches, was constructed by Professor Schumacher, and is given by Mr. Baily in the *Phil. Trans.* for 1837, p. 434.

Cause of the variations of the barometer. — Various theories have been proposed to account for those frequent

atmospherical changes which cause the rise and fall of the barometer, but none of them can be regarded as very satisfactory. Whatever tends to increase or diminish the vertical pressure will obviously cause the barometer to rise or fall; but the vertical pressure may be increased either by an influx of winds and the accumulation of air at any place, or by a diminution of the elasticity of the atmosphere. The presence of heat or of moisture augments the elasticity, and consequently reduces the weight of the vertical column. During the prevalence of northerly and easterly winds the barometer stands high, the elasticity being diminished by the cold. But the real difficulty, Professor Leslie remarks, "consists in explaining why the variations of the barometer should be greater in the high latitudes than between the tropics, and why they should exceed in all cases the quantities which calculation might assign. The only mode, perhaps, of removing the difficulty is to take into consideration the comparative slowness with which any force is propagated through the vast body of the atmosphere. An inequality may continue to accumulate in one spot before the counterbalancing influence of the distant portions of the aerial fluid can arrive to modify the result. In the higher latitudes, the narrow circle of air may be considered as in some measure insulated from the expanded ocean of atmosphere; and hence, perhaps, the variations of the barometer are concentrated there, and swelled beyond the due proportion." — *Encyc. Brit.*

Uses of the barometer.—The barometer is an instrument of great importance in astronomy, its indications forming an essential element in determining the amount of atmospherical refraction. (*See* REFRACTION.) It is also, on account of its application to the measurement of altitudes, indispensable in all researches connected with climate. (*See* HEIGHTS, MEASUREMENT OF.) The purpose for which it is most commonly sought after is to prognosticate the state of the weather. On land this is perhaps the least important of its applications, but the case is widely different at sea. A remarkable instance of its utility to the mariner is given by Dr. Arnott. "The marine barometer has not yet been in general use for many years, and the author was one of a numerous crew who probably owed their preservation to its almost miraculous warning. It was in a southern latitude; the sun had just set with placid appearance, closing a beautiful afternoon; and the usual mirth of the evening watch was proceeding, when the captain's order came to prepare with all haste for a storm; the barometer had begun to fall with appalling rapidity. As yet the oldest sailors had not perceived even a threatening in the sky, and were surprised at the extent and hurry of the preparation; but the required preparations were not completed, when a more awful hurricane burst upon them than the most experienced had ever braved. Nothing could withstand it; the sails, already furled and closely bound to the yards, were riven away in tatters; even the bare yards and masts were in great part disabled, and at one time the whole rigging had nearly fallen by the board. In that awful night, but for the little tube of mercury which had given the warning, neither the strength of the noble ship nor the skill and energies of the commander could have saved one man to tell the tale." (*Elements of Nat. Phil.* vol. i. p. 353.)

No certain rules can be laid down for prognosticating the state of the weather from the barometer. The following, taken from the *Saturday Magazine*, are probably of as general application as any that can be given. It is always to be remembered that what the barometer actually shows is the present pressure of the atmosphere; and that its variations correspond to atmospherical changes which have already taken place, the effects of which may follow their cause at a greater or less interval.

1. After a continuance of dry weather, if the barometer begins to fall slowly and steadily, rain will certainly ensue; but if the fine weather has been of long duration, the mercury may fall for two or three days before any perceptible change takes place, and the longer time elapses before the rain comes the longer the wet weather is likely to last.

2. Conversely, if after a great deal of wet weather, with the barometer below its mean height, the mercury begins to rise steadily and slowly, fine weather will come, though two or three wet days may first elapse; and the fine weather will be the more permanent in proportion to the length of time that passes before the perceptible change takes place.

3. On either of the two foregoing suppositions, if the change immediately ensues on the motion of the mercury the change will not be permanent.

4. If the barometer rise slowly and steadily for two days together or more, fine weather will come, though for those two days it may rain incessantly, and the reverse; but if the barometer rise for two days or more during rain, and then on the appearance of fine weather begins to fall again, that fine weather will be very transient, and *vice versa*.

5. A sudden fall of the barometer in the spring or autumn indicates wind; in the summer, during very hot weather, a thunderstorm may be expected; in winter, a sudden fall after frost of some continuance indicates a change of wind, with thaw and rain; but in a continued frost a rise of the mercury indicates approaching snow.

6. No rapid fluctuations of the barometer are to be interpreted as indicating either dry or wet weather of any continuance; it is only the slow, steady, and continued rise or fall that is to be attended to in this respect.

7. A rise of the mercury late in the autumn, after a long continuance of wet and windy weather, generally indicates a change of wind to the northern quarters, and the approach of frost.

See also the *Phil. Trans.*, No. 187., for Dr. Halley's Rules. Patrick's Rules, which have long been popularly known, were first published in *Harris's Lexicon Technicum*, art. "Barometer."

BA'ROMETZ. The hairy stem of a species of fern or Aspidium, which, from its procumbent position and shaggy surface, looks like a crouching animal; hence called *Scythian lamb*.

BA'RON. The lowest but most ancient title of British nobility. The dignity appears to have been originally territorial. The higher feudatories of England, after the Norman conquest, possessed baronies on which a certain number of knights' fees were dependent, and were bound to attend the king with a certain retinue of knights. But in process of time, many of the barons having lost by alienation great part of their lands, the distinction between *greater* and *lesser barons* began to arise; and the former alone constituted part of the great council of the sovereign, in their own right, until at some early period (supposed to have been about the reign of Henry III.) the practice of summoning individuals to parliament by the king's writ prevailed over the former usage. But this subject is involved in great uncertainty. It has, however, been very generally supposed that the dignity of baron, together with the right to sit in parliament, was at an early period annexed in many instances to the possession of certain lands or castles, which have thus been believed to confer *baronies by tenure*. But Sir Harris Nicolas, in his *Introduction to the Peerage*, gives strong reasons to show, in the first place, that it is by no means clear that persons seised of lands *per baroniam* were entitled to a summons to parliament in the reign of Edward the First; and, in the next place, that there is no positive proof of such a tenure having been legitimately established at any subsequent period. *Baronies by writ* were created by the king's writ of summons to parliament, when addressed to individuals by name. The first thus created were in 49 H. 3., of which two (Despenser and Roos) exist at the present day. Whether, however, the dignity thus created was originally hereditary, admits of a doubt; no words to that effect are found in the ancient writs. But, in point of fact, the next heir was summoned by writ, after the decease of his ancestor, in a great majority of instances; and it has been long settled, that a summons to parliament by the king's writ, addressed to an individual, creates a barony descendible to heirs general. The earliest creation of a *barony by letters patent* took place in the 11th year of Richard II. (that of Beauchamp of Kidderminster); and therefore when a dignity of earlier creation than that year is claimed, it is presumed to have originated in a summons by writ, and consequently to be descendible to heirs general. On the death of a baron by writ without issue male, but with more daughters than one, the barony falls into *abeyance* until only one daughter or the sole heir of one daughter survives. The word Baron (baro, or varo, to which some give a Latin and others a German derivation) appears to have simply signified "man," and in some cases freeman or citizen, in the laws of the Franks and other early nations. In France, the title of baron originally belonged only to those who were immediate vassals of the crown: it afterwards became applied in common usage to those who had the right of executing justice on their fiefs. The title of baron ranked, as in England, after those of duke, marquis, count, and viscount; except in Dauphiné and Britanny, where the baron had precedence of the three latter. In Germany the title of Baron (Freyherr) is extremely common; but a great distinction existed, under the Empire, between the barons who were created by sovereign lords, and the barons of the Empire, the former being those immediate lords who had no voice in the Diet.

BA'RONET, KNIGHT BARONET. The lowest degree of hereditary dignity in England. This order was instituted by King James I. in 1611, as a reward for the services of those who came forward to quell the insurrection in Ireland, and especially in the province of Ulster; each person who received it furnishing a supply sufficient to maintain thirty soldiers for three years. The creation is by patent under the great seal, and generally limited to the heirs male of the body of the grantee, although sometimes otherwise entailed. Baronets rank among themselves according to creation, and come next after the younger sons of barons. By a clause in

the patent of creation, the heir male apparent to the title can claim the honour of knighthood, on attaining the age of twenty-one, in the life of his father or grandfather. Baronets bear for distinction on their paternal coats the arms of Ulster, in a sinister hand, erect, open, and couped at the wrist, gules in a field argent. This augmentation is placed sometimes in the middle chief point, sometimes on the fess point, &c. as may be most convenient, but subject to certain rules of heraldry. Baronets of Ireland were instituted by James I. nine years after the creation of baronets in England, with similar privileges and badge. Baronets of Scotland, or Nova Scotia baronets, were created by Charles I. in 1625, in furtherance of a project of colonization in that part of America. Their badge is the ensign of Nova Scotia. It had long fallen into disuse; but was borne again in 1775, by way of revival of the order.

BA'RONS OF EXCHEQUER. Certain Judges in England and Scotland, to whom the administration of justice is committed in causes between the sovereign and his subjects relating to the revenue. In the former country the Court of Exchequer takes cognizance of private causes also. *See* Exchequer.

BA'RONY. A territorial subdivision in Ireland, which nearly corresponds with the hundred in England. Each barony is supposed to have been originally the district of a native chief. There are in all 252 baronies in Ireland.

BA'ROSCOPE. (Gr. βαρος, *weight*, and σκοπεω, *I observe.*) A term which has been sometimes given to the barometer. According to its derivation it signifies *observer of weight*, and is properly applied to instruments which indicate variations in the weight of the atmosphere, without giving the means of absolutely measuring it. The wheel barometer of Hooke is properly a baroscope.

BA'RRAS. The resin which exudes from wounds made in the bark of fir trees.

BA'RRATRY. A name applied by our law and that of other countries to various offences. In England, a "common barreter" is defined by Lord Coke to be a common mover and maintainer of suits in disturbance of the peace, and in taking and detaining the possession of houses and lands or goods by false inventions. Barratry, in this sense, is an indictable offence at common law. The obtaining benefices at Rome was also an offence of *barratry*. In maritime insurance, barratry is any act of the master or mariners of a criminal nature, or which is grossly negligent, tending to their own benefit, to the prejudice of the owner of the ship, and without his permission. In Scotland, the crime of a judge who receives a bribe for a judgment is called *barratry*.

BA'RREL. An English measure of capacity, varying with the nature of the liquid measured. In the old measures, a barrel denoted 31½ gallons of wine, 32 gallons of ale, or 36 gallons of beer. By a statute of 1 W. & M., the ale and beer barrels were equalized for every part of England except London, and ordered to contain 34 gallons. The term Barrel was formerly in use to denote, in a rough way, other sorts of goods. Thus, a barrel of salmon, 42 gallons; a barrel of soap, 256 pounds. In common language any hollow cylinder is called a barrel.

BARREN FLOWERS. Are those which either have stamens and no pistil, or which have neither stamens nor pistil.

BARRICA'DO. (Fr. barricade.) A defence either by intrenchment or raised work, made in a hasty manner, by barrels filled with earth, heaps of stones piled up, carts, trunks of trees, or any other materials which would obstruct the passage or advance of an opposing force. The famous day of the Barricades at Paris took place on the 12th of May, 1588, when the populace invested the troops of the king, Henry III., in the Louvre, and forced that sovereign to escape from Paris. The Barricades again formed an important feature in the revolution of July, 1830.

BA'RRIER. (Fr. barrière.) A piece of wood work erected to defend the entrance of a passage or intrenchment, with a moveable bar in the centre, which may be removed at pleasure. It is usually erected between the citadel and town.

BARRIER TREATY. In 1713, a negotiation concluded between the Dutch and the King of France shortly before the peace of Utrecht, by which the former reserved the right to hold garrisons in certain fortresses of the Spanish Netherlands.

BA'RRIS. A large baboon of the Guinea coast.

BA'RRISTER. An advocate admitted to plead at the bar in the English courts of common law and equity. Barristers were anciently styled apprentices at law, until their admission to the degree of sergeant. A student intending to be called to the bar must be admitted a member of one of the four Inns of Court (Inner and Middle Temple, Lincoln's Inn, and Gray's Inn), and reside for a certain time, during three years in some cases and five in others. The disputations or arguments (termed exercises) which were formerly required of a student have been reduced to mere matters of form. A barrister has no legal mode of recovering fees for his services.

BA'RROWS, or TUMULI, says Mr. Gough, in his *Sepulchral Monuments*, are the most ancient monuments in the world. The sepulchres of the heroes of the war of Troy are still distinguished, if tradition is to be relied upon, by the mounds raised over them. In these ancient barrows the base is said to have been generally formed of stones, the upper part consisting of a mound of earth. Barrows are found scattered over the plains of the Ukraine and of Tartary, and in great numbers in the Mississippi valley of North America. The barrows of England are supposed to be almost all of British construction; although the mounds properly so called are sometimes confounded with those tumuli found in Roman camps, where they serve as land marks, or for some military purpose. Of the antiquaries who have treated of these relics of ancient eras, Dr. Stukely and Sir R. Colt Hoare are the most eminent. They have been distinguished, according to peculiarities of form and construction, into long barrows, bowl, bell, pond, twin, cone, broad, &c. In the most ancient barrows, the bodies found are deposited within a cist or stone receptacle, with the head towards the north: in those of later date, this direction is not observed. The bones which have been discovered within the numerous barrows that have been opened were generally accompanied by utensils, weapons, &c.; and from the form and finish of these, some conjecture has been made as to the period of the interment. But these barrows, although generally sepulchral, are not uniformly so: in some, bones of animals only have been found. Barrow burial is said by Sir R. Hoare to have lasted from a period of unknown antiquity down to about the eighth century. Barrows are chiefly found in the chalk districts of Wilts and Dorsetshire.

BA'RTER. A rule of Arithmetic by which the values of commodities of different kinds are compared.

BARY'TA. (Greek. βαρυς, *heavy.*) The oxide of barium, composed of 70 barium and 8 oxygen. Baryta is commonly called an alkaline earth. It is of a grey colour, difficultly fusible, and poisonous. It is soluble in about 20 parts of cold water. It forms white salts with the acids, all of which are poisonous except the sulphate. The soluble salts of baryta are excellent tests of the presence of sulphuric acid, which they indicate in solution by a white precipitate, insoluble in water and in acids, and composed of 77 baryta and 40 sulphuric acid; 117 parts, therefore, of pure and dry sulphate of baryta are equivalent to 40 of sulphuric acid. There are only two abundant natural compounds of baryta: the *sulphate*, which occurs crystalline, and the *carbonate*. *Native sulphate of baryta*, *heavy spar*, or *baro-selenite*, is found in this country in Cumberland and Westmoreland; a variety from Derbyshire is provincially called *cawk*. Native *carbonate of baryta*, or *barolite*, was first discovered at Anglesark in Lancashire by Dr. Withering, and hence called Witherite. It occurs crystallised and massive. It consists of 77 baryta and 22 carbonic acid; its equivalent, therefore, is 99.

BARYTO-CALCITE. A mineral found at Alston in Cumberland: it occurs both massive and crystallised in oblique rhombic prisms. It contains about 66 per cent. of carbonate of baryta, and 34 of carbonate of lime.

BA'RYTONE. (Βαρυς, *grave*, and τονος, *tone.*) The male voice, the compass of which is between tenor and base. Also a musical instrument similar to the *viol di gamba*.

BASA'LT. A common species of trap-rock; it is essentially composed of felspar and augite, of a compact texture, and dark green, grey, or black colour. It is often found in regular columns, of which the Giant's Causeway and the Island of Staffa furnish magnificent examples.

BASANI'TE. A variety of silicious slate, sometimes used as a touchstone to determine the purity of gold by the colour of its streak. (From βασανος, *the trier.*)

BA'SCINET, or BA'SINET. A light basin-shaped helmet, worn by the infantry in the reigns of Edward II. and III., and of Richard II. (See *Grose on Ancient Armour.*)

BASE. In Geometry, the lowest side of any figure; as the base of a triangle, of a cone, &c. Any side of a figure may be taken as its base.

Base. A chemical term, chiefly applied to metallic oxides, or to the leading constituent of compounds. Thus, soda is called the base of sulphate of soda; and sodium is the metallic base of soda. Hence the distinction into salifiable and metallic bases.

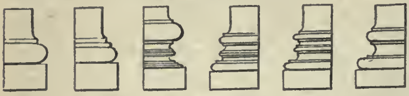
Base. In Music (frequently written Bass), the lowest part in a concert, whether vocal or instrumental. By some it is considered the fundamental or most important part; others regard the melody, or highest part, in that light.

Base, Clef. *See* Clef.

Base, Thorough. *See* Thorough Bass.

Base. (Gr. βασις, *a foundation.*) In Architecture,

generally a body which bears another. In the orders, it is the lower part of a column, moulded or plain, on which the shaft is placed. In the Grecian Doric, the columns are without bases, and stand immediately on the floor or pavement of the portico. The different bases are represented below, including the Attic base.



TUSCAN. ROMAN DORIC. IONIC. CORINTHIAN. COMPOSITE. ATTIC.

BASE'LLA. (A Malabar word.) A turning succulent-leaved Chenopodiaceous plant, native of the tropical parts of Asia, and commonly cultivated instead of spinach in the East Indies.

BA'SEMENT. (From Base.) In Architecture, the lowest story of a building.

BASIGY'NIUM. (Gr. βασις, *the base*, γυνη, *female*.) A stalk rising above the origin of the calyx, and bearing an ovary at its apex, as in Capparis.

BA'SIL. A fragrant aromatic herbaceous plant, the *Ocymum basilicum*, a native of India, whose leaves are much used in cookery for the purpose of giving a savoury flavour to dishes.

BA'SILIC. (Gr. βασιλικος, *royal*.) A pharmaceutical term, formerly applied to certain powders, ointments, &c. of pre-eminent virtues and activity.

BASI'LICA. (Gr. βασιλευς, *king*.) In Architecture, properly the palace of a king; but it afterwards came to signify an apartment which was usually provided in the houses of persons of consequence, where assemblies were held for dispensing justice. The Gordian family in their magnificent country house in the Via Prenestina had three basilicæ, each upwards of a hundred feet long. There was usually a basilica attached to every market for summary settlement of disputes that might arise, and it was surrounded by shops and other conveniences for traders. The difference between the Roman and Grecian basilica is described by Vitruvius, to whose work the reader may refer. We have in the article ARCHITECTURE (*quod vide*) given some account of the rise of the modern basilica for religious uses from the form of the more ancient one. Its form was that of a parallelogram, with a portico at each end, being covered by a roof supported by ranks of columns. Palladio applied the term to those buildings in the cities of Italy somewhat similar in use to our town halls.

BASILI'SCUS. A basilisk. The epithet is applied in Zoology to a most harmless genus of saurian reptiles, of the Iguanoid family, having no femoral pores; but with palatal teeth; a covering of small scales; and an elevated dorsal crest, supported by the vertebral spines, and extending from the neck to the middle of the tail. One of the species (*Basiliscus mitratus*) supports a mitre-shaped crest on the head.

BA'SIN. In Physical Geography, the space of country drained by a particular river; as the Basin of the Thames, Rhine, Rhone, &c. In Geology, depressed portions of strata, forming a hollow surrounded by hills, as the "London Basin," the "Paris Basin," &c.

BA'SIS. *See* BASE.

BASI'SOLUTE. (Lat. basis and solutus, *free*.) A name sometimes applied to those leaves which are prolonged at the base below the point of origin, as in the bracts of *Fumaria*, the leaves of *Sedum reflexum*, &c.

BA'SKET. (Lat. bascauda.) In Architecture, part of the Corinthian capital. *See* CAPITAL.

BASS. *See* BASE.

BASSETTE. (Diminutive of Basso.) In Music, the smallest species of the bass violin.

BASSOO'N. (Fr. basson.) A musical wind instrument made of wood, serving as the proper bass to the oboe and clarionet. The Italians call it *fagotto*, because composed of two pieces of wood *fagotted* as it were together. It is played by means of a bent mouth-piece and reed, and its compass is shown in the synoptical view of the different instruments at the end of the article MUSIC.

BASSO RILIEVO. *See* RILIEVO.

BASSO'RINE. A modification of gum, originally discovered by Vauquelin in gum bassora.

BA'STARD. A word of which the etymology is entirely uncertain. By the ancient legal course of precedent in England, the fact of birth during the marriage of the parents, or within a certain time after the death of the husband (extended in some cases to a great length, as in that of the Countess of Gloucester, temp. E. 2., to one year and seven months), was conclusive in favour of legitimacy. But this fact is now held to amount only to strong presumptive evidence, repellable by proof of non-access. The legal incapacities of an illegitimate child, by the law of England, relate wholly to the powers of inheritance and succession, to which he is in no respect entitled either as to real or personal property. In case of a divorce "a vinculo matrimonii" in the spiritual court, children born during the marriage are bastards by the law of England. The Scottish law is less strict in favour of legitimacy than that of England. Two species of legitimation have been adopted in it from the civil law: one, "per subsequens matrimonium," by the subsequent intermarriage of the parents (but a child born in Scotland, and legitimated by subsequent intermarriage in Scotland, is not entitled to succeed to real property in England; and, if born in England, remains a bastard to all intents and purposes); and, secondly, "per rescriptum principis," by letters of legitimation from the crown.

BASTARD STUCCO. In Architecture, plastering of three coats, whereof the first is usually roughing in, or rendering; the second floating, as in trowelled stucco; and the third or finishing coat contains a small quantity of hair besides the sand. Bastard stucco is not hand-floated, and the trowelling is done with less labour than what is called trowelled stucco.

BASTARD WING. (*Alula spuria*, Linn.) Three or five quill-like feathers, placed at a small joint rising at the middle part of the wing.

BASTI'LLE. In France, in the middle ages, towers and other outworks erected without the limits of towns were so called. The famous Bastille of Paris was an edifice of the same description, originally erected outside the city, near the modern Porte Saint Antoine. It was built by Hugues Aubriot, prévot des marchands, in 1369; and he is said to have been the first prisoner of state confined in it after it was employed for that purpose. The Bastille was taken by the people of Paris on the 14th of July, 1789, and demolished.

BASTINA'DO. (Ital. bastonnata, from bastone, *a stick*.) An ordinary mode of punishment in oriental countries, especially China, Turkey, and Persia. It is commonly inflicted upon the soles of the feet. According to the Turkish law, slaves and *rayahs* or tributaries alone are liable to it; but no such limitation is observed when the temper of a magistrate possessing summary authority is inflamed. This punishment is termed *zarb* in Turkish. It is extremely severe, although limited by law to the Jewish number of 39 blows, or 75 in some aggravated cases; but this regulation, like the other, is little observed in practice. (See generally, as to this species of infliction in penal law, the essay of Lanjuinais, *Sur la Bastonnade et la Flagellation penales*.)

BA'STION. A large projecting mass of earth or masonry at the angles of a fortified work, anciently called a bulwark. The modern bastion consists of two flanks, serving for the defence of the adjacent curtains, and two faces, making with each other an angle of 60° or upwards, which command the outworks and the ground before the fortification. The space between two bastions is called the curtain. The use of the bastions is to bring every point at the foot of the rampart as much as possible under the command of the guns, so that on whatever point a besieging army approaches it may be attacked sideways.

BAT. *See* VESPERTILIO, DERMOPTERA, CHEIROPTERA.

BATA'TAS. A species of convolvulaceous plant, *Convolvulus batatas*, a native of the East Indies, with fleshy sweet tubers. It is much cultivated for the sake of the latter in all the hotter parts of the world, where they are much esteemed as an article of food. Its name has now been popularly transferred to the potatoe, which has expelled it from cultivation in all temperate climates.

BATH. (From the Saxon bað.) In Architecture, a place for bathing. Among the ancients, the public baths were of very considerable extent, and consisted of a great number of apartments. These prodigious monuments of Roman magnificence seem to have been borrowed in some respects from the gymnasia of the Greeks, both the one and the other being instituted with a view to the exercise and health of the people. The word *thermæ*, which the Romans called these edifices signifies a place for the reception of hot baths; but both hot and cold were generally comprised in the same building. In later times, the Romans used the bath before they took their supper. The rich usually had hot and cold baths in their own houses, and it was not till the time of Augustus that the baths assumed an air of grandeur and magnificence. Different authors reckon nearly eight hundred baths in Rome. The most celebrated were those of Agrippa, Antoninus, Caracalla, Diocletian, Domitian, Nero, and Titus. Those of Diocletian are said to have been capable of accommodating eighteen hundred bathers. The vestiges of these stupendous buildings indicate the amazing magnificence of the age in which they were erected. Their pavements were mosaic; the ceilings vaulted, and richly gilt and painted; the walls encrusted with the rarest marbles. Many examples of ancient Greek sculpture have been restored to the world from these edifices. It was from the recesses of these buildings that Raphael took the hint for his decorations of the Vatican, and

largely from these resources drew the first restorers of the art.

BATH. In Chemistry, heated sand is often used as a medium for communicating heat, as glass and other vessels may be conveniently placed upon or immersed in it: sometimes water is used in the same way; hence *sand bath, water bath*, &c. The water bath is called by the old chemists Balneum Mariæ, and often abbreviated B.M.

BATH, ORDER OF THE. A British order of knighthood. On the day of his coronation, Henry IV. conferred the dignity of knighthood on forty-six esquires who had watched during the previous night, and bathed themselves, in pursuance of a very ancient custom, derived from the usages of the ancient Franks. It was usual, from this period, to make similar creations of knights on royal coronations, espousals, and similar solemnities; but the custom was discontinued after the coronation of Charles II., until George I., in the eleventh year of his reign, instituted the present order of the Bath by letters patent. It consisted, exclusive of the sovereign, of a grand-master and thirty-six companions; and was a military order. In 1815, the order was greatly extended (after several intermediate alterations), and is now composed of three classes — military and civil knights grand crosses, knights commanders, and knights companions, — who do not take the title or privilege of a knight bachelor, but take precedence of esquires. The badge worn by the grand crosses is now a golden cross of eight points, enamelled white, with a lion of England between the four principal angles; on the centre a sceptre erect, or, having on the sides a rose, thistle, and shamrock, engrafted between three imperial crowns proper, encircled with a riband gules; thereon the motto of the order, " Tria juncta in uno." They also wear a silver star. The badge of the knights commanders is the same with that of the knights grand crosses, but smaller; their cross somewhat different. The companions have only the badge without a star.

BA'THOS. (Gr. *βάθος, depth.*) A word invented to signify a ludicrous descent, in rhetoric, from elevated to mean thoughts. (*See* CLIMAX.) It has been chiefly rendered popular by Pope and Arbuthnot's jeu d'esprit, the " Treatise on the Bathos, by Martinus Scriblerus."

BATI'DEÆ. A small division of Urticaceous plants, containing but one genus, Batis, after which it is named. It yields soda in great quantity.

BA'TOLITES. A genus of fossil shells, considered by Cuvier as *hippurites.*

BA'TON. (Fr.) In Music, a term denoting a rest of four semibreves.

BATON is also the staff of a field marshal.

BA'TONNI'ER. (Mod. Lat. bastonarius.) In French, the elected president of an order or fraternity. The *batonnier* of the order of advocates is elected by the whole body. In ancient times he carried in their processions a staff (baton) with the flag of Saint Nicholas, whence the name. He is president of the council of discipline.

BATRA'CHIANS, BATRACHIA. (Gr. *βάτραχος, a frog.*) An order of Reptilia, including the frogs and toads, and all reptiles which, like them, have naked skins and external branchiæ, in the early stage of existence; those batrachia which retain the gills or gill-apertures throughout life are called "perennibranchiate," or " amphibious."

BA'TRACHOMY'OMA'CHIA. (Gr. *βατραχομυομαχία.*) *The Battle of the Frogs and Mice*, a mock heroic poem which has come down to us, and is attributed to Homer; but there is no probability that it was written by the author of the Iliad or Odyssey.

BA'TRACHOSPE'RMA. (Gr. *βάτραχος, a frog*, and *σπέρμα, seed.*) A name proposed for such Algaceous genera as are articulated and live in fresh water.

BATTA'LION. A division of the infantry in an army, composed of a variable number of men: at present, in the English service, it is about 750. One battalion generally constitutes a regiment; but some, as those of the Guards, consists of two battalions, and a regiment of artillery of eight. Each battalion is generally divided into ten companies; it is commanded by its own colonel; and several battalions or regiments are, on service, all united under one general officer, forming a brigade.

BA'TTARDEAU. (Fr. battre, and eau.) In Architecture, the same as *Cofferdam*, which see.

BA'TTEN. (Probably from the French bâton, from its slender width.) In Architecture, a name given by workmen to slips of wood, from two to four inches broad and one inch thick; the length considerable, but undefined.

BA'TTENED DOWN. Covering the hatchways in very bad weather with strong gratings, and these with painted canvass nailed under long pieces of wood (battens), to keep the water from getting below the decks.

BA'TTENING. (From batten.) In Architecture, narrow battens fixed to a wall, to which the laths for the plastering are nailed.

BA'TTER. (Probably from battre, Fr.) In Architecture, a term used by artificers to signify that a body does not stand upright, but inclines from you when you stand before it; when, on the contrary, it leans towards you, they describe its inclination by saying it overhangs.

BA'TTERING-RAM. An ancient military engine employed for beating down the walls of besieged fortresses. It consisted of a long heavy beam of timber, armed with iron at one extremity, and the effect was produced by pushing it violently with successive blows against the wall. The *ram* was worked in various ways. Sometimes it was simply supported by two files of soldiers, and the impetus given by a simultaneous thrust. More frequently it was slung from a cross beam, supported by two posts, by a rope or cable about its middle; in which case it had an oscillating motion, like a pendulum. A third sort was moved on rollers or wheels. Generally they were worked under a cover or shed (*vineæ* or *testudines*) to protect the assailants. These machines were often of immense size, and exceedingly ponderous, requiring 100 men to work them. Justus Lipsius describes a battering ram as 180 feet long, and two feet four inches in diameter, armed with an iron head weighing at least a ton and a half. The momentum of this ram, pushed forward by the united strength of 100 men, must have been equal to that of a 36-pound shot discharged point blank from a modern piece of heavy ordnance, and its efficacy in communicating a shock to the whole building very much greater.

BA'TTERY. A military term, denoting any raised place where cannon or mortars are planted. Batteries have various names, according to the different kinds of artillery employed, or the purposes they are designed to effect. *Breach batteries* are used to attack the face of a bastion, in order to make an accessible breach. *Batteries en echarpe* are those which play obliquely. *Ricochet battery*, one from which cannon are discharged with a very small quantity of powder and a little elevation, so as to carry the ball just over the parapet, where it rolls along the opposite rampart, and produces a destructive effect. They are placed perpendicular to the line to be enfiladed. In a ricochet battery, small mortars and howitzers are frequently used with effect in enfilading an enemy's ranks.

BA'TTLE. (Fr. bataille.) In the art Military, an engagement between two hostile armies for the accomplishment of some important object. A battle is the most important event in war: it is the consummation to which all the previous combinations of a general necessarily tend; it is that grand act of war which may decide the fate of kingdoms and of nations as well as that of armies and campaigns. In the early ages of the world a battle was merely a fierce and bloody struggle, the issue of which depended more on the physical strength of the combatants than on any scientific combinations which the general could adopt; but as the arts and sciences progressed, the military system was improved; and the battle of Marathon (the first well authenticated battle in profane history) demonstrated how far superiority in physical strength may be compensated by generalship and discipline. A further illustration of this fact is afforded in the subsequent battles of Platæa, Mantinea, and Leuctra, among the Greeks; and the banks of the Ticinus, the lake of Thrasymenus, and above all the plains of Cannæ, are memorable for engagements, which for ingenuity of design and dexterity of execution have excited the admiration of soldiers in every age. But to give even a faint sketch of the various exploits which were achieved by the Grecian so called *oblique* system, the Macedonian phalanx, and the Roman legion, and of the different military principles involved in their construction, would be to furnish a history of these different nations; and we must content ourselves with referring the reader to the article " Bataille," in the *Encyclopedie des Gens du Monde*, where some concise though scientific details upon this subject will be found. Though the weapons employed in battle in modern times are widely different from those in use among the ancients, and though many circumstances have combined to give an entirely different aspect to the military systems of the two periods, still it is surprising how strong a resemblance to each other is displayed in their ground-work; and it will be found on examination that the grand principles which even in the present century were adopted by Napoleon and the Duke of Wellington were practised, though imperfectly, by Epaminondas on the field of Leuctra. Indeed, it is a circumstance worthy of note, that the changes which in every age have taken place both in the manners and the weapons of nations have had no perceptible influence on the grand leading principles of military tactics. " Les tétrarchies," says a French author, "et les manipules sont representés chez les modernes par les compagnies: les xénagies ou syntagmes et les cohortes Romaines, par les bataillons; enfin, les phalanges et les légions, par les regimens, les brigades ou les divisions." There are three combinations of which a battle is susceptible: — 1. *Defensive*, which consists in taking up a position, and

defending it against the enemy. 2. *Offensive*, in which the enemy is sought to be harassed at all points and on all occasions. The third is a medium between these two, and presupposes on the part of the general sufficient skill to know when to make an attack, and when to act on the defensive. It is impossible to state precisely the principles which should guide a general in the adoption of one or other of these three systems, from the difficulty of providing against unexpected events which often occur to perplex or overturn the most matured and ingenious plans; but making due allowance for casualities of this nature, a reference to history will prove that design and ingenuity have generally triumphed over chance and accident; and that a skilful disposition of the troops, and the seizure of the proper moment for assuming the initiative, combined with courage and adroitness in prosecuting success, will ultimately be crowned with victory. For a full and elaborate view of the principles involved in a battle, the reader may consult with advantage *Jomini's Traité des Grandes Operations Militaires* (Paris, 1824); a system which is founded on the united principle of a *concentration of the forces*, and the *commencement of hostilities*.

BA'TTLE-AXE. A military weapon, which is purely offensive, and owes its origin to the Celtæ. It was not employed by the Greeks and Romans, though it was found among contemporary nations. At the siege of the Roman capitol by the Gauls under Brennus, the most distinguished warriors were armed with battle-axes; and Ammianus Marcellinus states, that this instrument formed part of the offensive armour of the Gauls from time immemorial. In England, Scotland, and Ireland, the battle-axe was much employed: the Lochaber axe, in particular, was long a formidable implement of destruction in the hands of the Scottish Highlander, and obtained almost a universal reputation.

BA'TTLEMENTS. (From battle.) In Architecture, a wall or parapet on the top of a building, with embrasures or open places to look through, or discharge missiles for the annoyance of an enemy.

BATTUE. (Fr.) In Sporting, a term indicating a practice of huntsmen which consists in encompassing a certain portion of the forest, and in endeavouring, by beating the bushes and with loud exclamations, to bring out wolves, foxes, or other animals of the chase.

BATTU'TA. (It. *a beating*.) In Music, the motion of beating with the hand or foot in directing the time.

BAUERA'CEÆ (so called from Mr. Bauer, their discoverer), a small natural order of New Holland shrubs with pretty purple flowers, related to *Saxifragaceæ*. There is but one genus.

BAULK. (From the Dutch.) Sometimes called Dram Timber. In Architecture, a piece of whole fir, being the trunk of a tree of that species of wood usually squared for building purposes. In the metropolis the term is only applied to small lengths from 18 to 25 feet, mostly under 10 inches square, tapering considerably, and with the angles so left that the baulk is not an exact square.

BAXTE'RIANS. In Ecclesiastical History, a name applied to those English theologians who adopted the sentiments of Richard Baxter on the subject of grace and free will, forming a sort of middle way between Calvinism and Arminianism. They never formed, strictly speaking, a sect, and the name is now disused: nevertheless, similarly modified religious opinions are common among nonconformists at this day.

BAY. (From the Dutch baye.) In Architecture, a division of a barn or other building, generally from 15 to 20 feet in length or breadth. In plasterers' work it is the space between the screeds prepared for regulating and working the floating rule. *See* SCREEDS.

BAY. (Fr. *baie*, Ital. *baia*, Span. *bahia*.) In Geography, a portion of the sea, inclosed between two capes or headlands, so that the opening is the widest part and the inlet gradually narrows within. It is thus distinguished from *gulf*, in which the opening is comparatively narrow. The distinction, however, is not always observed in nomenclature; *e. g.* Baffin's Bay, and Chesapeake Bay in America, are both more properly gulfs.

BA'YONET. A short triangular sword or dagger fixed upon the muzzle of a musket, which is thus transformed into a thrusting weapon. The original invention and subsequent improvement of the bayonet are due to the French, who first used it in the Netherlands in 1647, and the advantages which this weapon gained to that nation soon attracted notice to its merits. In the beginning of the eighteenth century, it was every where substituted for the pike, and in some instances it has decided the issue of an engagement without a single shot being fired. Many plans have been devised at different times to augment the efficiency of the bayonet, by turning it to the purposes of tilting and fencing; but when the cumbrousness of the instrument to which it is attached is considered, it will not seem surprising that all schemes of this nature have proved abortive. Cavalry are often counted by *horses*, and infantry by *bayonets*. (See *Guibert's Essai général de Tactique*.)

BAY SALT. (*See* SALT.) A large grained salt, obtained by the spontaneous evaporation of sea water in large shallow pits (bays) exposed to the full influence of sun and air; all coarse-grained salt is frequently known under the name of *bay salt*.

BAZA'AR. (From an Arabic word, signifying traffic or merchandise.) A large square or street where merchants in eastern countries have their shops or warehouses.

BDE'LLIUM. An African gum resin of a bitter nauseous taste, and a dark-brown colour. It is sometimes mixed with myrrh.

BDE'LLOSTOMES, BDELLOSTOMA. (Βδάλλω, and ςτομα, *a mouth adapted for suction*.) A genus of Cyclostomous fishes.

BEACH. In Geography, a shelving tract of sand or shingle washed by the sea or a freshwater lake, and interposed between the water and the land on which vegetation grows. The beach of the ocean is, generally speaking, little more than the space between low and high water mark; the beach of a lake, that between the water marks of the highest and lowest ordinary level of the lake. An inland sea without tide, such as the Mediterranean, has generally little beach, except on flat coasts, where the waters are apt to rise and fall considerably, according to the prevailing winds. *Raised beaches* exhibit a curious phenomenon in geology: they are tracts of shingle and gravel, indurated for the most part into the consistency of puddingstone or breccia, found on the sides of shelving ground at a level above that of some neighbouring lake or sea, in such a position as to leave no doubt that they had in ancient times been washed by its waters. They are found extending along large tracts in the vicinity of the great American lakes.

BE'ACON. (Sax. beacn or beacen, allied to the words *beck*, *beckon*, *i. e.* to point out, in the English language.) A fire lighted by way of signal on a height, or the place where such signals are usually made. Along the southern coast of England, many of the highest hills are provincially termed "beacon," from this circumstance. There is a celebrated poetical description of the transmission of news by fire signals, from height to height, in the *Agamemnon of Æschylus*. The English beacons were erected under the superintendence generally of the lord high admiral; they were usually pitch boxes, or fire pots, and their maintenance and watching was defrayed by a rate levied on the county. (See *Archæologia*, vols. i. and viii.)

BEAD. (Sax. beade.) In Architecture, a moulding whose vertical section is semicircular.

BEAK. In Botany, a hard sharp termination of any part of the fructification. It is Latinized by rostrum.

BEAM. (Sax. beam, *a tree*.) In Architecture, an horizontal piece of timber, used to resist a force or weight; as a tie beam, which acts as a string or chain by its tension; as a straining piece, where it acts by compression; as a bressummer, where it bears an insisting weight.

BEAM. In sea phrase, the width of a vessel. Thus a wide vessel is said to have *more beam* than a narrow one; the beams being the strong pieces of timber stretching across the ship from side to side, for the purpose of supporting the decks and retaining the sides at their proper distance. When a ship is lying entirely on her side, she is said to be *on her beam ends*. When this is the case in a hurricane or heavy gale, there is often no other resource to *right* the ship than cutting the masts away.

A-beam. In the direction perpendicular to the ship's length, a-midships. Thus an object seen from the middle of a vessel, 90 degrees or 8 points from the head or stern, is said to be a-beam.

BEA'MFILLING. In Architecture, the filling in masonry or brickwork between beams or joists, its height being equal to the depth of the timbers filled in.

BEAM-TREE. A deciduous British tree of small growth, inhabiting the mountainous parts of the country, and resembling a small apple tree, with berries like those of the mountain ash. Its leaves are strongly veined in a plaited manner, and white underneath; the wood is hard, compact, and tough, and is used for axletrees, naves of wheels, and cogs of machinery. The *Pyrus aria* of botanists.

BEAR. *See* URSUS.

BE'ARBERRY. The *Arctostaphylus uva ursi*. The leaves of this plant, under the name *uva ursi*, are used as an astringent and tonic in medicine.

BEARD. (*See* BARBA.) When applied to corn it is used in the sense of *Awn*, which also see.

BEARD. The gills or breathing organs of the oyster and other bivalves are vulgarly so called.

BE'ARER. (Sax. bapan, *to bear*.) In Architecture, any upright piece used to support another.

BE'ARING. In Geography and Navigation, the direction or point of the compass in which an object is seen; thus an object *bears* north, south, &c. when seen in these directions. When the distance of an object or point of land is specified besides the bearing, the place of the ship with respect to such object is obviously fixed; thus, the Land's

End N. 48°, E. 141 miles, determines the ship to be 141 miles in the S. 48° W. direction, or nearly south-west from the Land's End.

BEAR'S FOOT. *See* HELLEBORUS.

BEASTS. As charges in Heraldry, are said to be rampant, when represented rearing; sejant, when seated; statant, when standing; couchant, when lying; salient, when springing; passant, when walking (but the words *lodged*, *springing*, and *tripping*, are used of a beast of chase in these positions); gardant, when full-faced; regardant, looking back; dormant, sleeping; nascent, rising out of the middle of an ordinary; issuant, rising from its top or bottom. Two animals represented side by side, but moving in opposite directions, are said to be counter-passant, &c.

BEAT. (Beatan, *to beat.*) In Music, a reversed shake without a turn.

To *beat*, *beat up*, or *beat to windward*, in Navigation, making progress against the wind by a zigzag course, and is the same as working to windward.

BEAU IDEAL. (Fr.) In Painting, that beauty which is freed from the deformity and peculiarity found in nature in all individuals of a species. All the objects which nature exhibits to us have their blemishes and defects, though every eye is not capable of perceiving them; and it is only by long habit of observing what any objects of the same kind have in common that it acquires the faculty of discerning what each wants in particular. By such means the artist gains an idea of perfect nature, or what is called the *Beau Ideal*. *See* IDEAL.

BEAU'TY (Fr. beauté.) In the Fine Arts, that result of all the various perfections whereof an object is susceptible, which pleases the senses, and more particularly the eye and the ear. With the painter and sculptor nature, refined by selecting from the most perfect of the species, is the index and guide; but with the architect the creative power of nature herself is the model of imitation. Some of the sources of beauty have been seriously considered by no less a writer than Burke as consisting in smallness, smoothness, delicacy, and the like; but such speculations are too absurd for notice here. The primary source of all beauty in the three arts is *form*; on that alone must the artist depend if he would produce a work capable of pleasing. There is no doubt that in painting colour is a handmaid that decks her works with many charms; but they are all subordinate to that great effect which form, unaided by all accessaries, is capable of producing on the mind. As form is constituted by lines, it seems probable that an inquiry into their nature might lead the artist to the invention of beautiful forms; and it was doubtless this feeling which led Hogarth, in his *Analysis of Beauty*, to place so much to the account of the serpentine line. But in the arts generally the principles are infinitely more extended; for lines which, from their propriety in one art, are strikingly beautiful, become absolutely absurd as sources of beauty in others. Hence we arrive at one general conclusion, that in all of them fitness for the purpose and proportion to effect the object are the surest guide to beauty of line, and thence naturally to beauty of form. If this be so, no general laws save those dependent on fitness and proportion can be laid down; and perhaps it would not be a difficult task to trace to them all those associations which seem to be connected with the subject in its effect on the mind. Alison, in his elegant *Essays on the Nature and Principles of Taste*, appears to be much impressed with the feeling we have on this point; for he observes that "if there were any original and independent beauty in any *particular* form, the preference of this form would be early and decidedly marked both in the language of children and the opinions of mankind." We trust it may not be irreverent to close this article with a quotation which is as expressive of our notions of beauty as resulting from form as the inspired writer knew it to be true of qualities: "All flesh is not the same flesh; but there is one kind of flesh of men, another flesh of beasts, another of fishes, and another of birds. There are also celestial bodies, and bodies terrestrial; but the glory of the celestial is one, and the glory of the terrestrial is another."

BE'AVER. *See* CASTOR.

BE'CHICUS. (Gr. βὴξ, βηχὸς, *a cough.*) A medicine for the relief of coughs.

BED. (Sax. beð.) In Architecture, the horizontal surface on which the stones or bricks of walls lie in courses.

BED OF A STONE, BRICK, OR SLATE. In Architecture, the lower surface.

BE'DCHA'MBER, LORDS OF THE, or, as they were called before the accession of the House of Hanover, *Gentlemen of the Bedchamber*, are officers of the royal household, under the groom of the stole; their number has usually been twelve, and they wait in turn, a week each. This office is performed by *ladies* during the reign of a queen.

BED MOULDING. In Architecture, those mouldings in all the orders which are between the corona and frieze.

BED OF JUSTICE. (Fr. lit de justice.) In French History, a solemn proceeding to which the monarchs of France had recourse on particular occasions. As is well known, the parliament of that country had a right to resist any commands or decrees issued by the sovereign. If, however, the king insisted on the fulfilment of his wishes, he proceeded to hold a "lit de justice:" *i. e.* he went in person to parliament, attended by the chief officers of the court, and there, mounting the throne (called in the old French language "lit"), caused those commands or decrees which the parliament had rejected to be registered in his presence. This had the effect of intimidating the parliament into compliance; and the means which it usually adopted to intimate its dissatisfaction was to enter a protest against the whole proceeding.

BEDS. In Geology, seams of strata, thick or thin.

BEE. *See* APIS.

BEECH. One of the forest trees of the north of Europe, the *Fagus sylvatica* of botanists, belonging to the natural order *Corylaceæ*. Its fruit, or mast, consists of triangular nuts enclosed in a spiny husk or cupule, of the same nature as the cup of the acorn, only of a different shape, and covering the nuts all over. Its wood, which is hard and rather handsome, is brittle and perishable, and particularly liable to become wormeaten. It is chiefly used by turners and millwrights. The purple and copper beeches seen in plantations are seedling varieties of *Fagus sylvatica*.

BEE-EATER *See* MEROPS.

BEEF-EATER. (By corruption from the French *beauffetier*, an officer appointed to watch the beauffet, buffet, or side-board.) A popular appellation for the yeomen of the king's guard, partially derived from the circumstance that some of them originally were ranged at table on solemn festivals.

BEE'LZEBUB. (Heb.) A god of the Philistines, who had a famous temple at Ekron. His name signifies literally the destroyer of flies; and if we consider the torment which those insignificant insects occasion in the East, it will not seem surprising that the Philistines conferred on him this appellation. Besides, it is quite in conformity with the practice of other idolatrous nations to consider their gods as the destroyers of offensive vermin. Take, for instance, the Apollo Σμινθευς (the destroyer of rats) of the Greeks. Milton in his epic poem assigns him the second rank; and in the second book, where he is represented as rising to address the fallen angels, there is an air of majesty in his demeanour nowhere surpassed.

BEER. (From the German *bier.*) The wine of grain. It is usually made by fermenting an infusion of barley malt and of hops, and bears different names according to its strength and colour. It is nutritious from the sugar and mucilage which it contains, exhilarating from the spirit, and strengthening and narcotic from the hops. Mr. Brande obtained the following quantities of alcohol from 100 parts of different beers: — Burton ale, between 8 and 9; Edinburgh ale, 6 to 7; Dorchester ale, 5 to 6; the average of strong ales being between 6 and 7; brown stout, 6 to 7; London porter, about 4 (average); and London brewers' small beer between 1 and 2. *See* FERMENTATION.

BEET. (Celt. bett, *red.*) The sweet succulent root of *Beta vulgaris*, a Chenopodiaceous plant of biennial duration. It is used in the winter as a salad, for which purpose the red and yellow beets of Castelnaudari are the best; for the food of cattle, under the name of mangel wurzel; and for the extraction of sugar: for the last object a white-rooted variety with a purple crown is the most esteemed. Sea beet, *Beta maritima*, is a well-known and excellent substitute for spinach.

BE'ETLE. (Sax. bytel.) In Architecture, a large wooden hammer or mallet, with one, two, or three handles, for as many persons, with which piles, stakes, wedges, &c. are driven.

BEETLE. A name commonly given to the insects of the Coleopterous order, especially to such as are of a dark or obscure colour; it is also applied, but improperly, to the common pest of our kitchens, the blatta, or cockroach, which is an insect of the Orthopterous order.

BEGHA'RDS. A German word, signifying one who begs with importunity. In this sense, it was frequently applied to the Franciscan and other mendicant orders, denoting the practice by which they gained their subsistence. The Beghards formed a sort of intermediate class between the monks and laity, and were known under various denominations; as the tertianes or half monks of the mendicant orders, the fraternity of the weavers, the brethren of St. Alexius, &c. But the term has also been affixed to a set of persons who, in the thirteenth century, became notorious for the frequency and ardour of their prayers.

The BEGUINS were a class of women throughout Germany and the Netherlands, who as early as the eleventh century, without taking vows or following the rules of any order, united themselves for devotional and charitable purposes, and were distinguished from the great body

of the laity of those times by their industrious, pious, and secluded habits, and by their attention to the education of the young. Their conduct was imitated by men, who formed a union for similar purposes, and were called Beghards (see above). The Beguins continued to exist in Germany up to the Reformation, under the name of "seelen weiber" (spiritual women), from the interest they took in the spiritual concerns of their sex; and a society of them was even seen at Louvain, in the Netherlands, towards the close of last century. There are now in some Roman Catholic countries societies or beguinages of females, who live together after the manner of nuns without taking vows; but, by their mode of life and profession, maintaining the same intermediate state between the laity and the clergy which was first remarkable in the Beghards and Beguins of the eleventh century. The most celebrated is at Ghent.

BEGONIA'CEÆ. (Begonia, the principal genus.) A natural order of Polypetalous Exogens, with showy pink or white flowers and handsome succulent leaves, which are frequently richly coloured or gaily variegated, and have one side considerably larger than the other. Their leaves have large stipules, and a subacid flavour. Much difference of opinion exists among botanists as to their affinity. They generally inhabit the dampest parts of the tropics, and are favourites with cultivators both for their beauty and the facility with which they are maintained, in health.

BEHE'MOTH. (Hebrew.) The name of an animal, of which some of the characters and attributes are described in poetical language in the 40th chapter of the Book of Job. Much pains have been taken to identify the creature here referred to; but it must be remembered that the discovery and general adoption of a mode of description which combines at once exactness with brevity, and is applicable only to the object described, are the results of a recent and highly advanced state of zoological science. Even the prosaic, and, so far as they went, scientific descriptions of animals in the writings of Aristotle, are rarely so copious and precise as to enable a modern naturalist to identify the existing species there referred to. But the aim of Job in the verses in which he sings of *Thau*, *Leviathan*, *Behemoth*, was to show forth the power and wisdom of the Deity, and lower the pride of man, by appealing to the wonderful powers assigned to some of the most remarkable and formidable objects of animated nature with which he was acquainted; and it can hardly therefore be expected that curiosity, eager to hunt out the precise species alluded to, should be gratified. Sufficient source of doubt has always been left to shake the most sagacious conjectures; and some recent inquirers into Biblical zoology, perceiving that the properties of Behemoth were not manifested to the letter in any known existing species, have endeavoured to make the scriptural allusions square with the characters of one of the gigantic extinct animals which the study of fossil remains has brought to light: the *Iguanodon*, for example, a supposed herbivorous reptile, with a horn on the nose and a long and flexible tail, has been selected as the species described by Job. The allusion, in verse 17., to a part of the generative organs, which is visible externally only in the class of mammalia, renders it very improbable that Behemoth could be one of the Reptilia. The exclamation, also, "Behold he drinketh up a river and hasteth not! He trusteth that he can draw up Jordan into his mouth," could not with any appearance of truth be applied to a species of a class of animals of which the organization requires them to drink so little and so seldom. If a mammiferous quadruped, then Behemoth was a herbivorous and ungulate species: "He eateth grass as an ox" (verse 15.); but, unlike the males of the larger ruminants, he had not a divided scrotum, for "the sinews of his stones were wrapt together" (verse 17.) Thus from the few zoological characters which are brought under our consideration, we come to the conclusion that some huge pachyderm, "whose haunt was in the fens, whose place of retreat was encompassed by the willows of the brook, and overshadowed by trees, was "the chief of the ways of God," in the language and mind of the sacred poet.

As there exist differences of opinion among the best Hebrew scholars as to the exact signification of the first part of verse 17., which some have rendered "He sitteth up," and of the second part of verse 19., where allusion is made to some weapon, these become obviously unsafe elements, in the consideration of the zoological problem.

BELE'MNITES. (Gr. βελεμνον, *a dart.*) A genus of fossil Dibranchiate Cephalopods, the shells of which are chambered and perforated by a siphon, but internal. They are long, straight, and conical; and commonly called "thunder stones." These fossil remains are often found in chalk.

BEL-ESPRIT. (Fr.) A term formerly naturalized in England, applied to those individuals whose conversation or writings display an agreeable sprightliness or vivacity. (*Dict. Aca. Franç.*)

BE'LFRY. (Sax. bell, and Lat. ferre, *to carry.*) In Architecture, a tower or other place in which bells are hung. *See* CAMPANILE.

BE'LIAL. A Hebrew word, signifying wicked, worthless, and unprofitable. In Scripture, the sons of Eli are called sons of Belial, for their idolatrous and criminal conduct (1 Sam. ii. 12.); and likewise the inhabitants of Gibeah, who abused the prophet's wife. (Judg. xix. 22.) The apostle Paul (2 Cor. vi. 15.), in order to indicate in the strongest terms the high degree of virtue after which the Christian should strive, places Christ in direct opposition to Belial. Our own epic poet has immortalized the infamy of Belial, by assigning him a prominent place in his *Paradise Lost.*

> A fairer person lost not heaven; he seemed
> For dignity composed, and high exploit.
> But all was false and hollow, though his tongue
> Dropped manna, and could make the worse appear
> The better reason, to perplex and dash
> Maturest counsels, for his thoughts were low:
> To vice industrious, but to nobler deeds
> Timorous and slothful, &c.

In the *Paradise Regained*, Milton represents even Satan as fired with indignation at the impiety of Belial, and as administering to him a sharp rebuke. (*Vide* Addison's Critique on Milton in the *Spectator.*) To these quotations may be added an allusion to Belial by Wierus. (*Pseudomonarchia Dæmonum*, p. 919.) "Sunt quidam necromantici qui asserunt ipsum Salomonem, quodam die astutiâ cujusdam mulieris seductum, orando se inclinâsse versus simulacrum Belial nomine."

BELL. A vessel or hollow body of cast metal, formed to emit sound by the act of some instrument striking against it. Bells are probably of very ancient origin; they are mentioned as worn upon the high priest's robes, in the book of Exodus (ch. xxviii. ver. 3.) They were used among the Greeks in camps and garrisons. Church bells are said to have been invented by Paulinus, bishop of Nola in Campania (whence the term Campana), about the year 400. They are first mentioned in England by Bede, towards the end of the seventh century.

BELLA DONNA. (*Atropa bella donna.*) The deadly nightshade: it is an acro-narcotic poison. The name bella donna (*handsome lady*) is said to have been given from its having been used to improve the complexion. It contains the alkaloid *atropia*.

BELLE'ROPHON. (Gr. βελλεροφοντης; called also Hipponous.) In the fabulous history of Argos, the son of Glaucus, and grandson of Sisyphus (*Paus.* 2. 4.), who was obliged to flee from Corinth for the murder of Bellerus, and seek refuge at the court of Proetus. There Antæa, the wife of Proetus, conceived a violent attachment for him, which he requited as Joseph did the advances of Potiphar's wife. Nor does the analogy between the cases end here; for Antæa forthwith accused him to her husband of attempts on her virtue. Proetus, however, unwilling to violate the laws of hospitality, sent him to Tobates, king of Lycia, his wife's father, with a letter desiring him to put Bellerophon to death, and mentioning the cause. (Hence, a letter unfavourable to the bearer was called "Literæ Bellerophontis.") With this view, Tobates sent him on various perilous expeditions: first, against the Chimaera, a dreadful monster, which continually vomited flames (*Lucre.* v. 902.; *Virg. Æn.* vi. 288. vii. 785.), and which at that time devastated the country of Lycia, having the head of a lion, the middle of a goat, and the tail of a serpent. (*Ovid. Met.* ix. 646.) This monster, however, Bellerophon succeeded in destroying by the aid of a winged horse called Pegasus (*see* PEGASUS), which he had caught while drinking at the fountain Pirene in Corinth. In his next expeditions against the Solymi and the Amazons, he was equally successful (*Hom. Il.* vi. 155.), and consequently obtained the forgiveness of Tobates. Elated by his success, Bellerophon tried to fly to heaven on Pegasus; but Jupiter, enraged at his presumption, frustrated his attempts by sending an insect (œstrum) which stung the horse so violently that he became restive and threw his rider. Though maimed and shattered by the fall, Bellerophon was not killed; but he never perfectly recovered, and continued during the rest of his life to wander up and down in sorrow and dejection. (*Hom. Il.* vi. 201.) Bellerophon, we may add, was celebrated for his skill in horsemanship (*Hor.* Od. iii. 12. 7.), and is said to have first taught the art of riding. (*Plin.* iv. 56.)

BELLE'ROPHON. A fossil shell, the animal of which was probably allied to that of *argonauta*. The genus belongs to the carboniferous and older strata.

BELLES-LETTRES. (Fr.) Polite Literature. Almost all authors concur in censuring the vague and indefinite character of this term, as at one time every branch of knowledge has been included under this denomination, at another, excluded from it. Sometimes we are told that by the belles-lettres is meant a knowledge of the arts of oratory and poetry; sometimes that the true belles-lettres include natural philosophy,

geometry, and other essential parts of learning; and one author, in treating of the belles-lettres, introduces a discourse on the seven sacraments of the Romish church. In the division of the departments at the Lyceum of Arts, established at Paris in 1792, the belles-lettres comprehended general grammar, languages, rhetoric, geography, history, antiquities, and numismatics; whilst philosophy and the various branches of the mathematics were called, in contradistinction, sciences. Rollin and Rosenstein, who professedly treat of the belles-lettres, comprehend under the term all those instructive and pleasing branches of knowledge which chiefly occupy the memory and the understanding, and do not form part either of the superior sciences or of the mechanical professions. Belles-lettres, says Blair (after pointing out the tendencies of logical and ethical disquisitions), consider man as a being endowed with those powers of taste and imagination which were intended to embellish his mind, and to supply him with rational and useful entertainment. All that relates to beauty, harmony, grandeur, and elegance — all that can soothe the mind, gratify the fancy, or move the affections, belongs to their province. In an inquiry of this kind, reference must necessarily be made to Hume, who, both from the nature of his pursuits and the bent of his mind, was well qualified to give an opinion. Paraphrasing the well-known passage of a classic author, —

> Ingenuas didicisse fideliter artes
> Emollit mores, nec sinit esse feros, —

he asserts, that the belles-lettres improve our sensibility for all the tender and agreeable passions, at the same time that they render the mind incapable of the rougher and more boisterous emotions. Still the difficulty is not removed; for while all those writers concur in awarding a distinguished place in the category of learning to the "ingenuæ artes," the "literæ humaniores," as the belles-lettres are called, they have, if not thrown a veil of obscurity over the precise definition of the term, at least not condescended to remove it. If we have recourse to the Germans, we shall find that they comprehend under the denomination belles-lettres every branch of learning that is not cultivated with an ulterior view to pecuniary emolument; but their adoption of the term *belletristic*, to express all that relates to works of taste or æsthetics, does not appear to coincide with the definition above given by their professed lexicographers.

But though it would appear difficult to reduce this term within the limits of a precise and accurate definition, there can be little doubt that there are few terms which present so distinct a meaning to each individual mind. The influence of the belles-lettres has been felt and acknowledged in all ages. The beautiful tribute paid to them by Cicero in his defence of Archias is familiar to all. But we shall advert to the sentiments of another Roman, with whom we are more likely to sympathise, as he at least cannot be charged with special pleading. In the beautiful letter to Mæcenas, who was afflicted with some mental distemper, Horace first advises his friend to have recourse to the study of polite literature in particular, —

> Sunt *verba* et *voces* quibus hunc lenire dolorem
> Possis, et magnam morbi deponere partem;

and then concludes in these general terms, —

> Invidus, iracundus, iners, vinosus, amator,
> Nemo adeo ferus est, ut non mitescere possit,
> Si modo culturæ patientem commodet aurem.

But the high importance with which the same accomplished author has invested polite literature may be still better perceived in another of his epistles, —

> Trojani belli scriptorem . . . . .
> . . . . Præneste relegi,
> Qui, quid sit pulchrum, quid turpe, quid utile, quid non
> Planius et melius Chrysippo et Crantore dicit.

In this passage Horace pronounces Homer to be the most instructive teacher of moral and political philosophy; and indeed the tribute of respect which all the European nations pay to the Greeks in general, and to Homer in particular, as the authors of their refinement, sufficiently corroborates the opinion of the poet.

It would greatly exceed our limits to give even a cursory view of the belles-lettres in the decline and fall of the Roman empire; but we refer the reader to *Schlegel's History of Literature*, and to *Hallam's Introduction*, &c., for full information on this head. It may, however, be remarked, that during the long period of the middle ages (which has been often, though erroneously, considered as a blank in the history of the human mind) learning was almost wholly confined to the church; and though there was little original genius displayed in the province of imagination, yet here was preserved the germ of the future polite literature of Europe. As early as the 14th century, the spirit of polite literature, that had long been slumbering, was reanimated by the genius of Petrarch, and burst forth like a meteor in the Italian republics. Its genial influence was soon felt on this side the Alps; and in the year 1400, as Mr. Hallam observes, Spain, France, England, and Germany were in possession of a national literature. The traces of this spirit, however, were soon obliterated, and its effects gradually swallowed up in the wars that everywhere ensued, and in the all-absorbing taste for metaphysical and theological disquisitions that subsequently prevailed.

It is to the Reformation that may properly be ascribed the origin of polite literature in modern times; though, to use the words of Schlegel, the authors of that mighty spiritual revolution probably contemplated no other result from it than the emancipation of Europe from ecclesiastical bondage. Among the first-fruits of its effects upon the interests of the belles-lettres in England, it may suffice to mention the names of Spenser, Shakspeare, Dryden, and Milton, who have embodied in their writings all the riches of the English language, and whose works are of themselves sufficient to furnish any nation with a polite literature of which it might justly be proud. In France, too, shortly afterwards, literature assumed a novel and substantial form; and in the age of Louis XIV. there arose a mighty host of literary stars, which were only equalled in brilliancy by a contemporaneous galaxy of British genius.

The close of the last and the dawn of the present century may be regarded as an era in the history of polite literature throughout Europe. Never at any former period were the true nature and object, the wide extent and dignity, of the belles-lettres so universally appreciated. While, on the Continent, Göethe and Schiller were scattering from their rich and inexhaustible stores "thoughts that breathe, and words that burn," England could at the same time boast of the brilliant productions of the Great Unknown, whose influence on polite literature has been well compared to that of the bright luminary on the terrestrial globe. The rapid strides, too, that have been made in the art of criticism, the establishment of reviews in every country on a more comprehensive plan than was ever previously adopted, and the general ability with which these are executed, have greatly contributed to the formation and confirmation of a literary taste. In his admirable Essay on the Rise of the Arts and Sciences, Hume has remarked, that nothing is more favourable to the rise of politeness and learning than a number of neighbouring and independent states connected together by commerce and policy. Now, if we apply this observation to the various classes of society in the same country, and contrast the present state of society with that which existed even in the time of Hume, we may perhaps find another clue to the wide spread and cultivation of polite literature among us. At no very distant period, a broad line of demarcation was drawn between the literary and commercial classes of the community; in fact, literature and commerce stood separated like two different worlds revolving in different spheres. But the scene is changed; the framework of society has become more artificial and complicated; and we may now see the learning of the philosopher, the acuteness and promptitude of the man of business, and the earnestness and enthusiasm of the solitary artist, all brought into actual contact, and shedding each its influence upon the rest. *Schlegel's History of Literature.* (*See* art. LITERATURE in this work, and the authorities there referred to.)

BELL METAL. An alloy of 80 parts of copper and 20 of tin. The Indian gong metal is a similar alloy. An English bell metal analysed by Dr. Thomson was found to consist of 800 copper, 101 tin, 56 zinc, and 43 lead. Small shrill bells generally contain zinc.

BELLO'NA. (Lat. bellum.) In the mythology of the ancients, was the wife or sister or the sister wife of Mars, and was especially worshipped by the Romans as the goddess of war. She possessed a temple, built and dedicated to her by Appius Claudius, which stood in the Circus Flaminius, near the Porta Carmentalis. It was here that the senate granted audiences to foreign ambassadors, and received generals on their return from abroad. In front of this temple also stood the pillar against which the javelin was hurled, the usual preliminary among the Romans to a declaration of war. Bellona is generally depicted as the charioteer of Mars, with wild dishevelled hair, bloody garments, and a torch in her hand. Though the Romans were her chief worshippers, there were many temples dedicated to her service in Cappadocia and Paphlagonia. The priests of this goddess, who were termed *Bellonarii*, consecrated themselves by incisions in their bodies, and sacrificed to her honour the blood which flowed from their wounds.

BE'LLOWS. A machine contrived to propel air through a tube or orifice. It is used for blowing fires, supplying the pipes of organs, and other purposes, and is constructed according to various forms, but the principle is the same in all of them. The dimensions of a space in which air is confined are contracted; the air, being permitted to escape only at a small opening, rushes out

with a velocity proportional to the pressure and to the smallness of the opening.

BE'LLUÆ. (Lat. bellua, *any great beast.*) The term by which Linnæus designated an order of Mammalia, nearly corresponding to the Pachyderms of Cuvier.

BE'LOMANCY. (Gr. βελος, *javelin*, and μαντεια, *prophecy.*) Divination by the flight of arrows, common to various oriental nations, and especially observed by the Arabians. It has been performed in various modes; one of the most common is, to let fly arrows, with inscriptions on labels attached to them, and take for a guide the contents of that belonging to the arrow first found.

BEL'TANE, or BE'LTIN. (Said to be the "fire of Bel" or Belus.) May-day, and the traditional Celtic customs attached to it. The month of May is thus called in the present Irish language. This day is particularly celebrated by the herdsmen in the Highlands of Scotland. The Beltane-fire, Beltane-cake, &c., are all observances of this day.

BELTS. A name given to the zones or bands which appear on the disk of the planet Jupiter. They are situated near and parallel to the equator of the planet, and are supposed to be produced by clouds in its atmosphere arranged in parallel strata, by currents of wind, which, by reason of the rapid rotation of the planet, must in the equatorial regions blow always in the same direction.

BELVEDE'RE. (It. *a fine prospect.*) In Architecture, a small building at the top of a house or palace, constructed, as the name implies, to obtain a view of the country.

BELVISI'EÆ. (Belvisia, one of the genera.) In Botany, a natural order of monopetalous Exogens, inhabiting Africa on the west side. Scarcely anything is known of the species, and its affinities are quite unsettled. One of the species was called *Napoleona imperialis* by its discoverer, Palisot de Beauvois, after whom the genus typical of the order is now named.

BE'MBEX. A genus of Hymenopterous aculeate insects of the tribe *Fossores*, or burrowing sand-wasps; raised by Dr. Leech to the rank of a family (*Bembecidæ*), and including the genera *Bembex* proper, *Monedula*, and *Stizus*. Head transverse, with the upper lip exposed; tongue long, legs short; the brachia of the female furnished at the sides with very strong spines for burrowing in the sand. For the habits of this family, *see* Fossores.

BEMBI'DIUM. A name applied by Latreille to a genus of Coleopterous insects, of the tribe *Carabidæ*. Now raised to the rank of a family (*Bembidiidæ*), including the genera *Lymneum* 1, *Cillenum* 1, *Tachys* 8, *Philochthus* 6, *Ocys* 3, *Peryphus* 16, *Notaphus* 9, *Sopha* 11, *Tachypus* 9, *Bembidium* proper 4: the figures refer to the number of indigenous species in each of the genera. The common characters of the group are, cubits notched, elytra rounded at the extremity, abdomen not pedicellate, external maxillary palpi terminated by a very minute and acute joint, antennæ sub-elongate. The *Bembidiidæ* are generally found in low and damp situations, are of very small size, and glitter with polished metallic colours.

BEND. In Heraldry, an ordinary bounded by parallel lines, equally distant from the line joining the dexter base to the sinister chief. It contains the fifth part of the escutcheon if charged, and the third if not charged. The bend sinister, descending from the sinister chief to the dexter base, is the well-known difference which denotes bastardy, being borne on the paternal escutcheon of the bastard.

To Bend. The general sea term for fastening any thing; as to bend one rope to another, the cable to the anchor, a sail to a yard or gaff. Certain knots are called *bends;* as a carrick bend, a fisherman's bend, &c.

BENDS, called also WALES. A certain number of thick planks of the ship's side, from the water upwards.

BENEDI'CTINE MONKS. An order of monks that followed the rule of St. Benedict, which, as early as the 6th century, had extended itself through Italy, France, Spain, Germany, and England. The rules of Benedict, although founded no doubt on the old monastic institutions of Cassian (*Cassiani Opera*, Lips. 1733), were of a much more rational and comprehensive character. Avoiding the extreme rigour of the Eastern systems, he not only exacted a promise from all who entered a convent that they would remain for life, and strictly observe its rules (*Marten. Commen. in Regulas Bened.* Paris, 1690), but prescribed to them a variety of suitable employments. This system soon made rapid progress, and the monks began to be useful to society in various ways: reclaiming waste lands, promoting zealously the cause of education, preserving the history of the times in their chronicles, and multiplying the treasures of antiquity by their copyists. Under Charles the Great this order of monks was preferred to every other; and the spirit of inquiry which they then called into existence was perpetuated by the depth of their enthusiasm and the extent of their learning. To give even a cursory history of this order would far exceed our limits, as it embraces perhaps the palmiest days of ecclesiastical domination. (Vide *Gieseler's Kirchen-geschichte;* a work of great learning, and, as a book of reference, incomparable.) As is universally known, it is to the Benedictine monks that England (A. D. 596) is indebted for its conversion from idolatry. This order has produced a vast number of ancient writers and men of learning. Among others, Placidius Maurus founded the school of Germany; Alcuinus the university of Paris; Guido invented the scale of music; Dionysius Exiguus completed the collection of papal decrees (A. D. 510); and the most learned man of his time, the admiration of the whole Western world, the Venerable Bede, belonged to this order.

BE'NEFICE. (Lat. beneficium.) A word denoting a certain class of church preferments, viz. rectories, vicarages, perpetual curacies, and chaplaincies; and distinguished from a dignity, under which title are comprehended bishoprics, deaneries, and prebends. Under the Romans, certain grants of lands made to the veteran soldiers were called beneficia; and the same term was applied at the commencement of the feudal system to estates conferred by the sovereign and held under him: which afterwards assuming a hereditary character became "fiefs" properly so called. In the middle ages the popes assumed the feudal right with reference to ecclesiastical "patronage," and the term beneficium was hence applied to livings, &c., on the assumption that they were held under the pope as a superior lord. It was the assertion of this claim by Innocent III. and his successors which roused the jealousy of the European sovereigns, especially those of England and France; and from the contentions consequent upon this the first opening was made to the cause of Reformation.

BE'NEFIT OF CLERGY. In Law, originated in the immunities from municipal jurisdiction enjoyed in many states of Europe by the Roman Catholic clergy during the middle ages. When a person indicted for certain offences (most of those subjecting the offender to capital or corporeal punishment, excepting high treason) pleaded that he was a clerk or clergyman, and claimed privilege, he was demanded by his ordinary: a jury was summoned, and he was tried; and, according to their verdict, delivered to the ordinary as acquit or convict, to undergo canonical purgation, and to be discharged or punished according to the result of such purgation. The proof of clergy, at first strictly required, was at last so relaxed, that it was only necessary for the offender to show that he was able to read. The bishop's commissary was present, to decide whether or not he passed the test satisfactorily. This loose mode of acquiring the privilege was first restricted by the stat. 4 H. 7. c. 13., which provided that offenders who had been allowed their clergy should be "burnt in the thumb," and if they claimed it a second time, be required to give proof of being actually in orders. By 18 Eliz. c. 7., the second trial by compurgation before the ordinary (which had become a mere fiction) was abolished, and the judges were empowered to imprison the person who had benefit of clergy for a year, if they thought proper. By various subsequent statutes, the burning in the hand was commuted for transportation, whipping, &c., at the discretion of the judges; and the benefit was taken away altogether from a number of statutable felonies. By 5 Anne, c. 6., the ceremony of reading was abolished, benefit of clergy being granted indiscriminately to all entitled to it; and finally by one of the enactments commonly called Peel's Acts (7 & 8 G. 4. c. 28. s. 6) benefit of clergy was abolished altogether.

BENE'VOLENCE. (Lat.) In English History, a species of tax levied by the sovereign. As its name implies, it was nominally a gratuity; but was, in point of fact, exacted as a forced loan, with or without the condition of repayment, under the reigns of the Plantagenet kings. By a statute of Richard III. benevolences were declared illegal; but they were again exacted by Henry VII., and occasionally, by means of circulars under the privy seal, by his successors. By 13 C. 2. stat. 1. c. 4. no voluntary aid can be raised on behalf of the king without the authority of parliament; and the general illegality of levying money for the use of the crown without such authority was declared in 1688 by the Bill of Rights.

BEN NUTS. The seeds of an Arabian plant called *Moringa aptera;* they yield an oil, called oil of ben, and have been employed in syphilitic diseases.

BEN, OIL OF. The expressed oil of the nut of the *Moringa aptera.* This oil is remarkable for not becoming rancid by age; and as it is perfectly insipid and inodorous, it is used for extracting the fragrancy of certain flowers, such as jessamin, orange, &c. The same tree furnishes the *Lignun nephriticum*, supposed to be useful in certain affections of the kidneys.

BENT GRASS. A species of Agrostis, the bent and creeping stems of which are very difficult to eradicate.

BENTS. The withered stalks of grass standing in a pasture after the seeds have dropped.

BE'NZAMIDE. A compound, obtained by exposing chloride of benzule to ammoniacal gas.

BENZO'IC ACID. This acid forms a constituent of many balsams; it is generally obtained by heating benzoin, and collecting the acid vapours which are evolved and condense in brilliant acicular crystals. It is a compound of carbon, hydrogen, and oxygen; its equivalent being 120. Its combinations are called *Benzoates*.

BENZO'IN. The resinous exudation of the *Styrax benzoe*, a tree which is a native of Sumatra. Benzoin is a combination of resin and *benzoic acid*. It has a mottled or amygdaloid texture, and is composed of a mixture of brown and white parts. It has a fragrant odour.

BENZULE. (From benzoin, and ὕλη, *principle*.) A compound of carbon, hydrogen, and oxygen, regarded as the base of benzoic acid.

BERBERA'CEÆ, or BERBERIDEÆ. A natural order of plants, named after the genus Berberis, which is in fact the most important genus it contains. It is the only one whose fruit is succulent and eatable; that of the others is dry and hard.

BE'RBEREN. A yellow bitter principle, contained in the alcoholic extract of the root of the barberry tree.

BE'RBERRY. (Lat. berberis.) A spiny shrubby plant, bearing yellow flowers, and succulent one-celled fruit growing in racemes. It is one of a genus in which the fruit is universally fleshy and acid, although often less so than in the common kind (*Berberis vulgaris*). Some of the species have pinnated leaves, many are evergreens, and several have a black fruit; even the common sort has a variety of this description, as well as others with pale yellow and stoneless fruit. There is an idea among people in the country that a berberry bush brings blight to a wheat field; but the parasitical fungus which attacks the berberry is altogether different from that which produces the mildew of wheat, which cannot possibly be communicated by the one to the other.

BE'RGAMOT, ESSENCE OF. The essential oil of the rind of a small pear-shaped fruit, the produce of the *Citrus limetta bergamium*. It is much used as a perfume, and apt to be adulterated with the oils of orange and lemon peel, and with alcohol.

BERO'SUS. In Entomology, a genus of Coleopterous insects of the family *Hydrophilidæ*. They inhabit ponds, in which they may often be seen swimming in an inverted position.

BE'RYL. A mineral allied to the emerald, composed of 68 silica, 15 alumina, 14 glucine, 2 lime, 1 oxide of iron. It is usually transparent, pale green, and in beautiful crystals, much larger than those of the emerald. It is the *aquamarine* of the jewellers. The finest comes from Dauria, on the frontiers of China, from Siberia, and from Brazil.

BESI'MEN. An obsolete term for the spores or seeds of the lowest kinds of plants, especially of Algæ.

BE'TEL. The leaf of the betel or Siriboa pepper, which is chewed by the inhabitants of many parts of India along with a nut of the areca palm tree and lime; which substances are wrapped in the betel leaf. It is acrid and narcotic, and stains the saliva red.

BETHY'LUS. In Entomology, a genus of Hymenopterous insects of the family *Proctotrupidæ*.

BETRO'THMENT. A mutual compact between two parties, by which they bind themselves to marry. Betrothment was a legal contract by the Roman law, as it now is in that of various continental countries. In Germany, betrothments are either public, with the consent of relations and presence of witnesses; or private (clandestine), which in some countries are void, in others, although valid as contracts, punishable as misdemeanors. Public betrothment induces the obligation to marry. But according to modern practice an action for damages is almost the only way of enforcing it; a small fine or imprisonment being the utmost criminal penalty for the violation of the engagement.

BETULA'CEÆ. (Betula, one of the genera.) A small natural order of plants, containing the birch, after which it takes its name, and the common alder. The order formed part of what were formerly called *Amentaceæ*.

BE'VEL. (Lat. bivium, *branching road*.) In Architecture, an instrument for taking angles. One side of a solid body is said to be bevelled with respect to another when the angle contained between their two sides is greater or less than a right angle.

BEVEL ANGLE. A term used among artificers to denote an angle which is neither a right angle nor half a right angle.

BEVEL GEER. In Mechanics, a species of wheelwork, in which the axles of two wheels working into each other are neither parallel nor perpendicular, but inclined to one another in a certain angle. Wheels of this kind are also called conical wheels, because their teeth may be regarded as cut in the frustrum of a cone. *See* WHEEL.

BEY, or BEG. A Turkish and Tartar title of dignity, used with no very accurate application for lord, prince, or chief, and frequently subjoined to the proper names of persons of rank.

BEZA'NT. A gold coin struck at Byzantium (Constantinople): they varied in weight and in value. Bezants appear to have been current in England from the tenth century to the time of Edward III. Some of them weighed about twenty grains. According to Camden, a piece of gold which was anciently offered by the king on high festivals was called a *bizantine*, and valued at 15*l*. There were also white or silver bezants.

BEZANT. In Heraldry, a circle, or. The name is derived from the gold coins of the Greek empire, termed bezants, or byzantines, by the people of the West. It was probably introduced into coat armour by the Crusaders.

BE'ZOAR. A Persian word implying destructive of poison, and applied to certain intestinal concretions of animals, called bezoar stones, and supposed to possess such powers.

BI. (Lat. bis, *twice*.) Signifies, when attached to other words, two, twice, or double; as bicarbonate of potash, a compound of potash with two atoms of carbonic acid; bilocular, two cells; bivalve, two valves, &c.

BIARTI'CULATE. (Lat. bis, articulus, *joint*.) Applied in entomology to the antennæ of insects when they consist but of two joints, and also to the abdomen under the same circumstances, as in the *Nycteribia biarticulata*.

BIAURI'CULATE. (Lat. bis, auricula, *an auricle*.) In Comparative Anatomy, signifies a heart with two auricles, as in most bivalve molluscs, and in all reptiles, birds, and mammals.

BI'BLE. (Gr. βίβλος, *a book*; from whence the word came to be applied emphatically to the volume of the Old and New Testaments.)

The sixth article of the English Church enumerates the books of the Old Testament, which it considers of canonical authority; in which it follows the canon received by the Jews in the time of our Saviour. The apocryphal writings, which are accounted authentic by the Roman Catholics, are of undoubted antiquity, being comprised in the Septuagint edition of the Scriptures; but their authority has never been acknowledged by the Jews, who reckon twenty-four canonical books; nor are their originals found in the Hebrew language.

The canon of the New Testament is now received without variation, we believe, in all Christian communities. In the early period of the church, the authenticity of particular books was frequently disputed, and heretical sects attempted to foist other apocryphal writings into their place. The general consent, however, of the orthodox church may be inferred from catalogues extant in the writings of many of the Fathers throughout the first four centuries, and the express declaration of the council of Laodicca and others. Some latitude of opinion seems, however, to have been allowed in early times respecting the book of Revelations; and some of the Fathers confess that the genuineness of St. Paul's Epistle to the Hebrews, of that of James, of the second of Peter, and two last of John, was held by some to be undecided.

BIBLE SOCIETY, THE BRITISH AND FOREIGN. A society established in England in the year 1804, "with the sole object," as it is expressed in its regulations, "of encouraging a wider circulation of the Holy Scriptures without *note or comment*." The society took its rise from the circumstance of the complaints which had been made in Wales for some years previous, respecting the great deficiency of Bibles in the language of the Principality — a want which, it was urged, the Society for Promoting Christian Knowledge had very imperfectly supplied. The earliest promoters of this institution were the Rev. Mr. Charles of Bala, Mr. Hughes, and Mr. Steinkoff, minister of the German Lutheran Church. Among its principal patrons may be mentioned Lords Teignmouth and Gambier, Messrs. Wilberforce, Granville Sharp, and Charles Grant. This society has now auxiliary establishments connected with it not only in all the principal cities of the United Kingdom, but throughout Europe and North America.

The principle upon which the Bible Society acts has always been regarded with jealousy by the high church party in this country. In the first place, it is looked upon not only as a rival to the venerable Society for Promoting Christian Knowledge, which had been in action since the year 1699; but as casting some slur upon the latter as inefficient in its operation and erroneous in its principles. The younger society also admits as members the adherents of every religious denomination, and in its proceedings maintains an absolute neutrality among them — which its opponents consider incompatible with the profession of true churchmanship. Accordingly many controversies have been carried on between the champions of the two institutions: in the course of which, however, it would seem that the Bible Society has gained ground in the favour of the established church, from whence a large proportion of its subscribers are now derived. Among them are the names of several bishops, and many other dignitaries.

In the report for 1840, we find the total number of

Bibles and Testaments issued by this society since its foundation to be 12,322,471. The number issued during the year ending March, 1840, was 776,360. The income of the society for that year was 111,449*l*. 13*s*. 1*d*.

BI'BLICAL HISTORY and LITERATURE. The accounts of the books of the Jewish Scriptures antecedent to the captivity are few and indistinct; but they are referred to under the titles of "the law," "the books of Moses," and "the books of the law of Moses," by Daniel (ix. 11.), Ezra (vi. 18.), and Nehemiah (viii. 1.): there are also other passages from which it may be inferred, independent of the internal evidence of the books which we possess, that there existed such from an early period.

The canon of the Old Testament appears, however, to have been settled, and the limits of inspired Scripture determined about 50 years after the return from the captivity, by the authority of Ezra and the prophets of his day; the books of Nehemiah, Malachi, and Ezra himself being subsequently added. The sacred writings which came in later times to be incorporated in the collection of the Jewish Scriptures are known by the name of Apocrypha, or secret: they were undoubtedly held in respect by the Jews, and by the Christians afterwards; but Protestants deny that they were ever held to be inspired, or their authority placed on the same footing as that of the canonical Scriptures.

At a later period we find passages in the New Testament, in Philo, and most distinctly in Josephus, to prove the fact of this collection of the Scriptures into a volume. The books themselves are first specified by Origen, who enumerates twenty-two, in which number he coincides with Josephus. His list embraces all that we consider canonical, and rejects the Apocrypha.

The early versions which illustrate the question of the antiquity of the Hebrew Scriptures are the Samaritan Pentateuch, and the Septuagint or Greek translation. It is not to be supposed that the Samaritans would have adopted and translated the books of the Jews, unless they had been received prior to the separation and enmity of the two peoples, the period at latest of the return from the captivity. The Samaritan Pentateuch now extant is said to be a version from the earlier Hebrew Samaritan into the more modern Samaritan, and was made before the time of Origen. The part of the Septuagint which comprises the Pentateuch was made about the year B. C. 285; the translation of the other book into Hellenistic Greek appears to be of different and somewhat later dates.

Next in order to these may be mentioned the versions of the Old Testament in the earliest periods of Christianity, which are important, not as assisting us to ascertain the antiquity of the original, but as contributing to our knowledge of the genuine text. These may be divided into three classes.

I The Oriental, comprising—
- The Syriac or Peschito (literal), from the Hebrew, about the end of the first century—embracing both the Old and New Testaments.
- The Coptic, from the Septuagint—between centuries two and five. This embraces also the New Testament.
- The Ethiopic, from the Septuagint—in the fourth century: embraces the N. T.

II. The Latin, or Western:—
- The Italic, from the Septuagint, in either the first or second century; only fragments remain: it embraced also the New Testament.
- The Vulgate, made from the Hebrew by Jerome, A. D. 390. This translation is considered an ultimate authority by the church of Rome.
- The Gothic version of Ulphilas, which was made from the Greek of both the Old and New Testaments, in the fourth century, has not come down to us entire. Only a small part is in print.

III. The Greek, comprising—
- The version of Aquila.
- —— of Theodotian.
- —— of Symmachus.

All translated from the Hebrew; all of or near the second century; all exist only in the fragments of the Hexaple or combination of six versions by Origen.

The genuineness of the Hebrew text was preserved after the destruction of Jerusalem by the sedulous care of learned academies which flourished at Tiberias, Babylon, and other places, from the first to the twelfth centuries. The date of the Masora is generally fixed about the fifth century. This work consisted of a most minute enumeration of the sections, verses, words, and letters of the Scriptures; which has been so successful in fixing the genuine reading, that although there were discovered upwards of 800 discrepancies between the Oriental and Occidental Recensions, they all relate, with one single exception, to vowel points, and are of no kind of importance. For an account of the labours of the early Jewish schools of criticism in the interpretation of the Hebrew text, *see* art. TALMUD.

The integrity of the text of the New Testament has been established by the collation, wholly or in part, of 674 manuscripts, existing either entire or in fragments. These have been classified by modern critics according to recensions or families, the most simple of whose systems and that most approved, is Scholz's, who considers all the variations that exist in these MSS. to be resolvable into their having been transcribed from Constantinopolitan or Alexandrian exemplars. The former he considers to have been from the earliest times the most strict and faithful recension. It was that which was principally used in the liturgical offices of the East; and its fidelity is argued from the exact uniformity of all the MSS. which can be traced historically to a Constantinopolitan origin. This may be accounted for by the authority inherent in the text received in the centre of the imperial power and of the patriarchal jurisdiction. It is also consistent with the minute care with which the rites of the Constantinopolitan church were enjoined by its missionaries upon their converts; and also with the character of the Greek fathers, who present much greater exactness and uniformity in their quotations of the New Testament than the African. On the other hand, the Alexandrian copies have been written with a considerable degree of carelessness, and do not appear to have been intended, even in their own country, for reading in public service. They are said to partake in the rash and speculative spirit of the theologians of the Alexandrian church. The former of these recensions has been adopted in the Syriac, Gothic, and Sclavonic versions. It is that also which forms the basis of our modern texts. The latter was followed by several Latin, the Coptic, and Ethiopic translations. Erasmus conceived the idea of the Greek text having been purposely corrupted to suit the Vulgate, and assigns the council of Florence in 1439 as the authority by which this transaction was effected. This opinion continued to be held under the title of the Fœdus cum Græcis, with more or less discussion till modern times, by which it seems to be very generally rejected as untenable. It is known, on the contrary, that in the compilation of his translation, which bears the name of the Vulgate, the existing Latin version was corrected by Jerome from the Greek.

BIBLIO'GRAPHY. (Gr. *βίβλιον*, *a book*, and *γραφω*, *I describe*.) The science of books. The knowledge which is required to classify books, according to the various subjects on which they treat, has been termed intellectual bibliography; that of the external peculiarities of books, their editions, &c., material bibliography. The first branch borders closely on the province of criticism; for the most valuable bibliographical works, being what are termed in French "catalogues raisonnées," are those in which the lists of books are accompanied with some remarks on the character of their contents. The second branch of bibliography has been of late years cultivated with all the ardour attached to a fashionable and somewhat eccentric pursuit. The lovers of rare editions and curious copies of works, from being, to borrow a French term, "bibliophiles," have formed of late a peculiar sect entitled "bibliomaniacs," with whom the fancy for books has become a passion, like those of Dutch speculators for tulips and pictures. Many works of novel and curious research in this department of literature have been recently produced to guide their taste, and gratify their appetite. For the purposes of the common student, *Brunet's Manuel du Libraire*, although by no means complete, is still the most useful index to general literature. Many books of a similar character exist in English, but none that can be recommended as generally valuable; although some of those devoted to particular branches of the subject, especially to the learning of early editions, display much curious research. *Watt's Bibliotheca Britannica*, although useful, from its double arrangement according to subjects and authors, is a very imperfect work.

The following list contains a selection from among the most valuable works which we possess, in different departments of bibliography. But many of them, from the critical matter which they contain, may be considered to belong to the history of literature, as well as of books and editions.

I. ***Introductory Works on the Science of Bibliography.***
- *Peignot*, Manuel Bibliographique, 1800.
- *Peignot*, Dictionnaire Raisonné de Bibliologie, 3 vols. 8vo.
- *Achard*, Cours de Bibliographie, 3 vols. 8vo. Marseilles, 1807.
- *Horne, Thomas Hartwell*, Introduction to the Study of Bibliography, 2 vols. 8vo. Lond. 1814.
- *Denis*, Einleitung zur Bücherkunde, 2 vols. 4to. Vienna, 1796.
- *Boulard*, Traité Elementaire de Bibliographie.

II. ***Bibliography of the Oriental and Classical Languages.***
- *Clarke*, *Dr. Adam*, Bibliographical Dictionary and Miscellany, 8 vols. 12mo. Lond. 1802-6.

Le Long, Bibliotheca Sacra, 2 vols. fol. Paris, 1723.
Fabricius, Bibliotheca Græca, edited by Harles, 12 tom. 4to. Hamburg, 1790. 1809.
Fabricius, Bibliotheca Latina. By Ernesti. 3 vols. 8vo. 1773-74.
Fabricius, Mediæ et Infimæ Ætatis. By Manso. 3 vols. 4to. Patav. 1759.
Harwood's View of the various Editions of the Greek and Roman Classics, 1775.
Dibdin's Introduction to the Knowledge of rare and valuable Editions of the Classics, 2 vols. 8vo. 1827 (last edition).
Moss's Manual of Classical Bibliography, 2 vols. 8vo. 1825.
Degli Autori Classici Biblioteca Portabile (Boni and Gamba), 2 vols. 12mo. Venice, 1793.

III. *Bibliography of particular Sciences and Branches of Literature.*

Lipenius, Bibliothecæ (Theologica, Juridica, Philosophica, Medica), 6 vols. fol. The Juridica by itself has been reprinted, with supplements, &c. in 4 vols. Leipsic, 1775-89. The whole collection passes under the title of Bibliotheca Realis.
Meusel, Bibliotheca Historica.
Bibliotheque Historique de la France, 5 vols. folio, 1768, 1778.
Bridgman's Legal Bibliography, 8vo. Lond. 1807.
Murhard, Bibliotheca Mathematica.
Dryander, Catalogus Bibliothecæ Historiæ Naturalis Josephi Banks (a general account of books on natural history).
Lalande, Bibliotheque Astronomique, 4to. Paris, 1803.
Boucher de la Richarderie, Bibliotheque de Voyages. 6 vols. 8vo. Paris, 1808.

IV. *Bibliography of Modern Nations.*

Watt's Bibliotheca Britannica, 4 vols. 4to. Edin. 1819. This very laborious work contains a mere catalogue of works, arranged alphabetically, first under the head of writers, and then of subjects. A more complete, and more critical work on English Bibliography, is among the greatest desiderata of the present day. Dr. Watt's work contains many foreign articles; but is chiefly devoted to English literature.
Querard, La France Littéraire; a very valuable catalogue of French works, in all departments of literature. Paris, 1828.
Mazzuchelli, Autori d'Italia; a work containing literary history and biography, with bibliographical science. 2 t. fol. Brescia, 1753-63.
Foppen, Bibliotheca Belgica, 2 vols. 4to. 1739.

V. *Bibliographical Works on rare Books, Typographical Antiquities, early Editions, &c.*

Vogt, Catalogus Librorum Rariorum, 8vo. 1732.
Gerdesius, Florilegium Librorum Rariorum, 8vo. 1731.
Clement, Bibliothêque Curieuse, ou Catalogue Raisonné des Livres Rares, 4to. 1750-60. A minutely critical work.
Bauer, Bibliotheca Librorum Rariorum Universalis, 7 vols. 8vo. 1770-91.
Maittaire, Annales Typographici ab Artis inventæ Origine, 5 vols. 4to. Hamb. 1719-41. Several supplements have been published.
Panzer, Annales Typographici ab Artis inventæ Origine ad Annum 1500. (It is, however, carried down to 1536.) 11 vols. 4to. Nuremb. 1793. 1803.
Ames's Typographical Antiquities, first edition, 1749; republished by Mr. Huhet in 3 vols. 4to. 1790; and again by Dr. Dibdin.
Dibdin, Bibliotheca Spenceriana (a catalogue of books in the Spencer library, printed before 1500), 4 vols. 8vo. 1814. Well known, like most of the other works of this distinguished bibliographer, for the minuteness of its research and extreme beauty of embellishment.
La Serna Santander. Dictionnaire Bibliographique Choisi du Quinzième Siècle, 3 vols. 8vo. 1805.
De Bure, Bibliographie Instructive, ou Traité de la Connaissance des Livres rares et singuliers, with supplements, in all 10 vols. 8vo. Paris, 1713, 1782. The most practically useful work on the subject.
Osmont, Dictionnaire des Livres rares, 2 vols. 8vo. Paris, 1768.
Raynouard, Historie de l' Imprimeur des Aldes. *See* ALDINE EDITIONS.

VI. *General Bibliographies, and Miscellaneous Works.*

Dictionnaire Bibliographique, 3 vols. 8vo. Paris, 1790.
Brunet, Manuel du Libraire, 3rd and enlarged edition. 4 vols. 8vo. 1820. A work of the greatest utility. Two supplementary volumes were published in 1832.
Morhof, Polyhistor Literarius, Philosophicus et Practicus, first edition by Fabricius, 2 vols. 4to. 1747.
Saxii Onomasticon Literarium, 8 vols. 4to. 1759. 1803.

BICA'LCARATE. (Lat. bis, calcar, *a spur*.) When a limb or part is armed with two spurs.

BICE. In Painting, a light blue colour prepared from smalt. From it, by a mixture with yellow orpiment, another colour is formed of a green hue, bearing the same name.

BI'CEPS. (Lat. bis, *twice*, and caput, *head*.) An anatomical term, applied to muscles having a double insertion, or which arise by two heads.

BICO'LLIGATE. (Lat. bis, *twice*, colligo, *I bind together*.) In Ornithology, a term signifying the connexion of all the anterior toes by a basal web.

BI'COLOR. (Lat. bis, color, *colour*.) When an animal or part is of two colours.

BICO'RNIS. (Lat. bis, cornu, *a horn*.) In Zoology, when an animal or part has two horns, or two horn-like processes. In Anatomy, when the uterus has two divisions, like horns, as in most quadrupeds.

BICU'SPIS. (Lat.) A tooth with two points.

BIDE'NTATE. (Lat. bis, dens, *a tooth*.) When an animal has but two teeth, as the *Delphinus bidens*; or when a part has two tooth-like processes.

BIE'NNIAL. (Biennis, *of two years' duration*.) A term applied to plants which grow one year and flower the next, after which they perish; they only differ from annuals in requiring a longer period to fruit in. Most biennials, if sown early in the spring, will flower in the autumn, and then perish, thus actually becoming annuals.

BIESTINGS. The name given to the first milk yielded by a cow after calving.

BIFA'RIOUS. (Lat.) Arranged in two rows.

BI'FORATE. (Lat. bis, foro, *I pierce*.) Having two perforations, as the anthers of a Rhododendron.

BI'FORINES. Singular bodies lately discovered in the interior of the green pulpy part of the leaves of some Araceous plants. They are minute oval sacs, tapering to each end, where they are perforated; they are apparently composed of two bags one within the other, the space between the bags being filled with a transparent fluid, and the inner bag itself with fine spiculæ. When the biforine is placed in water it discharges its spiculæ with considerable violence, first from one end, and then from another, recoiling at every discharge, and eventually emptying itself, when it becomes a flaccid motionless bag. Nothing is known of the nature, use, or origin of these bodies.

BIFU'RCATE. (Lat. bis, furca, *a fork*.) When a part has two prongs like a fork.

BI'GAMY. (Lat. bis, *twice*, and Gr. γαμος, *marriage*.) The offence of contracting a second marriage during the life of the husband or wife, which, by the law of England, is felony, punishable by transportation for seven years, or imprisonment for two. Bigamy, by the canon law, signified a second marriage after the death of the first wife, or a marriage with a widow; and incapacitated the party contracting. *See* MARRIAGE, LAW OF.

BIGHT. Part of a rope between the ends; bight is also a shallow bay or hollow in the line of sea coast.

BIGNONIA'CEÆ. (So called from Bignon, a French man of letters, and the friend of Tournefort.) A natural order of Didynamous plants, usually having a twining stem, large trumpet-shaped flowers, and a pod-like capsule with winged seeds. Some of them are trees of considerable size, and furnish timber valuable in the countries where it is produced; but the greater part are interesting only for the beauty of their flowers, in which respect this order yields to no other. *Bignonia venusta*, *Pandoræ*, *æquinoctialis*, *cherere*, and *grandiflora*, are probably the handsomest twining plants known.

BI'JUGATE. (Lat. bis and jugum, *a yoke*.) Composed of two pairs of any thing; a term applied to leaves pinnated with two pairs of leaflets.

BIKH. A deleterious plant inhabiting Nepal, and used by the natives of that country to poison their wells when the British troops invaded it. The *Aconitum ferox* has been ascertained to be this poison, which, like that of all other Ranunculaceous plants, is volatile; and although highly dangerous when fresh, soon loses its activity when exposed to the air.

BILA'BIATE. (Lat. bis and labium, *a lip*.) When a flower has all or any of its parts collected into two separate parcels or lips. Thus a calyx having two of its sepals collected into one parcel, and the others into a second parcel, or a corolla with its five petals adhering two and three together, are bilabiate.

BILAME'LLATE. (Lat. bis, lamella, *a plate*.) When a part is divided longitudinally into two lamellæ.

BI'LBERRY. A small bush inhabiting the northern parts of Europe in mountainous situations, and bearing small black berries, which are eaten by country people, and are a favourite food of deer. It is the *Vaccinium myrtillus* of Botanists.

BILDSTEIN. (German.) A mineral composed chiefly of silica and alumina, with a little oxide of iron. It is commonly seen carved into Chinese figures.

BILE. (Lat. bilis; said to be derived from bis, *twice*, and lis, *contention*, as being the supposed cause of anger and dispute.) A fluid secreted in the liver, of a yellow colour, and a nauseous taste, compounded of sweet and bitter; it sinks in water, and mixes with it in all proportions; it is slightly alkaline, and feels soapy. It contains a peculiar bitter principle, which has been called *picromel*, and a little free soda and saline matters. According to Berzelius, the solid constituents of bile amount to about one tenth of its weight.

BILGE. The lower or flat part of the bottom of a ship on which she rests when aground. — Bilge of a cask, the middle part between the ends, in which the bung-hole is placed.

BILGED. Having the bottom stove in.

BILGE WATER. The water that collects in the bottom, by leakage or otherwise. It has usually a peculiar and offensive smell. When a ship is tight the bilge water when pumped up is dark; in a leaky ship, it comes up quite clear.

BI'LIARY CALCULI. Are concretions which form in the gall-bladder (gall stones) or bile-ducts. They are generally composed of a peculiar crystalline fatty matter, which has been called *cholesterine*.

BILL. A legislative measure introduced into parliament is so called until it has acquired the force of law by receiving the royal assent. Bills are either public or private; a distinction founded rather on usage and precedent, than on any exact definition. The immediate parliamentary consequence of the distinction is the payment of certain fees to the officers of the house, which are due by custom on private bills. According to Hatsell, this difference between private and public bills was recognised as long ago as 1607. It is a general rule of parliamentary proceeding, that the same bill or question cannot be twice offered in the same session. But at every stage of a bill, the whole of it is supposed to be before the house; and consequently if words have been inserted by way of amendment, the sense of the house may again be taken respecting them at a subsequent stage. *See* PARLIAMENT.

BILL OF SALE. In Law, a contract under seal, by which a man passes his interest in goods and chattels to another, and which does not require either valuable consideration or actual transfer of the goods to support it, as between the vendor and vendee; although as between the vendee and the vendor's creditors the absence of such consideration and transfer would in general be held indicative of fraud, and invalidate the contract.

BILL OF HEALTH. A certificate or instrument, signed by proper authorities, delivered to the masters of ships at the time of their clearing out from all ports or places suspected of being infested by particular disorders, certifying the state of health at the time that such ships sailed. Bills of health are of three kinds—*clean, foul*, and *suspected*, which are self-explanatory terms.

BILL OF LADING. A memorandum, subscribed by the master of a ship, acknowledging the receipt of goods intrusted to him for transportation, and binding himself (under certain exceptions) to deliver them to the person to whom they are addressed, in good condition, for a certain remuneration or freightage. Of bills of lading there are usually triplicate copies; one for the party transmitting the goods, another for the person to whom the goods are addressed, and the third for the master.

BILL OF EXCHANGE. *See* EXCHANGE.

BILL OF RIGHTS. In Law, the declaration delivered by the two houses of parliament to the Prince of Orange, February 13. 1688, at the period of his succession to the British throne; in which, after a full specification of various acts of James II. which were alleged to be illegal, the rights and privileges of the people were asserted.

BI'LLET. In Heraldry, a bearing of which the origin is very uncertain; represented of an oblong square form, sometimes showing the thickness, and always with a flat surface. Billetty, or semée of billets, signifies that the escutcheon or charge is strewed over with these bearings, without regard to particular number or station.

BI'LLION. In Numeration, denotes a million of millions, and is expressed by 1,0000,0000,0000. The French use the same word to denote a thousand millions. The term is probably a contraction of *bis* and *million*; whence the English signification, a million of millions, appears more according to analogy. Thus biquadratic means the square of a square, or the product of two quadratics.

BILLS OF MORTALITY, are accounts of the number of births and burials within a certain district in every week, month, quarter, or year. These were first compiled in London, after the great plague of 1593; and ten years afterwards began to be returned weekly. Several of the parishes now included within the metropolis (as Marylebone and Pancras) are not within the bills of mortality. *See* MORTALITY.

BI'LOBATE. (Lat. bis, lobus, *a lobe*.) When a part is divided into two lobes, or obtuse processes.

BILO'CULAR. (Lat. bis, locula, *a cell*.) Having two cells.

BIMA'CULATE. (Lat. bis, macula, *a spot*.) When an animal, or part, is marked with two spots.

BI'MANA. (Bimana, *two-handed*.) The term applied by Cuvier to the highest order of mammalia, of which man is the type and sole genus.

BIME'DIAL. In Geometry, when two lines commensurable only in power (for example, the diagonal and side of a square) are joined together, the sum is irrational with respect to either of the two lines, and is called by Euclid a *bimedial*.

BI'NARY ARITHMETIC. (Fr. binaire, from binus, *dual*, or by *twos*.) A species of arithmetic, proposed by Leibnitz, and founded on the shortest and simplest progression; namely, that which terminates with the second cipher. In the binary notation, therefore, only two characters are required, 1 and 0, the zero having the power of multiplying the number it follows by two, as in the common notation it multiplies by ten. The number *one* is represented by 1; *two*, by 10; *three*, by 11; *four*, by 100; *five*, by 101; *six*, by 110; *seven*, by 111; *eight*, by 1000; *nine*, by 1001; *ten*, by 1010, &c. This method of notation, though it may be applied with advantage in the investigation of some properties of numbers, would be inconvenient for common purposes, on account of the great number of characters required, even when the numbers to be expressed are small. We will give an example from the *Encyclopedie Methodique* of the method of expressing a number by the binary scale, and of finding the value of a number so expressed.

It is convenient to begin with forming a table of the powers of 2, namely, 2^0, 2^1, 2^2, 2^3, &c. They are 1, 2, 4, 8, 16, 32, 64, 128. Suppose, now, it were required to express the number 230 by the binary scale. Seek in the table the greatest power of 2 contained in 230; it is found to be 128, which is the 8th number in the table; hence the expression will contain 8 ciphers, and the first on the left hand is 1. Subtract 128 from 230, there remains 102; the highest power of 2 contained in this is 64, which is the seventh number in the table. The second cipher will therefore be also 1. Subtract 64 from 102, and there remains 38. But the sixth number in the table is 32, which is contained in 38; therefore the third cipher in the expression is still 1. Subtract 32 from 38, there remains 6; but the fifth number in the table is 16, which is not contained in 6; therefore the fourth cipher of the expression is 0. The fourth number in the table is 8, which is not contained in 6; therefore the fifth cipher must also be 0. The third number in the table is 4, which is contained in 6; therefore the sixth cipher will be 1. Subtracting 4 from 6 there remains 2; but the second number in the table is 2, therefore the seventh cipher is 1. The last difference is zero; therefore the last cipher in the expression is 0. Collecting all these results, we find the number 230 is expressed in the binary scale by 11100110.

Next, suppose it were required to determine the value of the expression 110101 in the binary scale. As there are here six ciphers, we look for the sixth number in the above table, and find 32, which is the value of the first cipher. The following cipher represents the fifth number, and is consequently equal to 16. The third cipher is 0, and its value nothing. The fourth cipher corresponds to the third number in the table, and represents 4. The fifth cipher is 0, and its value nothing. The last cipher corresponds to the first number of the table, which is 1. The whole expression, therefore, 110,101, is equivalent to $32 + 16 + 4 + 1 = 53$. It has been imagined, though on very slight grounds, that traces of the binary notation are discernible among the early monuments of China.

For information on the subject of arithmetical scales, see *Leslie's Philosophy of Arithmetic*.

BINARY MEASURE. (Lat. binarius, *belonging to two*.) In Music, that in which the raising the hand or foot is equal to that of falling, usually called common time. The Italians are accustomed after a recitative to use the phrase *a tempo giusto*, to indicate that the measure is to be beat true and correct, which is otherwise conducted in the recitative in order to express passion, &c.

BI'NAT. (Lat. bis and natus, *born*.) When two bodies of the same nature spring from the same point, as often happens in the segments of leaves.

BIND. (Ger. binden, *to fasten together*.) In Music, the same as a ligature or tie for the purpose of grouping notes together.

BIND. The indurated clay of coal mines. Binding in agriculture is tying up sheaves of corn.

BINE'RVATE. (Lat. bis, nerva, *a nerve*.) In Entomology, when the wing of an insect is supported by only two nerves.

BI'NNACLE. The case or stand in which the steering compass is placed; it is fixed near the tiller or wheel. At night the compass is illuminated by a lamp placed over it.

BI'NOCLE, or BINOCULAR TELESCOPE. (Lat. binus, *double*, and oculus, *the eye*.) A telescope to which both eyes may be applied at once, and in which, conse-

quently, an object may be observed with both eyes at the same time.

BINO'MIAL. (Lat. bis, *twice*, and Gr. νομος, *law*.) In Algebra, signifies a quantity composed of two terms, connected together by the signs + or −; thus, $a + b$ and $c - 5$ are binomial quantities.

BINO'MIAL THEOREM. A formula discovered by Newton, of singular use in algebra, by which a binomial quantity may be raised to any power m, the exponent m being either a whole number or a fraction, positive or negative. The formula is this: —

$$(a+b)^m = a^m + \frac{m}{1} a^{m-1} b + \frac{m(m-1)}{1 \quad 2} a^{m-2} b^2 + \frac{m(m-1)(m-2)}{1 \quad 2 \quad 3} a^{m-3} b^3 + \frac{m(m-1)(m-2)(m-3)}{1 \quad 2 \quad 3 \quad 4} a^{m-4} b^4 + \&c.$$

And the mere inspection of the terms will give a better idea of the manner in which they are successively formed than any explanation.

When the exponent m is a whole positive number, it is evident that the series has a finite number of terms; suppose, for example, $m = 3$, then $m - 3 = 0$; and all the terms into which $m - 3$ enters as a co-efficient become equal to zero, or vanish. But on looking at the series, we find $m - 3$ entering the fifth term, and it will continue in all the succeeding; therefore, when $m = 3$ the series can only have four terms; and, generally, the number of terms of the series exceeds the exponent by one. When m is a fractional number, or is negative, the series does not terminate, and will only express approximately the value of $(a+b)^m$ when it is convergent; that is to say, when every individual term of the series is greater than that which succeeds it. For example, let the expression to be developed be $(xx + y)^{\frac{1}{2}}$, which signifies the square root of the binomial $(x^2 + y)$. Comparing this with the above formula, we have evidently —

$$(xx + y)^{\frac{1}{2}} = xx^{\frac{1}{2}} + \tfrac{1}{2}\, xx^{\frac{1}{2}-1} y$$
$$+ \tfrac{1}{2}\left(\tfrac{1}{2} - 1\right) xx^{\frac{1}{2}-2} y^2 + \&c.$$
$$= x + \frac{y}{2x} + \frac{y^2}{8x^3} + \&c.$$

a series which goes on for ever; but which, supposing x greater than unity, approaches nearer and nearer to the true value of the root of $x^2 + y$, as the number of terms included becomes greater.

In order to determine whether in any given case the series is convergent, we have only to compare two successive terms of the development of $(a+b)^m$. For example, take the fourth and fifth; rejecting the common factors, the fourth is to the fifth as $a^{m-3} : \frac{m-3}{4} a^{m-4} b$; that is, as 1 to $\frac{m-3}{4} \cdot \frac{b}{a}$; therefore the fifth will be smaller than the fourth, or the series will be convergent if $(m-3)\,b$ is smaller than $4a$. In general, let n be the order of any term in the development of $(a+b)^m$: this term will be to the succeeding in the ratio of $1 : \frac{m-n+1}{n} : \frac{b}{a}$; and the terms will always go on decreasing, or the series will be convergent when $(m - n + 1)\; b$ is smaller than $n\,a$.

The principal use of the binomial theorem is to find approximate values of the roots of quantities by expanding them into series. The demonstrations which have been given of it are very numerous, and one or other of them may be found in any work on algebra. For one of the neatest and most concise we refer to the article "Algebra" in the *Encyclopedia Britannica*, 7th edition.

BIO'CELLATE. (Lat. bis, ocellus, *an eyelet*.) In Entomology, when an insect's wing is marked with two eye-like spots.

BIO'GRAPHY. (From the Greek word βίος, *life*, and γράφω, *I describe*.) The history of the life of an individual. Biography, in the progress of literature, appears to be nearly coeval with history itself. It has been ingeniously described as "history teaching by example;" and this mode of instruction was perhaps peculiarly appropriate to early and simple times, in which the relative importance of individual men to the society in which they lived was greater than it can ordinarily be in periods of more advanced civilisation. But, although we have notices of many biographical writers among the classical authors of Greece, none of their works have been preserved to us (if we except the short narrative of the exploits of Agesilaus by Xenophon, for his celebrated Memorabilia of Socrates are rather in the form of a collection of sayings and anecdotes than a memoir) of earlier date than the Roman Empire. It is to a comparatively late age that we owe all the more interesting works of this description which antiquity has bequeathed to us, some of which are among the most popular relics of the classical ages — the *Lives of Illustrious Men*, by Plutarch and Cornelius Nepos; the *Lives of the Cæsars*, by Suetonius, a work of which the details are strictly biographical; and the *Lives of the Philosophers*, by Diogenes Laertius. Biography may be said in strictness to differ from history not merely in the extent of the subject, but also, and perhaps more characteristically, in the mode in which that subject is treated. Thus, in classical literature, the works of Quintus Curtius and Arrian, although devoted exclusively to the actions of a single individual (Alexander), are not usually termed biographies; not only because the individual in question was the leader and foremost character in a course of great public events, but also because those public events form the subject matter of their works, and not the more peculiar details of the personal life of their heroes. They are therefore more accurately denominated histories than biographies. On the other hand, the *Lives of the Twelve Cæsars* by Suetonius form, as has been said, a series of biographies, although the persons who furnish the subject were, like Alexander, arbiters of the destinies of a great part of mankind; because the details which they contain are chiefly of a private and personal nature. It is the object of history, among its other lessons, to make us acquainted with the influence which the actions, the characters, and the thoughts of individual men have produced on the course of events affecting society in general: conversely, it appears to be the province of the biographer to detail the effects which have been produced by external occurrences and circumstances on the character and conduct of individuals. *See* Memoir.

BIPE'CTINATE. (Lat. bis, pecten, *a comb*.) When a part has two margins toothed like a comb.

BI'PELTATE. (Lat. bis, pelta, *a buckler*.) When an animal or part has a defence like a double shield.

BIPU'PILLATE. (Lat. bis, pupilla, *a pupil*.) In Entomology, when an eye-like spot on the wing of a butterfly has two dots or pupils within it of a different colour.

BIQUADRA'TIC. In Algebra, denotes the power immediately succeeding the cube; that is, the square of the square, or fourth power.

BIQUADRA'TIC EQUATION. Is an equation in which the unknown quantity rises to the fourth, but not to a higher power. An equation of this kind, when complete, is of the form $x^4 + Ax^3 + Bx^2 + Cx + D = o$, where A, B, C, and D, denote any known quantities whatever. Lewis Ferrari, an Italian geometer, and a pupil of the celebrated Cardan, made the discovery that the resolution of a biquadratic equation can always be reduced to that of a cubic equation. Of the various ways in which this reduction can be effected, the following, proposed by Euler, and explained at length in his *Algebra*, is perhaps the simplest. The first step of the process is to transform the given equation into another in which the second term is wanting. This can always be done by assuming $y - \frac{1}{4}A = x$, and substituting it for x in the proposed equation; a new equation will result, having the form

$$y^4 + p\,y^2 + q\,y + r = o, \qquad (1)$$

and it is only to the solution of this that our attention need be confined.

Assume $y = \sqrt{a} + \sqrt{b} + \sqrt{c}$, and suppose a, b, c, to be three roots of the cubic equation $z^3 + Pz^2 + Qz - R = o$. By the theory of equations the co-efficient of the second term is the sum of all the roots with their signs changed; the co-efficient of the third is the sum of the products of the roots combined by pairs; and the last term is the product of all the roots with the signs changed. We have therefore $a + b + c = -P$, $ab + ac + bc = Q$, and $abc = R$. From the assumed equation $y = \sqrt{a} + \sqrt{b} + \sqrt{c}$, we get by squaring $y^2 = a + b + c + 2(\sqrt{ab} + \sqrt{ac} + \sqrt{bc})$; whence, substituting $-P$ for $a + b + c$, and transposing

$$y^2 + P = 2(\sqrt{ab} + \sqrt{ac} + \sqrt{bc}).$$

Squaring this equation also, we get after reduction $y^4 + 2Py^2 + P^2 = 4(ab + ac + bc) + 8\sqrt{abc}\,(\sqrt{a} + \sqrt{b} + \sqrt{c})$, which, on substituting R and y for their values given above, becomes

$$y^4 + Py^2 + P^2 = 4Q + 8y\sqrt{R},$$

and by transposing

$$y^4 + 2Py^2 - 8y\sqrt{R} + P^2 - 4Q = o. \qquad (2)$$

Now, one of the roots of this biquadratic equation is $y = \sqrt{a} + \sqrt{b} + \sqrt{c}$; and a, b, c, are the three roots of the cubic equation, $z^3 + Pz^2 + Qz - R = o$; consequently, by resolving the cubic we get the values of a, b, c; and thence y, the root of the biquadratic, becomes known.

To apply this solution to the proposed equation (1), the co-efficients P, Q, R, of the resolved equation (2), must be determined in terms of p, q, r. Comparing the two equations,

$$y^4 + py^2 + qy + r = o, \qquad (1)$$
$$y^4 + 2Py^2 - 8\sqrt{R}y + P^2 - 4Q = o, \qquad (2)$$

we find $2P = p$, $-8\sqrt{R} = q$, $P^2 - 4Q = r$; whence $P = \frac{1}{2}p$, $Q = \frac{p^2 - 4r}{16}$, $R = \frac{q^2}{64}$. It follows, therefore,

that the roots of the proposed equation are expressed generally by $y = \sqrt{a} + \sqrt{b} + \sqrt{c}$, where a, b, c denote the roots of the cubic equation

$$z^3 + \frac{p}{2} z^2 + \frac{p^2 - 4r}{16} z - \frac{q^2}{64} = o. \qquad (3)$$

All the four roots of the biquadratic are involved in the expression $y = \sqrt{a} + \sqrt{b} + \sqrt{c}$; in order to discover each of them in particular, it is necessary to consider the changes of sign of which they admit. As the square root of any quantity a may be either $+\sqrt{a}$ or $-\sqrt{a}$, each of the three quantities, $\sqrt{a}$, $\sqrt{b}$, $\sqrt{c}$, may have either the sign $+$ or $-$ prefixed to it; whence the formula will give *eight* different expressions. But as the product of the three roots, $\sqrt{a}$, $\sqrt{b}$, $\sqrt{c}$, is equal to $\sqrt{R}$ or to $-\frac{1}{8} q$, it is obvious that when q is positive, their product must be negative, and this can only be the case when either only one or all three of them are negative. When q is negative the product must be positive, which can only be the case either when all three are positive, or two of them negative. There are consequently only four different expressions for q positive, and four for q negative, which in either case form the four roots of the biquadratic equation.

The co-efficients of the equation (3) involve fractions; but these may be removed by assuming $v = 4z$, and substituting for z its value in terms of v. It then becomes, more simply,

$$v^3 + 2pv^2 + (p^2 - 4r)v - q^2 = o, \qquad (4)$$

the roots of which are $\frac{1}{4}a$, $\frac{1}{4}b$, $\frac{1}{4}c$.

The rule for the resolution of a biquadratic equation is therefore as follows: —

Let $y^4 + py^2 + qy + r = o$ be the proposed equation, wanting its second term. Form the cubic equation $v^3 + 2pv^2 + (p^2 - 4r)v - q^2 = o$, and find its roots, which call a, b, c. Then the roots of the proposed biquadratic are,

when q is negative,	when q is positive,
$y = \frac{1}{2}(\sqrt{a} + \sqrt{b} + \sqrt{c})$	$y = \frac{1}{2}(-\sqrt{a} - \sqrt{b} - \sqrt{c})$
$y = \frac{1}{2}(\sqrt{a} - \sqrt{b} - \sqrt{c})$	$y = \frac{1}{2}(-\sqrt{a} + \sqrt{b} + \sqrt{c})$
$y = \frac{1}{2}(-\sqrt{a} + \sqrt{b} - \sqrt{c})$	$y = \frac{1}{2}(\sqrt{a} - \sqrt{b} + \sqrt{c})$
$y = \frac{1}{2}(-\sqrt{a} - \sqrt{b} + \sqrt{c})$	$y = \frac{1}{2}(\sqrt{a} + \sqrt{b} - \sqrt{c})$.

BIRA′DIATE. (Lat. bis, radius, *a ray*.) When a part has two rays.

BIRCH. A hardy tree inhabiting the north of Europe, Asia, and America. The common birch (*Betula alba*) is valuable for its capability of resisting extremes of both heat and cold; its timber is chiefly employed for fire wood. Its bark is extremely durable. The American birch (*B. lenta*) produces a hard heavy timber, much used by cabinet-makers; and the bark of *B. papyracea* is employed by the North American Indians for a variety of useful purposes.

BI′RDLIME. A glutinous substance extracted by boiling the bark of the holly tree; a similar substance may be obtained from misletoe, from the young shoots of elder, and some other plants.

BIRD OF PARADISE. A name originally applied to the species *Paradisea apoda*, Linn.; of which the skins, deprived of the wings, the feet, and the tail, have long formed a high-priced article of export from the eastern parts of the world. The value of these mutilated specimens of natural history arises chiefly from the extraordinary development and light and beautiful structure of the plumes which grow from the scapular and lateral regions of the body; and these plumes, combined with the velvety texture and brilliant metallic reflections of the ordinary feathers, especially those covering the head, render skins of the *Paradisea* ornaments highly and justly esteemed by the fair inhabitants of the most civilised countries. The presence of the remarkable plumage just alluded to, and the constant absence of the ordinary organs of locomotion in the imported specimens, easily gave rise to strange speculations as to the nature of the rare bird of the east; and the older naturalists delighted to describe it as destitute of feet, dwelling constantly in the air, wafted about in the bright beams of the sun independently of the ordinary mechanism of wings, and nourished with dew, and the nectar and even odour of flowers. To beings thus imagined to be raised above the dull earth, to enjoy etherial food and a perpetual habitation in the air, no name could be more appropriate than Birds of Paradise or Heaven. The march of inquiry has, however, dispelled the fancied attributes and false charms of these lovely beings, and has restored to them their wings and feet. The latter, indeed, are remarkable for their robustness: they have three toes in front and one behind, as in other *Passeres* of Cuvier, with the middle toe shorter than the tarsus, the outer toe united to it at its base, and the inner one joined to it for half the length of the first phalanx. The form of the beak corresponds with that which characterises the tribe *Conirostres* of Cuv.; and their true food, which consists not only of the pulpy and farinaceous parts of fruit, but also of worms, insects, the eggs and young of smaller birds, and even carrion, causes them to be ranked with the family of *Omnivores*, Cuv. In fact, they closely resemble in their habits our magpies and jays. The principal species of the genus *Paradisea* are the Great or Common Bird of Paradise (*Par. apoda* of Linnæus); the Royal Bird of Paradise (*Par. regia*); the Red Bird of Paradise (*Par. rubra*); the Magnificent Bird of Paradise (*Par. magnifica*); the Six-threaded Bird of Paradise (*Par. sexesetacea*), which is characterized by three long and thread-like feathers, which grow from each side of the body; the Superb Bird of Paradise (*Par. superba*), which is smaller than the preceding, but perhaps the most beautiful of the genus; the Small Bird of Paradise (*Par. minor*), which measures about nine inches from the point of the bill to the end of the tail; and, lastly, the White Bird of Paradise (*Par. alba*).

BIRD PEPPER. The small *Capsicum*, a species of the plant which affords Cayenne pepper.

BIRDS. In Heraldry, are said to be rising, displayed, close, volant, &c. according to the different postures in which they are represented. Birds of prey, and cocks, when beaked and legged of a different tincture from the body, are said to be *armed* of that tincture.

BIRD'S EYE VIEW. In the Fine Arts, a term used to denote a view arranged according to the laws of perspective, in which the point of sight or situation of the eye is placed at a very considerable height above the objects viewed and delineated. In architectural representations, it is used chiefly for the purpose of exhibiting the disposition of the different courts or quadrangles and roofs of a building. It is a useful method of representing battles, as also of giving a general notion of a small district of a country. As before observed, it is entirely dependent upon the same principles as those detailed in the article PERSPECTIVE, which see.

BIRD'S MOUTH. In Architecture, an interior angle or notch, cut across the grain at the extremity of a piece of timber for its reception on the edge of another piece; as a rafter, for instance, is received on a pole plate. Bird's mouth signifies also the internal angle of a polygon, its external angle being called a bull's nose.

BIRTH, EVIDENCE OF. By the French code civil it is required that a declaration shall be made of every birth to the proper officer, within three days, with production of the child. The "act of birth," setting forth the time and place of the event, sex and name of the child, and description of the father, is then immediately drawn up in the presence of two witnesses. It is entered on the register, and a copy kept by the parent. (*Code Civil*, art. 55.) In England by the 70th Canon, and statutes of 6 & 7 William 3. and 4 G. 4. c. 76., the minister of every parish is required to keep a register of births. But now, by the recent act for registering births, deaths, and marriages, 6 & 7 W. 4. c. 86., it is enacted that the parent, or occupier of a house in which a child is born, *may*, within 42 days after the birth, give notice to the district registrar; and *shall* give such information on being requested by the district registrar within the same time. After 42 days, the birth may be registered only in presence of the superintendant registrar, and on a peculiar declaration. After six months, registration of a birth cannot take place. Certified registers of births, as well as deaths, are to be forwarded after a certain time to the superintendant registrar, and copies of registers to the general register office. (Sects. 19. 21, 22, 23. 33, 34.)

BIRTH, or BERTH, OF A SHIP. The ground or space in which she is anchored, and which is said to be a *good birth*, or a *bad birth*; also, an apartment, as the midshipman's birth; also, the space allotted a seaman to sleep or hang his hammock in.

BIS. (Lat. *twice*.) In Music, a word placed over passages which have dots postfixed to one bar, and prefixed to a subsequent bar, signifying that the passage between the dots is to be twice played.

BI′SCUIT. (Fr. bis, *twice*, and cuit, *baked*.) In Sculpture, a species of porcelain, of which groups and figures in miniature are formed, which are twice passed through the furnace or oven. It is executed without glaze upon it. In Pottery, this term is applied to earthenware and porcelain, after it has been hardened in the fire, and before it receives the glaze: in this state it is permeable to water.

BISE′TOUS. (Lat. bis, seta, *a bristle*.) In Zoology, when an animal or part is furnished with two bristle-like appendages.

BISE′XUAL. (Of two sexes.) Is a term applied to flowers which contain both stamens and pistil within the same envelop: it is the same as the word hermaphrodite in botany.

BI′SHOP. (A word contracted from the Greek ἐπίσκοπος, Lat. episcopus, signifying literally an overseer.) In all denominations of Christians which admit the episcopal form of government, the bishop is the superior of the three orders, standing in rank and office distinct from the presbyter or priest. (*See* art. EPISCOPACY.) This distinct office consists in the power of ordination, confirmation, and consecration, none of which ceremonies may be performed by an inferior clergyman. The clergy of a diocese are subjected also to the ecclesiastical authority

of their bishop, who alone institutes to benefices, licenses curates, and has considerable discretionary power in requiring the residence of his clergy on their cures, and in superintending the discharge of their duties in them.

The mode of the appointment to bishoprics varies in different establishments. In early times the bishop was generally elected by his clergy. In the middle ages the pope assumed in most cases the absolute nomination, which claim has been given up in later times in many Catholic countries, where the king or clergy recommend, and the holy father only ratifies the appointment. In England the appointment is virtually in the hands of the sovereign, who upon the demise of the bishop receives from the dean and chapter intimation of the event, with a request for permission to supply the vacancy. The king accords his permission to that effect, and at the same time recommends a person to their choice — a recommendation which is equivalent to a command, as it cannot be waived without incurring the severe penalties of a præmunire.

BI′SMUTH. A brittle, yellowish-white metal, of a crystalline texture. Its specific gravity is 10·; it fuses at 476°, and at a red heat it sublimes in close vessels. It conducts heat less perfectly than most of the other metals. When strongly heated it burns with a bluish white flame, and is rapidly oxidized. Its equivalent upon the hydrogen scale is 71; and it forms only one salifiable oxide, the equivalent of which is 79. When nitrate of bismuth is dropped into water a white powder is thrown down, formerly called *magistery of bismuth* or *pearl white:* it is a subnitrate. A brown *peroxide of bismuth* is obtained by fusing the protoxide with caustic potash. Some of the alloys of bismuth are remarkable for their fusibility: a compound of 8 parts of bismuth, 5 of lead, and 3 of tin, melts in boiling water, and is commonly called *fusible metal.* The ores of bismuth are not common; but it occurs *native*, and combined with oxygen, sulphur, and arsenic. The Germans call it *wismuth.*

BI′SON. The trivial name of certain species of the Linnæan genus Bos, which differ from their congeners in having fourteen (*Bos bison*), or fifteen (*Bos Americanus*), instead of thirteen pairs of ribs. The common bison of the north of Europe (*Bos bison*), and the American bison, or bonassus (*Bos Americanus*), are the only known existing species of this group.

BISPINO′SUS. (Lat. bis, spina, *a spine.*) When an animal or part is armed with two spines.

BISSE′XTILE. (Lat. bis, *twice*, and sextilis, *sixth.*) The name given to the year which contains 366 days. The calendar used in all European countries is founded on that of the Romans, as reformed by Julius Cæsar. In the calendar of Cæsar, the length of the year was fixed at 365¼ days; and in order that the year should always begin with the beginning of a day, it was directed that every fourth year should contain 366 days, the other years having each 365. The additional day, which thus occurred every fourth year, was given to February, the shortest month, and was inserted in the calendar between the 24th and 25th days. In the peculiar method of reckoning the days of the month adopted by the Romans, namely, of reckoning backwards from the 1st of the succeeding month, it would have been very inconvenient to have interrupted the order of numeration; accordingly the 24th, which was called *sexto Calendas Martii*, was reckoned twice, and the supernumerary or repeated day called *bis sexto Calendas.* Hence the term *bissextile.* In English, *leap year* has the same signification.

In the Julian calendar every fourth year was bissextile; but this supposes the year to be 365¼ days, which errs in excess by 11 minutes 10·35 seconds. Accordingly, in the course of a few centuries, the error will amount to days, and cause the commencement of the year to change its place with respect to the seasons. When the Julian calendar was introduced, the equinox fell on the 25th of March; in 1582, when the calendar was reformed by Pope Gregory XIII., it had fallen back to the 11th; and as it was then supposed that the error of the Julian calendar amounted to three days in 400 years, it was ordered that the intercalary day should be omitted in all the years which terminate centuries, excepting those which are multiples of 400. The Gregorian rule of intercalation is therefore as follows: — Every year of which the number is divisible by 4 is a leap year; excepting the centesimal years, which are only leap years when divisible by 4 after suppressing the two zeros. Thus 1600 was a leap year; but 1700, 1800, and 1900, which would be bissextile in the Julian calendar, are common years in the Gregorian.

This regulation, though it would for a long time preserve the commencement of the year at the same place in the seasons, is not yet quite correct. It supposes the length of the year to be 365 days 5 h. 48 m. 12 seconds, which is too great by 22·38 seconds; an error which amounts to a day in 3866 years. As this number 3866 approaches to 4000, it was proposed by Delambre to correct the Gregorian rule by making the year 4000 and all its multiples common years. Should our present calendar continue to be in use 2000 years hence, posterity may then begin to consider whether they will adopt this suggestion. *See* CALENDAR.

BI′STORT. The root of the *Polygonum bistorta*, an indigenous plant; it is used in medicine as a powerful astringent.

BI′STRE. In Painting, a dark brown colour, made from the soot of dry wood, whereof for this purpose beech is preferable.

BI′SULCATE. (Lat. bis, *twice*, sulcus, *a fissure.*) In Mammalogy, a term signifying a foot resting upon two hoofed digits.

BIT. That part of the bridle which goes into the mouth of a horse.

BI′TTER PRINCIPLE. This term has been applied to certain products of the action of nitric acid upon animal and vegetable matters of an intensely bitter taste. *See* CARBAZOTIC ACID.

BI′TTERN. *See* ARDEA.

BITTERN. The residue of sea water after the common salt has been separated by evaporation. It contains *muriate of magnesia*, which gives it a bitter taste.

BITTER SALT. Sulphate of magnesia, or Epsom salt.

BITTER SPAR. A Mineralogical term, generally applied to certain crystallized varieties of *dolomite*, or double carbonates of lime and magnesia. It occurs in rhomboidal crystals, consisting of about 55 *per cent.* of carbonate of lime and 45 of carbonate of magnesia, sometimes with traces of iron and manganese.

BITU′MEN. (From πιτυς, *the pitch tree;* because it resembles pitch.) A variety of inflammable mineral substances, which, like pitch, burn with flame in the open air, is included under this term: such as *naphtha*, *pitroleum*, and *asphaltum.*

BITUMEN. Mineral pitch.

BITU′MINOUS SHALE. An argillaceous shale impregnated with bitumen: it commonly accompanies coal.

BIVA′LVES. (Lat. bis, *two*, and valva, *a valve.*) A term commonly applied to the Lamellibranchiate Acephalous Molluscs, on account of the structure of their shell, which consists of two parts or valves, joined together by an elastic ligament at the cardo, or hinge. The testaceous covering of the Palliobranchiates is also composed of two valves or shelly pieces; but these are never joined by elastic ligament.

BI′VOUAC. (Fr.) A term in the Military art, employed to denote the system by which soldiers on a march, or in expectation of an engagement, remain all night in the open air, in contradistinction to the systems of encampment and cantonment. This word is derived from the Lat. bis, *twice*, and the German wache, *a guard*, and signified originally the guard which was selected from the body of a regiment to keep watch during the night.

BIXA′CEÆ. A small natural order of plants, so called after the genus Bixa, the genus which produces the substance called arnotto, with which English cheeses are dyed of their peculiar reddish ochre colour. The species are all trees or shrubs inhabiting the tropics.

BLACK. (Sax. blac.) In Painting, the darkest colour of all; whereof the different sorts are lamp black, ivory black, Frankfort black, Spanish black, and Hart's black.

BLACK BIRD. *See* TURDUS.

BLACK CAP. This term is generally applied and understood to signify a species of frugivorous warbler (*Curruca atracapilla* of Bisson); but it is also occasionally given to the great titmouse (*Parus fringillago*), the marsh titmouse (*Parus palustris*), the black-headed bunting (*Emberiza schœmilus*), the stonechat (*Rubetra rubicola*), and even to the black-headed gull.

BLACK COCK. The name of a native species of grouse (*Tetrao*).

BLACK FLUX. A mixture of carbonate of potash and charcoal, obtained by deflagrating *tartar* with half its weight of *nitre.*

BLACK JACK. A term applied by the miners to certain sulphurets of zinc: the ore is also called *blende.*

BLACK LEAD. *See* PLUMBAGO and GRAPHITE.

BLACK LETTER. Is the name now applied to the old English or modern Gothic letter, which was introduced into England about the middle of the fourteenth century, and became the character generally used in MS. works before the art of printing was publicly practised in Europe. On the application of that art to the multiplying of books, about the middle of the fifteenth century, the block books, and subsequently those printed with moveable types, were in this character, to imitate writing, and were disposed of as manuscripts; and so perfect was the imitation, that it required great discrimination to distinguish the printed from the written. The first printed Bible, known as "the Mentz Bible without date," was an instance of this. Fust, the printer, sold copies in Paris as manuscripts; and as the demand increased on account of their beauty and correctness, he not only promptly supplied that increased demand, but even lowered the price: this

excited suspicion; and on comparing the copies they were found to be perfect facsimiles of each other, and being produced with such rapidity it was held to be totally impossible for the most expert scriptores to execute them with equal accuracy and despatch; and Fust was accused of producing them by means of magic. To avoid punishment for this crime, he was obliged to reveal the process by which they were produced.

Books printed before the year 1500 are generally in this character, and are styled black-letter books.

BLACK WASH. A lotion composed of calomel and limewater.

BLA'NCHING. In Gardening, is the whitening of the stems, stalks, or leaves of plants by tying them together, or earthing them up, so as to exclude the light, and thus to diminish the intensity of their native properties.

BLA'NK VERSE. In some modern languages, the heroic verse of five feet without rhymes. Blank verse is peculiar to the Italian, English, and German languages; having been imported into the two latter from the first. In Italian the line is of eleven syllables; and is used invariably in the drama, and frequently in serious poetry, epic or didactic. In English it was also first adopted by the dramatists, and transferred to epic poetry by Milton. The Miltonic verse is constructed with closer attention to the melody of the cadence and cæsura than the dramatic: it admits also less frequently of the eleventh syllable, which in English poetry must be regarded as a sort of license; while Shakspeare and other dramatists occasionally double the short syllable at the end, and thus extend the number to twelve.

BLAPS. A Fabrician genus of Coleopterous insects, now the type of a family (*Blapsidæ*), characterized by the absence of wings; maxillary palpi terminated by a large hatchet-shaped joint; body oblong and oval. All the species are of a dark or black colour, and have the elytra soldered together, and bent down at the sides of the abdomen so as to embrace that part. There are three British species of the genus *Blaps* proper, which are known by the trivial names of "darkling" or "church-yard beetles," and are regarded by the vulgar of this and other countries as insects of evil omen.

BLAS'PHEMY. (Gr. *βλασφημια*, probably from *βλαπτω, I injure; φημη, rumour.*) According to its supposed etymology signifies the offence of using injurious language, as calumny, reviling, &c.; and in this sense it is used in the New Testament; the word "railings," in 1 Tim. vi. 4., being in the original "blasphemies." But in the modern and restricted sense, "blasphemy" signifies the use of insulting, or derogatory, or unbelieving language, with respect to God and divine things. Under this meaning it has been considered a civil crime in most Christian countries, in imitation of the practice which prevailed among the Jews. (Levit. xxix.) In England, by common law, it was punishable with fine, imprisonment, and other corporal punishment. By 9 W. 3. c. 35. it was first made a statutable offence, and extended so as to comprehend even the mere denial of some fundamental doctrines of Christianity; and subjected to very severe inflictions. Unitarians were relieved from the penalties of this act by 3 G. 3. c. 170. But it is almost obsolete in practice with respect to other offenders.

BLASTE'MA. In Botany, the axis of growth of an embryo; that is to say, the plumula, the radicle, and the part which connects them, the cotyledons being removed.

BLASTEMA. In Anatomy, the homogeneous gelatinous and granular basis of the ovum, in which the organic elements characteristic of the different tissues are deposited in the early stages of development.

BLA'STING. *See* MINING.

BLASTOCA'RPOUS. (*Βλαστος, a germ*, and *καρπος, fruit.*) That kind of fruit which germinates inside the pericarp, as the mangrove.

BLASTODE'RM. (Gr. *βλαστος, germ, δερμα, skin.*) In Anatomy, the germinal skin or membrane, or that granular membrane or stratum which lies immediately beneath the membrana vitelli of the ovum, and which is the seat of development of all parts of the body of birds.

BLA'STUS. (*Βλαστανω, I germinate.*) A name sometimes given to the plumula and radicle of grasses.

BLA'TTA. A genus of nocturnal Orthopterous insects, commonly called cock-roaches, or black beetles. In modern Entomology, it forms the type of a family, including many genera.

BLA'ZONRY. The art of deciphering coats of arms; also, that of expressing or describing a coat of arms in appropriate language. The word is supposed to be derived from the German *blasen*, to blow, and to have originated in the ceremonial of tournaments, from which so many other terms and usages in heraldry are derived; it having been customary on these solemn occasions for the herald to blow a trumpet when he called out the arms of a knight on ushering him into the lists. Blazonry requires a knowledge of, 1. The points of the shield, which are nine in number (*see* POINTS); 2. The field, that is, the tincture or tinctures forming the ground of the coat (*see* TINCTURE); 3. The charges, or devices borne on the field (*see* CHARGE); 4. The ordinaries.

BLEA'CHING. (Ger. bleichen.) This process consists in a series of operations, by which the natural colours of various substances are discharged, so as to whiten them. It is effected either by the action of various solvents, aided by exposure to light, air, and moisture, upon the bleaching ground; or by the aid of chlorine. Cotton is more easily bleached than linen, in consequence of its being originally whiter, and having a less powerful attraction for the colouring matter. In bleaching these goods upon the old principle, warm water is first liberally applied to remove the weaver's paste or dressing; they are then *bucked*, or boiled in a weak alkaline ley; and after having been well washed, are spread out upon the grass, so as to be freely exposed to the joint agencies of light, air, and moisture; the bucking and exposure are alternately repeated as often as necessary; the goods are *soured*, that is, immersed in water slightly acidulated by sulphuric acid; lastly, they are very thoroughly washed and dried. By these operations the texture of the goods is to a certain extent impaired, and much time is required to complete the process, which also cannot be carried on in the winter months. But the exposure upon the bleaching ground is now to a great extent discontinued; and the same effect is obtained, after the process of bucking, by the action of weak solutions of *chlorine*, or of *chloride* of lime, which, if skilfully used, can scarcely be said to injure the goods more than the long-continued exposure. The theory of bleaching has not been satisfactorily developed; but, from such experiments as have been made in reference to it, it appears to be a process of oxidizement, and to depend upon some peculiar influence of *nascent* oxygen upon the colouring matter.

The colour of manufactured wool depends partly upon its own oil, and partly upon the applications made to it in the loom. These are got rid of in the fulling mill by the joint action of fullers' earth and soap; the cloth is then well washed and dried, and is tolerably white; if the slight yellow tint which it retains is objectionable, it is prevented by adding a little stone-blue to the washing water, or by exposure to the fumes of burning sulphur; this latter method, however, gives it a harsh feel, and if afterwards soaped its yellowishness returns.

The colour of raw silk depends upon a natural yellow varnish, which is got rid of by boiling it in white soap and water, and by repeated rincings. Certain articles of wove cotton, such as stockings, are bleached as usual, and finished by the action of *sulphurous acid*, or the fumes of burning sulphur. Straw is also whitened by a similar operation; and hence bleached straw hats are apt to have a disagreeable sulphurous smell. A good account of bleaching will be found in ***Parkes' Chemical Essays***.

BLE'ACHING POWDER. Chloride of lime, made by exposing slaked lime to the action of chlorine.

BLENDE. Native sulphuret of zinc.

BLE'NNIUS. (Gr. *βλεννα, slime.*) In Ichthyology, a genus of Acanthopterygious fishes, of the family of Gudgeons (*Gobioidæ*), remarkable for the quantity of mucus secreted from the skin, and for the viviparous generation of some of the species, of which the *Blennuis pholis*, a species common along the shores of Britain, is an example.

BLE'NNORRHŒ'A. (Gr. *βλεννα, mucus*, and *ῥεω, I flow.*) An inordinate discharge or secretion of mucus.

BLE'PHARITES. (Gr. *βλεφαρον, the eyelid.*) Inflammation of the eyelids.

BLIGHT. A term in common use for supposed atmospherical injuries received by plants. Before effects were traced to their causes with the same care that they are at present, the sudden discolouration of the leaves of plants, their death, or their being covered with minute insects or small excrescences, was called by the general name of blight; and this blight was attributed to some mysterious influence in the air, to the east wind, or to thunder, because these states of the atmosphere commonly accompanied the phenomena alluded to. It is now found that what is called blight is in some cases the effect of insects, to the progress of which the dry state of the atmosphere produced by east wind is peculiarly favourable; while in other cases, it is caused by parasitical fungi. The appearance of these fungi on corn crops is frequently designated by farmers as the fire blast; while on peach and other trees in gardens it is called mildew. The sudden death of plants, and also the withering and drying up of part of their leaves and branches, to which appearance the term blight should perhaps be restricted, are produced by the transpiration of water from the leaves taking place with greater rapidity than it can be supplied by the absorption of the roots. In very hot weather in summer, branches of fruit trees trained against walls, or of gooseberry bushes on espaliers, are sometimes withered up in a few minutes from this cause. What countrymen call the blight on standard apple or other fruit trees in orchards is commonly nothing more than the injuries done the leaves

and buds by the caterpillars of certain moths; that on thorn hedges, by the caterpillar of the saw fly, or of the ermine, or of some other moths; and that on roses, by the aphides or green fly.

BLIND WORM. An ophidian or serpent-like reptile, which is the type of the genus *Cecilia* (see that word). The term is also sometimes applied to the slow-worm. *See* ANGUIS.

BLI'NKERS. Expansions of the sides of the bridle of a horse, to prevent him from seeing on either side, but at the same time not to obstruct his vision in front.

BLIS'TER-FLY. *See* CANTHARIS.

BLOCK. (Teutonic.) In Architecture, a large unworked mass of marble or other stone. It is also vulgarly used to denote a modillion in a cornice.

BLOCK. In Navigation, the case that contains the wheel or *sheeve* of the pulley (which last term is not used at sea). Two or more blocks, with the rope, constitute a *tackle* (pronounced tācle). Blocks are also the pieces of wood and iron on which, piled up, the ship's keel is supported when she is in dock.

BLOCKA'DE. In International Law, the right to blockade the ports of an enemy in war, and to exclude neutrals, is limited by the following recognised principles: 1. The blockade must be substantial, by means of a sufficient force to prevent the entry or exit of vessels; otherwise a neutral is not bound to respect it. 2. It is essential that the neutral should have notice of the blockade; otherwise his ship cannot be justly condemned. A counter notice should also be given by the blockading power when the blockade has ceased. In England, a blockade is properly declared by the king in council.

BLO'CKING COURSE. In Architecture, a finishing course of masonry above a cornice.

BLOCK TIN. Tin cast into blocks or ingots: it is generally less pure than *grain tin*.

BLOOD. The fluid which circulates in the heart and blood-vessels. When viewed under the microscope it appears to consist of very minute *red globules* or spheroids floating in a colourless fluid. The average quantity in an adult man is estimated at about 28 lbs.: it is of two distinct colours in the arterial and venous systems; florid red approaching to scarlet in the former, and dark crimson in the latter. Its specific gravity is between 1·050 and 1·070. When drawn from its vessels it gelatinises or coagulates in the course of a few minutes of common temperature, and soon separates spontaneously into *serum* and *coagulum*. The serum is a yellowish soapy-feeling fluid, of the specific gravity of about 1·030. It exhibits a slight alkaline reaction upon test papers; when heated it becomes opaque, and at 156° it coagulates. It is also coagulated by alcohol, and by most of the acids; acetic acid and ether do not coagulate it; solutions of corrosive sublimate, of subacetate of lead, and of chloride platinum occasion precipitates in it, even when considerably diluted with water. These properties of serum are dependent upon the presence of a peculiar proximate animal principle called *albumen*; the same substance, and with very nearly the same properties, constitutes the *white of egg*, the coagulability of which by heat is well known. Besides the above there is another most delicate test of albumen in solution, which consists in adding to the liquid suspected to contain it a little strong *acetic acid*, and afterwards a few drops of *ferrocyanate of potash*. If albumen be present, a white cloud is produced. This is even a more accurate test than corrosive sublimate. White of egg is coagulated by ether, while serum is not. According to Marcet 1000 parts of serum of human blood are composed of water 900, albumen 86·8, muriates of potassa and soda 6·6, muco-extractive 4, carbonate of soda 1·65, sulphate of potassa 0·35, earthy phosphates 0·60.

The coagulum of the blood is of a more or less firm texture, and has a greater specific gravity than the serum. It contains the colouring particles of the blood; and when carefully washed, these are carried out of it, and a tenacious whitish matter remains, which has been termed *fibrine*, but which, in all essential points, has the properties of coagulated albumen.

The colouring matter of the blood, *hæmatosine*, may be obtained by evaporating its aqueous solution at a temperature below 100°; it then appears almost black, but resumes its red colour when dissolved in water. It is soluble in acids and in alkalies: these solutions are dark-coloured; but when mixed, so as to become *neutral*, the hæmatosine falls of a bright red colour. Accordingly, when the clot of blood is put into acids it becomes brown or blackish, and is very similarly discoloured by alkalies; but most neutral salts render it florid. Dr. Stevens has shown that carbonic acid in venous blood is the probable cause of its dingy hue, and that the saline matter of the serum confers the florid red upon arterial blood; and that by washing the saline matters out of the bright coagulum of arterial blood it gradually loses its brilliancy and resembles venous coagulum.

The following table shows the results of an analysis of human blood by Lecanu (*Annales de Chimie et Physique*, vol. xlviii.); considered *quantitively*, it must only be taken as a mean or approximate result.

Water	780·145
Fibrine	2·100
Colouring matter	133·000
Albumen	65·090
Fat and oily matter	3·740
Extractive matter	1·790
Albumen combined with soda	1·265
Chloride of sodium, potassium; Carbonates, Phosphates, Sulphates of potassa and soda	8·370
Carbonates of lime, magnesia; Phosphate of lime, magnesia, iron; Peroxide of iron	2·100
Loss	2·400
	1000·000

BLOOD ROOT. The root of the *Sanguinaria canadensis*, the juice of which is of a red colour.

BLO'ODSTONE. A dark green silicious mineral, variegated by red spots (heliotrope).

BLO'WPIPE. An instrument by which a small jet of air is directed laterally into the flame of a lamp or candle, so as to divert it in a long slender cone upon a piece of charcoal or other substance so placed as to receive it. When a flame is thus urged by the blowpipe the extreme heat is just at the tip of the outer white flame, where the combustion is most perfect, and where substances are rapidly burned or oxidized; whilst the interior blue flame, in consequence of its excess of combustible matter, abstracts oxygen from, or *reduces*, substances. So that several metals, when thus heated before the blowpipe, are alternately oxidized and deoxidized by being placed in the outer and inner flame. The blowpipe is of important service to the chemist in enabling him to ascertain easily and quickly the effects of intense heat upon a variety of substances; and he frequently has recourse to it in order to distinguish metallic and earthy minerals from each other, and to ascertain in a general way the nature of their component parts: it is, in fact, a most important auxiliary in all cases of qualitative analysis. Several treatises have been written on the use and indications of the blowpipe: the reader is especially referred to *Faraday's Chemical Manipulation*, Sect. IV. §3.

BLU'BBER. The cellular membrane in which the oil or fat of the whale is included. *See* WHALE.

BLUE. (Germ. blau.) In Painting, the colour of the sky. It is one of the seven original colours, and is of many sorts, whereof the principal are ultramarine, prussian blue, blue bice, and indigo.

BLUFFS. High banks presenting an abrupt form towards the sea or river.

BO'A. A genus of serpents, with the transverse scutæ of the abdomen and tail in a single row, and without a rattle or spur at the end of the tail. Some species attain an immense size; but the large serpents brought to this country, and called boa constrictors, are generally *Pythons*, and natives of Asia. The true boas are from South America.

BOARD. (Equivalent to the French *bureau*.) A word applied usually to certain individuals in a collective capacity, who are intrusted with the management of some public office or department. Thus the Commissioners of Customs, the Committee of the Privy Council for the Affairs of Trade, the Commissioners of Excise, &c., when assembled to transact the business of their respective offices are styled the Board of Customs, the Board of Trade, the Board of Excise, &c. But the term Board is used also in a more general sense, being applied to any individuals appointed by competent authority to deliberate on or superintend the operations of any private business or speculation.

BOARD. (Sax. bord.) In Architecture, a piece of timber of undefined length, more than four inches in breadth, and not more than two inches and an half in thickness. The section of a board is, however, sometimes triangular, or rather trapezoidal, one edge being very thin. This is called a feather-edged board.

BOA'TSWAIN. The second of the three warrant officers of a man of war; he has charge of the boats, rigging, anchors, and cables. It his duty to *turn the hands up*, or summon the whole crew, whenever they are required for any duty. He should from the nature of his duties be an active man, and a thorough seaman. The *boatswain's mates* assist the boatswain, summon the watches or other portions of the crew to duty, and inflict punishments.

BOAT. (Sax. bæt.) A term used in a general sense to denote any small ship or vessel, whether open or decked, and which may be propelled by oars, or by

sails, or by steam. They are accordingly of very different forms and constructions, according to the different purposes they are intended to serve. Under this term are comprehended barges, cutters, pinnaces, yawls, &c. *See* SHIP; STEAM NAVIGATION.

BO'BSTAYS. Stays or strong ropes to keep down the bowsprit during the plunging of the ship, and against the upward action of the head sails (jibs, fore-staysail, &c.), and to sustain the action of the stays or ropes, which keep the foremast, fore-topmast, &c., and therefore the main-topmast, from falling aft. They are necessarily very strong; they are attached to the bowsprit by *collars* placed about ⅔ of its length outside, and to the hull of the ship, by passing through holes in the *cutwater* or projecting head, and make an angle of about 30° more or less with the axis of the bowsprit. They are often made of chains.

BO'DY. In Physics, is a term applied to any portion of matter of which the existence can be perceived by any of our senses. According to the Peripatetics, body is composed of *matter, form*, and *privation*. In modern physics, body is regarded as an agglomeration of material particles. According to the different forms in which matter exists, bodies may be *solid, liquid*, or *gaseous*.

In Geometry, *body* is synonimous with *solid*. Thus we say the five regular *bodies*, or five regular *solids*. *See* SOLID.

BOG EARTH. A soil consisting chiefly of silicious and vegetable fibre; it is often accumulated in considerable quantity where waters have deposited the mud of boggy places. Many American shrubs and other plants and flowers will only thrive in such or similar soils, so that bog earth is in great request for such purposes. It may, to a certain extent, be artificially imitated by mixing the cuttings of grass with the mud of ponds and a sufficient quantity of sharp sand.

BOHE'A. A species of black tea. *See* TEA.

BOI'LING POINT. The temperature at which liquids are rapidly converted into vapour with the phenomena of *ebullition*. Thus the boiling point of water is 212°; of alcohol, 176°; of ether, 96°; of oil of turpentine, 316°; and of mercury, 662°; these being the respective temperatures at which these bodies continuously pass into the state of vapour.

BO'LDNESS. (Sax. balð.) In the Fine Arts, that fearlessness which an artist exhibits in his designs, arising from, and grounded on, a thorough knowledge of the principles of his art. Its antagonist is tameness or insipidity.

BOLE. (Gr. *βωλος, a mass.*) An argillaceous earthy mineral, generally reddened by oxide of iron; as is the case in the *Armenian bole*, which is used in tooth-powder, and to give colour to the fish sauce called *essence of anchovies*.

BOLE'RO. A peculiar species of dance very popular in Spain, and so called from the name of its inventor.

BOLE'TIC ACID. An acid contained in the juice of the *Boletus pseudo ignarius*.

BOLE'TUS. (Gr. *βωλος, a mass.*) A genus of fungi, numerous large species of which spring from the sides of trees when the rind is decayed, forming firm fleshy masses, which are generally smooth on the upper side, and pierced with holes on the lower. The spawn of such plants often forms what is called dry-rot, insinuating its fine delicate filamentous ramifications between the tubes of the wood, forcing them asunder, and so destroying the cohesion and solidity of timber. *Boletus igniarius* and *fomentarius* are the fungi which, when cut into thin slices, dried, and prepared with saltpetre, form common amadou, or the German tinder of the shops. *B. tuberosus* is used in Sweden, as a substitute for cork. *B. bovinus* is said to be a favourite food of oxen, deer, swine, and some other animals; it is even used for human food.

BOLOGNE'SE SCHOOL. In Painting, sometimes called the *Lombard school* of painting. It was founded by the Caracci, and its object was to unite the excellencies of the preceding schools (*see* PAINTING); hence it is occasionally called the *Eclectic school*. Among the principal painters which it numbered were Domenichino, Lanfranco, Corregio, Guido, Schidone, Caravagio, Zampieri, Primaticcio, &c.

BOLO'GNIAN STONE. A sulphate of baryta, found near Bologna, which, when heated with charcoal, becomes a powerful *solar phosphorus*.

BO'LTHEAD. A globular flask with a tubular neck, used in the chemical laboratory.

BO'LUS. (Latin, *a mass.*) A very large pill; or a medicine formed into an olive-shaped mass, not too large to be swallowed.

BOMB. In Artillery, a hollow ball or shell of cast-iron, having an orifice through which it is filled with gunpowder, and into which, when filled, a fusee is inserted, so adjusted that when the bomb falls at the place intended, the fusee ignites the powder in the shell, and blows it to pieces. The havoc which is thus produced in a besieged town or the ranks of an enemy is often very great. Bombs, or shells, as they are more frequently called, are of all sizes, from about 18 inches downwards, and are in general thrown from mortars or howitzers; sometimes from cannon. They appear to have been first used as part of the regular materiel of an army about the year 1634, in the wars of the Netherlands. The principal art in throwing shells is to make them fall at or near a given point. For this purpose the distance is calculated, and the charge of powder and elevation of the mortar regulated accordingly. Theoretical rules are of no great use. They must be derived from experiment and practice.

BO'MBARDIERS. *See* BRACHINUS.

BO'MBAX. (Βομβαξ.) A genus containing many species of very large trees, whose capsules are filled with a fine cottony substance enveloping the seeds. It gives its name to the natural order *Bombaceæ*, allied to Malvaceous plants, where it is associated with the celebrated Baobab, and many more gigantic inhabitants of tropical forests. The bombax trees are remarkable for forming on their sides next the ground huge buttresses, projecting so far from the parent trunk as to be capable of screening many men. The quantity of cotton yielded by these trees is enormous, and often covers the earth around the roots to the depth of several feet; it is unfortunately of too short a staple to be used for manufacturing purposes.

BO'MBAZINE. (Βομβυξ, *a silk worm.*) A fabric of which the warp is silk and the weft (or shoot) worsted. It is chiefly made in black, and as an article of mourning for female dress. The capital employed in Norwich, during the most flourishing period of the bombazine trade, amounted to 300,000*l.*, but at present it is below 100,000*l.*

BOMB VESSEL. A ship of war, intended for the bombardment of a town or place situated on the sea coast. They are of about 350 tons burthen, and carry one 13-inch and one 10-inch mortar, together with two 6-pounder guns, one 12-pounder, and eight 24-pounder carronades, having a crew of sixty-seven men, with the usual complement of officers, and a detachment of marine artillerymen for the purpose of working the guns. See *Spearman's British Gunner*.

BO'MBIC ACID. The acid contained in the silkworm, especially in its chrysalis state. It is supposed to resemble formic acid.

BO'MBYCI'LLA. A genus of omnivorous Passerine birds, of which the Bohemian wax-wing (*Bombycilla garrula*) is an example, and an occasional winter visitor of Britain.

BOMBY'LIUS. A Linnæan genus of Dipterous insects, and now the type of a family (*Bombyliidæ*), characterized by the great length of the oral instruments, which form a long and slender proboscis; body thick, short, hairy; thorax gibbous; wings extended horizontally; halteres exposed; antennæ short, approximate, composed of three joints, the last the longest, thickened and terminating obtusely; legs long and slender. The insects of this family have a rapid flight, and are very active; they subsist entirely on the nectar of flowers. They are of small size, and mostly exotic, affording types of many genera, of which only *Bombylius* proper and *Pthiria* afford British examples.

BO'MBYX. A Linnæan genus of Lepidopterous insects, now the type of a family (*Bombycidæ*), including many genera of nocturnal and post-meridian moths. These have been arranged under the following sub-families: — *Hepialidæ, Notodoxtidæ, Arctiidæ*, and *Bombycidæ* proper.

BONA DEA. In Roman Mythology, a goddess concerning whom a great diversity of opinion prevails, even among the writers of antiquity. On the authority of C. Labeo, she is represented by Macrobius, who treats at length upon her nature and worship, as synonimous with the Grecian Rhea or Cybele. The Bona Dea had two temples at Rome; but her rites were generally solemnised in the house of the consul or prætor. In the celebration of these rites only women participated, thereby indicating the peculiar chastity of the goddess. But a perusal of the ancient writers will convince the most sceptical that the exclusion of men from the solemnities of the Bona Dea was purely nominal, and that in the course of time the grossest licentiousness was practised during their celebration. (See *Cic: pro Milone: Juv. Sat.* VI.)

BONA'SSUS. *See* BISON.

BOND. (Sax. bonð.) In Architecture, the connection of one stone or brick with another by lapping them over each other in carrying up work, so that an inseparable mass of building may be formed, which could not be the case if every vertical joint was over that below it.

BOND. In Law, a deed whereby the obligor, or party binding himself, obliges himself, his heirs, executors, and administrators, to pay a certain sum of money, called the penalty, to another (the obligee) at a day appointed. There is a condition added, that if the obligor does some particular act the obligation shall be void, or else remain in full force. In case this condition is not performed, the bond becomes forfeited or absolute at law, and charges the obligor while living; and after

his death the obligation descends on the heir, who (in default of personal assets in the hands of the executor or administrator) is bound to disharge it, provided he have real assets by descent. The condition is usually (although not necessarily) included in the same deed, and at the foot of the obligation.

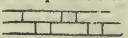
A bond without a condition is termed single (or *simplex obligatio*); and it becomes single by forfeiture, on non-performance of the condition. At law, the whole penalty mentioned in the bond was recoverable on such non-performance. But by the interposition of equity the obligee was discharged from paying more than the sum to which the obligor was reasonably entitled: viz. his principal, interest, and expenses, if the bond was for payment of a debt; or the damages accruing to him, if it was for the performance of a stipulated act. But by 4 & 5 Ann. c. 16. it was enacted that in case of a bond conditioned for payment of money, the payment of the sum due, with interest and costs, even though the bond be forfeited, and suit commenced thereon, shall be a full satisfaction and discharge; and on this footing the law now stands.

A bond on which neither principal nor interest has been demanded for twenty years will be presumed to have been satisfied; but length of time is not, strictly, a legal bar, but only a ground for the jury to presume satisfaction.

In a bond where several are bound severally, the obligee may, at his election, sue all the obligors together, or all of them apart, and have several judgments and executions: but he shall have satisfaction but once; for if it be by one only, that is sufficient to discharge the debt.

Bond, English. In Architecture, that disposition of bricks in a wall wherein the courses are alternately composed of *headers*, or bricks laid with their heads or ends towards the faces of the wall, and in the superior and inferior courses of *stretchers* or bricks, with their lengths parallel to the faces of the walls, as in the margin, in which the upper is called the heading, and the lower the stretching course.

Bond, Flemish. In Architecture, that disposition of bricks in a wall wherein each course has headers and stretchers alternately, as in the margin.



Bond or Lap of a Slate. In Architecture, the distance between the nail of the under slate and the lower edge of the upper slate.

BOND STONE. In Architecture, a stone running through the whole thickness of a wall at right angles to its face, for the purpose of binding the wall together in the direction of its thickness.

BOND TIMBER. In Architecture, timber worked in with a wall as it is carried up, for the purpose of tying it together in a longitudinal direction while the work is setting.

BONE. An important organ in the higher orders of animals (*see* Anatomy), forming the solid support of their fabric, and protecting the vital organs, such as the brain and the heart and lungs, from external pressure and injury. In the human skeleton there are commonly enumerated 260 distinct bones. They, however, admit of classification under three heads; namely, *long* or *cylindrical* bones, such as those of the extremities; *broad* and *flat* bones, such as those of the skull; and *short*, *square*, *irregular*, or *solid* bones, such as the vertebræ, and those of the wrist and instep, and the patella or knee-pan: the first bones are generally filled with marrow, and are admirable specimens of strength of structure with the least possible weight. The bones are covered by a membrane called *periosteum*, by which the ramifications of blood-vessels and nerves pass into the bone. In the growth of a bone, the gelatinous or cartilaginous portion, as it has sometimes been called, is first formed, and the earthy or indurating part is afterwards deposited. We are indebted to Mr. Hatchett for our principal information respecting the proximate chemical components of bone. (*Phil. Trans.* 1799 and 1800.) The soft parts consist of gelatine and albumen; and the hard portion is composed of phosphate of lime and carbonate of lime, with small quantities of other salts. The animal matter of bones amounts on an average to about half their weight, or, when dried, to between 30 and 40 *per cent.;* so that they contain a large relative proportion of nutritive matter. The bones, including their animal matter, are the most durable parts of the animal fabric; hence the proposal of storing them up, as occasional sources of nutriment; for not only is the cartilaginous portion unimpaired, in bones which have been kept dry for many years, but it has even been found perfect in bones of apparently antediluvian origin. The best mode of extracting the nutritious part of bone for human food consists in grinding it fine, and subjecting it with water to a heat of about 220° in a digester; or the earthy part may be removed by dilute muriatic acid. When dogs and some other animals devour bones, the nutritive part is abstracted by their gastric juice, and the earthy part is voided in their excrement, forming what was formerly called *album græcum.*

When bones are submitted to destructive distillation, the gelatine and albumen which they contain is abundantly productive of *ammonia;* hence a copious source of that alkali and its compounds; the residue is a mixture of the earthy part of the bone with charcoal, commonly termed *ivory* or *bone black.*

BONE DUST, or ground bones, has recently been used with the best effect as a *manure.* It is usually applied to light or turnip soils, which it has rendered in no ordinary degree productive. For further details on this curious and interesting subject, see article "Agriculture" in *M'Culloch's Statistics.* The importation of bones from distant countries to be used as manure is now carried on to a great extent.

BONE EARTH. The residue of bones which have been calcined so as to destroy the animal matter and carbon, and become converted into a white porous and friable substance, composed chiefly of phosphate of lime. According to Berzelius, 100 parts of human bones are composed of 51·04 phosphate of lime, 11·30 carbonate of lime, 2 fluoride of calcium, 1·20 soda and chloride of sodium, 1·16 phosphate of magnesia, and 33. 30 animal matter. Albumen, gelatine, and fat constitute the animal part of bone, the greater part of which remains in the form of a tough cartilage when bones are steeped in dilute muriatic acid.

BONI'TO. The name of a species of Scomberoid fishes (*Thynnus pelamis*, Cuv.), common in the tropical ocean, and well known to voyagers from its persecution of the flying-fish (*Exocœtus volitans*), and flying squid (*Loligo sagittata*).

BO'NZES. The priests of the religion of Fo are so called by Europeans; especially in China, the Birman Empire, Japan, and other districts of Eastern Asia.

BO'OBY. The English name of a genus of *Pelecanidæ;* they are also called gannets, noddies, and soland geese.

BOOK. (Ger. buch.) "The general name of almost every literary composition, but in a more limited sense applied only to such compositions as are large enough to form a volume." Short and fugitive pieces are denominated pamphlets, in contradistinction to books, which are of greater length, and embrace more general or permanent topics. To the various sizes and forms in which books appear appropriate appellations have been given; as folio, quarto, octavo, duodecimo, &c. The materials of which books have been composed have been extremely different in different nations, and in different periods of the progress of civilization. Plates of lead and copper, bricks, stone, and wood were anciently employed for this purpose. At a later period the bark of trees formed the chief material in the composition of books, as is indicated by the original signification of the term *book* itself, and its equivalent in some some other languages. The materials of books were afterwards derived from the Egyptian plant papyrus; but as the demand for books increased, more durable materials were sought for, and leather, made chiefly from the skins of goats or sheep, was employed for this purpose. Next followed the use of parchment, on which the ancient MSS. were chiefly written: but all these systems were swallowed up by the invention of paper (*quod vide*), which took place about the 13th century, and facilitated the circulation of knowledge to an incalculable extent. The first books were in the form of blocks and tablets; but when flexible materials came into use, it was found more convenient to roll them up in scrolls, called by the Greeks *κόνταξ*, and by the Romans *volumen.*

BOOK-KEEPING. In Commerce, the art of recording, in a regular, concise, and systematic manner, the transactions of merchants, traders, or other persons engaged in pursuits connected with money. It has not only the authority of experience to recommend it, but that of some of the sagest observers of human affairs; Dr. Johnson remarks, "that the counting-house of an accomplished merchant is a school of method, where the great science may be learned of ranging particulars under generals, of bringing the different parts of a transaction together, and of showing at one view a long series of dealing and exchange. Let no man (the Doctor adds) venture into large business while he is ignorant of the method of regulating books; never let him imagine that any degree of natural abilities will enable him to supply this deficiency, or preserve a multiplicity of affairs from inextricable confusion." There are two modes of keeping books of account; the one by what is termed *Single* and the other by *Double Entry.* Both are in very general use. The system of single entry is chiefly confined to the business of retail-dealers; it is much the simplest method of book-keeping, consisting only of a day-book and a ledger. In the day-book the dealer enters his sales and purchases, and in his ledger he carries the former to the debit of his customers, and the latter to the credit of the merchants who supply him with goods. By making at any time a list of the sums due to him by his customers,

and of those due by him to wholesale merchants, the retail dealer may, after adding to the debts due to him the value of his stock on hand, arrive at an approximation to the real state of his debts and assets. This, however, is but an imperfect and unsatisfactory mode of book-keeping; and, therefore, in the case of wholesale and mercantile business, where extensive and multifarious transactions have to be recorded, recourse is had to the system of *double entry*. This system possesses all the advantages of single entry, besides being so complete and comprehensive in its principles, and so certain in its results, as to admit of universal application. It may with equal advantage be adopted in the most limited as well as in the most extensive, in the most plain and simple as well as the most intricate and complicated concerns.

No very authentic accounts exist of the origin of book-keeping. The double entry system appears to have been first practised towards the latter part of the fifteenth century, in Venice and other towns in Italy, then the great emporium of the mercantile world, and from this circumstance it acquired the name of the *Italian method of book-keeping*. The advantages of the system, and the soundness of the principles on which it is based, soon became apparent; for we find it was adopted in England and France early in the sixteenth century, and has continued to be more and more practised down to the present day.

The great objects of a good method of book-keeping are to exhibit transactions as they occur, in the most minute detail, and ultimately in the most condensed form; advancing from the earliest stage to the latest by such clear and lucid steps as at all times to admit of every fact being traced in its progress, and security being obtained at every step against omission or error. For the attainment of such important objects, no mode of book-keeping has hitherto been devised at all approaching to the perfection of the Italian system by double entry. Every transaction in business is twofold; there can be no receipt without a payment, and no purchase without a sale, and consequently by presenting the same event or fact on both sides of the books, whence the name of double entry, the entries being simultaneous, become corroborative of each other. The circumstance of every transaction being entered on both sides of the ledger affords one of the most valuable results derived from the system of double entry, namely, a test of accuracy; inasmuch as the entries on the credit side must be equal to the entries on the debit side, otherwise the books will not balance.

The three principal books required under the Italian system of double entry are, a cash book, journal, and ledger. In the first of these every transaction is recorded where money forms one of its elements, and in practice these transactions are by some book-keepers carried direct from the cash book to the ledger without being passed through the journal at all. The journal, however, forms a most important part of the system. It exhibits a narrative of every transaction of which an actual transfer of money does not form one of the elements, arranging the facts in as simple and condensed a form as correctness and intelligibility will admit of, and the results of those entries in the journal are afterwards introduced into the ledger, which thereby becomes a sort of key to the detailed history of every transaction; whilst at the same time it furnishes a luminous compendium of the whole. In like manner when the cash transactions are passed through the journal they are at stated periods classed and arranged in a condensed form, and thence transferred to the ledger. This plan of introducing the cash transactions into the journal is considered much the best system, though attended with a little more trouble to the book-keeper, as it affords great facilities in balancing the books and testing the accuracy of the ledger, more particularly when the recent improvements upon the form of the journal, which were originally suggested by the late Mr. Jones, are adopted. By the plan referred to, the journal is advantageously ruled with four cash columns, two upon the left hand side for *entries debtor*, and two upon the right for *entries creditor;* and all the transactions being connected either with *personal* and *property* accounts or *nominal* accounts, such as charges, profit and loss, and so forth, they are classed accordingly in the columns on the Dr. or Cr. side of the journal respectively; and as the debit entries are at all times equal to the credit entries, the aggregate of the two columns on the Dr. side must tally with the aggregate of the two on the Cr. side of the journal. This too is found in practice to be a most useful check against posting the entries to wrong accounts in the ledger; for on balancing the books, by taking the amounts Dr. and Cr. posted to personal and property accounts, and the amounts Dr. and Cr. posted to nominal accounts in the ledger, and comparing them with the total amounts in the corresponding columns of the journal, it will be seen whether they agree: if they do not, it demonstrates that some entries must have been erroneously posted, which can then only be discovered by collating the books; but if the amounts do agree, then it affords at least strong presumptive evidence that the whole of the entries have been carried to the proper accounts. Experience and practice are occasionally suggesting minor improvements upon the forms of the cash book, journal, and ledger, to suit particular cases, as well as upon the subsidiary books required for gathering together the facts preparatory to their being transferred in a condensed form into the journal; and indeed an intelligent book-keeper may accomplish much by a judicious classification of the facts in the auxiliary books; but the fundamental principles of the Italian system of book-keeping, notwithstanding such occasional facilities and improved arrangements in the working of it, remain perfect and unchanged; and after the length of time they have successfully withstood all attempts at innovation or change, it may safely be affirmed that the system is the best hitherto discovered, and is deserving of the utmost confidence and general adoption.

We have already stated that the Italian system of book-keeping admits of universal application; and we may now observe that it is not confined to merchants' accounts, but is equally applicable to government accounts. In evidence of its being so, we may instance the East India Company, where the double entry system is used with the most perfect success in all the branches of that great and well-conducted establishment, financial as well as commercial. One great desideratum in a system of book-keeping for government accounts is centralization, which can alone be attained by a proper and well organized method of condensing the facts or elements of the accounts; and the Italian system unquestionably affords the most efficacious means of collecting and grouping the widely scattered elements of government accounts in a concise and intelligible shape, and ultimately exhibiting them in the clearest and most perfect state of centralization admitted of. Several of the ablest ministers of France from the days of Sully downwards, convinced of the necessity of a good system of book-keeping in the management of the public money, and satisfied of the efficiency and soundness of the principles of the Italian method, successively attempted to get the government accounts kept on that system. But it was not till the present century that it was successfully introduced. It has since, however, fully realized all that was anticipated of it by those great men; and has been found to answer so completely that it has been universally adopted in all the different departments of the state. Equally beneficial effects have resulted from the adaptation of the system to the public accounts in Holland, and confirmed the advantage of its application to government business. Similar laudable attempts have been more recently made in this country by some of our ablest practical statesmen (among whom Sir Henry Parnell deserves particular notice), to introduce the Italian mode of book-keeping in the government offices; and from the signal success with which the experiment has been crowned, it is to be hoped that in a few years the whole of our public accounts will be placed on one uniform plan of book-keeping by double entry, and be thereby rendered as clear and intelligible as the accounts of any merchant in London, instead of being wrapped up, as formerly, in impenetrable obscurity and useless mystery.

BOOM. (Dutch boom, *a tree.*) A nautical term, signifying a long pole run out from any part of a ship to stretch the bottoms of particular sails; whence *jib-boom*, *main-boom*, *studdingsail-boom*, &c.

BOOM. In Marine Fortification, signifies a strong chain or cable stretched across the mouth of a harbour or river, to prevent the enemy's ships from entering, and having a number of poles, bars, &c. fastened to it; whence the name.

BOOPS. A genus of fishes of the order *Acanthopterygii:* most of them occur in the Mediterranean.

BOO'TES. (Gr. *βους, an ox.*) One of the constellations.

BORA'CIC ACID. See BORON.

BORACI'TE. Native borate of magnesia.

BORA'GINA'CEÆ. Plants resembling the genus Borago, after which they are named. They usually have a mucilaginous sap, in which nitre exists in small quantities; wherefore they decrepitate when thrown upon the fire. It is found that liquor into which borago itself is plunged when fresh becomes cooled, and hence the *Borago officinalis* was the principal ingredient in what was called a "cool tankard." Boraginaceous plants have usually pretty, and sometimes very handsome flowers, arranged in a gyrate manner. Forget-me-not (*Myosotis*), Bugloss (*Echium*), *Anchusa*, and various species of *Lithospermum* are well-known favourites either among wild or cultivated plants. Most of them have their leaves covered with asperities, whence their old name of *Asperifoliæ;* and some, as *Anchusa tinctoria*, *Lithospermum tinctorium*, and several others, yield a deep purple dye from their roots.

BORA'SSUS. (*Βορασσος, the skin of the date.*) A genus of palm trees, usually called fan palms, because their gigantic leaves are formed of plates radiating from the

top of the petiole, and folded up after the manner of a lady's fan. *Borassus flabilliformis* is an Indian species, with a trunk from thirty to fifty feet high, and leaves with from seventy to eighty rays. The Hindoos consider it the king of trees. A most intoxicating liquor is obtained by fermenting its sap, which is also capable of yielding sugar in considerable quantity under proper management.

BORA'TES. Salts of the boracic acid.

BORAX. This salt is found native in some of the lakes of Thibet and Persia, and is imported from India under the name of *tincal*, which after purification forms the *refined borax* of commerce. Of late years borax has been obtained by combining *native boracic acid* with soda. Borax forms hexædral prisms, slightly efflorescent, and requiring 20 of cold and 6 of boiling water for solution. When heated, water of crystallization is driven off, and the residuary salt fuses into what is called *glass of borax*.

Crystallized borax consists of 68 boracic acid + 32 soda + 90 water. It has upon some tests an alkaline reaction, and has hence been called *sub-borate of soda*. Borax is chiefly used by workers in metals as a flux: it is also employed in medicine.

BO'RDER. In Gardening, a marginal space, always connected with a walk or some other object, to which it forms an accompaniment.

BORDER, or BORDURE. In Heraldry, according to French heralds, an honourable ordinary, which should occupy a third part of the shield. In English blazonry, it has generally been considered as a mark of difference to distinguish one branch of a family from another. It surrounds the field, is of equal breadth in every part, and occupies one fifth of the field. When there is a chief on the coat, the bordure is supposed to run under the chief; but it passes over other ordinaries, as a fess, &c.

BORE. A word used to express the sudden rise of the tide in certain estuaries.

BO'REAS. In Grecian Mythology, the son of Astræus and Aurora, and usually worshipped as the god of the north wind. There are few of the minor Grecian divinities of whom so strange and multifarious exploits are recorded as of Boreas; and it is interesting to trace to its source the allegory of all his adventures and achievements, and thence to elucidate the causes of his deification. The assiduity, for instance, with which the worship of Boreas was cultivated at Athens proceeded from gratitude, the north wind having on one occasion destroyed the fleet of the Persians when meditating the invasion of Attica. A similar cause induced the inhabitants of Megalopolis to consider Boreas as their guardian divinity, in whose honour they instituted an annual festival. With his usual partiality for mythological allusion, Milton has given Boreas a place in his *Paradise Lost*: —

> Now from the north
> Of Norumbega, and the Samoed shore,
> Bursting their brazen dungeon, armed with ice
> And snow, and hail, and stormy gust and flaw,
> Boreas and Cæcias and Argestes loud,
> And Thrascias rend the woods and seas upturn.

Boreas was usually represented with the feet of a serpent, his wings dripping with golden dew-drops, and the train of his garment sweeping along the ground.

BO'RON. The base of boracic acid, discovered by Davy in 1807. It may be procured by heating dry boracic acid with potassium. It is a dark olive-coloured substance, a nonconductor of electricity, insoluble in water, infusible, and of a specific gravity = 2. Heated to redness it burns into *boracic acid*, which consists of 20 boron + 48 oxygen.

Boracic acid is found in the hot springs, and amongst the volcanic products of the Lipari islands, and in the waters of Sasso in the Florentine territory; it also occurs in some minerals. It may be obtained by adding excess of sulphuric acid to a strong solution of borax. Its specific gravity is 1·48. In its usual state of scaly crystals it is a *hydrate*, composed of 68 dry acid + 27 water. In this state it requires about 30 parts of cold and 3 of boiling water for its solution. It dissolves in alcohol, and the solution burns with a characteristic green flame. It reddens litmus; but renders turmeric brown, like an alkali. When its water is driven off by fusing it at a high heat, the anhydrous acid concretes into a glassy substance of the specific gravity of 1·8. It is a useful flux, and was formerly used in medicine under the name of *Homberg's sedative salt*.

BO'ROUGH. A town possessed of certain municipal institutions, of which the name is derived by some from the Saxon word burg, meaning an inclosed place; by others from another word of the same language — borg, meaning pledge, which was applied to some of the associations for mutual liability established by the Saxon law. Boroughs, in the sense of the definition above given, must have, in some shape, existed very early in this as well as in other countries; but the origin as well in constitution as in name of the existing municipal system in England can be traced no higher than Saxon times, and the general and connected history of English boroughs does not begin before the Conquest.

According to Doomsday Book there were in England at that time eighty-two boroughs, including cities, differing considerably in the extent of their franchises as well as in their customs and mode of government; but agreeing in this general character, that they were communities established chiefly for the purposes of trade, endowed to that effect with certain franchises, such as that of a fair or market, and possessing as boroughs a special jurisdiction exercised in the the borough court-leet, and exclusive of the jurisdiction of the hundred, with which in the political scale a borough was co-equal. Some of them then held, and all were capable of holding, lands in common; and in respect of such land they held, as did also each burgess in respect of his own tenement, of some lord, by a species of tenure called burgage tenure, which was in fact only the ancient tenure in common socage, *i.e.* tenure by rent or service certain, which continued to prevail in boroughs after the general imposition upon other lands of the feudal or military service. The lordship of the land of the borough, and of the different tenements which it contained, must have belonged in the first instance to the lord of the manor within which it was situate; but all boroughs, in contemplation of law, held their franchises of the king.

Great obscurity prevails as to what was originally the internal constitution of boroughs, and as to how far it was popular or not, and how far also it was or was not uniform. It is certain that as early as the date of Doomsday Book the proportion between the number of burgesses and that of other inhabitants was very different in different boroughs; though the fact may be reconciled with the notion of a system originally popular (which has all along prevailed in some boroughs), upon the supposition that the franchise had either been usurped on the one hand, as has frequently happened in the case of larger communities, or abandoned on the other hand as of little value, on account of the liability that attached to it of contributing to the common charges. Much perplexity also arises on this subject from the intermixture in the same place of the guild and borough franchises (*see* GUILD), which prevailed to that extent that the guild-merchant, which appears to have been an incorporation, or an association by licence of all trades within the borough, is by some considered as identical in its constitution with the borough itself; and it is certain, at any rate, that the guild-merchant, though it did not in the first instance constitute the borough, yet in many places usurped its franchises and government, and finally assumed its name; so that, with the exception of burgage tenure, which still prevailed in some few places, and of birth, which was common to both institutions, the other modes of obtaining the freedom of a borough,—*i. e.* those of apprenticeship, purchase, or gift,—were introduced into the municipal system from the guild-merchant. Distinct from this in their relations and contests with the community of the borough at large were the guilds of particular trades, which succeeded in London in engrossing and parcelling among themselves, under the name of liveries, the whole of the municipal franchises.

All borough rights, being exceptive, rested either upon charter, or upon prescription, which supposes a charter. Some few of such charters were granted by Saxon kings: but they became much more frequent after the Conquest, the style and purport of these early documents being simply that of a grant to the *men* and *burgesses* of such a place of certain franchises, whether relating to trade, as that of a fair or market, or exemption from toll, or to jurisdiction, such as a commission of the peace and the right of holding sessions, which was first granted to any borough by Richard II. In the reign of Henry VI., a remarkable alteration took place in the style of these royal grants, it being then first that were granted, as it is said, charters of incorporation, strictly so called; though previous to that time boroughs, or the governing bodies that represented them, enjoyed all the privileges of a corporation, and since that time many have continued to enjoy them without any such special grant. From that time forth, however, the history of boroughs becomes identical, except as to the parliamentary franchise, with that of municipal corporations. These charters of incorporation did not, any more than did those which preceded them, pretend to regulate the internal constitution of boroughs. This very generally assumed the form of a government by a small and in great measure self-elected body, which had in most cases succeeded in engrossing not only the whole administration, and in a great degree the enjoyment also of the borough franchises and property, but the right also of granting, according to rules more or less arbitrary, admission into the subordinate body of burgesses or freemen. And even that body, where it existed, which was not always the case, was small in proportion to the whole number of inhabitants. It was the great object of the charters granted by the Tudor sovereigns to sanction and confirm the usurpations, if such they were, of these municipal oligarchies, with the view apparently of throwing the representation of boroughs (a right which had been conferred in the first

instance by Edward I., had since been extended by fresh grants, and was then becoming of considerable importance) into the hands of such as were most likely to be easily guided or controlled, either by the crown itself or by the great lords upon whose support it reckoned, and with whom it became usual about the same time to connect themselves with the boroughs in the neighbourhood of their possessions, under the honorary title of high stewards. The exclusive system of municipal government, which attained its height during the Stuart dynasty, continued unimpaired till the present time, when it was effectually put an end to by the Act for the Regulation of Municipal Corporations, passed in the year 1835. For an account of which, as well as of the other remarkable incidents in the history of our municipal institutions, which happened from the time of the Tudors to the present period, see title MUNICIPAL CORPORATIONS; and for an account of the *representation* of boroughs, and particularly of the *reform* in *their representation*, see title PARLIAMENT.

The account above given of English boroughs, both as to their origin and constitution, applies in all its general features to Scotch boroughs; with this qualification, that the government by close corporations was in the latter country more thoroughly and more generally prevalent until the reform in them, which preceded by a year the Municipal Regulation Bill applicable to this country; and resembled it in almost every thing but this, that it made the qualification for burgesship identical with that required to give a vote in the election of members, namely, the occcupancy of a house of the yearly value of 10*l*.

In Ireland the municipal system, as it now exists, is of considerably later origin than in Scotland or in England. It was transplanted, and gradually introduced from the latter country; and though with the same names and form of constitution as then existed there, had much more in it of a political character, being intended in the first instance as a support to the English against the Irish, and in later times to the Protestant against the Catholic, and was so used to the neglect of functions more properly municipal, which have therefore in many instances been intrusted to other hands by local acts of parliament. These distinctions of religion and birth aggravated also in other respects the vices of a close and exclusive system, which was there, as in Scotland, more generally and thoroughly established than it ever was in this country. A measure for the reform or abolition of the existing municipal corporations of Ireland is now pending before the legislature.

BOROUGH ENGLISH. In Law, is a customary mode of descent of lands in some ancient boroughs and manors, by which estates descend to the owner's youngest son; or if he has no issue, to his younger brother. *See* DESCENT.

BOS. (Lat. bos, *an ox*.) A genus of ruminating mammals, which is one of the most important in relation to the necessities and conveniences of man. To this genus belongs the domestic ox, in all its various breeds and varieties. With respect to the wild original of our numerous herds there is yet some obscurity; less, however, than hangs over the origin of other domesticated species. The wild cattle which approach nearest to the tame are those which inhabit the forests of the north-east of Europe; and the white cattle, which are still preserved in a state of purity at Craven, at Chillingham Park, and in Scotland. These are both referred to the species called *Bos taurus*, or *Bos urus*, or *Urus Scoticus*; but there is much reason for supposing this species to have been the domestic ox reverted to a state of nature. Another well-marked variety of this species is the Brahminy bull; characterised by the hump on the shoulders and the pendent dewlap.

The other known wild species of ox are the Gayal of India (*Bos gavæus*); the Yak of the mountains of Central Asia (*Bos grunniens*); lastly, there are the Buffaloes, which, though anatomically less distinct than the Bisons from the typical *Boves*, yet differ from the oxen as a group in many points. They have larger horns, which sometimes form a horny covering of great thickness to the whole frontal region; and they approach the Pachydermata in the thickness of the skin and the thinly scattered coarse hair. They frequent marshy grounds, and feed on a ranker and coarser herbage than the ox. The flesh of buffaloes is rank and coarse, and they are used chiefly as beasts of draught or burden. The two best marked species are the Indian or Arnee buffalo (*Bos arnee*), and the South African buffalo (*Bos caffer*).

BO'SSAGE. (French.) In Architecture, any projection left unwrought on the face of a stone for the purpose of afterwards sculpturing thereon, the sculpture being usually the last thing finished.

BO'STRICHUS. A genus of Coleopterous, Xylophagous, or wood-boring insects, now raised to the rank of a family (*Bostrichidæ*), including amongst its numerous genera three which contain species whose ravages have called forth the attention of the legislature both in this and other countries in consequence of the extensive destruction of valuable timber caused thereby. The species in question are the *Bostrichus ligniperda*, *Scolyttus destructor*, and *Tomicus typographus*; but the two latter are the most mischievous, and astonish by the amount of damage which is produced by insects of so small a size. The elm tree is the object of attack to the *S. destructor*; while the *T. typographicus* restricts its operations to the fir. The females attack the crevices of the bark, and perforate it in diverging lateral channels, in which from sixty to eighty eggs are deposited. At the end of fifteen days the larvæ are hatched, and forthwith commence the work of destruction, each gnawing a serpentine gallery between the bark and the wood, and gradually enlarging its burrow until the period when it is ready to pass into the pupa state; when, having finally become a perfect beetle, it directly bores through the portion of the tree which remains between the wood and the outer bark, and escapes through a small circular aperture in the latter. This emergence of the perfect insect takes place in the month of May; and in seasons favourable to their development they appear in swarms, and rise to a height exceeding that of the trees, and may be carried by the wind to another and distant part of the forest. The impregnation of the female takes place in the air; so that wherever they alight they are ready to recommence the work of destruction. The chief precautions and remedies which experience has suggested are to cut down the trees which are once attacked, immediately to bark them and to burn the bark, and to remove all felled timber without delay.

BOSWE'LLIA. A genus of Indian trees belonging to the natural order *Burseraceæ*, one species of which, *B. thurifera*, yields the resin called Olibanum, which seems to be a corruption of Luban, the name given by the Hindoos to this plant.

BOT. The name of the larvæ of the Dipterous insects of the family *Œstridæ* (which see).

BO'TANY. (Gr. *βοτανη*, *herb* or *grass*.) That branch of natural history which relates to the vegetable kingdom; not merely including the nomenclature and classification of plants, as some have supposed, but embracing all the phenomena of vegetable life in their widest extent.

Looking only at the first principles of the science, it is generally divided into the following heads:—

Organography, or the Structure (organization) of Plants.— This is a most important department; it comprehends whatever relates to the various forms of tissue of which plants are anatomically constructed; it explains the exact organization of all those parts through which the vital functions are performed; and it also teaches the relation that one part bears to another, with the dependence of the whole upon the common system. Without a perfect knowledge of Organography no systematical arrangement can be understood; for, being that part of science in which the laws of the symmetry of parts is comprehended, it must necessarily be the basis of all theory of classifications: and as to Descriptive Botany, which may be called the language of the science, it cannot have any logical precision, or be intelligible, unless the mind is distinctly impressed with the fundamental laws of this branch of study. Physiology itself, the highest branch all natural science, depends so absolutely upon an exact knowledge of the structure of parts, that any attempt to investigate the important laws of vegetable life must necessarily be abortive without a strict acquaintance with the more important details of organization. And by this is not meant merely a general idea of external form, or a vague notion of internal anatomy, but the most precise knowledge that the nature of the subject will admit.

Connected with this branch of study is what German botanists call Morphology, but which others think it better to consider a section of Organography. The word Morphology signifies literally the "science of changes or transformations." As applied to botany, it embraces a very interesting subject of inquiry, and one which, to all those who know the importance that attaches to comparative anatomy in the animal kingdom, cannot fail to be peculiarly interesting. Within the last thirty or forty years it has been clearly made out that all those parts which are familiarly known under the name of leaves, flowers, and fruit, are constructed, in all cases whatsoever, upon a simple uniform plan, out of one single organ in different states of modification and combination; and that there is no other difference between the flower of a rose and that of a nettle than what arises from modifications and combinations of this organ — which is the leaf. If it be doubted whether, considering the anomalous character of some of the lower orders of plants, all vegetables are without exception formed upon one and the same plan, it is impossible not to admit that, at least in all Phœnogamous plants, the flowers are composed of the same elements; that these elements are arranged in conformity to a few simple laws, far less variable than their appearance seems to indicate, and the study of which constitutes the basis of the theory of botany. These laws are so evident in a great number of cases, that one scarcely pays attention

to them; but curiosity is at once excited when they seem to be violated. Exact observation, however, shows that in such cases they are only masked; that is to say, an unusual application of two or three different laws produces an apparent anomaly, which is easily explained by a reference to the numerous cases of degeneracy, abortion, and cohesion with which the vegetable kingdom abounds. In such instances as this the botanist may be compared to the mineralogist, who discovers the primitive forms of crystals by means of their secondary forms. We are so accustomed to talk of plants bearing leaves and flowers and fruit, and it is so evident to our senses that extremely different organs really do exist under such names, that it seems inconceivable that parts so very dissimilar should all be only leaves in different states; that the pure white petals of the lily, the rich red flowers of the rose, the sweet-smelling blossoms of the jasmine and the orange, or the long trumpet-shaped corollas of the honeysuckle, should all be leaves; that the stamens in which the fertilizing powder is locked up, the pistils which are destined to receive the influence of the pollen, the ovula that they contain, and, finally, that the fruit which is the result of the action of the two last, are all so many parts formed out of one common organ, which in a particular and very frequent state is what we call a leaf. Botanists do not mean to say that he who eats an apple, or an orange, or a peach, is in a state of mental delusion, and that while he fancies himself to be enjoying the pleasure of gratifying his palate by the most delicious flavours he is really only chewing the leaves of these plants; but they assert that those appendages of a plant which are commonly called the leaves have a peculiar anatomical structure, and a certain relation to the stem on which they are borne, and being developed according to certain fixed laws, are always arranged upon a certain and uniform plan with respect to each other; and that all the other organs, whether calyx, corolla, stamens, pistils, or fruit, have an anatomical structure essentially the same, bear the same relation to the axis that they grow upon, are developed according to the same laws, are arranged upon the same certain and uniform plan with respect to each other, and, finally, are constantly becoming transformed into leaves of the ordinary appearance, thus losing the condition in which they are usually found, and reverting to their structural type. The admission of such propositions as these does not render our notions of the distinctions between the various organs more obscure than it was before, as some would assert; but on the contrary it enables us the better to understand the real nature of the organization of any part, and the plan upon which the most complicated arrangements of these organs have been effected. For example, who is to explain how it happens that buds occasionally spring from the axillæ of petals or sepals, that anthers are found having ovules, that branches push forth from the centre of pistils, that petals become antheriferous and stamens petaloid, unless the proposition is admitted that all those apparently different parts are formed upon a common plan, the type of which is a leaf, and are all therefore convertible into each other?

Another branch into which the science separates is *Physiology*, or the department which treats of the vital actions of plants. While organography is applicable to objects whether living or dead, physiology solely refers to them in a state of vitality. There is scarcely any part of natural history more difficult than this, if rigorous demonstration is required, nor, at the same time, one upon which there was in former days a greater degree of mere speculation. Like many other of the higher departments of natural philosophy, hypothesis preceded experiment; so that in the earlier history of botany we find scarcely a trace of those ideas which modern observation has certainly developed in a very remarkable manner.

In vegetable physiology it is not as in animal — we have not our highest order of beings endued with reason which we can study by aid of our own personal feelings and sensations, and from our knowledge of which we can proceed in a descending series to the determination of the vital functions of all other tribes. On the contrary, we are in the same position with regard to plants as a new and totally distinct race of animated beings would be to mollusca and the lowest orders of existing things, supposing such a race to have no knowledge whatever of animal economy beyond what could be learned from the study of mollusca themselves, to have a class of sensations and a structure wholly unlike our own, and finally to deduce its notions of the anatomy and vital system of mollusca, not from a comparison of them with other beings gradually and perhaps insensibly rising in perfection of organization till the relation of one part to another and the uses of all become more manifest, but wholly from the abstract consideration of the mollusca themselves. In such a case, speculation would most likely precede experimental observation, as was actually the case with plants.

It was not till after the invention of the microscope that even an imperfect knowledge of vegetable anatomy could be gained; and only when this great step was taken vegetable physiology began to establish itself upon a sure foundation. Consequent upon this discovery has been the accumulation of a considerable amount of positive knowledge of a world of organized beings having nothing in common with the race of man; with which we cannot communicate in the slightest degree; that have no volition by which we may occasionally regulate our judgment; whose texture is so frail that we cannot anatomise them without the destruction of life; whose functions are performed within an opaque dense covering that excludes every thing from our view; and which finally are so exceedingly simple in their organization, have so few different organs with which to execute their functions, that we are lost in amazement at effects so complicated and forms so various being brought about by means that are seemingly so inadequate. The world has learned from the vegetable physiologist, not only that plants breathe, feed, and digest, and how the functions of breathing, feeding, and digesting are carried on; they have ascertained by what means an increase in their dimensions are brought about, how their want of locomotive power is compensated for, and by what precise means their reproduction and multiplication are so wisely ordained as to be placed beyond obstruction by any natural impediments. In short, the exact use of every part of every plant, various as their forms and uses doubtless are, has been ascertained; and we are now entitled to say of plants as of animals, that their kingdom is rendered subject to the power, not only of man's physical energy, but of his mental resources. Perhaps no part of the creation illustrates more forcibly than the vegetable world, the admirable skill and foresight with which all the phenomena of the universe have been adapted by the Great Author of our being to the accomplishment of the objects for which they have been severally intended.

Take, for example, vegetable tissue. What can be conceived more wisely prepared! The cellular, capable of great extensibility, possessing also prodigious compressibility, its particles cohering either firmly or loosely according to circumstances, its sides composed of a most delicate membrane, through which fluid and gaseous matter passes readily in every direction, is destined to form the principal mass of the vegetable, and to execute all those functions with which absorption and respiration are connected; — the fibrous tissue, composed of myriads of threads compactly combined into bundles, dispersed through the cellular substance, how admirably does it supply the place of bones and nerves in the animal economy, affording strength and solidity and elasticity to the most delicate parts! While the vascular tissue, exclusively intended for the reception and rapid transmission of gaseous matter or of highly attenuated fluid from the roots to the extremities, how wisely is it contrived by its greater size and length, and how carefully is it prepared by its spiral structure, for extending and turning, as the cellular substance develops, to those parts where the peculiar matter that it contains is most required! Here there is no confusion of offices to perform; each has its peculiar part assigned it, for which it has been especially destined, and for which it is alone adapted.

Look at the leaves. The leaves are the organs in plants that correspond with the stomach in animals; that is to say, it is in them that the fluid matter taken up by the roots and injected into them from the stem, is digested and inspissated, and separated into the nutritious and excremental portions. To the naked eye the leaves appear to be merely flat plates of cellular substance traversed by veins; but examined with a microscope they are at once seen to be constructed upon a most simple plan — of any that can be conceived the most perfectly adapted to the end in view.

Digestion takes place in leaves chiefly by the absorption of carbonic acid and the respiration of oxygen, and by the evaporation of water; if this process were to be carried on without any provision against the variations which are constantly occurring in the state of the atmosphere, it is easy to conceive that in excessively dry weather leaves would lose all their moisture and constantly become parched up, while in wet weather they would be so gorged with moisture as to burst from distension. In order to prevent the occurrence of this, nature has enclosed leaves in a cuticle scarcely pervious either to air or moisture; and in this cuticle she has placed numerous mouths, called stomata, which have the power of opening and closing, according to the state of either the atmosphere or of the leaf itself, to regulate the absorption or respiration of either water or air. And in order to expose the tissue lying beneath this cuticle to the greatest possible atmospheric influence, the leaf is not a solid mass, as it appears to be, but is traversed in all directions by passages terminating in the mouths, and opening into cavities, where the air both of absorption and exhalation can freely circulate, and pass in or out so long as the mouths permit it. Nor is this all. Many leaves are constantly submerged beneath the surface of

water, where they are never exposed to atmospheric vicissitudes, can never evaporate, and being cut off from the air, can neither absorb carbonic acid from the air, nor discharge oxygen back into it in return. It is therefore obvious that the curious provision that has been made for the regulation of the action of aërial leaves would be useless in submersed ones; and accordingly we find that the latter have neither cuticle, nor mouths, nor cavernous parenchyma, but are thin but solid plates, the whole surface of whose cellular substance is in direct contact with the water, from the air contained in which the leaves must exclusively derive their nutriment. The employment of the same kind of organ, in different forms, for the purpose of effecting the varied objects that are to be provided for in the vegetable economy, is another and a most remarkable instance of the consummate wisdom and wonderful simplicity that are discoverable in all these things. Upon the birth of a plant one or two leaves are developed, which feed the infant until it is strong enough to develop one or two more; these last, not only like the first proceed without exception from opposite sides of the stem or body, but are so placed as to alternate with the first; and this goes on with unvarying uniformity, as long as growth continues; so that view a plant in whatever way you will, whether in its earliest state, or at the most advanced period of its existence, it will always be seen to exhibit the same beautiful symmetry as the most highly developed animals: one side counterpoises the other; whatever is discoverable on one side, equally exists upon the other. If it is necessary that a protection should be formed for securing the young and tender buds against cold, the leaves surrounding the buds suddenly contract into hard scales, perhaps exude some resinous or gummy matter, or clothe themselves in a deep covering of wool, and an impenetrable living shield is thus interposed between the bud and danger. A plant is to be rendered more beautiful to the eye — its leaves again contract, the spaces that usually separate them are obliterated, new colours are assumed, and petals are created resplendent with brilliant hues or exhaling the softest perfumes. Propagation is to be effected — the petals contract into stamens, their central substance becomes disintegrated in the form of pollen, and the interior of each grain of the latter is resolved into that living matter of which in a state of cohesion all nature is composed. A few leaves are rolled together in the form of pistillum, the apex of the midrib becomes denuded, and young buds are developed at the margins. A grain of pollen, the disintegrated tissue of the flowering leaf, falls upon the denuded apex of the fructifying leaf, absorbs moisture from it, distends, and finally produces a tube of inconceivable fineness, which abstracts from the pollen its impregnating matter, some of which descends the midrib into the womb of the leaf, and thence entering the young buds that are developed at its margins, is finally hatched, and appears at last in the form of embryo plants.

Such is the simplicity of the arrangements that are observable in the most perfectly formed, the most elaborately constructed plants. In the lower orders, the mode of formation, development, and propagation is still more simple. A vesicle elongates and distends until it becomes a tube; from the end of this tube more are generated that themselves give birth to others, and thus a simple branching plant is formed. In the inside of each tube by degrees a green matter is deposited; and after a certain period has elapsed is emitted in the form of little green vesicles, like that from which the plant originally sprang, and themselves capable of developing as new plants. In certain tubes, this dissolution takes place in a much more astonishing manner; not into inert green matter, but into moving particles having all the properties of spontaneous motion and animal existence. Soon, however, the moving particles elongate; thus losing their power of motion and becoming plants, to whose laws of life they ever after submit. Turpin has seen the *Monema comöides* resolve itself into naviculæ; Desmaziéres has shown the plants called *Mycodermata*, or what we name the mothery film of fermented liquor, to consist of monads growing end to end (*Ann. des Sc.* x.); and Treviranus (*Ann. des Sc.* x.) has detailed with exactness the metamorphoses in the life of the compound plant called *Batrachospermum glomeratum*. In this the filaments discharge a green matter and become colourless; the green matter consists of myriads of infusoriæ, of a round or elliptical figure; the latter collect by fives or sixes into a kind of star, become motionless, lengthen, and finally are transformed into young individuals of this undoubted plant.

These are far from being all the divisions into which Botany, or the study of the vegetable kingdom, may be subdivided; although they are no doubt among the most interesting. Besides these there is *Taxonomy*, or the principles of classification. It would be of little use that a man should know anatomy, and structure, and comparative organization, and have informed himself of all the leading principles of physiology, if he were unacquainted with the names of the objects he had been studying, and were consequently incapable of communicating his knowledge to others. At least, of whatever use it might be to himself, it could not be of advantage to any one else. But if he *is* acquainted with the names of known objects, and if he understands the rules of classification, he can then render his information available to others as well as to himself. And in like manner he can at all times determine what is known about any particular plant that he may have been studying; or if it be a kind previously unknown, he can find its place in the system, and by publishing a description of it, he can fix it there for the information of others.

But there is another way of looking at the utility of classification, which shows that what may to some appear but a dry and barren subject, is in reality one of the most important branches of the science. No man can know all things relating to such a science as this, — few men can learn many things; for this reason it is of importance that a means should be discovered of judging of what is unknown by what is known; and that by judiciously selecting a moderate number of objects for particular study, the inquirer may have a ready and by no means burthensome means of forming a clear knowledge of the whole vegetable kingdom. This is not difficult, if attention be paid to the doctrine of affinities. Every one must have seen that some species of plants are more like each other than they are like different species; without considering the matter botanically, every one must, for example, have remarked that a radish is more like a turnip than it is like a currant bush, that a pea is more like a bean than an apple, and that a cherry blossom is more like an apple blossom than a horse chesnut. These are rude instances of affinity on the one hand, and discrepancy on the other; but they are nevertheless perfectly explanatory of what is meant. Botanists find that classification may be founded upon a consideration of general resemblances and differences; and that by carefully examining the characteristic organs of plants, those species may be classed most nearly together which have the greatest degree of resemblance and the most perfect constitutional agreement. Now this being the case, it follows that a knowledge of one species is to a great extent a knowledge of many; and that a correct idea of a single individual of a group in the classification, provided that individual is well selected, amounts to a knowledge to a considerable extent of all the other species of the same group. For example, in the tribe of *Cruciferæ*, consisting of about 900 species, the study of the common radish, the mustard, or the cress, will give the student a very accurate general knowledge of the remaining 899, because they are all close modifications of the same forms. Again the common potatoe, rightly understood, represents the greater part of *Solanaceæ*, or at least of some hundred species belonging to that tribe; while the dead nettle, *Lamium album* or *rubrum*, stands as the representative of some 15 or 1600 species called *Labiatæ*. This would be of eminent importance if its advantage stopped here; but when it is considered that the properties of plants also accord in a very remarkable manner with their structure, and that those which are most closely approximated in a classification will most nearly resemble one another in their sensible properties, the advantages to be derived from a study of the laws of affinity cannot fail to be clearly perceived. For example, to use the same illustrations as before, any person acquainted with *Cruciferæ* would know that there is no instance of a poisonous or deleterious plant in the tribe, a point of great importance to be aware of; on the contrary, he would know that if they had succulent roots, they might be employed like the radish, and that their leaves are antiscorbutic; but if he met with an unknown plant, which, from its resemblance to the potatoe, he knew belonged to *Solanaceæ*, he would at once reject it as poisonous, or at least suspicious, unless it had tubers filled with fæcula, when he would except that portion, because all fæcula is wholesome, however poisonous the trees or plants may otherwise be that produce it, provided the deleterious matter that lies among it is removed by washing, or volatilized by the action of heat.

It is not, however, any kind of classification that leads to such ends. All artificial systems, as for instance that of Linnæus, are unproductive of such results. It is only the natural system of botany from which these important advantages are to be derived.

A fourth division of the science is the meaning of the terms employed in the science; or what was formerly called *Terminology*, and now more correctly *Glossology*. This is the least interesting part of the subject; but at the same time it is too important to be passed over lightly, because it is impossible either to understand the writings of botanists, or to make oneself intelligible to others, without being correctly informed of the meaning of the terms peculiar to the science. The state of Terminology at any given time may indeed be safely taken as indicative of the state of the whole science; for in propor-

tion as ideas are multiplied and knowledge rendered exact, are the terms required to express those ideas multiplied and their application rendered definite. A curious exemplification of this is to be found in the *Historia Plantarum* of Fuchs, a learned botanist of the 16th century. In the glossary prefixed to that work are comprehended only 132 terms of all kinds, many of which refer to measures, and are therefore not appertaining to botany; and of the remainder 29 belong to modifications of stems, 15 to differences of inflorescence, 6 to the fruit, but not one to any other part of the fructification. In the present state of botany, the terms that relate to the seed alone are probably as numerous as the whole that are comprehended in Fuchs' Glossology.

Another and very distinct branch of inquiry is into the rules to be observed in describing and naming plants; or what is called *Phytography*. The great object of descriptions in natural history is to enable any person to recognise a known species, after its station has been discovered by classification, and also to put those who may not have had the opportunity of examining a plant themselves into possession of all the facts necessary to acquire a just notion of its structure and affinities. It is therefore important that such descriptions should be drawn up according to certain conventional well-known rules, and not according to the caprice of individuals; and this not only for the sake of ensuring a uniformity of language, and in all cases the same order of treating the subject, but also to prevent descriptions being too general, to ensure attention to the most important points of structure, and at the same time to prevent their being more prolix than is really necessary. The rules of description are more especially intended to guard against the latter evil; for no mistake can be more common than to confound prolixity with precision.

The last branch into which the study of the science may be divided is the application of the preceding subjects to the art of discriminating species. This may be called the *Practice of Botany*, as the former belonged to its theory, and is by far the most difficult part of the subject. There is no difficulty in becoming acquainted with the fundamental principles of the science, because they naturally arise out of each other, and are dependent upon the just appreciation of a few simple laws; the various combinations of which, upon principles that it is easy to comprehend, constitute the differences that exist between organs themselves and their numerous modifications. But the practice of botany, although its study is essentially facilitated by an acquaintance with fundamental principles, and indeed cannot be usefully pursued without, yet it has peculiar difficulties of its own. It is often difficult to recognise organs in consequence of the manner in which they are masked by the modifications they have undergone; their combinations are frequently so intricate that great experience is necessary to enable an observer to judge of them correctly; their minuteness is often such as to render indispensable a use of the microscope, which requires peculiar dexterity and a good deal of practice; and finally the number of species is so great, that to bear in mind their distinctions is a heavy tax upon the memory. Difficulties of this nature are almost insurmountable by a student who is unaided by the experience of a teacher.

At what period of the world botany first began to be studied as a science, has not been satisfactorily ascertained. By some it has been referred to the highest ages of antiquity. We are assured that Moses and Solomon and other Jewish writers, especially the last, were botanists, and that traces of much knowledge of the science are to be found throughout the scriptures; but it seems difficult to assign Botany any such antiquity. That in the most remote ages man had his herbs and his roots; that he was acquainted with the properties of one plant, and the uses of another; that he gave them names, and that poets derived many of the beauties of their language from them, — was natural enough; but this had nothing to do with botany. The first dawn of that science broke from out of the deep investigations of the nature of matter and mind by the philosophers of Greece. How much they knew we have no accurate means of judging; but that they knew a great deal of vegetable physiology is obvious from their famous paradox, that plants are only inverted animals, — a sentiment which, however strangely it may sound, could only have arisen from an extensive knowledge of the vital phenomena of Vegetation. Nor could the doctrine of Aristotle, that all organic matter exhibits a series of successive degrees of development, have been conceived or promulgated, unless the philosophers of his day had possessed a practical acquaintance with vegetation much beyond that of the ages that succeeded.

Happy had it been for those ages if, instead of retrograding in the path of science, or rather stepping out of it altogether, they had only pursued the course commenced by Theophrastus 350 years before Christ. By that naturalist the beginning was made of applying particular terms to particular modifications of structure; he demonstrated the absence of all philosophical distinction between trees, shrubs, and herbs, — a distinction upon which his successors were fond of insisting; he speaks clearly of the parenchyma and woody fibre of wood, the former of which he calls the flesh; and he described accurately the difference between palm wood and that of trees with concentric layers; so that in point of fact the discovery of the difference between Dicotyledonous and Monocotyledonous wood was made by Theophrastus above 2000 years ago, although it was never applied to the purposes of systematic division till about thirty years since. Subsequently to this period, botanists almost disappeared for a long season. Those who have been dignified by historians with that title were either pharmacologists, like Dioscorides; or compilers, who, like Pliny, knew little themselves, and misunderstood those they copied; or *poets*, who drew much of the beauty of their language from the charms of nature; or *geoponical* writers, who were acquainted with those parts of husbandry which relate to physiological botany.

With whom the curious arts of budding and grafting, and striking plants by layers, or propagating them by taking advantage of the divisibility which distinguishes the vegetable from the animal kingdoms originated, is now unknown; but there is reason to believe that the greater part of the modifications of those processes was in the classical ages as well understood as now. That grafting was extensively undertaken, is obvious from these lines of a well-known poet of the Augustan age: —

> Et sæpe alterius ramos impunè videmus
> Vertere alterius, mutataq. insita mala
> Ferre pyrum, et prunis lapidosa rubescere corna.

But, what is much more curious, the delicate process of budding was as scientifically performed at that period as by the most skilful gardener of the present century. Nothing can be more precise than the following elegant description of Roman budding: —

> Nec modus inserere, atque oculos imponere simplex.
> Nam qua se medio trudunt de cortice gemmæ,
> Et tenues rumpunt tunicas, angustus in ipso
> Fit nodo sinus; huc aliena ex arbore germen
> Includunt, udoque docent inolescere libro.

Again of crown grafting: —

> Aut rursum enodes trunci resecantur, et alte
> Finditur in solidum cuneis via: deinde feraces
> Plantæ immittuntur: nec longum tempus et ingens
> Exiit ad cœlum ramis felicibus arbos,
> Miraturque novas frondes et non sua poma.

A cessation of all philosophical inquiry into the nature of vegetation endured about 1700 years, during the whole of which time scarcely a single addition was made to the stock of knowledge left behind him by Theophrastus. But with the revival of letters a new direction was given to researches in natural history. Men ceased to content themselves with blindly copying the writers of antiquity, and set themselves in earnest to examine the objects of nature that surrounded them. The woods, the plains, the rivers, the ocean, the valleys, and the mountains, were investigated with an ardour that soon made amends for ancient indifference. The first consequence of this was a discovery of the worthlessness of the greater part of those writers to whom the world had so long been bound in servile obedience. The spirit of inquiry once excited, men speedily learned to estimate rightly the greater value of facts than of assertions; one discovery produced another, and in a few years a new foundation was laid of that imperfect but beautiful science which constitutes modern botany. In the early part of the sixteenth century, John Manardi, a native of Ferrara, described the real nature of the anther. He was followed by a long train of writers of various merit, who at first indeed applied themselves exclusively to the collection of new species, but subsequently to an examination of the physiological characters of plants, and to the laws applied by nature to the government of the vegetable kingdom.

Up to the middle of the seventeenth century, vegetable physiology had been grounded upon observations entirely independent of anatomical investigation. But about this time the accurate inquiries of two naturalists, one an Englishman and the other an Italian, gave a new feature to the study; and what was vague or imaginary in the opinions entertained upon the vital functions of vegetables gave way to conclusions precise, and supported upon the firm basis of careful observation. The nature of cellular tissue, of spiral vessels, of ducts, of woody tissue; the composition of the internal parts of plants, and the functions of the whole — excited inquiry, and received reasonable if not accurate explanations. Collections of facts and of ideas accumulated on all hands, and the confusion that had once been caused by ignorance threatened again to overwhelm the science, in consequence of the rapid addition of new matter which

there was no means of keeping in order. Hence *systematists* sprung up; a race of inquirers to whose labours the present advanced state of botany is no doubt much to be ascribed. That the efforts of the earliest of these writers should have proved unsuccessful, will excite no surprise: with little knowledge of vegetable physiology or anatomy, for it must not be forgotten that for a long time, and even now, vegetable physiology and systematic botany were considered as distinct sciences, and with scarcely any notion of the laws of affinity and metamorphosis, they could not be expected to succeed. We should rather wonder at what they did, than at what they omitted to do. Many of them had great merit, especially John Ray, an English deprived clergyman, and Joseph Pitton de Tournefort, a professor of botany at Paris, who flourished in the end of the seventeenth century, and upon whose systems the modern arrangement according to natural orders is essentially founded. This, however, and all others, was for a time eclipsed by another, better adapted to the circumstances of the times, and emanating from a writer who, having the courage and talent to carry reformation into every branch of natural history, imparted a lustre to his peculiar system of classification which has only now, after the lapse of a century, fallen into disuse among men of science.

Charles Linné, or Linnæus, as he is usually called, was a person exactly adapted to the science of the time in which he lived. The various departments of natural history had not at that time any thing like their present extensive range, and might without difficulty be investigated by a single naturalist. They were all equally in need of revision and improvement; they all wanted a settled code of laws to reconcile the fluctuating and jarring opinions which at that time prevailed, and above all things the nomenclature of natural history required to be reduced to one uniform standard. For this Linnæus was peculiarly well adapted. Nature had gifted him with a logical accuracy of reasoning, and a neatness and perspicuity of expression, which carried with them a charm that the world was not slow to appreciate; and these produced the stronger impression, because naturalists had previously been but little accustomed to them. The opinions of Linnæus were received as if oracular, and their faults were lost in the splendour which they threw over the whole of the organic world. But unfortunately Linnæus knew nothing of vegetable physiology. His opinions upon this subject are among the most worthless which are recorded in the history of science; and consequently his writings lost much of the permanent value which the originality of his ideas and the acuteness of his perception would have otherwise insured them. But notwithstanding this defect, he not only established his famous method of arrangement, which for a long time susperseded all others, but laid the foundation, although upon imaginary principles, of the curious laws of morphology, upon which modern botany founds one of its greatest claims to perfection. The notion that all the parts of plants are mere modifications of leaves, faintly shadowed forth by Linnæus in his *Species Plantarum*, became the subject of a special and most original dissertation by the German poet Göthe, in 1790. This doctrine was believed by the botanists of that day to be worthy only of the poetical fame of its illustrious author; but he lived to see his opinions received, almost without change, by every botanist of reputation.

After the artificial system of Linnæus followed the natural system of Jussieu. Vegetable anatomy became an important branch of inquiry in the hands of Kieser; the researches of Knight and others gave a new character to vegetable physiology; and the early part of the present century has seen the science by these and other means assume an entirely new appearance. Our knowledge of the vital functions of plants reposes upon the sure basis of exact observation and careful experiments; the theory of the plan upon which the organs of vegetation and fructification are severally combined into so many numerous forms is settled upon the clearest evidence; and classifications, to a great degree freed from the trammels of prejudice or narrow views, have assumed that position in science to which their importance, when rightly studied, entitles them.

The only two botanical arrangements now in use are the Linnæan and the Natural. The former is an attempt at classifying plants according to their agreement in some single characters, without reference to their resemblances or differences in any other respect, just as words are arranged in a dictionary by the accordance of their initial letters; the other is a scheme for placing next each other all those plants which have the greatest resemblance, and at the greatest distance those which are most dissimilar. To effect this, every kind of structure that plants possess is made use of; distinctions derived from great physiological peculiarities are considered fundamental, and form classes; subordinate to them are characters derived from diversities of external structure, and they are valued according to their permanence or frequency, &c. The final result being the making up of the vegetable kingdom into associations, called natural orders, which are supposed to consist of genera more closely allied to each other than to any thing else. For an explanation of the details of these two kinds of classification the reader is referred to the separate works that have been published on the subject; space can be given in this place only to a very general account of them.

The sexual system of Linnæus depends upon the number and relative position or degree of combination of the stamens and styles. It has been so often explained, and is so rapidly falling into disuse, that we shall content ourselves with the shortest possible description of the classes and orders.

Class I.	Stamen 1	Monandria.
II.	Stamens 2	Diandria.
III.	Stamens 3	Triandria.
IV.	Stamens 4	Tetrandria.
V.	Stamens 5	Pentandria.
VI.	Stamens 6	Hexandria.
VII.	Stamens 7	Heptandria.
VIII.	Stamens 8	Octandria.
IX.	Stamens 9	Enneandria.
X.	Stamens 10	Decandria.
XI.	Stamens 12—19	Dodecandria.
XII.	Stamens 20 or more, inserted into the calyx	Icosandria.
XIII.	Stamens 20 or more, inserted into the receptacle	Polyandria.
XIV.	Stamens 2 long and 2 short	Didynamia.
XV.	Stamens 4 long and 2 short	Tetradynamia
XVI.	Stamens united by their filaments into a tube	Monadelphia.
XVII.	Stamens united by their filaments into two parcels	Diadelphia.
XVIII.	Stamens united by their filaments into several parcels	Polyadelphia.
XIX.	Stamens united by their anthers into a tube	Syngenesia.
XX.	Stamens united with the pistil	Gynandria.
XXI.	Stamens and pistils in separate flowers, but both growing on the same plant	Monœcia.
XXII.	Stamens and pistils not only in separate flowers, but those flowers situated upon two different plants	Diœcia.
XXIII.	Stamens and pistils separate in some flowers, united in others, either on the same plant, or two or three different ones	Polygamia.
XXIV.	Stamens and pistils either not ascertained, or not to be discovered with any certainty, insomuch that the plants cannot be referred to any of the foregoing classes	Cryptogamia.

The characters of the orders depend upon the number of the styles, or of the stigmas, if there be no style, in the first thirteen classes; such are accordingly named,—

Monogynia	style 1
Digynia	2
Trigynia	3
Tetragynia	4
Pentagynia	5
Hexagynia	6
Heptagynia	7
Octogynia	8
Enneagynia	9
Decagynia	10
Dodecagynia	12
Polygynia	more than 12.

In the 14th class, Didynamia, the orders depend upon the nature of the ovary. In *Gymnospermia*, the first order, the ovary is divided into four lobes, from the base of which proceeds a single style, and within each of which is contained a single seed. In *Angiospermia*, the 2nd order, the ovary is not lobed, and is usually two-celled, and many-seeded.

In the 15th class, Tetradynamia, the orders are characterized by the form of the fruit: *Siliquosæ* have a long pod; *Siliculosæ* have a short one.

The orders of the 16th, 17th, and 18th classes, Monadelphia, Diadelphia, and Polyadelphia, depend upon the number of the stamens, and have the same nomenclature as the thirteen first classes.

The orders of Syngenesia are determined by the ar-

rangement of their flowers, and by the sex of their florets: thus—

Polygamia has flowers crowded together in heads.

1. *Polygamia æqualis* has each floret hermaphrodite, or furnished with perfect stamens and pistil.
2. *Polygamia superflua* has the florets of the disk hermaphrodite; those of the ray female only.
3. *Polygamia frustranea* has the florets of the disk hermaphrodite; those of the ray sterile.
4. *Polygamia necessaria* has the florets of the disk male, of the ray female.
5. *Polygamia segregata* "has several florets, either simple or compound, but with a proper calyx, included within one common calyx."

Monogamia has the flowers separate, not crowded in heads. This order is generally abolished by Linnæan botanists, but for no good reason.

The orders of the 20th, 21st, and 22nd classes are distinguished by the number, &c. of the stamens.

The two orders of the 23rd class depend upon whether the genera are monœcious or diœcious.

The last class, *Cryptogamia*, is divided into orders according to the principles of the natural system, namely, 1. Filices; 2. Musci; 3. Hepaticæ; 4. Algæ; 5. Fungi.

With regard to the natural system of botany, that formed by Jussieu out of the views of Ray, Tournefort, and others, in combination with very numerous observations of his own, is the basis of what is at present understood by that name. It has, however, been much modified by succeeding systematists, and will undoubtedly undergo many more changes in its details. The view taken of the subject by De Candolle, the learned professor at Geneva, is thus stated by himself:—"I have established in my *Theorie Elémentaire*, that the proof of a classification of plants being natural is furnished when similar results are arrived at, whether from considerations drawn from the *reproductive* organs or from those of *vegetation.* Considered with reference to the organs of reproduction (or fructification), the vegetable kingdom has been divided by Linnæus into two grand series, the *Phanerogamous* and the *Cryptogamous.* These series are not merely distinguished because in the first the sexual organs are visible to the naked eye, and in the latter are microscopical. Such a difference, which might depend only upon the absolute size of the organs, could be in itself of little moment; but it is connected with a real difference of structure. Phanerogamous plants have their organs of fructification arranged upon a more or less symmetrical plan, and surrounded by integuments themselves also arranged symmetrically. Cryptogamous plants have the sexual organs disposed without order, and surrounded by integuments scarcely perceptible, and still more disorderly; or they have no sexual organs that have been proved to be so."

Phanerogamous plants have long been divided into *Dicotyledons*, or plants whose embryos present cotyledons opposite or verticillate upon the same plane, and whose minimum is consequently 2; and into *Monocotyledons*, whose cotyledons or earliest leaves are alternate, so that the minimum is 1, or that the first, when there are two, is more particularly intended to nourish the young plant.

Cryptogamous plants should in like manner be divided into two classes, the Ætheogamous and the Amphigamous. For the first I take the name of *Ætheogamous*, invented by Beauvois, but limiting its application. This term, which signifies plants with unusual fructification, suits well enough the class here indicated, and which is characterized by having sexual organs distinct and visible under the microscope, but formed upon a plan totally different from that of Phanerogamous plants; such are Equisetaceæ, Ferns, Lycopodiaceæ, Mosses, and Hepaticæ. I give the second class the name of *Amphigamæ*, to indicate the doubtful nature of their fructification; some authors have called them Agamæ, but that is, I think, to assert more than is quite certain. The character of Amphigamæ is to present to view no sexual organ, even under the microscope; but we cannot affirm that the spores that they produce have not received a sort of impregnation in the very cells which generated them. It is for the sake of expressing this doubt that I employ the word Amphigamæ. Thus with respect to their organs of reproduction, plants are clearly divided into four great classes. Let us next examine them with reference to their organs of vegetation. The first division that may be established is deduced from the absence or presence of vessels; and in this view I separate plants into two series—the *vascular*, which have vessels and stomates manifest during their whole life; and *cellular*, or those which consist of nothing but cellules either throughout their life or in their first foliaceous organs. Vascular plants are divided into *Exogens*, of which the wood increases by the addition of new layers placed on the outside of the older; and *Endogens*, whose trunk increases by the addition of new fibres to the centre of the cylinder already formed. Cellular plants, in like manner, are subdivided into *semi-vascular* and *cellular*. Under the first of these names I comprehend the orders which grow with leafy cotyledons, but composed of cellular tissue only, and destitute of stomates. Eventually they assume organs in which vessels and stomates exist: this development, which gives them some resemblance to Endogens, takes place rapidly in Equisetaceæ, Ferns, and Lycopodiaceæ; and the observations of anatomists have shown that the same thing occurs, but later and less perfectly, in Mosses and Hepaticæ; so that it is a matter of some doubt whether they ought to be referred to the semi-vascular or succeeding class. *Cellular* plants have long been known to be destitute of both vessels and stomates, and to present only a homogeneous mass, where the distinction of stem, leaves, and roots can only be established analogically.

Looking back at this explanation, it is obvious that the vegetable kingdom may be represented by the following table.

Divisions formed by the Organs of Fructification.		*Divisions formed by the Organs of Nutrition.*
I. PHANEROGAMOUS,	*or*	VASCULAR.
Class 1. Dicotyledons,	*or*	Exogens.
2. Monocotyledons,	*or*	Endogens.
II. CRYPTOGAMOUS,	*or*	CELLULAR.
3. Ætheogamous,	*or*	Semivascular.
4. Amphigamous,	*or*	Cellular.

Or, if it is preferred, in this other form, which is almost equally regular:—

I. SEXUAL, being furnished with sexual organs,	*or*	Having vessels and stomates at some period of their existence.
Class 1. Dicotyledons,	*or*	Exogens.
2. Monocotyledons,	*or*	Endogens.
3. Ætheogamous,	*or*	Semivascular.
II. Without distinct sexes,	*or*	Without either vessels or stomates at any age.
4. Amphigamous,	*or*	Cellular.

But notwithstanding the apparent clearness of this system, and the importance of the arguments upon which it is founded, it is far from being unobjectionable. In the first place, the distinction drawn between the two classes of Cryptogamic plants is unfounded, both as regards the presence or absence of both vessels and sexes. Ferns and Lycopodiacæ, in which the vascular system is most developed, have no more trace of sexes than Fungi; and on the other hand, in Mosses and Hepaticæ, in which there is the most distinct formation of something analogous to sexes, there is no trace whatever of a vascular system. The difference, then, between Amphigamæ and Ætheogamæ falls to the ground. and in fact is analogically bad; for there are vascular and cellular orders in both the great classes of Exogens and Endogens, which ought therefore themselves to be subdivided into vascular and cellular, in order to form a consistent system; and this difference appears to be connected with a very general tendency, visible in the vegetable kingdom, to produce an impoverished or degraded condition of all great types of structure. Thus, among Exogens, Onagracæ are merely cellular in Hippuris and Myriophyllum, Urticaceæ in Ceratophylleæ, and the orders Callitrichaceæ and Podostemaceæ are other instances of the same fact; and, in Endogens, Naiadaceæ and Pistiaceæ, or at least Lemna, are as completely cellular as Algaceæ.

In the next place, circumstances of greater importance are omitted by M. De Candolle from his statement than some of those included in it. If Cryptogamic are to be separated from Phanerogamous plants by their vegetation, it is rather by their manner of growth than by any peculiarity in their vascular system. Phanerogamous plants might be called *Pleurogens*, from their growing by the sides as well as at the ends, thus increasing symmetrically both in length, density, and thickness. Cryptogamous plants grow either by simple elongation, without increasing materially in density; or they expand irregularly in all directions, and hence have been termed *Acrogens.* No circumstance can well be more important than the manner in which impregnation takes place. In common Exogens there is an ovarian covering, through the tapering apex of which, called style, impregnation takes effect by aid of a part called the stigma; but in other Exogens impregnation is effected by direct contact between the egg or ovule and the pollen; and a simple mode of veining in the leaves, together with a very small development of the vascular system, accompany this. Hence such plants, called *Gymnosperms*, ought to be regarded as a class of as much importance as Exogens themselves. Again, among plants in some respects participating in the organization of Endogens are species called *Rhizanths*, having a fungoid vegetation, a nearly total absence of the vascular system, and a most remarkable method of propagation. With the ordinary sexes of Endogens they are said to combine the spores of Cryptogamic plants, and thus

hold a sort of middle station between the two great series of plants recognised by Linnæus. Such a kind of vegetation is far too important to be omitted from consideration in determining the classes, as the fundamental divisions of the vegetable kingdom are termed.

For these reasons the writer of the present notice has proposed a material modification of De Candolle's statement, which may be expressed as follows.

PLANTS,

According to their Fructification.		*According to their Vegetation.*
I. Having flowers and sexes (Phanerogamous),	*or*	I. Their axis increasing symmetrically in density and breadth as well as length (Pleurogens).
a. Minimum of cotyledons 2,	*or*	*a.* Stem in concentric layers (Exogens).
Class 1. *Dicotyledons*,	*or*	*Veins of leaves netted.*
Class 2. *Gymnosperms*,	*or*	*Veins of leaves netted or forked.*
b. Minimum of cotyledons 1,	*or*	*b.* Stem a confused mass of wood and cellular tissue.
Class 3. *Monocotyledons*,	*or*	*Veins of leaves parallel, and not netted.*
c. Acotyledons,	*or*	*c.* Vegetation fungoid.
Class 4. *Rhizanths.*		Class 4. *Rhizanths.*
II. Having neither flowers nor sexes,	*or*	II. Their axis increasing by simple elongation or irregular expansion.
Class 5. *Cryptogamic plants*,	*or*	Class 5. *Acrogens.*

For the details of this system the reader is referred to the *Natural System of Botany*, 2nd ed.

BOTA'NIC GARDEN. A garden devoted to the culture of a collection of plants, with reference to the science of botany. The legitimate object of gardens of this description appears to be to collect and cultivate, at the public expence, all the species and varieties of plants that can be cultivated in the given climate, with or without the aid of glass; and then to distribute these to private individuals throughout the district by which the botanic garden is supported. The most complete system of this kind ever established appears to have been that of France soon after the revolution. All the botanical articles that could be procured from other countries were sent to the botanic garden at Paris; and after they had borne seeds or been propagated there, the progeny was distributed among the provincial botanic gardens, of which there is one or more in every department. After being propagated in the provincial botanic gardens, the seeds or progeny were given out, free of expence, to whoever in the district to which the garden belonged thought fit to apply for them. As the useful species and varieties were as much attended to in these gardens as those which were cultivated only in a scientific point of view, the greatest facilities were thus given to the spread of every useful grain, pulse, culinary vegetable, and fruit, over the whole of France. Something of the same kind may be considered as taking place in Great Britain; but it is more the effect of accident than the result of design, as the giving out of plants is not considered in Britain as an essential part of the system of management of a royal or government botanic garden.

BO'TANY BAY RESIN. A yellow aromatic resin which exudes from the trunk of the *Acarois resinifera* of New Holland.

BOTRYLLA'RIANS, BOTRYLARIÆ. (Gr. βοτρυς, *a bunch of grapes.*) In Zoology, a family of singular compound Tunicaries or Ascidians, in which several distinct individuals are arranged in a circle round a central aperture common to the rectum of each, while the mouths are distinct and placed at the circumference.

BOTRYO'IDAL. (Gr. βοτρυς, *a bunch of grapes; ειδος, like.*) When a part is clustered like a bunch of grapes.

BO'TRYOLITE. (Gr. βοτρυς, *a cluster of grapes; λιθος, stone.*) Botryoidal siliceous borate of lime.

BO'TTOM HEAT. A term applied in Horticulture to the temperature communicated to certain soils by fermenting and decomposing substances placed underneath them: leaves, fresh dung, and the refuse bark of the tan-yard, are often used for this purpose; and the system is applied to pine-apples, melons, cucumbers, and other plants grown in pits or frames.

BOTTOM RAIL. (Sax. botm.) In Architecture, a term used for denoting the lowest horizontal rail of a framed door.

BO'TTOMRY. In Commercial Law, is in effect a mortgage of a ship, being an agreement entered into by an owner or his agent, whereby, in consideration of a sum of money advanced for the use of the ship, the borrower undertakes to repay the same, with interest, if the ship terminate her voyage successfully; and binds or hypothecates the ship for the performance of the contract. The instrument by which this contract is effected is sometimes in the shape of a deed poll, and sometimes in that of a bond. On bottomry contracts the lender runs the risk of the voyage, and in consideration of the risk the interest he may take is unlimited. The master has authority to hypothecate a ship or its freight (*see* RESPONDENTIA) at a foreign port, in case of necessity, for the purposes of the voyage. In such case, if the loan be not repaid within the time prescribed, the agent of the lenders applies to the Court of Admiralty, with certain affidavits, and procures authority to arrest the ship, which may be sold, if necessary, under the authority of the court. Where several loans of this description have been made on the same voyage, the last lender is entitled to priority of payment out of the proceeds of the sale.

BOU'DOIR. (Fr. bouder, *to pout.*) In Architecture, a small room or cabinet, usually near the bed-chamber and dressing room, for the private retirement of the master or mistress of the house.

BOU'GET, WATER-BUDGET, or DOSSER. In Heraldry, a bearing supposed to represent a vessel for carrying water

BOU'LTIN. (Fr.) In Architecture, a name given to a moulding whose section is nearly a quadrant of a circle, whose diameter being horizontal, the contour is convex in respect of a vertical to such diameter. It is more usually called the egg or quarter round.

BOU'NTY. In Commerce and the Arts, a premium paid by government to the producers, exporters, or importers of certain articles, or to those who employ ships in certain trades, when the profits resulting from these respective branches of industry are alleged to be insufficient. Bounties on *production* are usually given in the view of encouraging the establishment of some new branch of industry, or of fostering and extending a branch that is believed to be of paramount importance. Bounties on *exportation* and *importation* are granted to the exporters of certain British commodities on their taking oath, or in some cases giving bond, not to reland the same in England. Public opinion was formerly very divided as to the advantage of granting bounties; but at present the impolicy of such a practice appears to be almost universally admitted. For it will be found that in all old settled and wealthy countries, numbers of individuals are always ready to embark in every new undertaking, if it promise to be really advantageous, without any stimulus from government; and if a branch of industry already established be really important and suitable for the country, it will assuredly be prosecuted to the necessary extent without any encouragement beyond the natural demand for its produce. For further details upon this subject, see the article TARIFF.

BOU'NTY, QUEEN ANNE'S. The produce of the first fruits and tenths due to the crown (*see* art. FIRST FRUITS), which were made over by Queen Anne to a corporation established in the year 1704 for the purpose of augmenting poor livings under 50*l.* a year.

BOUSTROPHE'DON. (Gr. βοῦς, *an ox; στρεφω, I turn.*) A word descriptive of a mode of writing common among the early Greeks until nearly the middle of the fifth century before Christ; viz. in alternate lines from right to left and from left to right, as fields are ploughed in furrows having an alternate direction, from whence the derivation. *See* ALPHABET.

BOUT. In Agriculture, is one turn or course of a plough in ploughing a ridge.

BO'VEY COAL. A species of bituminous wood found at Bovey Hayfield, near Exeter.

BOW. An ancient weapon of offence, made of wood, horn, steel, or some other elastic substance, by which arrows are thrown. The force with which the arrow is propelled is proportioned to that with which the bow is bent, and to the quickness with which it recovers its former position.

BOW or BAY WINDOW. (Sax. boga, *a bow.*) In Architecture, a window projecting from the general face of a building, of a curved or polygonal form on the plan.

BO'WLDERS. Rounded masses of stone lying upon the surface, or loosely imbedded in the soil.

BO'WLINE. A rope from near the middle of the weather edge or leech of a sail, leading forward. Its use is to keep the leech forward, that the wind may get at the after side of the sail when very oblique to its direction.

BOWS. The two sides of the fore extremity of a vessel, as the starboard and larboard bows.

BO'WSPRIT. In Naval Architecture, is a kind of mast which rests slopewise on the head of the main stern, having its lower end fastened to the partners of the fore mast. It carries the sprit-sail, sprit top-sail, and jack-staff. It is exposed to violent action, especially from being struck by heavy seas, into which the ship, in plunging, dips it; and though very firmly secured by the bob-stays and side ropes called *shrouds*, is very often *carried away* or *sprung*.

BOX. (Πυξος, the Greek name of the plant.) The hard

compact wood of *Buxus sempervirens*, so much used by wood engravers, and for the turner's purposes. This evergreen bush or small tree is found all over Europe, even upon the chalk hills of England; but it acquires its largest dimensions in the south. It is from Turkey that the principal part of the wood is imported into England, under a duty of 5*l*. a ton: whether or not all this is really furnished by *Buxus sempervirens* is not known. It is not improbable that *Buxus balearica*, a larger species, too tender to thrive in this country, may furnish a part at least of that which comes from the Mediterranean. It is said that the wood of this species is coarser and of a brighter yellow than that of the common species. The box plant is best known for its use in gardens as edging to borders; the kind so employed is a dwarf variety of *Buxus sempervirens*.

BOX DRAIN. An underground drain, regularly built with upright sides and a flat stone or brick cover, so that the close section has the appearance of a square box.

BOX HAULING. In Navigation, is bringing a ship when close-hauled round upon the other tack, when she refuses to tack and there is not room to wear. By throwing the head sails aback she gets sternway; the helm thereupon being put a-lee, the ship's head falls rapidly off from the wind, which she soon brings aft; she is then speedily rounded-to with but little loss of ground.

BO'XING OFF. Throwing the head sails aback to force the ship's head rapidly off the wind.

BO'XING THE COMPASS. Repeating the points in order.

BO'XINGS. *See* LINING.

BRA'CCATE. (Bracca, *breeches*.) In Ornithology, when the feet are concealed by long feathers descending from the tibiæ.

BRACE. In Sea language, a rope fastened to the extremity of the yard, for the purpose of traversing the sails when it is necessary to change their position.

BRACE. (Fr. embrasser, *to embrace*.) In Architecture, an inclined piece of timber used in trussed partitions and in framed roofs, in order to form a triangle by which the assemblage of pieces composing the framing is stiffened. If a brace is used to support a rafter, it is called a strut. When braces are used in roofs and partitions they should be disposed in pairs, and introduced in opposite directions.

BRACE. (Fr. embrasser, *to embrace*.) In Music, the line or bracket at the beginning of each set of staves which ties them together in a vertical direction.

BRACHALY'TRA. (Gr. βραχυς, *short*; ελυτρον, *sheath*.) The name of an extensive group of Coleopterous insects, including all such as have the elytra so short as not to exceed one third the length of the abdomen. To this section belongs the well-known species called the devil's coach-horse (*Staphylinus oleus*).

BRA'CHIAL. (Lat. brachium, *the arm*.) Belonging to the arm; as brachial nerves, vessels, &c.

BRACHI'NUS. A genus of Coleopterous insects, now the type of a family (*Brachinidæ*), including those singular beetles which from their defensive anal explosions are termed "bombardiers." Of these there are five British species, the best known of which is the *Brachinus crepitans* of Linnæus.

BRA'CHIOMIS. The name given by Müller to a genus of Rotiferous Infusorial Animalcules, now subdivided into many distinct genera.

BRA'CHIOPODS, BRACHIOPODA. (Gr. βραχιων, *an arm*; πους, *a foot*.) An order of Acephalous or headless bivalve Mollusks, characterized by having the mantle organized so as to be serviceable for respiration, and by having two long fleshy, ciliated, spiral arms, or labiate processes; whence Cuvier conceived the name, which in his system designates a distinct class of Acephala. *See* PALLIOBRANCHIATES.

BRA'CHIUM. (Lat.) In Mammalogy, is restricted to the second segment of the anterior extremity, which is articulated proximally with the scapula, and distally with the antibrachium. In Entomology, signifies the first pair of legs of Hexapods, the direction of which is usually towards the head.

BRA'CHYCATALECTIC. (Gr. βραχυς, *short*, and καταληκτικος, *deficient*.) A verse wanting two syllables to complete its length (in Greek and Latin poetry).

BRACHY'GRAPHY. (Gr. βράχυς, *short*, and γράφω, *I write*.) The art of writing by abbreviations. (*See* TACHYGRAPHY.) The notæ Tironianæ, among the Romans, were a species of short-hand invented by one Tiro, a freedman of Cicero.

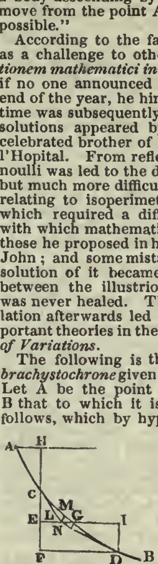
BRACHY'PTEROUS. (Gr. βραχυς, *short*; πτερον, *a wing*.) In Ornithology, when the folded wings of a bird do not reach to the base of the tail.

BRACHY'STOCHRONE. (Gr. βραχυς, *short*, and χρονος, *time*.) The name given by John Bernoulli to the curve which possesses this property, that a body setting out from a given point A, and impelled merely by the force of gravity, will arrive at another point B in a shorter time by moving in this curve, than if it followed any other direction. The problem of the *brachystochrone* is famous in the history of the new geometry. It was first proposed by John Bernoulli in the Leipsic *Acta Eruditorum* for June 1696, in the following terms: —

"Two points, A and B, being given in the same vertical plane; it is required to assign the path through which a body descending by its own gravity, and beginning to move from the point A, will arrive at B in the least time possible."

According to the fashion of that age, it was proposed as a challenge to other mathematicians, *ad cujus solutionem mathematici invitantur;* with the declaration that if no one announced the nature of the curve before the end of the year, he himself would make it known. The time was subsequently extended to a year, within which solutions appeared by Newton, James Bernoulli (the celebrated brother of the proposer), and the Marquis de l'Hopital. From reflecting on this problem, James Bernoulli was led to the discovery and solution of a kindred but much more difficult class of questions; namely, those relating to isoperimetrical figures, the investigation of which required a different kind of analysis from that with which mathematicians were yet acquainted. One of these he proposed in his turn as a challenge to his brother John; and some mistakes into which the latter fell in the solution of it became the occasion of an angry quarrel between the illustrious brothers, which unfortunately was never healed. The prosecution of a similar speculation afterwards led Lagrange to one of the most important theories in the higher mathematics — the *Calculus of Variations*.

The following is the solution of the problem of the *brachystochrone* given by James Bernoulli. (*Opera*, p.768.) Let A be the point from which the body is to move, B that to which it is to go, and A C D B the path it follows, which by hypothesis is wholly situated in the same plane. It is not necessary, however, that the plane be vertical. Take any small portion of the curve C D; then it is obvious that if A B be the path through which the body will descend from A to B in the least time possible, it must also pass from C to D in a shorter time than if it followed any other direction. For suppose



it to pass from C to D by another path, C L N D, in shorter time than by C M G D; then it must also pass from A to B in shorter time through A C L N D than through A C M G D, which is contrary to the hypothesis. This being premised, let A H be drawn horizontally through A, C H perpendicular and D F parallel to A H through the points C and D; also let C F be divided into two equal parts in E, and complete the parallelogram E F D I; the object is to find the point G in the straight line E I, or (which comes to the same thing) the inclination of the two elements of the curve C G and G D to each other, so that the time of descent through C G + time of descent through G D (which may be thus denoted, t C G + t G D) may be a minimum. For this purpose assume another point L in E I, so that G L may be regarded as infinitely small in comparison of E G; and having drawn C L and D L, let L M and G N be respectively perpendicular to C G and D L. Now, variable quantities when they are infinitely near their maxima or minima, may be regarded as constant; therefore t C L + t L D = t C G + t G D, and consequently t C G − t C L = t L D − t G D. By the theory of the descent of heavy bodies,

$$CE : CG = tCE : tCG,$$

and $CE : CL = tCE : tCL$;

therefore,

$$CE : CG - CL \text{ (or } MG) = tCE : tCG - tCL.$$

But by similar triangles,

$$MG : GL = EG : CG;$$

therefore, combining the two last proportions,

$$(1)\quad CE : GL = EG \times tCE : CG \times (tCG - tCL).$$

In like manner,

$$EF : GD = tEF : tGD$$

$$EF : LD = tEF : tLD;$$

therefore,

$$EF : LD - GD \text{ (or } LN) = tEF : tLD - tGD.$$

But $LN : GL = GI : GD$;

therefore,

$$(2)\quad EF \text{ (or } CE) : GL = GI \times tEF : GD \times (tLD - tGD).$$

From the two analogies (1) and (2), we have now $EG \times tCE : CG \times (tCG - tCL) = GI \times tEF : GD \times (tLD - tGD)$; or, $EG \times tCE : GI \times tEF = CG \times (tCG - tCL) : GD \times (tLD - tGD)$. But it was proved that $tCG - tCL = tLD - tGD$; and by the laws of falling bodies, t C E is reciprocally proportional to $\sqrt{HC}$, and t E F reciprocally as $\sqrt{HE}$; therefore by substitution,

$$\frac{EG}{\sqrt{HC}} : \frac{GI}{\sqrt{HE}} = CG : GD,$$

a known property of the common cycloid; which, there-

fore, is the brachystochrone, or curve of quickest descent. In the modern analysis the investigation of the brachystochrone is usually proposed as an example of the method of *Variations.*

BRA'CHYURES, BRA'CHYU'RA. (Gr. βραχυς, *short*, and ουρα, *a tail.*) A tribe of Decapodous Crustacea, in which the tail or post-abdomen is short, and folded beneath the trunk; commonly called "crabs."

BRA'CKET. (From brachietto, Ital.) In Architecture, a projecting piece for carrying a superincumbent weight. In large cornices executed in plaster the series of projecting pieces to which the laths are nailed is called bracketing.

BRA'CON. A Fabrician genus of Hymenopterous insects of the parasitic tribe of Pupivorous Ichneumons: it is now the type of a family (*Braconidæ*), distinguished from the true Ichneumons by having the maxillary palps five-jointed, and the labial ones either three or four-jointed, and by wanting the internal discoidal cell of the upper wings. The genera of this family are *Bracon* proper; *Aphidius*, the species of which prey upon the plant-lice; *Stephanus*, *Cœlinius*, *Spathius*, *Perilitus*, *Hybrizon*, *Leiophron*, *Agathis*, *Microdus*, *Hormius*, *Ichnentes*, *Microgaster*, and *Blacus*.

BRACT. An altered leaf, which is placed at the base of a flower on the outside of the calyx. It is the first attempt made by the common leaves to change into the floral organs. In general the bract is small and inconspicuous, but it occasionally acquires a considerable size and a brilliant colour, as in *Salira comosa* and *splendens*, and the Brazilian pine-apple, and more especially in the various kinds of Arum, where it constitutes the large enveloping leaf, called spath, in which the spadix of those extraordinary plants is enveloped. This word forms the adjectives *bractiscent*, assuming the appearance of a bract; *bractial*, furnished with bracts; *bractiolate*, having little bracts. A cupule is a collection of bracts united into a cup; an involucre is the same organs arranged in a whorl. The flowers of grasses and cyperaceous plants consist of nothing but little bracts called *paleæ* and *glumes.*

BRA'DYPODS, BRADY'PODA. (Gr. Βραδυς, *slow*, πους, *foot; slow-footed.*) A family of Macronyhous or Edentate Mammals, including the two-toed and three-toed sloths.

BRA'HMANS. (Βραχμανες among the Greeks, *Bràhman* in the Indian dialects, and *Bramin* among the Europeans.) The first or highest of the four castes of Hindoos, said to have proceeded from the mouth of Brahm (the seat of wisdom). They form the learned or sacerdotal class; and its members have maintained a more extensive sway than the priests of any other nation. Their chief privileges consist in reading the Veda or sacred volume, in instituting sacrifices, in imparting religious instruction, in asking alms, and in exemption from capital punishment. The whole life of the Brahmans is devoted to the study of the sacred writings, and is divided into four periods. The first begins at the age of seven, when the duty of the young novitiate consists in learning to read and write, in studying the Veda, and in familiarising himself with the privileges of his order. In the second stage of a Brahman's life he is allowed to marry, and to engage in commercial speculations. In the third stage, his religious duties become more numerous, and must be rigidly performed. But in the fourth period, the Brahman is admitted to personal communication with the Deity; and this stage is reckoned so pre-eminently holy, that in a single generation it imparts a greater stock of religious importance than is attainable by any other means in a thousand years. (*Menou's Instit.*) The origin of the Brahmans is merged in obscurity. While some ancient writers regard them as a branch of the old Gymnosophists (*Str. Geo.* t. ii. p. 1038.), Diodorus Siculus maintains that they are of much earlier origin. According to the accounts of the best Jewish writers, adopted by Shorestani (an Arabian author of great repute), and sanctioned by the authority of the learned Dr. Hyde (*De Rel. Vet. Persarum*, 31, 32.), the progenitor of the Brahmans was the patriarch Abraham, who in their language is styled Brachman or Brahman. But whatever may have been the origin of the Brahmans, it is certain that the whole learning of India was for ages in their hands. Many of the Grecian sages travelled into India to learn wisdom in that great storehouse of knowledge; and, among others, Pythagoras seems to have borrowed from them the greater part of his mystical philosophy; nay, it is even doubtful whether Aristotle himself did not derive both the materials and the arrangement of his system of logic from the same source. Of ancient Brahminical science the principal remains are their astronomical and trigonometrical methods, both of which have given rise to frequent and learned discussion. Among the modern Brahmans we look in vain for the deep learning that characterized the ancient members of this order; for, with the exception of metaphysical disquisitions, which have always been a favourite study among them, the learning of the present race of Brahmans is exceedingly meagre, being limited almost entirely to the construction of the almanack. Nor is it merely in point of learning that the modern Brahmans have degenerated from their ancestors. Their morals too are wofully deteriorated; and while they are the sole depositaries and ministers of a religion which in point of purity and sublimity of doctrine yields only to the Christian, their conduct is characterized by the most vile and licentious practices; a spirit of avarice, falsehood, and revenge is every where visible; and in many cases superstition and fanaticism have been exchanged for infidelity and atheism. But in spite of these grievous defects, this system maintains its ground; and neither the march of time, the inroads of the conqueror, nor any of the causes that operate in modifying or undermining other institutions, have been able to weaken or subvert the influence of the Brahmans. Whether Great Britain be destined, by the introduction and dissemination of education and Christianity, ultimately to effect what has hitherto baffled every effort, it is not for us to prognosticate; but, assuredly, whatever may be successful in eradicating the Brahminical system, and in substituting in its room a religion whose ministers will practise what they teach, will have achieved the brightest moral triumph in the annals of history. (See *Mills's British India; Asiatic Researches*, passim; *Coleman's Hindoo Mythology; Sir William Jones's History.*)

BRAIN. The chemical examination of the brain of animals was first undertaken by Vauquelin, who found in the human brain 80 water, 7 albumen, 4·53 white fatty matter, 0·70 red fatty matter, 1·12 osmazome, 1·5 phosphorus; acids, salts, and sulphur, 5·15. An elaborate dissertation upon the composition of brain has more lately been published by M. Couerbe (*Annales de Chim. et Phys.* lvi. 160.) He finds a large proportion of *cholesterine* in it; and asserts, as the result of repeated examinations, that the proportion of phosphorus in the brain of persons of sound intellect is from 2 to 2·5 per cent.; in the brain of maniacs it is from 3 to 4·5, and in that of idiots only from 1 to 1·5 per cent.

BRAIN, HUMAN, ANATOMY OF. The brain, or the general mass of nervous matter which occupies the cavity of the skull, constitutes about one thirty-fifth of the weight of the body; it is divided by anatomists into the *cerebrum*, which occupies the whole of the superior part of the cavity of the cranium; the *cerebellum*, which occupies the lower back part; and the *medulla oblongata*, which is the smallest portion, lying at the base of the cranium, beneath the cerebrum and cerebellum, and, passing out of the great foramen of the occipital, becomes as it were the origin of the spinal marrow. The brain is covered by three membranes, two of which are termed *matres*, from the old idea of their giving rise to all the other membranes of the body. The external membrane, more firm than the others, is termed *dura mater:* it is very dense and fibrous, and adheres every where to the inner surface of the cranium, to which it is connected by its vessels; its inner surface is smooth, and it sends off several folds, or *processes*, as they are called, which descend between certain portions of the brain. Of these the principal is the superior longitudinal process, or *falx cerebri*, which descends from the fore to the back part of the skull, between the hemispheres of the brain; from its posterior termination it sends off a layer or expansion, which extends across the back of the skull, and is called the *tentorium*, separating the cerebrum from the cerebellum; from the middle of the tentorium another membranous expansion descends between the lobes of the cerebellum, and terminates at the edge of the great occipital hole, or *foramen magnum*; this is termed the *falx cerebelli*. There are certain spaces or *sinuses* formed in the layers of the dura mater, which perform the office of veins in regard to the blood returning from different parts of the brain, by which any venous pressure upon the substance of the brain is prevented.

When the dura mater is removed, a thin transparent membrane investing the surface and convolutions of the brain is brought to view, which from the delicacy of its texture has been called the *arachnoid* membrane; it is not apparently vascular, and does not pass into the depressions between the convolutions; and it is difficultly separable from the third membrane, or *pia mater*, which is also extremely tender and delicate, but is highly vascular, and from it the blood vessels merge into the substance of the brain, ramifying with great minuteness upon its surface; it lines all the convolutions and cavities of the brain. On removing the upper part of the cranium, and turning aside the dura mater, the brain is seen, divided longitudinally into two ovoid hemispheres, separated, as already stated, by the falx; upon the under side each hemisphere is seen to be divided into three lobes; the two anterior lobes rest upon the orbital plates of the frontal bone; the middle lobes lie upon the fossæ formed by the temporal and sphenoid bones; and the posterior lobes rest upon the tentorium. The superficial convolutions of the brain are divided by clefts of about an inch in depth. On cutting into its substance, the exterior part of the brain appears of a different colour

from the interior, and has been termed the cineritious or cortical substance; it is greyish brown, very soft, and exhibits no appearance of a fibrous texture. Some suppose that it is glandular, and constituted almost entirely of vessels and cellular membrane; it covers the whole of the brain, and is about the tenth of an inch in thickness. The inner substance, termed the white or medullary part of the brain, is of a firmer texture, highly vascular, and when minutely examined appears fibrous, the fibres decussating with each other, and occasionally combining to form commissures.

The *cerebellum*, when viewed from below, is of an elliptical shape, its longest diameter being from side to side, and is divided into two hemispheres separated by the falx cerebelli. In the centre of the upper part of the cerebellum there is a prominence, termed the *vermiform process;* and the whole surface is fissured or sulcated, the pia mater passing between the fissures and conveying vessels to the substance, whilst the arachnoid tunic is merely extended over them.

Such is an outline of the anatomy of the human brain; the details can only be fully understood by reference to illustrative plates upon an adequate scale, which would be incompatible with the plan of this work.

It has been already stated that in man the brain averages in weight 1-35th of the body; it weighs, in fact, about two pounds and a half: in quadrupeds its relative bulk is remarkably smaller; in the dog it averages 1-120th of the weight of the animal; in the horse 1-450th; in the sheep 1-750th; and in the ox 1-800th. This statement has been adduced to show the direct relation between the bulk of the brain and the quantity of mind, the above animals being ranged in the order of their docility and intelligence.

On making a vertical section of either hemisphere of the cerebellum, a central white substance becomes apparent, which ramifies in an arborescent form, and is called *arbor vitæ;* the exterior covering is grey. In front of the cerebellum is a protuberance, termed *pons Varolii* or *tuber annulare;* it is divided by a central groove into two halves, and connected with the cerebrum and cerebellum each by two thick white chords called *cruræ:* the former, or crura cerebri, pass from the tuber forwards and outwards, under the middle part of each hemisphere, in which they are lost; and the latter, the crura cerebelli, are continued backwards and outwards, and terminate in either hemisphere of the cerebellum. The portion of the brain between the tuber annulare and the foramen of the occipital bone is called the *medulla oblongata*, and is continued into the spinal chord; on its anterior surface are four contiguous projections; the two interior ones are called *corpora pyramidalia*, and the two exterior *corpora olivaria.* On carefully removing the membranes which cover the medulla oblongata, and gently opening its middle groove, several white bands are seen passing obliquely from one side to the other, and mutually interwoven, and are termed the *decussating bands.*

The two sides of the brain are mutually connected by commissures or medullary bands, and those of the cerebellum by the pons varolii. The principal connection of the hemispheres of the cerebrum is by a broad medullary band, called the *corpus callosum.* The occasional intervals which separate the parts of the brain are termed *ventricles*, the largest of which are the two *lateral ventricles* in the interior of each hemisphere; their figure is irregular, and they are separated by a tender layer of cerebral matter termed the *septum lucidum;* they are lined by the pia mater. The *middle* or *third ventricle* is a fissure between two convex eminences, situated at the middle and back of the lateral ventricles, and termed *thalami optici.* The *fourth ventricle*, or *ventricle of the cerebellum*, is a cavity between the cerebrum, the tuber annulare, and the medulla oblongata.

BRAIRD. In the agriculture and gardening of Scotland, the term braird is applied to the springing up of seeds, which, when they come up well, are said to have a fine braird.

BRAKE. In Agriculture, a large harrow.

BRA'MA. (Hin.) The name of a divinity in the Hindu Mythology, the fables concerning whom are so numerous, that an accurate development of his character has been hitherto unattainable. As we learn from the Sanscrit lexilogists, the epithets applied to this divinity are very numerous: some of the most usual being "*Swayambhu*, the self-existent, *Parameshti*, who abides in the most exalted places, *Pitamaha*, the great father, *Prajápati*, the lord of creatures, *Lokesa*, the ruler of the world," &c. But the most distinct account of his nature and attributes is to be found in *Coleman's Mythology of the Hindus*, where he is represented as the grandfather of the gods, and equivalent to the Saturn of the Romans. *Brahm*, the highest divinity of the Hindus, to whose name so deep reverence is attached that it is considered criminal to pronounce it, is said to have given birth to Brahma, Vishnu, and Siva, simultaneously; and to have allotted to the first the province of creating, to the second that of preserving, and to the third that of destroying. Accordingly, ever since the creation of the world Brahma has had little or nothing to do, and it will not be till the tenth avatar or incarnation that his services will be put in requisition, when this world is to undergo total annihilation. Meanwhile, however, the other deities, Vishnu and Siva, are constantly engaged in their respective duties of preservation and destruction; and the Hindoos, with that recklessness of the future which is common to them with more civilised communities, lavish all their adoration upon those divinities from whom they expect to derive immediate advantage. Hence, throughout all India, the worship of Brahma is neglected; his altars are overturned, his temples destroyed; in short, nothing has been left but his name, and even that none of the best. Brahma is usually represented with four heads and four hands, either reclining upon a lote tree (the emblem of creation among the Hindoos), or riding upon a swan.

BRAN. The husk of wheat which immediately covers the grain, and which remains in the bolting machine. It is gently laxative; an infusion of it, under the name of *bran tea*, is frequently used as a domestic remedy for coughs and hoarseness. *Calico printers* employ bran and warm water with great success to remove colouring matter from those parts of their goods which are not mordanted.

BRA'NCHIÆ. (Βραγχια, *the gills of a fish.*) The term applied to all vascular organs of an animal body which are destined to submit the circulating fluid in a state of minute subdivision, for the purpose of respiration, to the influence of air contained in water.

BRANCHI'OPODS, BRANCHIO'PODA. (Gr. βραγχια, *gills;* and πους, *a foot.*) An order of Crustaceans, in which the locomotive extremities fulfil the functions of gills.

BRANCHIO'STEGANS, BRANCHIOSTEGI. (Βραγχια, *gills;* στεγω, *I cover.*) A tribe of cartilaginous fishes, comprehending those in which the gills are free, and covered by a membrane; including the sturgeon and chimæra.

BRA'NDY. The spirituous liquor obtained by the distillation of wine. When pure it is perfectly colourless, and only acquires a pale brown or yellow tint from the cask. The deep colour of common brandy, intended to imitate that which it acquires from great age in the cask, is generally given by the addition of burned sugar. The average proportion of alcohol in brandy varies from 48 to 54 *per cent.* The best brandy is made in France, the preference being generally given to that shipped from Cognac. The imports of brandy for home consumption amount to about 1,400,000 gallons a year; but there can be no doubt that the quantity would be much larger, were it not for the oppressive duty of 22*s*. 6*d*. a gallon, with which it is charged.

BRASS. An alloy of copper and zinc. The proportions vary according to the required colour: four parts of copper and one of zinc form an excellent brass. It is usually made by heating copper plates in a mixture of native oxide of zinc, or calamine and charcoal.

BRA'SSAGE. A sum formerly levied to defray the expense of coinage, and taken out of the intrinsic value of the coin. The term is supposed to be derived from *brachiorum labor.*

BRA'SSART. In Plate Armour, the piece which protected the upper arm, between the shoulder-piece and the elbow.

BRASSICA'CEÆ. (Brassica, one of the genera.) One of the names of Cruciferous plants, which see.

BRAZI'L NUT. A South American fruit, commonly sold in the markets of London; it is the seed of a large fruit tree, called *Bertholletia excelsa.*

BRAZIL WOOD. A valuable wood, imported from South America and the West Indies, where it is produced by certain species of *Cæsalpinia*, especially *C. echinata* and *Braziliensis;* large trees with repeatedly pinnated leaves, showy yellow flowers, and long richly coloured stamens. It is used for the preparation of a red dye, but the consumption of it in this country is inconsiderable. It fetches from 60*l*. to 80*l*. a ton in the London market, exclusive of the duty of 2*l*. a ton.

BREACH. In Fortification, a gap or opening made in any part of the walls of the besieged place by the cannon or mines of the besiegers.

BREAD. (Germ. brod.) This important article of food is made of the flour of different grains; but it is only those which contain gluten that admit of conversion into a light or porous and spongy bread, of which *wheaten bread* furnishes the best example. When flour is made into a tough paste or *dough* by the addition of a little water, rolled out into thin cakes, and more or less baked, it forms *biscuit.* For the formation of *bread* a certain degree of fermentation, not unlike vinous fermentation, is requisite, care being taken to avoid acetous fermentation, which renders the bread sour, and to most persons disagreeable. If dough be left to itself in a moderately warm place (between 80° and 120°), a degree of fermentation comes on, which, however, is sluggish, or,

if rapid, *acetous;* so that to effect that kind of fermentation requisite for the production of the best bread, a *ferment* is added, which is either *leaven* or dough which is already in a fermenting state, and which tends to accelerate the process in the mass to which it is added; or *yeast*, the peculiar matter which collects in the form of scum upon beer in the act of fermentation. Of these ferments leaven is slow and uncertain in its effect, and gives a sour and often slightly putrid flavour. Yeast is more effective; and when clean and good, it rapidly induces *panary fermentation;* but it is often bitter, and sometimes has a peculiarly disagreeable smell and taste.

All, then, that is essential to make a loaf of bread is dough to which a certain quantity of yeast has been added. This mixture is put into any convenient mould or form, or merely shaped into one mass; and after having been kept for a short time in rather a warm place, so that fermentation may have begun, it is subjected to the process of baking in a proper oven. Carbonic acid is generated; and the viscidity or texture of the dough preventing the immediate escape of that gas, the whole mass is puffed up by it, and a light porous bread is the result. Along with the carbonic acid traces of alcohol are at the same time produced, but so insignificant and impure as not to be worth notice; hence the attempts which have been made to collect it upon the large scale have entirely failed in an economical point of view. Other flour besides that of wheat will, under similar circumstances, undergo panary fermentation; but the result is a heavy, unpalatable, and often indigestible bread; so that the addition of a certain quantity of wheat flour is almost always had recourse to. It is the *gluten* in wheat which thus peculiarly fits it for the manufacture of bread, chiefly in consequence of the tough and elastic viscidity which it confers upon the dough.

It is well known that *home-made bread* and *baker's bread* are two very different things: the former is usually sweeter, lighter, and more retentive of moisture: the latter, if eaten soon after it has cooled, is pleasant and spongy; but if kept for more than two or three days, it becomes harsh and unpalatable. The cause of this difference may perhaps be obvious from the following details of the operations of the wholesale baker.

In making his dough he takes the water, or part of it, which he intends to use, and having slightly warmed it, dissolves in it a certain portion of salt; then he adds the yeast, and then a certain quantity of flour. This mixture is set aside in a warm place, where it soon begins to ferment. This process is called *setting the sponge;* and according to the relation which the water in it bears to the whole quantity to be used in the dough, it is called whole, half, or quartern sponge. The evolution of carbonic acid causes the sponge to heave and swell; and when the surface bursts it subsides, and then swells again, and so on; but the baker is careful to use it before this fermentation has communicated sourness to the mass. He then adds to the sponge the remaining quantity of flour, water, and salt which may be required to form dough of proper quality and consistence, and incorporates the whole by long and laborious kneadings till the entire mass acquires uniformity, and is so tough and elastic as to bear the pressure of the hand without adhering to it. It is then left for a few hours, during which fermentation goes on; and the inflated mass is again kneaded, so as to break down any lumps or portions which had accidentally escaped diffusion in the first operation, and to confer perfect uniformity on the whole. The dough is then weighed out into loaves, which are shaped, and put aside in a warm place for an hour or two, during which they swell up to about double their original size; they are then put into the oven and baked; during which operation they again enlarge considerably in bulk, in consequence of the dilatation of the previously generated carbonic acid pent up in the dough; for, as soon as the mass is exposed to the heat of the oven, the fermentation is put an end to.

If we compare the baked loaf with the flour of which it is composed, we shall find that panary fermentation has produced a considerable change in the latter. The gluten and the starch, which (exclusive of a trace of sugar) were the components of the flour, have mutually acted upon and altered each other; the toughness and viscidity of the gluten is gone, and the starch no longer forms a gelatinous mixture with hot water; a little sugar is generally formed, as well as alcohol; but the principal cause of the change in the characters of the flour is the evolution of carbon and of oxygen in the form of carbonic acid, the production of which is independent of the presence of external oxygen (or of air). Small quantities of alum are also, it is said, invariably used by the London bakers, with the view of whitening or bleaching the bread; for it may be observed, that whatever may be the quality of the flour which is used, home-made bread is always of a comparatively dingy hue. According to Mr. Accum (*On the Adulteration of Food*), the requisite quantity of alum for this purpose depends upon the quality of the flour. The mealman, he says, makes different sorts of flour from the same kind of grain. The best flour is chiefly used for biscuits and pastry, and the inferior kinds for bread. In London no fewer than six kinds of wheaten flour are brought into the market; they are called fine flour, seconds, middlings, coarse middlings, and twenty-penny. Beans and peas are also, according to the same authority, frequently ground up with London flour. The smallest quantity of alum used is from three to four ounces to the sack of flour of 240 pounds.

Another article occasionally employed in bread making is carbonate of ammonia. As it is wholly dissipated by the heat of the oven, none remains in the baked loaf. It renders the bread light, and perhaps neutralizes any acid that may have been formed (exclusive of carbonic acid); but it is too dear to be much employed. To some kind of biscuits it gives a peculiar shortness, and a few of the most celebrated manufacturers use it largely. The French chemists have accused the bakers of employing sulphate of copper or blue vitriol, for the purpose of improving the colour of the bread; but so dangerous and easily detected an addition can scarcely be supposed to be common. According to Mr. E. Davy, bread, especially that of indifferent flour, is materially improved by the addition of a little carbonate of magnesia, in the proportion of twenty to thirty grains to the pound of flour; it requires to be very intimately mixed with the dough. The most nefarious adulteration of bread consists, however, in the addition of certain insipid and colourless earthy substances, with a view of increasing its weight; such as pipe-clay, porcelain-clay, chalk, and plaister of Paris. These, however, are probably very rarely resorted to; though in one instance the writer of this article had occasion to examine a quantity of *biscuits*, which were adulterated with gypsum to the amount of 10 *per cent.*

BREAK. (Teut. brache.) In Architecture, any projection from the general surface of a building.

BREA'KERS. Waves that break, or fall over, from the shallowness of the water. In a gale, the tops of the seas generally break in this way more or less, from the progressive motion of the water at the surface before the wind, which is exceedingly dangerous for open boats. This is never confounded with the falling over of the whole wave, as the surf falls over on the beach.

BREA'KING JOINT. In Architecture, that disposition of stones and bricks in their courses by which vertical joints are not allowed to fall over each other. *See* Diagrams to BOND, ENGLISH and FLEMISH.

BREAKWA'TER. An artificial bank of stones, or the hull of a vessel, sunk to break the sea before its entrance into a roadstead or harbour. The breakwater at Plymouth is a great work of this kind. It is built across the sound, which it completely defends from a very heavy sea from the channel in south-westerly winds, and which formerly caused the loss of many ships. It is composed of large stones dropt from vessels constructed for the purpose. The sea, which for a time offers serious obstacles to the construction, works the stones together, and washes up shingle and sand, which, with the growth of sea-weed, consolidate the whole. The outer mole of the harbour of Civita Vecchia, still in good repair, was formed by the Emperor Trajan exactly in the same way as the breakwater at Plymouth. (*Plinii Epist.* lib. vi. ep. 31.) The breakwater at Cherbourg, constructed by Napoleon, is one of the greatest modern works of this class.

BREAM. The name of a soft-finned fish, common it many of the lakes and rivers of England, and one that breeds freely and thrives in ponds, if there be sufficient depth of water. It is the type of a particular subgenus of the Carp family (*Cyprinidæ*), which Cuvier has characterized under the name of *Abramis*. *See* ABRAMIS.

BREA'MING. In Nautical language, signifies cleaning the bottom of a vessel by fire. When the vessel is aground, fire being applied to the bottom loosens the pitch, or composition of sulphur and tallow, with which the bottom is sometimes covered to defend it from the worms, and which is then scraped off, together with the barnacles, grass, weeds, &c. that adhere to it.

BREA'STING. Breasting up a hedge is cutting the face of it on one side, so as to lay bare the principal upright stems of the plants.

BREAST PLOUGH. A kind of spade or shovel, with a cross piece at the extremity of the handle, which is applied to the breast, and by which the operator skims off a thin slice of turf from a grassy surface, as if he were ploughing. Turf thus obtained is chiefly used in thatching.

BREA'STSUMMER. (From Sax. bꞃeoꞅꞇ, and summer; *quære*, trabs summaria?) In Architecture, a beam which supports an exterior wall, the beam itself being carried by wooden or iron posts.

BREAST-WORK. In Fortification, an elevation of earth thrown up round a fortified place to protect the garrison from the enemy's fire.

BRE'CCIA. (It.) A rock composed of an agglutination of angular fragments.

BREECH OF A GUN. The solid part behind the bore.

BRE'ECHING, or BREECH BAND. Part of the harness of a carriage horse, by means of which he is enabled to push the carriage to which he is attached backwards, or to support its pressure in going down a hill.

BREEZE-FLIES. *See* ŒSTRIDÆ.

BREHON LAWS. The ancient laws of the Irish are so termed, from an Irish word signifying *judges*. It is supposed that some of the numerous written collections of these laws which still exist are of great antiquity; as old, perhaps, as the earlier ages of the Christian era. Prior to the Anglo-Norman invasion, Ireland was entirely governed by these laws. For an account of the nature of these laws, see *Lord Lyttleton's Henry II.* vol. v. p. 28., and the authorities there referred to.

BRE'NTUS. A Fabrician genus of Coleopterous insects, belonging to the Weevil tribe, or *Curculionidæ*; now the type of a family, called *Brenthidæ*, including about eight genera and seventy species. These insects are peculiar to hot climates: only one species, the *Brentus Italicus*, is found in Europe, and this has been referred by Germar to a particular sub-genus, *Arrhenodes*, all the other species of which are natives of the new world.

BRE'TTICES. In coal mines, wooden plankings to prevent the falling in of the strata.

BREVE. (Ital.) In Music, a note formed thus 𝅜 without a tail, and equivalent to two semibreves, or four minims. It is also that measure of quantity contained in two beats of the hand up and two down, but this only in common time with the mark 𝄵.

BRE'VET. In the French, signifies a royal act in writing conferring some privilege or distinction; as brevet d'invention, a patent. It is applied, in England, to a commission giving nominal rank higher than that for which pay is received; thus, a brevet major serves and draws pay as captain, &c.

BRE'VIARY. A book containing the offices of daily prayer according to the usage of the R. C. church. The offices are seven; viz. matins, lauds, first, third, sixth, and ninth vespers, and the compline. Anciently all Catholics were required to recite the breviary daily. The injunction is now confined to the clergy; of whom it is still strictly exacted.

BRE'VIPENNATES, *Brevipennes*. (Lat. brevis, *short*; penna, *quill*; *short-quilled*.) An epithet applied by Cuvier to distinguish the first family of his order *Grallæ* (Echassiers); the ostrich is the type of this family. *See* CURSORES.

BREW'ING. *See* FERMENTATION.

BRI'BERY. In English Law, is a term comprehending the offences of judges, ministerial officers, &c., receiving rewards or considerations to act contrary to their respective duties, which are severally misdemeanors at common law, and also punishable under several statutes. But in its most ordinary signification, it is the giving or receiving money to procure votes at parliamentary elections, or elections to public offices of trust. The statutes which at present chiefly regulate the offence of bribery at parliamentary elections are 2 G. 2. c. 24., and 49 G. 3. c. 118. The latter statute imposes a penalty of 1000*l.* on any one (if not returned, incapacity to serve in parliament for that place if returned) who "shall give or cause to be given, directly or indirectly, any sum of money, &c., upon any engagement that the person receiving shall procure, or endeavour to procure, &c., the return of any member," and imposes a fine of 800*l.* on the person receiving the bribe on such a promise or agreement. The former makes it an offence in any person "to procure or corrupt another to vote;" and it has been recently held, that the corruption is complete, as far as the corrupter is concerned, by the act of giving the money, whether the voter intend or not to act according to the wish of the briber.

BRICK. (Dutch bricke.) In Architecture, a mass of clay earth, sometimes mixed with coal ashes, chalk, and other substances, formed in a mould, and burnt in a kiln or clamp. The earth used for this purpose is of two sorts. The one a stiff clay, with little or no extraneous mixture, which produces a hard red brick; the other a yellowish-coloured fat earth, called loam, which produces a grey-coloured brick. The clay is usually tempered in a clay mill. For the sea coal ashes that are mixed with it in London, they substitute in the country a light sandy earth. In making the paste as little water should be introduced as possible. In moulding them, which is done in a wooden mould, a clever workman will mould about five thousand in fifteen hours. The kiln in which they are burnt is a large building, about 13 feet long, 10 feet 6 inches wide, and 12 feet high, furnished with a proper furnace. When otherwise burnt, the *clamp*, as it is called, is formed of the bricks themselves, generally oblong on the plan, and the foundations made with place bricks. Each course of bricks is laid on a layer of *breeze* or cinders; and flues are formed, filled with coals, breeze, and wood. The burning continues from twenty to thirty days. The size of bricks, when burnt, is required by the statute to be 8¼ inches long, 2¼ inches thick, and 4 inches wide. The different varieties of bricks are, *malms*, which are of a yellowish uniform colour and texture; *seconds*, not quite so uniform in colour and texture as malms; *red* and *grey stocks*, the former being burnt in kilns, both of a quality rather inferior to seconds; *place bricks* or *peckings*, sometimes called sandel or samel bricks, which are those furthest from the fire, and rarely well burnt, — these should never be used in a building where durability is required; *burrs* or *clinkers*, which are masses of several bricks run together in the clamp or kiln from the violent action of the fire; *fire bricks*, of a red colour, about 9 inches long, 4½ inches broad, and an inch and a half thick, — they are made for use in furnaces to resist the action of the fire, and from having been formerly manufactured in the neighbourhood of Windsor, they are sometimes called Windsor bricks; *paving bricks*, made for the purpose their name implies; *compass bricks* are circular on the plan, chiefly used in walling wells, and the like; *Dutch clinkers* or *Flemish bricks*, chiefly used in stables; the Dutch clinker is 6 inches long, 3 inches broad, and 1 inch thick.

BRICKLA'YING. In Architecture, the art of building with bricks, which is of very great antiquity. Pausanias mentions many structures in Greece which were built of bricks; and in Rome such buildings were very common. The walls of Babylon, attributed by Herodotus to Semiramis, were also of brick.

BRICKNO'GGING. In Architecture, brickwork carried up and filled in between timber framing.

BRICK TRIMMER. (Sax. ꞇꞃımman, *to build.*) In Architecture, a brick arch abutting against the wooden trimmer in front of a fireplace, to guard against accidents by fire.

BRI'DEWELL. A house of correction for offenders is commonly so called in England. The name is derived from the locality of the ancient London house of correction, which was an hospital, founded by Edward VI. on the site of St. Bride's well, in Black Friars, a well-known object of pilgrimage in Roman Catholic times. The original Bridewell is under the control of the lord mayor, and used as a receptacle for vagrants, place of punishment for apprentices, &c., within the jurisdiction of the city.

BRIDGE. (Sax. bꞃıᵹᵹe.) In Architecture, a structure for the purpose of connecting the opposite banks of a river, gorge, valley, &c. &c., by means of certain materials, forming a roadway from one side to the other. It may be of stone, brick, iron, timber, suspended chains or ropes; or the roadway may be formed by means of boats. Long previous to the introduction of bridges constructed upon geometrical principles, the modes of crossing rivers by throwing the trunks of trees across them, or by suspension of ropes, or twisting together the branches of trees from bank to bank, were so obvious that they must have been resorted to at an early period. The former method, however, could only have been practised over narrow streams, whilst the latter might have been carried to almost any required extent. Mungo Park found this mode employed in Africa; and in South America rope bridges of bujuco, or thongs made from the hides of oxen, are in use at the present day. Don Antonio de Ulloa tells us, that over some of the rivers of Peru the bujuco bridges are of such dimensions that loaded mules in droves pass over them, and especially on the river Apurimac, forming the high road for the trade carried on between Lima, Cuzco, and other places to the southward. Though such bridges are the contrivance of man in a less civilised state, they are the only means by which many streams whose currents are deep and rapid can be crossed; and the stupendous suspension bridges of the present day are but improvements on the simple scheme of the untutored architect of a savage tribe. When a stream is neither deep nor rapid, its breadth seems to present no obstacle to forming a roadway over it. Large stones placed across at intervals, on which other stones or beams of timber may be laid horizontally, would be the first step. Of this species appears to have been the bridge which, according to Herodotus, Nitocris constructed at Babylon over the Euphrates, and which is said by Diodorus Siculus to have been five furlongs in length. Of this sort also are many of the bridges in China. The bridges of the Chinese, however, appear to have been rather too highly extolled in the accounts of Du Halde and the missionaries, as may be gathered from the information obtained of the Foo-chow-foo bridge, during the voyage of the ship Amherst in 1832. It appears, from the testimony of Captain Parish, that the use of the arch with wedge-shaped stones converging towards the centre of the curve must have been known to the Chinese at a very early period.

In tracing the history of bridges among different nations, we shall see that local causes had great influence on the species of construction adopted by them.

A nation may have reached the highest point of art in its other public monuments, and have nevertheless done nothing worthy of our admiration in the construction of a bridge. In Egypt, for example, intersected as it is by a large and wide river subject to periodic inundations, the construction of bridges would have been as difficult as it would have been useless. All the intercourse which commerce required was easily carried on by the assistance of boats; and as respects the passage over the canals which abounded in the country, their depth and breadth were so small as to require none but the most simple expedients for connecting their opposite banks, nor any which involved the employment of science. In Greece, no vestige of a bridge occurs whose date is anterior to its occupation by the Romans; but this, had they even been acquainted with the use of the arch, might be accounted for on reasons directly the reverse of those which operated in Egypt. Greece is intersected by no river of any magnitude; and even those which seem to have some title to the name, are rather mountain torrents than those immense sheets of water, swelled in their course by innumerable tributary streams, that are to be found in other parts of the world. Here scarcely more could be wanted than a single arch, whose abutments would be found in the solid rocks which the stream separated.

Following up the history of bridges into Italy, we find a country much watered by large rivers, where the architecture of bridges became a necessary study, not only for the accommodation of the cities with which it abounded, but also for the service of the frequent military expeditions of the restless conquerors who occupied its lands. Rome, from its earliest foundation, must have put in requisition considerable skill in bridge architecture over the Tiber, rapid and subject as it is to sudden floods. The earliest bridges here were of timber; such was that which joined the Janiculum to the Mons Aventinus, and was called the Pons Sublicius, from the *sublicæ* (stakes) of which it was formed. (*Liv.* i. 33.) Without enumerating the bridges of Rome, some of which are still standing to attest the science of their architects, we must mention the Pons Narniensis, on the Flaminian way, near Narni, and about sixty miles from Rome. It was built by Augustus; and vestiges of it remain to the present day, one arch above 150 feet span and 100 feet high being still entire. But of works of art, perhaps the most wonderful ever raised was the bridge built by Trajan over the Danube. It consisted of twenty piers, whose height from their foundation was 150 feet, and 170 feet apart; its breadth being sixty feet. This stupendous work was demolished by Hadrian, the successor of Trajan, under the pretence that it might serve as a passage for the barbarians, if they became masters of it; but some writers have said it was through envy of the fame that attached to its founder. Over the Tagus in Spain an ancient Roman bridge, near Alcantara, is still partly standing. It consisted of six arches of eighty feet span, extending altogether 600 feet in length, and some of the arches 200 feet high above the water. Of the temporary bridges of the Romans, the most famous was that of timber thrown by Cæsar over the Rhine.

From the fall of the Roman Empire to the revival of the arts, the history of bridge architecture is, with the exception of the Moorish works in Spain, of no interest. It appears from Gautier, who uses the authority of Mag. Agricola of Aix, that when the arts began to revive in Europe an order was founded by St. Benezet, under the title of Brethren of the Bridge; and that under them was begun, in 1176, the bridge at Avignon, consisting of eighteen arches, and about 3000 feet in length. During the contentions of the Popes in 1385 some of its arches were destroyed, and in 1602 three others fell. In 1670 the ice destroyed all but the third pier, which, with the Chapel of St. Nicholas upon it, still remains. In 1354 a bridge of three arches was constructed at Verona, the roadway sloping from the city: the largest of its arches, which are segmental, is 160 feet span; but a still larger arch was built at Vielle-Brioude in France, over the Allier, in 1454, of nearly 184 feet span, which is the largest stone arch upon record. Among the most celebrated bridges of Italy, is that of the Rialto at Venice, whose span is 98½ feet. It was begun in 1588, and finished in 1591, from the designs of Antonio dal Ponte (*Sansovino's Venice*), though by most authors absurdly attributed to M. A. Buonarroti. In this city alone there are no less than 339 bridges; but they are mostly of small spans. We must not omit in this place the bridge Della Santissima Trinità at Florence, by Ammanati, which, as Milizia truly observes, has not been surpassed since the revival of architecture. It is of three arches, the middle one of 96 and the two side ones of 86 feet span, the width of the piers being 26 feet 9 inches; the breadth of the carriage and footways between the parapets is 33 feet. It has been usual for writers to call the form of the arches of this bridge cycloidal; but from our own measurements and most particular investigation, we can assert that they are not of that form. They are very slightly pointed, after the fashion of what is called the Tudor arch of this country; the point at the summit, which is extremely obtuse, being hidden by the ram's head sculptured on the key-stones. During the two last centuries, the French have advanced their bridge architecture to very great perfection; but more particularly in the latter part of the last century, in which appeared Perronet, the father of the modern system of the art, whose elegant designs have not since been improved upon either in France or any other country. His is the beautiful bridge of Neuilly over the Seine. It consists of five arches, each about 128 feet span and 32 feet rise: it was finished in 1774, and remains a splendid monument of the powers of its architect. Some of the more modern specimens of their bridges do great honour to the French school, in which beauty of form is united with sound engineering.

In England, the progress of bridge architecture has kept pace with that of the Continent; and if our bridges cannot boast the elegance in design of our lively neighbours, we are fully equal to them in boldness of conception and execution of the work. Indeed, if the designs of the late Messrs. Telford and Rennie had been equal to their engineering skill, no country in the world would have been able to compete with what we should have been able to exhibit. And here must not be forgotten the bridge over the river Taaf, near Llantrissart, in Glamorganshire, celebrated for its great span; the work of William Edwards, a country mason, in 1755. The chord line is 140 feet, and the versed sine 35 feet. As we can allow but short space for an account of the bridges which within the last eighty years have been built in this country, we must be content with the mention of that over the Thames, called the Southwark bridge, which is a stupendous exhibition of engineering skill, and far better in design than many of the other works of the late Mr. Rennie. This bridge is of cast-iron, and consists of three arches, the chord of the centre arch being 240 feet, and its versed sine 24 feet, or one tenth of its span. The frame-work of the arch at the vertex is 6 feet in height. We are not aware of any cast-iron bridge whose dimensions exceed those of this bridge, and do not think it therefore necessary to mention minor ones, of which there are many fine specimens in Great Britain.

Of timber bridges the boldest and most ingeniously constructed in Europe was that at Schaffhausen, in Switzerland, destroyed by the French in 1799. It was designed and executed by Ulric Grubenmann, a common carpenter of Tueffen, in 1758. The total length of this bridge was 364 feet, but it was relieved by a pier in the middle of the river. In America are some extraordinary specimens of timber bridges. Such is the Trenton bridge, over the Delaware, built in 1804, by Burr: its chord line is 200 feet, and its versed sine 32 feet, the height or thickness of the timber framing at the crown being only 32 inches. The bridge called the Colossus at Philadelphia, over the Schuylkill, is 340 feet span, with a versed sine or rise of only 20 feet, and the thickness of the timber at the vertex only 7 feet. It is the work of a person named Wernwag. Besides these two, there are many other timber bridges in America worthy the notice of the reader, which we regret we have not space to notice.

We shall close this portion of our subject by a short account of the suspension bridge over the Menai Strait, by the late Mr. Telford, as being the giant of its species, and rendering unnecessary any enumeration of others. It consists of one opening of 560 feet between the points of suspension, the height between high water and the under side of the roadway being 100 feet. The platform is 30 feet in breadth. The whole is suspended from four lines of strong iron cables by perpendicular rods 5 feet apart. On the tops of the pillars the cables pass over iron rollers, and are fixed under ground to iron frames, which are retained in their places by masonry. The weight of the whole bridge between the points of suspension is 489 tons. In Suspension bridges it has been found that the most trying circumstances under which they can be placed, as affecting the stability of their equilibrium, is the heavy and measured tread of a long line of infantry, whose feet drop at the same instant of time.

In the building of bridges, where piers are required in the stream for the support of the arches, it is important to place them as nearly as possible at right angles to the stream or current; and the piers should be made convex towards the stream, for their better resistance to floods. The position of a bridge moreover, should not be in a narrow part, nor one liable to swell with tides or floods, inasmuch as the contraction of the waterway increases the depth and velocity of the current, and may thus endanger the navigation as well as the bridge itself. It is usual to construct bridges with an odd number of arches, and this on several accounts; among which are, that the stream being usually most

powerful in the middle, an egress through that part is best provided for by having a central arch; and again, if the bridge be not perfectly horizontal, symmetry is gained by rising from the sides to the centre, and the whole roadway may be made one continued curve. When a bridge is equally high throughout, much saving of centering is made, because the arches being all equal two sets of centres will be sufficient. If, however, the bridge be higher in the middle than at the extremities, the arches on each side the centre one must diminish similarly, so as to be respectively symmetrical; and by this arrangement beauty is gained, and the centering for one side equally suits the other. It is desirable to construct a bridge with as few arches as circumstances will allow, that there may be a free passage for the water, as well as for the vessels that have to pass up and down, not to mention the saving of materials and labour where there are fewer piers and centres. When a single arch can be compassed, no more should be permitted. (For the mode of estimating the equilibrium of an arch, see the article ARCH.) The piers should be of sufficient solidity to resist the thrust or push of the arch, independent of other arches, so that the centering of an arch may be struck without danger of overturning the pier left naked; and the piers should also be spread as much as possible on their bases, and diminish gradually upwards from their foundations. The method of laying the foundations in a river is now usually by means of coffer-dams, which are large enclosures, made by piling round the space to be occupied by the pier, so as to render it water-tight, and then pumping out the water, and keeping the space dry till the pier is built up to the ordinary level of the water; but if the ground about be loose, this method cannot well be practised, and recourse is had to caissons, which are a species of flat-bottomed boat, in which the pier is built up to a certain height, and then sunk over the place where it is intended to remain, the bed of the river being dredged out to receive it, or piles driven on which it may lodge when the sides of the chest or caisson are knocked away In constructing the centres great care must be taken to make them incapable of bending or swerving while the arch is being turned, otherwise the form of the arch will be crippled. We here subjoin a table of some of the most celebrated bridges in Europe, chiefly in reference to their dimensions, and the relative spans and heights of their arches.

STONE BRIDGES.

Name of Bridge.	River.	Place.	Widest Arch.				Curve.	Architect.	Date.
			Span.		Height.				
			Ft.	In.	Ft.	In.			
Vielle-Brioude	Allier	Brioude	183	3	70	3	Segm. of circle	Grenier & Estone	1454
Ulm	Danube	Ulm	181	2	22	3	Segm. of circle	Wiebeking	1806
Castle Vecchio	Adige	Verona	159	10	53	3	Segm. of circle	Unknown	1354
Lavaur	Agout	Lavaur	159	10	64	8	Ellipse	Saget	1775
Claix	Drac	Grenoble	150	2	62	3	Segm. of circle	Unknown	1611
Pont y prydd	Taafe	Glamorgan	140	0	35	0	Segm. of circle	Edwards	1755
Neuilly	Seine	Near Paris	127	10	31	10	Ellipse	Perronet	1774
Mantes	Seine	Mantes	127	10	38	3	Ellipse	Hupeau & Perronet	1765
Waterloo	Thames	London	120	0	32	0	Ellipse	Rennie	1816
Tongueland		Kirkcudbright	118	0	38	0	Segm. of circle	Telford	1806
St. Esprit	Rhone	Languedoc	108	7	26	6	Segm. of circle	Unknown	1305
Munich	Isar	Munich	102	3	17	0	Segm. of circle	Wiebeking	1814
Orleans	Loire	Orleans	106	7	29	9	Ellipse	Hupeau	1760
Sarah	Liffey	Dublin	106	0	22	0	Ellipse	Stevens	1791
Montlion	Durance	Montlion	102	0	25	6	Ellipse	Delbergue-Cormont	1805
Vicenza	Bacchiglione	Vicenza	101	2	29	9	Segm. of circle	Unknown	
Blackfriars	Thames	London	100	0	41	6	Ellipse	Mylne	1771
Rialto	Canal	Venice	96	10	20	7	Segm. of circle	Ant. da Ponte	1591
Holy Trinity	Arno	Florence	95	3	14	10	Pointed	Ammanati	1569
Pont de la Concorde	Seine	Paris	93	9	9	8	Segm. of circle	Peronnet	1791
Jena	Seine	Paris	91	6	10	9	Segm. of circle	La Mandé	1815
Sisto	Tiber	Rome	83	4	41	8	Semicircle	Unknown	1474
Ponte Molle	Tiber	Rome	77	8	38	10	Semicircle	Unknown	100 B. C.
St. Maxence	Oise	St. Maxence	76	8	6	3	Segm. of circle	Perronet	1784

TIMBER BRIDGES.

Name of Bridge.	River.	Place.	Widest Arch.				Curve.	Architect.	Date.
			Span.		Height.				
			Ft.	In.	Ft.	In.			
Colossus	Schuylkill	Philadelphia	340	0	20	0	Segm. of circle	Wernwag	1813
Piscataqua	Piscataqua	N. America	250	0	27	4	Segm. of circle	Palmer	1794
Bamberg	Regnitz	Germany	208	0	17	4	Segm. of circle	Wiebeking	1809
Trenton	Delaware	Pennsylvania	200	0	32	0	Segm. of circle	Burr	1804
Writtenghen	- -	Switzerland	198	0	30	10	Segm. of circle	Grubenmann	
Pont Louis	Isar	Freysingen	154	0	13	6	Segm. of circle	Wiebeking	1809
Freysingen	Isar	Bavaria	153	0	11	6	Segm. of circle	Wiebeking	1808
Elsingen	Wertach	Elsingen	139	0	7	8	Segm. of circle	Wiebeking	1809
	Lech	Near Augsburg	114	0	8	9	Segm. of circle	Wiebeking	1808
Pont de la Cité	Seine	Paris	104	5	6	2	Segm. of circle	Dumoutier	1802

IRON BRIDGES.

Name of Bridge.	River.	Place.	Widest Arch.				Curve.	Architect.	Date.
			Span.		Height.				
			Ft.	In.	Ft.	In.			
Southwark	Thames	London	240	0	24	0	Segm. of circle	Rennie	1818
Sunderland	Wear	Sunderland	240	0	30	0	Segm. of circle	Wilson	1796
Buildwas	Severn	Buildwas	130	0	27	0	Segm. of circle	Telford	
Austerlitz	Seine	Paris	106	0	10	6	Segm. of circle	Lamandé	1806
Bristol	Avon	Bristol	100	0	15	0	Segm. of circle	Jessop	

BRI'DGING JOISTS. *See* JOISTS.

BRIEF. (Lat. brevis, *short.*) A word applied originally to a small written scroll; but it is used at present in several significations. In modern German the word brief signifies a letter.

1. In Ecclesiastical Law, letters addressed from the pope to temporal princes or communities on subjects of discipline or public affairs, are termed apostolical briefs. The name appears to have originated either in the concise formula with which they begin ("dilecto filio salutem et apostolicam benedictionem"), or in the difference that exists between this smaller kind of instrument and the ample bullæ (bulls) of the popes. Apostolical briefs are usually written upon paper, though sometimes parchment is used. They are sealed in red wax with the seal of the Fisherman (sub annulo Piscatoris), which is a symbol of St. Peter casting a net into the sea. (*Ciampini, Dissertatio de Abbrev. Munere*, cap. iii.)

2. In Law, the term brief is applied to an abridged narration of the facts of a case prepared for trial, with or without a reference to points of law involved in it, drawn up for the preliminary instruction of an advocate.

3. The term brief is applied in England to king's letters, issued to the archbishops, bishops, clergy, magistrates, and parochial officers, to authorize collections of money at the doors of the several churches and chapels throughout the country, in individual cases wherein application has been made for such assistance towards the building or repair of a particular church. This custom is supposed to have commenced after the disuse of papal briefs consequent on the Reformation. Within the last few years this practice has been dropped, and a king's letter is sent round at certain intervals to collect money for the use of the Incorporated Society for the Building of Churches generally throughout the country. The last collections were made in 1829, when something more

than 40,000*l.* was received; and in 1834, when the sum collected amounted to rather more than 30,000*l.*

BRIG. The general term for a vessel having two masts, with a boom mainsail, being otherwise square-rigged; that is, having her sails brought to yards hung horizontally by the middle.

BRIGA'DE. This term either implies the union of two or more regiments or battalions in one corps, or of a certain number of men or guns in one subdivision. A brigade of infantry may consist of from one to six battalions, and a brigade of cavalry of two or three regiments. Six pieces of ordnance form a brigade of artillery; and the horse artillery consists of twelve troops, to each of which is attached one such brigade of guns. A brigade of sappers consists of eight men. The commander of a brigade is called a brigadier-general.

BRI'GANTINE. A name often applied to a small brig of a foreign nation.

BRIGHT. (Sax. beorht.) In Painting, shining with light; a term applied to a picture in which the lights preponderate over the shadows.

BRILLA'NTE. (Ital.) In Music, prefixed to a movement, denotes that it is to be played in a gay and lively manner.

BRI'MSTONE. *See* SULPHUR.

BRI'STOL STONES, BRISTOL DIAMONDS. These are small and brilliant crystals of quartz, found in the vicinity of Bristol, and occasionally used for ornamental purposes.

BRI'TISH GUM. When starch is exposed to a temperature of about 600° it becomes of a brownish colour, and so far altered in its chemical characters as no longer to form a blue colour with iodine; it is also soluble in cold water. In this state it is used, under the above name, by calico printers.

BRO'ADCAST. Sowing seeds by casting them or scattering them abroad, so as to distribute them evenly over the entire surface of the soil, in opposition to sowing in drills or rows. The operation of sowing broadcast is generally performed by the hand, the operator carrying the seeds in a bag or sowing sheet, or in a basket. There are also machines for sowing broadcast, but they are not much in use. In general, all corns and grasses are sown broadcast; while pulse, and broad-leaved plants grown for their roots or leaves are sown in drills or rows. The term is sometimes applied to planting, but it is more generally restricted to sowing.

BRO'ADSIDE. A nautical term, signifying the discharge of the whole of the artillery on one side of a ship of war.

BRO'KEN-BACKED. A ship is said to be broken-backed when, in consequence of being loosened from age or injury, her frame droops at either end.

BRO'KEN-WINDED. A ruptured state of the air cells, chiefly on the edges of the lungs, in the horse, in consequence of which the expiration occupies more time than the inspiration of the air, and is laboriously and generally spasmodically effected. It is a disease which may admit of palliation, but not of cure; the animal becomes gradually less capable of exertion, and if urged on, he drops and dies.

BRO'KER. In Mercantile Law, a person employed about contracting for the disposal of property without being put in actual possession of it, as is the case with a factor. (*See* FACTOR.) But all agents answering to this definition are not brokers, nor has the term any very exact legal signification. Particular classes of brokers are, bill or exchange brokers, stock brokers, insurance brokers, pawnbrokers, and brokers who sell or appraise household furniture for rent. By 8 & 9 W. 3. c. 20. brokers in the city of London must be licensed by the mayor and aldermen, and grant a bond with a penalty of 500*l.* on their admission. According to mercantile usage, if goods within the city of London are sold by a broker to be paid for by a bill of exchange, the vendor, if not satisfied with the solvency of the purchaser, has a right within a reasonable time to annul the contract.

BRO'KERAGE. The per-centage paid the broker for his trouble in effecting a sale, or in negotiating any particular business.

BROME'LIA'CEÆ. (Bromelia, one of the genera.) A natural order of Endogenous plants inhabiting the tropical parts of the world, where they grow in the rich vegetable soil of forests, or upon the branches of trees, to which they cling by their twisting slender roots. They usually have hard leaves covered with a scurfiness easily rubbed off, and are so arranged as to be able to hold the water that lodges in their centre. Many of them will grow for months, and flower, when suspended in the air, after being severed from their roots. Their flowers are usually white, crimson, blue, or purple, and often exceedingly handsome. In the genus *Ananassa* the bracts and flowers are so fleshy, that they all grow together into a solid mass, and thus form the well-known fruit called the pine apple. *Tillandsia usneoides* is a curious species of this order, hanging down in long grey threads from the branches of trees in American forests, and so seldom flowering that it might be taken for some species of lichen; it is easily dried, and then used for stuffing mattresses, &c.

BROMINE. (Gr. βρωμος, *a strong odour.*) An undecompounded substance discovered in 1826 by M. Balard of Montpelier. In its general chemical habitudes it much resembles chlorine and iodine, and is generally associated with them. It exists, but in very minute quantities, in sea-water, and in the ashes of marine plants. It is usually extracted from *bittern* by the agency of chlorine. At common temperatures it is a very dark reddish liquid, of a powerful and suffocating odour, and emitting red vapour. Its specific gravity is about 3. It boils at 116°, and congeals at 4°. The density of its vapour is 5·5; 100 cubic inches at mean temperature and pressure weighing 167·25 grains. It is an electro-negative; it has bleaching powers, and it is very poisonous. Its equivalent number is about 78; it combines with hydrogen to form *hydrobromic acid gas*, 100 cubic inches of which weigh 84·7 grains. With oxygen it forms the *bromic acid.* Its combinations are termed *bromides;* they have not hitherto been applied to any use, but some of them are probably possessed of powerful medical qualities.

BRO'NCHIA. (Gr. βρογχος, *the throat.*) The smaller ramifications of the windpipe.

BRONCHI'TIS. Inflammation of the bronchia.

BRONCHOCE'LE. (Gr. βρογχος, *the throat,* and κηλη, *a tumour.*) A tumour on the fore part of the neck, being a morbid enlargement of the thyroid gland. From its prevalence in Derbyshire it is sometimes called the *Derbyshire neck*, and it is a very common disease among the inhabitants of mountainous districts, especially of the Alps. It has been attributed to some peculiarity of the water of those districts, but upon no satisfactory evidence. Iodine has lately been administered successfully in the cure of this and other glandular enlargements, but it is a medicine requiring to be used with caution.

BRONCHO'TOMY. (Gr. βρογχος, and τεμνω, *I cut.*) The operation of making an opening into the trachea in order to prevent suffocation.

BRONZE. (It. bronzo.) In Sculpture, a material used for casting statues, groups, &c., in a mould similar in principle to that wherefrom all plaister casts are produced. From the extraordinary dimensions which involve the chief differences between the operations of casting in brass and plaister, much intelligence and care on the part of the sculptor is necessary to produce the fac-simile of the work on which his labour has been expended. The material employed for the purpose is a compound chiefly consisting of copper, tin, and other metals. The process of procuring the cast depends on circumstances requiring much nice arrangement; but the reader will immediately conceive that though the difficulty of making such a mixture insinuate itself into every part of the often colossal mould is great, it is no more in reality than many of the large cast-iron foundings which are every day effected; though, from the nature of the human and other animal forms, it is difficult to conduct such an operation with any thing like a degree of certain attainment of the object without extraordinary means.

BRO'NZITE. A variety of diallage of a metallic or *bronze* colour.

BROOM. The *Spartium scoparium* or *Cytisus scoparius* of botanists, is an evergreen, green-branched shrub, native of sandy soils throughout Europe. It is sown extensively in this country as a shelter for game, and among the other plants in young plantations as a screen from the wind and a protection till the more important species can establish themselves. Its branches, which are tough, are made up into brooms, to which they have given their name.

BROWN. (Sax. brun.) In Painting, a dark dusky colour inclining towards red, of various degrees of depth, of which there are many sorts.

BROWN COAL. An imperfect kind of coal, which burns with a peculiar bituminous odour resembling that of peat. Its ligneous structure is sometimes so distinct that it has been called *bituminous wood.*

BROW'NISTS. The followers of Robert Brown, who in the year 1581 seceded from the English church, and established a sect upon the principle that every congregation should form a church independent (in matters of discipline and doctrine) of all others. In matters of doctrine he did not differ from the church; to which indeed he returned, and took preferment after some years. The Brownists underwent great persecution under Elizabeth, and retired in considerable numbers to Holland. From them, however, have sprung the Congregational Brethren and Independents, a very powerful sect in England at the present day. *See* INDEPENDENTS.

BROWN SPAR. A magnesian carbonate of lime tinged by oxide of iron and manganese.

BRU'CHUS. A Linnæan genus of Coleopterous insects, of the tribe *Rhyncophora*, now the type of a family (*Bruchidæ*), with the following characters: — upper lip distinct; head produced anteriorly into a broad flattened snout; palpi filiform; antennæ filiform or serrate; eyes notched; wing-sheaths not covering the extremity of the

body. The insects of this family deposit their eggs in the young grains or seeds of leguminous plants; the time of the hatching of the eggs is when the seeds have approached to maturity, and then the larvæ begin to feed voraciously upon them. One species, the *Bruchus granarius*, infests our peas; and the ravages of this insect, and the *Bruchus pisi*, have been so extensive as to call for legislative inteference: in France, for example in the year 1780, the sale of peas in the market was prohibited, in consequence of the damaged and unwholesome condition of those vegetables through the operations of the species of *Bruchidæ* above cited.

BRU'CIA. A vegeto-alkaloid, discovered by Pelletier and Caventou in the bark of the *Brucea antidysenterica;* and also associated in small relative proportion with *strychnia* in the nux vomica and St. Ignatius's bean. It is very bitter and poisonous.

BRU'NSWICK GREEN. A pigment obtained by exposing metallic copper to the action of muriate of ammonia. It is a compound of chloride and oxide of copper. Is is also generated by the action of sea water upon copper, as in the green matter which incrusts the copper sheathing of ships.

BRUSH. (Fr. brousse.) In Painting. *See* PENCIL.

BRU'TA. The term by which Linnæus designated an order of Mammals, including the elephant, manatee, and walrus, with the quadrupeds now forming the order *Edentata* of Cuvier.

BRYO'NIA. A bitter and somewhat poisonous principle, extracted from the root of the *Bryonia alba.*

BR'YONY. (Gr. βρυω, *I grow rapidly.*) A wild climbing plant belonging to the Cucurbitaceous order, with a large woody perennial root, and annual stems, which resemble those of a gourd, except that they are more slender, clinging to bushes by means of their twisting tendrils. The berries are scarlet, with a disagreeable odour when bruised. The leaves have five angular lobes, and are three or four inches broad, with many callous tubercles. The roots are violently purgative: they are now disused. It has been known to produce violent vomiting, tormina, profuse watery evacuations, and fainting. Cases are mentioned by Orfila and others where over doses have proved fatal. Bryonine, an active extractive principle, is among the most dangerous of vegetable poisons.

BU'BO. (Gr. βουβων, *the groin.*) A tumour very frequently occurring in the glands of the groin, and also in the arm pit. It is often the result of local absorption of irritating matter, as in venereal buboes; or is symptomatic of constitutional disease, as in the plague, scrofula, and some fevers.

BUBONO'CELE. (Gr. βουβων, *the groin*, and κηλη, *tumour.*) A rupture forming a tumour in the groin.

BU'CCANEE'RS. (Fr. boucanier, from boucan, a word of the Caraïb Indians, signifying meat preserved in a particular manner, which was adopted, together with the custom, by the French in the West Indies.) The pirates who infested the coasts of the West Indies and South America during the 17th and 18th centuries were so called. The association of these pirates is said to have commenced as early as the middle of the 16th; but in 1625 they obtained possession of St. Kitt's, and afterwards of Tobago, which thenceforward became for a long time the head quarters of the buccaneers, who formed a sort of seafaring republic, composed chiefly of English and French adventurers. Their chief object was war against the Spaniards, and plunder of their ships and settlements. After the peace of Ryswick, in 1697, they gradually disappeared from the seas. The *History of the Buccaneers of America*, by James Burney, is a well known and entertaining work. By French writers these pirates are commonly called *Flibustiers*, apparently a corruption of the English word *freebooters.*

BUCCINA'TOR. (Lat. buccina, *a trumpet.*) A muscle of the cheek called into action in various motions of the mouth, and especially in blowing a wind instrument.

BU'CCINUM. (Buccinum, *a trumpet* or *shell-fish.*) The name of a Linnæan genus of Vermes Testacea, characterized by having a shell with a smooth non-plicated columella, and with a fissure or short respiratory canal inflected towards the left. The mollusca with shells corresponding to this character are ranked amongst the Pectinibranchiate Gastropods by Cuvier, and have been subdivided into the following subgenera: —*Buccinum* proper, Brug., of which the whelk, *Buc. undatum*, is an example; *Nassa*, Lam.; *Eburna*, Lam.; *Ancillaria*, Lam.; *Dolium*, Lam.; *Perdix*, Mart.; *Harpa*, Lam.; *Purpura*, Brug.; *Monoceros*, Lam.; *Ricinula*, Lam.; *Concholepas*, Lam.; *Cassis*, Brug.; *Morio*, Montf.; *Terebra*, Brug.

BU'CCO. (Lat. bucca, *cheek.*) The name of a genus of Lygodactyle birds, called barbets. The scientific term relates to the tumefaction of the sides of the base of the bill; the trivial English name is derived from the bristly feathers which surround the base of the bill, and project beneath the chin like a beard. The genus is now the type of a family, including the barbets proper (*Bucco*), the Brazilian barbets or tamatias (*Tamatia*), and the barbicans of Buffon, which are limited to the warmer parts of India and Africa.

BUCENTAU'R. (Gr. βους, *an ox;* κενταυρος, *a centaur.*) A mythological monster, half man and half ox, as the Greek etymology of the word imports. This was also the name of the state galley of the Venetian doges, in which they annually sailed over a portion of the Adriatic on Ascension Day, and, dropping a ring into the sea, espoused it in the name of the republic, with the words, "Desponsamus te, mare, in signum veri perpetuique dominii."

BU'CEROS. (Gr. βους, *an ox*, and κερας, *a horn.*) A genus of Syndactylous Insessorial birds, remarkable for the prodigious size of the mandibles, the superior of which in some species supports a large horn-like protuberance. The birds of this genus are commonly called horn-bills; they are peculiar to the old world, and perform the same offices in wild nature as the toucans of America.

BU'CKA. A strong-smelling leaf imported from the Cape of Good Hope, and used medicinally as an antispasmodic. It is produced by *Diosma crenata* and some allied species.

BU'CKWHEAT. (A corruption of beechwheat.) A kind of grain, produced by the *Polygonum fagopyrum* of botanists. It has a triangular form, and is not unlike beechmast. In some countries it is cultivated as food for man, and even in this country its flour is said to enter into the composition of the thin cakes called crumpets; but its chief value is as food for pheasants, which are so fond of it that they may be decoyed from their preserves by its employment. It is said that some estates have been rapidly stocked with this description of game, at the expense of the neighbouring coverts, by the aid of a few fields of buckwheat.

BUCO'LICS. The Greek term for pastoral poems, meaning literally the songs of herdsmen (βουκολοι). We have considerable remains of this species of poetry in the poems of Theocritus, Bion, and Moschus, and the Eclogues of Virgil. The metre universally employed is the hexameter or heroic; but in pastoral poetry an easier flow of the lines was studied than in epics, and this was generally accomplished by introducing a larger proportion of the metrical feet called dactyls in the former than in the latter; but no rules were laid down on this point. This species of poetry has been cultivated also by most modern nations, and in England, France, and especially in Germany, with great success. Indeed, the last-mentioned country can boast among others of a Gessner, whose Idyls have been pronounced by some modern critics to be models of pastoral poetry, combining the most finished harmony of numbers with a simplicity and tenderness of sentiment and expression worthy of Theocritus himself.

BU'DDHISM. A religion which prevails over a great part of Asia; and, according to the estimates of some geographers, has a much greater number of worshippers than any other form of faith among mankind. China, the peninsula beyond the Ganges, Japan, and various Indian islands, are chiefly peopled by Buddhists. The founder of this religion, according to tradition, was an Indian prince, to whom the title of Buddha, or "The Sage," is assigned by his worshippers. The period to which his life is assigned is variously estimated, according to a variety of oriental traditions; but several of them coincide in referring it nearly to the tenth or eleventh century before Christ. Buddhism was expelled from India by the persecutions of the Brahmans, between the fifth and seventh centuries of our era. The doctrines of the Buddhists seem mainly to rest on the principle, that the world, and sensible objects contained in it, are manifestations of the Deity, but of a transient and delusive character; that the human soul is an emanation from Deity; that after death it will again be bound to matter, and subjected to the miseries and accidents of this life, unless the individual to whom it belongs by the attainment of wisdom through prayer and contemplation succeeds in liberating it from that necessity, and secures its absorption into that divine essence from which it sprang.

BU'DGET, in a general sense, means a condensed statement of the income and expenditure of a nation, or of any particular public department. In this country, however, the term is usually employed to designate the speech made by the chancellor of the exchequer when he gives a general view of the public revenue and expenditure, and intimates whether government intend to propose the imposition or repeal of any taxes, &c.

BU'FFALO. (Lat. bubalis.) A term originally applied to a species of antelope; but afterwards transferred, in the age of Martial, to different species of the ox. In modern zoology the Buffaloes, or the "Bubaline group" of the genus *Bos*, include those species which have the bony core of the horn excavated, with large cells or sinuses communicating with the cavity of the nose; the horns are flattened, and bend laterally with a backward direction, and are consequently less applicable for goring than in the Bisons,

or Taurine group of oxen: the head is large, with a narrow but convex forehead, and terminates in a broad muzzle. The Buffaloes are of large size, but low in proportion to their bulk; they have no hunch on the back, and only a small dewlap on the breast: the hide is generally black; the tail long and slender. The Buffaloes occupy the warm and tropical regions of the earth; they avoid hills, and prefer the coarse vegetation of the forest and swampy regions to those of open plains; they love to wallow and lie for hours sunk deep in water; they swim well, and cross the broadest rivers without hesitation; their gait is heavy, and they run almost always with the nose horizontal, being principally guided by the sense of smelling. In their combats, they usually strike or butt with the forehead, and when their opponent is thrown they endeavour to crush him with their knees; they trample on the body; and their vindictive fury is so lasting, that they will return again and again to glut their vengeance upon the same inanimate corpse: they herd together in small flocks, or live in pairs, but are never strictly gregarious in a wild state. The females bear calves two years following, but remain sterile the third; they propagate at four and a half years old, and discontinue after twelve. Their extreme aversion to red colours has been remarked both in India and at the Cape. The Arnee Buffalo (*Bos Arni*) is the species in which the horns attain the greatest size: there is a pair of horns in the British Museum considered by Col. Smith (from whose excellent description of the Ruminantia in the translation of the *Animal Kingdom* of Cuvier the preceding observations are chiefly derived) to be of the true or Great Arnee: each of these horns measures along the curve from base to tip, six feet three inches; circumference at the base, eighteen inches.

BUG. *See* CIMEX.

BU'GLE HORN. (From bucula, *a heifer*.) A musical wind brass instrument, latterly improved by keys, so as to be capable of all the inflexions of the scale.

BUHL. Ornamental furniture, in which tortoise-shell and various woods are inlaid with brass. The name is derived from its inventor.

BULB. (Gr. βολβος.) A collection of fleshy scales, arranged like those of a bud, of which the bulb is a slight modification, separating spontaneously from the stem to which it belongs, and emitting roots from its base. It is usually found underground, as in the hyacinth; but sometimes upon the surface of the stem in the axils of the leaves, as in the bulbiferous lily. The old botanists used to distinguish two sorts of bulbs, the tunicated and the solid: the former is the only one to which the name is now applied; the latter is the cormus, as in crocus.

BULBO'DIUM. A kind of underground stem, resembling a rhizoma.

BU'LBOGE'MMA. A name for those bulbs which grow on the stems of plants, as in the tiger lily and other species of that genus.

BU'LBOTU'BER. That kind of stem which the old botanists called a solid bulb, and the moderns more generally a cormus. It is a round solid underground stem, clothed with the withered remains of leaves, and producing buds on its surface, as in crocus.

BU'LE. (Gr. βουλη, *a council.*) By this name the Athenian senate was designated, the constitution of which was as follows:—When the people were divided into four tribes, each of these, according to the regulation of Solon, elected 100 representatives, thus making in all a deliberative body of 400 members. But when Cleisthenes increased the number of tribes to ten, the complement of the senate was raised to 500, fifty of which were sent by each tribe; when the tribes were finally increased to twelve, 100 more senators were added. All free-born Athenian citizens above thirty years of age were eligible to this office; but they were obliged to undergo a strict examination of their characters and morals. The senate was originally instituted by Solon to be a check on the assembly of the whole people (εκκλησια), before which, according to the Athenian constitution, no measures were allowed to be brought before they had first met with its approbation. *See* PRYTANES.

BULI'MIA. (Gr. βου, a syllable denoting *greatness* in compound words, and λιμος, *hunger*.) A morbid appetite for food.

BULKHEAD. The sea term for any partition, as of wood, canvass, or other material.

BULL, PAPAL. (Lat. bulla.) An instrument, ordinance, or decree of the pope, equivalent to the proclamations, edicts, letters patent, or ukases of secular princes. Bulls are written on parchment, to which a leaden seal is affixed, and are granted for the consecration of bishops, the promotion to benefices, and the celebration of jubilees, &c. The publication of papal bulls is termed fulmination; and it is done by one of three commissioners, to whom they are usually addressed. The bull is thus described by Matthew Paris:—Anno Dom. 1257. In bulla domini Papæ stat imago Pauli a dextris crucis in medio bullæ figurata, et Petri a sinistris.

BULL, GOLDEN. In German History, a term applied particularly to a statute or enactment of the emperor Charles IV., published A. D. 1356, in two diets held in succession at Nurimberg and Metz, for the purpose of fixing the laws in the election of the emperor, and of regulating the number and privileges of the electors. (Churfürsten.) The original copy of this instrument (which was long regarded as the Magna Charta of the German Empire, and continued in operation till its dissolution in 1806) is preserved at Frankfort on the Maine, and has a seal of gold appendant; whence the appellation Golden Bull is derived.

BU'LLA. (Lat.) A stud or boss, but more particularly an ornament in the shape of a heart, worn round the neck by noble Roman children till they were seventeen years old; when they assumed the manly dress of the toga, and suspended the bulla as a consecrated offering to the *lares* or household gods.

BU'LLA. (Lat. bulla, *a bubble*.) A genus of Acerous Gastropodous Mollusks, the shell of which is more or less globose, or inflated like a bubble; having no visible or projecting spire, which is concealed by the large external whorl, which is elevated above the rest. The columella makes a convex prominence, which gives a crescentic form to the aperture of the shell; the animal breathes by gills, but has no respiratory tube or siphon, and consequently the margin of the aperture of the shell is entire, or without a fissure or canal. All the species of bulla are remarkable for a shelly apparatus of three pieces which converts the stomach into a gizzard or triturating cavity. These gastric calcareous pieces have been described as a bivalve shell of a new genus.

BU'LLETIN. (Mod. Lat. bulleta.) In Diplomatics, a term equivalent to schedule, and variously applied to different sorts of public acts. In modern times, this name has been applied, especially in France, to reports of a state of facts issued by authority; as bulletins of health, bulletins of military events, &c.

BU'LLION. Uncoined gold and silver.

BULL'S EYE. In Architecture, a small circular opening or window.

BULL'S NOSE. In Architecture, the external angle of a polygon, or of two lines which meet at an obtuse angle.

BU'MBOAT. A boat allowed to attend a ship regularly to supply the sailors with articles of provisions, clothing, &c.

BUOYS. Vessels formed of wood, cork, or some light substance, moored or anchored so as to float over a certain spot, in order to indicate the situation of a shoal or sand bank, and mark out the course a ship is to follow. When used for this purpose, buoys are usually close vessels in the form of a cone, of large dimensions, in order that they may be seen from a distance; and generally painted of some particular colour, in order that they may be more readily distinguished from one another. Public buoys in this country are placed by warrant of Queen Elizabeth under the management of the Corporation of the Trinity House, and the amount of revenue annually collected for their use is between 11,000*l.* and 12,000*l.* Private buoys are used for the purpose of indicating the situation of ships' anchors (to which they are fastened by a rope), in order that the ship may be prevented from running foul of the anchor, and that the anchor and cable may be recovered when the latter happens to be broken, or has been cut.

BU'PHAGA. (Gr. βους, *ox*; φαγω, *I eat*.) A genus of Conirostral Passerine birds, of which the African beef-eater (*Buphaga Africana*) is the sole example. It derives its name from its habit of sedulously extracting from the backs of cattle the larvæ of æstri and other Dipterous insects which are deposited therein. The French name of this bird, "pique-bœuf," or "cattle-picker," more correctly denotes the peculiar habits of the bird than the scientific generic term.

BUPRE'STIS. (Lat. buprestis, *a noxious insect*.) The name of a Linnæan genus of Coleopterous Serricorn insects, now the type of a family (*Buprestidæ*), including the most splendid and brilliant beetles. Of this family upwards of a thousand species are known: by the French they are termed "Nichards."

BU'RDEN. (Fr. bourdon, *a staff*.) In Music, the drone or bass in some musical instruments, and the pipe or string that plays it. The bass pipe in the bagpipe is so called. Hence, that part of a song that is repeated at the end of every stanza is called the burden of it.

BUREAU'. (Fr.) Originally a writing table; afterwards applied to the office of any public or private functionary where business is transacted.

BUREAU'CRATIE, or BUREAUCRACY, is the system by which the business of administration is carried on in departments, each under the control of a chief, in contradistinction to those systems in which the officers of government have a co-ordinate authority.

BURE'TTE. An instrument occasionally used in the chemical laboratory, and in the assay office, for the purpose of dividing a given portion of any liquid into 100

or 1000 equal parts. (*Gay Lussac*, *Instruction sur l'Essai des Chlorures de Chaux.*)

BU'RGAGE TENURE. In Law, an ancient tenure proper to boroughs; under which tenements are held of the king, or other person, at a rent certain. In several boroughs such holdings conferred the electoral franchise previous to the Reform Act.

BU'RG-GRAVE. (Germ. burg, *castle;* graf, *count.*) In the German Empire, a castellan or lord of a castle, having the right of private justice, imposing taxes, &c.

BU'RGHERS and ANTIBURGHERS. In Ecclesiastical History. Owing to an undue exercise of patronage, which took place under the authority of the church of Scotland, or to the induction of a clergyman into a parish (Kinross) against the declared sentiments of the congregation, a schism took place in the church, which occasioned a secession from that establishment, and ultimately led to what is called the Burgher and Antiburgher denominations. Several clergymen, after years of painful discussion, having protested against the violent procedure in question, and having thrown off subordination to the ecclesiastical authorities, were deposed (1740) from the office of the ministry and their parishes declared vacant. (*Gillan's Acts of Assembly*, sect. *Patronage.*) These clergymen, eight in number, though cut off from all connection with the church, enjoyed the unabated confidence of their respective congregations, who almost to a man adhered to them. Previously to their final separation from the establishment, namely, in 1733, four of that number had virtually proclaimed their independence, and had constituted themselves into an ecclesiastical court, called the *Associate Synod.* To the deposed ministers and their adherents the name of *Seceders* was applied; and hence the origin of the *Secession Church* in Scotland. And so rapidly did this body increase, that so early as 1745, they formed themselves into a synod, which consisted of three different presbyteries. But while their numbers were thus augmented, and while the sphere of their influence was rapidly extending, a breach took place among themselves, which was characterized by as much agitation and violence as that which had recently caused their ejection from the established church. The Secession Synod having instituted an inquiry into the lawfulness of certain oaths, not imposed by parliament, but generally practised, a question arose as to the nature of the oath imposed in royal burghs on persons when admitted to the privileges of a burgess. The great point of debate was, whether it was lawful for a Seceder to swear the following clause: — "I profess and allow with my heart the true religion presently professed within this realm, and authorized by the laws thereof. I shall abide thereat, and defend the same to my life's end, renouncing the Roman religion called Papistry." The Synod was divided into two parties on this subject. The one contended, that though they had condemned the manner in which the established church was at present administered, they had not expressed and did not feel any objection to her standards; that, in seceding, they had not set up a new religion, but that, on the contrary, they had merely endeavoured to maintain in their original strictness and purity her constitutional principles both theological and ecclesiastical. The other party took a totally different view of the question, and insisted that the oath, being administered by members of the established church, must necessarily be taken in the sense in which it was understood by them; namely, as including all the corruption and inconsistencies that attached to that establishment, and as consequently incompatible with Seceding principles and the solemn testimony they had raised against her errors and backsliding. This dispute, which commenced at the meeting of the Synod in 1745, continued to be maintained with increasing acrimony for two years, or till 1747. The party that were in favour of the oath were called *Burghers;* the party that opposed it were termed *Antiburghers.* In vain did the Burghers offer to agree to a declaration discharging Seceders from swearing the oath as inexpedient under existing circumstances. The Antiburghers peremptorily refused any compromise, and insisted on an act being passed by the Synod declaring it sinful for a Seceder to adopt the oath. Nay, to such an extent was the controversy carried, and so violent were the opinions entertained on the side of the Antiburghers, that the ministers of this party had meanwhile made the oath a test of church communion, and had debarred from the Lord's Table such as maintained its lawfulness. At the spring meeting of the Synod in 1746, the party just named succeeded in carrying a vote to the effect that the oath was subversive of Secession principles. The Burghers protested against this decision. But at a meeting of the Synod in the subsequent year, the Antiburghers, being in a minority in a division on the same subject, withdrew in a body; Mr. Mair, one of their number, having previously protested that "hereby the Burghers had forfeited all their synodical powers, and that the whole power of the Synod devolved on himself and his party and such as clave to them." Next day, the Antiburghers held a synod composed exclusively of their own adherents, twenty-two in number, including ministers and elders, constituted themselves into a distinct and separate sect of Christians, and refused all connection or conference with the opposite party, except on the condition that the latter should appear as penitents at their bar. Nay, they libelled and cited them to this effect; but as the one party did not recognize themselves as responsible to the other, nothing resulted from the step; and the two bodies, followed by their respective congregations, constituted themselves into separate and independent churches. (*Brown's Hist. Acc. of the Rise and Progress of the Secession.*)

But, while the Secession was thus divided into two conflicting parties, the Burghers and Antiburghers, they both continued their separation from, and condemnation of, the established church. They adopted, it is true, her standards, namely, the Westminster Confession of Faith, the Catechism, Larger and Shorter, the Directory for Public Worship, and form of Presbyterian government; but they abrogated patronage unconditionally, and vested the choice of a minister exclusively in the members of each separate congregation. Indeed, the chief practical difference that obtained between the church of Scotland and the Seceding bodies consisted in the one cleaving to patronage, and in the other having abolished that system, and introduced popular election in its stead. Besides, though the church has always been governed by kirk sessions, presbyteries, synods, and a general assembly, the Burghers and Antiburghers, owing to the comparative paucity of their numbers, never adopted a general assembly. With them the synod was the supreme court, whose authority was final in all religious and ecclesiastical matters. The Seceders also were stricter Calvinists, and adopted more rigid discipline as to admission to church-membership, and to *sealing ordinances* (baptism and the Lord's Supper), than the church party had perhaps ever done. (*Ib.*)

Both the Burghers and Antiburghers continued each as rapidly to increase after their separation as the Secession had done when it formed one body; and the animosity which had characterized their disjunction gradually subsided. Indeed, by the time that the generation which witnessed this unhappy schism had passed away, all traces of hostility or opposition had disappeared. The burgess oath, too, which had been the cause of their disunion, fell into desuetude or had ceased to be imposed. The views of the two parties being otherwise identical, and both coinciding in their opposition to the established church, it is not to be wondered at that a wish became general among the members of both parties for a re-union. Overtures to that effect were accordingly made by their respective synods; and after having had many conferences and much discussion on the subject, this happy result was, without any compromise on either side, effected in 1820; and the two bodies, now united, assumed the denomination of the *United Associate Synod of the Secession Church.* At that time, the Burgher persuasion comprehended 10 presbyteries, embracing 120 congregations; and the Antiburghers 11 presbyteries, consisting of 141 congregations. Since their union, their conjoint influence and extension have been considerably on the increase; so that at this date (1841) the Associate Synod comprises no fewer than 360 congregations, with an equal number of ministers. They have not hitherto introduced a general assembly; nor do we hear that they intend to do so. But as they form a numerous, so they are a most respectable body of Christians; and their clergy are eminent not more for professional assiduity than for learning and talents. They are hostile to the establishment of a national church, and are in favour of what is now denominated voluntaryism. They nominate professors of divinity within their own body for the instruction of young men intended for the ministry; but these young men pursue their philosophical and literary studies at any of the Scottish Universities. Their curriculum of study, like that of the established church, extends to eight years. (*M'Culloch's Stat. Acc. of the British Empire*, vol. ii. pp. 425—7.)

BURGH MOTE. (Borough meeting.) A Saxon term for the borough court. *Bergh mote* is the title of a court of miners, held in Derbyshire.

BU'RGLARY. (Lat. burgi latrocinium, *robbery committed in a burg or fenced place.*) In Law, is the breaking and entering the dwelling-house of another in the night time, with intent to commit a felony. If the goods were actually stolen, it is usual to add a count for larceny in an indictment for burglary. This offence is punishable by transportation or imprisonment.

BU'RGOMASTER. (Germ. burgermeister, *chief of the citizens.*) The usual title of the chief municipal officer in German and Dutch towns. In the German free cities, the president of the executive council is styled burgermeister; but in many towns of importance, the title stadt-director (town-governor) has been recently substituted in its stead.

BURLE'SQUE. (Ital. burlare, *to jest.*) The Italian poesia burlesca signifies merely comic or sportive poetry;

but the term, in French and English, is more commonly restricted to compositions of which the humour consists in a ludicrous mixture of things high and low: as high thoughts clothed in low expressions; or, vice versâ, ordinary or base topics invested in the artificial dignity of poetic diction. The humour of parody or travestie (*see* PARODY) arises from the burlesque. *Burletta*, a slight comic musical drama, is derived from the same origin.

BU′RNET. A British plant, whose leaves have been used as a food for sheep. It grows on poor calcareous soils, where few other plants will succeed; and in this its principal value consists, together with its being perennial and remaining green all the winter. It is the *Poterium sanguisorba* of botanists.

BURNING GLASSES and BURNING MIRRORS. The name given to glasses or mirrors so formed as to collect the sun's rays which fall on them into a point or small surface, and thereby produce an intense heat, and set fire to combustible substances. The point at which the rays meet, and where the greatest heat is produced, is called the *focus* or *burning point*. The rays of light or heat may be concentrated either by refraction or reflection: in the former case they must pass through a transparent refracting substance, as glass formed into a proper shape; in the latter they fall on a concave polished surface of silvered glass or bright metal. Reflectors made of glass are usually termed mirrors, those of metal *speculæ*.

In preparing a burning glass, the first thing to be considered is the figure necessary to collect all the rays into the smallest possible space. Descartes, in his *Optics*, showed that a disk of glass, convex on the one side and concave on the other, the convex side being a portion of an elliptic surface, and the concave a portion of a sphere, would cause parallel rays falling on its convex side to converge in a single point; but the practical difficulties of forming a glass accurately into this shape are insuperable: both sides are therefore ground into portions of a sphere. In a refracting mirror the focal length depends on the curvature, or the radius of the sphere, and the refractive power of the substance of which the lens is formed; the focal length in a double convex lens of glass is exactly equal to the radius of curvature. The true form of the reflecting mirror is parabolic, and this form is frequently attempted in metal, which can be cast or hammered nearly into the proper shape; but, as in the case of the refractor, it is the spherical form only which is attempted in glass. The focal distance is equal to the radius of the concavity at the centre of the mirror.

Although the forms given by theory could be obtained in practice with mathematical precision, the solar rays could not even then be collected into a single point; the focus would still have a sensible magnitude. The reason of this is, that the rays which fall on the lens or mirror are not all parallel. Those which come from different parts of the sun's disk are very sensibly convergent, forming an angle of 32 minutes of a degree, equal to the apparent diameter of the sun. Hence the focal image must be of such a magnitude that lines drawn from its opposite edges to the centre of the lens or mirror must form an angle of 32′. Supposing, therefore, the glass or mirror to have a proper form, the space covered by the focus will be proportional only to the focal distance, and entirely independent of the magnitude of the lens or mirror. Hence it follows, that if a portion of the exterior edge of the lens or mirror were covered, the magnitude of the focal image would remain unaltered. The figure of the image is also always circular, independently of the shape of the lens; for example, if one half of the lens were covered, the image would be round as before, though the intensity of the light would then be reduced to one half.

In preparing telescopes or microscopes, where distinctness of vision is the most essential object, it is indispensable that the figure of the lens or mirror be perfectly true. In burning glasses perfect accuracy of figure is not so much required: it is only necessary that the rays be concentrated, the confusion of the image being of no consequence. The effect, however, depending on the number of rays that are brought within the limits of the focus, will necessarily be diminished by the aberration as well as imperfection of figure. When the lens is accurately constructed, and all the rays fall within the focus, the heating power of the solar rays is increased in the proportion of the square of the diameter of the lens to the square of the diameter of the focus. But it is found that, supposing the concentration the same, a much greater effect is produced by a focus of considerable magnitude than a very small one. A glass, for instance, of two inches diameter, with a concentrating power of 300, will produce a much feebler effect than another six inches diameter of the same power; the latter will inflame paper in two or three seconds, while the former will hardly inflame it at all. The reason is that when the heat is concentrated in a very small space it is rapidly dispersed into the surrounding mass; as the focus is increased the accumulation increases in a greater ratio than the dispersion, and the temperature rises. Hence a body in a mass of charcoal, or other substance of very slow conducting power, is fused much more readily than when exposed on all sides to the atmosphere, or imbedded in metal.

The method of exciting heat or producing fire by the concentration of the sun's rays was known from remote antiquity; but the most famous recorded achievement of this kind is that of Archimedes, who is reported to have burned by means of mirrors the Roman fleet in the harbour of Syracuse. Considerable doubts have prevailed respecting the truth of the relation, chiefly grounded on the circumstance that although the setting fire to the fleet is positively affirmed by Dion, Diodorus Siculus, Pappus, and others, no mention is made of it by Livy, Polybius, or Plutarch, who are otherwise minute in detailing the mechanical contrivances of Archimedes, and who were not likely to pass over so notable an occurrence without notice. Descartes went so far, indeed, as to treat the whole relation as fabulous, affirming the thing to be impracticable. Its practicability was, however, experimentally demonstrated by the celebrated Buffon, who, by a combination of plane reflecting mirrors, produced results which must be regarded as of still greater difficulty. With 168 mirrors, each about 6 inches square, he set fire to planks of beech 150 feet distance, and with the faint rays of the sun at Paris in the month of March. It is not necessary to suppose that Archimedes could not place his apparatus within that distance of the fleet of Marcellus; besides, by multiplying the number of glasses, the concentration of the rays may be increased almost to any extent. All this, however, does not prove the actual fact related of Archimedes. Buffon, with all the resources afforded by the advanced state of the arts in the middle of the 18th century, and after a number of experiments, succeeded, with considerable difficulty, in constructing an apparatus by means of which he could inflame combustible substances at a considerable distance. The low state of the arts in the time of Archimedes must have rendered the undertaking considerably more difficult. The silence of those historians who have detailed his other mechanical contrivances can hardly be accounted for, supposing the relation to be true. It seems, therefore, that though something of the kind was contemplated, and to a certain extent practised, the effect has been much exaggerated.

Among those who have amused themselves, in modern times, with the effects of burning glasses or mirrors, are reckoned Baron Napier, the illustrious inventor of the logarithms, Kircher, Dr. James Gregory, Sir Isaac Newton, and numerous others. The most powerful solid lens ever constructed was the work of Mr. Parker, an ingenious London artist. It was made of flint glass, was 3 feet in diameter, 3¼ inches thick at the centre, its focal distance 6 feet 8 inches, the diameter of the burning focus 1 inch, and its weight 212 pounds. The rays refracted by this lens were received on a second, the diameter of which in the frame was 13 inches, and its focal length 29 inches. The diameter of the focus of the combined lenses was half an inch; consequently, by the addition of the second lens, the burning power was increased four times. With this lens some of the most refractory substances were fused in a very short space of time: for example, 10 grs. of common slate in 2 seconds; 10 grs. of cast iron in 3 sec.; 10 grs. of lava in 7 sec.; 10 grs. of jasper in 25 seconds, &c. This glass was afterwards carried to China by one of the officers who accompanied Lord Macartney, and left at Pekin. (For detailed information on this subject, the reader may consult the article BURNING GLASSES in the *Ency. Brit.* 7th edition.)

BU′RSARS. (Lat. bursa.) Originally clerks or treasurers in convents: in more modern times, persons enabled to prosecute their studies at a university by means of funds derived from endowments. It is a singular circumstance that the latter acceptation of this term originated among the Poles, who, even in the 14th century, were accustomed to supply young men of talent with the means of travelling to Germany, and there studying philosophy under the guidance of the monks. This practice was soon adopted by other nations; and, there is now perhaps, no civilised country in which it does not exist, under the name of bursaries, fellowships, exhibitions, scholarships, &c. These endowments are of two kinds: either furnishing the student with the means of prosecuting his studies during the academical curriculum; or enabling him to devote himself, without distraction, to literary pursuits even after the expiration of this period. The Scottish and the Continental universities have adopted the former method; but at Oxford and Cambridge both kinds prevail. The following statistical observations on this subject, in reference to the principal universities of England and Ireland, are extracted from a paper compiled by the Rev. H. L. Jones, M. A., from the most authentic private as well as public documents, and read at Newcastle in August 1838, before the British Association for the Advancement of Science: — In Oxford

there are 24 heads of colleges with a revenue of 18,350*l.*; 557 fellows with 116,560*l.*; 393 scholarships with 6,030*l.*; 199 college officers with 15,650*l.*; 885 benefices and incumbents with 136,500*l.* The revenues of Cambridge, containing 17 colleges, are for an equal number of heads 12,650*l.*; 431 fellows, whose revenue is 90,330*l.*; 793 scholarships with 13,390*l.*; 179 college officers with 17,750*l.*; 252 prizes of the value of 1,038*l.*; 591 benefices and incumbents with 93,300*l.* In Dublin the head of Trinity College receives 2,000*l.*; 25 fellows, 25,400*l.*; 70 scholars, 2,100*l.*; 10 college officers, 20,000*l.*; 62 benefices and incumbents, 9,300*l.* These honours, however, are not open to general competition, being restricted in most cases, by the will of the testator, to natives of certain countries, or to the alumni of particular schools.

At Edinburgh University there are but few bursaries. George Heriot's Hospital (the most wealthy institution in Edinburgh) grants ten bursaries of 20*l.* per annum each, for four years, to individuals not connected with the hospital, who, after a comparative trial before a committee of the governors of the institution, are found duly qualified. There are, besides, a few bursaries of 7*l.* and 10*l.* each, given by the city of Edinburgh to students in the first year of their academical course; two of 10*l.* each to students named Stewart in the second year, and one of 100*l.* to a student selected from those called M'Pherson in the fourth year. To these may be added two ancient bursaries instituted for the benefit of Poles resident in Scotland, which, after lying dormant upwards of a century, were discovered and brought to light in 1837. At St. Andrews, there are several bursaries in the gift of the university; and at Aberdeen, besides the interest of 7000*l.* devoted to the maintenance of certain students at that university, there are a few valuable exhibitions to Cambridge. At Glasgow the most important endowments of this kind are a few exhibitions to Oxford; and those left by Dr. Williamson for Englishmen not connected with the established church. In France and Italy there are no bursaries allowed for the maintenance of students; but any individual, on the payment of a trifling sum, may frequent all the lecture rooms of the professors, who of course are maintained by government.

But it is in Germany that the system of bursaries is in full vigour. There every faculty in the different universities, every public academy, every cloister (for cloisters are still maintained even in the Protestant parts of Germany, though not for the education of priests), every noble family of importance, have bursaries, or, as they are called, Freytische (free tables), at their disposal. These vary in value from 10*l.* to 40*l.* a year, and cease at the expiration of the literary curriculum. As the different bodies or individuals in whom the presentation to these emoluments is vested may select the beneficiary at pleasure, little regard is paid to the real merit or the necessitous condition of the latter.

Whether endowments tend to the promotion of science and learning, is a question that is often discussed, but has not hitherto been solved. Those who maintain that endowments are prejudicial found their arguments on the well-known axiom of Smith, — that in no employment ought the competition to be increased beyond what it naturally demands. Now, as endowments allure into the learned professions, and particularly into the church, a host of individuals who would otherwise have adopted a different occupation, the unavoidable consequence is that the market is glutted, and the supply becomes greater than the demand. Besides, there are and ever will be sufficient numbers to work of their own accord in the accumulation of learning, and this spontaneous industry will be sufficient to keep up an adequate supply to be distributed throughout the country; for supply always equals demand, and demand is always commensurate with the real wants of the people. On the other hand, the advocates of endowments, while they admit the correctness of the above-mentioned axiom as a general rule, maintain that there are many exceptions. In every scientific occupation, they allege, the profits should be proportioned to the time and the labour bestowed in its prosecution. Now, from abstruse studies, such as the higher branches of mathematics, metaphysics, and classical literature, no adequate remuneration results; so that none but the wealthy can pursue these studies, and a reference to history will prove that this class has not been the foremost in classical or scientific attainment. Hence external encouragement is necessary at once to compensate for that want of remuneration to which such studies are exposed, and to divert into this channel a mass of applicable talent which would otherwise be turned to pursuits of more immediate profit and attraction.

BU'RSCHE. (Germ.) A youth, especially a student at a university.

BU'RSCHENSCHAFT. A league or secret association of students, formed in 1815, for the purpose, as was asserted, of the political regeneration of Germany, and suppressed, at least in name, by the exertions of the governments.

BURSCHEN COMMENT. The code of laws adopted by the students for the regulation of their demeanour amongst themselves, &c.

BURSERA'CEA. A natural order of fragrant trees and shrubs inhabiting the tropical parts of the world. They all are resinous and fragrant, although related botanically to Rhamnaceous plants which have no such properties. Indian frankincense, olibanum, colophon, the balsams of Acouchi, Gilead, and Mican, gum elim, and other similar substances, are obtained from plants of this order; besides oil, pitch, and turpentine, resembling the vegetable secretions bearing those names in Europe. They all have alternate unequally pinnate dotless leaves, and racemes or panicles of small green flowers. Their fruit is usually a drupe.

BURTHEN, or BURDEN, OF A SHIP. The weight of merchandise, &c. she is intended to carry. *See* TONNAGE.

BU'SHEL. An English measure of capacity, containing 8 gallons. By act of parliament, 5 George 4. c. 74., the Imperial gallon is declared the standard measure of capacity, and is directed to be made such as to contain 10 lbs. avoirdupois of distilled water, weighed in air at the temperature of 62° of Fahrenheit's thermometer, the barometer standing at 30 inches; or to contain 277 cubic inches and 274 thousandth parts of a cubic inch. Consequently the Imperial bushel contains 80 lbs. of distilled water, or 2218·192 cubic inches.

By the same act the bushel is declared the standard measure of capacity for *coals, culm, lime, fish, potatoes*, or *fruit*, and all other goods or things commonly sold by heaped measure, and is prescribed to contain 2815 cubic inches; the goods to be heaped up in the form of a cone to a height above the rim of the measure of at least three fourths of its depth.

The Winchester bushel, used in this country from the time of Henry VII. to 1826, contained 2150.42 cubic inches. The Imperial bushel is therefore to the Winchester bushel as 2218·192 to 2150·42, or as 1 to ·969447. Hence to convert Winchester bushels into Imperial, multiply by ·969447. *See* MEASURES.

BU'SHMEN. (Dutch, Bosjesmannen, *men of the wood.*) A name given by the Dutch colonists to some roaming tribes akin to the Hottentots, in the vicinity of the Cape of Good Hope. The description given by Governor Janssens of this people is very interesting. So deep are they sunk in barbarism as to be unacquainted even with the construction of huts or tents: "the burning sky being their canopy, and the scorching sand their bed." They are of a dark copper complexion, small in stature, and of a singularly malicious, wild, and intractable disposition.

BUSI'RIS. In Egyptian Mythology, a fabulous personage, of whose origin, exploits, and character Apollodorus, Herodotus, Diodorus Siculus, and other ancient writers have given a most discrepant account. His history is so intimately blended with that of Osiris, that we must refer the reader to that article for further particulars.

BU'SKIN. (Probably bootikin, or *little boot.*) A species of covering for the leg, or rather for the ancle and foot: generally used by English writers as a translation of cothurnus, caliga, and various other Greek and Latin words denoting different kinds of boots, &c. Hence *buskin*, in the sense of *cothurnus*, stands for the tragic drama, that species of dress having been worn in antiquity by tragic actors, in contradistinction to *soccus*, the boot or sock worn by comedians, and used for the comic drama.

> Great Fletcher never treads in *buskins* here,
> Nor greater Jonson dares in *socks* appear.
>
> DRYDEN.

BUST or BUSTO. (It. busto.) In Painting and Sculpture, the head, breast, and shoulders of the human figure.

BU'STARD. *See* OTIS.

BU'TTER. (Gr. βουτυρον, from βους, *a cow*, and τυρος, *cheese* or *coagulum.*) The oily part of milk: 100 parts of cream contain about 4·5 of butter and 3·5 curd; they are separated by the process of churning, during which the butter aggregates. Butter soon becomes sour and rancid, unless purified by melting and straining it so as to separate adhering curd; it is generally preserved by the addition of salt. Its *elain* or oily part has been called *butyrine.* When converted into soap it is said, in addition to the usual products, to afford three odorous volatile compounds, which have been termed by Chevreul the *butyric, capric*, and *caproic acids.*

BU'TTERFLY. The common English name of an extensive group of insects, as they appear in their last and fully developed state, when they constitute the most beautiful and elegant examples of their class. These insects belong to the order *Lepidoptera*, and to the section *Diurna* of Latreille, or the genus *Papilio* of Linnæus. (See those words.)

The changes of an animal form produced by the progressive expansion of the inclosed organs of the body,

and the successive shedding of the outer case or skin, are in no instances so striking or so extraordinary as in the present group of insects. These changes or metamorphoses, as they are commonly but incorrectly termed, have been a favourite theme to the divine and the poet, and a most attractive subject of research to the naturalist. The transition of the humble grub to the gorgeous imago is the subject of the following beautiful passage in the classical work (the *Introduction to Entomology*) of Kirby and Spence: — "Were a naturalist to announce to the world the discovery of an animal which for the first two years of its life existed in the form of a serpent; which then, penetrating into the earth, and weaving a shroud of pure silk of the finest texture, contracted itself within this covering into a body without external mouth or limbs, and resembling more than any thing else an Egyptian mummy; and which, lastly, after remaining in this state, without food and without motion, for three years longer, should at the end of that period burst its silken cerements, struggle through its earthy covering, and start into day a winged bird, — what, think you, would be the sensation excited by this piece of intelligence?" The subterraneous locality of the insect in its passive state, and the silken shroud, are, indeed, less applicable to the butterflies than to other insects; but the circumstances attending the transformations of these beautiful objects are not less remarkable than those of the beetles and moths.

The eggs of the butterfly are deposited on such plants as afford the nutriment most appropriate to the caterpillars that are to be excluded from them; thus the common white butterfly (*Pieris brassicæ*, Latr.) and other species oviposit upon cabbages, and hence have been termed *Brassicariæ:* the gaudy peacock-butterfly lays her eggs upon the nettle. The eggs are coated with a glutinous secretion as they are excluded from the parent, and thus provided with the means of adhesion to the leaves or stems of the plants selected.

The larvæ are long and cylindrical, and consist of thirteen segments, including the head; they have eight feet, and nine spiracles on each side. Those feet which are attached in pairs to the first three segments of the trunk inclose the parts which are developed into the permanent legs of the future butterfly; the remaining five pairs of feet are membranous, short and thick, and are finally lost with the moultings of the skin, whence they are called "pro-legs" by Kirby. The sides of the head are studded with twelve simple globular eyes, extremely minute, and very unlike the single large compound eye of the perfect insect. The mouth is provided with an apparatus characteristic of the mandibulate class of insects, having a pair of large and strong horny jaws working in a horizontal plane, and representing the "mandibulæ;" beneath these a pair of smaller and softer jaws or "maxillæ," and a fleshy lower lip or "labrum" united to the latter, and which is perforated by the outlets of the ducts of the complicated apparatus for secreting the silk. Such a condition of the "instrumenta cibaria" or mechanism of the mouth is in perfect harmony with the habits of the caterpillar, and with the part assigned to this larva or masked Lepidopterous insect in the great theatre of nature. It is there destined to crop and devour the solid succulent parts of the otherwise too luxuriant vegetation, and must have aws amd teeth to perform its task. In its subsequent and final character the butterfly luxuriates on the exquisitely elaborated juices of the flower, and has the power to raise itself above the dull earth, and to transport itself through aërial space.

> Where he arriving round about doth fly
> From bed to bed, from one to other border;
> And takes survey, with curious busy eye,
> Of every flower and herb there set in order.
> Now this, now that, he tasteth tenderly,
> Yet none of them he rudely does disorder;
> Ne with his feet their silken leaves deface,
> But pastures on the pleasure of each space.
>
> SPENSER.

But to exchange a solid for a fluid diet, the instruments of mastication must be converted into those of suction, and the mandibulate insect be transformed into the haustellate one. This is effected by an excessive elongation of the maxillæ, which are grooved each on that side which is turned towards its fellow; and, by the union of their opposed margins, these grooves are converted into a capillary canal, by which the nectar is pumped up into the mouth. When not in action, this siphon is coiled up in a series of spiral turns, and is protected by the other parts of the mouth, which retain their rudimental condition. The nymphs are almost always naked, and of an angular form; they are generally suspended by the tail, and reflect more or less of a golden lustre, whence they are termed *chrysalides* and *aureliæ*. Reaumur has given the best account of the singular operations by which the butterflies attach their aurelian cases to the points of suspension, and afterwards extricate themselves from these cases when their transformation is completed.

Some butterflies have all their six feet in the imago state well developed, and alike in both sexes; and the chrysalis, in addition to the ordinary terminal or posterior attachment, is looped up in a horizontal position by a silken band or sling passing round the body. The internal margin of the hinder lower pair of wings is concave or folded, and the tarsal hooks or spurs are well developed. These are the butterflies proper, the *Papiliones equites* of Linnæus. Those "knights" which bear red spots on the chest are the "Trojans" of Linnæus, and those without red spots on the chest bear the name of the Grecian heroes. Some of these butterfly-knights have the anterior pair of feet remarkably shorter than the others; and this arrest of development would seem to be compensated by greater powers of flight. The butterflies of the section thus characterized, or the *Nymphalidæ*, are also remarkable for the brilliancy of their colouring. Numerous other sections and subdivisions have been founded by modern entomologists upon characters afforded by modifications of the antennæ, palpi, and other parts. In the "Plebeian" butterflies of Linnæus the larvæ are oval, the chrysalides short, and the tarsal spurs of the imago are extremely small.

BU'TTER TREE. A remarkable plant found by Park in the interior of Africa, especially in Bambarra, yielding from its kernels, by pressure, a white, firm, rich butter, which, even in that climate, will keep well for a year without salt. Another species is the Phulwara tree of India (*Bassia butyracca*), whose seeds produce a firm, agreeable, buttery substance, of about the consistence and colour of hog's lard; it is used medicinally in rheumatic affections. The Illupie tree of Coromandel (*Bassia longifolia*), and the Madhuca tree of Bengal (*Bassia latifolia*), are other species having similar properties. They are large tropical trees, belonging to the natural order *Sapotaceæ*, and their timber is sometimes of excellent quality.

BU'TTERS, MINERAL. A name given by the old chemists to some of the *chlorides* on account of their soft butyraceous texture when recently prepared; such as *butter of antimony, of arsenic*, and *of bismuth.*

BU'TTERS, VEGETABLE. The concrete fixed oils, such as those of the cocoa and chocolate nuts, of the nutmeg, &c., which are solid at common temperatures, are often distinguished by the above term.

BU'TTON. The round mass of metal collected at the bottom of a crucible after fusion, or which remains in the cupel in the process of assaying, is called by this name.

BU'TTRESS. (Fr. aboutir, *to lie out.*) In Architecture, a mass of brickwork or masonry, built to resist the horizontal thrust of another mass. Buttresses are much used in Gothic architecture, to resist the thrust of the vaulting which covers the naves and aisles of cathedrals. When open they are called flying buttresses.

BUTTS. Short ridges of different lengths, which necessarily occur in the angle of a field when the direction of the ridges is not parallel to one of the sides.

BU'ZZARD. *See* FALCO.

BY'ARD. A piece of leather crossing the breast, used by the men who drag the sledges in coal mines.

BY-LAWS, or BYE-LAWS. (The first syllable from the Danish By, *town* or *hamlet.*) Orders and constitutions of corporations, courts-leet and courts-baron, commoners, or inhabitants of vills, &c., of which the effect is to impose obligations not enforced by common or statute law. The validity of by-laws rests on the authority of the parties making them, established either by immemorial custom, or by their corporate character; for the power of making by-laws is inherent in a corporation. But the superior courts of law have the power of annulling a by-law, if it be unreasonable, or in restraint of trade, or imposing a charge without any apparent benefit to the party, &c. By the Municipal Corporations Amendment Act (5 & 6 W. 4. c. 76. s. 90.) by-laws are to be made by the town council of the borough, and to be valid unless disallowed by the king in council within forty days.

BYRE. A word used in Scotland for a cow house.

BY'RRHUS. A Linnæan genus of minute Clavicorn Coleopterous insects, now the type of a family, including those pests of museums which feed in the larva state on bird-skins, preserved insects, &c. The genera in this family are *Byrrhus* proper, *Simplocaria, Oomorphus, Syncalapta, Nosodendron, Aspidiphorus, Trinodes*, and *Anthrenus*. Of the latter genus there are six British species, of which the *Anthrenus musæorum* may be regarded as the type.

BY'SSIFERS, *Byssifera.* (Lat. Byssus, and fero, *I carry.*) A family of Lamellibranchiate Acephalous Mollusks, comprehending those species which are attached to foreign bodies by means of a byssus.

BY'SSOLITE. (Gr. βυσσος, *flax*, and λιθος, *a stone.*) A soft fibrous mineral from the Alps.

BY'SSUS. (Gr. βυσσος, *fine flax.*) A fasciculus of shining semitransparent horny or silky filaments, secreted by a gland at the base of the foot in certain Lamellibranchiate Bivalves, and serving as an organ of adhesion to submarine rocks or other foreign bodies.

BYSSUS. A name formerly given to all those filamentous plants which inhabit cellars and other under-

ground close places, and on which no fructification is found; it was also applied to vegetation of a similar kind when found growing in the air. It is now certain that a large number of these supposed plants are merely the young state of certain kinds of fungi, or other plants of a low organization; and, although a few species are still retained in the genus, as *Byssus floccosa*, and others, it is by no means certain that they are really of a different nature.

BYZA'NTINE HISTORIANS. A series of Greek historians and authors, who lived under the Eastern Empire between the 6th and the 15th centuries. They may be divided into three classes: 1. Historians whose works form a continuous history of the Byzantine Empire from the fourth century of the Christian era down to the Turkish conquest of Constantinople. They are nearly thirty in number, with various shades of literary merit; but their works constitute the almost only authentic source of the history of that eventful period. 2. General chroniclers or historians, whose works, embracing a wider range than those of the former, treat chiefly of the chronography of the world from the oldest times. 3. Authors who confined their attention to the politics, statistics, antiquities, manners, &c. of the Romans. These two classes combined amount also to about thirty, and their writings give an excellent illustration of the times of which they treat, whether as historians, chroniclers, antiquaries, or politicians. The works of the Byzantine historians, &c. were collected and published by order of Louis XIV. in 36 vols. folio, Paris, 1645-1711. Another and more complete edition was published at Venice in 1729 and the following years. Besides these many of the Byzantine historians were published separately at different places. But all that had previously been done to evince the importance of these historians, by the publication of their works, was destined to be eclipsed in our own times. The late professor Niebuhr of Bonn, eminently fitted for the task by his attainments both natural and acquired, projected a new edition of the Byzantine Historians (*Corpus Scriptorum Historiæ Byzantinæ. Editio emendatior et Copiosior*, 8vo. Bonnæ, 1828), which he superintended till his death. Upwards of 34 volumes have already appeared; and the editorial management of the work is entrusted to Becker, Dindorf, and other distinguished philologists.

C.

C, the third letter of the English and most other European alphabets, is borrowed immediately from the Latin alphabet, in which it first appears; but is derived originally from the *κ* or *γ* of the Greeks. In English it is pronounced like *s* before *e* and *i*, and like *k* before *a*, *o*, *u*, and may consequently be considered as superfluous in the alphabet. According to orthographers there are few letters so susceptible of interchanges as this letter, and much ingenuity has been expended in exhibiting its convertibility. As an abbreviation, C is used in ancient MSS. for Caius, Cæsar, Consul, Civitas, &c.; and as a numeral for a hundred. It was the symbol of condemnation in the Roman tribunals (being abbreviated for *Condemno*); and was consequently termed *litera tristis*, in contradistinction to A (used for *Absolvo*), symbolical of acquittal, and thence called *litera salutaris*.

C. In Music, the name of one of the notes in the scale. It is a character also used for the signification of the time. *See* Music.

CAA'BA. The famous square stone in the temple of Mecca, the object of the adoration of the entire Mohammedan world. According to the tradition of the Arabs, it is the first spot on earth which was consecrated to the worship of the Deity, having been presented by the angel Gabriel to the patriarch Abraham on the occasion of the building of the temple. As is well known, Mohammed enjoined all his followers to visit the shrine of Mecca once in their lifetime; and to preserve continually on their minds a sense of their obligation to perform this duty, he directed that in all the multiplied acts of devotion which his religion prescribes, true believers should always turn their faces towards this holy place, called Kebla. It may be added, that the eastern authors frequently designate the temple in which the square stone is concealed, with all its appendages, as Caaba.

CABA'L. (Fr.) In History, was applied originally to the five cabinet ministers of Charles II.—Clifford, Ashley, Buckingham, Arlington, and Lauderdale — whose initials happened to form the word; and it has since been used for a junto of individuals, who, too insignificant in point of numbers to form a party, endeavour to effect their purposes by underhand measures.

CA'BALA. A Hebrew word signifying the oral tradition which the Rabbins conceive to complete the system of scriptural interpretation. They maintain that it was delivered in the first instance to Adam, and again to Abraham and Moses, by direct revelation; but that since the time of Esdras the memories of the priests and elders have sufficed to preserve it in all its purity. As the Masora details the literal explanation of the language of scripture, so the Cabala reveals the hidden truths of which it is the symbol. Every sentence, word, and letter of the inspired volume contain, according to these interpreters, a figurative as well as a direct sense. The former is also not uncommonly manifold; and a word may be interpreted according to the arithmetical power of the letters which compose it, which species of cabala is called *gematria*; or according to the meaning of each individual letter, the entire word thus constituting a sentence, which is called *notaricon*; or finally according to certain transpositions of the letters, which is denoted by the term *themurah*. What the mysterious doctrines of the cabala which were thus discovered actually were, is not very clearly ascertained; but the system seems to have been an invention of the philosophising Jews of the latter centuries preceding our era, with the view of accommodating the speculations of the Gnostics to the religion of the Old Testament.

The Christian cabalists in later times practised a kind of magic under this name, pretending to the power of divination by certain combinations of scriptural characters.

CABA'LLUS. In Mythology. *See* Pegasus.

CABIA'I. In Zoology, the name under which the Capibara or water-hog (*Hydrochorus capibara*, Erxl.) is described by Buffon. *See* Capibara.

CA'BINET. In Politics, the governing council of a country: from the cabinet or apartment in which the ruler transacts public business and assembles his privy council. In England a few of the ministers only are *ex officio* members of the cabinet. The ministers who are raised to this honour are styled by way of eminence Cabinet ministers, and are more immediately responsible for the acts of the sovereign, as well as for public measures. The distinction between the king's cabinet ministers and the rest of his privy council seems not to have been established in public usage in England before the reign of William III.

CAB'IRI. In Pagan Mythology, sacred priests or deified heroes, venerated by the Phœnicians originally as the founders of religion. Various opinions have been entertained concerning the nature and origin of the Cabiri; but from the multiplicity of names applied to them, together with the profound secrecy observed in the celebration of their rites, an almost impenetrable veil of mystery has been thrown around their history. They seem to have been men who, having communicated the art of melting metals, &c., were deified by a grateful posterity. Their worship was chiefly cultivated in the island of Samothracia, whence it was afterwards transferred to Lemnos, Imbros, and certain towns of Troas. (*Strabo*, x. 473.) They were styled the offspring of Vulcan, though their name was derived from their mother Cabera, daughter of Proteus. Their number is variously given. Those who were initiated in their rites were held to be secured against all danger by sea and land. Their distinguishing badge was a purple girdle. An ingenious account of the Cabiri has been given by Professor Müller of Göttingen, in a dissertation appended to his work on Orchomenus, wherein he rejects the Phœnician or oriental origin of the Cabiri, and regards their worship as purely Pelasgic, and down to a certain point the principal religion of the Greeks.

CA'BLE. (Gr. *καπλιον*, *a rope.*) The rope or chain by which the anchor of a ship is held. Cables in Europe, until within a recent period, were usually made of hemp, but of late years iron chains have come much into use. A hempen cable of 12 inches girth, and length 120 fathoms, weighs 3075 lbs. Since the weights of two cables of equal lengths will be as their sections, or squares of the girths, it is easy to deduce the following rule for the weight of any hempen cable: — Multiply the square of the girth in inches by 21·3 (or 21 nearly enough), the product is the weight in lbs. Since also as the breaking strain, or resistance against the force to part the cable, will be as the section, it will be as the weight, and will be found nearly by dividing the weight in lbs. by 100; the quotient is the breaking strain in tons. This rule is of course liable to great uncertainty from the quality or wear of the cable. Chain cables possess great advantages over hempen cables; they are not liable to be destroyed by chafing on rocky grounds, nor to become rotten and insecure from alternate exposure to the air and water; and by reason of their greater weight the strain is exerted on the cable rather than on the ship. In order that the ship may be enabled to let slip her cable in case of necessity, chain cables are furnished with bolts at distances from each other of a fathom or two, which can be readily withdrawn. A chain of which the section is 1 inch in diameter breaks with 16 tons; such a chain is equivalent to a 10 inch hemp cable nearly. And the dimensions of the chain cable corresponding to any hemp cable are therefore easily found by merely dividing the circumference of the hemp

cable by 10. The strength of every part of the chain is proved before it leaves the manufactory. The first patent for a chain cable was taken out in 1808 by Mr. Slater, a surgeon in the Royal Navy.

CA'BLED. In Architecture, the filling up the lower part of the flute of a column with a cylindrical piece like a cable.

CABO'MBEÆ. (Cabomba, the name of one of the genera.) In Botany, the name given by Richard to the natural order now called *Hydropeltideæ*.

CA'CHALOT. In Ichthyology, a name for the spermaceti or sperm whale (*Physeter macrocephalus*, Linn.).

CACHE'T, LETTRES DE. In France, under the ancient government, letters signed with the private seal (cachet) of the king. As warrants for the detention of private citizens, they appear to have been rarely employed before the 17th century. In the reign of Louis XIV. their use became frightfully common. But in other respects they had been not unfrequently made use of, even in earlier times, to interfere with the course of justice; as, by way of injunction to a party not to exercise certain authority, or pursue certain legal steps, &c. Lettres de cachet were never so multiplied as under the administration of Cardinal Fleury: not less than 80,000 are said to have been issued, without any legal judgment, in the proceedings against the Jansenists. Fifty-nine are said to have been issued against the family Mirabeau in the reigns of Louis XV. and XVI., of which twenty-two against the famous count himself. So scandalously were they abused, that there is an instance of a countess obtaining one for the imprisonment of her maid, who had repeated some scandal against her! They were abolished Jan. 15. 1790.

CACHE'XIA. (Gr. κακος, *bad*, and ἕξις, *a habit*.) A bad state or habit of body; whence the term *cachexiæ*, or cachectic disorders.

CA'CHOLONG. A milk-white chalcedony, originally found on the borders of the river Cach in Bucharia. Cholong, in the language of the Calmucks, is said to signify a stone.

CACHU'NDE. A celebrated Chinese medicine, composed chiefly of aromatic stimulants.

CA'CODÆ'MON. (Gr. κακοδαίμων, *an evil spirit*.) *See* DÆMON.

CACO'PHONY. (Gr. κακος, *bad*, and φωνη, *a sound*.) In Rhetoric, a defect of style, consisting in a harsh or disagreeable sound produced by the meeting of two or more letters or syllables, or by the too frequent repetition of the same letters or syllables: *e.g.*

And oft the ear the open vowels tire. — POPE.

CACTA'CEÆ. (Cactus, one of the genera.) A small natural order of Exogens, remarkable for their gay and large flowers, and for the grotesque forms of some of the species. They are found wild in hot dry countries, in arid situations, where they are enabled to exist because of the thickness of their skin, which allows very little moisture to be lost through it. Many of the species are like succulent Euphorbias, from which they are however known by their not milking when wounded. All the species are harmless; some have eatable fruit; and one, the *Opuntia cochinillifera*, is the favourite haunt of the cochineal insect.

CA'CUS. In Fabulous History, the son of Vulcan, a robber of Italy, whose dwelling was in the Aventine wood. His exploits form the subject of a fine episode in the 8th book of the *Æneid*. He was represented as a frightful monster of enormous strength, who, after a long life of crime, was at length slain by Hercules, from whom he had stolen some oxen. To express his gratitude for his victory, Hercules erected the *Ara Maxima;* and Evander, with his infant colony of Arcadians, performed divine honours to Hercules as their benefactor.

CA'DDICE-WORMS, or CASE-WORMS. The larvæ or grubs of the Trichopterous insects are so called, on account of being inclosed in a sheath or case. This is always composed of extraneous substances glued together by a cement excreted from the skin of the grub; and different species of the caddis-worm protect themselves by means of different materials thus joined together. Some, which pass their larva state under water and creep along the bottom, combine bits of sticks or rushes with small pebbles or shells, to make their cases heavier than water; others, which float on the top and gather their food from thence, form a slight and slender tube of a narrow slip of grass, which is rolled round the body in a spiral direction, with the edges so nicely fitting as to seem but one piece. In every case the worm adheres by a pair of hooks at its hinder extremity to the bottom of the sheath, and only protrudes the head and two following segments, the skin of which is harder than that covering the rest of the body. Those which creep at the bottom drag themselves along by means of their mandibles. At the conclusion of their existence as grubs, they moor their case to some large stone or other fixed and submerged body, and close the outlet by a net-work of silken threads, which prevents the entry of any inimical intruder, but admits the water necessary for respiration. They then cast their outer skin, and for a while remain in the usual passive condition of a pupa; and now the organizing energy is vigorously effecting the wonderful changes which lead to the full perfection of the insect. But, as it would be obviously dangerous to the air-breathing imago to be excluded in its first feeble state under water, the pupa here exhibits a locomotive power which is without a parallel in other orders of the metamorphotic insects: being provided with a pair of small and sharp hooks at the head, it cuts the threads with which in a previous state it had confined itself, and creeping out of the water casts off its pupa skin, and emerges a May-fly or *Phryganea*.

CA'DENCE. (Ital. cadenza, *a falling*.) In Music, the conclusion of a song, or of some parts thereof, in certain places of the piece, dividing it as it were into so many numbers or periods. The cadence takes place when the parts fall or terminate on a note or chord naturally expected by the ear, just as a period closes the sense in the paragraph of a discourse. A cadence is either perfect or imperfect. The former when it consists of two notes sung after each other, or by degrees conjoined in each of the two parts, the harmony of the fifth preceding that of the key note; and it is called perfect, because it satisfies the ear more than the latter. The latter imperfect; that is, when the key note with its harmony precedes that of the fifth without its added seventh. A cadence is said to be broken or interrupted when the bass rises a major or minor second, instead of falling a fifth.

CADE'T. (Fr.) A pupil in a military academy, whose aim is to qualify himself, by a due course of study, to enter the service of Her Majesty or that of the East India Company as an officer of the line, artillery, or engineers. In this country there are three grand institutions for the education of cadets: Sandhurst for the British line; Woolwich for the artillery and engineers; and Addiscombe for the Indian army, both line and artillery. The academy at Sandhurst was instituted by George III for the purpose of affording general and professional instruction to the sons of private or military gentlemen, with the view of their obtaining commissions in the British army without purchase. Before the commission is conferred, the cadet must undergo an examination before a competent board in the classics, mathematics, military drawing, &c. The expenses of this academy were formerly defrayed by government; but a change was recently introduced, by which the sons of private gentlemen must pay an annual sum of 125*l*., and the sons of general or other officers less sums in proportion to their rank.

The academy at Woolwich was established with the view of qualifying cadets for the artillery or engineers; and to this institution the master-general of the ordnance has the sole right of granting admission. As the nature of the establishment at Woolwich requires the prosecution of a more strict and professional course of study than at Sandhurst, the attention of the cadets is specially directed to geography; general history, ancient and modern; modern languages; military drawing and surveying; mathematics; engineering and fortification. After the lapse of four years, generally, the cadets undergo an examination in the above-mentioned branches of science; when the most distinguished are selected for the engineers, the others for the artillery. And here it may be observed, that not merely the cadet academy, but the whole vast establishment at Woolwich, its arsenal, its repository, its laboratory, are component parts of one and the same great school of military science.

As the college of Addiscombe is established for the education of officers of the line, artillery, and engineers for the Indian army, the plan of instruction pursued there combines the two systems adopted at Sandhurst and at Woolwich. In order to become a cadet in this institution, it is necessary to have the promise of a commission from a director of the East India Company; and after a prescribed examination, an appointment is obtained in one of the branches of the Indian army, according to the merit or pleasure of the cadet. We may here incidentally remark, that no cadet, even after being thoroughly versed in the theory of military science, is suffered to join the engineers either of the Queen's service or that of the E. I. Company, before he has gone through a regular course of practical instruction in sapping, mining, and the whole processes of a siege, as well as in other departments of field engineering, pontooning, the construction of military bridges, &c., in the admirable establishment for these purposes at Chatham. (*United Service Jour.*)

In France the academies for cadets which existed previously to the French Revolution have been merged in the Polytecnic schools.

The Dutch possess two institutions of this nature; one at Breda, the other at Delft.

In the United States there is one on nearly the same principle as that at Addiscombe.

In Germany every small state has a military school:

while those at Berlin, Vienna, and Munich are on so extensive a scale as to challenge a comparison with any similar institutions in Europe. In Germany, too, the word cadet has a wider signification than in this country, being applied to those persons who, without having frequented a military school, join the army in the expectation of obtaining a commission when they have gained a competent knowledge of the service.

In Russia there is a famous academy for cadets, which was instituted by Anna at St. Petersburg in 1732; and since its foundation has afforded instruction in military science to upwards of 9000 pupils, many of whom have acquired celebrity in the annals of Russian literature.

CA'DI. (In Arabic, *a judge.*) Among the Turks the inferior judges are styled Cadi. The Spanish Alcayde or Alcalde is derived from the same root.

CA'DMIUM. A white metal, much like tin; it fuses and volatilizes at a temperature a little below that at which tin melts. Specific gravity about 9. Its ores are associated with those of zinc. It was discovered in 1818 by Professor Stromeyer of Gottingen. Its equivalent number is 56. It forms a yellow salifiable oxide, composed of 56 cadmium + 8 oxygen = 64 oxide of cadmium. Its scarcity prevents its employment in the arts, but the oxide has been used as a pigment.

CADU'CEUS. In Antiquity, a rod of laurel or olive with a representation of two snakes twisted round it. It was the symbol of peace, and formed the chief badge of the Grecian heralds, whose persons were held sacred. In Mythology, the Caduceus was the symbol of Mercury, thence called Caducifer, to whom it was said to have been presented by Apollo in return for his invention of the lyre.

CADU'CIBR'ANCHIATES. (Lat. caducus, *fading;* branchiæ, *gills.*) Those Batrachians which undergo a metamorphosis, and lose their branchial apparatus before arriving at the period of maturity; as the frog, toad, salamander, and newt.

CADU'COUS. (Lat. cado, *I fall.*) In Botany, when a part is temporary, and soon disappears or falls off.

CÆ'CA. (Lat. cæcus, *blind.*) In Comparative Anatomy, the blind processes of the alimentary canal are generally so called. Those in fishes occur at the beginning of the intestines, where they are often numerous and long, representing the pancreas. In birds they are found near the termination of the intestines, and are generally two in number. In mammals the cæcum is commonly single, and situated at the beginning of the large intestines; it is of enormous size in the herbivorous species with simple stomachs. In the lower animals the intestinal glands which communicate with the intestines generally retain their primitive form of cæca.

CÆ'CUM. (Lat. cæcus, *blind.*) In Human Anatomy, the first portion of the large intestines, in which the *ileum* terminates by a valve. The cæcum is a kind of appendage to the intestinal canal, open at one end only, whence the name *blind gut;* it has a small process attached to it, called the *appendix cæci vermiformis.*

CÆ'SAR. This title, originally the name of a branch of the Julian family at Rome, was assumed as a mark of dignity by the emperors after Nero. It became subsequently the title of the presumptive heir to the empire, and the next title of dignity after Augustus; but was superseded in the Greek empire under Alexis Comnenus by that of Sebastocrator. In the West, it was assumed by the emperors of Germany; and, in German "Kaiser," is now the peculiar title of the emperor of Austria, who has succeeded to several of the dignities of the former.

CÆSA'REAN OPERATION. The extraction of the child from the womb by an operation. Julius Cæsar is said to have been thus brought into the world.

CÆSU'RA. (Lat. cædo, *I cut.*) In prosody, a metrical break in the verse, occasioned by the separation of the first syllable of a foot, forming the last of a word, from the next syllable, forming the first of another. In the Latin hexameter the principal cæsura, without which the line is unmusical, occurs generally after the tenth, sometimes not until after the fourteenth time (each long syllable containing two times, each short syllable one: *see* RHYTHM); thus,

Arma virumque cano | Trojæ qui primus ab oris
Speluncæ vivique lacus | at frigida Tempe.

The slight pause which follows the syllable at which the interruption takes place is termed the cæsural pause. In English verse a line is frequently musical without any cæsura at all; *i. e.* in which the pause takes place always at the end of a foot. But a cæsura in the middle of the third, and in the middle of the fourth foot of an heroic verse, are by no means uncommon, and particularly appropriate in blank verse, in which they represent the two common cæsuræ of the Latin hexameter.

I sing the sofa | I who lately sang
Of man's first disobedience | and the fruit.

In the first of these lines the cæsura is in the third, in the latter in the fourth foot.

CAFFE'IN. A bitter crystallizable substance contained in coffee. A portion of it volatilizes during the roasting of coffee. It has not been applied to any use.

CAHIE'R. (Fr.) Derived by some from the Lat. *codex*, by others from *quaternio*. It signifies in its proper sense a number of sheets of paper loosely tied together. In French history, it denotes the reports and proceedings of certain assemblies; as those of the clergy, the states general, the notables, &c. The famous cahiers presented by the states general to the king of France at their convocation on the 24th of June, 1789, contain the best account of the then state of France. They were systematized and condensed in a book in 3 volumes, called "L'Esprit des Cahiers," to which the reader is referred.

CAI'NCIC ACID. A peculiar acid discovered by Pelletier and Caventou in the bark of the cainca root, a Brazilian shrub employed for the cure of intermittent fever.

CAI'NITES. A strange sect of heretics, who appeared about 159, A.D. They probably originated in some of the various schools of Manicheism; and, if their doctrines are truly reported to us, they are said to have asserted that the power which created heaven and earth was the evil principle; that Cain, Esau, Korah, the people of Sodom, and others whom the Old Testament represents as victims of peculiar divine judgments, were in fact children of the good principle, and enemies of the evil. Some of them are said to have published a gospel of Judas on the same principle. The Quintilianists, so called from a lady named Quintilia, of whom Tertullian speaks, were an offset of this sect.

ÇA IRA, ÇA IRA. (Literally, *it* (the Revolution) *shall go on.*) The burden of a famous revolutionary song, which was composed in the year 1790 in denunciation of the French aristocracy. The tune and sentiments of this song were much inferior to those of the Marseillaise Hymn ("Allons enfans de la patrie"), the object of which was to rouse the French to defend their country against foreign aggression.

CAIRN. A word of Celtic origin, used to denote the piles of stones of a conical form so frequently found on the tops of hills, &c. in various districts; erected probably, as Sir R. C. Hoare observes, in general, for the mere purpose of memorials, although some have assigned to them a peculiar character, as receptacles for the bodies of criminals burnt in the wicker images of the Druids, &c. According to some antiquaries, *cairn* is distinct from *carnedd*, the Welsh name for heaps of stones on the tops of high mountains (Carnedd David, Carnedd Llewellyn, &c.), which are said to have been sacrificial. Some cairns are undoubtedly sepulchral. In common language, a cairn is distinguished from a barrow, the former being a heap of stones, the latter a mound of earth; but in all probability they had for the most part the same object, and the difference of materials was merely occasioned by local circumstances. *See* BARROW.

CAIRNGO'RM STONE. A yellow or brown variety of rock crystal or crystallized silica, from the mountain Cairngorm in Scotland.

CA'ISSON. (Fr.) In Architecture, a sunken panel in a flat or vaulted ceiling, or in the soffit of a cornice. In ceilings they are of various geometrical forms, and often enriched with rosettes or other ornaments. *Caisson*, in bridge building, is a large chest or vessel in which the piers of a bridge are built. This sinking as the work advances, its bottom at last comes in contact with the bed of the river, when the sides are disengaged, its construction being such as to admit of their being thus detached without injury to the floor or bottom.

CA'JEPUT OIL. A volatile oil obtained by distilling the leaves of the *Melaleuca minor*, a shrub abundant in Amboyna and Borneo, whence the oil is imported. This oil is of various shades of green, highly pungent and aromatic, and powerfully stimulant and diaphoretic. It has been much extolled as a remedy in the Asiatic cholera, but other essential oils are probably as effectual.

CA'LAMARY. (Calamus, *a pen;* theca calamaria, *the pen-fish.*) A Cephalopod; so called because it has a horny substance shaped like a quill in its back, and contains an ink-bag in its visceral sac: it is the *Loligo vulgaris* of Cuvier.

CA'LAMINE. A native carbonate of zinc, *Lapis calaminaris*. It is a zinc ore used in the manufacture of brass.

CA'LAMUS. (Gr. καλαμος, *a reed.*) A name occasionally employed in botany for such simple fistular stems, without articulations, as occur in rushes and similar plants.

CA'LAMUS AROMA'TICUS. The rhizoma of the *Acorus calamus*, common over the whole of Europe in moist situations; it is usually known under the name of *sweet flag*. An infusion of the root is a good aromatic tonic. It yields a very small portion of essential oil when distilled with water (scarcely exceeding a thousandth part of its weight), which is used by perfumers.

CALA'THIUM, or CALATHIDIUM. (Gr. καλαθος, *a cup.*) Is a botanical term, employed by some German

botanists to denote that kind of depressed contracted inflorescence which is found in composite flowers. It is in reality an umbel with all the flowers sessile.

CALATRA'VA, ORDER OF, IN SPAIN, so denominated from a castle taken from the Moors, was instituted by Sancho III. King of Castile, in 1158. The kings of Spain are perpetual grand masters of this order of knighthood.

CA'LCAR. (Lat. calcar, *a spur.*) This term is applied by botanists to all hollow prolongations downwards of leaves or the parts of a flower. The long hollow horns which hang down from one of the sepals of a Tropœlum, or from the labellum of an Orchis, or the curved bodies enclosed within the hood of an Aconite flower, are described by this name.

CALCA'REOUS SOIL. (Lat. calx, *lime.*) Soil of which lime forms a principal component part. Kirwan alleges that no soil will continue long fertile that does not contain some proportion of lime; and this has been subsequently proved by what takes place in North America. See *Ruffin's Essay on Calcareous Manures.*

CALCEOLA'RIA. (Calceolus, *a small slipper.*) A genus of beautiful herbaceous or shrubby plants with yellow, or orange, or purple flowers, the lower half of which is shaped something like an old-fashioned slipper. They naturally inhabit rocks, rich plains, and woods, in Chili, Peru, or New Grenada. In this country many of them are hardy enough to live in the open air in summer; and some will even endure our winters, if not very severe. They are, however, all cultivated with most success if regarded as greenhouse plants.

CALCINA'TION. The reduction of substances to cinder or ash. The term is derived from the Latin word *calx*, quicklime, which, as is well known, is prepared by the action of heat upon limestone; and hence the old chemists employed the word *calcination* to express any supposed analogous change, metallic substances being apparently converted into earthy matter by calcination.

CA'LCIUM. The metallic base of lime, discovered in 1808 by Davy. This substance has hitherto been obtained in such small quantities, that its properties have not been accurately investigated. It is probably a brilliant white metal, highly inflammable, and more than twice as heavy as water. Combined with oxygen it forms lime, which consists of 20 calcium + 8 oxygen = 28 lime.

CALC-SI'NTER. (German. From kalk, *lime*, and sintern, *to drop.*) The calcareous deposit of certain springs.

CALC-SPAR. Calcareous spar, or crystallized carbonate of lime.

CA'LCULA'TION, CA'LCULUS. (Lat. calculus, *a small pebble*, the Romans having made use of pebbles in casting up accounts.) In modern language, the term *calculus* is employed to denote any branch, or any operation of mathematics, which requires or may involve numerical calculation; and therefore may be applied to the whole of the mathematical sciences, excepting pure geometry. Thus that part of algebra which treats of exponents is called the *experimental calculus.* In like manner the phrases *calculus of definite integrals*, *calculus of functions*, *calculus of variations*, &c., are used to denote certain branches of the higher mathematics. *See* DIFFERENTIAL CALCULUS, INTEGRAL CALCULUS, VARIATIONS.

CA'LCULUS. (Dimin. of calx, *a limestone.*) In Physiology, the general term for inorganic concretions of various kinds, formed in various parts of the body, and bearing in shape or composition a general resemblance to stones. The term *calculus* is, however, generally confined to urinary concretions. *See* URINE.

CALDA'RIUM. (Lat.) In Ancient Architecture, by some authors used in the same sense as Laconicum, was an apartment in the baths heated for the purpose of causing perspiration. Vitruvius, however, used the word to signify a hot bath.

CALEA'NTHUM. Pliny's term for copperas.

CA'LEMBOURG. A French expression for that kind of witticism which in English is denominated a pun. A certain Westphalian Count Calemberg (Kahlenberg), who visited Paris in the reign of Louis XV., and was famous for his blunders in the French language, is said to be the person immortalized by the employment of his name to designate this species of jeu de mots.

CA'LENDAR. A distribution or division of time into periods adapted to the purposes of civil life; also a table or register of such divisions, exhibiting the order in which the seasons, months, festivals, and holidays succeed each other during the year. The word is derived from the ancient Latin verb *calare*, to call. In the early ages of Rome, it was the custom for the pontiffs to call the people together on the first day of each month, to apprise them of the days that were to be kept sacred in the course of it. Hence *dies calendæ*, the calends or first days of the different months.

The calendars in use throughout Europe are borrowed from that of the Romans. Romulus is supposed to have first undertaken to divide the year in such a manner that certain epochs should return periodically after a revolution of the sun; but the knowledge of astronomy was not then sufficiently advanced to allow this to be done with much precision. He placed the commencement of the year in spring, and divided it into 10 months — March, April, May, June, Quintilis, Sextilis, September, October, November, and December. March, May, Quintilis, and October contained thirty-one days each; the other six contained only thirty. The names Quintilis and Sextilis remained in the calendar till the end of the republic, when they were changed into July and August; the former in flattery of Julius Cæsar, and the latter of Augustus.

The year of Romulus contained only 304 days. Numa added two months; January to the beginning of the year, and February to the end. About the year 452 B. C. this arrangement was changed by the Decemvirs, who placed February after January; since that time the order of the months has remained undisturbed. In Numa's year the months consisted of 29 and 30 days alternately, to correspond with the synodic revolution of the moon. The year would therefore consist of 354 days; but one day was added to make the number odd, as being more lucky. In order to produce a correspondence with the solar year, Numa ordered an intercalary month to be inserted every second year between the 23rd and 24th of February, consisting alternately of 22 and 23 days. Had this regulation been strictly adhered to, the mean length of the year would have been 365¼ days, and the months would have continued for a long time to correspond with the same seasons. But a discretionary power over the intercalary month was exercised by the pontiffs, who frequently abused it for the purpose of hastening or retarding the days of the election of magistrates; and the Roman calendar continued in a state of uncertainty and confusion till the time of Julius Cæsar, when the civil equinox differed from the astronomical by three months.

Under the advice of the astronomer Sosigenes, Cæsar abolished the lunar year, and regulated the civil year entirely by the sun. He decreed that the common year should consist of 365 days; but that every fourth year should contain 366. In distributing the days among the different months, he ordered that the odd months, that is, the first, third, fifth, seventh, ninth, and eleventh, should contain each 31 days, and the other months 30; excepting February, which in common years was to contain only 29 days, but every fourth year 30 days. This natural and convenient arrangement was interrupted to gratify the frivolous vanity of Augustus, by giving August, the month named after him, an equal number of days with July, which was named after the first Cæsar. The intercalary day, which occurred every fourth year, was inserted between the 24th and 25th of February. According to the peculiar and awkward manner of reckoning adopted by the Romans, the 24th of February was called the sixth before the calends of March, *sexto calendas.* In the intercalary year this day was repeated, and called *bis-sexto calendas;* whence the term *bissextile.* The corresponding English term, *leap year*, appears less correct, as it seems to imply that a day was *leapt* over instead of being thrust in. It may be remarked, that in the ecclesiastical calendar the intercalary day is still inserted between the 24th and 25th of February.

The Julian year consisted of 365¼ days, and consequently differed in excess by 11 minutes 10·35 sec. from the true solar year, which consists of 365 d. 5 h. 48 m. 49·62 sec. In consequence of this difference the astronomical equinox, in the course of a few centuries, sensibly fell back towards the beginning of the year. In the time of Julius Cæsar it corresponded to the 25th of March; in the sixteenth century it had retrograded to the 11th. The correction of this error was one of the purposes sought to be obtained by the reformation of the calendar effected by Pope Gregory XIII. in 1582. By suppressing 10 days in the calendar, Gregory restored the equinox to the 21st of March, the day on which it fell at the time of the Council of Nice in 325; the place of Easter and the other moveable church feasts in the ecclesiastical calendar having been prescribed at that council. And in order that the same inconvenience might be prevented in future, he ordered the intercalation which took place every fourth year to be omitted in years ending centuries; that is to say, on the 100th, 200th, &c.; excepting on the 400th, and the years which are multiples of 400. The Gregorian rule of intercalation may therefore be expressed as follows: —

"Every year of which the number is divisible by 4 without a remainder is a leap year, excepting the centesimal years, which are only leap years when divisible by 4 after suppressing the two zeros." Thus 1600 was a leap year; 1700 and 1800 were common years; 1900 will be a common year, 2000 a leap year, and so on.

The Gregorian method of intercalation thus gives 97 intercalations in 400 years; consequently 400 years contain $400 \times 365 + 97 = 146097$ days, and therefore the length of one year is 365·2425 days, or 365 d. 5 h. 49m. 12 sec., which exceeds the true solar year by 22·38 sec., an error which amounts only to one day in 3866 years.

If an astronomer were required, without any reference to established usages, to give a rule of intercalation by which the commencement of the civil year, while it always coincided with the commencement of a day, should deviate the least possible from the same instant of the solar year, he would proceed as follows:—The length of the mean solar year being 365·242241 days, the excess above a whole number of days is ·242241, which converted into a continued fraction becomes

$$\cfrac{1}{4+\cfrac{1}{7+\cfrac{1}{1+\cfrac{1}{4+\cfrac{1}{7+\cfrac{1}{1+,\ \&c.}}}}}}$$

Whence the following series of approximative fractions is derived.

$$\frac{1}{4},\quad \frac{7}{29},\quad \frac{8}{33},\quad \frac{39}{161},\quad \frac{281}{1160},\quad \frac{320}{1321},\ \&c.$$

Of these the first gives an intercalation of 1 day in 4 years, which supposes the year to be 365¼ days. The second gives 7 intercalations in 29 years, and supposes the length of the year to be 365 d. 5 h. 47 m. 35 sec., which is somewhat too small. The third fraction, $\frac{8}{33}$, is remarkable, as giving a year which differs in excess from the true solar by 15·38 seconds; so that by intercalating 8 times in 33 years, or 7 times successively at the end of every fourth year, and once at the end of the fifth year, the difference between the civil and solar year would only accumulate to a day in about 5600 years, while in the Gregorian calendar the error amounts to a day in 3860 years. Nevertheless the Gregorian rule has this advantage, that leap year is always readily distinguished.

The Gregorian calendar was received immediately or shortly after its promulgation by all the Roman Catholic countries of Europe. The Protestant states of Germany, and the kingdom of Denmark, adhered to the Julian calendar till 1700; and in England the alteration was successfully opposed by popular prejudices till 1752. In that year the Julian calendar, or *old style*, as it was called, was formally abolished by act of parliament, and the date used in all public transactions rendered coincident with that followed in other European countries, by enacting that the day following the 2nd of September of the year 1752 should be called the 14th of that month. When the alteration was made by Gregory it was only necessary to drop 10 days; the year 1700 having intervened, which was a common year in the Gregorian but a leap year in the Julian calendar, it was now necessary to drop 11 days. The old style is still adhered to in Russia and the countries following the communion of the Greek church; the difference of date in the present century amounts to twelve days.

Ecclesiastical Calendar.—The adaptation of the civil to the solar year is attended with no difficulty; but the church calendar for regulating the moveable feasts imposes conditions less easily satisfied. The early Christians borrowed a portion of their ritual from the Jews. The Jewish year was luni-solar; that is to say, depended on the moon as well as on the sun. Easter, the principal Christian festival, in imitation of the Jewish passover, was celebrated about the time of the full moon. Differences of opinion, and consequently disputations, soon arose as to the proper day on which the celebration should be held. In order to put an end to an unseemly contention, the Council of Nice laid down a specific rule, and ordered that Easter should always be celebrated on the Sunday which immediately follows the full moon that happens upon, or next after, the day of the vernal equinox. In order to determine Easter according to this rule for any particular year, it is necessary to reconcile three periods; namely, the week, the lunar month, and the solar year. To find the day of the week on which any given day of the year falls, it is necessary to know on what day of the week the year began. In the Julian calendar this was easily found by means of a short period or cycle of 28 years (*see* Cycle), after which the year begins with the same day of the week. In the Gregorian calendar this order is interrupted by the omission of the intercalation in the last year of the century. But to render any calculation unnecessary a table is given in the prayer books, showing the correspondence of the days of the year and the week for the current century. (*See* also Dominical Letter.) The connection of the lunar month with the solar year is an ancient problem, for the resolution of which the Greeks invented cycles or periods, which remained in use with some modifications till the time of the Gregorian reformation. (*See* Metonic Cycle, Golden Number.) The author of the Gregorian calendar, Luigi Lillo Ghiraldi, or, as he is frequently called, Aloysius Lilius, employed for the same purpose a set of numbers called Epacts (for an explanation of the use of which *see* Epact). It is to be desired that this complicated system of rules and tables were rendered unnecessary by abolishing the use of the lunar month, and causing Easter to fall invariably on the same Sunday of a calendar month; for example, on the first or second Sunday of April.

New French Calendar.—A new reform of the calendar was attempted to be introduced in France during the period of the Revolution. The commencement of the year was fixed at the autumnal equinox, which nearly coincided with the epoch of the foundation of the republic. The names of the ancient months were abolished, and others substituted having reference to agricultural labours, or the state of nature in the different seasons of the year. But the alteration was found to be inconvenient and impracticable, and after a few years was formally abandoned. (Cycle, Era, Hejira, Year.)

CA'LENDER. A machine for pressing and smoothing cloth and other articles, which when so prepared are said to be *calendered*. It literally means *hot-pressing;* from *calor*, heat.

CA'LENDS, in the ancient Roman calendar, were the first days of each month. The Roman month was divided into three periods by the *Calends*, the *Nones*, and the *Ides*. The *Calends* were invariably placed at the beginning of the month; the *Ides* at the middle of the month, on the 13th or 15th; and the *Nones* (*novem*, nine) were the ninth day before the Ides, counting inclusively. From these three terms the days were counted backwards, in the following manner:—Those days comprised between the calends and the nones were denominated *days before the nones;* those between the nones and the ides, *days before the ides;* and those from the ides to the end of the month, *days before the calends*. Hence the phrases *pridie calendas, tertio calendas*, &c.; meaning the second day before the calends, or last day of the month, the third day before the calends, or last but one of the month (the *calends* or first day of the following month being included in the reckoning), and so on. In the months of March, May, July, and October, the ides fell on the 15th day, and the nones, consequently, on the 7th. In all the other months the ides fell on the 13th, and the nones, consequently, on the 7th. The number of days receiving their denomination from the calends depended on the number of days in the month and the day on which the ides fell. For example, if the month had thirty-one days, and the ides fell on the 13th (as happened in January, August, nd December), there would remain eighteen days after the ides, which, added to the first of the following month, made nineteen days of calends. Hence the 14th day of January was styled the *nineteenth before the calends* of February; the following day, or 15th of the month, was *the eighteenth before the calends*, and so on.

CALE'NDULIN. A mucilaginous substance or species of gum obtained from the *marigold*.

CA'LENTURE. (Lat. caleo.) A delirious fever, produced by the sun, in which it is common for the patient to imagine the sea to be green fields.

CA'LIBER, or CALIPER. (Fr. calibre.) The thickness or diameter of any round or cylindrical body, as of the bore of a gun or of its ball.

CA'LICO-PRINTING. The art of producing figured patterns upon calico; they are transferred to its surface by blocks, copper plates, or engraved cylinders, by which the colours are directly printed, or by which *mordants* are so applied that when the calico is immersed in a colouring bath, the colour only adheres or is produced upon the parts to which the mordant had been previously applied. *See* Dyeing.

CA'LIDUCT. (Lat. calidus, *hot*, and ductus, *a conveyance*.) In Architecture, a pipe or flue for the distribution of heat in an apartment or house.

CALIGI'DÆ. A family of parasitic Entomostracous Crustaceans, belonging to the order *Siphonostoma*, characterized by having the mouth organized for piercing and suction. The parasites of this family prey almost exclusively upon fish, and are commonly called fish-lice. Gold-fish are sometimes infested to an almost incredible extent with a species, the *Monoculus foliaceus* of Linnæus, which is nearly a quarter of an inch long, having the body covered with a broad round transparent shield, notched behind to give free motion to the tail. The first pair of legs are shaped like a cupping-glass, and for the purpose of holding on; the four last pairs are formed for swimming, and terminated each by two long and feathered filaments, probably subservient to respiration.

CA'LIPER COMPASSES, or simply Calipers, are compasses with curved legs, for measuring the caliber or diameter of cylinders, balls, or other round bodies. Calipers of the best sort are made with a scale having different sets of numbers engraved on it, like a sliding rule, for the purpose of exhibiting at once various relations depending on the magnitude of the diameter of the body measured. Thus, as the weights of balls of the same metal are in a constant ratio to the cubes of their diameters

the scale may be so graduated and numbered that the observer may read off either the diameter in inches, or the weight in pounds. Other numbers having a less immediate application are also frequently attached: for example, the degrees of a circle, the proportions of troy and avoirdupois weight, tables of the specific gravities and weights of bodies, &c. It is obvious that these may be varied infinitely, according to the purposes proposed to be accomplished. This word is probably derived from the Greek καλλειπω, *I leave behind*.

CA'LIPH. (Arab. khalifah.) Originally a deputy or lieutenant, but afterwards applied chiefly to the successors or representatives of Mohammed, who exercised the highest spiritual and temporal jurisdiction over the "Faithful." At first there was little difficulty in determining the right of succession to the caliphat, as it devolved on the immediate descendants or relations of the prophet: but in the course of time violent disputes arose upon this point among several Mohammedan dynasties, and led to the establishment of the caliphats of Africa (Fatimide), and of Spain (Omayzade), which were contemporary with that of the Abassides of Bagdad. The splendour of the empire founded by Mohammed reached its highest pitch towards the beginning of the ninth century, under the famous Haroun al Raschid. The period of its decline may be dated from the commencement of the tenth century; and for the last 200 years the appellation of caliph has been swallowed up in *Shah*, *Sultan*, *Emir*, and other titles peculiar to the east.

CALI'PPIC PERIOD. In Ancient Chronology, is a correction of the Metônic cycle proposed by Calippus. The Metonic cycle was a period of nineteen solar years, at the end of which time the new moons return again on the same days of the year. The period contained exactly 6940 days. Now 6940 days exceeds 235 lunations by only seven hours and a half. At the end of four cycles, or 76 years, the accumulated excess of 7½ hours amounts to one whole day and six hours. Calippus therefore proposed to quadruple the period of Meton, and to deduct a day at the end of it by changing one of the months of 30 days into a month of 29 days. (*See* METONIC CYCLE.) The period of Calippus is sometimes referred to as a date by Ptolemy.

CALI'XTINES. One division of the Bohemian Reformers, who in the 15th century protested against the errors of the church of Rome, and maintained their independence by force of arms. After the death of Huss, his followers split into two principal parties, under the names of Taborites and Calixtines; of which the latter were the most moderate, and held out chiefly on the ground of the refusal of the cup (calix) to the laity, whence they derived their name. Their hostility was at length propitiated by indulgence on this point: the church of Rome declaring expressly at the same time that the giving or withholding of the sacramental wine is a matter of ecclesiastical ordinance merely, and neither the one nor the other essential to the reception of the benefits of the eucharist. The council of Basle (1431) says,— Sive sub unâ specie sive duplici quis communicat, secundum ordinationem seu observationem ecclesiæ, proficit dignè communicantibus ad salutem.

The same name is given to the followers of Calixtus, a German divine of the 17th century, who proposed a reconciliation between the Roman Catholics, Lutherans, and Reformed church, on the basis of the Apostles' Creed.

CALLI'GRAPHY. (Gr. κάλλος, *beauty*, and γράφω, *I write*.) The art of beautiful writing. The scribes who made a profession of copying manuscripts, before the invention of printing, have been termed Calligraphers. Their art consisted not merely in writing, but also in embellishing their work with ornamental devices, although illumination (which see) was also practised as a distinct employment. Among the MSS. of the early part of the middle ages which we possess, there are some sumptuous specimens of the art, written in letters of gold, vermilion, &c. and on leaves of different colours, but that fashion went early out of use; and in general it may be said, that the current writing of calligraphers diminished in beauty and in laborious minuteness, especially in Italy, during the centuries immediately preceding the invention of printing.

CALLIO'NYMUS. (Gr. καλλος, *beauty*, and ονομα, *a name*.) A genus of beautiful spiny-finned fishes, with very small gill openings; ventral fins under the throat, and larger than the pectorals; head oblong, flattened; eyes placed near to each other, and directed upwards; no teeth on the palate; intermaxillaries capable of considerable protrusion. They have no air bladder. The gemmeous, or golden dragonet (*Callionymus lyra*), is a British example of this genus.

CALLI'OPE. (Gr. καλλος, *beauty*, and οψ, *the voice*.) In Mythology, one of the Muses usually associated with Homer in the statues of antiquity, and thence considered as the patroness of heroic poetry.

CALLI'TRICHA'CEÆ. (Callitriche, the only genus.) A small cluster of imperfectly organized water plants, the natural relation of which is unsettled. By some they are considered allies of *Urticaceæ*, by others of *Naiadaceæ*, and others Monocotyledons.

CALLORHY'NCHUS. *See* CHIMÆRA.

CA'LLUS. In Osteology, the matter which unites the divided ends of broken bones: it is a secretion of new bony matter.

CA'LOMEL. The old chemical name of *chloride of mercury*. The word is perhaps derived from καλος, *fair*, and μελας, *black*. It is prepared by rubbing mercury with corrosive sublimate, which forms a *black* mixture, which, by the application of heat, yields a *white* sublimate of calomel. It is much used in medicine, especially as a purgative. It consists of 200 mercury + 36 chlorine = 236 chloride of mercury or calomel.

CALO'RIC. (Lat. caleo, *I am warm*.) A term applied by the French chemists to designate *the matter of heat*, it being assumed that the phenomena of heat are dependent upon the presence of a highly attenuated, mobile, and imponderable form of matter. *See* HEAT.

CALORI'FIC RAYS. A term applied to the invisible heating rays which emanate from the sun, and from burning and heated bodies.

CALOR'IMETER. (Lat. calor, *heat*, and metrum, *a measure*.) An instrument for measuring the quantity of heat given out by bodies in passing from one temperature to another.

CALORIMO'TOR. (Lat. calor, *heat*, and moveo, *I put in motion*.) This term has occasionally been applied to a peculiar form of the voltaic apparatus composed of one pair of plates of great extent of surface, the electricity of which, when transmitted through good conductors, produces intense heat.

CA'LOSO'MA. (Gr. καλος, *beautiful*; σωμα, *body*.) A genus of most splendid Coleopterous insects, belonging to the family *Carabidæ*, or ground beetles. In this genus the jaws are toothless, or rather devoid of notches; the maxillary palpes terminate in a large joint, and the abdomen is broad. There are two British species: *Calosoma sycophanta*, so called because its grub insinuates itself into the nests of gregarious caterpillars, and feeds upon them; and *Calosoma inquisitor*. In speculating on the exception which the Calosomes present among the *Carabidæ*, in the brilliant colours which are developed in them, an explanation seems to be afforded by a difference in their habits: they frequent trees, and are more exposed to the light than their hole-and-corner congeners, the ground-beetles.

CA'LOYERS. Monks of the Greek church, who follow the rule of St. Basil.

CALP. An argillo-ferruginous limestone.

CALU'MBA. The root of the *Cocculus palmatus*. It is dried in slices of a yellowish grey colour, and is generally worm-eaten. It has a bitter and slightly pungent taste, and is very mucilaginous. Calumba root is an excellent tonic medicine, especially in debility of stomach and intestines: about ten grains of the powder may be taken twice or thrice a day. The Mozambique name of this plant is Kalumba.

CA'LUMET. (Lat. calamus, *a reed*.) In Modern History, a large beautifully adorned pipe, used by the North American Indians as the emblem of peace. (*Harris's Voyages*, vol. ii. p. 908.) The first notice of the calumet among European writers is to be found in Ferdinand de Soto's account of his expedition through the southern provinces in 1470.

CA'LVINISTS. The followers of Calvin, the second great reformer of the 16th century, and founder of the church of Geneva. The distinguishing tenets of this celebrated theologian refer to points both of discipline and doctrine. He was the first to reject the episcopal form of church government, originally, it is said, with great reluctance, and compelled thereto by the want of regularly ordained ministers; but he afterwards maintained the exclusive divine appointment of the Presbyterian system, which has since obtained favour in Scotland, and among the Protestants of France, and has had numerous adherents in this country and America. The doctrinal opinions of Calvin, however, have not been permanently received among those who have adopted his views respecting the ministry. On the contrary, in England and Geneva, there are many Presbyterians Arminian in sentiment. It was at the Synod of Dort, in 1618, that the points in dispute between the Calvinists and Arminians were most accurately distinguished, and arranged under five heads, upon which the former party asserted the following opinions:—

1. Of predestination—that all men have sinned in Adam, and are become liable to the curse; but that God has by an eternal decree chosen some from the beginning, to whom he should impart faith of his free grace, and consequently salvation.

2. Of the death of Christ—that it is a sufficient sacrifice for the sins of the whole world; and that some only believe and are saved, whereas many perish in unbelief, arises not from any defect in this sacrifice, but from the perversity of the non-elect.

3. Of man's corruption—that all men are conceived

in sin and born the children of wrath, and are neither willing nor able to return to God without the aid of the Holy Spirit.

4. Of grace and free will—that the influence of the Spirit upon our fallen natures does not force, but only quickens and corrects them, inducing them gently to turn themselves towards God by an exercise of their free will.

5. Of perseverance—that God does not wholly take away his Spirit from his own children, even in lamentable falls; nor does he permit them to fall finally from the grace of adoption and the state of justification.

These opinions, which were laid down at the Synod of Dort, represent the sentiments of the founder of this school, and of the ancient or *strict* Calvinists. In modern times another class of *Moderate Calvinists* has arisen, who differ from these in holding lower notions concerning reprobation and the extent of Christ's sacrifice. For other subdivisions among the Calvinists, see articles SUB-LAPSARIANS and SUPRA-LAPSARIANS.

CALX. A name applied by the alchemists to all products of combustion, especially those obtained from the metals, which were supposed to be converted into a species of *earth*.

CALY'BIO. (Gr. καλυβη, *a cottage.*) A name adopted by some carpologists, for such a one-celled, inferior, one or few-seeded fruit, enclosed in a cupule, as the acorn of the oak, the mast of beech, &c.

CA'LYCANTHA'CEÆ. (Calycanthus, one of the genera.) A small natural order of plants related to *Rosaceæ*. They are all shrubs with fragrant flowers, and inhabit North America or Japan. Some of them resemble the genus *Illicium* in their flowers.

CA'LYCERA'CEÆ. (Calycera, one of the genera.) A natural order of plants related to *Compositæ*, from which they differ very little, excepting that their seeds are pendulous and albuminous, and their anthers half united. The species are woody herbaceous plants, inhabiting the warmer parts of South America.

CALY'CULUS. A diminutive of *Calyx*, which see.

CALY'MENE. (Gr. κεκαλυμμενη, *concealed.*) A name devised to express the obscure nature of a genus of Trilobites (fossil crustaceans), to which it is attached, and which is distinguished from all other Trilobites by the faculty which the species possesses of rolling the body up into the form of a ball, in the same manner as the recent genera *Sphæroma, Armadillo, Glomeris;* viz. by approximating the two extremes of the trunk at the under part. The anterior segment or shield of Calymene is as broad or broader than it is long, and supports two compound prominent eyes; the posterior or terminal segment forms a sort of triangular elongated tail.

CALY'PSO. (Gr.) In Fabulous History, a daughter of Atlas, according to Homer, but of Oceanus and Thetys, according to Hesiod, was the queen of the island Ogygia. On this island Ulysses suffered shipwreck; and Calypso, by the united influence of her love and spells, prevailed on him to remain and share her sceptre. After the lapse of seven years, however, his desire to revisit his native country became irrepressible, and he resolved to forego his honours in Ogygia. Calypso tried every expedient, offering him even the bribe of immortality, to induce him to remain; but all her efforts proved unavailing, and on his departure she died of grief. The island of Ogygia, placed by Pliny (iii. 10.) off the Lacinian promontory, between the Tarentine and Scyllian bays, has long since been engulfed in the ocean, along with the famous islands of the Sirens.

CALYPTRÆ'A. (Gr. καλυπτρα, *a covering.*) The name of a genus of Gastropods, having a patelliform shell, to the concavity of which adheres either a smaller conical shell, like a cup in a saucer, or a semicircular testaceous process, forming the commencement of a columella. The branchiæ consist of a single row of long and slender filaments. The foot is circular, expanded, and furnished with two anterior processes. The genus, originally established by Lamarck, is now divided into the subgenera *Calypeopsis, Crepipatella*, and *Calyptræa*.

CA'LYX. (Gr. καλυξ, *a cup.*) The name given by botanists to the outermost of the enveloping organs of a flower. It is usually green, and sometimes bears a great resemblance to leaves; but it is also frequently richly coloured, as in the *Mirabilis, Salvia splendens*, &c. This organ appears to have the office of protecting the more tender parts lying within it, and is therefore usually present in flowers; when absent, its protecting office is always performed by some modification of bracts, as in the Arum and the Willow. If it is adherent to the sides of the ovary, it is called superior; if partially adherent, half superior; and if quite free from the sides of the ovary, it is inferior. In systematical botany these differences are of great importance.

CAMARI'LLA. (Span.) The *little* or private chamber of the sovereign of Spain (equivalent to the *petits appartements* of the old French regime); but the term is generally applied to his immediate confidants, who are usually all-powerful in the government of the country. In England the term is nearly synonymous with *clique*.

CA'MBER. (Fr. cambrer, *to bend.*) In Architecture, the convexity of the upper and concavity of the under side of a beam, by which it is prevented from becoming straight or concave at top either by its own weight, or by the loading it may have to carry.

CA'MBIUM. (A low Latin word for liquid which becomes glutinous.) A viscid secretion formed between the liber and alburnum of Exogenous trees in the early spring, when vegetation recommences. It is supposed by some physiologists to be the matter out of which new wood and bark are formed; by others to be a preparation of organizable matter, out of which the horizontal growth of the cellular system, and the vertical growth of the woody system, may be nourished during their respective development. It disappears as soon as the new wood and bark have been completely formed.

CA'MBRIC. A delicate linen fabric, which was originally manufactured at *Cambray*.

CA'MEL. A machine invented by the Dutch for carrying vessels into harbours where there is not a sufficient depth of water. It consisted of two large boxes, or half ships, built in such a manner that they could be applied on each side of the hull of a large vessel. On the deck of each part of the camel a number of horizontal windlasses were placed, from which ropes proceeded, on one side, and being carried under the keel of the vessel, were attached to the windlasses on the deck of the other part. When about to be used as much water as necessary was suffered to run into them; all the ropes were then cast loose, and large beams were placed horizontally through the port-holes of the vessel, the ends resting on the camels alongside. When the ropes were made fast, and the vessel properly secured, the water was pumped out, on which the camels rose and bore up the vessel. (*Beckman's History of Inventions*, vol. iii. p. 337.)

CAME'LEON or CHAMÆLION MINERAL. Manganesate of potash, obtained by melting a mixture of potash and black oxide of manganese. When put into water the solution is first green, and passes through a variety of tints of green, purple, and red, till at length it becomes colourless.

CAME'LIDÆ. (Camelus, *a camel.*) A family of ruminant Mammalia, which deviates from the rest of the order in the presence of two incisors in the upper jaw, and the absence of cotyledons in the uterus and fœtal membranes. The camel and dromedary of the old world, and the llama, guanacho, and vicugna of the new world, are the existing species of this family.

The old world Camelidæ (*Camelus*) are especially organized for existence in the arid and barren deserts of Asia and Africa. They have a broad, expanded, elastic foot, terminated in front by two comparatively small hoofs, and well defended beneath by a felt of coarse hair. The new world Camelidæ (*Auchenia*) have narrower feet, and the hoofs are bent in the form of claws, adapted to climb the steep passes of the mountain ranges of South America, to which continent they are confined.

Besides the peculiar characters above mentioned, the camels present a modification in the structure of the stomach which is not present in any other family of Ruminantia. There are developed from the sides of the first cavity of the stomach or paunch two series of cells, into which experiment has proved that the water which the animal drinks almost exclusively passes, and where it can be kept apart from the solid contents of the paunch in a quantity of several quarts. Surely the final relation of such a modification of structure to the peculiar physical characteristic of the localities to which the animal possessing it is confined must force itself irresistibly on the mind. But besides a reservoir of water to meet the exigencies of long journeys across the desert, the dromedary and camel are provided with a storehouse of solid nutriment on which they can draw for supplies long after every digestible part has been extracted from the contents of the stomach: this storehouse consists of one or two large collections of fat stored up in ligamentous cells supported by the spines of the dorsal vertebræ, and forming what are called the humps. When the camel is in a region of fertility the hump becomes plump and expanded; but after a protracted journey in the wilderness it becomes shrivelled and reduced to its ligamentous constituent, in consequence of the absorption of the fat. Buffon carried his teleological reasoning, or the ascription of design, so far as to assert that the humps on the backs of the camel were badges of slavery, and intended to adapt them to the burthens of their task-masters; and he supported this ingenious idea by the unfounded assertion that the dorsal prominences did not belong to the camels in free nature. But the true uses of the fatty humps, as of the water-cells, relate to the exigencies of the Camelidæ of the deserts under every condition. The complete adaptation of the camel for the dreary wastes in which it is destined to exist, is further illustrated by some minor modifications in its structure. The nostrils are narrow oblique slits, defended with hair at their margins, and provided with a sphincter muscle, like the eyelids; so that the animal can close them at pleasure. This action

is of great service in excluding the fine and penetrating sand which is drifted along in clouds by the storms of the desert. The expanded sole of the foot, elastic as a cushion, prevents the leg from sinking in the loose surface: the long joints and lofty tread of the camel are equally adapted for a rapid progression along loose sandy plains. Thus to the Arab of the scorching desert the camel is as valuable, and indeed as essential, as the reindeer to the Laplander in his region of perpetual snow. The one animal, like the other, serves, while living, for all the purposes of draught and burden, and supplies his master's family with milk. When dead the flesh of the camel is eaten, though it is coarser than that of the ordinary Ruminants: its hide, which approaches that of the Pachyderms in thickness and strength, is applied to the manufacture of saddles, harness, pitchers, shields, and various other articles. The finer hair is manufactured into articles of clothing, and the coarser hair is woven into a kind of matting for the covering of tents. By day the camels transport their owner and his family, with all their property, from place to place. By night the body of the recumbent beast of burden serves as a pillow for his master; or if the air be agitated, the camels are arranged to windward, so as to form a barrier against the ever-shifting sands.

The camel is the sole medium of communication between those countries which, are separated by extensive deserts; in the beautiful and expressive metaphor of eastern speech, it is "the ship of the desert," and in truth it is the only ship by which the wilderness can be navigated with certainty and safety. A stout Arabian camel can travel with a load of 800 pounds at the rate of about three miles in the hour. The swifter varieties, as the light dromedary or "mahairy," are said to carry a single rider over a space of from 70 to 100 miles in 24 hours, and that for several days in succession.

CAME'LLIA. (In honour of Kamel, a Spanish Jesuit.) A beautiful genus of evergreen shrubs inhabiting China and Japan. Several species are known; one of which, *C. oleifera*, furnishes the Chinese with abundance of oil used for various domestic purposes; others are small-flowered and unimportant; but one, *C. japonica*, is among the most beautiful species in the vegetable kingdom. It is from this that the multitudes of double varieties, now common ornaments of gardens in the spring, have been obtained by sowing seeds. Most of the varieties originated with the Chinese and Japanese; but many very fine ones have been raised in this country and Belgium. They are usually cultivated in pots, but are never seen in perfection unless planted in the open ground beneath a glass roof: under such circumstances they only require to be guarded from severe frost by some kind of heating apparatus. In some parts of England, and even near London, they are occasionally grown in the open air, but with little success.

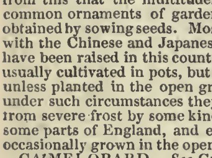
CA'MELOPARD. *See* GIRAFFE.

CAME'LOPARDA'LIS. One of the constellations formed by Hevelius in the northern hemisphere. It is situated between Cepheus, Cassiopeia, Perseus, Ursa Major, Ursa Minor, and Draco.

CA'MEO. A word of doubtful origin, applied to gems of various colours sculptured in relief. The art of engraving on gems boasts of high antiquity, having been practised with various degrees of success by the Egyptians, Greeks, and Romans. It was again revived in Italy in the 15th century, and is even at the present day cultivated with great avidity and considerable success. The cameos of the ancients were usually confined to the agate, onyx, and sard, which, on account of the variety of their strata, were better accommodated to a display of the artist's talents; but they are also occasionally found executed on opal, beryl, or emerald, and even on a sort of factitious stone, the *Vitrum obsidianum* of Pliny, distinguished by the moderns as the antique paste. (*Encyc. Metr.*) One of the most famous cameos is the onyx at present in Paris, called the *apotheosis of Augustus*. It is one foot in height and ten inches in width.

CA'MERA LU'CIDA. The name given by Dr. Hooke to an instrument contrived by him for making the image of any object appear on a wall in a light room either by day or by night. It is described in the *Phil. Trans.* vol. xxxviii. p. 741.

The instrument now known by the name of Camera Lucida is a very ingenious invention of the late Dr. Wollaston, for the purpose of enabling any one, without a knowledge of the rules of drawing or perspective, to delineate distant objects, or trace the outlines of landscapes &c., with perfect accuracy. It consists of a quadrangular glass prism, *a*, *b*, *c*, *d*, by means of which rays of light are bent, by two reflections, into a path at right angles to their previous direction. A ray of light proceeding from O enters the face of the prism at *a*, and continues its course in a straight line till it meets



the adjacent side of the prism at *b*, and making with it a very acute angle, is wholly reflected in the direction *b c*. At *c* it again meets the side of the prism, and is in like manner reflected in the direction *c* E. The eye being placed at E, sees the image of the object on the surface of the prism at *c*, and refers it to P, on a plane M N, which may be covered with a sheet of white paper. The point of a pencil can also be seen on the paper, and thus the accurate outline of the object may be traced. It is easy to see from this the proper form which the crystal should have. Suppose the two reflections to be equal, then the ray will be bent 45° from its original path by the first, and also 45° by the second; and the four angles which it makes with the faces of the prism at *b* and *c* are each 22½°; hence the faces *a* and *d* being perpendicular, the faces *a* and *b* must be inclined in an angle equal to three fourths of a right angle, or 67½°; *b* and *c* must make an angle of 135°, or three fourths of two right angles; and *c* and *d* make an angle of 67½°. By the laws of optics, the size of the picture will bear the same relation to the object delineated, that the distance of the eye from the paper bears to the distance of the object. Hence, in order to increase or diminish the size of the picture, the prism is mounted in a brass frame, supported by brass tubes capable of being lengthened or shortened at pleasure. A thin brass plate, affixed to the upper surface of the prism, and having a small hole in it for the observer to look through, keeps the eye in its proper place, and procures steadiness of vision. A convex lens may be placed over the hole in the brass plate, for the purpose of magnifying the image; or a concave lens placed before the prism at *a* will adapt it to short-sighted persons. The instrument is extremely convenient, on account of its portability.

The construction of the camera lucida may be varied in several ways. The following was proposed by professor Amici. A parallel piece of

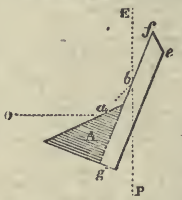
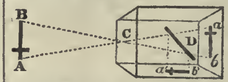


plate glass, *e f g*, is connected with a reflecting speculum A. The ray of light proceeding from O is reflected from the speculum at *a* to the plate glass at *b*, and there reflected again to the eye at E. The frame in which the instrument is placed has a rectangular opening at the top, through which the eye receives the image, and is prevented from receiving the rays coming directly from the metallic mirror. The image is referred to a plane below at P, where the pencil is seen through the glass.

CA'MERA OBSCU'RA, or DARK CHAMBER, is an optical apparatus, by which the images of external objects are thrown on a white surface, and represented in a vivid manner in their proper colours, shapes, &c. Hence the apparatus may be used for the purposes of delineation, as well as the camera lucida; but as it is from its construction less convenient, it is chiefly used as a source of amusement, or for explaining the nature of vision.

The theory of the Camera Obscura is shortly this.



Through a convex lens, or small circular hole at C, the light is admitted into a darkened room or box, so that rays proceeding from an object A B, and falling on a white ground within the room, paint an image of the object on it in an inverted position, *a b*. But the image is easily restored to its natural position by causing the rays to pass through two convex lenses inserted in a draw tube placed in the opening C. Sometimes a mirror D is placed in the interior of the box, making an angle of 45° with its sides, whereby the image is thrown down on the bottom of the box at *a b*, and by means of the reflection restored to its natural position. The best ground for receiving the image is plaster of Paris, formed somewhat concave. The image is viewed through an oblong aperture cut in the box. The most perfect camera obscura is formed by placing an inclined mirror in a revolving frame at the top of a building, by which the rays are thrown down on a convex lens in the roof, and the images of all the surrounding objects received on a table. The images being accompanied by the motions belonging to the objects, a very pleasing picture is formed. The invention of the camera obscura is usually ascribed to Baptista Porta; it was, however, known to Friar Bacon, in the 13th century.

CAMERALI'STICS. (Lat. camera, *a chamber*.) A word that has recently been introduced into the English language to signify the science of public finance. It is of German origin (the equivalent term in that language being *Kammeralien*), and derives its signification from certain officers (called Kammer-räthe) appointed by most of the petty princes of Germany to superintend their accounts, and disburse all payments.

CA'MERATED. (Lat. camera.) A term applied to the shells of certain Cephalopods which are divided by transverse partitions into a series of chambers which are traversed by a siphon. Most of the species are now extinct.

CAMERO'NIANS. The strictest sect of Scottish Presbyterians; so called from the Rev. Richard Cameron, one of the most eminent of their leaders. The origin of this sect is briefly told. Charles II., on his restoration in 1660, found presbytery to be the existing national church; and though he had, at one time, sworn to maintain that faith, yet thinking it incompatible with monarchical government, he lost no time in superseding it, and establishing episcopacy in its room. This he did in direct opposition, not merely to his own solemn obligations, but to the principles and predilections of his Scottish subjects. And the result was such as might have been anticipated. The presbyterian clergy, though driven from their parishes and deprived of their incomes, continued to preach and hold meetings, or *conventicles*, as these assemblages were contemptuously called, for the celebration of religious ordinances; and their influence with the people seemed to increase in proportion as means were taken to silence or crush them. Under these circumstances, Charles, finding that rigour failed in producing the effect at which he aimed, and the number of episcopalian ministers being insufficient to fill the vacancies that had been occasioned by his violent change of the national religion, had recourse to a plan, ostensibly liberal and mild, but which did by no means realize the views which he had anticipated from it. In 1669, he granted what he called an *indulgence*, or permission to such of the ejected ministers as had meanwhile "lived peaceably and orderly," or, in other words, who had not signalized themselves by holding conventicles, to return to their several parishes (if these were vacant), or to accept presentation to such other parishes as were vacant. A similar indulgence was issued in 1672; but both of them were marked by restrictions and conditions which were any thing but agreeable to tender consciences. (*Wodrow's Church Hist.* 8vo ed. vol. ii. p. 130-31.) This indulgence emanated solely from the king, and had not been submitted to the consideration of the church, and was, in consequence, regarded by many as tantamount to a recognition of the royal authority in matters *ecclesiastical* as well as civil, and as subversive both of the national covenants (*Acts of Assembly, apud* an. 1649), to which they had sworn, and of presbytery itself, which acknowledged no head but Jesus Christ. Some of the more moderate of the clergy, however, did not think it inconsistent either with their vows or principles to accept it; others complied with it, regarding it as an encroachment on their religious rights, but satisfying their conscience by giving an open testimony against it and the ecclesiastical authority assumed by the king; while there were some who preferred principle to expediency, and peremptorily refused compliance on any terms, and resisted every effort to procure their acquiescence. These were the persons who were afterwards denominated Cameronians. (*Wodrow*, iii. 202.)

The Cameronians were influenced in the line of conduct which they pursued solely by conscientious motives. Rather than acknowledge the authority of the king in matters ecclesiastical, or abate one iota of their indefeasible rights and privileges, they were willing to separate from their conforming brethren, and to encounter all the evils and disabilities which such a step had evidently a tendency to produce. They became at once the object not only of the disapprobation of their indulged brethren, but of the vindictive and cruel rage of a tyrannical government. On the principle that "oppression drives a wise man mad," they pushed their views to the utmost extremity; and, while they vilified the Presbyterians whose opinions, both religious and ecclesiastical, were more moderate than their own, they stigmatized the king and government as unscriptural and Erastian. In short, while they arrogated to themselves absolute liberty of conscience and of judgment, they exhibited the greatest intolerance towards others who entertained different sentiments. When persecuted and proscribed, when many of them were imprisoned, and not a few of them suffered martyrdom, they began to consider their king as a tyrant; and they publicly declared, that "by his perjury in violating his covenanted vows, by his arbitrary government, and his usurpation over their civil and religious liberties, he had dissolved their allegiance and forfeited all right and title to the crown." (*Laing's Hist. of Scot.* vol. iv. p. iii.) They also protested against the succession of his brother, on account of his popery and his breach of covenant to God and the church. To these sentiments Cameron, their leader, and a party of about twenty others, all armed, gave public utterance in a *declaration* read at Sanquhar, and affixed to the market-cross of that town. (*Wodrow*, iii. 312.) This was the signal for more prompt and decisive measures on the part of government. The party were soon after (20th July, 1680) surprised at Airsmoss, a morass on the confines of the counties of Ayr and Dumfries. Cameron and his brother fell on the field; while sixteen were taken prisoners, and soon after perished as traitors on the scaffold; the remainder of the party, with some peasants who had joined them, fled. But their spirit was not intimidated, nor was their enthusiasm abated. Cargill, who was now their leader, and who was shortly after apprehended and publicly executed, pronounced at a public meeting of the party at Torwood, near Stirling, a solemn excommunication against their persecutors, including the Duke of York and the king himself. (*Hind Let Loose, passim; Laing*, iv. 112-13.)

Meanwhile, the Cameronians had formed themselves into a more regular body; and, in 1681, agreed to hold quarterly or more frequent meetings, and took the name of *The Societies United in Correspondence.* They thus acted more in concert; and their fortitude and zeal became, if possible, more intense. They were now altogether alienated from the indulged ministers and the general public; and their meetings for religious worship and for the celebration of ordinances were, for the sake of safety, confined to the mountains, or to sequestered and remote spots. They still continued the objects of the most ruthless persecution. But while proscribed and chased like beasts of prey by the government, no respect being shown to age or sex or condition, and while numbers of them, including their most popular ministers, perished on the scaffold or at the stake, they began to disagree among themselves. Some of them having been dissatisfied with the language of the *Sanquhar Declaration*, certain portions of it had been amended or explained. A considerable number took offence at the violence of Renwick, now at the head of the party; and not only separated from them, but published testimonies against some of their proceedings. The one party were averse to unite with such as would not go to the same extreme as themselves; while the other, more moderate in their principles, were for making common cause with all who held the same general sentiments, and were exposed to the same persecutions. It was at this period (1687) that Renwick drew up their *Informatory Vindication*, which in spirit was the same as the *Sanquhar Declaration.* But the breach was never healed. It is unnecessary, however, to give a more minute account either of their proceedings or their sufferings. Renwick, who was beheaded in 1688, was the last Scottish martyr. The revolution put an end to the sufferings of the Cameronians, and to persecution for conscience' sake. (*Scotch Worthies*, § Renwick, Hackston of Rathillet, &c.; *Hind Let Loose.*)

The services of this proscribed party at this crisis were of an important kind. Suffering as they had long done at the hand of a sanguinary government, and alive as they were to the value of civil and religious liberty, they espoused the cause of the Prince of Orange with an enthusiasm and bravery worthy of their character. A regiment of 800 Cameronians was speedily raised; and their heroism as displayed at Dunkeld and other places has extorted the praise of history. A regiment bearing the name still exists. (*Laing*, iv. 194. 208. 232.)

But the Cameronians, though they occupy a prominent place in the history of the reigns of Charles, and of James II. his successor, never formed a very numerous body. After the revolution, when they were allowed to worship God according to their conscience without fear or danger, they gradually became an obscure as they were a small sect. Nor did they think of forming themselves into a regular church till 1743, when, under the direction of the Rev. M. M'Millan * and other leaders, they "formed and established a presbytery in the name of Christ, the alone king and head of the church, under the title of the Reformed Presbytery." As they became more numerous, they took the title of the Reformed Presbyterian Synod. But at this moment (1841) the synod consists only of six presbyteries, embracing thirty-five congregations, most of them being very small.

The nature of the tenets and doctrines of the Cameronians may account for their never having become a numerous sect. They denied the authority of civil rulers, unless these had sworn and subscribed the national covenants; and of course they refused to include the names of such rulers, even that of the sovereign himself, either in their public or private prayers. They contended that the civil magistrate is bound to suppress error, and to encourage the true religion; and that the covenants are binding on all posterity. These opinions, however, they have gradually modified or abandoned. They now pray for the sovereign and civil magistrates, and have virtually renounced the covenants. They are also in favour of a national church; and would have no hesitation to unite with the present established church of Scotland

* They are often called *M'Millanites*, in honour of this person. They are also known by the name of *Hills People*, from the circumstance that, till within the last fifty years, they held public worship almost exclusively in the open air on the side of some hill, in honour of their persecuted forefathers in the time of Charles II. This practice they have now laid aside, and avail themselves of stone edifices for churches like other sects. *See* MACMILLANITES.

if patronage was abolished, and if the right of electing their own ministers were conferred on the people. They adopt the Westminster Confession of Faith, and all the standards and formulas of the church of Scotland. Their ministers are strict disciplinarians, adopt the Calvinistic creed in its most rigid sense, are peculiarly assiduous and faithful, and as a body the Cameronians now form a most unobtrusive, respectable, and exemplary sect of Christians.

CA'MISARDS. In French History, the Protestant insurgents in the Cevennes, after the revocation of the edict of Nantes, were so called, from having worn their shirts over their dress by way of disguise on the occasion of some nocturnal attacks. Their principal leader, Cavalier, succeeded so far as to effect a capitulation in their favour with the French government. He subsequently entered the English service, and at his death was governor of Jersey.

CA'MLET. A stuff or cloth, consisting of a mixture of wool and silk, or of wool and camel's hair.

CAMO'ENÆ. (Derivation unknown.) A Roman appellation of the Muses.

CAMP. In the art Military, a word of doubtful etymology, signifying the station of an army, with its artillery, baggage, and other appendages, when it has taken the field for the purposes of war. The history of camps involves that of the military art in all ages and in all countries; and in proportion to the skill displayed by any nation in the science of castrametation, may an accurate estimate be formed of its attainments in other departments of military tactics. The Lacedæmonians appear to have been the first people in profane history who directed their attention to this subject. Their camps, whenever it was practicable, were of a circular form, which was said to possess the advantage that from the centre, where the general with the flower of the troops lay, help could soonest be afforded to any point menaced by the enemy. The other states of Greece, Macedonia, and Carthage borrowed the grand principles of choosing and tracing their camps from the Lacedæmonians; but accommodated the form, the arrangement, and disposition of the same to the nature and strength of the ground which they intended to occupy. It was from the Romans that the art of castrametation first acquired any systematic regularity. The form of the Roman camp was invariably quadrangular; it was surrounded by regular intrenchments, and was so admirably arranged that each cohort, legion, and individual knew exactly the point which he ought to occupy, and the part to which instant attention should be directed in the event of alarm. It would exceed our limits to give an account of the construction of the Roman camps, and of the arrangement of the troops in them. The reader will find ample details and comments upon this subject in the works of Polybius and Vegetius, and in General Roy's *Military Antiquities of the Romans in Britain.* The *Penny Cyclopædia* contains an able account of the different systems of castrametation.

CAMP. In Agriculture, a heap of turnips, potatoes, or other roots, laid up for preserving through the winter; in some places called a *pie*, and in others a *bury*.

CAMPAI'GN. (Fr.) An uninterrupted series of military operations in the field. *See* WAR.

CAMPANI'LE. (It. campana, *a bell.*) In Architecture, properly a tower for containing a bell or bells. Though the word has been adopted in the English language, and applied to the bell towers of churches, it more properly belongs to those towers near churches, but detached from them, to be seen in many of the cities of Italy. The principal of these are the Campanile of Cremona, which is of the extraordinary height of 396 feet; that of Florence, 268 feet high, built from the design of Giotto; the Garisendi tower at Bologna, built in 1110, which is 147 feet high, and is 8 feet 8 inches out of an upright; and very near to it in the same city another tower, bearing the name of Asinelli, 327 feet in height, and leaning from the perpendicular 3 feet 8 inches, but which, seen, as it always is, in company with the first, seems to lean but little. The last we shall name is that which is commonly called the leaning tower of Pisa, and perhaps the most remarkable of all. It is 151 feet high, and overhangs 12 feet 9 inches. Its general form possesses elegance, and is that of a cylinder encircled by 8 tiers of columns over each other, and each with an entablature. The columns are all of marble, and the upper tier is recessed back.

CAMPA'NULA. (Lat. campana, *a bell.*) A very large genus of hardy herbaceous plants and annuals, inhabiting the temperate parts of both the eastern and western hemispheres, but most abundant in the latter. They have blue or white flowers, often of considerable size, on which account most of the species are favourites in gardens. In M. Alphonso de Candolle's account of the genus, published in 1830, after separating from it several groups, 152 species are enumerated. The only useful plant among them is *C. rapunculus*, the radish-like sort of which is sometimes eaten under the name of Rampion.

CAMPE'ACHY WOOD. Logwood. Brought from *Campeachy*, in the bay of Honduras.

CAMPHE'NE, or CAMPHOGEN. A term applied by chemists to a hydrocarbon, composed of ten atoms of carbon = 60, and eight of hydrogen = 8; it is therefore represented by the equivalent number 68. It is identical with pure *oil of turpentine;* and camphor is its protoxide, that substance being composed of 68 camphogen + 8 oxygen; camphor is therefore represented by the equivalent number 76.

CA'MPHOR. A concrete volatile and highly odorous substance, obtained by distillation from the *Laurus camphora*, or camphor laurel, which is a native of Japan. It is also found ready formed in the wood of the *Driabalanops camphora*, a tree which flourishes in Borneo and Sumatra. What is called *crude* or *rough* camphor is in small grey pieces and crystals; it is purified by sublimation, and is found in commerce in circular cakes weighing about 8 lbs. each, white, translucent, and somewhat tough and crystalline in texture. Camphor is chiefly used in medicine: it dissolves very sparingly in water, and the solution is called *camphor julep;* it dissolves abundantly in alcohol, forming *camphorated spirit of wine.*

CA'MPHORATES. Compounds of camphoric acid.

CAMPHO'RIC ACID. An acid obtained by boiling camphor in nitric acid. It consists of 60 carbon, 8 hydrogen, and 5 oxygen; or of one atom of camphor and four atoms of oxygen.

CA'MPULI'TROPOUS. (Gr. καμπτω, *I curve*, and τρεπω, *I turn.*) In Botany, a name given to such ovules as bend down upon themselves till their apex touches the base. They are extremely common in plants, and are more particularly those in which a *raphé* exists; the latter being a bundle of vessels, whose office is to maintain a communication between the base of the nucleus and the base of the seed.

CANA'L. (Lat.) An artificial channel filled with water, formed for the purposes of draining, of irrigation, of supplying towns with water, or of inland navigation. Illustrative of the first, may be cited the canal which extends from the Fúcine Lake (now Lake Celano) into the river Liri; of the second, the canals with which ancient Egypt was intersected; of the third, the artificial aqueducts of antiquity, or in modern times the New River, by which London is in a great measure supplied with water from Hertfordshire; but it is to channels for the purpose of inland navigation that the term *canal* is usually confined.

That the importance of canals as a means of inland navigation attracted attention even in the earliest ages, is manifest from the "fossæ Philistinæ," large canals (*Pliny*, iii. 16.) at the south of the Eridanus in Liguria, the origin of which is ascribed by Mr. Bryant to the Canaanites, who at an early period migrated from Philistia; as well as from the grand design of the Cnidians, a people of Caria in Asia Minor, to dig a channel through the isthmus which joined their territory to the continent. (*Her.* ii. 78.) The attempt, too, of the Egyptians at a later period to unite the Nile with the Red Sea by a canal has been often recorded, though it is difficult at the present day to discover the least traces of its existence. The Greeks, who received the first principles of commerce and the arts from the Egyptians and Phœnicians, and who, improving upon the models transmitted to them, afterwards reached an unexampled pitch of civilisation, conceived the magnificent design of making a navigable passage from the Ionian Sea into the Archipelago, by cutting a canal across the isthmus of Corinth. This undertaking, however, proved abortive; and though the attempt was again renewed by several of the Roman emperors, it still remained without success. In the reign of Augustus, Drusus succeeded in excavating a canal from the Rhine to the Issel, and formed, as we are told by Pliny, a new mouth from the Rhine to the sea. A canal between the Rhine and the Maese, supposed to be that now commencing at Leyden and passing Delft to its junction with the Maese at Sluys, was likewise formed by the Romans. But, as has been often observed, it was by bending nations under the same yoke, and not by uniting them in commercial ties, that the Romans sought to extend international communications; hence their canals were usually formed for the purposes of draining or of warfare. There can be little doubt, however, that it was the Romans who introduced into their provinces the models of internal communication which in modern times have undergone such immense improvement, and which have been converted to a purpose nobler than conquest — the interchange of the productions of labour.

There is no country in the world where the advantages of canals are more appreciated than in China. From time immemorial the rivers that intersect that vast empire have been united by innumerable canals; and the Grand Canal is said to be the most stupendous work of the kind that has ever been executed. (*Raynal, Hist. Phil.* i. 102.) Russia, too, exhibits a remarkable degree of enterprise in the construction of canals for the

purpose of inland navigation; and though innumerable difficulties peculiar to that country for a long period impeded the progress of works of this description, that empire is now traversed by an unbroken line of water communication from St. Petersburg to the Caspian Sea.

The canals constructed during the period of the glory of Italy are very numerous; but though many of these are navigable, their primary object has been to communicate to both banks of the Po the various productions of the country.

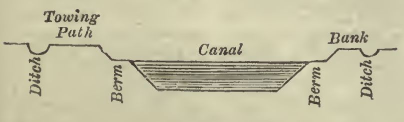
In the Netherlands, the construction of canals commenced in the 12th century, when Flanders became the commercial entrepôt of Europe; and to the large share which canals possess in its economical arrangements is to be ascribed chiefly the prosperity of Holland in the present day. From the structure of that country, canals are formed with peculiar facility; and there is not a town or a village which is not furnished with a canal of greater or smaller dimensions. France has from a distant period exercised its skill in the construction of canals for inland navigation. The first was the canal of Briare, which opens a communication between the Loire and the Seine, and then between Paris and the western provinces, and is of immense importance in inland commerce. Omitting many works of this kind, completed, in progress, or projected in that country, the canal of Languedoc may be mentioned, which was intended to unite the Mediterranean with the Atlantic, and was considered a stupendous undertaking. It is 150 miles long, is supplied by a number of rivulets, and is provided at proper intervals with 114 locks and sluices.

A reference to the earlier history of Spain, Sweden, and Denmark, and to the more recent accounts of Austria, Prussia, and above all America, will show to what extent these several states have endeavoured by the construction of canals to develop internal resources, and to distribute universally the productions of labour.

It is a singular circumstance that Great Britain, generally foremost in the race of civilisation, and possessing so many natural means for the formation of canals, from its insular position and its numerous rivers, was the last country in Europe to avail itself of its advantages. It is true that at different periods of our history the importance of inland navigation was deeply felt, and various expedients were adopted for removing obstructions in the rivers of England, with the view of facilitating internal commerce; but it was not till the middle of the last century that the construction of canals began to enter into the system of British economy. In the year 1755 an impulse was given to the progress of British industry by the project, which originated with the Duke of Bridgewater, of forming a canal between Worsley and Manchester; a project which was altered and extended by three successive acts of parliament to admit of greater comprehensiveness in its execution, and has formed the basis of every succeeding plan of canalisation in this country. The example then set by the Duke of Bridgewater was speedily followed: the large amount of capital in England, which is ever ready to be invested in undertakings that are likely to prove profitable, soon found its way into this channel, and in a short time the country became intersected with navigable canals.

The section of a canal is usually a trapezium, of which two sides are parallel and horizontal, and the other two equally inclined to the horizon. The inclination depends on the nature of the soil. It is least in tenacious earth, and greatest in loose soil; but no soil will maintain itself, unless the base of the slope exceeds its height at least in the ratio of four to three. In loose soils the base requires to be twice as great as the height.

A canal is usually confined between a bank on one side, and a towing path on the other, the breadth of whose upper surface must be sufficient for a road on which the animals employed in draught may easily pass. This requires the breadth of the upper surface to be at least 9 feet. The usual rule for the other bank is to make the breadth at top equal to the height, measured from the bottom of the canal: but in this case there should be a *berm* of a foot, or a foot and half, at the level of the water, which increases the thickness of the bank at bottom, and prevents the wash of the banks from falling into the canal. To prevent the entrance of rain-water, a *counter-ditch* is formed on the outside of each of the banks. The profile of a well-constructed canal will therefore present the following figure:—



The dimensions of navigable canals must depend on the size of the vessels intended to navigate them. In order that they may permit two vessels to pass each other with freedom, the breadth at bottom is usually made twice as great as the breadth of the beam of the vessels: the depth requires to be at least one foot more than the vessel's draught of water.

The bed of a canal must be absolutely level, or have no more slope than is necessary to convey water to replace that which has been wasted. Hence, when a canal intersects a sloping country in a series of channels at different levels, means must be provided to enable vessels to pass from one level to another. This is commonly effected by means of a *lock*.

The invention of locks as a means of carrying a canal through an undulating country has given an entirely new feature to the inland navigation of Europe. Various nations have claimed the honour of this invention; but it would appear that the controversy which has arisen on the subject is not yet settled. "A lock is a chamber, formed of masonry, occupying the whole bed of the canal where the difference of level is to be overcome. This chamber is so contrived that the level of the water which it contains may be made to coincide with either the upper or lower level of the canal. This is effected by two pairs of gates, one of which pairs is placed at each end of the chamber of the lock. By this means, while the gates at the lower end of the chamber are opened, and those at the upper end are closed, the water in the chamber will stand at the lower level of the canal; and, on the contrary, when the lower gates are closed, and the upper gates are opened, the level of the water in the lock will coincide with the level of the water in the upper part of the canal. In the first case, a boat may be floated into the lock from the lower part of the canal; and if then the gates be closed, and water is admitted into the lock from the upper level until the surface of the lock is in a line with the water above, the boat will be floated up, and on the opening of the upper gates may be passed onward. By reversing the course of procedure, boats may be as readily conveyed from the upper to the lower level." *See* LOCK.

The supply of water required for maintaining a canal depends on the *lockage* or quantity wasted in passing a vessel through the locks, on the evaporation from the surface, and on the leakage. It has been found by experiment that the annual quantity of evaporation from the canal of Languedoc is 32 inches; that is to say, the body of water required to supply this waste is equal to a parallelopiped whose base is the whole surface of water in the canal, and whose altitude is 32 inches: in most calculations it has been customary to take this altitude at 36 inches. With respect to the leakage, when the soil is porous the inner surface of the banks may be lined with an earth retentive of water, or a portion of the middle of each bank may be built up with earth of this character. The operation of lining a bank with clay, or earth retentive of moisture, is called *puddling*.

The advantages derived from canals are now so generally known and acknowledged, as to render it almost superfluous to allude to the question. The beneficial effects of canals are felt in a greater or less degree by all classes of society: by their means the manufacturer is enabled to collect his materials and his fuel with less labour and expense; the farmer obtains a supply of manure at a cheap rate, and a ready conveyance of his produce to the most profitable market; and the merchant is enabled to extend his commerce by exporting greater quantities and varieties of goods from places remote from the sea, and by more easily supplying a wider extent of inland country with articles of foreign produce. In short, general arguments in favour of canals are superseded by the rapidly improving and thriving state of all the cities, towns, and villages in their neighbourhood; while the great works of every kind to which they have been conducted, and to which a large portion of them owe their rise, are their best recommendation. Some years ago, when the formation of railroads became a favourite speculation, no small degree of alarm was experienced by those interested in the prosperity of canals, lest they should diminish in importance, or in fact be entirely superseded by the introduction of railroads. Experience has, however, hitherto shown that the fears entertained on this subject were perfectly groundless; for, as railways are constructed chiefly for the expeditious transport of passengers and goods, and from the expense incurred in their construction and maintenance a higher rate of toll must be levied in order to pay the proprietors, this mode of conveyance is not likely to interfere with that description of goods which form the chief traffic of canals, and for which *cheapness*, not *expedition* of transport, is required. (For detailed information on the subject of canals, the reader is referred to *Phillips's General History of Inland Navigation;* and to *Nichols, Priestley, and Walker's Historical Account of the Navigable Rivers, Canals, &c. of Great Britain.*)

CANALI'CULATE. (Lat. canalis, *a water pipe.*)

In Zoology, is said of a surface when it has a longitudinal impressed line or channel.

CANALI'CULATE. (Lat. canalis, *a water pipe.*) Is said of leaves or other parts when the edges are so much turned upwards as to produce the appearance of a channel or gutter.

CANALI'FERA. (Lat. canalis, *a canal;* fero, *I bear.*) The name of a tribe of Zoophagous Univalves, or Gastropods, of which the shell is characterized by a long straight canal terminating its mouth.

CANA'RY-BIRD. Two distinct species of finch (*Carduelis*) appear to have afforded the different varieties of singing bird familiarly known by this name. The one which is best known in its wild state is the *Carduelis canaria* of Cuvier, and is very abundant in Madeira, where its characters and habits have been observed with much attention by Dr. Heineken. "It builds," says this naturalist, "in thick bushy high shrubs and trees, with roots, moss, feathers, hair, &c.; pairs in February; lays from four to six pale blue eggs; and hatches five, and often six times in the season. It is a delightful songster, with, beyond doubt, much of the nightingale's and sky-lark's, but none of the wood-lark's song."—"A pure wild song from an island canary, at liberty, in full throat, in a part of the country so distant from the haunts of men that it is quite unsophisticated, is unequalled, in its kind, by any thing I have ever heard in the way of bird-music." The canary-bird was brought into Europe as early as the 16th century, and is supposed to have spread from the coast of Italy, where a vessel, which was bringing to Leghorn a number of these birds besides its merchandise, was wrecked. As, however, they were males chiefly which were thus introduced, they were for some time scarce; and it is only of late years that their education and the proper mode of treating them have been known.

CANA'STER. The rush basket in which tobacco is packed in Spanish America; whence *canaster tobacco.*

CA'NCEL. (Fr. canceller.) In Printing, is the suppression of a leaf or more of a book, owing to some error of importance having escaped detection, or some fact being mis-stated, or some new discovery being made, or some change having taken place in the author's arrangements after that part of a work has been printed, and substituting for the portion cancelled a corrected leaf, &c. which is usually distinguished by one of the following signs at the bottom of the page, *, †, ‡, §, as a guide to the bookbinder.

CANCELLA'RIA. (Fr. canceller.) A Lamarckian genus of Trachelipod Testacea, having the shell oval or turreted; base of the aperture sub-canaliculate; canal very short; columella plicate; the plaits usually transverse, varying in number; lip internally furrowed; operculum horny. The reticulated Cancellaria (*Cancellaria reticulata,* Lam.) is a well-known species, from the Atlantic Ocean.

CA'NCELLATE. (Lat. cancelli, *lattices.*) Is a term applied to leaves consisting entirely of veins, without connecting parenchyma; so that the whole leaf looks like a plate of open network. Instances of this kind occur in *Hydrogeton fenestralis,* but are extremely rare.

CA'NCER. (Lat.) The *Crab.* The fourth sign of the zodiac, which the sun enters about the 21st of June, when he reaches his greatest northern declination. The parallel circle through this point is called the *Tropic of Cancer.*

CANCER. The Linnæan generic name for the modern Brachyurous family of Crustaceans.

CANCER. A disease chiefly attacking the glands, consisting of a schirrous tumour, terminating in an ill-conditioned and deep ulcer, generally attended by excruciating pain. When the cancerous character of a tumour is once ascertained, its extirpation, where practicable, is the only chance of effectual relief. The large blue veins which ramify round a cancer of the breast were compared by old authors to the claws of a crab, whence the name of this disease.

CANCRO'MA. A genus of *Grallatores* or wading birds, belonging to Cuvier's family of *Pressirostres,* or compressed-billed waders, including only one known species, the Boatbill; so called from the form and structure of the bill, which characterizes the genus. The bill is flattened or depressed, not compressed; and is composed of two boat-shaped or spoon-shaped mandibles, with their concavities applied towards each other, the upper one having a strong and sharp tooth near the point. The Boatbill inhabits the banks of the Orinooko, and other large rivers of South America which are subject to flooding in the rainy season.

CANDELA'BRUM. (Lat. candela, *a lamp or candle.*) A stand or support on which the ancients placed a lamp. Candelabra varied in form, and were highly decorated with the stems and leaves of plants, parts of animals, flowers, and the like. There was no article of ancient furniture in which more taste and elegance were displayed than in the designs of candelabra. The etymology of the word would seem to assimilate the candelabrum to our candlestick; it is, however, quite certain that the word *candela* was nothing more than a lamp, and that the candelabrum was but a support more or less heavy in construction upon which the lamp was placed, or whose top was hollowed out for the reception of oil or some other combustible. The great variety observable in ancient candelabra was not so dependent on the caprice of the artist, as on the different uses to which they were first applied. Before the employment of oil the mode of illuminating an apartment was by means of dry wood burnt on *braziers* (basins for holding fuel) supported by tripods. The Greeks, always delighting to preserve some reminiscence of an ancient usage, thence adhered to the triangular form in this article of furniture, and their example was imitated by the Romans. Generally speaking, there are two species of candelabra: those which ending upwards in the form of a brazier, so nearly approach the form of a portable altar as to be almost confounded with it. This species must be classed with the tripod, and there seems ground for believing that it was used only in temples or in small chapels. Of this sort was that carried off by Verres; and Cicero informs us that in Sicily every house was supplied with one in silver. Of this species also are those most frequently sculptured in friezes, usually accompanied by genii and instruments of sacrifice. The other species of candelabra, whose accessaries and ornaments are of the same character as in those first described, are much higher, and of marble. Of this kind Rome furnishes an abundance of examples; but, as Winkelman observes, not one has been found in bronze.

The marble candelabra exhibit as much variety in the forms of the vase or brazier, which it is their principal end to support, as in the body and base of the support itself. Sometimes they are capricious to excess, the foliage, contrivance, and design being such as to display more skill than propriety of taste. Others, however, there are which are exquisite models of form, taste, ornament, and execution. The museum at the Vatican contains possibly the finest collection in Europe of this species. There is one to be seen there upwards of seven feet high, resting on griffins' or lions' paws. The general form of its shaft is that of a baluster, which supports a vase-shaped basin; it is highly decorated with foliage and bassi-rilievi of bacchantes. Our British museum presents some specimens; beautiful, but not of the first class. For full information on this species, the reader should turn to the splendid works of Piranesi. Lachausse thinks that marble candelabra were used in temples more for the purpose of adding splendour to the service than of lighting it; but it seems probable that many with which we are acquainted, such as those that were found in the baths of Titus, where numbers of the apartments did not receive the light of day, actually held artificial light. The most curious specimens of candelabra, as respects form, use, and workmanship, are those excavated at Herculaneum and Pompeii. These are all of bronze; and that they were employed for domestic purposes is proved from the representation, on an Etruscan vase, of one which serves to give light to the guests assembled round a banquet table. They are slender in their proportions, and perfectly portable, rarely exceeding five feet in height. It is to be observed, that none of the candelabra hitherto found exhibit any appearance of a socket or of a spike at top, from which an inference of the use of candles could be drawn.

CANDIDA'TI. (Lat. candidus, *white.*) In Roman Antiquities, so called from their being arrayed in white garments, were the aspirants for public offices. In this dress they canvassed the different tribes, harangued the people, extolled their own exploits, and, as the case might happen, exhibited the wounds which they had received in the service of their country. The forms of election among the Romans were remarkably strict. Every candidate for public offices was compelled to pass two years in probationary service; and even then his appointment, which could only be ratified by numerous and imposing solemnities, did not generally take place until he had spent five months as magistrate elect in familiarizing himself with the duties of his office. Notwithstanding the severity of the Roman laws against corruption, the practice of bribery was constantly resorted to, and a full purse and fair promises went far to supply the want of ability and integrity.

CA'NDLEMAS. A church festival, held on the 2nd of February, to commemorate the purification of the Virgin. The name probably arose from the number of lighted candles used in the processions of the day; or perhaps from a custom of consecrating candles on that day for the rest of the year. This practice was abolished in England in the second year of the reign of Edward VI.

CA'NDLES. These are an important article of manufacture, and may be composed of a variety of materials: the principal are,—1. *Wax candles,* which are made by pouring melted wax over the wicks, which for the convenience of turning and placing them successively over the cauldron, are usually attached to the circum-

ference of a hoop; when of a proper thickness, they are rolled smooth upon a table, and the ends are cut and trimmed. It is in consequence of this method of manufacture, that when we cut a wax candle we observe it composed of successive layers or coats. Attempts have been made to cast wax candles in moulds, but those which are thus made never burn so well as those which are *poured*. 2. *Spermaceti candles*, or mixtures of wax and spermaceti. This material forms a very good and cleanly candle; but in consequence of its ready fusibility and hardness when concrete, it does not admit of being carried about without spilling the melted material. The fused portions also, which run down the candle, are apt to curl up and fall upon the table. 3. *Composition candles*. This term was originally conferred by a manufacturer who had a large stock of spermaceti candles on hand which were of a dirty hue, and which therefore were unsaleable; he advertised them under the above name, and they were soon disposed of, under the notion of their being composed of some new combination of materials. The term has since been applied to various mixtures; but what are now sold under the name of composition candles are chiefly mixtures of spermaceti, tallow, and a little resin, and occasionally wax. 4. *Tallow candles*, which are either cast upon the wick in pewter moulds, or made by dipping the wicks, attached in rows to proper frames, into melted tallow. 5. *Stearine candles*. Under this term we may include cocoa-nut oil candles, and a few others made of the stearine, or what may be compared to the *spermaceti* of the vegetable oils. The stearine, or rather the *stearic acid* of tallow, is also now extensively employed for making candles.

A candle may be considered as a portable gas apparatus, and its philosophical history involves a number of very curious points, which we can only superficially advert to here. The combustible material, in a state of fusion, is drawn up in successive portions by capillary attraction into the heated part of the wick, the texture, materials, and dimensions of which are matters of much importance. If the wick be too large, the candle flares and smokes, producing a peculiar suffocating smell in the room, and often wanting snuffing, as we constantly see in badly made mould candles; if, on the contrary, the wick be too small, the candle burns dimly and gutters, in the former case, unburned carbon soon collects in the upper part of the flame, and if not removed is apt to fall into the cup of the candle, where it forms a kind of second wick, rapidly melting away the tallow and disfiguring the candle, and occasionally, where candles are inadvertently left burning, falling upon the table and setting fire to any thing within its reach. This evil may to a great extent be prevented by inclining the candle at an angle of about 45 degrees, so as to keep the upper part of the wick out of the flame. In this way the air has access to it, and the charcoal which otherwise collects into a head is burned as soon as deposited. Where it is required to keep a common tallow candle burning during the night, the necessity for snuffing, and the risk of mischief, may be prevented by so inclining it; and candlesticks have been contrived for the purpose, which are useful and effective, but very unseemly. With good wax the wick is more easily adjusted to the wants of the flame, and the necessity of snuffing to a great extent prevented; but adulterated wax is often more troublesome than tallow. Great care is also requisite in selecting the cotton for the wicks of candles, which should be of such a nature as to leave no ash, or scarcely any, when burned. The wick is occasionally impregnated with different substances, and sometimes so platted as to curl out of the flame; but the details of these contrivances would be foreign to the object of this work. The following table contains the results of some experiments made by Dr. Ure, with a view of ascertaining the relative intensities of light and the duration of different candles: —

Number in a pound.	Duration of a candle.	Weight in grains.	Consumption per hour in grains.	Proportion of light.	Economy of light.	Candles equal to one Argand.
10 Mould	5h. 9m.	682	132	12·25	68·0	5.70
10 Dipped	4 36	672	150	13·00	65·5	5·25
8 Mould	6 31	856	132	10·50	59·5	6·60
6 Ditto	7 2½	1160	163	14·66	66·0	5·00
4 Ditto	9 36	1787	186	20·25	80·9	3·50
Argand oil flame		- -	512	69·40	100·0	

In reference to the above table, it appears from Dr. Ure's experiments that one-eighth of a gallon of good oil, weighing 6010 grains, or 13 and 1-10th ounces avoirdupois, lasts in a bright argand lamp 11 hours 44 minutes. The weight of oil it consumes per hour is equal to four times the weight of tallow in candles eight to the pound, and 3 and 1-7th times the weight of tallow in candles six to the pound; but, its light being equal to that of five of the latter candles, it appears from the above table, that 2 lbs. weight of oil, value one shilling, in an argand lamp, are equivalent in illuminating power to 3 lbs. of tallow candles, which cost about three shillings. The larger the flame in the above candles, the greater the economy of light. (*Ure's Dictionary of Chemistry.*) In reference to the comparative cost of coal gas, oil, tallow, and wax, it appears that the cost of a lamp fed by gas, and giving the light of seven candles, will be about one penny per hour; of an argand lamp fed with spermaceti oil, about threepence; of mould candles about threepence halfpenny; and of wax candles about one shilling. Ninety cubic feet of good coal gas, value about one shilling, will produce the light of about 10 wax candles for one hour.

CANE'LLA. (Dim. of canna, *a reed.*) The bark of the *Canella alba*, imported from the West Indies in quilled pieces of a pale buff colour, and a biting aromatic flavour. It is occasionally used in medicine.

CANE'LLEÆ. (Canella, one of the genera.) A small natural order of plants, supposed to be related to *Clusiaceæ;* but very imperfectly known. They consist of South American shrubs or trees; one of which, *Canella alba*, is aromatic, and yields the wild cinnamon of the West Indies. The bark of that species is used medicinally against scurvy.

CANE'PHORÆ. (Gr. κανηφόρος, *bearing a basket.*) In Architecture, figures of young persons of either sex, bearing on their heads baskets containing materials for sacrifice. They are frequently confounded with caryatides, from their resemblance in respect of attitude and the modern abuse of their application. *See* CARYATIDES.

CA'NES VENA'TICI. The *Greyhounds.* One of the constellations formed by Hevelius in the northern hemisphere. It is represented on the celestial globes and charts by the figures of two dogs, which are also distinguished by the names of *Asterion* and *Chara*.

CANI'CULAR DAYS, or DOG DAYS. The name given to certain days of the year, during which the heat is usually the greatest. They are reckoned about 40, and are set down in the almanacs as beginning on the 3rd day of July, and ending on the 11th of August. In the time of the ancient astronomers, the remarkable star Sirius, called also *Canicula*, or the *Dog Star*, rose heliacally, that is, just before the sun, about the beginning of July; and the sultry heat which usually prevails at that season, with all its disagreeable effects, among which the tendency of dogs to become mad is not one of the least disagreeable, were ascribed to the malignant rage of the star. Owing to the precession of the equinoxes, the heliacal rising of Sirius now takes place later in the year, and in a cooler season; so that the *dog days* have not now that relation to the particular position of the *Dog Star* from which they obtained their name.

CANI'CULAR YEAR. The ancient solar year of the Egyptians; so called because its commencement was determined by the heliacal rising of the Dog Star. The Egyptians chose this star for their observations, either on account of its superior brightness, or because its heliacal rising corresponded with the annual overflow of the Nile. At a very early period of history the Egyptians had perceived that the solar year contains 365¼ days; for their common years consisted of 365 days, and every fourth year of 366, as in the Julian Calendar.

CANI'NES. (Lat. canis, *a dog.*) The pointed, often long teeth, which succeed the incisors; called *dentes canini*, or *laniarii.*

CA'NIS. (Lat. canis, *a dog.*) The name of a genus of Digitigrade Mammalia, restricted in the modern systems of Zoology to the species of dog, wolf, and jackal; but by Linnæus applied in a wider sense to include the fox and hyena. With respect to the latter animal its enormously developed anal scent-glands, its brief coition, and its mane indicate it to belong to the family of the skunks and genets rather than to that of the dogs, while the prickly tongue and dentition of the hyena approximate it to the cats. The foxes are generically distinguished from the dogs by the pupils of the eye, which during the day have the form of a vertical fissure, by their less notched upper incisors, and by their longer and more bushy tail. The true characters of the genus *canis* are six incisors and two canines in each jaw, six molars on each side of the upper jaw, and seven molars on each side of the lower jaw, making in all forty-two teeth, of which there are twenty in the upper and twenty-two in the lower jaw. The first three molars in the upper, and the first four molars in the under jaw, are trenchant and pointed or lacerating teeth; the succeeding molar in the upper jaw is very large, with two sharp cutting points towards the outer edge, and a small tubercle on the inner side interiorly; the others are smaller, and all furnished with tubercles: the first of these tuberculate molars in the upper jaw is very large. In all the wild varieties of the species of canis the muzzle is elongated, and the ears are carried erect; the tongue is unprovided with cuticular spines; the fore feet have five toes, the hind feet

four only; both are armed with non-retractile claws; the cœcum is cylindrical, and coiled upon itself; the anal glands are of moderate size; the coitus is prolonged. The dog (*Canis familiaris*, L.) is distinguished from the wolf and jackal by his recurved tail; but the varieties, as to size, form, colour, and quality of the hair, are almost infinite. The dog is the most complete, singular, and useful conquest ever made by man over the brute creation: each individual is devoted to his particular master, assumes his manners, knows and defends his property, and remains attached to him till death; and all this neither from constraint nor want, but solely from the purest gratitude and truest friendship. The swiftness, strength, and scent of the dog have rendered him man's powerful ally against all other animals, and have perhaps mainly contributed to the establishment of society. Some naturalists think the dog is a reclaimed wolf, and others that he is a domesticated jackal; nevertheless, those dogs that have become wild again revert neither into the one nor the other species. The wild dogs, and those that belong to savages, as the dingo, resemble, it is true, the wolf in the shape of the head, their straight pricked ears, rough and thick hair, long bushy tail, and lounging gait; moreover, they never bark, but utter a sharp cry or long melancholy howl, like the jackal and wolf; yet they are plainly distinct from both. The Esquimaux dogs present the first traces of a deviation from the wild type; the figure of the legs is more determined, and their pace bolder and more rapid: still they manifest their near relationship to the wolf in their sharp nose, pricked ears, and inability to bark. The Esquimaux and the people of Kamtschatka use these dogs as beasts of draught: six or seven dogs will draw a sledge laden with eight or ten hundred weight at the rate of seven or eight miles an hour, and will easily, under these circumstances, perform a journey of fifty or sixty miles a day, when the snow is hard and smooth, and the road level. The dogs thus employed have a simple harness of deer or seal skin going round the neck by one bight, and another for each of the fore-legs, with a single thong leading over the back, and attached to the sledge as a trace. "Though they appear," says Captain Parry, "to be at first sight huddled together without regard to regularity, there is in fact considerable attention paid to their arrangement, particularly in the selection of a dog of peculiar spirit and sagacity, who is allowed by a longer trace to precede the rest as leader, and to whom, in turning to the right or left, the driver usually addresses himself."

The Newfoundland dog may be regarded as the next remove from the Esquimaux variety. These fine and sagacious animals are employed in their native island to draw sledges and carts laden with wood and fish, and to render many other useful services performed elsewhere by the horse. The readiness with which the Newfoundland dog takes the water, his aptitude to fetch and carry, and his powerful and active swimming, have been the means of preserving the lives of many human beings. Another variety of dog nearly allied to the Newfoundland breed, and belonging to the same subdivision (*Avicularius*, Linn., or spaniel-tribe), has been trained by the benevolent monks of the convent situated near the top of the mountain of Great St. Bernard, to hunt out and extricate such unfortunate travellers as may have been buried under the snow-drifts or avalanches, while attempting the neighbouring dangerous pass between Switzerland and Savoy. One of these noble animals was decorated with a medal in commemoration of his having saved the lives of twenty-two persons, who must otherwise have perished. In the museum at Berne is still preserved the stuffed skin of "Barry," another of these dogs, together with the bottle and collar which he bore in his lifetime; for the good fathers, with a provident care to afford every chance of escape to the unfortunate travellers, fasten a flask of spirits about the neck of the dog before he starts on his search. Barry having discovered a boy whose mother had been destroyed by an avalanche, unhurt and asleep in the hollow of a glacier, and almost stiff with cold, delivered to him the bottle suspended from his neck; and when he had refreshed himself, found means to induce him to mount upon his back, and thus carried him to the gate of the convent. This dog had been the means of rescuing from death upwards of forty persons before he was superannuated; when he was sent to pass the remainder of his days, on a pension, in a more genial climate at Berne.

In our own country the shepherd's dog offers the example of one of the purest races of the domesticated animal, and that which, in its straight ears, its hair, and tail, approaches nearest to the original stock. The sagacity of this variety in the peculiar department in which his services are rendered to man is well known, and has been illustrated by a hundred interesting anecdotes. The shepherd's dog, though outwardly resembling in many points the "dingo," possesses a greater cerebral development, which continues to increase together with intelligence in the spaniel and barbet. Guided by the form of the cranium, we should associate the spaniel and its intermediate varieties with the shepherd's dog, the wolf dog, the Newfoundland and Mount St. Bernard's dog, and the Esquimaux dogs in one family (*Sagaces*).

A comparison of the crania indicates a closer affinity of the "dingo" with the family *Pugnaces*, including the mastiff and Danish dog, than with the *Sagaces*. After the pugnaceous mastiff and its varieties, as the bulldog, remarkable for the shortness and strength of its jaws, come the hound, the pointer, and the terrier in the order of cerebral development. The varieties of this family (*Venantes*) differ between themselves chiefly in the size and proportions of the limbs; the greyhound is longer and more lank, its frontal sinuses are smaller, and its scent weaker.

The bandy-legged turnspits, and the small pet dogs, as the pugs, poodles, Italian greyhounds, king Charles's breed, &c., are the most degenerated productions of the genus, and exhibit the most striking instances of that power to which man subjects all nature.

With some exceptions among this latter anomalous group all the domestic varieties of the genus *Canis* are easily and naturally referable to one or other of the three great tribes above mentioned, of which the mastiff, the hound, and the spaniel may be regarded as the several types, and which we have named *Pugnaces*, *Venantes*, and *Sagaces*, from their prominent aptitude respectively for the combat, the chase, and those more varied and complicated services which seem to demand for their fulfilment a greater amount of intelligence in our canine auxiliaries.

In all the varieties of the dog the following circumstances in his economy are constant:—He is born with his eyes closed; he opens them on the tenth or twelfth day; his teeth commence changing in the fourth month; and his full growth is attained at the expiration of the second year. The period of gestation is sixty-three days, and from six to twelve pups are produced at a birth. The dog is old at fifteen years, and seldom lives beyond twenty. His vigilance and bark are universally known.

CA'NIS MA'JOR. (Lat.) The *Greater Dog*. One of the 48 constellations of Ptolemy, in the southern hemisphere, and under the feet of Orion. Sirius, the brightest of all the fixed stars, belongs to this constellation.

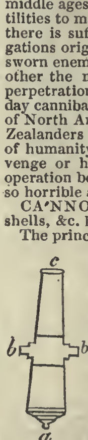
CA'NIS MINOR. The *Lesser Dog*. Is also one of Ptolemy's 48 constellations. It is in the northern hemisphere, just below Gemini. Its most conspicuous star is Procyon, of the first magnitude.

CA'NNELL COAL. (Perhaps *candle* coal, from the flame with which it burns.) A species of coal, found in most of the English collieries, especially at Wigan in Lancashire. It is difficultly frangible, and does not soil the fingers; when burning it splits and crackles, but does not cake, and leaves 3 or 4 *per cent.* of ash. It is sometimes worked into ornamental utensils, like jet.

CA'NNIBALS, or ANTHROPOPHAGI. Persons that devour human flesh. The ancient authors, but especially Herodotus, have recorded instances both of individual and national addiction to this revolting practice, as in the case of Polyphemus, the Massagetæ, and the Issedones; and though there is unquestionably a large portion of fable grafted on these traditional facts, it would be rash wholly to reject an account which the testimony of subsequent history so strongly corroborates. In the middle ages it was customary for parties engaged in hostilities to make mutual accusations of cannibalism; but there is sufficient ground for believing that such allegations originated more in a desire, natural, perhaps, to sworn enemies in those rude times, of fixing upon each other the most barbarous practices, than in any actual perpetration of this deed on either side. At the present day cannibalism is practised by some of the Indian tribes of North America, the Battas of Sumatra, and the New Zealanders; though it must be admitted, to the honour of humanity, that the most violent passions, such as revenge or hatred, or the pressure of want, must be in operation before even the wildest savage will indulge in so horrible a banquet.

CA'NNON. A military engine for projecting balls, shells, &c. by the force of gun-powder.

The principal parts of a cannon are, 1. The *breech*, which is the solid metal from the bottom of the bore or concave cylinder to the extremity of the *cascabel*, *a*. 2. The *trunnions*, *b b*, which project on each side, and serve to support the cannon in equilibrio, their axis being in the vertical plane passing through the centre of gravity, but intersecting it below that point. 3. The *bore* or cylindrical cavity. This in several sorts of cannon is made of smaller diameter towards the breech, thus assuming the shape of two cylinders united by a portion of a spherical surface. The smaller part of the bore is of such a length as to receive the maximum service charge of gun-powder, and is called the *chamber*. The entrance of the bore, *c*, is called the mouth or muzzle.



Cannon are made either of cast iron or brass, the

latter being an alloy of copper and tin in the proportion of about 10 parts of copper to 1 of tin, and called gun-metal. This has a greater tenacity than iron, but is objectionable on account of its greater density and higher price, besides being liable in rapid service to soften and droop at the muzzle, whereby it is rendered unserviceable. Since the advantage of using smaller charges of gun-powder was discovered, cast iron, though possessing less tenacity than gun metal, has been substituted for ship, garrison, and battering guns. But the the smaller species of cannon (field-pieces) continue to be made generally of brass; for by reason of the rapid cooling of the iron in small masses its strength is considerably impaired, so that it is difficult to be procured of the requisite quality.

Cannon were formerly cast with a cave or hollow, but they are now always cast solid; experience having shown that when cast solid they are stronger, and less liable to burst; that the metal is freer from honeycombs; and that the bore can be rendered more perfect, and its axis made to coincide more accurately with that of the piece. In boring cannon, the gun itself is made to revolve about the bit or borer, the size of which is successively increased.

In service cannon are mounted on carriages, by which they may be removed from place to place. They are supported on the carriage by the trunnions, about which they move as on an axle; and the form of the carriage is such as to admit of their being elevated or depressed a few degrees above or below the horizontal plane. *See* GUN, GUNNERY, HOWITZER, MORTAR.

CA'NNON BONE. In Farriery, signifies the single metarcarpal or metatarsal bone of the horse.

CA'NNON METAL. Bronze; an alloy of copper with eight or ten *per cent.* of tin.

CANOE'. A boat made of a single trunk of a tree hollowed out. Some are made of pieces of bark fastened together; these should be properly called boats. They are of various sizes, and are generally propelled by one, or if large by two or more paddles, like wooden shovels.

CA'NON. (Gr. κανων, *a rule.*) A word of various significations, of which we can only enumerate the principal.

1. In cathedral and collegiate churches there are canons who perform some of the services, and are possessed of certain revenues connected with them. These are, strictly speaking, *residentiary* canons: *foreign* canons are those to whom collegiate revenues are assigned without the exaction of any duty.

2. The laws and ordinances of ecclesiastical councils are called canons.

3. The canon of scripture signifies the authorized and received catalogue of the sacred books. The canon of the Old Test., as received by the Romanists, differs from that of the Protestant churches in regarding as inspired those books which we reject under the term Apocrypha. The catalogue received by the Jews themselves, which we adopt, was first enlarged by the Council of Carthage to the extent in which it is held by our opponents, and that decision was formally confirmed by the Council of Trent. In the canon of the New Test., however, the agreement of Christian churches may be considered unanimous. There exist a series of enumerations of the sacred books of the latter covenant in the writings of the first four centuries, the general agreement of which, and the satisfactory reasons which can be assigned in most cases of omission — there are no additions — distinctly mark the universality of the judgment of the early churches in this matter.

CA'NON. In Music, a perpetual fugue. The original method of writing this was on one line, with marks thereon, to show where the parts that imitate were to begin and end. This, however, was what the Italians more particularly call *canone chiuso* (shut), or *canone in corpo.*

CA'NONESS. A description of religious women in France and Germany. Their convents were termed *colleges*. They did not live in seclusion. The college of Remiremont was the oldest establishment of this order in France. Similar noble monasteries still exist in Germany, and the revenues and dignities of some belong to Protestants.

CANO'NICAL HOURS. Stated times of the day set apart, more especially by the Romish church, for devotional purposes. In England the canonical hours are from 8 to 12 in the forenoon, before or after which the ceremony of marriage cannot be legally performed in any parish church.

CA'NONIZA'TION. A ceremony in the Romish church, by which holy men deceased are enrolled in the catalogue of saints. The privilege of canonizing was originally common to all bishops, and was first confined to the Pope by Alexander III. in 1170. When it is proposed to canonize any person, a formal process is instituted, by which his merits or demerits are investigated. Hereupon the *beatification* of the person in question is pronounced by the Pope, and his canonization follows upon the production of testimony to miracles performed at his tomb or by his remains. The day of his death is generally selected to be kept in his honour, and is inserted as such in the calendar. The last instance of canonization took place in 1803.

CANO'PUS, or CANOBUS. (Gr. Κανωπος, the name of a place in Egypt.) A bright star of the first magnitude in the rudder of Argo, one of the southern constellations. As its declination is about 52½° south, it is not visible in our hemisphere beyond the 40th degree of latitude.

CA'NOPY. (Gr. κωνωπειον.) In Architecture, an ornamented covering over a seat of state, and in its extended signification any covering which affords protection from above.

CANT. In sea phrase, to turn over or round; a cant is also a piece of wood laid on the deck for the support of a bulk-head.

CANTA'TA. (It. cantare, *to sing.*) In Music, a song or composition intermixed with recitative, usually for a single voice with a thorough bass.

CANTHA'RIDES. (Gr. κανθαρος, *a beetle.*) Spanish flies. The *Cantharis vesicatoria*, or blistering fly. These insects are chiefly brought from Astracan and Sicily: they should be free from mould and dust, of a peculiar but not very strong or nauseous odour, and of a brilliant golden green colour. These flies furnish us with the only ready and certain means of raising an effective blister upon the skin, for which purpose they are reduced to powder, mixed with ointment or lard, and spread thinly upon a piece of leather, which is then applied to the part affected. Their operation is very different in different habits and constitutions: sometimes they produce much local pain and inconvenience, and great general excitement and irritation of the urinary organs; at others they are comparatively quiet in their action; and the blister being applied at bed-time, is found in the morning to have raised the cuticle with a large quantity of serous fluid underneath it, and the patient has scarcely been aware of its agency. The object of applying a blister is generally to transfer internal inflammatory action to the surface; and in deep-seated inflammations, and painful affections of the viscera and larger joints and muscles, they are often astonishingly effective. But blisters should not be incautiously applied: they sometimes produce troublesome sores, and are followed by erisipelatous inflammation. Care should also be taken to confine then, by a margin of adhesive plaster or other means, to the part upon which they are intended to operate, as they sometimes are displaced, and give rise to awkward accidents. When cantharides are taken internally, they are violently stimulant to the urinary and generative organs.

CA'NTHUS. (Lat.) The corner of the eye, where the upper and under eyelids meet.

CANTILE'VER. (Probably from canterii labrum, *the lip of a rafter.*) In Architecture, a piece of wood framed into the front or side of a house, and projecting from it, to sustain the eaves and mouldings over them.

CA'NTO. *See* SOPRANO.

CA'NTO-FE'RMO. (Ital. *firm song.*) In Music, the subject song. Every part that is the subject of counterpoint, whether plain or figured, is called by the Italians *canto fermo.*

CA'NTON. In Heraldry, an ordinary formed either at the dexter or sinister chief of the escutcheon, by two lines meeting at right angles, proceeding from the top or sides of the shield. By the word canton is always understood a canton dexter, unless otherwise expressed.

CANTON. (Gr. κανθος, *an angle;* or Lat. centum, *a hundred.*) In Geography, originally a quarter of a city regarded as separated or detached from the rest; but applied chiefly at present to the twenty-two districts of which Switzerland is composed, and which, though forming a confederate union like the United States of America, are governed each by a separate judicature and particular laws.

CANTO'NMENT. In the art Military, that distinct situation which soldiers occupy when quartered in different parts of a town, for want of barracks or caserns to contain them.

CA'NVAS. (Ital.) A very clear unbleached cloth of hemp or flax, woven regularly in little squares, chiefly used to make sails for shipping. Besides serving for various domestic purposes, such as for the ground of tapestry work, canvas forms the cloth on which painters usually draw their pictures.

CANZO'NE. (Latin, Provençal, and Italian, cantare, *to sing.*) A kind of lyric poem. Adopted, with some alteration, from the poetry of the Troubadours, it found its way into Italy in the thirteenth century. It is divided, like the Greek strophic ode, into stanzas, in which the number and place of rhymes and metre of verses respectively correspond. The last stanza, commonly shorter than the others (the epodus of the ode), is called *congedo*, or *ripressa* (in old French *l'envoy*), and consisted, generally, of a valedictory address to the canzon itself. This form of poetry was adapted by Petrarch to the expression of

many different veins of thought — sonorous, elevated, and heroic. The Pindaric ode, somewhat more regular than the canzon, was introduced by Chiabrera. The canzonet was a sort of canzon in short verses, a favourite form with the poets of the fifteenth century.

CANZONE'TTA. (Dimin. of canzone.) In Music, a short song. The Neapolitan canzonet has two strains, each of which is, like the French vaudeville, sung twice over. The Sicilian canzonet is n a species of jig-time, with six or twelve quavers in the bar. Sometimes both are rondeaus, and repeat the first strain for an ending.

CAOU'TCHOUC. This curious substance is the inspissated juice or sap of several plants: the principal supplies are from South America, and are derived from the *Siphonia elastica* (Hevea caoutchouc), and probably from other Euphorbiaceous plants. It is often termed *gum elastic* and *Indian rubber*. Its general properties and uses are well known. Among its more recent applications are those of elastic wove fabrics, formed of caoutchouc stretched into threads and covered with cotton; and various water-proof clothing, which is made by interposing a layer of caoutchouc between two folds of the cloth, and then forcibly uniting them by pressure. For this purpose the caoutchouc is dissolved by coal naphtha, and in that state brushed over the surfaces which are to be united.

Caoutchouc is a compound of carbon and hydrogen; when heated it fuses, and afterwards remains viscid; when subjected to destructive distillation at a high temperature, it yields four fifths of its weight of a highly inflammable and very light volatile oily liquid (hydrocarbon), which has been called *caoutchoucine*, and which is a good solvent of the unaltered caoutchouc. Washed sulphuric ether dissolves caoutchouc, and it is also soluble in several essential oils; but of these latter solutions the greater number leave it in a sticky state on evaporation.

CAPA'CITY FOR HEAT. Experiment shows that different quantities of heat are required to raise different bodies to the same temperature, and those substances which require the largest quantity of heat to be raised to a given temperature are said to have the greatest *capacity for heat*. *See* Specific Heat.

CAPE. (Lat. caput, *a head*.) In Geography, is the term used to indicate the extreme point of a promontory, or of that portion of land which juts out into the sea beyond the general line of the coast; as Cape Taenarus or Matapan, the most southern part of Europe; the Cape of Good Hope, the most southern part of Africa; Cape Horn, the southern extremity of America, &c. On rocky and much indented coasts capes generally terminate in acute angles, whence they are sometimes denominated *points*; and if the portion of the land which projects is small or not high, the appellation *ness* in England, and in Scotland that of *mull*, is assigned to it, as Sheerness, the Mull of Galloway.

CAPE'LLA. A star of the first magnitude in the left shoulder of Auriga.

CA'PERS. The buds or unexpanded flowers of the *Capparis spinosa*, in common use as a pickle.

CA'PIAS AD RESPONDENDUM. In Law, a writ for the commencement of personal actions to arrest a party who is at large or already in custody of a sheriff.

CA'PIAS AD SA'TISFA'CIE'NDUM. Shortly called *ca. sa.*) In Law, a judicial writ of execution which issues out on the record of a judgment, where there is a recovery in the courts of Westminster, of debt, damages, &c. By this writ the sheriff is commanded to take the body of the defendant in execution. This is the highest execution which can be had against a defendant, and no other can be afterwards had against his lands or goods, unless he die in custody.

CAPI'BARA. The largest known Rodent quadruped. It is of aquatic habits, and frequents the rivers of South America. It is the type of the genus *Hydrochærus*, signifying "water-hog," by which name it is sometimes known.

CAPILLA'IRE. Simple syrup flavoured with orange flowers, or orange flower water, generally goes under this name, which is derived from the mucilaginous syrup directed in old Pharmacopœias to be made of the *Adiantum capillus veneris*.

CAPI'LLAMENTUM. (Lat. capillus, *a hair*.) An old name of the filament of a flower. *See* Filament.

CAPI'LLARY. Long and slender, like a hair.

CAPI'LLARY A'CTION. (Lat. capillus, *a hair*.) When a very narrow glass tube, open at both ends, is inserted in a vessel containing water, the water immediately rises in the tube, and remains suspended at some height above its level in the vessel. If the same tube is plunged into mercury, the mercury in the tube stands at a lower level than in the vessel. These effects are most sonspicuous when the width of the bore of the tube is so small as to resemble a hair; whence the cause of the phenomena has been termed *capillary action*, from the Latin *capillus*, which signifies a hair.

The operation of the same forces which cause the elevation of water and depression of mercury in glass tubes, gives rise to a multitude of other phenomena with which every one is familiar. If a piece of sugar, or sponge, or blotting paper, is brought into contact with water at one extremity, the fluid immediately passes through it and moistens its whole substance. A mass of wetted thread or cloth, hanging over the edge of a basin from the water within it, will empty it as a siphon would. The rise of the oil in the wick of a lamp, of the sap in trees, the functions of the excretory vascular system in plants and animals, depend on the same causes. Capillary action is, in short, only an instance of the operation of that species of attraction which is exerted among the elementary particles of matter within very small or insensible distances, which is called *molecular attraction*, and which gives rise to some of the most important phenomena of the physical world; such as the vibrations of solid bodies, the refraction of light, and chemical actions of all kinds.

The phenomenon of the elevation of water in narrow tubes began to attract the attention of experimental philosophers about the beginning of the last century; but neither the method of calculating the effects of the forces exerted among the elementary molecules of matter, nor their mode of operation, was then understood, and consequently no satisfactory theory was proposed. Two facts, however, of considerable importance were established by Hauksbee. The first is, that the ascent of the liquid is quite independent of the thickness of the tube; and the second, that if two rectangular plates of glass having their edges joined in a vertical line, and forming a very acute angle with each other, are dipped into water, the fluid which rises between them takes the form of the equilateral hyperbola. On considering the phenomenon attentively, it was easy to see that as the height of the fluid between the plates at any point in the curve was inversely proportional to the distance of the plates at that point, it must follow that in capillary tubes the ascent would be inversely proportional to the diameter of the tube. The theory of the phenomenon, however, still remained unexplained.

Dr. Jurin ascribed the ascent of the liquid to the attraction of the ring of the tube immediately above it. But this was merely a vague explanation, and is now known to be altogether erroneous. Clairaut, in his celebrated work on the Figure of the Earth, was the first who analyzed exactly the different forces which concur in elevating the liquid in a capillary tube, and reduced the phenomena to the ordinary laws of the equilibrium of fluids. Some of his suppositions respecting the nature of the forces in action were erroneous; for example, he supposed the attraction of the internal surface of the tube on the liquid to be exerted not only at a sensible distance, but to extend even to the diameter. He failed to prove from theory that the ascent must be inversely proportional to the diameter of the tube; but he showed that several hypotheses might be made with respect to the law of attraction from which that law of ascent would follow; and he demonstrated a very remarkable result, namely, that if the attraction which the particles of the tube exercise on the fluid and the attraction which the particles of the fluid exercise on each other follow the same law, and differ from each other only in intensity, the fluid will rise in the tube when the first of these attractions exceeds half the second. The error of Dr. Jurin's hypothesis was first clearly pointed out by Professor Leslie, in a paper inserted in the *Philosophical Magazine*, in 1802. Mr. Leslie's argument was shortly this: If the ring of the tube immediately above the liquid in a capillary tube attract it upwards, how does it happen that the ring immediately below the surface does not attract it downwards, in which case the forces would be balanced, and there would be no elevation? The fact is, that as the action of the molecules of the tube is confined within very narrow limits, its direction must be at right angles to the sides of the tube. Nor is it difficult to conceive how a lateral action may yet cause a perpendicular ascent. It is a fundamental property of fluids, that any force impressed in one direction is propagated equally in every direction; the tendency of the fluid, therefore, to approach the glass will occasion it to spread over the internal cavity of the tube, and consequently to mount upwards. Mr. Leslie's explanation, though correct in principle, served in no way to advance the theory; indeed little notice appears to have been taken of it till its importance was pointed out by Mr. Ivory. Another important fact was discovered by Dr. Young, who showed, in a paper on the *Cohesion of Fluids*, in the *Phil. Trans.* for 1805, that the angle made by the surface of the fluid with the sides of the tube is invariable, the fluid and the materials of the tube remaining the same, and being supposed homogeneous.

But a complete exposition of the theory of capillary phenomena was reserved for Laplace. In two Supplements to the *Mécanique Céleste*, published in 1806 and 1807, Laplace, assuming the force of molecular action to extend only to insensible or imperceptible distances, determined the separate influences of the cohesive attraction of the molecules of the fluid to each other, and the adhesive

force with which they cling to the tube. This analysis of the forces by which the capillary phenomena are produced conducted him to an equation in which the whole theory is included. It consisted of two parts: the first belonging to those points of the surface of the fluid whose distance from the sides of the tube is greater than the radius of the sphere of molecular action; and the other belonging to those points of the surface which are in immediate contact with the sides of the tube, or at least within the sphere of the action of its molecules. The first term is general, and the same for all surfaces; the other varies with the curvature in each particular case. Mr. Ivory afterwards showed that of the two quantities which enter into the formula of Laplace, the one denotes the direct pressure caused by the attraction of a fluid mass bounded by a plane; and the other the derivative force acting laterally, which is a necessary consequence of the direct pressure. (*Ency.Brit.* art. "Capillary Action.")

The latest and most important work on capillary action is by Poisson, *Nouvelle Théorie de l'Action Capillaire*, 1831. Its object was to correct the theory of Laplace by supplying an important omission in the physical data, namely, the rapid diminution of density which takes place near the free surface of the fluid, and near the sides of the tube. Now this circumstance, though it had been entirely overlooked by all former inquirers, is not only essential to the right investigation of the effects of capillary action, but it is demonstrated by Poisson that if there was no diminution of density near the superficial parts of the liquid, the surface would remain plane and horizontal, and there would neither be elevation nor depression in the capillary tube. The molecular forces, therefore, which produce the capillary phenomena, are modified not only by the curvature of the surface, according to the previous theory, but also by the particular state of liquids at their surfaces.

The power of supporting the fluid column depends entirely on the width of the tube at its upper extremity. If the tube bulge out below, the water will not rise in it spontaneously; but if plunged into a basin till the water reaches the capillary part, and then lifted up, the water will remain suspended at exactly the same height as in a tube having the same capillary bore throughout. The lower and wide part of the vessel may consist of metal, or any other substance, different from glass. It is sufficient that the cavity terminate above in a capillary glass tube.

The phenomenon of the depression of mercury in capillary tubes may be considered as the inverse of that of the elevation of water. The molecules of water have a greater attraction for glass than for each other; those of mercury, on the contrary, attract each other more powerfully than they are attracted by glass. If a drop of mercury, adhering to the edge of a plate of glass, is presented to a mass of the same fluid, it immediately leaves the glass and unites with the mass. When a plate of glass is plunged into mercury, the mercury is depressed, and forms a convex surface on both sides of the plate. In a glass tube the surface of mercury is always convex, provided the inside of the tube be perfectly clean, and the mercury free from impurities. All these phenomena clearly indicate the excess of the mutual attraction of the particles of mercury above their adhesion to the sides of the glass.

From some experiments made by *Casbois* at Metz, it appeared to result, that mercury purified with great care forms a concave surface in the interior of a glass tube, and consequently rises above the level, like an aqueous fluid. It is now generally admitted, however, that these experiments were fallacious, in consequence of the inner surface of the tube having been lined with a slight, and perhaps imperceptible, oxydation produced by the boiling of the mercury. In preparing barometers, it has been the custom to boil the mercury in the tube; when this operation is performed, great caution is requisite to prevent the oxydation from taking place.

The form of the surface of the fluid in the tube indicates the relation of the cohesive force of its particles to their attraction for the tube. The attraction of water to glass is superior to half the cohesion of the aqueous particles to one another; consequently water within a capillary tube assumes a concave surface, and rises. Mercury, on the other hand, assumes a convex surface, and is depressed; because its molecules attract one another with a force more than double that with which they adhere to glass. The radius of curvature of the bounding surface at the middle point is proportional to the width of the tube. It is stated by Professor Leslie as the result of his experiments, that the depression of mercury in capillary tubes may be estimated at unity divided by 68 times the diameter expressed in inches. Hence if the width of the bore is one fourth of an inch, the depression of the mercury is one seventeenth of an inch. On this account it is necessary, in accurate barometric observations, to apply a correction for capillary action, which is less in proportion as the diameter of the tube is greater. The best treatises on this subject have already been referred to; viz. that of Laplace, in the *Mécanique Céleste*, tome iv.; of Mr. Ivory, in the *Encyclopédia Britannica;* and of Poisson, *Nouvelle Théorie de l'Action Capillaire.*

CAPI'LLARY VESSELS. (Lat. capillus, *a hair.*) Anatomists give this term to the minutest ramifications of the arteries and other vessels.

CAPILLI'TUM. (Lat. capillus, *a hair.*) A kind of purse or net in which the spores of Trichia and similar fungi are retained.

CA'PITAL. (Lat. caput, *a head.*) In Architecture, the head or uppermost member of any part of a building; but it is generally applied in a restricted sense to that of a column or pilaster of the several orders, as in the figures here given, in which it will be seen that the Tuscan capital (No. 1.) consists of an abacus or square shelf at the top, and thereunder an ovolo or quarter round, and under that a neck terminated by an astragal or fillet, which latter is

1 2 3 4 5

always considered as part of the column itself. The Roman Doric capital (No. 2.) here given has an abacus, ovolo, and neck like the last; and also in addition three annulets under the ovolo, and a cyma or ogee with its fillet over the abacus. The Grecian Doric, however, has only a square abacus, ovolo, and small fillets. The Ionic (No. 3.) capital consists of three leading parts: an abacus, composed of an ogee and fillet; a rind, which forms the scrolls; and an ovolo and astragal at the lower part. The Corinthian and Composite capitals (Nos. 4. and 5.) consist of an abacus (*see* Abacus) of peculiar form, and are decorated with leaves.

Ca'pital. In Political Economy, that portion of the produce of labour saved from immediate consumption which is employed to maintain productive labourers, or to facilitate production. (*See* Political Economy.) In Commerce, and as applied to individuals, capital is understood to mean the sum of money which a merchant embarks in any undertaking, or which he contributes to the common stock of a partnership.

CAPITA'TION. (Lat. caput, *head.*) A tax imposed on the population by the head; *e. g.* on every one, or every male, every one above a certain age, &c. (*See* Poll-Tax.) In France, the ancient capitation is now replaced by personal and other direct contributions.

CA'PITE. In Law, tenure *in capite* (Ang. *in chief*) signifies in the language of feudal law a direct holding of the king, the ultimate sovereign, without the intervention of any mesne lord. In England, tenants in capite were either by knight-service or socage; which were converted into common socage by the act 12 Ch. II. c. 24., abolishing feudal tenures.

CA'PITE CENSI. In Roman Antiquity, the lowest rank of Roman citizens; so called because they were rather counted by their *heads* than by their estates. (*Aul. Gell.* lib. vii. cap. 13.)

CAPI'TULA'TION. In its original sense, a writing drawn up in several *capitula* or heads. In the language of Military Law, the articles of surrender, when a garrison or other force surrenders to an enemy on terms, and not at discretion. In Ecclesiastical History, articles sworn by bishops and other prelates on admission to their dignities were styled capitulations. So also was the oath tendered first to Charles V., and then to the emperors of Germany who succeeded him, by the electors, termed the election capitulation (wahl capitulation).

CA'PNOMA'NCY. (Gr. *καπνος, smoke; μαντεια, prophecy.*) Divination by smoke was practised among the ancients, both by throwing on the fire seed of poppy and other herbs, and observing the figures which might be fancied in the smoke; and by observing the smoke of sacrifices.

CA'PNOMOR. (Gr. *καπνος, smoke,* and *μοιρα, part.*) An oily substance of a pungent and rather agreeable odour obtained from the tar of wood.

CAPONNIE'RE. In Fortification, a passage leading from one work to another, protected on each side by a wall or parapet, generally of earth, sloping to the bottom of the ditch. When a passage is thus protected on one side only, it is called a demi-caponniere.

CAPPA'RIDA'CEÆ. (Capparis, one of the genera.) A natural order of Exogenous plants, consisting of annuals, perennials, bushes, and trees, inhabiting the warmer parts of the world. They have all a powerful pungent or even acrid taste, and have been in some cases used as substitutes for the common mustard; in others they have proved severe poisons. In general their flowers are very beautiful, on account not only of their size, but of their long silken stamens, which are often gaily coloured. The common caper-bush, a native of rocky places in the North of Europe, is a species of the genus *Capparis*, and

yields the flower-buds which, pickled in vinegar, are sold in the shops as an agreeable sauce for various dishes.

CAPRE'LLA. A genus of Crustaceous animals belonging to the order *Læmodipoda*, found commonly on sea-weed. Montague, who describes a species of this genus in the seventh volume of the *Linnæan Transactions*, says the female differs in possessing several plates or valves beneath the body, situated between the two pairs of fins, the use of which is to carry and protect its eggs or young; at which time they extend very considerably, and form a kind of pouch distended with ova, fifteen or twenty of which are easily distinguished between the transparent plates. In this part a very strong pulsation is visible. While examining a female under a water-microscope, the author was surprised to observe not less than ten young ones crawl from the abdominal pouch of the parent, all perfectly formed, and moving with considerable agility over the body of the mother, holding fast by their hind claws and erecting their heads and arms. The characters of the genus, or rather family (*Caprellidæ*), are, body of narrow linear form; eyes composite, and placed behind; legs long and slender, and variable in number, the last joint of the second pair being often toothed on the under side.

CAPRE'OLUS. (The tendril of a vine.) The old botanical name of the tendril of a plant; the term *cirrhus* is now preferred.

CAPRI'CCIO. (Ital. *whim, fancy.*) In Music, a term applied to certain pieces, wherein the composer gives way to his fancy, without confining himself to particular measures or keys; called also *Fantasia*.

CA'PRICO'RNS. (Lat. capricornus.) The name of one of the three divisions of Tetramerous beetles; including those which have the antennæ filiform or setaceous, and generally exceeding the length of the body; eyes lunate, and enclosing the base of the antennæ; jaws very robust, with short palpi; thorax often spined at the sides; the three basal joints of the tarsi dilated, and cushioned on the under surface; the third deeply cleft at the extremity, and receiving the minute ball at the base of the slender and long terminal joint. This division comprehends four great families,—*Prionidæ*, *Cerambycidæ*, *Lamiidæ*, and *Lepturidæ;* and corresponds very nearly with the Linnæan genera *Cerambyx*, *Necydalis*, and *Leptura*. The offices of the capricorn beetles in the economy of nature is to restrain the excessive multiplication of vegetable species in the warmer climates of the globe. The larvæ reside within the wood or beneath the bark of trees.

CA'PRICO'RNUS. (Lat.) *The Wild Goat.* The tenth sign of the Zodiac, which the sun enters about the 21st of December, at the winter solstice. The parallel circle passing through the first point of this sign is called the *Tropic of Capricorn.*

CA'PRIFO'LIA'CEÆ. (Caprifolium, one of the genera.) A rather large natural order of plants, consisting of twining and erect shrubs, and herbaceous or woody plants, and even of trees, with simple or pinnated leaves, and flowers of most dissimilar forms, but all monopetalous. The most common plants belonging to this order are the woodbine, the St. Peter's wort, the Tartarian and fly honeysuckle, the numerous species of viburnum, and the elder-tree. These all agree with the natural order *Cinchonaceæ* in most respects, except the absence of stipules at the base of the leaves.

CAPRIFO'LIUM. (Lat. capra, *a goat,* and folium, *a leaf.*) Is the genus to which the wild honeysuckle (*C. periclymenum*) belongs. It consists of twining shrubs inhabiting the northern hemisphere exclusively, and in most cases having long tubular flowers of singular sweetness. Many species are known to botanists, the most interesting of which are those from the north of India, China, and Japan, the fragrance of which is superior to that of all others; of these *C. flexuosum*, now common in gardens, is the best.

CA'PROIC ACID. (Lat. capra, *a goat.*) One of the acids formed during the saponification of butter; it has a rank goat-like odour.

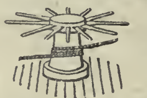
CA'PROMYS. (Gr. καπρος, *a boar*, and μυς, *a mouse.*) The name of a genus of Rodent Mammalia, exclusively confined to the island of Cuba, where they go by the name of Houtias.

They have four molars on each side of each jaw, in which the enamel is so folded as to form three angles on the outer margin and one on the inner, in the upper teeth; the reverse in the lower teeth. The liver is remarkably subdivided in the rodents of this genus.

CA'PROS. (Gr. καπρος, *a boar.*) A name applied by Lacipede to a subgenus of Acanthopterygious fishes, which he separated from the dories (*Zeus*), and of which the boar fish (*Zeus aper*, Linn.) may be regarded as the type. A specimen of this fish has been taken at Mount's Bay, and another near Bridgewater, but is rare as a British species.

CA'PSICUM. (Gr. καπτω, *I bite;* from its pungency.) The berry or seed-vessel of different species of capsicum. The larger pods of the *Capsicum annuum*, and the smaller ones of the *C. baccatum* or *bird pepper*, when powdered, form the *Kyan pepper* of commerce, so well known as a powerful condiment, and often useful as a stimulating medicine. Kyan pepper is often grossly adulterated with common salt, and occasionally red lead and earthy powders are said to be added to it: it often has a disagreeable rancid odour, owing to its being sprinkled with oil to prevent its dust affecting those who powder and sift it.

CA'PSTAN, sometimes called CAPSTERN. (Fr. cabestan.) A strong massive piece of timber, in the form of a cylinder or truncated cone, round which a rope is coiled; and being turned by means of bars or levers, it affords an advantageous mode of applying power to overcome an obstacle. The capstan is chiefly employed in ships, where it is used for weighing anchors, hoisting sails, &c. It is generally placed vertically, the lower end being let down through the deck of the ship, and the levers inserted in holes in the head or top; so that the force of the men can be exerted continuously, and that there may be no necessity for removing the levers from one hole to another, as is the case when it is placed horizontally. The power of the capstan may be greatly increased by adapting an arrangement of wheel work to it — an improvement which has been adopted for several years past in the royal navy.



CA'PSULA. (Dim. of capsa, *a box.*) This word is generally applied by botanists to all dry fruits which are dehiscent, whether they are many-seeded or few-seeded, simple or compound; and in such cases some expletive is added to indicate the particular nature of the fruit. Thus *Capsula circumscissa* is cut round by a circular line dividing it into two parts; *C. siliquiformis* is long and taper, like the pod of a mustard-plant; *C. baccata* is when the pericarp is succulent; *C. tricoccea*, when a dry capsule bursts into three separate closed pieces. Sometimes, for special carpological purposes, the word capsula is limited in its application to such dry compound fruits as open by valves, and have an indefinite number of seeds; as in *Digitalis*, *Scrophularia*, the common lilac, &c.

CA'PSULE. In Chemistry, a small shallow evaporating vessel or dish.

CA'PTAIN. In the Army, the commander of a troop of cavalry or of a company of infantry. The price of a captain's commission is different in the different branches of the British service: in the life guards, for instance, it is 3,500*l.*; in the dragoons 3,225*l.*; in the foot guards with the rank of lieut.-colonel, 4800*l.*; in the infantry 1,800*l.* The full pay of a captain in the life and foot guards is 15*s.* a day, in horse regiments 14*s.* 7*d.*, and in the infantry 11*s.* 7*d.*

CA'PTAIN. In the Royal Navy, is the title of the officer commanding a ship of a certain size. The title of post captain, which was the proper rank of captain, and answered to colonel in the army, has been for some time in disuse. The captain is next in rank above the commander: he rises by regular succession to the rank of admiral; under the condition, however, that he must at some time have commanded a ship of the line.

The heads of small parties or gangs of men in certain stations of the ship are also called captains; as of the forecastle, the tops, &c. The pay of a captain in the navy varies with the rate of the ship, from 61*l.* 7*s.* per month for a first-rate, to 26*l.* 17*s.* for a sixth-rate.

CA'PTION. (Lat. capio, *I take.*) In Law, a certificate signed by commissioners, to testify their execution of any commission in law or equity. Also, the act of taking a man into arrest. The caption of an indictment is the designation of the style of the court before which the jurors make their presentment.

CAPTI'VITY. In Sacred History, a punishment which God inflicted upon the Jews for their vices and infidelity. The first captivity was that of Egypt, from which the Israelites were delivered by Moses; then followed six captivities during the government of the judges: but the greatest and most remarkable were those of Judah and Israel, which happened under the kings of these different kingdoms.

CA'PUCHINS. In Ecclesiastical History. *See* FRANCISCANS.

CA'PUT MO'RTUUM. The inert residue of the distillation and sublimation of different substances. When sulphate of iron, for instance, or green vitriol, is distilled at a red heat it leaves a residue of red oxide of iron, which the old chemists called *caput mortuum vitrioli.* These residuary products were represented in alchemical writings by the symbol of a death's head and cross bones.

CAR. (Lat. carrus, *a cart.*) Any rude cart. The Irish car is a one-horse cart, with very low broad wheels, used for carting out manure and carting home grain in the case of soft peaty soils. The Irish jaunting car is a kind of one-horse chaise, commonly without springs, in

which the people sit back to back, and with their faces looking sideways.

CARABI'DÆ. (Lat. carabus.) A family of Pentamerous beetles, characterized by having a bilobed upper lip, smooth jaws (*maxillæ*), an entire tooth in the centre of the notch of the mentum or chin-process, and dilated tarsi in the males. The majority of the British species have the elytra soldered together. The *Carabidæ* generally defend themselves by discharging from the extremity of the body an acrid fluid, and emit a fetid odour. They are amongst the most ravenous of beetles, and prey on other insects, for which they lurk beneath stones, the bark of trees, &c.

CA'RABINE. (It. carabino.) Called also Petronel. A fire-arm used by cavalry, smaller in the bore and shorter in the barrel than a musket. The soldiers who use this species of arms are called Carabineers.

CARAGA'NA. (Carachana, the Mogul name.) A genus of pretty hardy shrubs, inhabiting the Russian dominions in Asia. *C. sibirica*, *attagana*, and *chamlagu* are common in the shrubberies of this country, where they flower in the months of June and July. *C. jubata* is a singular scrubby plant, with the branches closely covered by the leafy, spiny, ragged petioles.

CARA'NNA. A resin brought from South America, of an aromatic odour; formerly used in plasters.

CA'RANX. (Derivation unknown.) A genus of spiny-finned fishes, belonging to the *Scomberidæ* or mackerel family; but differing from the true mackerel in having a series of scales, with ridges or keels in the middle, ranged along the lateral line. From this resemblance they are commonly termed "bastard mackerel."

CARA'SSÆ. The bony vault which protects the upper part of the body of the Chelonians, or tortoises and turtles, and which results from the union by suture of the dilated and flattened parts of the vertebræ and ribs. The analogous part of the body of the crab is also called carassæ; but this is not composed of corresponding parts to those of the tortoise, but of a calcified integument.

CA'RAT. "The fruit of the tree called Kuara is a red bean, which seems in the earliest times to have been used for a weight of gold. This bean is called *carat*. (*Bruce's Travels*.) Morin derives the word from the Arab *kyrat*, a weight; which he thinks is from the Greek *κερατιον*, a small weight." (*Todd's Johnson*.) A carat is a weight of 4 grains, used in weighing diamonds. The term carat is also used in reference to the fineness of gold; in expressing which the mass spoken of is supposed to weigh 24 carats, of 12 grains each; and the pure gold is called *fine*. Thus, if gold be said to be 22 carats fine (or standard), it is implied that 22-24ths are pure gold, and 2-24ths alloy. In the process of assaying gold, the real quantity taken is very small, generally from 6 to 12 grains; and this is termed the *assay pound*. It is subdivided into 24 carats, and each carat into 4 assay grains, and each grain into quarters; so that there are 384 separate reports for gold. When the gold assay pound is only 6 grains, the quarter assay grain only weighs 1-64th of a grain. This will give an idea of the accuracy required in the weights and scales used for such delicate operations. See ALLOY and ASSAY.

CA'RAVAN. (Pers. cârvân, *a trader*.) A company of merchants, travellers, or pilgrims, who associate together in many parts of Asia and Africa, that they may travel with greater security through deserts and other places infested with robbers or exposed to other dangers. The commercial intercourse of Eastern and African nations has from the remotest ages been chiefly carried on by means of caravans, as the governments that have sprung up in those continents have seldom been able, even if they had had the will, to render travelling safe or practicable for individuals. Since the establishment of the Mohammedan faith religious motives, conspiring with those of a less exalted character, have tended to augment the intercourse between different parts of the Eastern world, and to increase the number and magnitude of the caravans. Mohammed, as is well known, enjoined all his followers to visit Mecca once in their lifetime; and in obedience to a command so solemnly enjoined and sedulously inculcated, large caravans assemble for this purpose in every country where the Mohammedan faith is established. There are four regular caravans which proceed annually to Mecca; the first from Damascus, composed of pilgrims, travellers, and merchants, from Europe and Asia; the second from Cairo, for the Mohammedans of Barbary; the third from Zibith, near the mouth of the Red Sea, where those of Arabia and India meet; the fourth from Babylon, where the Persians assemble. Every caravan is under the command of a chief or aga (caravanbachi), who has frequently under him such a number of troops or forces as is deemed sufficient for its defence. When it is practicable they encamp near wells or rivulets, and observe a regular discipline. Camels are almost uniformly used as a means of conveyance, in preference to the horse or any other animal, on account of their wonderful patience of fatigue, and their peculiarity of structure, which so admirably fits them for travelling through desert wastes. (*See* CAMEL.) For further details on the subject of caravans the reader may consult *M'Culloch's Commercial Dictionary*, and the authorities there referred to.

CARAVA'NSERA. A large public building, or inn, appropriated for the reception and lodgment of caravans in the desert. Though serving in lieu of inns, there is this essential difference between them, that the traveller finds nothing in the caravansera for the use either of himself or his cattle, but must carry all his provisions and necessaries with him. Caravanseras are also numerous in cities, where they serve not only as inns, but as shops, warehouses, and even exchanges.

CA'RAWAYS. The fruit or seed of the *Carum carui*, an indigenous umbelliferous plant. English caraways are more plump and aromatic than the Dutch or foreign, which are apt to be mouldy and of little flavour. They yield about 3 per cent. of essential oil when carefully distilled with water. They are a good addition to purgative and other remedies to prevent griping and flatulency; but their chief consumption is among gingerbread bakers, confectioners, and pastrycooks.

CARBAZO'TIC ACID. A crystallizable acid and bitter substance, composed of carbon, azote, and oxygen; obtained by the action of nitric acid on indigo and some other vegetable and animal substances. It is the bitter principle of Welter.

CA'RBON. (Lat. carbo.) This term is used in chemistry to signify the pure combustible base of the varieties of charcoal and other carbonaceous matters; the diamond is pure carbon in a crystalline form. Carbon is an elementary substance, which combines with oxygen in two proportions, forming *carbonic acid* and *carbonic oxide*.

CA'RBONATES. Salts containing carbonic acid. They are recognized by the effervescence which is excited when they are put into dilute muriatic acid. *Carbonate of lime* is one of the most important of these compounds, forming the varieties of marble, limestone, calcareous spar, chalk, &c. Carbonate of lime consists of

Lime	1 atom	=	28	56
Carbonic acid	1	=	22	44
	1		50	100

Carbonate of potash and carbonate of soda are also important salts. (*See* POTASH, SODA.) *Carbonate of ammonia* is used in medicine; it is a white pungent salt, commonly known under the name of *smelling salt*. *Spirit of hartshorn* is a solution of impure carbonate of ammonia, obtained by distilling bone or horn.

CARBO'NIC ACID. This important compound is obtained when any form of carbon, such as the diamond or pure charcoal, is burned in oxygen gas. It consists of 6 carbon + 16 oxygen = 22 carbonic acid; or of

Carbon	1 atom	6	27·27
Oxygen	2	16	72·73
	1	22	100·00

100 cubical inches of carbonic acid gas weigh 47·3 grains. Under a pressure of 36 atmospheres, at the temperature of 32°, it becomes liquid; and when the pressure which retains it in the liquid state is removed, the rapidity of the evaporation, and the sudden and enormous expansion of the vapour, are such as to produce a degree of cold under which the acid solidifies, forming a white concrete substance possessed of very extraordinary properties. Mr. Faraday was the first who liquefied carbonic acid, but it was first described as a solid by M. Thilourier.

At common temperatures and pressures water absorbs its own volume of carbonic acid; under a pressure of 2 atmospheres it dissolves twice its volume, and so on. Carbonic acid imparts briskness and a slightly pungent and sour taste to water thus impregnated with it; it also confers the effervescent quality upon many mineral springs. Carbonic acid is recognized by its rendering lime-water turbid. It extinguishes flame and suffocates animals; hence the miners call it *choke damp*. Carbonic acid is contained in marble, chalk, and all the varieties of limestone, from which it is extracted by strong heat, as in the process of *burning* lime; or by the action of stronger acids, in which case the carbonic acid escapes with *effervescence*. Mountains of limestone, therefore, are great natural repositories of carbonic acid. This gas is also produced during the respiration of animals, and is evolved in the process of fermentation.

CARBO'NIC OXIDE. A gas composed of

Carbon	1 atom	6	42·8
Oxygen	1	8	57·2
	4	14	100·0

100 cubical inches weigh 30·2 grains. It is fatal to animals, and extinguishes flame; but it burns in contact with air, and forms carbonic acid. It is obtained by passing carbonic acid over red-hot charcoal, or by heating a

mixture of chalk or pounded marble and iron or zinc filings to redness. It is not absorbed by water.

CA'RBONI'FEROUS. (Lat. carbo, *coal*, and fero, *I bear.*) A geological term, generally applied to beds or strata containing coal.

CA'RBOY. A large globular bottle of green glass protected by basket work. Carboys are seldom used, except for containing certain acids and other highly corrosive liquids likely to act upon stone-ware. A carboy of oil of vitriol usually contains about 160 lbs. of that acid, or 12 gallons of water.

CARBU'NCLE. The ancient name of a gem, probably corresponding with our precious *garnet*.

CARBU'NCLE. A hard circumscribed inflammatory tumour, which generally arises on the neck or back, and soon forms a fetid discharge, and acquires a tendency to gangrene. It is a kind of malignant boil, spreading under the skin, and producing a morbid inflammatory action of the surrounding parts. Poultices and free incisions to let out the matter, and afterwards emollient fomentations, are the most effective remedies. This disease is called *anthrax*, from the Greek, signifying a burning coal; of which *carbunculus*, from *carbo*, is the Latin diminutive.

CA'RBURETS. In Chemistry, the generic term for compounds of carbon with the simple combustibles.

CA'RBURET OF SULPHUR. A liquid compound of carbon and sulphur, obtained by passing the vapour of sulphur over red-hot charcoal. It was formerly termed *alcohol of sulphur*. It forms compounds, which have been termed *carbo-sulphurets*.

CA'RBURETTED HY'DROGEN. Under this term chemists describe two gaseous compounds of carbon and hydrogen; the one they call *light hydrocarbonate*, the other *olefiant gas*.

Light carburetted hydrogen is evolved abundantly in some coal mines, where it is known under the name of *fire damp*, and is the cause of those tremendous explosions which were so frequent before the invention of the safety lamp by Sir H. Davy: it is also evolved by the mud at the bottom of stagnant waters, where it results from the decay of vegetable matter. This gas is much lighter than atmospheric air, 100 cubical inches weighing between 17 and 18 grains. It burns with a yellow flame, is inodorous, and not absorbed by water. It consists of 6 carbon + 2 hydrogen. When mixed with three volumes of oxygen, or with eight or ten of common air, it explodes with great violence when inflamed, and produces water and carbonic acid.

Olefiant gas received its name from its property of forming, when mixed with chlorine, a liquid of an oily appearance. It is obtained by distilling a mixture of alcohol with twice its bulk of sulphuric acid, and may be collected over water; which, however, absorbs about one eighth of its volume of the gas. It has a slightly ethereal odour; it extinguishes flame; is unrespirable; burns with a dense white light; and when mixed with three or four volumes of oxygen or ten or twelve of air, it detonates on the approach of flame with great violence. It is nearly of the same specific gravity as atmospheric air; and from the quantity of oxygen required to convert its elements into carbonic acid and water, it is shown to consist of two atoms of carbon and two of hydrogen, its equivalent being 14; or of one volume of carbon vapour and two volumes of hydrogen, so condensed as to form one volume of olefiant gas.

CA'RCASS. In Artillery, a hollow case formed of ribs of iron, covered with cloth, or sometimes iron with holes in it. The carcass, being filled with combustible materials, is thrown from a mortar into a besieged place with a view to set the buildings on fire.

CA'RCERES. (Lat. carcer, *a prison.*) In Ancient Architecture, the cells at the end of a circus, in which were stationed the chariots and horses that contended for the prizes, so that they might be able to start simultaneously at the given signal.

CARCE'RULUS. (Lat. dim. of carcer, *a little prison.*) A name given by botanists to such fruits as those of the lime tree, the *Tropæolum*, &c.; which consist of a small number of dry indehiscent few-seeded cells cohering round a central axis.

CARCINO'MA. (Gr. καρκινος, *a cancer.*) A cancerous tumour.

CA'RDAMOMS. Seeds of the *Alpinia cardamomum*. These seeds are imported from Bengal: there are several varieties; but those pods which are small, short and thick, and heavy, are preferred. The seeds themselves are very pungent and aromatic; the containing capsule is quite insipid. Their chief use is in medicine, especially in combination with cathartics and bitters. They yield an essential oil by distillation, to which their virtues are to be ascribed.

CA'RDIAC. (Gr. καρδια, *the heart.*) Belonging to or connected with the heart. The superior opening of the stomach is called the *cardia*, or *cardiac end*, from its proximity to the heart.

CA'RDIA'CEANS, or CARDIACEA. (Lat. cardium, *a cockle.*) A numerous and beautiful family of Lamellibranchiate Dimiary Bivalve Mollusks, including those species in which the mantle is open anteriorly for the foot; and also has two distinct orifices, one for respiration, the other for excretion, as in the cockle (*Cardium edule*). The shell is characterized by having at the hinge irregular primary teeth, both in form and situation, and generally accompanied by one or two lateral teeth. The genera composing this family are *Isocardia*, *Hiatella*, *Cypricardia*, *Cardita*, *Cardium*.

CARDIA'LGIA. (Gr. καρδια, and αλγος, *pain.*) Anxiety and pain about the region of the stomach, frequently attended by a sense of gnawing and heat, and hence called *heartburn*. It is a common symptom of indigestion, and accompanied by salt and acid eructations. After excess in eating and drinking, a fit of heartburn may often be prevented by a teaspoonful of carbonate of magnesia, taken in cinnamon or in soda water, at bed time; 20 or 30 grains of bicarbonate of soda in cold chamomile tea is also an effective preventive. Where the disease is symptomatic of organic mischief, these antacid remedies must be cautiously administered.

CA'RDINAL. (Lat. cardo, *a hinge.*) An epithet implying importance; in which sense it is applied to the principal virtues, the four points of the compass, &c.; and in theological language originally to parish churches, as distinguished from chapels and oratories; from whence it was transferred to the clergy who ministered in such churches. In later times the epithet was restricted to the seven bishops of Rome, and the sees within its territory, and the clergy of the eight and twenty principal churches of that city: from whence the college of cardinals takes its origin. The number of which this college consisted has varied in the course of time. It has for some centuries been limited to seventy; of whom six are bishops, fifty presbyters, and fourteen deacons; and the election of the pope, which is performed by these personages assembled in conclave, is thus concurred in by the three orders of clergy through their representatives. The period at which this election was confined to the cardinals is variously stated. Some have asserted that such was the case as early as 1058; others not before 1562. It is now understood that the pope must be chosen from among this body. The cardinals are distinguished by a scarlet hat, and a short purple mantle worn over the rochet. Their rank is next to that of the pope, to whom they form a political and ecclesiastical council. For further details on the duties of cardinals, see CONSISTORIUM and CONCLAVE.

CA'RDINAL POINTS. (Lat. cardo, *a hinge.*) In Geography, the east, west, south, and north points of the horizon. In Astrology, the cardinal points are those of the rising and setting of the sun, and the zenith and nadir. (COMPASS.)

CA'RDIOID. (Gr. καρδια, *heart*, and ειδος, *form.*) An algebraic curve, so called from its resemblance to a heart.

CARDI'TIS. Inflammation of the heart.

CARDOO'N. A kind of artichoke. The *Cynara cardunculus*.

CARDUE'LIS. (Lat. carduus, *a thistle.*) A genus of Conirostral Perchers (*Insessores*) or Passerine birds, of the finch tribe (*Fringillidæ*), including the goldfinch (*Carduelis elegans*), aberdevine (*Carduelis spinus*), and other British siskins, the habits of which are less arboreal than in the true finches, and which feed principally on the seeds of the thistle and other composite plants.

CAREE'NING. The laying of a ship over to get at leaks or injuries in the bottom. This is commonly called heaving down. To careen implies also to *heel* or lie over generally. Heaving down is never practised with a large ship, except where there are no docks, as the great forces which must be applied to the mast heads to get her over are liable to strain the hull.

CA'RET. (Lat. careo, *I am wanting.*) In Grammar, a character in this form ʌ, denoting that something has been omitted, and is interlined.

CARIA'MA. *See* DICHOLOPHUS.

CA'RICATU'RE. (It. caricare, *to load* or *charge.*) In Painting, an exaggerated representation of any object, in which any natural defects are overcharged, so as to make it appear ridiculous.

CARI'CHIUM. (Lat. carex, *sedge.*) A genus of land-snails, so called from their habitat among sedge, wet leaves, grass, &c. Of these sedge-shells, *Carichium minimum* is British, and may be found about Acton.

CA'RIES. A decayed bone or tooth.

CARI'LLON. A tune performed upon bells.

CARI'NA. (Lat. carina, *the keel of a boat.*) In Botanical language, is the sharp thin back of any organ; the back of a leaf folded up if thin and sharp, the winged rim that occupies the back of certain fruits, the sharp-backed part of a glume or bract, all bear this name. It is also applied to the two anterior petals of a Papilionaceous flower, which adhere by their lower edges into a body something like a boat.

CARINA'RIA. (Lat. carina, *a keel.*) A genus of

Heteropodous Mollusks, characterized by having the viscera, as the heart, liver, branchiæ, generative organs, &c., protruded from the body, and encased in an extremely fragile, beautiful, sub-transparent, symmetrical, compressed shell. The summit of the shell is slightly involuted, but never enters the aperture; the convexity of the shell is terminated by a single keel.

CA'RINATE. (Lat. carina, *a keel.*) In Zoology, when a surface has a longitudinal elevated line, like the keel of a vessel.

CA'RMELITE. *See* ORDERS, MENDICANT.

CA'RMINE. A brilliant lake, made of the colouring matter of the cochineal insect combined with alumina and a little oxide of tin.

CA'RMINATIVE. (Lat. carmen, *a verse or charm.*) Medicines which allay flatulency, and pain of the stomach and bowels arising from it.

CARNA'TION. (Lat. carneus, *flesh-coloured.*) A favourite florist's plant, obtained by art from the wild *Dianthus caryophyllus*. Its flowers are deliciously fragrant; and although in the unimproved state they are a uniform deep red, they have been rendered beautifully striped and variegated by successive changes in the hands of the gardener. The most succesful cultivators of carnations are the Germans, who possess some hundred varieties, and supply the principal part of the seed used in other parts of Europe. These varieties are arranged in three classes, *flakes*, *bizarres*, and *piccotees:* the first have ten colours in their flowers, and broad stripes; the second have irregular spots and stripes, and not fewer than three colours; the last are spotted or dotted with scarlet, red, purple, &c., upon a white or yellow ground.

CARNA'TION-GRASS. (Lat. caro, *flesh.*) Any coarse species of carex is so named in the north of England and Scotland.

CARNA'TIONS. (Lat. caro, *flesh.*) In Painting, the parts of a picture which represent the naked limbs, &c.

CARNE'IA. (Gr. καρνεια.) A festival observed in most of the cities of Greece, and especially at Sparta, in honour of Apollo, surnamed Carneius. The festival lasted nine days, and was conducted in imitation of the method of living in camps; for nine tents were erected, in each of which nine men of three different tribes lived nine days.

CARNE'LIAN. A red or flesh-coloured calcedony. The finest specimens come from India, and are in great request for seal-stones, beads, &c.

CAR'NEONS. (Lat. caro, *flesh.*) A soft fleshy substance.

CA'RNIVAL. (Lat. carni vale, *farewell to meat.*) A festival celebrated with much merriment and revelry in Catholic countries, and especially at Rome and Venice, during the week before the commencement of Lent; deriving its Italian name from the farewell to flesh or meat which introduces the great fast of the church.

CARNI'VORA. (Lat. caro, *flesh*, and voro, *I devour.*) The second tribe of Cuvier's order *Feræ* (*Carnassiers*), including those species of which the teeth are peculiarly adapted for destroying living prey, and for tearing, dividing, or bruising flesh. They have incisors in each jaw, two long and pointed canines; and the molars are never beset with small conical points or tubercles, as in the insectivorous tribe of the same order. The carnivorous tribe is divided into those which tread on the sole of the foot (*Plantigrades*), and those which run on the last joints of the toes (*Digitigrades*).

CAROCO'LLA. (Lat. caro, *flesh;* and Gr. κολλη, *glue.*) A genus of land-snails, so named from the tenacity with which their fleshy foot adheres to limestone rocks. The variegated carocolla (*Car. lapicida*, Lam.) is a native species, and has been found on Juniper Hill, Box Hill, Surrey.

CA'ROMEL. Sugar melted till it acquires a brown colour and exhales a peculiar odour.

CARO'TID. An artery of the neck. There is one on each side of the cervical vertebræ which supply the head with blood. If these vessels are tied, the animal becomes insensible; hence the term, from καροω, *I put to sleep.*

CARP. *See* CYPRINUS.

CA'RPADE'LIUM. (Gr. καρπος, *fruit*, and δηλος, *plain.*) A little-used name, applied in botany to all indehiscent, many-celled, inferior fruits, with a single seed in each cell; as in Umbelliferous or Apiaceous plants.

CA'RPEL. (Gr. καρπος, *fruit.*) A name contrived by modern botanists to denote the separate pistils out of which a fruit, consisting of more pistils than one, is composed. In its most simple state a fruit consists of a one-celled ovary, and a style and stigma, united into a pistil, as in the plum; but in most cases several such pistils are formed within the same flower, and are united in various ways into one compound body, to which the name of pistil is also applied. In the latter case the single pistils are called carpels. The pistil may nevertheless consist of one carpel only. The theory of the structure of the fruit of plants turns upon the relative position which carpels bear to each other in their united state; and upon their correspondence in this respect with leaves, of which they are undoubtedly modifications.

CA'RPENTER. The third warrant officer on board a man of war. He has the charge of the boats. It is his duty, with his mates, to attend constantly to the state of the well, in order that a leak may be immediately reported.

CA'RPENTRY. (Lat. carpentum, *carved wood:*) In Building and Architecture, an assemblage of pieces of timber connected by framing or letting them into each other, as are the pieces of a roof, floor, centre, &c. It is distinguished from *joinery* by being put together without the use of other edge tools than the axe, adze, saw, and chisel; whereas joinery requires the use of the plane. The leading points to be attended to in sound carpentry are, 1st, The quality of the timber used; 2nd, The disposition of the pieces of timber, so that each may be in such direction, considered with reference to the fibres of the wood, as to be most capable of performing its office properly; 3rd, The forms and dimensions of the pieces; 4th, The manner of framing the pieces into each other, or otherwise uniting them by means of iron or other metal.

CA'RPET. An ornamental covering for the floor. The manufacture of carpets is carried on in great perfection in this country. The principal varieties are the Brussels, Axminster, Wilton, Kidderminster, and Venetian. They are generally composed of linen and worsted. In some the pile is cut so as to give the carpet the character of velvet; as in the Wilton carpets. Kidderminster or Scotch carpets are entirely fabricated of wool.

CA'RPET WAY. Any strip or border of green sward left round the margin of a ploughed field.

CA'RPOBA'LSAMUM. (Gr. καρπος, *fruit*, and βαλσαμον, *balsam.*) The exudation of the fruit of the *Amysis Gileadensis;* a variety of *balm of Gilead.*

CA'RPOLITES. (Gr. καρπος, *fruit*, and λιθος, *a stone.*) Fossil fruits and seeds.

CARPO'PHORUM. (Gr. καρπος, *fruit*, and φερω, *I bear.*) The name of the central column, which, in the fruit of the Geranium, the Euphorbia, or Apiaceous plants, bears the ripe carpels, and holds them together when they attempt to separate at maturity.

CA'RREL, or QUARREL. The arrow used in cross-bows, the head of which was four-sided; a cross-bow bolt.

CA'RRONADE. A kind of short iron gun, which is attached to its carriage by a joint and bolt underneath the piece, instead of trunnions. It is only in this respect and in its dimensions that it differs from other guns or howitzers. The name is derived from Carron, a village in Stirlingshire, where this gun was first made.

CARSE LAND. Alluvial soil in a state of aration.

CART. An open box, placed upon two or more wheels, and constructed with shafts, so as to admit of being drawn by one or more horses. In agriculture, carts are used for carting or carrying from one point to another soils, manures, and produce. For this purpose there are the close cart, single or double, that is, for one or for two horses; the corn cart, single or double, constructed of open work, and used for carrying hay, and for conveying corn in the sheaf from the field to the rickyard, &c.; and the stone or quarry cart, consisting of a strong bottom and low wheels, for conveying large stones. Besides these, there are the three-wheeled cart, with low wheels, for carting soil, stones, &c., to a short distance; the timber cart, which is nothing more than two pairs of wheels and axles joined by a pole, and used for conveying large trunks of trees from the place where they have been felled to the place where they are to be manufactured; and the box cart, or cart with close bottom and sides, which is used for conveying soils, manure, and small articles, commonly constructed so as to admit of discharging the load by elevating one end of the box and lowering the other; and to carts having this contrivance the term coup cart is applied in Scotland, and till cart in England.

CARTE BLANCHE. (Fr.) A paper containing nothing but the signature of the party who grants it, in order that the party to whom it has been delivered may insert such conditions as he chooses to prescribe. This term is used in a general sense to express an unlimited authority delegated by one individual to another: thus a general is said to have carte blanche, when his sovereign has granted him permission to use his own discretion in conducting the operations of war.

CA'RTEL. In Military language, an agreement for the exchange of prisoners. Also, a challenge to fight a duel. A cartel ship is one commissioned, in time of war, to carry proposals of any kind between belligerent powers.

CARTE'SIAN PHILOSOPHY. The philosophical system of René des Cartes (born 1596), a native of France, perhaps the most original thinker that country has produced. Des Cartes was the contemporary of Bacon, and exercised an equally powerful influence, though in a manner widely different, on the progress of philosophy in Europe. Both equally undertook the task of demolishing the old scholastic system, and of substituting in its place a more comprehensive method and a more living

spirit of philosophising. But what Bacon strove to accomplish by calling men's attention to experiment and observation of nature, Des Cartes proposed to attain by the search for a first and self-evident ground of all knowledge. This he finds in the art of consciousness, involving necessarily the idea of self or mind. (*Cogito ergo sum.*) Consciousness is the act of thought, constitutes the essence of the soul, and is that which distinguishes it from matter. The ideas or objects of consciousness are of three kinds,—acquired, compounded, and innate. Of the last sort is the idea of God, or the Absolute Being, which, as being the ground of all reality, is itself its own demonstration. God, the Author of the universe, upholds it in its course by his perpetual co-operation, or, in Cartesian language, assistance. All physical phenomena Des Cartes endeavoured to account for by his celebrated *vortices*—motions excited by God, the source of all motion. The singular mixture of philosophical depth and extravagant hypothesis that prevails in the writings of this philosopher obtained for him, as might have been expected, a large number of warm adherents, and of equally violent opponents. Among the former may be enumerated the celebrated Pascal, Malebranche, and Spinoza. The two latter deviated indeed in many important points from the views of Des Cartes; but the main features of his philosophy are preserved alike in the religious mysticism of the one and the systematic pantheism of the other.

CA'RTHAMUS. *See* SAFFLOWER.

CARTHU'SIANS. In Ecclesiastical History, a religious order, instituted by St. Bruno in 1086: so called from their original seat, Chartreuse. They followed the rule of the Benedictines (quod vide), with the addition of various austerities, and employed themselves in the same literary and mechanical pursuits. Soon after their institution the Carthusians were introduced into England, where in the lapse of time they succeeded in establishing nine houses of their order, among which was the Charterhouse in London. (See *Histoire des Ordres Monastiques*, vol. vii.)

CA'RTILAGE, CARTILAGO. (Lat. caro, *flesh*.) A white elastic substance, intermediate between bone and ligament, and having the chemical properties of condensed albumen. It is commonly called *gristle*.

CARTILAGI'NEANS, CARTILAGINEI. A subclass of fishes, in which the endo-skeleton never passes beyond the primitive condition of gristle or cartilage. *See* CHONDROPTERYGII.

CARTOO'N. (It. cartone.) In Painting, a sketch made as a pattern for tapestry. The name is also given to large sketches on coarse or other paper for fresco subjects; in which case, when the stucco is setting the outlines are pricked through on to it so that a correct outline may be expeditiously obtained. We subjoin the following account of the cartoons of Raffaelle at Hampton Court.—These celebrated works, originally thirteen in number, are a magnificent series of coloured designs, representing the origin, sanction, economy, and progress of the Christian religion. They were made originally for the copies in tapestry, still, we believe, annually exhibited in the colonnade of the Vatican, wrought at Arras by command of Leo X. at an expense of 7000 crowns of gold. These were carried off at the plundering of Rome in 1527 by the Spanish army; but Montmorenci, the French general, found and restored them to their former station. In our own days they were again carried off when the French seized the government of Rome, and were afterwards purchased by that excellent pontiff Pius VII.

Seven of the original pictures were purchased by Charles the First, and are now preserved at the royal palace at Hampton Court. Richardson (*Theory of Painting*) gives an historical and critical description of them, and considers them better calculated to convey a true notion of the genius of Raffaelle than even the loggia of the Vatican. The object that Charles had in view when he purchased the seven cartoons above mentioned, was to supply the manufacture then at Mortlake with subjects of a higher character than Francis Cleyre, its superintendant, could himself invent; and there is evidence that some of them were actually copied there, and that they are still preserved, probably at Petworth.

In whatever light, says Fuseli, we consider their invention—as parts of *one whole* relative to each other, or independent *each of the rest* and as single subjects,—there can be scarcely named a beauty or a mystery of which the cartoons furnish not an instance or a clue. They are poised between perspicuity and pregnancy of moment: the Death of Ananias, the Sacrifice at Lystra, Paul on the Areopagus, will furnish us with conclusions for the remainder. In Paul announcing his God from the height of the Areopagus, the same sagacious critic observes that enthusiasm and curiosity make up the subject. Simplicity of attitude invests the speaker with sublimity; the parallelism of his action invigorates his energy; situation gives him command over the whole; the light in which he is placed attracts the first glance; he appears the organ of a superior power. The assembly, though selected with characteristic art for the purpose, are the natural offspring of the place and moment. The involved meditation of the Stoic, the Cynic's ironic sneer, the incredulous smile of the elegant Epicurean, the eager disputants of the academy, the elevated attention of Plato's school, the rankling malice of the Rabbi, the magician's mysterious glance, repeat in louder or in lower tones the novel doctrine; but whilst curiosity and meditation, loud debate and fixed prejudice, tell, ponder on, repeat, reject, discuss it, the animated gesture of Dionysius and Damaris announce the power of its tenets, and—what the artist chiefly aimed at—the established belief of immortality. We have selected the above as a specimen of the critical examination which the reader may apply to the remaining six of this extraordinary series of pictures, in which the power of combining the drama with pure historic fact has never been surpassed.

The cartoons have been several times engraved; first by Gribelin in the reign of Queen Anne; then by Dorigny; and afterwards by inferior artists, most probably from the engravings themselves of those that preceded them. They were likewise engraved on a small scale by Fittler, and more recently in a superior style by Holloway. The late Prince Hoare, Esq., secretary for foreign correspondence to the Royal Academy, was possessed of a very fine cartoon by Raffaelle, the subject of which was the Murder of the Innocents.

CARTOU'CH. (It. cartoccio.) In Architecture, the same as *modillion* (which see), except that this term is used almost exclusively to signify the blocks or modillions applied at the eaves of a house. Some have used the term to denote the ornament of the key-stone of an arch, which seems to represent a scroll of paper partly unrolled.

CARTOU'CHE. A Military term, signifying a strong case or box for holding balls.

CA'RTRIDGE. A case of paper or pasteboard holding the exact charge of a firearm. Those of cannon and mortars are sometimes of tin or wood, but most frequently flannel, bags of this material being found the most convenient.

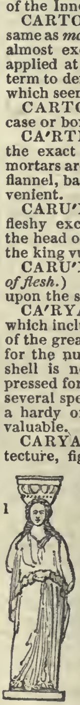
CARU'NCLE. (Dim. of caro, *flesh*.) A naked soft fleshy excrescence, often ornamenting some parts of the head of birds; as, *e.g.* the caruncle on the cere of the king vulture (*Vultur papa*, Lin.).

CARU'NCULA. (Dim. of caro, *flesh; a little piece of flesh*.) A small protuberance found near the hilum upon the seed of *Euphorbia lathyris* and other plants.

CA'RYA. (Gr. *κάρυον, a nut*.) The genus of plants which includes the hickory nut of North America; a tree of the greatest value, for its tough elastic wood, as well as for the nuts, which resemble walnuts, except that their shell is not furrowed, and which are much eaten and pressed for their oil in their native country. There are several species of Carya; but *C. alba*, the white hickory, a hardy ornamental tree in this country, is the most valuable.

CARYA'TIDES. (Gr. *καρυα, a nut tree*.) In Architecture, figures used instead of columns to support an entablature. The origin of them, according to Vitruvius, is as follows—"Carya, a city of Peloponnesus, took part with the Persians against the Grecian states. When the country was freed from its invaders, the Greeks turned their arms against the Caryans, and upon the capture of the city put the males to the sword, and led the women into captivity. The architects of that time, for the purpose of perpetuating the ignominy of this people, instead of columns in the porticos of their buildings, substituted statues of these women, faithfully copying their ornaments, and the drapery with which they were attired; the mode of which they were not permitted to change."

1



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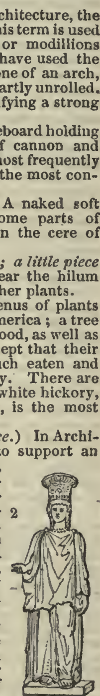


The writer of the articles on art in this work was the first author on architecture who endeavoured to show the want of truth in this account, and that on two grounds:—first, because the circumstance is not mentioned by any of the Greek historians; and secondly, because long previous to the time assigned by Vitruvius, figures of men, women, and animals were employed for this purpose. They appear to have acquired their name from their employment in temples to Diana, by whom the Lacedæmonians are supposed to have been made acquainted with the story of Carya, turned into a nut tree by Bacchus, who at the same time transformed her sisters into stones, and thence worshipped under the name of Caryatis. From their employment in temples dedicated to the goddess, they were used in other buildings as representations of the nymphs who assisted at the mysteries of the patron goddess. The figure No. 1. above given is a Caryatid, from the Pandroseum at Athens; No. 2. is a Canephora (see that word). When figures of the male sex are used they are called Persians.

CARYO'CAR. (Gr. *καρυον, a hard-shelled fruit.*) A genus of trees inhabiting the forests of tropical America, especially Guayana; one of them, found in woods near Mariquita, is said to attain the height of 240 feet. The Saouari (vulgarly called Sawarrow) nuts of the shops, a delicious fruit, with a large soft buttery kernel, are the seeds of *Caryocar glabrum* and other species. Properly the name Saouari applies to *Caryocar butryosum.*

CA'RYOPHY'LLIA. *See* MADREPORE.

CA'RYOPHYLLA'CEOUS (Lat. caryophyllus, *the garden pink*), is sometimes said of corollas consisting of petals having long claws dilating into a broad limb; as in the garden pink.

CA'RYO'PSIS. (Gr. *καρυον, a nut*, and *οψις, resemblance.*) The technical name of the grain of corn. It is an indehiscent one-celled fruit, with a membranous pericarp adhering firmly to the seed.

CASCARI'LLA. (Span. dim. of cascara, *bark.*) The bark of the *Croton eleutheria*, imported for medical use from Jamaica and the Bahama Islands. It is bitter and aromatic, and when burned it diffuses an odour much resembling that of musk.

CASE. (Lat. casus; from cado, *I fall.*) In Grammar, that modification of a noun which designates the relation in which a substance is conceived to exist in regard to some other substance. This end is commonly attained in language by changes in the termination of nouns. In English there are but three cases; the nominative, the genitive or possessive, and the accusative or objective case; the last only in pronouns. All other varieties of relation are expressed by prepositions. *See* GRAMMAR.

CASE. (Fr. casse.) Is the receptacle for the types, from which the compositor gathers them separately, and arranges them in lines and pages to print from. They are always in pairs; one of which is styled the upper case, and is divided into ninety-eight boxes or recesses of equal size, in which are deposited the capitals, small capitals, accented letters, figures, &c.; the other is styled the lower case, and is divided into fifty-three boxes or recesses of unequal size, containing the small letters, spaces, &c., the letters most in use having the largest boxes assigned to them. The cases are two feet nine inches long, one foot four inches and a half broad, and a full inch in depth.

CA'SEIC ACID. A peculiar acid extracted from cheese.

CA'SEMATE. In Fortification, a vault or arch of stonework in the flank of a bastion, serving as a battery.

CA'SEMENT. (It. casamento.) In Architecture, a portion of a window sash hung on hinges. It is used also to denote the moulding called a *scotia*, which see.

CASE'RNS, or CAZERNS. Huts erected on the ramparts, or between the ramparts and the houses, of fortified towns, serving as temporary lodgings for the soldiers on duty.

CASE-SHOT, or CANISTER-SHOT, signifies musket balls, stones, pieces of iron, &c. put into cases or tin canisters, and discharged from pieces of ordnance.

CA'SEUM. (Lat.) The basis of cheese. The purified curd of milk.

CASH. In Commerce, the ready money, bills, drafts, bonds, and all immediately negotiable paper in an individual's possession.

CASSAMU'NAR. A root brought from the East Indies, and formerly used in medicine as a warm bitter.

CASSA'TION, COURT OF. The highest judicial institution in France; so termed from possessing the power to quash (casser) the decrees of inferior courts. It is a court of appeal in criminal as well as civil cases. The tribunal of cassation was first introduced, as a court wholly independent of the king and his council, in 1790. This court has a president, and three presidents of sections; but the minister of justice, as keeper of the seals (*garde des sceaux*), has the right of presiding in cases where it sits on appeal from the cours royales. The three sections are,—1. Des requêtes, which decides on the admissibility of petitions of appeal in civil cases; 2. De cassation civile; 3. De cassation criminelle. The decision of the court of cassation has the effect of sending back the case to the inferior courts. If, after a decision has been reversed, a second court decides the same case in the same way, on appeal being entered again the court of cassation must either repeat its reversal by the unanimous consent of all the three sections, or it must request an authentic explanation of the law from the government; and, after a third conflicting decision, such authentic explanation becomes absolutely necessary. The inferior judges of the three sections of the court of cassation are styled counsellors.

CASSA'VA. A species of starch obtained from the roots of the *Jatropha manihot.*

CA'SSIA. (From the Arabic.) The bark of the *Laurus cassia;* its flavour somewhat resembles that of cinnamon, and it yields an essential oil, which is pungent and stimulant.

CASSI'DEOUS. (Lat. cassis, *a helmet.*) When the upper petal of a flower is dilated into a broad helmet-shaped leaf, as in the genus *Aconitum.*

CASSI'DIDÆ. (Lat. cassis, *a helmet.*) A family of Tetramerous Coleopterans, generally known by the name of tortoise-beetles, distinguished by having straight short filiform antennæ, inserted close together in the upper surface of the head; mouth situated on the under surface of the head, with strong and broad mandibles; legs short, with the tarsi flattened, the third joint deeply cleft, receiving between its lobes the terminal joint; margins of the thorax and elytra much dilated, so as to give the insects the appearance of small tortoises The larva of the *Cassididæ* is remarkable for an apparatus, or anal fork, by which it collects and forms of its excrements a kind of parachute, or defensive covering.

The genera of *Cassididæ* are, *Alurnus, Hispa, Chalepus, Imatidium,* and *Cassida;* the latter is the only indigenous genus, and of this the most common example is the *Cassida equestria* of Fabricius.

CA'SSIOPE'IA. One of the constellations of the northern hemisphere.

CA'SSIS. (Lat.) A genus of Gastropodous Mollusks, separated by Lamarck from the Linnæan genus *Buccinum*, and including the species of which the shells are commonly called "helmets." The nacreous or inner layer of these shells are exquisitely sculptured by Italian artists in imitation of antique cameos; the different coloured strata resembling the onyx and other precious stones.

CA'SSIUS, PURPLE OF. So called from its inventor. A beautiful purple used in porcelain painting, and for staining glass. It is formed by immersing tin in a solution of gold. It is probably a mixture of oxide of tin and finely divided gold.

CA'SSOWARY. (Casuarius, from the Malay word cassuwaris.) A genus of Coursers or Struthious birds, inhabiting the island of Java, in which the wings are shorter than in the ostrich, and are armed with strong spines, for the purpose of combat or defence. The head is surmounted by a bony protuberance covered with horn.

CASSYTHA'CEÆ. (Cassytha, the only genus.) A most singular natural order of plants, having the fructification of *Lauraceæ*, and the manner of growth and general appearance of a *Rhipsalis*, or rather a *Cuscuta.* They inhabit the tropical parts of the world.

CAST. In Sculpture. *See* MOULDING.

CASTA'NEA. (Castana, a city of Thessaly.) A genus of trees or shrubs, related to the oak, and producing for fruit the seed-like nuts called chesnuts in this country. The common Spanish chesnuts, of which upwards of 20,000 bushels are annually imported from the south of Europe, are the fruit of *C. vesca;* a much smaller nut is obtained in North America from the *C. pumila*, or the Chinquapin chesnut. The timber of the common Spanish chesnut is good and durable, more so than that of the oak, when the latter is young; but it is a mistake to suppose that the ancient roofs and beams occasionally found in buildings of the Norman era, and which carpenters call chesnut, are the wood of this tree. Such instances all belong to the kind of oak called *Quercus sessiliflora*. The genus *Castanea* differs from *Quercus*, among other things, in having the nuts enclosed in a spiny closed-up cup, instead of a shallow open one; but in the East Indies, where both oaks and chesnuts assume very remarkable forms, the two approach each other sometimes so nearly in this particular, that it is difficult to distinguish them.

CA'STANETS. (Fr. castagnettes.) Small wooden or ivory musical instruments, played by being tied to the fingers, and thus rattled by dancers to the time of the music of the dance. They are chiefly used in Spain.

CASTE. A term borrowed from the Portuguese settlers in India, which is used to denote the hereditary classes into which the population of Hindoostan is divided, according to the religious law of Brama. The origin of these classes is detailed in the sacred book which contains the ordinances of Menu. According to this authority, the Brahmin, the Cshatriya, the Vaisya, and the Sudra sprang respectively from the mouth, the arm, the thigh, and the foot of Brahma. 1. The class of Brahmins, or priests, whose name signifies *scripture*, are far exalted above the rest in honour and privilege, and should be devoted entirely to prayer and meditation, or at least to the most exalted concerns of life. Many Brahmins, however, do in fact engage in secular pursuits, not only as ministers of sovereign princes (an office for which, according to the ordinances above cited, they are indeed peculiarly fitted), but also, in Guzerat and other parts of Western India, as merchants, or in the lower employment of messengers and porters; while many enter the Company's service as private soldiers. These, however, are Brahmins of the first and second classes (Brachmachari and Grihast'ha), youths or married men who as yet live in the world; from which the two higher classes, Vanaprastha and Sunnyassi, are wholly divorced: from these spring the various orders of fanatics with which India swarms. 2. The Kshatriya, or soldier caste, whose name indicates *protection*. To this belong not only the high military classes, but in some parts of India whole tribes, as the Seikhs, &c. 3. The Vaisya, or commercial class (*wealth*). 4. The Sudra, or caste of tillers of the soil

(*labour*). These are deeply degraded below not only the Brahmins, but the other two castes; and even the reading of the Vedas or sacred books is forbidden to them. Besides these four grand divisions, the Hindoos have many subdivisions of caste, and no fewer than thirty-six are reckoned which are all inferior to the Sudra. These descend, according to the mythological history of the Hindoos, from the "Burren Sunker" or mixed class, proceeding from the confusion of castes which took place under the reign of a wicked and irreligious monarch. Finally, the Pariahs and some other races are considered as having no caste at all, and mere outcasts from humanity. Traces of the system of caste, which confines employments to hereditary classes, are to be found in the institutions of many countries, and in the history of many more. That the Egyptian nation was thus divided, is well known; and it is supposed that similar institutions prevailed in the ancient Assyrian empires. If Plato can be relied on as an authority, the Athenians in the first ages of their commonwealth were divided into five classes of the same description — priests, handicraftsmen, shepherds and hunters, ploughmen, soldiers. And it is said that the Cretans were divided, according to the laws of Minos, in the same manner as the Egyptians.

CA'STELLATED. (Lat. castellum, *a castle.*) In Architecture, a building in the style of a castle.

CA'STING. (Dan. kaster, *to throw.*) In Architecture, a term used to denote the bending of the surfaces of a piece of wood from their original state, caused either by the gravity of the material, or by its being subject to unequal temperature, moisture, or the uuuniform texture of the material. Called also Warping.

CASTING. In Foundery, the running of liquid metal into a mould prepared for that purpose. *See* FOUNDERY.

CA'STING OF DRAPERIES. In Painting, the disposition of the folds of the garments wherewith the figures in a picture are clothed. Carlo Maratti thought that the disposition of drapery was a more difficult art than even that of drawing the human figure, and that a student might be more easily taught the latter than the former. Inferior painters enter into the minute discriminations of quality in drapery; but, as Sir Joshua Reynolds has well observed in his Fourth Discourse, with the historical painter "the clothing is neither woollen nor linen, nor silk, satin, nor velvet: it is drapery; it is nothing more."

CA'STING OFF COPY. In Printing, is to ascertain accurately how many pages in print a given quantity of manuscript copy will make; or how many pages a given quantity of printed copy will make when the size of the book and the type are changed; also when a given quantity of manuscript copy is delivered, with directions that it is to make a certain number of pages in print, to determine the size of the page and the size of the type. This is usually done by composing a line or two of the copy, when, supposing a line and a half of it makes a line of print, it becomes a mere arithmetical question. Supposing there are 12,000 lines of copy, it will make 8,000 lines in print, which, at 24 lines to a page, will be 333 pages, and with the title, short pages, &c. equal 14 sheets in 12mo.; about the general quantity in a volume of modern novels.

CA'STLE. (Lat. castellum; or Sax. caꞅtel.) In Architecture, a building fortified for military defence; also a house with towers, usually encompassed with walls and moats, and having a donjon or keep in the centre. The principal castles of England at present are, the Tower of London, Dover, Windsor, Norwich, &c.; but at one time those of Harwood, Spofford, Kenilworth, Warwick, Arundel, and others might have vied with them in importance. The characteristics of a castle are its valla (embankments) and fossæ (ditches); from the former of which the walls rise, usually crowned by battlements, and flanked by circular or polygonal bastions at the angles formed by the walls; these latter were pierced for gates with fixed or draw bridges and towers on each side; the gates, which were of considerable strength, were further guarded by descending gratings, called portcullises; all the apertures were as small as they could be made, consistently with internal lighting. The component parts of a castle were, the foss or mote, with its bridge; the barbican, which was in advance of the castle, being a raised mound or tower, the outer walls having terraces towards the castle, with their bastions, as above mentioned; the gate-house, flanked by towers, and crowned with projections, called machicolations, through which heavy materials or molten lead were dropt on the assailants entering the gateway; the outer ballium, or area within the castle, which was separated from the inner ballium by an embattled wall with a gate-house, and in which the stables and other offices usually stood; and the inner ballium, for the residence of the owner or governor and his retinue; this, at one corner, or in the centre, had a donjon or keep tower, which was the strong hold of the place, wherein was a state apartment; a well and a chapel; the former usually, and the latter frequently, are found in ancient castles.

For further information on the subject the reader is referred to *King's Mun. Antiq.* fol. 4 vols; the *Archæologia* in several places; *Leland's Collect.* vol. ii.; *Woolnoth's Ancient Castles of England and Wales*, &c. &c.

CA'STOR. The generic name of the beaver. (*Castor fiber*, Linn.)

CA'STOR. A peculiar concrete substance, contained in oval pouches situated near the anus of the *Castor fiber* or *beaver*. There are four of these pouches; two contain a species of fat; while the two larger ones include in their membranous cells a viscid fetid substance, which is the *castor* of the Materia Medica. It is imported from Russia, Prussia, and Poland, and from Canada: the latter, known in trade under the name of *New England castor*, is very inferior. It is said to be an antispasmodic.

CA'STOR AND PO'LLUX. The name given to a meteor which sometimes appears at sea, attached to the extremities of the masts of ships under the form of balls of fire. When one ball only is seen, it is called Helena. The meteor is generally supposed to indicate the cessation of a storm, or a future calm; but Helena, or one ball only, to portend bad weather.

CA'SUA'RINA'CEÆ. (Casuarina, one of the genera.) A curious natural order of plants, inhabiting New Holland, some parts of India, and the South Sea Islands, with long slender creeping branches, resembling those of *Equisetum*, and bearing scales only in the place of leaves. The order is nearly allied to *Myricanceæ*, and belongs to the most imperfect forms of Exogenous vegetation.

CA'SUIST, CA'SUISTRY. In Theology, a casuist is a doctor charged with the decision of cases of conscience. The Jesuits were distinguished for the cultivation of this mixed subject of theology and ethics; which was admirably calculated to promote the crafty policy of that order. The science of casuistry, however, has been cultivated in the Protestant as well as the Papal church; and until very recently there was a professor of casuistry at Cambridge. (See *Mayer's Bibliotheca of Casuists.*)

CAT. *See* FELIS, or FELINÆ.

CAT. A ship employed in the coal trade.

CAT. Tackle by which the anchor is raised to the cathead. See *Falconer's Dict.*

CA'TABA'PTISTS. (Gr. κατα, *against*, and βαπτιζω, *I baptize.*) In Ecclesiastical History, a general term to designate all the sects which have denied the necessity of baptism generally, or have opposed infant baptism. *See* BAPTISTS, QUAKERS, SOCINIANS, &c.

CA'TACA'USTICS. (Gr. κατακαιω, *I burn.*) In Optics or Geometry, are the *caustic* curves formed by the reflection of the rays of light, and so called to distinguish them from the *diacaustic*, which are formed by refracted rays. *See* CAUSTIC.

CA'TACHRE'SIS. (Gr. κατα, in the sense of *beside*, and χρησις, *use.*) In Rhetoric, a figure by which a word is used in a sense analogous to its own. *See* METAPHOR.

CA'TACLE'SIUM. (Gr. κατα, *against*, and κλειω, *I enclose.*) A name applied sometimes to such fruit as that of *Mirabilis*, which consists of a membranous indehiscent pericarp enclosed within a hard pericarp-like tube of the calyx.

CA'TACLY'SM. (Gr. κατακλυσμος, *an inundation, a deluge.*) Geologists apply the word to signify the various great inundations which they conceive to have occurred at different periods in the history of the globe.

CA'TACOMBS. (Gr. κατα, *against*, and κυμβος, *a hollow place.*) In Architecture, subterraneous places used for burying the dead. The hypogæa, crypta, and cimeteria of the ancients were used for the same purpose. In some cities those vast excavations were made use of for other purposes than those of sepulture; at Syracuse, for instance, the same cavern served for a prison as well as a public cemetery. It has been said that in the early ages of Christianity they also served as places of devotion. The most celebrated for their extent are those of Rome, Naples, Syracuse, &c.; and the more modern ones of Paris, which have been formed by quarrying for the stone with which the city is built.

CA'TACOU'STICS, or CATAPHO'NICS. (Gr. κατα, *about*; ακουω, *I hear*; φωνεω, *I speak.*) The science of reflected sounds; or that part of acoustics which treats of the properties of echoes, or in general of sounds which do not come to the ear directly but after having been reflected by some substance. *See* ECHO and SOUND.

CA'TAFA'LCO. (Ital. *a scaffold.*) In Architecture, a temporary structure of carpentry, decorated with painting and sculpture, representing a tomb or cenotaph, and used in funeral ceremonies. That used at the final interment of Michael Angelo at Florence was of the most magnificent description, and perhaps unequalled as to the art employed on it by any used before or since.

CA'TALE'CTIC. (Gr. καταληκτικος, *deficient.*) In Greek and Latin poetry, a verse wanting one syllable of its proper length: *acatalectic*, a verse complete in length; *hypercatalectic*, having one syllable too many; *brachycatalectic*, wanting two syllables.

CA'TALEPSY. (Gr. καταλαμβανω, *I seize.*) A disease in which the functions of the organs of sense and

motion are suspended, whilst the heart continues to pulsate. The patients are said to be in a *trance;* and in this state they remain for some hours, or even days. Ammoniacal and etherial stimulants are the most effectual restoratives.

CA'TALOGUE RAISONNE'. In Bibliography, a catalogue of books, classed under the heads of their several subjects, and with a general abstract of the contents of works where the title does not sufficiently indicate it; thus serving as a manual, to direct the reader to the sources of information on any particular topic. The want of alphabetical arrangement is supplied by an index at the end. The catalogue of the French *Bibliotheque Royale* (10 vols. fol. 1739—53) is said to be the best work of this description, as far as it extends.

CA'TAMARA'N. A sort of raft used chiefly by the Indians on the Coromandel coast for the purposes of fishing. It is composed of three pieces of wood lashed together, the middle piece being longer and broader than the others; and it is almost the only kind of boat that can live in the surf that prevails on that coast. Catamaran was also the name given to the floating batteries with which the French at the commencement of the present century meditated the invasion of England.

CATAME'NIA. (Gr. κατα, *according to*, and μην, *a month.*) The monthly uterine evacuation.

CA'TAPE'TALOUS. (Gr. κατα, *against;* πεταλον, *a petal.*) When the petals of a flower are held together by stamens which grow to their bases, as in the mallow.

CA'TAPHRA'CTED. (Gr. καταφρακτος.) Covered with a hard callous skin, or with horny or bony plates or scales closely joined together. Among the ancients, cavalry equipped with complete defensive armour were termed *equites cataphracti.*

CA'TAPLASM. (Gr. καταπλασσω.) A poultice.

CA'TAPULT. (Gr. κατα, *against*, and πελτη, *a shield.*) A military engine used by the ancients for throwing stones, long darts, or javelins. The catapult is often confounded with the balista; but the latter engine seems to have been chiefly used for the purpose of propelling stones, while the former more frequently was employed with other missiles. Their size and construction were various, but the principle of action was the same in all; namely, the elastic force with which twisted rope uncoils itself.

CA'TARACT. (Gr. καταρρασσω, *I confound.*) An opacity of the crystalline lens of the eye, producing confused or indistinct vision, or total blindness, according to the less or greater extent of the thickening: it is sometimes rapid, and often very slow in its progress. It is distinguished from *gutta serena* by the visible opacity of the lens, and by the iris contracting upon exposure of the eye to light. This disease is curable either by depressing or extracting the lens, operations which are performed with wonderful dexterity by some of our oculists.

CATA'RRH. (Gr. καταρρεω, *I flow down.*) The complaint commonly called a *cold in the head*, generally attended by running from the eyes and nose, sneezing, hoarseness, and commonly ending in cough. It is produced by sudden changes of air or temperature, and by exposure to draughts of air. In its usual form domestic remedies relieve it,—diluents, mild aperients, and abstinence from wine and animal food; but when attended by fever, headache, tightness about the forehead, and difficult breathing, it often requires more serious attention, for, if neglected, it may lead to much mischief.

CA'TARRHINES, *Catarrhina.* (Gr. κατα, *at*, and ῥιν, *nose.*) A tribe of Quadrumanes, including those which have the nostrils approximated, and the intervening septum narrow; as in the apes of the old world.

CATA'STROPHE. (Gr. καταστρεφω, *I overturn.*) In modern literary language, the final event of a drama or romance, to which the other events are subsidiary. The περιπετεια, or revolution, indicated by Aristotle as one of the parts of the drama, was a change in the fortunes of the principal personages of the play; as, the fall of Œdipus from sovereignty into extreme misery and banishment, in the *Œdipus Tyrannus.* Some such change is generally involved in the idea of a catastrophe: thus, marriage is the ordinary catastrophe of a comedy or a novel, as some disastrous change is that of a tragedy.

CA'TCH-DRAINS. Open drains across a declivity to intercept surface water. The term is sometimes also applied to under drains across a declivity.

CA'TCHWORK-MEADOWS. Grass lands with very regular surfaces, subjected to irrigation, the water as it descends the declivities being intercepted by catchdrains.

CA'TECHISM. (Gr. κατηχεω, *I instruct.*) A form of instruction by question and answer, appropriated by general usage to instruction in religious subjects, and more especially to the set forms which most churches have authorised for the instruction of children in the elements of religion. The English church catechism is intended to be an exposition of the vow made at baptism, and till the time of James I. consisted only of the *renunciation* or repetition of the baptismal vow, the creed, and the Lord's Prayer. The latter portion, explaining the nature of the sacraments, was added after the conference at Hampton Court. The catechism of the Council of Trent, or *Catechismus ad Parochos*, was set forth by the Roman Catholic divines for the use and direction of the clergy, and contains an ample account of the whole sum of the Romish doctrines. It was approved by Pius V., and published in 1566. (See *Bingham's Antiq.* b. x. ch. 1, 2.)

CA'TECHU. A Japanese word, signifying the juice of a tree. The extract of the *Acacia catechu*, an astringent substance, consisting of tan and extractive matter, imported chiefly from Bengal and Bombay. Its principal use is in medicine.

CATECHU'MEN. (Gr. κατηχουμενος.) He who learns the elements of any science: one who is undergoing a course of religious instruction with a view to his admission into the church. The Christian society in the early ages was divided into two classes, Fideles and Catechumeni; the former being those who had been admitted by baptism into the entire privileges of the church, the latter such as were preparing for that admission.

CA'TEGOREMA'TIC. (Gr. κατηγορεω, *I predicate.*) In Logic, when a word is capable of being employed by itself as a *term*, or predicate of a proposition.

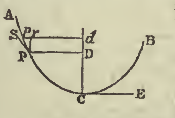
CATEGO'RICAL PROPOSITION. (Gr. κατηγορεω, *I declare something of another.*) In Logic, a proposition which affirms or denies, absolutely and without any condition, that the subject does or does not agree with the predicate. (*See* PROPOSITION.) Categorical propositions are said to be pure (those which simply assert one thing of another), and modal (those which assert one thing of another under a certain mode or form). But this is a distinction arising out of the poverty of language only, and no essential difference between the two classes; *e. g.* "the king reigns" is a pure categorical proposition; "the king reigns justly" is said to be modal. But it is evident that if our language had a single word to express the whole idea (to reign justly), the latter would be called pure likewise. All cases of modal categoricals may probably be resolved into similar instances of the deficiency of words to express complicated notions.

CA'TEGORY. (Gr. κατηγορια.) In Logic and Metaphysics, a Greek word, signifying originally that which may be said or predicated of a thing; a general term in reference to a less general one which is included under it. By Aristotle, from whom the word, and its corresponding Latin term *predicate*, was borrowed by the schoolmen, it was applied to denote the *most general* of the attributes that may be assigned to a subject. Of these he attempted an enumeration, under the names of substance, quantity, quality, relation, place, time, condition, state or habitude, action, and passion. The word has been revived in modern times by Kant, to express the most general of the modes in which a thing can be raised from an object of sense to an object of intellect; or, in other words, the forms or conditions which must pre-exist in the understanding, in order that an act of intelligence may take place. For an account of these see art. KANTIAN PHILOSOPHY. The difference between the categories of Kant and those of Aristotle is this, that the latter are mere generalizations from experience, which may consequently be multiplied indefinitely; whereas the former result from a professedly exhaustive analysis of the human understanding as it is in itself, or formally, that is, apart from all consideration of its object-matter.

CATENA'RIAN ARCH. (Lat. catena, *a chain.*) In Architecture, an arch whose form is that of a chord or chain suspended from two fixed points at its extremities.

CATE'NARY. (Lat. catena, *a chain.*) The curve into which a chord or flexible chain of uniform density and thickness forms itself when suspended or allowed to hang freely from two points. This curve was first noticed by Galileo, who proposed it as the proper figure for an arch of equilibrium; but he imagined it to be the same as the parabola. Its true nature was first demonstrated by James Bernoulli, and its various properties soon after pointed out by John Bernoulli, Huygens, and Leibnitz. It is interesting on account of the light it throws on the theory of arches, and also by reason of its application to the construction of suspension bridges.

The equation of the catenary may be found as follows: let A and B be the points of suspension, and C the lowest point in the curve. Draw C D perpendicular to the horizon, and through any two points P and p very near each other, draw P D and $p\,d$ perpendicular to C D; draw also P r parallel to C D, and let P S be the tangent at P. Now, the chain having assumed this form, the equilibrium would not be disturbed by supposing the part C P to become rigid. In this case it would be kept at rest by three forces; namely, the tension at its two extremities, and its own weight. The tension at C is exerted in the direction C E or $p\,r$, that at P in the direction P S or Pp, and the weight in the vertical Pr. These three forces are therefore, by the principles of mechanics, proportional to $p\,r$, p P, and P r; that



is, making $CD = x$, $DP = y$, and $CP = z$, proportional to the differentials of these quantities, or to dx, dy, dz. But the tension CE (arising from the part of the chain CB) is constant; suppose it therefore equal to a, and the chain being uniform, the weight of CP is proportional to its length, or to z; therefore we have $a : z = dy : dx$, or $a\,dx = z\,dy$, which is the differential equation of the curve. On substituting $\sqrt{dz^2 - dx^2}$ for dy, and integrating, there results $x^2 + 2\,ax = z^2$, which is an equation between the arc and the absciss. The curve cannot be expressed by a simple algebraic equation between the absciss and ordinate, and is consequently of the mechanical kind. The constant quantity a is called the parameter; and one of the most remarkable properties of the curve is, that the rectangle contained by the parameter and an ordinate is equal to the natural logarithm of the ratio of the parameter to the sum of the parameter, the absciss, and the arc.

CATE'NULATE. (Lat. catena, *a chain.*) When a surface presents a series of elevated ridges or oblong tubercles resembling a chain.

CA'TERPILLAR. The name of the larvæ of Lepidopterous insects.

CA'THARI. (Gr. καθαρος, *pure.*) An oriental sect of Christians. *See* PAULICIANS.

CATHAR'TIC. (Gr. καθαιρω, *I purge.*) That which increases the action of the bowels. The term is commonly applied to medicines which do this with some degree of violence: among the milder cathartics, jalap, senna, calomel, and saline purges are the most used; those which are *drastic* are croton oil and elaterium.

CATHA'RTIN. The active or purgative principle of senna.

CAT-HEAD. A Nautical term, signifying a strong inclined piece of timber projecting from either bow of a ship, to which the ring of the bower anchor is secured. The block or pulley hooked to the ring is called the *cat-block*, the rope the *cat-fall.*

CATHE'DRAL. (Gr. καθεδρα, *a seat or throne.*) The principal church of a diocese, in which is the throne of the bishop. The term cathedra was originally applied to the seats in which the bishop and presbyters sate in their assemblies, which were held in the rooms in which the worship of the first Christians was also performed before they had liberty to erect temples for that purpose. In after times the choir of the cathedral church was made to terminate in a semicircular or polygonal apsis; and in the recess thus formed were placed the throne of the bishop in the centre, and seats of an inferior class for presbyters. In modern cathedrals the bishop's throne is in the choir, and generally on the south side. (*Bingham*, viii. 6. 10.)

CA'THETA and CATHETUS. (Gr. καθετος, *let down.*) In Architecture, a vertical line falling from the extremity of the underside of the cymatium of the Ionic capital through the centre of the volute.

CA'THETER. (Gr. καθιημι, *I thrust into.*) A tube which may be introduced by the urethra into the bladder for the purpose of drawing off the urine.

CA'THOLIC. (Gr. καθολικος, *universal.*) A word which occurs in the New Test. in the titles of certain of the Epistles,—those of James, Peter, and John,—signifying that they are addressed to the whole or universal body of Christians, and not to a particular section of them. Hence the term has been used in later times to distinguish the church of Christ from all heretics and schismatics, and has been assumed by particular churches either to separate themselves from all others, as the Romish; or to include themselves as individual members of the universal body, represented under different and subordinate local names, as the English episcopal church. The Romish church appeals to the decisions of the Council of Trent for its most complete and definite rule of faith, and allows no one to be a member of the Catholic church who rejects any of the tenets therein enforced. (*See* art. ROMAN CATHOLIC.) The English church considers itself a member of the Catholic, but passes no judgment as to what variations from its own formularies incur the guilt of heresy and incapacitate from such incorporation. *See* art. CHURCH.

CATHO'LICON. (In old Pharmacy.) An universal medicine.

CA'TKIN. The English name of the inflorescence of the poplar, willow, and similar trees. A catkin is a close spike, composed of scales overlapping each other, and falls off the parent plant as soon as its office of flowering or fruiting is accomplished.

CATO'PTRICS. (Gr. κατοπτρον, *a mirror;* compounded of κατα and οπτομαι, *I see.*) Is that part of the science of optics which treats of the laws of reflected light, and the phenomena of vision produced by reflection. For details connected with this interesting branch of natural philosophy, see the terms MIRROR, OPTICS, REFLECTION.

The principal authors who have treated of Catoptrics are, Euclid; Alhazen and Vitellion, in the 11th and 12th centuries; James Gregory in his *Optica Promota;* Barrow, Smith, Tacquet, and all modern writers on the subject of Light or Optics.

CAT'S-EYE. A beautiful siliceous mineral (probably quartz), penetrated by fibres of asbestos, which, when polished, reflects an effulgent pearly light, much resembling the mutable reflections from the eye of a cat. Hence the Anglicised French term *chatoyánt.*

CAT'S-TAIL GRASS. In Botany, a valuable meadow grass, usually forming part of all good lowland pastures. It is the *Phleum pratense*, a plant with a soft narrow cylindrical head, resembling that of the meadow foxtail.

CA'TTLE. Domesticated animals of the cow kind, which are found accompanying man in every civilized country, and in every climate. The native country of the type of British cattle is supposed by some to be Asia, and by others to be Africa; but in this case, as in all others where an animal or a plant has been long in a state of domestication, the origin of the species is involved in obscurity. When the tame cattle of any country are allowed to run wild and breed in that country, uncontrolled by man, the habits which belong to the animal in its savage state become, in the course of three or four generations, modified according to the natural supplies of food and the character of the climate. Hence, though cattle are not indigenous to Britain, South America, or the Sandwich Islands, we have in the former country a breed of wild cattle in one or two gentlemen's parks, as at Chillingham in Northumberland, which are quite different from the wild cattle of the fertile soils of South America, as these again are different from the wild cattle of the Sandwich Islands, though all undoubtedly the descendants of tame animals. Those in the Sandwich Islands, in particular, are known to be the offspring of the tame cattle that were left there by Vancouver, and which can now be only caught alive by entrapping them in disguised pits; into one of which the unfortunate botanist Douglas fell, and was gored to death by a bull who happened to be in it at the time. The domestic cattle of Britain may be divided into two races: those of large size adapted for the plains, and those of smaller size adapted for the mountains. Of each of these classes there are several breeds; such as the Highland and the Welch cattle, among the latter; and the Lancashire, the Yorkshire, and the Herefordshire cattle, among the former. There is also an intermediate breed, adapted for moderately hilly countries; such as the Galloway and Fife breeds in Scotland, and the Alderney and Guernsey cattle in England. The best beef brought to the London market is that of cattle of the Highland breed fed in English pastures, or on turnips. The best milk cow for general purposes is the Ayrshire; the best for cream and butter, the Alderney; and the best for immense quantities of milk, the Lancashire. Hence the latter are generally employed in public dairies, the Ayrshire by farmers and cottagers, and the Alderney by the higher classes.

CA'TULUS. (Lat. catulus, *the young of any thing.*) The old botanical name of the catkin of a plant, which see.

CAU'DA. (Lat.) That portion of an animal which is supported by vertebræ behind the sacrum; or which, as in fishes, have inferior spinous processes. In Entomology it signifies that part of the abdomen which becomes suddenly slender, and terminates in a long jointed tail, as in the scorpion.

CAU'DAT. (Lat. cauda, *a tail.*) When the apex of any organ in a plant is prolonged into a long slender point; this is not of rare occurrence, and is more especially common in Araceous and Aristolochiaceous plants.

CAU'DEX. (Lat. caudex, *a trunk.*) The Linnæan name of what is now more generally called the axis of vegetation; the woody centre round which the leafy and leaf-like organs are arranged. The *caudex ascendens* was the stem, the *c. descendens* the root of a plant.

CAUDI'CULA. (Lat. dim. of caudex.) A thin, elastic, semitransparent process of the pollen masses of Orchidaceous plants, by means of which the pollen is brought in contact with the stigma or stigmatic gland. Its exact nature, use, and origin are unknown.

CAUL. The trivial appellation of the *amnion* when it comes away in child-birth. It is regarded by the superstitious as a charm against shipwreck.

CAULI'COLUS. (Lat. caulis, *a stalk.*) In Architecture, the small stalk under the volutes of the Corinthian capital, which it seems to support.

CAULI'CULUS. (Dim. of caulis, *a stem.*) In Botany, the slender part which connects the cotyledon of a seed with the radicle. It is usually considered a part of the radicle, but recent observations seem to show that it is rather an extension of the stem. Its office is to lengthen rapidly when germination takes place, and thus to bring the true radicle into contact with the earth upon which it has to feed.

CAU'LINE. (Lat. caulis, *a stem.*) Any thing that grows to, or springs from, the stem of a plant. Cauline

leaves are those which grow upon the stem, prickles such as are borne by the same part, and so on.

CAULK, or CALK, to stuff the seams or openings between the planks of a ship with oakum, which is rope untwisted into its original state of fibre. The oakum is forced in by a caulking chisel and mallet. It has been found necessary, when a ship has worked the oakum out of the seams, to fill them with rope. Caulking affords fixedness to the whole frame, and is therefore a great support. The quantity of oakum used in a large ship is very great; in a large three-decker it is near 30 tons, or upwards of four cables.

When the seams are caulked, melted pitch is poured on the seams of the decks out of a pitch ladle; in other places it is laid on with a pitch mop: this is called *paying* the seams.

CAULOCA'RPOUS. (Gr. *καυλος, the stem of a plant*, and *καρπος, fruit.*) A name applied by De Candolle to such plants as, like trees and shrubs, annually produce flowers and fruit on their branches without perishing.

CAUSE. Four kinds of causes have been distinguished by logicians: — *the material, the efficient, the formal*, and *the final*. The *material* cause of a thing is that out of which that thing is made; in other words, that which is the ground of the possibility of a thing's coming into existence: *e. g.* the marble out of which a statue is made. The *efficient* cause is that in which resides the moving power requisite in order to render the possible existence actual; as the sculptor. The *final* cause of the thing is that very thing in its completeness; as the statue when made. The *formal* cause is that which must supervene to the matter, in order to give the thing its precise individual existence as that thing and no other; as the shape which the sculptor communicates to the marble. This distinction is derived originally from Aristotle, with whom, however, it is rather a metaphysical than a logical determination. *See* ARISTOTELIAN PHILOSOPHY.

In popular language, the *final* cause is synonymous with the purpose to which any object is supposed to contribute, though that purpose be wholly external to the thing caused.

CAU'STIC CURVE. (Gr. *καιω, I burn.*) In the Transcendental Geometry, is the name given to the curve to which the rays of light, reflected or refracted by another curve, are tangents. Caustics are consequently of two kinds, *catacaustics* and *diacaustics;* the former being caustics by reflection, and the latter caustics by refraction. Catacaustics are generated thus: Suppose rays, as B M, B M′, &c. (*fig.* 1.) to issue from a luminous point B, and to be reflected by the curve A M D, so that the angle of incidence equals the angle of reflection; the curve line H F F′, which touches all the reflected rays (produced, if necessary), is called the *catacaustic*, or caustic by reflection. *Diacaustics* are produced in a way entirely similar. Thus: Suppose rays, B M, B M′, &c. (*fig.* 2.), issuing from a luminous point B, to be refracted by the curve A M M′, so that the sines of incidence are to the sines of refraction in a constant given ratio; then the curve H F F′, which touches all the refracted rays, is called the *diacaustic*, or caustic by refraction.

fig. 1.

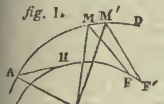
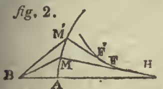


fig. 2.



The term *caustic* has been applied to these curves because the rays of light being collected along the curve in a greater quantity than elsewhere, heat is produced, particularly if the collection of rays is considerable. In parabolic mirrors, when the luminous rays strike the mirrors in a direction parallel to the axis, the caustic merges in a single point, which is the focus of the mirror. All the conic sections have this property, that luminous rays issuing from one focus are reflected by the curve into the other focus; but in respect of all other curves, the several reflected pencils are collected, not into a single point, but into a series of brilliant points or foci, the assemblage of which forms a bright curved track, or caustic, which is mathematically defined as above.

The attention of geometers was first called to this species of curve lines by Tchirnhausen, who demonstrated some of their properties to the Academy of Sciences of Paris in 1682. One property, common to all of them, is remarkable; namely, that when the curves by which they are produced are algebraic, the caustics are rectifiable; in other words, straight lines can be found to which they are equal. In fact, any portion H F of the catacaustic (*fig.* 1.) is equal to the difference between the sums of B M and M F, and B A and A H; or $HF = BM + MF - (BA + AH)$. In the diacaustic (*fig.* 2.) we have for the length of the curve $HF = AH - MF - n\,(BM - BA)$, where n is the constant ratio of the sine of incidence to refraction. If, therefore, the lengths of the radii and tangents can be expressed algebraically, the length of the caustic can also be exhibited by an algebraic expression. This circumstance having been noticed before the invention of the infinitesimal calculus, excited much interest among mathematicians, because it was then generally imagined that no curve line could be rectified.

The catacaustic may be experimentally exhibited by exposing the inside of a smooth bowl, containing any liquid not diaphanous (milk, for example, or still better, ink) to the sunbeams, or any strong light. The caustic, which in this case is an epicycloid, will appear beautifully delineated on the surface of the fluid. Another experiment, proposed by Sir David Brewster, exhibits the curves still more strikingly. Take a plate of polished metal, thin enough to be bent easily into a concave form, and place it perpendicularly on a sheet of white paper. If we expose this apparatus to the sun, holding the plane of the paper in such a manner that it may pass near the sun, without, however, intersecting it, the caustic will be exhibited on the paper as a well-defined curve of light. The interior part will be more brilliant than the exterior, and the light will diminish gradually and very rapidly at a little distance from the caustic. By varying the size of the plate, and bending it into curves of different shapes, all the different kinds of catacaustics, with their points of inflexion, &c., will be beautifully developed. (*Brewster's Optics, Cabinet Cyclopedia.*)

This subject being intimately connected with the concentration and dispersion of the rays of light by reflecting and refracting surfaces, is of great importance in practical optics. (De la Hire, *Traité des Epicycloides; Smith's Optics;* J. Bernoulli, *Opera Omnia*, vol. iii.; L'Hopital, *Analyse des Infiniments Petits;* Gergonne, *Annales des Mathematiques;* De la Rive, *Dissertation sur les Caustiques; Ency. Met.* art. "Light.")

CAU'STIC LUNAR. Fused nitrate of silver.

CAU'STICS. Substances which corrode and destroy the texture of the skin and of organized bodies.

CAU'TERY. The ancients divided cauteries into *actual* and *potential*. The former term is applied to red-hot iron; the latter to pure potash.

CAU'TIONARY. In Scottish Law, is the obligation by which a party becomes surety for another; answering to the English term guarantee. It is defined by Stair, "the promise or contract of a man not for himself but another." The guarantor is termed "cautioner."

CAVÆ'DIUM. (Lat.) In Ancient Architecture, an open quadrangle or court within a house. The cavædia described by Vitruvius are of five species; Tuscanicum, Corinthium, Tetrastylon (with four columns), Displuviatum (uncovered), and Testudinatum (vaulted). Though some authors make the cavædium the same as atrium and vestibulum, it was essentially different.

CA'VALIER. In Fortification, a sort of interior bastion, several feet more elevated than the principal bastion of the fortress in which it is formed. The use of the cavalier is twofold: it serves either to defilade the works from the fire of an enemy on an adjacent height, or to command the trenches of the besiegers. Cavaliers are sometimes constructed in the gorges, or on the middle of the curtain, and their form is the semicircular; but when they are within the bastion they are now built with straight faces and flanks parallel to those of the work in which they are placed. French cavaliers are works raised by the besiegers on the glacis of a fortress, for the purpose of enabling them to direct a fire of musketry into the covered way.

CA'VALIER (derived probably from the Latin word caballus, *a pack-horse*), was used originally in a general sense for a horse soldier; but the term has acquired historical importance from its having been applied to the adherents of Charles I. in contradistinction to the *Roundheads* (quod vide), the supporters of the parliament.

CA'VALRY. (Fr.) A body of soldiers furnished with horses for war. This arm can boast of high antiquity, and is so peculiarly useful and necessary for a great variety of operations, that it has in all ages been held by the greatest generals in high estimation. The efficacy of cavalry arises principally from its adaptation to speedy movements, which enables a commander to avail himself immediately of a decisive moment when the enemy exposes a weak point, or when disorder appears in his ranks, for completing his defeat by disconcerting him by a sudden attack. It is singularly useful in protecting the wings and centre of an army, for furnishing detachments, for escorts, for forming blockades, for intercepting the supplies of the enemy, for foraging, for procuring intelligence, for covering a retreat, &c. The successful services which troops of this description have performed, and the number of decisive advantages which have been obtained by means of them in the most important battles of which history ancient and modern furnishes the details, prove incontestably the utility of this arm. The use of cavalry, however, is necessarily limited by the nature of the ground. Open and level countries are favourable to its operations; in forests, in

mountainous districts, on a marshy soil, &c. It is but of little avail. Among the Greeks and Romans, the cavalry was regarded as the most respectable class of troops, and its ranks were supplied especially from the *elite* of the nobility. In the middle ages a similar feeling seems to have prevailed; for, in the early French monarchy, and in the Anglo-Saxon kingdoms of Britain, the men of wealth and noble birth distinguished themselves in the field from those of inferior rank by being well armed and mounted on horses; and from the mode of warfare then practised, as well as from the peculiarities adopted in the organization of troops, cavalry constituted almost the only efficient arm of battle down to the introduction of standing armies.

The invention of gunpowder, and the subsequent employment of artillery in the field, deprived the heavy-armed cavalry of those times of all the advantages it possessed over the infantry, and rendered its movements awkward and inefficient. It was reserved, however, for Gustavus Adolphus to show the real utility of this arm by discovering the services on which it should properly be employed, and by stripping it of all unnecessary encumbrances to supersede by *rapidity of motion* the value it formerly possessed in *weight*. Since that time cavalry has often turned the scale of fortune in war: the battle of Rossbach, for instance, in 1757, one of the most brilliant victories either of ancient or modern times, was entirely decided by this arm.

Modern cavalry consists of two grand classes—*heavy* and *light* horse; which are again susceptible of further subdivisions, according to the purposes to which they are subservient. The British cavalry consists of two regiments of life guards, the royal regiment of horse guards, seven regiments of dragoon guards, and seventeen regiments of light dragoons, of which four are called hussars and four lancers. (For the history, use, accoutrements, and arms of these different branches, see the separate articles.) A regiment of cavalry is divided into four squadrons, and each of these into two troops. A troop consists of 80 men; and to each troop there is attached a captain, a lieutenant, and a cornet.

CAVATI'NA. (It. dimin. of cavata, *cut off.*) In Music, a species of air, generally short, and having neither a repeat nor second strain, often inserted in obligato recitatives. The sudden changes from recitative to a measured movement and the reverse are useful in producing expression.

CA'VEA. (Lat.) In Ancient Architecture, the subterranean cells in an amphitheatre wherein the wild beasts were confined in readiness for the fights of the arena. In the end, the amphitheatre itself, by synechdoche, was called cavea; in which sense it is employed by Ammianus Marcellinus: "Alter in amphitheatrali caveâ cum adfuturus spectaculis introiret." Lib. xxix. cap. I.

CA'VEAT. In Law, a notice or caution given by a party interested to a judge or other officer, in order to stay proceedings by him; as, in the spiritual courts, a caveat is put in to stop the granting of probate or administration.

CAVE'TTO. (Lat. cavus, *hollow.*) In Architecture, a hollowed moulding, whose profile is a quadrant of a circle: it is principally used in cornices.

CA'VIA. The Linnæan generic name of a Cuvierian family of Rodents, including the guinea-pig,—*Agouti*, *Paca*, and *Capibara*.

CAVIA'RE. The salted roe of the sturgeon, much esteemed by the Russians as an article of food, and frequently brought as a delicacy to this country; it is an oily unwholesome article.

CA'VICORNS, *Cavicornia*. (Lat. cavus, *hollow*, and cornu, *horn.*) The name of the tribe of Ruminants comprehending those which have the horns hollowed out like a sheath and implanted on bony processes of the os frontis, as in the antelope.

CA'VITARIES, *Entozoa cavitaria*. (Lat. cavitas, *a hollow.*) Intestinal worms, or Entozoa, which have an intestinal canal floating in a distinct abdominal cavity.

CAY'MAN, or CAIMAN. A name, says Marcgrave, applied to the crocodiles by the negroes of Congo. According to Bontius it was originally derived from an eastern dialect (*per totam Indiam cayman audit*). It appears, however, that Marcgrave is correct; for the negroes in the West Indies have been heard to call the crocodiles which they have seen there for the first time *caïman;* and the name has been diffused over the new continent by the negroes, and applied to most of the American species indiscriminately. It is restricted by Cuvier to the alligators. *See* ALLIGATOR.

CE'DRELA'CEÆ. (Cedrela, one of the genera.) A very important, though small, natural order of plants, allied to *Meliaceæ*, from which they differ in having winged indefinite seed. Most of the species are trees of large size. *Swietenia mahogani* yields mahogany, in the woods of the Spanish main; *Chloroxylon swietenia*, Indian satin-wood; while the yellow wood and the cedar of New Holland are the produce of others. In general their bark is powerfully astringent; that of *Soymida febrifuga* and mahogany itself is a potent febrifuge; that of *Cedrela toona* is a most valuable tonic in the Malayan archipelago; and *Khaya senegalensis* yields a similar remedy for the dangerous fevers of the Gold Coast.

CE'ILING. (Fr. ceil, *a canopy or covering.*) In Architecture, the upper horizontal or curved surface of an apartment opposite the floor, usually finished with plastered work. In executing ceiling the best mode is that in which the setting coat is composed of putty and plaster, technically called *gauge*. Common ceilings are executed with plaster without hair, the same as the finishing coat in walls left for paper.

CELASTRA'CEÆ. (Celastrus, one of the genera.) A natural order of shrubby Exogens, formerly confounded with *Rhamnaceæ*, but separated by Brown, chiefly because of the relation that the stamens bear to the petals and the different æstivation of the calyx. Allied, according to Brongniart, to *Malpighiaceæ*, through *Hippocrateæ*, a small order which scarcely differs from this order. *Celastraceæ* are natives of the warmer climates, especially of the tropics, and their general characters appear to be of a stimulating acrid nature: none of any popular interest.

CE'LERES. (Lat. celer, *swift.*) In Ancient History, the body of cavalry instituted by Romulus when he settled the constitution of Rome. They consisted of those among the citizens who were rich enough to furnish a horse. They are said to have been 300 in number, and to have been subdivided into three centuries, under the name of Ramnes, Titienses, and Luceres; but this seems to proceed on the false supposition that the three tribes known by these names were among the institutions of Romulus. The number of the centuries of the Celeres was raised to six by Tarquinius Priscus: this was the origin of the Equites or knights, who in after times formed a separate class of citizens.

CE'LIBACY. (Lat. cælebs, *unmarried.*) The legal condition of unmarried persons. This condition was subjected by the laws of the Roman emperors to a variety of penal consequences. The most remarkable of their enactments, and that on which the subsequent jurisprudence on this subject was in a great measure founded, was the *Lex Julia* or *Papia-Poppæa*, enacted under the authorization of Augustus. By these laws unmarried persons could receive nothing by will from strangers, and were subjected to many other legal disabilities (*see* LAW, ROMAN); from which, however, they were successively relieved by later laws passed in the decline of the empire, and especially after the mistaken zeal of the Christian divines of that age had invested celibacy with attributes of sanctity. It was at an early period in the history of the Christian church that ministers were exhorted to celibacy by those who laid claims to a higher degree of sanctity. At the Council of Nice, in A. D. 325, the proposition to enforce it as a general law was rejected. But at that of Arles, in 340, it was adopted; married persons being indeed held admissible into the church, but only on the terms of separating from their wives on ordination. It had become the common practice of the Latin church in the reign of Gregory the Great (end of the 6th century), and was more fully enforced, after a period of relaxation, in the 11th. It was proposed to the Council of Trent by Charles V. (in the interim), that married priests should retain their wives; but this was rejected. In the Greek church, celibacy was ordained for bishops at the council of Tralle, A. D. 695; but clergymen below the degree of episcopacy are allowed to marry. Hence the higher dignities of that church are necessarily filled by monks.

CELL. (Lat. cella.) In Ancient Architecture, the part of a temple within the walls; also called the *naos*. The part of the temple in front of the cell was called the *pronaos*, and that in the rear the *posticum*.

CE'LLAR. (Fr. cellier.) In Architecture, the lower story of a building, when wholly or partly under the level of the ground.

CE'LLEPORES, CELLEPORÆ. (Lat. cella, *a cell;* porus, *a pore.*) A genus of flexible cellular Polyps, including those in which each of the cells is pierced with a minute pore.

CE'LLULAR TISSUE. A substance consisting of little bladders or vesicles of various figures adhering together in masses. It constitutes the principal part of all plants, and may be regarded as an organic basis, into which other kinds of tissue are introduced, or from which they are created. It exists exclusively in the embryo of a plant until vitality has been excited, and new forms of tissue developed in consequence. *See* BOTANY.

CEME'NT. (Lat. cementum.) In Architecture, the medium for causing the adherence of stones or bricks to each other, formed of lime, sand, and water. The best cement is obtained from limestone, in preference to chalk; and the sand best adapted to the formation of it is that of a river, called drift sand.

CEME'NT. In Anatomy, the substance which joins together the plates of compound teeth, like those of the elephant, and which fills up the folds and cavities in the teeth of Ruminants and Pachyderms; and which also covers all that part of a simple tooth which is not coated

with enamel. The cement is characterized, like true bone, by the presence of the Purkinjian corpuscles.

CEMENT, PARKER'S. *See* SEPTARIA.

CEMENTA'TION. When a solid body is surrounded by the powder of other substances, and the whole heated to redness, the process is termed *cementation*. Iron is said to be converted into steel by cementation with charcoal.

CE'METERY. (Gr. κειμαι, *I lie dead*.) In Architecture, an edifice or area where the dead are interred. The most celebrated public cemeteries of Europe are those of Naples, one near Bologna, of Pisa, and the more modern Parisian one of Pere la Chaise. That of Pisa is particularly distinguished by the beauty of its form and architecture, which is early Italian Gothic. It is 490 feet long, 170 feet wide, and 60 feet high, cloistered round the four sides, and contains 50 ship-loads of earth, which the Pisans brought from Jerusalem. It was long matter of complaint and regret that England possessed no public cemeteries; and in the year 1832 a company was formed in London with the view of supplying this desideratum. The land selected for the first experiment contains in extent about 50 acres, and is situated at Kensal Green on the south of the Harrow road. This receptacle for the dead is denominated "All Souls Cemetery;" and whether we regard the good taste or the public spirit displayed by its projectors, it is well entitled to the support of the community. (See the *British Cyclopædia*.) Since that time various cemeteries have been designed and formed in different parts of the country; and there is every ground to believe that, independently of other advantages, the benefits which cannot fail to accrue to the health of large towns, particularly, from schemes of this nature will ultimately lead to their general adoption. In the *Companion to the British Almanac* for 1839, there is an excellent description of the *Norwood* and *Highgate* cemeteries, and some of the previous numbers of the same publication contain an account of all similar works in England then in progress or completed.

CENO'BIO. A term invented by Mirbel to denote a regular fruit, divided from the base into several acephalous pericarpia; that is to say, pericarpia not marked on the summit by the stigmatic scar, the style having been inserted at their base, as in *Labiatæ*, *Boraginaceæ*.

CE'NOTAPH. (Gr. κενος, *empty*, and ταφος, *a sepulchre*.) In Architecture, a monument erected to the memory of a person who lies interred elsewhere.

CE'NSOR. In Ancient History, the title of two Roman magistrates originally created for the purpose of taking the census, or register of the number and property of citizens. But their powers were much increased subsequently, when they had the inspection of the morals of the citizens committed to them, with authority to degrade senators and knights from their respective orders, and remove other citizens from their tribes, depriving them of all their privileges except liberty; which was termed making them Ærarians. They had also the power of making contracts for public buildings and the supply of victims for sacrifices.

The office of censor was not a permanent one, but was renewed from time to time, as its functions were felt to be needed in the state. It was always filled by consulars of the highest merit, and was esteemed an honour even greater than that of the consulate itself: no person might be twice invested with it; and if one of the censors died, another was not substituted in his room, but his surviving colleague was obliged to resign. The office of censor was abolished under the emperors, who, however, exercised the greater part of its functions. It was attempted to be revived in the person of Valerian by Decius, but he was cut off before he could accomplish his purpose.

CE'NSUS. In Ancient History, a population return of the Roman citizens, including a valuation of each man's property, and a registration of his tribe, family, children, and servants.

The secondary senses of the word are, a tax levied according to the above-mentioned valuation; and the amount of any individual's property. A senator's census was the amount of property necessary for a member of the senate, which was equal to between 6000*l*. and 7000*l*. of our money; but this was raised by Augustus to about 10,000*l*. A knight's census was something more than 3000*l*.

The term census, in modern political phraseology, signifies an enumeration of the inhabitants of a country; such as has taken place in England by act of parliament in 1801, 1811, 1821, 1831.

CE'NTAURS. In Greek Mythology, a fabulous race of beings, half man and half horse, who are said to have inhabited part of Thessaly, and waged constant war with the hostile tribe of Lapithæ.

CENTAU'RUS, the CENTAUR. One of the forty-eight ancient constellations formed by Ptolemy, situated in the southern hemisphere, and under the tail of Hydra. The Centaur is represented as half man, half horse; the human part only of the figure is visible above our horizon.

CE'NTERING. (Lat. centrum.) In Architecture, the temporary woodwork or framing on which any vaulted work is constructed; sometimes called also a centre.

CE'NTIGRADE DIVI'SION. The division into *grades* or degrees by hundredth parts. A unit of any denomination being divided into a 100 equal parts, forms a centigrade scale; but the term most frequently occurs in scientific works, in reference to the French division of the scale of the thermometer. The fixed points of the thermometric scale are the points at which water freezes on the one hand, and boils on the other; the distance between these two points being divided into a 100 degrees, the centigrade scale is formed. In Fahrenheit's scale, which is usually applied to the thermometer in this country, the same distance is divided into 180 degrees; a degree of the centigrade scale is therefore greater than a degree of Fahrenheit in the proportion of 180 to 100, or of 9 to 5. Any number of degrees, therefore, on the centigrade scale, being multiplied by 9 and divided by 5, will give the equivalent number of degrees of Fahrenheit. But in comparing temperatures expressed by the two scales, it is necessary to recollect that the zero of Fahrenheit's scale is not placed at the freezing point, but 32° below it. An example will best show how this is to be taken into account. Let it be required to express on Fahrenheit's scale the temperature corresponding to 10° centigrade. Here $10 \times 9 \div 5 = 18$; to this add 32, and we have $18 + 32 = 50$; so that 10 degrees of the centigrade scale correspond to 50 degrees of Fahrenheit's.

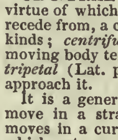
CE'NTIPEDE. (Lat. centum, *a hundred*, and pes, *foot*.) The name of the Myriapodous insects belonging to the genus *Scolopendra* of Linnæus. They are wingless; and the largest species possess, when full grown, more than fifty and less than two hundred pairs of feet.

CE'NTO. (Gr. κεντρων, *a patchwork cloak or garment*.) A word employed to designate a collection of separate verses from the works of one or more poets, arranged so as to form a distinct poem. The only classical example of a cento left to us is that of Ausonius, who composed a nuptial idyll out of Virgilian verses; in which, however, the words are also perverted into a new meaning. In his prologue to this piece Ausonius describes the cento, and gives rules for its composition.

CE'NTRAL FORCE. The power or energy in virtue of which bodies in motion tend to approach, or recede from, a centre. Hence central forces are of two kinds; *centrifugal* (Lat. fugere, *to avoid*), when the moving body tends to recede from the centre; and *centripetal* (Lat. petere, *to seek*), when the body tends to approach it.

It is a general law of matter, that all bodies tend to move in a straight line; consequently, when a body moves in a curve, there must necessarily be some force which acts upon it, and deflects it from the rectilinear direction, and constrains it to move in the curve; and if this force were removed, or its action suspended, the body would immediately fly off in a straight line, forming a tangent to the curve at the point in which it was moving when the force ceased to act. A stone whirled rapidly round the hand in a sling affords a familiar illustration. The effort with which it tends to fly off is the centrifugal force; the reaction of the hand, communicated through the string, may be regarded as a centripetal force, which confines the stone to its circular path. When the string is let slip, the centrifugal force is not counteracted, and the stone flies off in the direction of the tangent.

The laws of central forces, of the greatest importance in the theory of the planetary revolutions, were first proposed by Huygens, in his celebrated work, entitled *Horologium Oscillatorium*. The case which it is most important to analyse is that of a body moving in the circumference of a circle with a uniform velocity. To find an expression for the centrifugal force of a body revolving uniformly in a circle, let $r =$ the radius of the circle, $v =$ the velocity of the body, and let AB be the arc described in the infinitely small time t; we have then (the space described being as the velocity and the time of description) $AB = vt$. But AB being by hypothesis a very small arc, may be considered as equal to its chord, which is a mean proportional between the diameter $2r$, and the versed sine AC. Hence, $AC \cdot 2r = AB^2 = v^2 t^2$, and consequently $AC = \frac{v^2 t^2}{2r}$. Now AC is the effect produced by the central force, or rather the accelerating force exerted in the direction of the centre (that which prevents the body at A from flying off in the direction of the tangent AD), in the time t; and the accelerating force being measured by the quotient which is obtained by dividing twice the space described by the square of the time (*see* DYNAMICS, FORCE), the accelerating force in the direction of the centre becomes $\frac{2AC}{t^2}$. Calling this central force f, and substituting for AC its value, we find $f = \frac{v^2}{r}$; that is to say, the central force of a body describing a circle with a uniform velocity is directly



proportional to the square of the velocity, and inversely as the radius of the circle.

This expression may be put under a different form. Let t = the time required to describe the whole circumference $2\pi r$, and we have $2\pi r = v t$; whence $v = \frac{2\pi r}{t}$ and consequently $f = \frac{4\pi^2}{t^2} r$; whence the central force is directly as the radius of the orbit, and inversely as the square of the periodic time.

If the law of the force be such that its intensity is reciprocally proportional to the square of the distance from the centre, then the squares of the periodic times of two bodies describing different circles about the same centre are proportional to the cubes of the distances. For let F and f be the two forces, V and v the velocities of the two bodies, R and r the radii of their circles, and T and t the times respectively; then, by what has been already shown,

$$F = \frac{V^2}{R},\ f = \frac{v^2}{r};$$

but by hypothesis, $F : f :: r^2 : R^2$;

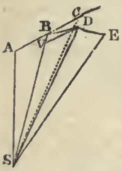
therefore, $\frac{V^2}{R} : \frac{v^2}{r} :: r^2 : R^2$;

but $V^2 : v^2 :: \frac{R^2}{T^2} : \frac{r^2}{t^2}$

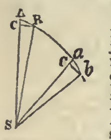
therefore, $T^2 : t^2 :: R^3 : r^3$;

or the squares of the times are as the cubes of the radii. This remarkable property was discovered by Kepler to belong to the planetary orbits. *See* KEPLER'S LAWS.

When a point is urged by one accelerating force only, constantly directed towards a fixed point, the path will be a plane curve, and the areas described around this point by the radius vector are proportional to the times employed in describing them. Suppose the time to be divided into equal portions, and that in the first portion of time the body, in virtue of the projectile force impressed on it, describes the line A B. If no other force acted upon it, in the second portion of time it would describe B C = A B; therefore, on drawing the radii A S, B S, C S, to the centre of force, the triangles A S B and B S C would be equal. But suppose the central force acting on the body while it would move from B to C to act instantaneously at B, so as to cause the body to descend through B V; draw V D parallel and equal to B C, and join B D, then at the end of the second portion of time the body will be at D. Now as the central force acts in the direction B V in the plane of A S B, the body must continue to move in that plane; and on joining C D and S D, the triangle B D S, on account of the parallel lines, is equal to B C S, and therefore equal to A B S. In like manner it may be proved that if E be the point at which the body arrives at the end of the third instant, the triangle D E S is equal to A B S. Suppose, therefore, the number of the triangles to become infinitely great, and their areas infinitely small, the path of the body will become a curve line; and the elementary spaces being proportional to the elements of the time, their sums or integrals must continue to have the same proportion. (*Newton's Principia*, Sect. II.)



From this proposition it follows, that when a body describes a curve in virtue of a central force, the centrifugal force at every point varies as the cube of the distance from the centre, whatever the nature of the force by which it is attracted to the centre may be. For let A B and $a b$ be the two arcs described at different points of the curve in the infinitely small time t, then, by the proposition just demonstrated, A S B = a S b. But make B C and $b c$ respectively perpendicular to S A and S a, then A S B = ½ A S × B C, and a S b = ½ a S × $b c$; hence A S × B C = a S × $b c$, and B C² : $b c^2$ :: a S² : A S². Now B C² = 2 A S × A C (the square of A C being neglected as infinitely small), and $b c^2 = 2 a$S × $a c$; therefore, A S × A C : a S × $a c$ :: a S² : A S², and consequently



$$AC : ac :: \frac{1}{AS^3} : \frac{1}{aS^3}$$

But A C is the measure of the centrifugal force at A, and $a c$ is its measure at a; therefore, denoting the distances at these points by R and r, we have the centrifugal force at A to the centrifugal force at a, as $\frac{1}{R^3} : \frac{1}{r^3}$. Hence we may perceive the reason why a body in moving round a centre of force may alternately approach to, and recede from, that centre, as the planets in describing elliptic orbits about the sun. Suppose the attractive force, like gravity, to vary inversely as the square of the distance from the attracting point: if the planet approached 10 times nearer to the sun, the attractive force would be augmented 100 times; but the centrifugal force would become 1000 times greater, and consequently there must be some point at which this force will overcome the former, and determine the planet again to recede.

The doctrine of central forces has its principal application in astronomy. By the comparison of a great number of planetary observations, Kepler discovered that each of the planets, while its distance from the sun is variable, moves in such a manner that a straight line drawn from it to the sun describes equal areas in equal times. But this is the law by which bodies move under the influence of a central force (as is demonstrated above). It follows, therefore, that the force by which the planets describe their orbits is a central force, and directed to a point within the orbit. Newton demonstrated that the velocities of a body at different points of the curve which it describes about a centre of force, are inversely as the perpendiculars drawn from the centre to the tangents at these points. The comparison of this proposition with the elliptic motion of the planets leads directly to the conclusion that the forces by which the planetary motions are sustained are directed to the centre of the sun, and vary inversely as the squares of the distances of the planets from that body.

Mathematicians have investigated the orbits which bodies must describe under various hypotheses respecting the law of the central force, and they have found that there are only two cases in which a system of bodies like the sun and planets, mutually attracting each other, could permanently exist. One of these is an imaginary case, in which the force varies directly as the distance of the body; the other is the case presented by nature, in which the force follows the inverse ratio of the square of the distance. In all other cases the mutual action of the bodies would produce permanent derangements, which at length would of necessity subvert the system.

When the force varies inversely as the square of the distance, the orbit which is described about a fixed centre must necessarily be one of the three conic sections; but it will depend upon the velocity with which it is at first projected whether the orbit be an ellipse, a parabola, or an hyperbola. If the central force were supposed to vary as the inverse cube of the distance, a body would describe a circle in one particular case, namely, when the velocity of projection is equal to that which would be acquired by falling from an infinite distance, and then applied in a direction at right angles to the radius vector. In all other cases it would describe a spiral. If the central force diminishes more rapidly than the inverse cube of the distance, the orbit would in all cases describe a spiral; so that if the solar force acted according to a law of this sort, every planet would at length either fall into the sun, or fly off to an infinite distance. (*Principia*, Book I. See also *Herschel's Astronomy*, *Cab. Encyc.*)

CE'NTRE. (Lat. centrum.) This term has numerous applications in Geometry and Mechanics: thus, *centre* of a *circle*, or of an *ellipse*, is the middle point of any diameter; *centre* of a *curve* is the point where two diameters intersect each other; and in mechanics we speak of centres of attraction, conversion, equilibrium, gravity, percussion, oscillation, &c.

CE'NTRE OF ATTRACTION, also called *Centre of Gravitation*, is the point to which bodies tend in consequence of the action of gravity.

CE'NTRE OF CONVERSION is the point in a body about which it turns when a force is applied to any part of it, or unequal forces to its different parts. For example, suppose a rod laid on a table to be struck near one extremity in a direction perpendicular to its length; the rod will turn round, but there will be one point in it which remains at rest, or about which, as a centre, the other points turn. This point is the *centre of conversion*.

CE'NTRE OF EQUILIBRIUM of a system of bodies is a point such that if the system were suspended from it, the whole would remain in equilibrium. Thus, the fulcrum or point of support of a lever is its centre of equilibrium.

CE'NTRE OF GRAVITY. A term employed in Mechanics to denote a certain point in the interior of a body, or system of bodies connected with each other in an invariable manner, so situated that any plane whatever which passes through it divides the body into two segments of which the weights are exactly equal. Hence, if the centre of gravity of any body or system of bodies be sustained, the whole will remain at rest; for the weights on both sides of a vertical plane passing through the point of support being equal, the body can have no tendency to angular motion.

Let there be a system of bodies A, B, C, D, E, placed horizontally in the same straight line,

S A B O C D E

and connected with each other in an invariable manner; and suppose O to be the centre of gravity of the system:

by the definition of the centre of gravity, if the system is supported at O, the weights on both sides of O, or the effort which the bodies make to turn about that point on opposite sides of O, will exactly counterbalance each other, and the whole will remain at rest. But the effect of A in turning the system about O depends on the quantity of matter in A, and its distance from O, or the length of the arm of the lever at the extremity of which it acts. The whole effect of the body A is therefore proportional to the mass of A multiplied into the length of the line O A. The same reasoning obviously applies to each of the other bodies, B, C, D, and E; consequently, taking these letters to represent the masses of the bodies respectively, we have, by the definition,

$$A \cdot OA + B \cdot OB = C \cdot OC + D \cdot OD + E \cdot OE.$$

Now suppose it were required to determine from this property the position of the centre of gravity of the united bodies, or its distance from a given point S in the same straight line: on making $SA = a$, $SB = b$, $SC = c$, $SD = d$, $SE = e$, and the unknown distance $SO = x$, we shall have $OA = x - a$, $OB = x - b$, $OC = c - x$, $OD = d - x$, and $OE = e - x$. Therefore by substitution,

$$A(x-a) + B(x-b) = C(c-x) + D(d-x) + E(e-x);$$

and by transposition,

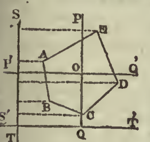
$$(A+B+C+D+E)\,x = aA + bB + cC + dD + eE;$$

whence $x = \dfrac{aA + bB + cC + dD + eE}{A+B+C+D+E}$;

that is to say, the distance of the centre of gravity of the given system from a given point is equal to the sum of the products of all the masses into their distances from the point divided by the sum of the masses.

It is obvious, from the equation now given, that the effect of all the bodies to produce motion about the point S, is the same as if they were all united in their common centre of gravity O. It is also obvious that the form of the equation will be exactly the same, whatever may be the number of bodies belonging to the system; and as every body may be regarded as composed of elementary particles, the reasoning which applies to a system of particles, connected with one another in an invariable manner, also applies to solid bodies of any kind.

The bodies composing the system have been supposed to be arranged in a straight line; but the centre of gravity will be found precisely in the same manner, whatever their relative situations may be. Suppose them to be situated all in the same plane, and that their centre of gravity is O, the position of which it is required to find. Let P Q be any straight line, in the same plane with the bodies, passing through O; then in order that there may be no tendency to motion about the line P Q, the sum of the products of all the bodies on one side of P Q into their respective distances from that line, must be equal to the sum of the products of all the bodies on the other side of P Q into their respective distances. If, therefore, S T be a straight line parallel to P Q, and if the distances of A, B, C, &c. from S T, be denoted respectively by a, b, c, &c., and the distance of O from the same line by x, then we shall have as before,



$$x = \frac{aA + bB + cC + \&c.}{A + B + C + \&c.}$$

This does not yet give us the centre of gravity; but it gives its distance from a given straight line S T, and consequently gives the position of the straight line P Q, in which the centre of gravity is situated. If then we draw another line S′ T′, and denote its distances from A, B, C, &c., by a', b', c', &c., respectively, and put x' equal to its distance O Q from O, we shall have

$$x' = \frac{a'A + b'B + c'C + \&c.}{A + B + C + \&c.};$$

and consequently the position of another straight line P′ Q′ passing through the centre of gravity, and parallel to S′ T′. Therefore, the centre of gravity is given by the intersection of the two straight lines P Q and P′ Q′.

Lastly, suppose the bodies composing the system not to be situated all in the same plane. In this case, the situation of each of the given bodies must be referred to three planes given in position; and it is most convenient to assume three planes which intersect each other at right angles; one of them horizontal, and consequently the other two vertical. Let the distances of the given bodies A, B, C, &c. from the given horizontal plane be respectively a, b, c, &c.; their distances from one of the vertical planes a', b', c', &c.; and from the other, a'', b'', c'', &c.; then, if we take

$$x = \frac{aA + bB + cC + \&c.}{A + B + C + \&c.},$$

the centre of gravity is in a horizontal plane, at the distance x from the given horizontal plane.

Take also $x' = \dfrac{a'A + b'B + c'C + \&c.}{A + B + C + \&c.}$, and the centre of gravity is in a plane parallel to the first of the two given vertical planes, and distant from it by the line x'.

In the intersection of these two planes, take a point distant from the second vertical plane by a quantity $x'' = \dfrac{a''A + b''B + c''C + \&c.}{A + B + C + \&c.}$: this point will be the centre of gravity of the given bodies.

In the notation of the differential calculus, these formulas are expressed as follows:—Let dm be the element of the mass, the co-ordinates of which, referred to three rectangular planes, are x, y, z; and let the distances of the centre of gravity of the mass from the same planes be respectively X, Y, Z; then the position of that centre is determined by the three equations;

$$X = \int \frac{x\,dm}{m},\quad Y = \int \frac{y\,dm}{m},\quad Z = \int \frac{z\,dm}{m}$$

The determination of the centre of gravity of solids in general requires the application of the integral calculus, and is sometimes effected with considerable labour; there are, however, many particular cases in which it is known immediately, and requires no calculation. Thus, the centre of gravity of a sphere or ellipsoid is evidently at the centre of the figure; that of a parallelopiped is at the common intersection of its four diagonals; that of a cylinder with parallel ends at the middle of its axis. The centre of gravity of a circle or ellipse is also at the centre of the figure; and that of a parallelogram at the intersection of its diagonals. The centre of gravity of a straight line is at the middle of the line, whence we easily find that of the perimeter of any polygon. "When the body can be divided into two parts, their common centre of gravity may be found by dividing the distance between the centres of gravity of the two parts in the reciprocal proportion of their weights. This principle may be extended to bodies which are more complex. Thus the centre of gravity of two portions being determined, they may be conceived to be united in that point, and connected with a third portion, and the centre of the three portions found. All these again may be supposed collected in this last point, and made to balance against a fourth portion, and their common centre of gravity computed. In this way the process may by successive steps be carried to any extent, and whatever order is followed the result will be always the same." (*Leslie's Elements of Nat. Phil.*)

The centre of gravity of a triangle is in the straight line drawn from any one of its angles to bisect the opposite side, and at the distance of two thirds of the whole line from the vertex. The centre of gravity of a pyramid is in the straight line drawn from the vertex to the centre of gravity of the base, and at three fourths of the distance of this line from the vertex. The centre of gravity of a hemisphere is in the diameter, and at the distance of five eighths of the radius from the summit.

The centre of gravity of irregular bodies may be found mechanically in various ways. If the body be poised in two different positions on a sharp edge, the vertical drawn from the point of intersection will pass through the centre of gravity. Or if a loose thread or string have its ends fastened to two distinct points of the body, and the body be thus suspended in two different positions from a fixed point, the verticals let fall from this will cross in the centre of gravity.

It is a remarkable property of the centre of gravity, that if a plane figure be generated by the revolution of a given line, or a solid by the revolution of a given plane figure, the area in the first case, or the volume in the second, is equal to the product of the generating quantity into the length of the line described by its centre of gravity. This property, which is frequently of use in determining the quadrature of curves and the cubature of solids, is called *Guldin's theorem;* though it is found in the *Collections of Pappus*.

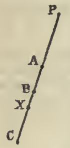
Another elegant geometrical property of the centre of gravity is, that in any given plane the sum of the squares of the distances of any number of physical points from their common centre of gravity, is less than the sum of the squares of their distances from any point in the circumference of a circle described about that centre, by the square of the radius multiplied by the number of those points. Hence it follows that the sum of the squares of the distances of any number of points from their common centre of gravity is always a *minimum*.

For a complete explanation of the method of applying the calculus to the determination of the centre of gravity of bodies, we refer to the *Traité de Mécanique* of Poisson, tom. i. The subject necessarily occupies a part of every work on statics.

Ce′ntre of Gyration of a body, or system of bodies, is a point in which if the whole mass were collected, a force applied at any distance from the axis of suspension would communicate to the mass thus collected the same

angular velocity that it would have communicated to the system in its first condition.

It is evident from the definition that the point in question must have this property, that if the whole mass were united in it, the moment of inertia, or the power of resisting the effort of any force, will be the same as the moment of inertia of the body in its first state. Let,



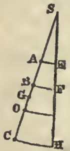
therefore, A, B, and C be a system of bodies, connected in an invariable manner, and turning about an axis P. Let a, b, and c be the respective distances of A, B, and C from P; and conceive X to be another body placed at a distance x from the axis, such that its moment of inertia is equal to the moment of inertia of A. Then, by the principles of mechanics, the moment of inertia of A is $A \cdot a^2$, and that of X is $X \cdot x^2$; therefore, by hypothesis, $X \cdot x^2 = A \cdot a^2$. In like manner, conceive another body Y to be placed at the distance x from the axis, such that its moment of inertia is equal to that of B, or such that $Y \cdot x^2 = B \cdot b^2$; and let a third body Z be placed at the same point, such that $Z \cdot x^2 = C \cdot c^2$. Taking the sums of these equals we have $(X + Y + Z)\, x^2 = A \cdot a^2 + B \cdot b^2 + C \cdot c^2$. Now in this equation we are at liberty to give either to $X + Y + Z$ or to x any value we please. Let us then suppose $X + Y + Z = A + B + C$ (which is evidently the same as supposing all the matter in the system united at the point whose distance is x), and we shall have

$$x = \left(\frac{A \cdot a^2 + B \cdot b^2 + C \cdot c^2}{A + B + C}\right)^{\frac{1}{2}}$$

to express the distance of the centre of gyration from the axis.

Centre of Oscillation is that point in a body, oscillating about a fixed axis, into which if the whole mass were collected, the body would vibrate through a given angle by the force of gravity in the same time as in its first condition.

In order to find the point having this property, conceive the weights A, B, and C fixed to a slender inflexible rod, vibrating about the point S, the



centre of oscillation being at O. In every position of the system, the tangents to the arcs which the bodies respectively describe make equal angles with the horizon; consequently the bodies are all urged by the same proportion of the total force of gravity. But if the bodies had not been connected with each other, their descent through similar arcs, A E, B F, C H, in the same interval of time, would require the accelerating forces to be proportional to those arcs, or to SA, SB, S C. Let S O, therefore, represent the accelerating force at O; then A O and B O will denote the excess of the force by which A and B are respectively accelerated, and C O the excess of the force by which C is retarded. But the effects of these forces on the motion of the system must be proportional to the weights of the bodies; and by the principles of the lever, they must also be proportional to the respective distances of the bodies from the point of suspension. They are consequently represented by $A \cdot SA \cdot AO$, $B \cdot SB \cdot BO$, and $C \cdot SC \cdot CO$. But the accelerating action at the centre O must necessarily be equal to that of retardation; consequently $A \cdot SA \cdot AO + B \cdot SB \cdot BO = C \cdot SC \cdot CO$. Now let $SA = a$, $SB = b$, $SC = c$, and $SO = f$, and the equation becomes by substitution $A \cdot a\,(f - a) + B \cdot b\,(f - b) = C \cdot c\,(c - f)$, or $(A \cdot a + B \cdot b + C \cdot c)\, f = A \cdot a^2 + B \cdot b^2 + C \cdot c^2$; whence

$$f = \frac{A \cdot a^2 + B \cdot b^2 + C \cdot c^2}{A \cdot a + B \cdot b + C \cdot c};$$

that is to say, the distance of the centre of oscillation from the point of suspension, or the length of the simple pendulum which vibrates in the same time with the compound body, is found by taking the sum of the products of the weights into the squares of their distances from the axis of the pendulum, and dividing this sum by the sum of the products of the weights into their distances simply.

Though the system has here been supposed to be formed of separate bodies, the principle is universal, and applies to bodies of any form. Let dm represent an element of the body, and x its distances from the point of suspension, then $f = \dfrac{\int x^2\, dm}{\int x\ \, dm}$.

It may be remarked, that the denominator $A \cdot a + B \cdot b + C \cdot c$ is equal to $(A + B + C) \cdot SG$, the point G being the centre of gravity of the bodies. Now if we denote the distances of A, B, and C from the centre of gravity G by α, β, γ respectively, and make $SG = h$, we shall have $a = h - \alpha$, $b = h - \beta$, and $c = h + \gamma$; whence by involution and substituting in the numerator, and observing that $A\alpha + B\beta - C\gamma = 0$, we shall find $A \cdot a^2 + B \cdot b^2 + C \cdot c^2 = h^2(A + B + C) + A \cdot \alpha^2 + B \cdot \beta^2 + C \cdot \gamma^2$; therefore, since $OG = SO - SG = f - h$,

$$OG = \frac{A \cdot \alpha^2 + B \cdot \beta^2 + C \cdot \gamma^2}{(A + B + C)\, SG},$$

an equation which gives the distance of the centre of oscillation from the centre of gravity.

This last equation indicates a very remarkable property of the centre of oscillation. As the two quantities O G and S G may change places without disturbing the equality, it follows that the centre of oscillation and the point of suspension are interchangeable; in other words, if the system were suspended from O, it would vibrate exactly in the same time as when suspended from S. This property was noticed by Huygens, and was first practically applied to the purpose of finding the length of the seconds' pendulum by Captain Kater. The application is made as follows: — Let a bar of iron, for example, about four feet long, be suspended from a point A, at the distance of four or five inches from one of its extremities, and observe the number of vibrations it makes in a given time. Then suspend it from another point B, near its other extremity, and let the point of suspension B be moved backwards or forwards till it makes exactly the same number of vibrations in a given time as when suspended from A. Then the distance between A and B is the length of the isochronous simple pendulum.

On comparing the three expressions for the centre of gravity, the centre of gyration, and the centre of oscillation, it will be seen that the distance of the centre of gyration from the axis is a mean proportional between the distances of the centres of gravity and oscillation.

The method of determining the centre of oscillation of compound pendulums was first given by Huygens in his celebrated work *Horologium Oscillatorium.* His demonstration, however, was founded on an indirect principle, which was rather assumed than proved. It consists in this, that if several weights attached in any manner to an inflexible rod or pendulum descend by the action of gravity, and if at any instant they were detached or disengaged from each other, each of them, in virtue of the velocity it had acquired during its descent, would mount to such a height that the common centre of gravity of all of them would reach exactly the same height as that from which it descended. The first direct demonstration on the principle of the lever was given by James Bernoulli, in the *Memoirs of the Academy of Sciences of Paris* for 1703. An interesting history of this problem may be found in the first volume of *Lagrange's Mécanique Analytique.*

Ce'ntre of Percussion. The point in a solid body, or system of bodies, into which, if the whole matter were supposed to be collected, the effect produced by striking against another body would be the greatest possible; or it may be defined to be the point in the axis of a moving body at which, if stopped by an immoveable obstacle, the body would rest in equilibrio, without inclining to either side, or acting on the centre of suspension.

When the percutient body revolves about a fixed axis, the centre of percussion is at the same point with the centre of oscillation; but when it moves with a parallel motion, the centre of percussion is the same as the centre of gravity.

Ce'ntre of Pressure, of a fluid against a surface, is that point at which if a force were applied equal to the pressure, and acting in an opposite direction, the surface would remain at rest.

Ce'ntre of Rotation. The point about which a body circulates. It is the same as the centre of motion.

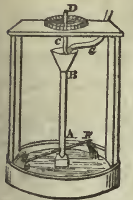
Ce'ntre of Spontaneous Rotation. The name first applied by John Bernoulli to the point about which a body, all whose parts are at liberty to move, and which has been struck in a direction not passing through the centre of gravity, begins to turn.

CENTRI'FUGAL. (Lat. centrum, and fugio, *I retreat.*) A term employed in describing the inflorescence of plants, when, in a head of flowers, the central one opens first, and those of the circumference last. It is also used by carpologists in describing seeds when the apex of an embryo is turned away from the centre of a fruit.

CENTRI'FUGAL FORCE. The force by which a body in rotation tends to recede from the centre of motion: Centripetal Force, that by which a body in motion is urged towards a centre, and compelled to describe a curve instead of a straight line. *See* Central Force.

CENTRI'FUGAL MACHI'NE. A machine moved by the centrifugal force of water; frequently called, from its inventor, *Barker's Mill.* It consists of a hollow metal cylinder or pipe of metal placed upright, and resting on a pointed steel pivot at A. The pipe is widened or extended into a funnel shape at the top B, and is kept in its position by a vertical steel axis C D, passing through a frame at the top. Towards the lower extremity, two or more small pipes A E, A F, with closed external ends, are inserted at right angles to the axis. In the side of

each of these an orifice is made as near as possible to the end, and on opposite sides, so that water from them may spout horizontally in opposite directions. Water is conveyed into the funnel at the top, through the pipe G, in such quantities that the tube is kept constantly full, while the discharge is going on at the orifice near the extremities of the horizontal pipes. In this state of things the resistance or reaction generated by the water issuing from the side holes is such as to throw the vertical pipe, with its arms and axis, into rapid rotatory motion; and this axis may communicate its motion or power to wheel-work or machinery, or to a mill-stone connected with its upper end. (See *Library of Useful Knowledge*, "Treatise on Hydraulics;" also *Ferguson's Lectures*, by Brewster; or *Lardner's Cabinet Cyclopedia*, "Hydrostatics and Pneumatics.") A machine of the same construction, but having the arms at the upper end, and turned rapidly by means of a wheel and pinion, was invented by a Mr. Erskine for raising water. Centrifugal Machine is also used synonymously with *Whirling Machine*.



CE'NTRING. *See* CENTERING.

CENTRI'PETAL. (Lat. centrum, and peto, *I seek.*) A term employed in describing the inflorescence of plants, when, in the unfolding of a head of flowers, those at the circumference open first, and those in the centre last. It is also used by carpologists in describing seeds when the apex of an embryo is directed towards the centre of a fruit.

CENTRI'SCUS. (Gr. κεντρις, *a spine.*) A genus of Acanthopterygious fishes, having the foremost dorsal placed far backwards, and with its first spine remarkable for its length and strength; the mouth is slender and elongated, whence they have obtained the name of "sea-snipes."

CE'NTRUM. (Gr. κεντρον, *centre.*) A term applied by Fries technically to designate the typical division of the groups of species and genera, in his circular arrangement of *Fungi*. Many generic names are compounded, having this word for their root, as *Centrogaster*, *Centrolophus*, *Centropristis*, and *Centronotus*, all genera of spiny-finned fishes; *Centropus*, a genus of birds, allied to the Cuckoos, &c.

CENTU'MVIRI. In Ancient History, Roman judges chosen three from each of the thirty-five tribes, so that properly there were 105; but they were called *centumviri*, or the hundred, from the round number. The principal causes that came under them were those concerning testaments and inheritances. In the time of Augustus they formed the council of the prætor; but afterwards their number was increased to 180, and they were divided into four councils, which, however, were sometimes combined into two courts, or even into one. Ten persons (*decemviri*) were appointed, five senators and five equites, to assemble these councils and preside in them in the absence of the prætor.

CE'NTURIES. (Lat. centuriæ.) In Ancient History, the divisions in which the Roman people voted at the Comitia Centuriata. They were instituted by Servius Tullius for the purpose of throwing political power into the hands of the plebeians. The patricians were represented by six centuries of knights, and twelve centuries of knights were added to these from the plebeians. The rest of the plebeians and clients were divided into five classes, according to the amount of their property; the lower limits of each being respectively 100,000, 75,000, 50,000, 25,000, 12,500 asses. The first of these classes was subdivided into eighty centuries; the next three into twenty each; and the last into thirty. The centuries of each class were again separated into two equal numbers of old and young. By this distribution the preponderance was given to property, though the rich classes were of course outnumbered by the poorer. Besides these centuries there were divisions in other bodies that went by the same name, as in the army half a maniple was called a century.

CENTU'RION. In Ancient History, an officer in the Roman army, who had the command of half a maniple, or one sixtieth part of a legion. The word centurion signifies the commander of 100 men; but this number was in fact seldom complete, as the legion generally fell far short of its full complement. One of the two centurions of each maniple had a precedence before the other; and the centurion of the first century of the first maniple of the Triarians presided over all the others, and had the charge of the eagle or chief standard of the legion, which gave him the privilege of ranking with the knights. The badge of a centurion was a vine rod.

CEPHALA'NTHIUM. (Gr. κεφαλη, *the head*, and ανθος, *a flower.*) A term invented by Richard to express the head or capitate inflorescence of a composite plant.

CEPHA'LIC. (Gr. κεφαλη, *the head.*) Medicines used for the relief of diseases of the head are frequently termed *cephalic remedies*.

CEPHALI'TIS. Inflammation of the brain.

CEPHALO'DIUM. (Gr. κεφαλη, *a head.*) In Botany, a term used by systematic writers on lichens, and signifying the figure of a convex shield without an elevated rim: it is called also a tuberculum.

CE'PHALO'PHORA. (Gr. κεφαλη, *the head*, and φερω, *I bear.*) A name substituted by De Blainville in his system of Malacology for the "Cephalopoda" of Cuvier.

CEPHA'LOPODS, *Cephalopoda*. (Gr. κεφαλη, *the head*, and πους, *the foot.*) A class of Molluscous animals having the head situated between the body and the feet; these latter organs consist of a number of fleshy processes, which project forwards from the circumference of the head, and more or less conceal the mouth. The Cephalopods are the first class of *Mollusca* in the system of Cuvier, and the most highly organized of invertebrate animals. They alone present indubitable rudiments of an internal skeleton, developed for the purpose of protecting a brain and lodging organs of sight, and, in most of the existing species, organs of hearing. In these also there are distinct hearts both for the systemic and pulmonary circulations; and highly complicated digestive, secretory, respiratory, and generative organs. The sexes are in distinct individuals. All the species are marine. The principal features of the organization of this class of Invertebrata are described by Aristotle, and their habits were better understood by that ancient author than by modern naturalists of the present day. The Cephalopods are described and grouped together in the *Historia Animalium*, under the name of "Malakia."

CE'PHALOTA'CEÆ. (Cephalotus, the only genus.) A small natural order of Exogens, allied, according to Labillardiere, to *Rosaceæ*, according to Brown to *Francoaceæ* and *Crassulaceæ*. Its affinity appears, however, to be greater with *Dionea* than with the previous orders. It consists of a single species, with pitcher-like bodies mixed with its leaves; it is a marsh plant inhabiting New Holland.

CE'PHALO-THO'RAX. (Gr. κεφαλη, *the head*, and θωραξ, *the chest.*) The first segment of Arachnidans and Crustaceans, which includes the head and thorax of insects.

CE'POLA. (Der. unknown.) The name of a genus of spiny-finned fishes, including the common riband-fish (*Cepola rubescens*) of our coasts.

CERA'CEUS. (Lat. cera, *wax.*) In Botany, waxy. Applied to the substance of such bodies as have the texture and colour of new wax, as the pollen masses of particular kinds of Orchis.

CE'RAMBY'CIDÆ. A family of Capricorn beetles, characterized by antennæ generally exceeding the length of the body; a large and distinct labium; strong horny mandibles; maxillæ terminated by two distinct hairy lobes; eyes kidney-shaped, with the antennæ situated in the concavity; body generally long and narrow. The numerous insects of this vegetable-feeding family are arranged in many subgenera, of which the following are indigenous: *Acanthocinus*, *Aphelocnemia*, *Callidium*, *Cerambyx*, *Clytus*, *Lamia*, *Molorchus*, *Monochamus*, *Obrium*, *Pogonocherus*, *Saperda*, and *Stenopterus*. One of the most remarkable species of our country is the musk-beetle (*Cerambyx moschatus* of Linnæus, *Callichroma* of Latreille), which, when alive, disseminates an odour resembling sometimes that of the otto of roses.

CE'RASIN. Cherry-tree gum. A generic name given to those kinds of gum which swell and soften, but do not readily dissolve in water.

CERA'STES. (Gr. κερας, *a horn.*) The name of a genus of poisonous serpents, characterized by having a pointed recurved horny process standing up over each eye: the horned vipers, as they are termed, are peculiar to Africa.

CE'RATE. (Gr. κηρος, or Lat. cera, *wax.*) An ointment generally compounded of wax and oil or spermaceti.

CERA'TIUM. (Gr. κερας, *a horn.*) A one-celled, many-seeded, superior linear fruit; dehiscent by two valves separating from the replum; the seeds attached to two spongy placentæ adhering to the replum, and alternate with the lobes of the stigma. It differs from the Siliqua in the lobes of the stigma being alternate with the placenta, not opposite.

CE'RATOPHYLLA'CEÆ. (Ceratophyllum, the only genus.) A small natural order of Exogens, allied, according to Richard, to *Coniferæ*, but to which it seems to have no kind of affinity. According to De Candolle it should be placed near *Hippuris* and *Myriophyllum*, from which it differs in its superior ovary; according to Agarh it belongs to *Fluviales*: its affinity, however, appears to be greatest with *Urticaceæ*, of which it may be regarded as a degeneration. The order consists but of one genus, which is found in the ditches of Europe, being constantly submerged, and floating with its long green leaves after the manner of a Conferva. The

embryo appears to be decidedly Polycotyledonous; otherwise the plant would certainly be referred to *Naiadaceæ*.

CERATO'PHYTES, *Ceratophyta*. (Gr. κεϱας, *a horn*, and φυτον, *a plant*.) A name applied by Cuvier to a family of Corticiferous Polyps, comprehending those in which the internal axis resembles horn or wood.

CE'RATRIN. The bitter principle of Iceland moss.

CE'RBERUS. In Mythology, a monster usually represented as the guardian of the entrance to the infernal regions, and described by the ancient authors as possessing three, fifty, or even a hundred heads.

CERCA'RIÆ. (Gr. κεϱκος, *a tail*.) A family of Infusoria, having an enlarged body with a slender tail-like appendage. The body of the true *Cercariæ* of vegetable Infusiores is rounded, that of the Zoosperms or animalcules of the seminal secretion is flattened. *See* Zoospermes.

CERCO'PIDÆ. *See* Cicadellans.

CE'RCOPITHE'CUS. (Gr. κεϱκος, *a tail*, and πιθηκος, *an ape*.) The name of the genus of Quadrumanes, including those which have long tails, but not prehensile; or the "monkeys" of the old world.

CERE. (Lat. cera, *wax*.) In Ornithology, the naked and generally coloured skin which covers the base of the bill in some birds, as in those of the hawk tribe (*Falconidæ*).

CE'REAL GRASSES. (Lat. ceres, *corn*.) Grasses which produce the bread corns; such as wheat, rye, barley, oats, maize, rice, and millet.

CEREBE'LLUM. (Lat. dim. of cerebrum, *the brain*.) The little brain; the posterior of the medullary masses which compose the brain of vertebrate animals. It is a single organ. *See* Brain.

CERE'BRUM. (Lat.) The third medullary mass of the brain, counting from behind forwards: it is divided in the mesial line into two lateral lobes or hemispheres, and is the only part of the cerebral organ whose development bears relation to the intelligence of the species.

CEREMO'NIAL OF EUROPEAN POWERS, comprises—1. The particular titles due to sovereigns in different states; the imperial title being considered as expressing some sort of superiority over the royal, and having been in consequence assumed by various kings in their public acts (as the King of England since the union of the crowns). 2. The acknowledgment of sovereign titles, the right to confer which was formerly claimed by the Popes as their own prerogative, but they are now assumed by princes, and confirmed by the acknowledgment of other sovereigns. 3. The respective prerogatives of different sovereigns; which species of precedence is that which has occasioned the greatest amount of discussion and dispute when sovereigns, or their representatives, have been brought together. In 1504, Pope Julius II. arranged the rank of European powers in the following order: 1. The Roman Emperor; 2. The King of Rome; 3. France; 4. Castile; 5. Aragon; 6. Portugal; 7. England; 8. Sicily; 9. Scotland; 10. Hungary; 11. Navarre; 12. Cyprus; 13. Bohemia; 14. Poland; 15. Denmark; 16. Republic of Venice; 17. Duke of Britanny; 18. Burgundy; 19. Elector of Bavaria; 20. Saxony; 21. Brandenburg; 22. Archduke of Austria; 23. Duke of Savoy; 24. Grand Duke of Florence; 25. Duke of Milan; 26. Bavaria; 27. Lorraine. This arrangement, however, gave birth to repeated contests. At present, where precedence is not considered as established between rulers of equal dignity, each concedes to the other precedence at home; and when they meet on the territory of a third party, they take precedence alternately until some arrangement is effected

CE'REMONIES, MASTER OF THE. An officer of the king's household instituted by James I. for the more honourable reception of ambassadors and strangers of quality: it is his duty to attend and regulate all matters of etiquette in the drawing room and the levee, and on all occasions where the state of a court is to be maintained.

CEREO'PSIS. The generic name of an Australian goose, characterized by a green cere-like naked membrane covering the upper parts of the base of the bill. It has bred frequently in this country, and there is every probability that it will ultimately become naturalized.

CE'RES. One of the four new or telescopic planets which revolve between the orbits of Mars and Jupiter. It was discovered by Piazzi on the 1st of January, 1801. Ceres is a very small planet, its apparent diameter, according to Schroeter, being only 3·48″, which at its mean distance corresponds to about 1600 miles; but according to Sir W. Herschel its apparent diameter is only 0·35″, or 160 miles. The difficulty of distinguishing its real disk, on account of the nebulosity by which it is surrounded, accounts for the discrepancy. Its mean distance from the sun is rather more than three times the distance of the sun from the earth. *See* Planet.

Ce'res. In Mythology, the Latin goddess corresponding to the Grecian Demeter (Δημήτηϱ), was the patroness of tillage. She was the daughter of Saturn and Rhea, and, by Jupiter, mother of Proserpine. The most remarkable thing connected with this goddess was the celebration of the Eleusinian mysteries, over which she presided.

CE'REUS. (Lat. cera, *wax*.) In Botany, a colour, surface, or texture which resembles that of wax.

CE'RIN. The portion of wax which dissolves in boiling alcohol. Also a peculiar waxy substance obtained by boiling grated cork in alcohol.

CERI'NTHIANS. Followers of Cerinthus, a heretic of the first or second century, who embraced certain gnostical views respecting the natures and relations of God the Father and Son. He conceived the supreme God to be the father or originator both of the Deity from whom proceeded the O. Test. and of Christ; that the God of the Jews was also the creator of this world; and that his dominion over it was superseded by the mission of Christ, who was a son of the supreme Deity residing in a human body. *See* Gnostics.

CE'RIO. A term invented by Murleel to denote the fruit called a Caryopsis, which see.

CE'RITE. A silicious oxide of cerium.

CE'RIUM. A metal named after the planet Ceres, and discovered in 1803 by Hisinger and Berzelius in a Swedish mineral termed *cerite*, and since found by Dr. Thomson in *Allanite*, a mineral from Greenland. It is said to be a white brittle metal, very difficult of fusion, and volatile when intensely heated; but we are scarcely acquainted with it in its metallic state. Its equivalent number appears to be 48, on the hydrogen scale.

CE'RINUS. (Lat. cera, *wax*.) In Botany, waxy yellow; a term used in describing colour, to denote a dull yellow with a slight mixture of reddish brown.

CERO'MA. (Gr. κήϱωμα.) In Ancient Architecture, the apartment in a bath or gymnasium in which persons anointed themselves with a composition of oil and wax.

CEROPLA'STIC. (Gr. κηϱος, *wax*, and πλαστικη τεχνη, *the art of the modeller or carver*.) The art of modelling in wax, one of very high antiquity. From the testimony of Pliny we learn that Lysistratus, the brother of Lysippus, was the first that used wax for modelling the human figure. He lived in the time of Alexander the Great, and was a native of Sicyon.

CEROSTRO'TUM, or CESTRO'TUM. (Gr. κηϱος, *wax*, and στϱωτος, *spread*.) A species of encaustic painting, executed chiefly on horn or ivory with a particular sort of stylum called a cestrum, which was pointed at one end and flat on the other. The cestrum was heated, and with it the lines of the subject were burnt in, and wax introduced into the furrows made by the heated instrument. (See *Pliny*, lib. xi. cap. 37., also lib. xvi. cap. 48.; also *Salmas. ad Solin.* p. 231.) Doors were sometimes ornamented with this species of painting. *Ausonius*, Epigr. 26. v. 10.—

Ceris inurens januarum limina,
Et atriorum pegmata.

CE'RTHIA. (Gr. κεϱθεις, part. of κειϱω, *I clip or shear*.) A genus of Anisodactyle or uneven-toed Tenuirostral or slender-billed Passerine birds, commonly known by the name of Creepers. The common tree-creeper (*Certhia familiaris*, Linn.) is a well-known native species.

CE'RTIORA'RI. In Law, is an original writ issuing out of Chancery or the King's Bench, directed to the judges or officers of inferior courts, commanding them to *certify* or return the records of a cause depending before them. By this writ indictments and many other proceedings may be removed from any inferior court of jurisdiction into the King's Bench. It lies generally in all judicial proceedings in which a writ of error does not lie; but not, in common cases, to remove a cause out of an inferior court after verdict.

CE'RULIN. Indigo which has been dissolved in sulphuric acid.

CERU'MEN. (Lat. cera, *wax*.) The secretion which lines the external auditory canal. It consists of albumen, an oily matter, a colouring matter, soda, and phosphate of lime.

CE'RUSE. (Lat. cerussa.) Carbonate of lead, the basis of white oil-paint. It is commonly called *white lead*.

CERVI'NUS. (Lat. cervus, *a stag*.) In Botany, fawn-coloured.

CE'RVIX. (Literally the lower part of the neck.) An obsolete botanical term, superseded by that of *Rhizoma*, which see.

CE'SSIO BONO'RUM. In the Civil Law (and in the modern jurisprudence of France, Spain, Holland, and Scotland), a yielding up on the part of an insolvent trader of his estate and effects to creditors, under the authority of the competent court; analogous to the assignment of estate and effects under a fiat in bankruptcy in England. See as to the several regulations respecting the *cessio bonorum* in these different countries, *Burge's Commentaries on Colonial and Foreign Laws*, iii. 890. &c.

CE'STOI'DEANS, Cestoidea. (Gr. κεστὸς, *embroidered*, and ειδος, *likeness; riband-like*.) The name of an order of Sterelmintha, or Parenchymatous Entozoa, including those which are commonly called tape-worms.

CESTRA'CEÆ. (Cestrum, one of the genera.) In Botany, a very small group of plants, most usually combined with *Solanaceæ*, but by some botanists separated on account of their straight embryo, foliaceous cotyledons, and valvate corolla. Some of the species have fragrant flowers, especially at night; others emit an unpleasant odour. Some are astringent, others are said to be poisonous.

CESTRA'CION. (Gr. κεστρεαιος, *the name of a fish.*) In Ichthyology, a genus of sharks, characterized by having two kinds of teeth, disposed in oblique subspiral rows; those at the anterior part of the jaws are pointed, and adapted for seizing or grappling shell-fish, &c.; those at the middle and back part of the jaws are flattened for crushing the same: the fishes of this genus are also remarkable for the large spine placed in front of the first dorsal fin. Only two existing species of this genus are known, one of which is called "the Port Jackson shark;" the fossil remains of Cestracions are numerous.

CE'STRUM. (Lat.) In Painting, a tool used by the ancients in executing the species of pictures called *cerostroti*. *See* CEROSTROTUM.

CETA'CEANS, *Cetacea*. (Gr. κητος, *a whale.*) An order of Mammals living in the sea or large rivers, and shaped like fishes for moving habitually in the watery element, having the posterior part of the spine disencumbered of a sacrum and hinder extremities to allow the tail to have a due freedom and extent of motion. They breathe air, have warm blood, and a double circulation, like the rest of the class to which they belong; they are consequently compelled to resort to the surface for the purpose of respiration; and the tail-fin is accordingly horizontal, and not vertical, as in true fishes.

CE'TE. (Gr. κητος, *a whale.*) The name of the sixth order of Mammalia in the *Systemæ Naturæ* of Linnæus, containing those marine species which are devoid of hinder extremities. The group corresponds with the carnivorous group of the modern *Cetacea*, the manatee being associated in the Linnæan system with the elephant.

CE'TIC ACID. The result of the action of alkalis upon *cetine*.

CE'TINE. Pure spermaceti.

CE'TUS. (Gr. κητος, *the whale.*) One of Ptolemy's forty-eight constellations, in the southern hemisphere.

CEVA'DIC ACID. An acid contained in the seed of the *Veratrum sabadilla*.

CEVADI'LLA. *See* SABADILLA.

CE'YLANITE. A mineral found in rounded grains or small crystals, nearly opaque, and of a dark blue or black colour; it was first observed in the sand of the rivers of Ceylon.

CHABA'SIE. A variety of zeolite. (From a Greek word signifying a particular kind of stone.)

CHACO'NE, or CIACONE. (Spanish.) In Music, a kind of dance resembling a saraband, of Moorish origin. The bass of it consists of four notes, which proceed in conjoint degrees, whereon the harmonies are made with the same burden. Some have derived this dance from *cieco*, a blind man, its supposed inventor.

CHAFF. The husk or withered calyx of grasses, and more especially of the bread corns. The term is also applied to straw or hay cut into very short lengths, and used for mixing with corn, roots, or other food for horses or cattle. This kind of chaff, in greater lengths, is also used for mixing with mortar on some parts of the Continent, more particularly in Germany and Russia; and it is used as a substitute for hair in making plaster for rooms. Both stubble and cut hay were used by the ancient Egyptians in making bricks.

CHAFF OF THE RECEPTACLE. A term used by some botanists to denote the bracts which are stationed upon the receptacle of Composite flowers, between the florets; they have generally a membranous texture, and no colour, and are usually called Paleæ.

CHA'FFY, PALEACEOUS. When a surface is covered with small, weak, erect membranous scales, resembling the chaff of corn, as the receptacle of many Composite plants.

CHAI'LLETIA'CEÆ. (Chailletia, one of the genera.) A natural order of shrubby arborescent Exogens, placed by De Candolle between *Homaliaceæ* and *Aquilariaceæ*; agreeing with the former in the presence of glands round the ovary, but differing in its superior ovary, with the placenta in the axis, and in many other characters. Its affinity, however, appears to be greatest with *Rhamnaceæ*, with which it agrees in habit. It inhabits the hotter parts of the world, and some species are said to be poisonous.

CHALA'ZA. (Gr. χαλαζα, in the sense of *a knob.*) In Botany, the vascular disk caused by the expansion of the vessels of the raphe, upon reaching the base of the nucleus of an ovule, after passing up the side of the latter.

CHALA'ZÆ. (Gr. χαλαζα, *hail.*) A name applied to the two membranous twisted chords attached to near the poles of the yolk of an egg, and serving to maintain it in such a position that the cicatricula shall always be uppermost, and consequently nearest the source of heat during the process of incubation.

CHALCE'DONY. A semitransparent silicious mineral, apparently formed by the infiltration of silicious matters originally in a state of solution. It is of various colours, and often banded. The finest specimens are said to have been originally found at Chalcedon in Asia.

CHALCI'DICUM. (Lat.) In Ancient Architecture, according to Festus so named from Chalcis, a city in Eubœa. A term used by Vitruvius to denote a large building appropriated to the purpose of administering justice, or according to others the tribunal itself.

CHALCO'GRAPHY. (Gr. χαλκος, *brass*, and γραφω, *I write.*) The art of engraving on copper or brass.

CHA'LDRON. (Lat. chaldarium; Fr. chaudron, whence also cauldron.) A measure containing 36 bushels heaped measure.

CHALK. (Germ. kalk.) Earthy carbonate of lime. It forms an important geological feature of this country, the chalk hills which form the white cliffs of our shores having conferred the name of ALBION upon the island. Geologically considered, it is an important feature among the secondary rocks. The cretaceous formation is characterized by peculiar fossils, and especially by containing *flints*. The ranges of chalk hills in the south of England are very extensive, and the landscape which they constitute peculiar for the smooth and rounded outline of its hills, their monotony of surface, and the singular cup-shaped concavities and deep hollows in which their sides abound. Between Dunstable and Shaftesbury the chalk hills attain an elevation of nearly 1000 feet above the level of the sea. Between Lewes in Sussex and Alton in Hampshire there are several similar elevations.

CHALK STONES. The concretions formed in the joints of persons who have long suffered from gout were once supposed of a chalky nature, and acquired the above name. They are chiefly composed of uric acid in combination with soda.

CHA'LLENGE. In Law, an exception to jurors who are returned to serve on a trial. *See* JURY.

CHALY'BEATE. (Gr. χαλυψ.) The Chalybes were a Scythian people who dug iron. Medicines and mineral waters containing iron are called *chalybeates*.

CHA'MA. (Gr. χαω, *I gape.*) The cockle.

CHAMA'CEANS. (Lat. chamacea.) In Conchology, the family of Acephalous Lamellibranchiate Mollusks, of which the genus *Chama*, or clam-shells, is the type. The group is characterized among bivalves by having the mantle perforated by three apertures; one for the passage of the foot, another for the respiratory currents, and a third for the escape of the excrements.

CHAMÆ'LEON, *Chameleo*. (Gr. χαμαιλεων, *a lizard.*) A genus of Saurian reptiles with small tubercular scales, and the tail and feet organized for clinging to the branches of trees. The chameleons subsist not on air, as poets feign and the uninformed believe, but on flies and other insects, which are caught by means of a remarkably long and extensible tongue, terminated by a finger-shaped process like the elephant's proboscis, and which the chameleon can dart upon its prey with great rapidity. The rete mucosum or coloured layer of the skin contains two kinds of pigment, situated in different layers; the deeper seated layer is of a deep green or violet red colour, the superficial pigment is of a greyish colour; the deep-seated pigment is contained in branched cavities, and is moveable, producing by its partial accumulation and varying proportions with the superficial layer the changes of colour for which the chameleon has in all ages been remarkable.

CHAMÆ'LEON MINERAL. A compound of manganesic acid and potash, which presents a variety of tints when dissolved in water.

CHA'MBER. (Fr. chambre.) In Architecture, properly a room vaulted or arched; but now generally used in a more restricted sense to mean an apartment appropriated to lodging. With the French the word has a much more extensive meaning; but with us the almost only use of it, beyond what is above stated, is as applied in a palace to the room in which the sovereign receives the subject, which is called the Presence Chamber.

CHA'MBERLAIN. (Fr. chambellan; Germ. kammerherr.) A high officer in all European courts. Originally the chamberlain was the keeper of the treasure-chamber (camera, in the 10th century); and this meaning of the word is still preserved, in the usages of corporations of London and other places, where the chamberlain is the officer who keeps the money belonging to the municipal body. But, in modern times, the court officer styled chamberlain has the charge of the private apartments of the sovereign or noble to whom he is attached. In England, the lord great chamberlain, or king's chamberlain, is one of the three great officers of the king's household. He has the control of all the officers above stairs, except the precinct of the king's bedchamber, which is under the government of the groom of the stole.

Under him are the vice-chamberlain, lord of the bedchamber, &c.; the chaplains, officers of the wardrobe, physicians, tradesmen, artizans, and others retained in his majesty's service are in his department, and sworn into office by him. He is commonly one of the highest nobility of the country; in virtue of his situation he precedes dukes. The emblem of office appropriated to the chamberlain in European courts is a gold key, generally suspended from two gold buttons.

The LORD GREAT CHAMBERLAIN OF ENGLAND (not of the household) is the sixth great officer of state. This office belonged for many centuries to the noble family of De Vere, Earls of Oxford; afterward to that of Bertie, Lords Willoughby de Eresby and Dukes of Ancaster. In that line it became vested in coheiresses, by whom the present deputy chamberlain (Lord Gwydir) is appointed.

CHA'MBRE ARDENTE. In French History, a name given to the tribunal which was instituted by Francis I. for the purpose of trying and burning heretics; and also the extraordinary commissions established under Louis XIV. for the examination of prisoners, and under the regent Duke of Orleans against public officers charged with certain offences against the revenues, and those guilty of fraud in the matter of Law's bank.

CHA'MBRE DES COMPTES. (Chamber of Accounts.) In French History, a great court established for various purposes; as for the registration of edicts, ordinances, letters patent, treaties of peace, &c. The sovereign chambre des comptes was at Paris: there were also inferior courts in ten provincial cities.

CHA'MFER. (Fr. chamfrein.) In Architecture, the edge of anything originally right-angled cut aslope or bevel, so that the plane it then forms is inclined less than a right angle to the other planes with which it intersects.

CHA'MOMILE FLOWERS. The flower-heads of the *Anthemis nobilis*, or common chamomile. They are used in medicine in consequence of their bitter extract, which is strengthening, and of their essential oil, which is aromatic and stimulant.

CHAMP DE MARS. In French History, the public assemblies of the Franks, which were held in the open air, and annually in the month of March; from whence the name. Under Pepin and some of his successors they were termed Champs de Mai. An extensive open space in Paris, appropriated to various public solemnities, is termed the Champ de Mars; a name which seems also intended to recall the ancient Campus Martius, or public field of Rome.

CHA'MPERTY. In Law, is a species of maintenance, being a bargain with the plaintiff or defendant in a suit for the "campi partitio," or division of the land or thing in dispute between the party, if he prevails at law, and the champerter, on the latter's bearing the expense of the suit. It is a punishable offence both by common law and by statute.

CHA'MPION. (From the Italian campione, derived from campo, *field;* or from the ancient German and Gothic kempe, kiempe, *a warrior;* whence some have derived also the Spanish campeador, a title of the *Cid.*) One who fights a public combat, or engages to do so, in his own or another man's quarrel. On the issue in a writ of right trial by battle might formerly be demanded; and in this case (*see* WAGER OF BATTLE), each party appeared in the field by his champion. The judicial combat in criminal cases might in some countries, although not in England, be fought by a champion for either of the parties, if an ecclesiastic, woman, or child. The office of champion of the crown of England is of great antiquity; the manor of Scrivelsby in Lincolnshire having been held from time immemorial in grand serjeantcy, on condition that the lord thereof shall be the king's champion. This manor was long held by the family of Marmion; it passed, in the 20th year of Edward I., to the family of Dymocke, in which it has since continued. The champion appears in Westminster Hall at the coronation, between the courses of the royal banquet, in complete armour; his challenge is proclaimed by the herald, waging battle with any person who shall deny or gainsay the title of the king, three times; and the champion throws down his gauntlet. In 1821, at the coronation of George IV., it was decided that this office could be performed by deputy; and W. Dymocke being in orders, his place was supplied by his eldest son.

CHANCE. A term applied to events that are supposed to happen without any known or necessary cause; or rather, of which the cause is such that they may happen in one way as well as another. Thus, when a piece of money is tossed up into the air, as no reason can be given why it should fall on one side rather than on the other, it is said to be an even chance which of the sides shall turn up. For an account of this branch of mathematics, sometimes called the *Doctrine of Chances*, see PROBABILITY.

CHA'NCEL. (Lat. cancellus.) In Architecture, the part of the choir of a church between the altar and the lattices (cancelli) or balustrades that enclose it. This is the strict meaning; but in many cases the chancel extends much further into the church, the original divisions having been removed for the greater accommodation of the congregation.

CHA'NCELLOR. (Lat. cancellarius.) A high officer in many European states. The cancellarius under the Roman emperors is supposed to have been a notary or scribe, and his title to have been derived from the cancelli or railing behind which he sate. In ecclesiastical matters, every bishop had (and continues to have) his chancellor, the principal judge of his consistory. The chancellor of France began to be an officer of importance under the Frankish kings, especially after the office of referendary had become merged in his, about the ninth century. In 1223 he was made the first minister of the crown, and rank next after the princes of the blood was assigned to him. The offices of chancellor and keeper of the seals were frequently united.

CHANCELLOR, ARCH, OF THE EMPIRE. This office, under the elective empire of Germany, belonged to the archbishop elector of Mentz. The archbishop of Cologne was titular arch-chancellor of Italy, the archbishop of Treves of Gaul and Arles.

CHANCELLOR OF A DIOCESE. The keeper of the seals of an archbishop or bishop. This office now includes those of official principal, whose duty is to hear and decide matters of temporal cognizance determinable in the bishop's court; and vicar-general, who exercises the jurisdiction properly spiritual.

CHANCELLOR OF THE EXCHEQUER. The highest finance minister of the British government. This office is from its nature necessarily entrusted to a commoner, and is commonly united to that of first lord of the treasury when the premier happens to be below the peerage. The chancellor, as an officer of the Court of Exchequer, has precedence above the barons of that court.

CHANCELLOR OF A UNIVERSITY. The head of the corporate bodies by whom he is elected. He exercises exclusive jurisdiction in all civil actions and suits where a member of the university or privileged person is one of the parties, except in cases where the right to freehold is concerned. The duties of the respective chancellors of Oxford and Cambridge are in nearly all cases discharged by a vice-chancellor.

CHANCELLOR, CHANCERY. The office of chancellor is the most ancient as well as the highest of all judicial offices in the kingdom; for though the superior antiquity of his jurisdiction has been questioned, the establishment of the office itself was certainly prior to the institution of any existing court of justice, the name as well as some of the functions, which were borrowed from the "cancellarii" of the later Roman emperors, having been introduced into this country within the first three centuries that followed the dissolution of the Western Empire.

In addition to his judicial functions, which are various and extensive, the chancellor is now by virtue of his office privy councillor, and when a peer speaker of the House of Lords; over all the members of which, with the exception of the archbishop of Canterbury, he then has precedence in rank. As chief conservator of the peace, he has the nomination of all magistrates throughout the kingdom; and he is the patron of all livings of the crown under the value of twenty marks in the king's books. He has also the right of appointment to almost all the offices in the Court of Chancery, particularly to the office of master; and has very great influence over the appointment of any of the other judges both of common law and equity. He still retains also the title of keeper of the king's conscience, a duty originally incident to his situation in the king's chapel, over the service of which he presided; and this office may perhaps have afforded a ground for that part of his jurisdiction which professes to remedy what is contrary to equity and good conscience. It is further his duty to issue the writs for the convocation of parliament; and all acts there passed, as well as many records and documents affecting the rights of individuals, — as to the latter in order to their validity, — are enrolled and kept in chancery, under the immediate care and custody of the master of the rolls, himself an officer of that court. The custody of the great seal is the peculiar and essential mark of the chancellor's dignity; and by delivery of that and the proper oaths taken the office is created, with all such of its rights as can be exercised by a chancellor not being a peer.

The jurisdiction of the chancellor is of various sorts. And, first, as to his common law jurisdiction. By this is meant that part of the chancellor's jurisdiction which is regulated by the same principles, and exercised according to similar forms, as the jurisdiction of the other courts of common law. This is by far the most ancient branch of the chancery judicature, and seems to have been originally incident to the nature of the chancellor's office, whose chief business it was to advise the sovereign on the subject of grants, charters, and letters patent, and to

authenticate them by affixing the great seal after the introduction of that symbol. Out of this naturally arose a jurisdiction in all matters between the crown and its grantees, and the right to repeal or cancel all grants, charters, and letters patent, which should afterwards appear to be contrary to law, or in other respects improperly obtained. In like manner the chancellor had jurisdiction in other matters arising out of commissions under the great seal; such as returns made in pursuance of inquiries under such commissions as to the right of the crown to goods or lands of the subject either by escheat, forfeiture, or any other cause; these were legally called offices.

To the same court also belonged originally, in the time of feudal tenures, jurisdiction in the case of wardship, and some other matters arising out of such tenures between the crown and its tenants in capite; but it should be observed, that as this court has not the power of summoning a jury, it can in no case try an issue of fact. It is called the Court of the Petty Bag, literally from the size of the bag in which its writs are deposited. To the common law department of chancery belongs also the issuing of original writs; that is to say, precepts addressed to the party complained of, stating the nature of the complaint made against him, requiring him to do justice to it, or show cause to the contrary; such writs being originally the first and a necessary step in all causes which were tried before either of the three great courts, or in the "aula regia," before its division into separate courts.

In this department of his office the chancellor was assisted by officers named cursitors, whom he was empowered to nominate for that purpose, and upon whom the whole business of devising writs soon devolved. The chancery has hence been called Officina Brevium, or workshop of writs; and is, or was, in respect of the necessity of such writs, the foundation or fountain head of all justice; but this necessity, which had in practice long been satisfied by a fiction, has been in terms dispensed with by the 2d W. IV. c. 39. The receptacle in which these writs were kept was called the Hanaper, — literally a basket; and hence the office from which they issued was called the Hanaper Office.

But by far the most extensive as well as most important branch of the chancellor's jurisdiction is the equitable; indeed, it is that branch alone which is commonly meant by the term chancery. In this department of his office the chancellor is assisted by the master of the rolls and the vice-chancellor; the first of which is a very ancient office, and the second was established by act of parliament in the 53rd year of George III.; who, though they each sit in separate courts, and exercise their jurisdiction severally, yet together with the lord chancellor constitute one court of chancery, in which all orders and decrees, though most commonly made either by the master of the rolls or the vice-chancellor, require the signature of the chancellor himself, to whom an appeal also lies from the decisions of either of the two inferior judges; but such appeals are in strictness of speech rehearings, the chancellor being by legal fiction supposed to be present in every department of the Court of Chancery. The hearing of such appeals, and of incidental applications, called motions, in original causes, constitutes the ordinary business of the lord chancellor, it not being the usual practice to bring causes in the first instance before him.

The general object and character of this equitable jurisdiction is to supply, in civil matters, the deficiencies of the other courts of justice, whether those deficiencies consist in the imperfections of the machinery of those courts, or in their too rigid adherence to peculiar forms, whereby certain classes of rights become excluded from the benefit of their protection. The origin of this equitable jurisdiction is generally sought for in that remnant of judicial power which is alleged to have been left in that part of the "aula regia" which was not included in either of its subdivisions (*see* King's Bench, Common Pleas), and of which residuary part the chancellor was certainly, since the suppression of the office of justiciary, the principal member, and was thus easily enabled to assume whatever judicial power was left undelegated to the other courts. That such remnant of power was adequate to all purposes to which it was moulded, is inferred from the supreme and comprehensive nature of the "aula regia" itself, which must be supposed to have been invested originally with full power to do complete and perfect justice, and of which the remnant therefore still retained an undefined measure of authority sufficient to supply what should prove, on experience, to be wanting in the other courts. This view of the subject is strengthened by the fact that the Court of Exchequer, which was not a part of the aula regia, but a collateral and equal court, or rather perhaps the aula regia in a different shape, has also its equitable jurisdiction, as if that were a necessary part of all complete systems of judicature. Possibly also the idea of paramount and universal authority annexed to the right of framing writs in all actions, or, in other words, of devising remedies for every species of wrong, may have laid the foundation in theory for this supplemental code, as it was certainly the discovery of a new writ, or a new application of an old one, which practically enabled the chancellors to carry their equitable views into effect.

This was the writ of subpœna: a writ returnable in chancery, and calling upon the person to whom it was directed to appeal there, and answer upon oath the complaint that was made against him. The invention of this writ is attributed to John Waltham, Bishop of Salisbury, who was chancellor in the reign of Richard II.; and it is upon the power thereby acquired that rests even now the equitable jurisdiction of the chancery.

Similar in principle to this is the equitable jurisdiction of the Court of Exchequer; which is concurrent with that of the Court of Chancery in all matters of equitable relief, though it can only be called into action by a fiction stated in the pleadings, and which it is not allowable to deny — that the plaintiff is a debtor of the crown, and will by deprivation of the right for which the suit is brought be less able to satisfy such debt. Wherever, therefore, in the course of this or other articles the words *equity* or *courts of equity* occur, they must be taken as applying to the principles and jurisdiction as well of the Exchequer as of the Chancery.

The usual division of the objects of equitable jurisdiction is into Trust, Fraud, Accident, Agreement, and Account.

As courts of equity take into their consideration a far greater variety of circumstances than do courts of law, and as evidence of no fact not suggested by the pleadings is admissible, the written pleadings are necessarily more copious and important than they are at law; and there is further this most essential difference, that the pleadings on the part of the defendant, *i. e.* his answer, are upon oath. With regard to evidence the same general rules prevail in equity as in law, as to the admissibility of proofs, the relevancy of facts, and the competency of witnesses, and even the propriety of the questions that may be put; but the manner of taking evidence is different, for with few exceptions, and those as to very simple facts, evidence in equity is taken either under a commission to examine, or by the official examiners in London, and is produced before the court in a written shape. Where special applications are made during a cause for something to be done in that cause, or, as may sometimes be done, when applications for an order of the court are made without instituting a suit, the evidence adduced is by affidavit. The hearing of such applications, which is either upon written *petition* or by motion upon written notice, constitutes a great part of the business of the court. Evidence of facts not essential in the first instance to the interposition of the court, is usually taken in the master's office upon a reference made to him. The Court of Chancery has also jurisdiction in the guardianship of infants and the management of charities; and the lord chancellor personally has, by special delegation from the crown, jurisdiction in the case of lunatics, which is exercised according to the forms of the old common law jurisdiction of the court upon commission issued.

The appellate jurisdiction of the chancellor in bankruptcy is stated under that title.

CHANCE-MEDLEY. (A corruption of the French *chaude mclée*.) In Law, signified originally a casual affray or riot, accompanied with violence, but without deliberation or preconceived malice; but is applied at present to a particular kind of homicide, — viz. the killing of another in self-defence in a sudden encounter, without *malice prépense*.

CHANGE OF SEED. In Agriculture, the practice of procuring seed produced in a different soil and climate from that in which it is to be grown as a crop; and which is found to be sometimes beneficial, and sometimes injurious, according as the new seed may have been matured in a better or worse climate and soil than those in which it is to be grown.

CHA'NNELS OF A SHIP. Strong narrow platforms of thick plank, projecting from the outside of the ship, abreast each mast, to extend the shrouds, and thereby increase the support of the rigging.

CHANT. (Fr. chanter, *to sing*.) In Music, an ecclesiastical song usually adapted to the psalms and litanies. There have been several sorts, of which the first was the Ambrosian, invented by St. Ambrose, bishop of Milan. The Gregorian chant, which was introduced by Pope Gregory, is still in use in the Roman church, and is the foundation of all that is grand and elevated in music.

CHA'NTRY. (Lat. cantaria.) A little chapel or altar, commonly in some church, endowed (before the Reformation) with revenues for the maintenance of a priest to perform prayers for the soul of the founder and others. Chantries were dissolved in England by 1 Ed. 6. c. 14.

CHA'PEL. (Lat. capella.) In Architecture, a building for religious worship, erected separately from a

church, and served by a chaplain. In Catholic churches and Protestant cathedrals, chapels are usually annexed in the recesses on the sides of the aisles; these are also called chantries.

Chapel. (Fr. chapelle.) In Printing, is the junction of the workmen in an office for the purpose of promoting and enforcing order and regularity in the business, the preservation of the materials, the arrangement of the price of any doubtful work, and the care of the lights. These objects are accomplished by fines.

Moxon, who published his work on printing in 1683, says, "every *Printing-house* is, by the custom of time out of mind, called a *chappel*." It is supposed that the term originated from the circumstance of Caxton, on the introduction of the art into England, practising it in a chapel attached to Westminster Abbey.

The president is termed "the father of the chapel," and is elected; the workmen are styled "members of the chapel;" and this association takes cognizance of all offences, real or imaginary, committed within the office, and punishes the offender by inflicting a fine in proportion to the offence. The process of calling a chapel is by giving the father a halfpenny and desiring him to summon a chapel, stating to him the object; the father then directs the youngest journeyman to announce to all the members the time when it will be held; when the subject is discussed, and the decision taken by vote.

It is an axiom that the chapel is always right, consequently there is no appeal from its decision, and to dispute this would subject the party to its displeasure. It has various ways of enforcing obedience to its dictates.

Chapel. A place of divine worship, either connected with a private establishment, as a nobleman's house, a college, &c.; or subsidiary to a parish church for the sake of additional accommodation (in which case it is called a chapel of ease); or a meeting-house belonging to a Dissenting congregation.

CHA'PLAIN. (Lat. capellanus.) Properly the minister of a chapel. The privilege which the king and nobility enjoy of appointing private chaplains arises from the ancient custom of using domestic chapels for family worship. The limitations under which this privilege may be exercised are set forth in certain statutes of Henry VIII. Under the existing law a nobleman's chaplain may hold two benefices; but the chaplain of a judge, &c. only one: on which, however, he is not obliged to reside.

CHA'PLET. (Ital. ciappelletto.) A string of beads used by Roman Catholics to count the number of their prayers; these prayers consist for the most part of Ave Marias, Paternosters, and Credos. Another name for the chaplet is Rosary. The invention of the practice is generally attributed to St. Dominic.

Chaplet. (Fr. chapelet.) In Architecture, a moulding carved into beads, olives, and the like.

CHA'PTER. (Lat. capitulus; from caput, *head*.) The society of canons in a cathedral or collegiate church, of which the dean is the head, which forms the council of the bishop, and in which his election rested before Henry VIII.; since whom the power of the chapter in this particular (in the English church) has become merely nominal. *See* art. Bishop.

CHA'PTER-HOUSE. (Lat. capitulum.) In Architecture, the apartment (usually attached) of a cathedral or collegiate church in which the heads of the church or the chapter meet to transact business.

CHARA'CEÆ. (Chara, one of the genera.) A natural order of Acrogens entirely destitute of a vascular system, and composed almost exclusively of tubes; placed by Linnæus near to Lichens and to Phænogamous plants; by Jussieu and De Candolle, with *Naiadaceæ;* by Brown, at the end of *Hydrocharaceæ;* by Leman, to *Halorageæ;* by Von Martius, Agardh, and Wallroth, to *Confervæ;* and finally admitted as a distinct order by Richard, Kunth, De Candolle, Adolphe Brogniart, Greville, Hooker, and others: consists of but two genera, which inhabit the fresh and salt waters of most countries. They are remarkable for the distinctness with which the rotation of their fluids may be seen under the microscope. In the opinion of some Italian writers, the insalubrity of the neighbourhood of Rome is owing to the great quantity of chara which inhabits all the pools, and renders them intolerably offensive.

CHA'RACTER. (Gr. χαρακτηρ.) In the Fine Arts, a distinctive property or mark by which any object is separated from another. In physics as in morals, and also in the fine arts, there are three species of character; Essential, Distinctive or Accidental, and Relative. *Essential character* is that type stamped by nature on all her works; that great indication observable in the general divisions of the three kingdoms of nature; those distinctions of different classes of beings, of sexes and ages; in short, of all those great external marks which prevent the confusion of one species with another. *Distinctive* or *accidental character* is that dependent on particular circumstances; on all those varieties of development which a vast number of visible or invisible causes stamp on the same species, according to the difference of their position; as on individuals of the same species, according to the difference of the elements which modify their forms and the influences which some actions may have upon them. *Relative character* is a more particular indication of certain faculties relative to the different properties with which nature has endowed certain species or individuals, in which may be recognized the purposes to which they are more especially destined. In morals *essential character* consists in that uniformity of general habits which forms the peculiar instinct of each species of beings, and which indicates uniformly their inclinations, their predominating tastes, and those propensities which can never be changed by accidental causes. *Distinctive character* is that which peculiar habits of organization, circumstances, social institutions, and all those exceptions which in the very order of nature become suitable to an individual or one of the same species, being in fact but a modification of essential character. *Relative character* is the impression or development in a particular manner of certain qualities suited to a certain end, or to a certain mode of existence, indicating to what purposes the beings in question are suited, and manifesting a co-relation between what the species appears and that for which it is adapted.

The arts are and indeed can be but the result of nature in all countries, of the nations that inhabit them, and of the individuals of which a nation is composed. Nature influences nations, nations men, and men the arts. These are governed either mediately or immediately by an influence more or less dependent on the great natural causes of climate, government, and education, which constitute the essential character of every country; on secondary and political causes, in which nations differ; and on particular causes, which modify individuals. The arts do but imitate this process: according to the particular spot in which they spring up, their imitation embraces either nature in general or parts of nature; either material forms and the sensible images of things, or the moral affections and intellectual ideas of things; but of whatever kind the imitation be, to whatever object it may be directed, the arts are but the faithful mirrors which reflect in every country the physical and moral qualities of nature, of nations, and of the individuals of which the latter are composed. Before judging, therefore, of the imitation, it becomes necessary to judge of the model; and before we can ascertain in what the character of the arts consists, we must know on what its character depends in nature. We have been thus particular in giving some general notions of character, which must be felt before we can be qualified to judge of the character of the arts in any country. The character peculiar to himself which an artist imparts to his work is but a modification of the foregoing principles: more easily, perhaps, may be understood that distinctive character which a work of art requires that it may seem proper and suitable to its end. That character which marks species was well understood by the ancients; and if we may trust Martial, Phidias excelled in catching it. Of his fishes the poet says, "Adde aquam, natabunt."

CHARACTERI'STIC OF A LOGARITHM. The same as index or exponent; meaning the figure prefixed to the logarithm, or preceding the point, and which indicates the integer places or figures in the number to which the logarithm corresponds.

CHA'RACTERS. (Gr. χαρακτηρ, *a mark*.) In Music, the conventional forms in musical writing and printing used for the signs of clefs, notes, rests, &c.

CHARA'DE. (Fr.) A species of riddle, the subject of which is a name or a word that is proposed for solution from an enigmatical description of its several syllables taken separately as so many individual words, and then from a similar description of the whole name or word. A charade can only be called complete if the different enigmas which it contains are brought into a proper relation to each other, and as a whole unite in an epigrammatic point. The following charade, which we borrow from the *Dictionnaire de l'Academie Française*, may be regarded as a good specimen of this species of riddle:—"My first makes use of my second to eat my whole;" the solution being *chien-dent* or dog's grass. The word *charade*, like the term *calembourg* (quod vide), has been applied to this sort of amusement, from the name of its inventor.

CHARA'DRIUS. (Lat.) A bird mentioned by Pliny. The name of a very interesting genus of wading birds, or *Grallatores*, including the British plover and allied species. In modern Ornithology, the Linnæan genus which included the long-legged plover (*Himantopus*), the stone curlew (*Œdicnemus*), and other species is raised to the rank of a family called *Charadriadæ*.

CHA'RCOAL. A form of carbon, obtained by burning wood with the imperfect access of air, or by heating or distilling it in iron cylinders so constructed as to allow of the collection of the volatile products; among which are *tar*, and *pyroligneous acid*, which is impure vinegar. Charcoal, exclusive of its important use as a fuel, is

possessed of some curious and valuable properties. It is a very bad conductor of heat; and hence powdered charcoal is used to surround tubes and vessels which are required to retain their heat. It is not injured by air and moisture; hence stakes and piles are superficially charred to preserve them. It is infusible; and provided air be carefully excluded, it undergoes no change in most intense heats. It absorbs air and moisture, and also the colouring and odoriferous parts of many animal and vegetable substances. Tainted flesh and putrid water are thus sweetened by the action of powdered charcoal, especially by what is called *animal charcoal*, obtained by burning bone, or the clippings of hides, leather, &c. Coloured vegetable solutions filtered through well burned charcoal are materially decoloured by it: when burned in oxygen or air, it is converted into *carbonic acid*. (*See* DIAMOND and CARBON.) Common charcoal intended merely for fuel is prepared by cutting pieces of wood from 1 in. to 3 in. in diameter into lengths of from 1 ft. to 3 ft., forming them into a conical pile, and covering them with turf or clay; leaving two or three small holes, close to the ground, for lighting the wood and boring through the turf in the upper part of the cone, a few other small holes for the escape of the smoke. The pile being lighted at the several holes along the bottom, continues burning with a slow smouldering flame for a week or two, and is allowed to cool before the turf is removed. In the case of very high winds, the holes to the windward are stopped, to prevent combustion from going on with too great rapidity. Charcoal obtained by distilling beech-wood, log-wood, willow, and other woods which are free from resin, is called *cylinder charcoal*. The charcoal employed in the manufacture of gunpowder is now always so prepared.

CHARDS. The footstalks and midrib of artichokes, cardoons, and the white beet are so called. In the case of the artichoke and cardoon, the leaves are tied up, and the light excluded by straw ropes or by soil, in order to blanch the chard, and deprive it of its natural bitterness; after which, when dressed, it becomes an agreeable vegetable. The leaves of the white beet, not being naturally bitter, do not require blanching to render them fit for use.

CHA'RFRON, or CHAMP-FREIN. In Plate-armour, plates of steel or pieces of leather, to protect the face of a horse.

CHARGE. In Gunnery, is the quantity of powder and weight of ball with which guns are loaded. For proving cannon, the charge of powder is equal to the weight of the ball; but for service it is about one half, or more frequently about one third the weight of the ball. Dr. Hutton in his Mathematical Dictionary states that different charges of powder, with the same weight of ball, produce different velocities in the ball, which are in the sub-duplicate ratios of the weight of powder; and when the weight of powder is the same, and the ball varied, the velocity produced is in the reciprocal sub-duplicate ratio of the weight of the ball; which is agreeable both to theory and practice. He states also, that from many experiments made by him on this subject, he found the length of the charge producing the greatest velocity in guns of various lengths of bore, from 15 to 40 calibers, to be as follows:—

Length of bore in calibers.	Length of charge for greatest velocity.
15	3-16ths.
20	3-12ths.
30	3-16ths.
40	3-20ths.

CHARGE. In Heraldry, signifies the various bearings, *i.e.* ordinaries and figures, depicted on the escutcheon. A shield is said to be *charged* with the bearings depicted on it; and so is an ordinary or other charge, when it bears another device upon it.

CHARGE and OVERCHARGE. In Painting, a term applied to any exaggeration of character, expression from colour, &c.

CHARGE' D'AFFAIRES. The third or lowest class of foreign ministers, according to the regulations adopted at the congress of Vienna.

CHA'RITY, SISTERS OF. The name by which an institution of females is known in France, whose office is to attend the sick, and who form a similar society to that of the Beguins in Flanders. *See* BEGUINS.

CHA'RLES'S WAIN. A name sometimes given by astronomical writers to the constellation Ursa Major, or Great Bear. It has sometimes also been applied to the Little Bear.

CHA'RLOCK. A common name in the northern counties for one of the most common weeds, *Raphanus raphanistrum*. The plants when young are remarkably like those of the common turnip; but they are easily distinguished by the taste, which is hot and bitter; while that of the turnip is mild. Cold wet lands are more subject to the charlock than warm calcareous soils. As sheep are remarkably fond of the plant, they are frequently turned into corn fields where it abounds, in which case it is found that they do not touch the corn while any of the charlock remains. That excellent husbandman Mr. Lisle, having sown charlock seed and turnip seed at the same time, found that the latter came up in three days, while the charlock required ten. The seed, when buried in the soil to a certain depth, will retain its vital properties for an unknown length of time; grass lands that have not been ploughed within the memory of man having, when broken up, produced abundance of this plant.

CHA'RON. (Gr. χάρων.) In Mythology, the ferryman of hell, who conducted the souls of the departed in a boat across the Stygian lake to receive judgment from Œacus, Rhadamanthus, and Minos, the judges of the infernal regions. He received an obolus from every passenger, for which reason the ancients used to put that piece of money in the mouths of the dead. He was said to be the son of Erebus and Night.

CHA'RRED WOOD. Wood, the outer surface of which has been carbonized by burning, in order to preserve it from decay when it is buried in the soil.

CHA'RRING OF POSTS. The practice of carbonizing by burning that portion of the surface of wooden posts which is to be inserted in the ground. The object is to prevent the posts from decaying, more especially at the surface of the ground, or, as the common phrase is, between wind and water. The practice is common in most parts of Europe, and even in Russia and Sweden, though timber is there so abundant.

CHART. A hydrographic map for the use of navigators, being a projection of some part of a coast on a plane surface. Charts as well as ordinary maps may be constructed on any of the principles by which a spherical surface is represented on a plane; but they are generally laid down according to Mercator's projection, in which the meridians, and consequently also the parallels of latitude, are represented by parallel straight lines, the degrees of longitude on all the parallels being equal to those of the equator, and the degrees of latitude being increased from the equator towards the pole, so as to bear always the same ratio to the degrees of longitude which they do on the sphere itself. *See* MAP and PROJECTION.

CHARTA'CEUS. (Lat. charta, *paper*.) Papery; indicating the paper-like texture and substance of most leaves.

CHA'RTA, MA'GNA, in English History. The "Great Charter of the Realm" was signed by King John in 1215, and confirmed by his successor Henry III. It is reported to have been chiefly drawn up by the Earl of Pembroke and Stephen Langton, Archbishop of Canterbury. Its most important articles are those which provide that no freeman shall be taken or imprisoned or proceeded against, "except by the lawful judgment of his peers or by the law of the land," and that no scutage or aid should be imposed in the kingdom (except certain feudal dues from tenants of the crown) unless by the common council of the kingdom. The remaining and greater part of it is directed against abuses of the king's power as feudal superior.

CHARTE. (Lat. charta, *paper*.) In French History, originally used to indicate the rights and privileges granted by the French kings to various towns and communities; but applied at present to the fundamental law of the French monarchy, as established on the restoration of Louis XVIII. in 1814. The *Charte* consists of 69 articles, and is founded on principles analogous to those of the British constitution, as embodied originally in the Magna Charta, and subsequently extended in the Bill of Rights. As is well known, it was the violation of an article of the *Charte* by the Ministers of Charles X. that led to the revolution of 1830, the expulsion of that monarch from the throne, and the establishment of the present dynasty. Since that time the *Charte* has undergone a few modifications, the chief of which consists in the abolition of the hereditary peerage. (See the *Almanac Royal et National*, published annually.)

CHA'RTER-PARTY. (Fr. parti, *divided*.) In Mercantile Law, is defined to be a contract, by which the owner or master of a ship hires or lets the whole or a principal part of it to a freighter for the conveyance of goods, under certain specified conditions, on a determined voyage to one or more places. A charter-party is generally under seal; but a printed or written instrument signed by the parties, called a memorandum of a charter-party, is binding if no charter-party be executed. A voyage may be performed in part under a charter-party, and in part under a parol agreement; but the terms of a charter-party cannot be altered by parol evidence, although they may be explained by mercantile usage. The instrument expresses the freight to be paid, and generally, but not necessarily, the burden of the ship; together with some usual covenants, and others at the discretion of the parties.

CHA'RTULARY. In Diplomatics, a collection of the charters belonging to a church or religious house.

CHASE. (Fr. chassis.) In Printing, an iron frame six tenths of an inch in thickness, in which pages are wedged up to secure the letters from separating or dropping out in the process of printing. Chases are of

different dimensions, according to the number of pages in a sheet, and the size of the paper: in the printing of books there are two bars fixed across at right angles, called crosses, so as to divide the chase into quarters for greater security. The thickness is always the same, however large the chase, being lower than the types, for the purpose of keeping the margin of the paper clean.

CHASE. A row or rank of plants or trees, and more especially of hedge plants; also an extent of waste or forest land.

CHASE. In Nautical language, pursuit; also the vessel pursued.

CHA'SER. The vessel pursuing. Also guns at the head and stern for firing when in chase.

CHA'SING, or ENCHASING. In Sculpture, the art of embossing or making bassi rillevi in metals. The work is punched out from the back, and then cut on steel blocks or puncheons, and cleared with small chisels and gravers.

CHAT-POTA'TOES. Small potatoes, only fit for giving to pigs or boiling for poultry.

CHAT-WOOD. Small sticks and spray, only fit for fuel.

CHAU'NTRY. *See* CHAPEL.

CHAYA ROOT. The root of the *Oldenlandia umbellata*, cultivated upon the Coromandel coast as a red dye stuff.

CHEESE. The curd of milk compressed into solid masses of different sizes and shapes; and, when intended for keeping, salted and dried, and sometimes coloured and flavoured. It is almost always made from the milk of cows, but occasionally from that of ewes, and sometimes, though very rarely, from the milk of goats. The following are the principal British cheeses: — *Brickbat*, formed of new milk and cream, chiefly in Wiltshire, in the autumn, and sold in little square pieces about the size of brickbats. *Cheddar*, round thick cheeses, weighing about 150 or 200 pounds, with a spongy appearance, and the eyes or vesicles filled with a rich oil. *Cheshire*, large round thick cheeses, commonly weighing from 100 to 200 pounds each; solid, homogeneous, and dry and friable rather than viscid. They are made from the whole of the milk and cream; the morning's milk being mixed with that of the preceding evening previously warmed. *Derbyshire*, is a small white rich cheese. *Dunlop*, originally made in Ayrshire, but now general throughout Scotland, is large, round, white, buttery, and weighs from 30 to 60 pounds. This and the Derbyshire cheese are very much alike in form, colour, and flavour. *Gloucester*, large, round, and mild; buttery rather than friable. There are two kinds, the single and double Gloucester; the single is made of the milk deprived of about half the cream, and the double of the milk with the whole of the cream. *Green* or *Sage* cheese may be made of any of the other kinds, by mixing the milk before it has curdled with a decoction of sage leaves, among which some put a few flowers of marigold and leaves of parsley. In the Highlands of Scotland the leaves or seeds of lovage are added to the sage, which communicate a very strong flavour. *Lincolnshire* is made of new milk and cream; it is quite soft, not above 2 inches thick, and will not keep more than two or three months. *Norfolk*, the weight is generally from 30 to 50 pounds; the curd is dyed yellow with arnotto or saffron; and though not a rich cheese, it is considered a good keeper. *Soft* or *Slip-coat* is a small soft rich cheese, which might almost be mistaken for butter, if it were not white, and which must be eaten in a week or two after making. *Stilton*, so named from the town in Huntingdonshire where it was first brought into notice, but which is made principally in Leicestershire. It is solid, rich, buttery, and white; and, unlike all the other cheeses which have been mentioned, it is twice as high as it is broad. It is much improved by keeping, and is seldom used before it is two years old. It is the dearest of all English cheeses, the price being generally to that of Chester as 2 to 1, or 2 to 1¼. In order to induce premature decay and the consequent appearance of age in these cheeses, it is said the makers sometimes bury them in masses of fermenting straw. *Cottenham*, so named from a town in Cambridgeshire; it differs chiefly from the cream cheese of Stilton in being flat, broader, and superiorly flavoured. The flavour is said to be owing to the rich grasses which grow on the fens. *Suffolk*, or *skim-milk*, is round and thin, weighing from 25 to 30 pounds each, and is the best keeping cheese made in England. *Wiltshire* resembles the Cheshire; but is poorer, and of inferior flavour. It is apt to become scurfy, to prevent which it is generally coated over with red paint. *Yorkshire*, or *cream cheese*, is the same as the slip-coat cheese, already mentioned.

Foreign Cheeses. — The most remarkable of these are the following: — *Parmesan* is chiefly made at Parma and other places in Lombardy, of the curd of skimmed milk hardened by heat. Its flavour is said to be owing to the rich pastures of that part of Italy, where all plants, from the greater quantity of bright sunshine than in Britain, have doubtless their aromatic properties greatly increased. *Swiss cheese* is of various kinds; but the chief sorts are the Gruyere or Jura cheese, and Schabzieger or green cheese; the last is flavoured with the seeds and leaves of the melilot (*Melilotus officinalis*). *German cheeses* are of different kinds; but none are celebrated, unless we except that of Westphalia, which is made up into round balls or short cylinders, under a pound weight each. The peculiar flavour which this cheese acquires arises from the curd being allowed to become putrid before it is compressed. In Holland very good cheese is made, particularly the Edam and Gouda cheeses; the former is very salt, and keeps well at sea. In many parts of the Continent, and even in the interior of Poland and Russia, there are imitations of English cheese made; but what may be called the indigenous cheese of the Russian empire is nothing more than salted curd put into a bag and powerfully pressed, and taken to market as soon as it is made, in the same manner as butter is. In some places, instead of a press, the whey is forced out of the curd by putting it into a long cloth midway between the two ends, while a person at each end twists the cloth in an opposite direction, and thus wrings out the whey. In some miserable Russian villages the curd is exposed for sale in small lumps, retaining the marks of the fingers, which shows that no other pressure has been employed than what can be given with the hand.

In France the Roquefort cheese is the most esteemed, and next that of Neufchatel. The former somewhat resembles Stilton, but is much inferior; and the latter is a cream cheese, seldom exceeding a quarter of a pound in weight.

CHEESE-MITE. *See* PIOPHILA.

CHEE'TAH, or CHEETA. A Mahratta vernacular name, applied both to the *Felis jubata* and the *Felis leopardus*. It is to the former species, or hunting leopard, that the term is confined in this country.

CHEI'RONE'CTES. (Gr. χειρ, *hand*, and νηχω, *I swim*.) A genus of spine-finned fishes, having the pectoral fins supported, like short feet, upon peduncles. By means of this organization the cheironects can creep over the mud or sand when left dry by the receding tide; they also propel themselves along by short leaps, and in this way seize upon insects which may be hovering about; whence they have obtained the name of frog-fishes. The gill cavity is large, but the outlet very small, and the quantity of water which can thus be retained enables the cheironects to remain out of water longer than fishes in general can do. The term *Cheironectes* is applied by Illiger to a genus of opossum having the hinder hands webbed. Some naturalists adopt this application of the term, and apply to the genus of fishes so called by Cuvier the name *Antennarius*, originally given to the cheironects by Commerson.

CHEIRO'PTERA. (Gr. χειρ, *a hand*, and πτερον, *a wing*.) An order of Mammalia, characterized by having the anterior extremities, and especially the hands, so modified as to serve the office of wings, the fingers being extremely lengthened, and connected together by a thin membrane. Of this order the common bat (*Vespertilio murinus*) may be regarded as the type. The order includes very numerous and diversified species, which have been grouped by De Blainville, who has devoted an especial study to them, into three principal divisions. Of these the *first* includes the largest species, called "flying-foxes:" they are, however, vegetable-feeders, and are characterized by having the ears and nose of a simple form; the two innermost fingers of the hand armed with claws, and of the ordinary structure; the tail, and the web of skin connecting the hind-legs, and called the "interfemoral" web, very short, or wanting; and lastly, by having the molar teeth separated by intervals, and of simple structure. These bats are distributed over the warmer latitudes of the old continent, and extend to the islands of the Pacific ocean. The *second* division has the nose complicated by variously shaped and grotesque membranous foliations; the first or innermost digit alone retains its ordinary structure and armature; the molar teeth are beset with sharp tubercles; and the food of these species consists of insects, or the blood of higher organized and larger animals. The vampire-bats of South America belong to this group, which also includes the horse-shoe bats (*Rhinolophi*), and other genera distributed over all parts of the old world. The *third* division of *Cheiroptera* has the nose constantly simple; the other characters as in the second. It includes the bats properly so called, which are uniformly insectivorous, and of small size.

CHE'LA. (Gr. χηλη, *pincers*.) The first pair of forcipated extremities of the crab, lobster, and other crustaceans.

CHE'LICERES. (Gr. χηλη, *pincers*, and κερας, *a horn*.) The term applied by Latreille to two appendages of the head of the Arachnidans, or spiders and scorpions, which appendages he considers as representing the mesial antennæ of the *Decapod Crustacea*, here converted into manducatory organs.

CHELO'NIANS, *Chelonia*. (Gr. χελωνη, *a tortoise*.) The order of Reptiles, including the tortoises, terrapenes,

and turtles; characterized by the body being inclosed between a double shield or shell, out of which extend the head, tail, and four extremities. The land tortoises have the power of retracting all these parts within the shell.

CHEMISTRY. (The word is probably derived from the Coptic root *chems* or *hhems*, signifying *obscure* or *secret*. The German word *geheim* is apparently of the same origin.)

Chemistry is a department of science, the objects of which are to investigate the nature and properties of the elements of matter, and their mutual actions and combinations; to ascertain the proportions in which they unite, and the modes of separating them when united; and to inquire into the laws and powers which preside over and affect these agencies. As an *art*, chemistry may be traced to a very remote period; but it can scarcely be said to have existed as a *science* previous to the commencement of the seventeenth century: and in tracing its early history we shall find the principal materials upon which it is founded in the works of Bacon, Boyle, Hooke, Mayow, and Newton.

As *induction from experiment* is the exclusive basis of chemical science, little progress could be made in it till the futility of the ancient philosophical systems had been exposed, and their influence annihilated, and till the necessity of that form of severe experimental inquiry had been established which "first procures the light, and then shows the way by its means." Upon such foundations, laid by Bacon, the other philosophers whose names have been mentioned proceeded to bring together and arrange the materials which had been furnished by their predecessors, and were thence led into that train of true philosophical reasoning and research which served as an emulatory example to their immediate successors, and which has led in our times to the gigantic results of modern discovery.

It is well known that the alchemists had accumulated a number of valuable but isolated chemical facts, and that they had explored with considerable diligence the abstract properties and mutual agencies and relations of the greater number of natural products; but, with few exceptions, they neglected their useful and obvious applications, and wasted their labours upon unattainable and chimerical projects. Their discoveries and inventions, as Lord Bacon justly and forcibly observes, "are well represented in the fable of the old man who left an estate to his children, buried, as he said, in his vineyard, which therefore they fell to dig and search for with great diligence; whereby, though they found no gold in substance, yet they received an abundant vintage for their labour. So assuredly has the search and stir to make gold produced a great number of fruitful experiments."

Alchemical speculations, including the attempts at the conversion of mercury into gold, and the search after antidotes and universal remedies, were vigorously carried on during the sixteenth and seventeenth centuries; and many amusing accounts of the professors and adepts of those periods have been handed down to us by the chemical historians of the time. Those who are curious upon these subjects may consult Mangetus, *Bibliotheca Chemica*, and the *Theatrum Chemicum* of Elias Ashmole: the latter contains "several poeticall pieces of our famous English philosophers, who have written the hermetique mysteries in their owne ancient language," but their perusal is labour lost; not so, however, with Basil Valentine, Paracelsus, Van Helmont, and Glauber, in whose writings we not only find the materials so happily worked upon by Hooke and Mayow, but which also abound in announcements of important practical discoveries, and in hints to which many of the improvements of modern times may be plausibly traced.

Basil Valentine of Erfurt was born about the year 1400; his writings, although tinctured with the follies of alchemy, are full of shrewd and intelligent remarks: he was the discoverer, apparently, of nitric and of sulphuric acid, and of many antimonial preparations, which are fully described in his *Triumphal Chariot*. Philip Hochener, more commonly known under the name of Paracelsus, and who died in 1541 at Saltzburgh, in the forty-third year of his age, is chiefly celebrated for the boldness and assiduity with which he introduced chemical preparations into the practice of medicine; he did little, however, as a discoverer. Van Helmont, one of the soundest writers of his period, was the first who seems to have paid attention to the nature of gaseous bodies, and to the distinction between permanent gases and vapours: the word *gas* first occurs in his works; and under the term *gas silvestre*, he seems to allude to what was afterwards termed *fixed air*. None, however, of these early practical chemists come into competition with Glauber. He was an active experimentalist, and an acute reasoner; and in reference to his discoveries we may enumerate among them the distillation of muriatic acid from a mixture of sulphuric acid and common salt; the purification of the residuary sulphate of soda, which he termed *sal mirabile*, and which still bears his name; the production of ammonia by the distillation of bone, and its conversion into *sal ammoniac* by the addition of *spirit of salt;* the preparation of sulphate of ammonia, which he terms *secret sal ammoniac;* the formation of blue vitriol by the action of sulphuric acid upon the green rust of copper; the composition of numerous earthy, alkaline, and metallic salts; and lastly, the evolution of vinegar during the destructive distillation of wood, for which he describes and delineates the distillatory apparatus, under the name of "a press for extracting the juice of wood," and the uses of which, together with those of the oil of tar and other products, he describes at length, closing his discourse with a statement of his apprehension that he shall be by many disbelieved; but "it contented me," he says, "that I have written the truth, and lighted a candle to my neighbours." Glauber also published a pamphlet, entitled "*The Consolation of Navigators; in which is taught how they who travel by sea may preserve themselves from hunger and thirst, and also from those diseases which are wont to happen in long voyages: written for the health, comfort, and solace of all those who travel by water for the good of their country.*" The sensible plan of employing extract of malt as a portable vegetable diet, and diluted muriatic acid to quench thirst, is here recommended; and many of the medicinal uses of that acid are dwelt upon, among which are some that have been claimed as recent discoveries. On the whole, there is no author, contemporary with Glauber, who has written so much to the purpose, and who, as it were, anticipated so many of our modern scientific improvements.

Reverting to the names of Boyle and his eminent associates, we are reminded of the origin of the *Royal Society of London for the Improvement of Natural Knowledge*, which was incorporated by Charles II. in the year 1662, and of which Boyle and Hooke were active and distinguished members. Boyle died in 1691. His station in life, his mild and prepossessing disposition, his strict honour and integrity, and the unaffected earnestness with which he promoted experimental inquiry, tended to shed a lustre on his pursuits, to elevate their character with the world, and to draw into their precincts many who without such an example would have passed their lives in that listless inactivity then too common with those upon whom fortune smiled: among these Mr. Boyle made many converts.

Boyle's Essays on the successfulness and unsuccessfulness of Experiments, and the Preface to his Philosophical Writings, are in the genuine spirit of experimental research; but the new and important aspect assumed about this time by such pursuits is perhaps chiefly due to Dr. Robert Hooke (born in the Isle of Wight in 1635, and died in London in 1702). Among his views and discoveries which bear upon the progress of chemical philosophy, the most important are those relating to the phenomena of combustion, and to the part which the air performs in that process; his notions upon these subjects are remarkable for their boldness as differing from the prevailing theories of the day, and for their correctness as superseding the objections to which those theories were liable. From the hints contained in the writings of the alchemists, it appears that the phenomena of combustion were referred to a subtile and highly volatile principle, which, agitated and expanded by heat, produced *flame* and *fire*. When metals were exposed to the action of heat the greater number of them were observed to alter their appearance, and, losing their brilliancy, became converted into an earth-like powder or *calx*. It was generally admitted that in this process the particles of the combustible were thrown into violent vibrations, and in that way transformed into heat and light. But it had been also remarked that in certain cases of combustion, and especially as regards the metals, the phenomenon was attended by an actual increase of weight in the burning body, and that this result was incompatible with the theory which assumed the conversion of the combustible into heat and light, or the evolution of that principle of inflammability which by Becher and Stahl and the chemists of that school was termed *phlogiston*. About the year 1630 a remarkable tract appeared in France relating to this subject, by Jean Rey, a physician of Perigord. Le Brun had melted two pounds six ounces of lead, and found that in six hours the whole had been converted into calx; but that instead of having lost *phlogiston*, or any other ponderable matter, it had actually increased in weight to the extent of many ounces. Puzzled by this result, he consulted Rey as to its cause, who immediately undertook an experimental inquiry, which led him to refer the increase in weight in this and similar cases to the *fixation of air*. This inference was amply supported by the researches of Boyle and of Hooke: the former found that no combustible would burn under the exhausted receiver of the *air-pump*, and consequently that the presence of air was requisite; and Hooke, finding that however intensely charcoal was heated, it would not *burn* when air was excluded, infers "that air is the universal dissolvent of inflammable bodies, and that this dissolution generates heat, which we call *fire*." But he went a step beyond this, and

attributes the power of supporting combustion to a principle in the atmosphere, "like unto, or the very same as, that which is fixed in saltpetre;" for he had observed the power of that salt as a supporter of combustion. His words are as follow:—"The dissolving parts of the air are but few, and hence the atmosphere is like those spirits which have much phlegm mixed with them, and become soon glutted; whereas saltpetre abounds more in those solvent particles, and hence a little will dissolve a great sulphurous body quickly and violently; and as other solvents, though but weak, quickly consume the dissoluble body if the supply be renovated, so air applied to a shining body by a bellows will dissolve it as rapidly as saltpetre." From all which he concludes that there is no element of fire, but that flame results from the mutual chemical action of the combustible upon a part of the atmosphere. (*Hooke's Micrographia.*) Hooke also alludes to the part performed by *air* in the process of respiration; and in his *Lampas*, published in 1677, has given a beautiful explanation of the burning of a candle. He attributes the light and heat to the action of the air upon the combustible matter of the flame, and shows that the interior of the flame is not luminous, by the simple expedient of viewing its section through a thin piece of glass or of mica.

These doctrines of Hooke were further illustrated by John Mayow (born in Cornwall 1645, died in London 1679), who not only experimentally corroborated them, but pointed out the connection between combustion and respiration, and showed that that part of the air concerned in the support of flame was also essential to the life of animals. He placed a candle under a bell-glass, and when it would no longer burn, he found that on rekindling it it was immediately extinguished by the same air; he then placed a mouse in a confined portion of air, and it soon manifested the want of its renewal; he then put the mouse under the same bell-glass with the candle, and found that it only lived half the time that it had survived without the candle; he then reversed the experiment, and endeavoured to burn a candle in air which had been breathed, and finding that it went out, he concluded that the "nitro-aerial particles" of the air were as essential to respiration as to combustion, and that they were in both cases *absorbed;* and he even refers *animal heat* to the influence of the air upon the blood.

But Mayow's claim to a distinguished place in the history of chemistry is not merely founded upon the sagacity with which he followed up these views; he was the first who distinctly expounded the nature of *chemical affinity*, and who taught its independence of those mechanical forms of the particles of matter to which it had been referred, and showed, contrary to the prevailing tenets, that in cases of combination the particles of the acting bodies were not annihilated, but that they still existed in the compound, and might again be elicited from it with all their former powers and properties. These notions he illustrates by a series of extremely apposite experiments; and proceeds to explain *decomposition* upon the principle of inequality in the respective attractive forces of the acting bodies, a doctrine which was afterwards verified and further explained by Newton, whose masterly sketch of a theory of chemical attraction, given in the queries to the third book of Optics, is nearly in the language and entirely in the spirit of his predecessor. The theory of combustion and of affinity, thus established upon the basis of experiment by Hooke and Mayow, constitute the foundation upon which most of the superstructure of modern chemistry rests; the former was extended and embellished by Lavoisier, and the latter has gradually risen into the atomic and equivalent doctrine. There are three principal points connected with the vast extension and importance of chemical science as we now find it, to which it becomes necessary therefore to allude; namely, the investigations relating to the philosophy of *heat*, those connected with *pneumatic chemistry*, and those establishing the connection of *electrical* with *chemical* phenomena.

It was not till towards the middle of the seventeenth century that such perfection was given to the construction of the *thermometer* as to enable it to be used as an accurate and comparative measure of temperature. Dr. Halley seems to have been the first who applied the uniform temperature of boiling water to obtain one fixed point for its graduation; the constant temperature of water in the act of freezing seems also to have been noticed about the same time by the Florentine academicians, and by Newton; and these two points being thus determined and ascertained, together with the causes of their occasional discrepancies, the graduation of the thermometer became easy, especially when the advantages of mercury had been pointed out by Halley, together with the mode of sealing it in the thermometer tube. (*See* THERMOMETER.) But the great and important step in the philosophy of heat was the consequence of Dr. Black's discovery of the state in which heat exists in liquids and vapours, and upon which he founded his beautiful theory of *latent heat*. This theory gave a satisfactory solution of a multitude of natural and artificial phenomena previously unexplained or unobserved, and laid the foundation of those wonderful improvements in the theoretical and practical construction of the steam engine which were soon afterwards carried into effect by Watt.

Dr. Black was born in 1728 on the banks of the Garonne, and educated at Belfast, and afterwards at Glasgow: in 1766 he was appointed to the chemical chair in the university of Edinburgh, where he died in 1799. He not only made the grand discovery of the latency of heat, but he enriched chemistry with other discoveries; among which that of the presence of carbonic acid in the mild earths and alkalies, and the cause of their causticity, was especially perfect and important. These facts, including also the discovery of carbonic acid, or, as it was then called, *fixed air*, were first published in 1756; his ideas respecting the combinations of heat with ponderable matter were perfected in 1764.

Another and distinct series of inquiries, having important bearings upon the philosophy of heat, had its origin with the Florentine academicians towards the end of the seventeenth century, and was afterwards sagaciously followed up by Scheele, Leslie, and others; it relates to the *phenomena of radiation*, to the manner in which heat is propagated through space, and to those of its emanation from luminous and incandescent bodies, and to its connection with light.

Pneumatic Chemistry had its origin in the experiments of Hooke and Mayow, and was subsequently extended by Hales, and more especially by Priestley. Mayow obtained hydrogen gas by the action of iron on dilute sulphuric acid, and observed the formation of nitrous gas during the action of aquafortis upon the same metal; but it was not till the commencement of the last century that the distinctive characters of the gases and their importance as chemical agents began to be duly appreciated. Connected also with this subject is the rise and progress of the chemical physiology of vegetation. Dr. Stephen Hales was born in Kent in 1677, and died at Teddington in 1761. He began the communication of his researches to the Royal Society in 1717, and in 1727 published his "*Statical Essays, containing an essay towards a natural history of vegetation, of use to those who are curious in the culture and improvement of gardening; also a specimen of an attempt to analyse the air by a great variety of chemico-statical experiments, which were read at several meetings before the Royal Society.*" In 1733 a second volume of these Essays was published, containing "*Hæmastatics, and experiments on the stone of the kidney and bladder.*" In his various experimental researches detailed in these essays, Dr. Hales describes many curious facts, and shows much ingenuity in the contrivance of apparatus; but he furnishes a striking instance of the facility with which the mind is led away from the true path of discovery by preconceived opinions; for having predetermined that the various gaseous products which he obtained were mere modifications and contaminations of common air, he missed much that was fairly within his grasp. He observed, for instance, that air was absorbed during the combustion of phosphorus in close vessels, but he examined none of the products; he collected the air evolved during the destructive distillation of wood, and found it fatal to animals; from Newcastle coal he obtained one third of its weight of gas; and from nitre, 180 times its bulk; but he did not leisurely examine any of these products. He found that iron filings and oil of vitriol would not evolve gas unless water was present; but instead of stopping to examine the properties of the hydrogen gas which he thus obtained, he hastens on to irrelevant observations, being more eager to multiply experiments than to examine their results. In the same way he details with minute accuracy the quantity of air generated during the distillation of blood, tallow, sal ammoniac, and many other substances, without drawing a single useful inference. In his experiments on respiration too, he obtained results of extreme interest, and is often upon the verge of most important discoveries; but instead of being incited by the novelty of his results, and the extent of the field of investigation opened by his researches, he drops them upon the occurrence of the slightest difficulty. His examination, however, of the motion of the sap in vegetables was pursued upon a more regular and satisfactory plan; he ascertained the quantity of matter imbibed and perspired by several plants and trees; the proportion daily lost by the leaves, and their influence upon the absorptive powers of the root; and the relation of various states of the atmosphere as to temperature and moisture upon these functions. He endeavoured to confer different flavours upon fruits by impregnating the soil with perfumed waters, and he found that the odorous particles were rejected by the living vessels, but that they affected the dead parts of the tree; he compares the functions of the leaves of evergreens with those of deciduous shrubs and trees; he notices the effect of cutting a ring of bark off the branch of a tree in promoting the growth of its leaves and fruit; and, lastly, shows that air is some-

times absorbed or inspired by plants, and gives some interesting views relative to the germination of seeds.

When it is recollected that Hales wrote at the commencement of the last century, that few models of good scientific composition were then extant, and that a pompous and obscure style was prevalent among most of his contemporaries, we must admire the perspicuous and unadorned manner in which he details his facts and observations. He has in this respect all the merit which belongs to Boyle without his diffusiveness; and a pleasing vein of sound and unaffected morality accompanies his arguments, and leads him, whilst endeavouring to unveil the mysteries of nature, to direct our attention with becoming modesty to the extreme penury of man's wisdom, when compared with the admirable adjustments of causes and effects discoverable in the lowliest works of the Creator.

But although Mayow, Hooke, and Hales had done much towards establishing the interest and importance of gaseous chemistry, it is to Dr. Joseph Priestley (born at Fieldhead, near Leeds, 1733; died in Pennsylvania, 1804) that we owe the principal progress in this branch of our science. He directed his attention to it with a degree of activity and skill then peculiarly his own, and in the number of his discoveries left his contemporaries far behind, while he certainly rivalled them in their interest and importance, which is the more surprising when we reflect that he generally seems to have considered his philosophical studies as subordinate to his more severe and serious occupations. He first turned his attention to chemistry about the year 1768. He used to amuse himself with experiments on fixed air and on artificial mineral waters; and one experiment, as he says, leading to another, he soon collected those materials which he laid before the Royal Society in 1772, under the title of *Observations on different Kinds of Air*. It was on the 1st of August, 1774, that he made the great discovery upon which so much of the subsequent progress of chemical science has depended, namely, that of *oxygen gas*. He obtained it by exposing a quantity of *red precipitate of mercury* to the action of the sun's rays concentrated upon it by a lens; the red precipitate was contained in a flask filled up with mercury, and inverted in a basin containing the same metal. "I presently found," he says, "that by means of this lens air was expelled from it very readily. Having got several times as much as the bulk of my materials, I admitted water to it, and found that it was not imbibed by it; but what surprised me more than I can well express was, that a candle burned in this air with a remarkably vigorous flame, very much like that enlarged flame with which a candle burns in nitrous air exposed to iron or liver of sulphur; but, as I got nothing like this remarkable appearance from any kind of air besides this particular modification of nitrous air, and I knew no nitrous acid was used in the preparation of the *mercurius calcinatus*, I was utterly at a loss how to account for it." He then goes on to show that *red lead* and *nitre* also afford oxygen at a red heat, and calls it, consistently with the theory of combustion which was then prevalent, *dephlogisticated air*, regarding it as common air deprived of phlogiston, and consequently possessed of a powerful affinity for that imaginary principle.

Shortly after the discovery of oxygen, Priestley ascertained that plants had the power of purifying air which had been vitiated by the respiration of animals, and that oxygen was evolved by aquatic plants in water containing carbonic acid. Nitrous and nitric oxide, muriatic acid, and ammonia were also amongst his gaseous discoveries. In 1772 Dr. Rutherford had demonstrated that a large portion of the atmosphere consisted of a peculiar gas differing from fixed air, yet, like it, extinguishing flame and unfit for respiration; to this component part of the atmosphere Dr. Priestley gave the name of *phlogisticated air*, and pointed out the means of ascertaining its relative proportion to the oxygen of the air by the agency of nitrous gas.

Another celebrated name connected with the progress of this department of chemical science is that of Cavendish. In 1776 he presented the Royal Society with a dissertation on inflammable, fixed, and nitrous air. The two latter gases had been well described by his contemporaries; but nothing very precise was known respecting inflammable air, till its sources and properties were described in Cavendish's masterly paper. He found that it was the lightest known substance, and in conjunction with Watt he showed that by combustion with oxygen *water* was the only result; hence the term *hydrogen* subsequently applied to this gas. Cavendish also discovered the composition of nitric acid; and by passing a succession of electric sparks through common air, and through artificial mixtures of oxygen and nitrogen, he succeeded in effecting their combination, and in producing that acid.

Two capital and extremely important steps were thus made in chemical science, chiefly by the joint labours of Priestley and of Cavendish; namely, the composition of the atmosphere and of water; and about the same time Scheele (born at Stralsund in 1742, and died at Köping near Stockholm in 1786), in his dissertation on Manganese, made known the existence of chlorine, or, as he then termed it, of dephlogisticated muriatic acid gas. His "Observations and Experiments on Air and Fire," and on "Heat and Light," are also masterly productions, and contributed, in conjunction with the labours of his eminent contemporaries, to invest chemistry with a degree of interest and importance which gave it an entirely new and distinct aspect, and an elevated rank in physical science.

It was at this period that Lavoisier and his associates in Paris undertook that celebrated reform of chemical nomenclature which ended in the banishment of phlogiston, and introduced a logical precision before unknown into the precincts of chemistry. Lavoisier experimented upon a magnificent scale, and with a degree of statical accuracy which stamped his researches with a new and valuable character. By a series of beautiful experiments he determined the relative proportions of the elements of the atmosphere and of those of water; he rejected all supporters of combustion except oxygen, and regarded it as the sole source of the heat and light evolved during that process; he endeavoured to prove that gases were constituted by the union of ponderable bases with *caloric*, or the *matter of heat*, and examined, upon a splendid scale and with princely apparatus, the results of the combustion of sulphur, phosphorus, carbon, and the metals; he inferred that oxygen was the universal *acidifying* principle; and by a series of well conceived researches he demonstrated the identity of charcoal and the diamond, and showed that when burned in oxygen they yielded carbonic acid gas. Lavoisier was also the first who examined with requisite accuracy the products of the distillation of animal and vegetable substances; he also inquired with more success than any of his predecessors into the phenomena of fermentation, and, by examining the contents of certain vegetable juices, previous to and after that process, he drew some curious and important conclusions respecting the changes that take place: he also extended and corroborated Scheele's views as to the importance of the chemical agencies of light.

These, and a variety of other details, are embodied in Lavoisier's *Elemens de Chimie*, which appeared at Paris in 1789; a work which eminently displays the extent and perspicuity of his views as a theoretical and experimental philosopher, and which contains a masterly refutation of the phlogistic doctrines. The abstract facts, however, upon which this refutation rests may be traced to Mayow, Hooke, Priestley, and Scheele. It has been stated that the prominent features of the French theory were its explanation of the phenomena of combustion and of acidification, the presence of oxygen being deemed essential in both cases. That air is the food of fire was known at a very remote period; that it causes the increase of weight sustained by metals during their calcination was shown by Rey early in the seventeenth century; that a part only of the atmosphere, identical with a matter contained in saltpetre, is concerned in the support of flame, was explained by Hooke in 1667; and that the vital, or igneous spirit, as he terms it, contributes to the formation of acids was asserted by Mayow in 1674. Here, therefore, without even infringing upon the eighteenth century, we have, in explicit detail, the principal facts and arguments requisite for the construction of the French theory; and if to these we add the discovery of oxygen by Priestley, and of the composition of water and of nitric acid by Watt and Cavendish, what then becomes of its title to originality?

The influence of the researches connected with the philosophy of heat, and of those relating to the production, properties, and constitution of the gases, upon the improvement and extension of chemistry, will now be apparent; but one of the most fertile sources of its recent progress is of a distinct and remarkable origin, namely, the discovery of *the chemical influences of electricity*.

In 1790 Galvani of Bologna ascertained that certain spasmodic or convulsive contractions might be produced by the action of electricity upon the nerves of a recently killed animal; and that if the sciatic nerve of a frog be laid bare and touched with a piece of zinc, whilst at the same time the muscle is touched with gold, similar effects to those of electricity are produced whenever the metals were brought into contact, or connected together by conductors of electricity; if nonconductors were used, no spasm ensued. He accounted for these and similar effects by assuming that the nerves and muscles were in opposite electrical states, and that the spasms were the consequence of their annihilation or discharge.

Volta, on the other hand, finding that two different metals were essential, referred the phenomena to the electromotive power of the metals; and following up this idea, he soon succeeded in producing that extraordinary form of electro-generative apparatus which is now known under the name of the Voltaic pile or battery, consisting of al-

ternations of two metals with an intervening fluid: zinc, copper, and diluted acids are the substances now generally resorted to. It has lately been shown by Faraday that *chemical action* is the exclusive source of the electricity of these Voltaic arrangements; but their history and the theory of their phenomena will be given elsewhere.

In the year 1800 the *chemical powers* of the Voltaic pile were first observed in regard to the decomposition of water and certain saline solutions, by Messrs. Nicholson and Carlisle; these were more accurately investigated in 1803 by Hisinger and Berzelius; and in 1806 Sir H. Davy communicated his celebrated lecture "On some Chemical Agencies of Electricity" to the Royal Society. He had previously (1801) given a paper to the Society containing an account of some galvanic combinations formed by the arrangement of single metallic plates and fluids, analogous to the galvanic apparatus of Volta; but it was not till the publication of the Bakerian Lecture above alluded to that the importance of *electro-chemical science* could be appreciated. It contains a masterly outline of the subject; and its details present a fine specimen of experimental inquiry, especially in reference to the manner in which he traces out the decomposing powers of an electrical current in effecting the separation of the elements of water, the skill with which the conflicting results of other experimentalists are examined and explained, the caution with which he proceeds from experiment to theory, and the sagacity with which he employs theoretical views as the source of new experimental inquiries. Following the path which he had thus opened for himself, it led him on to the most important and extraordinary results, among which were the decomposition of the alkalis and earths, and the discovery of an entirely new class of metals.

But the eradication of established errors is perhaps a more difficult task than the promulgation of new theories; and in this Davy rendered a memorable service to chemistry by his several papers on "Oxymuriatic Acid," in which he successfully establishes the views of Scheele regarding its nature, and refutes and subverts those of the French school, and which had been sanctioned by the chemists of Europe: he demonstrates the existence of acids without oxygen, and lays the foundation of the theory of the *hydracids*.

To these masterly researches Davy added a third series, of equal if not superior importance; those relating to the *safety lamp*. His first paper upon this subject is printed in the *Philosophical Transactions* for 1815, and was followed by four others. Finding that flame would not recede through tubes of very small diameter, the idea occurred to him of constructing a lamp which should have no connection with the surrounding air except by capillary tubes; and he inferred from previous experiments that such a lamp might safely be employed in coal mines infested by fire-damp. He then endeavoured to ascertain the extent to which the tubes might be *shortened* without interfering with this principle of safety, and was thus led to cut them down, till their transverse section resembled a series of meshes. This approached so closely to *wire-gauze* that he was induced to try how far that tissue would prevent the passage of flame; and finding it effectual, he employed it in the construction of his lamp, and ultimately adopted the simple and efficient arrangement now in general and successful use. During the experimental investigations upon which the discovery of the safety lamp was founded, Davy ascertained a number of curious facts respecting the constitution and temperature of flame, which, with other parts of his general inquiry, are not less ingenious than original. In November, 1820, Sir H. Davy became president of the Royal Society, and continued to contribute papers as heretofore, some of them upon subjects of much interest, ably and philosophically discussed: among them the essays on the modes of protecting the copper sheathing of ships deserve especial notice; they have furnished hints for the preservation of iron and other corrodible metals from the influence of air and water, and promise to lead to results of great practical importance. In the course of the year 1827 his health became seriously impaired; he passed the greater part of the year 1828 in Italy, and terminated his memorable existence at Geneva in May, 1829, in the fifty-second year of his age.

We have now briefly sketched the principal circumstances in the history of chemistry bearing upon its origin and progress as a science, without, however, adverting to the labours of contemporaries; it remains to add a short notice respecting the art of *Analysis*, and the important consequences of which the prosecution of that branch of the science has been productive.

Analysis was first scientifically pursued by Bergman of Sweden. He was born in 1735, and died in 1781, in consequence, as is said, of too intense application to his studies. The use of *tests* for the discovery of certain substances held in aqueous and other solutions, is first particularly dwelt upon by Boyle. He used vegetable colours for the detection of acids and alkalis, and noticed the cloudiness produced by nitrate of silver in solution of common salt. In 1667 Du Clos undertook an examination of the mineral waters of France, and in 1686 Hierne published some clever experiments upon the same subject in Sweden. In 1726 Boulduc used spirit of wine to precipitate the salts insoluble in that menstruum; in 1755 Venel pointed out the existence of fixed air in the waters of Selters, Spa, and Pyrmont; Lane, in 1769, showed the method of imitating chalybeate springs; and in 1772 Priestley published directions for saturating water with fixed air. The above and other tests were particularly examined, their accuracy compared, and the best modes of applying them pointed out by Bergman: his dissertations on the waters of Upsal, on sea-water, and on the artificial preparation of medicated waters, each exhibit proofs of his skill as an analyst, and accuracy as an experimenter. He also turned his attention to the analysis of minerals; his essay, entitled *De Minerarum Docimasiâ Humidâ*, must be considered as the parent source of that branch of analytic chemistry so successfully followed up, though upon a limited scale, by Scheele, and in the improvement and extension of which Klaproth passed his long and laborious life. Klaproth was born at Wernigerode in Prussia in 1743, and died at Berlin in 1817. He published 207 essays in his "Contributions towards the Chemical Knowledge of Mineral Substances." Another eminent name among chemical analysts is that of Vauquelin, who died at an advanced age in Paris in 1829. He was originally a peasant boy in Normandy, and afterwards was employed in Fourcroy's laboratory, where he not only acquired great dexterity in the ordinary duties of his situation, but became an expert and original analyst. He afterwards rose to high eminence in his profession; and his numerous and important contributions and discoveries are lasting monuments of his skill and industry.

Among the improvers of analytical chemistry in this country Chenevix, Howard, and Tennant deserve particular mention; but to none is this part of the science more deeply indebted than to Dr. Wollaston. With him and Davy all that is practically useful in the theory of definite proportionals, or, as it is often called, the *Atomic Theory*, may be said to have originated; though the facts upon which it is founded were chiefly furnished by the German analysts, and by Higgins of Dublin.

We have in another place given some account of this important subject, and have endeavoured to explain the facts upon which it is founded, and the results to which it leads: its promulgation with us is mainly attributable to Wollaston's suggestions contained in his paper "On a Synoptic Scale of Chemical Equivalents," brought before the Royal Society in November, 1813. Many years previously he had established the important doctrine of multiple proportions in a paper "On Superacid and Subacid Salts." He now showed the practical applications of which the theory was susceptible; and, by connecting the scale of equivalents with Gunter's sliding rule, has put into the hands of the chemist an instrument infinite in its uses, and equally essential to the student, the adept, and the manufacturer.

There remains to be noticed a distinct branch of chemistry of extreme interest and importance, but beset with peculiar difficulties; namely, that relating to *organic substances*. Some progress was made in it by Scheele; but it has chiefly been enriched by the labours of modern and contemporary philosophers, and in their hands has assumed an entirely new aspect. The composition of organic bodies may be viewed in two ways; either as relates to their ultimate elements, or to their proximate groups. The former are remarkably few in number, and are almost exclusively confined to four; namely, carbon, hydrogen, oxygen, and nitrogen. These, by their varied and extraordinary union, give rise to innumerable secondary products or proximate principles. That the same elementary forms of matter should give rise to such infinitely varied products, merely in consequence of the varying proportions in which they are combined and the circumstances under which they have been presented to each other; that food and poisons, alkalis and acids, sweets and bitters, and, in short, the most opposite and dissimilar qualities, should arise out of such causes—is extremely remarkable; and although every day is adding to our information, and clearing difficulties from this department of chemistry, it is but in its infant state.

In looking at the present state of chemistry, it must be allowed that it exhibits a most promising aspect; the study of its abstract principles is calculated to keep the curiosity constantly on the alert, and awaken an intense and peculiar interest; and it is quite impossible to glance at its recent progress, and at the extraordinary discoveries which are daily rewarding the labours of its skilful cultivators, without anticipating most important consequences. Should its progress during the ensuing century only equal that of the past, it must lead to results deeply affecting the interests and welfare of mankind; but as it has hitherto acquired strength with its progress, its wonders may be expected to accumulate in a much higher ratio. We already seem to be on the brink of some great discovery connected with those powers and

properties of matter which we call *electrical*. Their association with, and convertibility as it were into, heat, light, and magnetism, and their identity with the cause of chemical affinity, have already been turned to great account; and it is only necessary to assume the possession of a more unlimited command that we at present enjoy over the production or evolution of this extraordinary agent, less dependent and scanty means of summoning it into existence or activity, and a more intimate acquaintance with its forms and qualities, to confer the highest interest upon our speculations. Its chemical powers would then be perpetually called into action as a substitute for the more sluggish or circuitous and difficult methods of ordinary decomposition. Its single application to the evolution of oxygen and hydrogen from water would alone work wonders; whilst the facility of its conveyance and transmission, its ubiquity, and its varied attributes in those different states which for want of more explicit knowledge of their cause have been termed *quantity* and *tension*, seem to point it out as of unlimited application to human uses. Through its instrumentality telegraphic communication has not only been accelerated, but rendered independent of weather, and equally facile by night as by day; and even in the present state of this invention there seems no reason against such conveyance of our thoughts, wants, and wishes, so as to transmit them over the globe with a rapidity as much beyond all previous experience, as the travelling on a rail-road exceeds that of a common carriage.

Connected, therefore, with the progress of the higher departments of chemical science, and indeed intimately interwoven with it, is the advancement of its application to all the arts of life. It is often supposed that the successful applications of chemistry to the arts have been rather the results of accident or chance than the consequence of those apparently abstract studies, and curious rather than useful discoveries, as they are called, in which the truly philosophical chemist is engaged, and in which his labours terminate; but experience justifies no such conclusion. There can be no doubt that Black's researches into those effects of heat which are connected with changes in the state and form of bodies, and especially with the constitution of vapour, led Watt into that train of reasoning by which his improvements in the steam engine were ultimately effected. Most of the wonders of modern chemistry must be referred to Galvani's experiments on a dead frog. They led Volta to the construction of the electric pile; and, in the hands of Davy and his successors, what important conquests have been attained, and what extraordinary consequences are daily flowing from a source so apparently unpromising and irrelevant! Independent of the new agents which have been placed in the hands of the experimentalist, and of the new and important theoretical considerations which arise out of them, the whole aspect and character of a great department of physical science has been wonderfully changed, extended, and improved; the cause of magnetism has been developed; and a power no less extraordinary and applicable to human uses than light and heat, perhaps indeed the parent of both, is gradually showing us its mysterious relations. Of two great practical consequences have these inquiries already been productive; namely, the electrical telegraph, and the preservation of metals from corrosion. That others are upon the eve of their development cannot be doubted; and in proportion as our knowledge of this agent and consequent power over it is extended, those ends must certainly be attained which we have above ventured to anticipate.

From other departments of this science we are constantly acquiring similar benefits: the progress of gas illumination, the great improvements in metallurgic operations, in the arts of dyeing and calico-printing, in the manufacture of cements, in the preservation of timber from dry-rot, in gilding and silvering the metals, are only a few of the cases in point; even the difficult and apparently isolated researches into the relative proportions of the ultimate elements of the proximate organic products, and the application of the atomic theory to those researches, have not been fruitless, considered in reference to what are termed their practical results and popular and useful applications. The brewer and the distiller are reaping the benefits of such inquiries; the conversion of starch, and even of wood, into sugar, are the practical consequences of theoretical inferences; from the destructive distillation of ligneous matter we are already furnished with our chief supply of vinegar, and with a liquid which, as a combustible and a solvent, has to a great extent superseded the use of alcohol, and may possibly take its place at no very remote period as an intoxicating stimulant: the saw-dust of certain woods has been shown susceptible of conversion into nutriment; and the analysis of bone points it out, when properly prepared, as almost equal to its weight of flesh as an article of human food. In short, of the arts of life the greater number are dependent upon chemical principles; many of them, and perhaps the most important, are exclusively so; others, though apparently mechanical, involve chemical principles: hence the great and growing importance of chemical science as a branch of general education bearing upon political economy, and upon the prosperity of the arts and manufactures.

Having given this outline of the rise, progress, uses, and applications of chemical science, we must refer to other articles for more explicit information upon the different heads that have been alluded to. In reference to further details respecting the history of this department of knowledge, especially as relates to alchemy and to the history of chemical inventions, we may refer to Dr. Thomson's *History of Chemistry*, and to the prefatory chapter of Mr. Brande's *Manual*.

The extent necessarily occupied by chemistry in a map of human knowledge will be evident from the brief definition of the science given at the outset of this article; for it not only leads us to inquire into the composition of every product of nature and of art, but to examine the elements of all the forms of matter, and the laws which govern their mutual actions and reactions. The questions which a chemist propounds to himself, in examining any newly discovered substance, involve therefore a long train of inquiries, which can only be answered and worked out by multiplied *experiments*; for it is impossible to move onwards in this science except upon the basis of experimental research. Accordingly, when a body of unknown nature is presented to us, we endeavour, first to ascertain whether it be a *simple* or a *compound* substance. If simple, to what class of elementary bodies does it belong; is it combustible or incombustible; is it electro-negative or electro-positive; how is it affected by heat; what are its relations to other forms of matter; what its powers of combination; what are the proportions in which it unites with other substances; what are its characters and those of its combinations as a chemical and physiological agent; what are its uses in the arts and in medicine? If it be a compound substance, we inquire into the nature and number of its component parts: are they new, or are they known elements; in what proportions are they combined? We also, as before, examine its thermal and electrical relations, and its useful applications. These, and many other questions which arise in the course of chemical investigation, involve as it were several distinct branches of inquiry, and lead us to contemplate chemistry under two points of view; namely, as an independent science, which embraces the whole field of chemical knowledge, and investigates the chemical relations of bodies without reference to any extraneous considerations—this is *pure, theoretical*, or *philosophical chemistry*; and secondly, as a science having certain objects in common with others, as with mineralogy, medicine, physiology, and the arts — this being *applied chemistry*.

In a subject then so extensive and complicated as chemistry, *systematic arrangement* is of the utmost importance to the teacher and student. In the broad principles of arrangement most writers agree; but in minor details each generally pursues a path of his own. It would be useless, even if it were possible, to enumerate the details of these arrangements as adopted by the leading didactic writers on chemistry; but the basis upon which they are founded deserves a few words of explanation.

The objects of chemistry are all included under one or other of the following heads; namely, —

1. The general powers and properties of matter.
2. The chemistry of elementary substances.
3. The chemistry of compounds.

And each of these require several subdivisions. Thus, under the first head, we include *attraction* and *affinity, heat, light*, and *electricity*; under the second head are included the chemical history and properties of the ponderable *elementary substances*, and their mutual *reactions*, which of course leads on to the third head; namely, to the chemical history and properties of *compound bodies*. To render the systematic arrangements of the elements and their compounds intelligible, it will be necessary to enumerate the former, and point out such of their characters as are connected with their classification.

Every substance upon our globe contains one or more of the following *fifty-four* elementary or simple bodies: some of them are of extremely rare occurrence, others abundant and always with and about us. It will be observed that by far the greater number of them come under the denomination of *metals*; of the others, oxygen, hydrogen, carbon, and nitrogen, are by far of most frequent occurrence, as will be obvious when it is recollected that air and water and all vegetable and animal products include two or more of the last-mentioned substances.

The equivalent or combining proportions of these elements, although mentioned under individual substances in this work, are here subjoined (*see* the articles AFFINITY, ATOMIC THEORY, and EQUIVALENTS), and also the *symbols* by which they are represented.

Table of the Simple Substances, with their Symbols and Equivalent or Combining Weights.

	Equivalents, Hydrogen = 1.	Symbol. (Brande.)	Symbol. (Berzelius.)	Equivalents, Oxygen = 1.
1 Aluminum -	10	*al.*	Al.	1·25
2 Antimony -	65	*ant.*	Sb.	8·125
3 Arsenic - -	38	*ar.*	As.	4·75
4 Barium - -	69	*ba.*	Ba·	8·625
5 Bismuth - -	72	*bi.*	Bi.	9·
6 Boron - -	20	*bo.*	B.	2·5
7 Bromine - -	78	*b.*	Br.	9·75
8 Cadmium -	56	*cad.*	Cd.	7·
9 Calcium - -	20	*cal.*	Ca.	2·5
10 Carbon - -	6	*car.*	C.	0·75
11 Cerium - -	48	*ce.*	Ce.	6·
12 Chlorine -	36	*c.*	Cl.	4·5
13 Chromium -	28	*chr.*	Cr.	3·5
14 Cobalt - -	30	*cob.*	Co.	3·75
15 Columbium -	185	*col.*	Ta.	23·125
16 Copper - -	32	*cu.*	Cu.	4·
17 Fluorine - -	18	*f.*	F.	2·28
18 Glucium -	18	*gl.*	G.	2·25
19 Gold - -	200	*au.*	Au.	25·
20 Hydrogen -	1	*h.*	H.	0·125
21 Iodine - -	125	*i.*	I.	15·625
22 Iridium -	96	*ir.*	Ir.	12·
23 Iron - -	28	*fe.*	Fe.	3·5
24 Lead - -	104	*pl.*	Pb.	13·
25 Lithium	10	*li.*	L.	1·25
26 Magnesium	12	*mag.*	Mg.	1·5
27 Manganese	28	*man.*	Mn.	3·5
28 Mercury -	200	*hg.*	Hg.	25·
29 Molybdenum -	48	*mol.*	Mo.	6·
30 Nickel - -	28	*nic.*	Ni.	3·5
31 Nitrogen	14	*n.*	N.	1·75
32 Osmium	100	*os.*	Os.	12·5
33 Oxygen	8	o.	O.	1·
34 Palladium	54	*pal.*	Pd.	6·75
35 Phosphorus	16	*p.*	P.	2·
36 Platinum	96	*pla.*	Pl.	12·
37 Potassium -	40	*po.*	K.	5·
38 Rhodium	45	*rh.*	R.	5·625
39 Selenium	40	*se.*	Se.	5·
40 Silicium -	8	*si.*	Si.	1·
41 Silver -	110	*ag.*	Aq.	13·75
42 Sodium -	24	*so.*	Na.	3·
43 Strontium -	44	*str.*	Sr.	5·5
44 Sulphur -	16	*s.*	S.	2·
45 Tellurium -	32	*tel.*	Te.	4·
46 Thorium -	60	*th.*	Th.	7·5
47 Tin -	58	*sta.*	Sn.	7·25
48 Titanium -	24	*ti.*	Ti.	3·
49 Tungsten -	100	*tu.*	W.	12·5
50 Vanadium -	68	*va.*	V.	8·5
51 Uranium -	217	*ur.*	U.	27·12
52 Yttrium -	32	*yt.*	Y.	4·
53 Zinc -	32	*zn.*	Zn.	4·
54 Zirconium -	30	*zir.*	Zr.	3·75

The examination of the physical and chemical properties of the preceding elements of matter leads us to classify them according to their analogies. The greater number of them possess the characters of *metals*. Several resemble the metals in certain respects, but are in others widely different; these therefore have been termed *metalloids*. A few are distinguished by entering into peculiar and distinct saline combinations, of which common salt may be taken as the type; these therefore have been termed *halogens*. And lastly, three of the elements are only known in the gaseous form; they have neither been liquified nor solidified, but whenever they are isolated they present themselves as permanent gases; hence they have been designated *gazolytes*. This is the classification of the elementary bodies suggested by Berzelius, and it represents them as follows: —

I.	II.	III.	IV.
Gazolytes.	*Halogens.*	*Metalloids.*	*Metals.*
Oxygen.	Chlorine.	Sulphur.	
Hydrogen.	Iodine.	Phosphorus.	
Nitrogen.	Bromine.	Carbon.	
	Fluorine.	Boron.	

The metals, by far the most numerous of the elementary bodies, are themselves the subjects of various classifications, among which the following is perhaps the most convenient; they are arranged nearly in the order of their respective attractions for oxygen: —

I.	II.	III.
Potassium.	Manganese.	Copper.
Sodium.	Iron.	Lead.
Lithium.	Zinc.	Antimony.
Calcium.	Tin.	Bismuth.
Barium.	Cadmium.	Uranium.
Strontium.	Cobalt.	Titanium.
Magnesium.	Nickel.	Cerium.
		Tellurium.

IV.	V.	VI.
Arsenic.	Mercury.	Glucium.
Molybdenum.	Silver.	Zirconium.
Chromium.	Gold.	Yttrium.
Vanadium.	Platinum.	Thorium.
Tungsten.	Palladium.	Aluminum.
Columbium.	Rhodium.	Silicium.
	Osmium.	
	Iridium.	

The substances in the last division have been but imperfectly examined, and silicium should perhaps rather be regarded as a metalloid than a metal.

In one or other, then, of these classes each elementary body will find a place, but the arrangement only relates to the simple substances; the classification of their *combinations*, which are almost indefinite, is a much more intricate and difficult subject, and it would be impossible here to give even an outline of the different plans which have been pursued or suggested. As far, however, as the teacher of chemistry is concerned, none of the systematic arrangements of compounds can be conveniently adopted; his best plan, therefore, is to develope their history and properties as he proceeds. Having, for instance, discussed the abstract properties of *oxygen* and *hydrogen*, he proceeds to the *compound* which they form, and which is *water*; then he proceeds to the third element, *nitrogen*, and its *combinations* with those previously described; thus, nitrogen and oxygen form five distinct compounds, namely, *protoxide* and *binoxide* of nitrogen, and *hyponitrous*, *nitrous*, and *nitric* acids. Nitrogen also combines with hydrogen to form *ammonia*, and ammonia combines with nitric acid to form the salt called *nitrate of ammonia*. In a state of *mixture*, nitrogen and oxygen constitute the great bulk of the *atmosphere*.

From this brief notice of the mode of dealing with the three elementary bodies of the first class, the reader will readily understand the method of applying the same principle to the entire list; the student will thus be conducted, step by step, from the simplest to the most complicated chemical combinations. It is always convenient, however, in adopting this plan, to exclude the products of organization, and to consider them apart, under a separate head, entitled *organic chemistry*, which is of course subdivided into the *chemistry of vegetable* and of *animal products*.

If, having studied chemistry upon this plan, we look back upon the path which has been traversed, we shall immediately see that the *compounds* may be grouped into classes, related to each other by certain analogies both of properties and composition. Thus we have the class of *oxides*, or combinations of oxygen which are not acid; of *chlorides*, *iodides*, &c., and of *acids*; and these again subdivided into *oxyacids*, and *hydracids*; and lastly, the numerous class of *salts*, or compounds of the acids with salifiable bases.

When compound bodies are susceptible of electro-chemical decomposition (or *electrolytes*) the elements always tend to one or other pole; in other words, they are either separated at the point or surface at which the (presumed) electrical current enters, or at the surface at which it leaves the electrolyte; hence the arrangement of the elements into *electro-negative* bodies, or those which tend to the *anode*, and *electro-positive* bodies, or those which tend to the *cathode* (using the terms anode and cathode in reference to the ingress and egress of the electric influence); oxygen, the halogens, and sulphur are *anions*, or electro-negatives; hydrogen, and probably all the metals, are *cathions*, or electro-positives. A good arrangement of the elementary bodies is founded upon such properties; and although there are several whose electrical relations have not hitherto been accurately determined, the *electro-chemical arrangement* is that which will probably be most generally adopted.

CHE'NOPODIA'CEÆ. (Chenopodium, one of the genera.) A natural order of herbaceous Exogens, distinguished with difficulty from *Amarantaceæ* by their herbaceous calyx; from *Phytolaccaceæ* by their solitary carpel, and the stamens never exceeding the number of the segments of the calyx, to which they are opposite. They consist of weeds inhabiting most parts of the world, abounding least within the tropics; and they possess few sensible properties. *Chenopodium anthelminticum* produces the *wormseed oil* of the shops; but in consequence of their insipidity the species are often used for food, as in the case of spinach, &c. Chevalier has remarked the curious fact of *Chenopodium vulvaria* exhaling pure ammonia during its whole existence.

CHE'QUY, CHE'CKY, or CHE'QUERED. In Heraldry, a term used when a field or charge is divided by transverse lines, paleways and fessways, into equal parts or squares of different tinctures.

CHERT. A silicious mineral approaching the characters of flint.

CHE'RUBIM. *See* Seraphim.

CHEVA'L DE FRISE. A large and strong piece of timber, traversed with wooden spikes, pointed with iron. It is laid in a breach to impede the advance of cavalry.

CHEVALIE'R (Fr. cheval, *a horse*), is used synonymously with the Eng. knight, Lat. eques, and Germ. ritter.

CHEVRE'TTE. In Artillery, an engine used for raising guns or mortars into their carriages.

CHE'VRON. In Heraldry, one of the nine honourable ordinaries. It may be defined as consisting of the lower half of a saltire (*see* Saltire), brought to a point on the upper side; and the object from which its name is derived accurately resembles it in shape: chevron, in

old French, meaning the support of a roof formed by two rafters leaning against one another. A chevron standing on one side of the escutcheon is said to be tourny, dexter, or sinister.

CHE'VRONEL. In Heraldry, an ordinary of the same shape with the chevron, but containing only half its dimensions.

CHI'AN TURPENTINE. A species of turpentine brought originally from the island of Chios: it is the produce of the *Pistacia terebinthus*.

CHIA'RO SCURO. (It. *clear obscure*.) In Painting, the art of so disposing the lights, both positive and reflected, and the shadows of a picture in such a manner, that the objects may stand out and be naturally relieved from one another. Its name, however, seems more naturally to point to those parts of represented objects which, though in shadow, have the intensity of such shadow lessened by the reflection of a light body against them. It is a branch of the doctrine of Sciography.

CHI'CA. A red colouring matter used by some tribes of American Indians to stain the skin: it is extracted from a species of *Bignonia*.

CHI'CKEN POX. (*Varicella* of medical writers.) An eruptive disease, which, though frequently very mild in its attack, is often also violent and attended by much fever. The eruption consists of smooth vesicles of various sizes, which afterwards become whitish and straw-coloured; about the fourth day they break and scab off, seldom leaving marks, or at least not more than a few, upon the most delicate parts of the face, or where they happen to have been large or accidentally scratched or irritated. In very warm weather the fluid in the vesicles becomes yellow, and apparently purulent, so as closely to resemble small-pox in appearance; and under some circumstances the eruptive fever has not only been considerable, but preceded by delirium. The distinctive or diagnostic characters by which we distinguish chicken-pox from small-pox are,—1st, the comparative mildness of the preliminary fever, which indeed is often unobserved in strong and merry children, and nothing known of the complaint till spots are observed about the face and breast: 2d, the rapidity with which the eruption attains maturity and proceeds through its stages, the scabs forming crusts about the fourth or fifth day, which does not happen in the small-pox till the tenth or eleventh: 3d, the fluid in the vesicles is usually transparent, or only milky, whereas in small-pox it has a purulent appearance from the commencement. Like the small-pox, it very rarely attacks the same individual more than once. In the treatment of this disease little else is in most cases requisite than to keep the patient cool, to abstain from meat, to give diluents and mild aperients, and occasionally, at the commencement, a dose of calomel and rhubarb. In bad cases, the whole body is covered with eruption, in mild ones there shall only be a very few vesicles; and it not uncommonly happens that where several children have it in succession, one or two will escape with little else than slight restlessness and very trivial febrile symptoms. It is, however, by no means so trifling a disease as many writers have represented it, and if not closely watched over, may be mistaken for small-pox.

CHIEF. (Fr. chef, *head*.) In Heraldry, the upper part of the escutcheon, divided into three points, dexter, middle, and sinister. A chief, as an ordinary, is a fess removed to the upper part of the escutcheon. Charges, in the situation of the chief, are described as "in chief."

CHI'LBLAIN. An inflammatory swelling, of a purplish colour, produced by exposure of the extremities to cold: it is generally attended with itching, and often with shooting pains. Children, especially those of a scrofulous habit, and old persons, suffer most from chilblains; but they are not unfrequently produced at all times by holding the hands or feet to the fire after they have been exposed to great cold; in which case, the difference of temperature is such as actually to burn the part, for few persons are aware of the high temperature excited by the radiant heat of a common fire upon substances held near it. Warm socks and gloves are the best preventives against this affection, and the itching and pain are generally relieved by moderately stimulating applications; such as equal parts of solution of acetate of ammonia or of vinegar and spirit of wine, or of oil of turpentine and soap liniment. If the part should break or ulcerate, stimulating dressings, such as the resin or elemi ointment, are most serviceable, or in some cases mild escharotics.

CHI'LIAD. (Gr. χιλιας, *a thousand*.) An assemblage of things grouped or ranged by thousands. The word is chiefly used by the early computers of logarithmic tables, who expressed the extent of the table by saying it contained the logarithms of so many *chiliads* of absolute numbers.

CHI'LIASTS. In Ecclesiastical History, believers in the second advent of Christ to reign a thousand years on earth. *See* MILLENNIUM.

CHILOGNA'THES, *Chilognatha*. (Gr. χειλος, *a lip*, and γναθος, *a jaw*.) An order of the class *Myriapoda* or *Centipedes*, in which the two mandibles and the tongue are united together to form a large lower lip.

CHILO'MA. In Zoology, the upper lip or muzzle of a quadruped is so called when it is tumid, and continued uninterruptedly from the nostril, as in the camel.

CHI'LOPODS, *Chilopoda*. (Gr. χειλος, *a lip*, and πους, *a foot*.) An order of the class *Myriapoda* or *Centipedes*, in which the lower lip is formed by a pair of feet.

CHI'LTERN HUNDREDS, in Politics. The tract anciently called the Chiltern Hundreds extends through part of Buckingham and Oxford shires. The steward of these hundreds was an officer appointed by the crown to keep the peace there. As members of parliament, strictly speaking, cannot resign their seats, the mode of abandoning them is by accepting a nominal office (such as this stewardship) under the crown, which vacates the seat of the party taking it.

CHIMÆ'RA. In Mythology, a fabulous monster, slain by Bellerophon in Lycia. According to the lines in the *Iliad*, vi. 181. (which, however, are suspected of spuriousness), it had the head of a lion, the body of a goat, and tail of a serpent. (See Heyne's observations on this passage.) Many other forms were assigned to the Chimæra, the poets having vied with each other in representing it as the personification of all that is horrible and terrific. It has usually been depicted as vomiting forth flames:—

> —— Tremendæ
> Flamma chimæræ.—HOR. Od. IV. 2. 15.

From this fabulous story is probably derived the application of the term *chimera*, in nearly all the modern languages of Europe, to any wild or incongruous fancy arising in the mind.

CHIMÆRA. In Ichthyology, the name of a genus of Branchiostegous cartilaginous fishes; the best known species, which inhabits the northern seas, and has occasionally been taken on our own coast, is sometimes called "king of the herrings."

CHI'MNEY. (Fr. cheminée.) The place in a room where the fire is burnt, and from which the smoke is carried away by means of a conduit called a flue. Chimneys are usually made by projection from a wall, and recess in the same from the floor, ascending within the limits of the projection and recess. That part of the opening which faces the room is properly the *fire-place*, the stone or marble under which is called the *hearth*. That on a level with, and in front of it, is called the *slab*. The vertical sides of the opening are called *jambs*. The head of the foreplate resting on the jambs is called the *mantle*; and the cavity or hollow from the fire-place to the top of the room is called the *funnel*. The part of the funnel which contracts as it ascends is termed the *gathering*, or by some the *gathering of the wings*. The tube or cavity of a parallelogrammatic form on the plan, from where the gathering ceases up to the top of the chimney, is called the *flue*. The part between the gathering and the flue is called the *throat*. The part of the wall facing the room and forming one side of the funnel parallel thereto, or the part of the wall forming the sides of the funnels, where there are more than one, is the *breast*. In external walls that side of the funnel opposite the breast is called the *back*. When there is more than one chimney in the same wall, the solid parts that divide them are called *withs*. And when several chimneys are collected into one mass, it is called a *stack of chimneys*. The part which rises above the roof for discharging the smoke into the air is called a *chimney shaft*, whose horizontal upper surface is termed the *chimney top*.

The *covings* were formerly placed at right angles to the face of the wall, and the chimney was finished in that manner; but Count Rumford showed that more heat is obtained from the fire by reflexion when the covings are placed in an oblique position. He likewise directed that the fire itself should be kept as near to the hearth as possible, and that the throat of the chimney should be constructed much narrower than had been practised, with a view to prevent the escape of so much heated air as happened with wide throats. If the throat be too near the fire, the draught will be too strong, and the fuel will be wasted; and if it be too high up, the draught will be too languid, and there will be a danger of the smoke being occasionally beat back into the room. Before Count Rumford directed his attention to this subject, smoky chimneys were very common; but by studying his principles, these at present seldom occur. *See* FIREPLACE, GRATE, STOVE.

CHIMPANZEE, CHIMPANSE, or QUIMPESE'. Native names of the African orang (*Simia troglodytes*, Blum.). It is of a black colour, and attains the height of between four and five feet, measured in a straight line from the vertex to the heel. This species, which of all the brute creation approaches nearest to man, has been hitherto brought alive to this country only in a young state, and a knowledge of the osteological structure of the adult has been but very recently acquired.

It differs from the Asiatic or red Orang not only in colour, but in the greater size of the external ears, the

more prominent ridge above the eyes, the relative shortness of the arms, and the greater development of the thumb of the hind foot, which has constantly two phalanges and a nail.

The principal osteological differences are the following: — The cranium is flatter and broader in proportion to the face. The supraciliary ridges are more developed; and the great interparietal and lambdoidal crests, which render so remarkable the skull of the adult orang, are wanting. The interorbital space is broader. The occipital foramen has a more central position. The anterior condyloid foramen is single on each side, while in the orang it is double. The intermaxillary sutures are obliterated before the deciduous incisors are shed. The incisive and canine teeth are of smaller proportional size. There are thirteen pairs of ribs instead of twelve pairs, as in the orang; and consequently there are thirteen dorsal vertebræ. The sternal bones form a single row. The chimpanzee further differs from the orang-utan in the non-division of the pisiform bone of the wrist; and in the depression at the head of the femur, corresponding to the interarticular ligament of the hip-joint, which is wanting in the orang.

The habits and deportment of the chimpanzee, as observed in those young specimens which have been brought alive to this country, are of peculiar interest, from the high degree in which inquisitiveness, perception, memory, and docility are manifested; and by the gravity and consideration with which many even of its ludicrous and playful actions are performed. It is probable, however, that in the adult much of this intelligence gives way to the fiercer traits of the brute nature. The negroes which inhabit the forests in the interior of Africa have a general, and doubtless well-founded dread of the great black ape. Vague accounts are repeated in succeeding systems of natural history of the gregarious habits of the chimpanzee; its policy, as shown in the construction of rude huts, and other but much less probable feats. The truth is, however, that we have much more certain knowledge of the habits of the duck-billed platypus of Australia than of the adult chimpanzee, which is the most interesting of all the Mammalia, from the close approach which it makes to the human species.

CHI'NA ROOT. The root of the *Smilax China*, so called because imported from China. It was formerly used in the same cases in which sarsaparilla is now given.

CHINCHI'LLA. The generic appellation founded on the South American or local name "chinchille," or "little chinche," and applied to a genus of gnawing Mammalia or Rodents, peculiar to the South American continent. It is from a species of this genus (*Chinchilla lanigera*) that the grey fur is obtained, which has been so much prized in Europe for many years; but the exact nature of the animal itself has been only very recently ascertained, by the examination of specimens which have been procured for the menagerie of the Zoological Society.

CHI'NCOUGH. *See* WHOOPING COUGH.

CHINE'SE ARCHITECTURE. *See* ARCHITECTURE.

CHINTZ. A peculiar pattern upon printed calicos, in which flowers and other devices are printed in five or six different colours, upon white and coloured grounds. A good chintz pattern in fast colours is one of the most surprising and difficult efforts of the art.

CHIRA'GRA. (Gr. χειρ, *the hand*, and αγρα, *a seizure.*) Gout in the hands.

CHI'ROGRAPH. (Gr. χείρ, and γράφω, *I write.*) In Diplomatics, a species of instrument contrived for the purpose for which indentures were devised; viz. the enabling different parties to retain authenticated counterparts of the deed. Some word (commonly the word *chirographum*, whence the name) was written between the two copies on the same sheet, and cut through lengthwise when they were divided.

CHIRO'LOGY. (Gr. χείρ, and λόγος, *discourse.*) The language of the fingers; sometimes called *dactylology*, from δάκτυλος, *the finger.*

CHI'ROMANCY, or PALMISTRY. (Gr. χείρ, and μάντεια, *divination.*) The imaginary art of divination by the lines of the hand. According to the science of Chiromancy, the lines on the palm of the hand are divided into principal and inferior: the former are five — the line of life; the line of the liver, or natural mean; the line of the brain; the thoral line, or line of fortune; the dragon's tail, or discriminal line, between the hand and the arm. Various other modes of divination were practised by observation of the hand and its parts; onychomancy (from onyx, a nail), dactylomancy (from the fingers), &c. The practice of chiromancy, once defended and explained by grave and learned authors, is now chiefly left to be exercised by the gipsies.

CHIRO'NOMY. (Gr. χείρ, and νόμος, *law.*) The science which treats of the rules of gesticulation, or pantomime, and oratorical action.

CHI'TON. (Gr. χιτων, *a garment.*) The name of a genus of Gastropodous Mollusks, which have a series of testaceous symmetrical pieces implanted in the back part of the mantle.

CHI'VALRY. (From the French chevalier, *knight.*) The usages and customs pertaining to the order of knighthood. The general system of manners and tone of sentiments which the institution of knighthood, strictly pursued, was calculated to produce, and did in part produce, during the middle ages in Europe, is comprehended in ordinary language under the term of chivalry. This imaginary institution of chivalry, such as it is represented in the old romances, had assuredly no full existence at any period in the usages of actual life. It was the ideal perfection of a code of morals and pursuits which was in truth only partially adopted; and bore the same relation to the real life of the middle ages, which the philosophical excellence aimed at by the various sects of antiquity bore to the real conduct of their professors. But, in both instances, a system of abstract perfection was propounded in theory, which, although the defect of human nature prevented it from being reduced into practice, yet exercised a very important influence in modelling the minds, and even controlling the actions, of those who adopted it. The vivifying principle of ancient philosophy was ideal virtue; that of chivalry, the ideal point of honour.

The origin of chivalry has often been traced to the German tribes; nor has its spirit ever penetrated very deeply into the usages of any country in which these tribes have not either produced the ancestors of the great body of the nation, or at least the conquering and governing class, which transfused its habits and sentiments into that body. Thus Germany and France, and England, whose gentry derive their origin from both, have been the countries most distinguished for the prevalence of this institution. The martial spirit of the Spaniards was indeed partly animated by it; but in their country it always bore something of the character of a foreign importation, modified by the circumstances of their juxtaposition with the Arab race. In Italy, it existed only among those classes which imitated the manners of France and Germany, and never entered into the general character of the natives, notwithstanding the popularity of the poetical romances of chivalry. Among the Sclavonic nations it has never prevailed extensively; although the feudal constitution of Polish society derived a certain tincture from it, it never penetrated into Russia. It has been often remarked, that it is only within the last two or three generations that the nobility of that country, by their intercourse with the nations of Western Europe, have derived something of the spirit of the chivalrous code, so far as it still subsists among ourselves: the point of honour, and its peculiar concomitant the usage of the duel, were scarcely known in Russia before the present century.

Chivalry originated in the feudal attachment of warriors to the person of their king or chief, which has been so often described as characteristic of the ancient Germans. Hence the English word knight, which, when the Norman "chevaliers" were first known among us, was spontaneously used as the translation of their title, signifies in its origin our "knit," or attached to another, — a servant or attendant. At what precise time the devotional character was added to the original martial impress of national usages, and the compound system of chivalry were thus produced, it is not easy to ascertain. It has been said that the investiture of the knight was purely military until the reign of Charlemagne; and it may be supposed that the wars of the Franks against the Saracens first blended the ardour of war and religion together, and that the Crusades completed the union. At the latter period were instituted the two celebrated military orders of monks, the Templars and Hospitallers (see those articles), the code of whose government combined monastic and knightly usages. After valour and devotion, the third characteristic feature of chivalry was gallantry to the fair sex; and the source of this sentiment also has been traced to the habits and feelings of the Northern tribes, among whom woman was looked on with a much more exalted sense of her dignity than in the most civilized countries of antiquity. It is needless to add, that this romantic feeling, however high its precepts may have sounded in theory, degenerated into licentiousness in actual life. M. de Sainte Palaye, the learned French historian of the usages of chivalry, has brought instances enough to prove the extreme depravation of manners which prevailed, even in those courts and at those periods in which the spirit of chivalry was most prevalent. If the Crusades communicated to chivalry its devotional character, it is in the poetry of the Troubadours about the same period, in the 12th and 13th centuries, that we find its peculiarity of devotion to the female sex first developed. But in their verses it does not appear clothed with the romantic purity with which it was afterwards invested by the writers of the heroic tales of chivalry; and still less in those of the contemporary French writers of the *Fabliaux*, from whose compositions we draw the most authentic monuments which we possess in this curious branch of antiquarian research. The knight, or even the esquire, was bound to follow a single lady and dedicate himself to her service; but little delicacy is either

intimated or enjoined in the relations which subsisted between them, and his devotion to her was considered as entitling him to every recompence love could bestow.

The 14th century was the brilliant period of chivalry; when its usages, originally formed in the manners of the people, had become fixed and embellished by the fictions of the writers of romances; and when princes and chieftains, forming their idea of the institution rather from the descriptions contained in them than from real life, sought to bring back their courts and camps to the likeness of those ideal models of perfection. It may be more truly said that the romances of chivalry were the prototypes of that state of courtly society which existed in the reigns of our Edward III. and Richard II., and of which Froissart has left us such accurate and lively representations, than that existing manners and sentiments furnished the subject-matter of those romances. These fictions, of which the heroes were taken from among a long list of fanciful personages, in whose history a little tradition of past events was blended with a much larger proportion of fable, represented the knight not only as devoted to the service of his religion, his lord, and his mistress, but also as consecrated to the general service of the oppressed and maintenance of right all over the world. There can be little doubt that the peculiar ceremonies which, in the 14th and 15th centuries, accompanied the creation of a knight,—the vow of chivalry, the watching, prayer, and fasting, &c.—were borrowed by romantic imaginations from such fabulous recitals, which were read and related in every courtly company. In the reign of Edward III., the romantic part of chivalry, as we have said, was more closely transfused into real manners than at any period either preceding or subsequent. Before that period, the manners of the knights and dames had exhibited but little of that polish and refinement, their sentiments but little of that generosity, which were the subjects of so much imaginary description; and, in later times, chivalry gradually decayed. Its usages were maintained with even more of magnificence than before; its various rites, titles, and distinctions subsisted for a long period in most European countries, and partly remain to this day; but the spirit of feudal devotedness was quenched by the multiplication of mercenary troops; adherence to a feudal lord was superseded by the more general feelings of national patriotism (which, singularly enough, was almost wholly omitted in the chivalric code), and the extravagances into which the imaginary point of honour had led its votaries fell into discredit and ridicule.

It is, therefore, to the 14th century, and especially to that part of its chronicles preserved by the true annalist of chivalry, Froissart, that we must look for the period when the line between real society and that represented in romances was most nearly broken down. When the usages of chivalry were most flourishing, all men of noble birth (except the highest) were supposed to pass through three orders or gradations. They first lived as pages in the train of nobles and chiefs of high rank; next, as esquires, they attached themselves to the person of some individual knight, to whom they were bound by a strict law of obedience, and for whom they were bound to incur every danger, and, if necessary, sacrifice their lives; and, thirdly, they were promoted to the rank of knighthood. (For the different orders of knighthood see KNIGHT.) It is sufficient to observe here, that however great the distinction might be between knights in point of rank and wealth, custom established a species of equality among all of the same order, which may be said to subsist among gentlemen of the present day. They formed, all over Europe, a common corporation, as it were, possessing certain rights, and owing each other certain mutual duties and forbearances. They were united, not by the ties of country, but by those of feudal obedience, which attached every knight to the banner of his liege lord, from whom he held his fee; but little or rather no dishonour attached to knights who were under no such feudal tie, if they chose their own chieftain wherever they thought fit: they were free adventurers, whose order was a passport in every service; and, in the actual conflict, the hostility of knights was moderated by usage. Thus, it was dishonourable in any knight to take a knight's life if disarmed, and not to set him free when a prisoner on receiving a fitting ransom. Manny and Chandos, the two most celebrated of Edward III.'s knights, were attached wholly to the banner of their sovereign, and not to that of their country; and although the French constable Dugueselin, the third among these mirrors of chivalry, appears to have been devoted to the cause of France as well as that of his master, this double loyalty found few imitators. In peace, also, knights of all countries were welcome visitors at the courts of chivalric sovereigns; and all enjoyed the privilege of presenting themselves at the tournament, and contending there for the prize.

With regard to the point of honour, which forms the most important feature in the usages of chivalry, see some details under the article DUEL. The principal objects to which it related were, religious belief; fealty to the feudal superior; devotion to some one selected lady; and, finally, the general character for honour and courtesy which it was incumbent on a knight to maintain; for although his imaginary duties, as a knight errant, to avenge wrong and succour the oppressed on every occasion, were not of course very strictly put in practice, yet his vow to perform those duties attached to his character a certain degree of sacredness which it was necessary to maintain. Chivalrous honour was chiefly supported in two ways: first, by the single combat or duel, whether on account of serious provocation or by way of trial of strength; secondly, by the performance of vows, often of the most frivolous and extravagant nature. These latter were generally undertaken for the honour of the ladies. Many historical instances of these absurd yet daring follies are preserved by Froissart. They, with other usages of knighthood, were long preserved among those who aimed at the reputation of chivalry, after these usages had ceased to form a part of the ordinary customs of society. Thus, the instances which Froissart relates of knights riding alone up to the barriers of fenced cities, &c., were imitated in after times, and at no less personal hazard, by such romantic personages as Lord Herbert of Cherbury, whose feats performed in rivalry with the French champion Balagny are mentioned in his Memoirs. But the vows did not only relate to martial achievements, but to others of a more extravagant and grotesque character. We need only refer to Monstrelet's narrative of the company called "Galois" of knights and ladies, who bound themselves, for love of each other, to follow a particular code of usages; of which a part consisted in wearing thick clothes in summer and thin in winter, to show that the power of their love rendered them insensible to the difference of seasons; a vow which was maintained with such perseverance, that the greater part of the devoted company actually died of cold. (See also the *History of the Vow of the Heron Sainte Palaye*, vol. iii.) The commencement of such extravagances, however, was rather a sign of the decline of the true spirit of chivalry. It decayed with the progress of mercenary armies and the decline of feudal institutions through the 15th century; in the 16th, it was little more than a lively recollection of past ages, which knights such as Bayard and sovereigns such as Francis I. and Henry VIII. strove to revive; and, finally, it became extinguished amid religious discords, leaving as its only relic the code of honour, which is still considered as governing the conduct of the gentleman.

CHLA'MYPHORE, *Chlamyphorus*. (Gr. χλαμυς, *a cloak*, and φερω, *I carry*.) A name given to a small species of Armadillo, which is covered by its coat of mail as by a cloak. The animal is not above 6 inches long, and, like the rest of its genus, inhabits exclusively the continent of South America. It is interesting from the analogy of its skeleton and coat of mail to those of the gigantic extinct megatherium.

CHLENA'CEÆ. (Gr. χλαινα, *a cloak*. All the names belonging to this order are compounded of this word, used in a figurative sense for an involucrum.) A natural order of shrubby or arborescent Exogens, allied to *Malvaceæ*, on account of their monadelphous stamens and involucrated flowers, but referred by Jussieu to the vicinity of *Ebenaceæ;* it, however, appears, from their imbricated calyx, regular flowers, and albumen, that they have the greatest affinity with *Cistaceæ*. They are all natives of Madagascar; beautiful in their flowers, but of no known use; and are, in fact, but little known even to botanists.

CHLO'RAL. (From the first syllables of *chlorine* and *alcohol*.) A liquid composed of chlorine, carbon, and oxygen, obtained by the action of chlorine upon alcohol.

CHLORANTHA'CEÆ. (Chloranthus, one of the genera.) A small natural order of apetalous Exogens, nearly allied to *Saururaceæ* and *Piperaceæ;* from both of which it differs in wanting a sac to the embryo, and in having a pendulous ovule and opposite leaves with intermediate stipules. Blume places these plants near to *Opercularineæ*. They are natives of the hotter parts of the world, and appear to possess stimulating properties of great importance. *Chloranthus officinalis* and *brachystachys*, although not officinal in Europe, are believed to be among the most powerful of stimulating agents.

CHLO'RATES. Combinations of chloric acid with salifiable bases. Of these salts the *chlorate of potash* is best known; it was formerly called *oxymuriate of potash*. When mixed with combustibles, such as sulphur or charcoal, and some of the metals, it forms highly explosive compounds, which ignite by a blow or by friction, or upon the contact of sulphuric acid. A mixture of this salt with sugar, or with sulphuret of antimony, is used for tipping the *matches* which inflame when dipped into sulphuric acid, or when briskly drawn through a piece of emery paper. Chlorate of potash consists of 76 chlorine acid + 48 potassa = 124 of the chlorate.

CHLO'RIDES. Combinations of chlorine, corresponding with the oxides. Common salt is a *chloride of sodium;* that is, a binary compound of chlorine and sodium. Where there are two chlorides of the same

base, the relative proportions of chlorine in them are almost invariably as 1 to 2; hence the terms *protochloride* and *bichloride*. Calomel and corrosive sublimate are the protochloride and bichloride of mercury. The latter is frequently termed *perchloride*. In calomel 200 of mercury are combined with 36 of chlorine, and in corrosive sublimate with twice 36 or 72.

CHLO'RINE. (Gr. χλωρος, *green*.) This gas was discovered in 1774 by Scheele, who called it *dephlogisticated muriatic acid*; the French nomenclaturists afterwards termed it *oxygenated muriatic acid*, conceiving it to be a compound of oxygen and muriatic acid. This erroneous view of its nature was corrected in 1809 by Sir H. Davy, who gave it the present name, indicative of its colour. Chlorine is a simple substance, existing at common temperatures and pressures in the gaseous state; but when subjected to a pressure of about four atmospheres it becomes condensed into a yellow transparent liquid, which is a non-conductor of electricity. 100 cubical inches of chlorine, at mean temperature and pressure, weigh between 76 and 77 grains: water absorbs twice its volume, and acquires a yellow colour, and the peculiar suffocating odour of the gas. When humid chlorine is exposed to a temperature of 32°, it assumes a crystalline form; this *hydrate of chlorine* consists of 1 equivalent of chlorine $= 36 + 10$ of water $= 9 \times 10$ or 90. Chlorine is not only unrespirable, but very injurious when breathed, even if largely diluted: a taper burns in it with a red smoky flame, and is soon extinguished. Some of the metals, when finely divided, spontaneously take fire in chlorine, such as brass leaf, or powdered antimony. A remarkable property of chlorine is its power of destroying almost all vegetable and animal colours; hence the important application of this gas and of some of its combinations to the *art of bleaching*. It also destroys the putrid odour of decomposing vegetable and animal substances, and infectious effluvia of all kinds, whence its use in fumigation, and in preventing the spread of infectious and contagious matter, and purifying noxious atmospheres.

The great natural source of chlorine is *common salt*, which contains it in the proportion of about 60 *per cent*. It is procured by decomposing common salt by the joint agency of sulphuric acid and peroxide of manganese. The best proportions are 3 parts of salt and 1 of oxide of manganese; these are well mixed, and put into a retort with 2 parts of sulphuric acid previously diluted with 2 of water. Chlorine is evolved, and its extrication is quickened by the application of a gentle heat. Chlorine may also be obtained from a mixture of muriatic acid with half its weight of black oxide of manganese. The gas may be collected over water, and should be preserved in bottles with glass stoppers; if left in the contact of water, it is soon absorbed. *See* Muriatic Acid.

CHLORI'ODINE, or CHLORIO'DIC ACID. A compound of chlorine and iodine.

CHLO'RITE. (Gr. χλωρος.) An earthy mineral of a *green* colour, often found in the cavities and veins of slate rocks.

CHLO'RO. (Gr. χλωρος.) A term used in the composition of botanical and other scientific words formed from the Greek, to indicate a clear lively green colour without any mixture.

CHLO'ROCARBO'NIC ACID. A compound formed by exposing a mixture of chlorine and carbonic oxide to the action of light.

CHLO'ROCYA'NIC ACID. A compound of chlorine and cyanogen.

CHLORO'METER. (Gr. χλωρος, and μετρον, *a measure*.) An instrument for the purpose of testing the decolouring or bleaching powers of *chloride of lime*, by which the relative values of different samples of that important bleaching and disinfecting compound may be ascertained.

CHLO'ROPHAITE. (Gr. χλωρος, and φαιος, *black*.) A mineral, which when recently broken is green, but afterwards becomes black.

CHLO'ROPHANE. (Gr. χλωρος, and φαινω, *I shine*.) A species of fluor spar, which, when heated, shines with a beautiful pale green light.

CHLOROPHYLL. (Gr. χλωρος, and φυλλον, *a leaf*.) The green colouring matter of the leaves of plants.

CHLORO'SIS (Gr. χλωρος), or ETIOLATION. In Botany, is a species of constitutional debility; the affected individual being pale, and destitute of a healthy green: the stems are weak, long, and slender; no flowers are produced; and the plant is readily killed. It is believed that this malady is exclusively produced in plants by want of sufficient light.

Chlorosis. (Gr. χλωρος.) In Medicine, a disease giving a peculiar sallowness to the countenance, hence called the *green sickness*. It chiefly affects young females; its symptoms are extremely various, but generally referable to imperfect or suppressed menstrual evacuation. Tonics, chalybeates, aloetics, sea and cold bathing, and slight electric shocks passed through the pelvis, together with due amusement and exercise, are among the principal remedial agents.

CHLO'ROXA'LIC ACID. A compound obtained by exposing acetic acid and chlorine to bright sunshine. Its elements are in such proportion, that it may be regarded as a compound of 1 equivalent of hydrochloric acid and 1 of oxalic acid.

CHLO'RURETS. Compounds of chlorine. *See* Chlorides.

CHO'ANITES. (Gr. χοανη, *a funnel*.) A genus of extinct Zoophytes, so called on account of their fossil skeleton or polypary presenting in general a funnel-shaped figure, though sometimes they are globular or subcylindrical. This genus holds an intermediate place between *Alcyonium* and *Ventriculites*: it is distinguished from the former by having a central cavity at the upper part, and from the latter by not having an outer reticulate surface. One species, the *Choanites königii*, is found in abundance in the loose flints beneath the turf near the race course at Lewes in Sussex, and appears to have been common in the upper beds of the chalk.

CHO'COLATE. A term said to be compounded of two Indian words, choco, *sound*, and alta, *water*, from the noise made in its preparation. Chocolate is made by triturating the roasted cocoa nut into a paste in a heated mortar, sugar and some aromatics being occasionally added; the oily matter of the nut gives it whilst hot a due consistence, so that it is cast in tin moulds, in which it concretes, on cooling, into cakes. It is a rich article of diet, and apt to disagree with weak stomachs.

CHOIR. (Gr. χορος.) In Architecture, the part of a church in which the choristers sing divine service. In former times it was raised separate from the altar, with a pulpit on each side, in which the epistles and gospels were sung, as is still the case in several churches on the Continent. It was separated from the nave in the time of Constantine. In nunneries, the choir is a large apartment, separated by a grate from the body of the church, where the nuns chant the service. This term is used also in music to signify a band of singers in different parts.

CHOKE DAMP. A term applied by well-diggers and miners to *carbonic acid gas*.

CHO'LAGOGUE. (Gr. χολη, *bile*, and αγω, *I evacuate*.) A term applied by ancient medical writers to certain purgative remedies which produce bilious evacuations.

CHOLE'DOCHUS. (Gr. χολη, and δεχομαι, *I receive*.) One of the ducts of the liver is called the *ductus communis choledochus*.

CHO'LERA. (Gr. χολη, and ῥέω, *I flow*.) A disease accompanied by vomiting and purging, with great pain and debility, and apparently arising from excess or acrimony of bile: it is most common at the close of summer and beginning of autumn, and seems to be produced by cold, suppressed perspiration, indigestible fruits, &c. It generally commences with a sense of pain about the bowels, fever, thirst, an irregular pulse, and severe vomiting and purging of bilious matter: in favourable cases these symptoms subside in a few days with the aid of opiates, mucilaginous diluents, and mild aperients followed by tonics; but in severe cases great exhaustion ensues, attended by depression of spirits, anxiety, hurried respiration, cold sweats, hiccup, low and fluttering pulse, and the patients rapidly sink, and are sometimes carried off within twenty-four hours. In such cases warm fomentations sometimes relieve the pain, and effervescent saline draughts check the sickness, and enable the stomach to bear large doses of opium.

Cho'lera, Asia'tic. The term *Asiatic* or *Spasmodic Cholera* has been applied to a new and most appalling form of pestilential disease, which seems to have been but indistinctly known prior to the year 1817. It made its appearance in August that year at Jessore, after having previously raged to a formidable extent in the south of Bengal, and thence it spread over a great part of Asia, carrying off millions of human beings. In 1823 it broke out at Astracan, but did not at that time extend further into Russia; in 1828, however, it appeared at Orenburg, and during the autumn of that year and the spring of 1829 it spread over a considerable part of the Russian dominions. It raged at Moscow in September, 1830; and having been apparently carried by the Russian army into Poland, it propagated itself through different parts of Europe, and reached this country. The symptoms of this, as of other disorders, vary considerably at different times and in different individuals; but as our object here is briefly to describe the characteristic features of the disease in their unalloyed form, we shall omit all unnecessary details, and place before our readers a short account of its effects in its worst and by no means uncommon form.

The first circumstance that strikes us in regard to the attacks of this disease is their suddenness. A person in apparent health feels slightly giddy, chilly, or sick, and in the course of two or three hours sinks into a state of extraordinary and alarming debility; the countenance assumes a deadly paleness, and the skin feels and looks like that of a corpse; the pulse falls, flutters, and is al-

most imperceptible; a livid circle surrounds the sunken eyes; the tongue is slightly furred, and the breath cold. Under this excessive and extraordinary prostration the patients sometimes die in the course of a very few hours; otherwise it is succeeded by vomiting and purging, the voided matters resembling turbid whey, and being in fact a serous fluid with floating shreds or flocculi of coagulated albumen; and now cramp assails the extremities, and afterwards the abdomen, producing spasms of varying but sometimes of extreme violence; great pain and heat about the region of the stomach, and intolerable weight and anguish round the heart are complained of, with much thirst and anxiety; the voice faulters, and the unfortunate sufferer asks frequently, in plaintive and broken whispers, for cold water; the secretions of urine, bile, and saliva appear, in this state of things, as if entirely suspended; the evacuations have a singular fœtor, and the breath and perspiration have that peculiar odour which announces the rapid approach of death. Towards the close of this horrid scene, the respiration becomes very slow, the tendons of the extremities quiver, the sufferer is unable to swallow, insensibility succeeds, and after one or two long and convulsive sobs he dies. The mind, even at last, is scarcely ever much disturbed; but towards the close the patient sinks into a state of apathy, and appears desirous of being left to his fate. Attacks of this kind generally prove fatal in from four to eight hours.

If from this extreme case we turn to what may be termed milder forms of the disease, the same general train of symptoms are observed; but they are less rapid in their succession, and there is more time and opportunity to resort to the resources of art. The attack begins with sickness or purging, succeeded by uneasiness and heat about the pit of the stomach; the matters which are thrown off from the stomach and bowels gradually assume the appearance of rice water; the countenance shrinks; the constriction of the thorax and cramps and spasms follow; and in the course of twenty-four to thirty-six hours the patient dies, in many instances delirious or comatose.

Those who survive seventy-two hours generally recover, as far as the primary symptoms are concerned; the spasms and difficulty of breathing give way, the natural warmth of the body is restored, and the pulse returns to something like its natural standard. The most favourable symptoms are sleep, perspiration, return of the secretion of urine and of bile, accompanied by proportionate improvement in the pulse and aspect of the features; but, even under these apparently and really favourable symptoms, fever of a low or continued character may ensue, — it indeed sometimes immediately follows the blue stage or collapse; and if not relieved by a critical perspiration on the second or third day, the pulse quickens, the face is flushed, there is drowsiness and suffusion of the eyes, stupor, a foul mouth, and other symptoms of mixed or typhus fever, which terminate fatally from the fourth to the eighth day, or even later, in those very individuals who had been saved in the first or cold stage.

The appearances observed on dissection of those who died within eight or ten hours were, a relaxed and pale state of the stomach and intestines; absence of bile and of fæces in the intestines; an empty and contracted bladder; congestion in the venous circulation of the large vessels; the gall-bladder full of bile, but not passing into the intestine. In more protracted cases other appearances occasionally occurred, more especially serous effusion upon and in the brain, with congestion of the vessels, and other usual appearances of febrile disease. In all cases the blood presents a more or less morbid appearance, and is often of a very dark colour and increased consistence, so as to have been compared to tar.

The pathology of cholera is as yet most imperfectly understood; nor has it been satisfactorily ascertained whether it is or is not contagious; the general opinion, however, is in favour of its contagious nature, and there cannot be the least doubt of the propriety of enforcing the most rigid precautionary measures founded upon such an opinion.

Details respecting the *medical treatment* of cholera would be out of place in this work; and the plans to be pursued vary so much with circumstances, as to render it impossible to condense into small limits a general view of this important subject.

Emetics are among the earliest measures which should be put in practice; they should be such as act certainly and rapidly, and conjoined with stimulants, such as essential oils and capsicum. *Blood-letting* has been adopted by many practitioners in the early stages of the disease. Its favourable effect is to cause the pulse to rise; if it produce faintness, it must be immediately put a stop to, and should be followed by the application of warm air, and other dry warmth. Large doses of calomel, with or without opium, are resorted to to remove local congestion, and especially to stimulate the liver; and these means are assisted and the general powers of the system kept up by ether, ammonia, brandy, and volatile oils, in such quantities and forms as the particular circumstances of the respective cases may point out. If the irritability of stomach continues, flannels soaked in very hot water, and then sprinkled with oil of turpentine, should be applied to the region of the stomach and abdomen.

The great object of all those remedies applicable to the first stage of the disease is to enable the system to rally from its depressing effects, to bring about re-action, and to stimulate the nervous and vascular systems; but then the utmost circumspection is required in reference to the injurious effects which this plan will induce, if carried too far. Here, however, the symptoms are usually those of typhoid or continued fever, and are to be treated accordingly, great attention being always paid to the state of the biliary and urinary secretions, and to the evacuations from the bowels.

Besides the treatment founded upon the above outline, other and very dissimilar plans have been adopted, founded upon the change which the blood appears to suffer in this disease. It has been by some presumed that in all cases of cholera, the saline matters of the blood, along with a large quantity of its water, are thrown off by the intestines, constituting the characteristic serous discharge above adverted to; and that the residuary blood becomes thick and black, in consequence of the deficiency of its salts. Dr. Stevens therefore proposed the administration of large doses of common salt, occasionally mixed with nitre and chlorate of potash; and from this plan the best effects have, according to some, resulted, while in the hands of others it has entirely failed. The truth is, that in the worst attacks of the disease the approach of death is so quick that there is scarcely time for any thing to take effect; and where it is less rapid, the symptoms must guide the treatment: amongst these it must be confessed that there are seldom any which would justify the prudent practitioner in drenching the bowels with salt and water.

But the bolder advocates of what has been termed the *saline treatment* of cholera have gone a step further, and have dared to inject saline solutions into the veins: how far such extraordinary means are justifiable, will appear from the following statement. (*Pereira, Elements of Materia Medica*, part i. 313.) "This plan was, I believe, first practised by Dr. Latta. (*Med. Gaz.* x. 257.) The quantity of saline solution which has been in some cases injected is enormous, and almost incredible. In one case 120 ounces were injected at once, and repeated to the amount of 330 ounces in twelve hours. In another, 376 ounces were thrown into the veins, between Sunday at eleven o'clock A.M. and Tuesday at four P.M.; that is, in the course of fifty-three hours, upwards of 31 pounds, The solution used consisted of two drachms of muriate and two scruples of carbonate of soda to 60 ounces of water. It was at the temperature of 108° or 110° Fahr. In another series of cases 40 pounds were injected in twenty hours; 132 ounces in the first two hours; 8 pounds in half an hour! The *immediate* effects of these injections, in a large majority of cases, were most astonishing; — restoration of pulse, improvement in the respiration, voice, and general appearance, return of consciousness, and a feeling of comfort. In many instances, however, these effects were only temporary, and were followed by collapse and death."

The reports as to the ultimate benefit of this treatment in cholera are so contradictory, that it is difficult to form a correct estimate of it. "That it failed in a large proportion of cases after an extensive trial, and greatly disappointed some of its stanchest supporters, cannot be doubted. Dr. Griffin states that all the published cases of injection which he can find recorded amount to 282, of which 221 died, while 61 only recovered; but he thinks that the average recoveries from collapse by this method of treatment far exceeded the amount of any other treatment in the same district and under the same circumstances." (*Med. Gaz.* xxii. 319.)

A vast quantity of matter has been published in reference to the history, symptoms, and treatment of pestilential cholera. Among those works upon the subject, the general reader may consult the following with advantage; namely, the Reports published by order of Government under the superintendence of the Medical Board; *History of the Epidemic Cholera, by B. Hawkins, M.D., &c.; Mr. Bell's Letter to Sir H. Halford; the Report of Drs. Russell and Barry; Dr. James Copland on Pestilential Cholera;* and a paper in the Ninety-first Number of the *Quarterly Review* for November, 1831.

CHOLE'STERINE. (Gr. χολη, and στερεος, *solid.*) The matter which forms the basis of most gall stones.

CHONDRO'LOGY. (Gr. χονδρος, *a cartilage*, and λογος, *a discourse.*) The history of cartilages.

CHO'NDROPTERY'GIANS, *Chondropterygii.* (Gr. χονδρος, *a cartilage*, and πτερυξ, *a fin; gristly-finned.*) The name of Cuvier's last order of fishes, characterized by the gristly nature of all the spines which support the fins. The whole internal skeleton in this order is cartilaginous.

CHORA'GIC MONUMENT. (Gr χορος.) In

Grecian Architecture, a monument erected in honour of the Choragus who gained the prize by the exhibition of the best musical or theatrical entertainment at the festivals of Bacchus. The Choragi were the heads of the ten tribes at Athens, who overlooked and arranged the games at their own expense. The prize was usually a tripod, which the victor was bound publicly to exhibit, for which purpose a building or column was usually erected. The remains of two very fine monuments of this sort, viz. those of Lysicrates and Thrasyllus, are still to be seen at Athens.

CHORD. (Gr. χορδη, *the string of a lyre.*) In Music, a combination of two or more sounds heard contemporaneously, forming a concord or a discord between them.

Chord. In Geometry, is the straight line which joins the two extremities of the arc of a curve; so called from the resemblance which the arc and chord together have to a bow and its string, the chord representing the string. The chord of an arc is equal to the size of half the arc; hence, to find the length of the chord of any given arc, multiply the diameter by the sine of half the arc. Tables of chords are given in some of the older works on trigonometry; but they have been superseded by the tables of sines, which are much more convenient for trigonometrical calculations.

CHOREA. (Gr. χορος, *a chorus;* the ancient accompaniment to dancing.) The disease commonly called *St. Vitus's dance.* It shows itself by convulsive motions of the limbs, face, head, and trunk, varying extremely in extent and violence; the speech is often more or less affected, and frequently the mental energies become grievously impaired. It is most common in early life, as from the age of ten or twelve to puberty; and makes its approach gradually in persons chiefly of debilitated constitutions: the appetite is generally ravenous at first, and the bowels costive; various convulsive motions then ensue, and only cease during sleep, which, however, is seldom sound. This is one of those diseases which require especial attention in its early stages, and which even in its slightest forms, when once habitual, is very difficult to manage. The leading treatment consists in the judicious administration of aperients and brisk purges, so as to clear the stomach and bowels thoroughly of all irritating matters; the constitution may at the same time be strengthened by tonics and chalybeates, with occasional stimulants; and some of the more urgent spasmodic symptoms may be sometimes cautiously encountered by opium, camphor, henbane, and ether. Cold bathing also has its advantages when circumspectly resorted to; and the mind must be diverted by change of air and scene. The diet should be very regular, nutritive, and never in excess. In this complaint much will depend upon the exertions of the patient himself, who, though relieved of the more urgent symptoms, will often retain relics of his disorder through a long life.

CHO'REPI'SCOPI. (Gr. χωρα, *a country place*, and επισκοπος, *a bishop.*) Country bishops; persons appointed by the bishops in the early periods of Christianity to superintend the rural districts which appertained to their dioceses, but which were at an inconvenient distance from the city in which they abode themselves. The class of chorepiscopi is represented as holding a middle rank between the bishops and the presbyters.

CHO'RION. (Gr. χωρα, *a receptacle.*) The external membrane which envelopes the *fœtus in utero*, between which and the amnion there is a gelatinous fluid. Its interior surface is smooth, but exteriorly it is shaggy and vascular.

CHORO'GRAPHY. (Gr. χωρα, *district*, and γραφω, *I describe.*) The description of a district, in contradistinction to geography (the description of the earth or of countries) and topography (the description of particular spots)

CHO'ROID MEMBRANE OF THE EYE. The second tunic of the eye lying under the sclerotic, with which it has a vascular connection: it commences at the optic nerve, and passes forward with the sclerotic to the beginning of the transparent cornea, where it firmly adheres to the sclerotic by a cellular membrane, forming a white fringe called the *ciliary circle;* it then recedes from the sclerotic and cornea, forming a round coloured disc called the *iris*, and its posterior surface is termed *uvea.* The choroid membrane is very vascular, and its external stellated vessels are called *vasa verticosa.* Its internal surface is covered by a *black pigment.*

CHO'ROID PLE'XUS. A plexus of blood-vessels situated in the lateral ventricles of the brain.

CHO'RUS. Gr. χόρος.) A band of singers and dancers who performed odes in honour of the gods, particularly Bacchus. The chorus formed an important part of the Greek tragedies and early comedies, which were interspersed with odes. There were likewise several other choruses besides these, as the Dithyrambic; and the exhibition of these was one of the public burthens imposed on the richest private citizens of Athens. It was called the choregia (χορηγία). *See* Drama, and Choragic Monument.

Chorus. In Music, the joint performance of music by the whole of the members of the orchestra.

CHOU'ANS. In French History, the royalist insurgents on the right bank of the Loire during the revolution when the Vendeans rose on the left, were thus popularly named; according to some, from the cry of the screech-owl (*chat-huant*), an imitation of which was a signal during their nightly meetings. They were for the most part brigands, and their object rapine rather than civil war. After the revolution of 1830, they made a transient reappearance in the neighbourhood of Nantes and Le Mans.

CHREMATI'STICS. (Gr. χρηματα, *wealth.*) The science of wealth; a name given by Continental writers to the science of political economy, or rather to what in their view constitutes a portion of the science. They consider political economy as a term more properly applicable to the whole range of subjects which comprise the material welfare of states and citizens, and chrematistics (by which they mean nearly the same science which M'Culloch and most other English writers describe as political economy) as merely a branch of it. See especially M. de Sismondi, *Etudes sur l'Economie Politique.* See also Chrysology.

CHRESTO'MATHY. (Gr. χρηστος, *useful*, and μανθανω, *I learn.*) According to the etymology, that which it is useful to learn. The Greeks frequently formed commonplace books by collecting the various passages to which, in the course of reading, they had affixed the mark χ (χρηστος). Hence books of extracts chosen with a view to utility have received this name.

CHRISM. (Gr. χρισμα, from χριω, *I anoint.*) The oil which is used both in the Greek and the Roman churches in the administration of baptism, confirmation, ordination, and extreme unction.

CHRI'STENDOM. A word sometimes employed in such a sense as to comprehend all nations in which Christianity prevails: more commonly, all realms governed under Christian sovereigns and institutions. Thus European Turkey, although three fourths of its inhabitants are Christians, is not in ordinary language included within the term Christendom. The history of the fortunes of Christianity, in respect of its geographical extension, presents remarkable periods of advance and decline. After the conversion of Constantine, and the gradual decay of Paganism, Christianity continued to spread, but chiefly in the direction of east and south, for more than three centuries, the barbarian conquerors of the Roman provinces soon adopting it. About the middle of the seventh century, Christendom comprehended Europe south and west of the Rhine and Danube; Africa north of the Great Desert; Abyssinia; parts of Nubia; Asia to the Euphrates; Armenia, and part of Arabia; and that small colony in southern India which subsists to this day. The Saracen power rose by conquest from this extensive empire. In little more than a century, Christendom was deprived of nearly all its Asiatic provinces, of which the faithful inhabitants were reduced to a tributary condition: of the whole of northern Africa, in which they were exterminated or converted: and of Spain. Sicily, the latest conquest of the Saracens, was occupied by them about 830. But just at the same epoch, or that of lowest decline, Charlemagne began to extend the limits of Christendom in the north; and the second period of advance extends through the 9th, 10th, and 11th centuries, in which "the reign of the gospel and the church was extended over the north: Bulgaria, Hungary, Bohemia, Saxony, Denmark, Norway, Sweden, and Russia." (*Gibbon*, chap. 55.) From that time to the 16th century, Christianity gradually reconquered Spain on the one hand; while, on the other, the newly arisen power of the Turks wrested from it the remainder of its Asiatic territories and the European provinces of the Greek empire. Since that period no important changes have taken place in the relative extent of Christendom and Islamism; but the vast continent of America, as far as it has been colonized, has been added to the former, and the rapid increase of its communities in numbers and civilization has greatly enhanced their comparative importance. The number of Christians inhabiting Europe and America, and scattered in the other parts of the globe, may perhaps be estimated conjecturally as follows:—

Roman Catholic church -	- 144,000,000
Reformed churches -	- 60,000,000
Greek and other Oriental churches	- 66,000,000
	270,000,000

CHRISTIA'NITY. The religion of Jesus Christ. From the period when the disciples "were called Christians first in Antioch" (Acts, xi. 26.) down to the present day, the main doctrines of the gospel, and the great moral principles which it reveals and confirms, have been preserved without interruption in the church. But notwithstanding this substantial unity, it cannot be denied that the character of the religion has been very materially coloured throughout all its history by the circum-

stances and genius of different nations and ages. The first marked forms of opinion which acquired consistency among the general body of Christians tended in two very different directions. The *Judaizing* Christians clung to the ordinances of the elder religion, and strove to teach the separation from it as slightly as possible; under the names of Nazareans, &c., they existed as late as the 4th century, but ceased after the first to exercise any very extensive influence on the church. The *speculative* Christians placed figurative interpretations both on the external facts and mysteries of the religion, or sought to connect it with the philosophical and theurgical systems of the ancient world. Apollos of Alexandria was the first teacher, it is commonly said, who introduced this speculative tendency into Christianity; and St. Paul, while he does not condemn Apollos, dwells on the evils produced by those who from his teaching deduced as it were a separate body of doctrine (1 Cor. iii.). In this way arose,—1. The early heretics the Nicolaitanes and followers of Cerinthus, and the Gnostics, professors of the "knowledge falsely so called" (ψευδώνυμος γνῶσις) of St. Paul. 2. At a later period, the Manichæans, who imported into Christianity the notion of the rival principles of good and evil, which continued for many ages to possess adherents. 3. Within the church itself, the *Alexandrian school of theology*, which has exercised a more permanent influence. This school, in the second and third centuries, became partially tinged with the sentiments of Platonic philosophy; and was characterized by the acute and refining spirit of the East. Like the Gnostics, its chief doctors encouraged the notion of a mystical or second meaning in the revelations of the faith, of which the key was in the possession of the learned only (Clemens, Origen, &c.). In the mean time, the main body of believers, comparatively unaffected by the influence of science and speculation, was gradually acquiring new views of a different and more positive character. During the first three centuries after the apostolical times, the opinions respecting the authority of the priesthood, attachment to forms and ordinances, the honour paid to individual purity of life (and especially to constancy under persecution), gradually and steadily increased and strengthened. In the West, and particularly in Africa, these tendencies became peculiarly strong. The Montanists, Donatists, and Novatians separated successively from the church, on the score of its defection from an imaginary standard of personal purity; and when Africa began to have a school of theology of her own (Tertullian, Cyprian, and others, to Augustine), this was the direction of its labours. In that theology all is dogmatical, nothing speculative. Every thing is taken in its most literal and naked sense: God himself is not personal only, but invested almost with the attributes of a human agent. Both doctrines and ordinances are as definite as possible, and the utmost rigour of practice enjoined. The history of the African church affords a momentous commentary on their strainings after imaginary perfection. After two centuries of discord and decay from the time of Augustine, it was not only subdued but obliterated by the first assault of the Mohammedans. The early heretics had entertained theoretical notions respecting the inferiority of Christ to the Father; but the Arians, in the last half of the 3d century, were the first to preach it as the doctrine of the church, and seek to confirm it by appeal to antiquity. The council of Nice (A. D. 325) condemned this opinion; and by the concurring declarations of bishops from all parts of Christendom afforded the strongest testimony to the fact, that the Catholic sentiment of the church had always been opposed to it. But the Arians, and other sects differing from the church by various shades of opinion on the same subject, continued to subsist until the 6th century, during which these controversies partly died away in the West, amidst the misery and barbarism of the age, and partly were extinguished by the authority of the church. It was thus that the governors of the church were first driven to protect its fundamental doctrines by reducing them to formal propositions embodied in creeds and the canons of councils (especially the six Œcumenical or general, which were held from A. D. 381 to 680). Thus, in the West, speculation was effectually subdued. In the East, it still lingered in vain but refined distinction respecting the nature and relations of the persons of the Trinity (the Nestorian, Monophysite, and Monothelite heresies). Meantime a new and most important feature of Christianity was developing itself. A solitary believer, who left the world and retired into the deserts of Egypt (Antonius, A. D. 311), set an example which was followed by innumerable Christians with a fervour alike contagious and irresistible. The calamities of the empire, and the wretched state of society, seem to have aided the mistaken tendencies of devotion in producing this carelessness of life and its duties. It is scarcely possible to exaggerate the evils produced by the spirit of monachism in the 4th and 5th centuries: the contempt for all the social habits and social virtues; the ferocious zeal, sometimes venting itself against Paganism and sometimes against brethren; the unregulated, wandering, untameable disposition which it engendered, and which the spirit of the age dignified with the title of celestial piety. Whatever Christianity may owe to the great fathers of the church, Augustine, Ambrose, Jerome, Basil, Chrysostom, we must not forget the encouragement which they all administered to this destructive error, far more mischievous than any of the heresies which they combated. At length, when the evils of this anarchical system had become almost intolerable, arose the lawgivers of monachism in the West. Benedict (A. D. 529), and still more Cassiodorus, strove to bring religious persons under a temperate and liberal rule of government: their attention was called to what they had hitherto despised as secular pursuits, especially agriculture and literature, together with a more regulated piety; and thus monachism, which in a time of declining civilization had powerfully accelerated decay, became, in a time of barbarism, an agent of preservation and improvement. In A. D. 716, the separation between the Greek and Western churches, which had long been provoked by the gradual usurpations of the Roman bishop over the latter, became really complete through the controversy respecting images, although not formally acknowledged until the middle of the 11th century. This era is important, as those corruptions of Christianity which, according to Protestants, disfigure both the Greek and Roman Catholic churches are evidently anterior to it,—those peculiar to the latter posterior. Thus, the honour paid to saints, relics, &c., the adoration of the Virgin Mary (which seems to have been partly a result of the Nestorian controversy), monachism, &c., are common to both, and therefore ancient: the exclusively Roman tenets, transubstantiation, papal infallibility, purgatory, &c., are accounted by Protestants comparatively modern doctrines, to which the whole church has never agreed; while celibacy, which the Roman pontiffs with great difficulty succeeded in imposing on the whole clergy in the 11th century, is observed in the Greek church only by the higher dignitaries. For several centuries after this separation, the external history of Christianity in the West presents us with little more than the vicissitudes and disputes of monastic orders, the strife of ecclesiastical dignitaries with each other and with temporal sovereigns, the growth of superstitious observances among the laity, the union of the religious with the military spirit, and the increasing power of the pope; yet, under all these disadvantages, the impartial observer may discern the great principles of religion still preserved, and still working beneath the surface of society for its gradual purification. The 12th century was a period of revival in the West, both in point of learning and religion. The military spirit of devotion found ample employment in the crusades. The rise of the scholastic philosophy (A. D. 1100) gave a new and peculiar character to the study of theology. Among the lower classes a powerful spirit of religious reform began rapidly to extend itself, especially in Italy and the south of France. A strictness of life amounting almost to asceticism, a revolt rather against the wealth and temporal supremacy of the clergy than their doctrines, were the first characteristics of the reforming sects; but to these was soon added an addiction to mystical tenets and observances. The Cathari, Waldenses, Albigenses, &c. all partook more or less of these common peculiarities; but how far they had really adopted, if at all, those Manichæan opinions (derived through the medium of the Paulicians, a sect which long subsisted in the East) with which they were charged by their opponents, will probably never be ascertained. These sectaries, in their hostility to the Catholic priesthood, had to a great extent usurped their province as religious advisers of the poor and uninstructed with prayer, preaching, and even auricular confession. It was this peculiar form of the impending danger which induced the church (after it had openly condemned the new doctrines) to give ample encouragement to the institution of the *Mendicant orders* (in the beginning of the 13th century), one of the most important events in the history of Christianity. These bodies met the sectaries on their own ground, by the assumption of asceticism, poverty, and the popular practices which had availed the former. They were also employed by the church in the sterner task of putting down by force heretical opposition, and completed the extirpation of the Albigenses begun by the sword of the Crusaders. But they extended their hostility to learning and science, and to all the established institutions of the time, and became as much hated by the secular priesthood (or parish clergy, so called in distinction to those who have renounced the world and are bound by monastic rule, called regulars), and by the old and wealthy orders, as by the heretics themselves. Under the influence of persecution the development of the age was checked. From the middle of the 13th century to the end of the 14th the church of Rome met with little opposition from sectaries, and underwent little change in respect of doctrine and discipline; but during the same

period the increasing power of princes, the long removal of the seat of papal power from Rome, and various other causes, sensibly diminished its temporal authority. In the next century, the same causes continued to act, while the revived energy of reforming sects (Lollards, Hussites, &c.) and the rapid spread of literature and learning proved still more hostile to its spiritual power. Thus the way was prepared for the great events of the Reformation. To trace the history of Christianity from that period onwards, would be impossible within our present limits. It may be sufficient to direct the reader to the general outline of the most marked events, omitting those of a nature merely political or ecclesiastical. *In the Roman Catholic church*, the definite establishment of her doctrines by the council of Trent, which met A.D. 1546; the foundation of the order of Jesuits, its rapid increase in power and influence, and the gradual decline of the other monastic orders; the rise, progress, and condemnation of Jansenism in France, in the 17th and 18th centuries; the suppression of the Jesuits, in 1773, and overthrow of other monastic orders in France at the revolution, —an example since followed in other countries; the revival of the Jesuits, 1814. *In Reformed countries*, the early division of Protestants into Lutheran and Calvinist, besides many subordinate sects; the foundation of the church of England under Edward VI., partaking in some degree the character of the two; the rapid advance of Calvinism and kindred opinions in the 17th century in England, Holland, and Scotland; their decline in the first of these countries by the re-establishment of the church in 1660, and the prevalence of Arminian sentiments within it, and on the Continent by a gradual tendency to a more liberal system of theology; the establishment of the three confessions (Roman Catholic, Lutheran, and Reformed or Calvinist) on an equal footing in Germany by the peace of Westphalia, 1648; the gradual approach of Protestant, especially Lutheran, divines towards what has been called the rationalist system of religion in the last part of the 18th century; the rise of Methodism in England, and of cognate systems on the Continent; the union effected by the present king of Prussia and other German sovereigns between the Lutheran and Calvinistic bodies in their respective dominions.

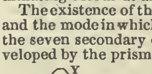
CHRISTIAN KNOWLEDGE, SOCIETY FOR PROMOTING. This society was founded in the year 1699 for the objects which the name imports. It promotes these objects principally by the diffusion of religious and moral tracts. It has also circulated vast numbers of copies of the Bible and Testament, and of the Book of Common Prayer and other authorized expositions of faith. It is entirely supported by the established church, and is a powerful engine for the instruction of the people in the principles of that body.

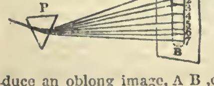
CHROMA'TIC. (Gr. χρωμα, *colour*.) In Music, the introduction of semitones between each of the tones in the diatonic scale.

CHROMA'TICS. (Gr. χρωμα.) That part of optics which treats of the colours of light and of natural bodies. This is a very important branch of physical science, and one which of late years has been prosecuted with great assiduity. Until Newton undertook his memorable experiments on the refraction of light, the cause of the different colours of bodies had never received any satisfactory explanation: such, indeed, was the difficulty which the ancients attached to this subject, that Plato considered it to be an usurpation of the rights of the Deity to attempt the investigation of this mystery of nature. The discovery of the difference of refrangibility in the coloured rays of the solar spectrum afforded a clue to the solution of the problem; and Newton demonstrated, by a series of decisive experiments, that colour depends not on any modification of light acquired by reflection or refraction, but is inherent in the light itself; the solar beam being composed of rays of all the colours contained in the spectrum, which are differently affected in passing through refracting media. This hypothesis of the existence of different species of luminous molecules is founded on the other hypothesis, that light is a substance emitted from the sun or luminous body, and is indeed a necessary consequence of that theory; for if colour depended merely on a difference of the masses, or of the initial velocities of the particles, it would follow that the dispersion of the rays, in passing through a prism, would always be proportional to the refraction, which, as is well known, is contrary to experience.

Colours of the Solar Spectrum. — Let a beam of solar light be admitted through a small aperture in the window shutter of a darkened room, and it will form on the opposite wall, or on a screen, a circular image of the sun. But if a prism, P, be interposed, the refracted beam, instead of forming a bright white spot, will produce an oblong image, A B, called the solar spectrum, the sides of which are terminated by two vertical straight lines, and the ends by semicircles. This lengthened image consists of *seven* principal colours, which melt into each other by insensible gradations; namely, *red*, *orange*, *yellow*, *green*, *blue*, *indigo*, and *violet*, arranged in the order now written, the red being at the lower end B. Newton, by whom this experiment was first performed, conceived these to be produced by so many distinct species of homogeneous light co-existing in the solar beam, and that all other shades of colour are produced by blending them together in certain proportions. As it is impossible to define the limit at which one colour ends and another begins, and as the spectrum is in fact composed of an infinite number of different shades, the above division is entirely arbitrary. Another observer of the phenomenon for the first time would probably have fixed on a greater or smaller number. Newton, it appears, was influenced by a fanciful idea that an analogy, or rather identity of ratios, subsists between the divisions of the spectrum formed by the seven colours which he assigned to it, and those of the musical scale. But the resemblance which suggested this analogy to Newton was purely accidental, and depended, as has since been found, on the nature of the substance of which his prism was formed; for though the colours are invariably arranged in the same order, they expand very differently, according to the nature of the refracting substance; and, consequently, the relative magnitudes of the spaces which they occupy in the spectrum are entirely altered. Tobias Mayer, in an essay, *De Affinitate Colorum* (Opera inedita, 1775), regards all colours as arising from three primitive colours, *red, yellow, blue*. But a mixture of red and green in certain proportions produces a colour which, so far as the eye can judge, is perfectly identical with the yellow of the spectrum; and a mixture of green and violet also produces a perfect blue: hence it was suggested by Dr. Young that the innumerable shades of the spectrum are all compounded of *red*, *green*, and *violet*. Sir David Brewster, however, inferred from experiments on the absorption of light in passing through coloured media, that green and violet are both compound colours, separable by prisms of coloured glass; and he adopts the hypothesis of Mayer, that the three simple homogeneous colours are red, yellow, and blue. He supposes the solar spectrum to consist of three spectra of equal lengths; a *red* spectrum, a *yellow* spectrum, and a *blue* spectrum. The primary red spectrum has its maximum of intensity about the middle of the red space in the solar spectrum; the primary yellow, about the middle of the yellow space; and the primary blue has its maximum between the blue and the indigo space; the two minima of each of the three spectra coinciding at the two extremities of the solar spectrum. From this view of the subject it follows that *red, yellow*, and *blue* light exist at every point of the solar spectrum; and that as a certain portion of red, yellow, and blue constitutes white light, the colour of every point of the spectrum may be considered as consisting of the predominating colour at any point mixed with white light.

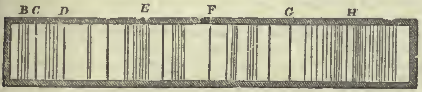
The existence of three primary colours in the spectrum, and the mode in which they produce by their combination the seven secondary or compound colours which are developed by the prism, are illustrated by Sir D. Brewster as follows: — Let M N be the prismatic spectrum consisting of three primary spectra of the same lengths, M N, viz., a red, a yellow, and a blue spectrum. The red spectrum has its maximum intensity at R; and this intensity may be represented by the distance of the point R from M N. The intensity declines rapidly to M and slowly to N, at both of which points it vanishes. The yellow spectrum has its maximum intensity at Y, the intensity declining to zero at M and N; and the blue has its maximum intensity at B, declining to nothing at M and N. The general curve which represents the total illumination at any point will be outside these three curves, and its ordinate at any point will be equal to the sum of the three ordinates at the same point. Thus the ordinate of the general curve at the point Y will be equal to the ordinate of the yellow curve, which we may suppose to be 10; added to that of the red curve, which may be 2; and that of the blue, which may be 1. Hence the general ordinate will be 13. Now, if we suppose that 3 parts of yellow, 2 of red, and 1 of blue make white, we shall have the colour at Y equal to 3+2+1, equal to 6 parts of white mixed with 7 parts of yellow; that is, the compound tint at Y will be a bright yellow, without any trace of red or blue. As these colours all occupy the same space in the spectrum, they cannot be separated by the prism; and if we could find a coloured glass which would absorb 7 parts of the yellow, we should obtain at the point Y a white light, which the prism would not decompose. (*Brewster's Optics*, in *Lardner's Cyclopædia*, p. 74.)





Dark Lines in the Spectrum.—One of the most curious, and, with reference to the theory of light, one of the most important optical discoveries of modern times, is the

existence of a great number of dark lines, or fixed rays, in the solar spectrum, parallel to one another, and perpendicular to its length. These dark lines were first perceived by Dr. Wollaston; but it was Fraunhofer, a celebrated optician of Munich, who first accurately described the phenomenon, and pointed out the uses to which it could be applied. In order to perceive these lines, considerable management is necessary. The prism employed must be perfectly free from veins, and the light must enter and emerge from it at equal angles; it is necessary also to employ a telescope. They are distributed very unequally through the spectrum, and the whole number amounts nearly to 600. Seven groups, which are more



easily perceived than the others, and which are distributed over the principal colours of the spectrum, have been distinguished by Fraunhofer by the letters B, C, D, E, F, G, H. Of these B is in the red space, near its outer end. C, which is a single line, and blacker than others contiguous to it, is near the limit of the red next the orange. D is in the orange, and near the yellow; it is composed of two lines of equal darkness very close to each other, and is easily distinguished. E is in the green, and consists of seven or eight rays. F is in the blue, G in the indigo, and H in the violet. Besides these there are several other very remarkable groups, particularly one in the green, between E and F, which is composed of three strong lines. The circumstance which renders the discovery of these lines extremely important is, that they always preserve the same relative positions in respect of the boundaries of the coloured spaces; and though their distances vary with the nature of the prism by which they are produced, their number and order remain absolutely invariable, so long as the light proceeds from the same source. For an account of the spectra formed by different lights, see *Brewster's Optics*, p. 87.

Colours of Natural Bodies. — The separation of light into different colours by refraction having been established as an optical fact, a different task remained, viz. that of showing in what manner refraction could take place so as to produce the permanent colours of natural bodies. Newton proved that the colour of any body is not the result of any quality inherent in that body, or in the particles by which it may be tinged, but is merely a property of the light in which they happen to be placed. The peculiar colours of bodies are only exhibited in a white light. If they are viewed by simple and homogeneous light of any colour, they appear of the colour of that light and no other. Thus, the leaf of a plant, for example, which in the white light of day appears green, if illuminated by homogeneous *red* light, appears *red;* if by homogeneous *yellow* light, *yellow*, and so on. Hence we conclude that one body is red, and another violet, because the one is *disposed* to reflect the red or least refrangible rays, and the other the violet or most refrangible. But the difficulty consists in explaining the cause of this *disposition* or transient condition of the body, which renders it fit to reflect rays of one colour and absorb those of another. Newton has attempted, in his *Treatise of Optics*, to refer it to the constitution or elementary structure of bodies. The principles or propositions on which his theory are founded are the following:— 1. Bodies that have the greatest refractive powers reflect the greatest quantity of light; and at the confines of equally refracting media there is no reflexion. 2. The least parts of almost all natural bodies are in some measure transparent. 3. Between the particles of bodies are many pores or spaces, either empty or filled with media of less density than the particles. 4. The particles of bodies, and their pores or spaces between the particles, have some definite size.

Upon these principles, Newton thus explains the origin of *transparency*, *opacity*, and *colour*. Transparency he considers as arising from the particles and their intervals or pores being too small to cause reflexion at their common surfaces, so that all the light which enters transparent bodies passes through them without any portion of it being turned from its path by reflexion. Opacity in bodies arises, he thinks, from an opposite cause; viz. when the parts of bodies are of such a size as to be capable of reflecting the light which falls on them, in which case the light is stopped or stifled by the multitude of reflexions. The colours of natural bodies have the same origin as the colours of thin plates or soap bubbles; their transparent particles, according to their several sizes, reflecting rays of one colour and transmitting those of another. For if a thinned or plated body, which, being of an uneven thickness, appears all over of one uniform colour, should be slit into threads, or broken into fragments of the same thickness with the plate or film, every thread or fragment should keep its colour; and, consequently, a heap of such threads or fragments should constitute a mass or powder of the same colour which the plate exhibited before it was broken; and the parts of all natural bodies being like so many fragments of a plate, must, on the same grounds, exhibit the same colour. (See *Newton's Optics*, book ii.; or *Brewster's Life of Newton*, p. 81.)

Such are the general principles of the Newtonian theory of colours; but there are numerous classes of phenomena, some of which were known in the time of Newton, but many more which have been discovered since, of which they fail to afford any explanation, and to which, indeed, they are wholly inapplicable. The ingenuity of its warmest supporters has not yet been able to explain by this theory the total absence of all reflected light from the particles of transparent coloured media, such as coloured gems, coloured glasses or fluids, &c. For these reasons, and many others depending on optical phenomena not connected with colours, philosophers have of late years manifested a disposition to abandon the theory of the emission of light, and to return to that of Huygens, who supposed light to be produced by the vibrations or undulations of an ethereal fluid of great elasticity, which pervades all space and penetrates all substances. *See* LIGHT.

Without entering into the subject of the propagation of light, it may be sufficient to remark, that the ordinary phenomena of colours may be explained on the principle of absorption. Every substance, how opake soever it may be, transmits light, at least through a very small thickness; thus gold when reduced into thin leaf is translucent. From this fact it is assumed as a principle, that every particle of ponderable matter has the faculty of absorbing or extinguishing a determinate fraction of the luminous rays which fall on it or pass very near it, the remainder being reflected or transmitted. This fraction varies with the colour or species of colour of the incident luminous rays, and with the nature of the particle. For light of the same colour we may suppose it constant, whatever be the number of incident rays: so that the intensity of a homogeneous light, which has traversed a diaphanous plate composed of equidistant particles of the same nature, will diminish in a geometrical, when the thickness of the plate increases in an arithmetical, progression. White light falling on the surface of an opake body is not totally reflected at the surface, for, as has been just remarked, no substance is perfectly opake: a portion of the incident light therefore penetrates the superficies of every body on which it falls, and is reflected by particles beneath the surface, and, in consequence of this interior reflection, is again emitted from the medium. But whilst the ray is thus penetrating and escaping from the body, the different colours of which it is composed suffer unequal absorptions; and on the totality of these absorptions depends the compound colour of the reflected ray, or the natural colour of the body. In this manner are explained the effects produced by coloured glasses, the blue colour of the sky, and the various tints of great masses of water.

The phenomena of the colours of thm lamina, as soap bubbles, plates of mica, and of striated and grooved surfaces, are among the most difficult of explanation; and it is here that the undulating theory, which accounts for them by the *interference* of the light reflected from the second surface of the plate with that reflected from the second, possesses its greatest advantage. For further information on this subject, see the terms INTERFERENCE, LIGHT, REFRACTION.

CHROMIUM. (Gr. χρωμα, *colour.*) A metal discovered by Vauquelin in 1797. It exists chiefly in two native compounds; the one formerly called *red lead* of Siberia, which is a *chromate of lead;* the other, a compound of the oxides of chromium and iron. Chromium is a whitish, brittle, and very infusible metal; sp. gr. 5·5. When heated with nitre it is converted into *chromic acid.* Its equivalent number is 28. It forms two compounds with oxygen,—a green oxide, and a red peroxide; the latter being sour, and combining with salefiable bases, is called *chromic acid.* The oxide consists of 28 chromium + 12 oxygen; and chromic acid of 28 chromium + 24 oxygen. Chromic acid is of a red colour, and forms a variety of *coloured* compounds, some of which are much used in the arts; such as the *chromate* and *bichromate of potash*, largely manufactured for the use of calico printers, and the *chromates of lead*, employed as yellow and red dyes and paints. The oxide of chroma is green, and furnishes a valuable colour for porcelain and in enamel. Chromic acid gives colour to the ruby, and the green of the emerald is due to oxide of chroma.

CHRO'NIC. (Gr. χρονος, *time.*) Diseases of long duration are termed *chronic*, in opposition to those of more rapid progress, which are called *acute*.

CHRO'NICLE. In Literature, an historical register of events in the order of time. Most of the historians of the middle ages were chroniclers who set down the

events which happened within the range of their information, according to the succession of years.

CHRO'NICLES. The name of two books in the canon of scripture. They consist of an abridgment of sacred history from its commencement down to the return of the Jews from the Babylonish captivity, and are called by the Septuagint παραλειπομενα (lit. things omitted), because they contain many supplemental relations omitted in the other historical books. It has been generally supposed that the Chronicles were compiled by Ezra, though circumstances are not wanting to diminish the probability of this conjecture. Eichhorn (*Einleitung*, vol. ii.) gives as his reasons for attributing them to Ezra their similarity in point of style, idiom, and orthography to the books of Kings and Ezra; while the opponents of this view base their opinion on the discrepancies that occur throughout Chronicles and Kings, in regard to facts, dates, numbers, names, and genealogies. (For a learned exposition of this subject, see the *Penny Cyclopædia*, and the authorities there referred to.)

CHRO'NOGRAM. (Gr. χρονος, *time*, and γραφω, *I describe.*) An inscription comprehending a date, which may be read by selecting all or some of the numeral letters, which are frequently written in these curious trifles in larger characters than the rest; as,

"ChrIstVs DVX ergo trIVMphVs."

(A medal of Gustavus Adolphus.) Sometimes united with an anagram; as one in honour of General Monk,

"GeorgIVs MonCe DVx de AumarLe;".

which may be read,

"Ego Regem reduxi, Ano. Sa. MDCLVV."

CHRONO'LOGY. (Gr. χρονος, and λογος, *discourse.*) Literally, the doctrine of time: is the science which treats of the various divisions of time, and of the order and succession of events.

In order to ascertain and register the intervals of time between different events, two things must necessarily be assumed: — 1st, An epoch or fixed point in time to which all events, whether preceding or succeeding, may be referred; and 2nd, A measure or definite portion of time, by which the intervals between the fixed epoch and other events may be estimated. Of these the first is entirely arbitrary, and the second arbitrary to a certain extent; for though certain periods are marked out by the recurrence of natural phenomena, a choice of these phenomena must be made. It is on account of the arbitrary nature of these two elements, on which all chronological reckoning depends, that so much confusion and uncertainty exist respecting the dates of historical events.

The diversity of epochs which have been assumed as the origin of chronological reckoning, is a natural consequence of the manner in which science and civilization have spread over the world. In the early ages the different communities or tribes into which mankind were divided began to date their years each from some event remarkable only in reference to its own individual history, but of which other tribes were either ignorant, or regarded with indifference. Hence not only different nations, but almost every individual historian or compiler of annals, adopted an epoch of his own. Events of local or temporary interest were also constantly occurring in every community which would appear of greater importance than those which were long past, and consequently be adopted as new historical dates. The foundation of a monarchy or a city, or the accession of a king, were events of this class; and accordingly are epochs of frequent occurrence in the ancient annals. Religion also came in to increase the confusion caused by political changes. Soon after the introduction of Christianity, the various sects began to establish eras, commencing with events connected with the appearance of Christ; but no regard was given to uniformity. In like manner, the Mohammedans employ dates having reference to the origin of their faith. All these circumstances have conspired to render it a task of extreme difficulty for modern historians to ascertain the order of the political occurrences of ancient times.

But it is not merely the number of chronological epochs and the various origins of eras that have caused the perplexity; the measure by which long intervals were compared varied in different countries, and in different ages, and hence arises another source of confusion in arranging the order of time. In the scripture history, the lapse of time is frequently estimated by generations or reigns of kings. Some of the historians of early Greece reckoned by the succession of the priestesses of Juno; others by that of the ephori of Sparta; and others again by the archons of Athens. Even when the length of the solar year began to be used as the measure of time, uniformity was not obtained. The length of the solar year is a fixed element in nature, and liable to no variation. But neither the commencement or termination of the year is marked by any conspicuous sign. Its precise length can only be ascertained by a long-continued series of astronomical observations. Rude nations were therefore unacquainted with it; and even when it had become known with considerable accuracy, it was still necessary to form a civil year, and adapt it to the seasons, the solar year not being composed of an exact number of days. Most nations had recourse to intercalations (*see* CALENDAR) for this purpose. The ancient Egyptians followed a purely solar year, which consisted of exactly 365 days. Its commencement, therefore, fell one day earlier with respect to the seasons every four years, and in the period of about 1460 years would successively fall on every day in the year, and a whole year be gained in the reckoning. The civil year of the Jews, the Greeks, and many other nations, was regulated partly by the sun and partly by the moon, which rendered its adjustment still more complicated and difficult. The Mohammedan year is purely lunar; and we can only pass from their calendar to the *Gregorian*, which is used in Christian countries, by first finding the number of days from the commencement of their era to any given event, and then turning them back into Gregorian years. (*See* HEGIRA.) The Chinese, Hindoos, and some other Asiatic nations, have epochs and methods of reckoning peculiar to themselves.

For these reasons, and numerous others that might easily be adduced, it is very seldom that the precise interval between the events mentioned in ancient history and modern dates can be determined with any degree of certainty, and great discrepancies exist among the computations of different chronologers. A remarkable instance of this occurs with regard to the computations made to determine the epoch of the creation of the world from the scripture history. Desvignoles, in the preface to his *Chronology of Sacred History*, mentions that he had collected upwards of two hundred different calculations, the shortest of which reckons only 3483 years between the creation and commencement of the common era, and the longest 6984; the difference being no less than thirty-five centuries. The most important works on chronology are, *Usher's Annales Veteris et Novi Testamenti; Newton's Chronology; Blair's Chronology and History of the World; Playfair's Chronology; Tables Chronologiques de l'Histoire Ancienne et Moderne*, by Thouret; and above all others, *L'Art de Verifier les Dates.*

CHRONO'METER. (Gr. χρονος, *time*, and μετρον, *measure.*) A watch of peculiar construction, and great perfection of workmanship, used for determining geographical longitudes, or other purposes where time must be measured with extreme accuracy. The chronometer differs from the ordinary watch in the principle of its escapement, which is so constructed that the balance is entirely free from the wheels during the greater part of its vibration; and also in having the balance compensated for variations of temperature. Marine chronometers generally beat half seconds, and are hung in gimbals, in boxes about six or eight inches square. The pocket chronometer does not differ in appearance from the ordinary watch, excepting that it is generally a little larger. Chronometers are of immense utility in navigation; and ships going on distant voyages are usually furnished with several, for the purpose of checking one another, and also to guard against the effects of accidental derangement in any single one. The accuracy with which some of the better sort of chronometers have been found to perform is truly astonishing; the error in a two months' voyage not exceeding two or three seconds.

CHRY'SALIS. (Gr. χρυσος, *gold.*) The second state of a Metabolian or changeable insect, in which it becomes inactive, takes no food, and is inclosed in a transparent covering, which in many instances reflects a metallic lustre; whence the name.

CHRY'SOBA'LANA'CEÆ. (Chrysobalanus, one of the genera.) A natural order of shrubby or arborescent Exogens, chiefly inhabiting the hotter parts of the world. They are very nearly related to *Rosaceæ*, from which they differ in having a style proceeding from the very base of the ovary, and irregular stamens and petals. The species are of little importance. The fruit of *Chrysobalanus icaco* is eaten in the West Indies under the name of the cocoa plum, and that of some others is used in other countries in a similar way.

CHRYSO'BERIL. This mineral occurs in small rounded masses, and in crystals; it is very hard, transparent or translucent, and of different shades of greenish yellow. It is employed in jewellery. It has been brought from Brazil; and is associated in the sand of the Ceylonese rivers with rubies and sapphires. The *cymophane* of Hauy, which is a species of chrysoberil, consists of alumina 76·7, glucina 17·8, oxide of iron 5·5.

CHRYSOCHLORE. (Gr. χρυσος, *gold*, and χλωρος, *green.*) A species of mole, *Chrysochloris capensis*, inhabiting the Cape of Good Hope, the fur of which reflects most brilliant metallic hues of green and gold.

CHRYSOCO'LLA. The Greek name for borax.

CHRYSO'GRAPHY. (Gr. χρυσος, *gold*, and γραφω,

I write.) The art of writing in letters of gold: a sumptuous fashion, practised by the writers of manuscripts, chiefly in the early part of the middle ages, when the leaves of parchment which contained the writing were also dyed with purple and other colours.

CHRY'SOLITE. (Gr. χρυσος, and λιθος, *a stone.*) A crystallized mineral, often of a golden yellow colour. It is a ferriferous *silicate of magnesia*, and is sometimes used in jewellery.

CHRYSO'LOGY. (Gr. χρυσος, *gold*, and λογος, *discourse.*) A name by which some Continental writers distinguish that branch of political economy which relates to the production of wealth.

CHRYSO'MELA. (Gr. χρυσος, *gold*, and μελας, *black.*) The name of a Linnæan genus of Coleopterous insects, now the type of an extensive group, divisible into three families; viz. the *Chrysomelidæ* proper, characterized by having the antennæ remote from each other at the base; *Cassididæ*, having the antennæ arising close together, but concealed at the base by the thorax; and *Galeracidæ*, having the antennæ close together at the base, but not concealed by the thorax. The characters which these three families possess in common are, a small body of an oval or rounded form; antennæ seldom so long as the body; legs of a moderate length, but rather thickened; and tarsi with the three basal joints dilated and spongy beneath, forming a kind of cushion. The insects of the present tribe are of sluggish habits, and feed upon the leaves of various vegetables, both in the larva and imago state, being characterized in the latter period by their brilliant metallic tints; whence their name. The larva of one of the British species (*Eumolpus vitis*, Fabr.) preys upon the young buds and leaves of the vine, and by its attacks upon the footstalk of the grape bunch so injures the nutrient vessels, as to cause the destruction or deterioration of the fruit. In the wine countries of Europe the ravages of this insect are often very serious, and much dreaded.

CHRY'SOPRASE. (Gr. χρυσοπρασος.) A pale green silicious mineral, generally semitransparent. It is tinged by oxide of nickel, and much esteemed for ornamental purposes.

CHURCH. (Gr. κυριακον, from κυριος, *Lord.*) A building dedicated to the Lord. The word *church*, however, is not confined to this signification, but answers to all the senses in which ἐκκλησια (Fr. église) is used in the New Testament, which, from its original meaning of a *convened assembly*, is employed, 1st, to denote the whole body of true believers, or the visible church; 2nd, in addition to these, the spirits of the just made perfect, or the invisible church; 3rd, any congregation of Christians met together in a single place, or the body of believers resident in a town or district; and 4th, the edifice in which they meet for divine worship. To these we may add a fifth sense of the modern term church, when it is applied to a distinct religious community; as the Romish, the English, the Lutheran, &c. The true definition of the visible church has been a matter of much controversy. The English church, in her 19th article, explains it to be "a congregation of faithful men, in which the pure word of God is preached, and the sacraments duly administered, according to Christ's ordinance, in all those things that of necessity are requisite to the same." What these necessary requisites are is not dogmatically laid down, whence many communities come to be comprehended in the visible church by English divines which the Romish and other authorities exclude. Many sects, however, extend the pale still further, not considering the reception of the sacraments as any test of churchmanship, but referring it solely to the earnest belief and moral conduct of individuals.

CHURCH. In Architecture, a building dedicated to the performance of Christian worship. Under the art. ARCHITECTURE an account is given of the Basilicæ which were first used for the assembly of the early Christians, to which the reader is referred. Among the first of the churches was that of St. Peter's at Rome, about the year 326, nearly on the site of the present church; and it is supposed that the first church of St. Sophia at Constantinople was built somewhat on its model. That which was afterwards erected by Justinian seems in its turn to have afforded the model of St. Mark's at Venice, which was the first in Italy constructed with pendentives and a dome, the former affording the means of covering a square plan with an hemispherical vault. The four most celebrated churches in Europe erected since the revival of the arts are, St. Peter's at Rome, which stands on an area of 227,069 feet superficial; Sta. Maria del Fiore at Florence, standing on 84,802 feet; St. Paul's, London, which stands on 84,025 feet; and St. Genevieve at Paris, 60,287 feet. The churches on the Continent are usually ranged under seven classes: *Pontifical*, as St. Peter's, where the pope occasionally officiates; *Patriarchal*, where the government is in a patriarch; *Metropolitan*, where an archbishop is the head; *Cathedral*, where a bishop presides; *Collegiate*, when attached to a college; *Parochial*, attached to a parish; and *Conventual*, when belonging to a convent.

CHU'SITE. (Gr. χυω, *I pour.*) A very fusible mineral found near Limbourg.

CHYA'ZIC ACID. From the initials of *carbon*, *hydrogen*, and *azote*. A term applied to the compounds of hydrocyanic acid.

CHYLE. (Gr. χυλος.) The nutritious fluid prepared from the chyme, and imbibed by the lacteals to be conveyed to the thoracic duct and venous system. It contains about 10 per cent. of solid matter. In most mammals it is white; in birds transparent, except in some that live on ants and insects, as the wood-pecker, which has been observed to be opake; it is white in the crocodile, but colourless and transparent in other reptiles and in fishes.

CHY'LOPOIE'TIC. (Gr. χυλος, and ποιεω, *I make.*) Organs concerned in the formation of chyle; hence the stomach, duodenum, and liver are termed chylopoietic viscera.

CHYME. (Gr. χυμος, *juice.*) The pulpy layer of nutritious digested matter which adheres to the inner surface of the intestine, and yields the chyle by admixture with the biliary secretion.

CIBO'RIUM. (Gr. κιβωριον.) In Architecture, an insulated erection open on each side, with arches, and having a dome of ogee form carried or supported by four columns. It is also used to denote the coffer or case which contains the Host.

CICA'DA. (Lat. *a grass-hopper.*) The name of a Linnæan genus of insects, celebrated in all ages for their powers of song or shrill chirp.

> Et cantu querulæ rumpent arbusta cicadæ,
> (*Georgics*, iii.)

sings Virgil; which Dryden renders,

> When creaking *grass-hoppers* on shrubs complain:

although it is evident that Virgil alluded to the insects of the present genus, which habitually frequent shrubs and trees, and feed on their juices, having a peculiar apparatus for piercing the bark and sucking out the juice. They are therefore more accurately described by Lord Byron, as

> The shrill Cicadæ, people of the pine.

The *manna* of the shops is the inspissated juice of the *Fraxinus ornus*, poured out from the wounds inflicted by the *Cicada orni*. The organ of sound is peculiar to the male, and is situated on each side of the under and anterior part of the abdomen. The insects referable to the Linnæan genus *Cicadæ* are now separated into three families — *Cicadidæ*, *Fulgeridæ*, and *Cercopidæ*.

CICA'TRIX. (Lat.) The scar which remains after the skinning over of a wound.

CICERO'NE. (Ital.) A name originally given by the Italians to those persons who pointed out to travellers the interesting objects with which Italy abounds; but applied universally at present to any individual who acts as *a guide*. This application of the term Cicerone has probably its origin in the ironical exclamation, "E un Cicerone" (he is a Cicero), being elicited from the traveller by the well-known garrulity of the Italian guides.

CICHORA'CEÆ. (Gr. κιχωρη, name of the herb *Cichory.*) One of the four divisions of *Compositæ*, a very extensive order of herbaceous or shrubby Exogens. The plants belonging to this division have a milky juice, and form a connecting link between *Compositæ* and *Campanulaceæ*. They inhabit the whole world, and are characterized by all the florets of the flower-heads being alike and ligulate. Lettuce, succory, and endive are familiar examples of *Cichoraceæ*, which are generally bitter, with a soporific quality resembling that of opium.

CICI'NDELA. (Lat. cicendela, *a glow-worm.*) A name applied by Linnæus to a genus of beetles, which is placed at the head of the order *Coleoptera*, from the circumstance of the outer lobe of the maxillæ being converted into an additional pair of feelers, called internal maxillary palpi. The mandibles are very strong, and armed with strong teeth; the maxillæ are terminated by a moveable spur; the eyes are large and prominent; and the wings generally well developed. Endowed with such powers of perception, locomotion, and destruction, it may be readily inferred that these insects are a cruel and predatory race. Like the carnivora of a higher class, they are remarkable for the beauty of their colours, and were termed by Linnæus the tigers of the insect world. The species referable to the Linnæan *Cicindela* are extremely numerous, and are divided into twenty subgenera; of which one only is British, and to this the term *Cicindela* is restricted.

CICISBE'O. (Ital.) A word synonymous with *cavalier servente*, and applied to a class of persons in Italy who attend on married ladies with all the respect and devotion of lovers. Formerly the establishment of a fashionable lady was not considered complete without a cicisbeo, whose duty it was to accompany her to private parties and public amusements, to escort her in her walks, and in short to be always at her side ready for her commands. This practice is now, however, on the decline. Though

the office of a cicisbeo has been the subject of frequent invective, it has not been without its advocates and admirers. Among others, Baretti has taken great pains to vindicate this custom in his *Account of the Manners, &c. of Italy*, vol. i. c. 8. He ascribes it to a spirit of gallantry derived from the ages of chivalry, and much heightened and refined by the revival of the Platonic philosophy in Italy about the 13th century, and by the verses of Petrarch and his numerous imitators.

CICO'NIA. (Lat. *a stork.*) A genus of wading birds of the tribe *Cultrirostres* of Cuvier; including the white stork (*Ciconia alba*), the black stork (*Ciconia nigra*), and the American stork (*Ciconia magnari*).

CID. (Arab. seid, *lord.*) The name given to an epic poem of the Spaniards which celebrates the exploits of their national hero, Roderigo Diaz, Count of Bivar. It is supposed to have been written in the 13th century, about 150 years after the hero's death; but unfortunately the author's name has not been transmitted to posterity. (See *Southey's Chronicle of the Cid.*)

CI'DER. A fermented liquor made from the juice of apples. Cider is made in all the temperate climates of the world which are not sufficiently warm for maturing the grape, and where the cold is not so great as to reduce the inhabitants to only the beer produced by a fermented decoction of grain. Cider is formed by grinding or crushing the apples when ripe, either in a circular stone trough by a stone roller turned by a horse (which is the common practice in Worcestershire, Herefordshire, &c.), or between fluted or spiky, and afterwards between smooth rollers of wood or iron, driven by men (as practised in Devonshire, and in most places where cider is made on a small scale). The apples, including the core and the seeds, being reduced to a pulp by crushing or grinding, the mass is put into a haircloth and powerfully pressed; and the liquor which runs from it is put into casks, where it is allowed to ferment, the casks being freely exposed to the air in the shade; the progress of the fermentation is then carefully watched, and as the sediment has subsided the liquor is racked off; on the proper time being chosen for doing this depends the excellence of the cider. The best cider, other circumstances being the same, is that in which the fermentation has gone on slowly, and where the vinous fermentation has not gone so far as to become acetous. The check to fermentation consists in racking off from one cask to another. Before winter the casks are removed to a cellar, and by the following spring the liquor is fit for use, or for bottling. The principal cider counties in England are Worcestershire, Herefordshire, and Devonshire. The Worcestershire and Herefordshire cider will keep from twenty to thirty years; while the best Devonshire cider will rarely keep more than five or six years.

CI'LIA. (Lat. cilium, *an eyelash.*) The hairs which grow from the margin of the eyelids; the term is also applied to microscopic filaments or plates which project from animal membranes and are endowed with quick vibratile motion. In most of the lower animals the respiratory function is effected by means of the vibratile cilia; many animalcules and the gemmules of the Acrites move by a similar mechanism; and it has recently been ascertained that vibratile cilia have a share in the performance of some important functions in the highest classes of the animal kingdom, where they have been detected on the membrane lining the female generative and respiratory passages, and the ventricles of the brain.

Cilia. In Botany, long hairs situated upon the margin of a vegetable body, as on the leaves of the *Sempervivum tectorum.*

CI'LIARY. (Lat. cilium.) The *ciliary ligament* of the eye is the circular portion that divides the choroid membrane from the iris, and which adheres to the sclerotic coat. The *ciliary processes* are the white folds at the margin of the *uvea* in the eye, which proceed from it to the crystalline lens.

CI'LIATED. (Lat. cilium.) A term used in describing the surface of an organ, to denote the presence at the margin of fine hairs resembling the eyelash, as in the leaves of *Luzula pilosa.*

CI'LIOGRADE, *Ciliograda.* (Lat. cilium and gradior, *I proceed.*) The name of a tribe of Acalephans or sea-nettles, comprehending those which swim by means of cilia.

CI'MEX. (Lat. cimex, *a bug.*) A Linnæan genus of Hemipterous insects, now subdivided into the following families,—*Pentatomidæ, Coroidæ, Lygoidæ, Cypridæ, Cimicidæ, Reduviidæ, Acanthidæ, Hydrometridæ.* Each of these families includes several genera, and each genus comprises many species; in all the mouth consists of one lengthened and jointed proboscis, including several fine sharp bristle-like processes, which are employed in wounding the vegetable or animal substances on the juices of which these insects feed. The bed-bug (*Cimex lectularius*) may be regarded as a type of this extensive tribe of insects.

CI'MOLITE. A mineral found in the island of Cimola in amorphous earthy masses: it is a hydrated silicate of alumina.

CINCHO'NA. The generic name of certain trees yielding a bitter febrifuge bark, the virtues of which are to be ascribed to the presence of the vegetable alkaloids called *cinchonia* and *quinia.*

Three species of cinchona bark are directed in the London Pharmacopœia to be kept for medical use; namely, the *pale, yellow,* and *red barks.* The first of these is furnished by *C. condaminea,* and contains cinchonia; the second, yielded by *C. lanceolata,* produces quinia; and the third, whose origin is not ascertained, possesses a mixture of the two.

CINCHONA'CEÆ. (Cinchona, one of the genera.) A natural order of shrubby or arborescent Exogens, almost exclusively inhabiting the tropics and the hotter parts of the world. They are in some respects allied to *Compositæ,* from which their distinct stamens, bilocular or plurilocular ovary, and inflorescence distinguish them. They are divided from *Apocynaceæ* by the æstivation of the corolla, the presence of stipules, and the inferior ovary; although, according to Brown, there exists a genus in equinoctial Africa which has the interpetiolary stipules and seeds of *Cinchonaceæ,* and the superior ovary of *Apocynaceæ,* thus connecting the two orders. They are most nearly related to *Caprifoliaceæ,* being only separated from them by their interpetiolary stipules. Brown describes a tribe called *Opercularineæ* as having but one seed, and the number of stamens unequal to the lobes of the corolla; thus occupying, as it would seem, an intermediate position between *Cinchonaceæ* and *Dipsaceæ.* Powerful febrifugal properties in their bark or emetic in the roots are the great features of this order, the most efficient products of which are *cinchona* and *ipecacuanha.* Many of the plants of the order are fragrant and of great beauty; but, with the exception of the *Gardenea, Lucula,* and a few others, the handsome kinds are hardly known to cultivators.

CI'NCTURE. (Lat. cingo, *I surround.*) In Architecture, the ring, list, or fillet at the top and bottom of a column, which divides the shaft of the column from its capital and base.

CINE'REOUS. (Lat. cinis, *ashes.*) Grey; the colour of wood-ashes.

CI'NGULUM. (Lat. cingulum, *a girdle.*) In Zoology, is technically applied to the neck of a tooth, or to that more or less distinct constriction which separates the crown from the fang. The term *cingula* is also given to the transverse series of bony pieces connected together by tegumentary flexile joints, as in the middle part of the armour of the armadillo.

CI'NNABAR. An Indian name, given, according to Pliny, to a mixture of the blood of the dragon and elephant, and other substances of similar colour. It is now exclusively applied to the red pigment called *vermilion.* It is a *bisulphuret of mercury,* composed of 200 mercury + 32 sulphur.

CI'NNAMON. The bark of the *Cinnamomum zeylanicum.* This tree is a native of Ceylon, whence the finest cinnamon is obtained; it is of an astringent and highly aromatic and warm flavour, and yields by distillation an extremely fragrant and pungent volatile oil, kept for pharmaceutical use under the name of *oil of cinnamon.* An inferior kind of cinnamon is often met with in commerce, which is remarkably deficient in flavour.

CI'NNAMON STONE. (So called from its colour.) A silicate of lime, alumine, and oxide of iron, from Ceylon. It occurs massive and in rounded pieces in the sand of rivers; some of these are occasionally cut and polished for jewellery.

CINQUE PORTS, or FIVE PORTS. The seaport towns of Dover, Sandwich, Hastings, Hithe, and Romney; to which three others were afterwards added, viz. Winchilsea, Rye, and Seaford. These towns are incorporated, with peculiar privileges; are under the government of a lord warden, to whom writs for the return of members to parliament from them are directed; and the members so returned are termed Barons of the Cinque Ports.

CI'PHER. (Heb. saphar, *to number.*) The character 0 in numeral notation, which, standing by itself, signifies *nothing,* or the privation of value. When combined with other numeral characters, its use is to determine their position with regard to the unit's place, and consequently the power of ten, by which their absolute values must be severally multiplied to produce the number they are intended to represent.

Cipher is sometimes used in common language to signify any arithmetical character; hence the verb *to cipher,* which signifies to perform an arithmetical operation. This term, which is found in all European languages, was no doubt introduced into Spain by the Saracens, along with the Arabic figures, which appear to have come into use among astronomers in the thirteenth or early in the fourteenth century (for the time of their first introduction is not certainly known), and to have been gradually circulated over Europe in the almanacs.

CI'POLIN. A green marble with white zones, somewhat like the section of an onion.

CI'RCINNATE. (Lat. circino, *I make a circle.*) A term used in describing the æstivation of flowers, and the direction of plants in general, to denote those which are rolled spirally downwards, so that they are bent like the head of a crosier; as the shoots of young ferns, the inflorescence of Boraginaceous plants, the leaves of the Sundew.

CI'RCLE. (Lat. circulus.) In Geometry, a plane figure contained by one line, which is called the circumference, and such that all straight lines drawn from a certain point within the figure to the circumference are equal to one another. The point which possesses this property is called the centre of the circle. The straight line and the circle are the only figures admitted into plane or elementary geometry, all questions in that branch of mathematics depending on the intersections of straight lines with straight lines, of straight lines with circles, or of circles with circles. This distinction was established by the ancient geometricians, who regarded the other geometrical figures as formed by the intersections of planes with solids, and thence denominated problems, for the solution of which the properties of other figures than the straight line and the circle were required,—*solid problems.* The algebraic analysis points to a different distinction. An equation between two indeterminate quantities, neither of which rises above the first degree, represents a straight line. When either or both of the interminate quantities rise to the second degree, the equation may represent a circle, an ellipse, an hyperbola, or a parabola. The circle thus belongs to the same class of curve lines as those which have been termed conic sections; and in fact a cone may be cut by a plane so that the section shall be a circle, as well as any one of the other three curves.

The circle derives its chief importance from its application to trigonometry, or the measurement of angles. Instead of directly comparing angles with one another, it is more convenient to compare the arcs (described with the same radius) contained between the sides of the angle. The numerical relations of different angles, or the corresponding arcs, are expressed as follows:—The circle is divided into four equal parts, and the four portions of the circumference thus formed serve as the measure of four right angles, which comprehend the whole space about the centre. Each of these *quarters* of the circumference is divided into 90 equal parts, called *degrees.* The whole circumference, therefore, contains four times 90, or 360 degrees. This division, adopted in the most ancient times, appears sufficiently capricious; nevertheless it is very convenient, inasmuch as the number 360 contains many primes, and consequently permits many subdivisions into parts expressible by whole numbers. Thus, the half contains 180 degrees; the third, 120; the fourth, 90; the fifth, 72; the sixth, 60; the eighth, 45; the tenth, 36; the twelfth, 30; the fifteenth, 24, &c. In order to measure smaller parts of an angle than a degree, the degree is subdivided into 60 minutes or *primes*, and the minute into 60 seconds. Since the decimal arithmetic came into general use, the sexagesimal division is not carried farther than seconds in expressing angular magnitude, the parts of a second being now always represented by decimals. The whole circumference of the circle contains 21,600 minutes or 1,296,000 seconds.

The rectification of the circle, or the determination of the ratio of the circumference to the diameter, is a problem which has exercised the ingenuity of mathematicians in all ages. It cannot be expressed in finite numbers; but numerous series have been invented from which it may be computed to any required degree of precision. Archimedes, in his treatise *De Dimensione Circuli*, proved that if the diameter is expressed by 7, the circumference is very nearly 22. A nearer ratio, which is generally used in ordinary measurements, is 113 to 355; and it has the advantage of being easily remembered, the numbers being formed of the three first odd numbers, each repeated. Vieta carried the approximation to 10 places of figures, and Van Ceulen to 36. Mr. Abraham Sharp computed the ratio to 72 places of figures; and finally De Lagny, in the *Memoirs of the Academy of Sciences of Paris*, extended it to 128; an example of patient industry without a use. Supposing the diameter 1, the first thirty-six figures by which the circumference is expressed (or the ratio found by Van Ceulen) are

3·14159,26535,89793,23846,26433,83279,50288.

Of the series by which the circumference is expressed in terms of the diameter, one of the simplest is

$$c = 4 \times \left(1 - \tfrac{1}{3} + \tfrac{1}{5} - \tfrac{1}{7} + \tfrac{1}{9} - \tfrac{1}{11} + \tfrac{1}{13} - \tfrac{1}{15} +, \&c.\right);$$

but the following is better adapted for calculation,

$$c = 4 \times \left(1 - \frac{\cdot 1}{2 \cdot 3} - \frac{1}{2 \cdot 4 \cdot 5} - \frac{1 \cdot 3}{2 \cdot 4 \cdot 6 \cdot 7} - \frac{1 \cdot 3 \cdot 5}{2 \cdot 4 \cdot 6 \cdot 8 \cdot 9}, \&c.\right)$$

The areas of circles, as of plane similar figures, are to one another in the ratio of the squares of their diameters. If the diameter is unit, the area is one fourth of the circumference, and is expressed by the decimal ·7853981633974483, &c. to sixteen places. This is nearly in the proportion of 14 to 11, which was the approximation given by Archimedes. Some of the series by which the ratio of the area of a circle to the square of its diameter is expressed are curious. The following was given by Dr. Wallis in his *Arithmetic of Infinities:*—

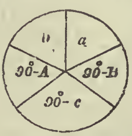
$$\frac{2 \times 4 \times 4 \times 6 \times 6 \times 8 \times, \&c.}{3 \times 3 \times 5 \times 5 \times 7 \times 7 \times, \&c.}$$

This is the same as $\frac{8}{9} \times \frac{24}{25} \times \frac{48}{49} \times$, &c., the denominators being the squares of the odd numbers, and the numerators differing from the denominators by unity. Since the invention of the infinitesimal calculus the discovery of series for the rectification and quadrature of the circle is a matter of comparative facility. A number of them may be seen in *Euler's Introductio in Analysin Infinitorum.*

CI'RCUITS. (Lat. circumeo, *I go round.*) In England, Scotland, and Ireland, divisions of the kingdom appointed for the judges of assize; two of whom go each circuit twice a year, to deliver the gaols and try issues at nisi prius. England is divided into six circuits—Home, Midland, Oxford, Norfolk, Western, Northern; Wales into the North and South Welsh circuits. A single judge travels each of the Welsh circuits, and these two meet at Chester to transact the business of that county. The judges choose their own circuits; the three chiefs, and the puisne judges, in order of seniority, making their election. The circuits are after Hilary and Trinity Terms, and vary in their duration from three to seven or eight weeks. (*See* COURTS, SUPERIOR; and ASSIZE.) The circuit or assize towns in most counties have been fixed by immemorial usage, but some changes have recently been made by the authority of the privy council. Barristers at the common law bar choose their circuits on first embarking in their profession, and etiquette allows of only one subsequent change. The insolvent commissioners also make circuits thrice a year through the kingdom for the discharge of debtors.

CI'RCULAR INSTRUMENTS. The name given to any astronomical or nautical instrument for measuring angles, in which the graduation extends round the whole circumference, or to 360°. Formerly it was thought sufficient to carry the divisions over a portion of a circle only, whence the quadrants, sextants, and octants, once so common; but experience has shown that entire circles (especially where the instruments are of considerable size) have a great advantage over graduated segments; and hence, excepting the sea-sextant, the latter are now seldom used. The principal circular instruments used in astronomy are *altitude* and *azimuth circles*, *mural circles*, *reflecting circles*, and *repeating circles.* The altitude and azimuth circle, as its name implies, is used for measuring the altitudes and azimuths of stars; it is consequently composed of two graduated circles, one vertical and the other horizontal. This is a sort of universal instrument, being applicable to almost all the purposes of astronomy. The *mural circle* is so called because it is supported by means of a long axis passing into a *wall*, the plane of the circle being parallel to the wall. The instrument is placed in the meridian, and is used for determining the polar or zenith distances of celestial objects. (*See* MURAL CIRCLE.) The *reflecting circle* carries a mirror, by means of which an object is seen by reflected vision; another object is viewed directly; the two are brought to coincide, and the angular distance between them is measured by the inclination of the mirror to the axis of the telescope. (*See* SEXTANT.) The *repeating circle*, or *multiplying circle*, is so contrived that the observer is enabled to repeat or multiply the observation, by reading it off successively on different parts of the graduated limb. A number of values being thus found, the mean of the whole is taken as the correct result. This instrument is sometimes called Borda's circle, from the name of its improver. *See* REPEATING CIRCLE.

CI'RCULAR PARTS. In Trigonometry, the name given to a proposition invented by Lord Napier, and demonstrated in his *Mirifici Logarithmorum Canonis Descriptio*, which gives all the relations between the parts of a right-angled spherical triangle in two formulæ. It is this:—In any right-angled spherical triangle, let *a* and *b* denote the sides, *c* the hypothenuse, and A and B the angles opposite to *a* and *b* respectively. Take the two sides, and the complements of the hypothenuse and of the two angles, and write them in order round a circle, as in the annexed diagram; then, if any one part be called the *middle* part, the two next to it are the *adjacent* parts, and the other two the *opposite* parts; and the two following rules will hold good:—



1. The sine of the *middle* part is equal to the product of the tangents of the *adjacent* parts. 2. The sine of the middle part is equal to the product of the cosines of the *opposite* parts. Thus,

$$\text{Sin. } a = \tan. b, \tan. (90 - B).$$
$$\text{Sin. } a = \cos. (90^\circ - A) \cos. (90^\circ - c).$$

CI'RCULATING DECIMALS. Are decimals in which two or more figures are constantly repeated in the same order; thus, 09, 09,09, &c.; 234,234,234, &c.; ·142587, ·142857, 1, &c. A decimal of this sort is equal to a vulgar fraction of which the numerator is the *period* or circulating figures, and the denominator as may *nines* as there are figures in the numerator.

CIRCUMCI'SION. The initiatory rite of the Jewish covenant; which, as is recorded, was first enjoined to Abraham by God, and after his posterity had neglected it during their wanderings through the desert, was solemnly renewed upon the passage of the Jordan. (Josh. v. 1—10.)

This custom of cutting off the foreskin has been long prevalent among Eastern nations. Herodotus refers to it as the practice of the Egyptians and Ethiopians, and as borrowed from them by the Phœnicians and Syrians. It does not appear, however, to have been considered by these nations in the light of a religious ceremony. It is enforced by the Koran upon all the disciples of Mahomet, whether from an idea of salubrity vulgarly attributed to it in the East, or merely as a distinguishing rite.

CIRCU'MFERENTOR. An instrument used by surveyors for taking angles. It consists of a graduated brass circle and an index all of one piece, and carrying a magnetic needle suspended above the centre of the circle. The index being directed to an object, the angle which it makes with the magnetic meridian is noted. The index is then directed to the second object, and the angle it makes with the same meridian observed in like manner. The difference (or sum, as the case may be) of the two observed angles gives the angle between the two objects. It is evident that only a very rough approximation can be obtained in this manner. For the purposes of surveying, a pocket sextant is a far preferable instrument.

CI'RCUMFLE'XUS A muscle of the palate: the term is also applied to arteries which wind round bones or joints.

CI'RCUMPO'LAR STARS. Are those stars which at any given place move round the pole, or complete their diurnal circles, without setting. The number of stars so circumstanced increases with the latitude of the place or the elevation of the pole above the horizon.

CIR'CUMSCI'SSILE. (Lat. circumscindo, *I cut round.*) A mode of dehiscence observed in the fruit of some plants; it occurs by a transverse circular separation of the sides of the ovary, as in *Anagallis*, *Hyoscyamus*, and is analogous to the transverse articulations found in the leaf of the orange or the pod of ornithopus.

CI'RCUMSCRI'PTION. (Lat. circumscriptio, *a boundary.*) The line representing the two edges of a leaf, *i. e.* its margin; it is also used to denote the figure represented by the margin of any other body.

CI'RCUMVALLA'TION. (Lat. circum, *about*, and vallum, *a rampart.*) In Fortification, a trench or bulwark thrown up about a camp or besieged city, composed of the earth dug up from the ditch and of sharp stakes planted in it.

CI'RCUS. A straight long narrow building, whose length to its breadth was generally as five to one. It was divided down the centre by an ornamented barrier called the spina, and was used by the Romans for the exhibition of public spectacles and chariot races. There were several of these at Rome, of which the most celebrated was the Circus Maximus.

Julius Cæsar improved and altered the Circus Maximus; and that it might serve for the purpose of a naumachia, supplied it with water. Augustus added to it the celebrated obelisk now standing in the Piazza del Popolo. No vestiges of this circus remain. Besides these were at Rome the Circi of Flaminius, near the Pantheon; Agonalis, occupying the site of what is now the Piazza Navona; of Nero, on a portion whereof St. Peter's stands; Florus, Antoninus, and Aurelian, no longer even in ruins; and that of Caracalla, which was 738 feet in length, and is sufficiently perfect in the present day to exhibit its plan and distribution in the most satisfactory manner.

The spectacles exhibited in the circus were called the Circensian Games, and consisted chiefly of chariot and horse races. The Romans were passionately fond of them, and more particularly of the chariot races, which excited so great an interest in the times of the emperors as to divide the whole population of the city into factions, known by the names of the colours worn by the different charioteers. The disputes of these factions sometimes led to serious disturbances, and even bloodshed.

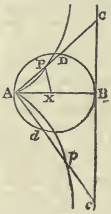
CI'RRHOUS. (Lat. cirrus, *a tendril.*) A term used in describing the apices of bodies, to indicate those that are terminated by a spiral or flexuose filiform appendage, arising from an elongation of the costa, as in the leaf of *Gloriosa lupercha.* It is also applied to modifications of branches, inflorescence, the petiole, &c. when such parts assume the state of a twisting body, which enables the plant belonging to it to raise itself upon neighbouring objects.

CI'RRIPEDS, *Cirripedia.* (Lat. cirrus, and pes, *a foot; curly-footed.*) A class of fixed homogangliate animals, characterized by having a number of long, curled, articulated, setigerous processes, analogous to the feet of the Crustaceans, which project from the central aperture of the multivalve shell protecting the body. These animals are commonly called barnacles and acorn-shells. *See* LEPADITES and BALANITES.

CI'RROUS. Furnished with tendril-like appendages.

CI'RSOCE'LE. (Gr. *κιρσος, a dilated vein,* and *κηλη, a tumour.*) A morbid enlargement of the spermatic veins in the groin.

CI'SSOID. In Geometry, a curve line of the second order, invented by Diocles, with a view to the solution of the famous problem of the *duplication of the cube*, or the insertion of two mean proportionals between two given straight lines. Its name is derived from *κισσος, ivy;* because the curve appears to mount along its asymptote as ivy climbs on the tall trunk of a tree. The curve is described as follows:—



From A, one of the extremities of the diameter of a circle, draw a straight line, A C (or a c), to meet the tangent through the other extremity, and make C P equal to the intercepted chord A D; the point P will trace the cissoid. The line A C may be conceived to turn on both sides of the diameter A B till it falls into the position of a tangent to the circle at A. The curve, therefore, consists of two infinite branches, which approach always nearer to the tangent C B c without ever meeting it, whence this line is an asymptote to the cissoid. The point A being taken for the origin of the co-ordinates, and the diameter A B as the axis of the abscissa, the equation of the curve is $x^3 = (a-x)\, y^2$, a being the diameter of the generating circle. One of the most remarkable properties of the cissoid is, that the whole space lying between the double branches and the asymptote is equal to triple the area of the generating circle. A method of describing the cissoid mechanically by the motion of a rectangular rule, is given in *Newton's Universal Arithmetic.*

CIST. (Gr. *κίστη, a chest.*) In Architecture and Sculpture, a chest or basket. It is a term usually applied to the mystic baskets employed in processions connected with the Eleusinian mysteries. They were originally of wicker work, and when afterwards made of metal the form and texture were preserved in imitation of the original material. When sculptured on antique monuments it indicates some connection with the mysteries of Ceres and Bacchus.

CISTA'CEÆ. (Cistus, one of the genera.) A natural order of shrubby or herbaceous Exogens inhabiting chiefly the countries of the south of Europe and North America. They are distinguished from *Violaceæ* by their indefinite stamens and inverted embryo; from *Bixaceæ* by the last character, by their mealy albumen, habit, and not having the leaves ever dotted; from *Hypericaceæ* by the latter character, and the structure of the fruit. They are allied to *Papaveraceæ* by the genus *Dendromecon;* but their true station appears to be in the vicinity of *Linaceæ*, to which they approach by the genus *Lechea.* They are often plants of great beauty, but possess no sensible properties, excepting the *Cistus creticus* and a few others, which yield the resinous balsamic substance called gum labdanum.

CI'STERN. (Lat. cisterna, from Gr. *κίστη.*) In Architecture, a reservoir or receptacle of water for public or domestic use. When made of brick or stone it is commonly called a tank.

CI'STVAEN. A species of stone receptacle, often found in barrows (generally at the east end), containing the bones of the persons interred there. Cistvaens are commonly three stones placed on edge, like the three sides of a box, with a stone cover. Some which are styled cistvaens by Sir R. Hoare and other antiquaries are, however, not sepulchral.

CITA'TION. (Lat. cito, *I call.*) In Ecclesiastical Law, an act whereby the defendant, on the application of the plaintiff, is commanded to appear in court on a certain day in order to enter into a suit. In the Civil Law, reference to an authority or precedent in the course of a pleading is termed a citation; and hence the common use of the word in the same sense with quotation, allegation of instances, &c.

CI'TRATES. The salts of citric acid.

CITRE'NE. A crystalline compound of hydrogen and carbon, obtained from the essential oil of lemons.

CI'TRIC ACID. (Lat. citrus, *the lemon.*) The pure

acid part of lemon and lime juice; it is also found in other fruits. Crystallized citric acid is largely prepared for domestic use.

CI'TY. (Lat. civitas.) A borough or town corporate, which is or has been the seat of a bishop, or the capital of his see; and it differs in no respect but that of superior dignity from another borough. Some cities and a few boroughs are counties in themselves

CI'VET. A brown semifluid matter contained in a gland near the anus of the *Viverra civetta* or *civet cat:* its odour is offensive unless extremely diluted, and then in combination with other perfumes it adds to their energy.

CI'VIL ARCHITECTURE. *See* ARCHITECTURE.

CIVI'LIAN. One learned in the Civil or Roman Law; particularly a member of the "College of Doctors of Law exercent in the Ecclesiastical and Admiralty Courts" in England and Wales, in which courts the civil law is recognized. (*See* LAW, CIVIL.) Practice as an advocate in those courts is confined to members of this college, who must have taken the degree of Doctor of Law in the university of Oxford or Cambridge.

CI'VIL LIST. The term formerly applied to the list of all the expenses of the government, or "of all the heads of public expenditure, excepting those of the army, the navy, and the other military departments;" but confined at present by the act 1 W. 4. c. 25. to expenses proper for the maintenance of her majesty's household. In England the civil list is fixed in the first session of parliament after the accession of the sovereign, and is then understood to be granted for the whole period of his reign.

CLAMP. (From the French.) In Architecture, a piece of wood fixed to another with a mortise and tenon, or a groove and tongue, so that the fibres of the piece thus fixed cross those of the other, and thereby prevent it from casting or warping.

CLAMP. In Brickmaking, a large mass of bricks, generally quadrangular on the plan, and 6, 7, or 8 feet high, arranged in the brick field for burning, which is effected by flues prepared in stacking the clamp, and breeze or cinders layed between each course of bricks.

CLAN. (Said to be derived from the Gaelic clann, *descendants or issue.*) The clans of the Scottish Highlands are tribes consisting of many families all bearing the same surname, which according to tradition descend from a common ancestor. But it is more probable that most clans were formed of an aggregate of different families, the inferior standing to the superior in the same sort of relation as the Roman clients to their patrons, and by degrees assuming the same name. Some clans, however, are divided into branches, each possessing a distinct surname. The chieftainship of every clan descends regularly through heirs male; but in the earliest times of their history the rights of primogeniture were not very distinctly defined. The Gaelic clans occupy the northern and western with part of the central shires of the country. A Gaelic manuscript lately discovered containing genealogies of the Highland clans, and supposed to have been written about the year 1440, should seem to carry back the antiquity of the singular institution of clanship even to a remoter period than was previously believed.

CLA'RET. This term is applied to several of the Bourdeaux wines; it is derived from the Latin claretum, from clarere, *to be clear. See* WINE.

CLA'RINET. (It. clarino.) A wooden musical wind instrument, whose mouth partakes of the trumpet form, and is played by holes and keys: said to have been invented about the year 1600 by John Christopher Denner of Leipsic. Like the oboe it is played with a reed mouthpiece, though it is of somewhat different form.

CLA'SSES. In Ancient History, this term is particularly applied to the division of the Roman people made by Servius Tullius for the purpose of distributing them into centuries. *See* CENTURIES.

CLA'SSIC. (Lat. classis, *a class.*) In the Fine Arts, a term denoting such an arrangement of a subject that all the accessories or parts are suitable to the general design, and such that nothing be introduced which does not strictly belong to the particular class under which it is placed.

CLASSIC. In Antiquity, the Roman people were divided into classes, and the highest order were by pre-eminence termed *classici.* Hence the name came to signify the highest and purest class of writers in any language; although, down to a comparatively recent period, the term was used merely to denote the most esteemed Greek and Latin authors. Nothing marks more strongly the increased attention to, and appreciation of, modern literature, than the now universal application of the term to modern languages also, and the establishment in this manner of a line between those authors whom we regard as models and authorities in point of style, and those who are not so highly esteemed. An author is said to be *classical* if public opinion has placed him in the former order: language, or an expression, to be *classical,* if it be such as has been used in a similar sense and under similar rules of construction by those authors. The epithet classical, as applied to ancient authors, is determined less by the purity of their style than by the period at which they wrote. Thus we speak of the classical age of Greek or Latin writing. With respect to the former, the classical age begins with Homer, the earliest Greek writer with whom we are acquainted. The purest age of Greek classical literature may be said to end about the time of the Macedonian conquest, or about 300 B.C.; but, in a wider sense, it extends to the time of the Antonines, and embraces a much larger catalogue of authors; while the centuries subsequent to that time produced a few, who by the purity of their style deserve to be ranked with earlier classics. The Latin classical period is shorter: its earliest writer is Plautus, and the language may be said to have lost its classical character about the same time with the Greek, *i.e.* the reigns of the Antonines; although this limit is arbitrary, and some later writers (even down to Claudian) are generally included among classics. Within the Latin classical era there is a more restricted period of the purest Latinity, comprising the age of Cicero and that of Augustus.

CLA'SSIFICA'TION. (Lat. classis, *a class.*) In the Fine Arts, an arrangement by which objects of the fine arts are distributed in classes; as, for instance, in galleries of paintings, the works should be arranged in schools, each school being subject to a chronological order of the masters. In Numismatology, the coins should be arranged by countries, and these again in chronological order of the monarchs; and the like of other branches of the arts.

CLASSIFICATION, in Natural History, denotes the arrangement or assortment of various objects into those several classes denoted by appellatives which are called genera and species. For classification in Botany, Zoology, Medicine, Chemistry, &c., see the separate articles.

CLAU'SA. (Lat. clausus, *shut.*) A name given by Cuvier to a family of Acephalous bivalves, comprehending those which have the mantle open at one end, or near the middle, for the passage of the foot, and prolonged at the opposite end into a double tube for respiration and excretion.

CLAUSI'LIA. (Lat. clausus.) A genus of land-snails, so named because the aperture of the shell is closed internally by a spiral lid. Many species of this genus are natives of Great Britain. The rugose or dark close-shell (*Clausilia rugosa,* Drap.) is not uncommon at Charlton, where it may be found under stones. *Clausilia biplicata,* Leach, is found at Battersea.

CLA'VATE. (Lat. clava, *a club.*) Club-shaped; as when a body is linear at the base, but towards the apex growing gradually broader.

CLA'VICLE. (Lat. clavicula, from clavis, *a key.*) The bone situated between the sternum or breast-bone and the acromion process of the scapula or blade-bone. The megatherium is the largest mammal which possesses this bone.

CLA'VUS. (Lat. clavus, *a nail.*) In Agriculture, an excrescence from the grains of rye, of a brown or blackish colour. It is a parasitical fungus, called *Spermoedia clavus,* and is a valuable agent in exciting uterine action during labour. A severe pain in the forehead compared to the driving of a nail into the skull has been called *clavus* by medical writers.

CLAW, or UNGUIS. The narrow part at the base of a petal which takes the place of the footstalk of a leaf, of which it is a modification.

CLAY. In Chemistry, a term generally applied to a variety of *plastic* earthy compounds of different colours, and having much attraction for water. They are essential in the manufacture of pottery, and consist of silica, with variable quantities of alumina, and generally some oxide of iron.

CLAY. In Agriculture, one of the most common ingredients that enter into the composition of soils. Indeed, it may be asserted that no soil whatever will maintain its fertility for any length of time without a due proportion of clay in its composition. The most fertile soils in the world are the alluvial deposits on the banks of rivers; and these, in an agricultural sense, all belong to clayey soil. In many cases the clays of agriculture are intimately united with calcareous earths, and in others with sand; but in both cases these earths are in a state of such minute division, that the mixture has all the appearance and the mechanical properties of a strong clay, and they are treated by cultivators accordingly. Among the most tenacious clays of Britain are those of Middlesex; and these, when examined, are found in many cases to contain a considerable proportion of lime, and in others of sand. The best wheats are everywhere, both in Britain and on the Continent, grown on calcareous clays; and also the best fruits and flowers of the Rosaceous kind, such as apples, pears, plums, cherries, roses, &c.; but it is remarkable that the grape, when grown on clayey soil, produces neither high-flavoured fruit, nor good wine.

CLAYEY SOIL. Soil in which clay is the principal earthy ingredient. Soils of this description when first subjected to cultivation are expensive to labour, and uncertain in their produce; but after they have been drained, cultivated, limed, and manured for two or three generations, they become the most fertile of all soils, producing immense crops of wheat, beans, clover, rye-grass, &c.

CLEA'RING OF LAND. Removing such objects as impede the progress of the plough; such as stones, bushes, hillocks, and other obstructions.

CLEF. (Fr.) In Music, a mark prefixed to a staff, showing the tone or key in which a piece of music begins; or it is a letter or other sign marked on a line, which determines the name of all those of the degree whereon it is placed. A clef is always placed on a line, never on a space.

CLE'FT-GRAFTING. A mode of grafting, in which the scion is inserted in a cleft made in the stock. *See* GRAFTING.

CLEPSY'DRA. (Gr. κλεψύδρα, from κλέπτω, *I conceal*, and ὕδωρ, *water*.) Water clock; an ancient instrument for measuring time by the gradual emptying of a large vessel of water through an orifice of a determinate magnitude. Clepsydras were first brought into use in Egypt under the reign of the Ptolemys, and seem to have been common in Rome, though they were employed chiefly in winter; in summer sun-dials were used. Though clepsydras are attended with several inconveniences, the principal of which is the unequal rapidity of the flow caused either by a variation in the depth of the water in the containing vessel, or of temperature, or barometric pressure, they are nevertheless susceptible of considerable accuracy; and before the invention of clocks and watches, astronomers had no other dependence than on them for measuring small portions of time. At present they are abandoned, because pendulum clocks and watches are much more convenient, as well as infinitely more exact. In one case has the revival of their use been proposed; namely, for the accurate measurement of very small intervals of time by the flowing of mercury from a small orifice in the bottom of a vessel kept constantly filled to a fixed height. The stream is intercepted at the moment of noting any event, and diverted aside into a receiver, into which it continues to run till the moment of noting any other event, when the intercepting cause is suddenly removed. The stream then flows in its original course, and ceases to run into the receiver. The weight of mercury received, compared with the weight of that which passes through the orifice in a given time, observed by the clock, gives the interval between the events. This ingenious application of the principle of the clepsydra is due to the late Captain Kater.

CLE'RGY. The ecclesiastical body as distinguished from the laity. The word clergy seems to be derived from Gr. κλῆρος, *a lot or inheritance;* Lat. clerus, whence clericus, *a clerk or clergyman;* plur. clerici, whence *clergé, clergy;* and is supposed to allude to a custom, which, however, was never general, of choosing the clergy by lot; or, as St. Jerome says, to signify that the clergy are the lot and portion of the Lord, or the Lord is their lot. Perhaps the true derivation is rather to be traced from the lots (κλῆροι) by which the apostles chose Matthias to be one of their number. (Acts, 1. 26.)

Clerk (Lat. clericus) is still the legal appellation of a clergyman. The clergy being exclusively the learned part of the community in the middle ages, the word hence came to signify an educated person; and thus acquired the sense of a scribe or writer in France and England.

CLI'ENTS. (Lat. cliens, from the old word cluo, *I hear or obey*.) In Ancient History, a numerous body of the Roman citizens, so termed relatively to their patrons or protectors. This relation was in many respects similar to that of a serf to his feudal lord, but bore a much milder form. It was the duty of the patron to watch over the interests of his clients and protect them from aggression, and appear for them in lawsuits. He also frequently made them grants of land on lease. In return the client was bound to defend his patron, and contribute towards any extraordinary expences he might be subject to; as the portioning his daughters, the payment of a fine imposed by the state, &c. He might not appear as accuser or witness against him in judicial proceedings, a prohibition which was reciprocal. If he committed any offence against his patron, he was obliged to submit to him as his judge; and in ancient times it appears that the power of life and death was held by the latter. On the other hand, his security against oppression at the hands of his patron lay in the injunctions and authority of religion, which rendered the bond of union inviolably sacred, as that between father and son. The origin of this relation cannot now be traced; but it seems to have existed, with various modifications, throughout Italy and Greece. In Rome it appears at the foundation of the city by Romulus, when every family not included among the patricians was obliged to find itself a patron from their number. The body of clients was afterwards increased by the institution by which foreigners, who, as allies of Rome, had a share in its franchise, might choose themselves patrons on their coming to settle in the city. The obligations of clients were hereditary, and could not be shaken off unless through the decay of the family of the patron. This body alone in earlier times furnished artizans and shopkeepers; they had votes in the Comitia Centuriata; and though generally confounded with the plebeians, were undoubtedly perfectly distinct from them, as we continually meet in history with instances of their joining the patricians in opposition to the former; and when some of the plebeian houses became powerful, they themselves attached bodies of clients.

It has been seen that among the other duties of a Roman patron towards his client was that of maintaining his cause gratuitously in legal proceedings. Hence the term "client" has become appropriated in modern times to one whose cause is prosecuted or defended and his person represented by an advocate. The custom of practising gratuitously as advocates long prevailed among the Roman patricians; and from it the usage was derived, which still obtains among ourselves, of considering the fee of a counsel as "quiddam honorarium," a gratuity, which cannot be legally claimed. At present, the etiquette of the English bar appears to be this — that a barrister cannot refuse, without strong grounds for such refusal, to undertake any cause which is offered him; that he cannot refuse, without reasonable excuse, to plead gratuitously the cause of a client who sues regularly "in formâ pauperis;" or to defend a prisoner, if called on to do so by the court; and that he can receive no instructions with a fee except through the medium of a regularly authorized agent of his client (attorney or solicitor). An application to a barrister, with the customary fee, to undertake a cause in which he is not yet instructed, is called a "retainer," and secures his services for the client. An application to undertake all causes for a particular client is a *general* retainer.

CLIMACTE'RICAL YEAR. (Gr. κλιμακτὴρ, from κλῖμαξ, *ladder, scale.*) Certain years in the life of man have been from great antiquity supposed to have a peculiar importance, and to be liable to singular vicissitudes in his health and fortunes. This superstitious belief is said to have originated in the doctrines of Pythagoras. The well-known notice of the climacterical year sixty-three, supposed to be particularly dangerous to old men, in a letter of Augustus Cæsar preserved by Aulus Gellius, evinces its prevalence among the Romans. This year has been called by some astrological writers "heroicus," as having been peculiarly fatal to great men. The virtue of this year seems to consist in its being a multiple of the two mystical numbers, seven and nine. It is certainly singular that usage should have attached in all countries peculiar distinctions to those years which are denoted by compounds of the number seven. Thus fourteen has been fixed for various purposes as the epoch of puberty, twenty-one of full age; thirty-five is selected by Aristotle as the period when the body is in its highest physical vigour. The same author supposes the vigour of the mind to be perfected at forty-nine: sixty-three is the grand climacterical year; seventy the limit of the ordinary age of man. Bodinus says that seven is the climacterical number in men and six in women. The term *climacteric disease* has more lately been applied to that declension of bodily and vital powers which is frequently observed to come on in the latter period of life, and from which many persons again rally so as to attain extreme old age.

CLI'MATE. (Gr. κλίμα, from κλίνω, *I incline.*) Among the ancient geographers, was applied to denote that obliquity of the sphere with respect to the horizon which gives rise to the inequality of day and night. They divided the space comprehended between the equator and the pole into thirty parts, which they denominated *Climates* or *Inclinations;* viz. twenty-four between the equator and polar circle, and six between the polar circle and the pole. The first are called *half-hour* climates, because from one to another the longest day receives an augmentation of half an hour; the second are called *month* climates, because at the two parallels between which any one of them is comprehended the difference of the time of perpetual sunshine is one month. The first half-hour climate reaches from the equator to that parallel of latitude where the length of the longest day is twelve hours and a half; the second ends at the parallel where the longest day is thirteen hours, and so on. If, therefore, from the number of hours in the longest day at any particular place we subtract twelve, the number of half hours remaining will indicate the climate in which that place is situated. Thus, the longest day at London being a little more than sixteen hours and a half, London is situated in the tenth climate.

The first month climate extends from the polar circle to the parallel under which the sun continues above the horizon during a month; the second reaches from the

first to the parallel where the sun continues visible during two months; and so on to the poles, at which the sun is alternately visible and invisible during half the year.

Instead of the divisions which we have now described, Ptolemy adopted climates corresponding to the increase of a quarter of an hour in the length of the longest day. The space from the equator to the polar circle would thus be divided into forty-eight instead of twenty-four zones; but as these in the higher latitudes became very narrow, he carried the quarter-hour climates only to the twenty-fourth, that is, to the parallel at which the longest day is eighteen hours. From eighteen to twenty hours he proceeds by half-hour climates; from twenty to twenty-four hours the breadth of the climate is estimated by the difference of a whole hour in the length of the day. The determination of the parallels at which the different climates begin and end is equivalent to this problem: — Having given the length of the longest day to find the latitude of the place? The tangent of the latitude is equal to the sine of the excess of the semi-diurnal arc above a quadrant multiplied into the co-tangent of the obliquity.

Climate, in its most ordinary and general acceptation, embraces all those modifications of the atmosphere by which our organs are sensibly affected; such as temperature, humidity, variations of barometric pressure, the tranquillity of the atmosphere or the effects of winds, the intensity of electric pressure, the purity of the air or its mixture with gaseous emanations more or less salubrious; and lastly, the habitual diaphaneity of the atmosphere, — that serenity of the sky so important on account of the influence which it exercises not only on the radiation of the ground, on the development of organic tissues in vegetables and the ripening of fruits, but also on the *ensemble* of moral sensations which mankind experience in the different zones. There are two general causes on which the climate peculiar to any country principally depends — 1st, its distance from the equator; and 2nd, its altitude above the level of the sea; but their effect is generally modified by many circumstances exerting a partial influence. Among these may be enumerated the configuration and extent of the country; its inclination and local exposure; the direction of the chains of mountains by which it is intersected, or which are in its vicinity; the nature of the soil as it is more or less favourable to radiation and evaporation; the proximity to, or distance from, seas; the action of winds blending the temperatures of different latitudes; and even the changes produced by cultivation. The appreciation of all these causes, which modify the results deduced from the consideration of latitude and elevation alone, and the effect produced by their combined operation, constitutes the science of *climatology*.

Effect of Geographical Position. — The principal part of the temperature enjoyed by any country depends on the heat which it receives directly from the sun. In estimating the amount of solar heat received by any given space on the surface of the earth in the course of a whole year, we may suppose the sun to remain constantly in the equator, because the excess of heat above the mean in summer is exactly balanced by its defect in winter. Now, the effect produced on any given portion of the surface will depend on the number of rays that fall on that surface, and on the obliquity of their direction with respect to it. But the number of rays falling on a zone of any given breadth, a degree for example, is proportional to the cosine of its latitude; and the effect of a single ray in consequence of its oblique impact is diminished also in proportion to the cosine of the latitude; the diminution of the mean temperature, therefore, in going from the equator to the poles, must be proportional to the square of the cosine of the latitude. It hence follows that the variations of the mean temperature must be most rapid about the middle latitude of 45°; and this result of theory agrees perfectly with observation. Within the temperate zone the character of the climate changes rapidly. Thus in the south of France, and in Italy, nearly under the 45th parallel, the region of the vine is found contiguous to that of the olive and fig-tree. On the other hand, very little increase of heat is observed from the tropic to the equator; and at the other extremity of the arc, from the arctic circle to the highest latitude that has been reached, the intensity of cold is not greatly augmented. The law of the square of the cosine gives a variation of only about eight degrees of Fahrenheit's scale from the polar circle to the pole. In the system of climates of western Europe, the mean temperature at the latitude of 45° is about 13° or 13·5° of the centigrade scale (55° to 56° of Fahrenheit). The mean temperature under the equator ought therefore to be, by the theory, 26° or 27° (centigrade); and at any other place it will be found by multiplying the constant number 27 into the square of the cosine of the latitude.

Effect of Altitude. — That a greater degree of cold prevails in the upper regions of the atmosphere than at low levels would be manifest by the snowy covering of the summits of very elevated mountains in all latitudes, even if no direct experiments had been made on the temperature that prevails there. These, however, have been made in great number; and the constant and regular decrease of the temperature in ascending above the surface of the earth, to such altitude at least as can be reached, has not only been fully established, but the law according to which the decrease takes place determined with considerable certainty. According to theory the decrements of heat in ascending the higher regions should follow the same proportion as the decrements of the density; but this law is greatly disturbed by local peculiarities. The variation of temperature at different altitudes is the simultaneous effect of three general causes, — 1st, the absorption of rays of light in their passage through the atmosphere, which is much greater in the dense strata near the surface of the earth than in the upper regions; 2d, the radiation from the surface; and 3d, the ascending current; the two last also producing a greater effect on the strata near the surface. Any circumstance, therefore, which modifies these causes, must also modify the law which connects the decrease of heat with the elevation. It will be slower above the surface of the sea or a country covered with snow than above a desert destitute of vegetables, or a surface of sand; and it will be more rapid above the sloping sides of a conical mountain than over a cordillera which presents plains of great magnitude elevated in stages above one another. Nevertheless at great altitudes the disturbing influences of these causes becomes insensible, and a very considerable degree of uniformity in the temperature constantlyprevails. In the torrid zone, Humboldt, from a mean of many observations, found that between the altitudes of 3000 and 5800 metres (9840 and 19,000 feet) an increase of elevation, amounting to 191·4 metres, produced a diminution of 1° of the centigrade thermometer. This corresponds to 349 English feet for 1° of Fahrenheit. Professor Leslie (*Ency. Brit.* art. "Climate") estimates that the diminution of temperature of 1° of Fahrenheit's scale corresponds to an ascent of 300 feet. But this will hold true only of moderate elevations. At the altitudes of 1 mile, 2 miles, 3 miles, 4 miles, and 5 miles, the increase of elevation corresponding to 1° Fah. will be respectively 295, 277, 252, 223, and 192 feet. The allowance of 1° of Fah. for every 100 yards of ascent is, however, a rule of easy recollection, and in ordinary cases may be taken as a sufficient approximation.

Configuration. — The form of the limits of any large mass of land as determined by its contact with the ocean, that is to say, the greater or less extent of coast it possesses in proportion to its area, exercises a considerable influence on the climate. The small amount of variation in the temperature of the ocean tends to equalize the periodic distribution of heat among the different seasons of the year, and the proximity of a great mass of water moderates by its action on the winds the heat of summer and the cold of winter. Hence the great contrast between the climate of islands and coasts, and the climate of the interior of vast continents. Europe presents a remarkable example of this contrast. From Orleans and Paris to London, Dublin, Edinburgh, and even farther north, the mean temperature of the year decreases very little, notwithstanding the increase of latitude; while in the eastern part of the Continent each degree of latitude, according to Humboldt, produces a variation of 1·1° Fah. in the mean temperature. A small island, a tongue of land, or an indented coast, in contact with a great mass of water, which preserves in winter a considerable portion of the heat acquired during the summer, possesses a more moderate climate, milder winters, and fresher summers, and in the higher latitudes a somewhat higher mean temperature, than the interior of great continuous masses of land under the same latitude. The diminution of the mean annual temperature from the western shores of Europe to beyond the meridian of the Caspian is remarkable. Amsterdam and Warsaw are situated very nearly under the same parallel of latitude, that of the first being 52° 22′, and that of the second 52° 14′; but the mean annual temperature of Amsterdam is 53·4° Fah., while that of Warsaw is only 46·48°. The latitude of Copenhagen is 55° 41′, and that of Kasan 55° 48′; but the mean annual temperature of Copenhagen is 45·7°, that of Kasan 37·6°. The climate of a country is influenced not only by its horizontal configuration, but also by its *relief*, or vertical configuration. Mountains affect the climate of the adjacent plains in various ways — by the reverberation of heat from naked rocks; by affording shelter from certain predominating winds; and by giving rise to descending currents of cold air from the higher regions of the atmosphere, in consequence of the disturbance of the equilibrium of heat produced by the radiation from their sides and summits. The local exposure of a country also, or its inclination to or from the equator, which may be included under the title configuration, has a powerful influence on its mean annual temperature. Generally speaking, the local exposure is connected with

and depends upon the position of the mountain chains, and both conspire to increase or diminish the mean temperature at the same time. For example, when the general inclination of an extensive tract of country is towards the south, the northern side is bounded by ranges of mountains; so that while the sun's rays fall upon it at a less oblique angle, it is sheltered from the cold winds blowing from a higher latitude.

Climate of Europe. — In a general view, Europe may be regarded as a peninsular prolongation of the ancient continent, broken and intersected by numerous arms of the ocean, and by inland seas. The predominating winds are from the west; and these, for the whole of the western portion, are sea winds, greatly softened by blowing over a mass of water, of which the superficial temperature, even in the month of January, at the parallels of 45° and 50°, does not fall below 48° and 51° of Fahrenheit. It is placed directly north of an immense tract of tropical land (Africa and Arabia), which by its diurnal radiation contributes powerfully to elevate the temperature. On the northern side the cold belonging to the latitude is mitigated by numerous favourable circumstances. A very small portion of land lies within the polar circle; and the whole of the northern extremity is separated from the polar ice by a zone of open sea, the temperature of which is maintained at a considerable elevation in consequence of its communication with the Atlantic ocean, and of the existence of the gulf stream, which conveys a portion of the temperature of the gulf of Mexico into the polar seas.

Climate of Asia.—The circumstances which contribute to render the climate of Europe mild and temperate are nearly all reversed in respect of Asia. Its northern boundary extends beyond the parallel of 70°, and in some places reaches to 75°. In every part it extends to the winter limit of the polar ice, and only a very narrow zone of water is interposed between the ice and the land during the short summer of these high latitudes. The north winds, not obstructed by any chain of mountains, blow with unmitigated severity over an icy plain, extending northward to the pole, and eastward to the point of maximum cold, which appears to be situated near the meridian of Behring's straits. The refrigerating influence of these winds is not counteracted by arid deserts on the southern side of the continent. From the meridian of the Ourals to that of Cape Tchoukotski, through 140 degrees of longitude, there is no land under the equator, excepting the inconsiderable portion formed by the islands of Sumatra, Borneo, Celebes, and Gilolo; consequently the Asiatic countries situated in the temperate zone are not warmed by ascending currents of heated air, such as those which rise from the deserts of Africa and are so beneficial to Europe. The position of the great mountain chains and the general elevation of the country also powerfully contribute to diminish the temperature. The Himalaya and Kuen-lun, through a great extent of the continent, present an effectual barrier to the warm winds which come from the equator. Elevated plains and groups of lofty mountains accumulate, and preserve the snow till late in the summer, and give rise to descending currents of air which cool down the temperature of the circumjacent countries. Lastly, Asia being bounded on the western side by Europe, the west or predominating winds are land winds for the greater part of the continent, and their severity is increased by the great enlargement of the land towards the north. (*Humboldt, Fragmens Asiatiques; Daniell's Meteorological Essays; Murray's Ency. of Geography.*)

CLI'MAX. (Gr. κλίμαξ, *gradation.*) In Rhetoric, a figure by which several propositions, or several objects, are placed before the mind of the hearer or reader in such an order that the proposition or object calculated to produce the least impression shall strike it first, and that the rest shall follow in regular gradation. Anti-climax is the converse figure, in which the ideas sink in succession. This forms a principal cause of that vice of composition of which so many ludicrous illustrations have been given under the name of Bathos.

CLINAN'THIUM. (Gr. κλινη, *a bed*, and ανθος, *a flower.*) A term used to express the receptacle of a composite plant. It is the dilated apex of a flowering branch covered over by small flowers enclosed within an involucre.

CLI'NICAL. (Gr. κλινη.) This term is generally used medically; a *clinical lecture*, for instance, is the instruction which the teacher gives his pupil at the bedside of the patient.

CLI'NIUM. (Gr. κλινη.) A term occasionally used in botany to denote the summit of a floral branch, of which the carpella are the termination. It is the same as the *torus* of the modern French school, and one of the parts called receptacle by Linnæus, as in the strawberry.

CLI'NKERS. See BRICKS.

CLI'NOID. (Gr. κλινη, and ειδος, *likeness.*) This term has been improperly applied to certain processes of the *sphenoid bone.*

CLINO'METER. (Gr. κλινω, *I bend*, and μετρον, *a measure.*) An instrument for measuring the *dip* of mineral strata. (*Geol. Trans.* vol. iii.)

CLI'O. (Gr. κλειω, *I celebrate.*) In Mythology, the muse who was usually supposed to preside over history, though she sometimes invaded the province of her sister Calliope, the goddess of epic poetry. In his magnificent ode (Book 1. Ode 12.) addressed to Augustus, Horace invokes Clio as the patroness of the flute or the lyre, or in other words of lyric poetry:—

Quem virum aut heroa lyra vel acri
Tibia sumes celebrare, Clio, &c.

CLIO. In Zoology, applied by Linnæus to a genus of *Vermes*, and by Cuvier to a genus of Pteropodous Mollusks; one species of which, the *Clio borealis*, abounds in the northern seas; and although not exceeding an inch in length, it forms a great proportion of the food of the whalebone whale, *Balœna mysticetus.*

CLOA'CA. (Lat.) The excrementory cavity in which, in birds, reptiles, many fishes, and some mammals, the intestinal canal, urinary ducts, and genital passages terminate.

CLOCK. *See* HOROLOGY.

CLOI'STER (Lat. claustrum.) In Architecture, an arcade or colonnade round an open court.

CLOSE. In Music. *See* CADENCE.

CLOSE. A small field, enclosed or hedged about.

CLO'SE-HAULED; that is, the tacks close down, the sheets aft, the yards braced sharp up, and the bowlines hauled, the ship making her progress as near the direction of the wind as she can.

CLO'SERS. In Architecture, the pieces (or bats), less or greater than half a brick, that are used to close in the end of a course of brickwork. In English as well as Flemish bond (*see* BOND), the length of a brick being but nine inches, and its width four inches and a half, in order that the vertical joint may be broken at the end of the first stretcher, a quarter brick (or bat) must be interposed to preserve the continuity of the bond; this is called a *queen closer.* A similar preservation of the bond may be obtained by inserting a three-quarter bat at the angle in the stretching course; this is called a *king closer.* In both cases a horizontal lap of two inches and a half is left for the next header.

CLOUD. A visible mass or collection of minute particles of water suspended in the atmosphere. Clouds differ from fogs or mists only in occupying a more elevated position; in all cases the origin is the same, namely, the vapours which rise from collections of water, and indeed from the whole surface of the earth. These aqueous vapours are condensed in the higher and colder regions of the atmosphere, and thus lose their transparency and become visible. Clouds differ very greatly in respect of form, magnitude, density, &c. These differences depend on the quantity of vapour of which they are composed, and the situations which they take as they unite with one another; and are determined in a great measure by the direction and velocity of the motion communicated to them by the wind. The height at which they float in the atmosphere is determined by their specific gravity, and consequently varies with their density. Thin light clouds are observed higher than the summits of the loftiest mountains, while those which are dense and thick rise only to a small distance above the surface of the earth. It is very difficult to determine their average elevation: it is supposed to be between two and three miles, but it varies at different times of the year.

Clouds were distributed by Mr. Luke Howard into three primary formations,—the *Cirrus*, the *Cumulus*, and the *Stratus.* But besides these he admitted four other varieties,—the *Cirro-cumulus*, the *Cirro-stratus*, the *Cumulo-stratus*, and the *Cumulo-cirrostratus* or *Nimbus.* The *Cirrus* consists of fibres or curling streaks, which diverge in all directions. It occupies the highest region, and is frequently the first cloud which is seen after a continuance of clear weather. The *Cumulus* is a convex aggregate of watery particles, increasing upwards from a horizontal base, and assuming more or less of a conical figure. The *Stratus* consists of horizontal layers, and comprehends fogs and mists. It is the lowest of the clouds, its under surface usually resting on the earth or water. The *Cirro-cumulus* is intermediate between the cirrus and cumulus, and is composed of small well-defined masses closely arranged. The *Cirro-stratus*, intermediate between the cirrus and stratus, consists of horizontal masses separated into groups, with which the sky is sometimes so mottled as to suggest the idea of resemblance to the back of the mackarel. The prevalence of the cirro-stratus is usually followed by bad weather. The *Cumulo-stratus*, or *twain cloud*, partakes of the appearance of the cumulus and stratus or cirro-stratus. The *Nimbus*, or *rain cloud*, is that into which the others resolve themselves when rain falls.

The above nomenclature is sufficiently fanciful; nevertheless it enables the meteorologist to convey more precise ideas in describing the diversified forms under which masses of clouds present themselves and their connection with the changes of the weather. These

forms are, however, frequently so indefinite and shapeless, that it is difficult, if not impossible, to refer them to any one of the preceding modifications. A tendency, however, to one or other of them may in general be traced. (*Howard's Arrangement and Nomenclature of Clouds*, in the 16th and 17th vols. of the *Philosophical Magazine; Foster on Atmospheric Phenomena; Murray's Encyclopedia of Geography*, p. 168.; *Companion to the British Almanac* for 1830, &c. See also *Dalton's Meteorological Essays*, 1793.)

CLOU'TED or CLO'TTED CREAM. The cream produced on the surface of milk by setting a pan of new milk on a hot hearth is so named. It is chiefly used as a kind of entremet, and, when mixed with new milk, is eaten along with fruit pies, strawberries, raspberries, &c.: it is also eaten without milk, spread on bread.

CLOVES. (Lat. clavus, *a nail.*) The smaller bulbs formed in the axillæ of the scales of a mother bulb, as in garlic.

CLOVES. The unexpanded flower-buds of the *Caryophyllus aromaticus*, a low branching tree cultivated in the Dutch settlements in India. The finest cloves are from Amboyna; they are of a bright brown colour, extremely fragrant, and hot and acrid upon the tongue; they abound in essential oil, which may be pressed out of their pores by the nail, and which is generally obtained by distillation with water, to the amount of from 15 to 20 *per cent.* It is sold in commerce under the name of *oil of cloves*, and chiefly used in medicine, and occasionally in perfumery. The fruit of the clove tree was employed in old pharmacy under the name of *anthophylli.*

CLUBS *See* SOCIETIES.

CLUB MOSS. (*Lycopodium clavatum.*) The seeds of this moss, which are very minute, and resemble an impalpable yellow powder, are used in theatres to imitate lightning; when thrown across a flame, they produce a sudden flare: they contain a peculiar oil.

CLUMP. A mass of trees or shrubs, or both, generally roundish and compact in its outline, and always small as compared with extensive plantations. The word appears to have been first used in planting and gardening in the time of the celebrated landscape gardener Brown, about the middle of the 18th century. Brown distributed his clumps at irregular distances over the entire surface of any piece of ground that was intended to be made a park; surrounding the park at the same time with a belt of plantation. The intention of Brown in planting these clumps was to nurse up a few trees in each clump, which should remain as groups or single objects after all the other trees of the clump were removed; but as thinning and the removal of the boundary fence of these clumps very seldom took place, they have grown up in most cases deformities rather than beauties. The term clump as applied to a plantation has long since become one of reproach.

CLUMP. The compressed clay of coal strata.

CLYPEA'STER. (Lat. clypeus, *a buckler*, and astrum, *a star.*) A genus of sea-urchins (*Echinidæ*) of a flattened, shield-like form, with a submarginal vent. This genus is termed *Echinanthus* by Klein.

CLY'PEATE. (Lat. clypeus.) Shield-like: it is the same as scutate.

CLY'SSUS. An alchemical name for the water obtained by deflagrating nitre with charcoal: the vessels were generally burst in the operation; but when it succeeded the few drops of water obtained were highly prized for medical use.

COACE'RVATE. (Lat. con, *together*, and acervus, *a heap.*) Accumulated. A term applied by older physiologists to certain secretions or excretions long retained.

COADJU'TOR. In Ecclesiastical matters, the assistant of a bishop or other prelate (in some instances even of a canon or prebendary, but the latter usage was irregular). These assistants, in France and other countries, were instituted by the pope. A coadjutor was equal in rank to the dignitary whose functions he might on occasion supply; hence the coadjutor of a bishop was himself consecrated a bishop *in partibus infidelium.* The celebrated Cardinal de Retz was known by the title of the Coadjutor of Paris during the most active period of his career, having the administration of the temporalities of that see, which belonged to his uncle the Archbishop de Retz. Coadjutors usually succeeded their principals in their dignities; and hence arose an abuse which tended towards making ecclesiastical dignities hereditary, nephews and other relatives of bishops being named their coadjutors. The institution of coadjutors to bishoprics is preserved by the French concordat of 1801.

COA'DUNATE. (Lat. con, ad, and una, *together.*) Two or more parts joined together.

COAL. (Germ. kohle.) This highly important substance is found in beds or strata in that group of the secondary rocks which includes the red sandstone and mountain limestone formations, and which is commonly called the *carboniferous group*, or *coal measures*. From the peculiarities of their deposition they are often spoken of under the names of *coal basins*, and *coal fields*. There are two or three points, and those of much theoretical importance, respecting the origin of coal, on which geological authorities are nearly unanimous. The one is, that our present coal is exclusively of vegetable origin, formed apparently from the destruction of vast forests; and the prodigious quantities of timber drifted by some of the great rivers of the world into the present ocean render it not improbable that a similar formation may now be carrying on in the depths of certain parts of the sea. Secondly, from the nature of the preserved vegetables it appears probable that the climate of these parts was not merely tropical, but ultratropical. It may also be inferred that the coal strata were deposited in the neighbourhood, and often probably upon the verge, of extensive tracts of dry land; for the trees that are found in coal strata are often like those of *our* submarine forests, as far as position goes. And, finally, the deposits of coal appear afterwards to have been elevated, and often singularly dislocated and contorted by forces acting from below, and probably of a volcanic nature.

In some coal fields there are appearances which justify the term *coal basin:* they are of limited extent, frequently dip as it were to a common centre, and consist of various beds of sandstone, shale, and coal, irregularly stratified; and sometimes mixed with conglomerates, showing a mechanical origin.

That these deposits have taken place, and that the change of wood into coal has often been effected under great pressure, and often under pressure and heat, seems evident from the appearance of some of the vegetable masses, and also from the manner in which the carburetted hydrogen escapes in the form of *blowers* and eructations from the strata, as if pent up in their cavities under vast condensation, and even sometimes, perhaps, in a liquid form.

Though there are often many beds and seams of coal in one field, it is seldom that many of them are worked. They are generally of uniform thickness through a great extent, but are sometimes subject to irregularities. When less than two feet thick they are seldom worked to any great extent. The nature of the upper stratum, or stony matter of the *roof*, is very important: if compact, it is secure from falling, and keeps out water; if loose, the expense incurred in supporting it absorbs the profits of the coal.

The deepest coal mines in England are those of Northumberland and Durham, which are worked nearly 1000 feet below the surface. The thickest bed of coal is said to be at Wood Mill Hill colliery in Staffordshire, and to exceed 40 feet. From 6 to 9 feet is the average thickness of the most productive seams. The coal generally most esteemed is that of the northern districts, — Northumberland, Durham, and Yorkshire. It abounds in bitumen, softens and swells in the fire, and throws out jets of flame; it coheres, and therefore burns hollow and requires poking; it furnishes cinders, and but little ash. Most of the coal from the west of England blazes and burns briskly, being much more easily kindled than the other; it requires no poking, because it has no tendency to cake; it affords no cinders, and leaves a dusty white ash. *Culm* contains scarcely any bitumen; it abounds in earthy matter, and somewhat resembles bad coke.

Coal is the most valuable of all the mineral substances from which Britain derives her prosperity, and, indeed, may be regarded as the main support of the whole system of British production. It fuses the metals, produces the steam which sets the machinery in motion, and, in short, may be said to render all the resources of this country available for use. The annual consumption of coal, throughout the British Empire, is estimated at 28,575,000 tons. The coal trade gives occupation to nearly 200,000 persons. In 1838, the total quantity of coal shipped was 7,190,433 tons: of which, from the Tyne and Wear, 4,628,000; South Wales, 1,228,300; Whitehaven, 395,000. The export was 2,449,417 tons, chiefly to Ireland, France, the Netherlands, Germany, Denmark, British America, and the United States. The imports into London in 1839 amounted to 2,638,256 tons, brought by 7500 vessels.

CO'BALT. (Germ. kobold, *a devil.*) A term applied to this metal by the German miners, who considered it unfavourable to the presence of the more important metals.

Cobalt is a brittle metal of a reddish grey colour; its specific gravity is 7·8. It fuses at a temperature a little below that required for the fusion of iron. It is magnetic. When heated red hot, and freely exposed to air, cobalt absorbs oxygen. Its equivalent number is 30; and the salifiable, or protoxide of cobalt, consists of 30 cobalt + 8 oxygen = 38 oxide of cobalt. The oxide of cobalt is nearly black; but when in the state of hydrate, or when largely diluted by fusion with glass or borax, it produces its characteristic blue colour; and as this colour is permanent at very high temperatures, it is an invaluable article in the manufacture of porcelain and pottery, all the blue colours of which are derived from oxide of cobalt. When fused with glass it communicates a blue tint without impairing its transparency. A very deep blue

glass of this kind when finely powdered acquires a pale and brilliant colour, and is called *smalt*. Impure oxide of cobalt is known in commerce under the name of *zaffre*. Cobalt is said by Stromeyer to exist in all meteoric iron, although in very small quantity. In its ores it is always associated with arsenic, and zaffre is prepared by roasting these native arseniurets of cobalt.

CO'BBLES. Lumps of coal from the size of an egg to that of a football.

COBI'TIS. (Lat. cobio, *a gudgeon.*) A genus of soft-finned fishes, belonging to the *Cyprinidæ* or carp family; and characterized by a small head; an elongated body; the skin covered with small scales; ventral fins placed far backwards, with one small dorsal fin above them; mouth small and toothless; gill-openings very small, and with three rays. Of this genus the loche (*Cobitis barbatula*) inhabits the clear running streams of Britain. The pond loche (*Cobitis fossilis*) is a larger species. It is remarkably sensitive to atmospheric changes, and when confined in a glass-globe may be observed to sink to the bottom in a state of quiescence when the weather is cold and gloomy; but in boisterous weather it comes to the surface and swims about with great rapidity. It also swallows air, which it discharges from the vent, partly converted into carbonic acid gas.

CO'BLE. A small boat or canoe, used chiefly on the rivers and lakes of Wales, and the borders.

CO'B-WALLS. Walls formed of mud mixed with straw; not uncommon in some districts of England. The best cob-walls are in Somersetshire.

COCCINE'LLA. (Dim. of Lat. coccinus, *crimson.*) A genus of Trimerous Coleopterous insects, including many small species, usually ornamented with scarlet spots, and familiarly known as lady-birds, lady-cows, &c. In France these small beetles are dedicated to the Virgin, and called Bêtes de la Vièrge. They are, in fact, of great service to the agriculturist, and especially to the hop-grower; for they destroy the *Aphides*, or plant-lice, in vast numbers, feeding on them both in the larva and perfect state.

CO'CCOLITE. (Gr. κοκκος, *a grain*, and λιθος, *stone.*) A mineral of a concretional or granular texture.

COCCOO'N. The silken case which the larvæ of certain insects spin for the purpose of a covering during the period of their metamorphosis, and which some spiders prepare as a protection to their ova during the development of the young. The cod or coccoon of the silk-worm is a well-known example of the most valuable of these productions.

CO'CCULUS INDICUS. The fruit of the *Menispermum cocculus*, imported from the East Indies. It contains a poisonous principle, which has been termed *picrotoxia*. It is often used to poison fishes: a few handfuls of it ground into coarse powder, and thrown into a pond, bring the fish, in the course of a few hours, to the surface in an intoxicated or poisoned state; but if quickly removed into fresh water, they recover. It is sometimes added to ale to increase its stupefying quality.

CO'CCUM. (Gr. κοκκων, *a pomegranate stone.*) A term invented by Gærtner to denote a pericarp of dry elastic pieces or cocci, as in Diosnia, &c.

CO'CCUS. (Lat. coccus, *scarlet cloth.*) A name given by Linnæus to a genus of Hemipterous insects, including the Mexican species, the cochineal insect (*Coccus cacti*, L.), which feeds on *Cacteæ*, and which affords the well-known fine red dye.

CO'CHINEAL. The *Coccus cacti*. This valuable insect was first introduced into Europe about the year 1523. It is imported from Mexico and New Spain. It feeds on several species of cactus. It is small, rugose, and of a deep mulberry colour. They are scraped from the plants into bags, killed by boiling water, and dried in the sun. Those are preferred which are plump, of a peculiar silvery appearance, and which yield a brilliant crimson when rubbed to powder. Cochineal is sometimes adulterated by the admixture of a manufactured article composed of coloured dough. This is detected by the action of boiling water, which dissolves and disintegrates the imitation, but has little effect upon the real insect. The principal component of cochineal is a peculiar colouring matter, which has been called *carminium* and *cochinelia*. It is obtained by digesting the powder of cochineal first in ether, which takes up fat, and then in alcohol, which dissolves the cochinelia. Acids change its colour from crimson to an orange red, and alkalies turn it violet. When mixed with recently precipitated aluminous earth, it forms a beautiful lake. Cochineal yields a brilliant scarlet dye, which is produced by fixing the colouring matter of the insect by a mordant of alumina and oxide of tin, and exalting the colour by the action of supertartrate of potash.

CO'CHLEAN. (Lat. cochlear, *a spoon.*) A term used in describing the æstivation of a flower, to express one piece being larger than the others, and hollowed like a helmet or bowl, covering all the others, as in Aconitum, &c.

COCHLEARE. A spoon; the bowls of spoons being formerly made of the shape of a cockle-shell, and often fluted.

COCHLEA'TE. (Lat. cochlea, *a shell*, *a cockle.*) A term used in describing the general form of bodies, to denote any that are twisted in a short spire, so as to resemble the convolutions of a snail-shell; as the pod of *Medicago cochleata*. It also means a concave body like that of one of the valves of a cockle-shell, as in *Epidendrum cochleatum*.

CO'CKET. In Commerce, a scroll of parchment, signed and delivered by the officers of the custom-house to merchants upon entering their goods, to certify that their merchandise is customed and may be discharged.

CO'CKLE-OAST. That part of a hop-kiln or oast where the fire is made.

CO'CK-LOFT. The highest loft, or garret, in any building.

CO'CKNEY. A contemptuous appellation of a citizen of London. Various derivations have been assigned to this word, all of which are more distinguished for ingenuity than probability. But whatever may be the origin of the term, its antiquity cannot be disputed, as it is mentioned in some verses generally attributed to Hugh Bagot, Earl of Norfolk, in the reign of Henry II.: —

> Were I in my castle at Bungey,
> Upon the river of Waverney,
> I would ne care for the king of Cockeney (*i. e.* of London).

CO'CK-PIT. The after part of the orlop deck, or deck below the lower deck, and altogether below the water. Here, in line-of-battle ships, are the cabins of several of the officers. The cock-pit is appropriated to the use of the wounded in time of action. There is also a fore cock-pit in the fore part of the ship, and sometimes an after cock-pit.

Cock-Pit is the name given to the place where game cocks fight their battles. The room in Westminster in which her Majesty's privy council hold their sittings is called the *cock-pit*, from its having been the site of what was formerly the cock-pit belonging to the palace at Whitehall.

COCY'TUS. (Gr. κωκυτός, *lamentation;* from κωκύω, *I bewail.*) In Mythology, the river of Lamentations, which was one of the streams that washed the shores of the mythological hell, and prevented the imprisoned souls from returning to the earth. Milton alludes to it thus (*Par. Lost*, book ii.): —

> Cocytus named of lamentations loud
> Heard on the rueful stream.

CO'DA. (It. coda, *a tail.*) In Music, the passage at the end of a movement which follows a lengthened perfect cadence. In some cases it consists of merely one phrase, in others it is carried to a great extent. At the conclusion of a canon or fugue, it often serves to end the piece which might otherwise be carried on to infinity.

CODE (from the Latin codex, *a manuscript*), signifies, in the language of jurisprudence, any collection of laws digested and reduced into an orderly arrangement, whether by public authority or by the private labour of learned men. But, in the ordinary sense, the word Code is only used to signify a compilation of laws by authority. Five collections of Roman law are designated by the title of *codes*: — that of Sextus Papirius, which only exists in fragments discovered by various authors, but which contained the laws of the Roman kings; the Gregorian, the compilation of an unknown author, about the reign of Constantine; the Hermogenian, of which the author is also doubtful, and the date nearly the same; the Theodosian, framed under the order of the emperor Theodosius the younger, and containing the constitutions of the emperors from the time of Constantine to his own (from which, until the greater works of Justinian became publicly known in modern Europe, the jurisconsults of the dark ages drew the greater part of their knowledge of Roman law); and, lastly, that of Justinian, A. D. 529. Of the codes of law now recognised in modern states the most remarkable are, in order of time — the code of Frederic the Great of Prussia; that of Catherine of Russia, confined to criminal jurisprudence; that of Joseph II. of Austria; and the Code Napoleon in France. This title, though sometimes given in general language to all the digests of law made under that emperor, is appropriated by French lawyers to the greatest of his works, the Code Civil. The project for this code was drawn up, in 1801, by five commissioners, by them reported to the Court of Cassation, and thence carried to the Conseil d'Etat: in that body it was fully discussed, clause by clause. Besides the Code Civil, the written French law comprises five other codes; viz. the Code Pénal; the two Codes of Procedure, civil and criminal; the Code de Commerce; and, finally, the Code Forestier, or collection of laws relative to the administration of the woods, published in 1827 under Charles X.

CODE'INE, or CODEIA. (Gr. κωδια, *the poppy head.*) An alkaline substance, discovered in 1832 by Robiquet in opium. It was at first confounded with morphia.

CODE'TTA. (Dimin. of coda.) In Music, a short

passage which connects one section with another, and not composing part of a regular section.

CO'DEX. A manuscript: in its original sense (Latin) the inner bark of a tree, which was used for the purposes of writing. The word was thence transferred by the Romans to signify a piece of writing, on whatever material; *e. g.* with the stylus on tablets lined with wax, or on a roll of parchment or paper. In modern Latin, a manuscript volume. *Codex rescriptus* or *palimpsestus* is a manuscript consisting of leaves, from which some earlier writing has been erased in order to afford room for the insertion of more recent. Many such codices exist; and from the imperfect nature of the erasing process, the earlier writing has in some instances been restored. Considerable fragments of classical works, previously considered as lost, have been thus recovered by the Abate Mai from among the contents of the Ambrosian Library at Milan.

CO'DICIL. (Lat. codicillus, diminutive of codex, *a manuscript.*) In Law, an addition or supplement to a will, for the purpose of altering, explaining, or adding to its contents. Of codicils, as of wills, the latter prevails where it contains provisions contradictory to those of a former. By the recent Wills Act (1 Vict. c. 26.), every codicil must be executed in the same manner as is thereby made requisite in the case of a will; viz. signed by the testator in the presence of two witnesses at one time. *See* WILL.

COEFFI'CIENT. In Algebra, a number or known quantity prefixed as a multiplier to a variable or an unknown quantity. Thus, in the equation $a x^m + 6 b x^n = o$, a is the multiplier or *coefficient* of x^m, and $6 b$ is the *coefficient* of x^n. When no number or coefficient is prefixed, unity or 1 is understood. *See* EQUATION.

CŒLACA'NTHIDÆ. (Gr. κοιλος, *hollow*, and ακανθος, *a spine.*) A family of Ganoid fishes in the system of Agassiz; so called on account of the species composing it being armed with hollow spines. The following interesting fossil genera, *Holoptychius* and *Cœlacanthus* proper, belong to this family.

CŒ'LELMI'NTHA. (Gr. κοιλος, and ἑλμινς, *a worm.*) The name of a class of Entozoa, including part of the cavitary intestinal worms of Cuvier, or those which are characterized by having an alimentary canal contained in a distinct abdominal cavity.

CŒLE'STINE. A mineralogical name of *sulphate of strontia* (from its blue tint).

CŒ'LIAC. (Gr. κοιλια, *the belly.*) A painful species of diarrhœa has been by some medical writers called the *cœliac passion*. The cœliac artery is the first branch of the aorta in the abdomen.

CŒNA'CULUM. (Lat.) In ancient Architecture, the eating or supper room of the Romans. In the early periods of the Roman history, the upper story of their houses, which rarely consisted of more than two, seems to have been called by this name.

CŒNA'TIO. (Lat.) In ancient Architecture, an apartment for taking refreshment in the lower part of the Roman houses.

CŒNO'BIO. (Gr. κοινος, *common*, and βιος, *life.*) A name invented by the French botanists, to distinguish that class of fruits which consists of two or more carpels separate at the apex and united at the base, from the middle of which a single style arises. It occurs in Lamiaceæ, &c.

CŒ'NOBITE. (Gr. κοινος, and βιος, *life.*) One who lives under a rule in a religious community, as distinguished from an anchoret or hermit, who lives in solitude. *See* ANCHORET.

CŒ'NURE, *Cœnurus*. (Gr. κοινος, and ουρα, *a tail.*) The hydatid which infests the brain of sheep is so called, because the dilated cyst is the common termination or basis of attachment of many heads and bodies. The disease called "staggers" is produced by this parasite.

CO'FFEE. The berries of the *Coffea arabica*. These, when roasted, powdered, and infused in boiling water, yield the well-known beverage called coffee. It is exhilarating, and operates upon many persons as an aperient. *See* CAFFEIN.

CO'FFER. (Sax. copne.) In Architecture, a sunk panel in vaults and domes, and also in the soffit or under side of the Corinthian cornice, usually decorated in the centre with a flower.

CO'FFER-DAM. In Architecture, and Bridge-building, a case of piling, water-tight, fixed in the bed of a river for the purpose of laying the bottom dry for a space large enough to build the pier on. Coffer-dams are formed in various ways, either by a single inclosure or a double one, with clay or chalk rammed in between the two to prevent the water from coming through the sides. They are also made either with piles only, driven close together, and sometimes notched or dovetailed into one another; or, if the water is not very deep, by piles driven at a distance of five or six feet from each other, and grooved in the sides with boards let down between them in the grooves. In order to build in coffer-dams a very good natural bottom of solid earth or clay is required; for though the sides be made water-tight, if the bed of the river be of a loose consistence, the water will ooze up through it in too great a quantity to permit the operations to be carried on. It is almost needless to remark that the sides must be very strong, and well braced in the inside to resist the pressure of the ambient water. (*Hutton's Tracts* vol. i.)

CO'GNIZANCE, *Conusance*. In Law, an acknowledgment of a fine, of taking a distress, &c. It also signifies the power which a court has to hear and determine a particular species of suit.

COGNO'MEN. In Antiquities, the last of the three names by which all Romans, at least those of good family, were designated. It served to mark the house (*see* FAMILIA) to which they belonged, as the other two names, viz. the *prænomen* and *nomen*, served respectively to denote the individual and the class (*see* GENS) to which his family belonged.

COGNO'VIT. (Lat.) In Law, is a confession whereby a defendant admits that the plaintiff's cause of action against him is just (cognovit actionem), and suffers judgment to be entered against him without trial.

COHE'SION. (Lat. cohæreo, *I hold together.*) In Natural Philosophy, is the force or attraction with which the particles of homogeneous bodies are kept attached to each other, or with which they resist separation. Cohesion is thus distinguished from *adhesion;* the latter term denoting the attractive force existing between two different bodies brought into contact, as a drop of water on a plate of glass; or between two bodies of the same matter, as two lumps of lead, when their smooth surfaces have been pressed together. The three different forms which matter assumes, — solid, liquid, and gaseous, — are determined by the degree of cohesive force existing among the elementary particles. In solids this force is great, and, in fact, is that which causes solidity; in liquids it is less powerful, but still sufficiently manifest in the *drops* or globular form assumed by small quantities of water or mercury poured on a table. In the case of aeriform fluids it may be regarded as negative, the particles having a tendency to repel each other. The cohesive force of the elementery particles of matter depends on the distances of the particles from each other; but of the law according to which its intensity increases or diminishes nothing is known, excepting that the force decreases rapidly as the distance increases, and vanishes altogether when the distance becomes so great as to be appreciable to the senses.

It is a problem of very great importance to determine the cohesive power of the materials employed in mechanical structures. Numerous experiments have been made for this purpose; and their results have not only a practical utility, but throw much light on the constitution of bodies. When a bar of metal, a beam of wood, or a rope is stretched lengthwise, the tension which it bears, or the cohesive power evolved, is equal to the accumulated attraction of all the particles in any transverse section. The longitudinal distension which takes place before disrupture is at first proportional to this attraction, but afterwards increases in a more rapid progression. "A bar of soft iron will stretch uniformly by continuing to append to it equal weights till it be loaded with half as much as it can bear; beyond that limit, however, its extension will become doubled by each addition of the eighth part of the disruptive force. Suppose the bar to be an inch square, and 1000 inches in length; 36,000 lbs. avoirdupois will draw it out one inch, but 45,000 lbs. will stretch it 2 inches, 54,000 lbs. 4 inches, 63,000 lbs. 8 inches, and 72,000 lbs. 16 inches, where it would finally break." (*Leslie's Nat. Philosophy.*)

The following is a tabular view of the absolute cohesion of the principal kinds of timber employed in building and carpentry, showing the load which would rend a prism of an inch square, and the length of the prism which, if suspended, would be torn asunder by its own weight: —

Teak	12,915 lbs.	36,049 feet.
Oak	11,880	32,900
Sycamore	9,630	35,800
Beech	12,225	38,940
Ash	14,130	42,080
Elm	9,720	39,050
Memel fir	9,540	40,500
Christiana deal	12,346	55,500
Larch	12,240	42,160

The above numbers must be regarded as only approximative, and representing the average cohesive force of the different kinds of wood specified; for the force differs greatly in different specimens of the same sort, and even in different parts of the same timber. Thus in the tables given by Professor Barlow of experiments on the direct cohesion of different woods, we find the weight required to tear asunder a prism of an inch square varying as under: — Fir, from 11,000 to 13,448 lbs.; ash, from

15,784 to 17,850 lbs.; oak, from 8,889 to 12008 lbs.; teak, from 14,662 to 15,405 lbs.; pear, from 8,834 to 11,537 lbs., &c. (*Barlow on the Strength of Materials*, 1837.)

The metals differ more widely from each other in their cohesive strength than the several species of wood or vegetable fibres. According to the experiments of Mr. George Rennie in 1817, the cohesive power of a rod an inch square of different metals, in pounds avoirdupois, with the corresponding length in feet, is as follows: —

Cast steel - -	134,256 lbs.	—	39,455 feet.
Swedish malleable iron	72,064	—	19,740
English ditto - -	55,872	—	16,938
Cast iron - - - -	19,096	—	6,110
Cast copper - -	19,072	—	5,003
Yellow brass - -	17,958	—	5,180
Cast tin - - -	4,736	—	1,496
Cast lead - - - -	1,824	—	348

It is difficult to measure directly the cohesion of fluids (and it is very considerably affected by the temperature); but an approximation may be derived from the magnitude of drops, and the thickness of liquid sheets, heaped upon a horizontal surface. In this view, says Professor Leslie, let us trace the formation of a drop of water as it slowly collects at the end of a capillary siphon. The mutual attraction of the particles always rounds the under part of the pendant fluid, which continues to lengthen till its accumulating weight begins to overcome the cohesion of the particles. But this force being 75 grains for each horizontal square inch, while a cubical inch of water weighs 252½ grains, must correspond to the pull of a cylinder of ·18 inch high, which will influence also the breadth of the pendant liquid. Beyond this limit a separation will ensue, when the cylinder merges into a sphere a little wider, or about 2-10ths of an inch diameter.

The cohesion among the particles of alcohol and of sulphuric acid being respectively the fifth part of 215 and 460 grains, the weight of a cubic inch of each of these fluids, a drop of them should measure ·17 of an inch in diameter. The cohesive force of quicksilver at the ordinary temperature amounts to 312 grains on each horizontal inch, while a cubic inch of it weighs 3424 grains; the drop must separate when its mean depth approaches to the 9-100th part of an inch. (*Elements of Nat. Philosophy*, p. 369.)

With respect to the ultimate agent by which the effects of cohesion are produced, it is remarked by Dr. T. Young, that if it is allowable to seek for any other agent than a fundamental property of matter, appearances extremely similar might be derived from the pressure of a universal medium of great elasticity. But all suppositions founded on such analogies must be considered as merely conjectural; and our knowledge of every thing which relates to the intimate constitution of matter, partly from the intricacy of the subject, and partly for want of sufficient experiments, is at present in a state of great uncertainty and imperfection. (*Young's Lectures on Nat. Philosophy*, vol. i. p. 630.) *See* Strength of Materials.

COHOBA'TION. The repeated distillation of the same liquid from the same materials. The term was invented by Paracelsus.

CO'HORT. The tenth part of a Roman legion. (*See* Legion.) The *Prætorian cohort* was a body of picked troops who attended the general, and was first instituted by Scipio Africanus.

COI'NAGE. Under this term we shall give a brief outline of the proceedings in reference to the manufacture of coin, as carried on in the Royal Mint of London.

When a parcel of gold is brought to the mint in ingots, they are deposited with the master's assay-master, who makes an assay of each ingot; and when he is ready to deliver his reports upon them, the importers are required to attend at the mint, where the weigher and teller reads over the said reports to them. They are then recorded in the journals of the master, comptroller, and master's first clerk and melter; and a mint bill is given to the importer, certifying the weight, fineness, and value of the ingots, and signed by the deputy master, comptroller, and king's (or queen's) clerk, which bill is returned upon the delivery of the bullion to the importers in the state of coin. The bullion is then delivered to the melter, who, guided by the assayer's report, adds either alloy or fine gold (when either are required), so as to reduce the mass to *standard fineness* (that is, 22 parts of pure gold and 2 of alloy), and melts and casts the metal into bars of convenient form for rolling; each bar, when intended for coinage in sovereigns, being an inch and a half by one inch square, and about two feet in length, and weighing about 26 pounds. A piece is then taken from each extremity of each bar and delivered to the king's assay-master, whose duty it is to ascertain that the said bars are of standard fineness before he allows them to be delivered to the moneyers, who next receive them for the purpose of coinage.

These preliminary operations are nearly the same as regards silver bullion.

When the moneyers, or responsible manufacturers of the coin, receive bars from the melter, they are rolled and drawn into plates of proper thickness, which require to be most nicely adjusted, so that a piece of proper size punched out of any part of the plate may have the exact weight of the intended coin; the *blanks* are then cut out of these plates, which are thus reduced to the state of *scissel*, and remelted (under due checks and precautions), to be again cast into bars. The blanks (amounting to about two thirds, and the scissel to one third of the weight of the original plate of metal) are next annealed, and passed through the *marking machine*, by which the edge of each piece is made smooth and a little raised; they are then cleaned or *blanched* by being put for a few minutes into a hot and very dilute sulphuric acid, after which they are thoroughly washed and dried, and are ready to be *stamped* or coined. This operation is performed in presses moved by mechanical power, and consists in placing the blanks between two steel dies, upon one of which is engraved the obverse and upon the other the reverse of the coin, so as to give an impression in relief; while the spreading of the piece in a lateral direction is prevented by the rising of a collar at the moment the blow is struck, in which collar is engraved the *milling*, which is thus transferred to the edge of the piece at the same moment that the impressions of the dies are taken upon its two surfaces. The coining presses at the mint are attended by boys, who only have to fill a tube or species of hopper with the blanks; the operation of laying the blank upon the dies, and again throwing it off when stamped, being effected by the machinery connected with the press, thus preventing the risk of crushing the fingers of the persons who used to be employed in this department before these *layers on*, as they are technically called, were adopted. In the coining room at the mint there are eight presses, each adapted for every species of coin; each press strikes upon an average 60 pieces per minute, or 3600 per hour; so that in the day's work of 10 hours each press produces 36,000 pieces; and the eight presses (supposing, which is rarely the case, that they are all in use) stamp 288,000 pieces daily. The money when thus completed is weighed up in what are called *journey weights* for delivery to the importers of the bullion; the gold in 15 lbs. and the silver in 60 lbs. troy. But, before any coin is suffered to pass out of the mint, it is inspected as to its workmanship; and if any journeys are faulty or imperfect in this respect, they may be cut and returned to the moneyers for recoinage. The weight and fineness of the money are also ultimately examined and insured by the process of *pixing*, which consists in taking promiscuously from every journey weight of coin a pound in tale, which is delivered by the weigher and teller to the king's assay-master, who carefully weighs it, and declares aloud the *minus* or *plus* upon each pound (if it be not *standard* or exact), which is recorded by the king's assayer, by the comptroller, and by the king's clerk. This determines whether the moneyers have made the money within the *remedy* allowed upon the pound troy; but, as the remedy upon the pound is divided among the number of pieces in it, the comptroller weighs several of the pieces individually, and if they are not within the allowed limits, can, in conjunction with the other check officers assembled on this duty, return the coin to the moneyers to be remelted and recoined at their expense. From the same pound weight of gold or silver the comptroller also takes two pieces, one of which is handed to the king's assay-master to assay, in order to prove that the metal has undergone no deterioration in any of the processes of its manufacture; the other piece is sealed up in a packet and consigned to the *pix box*, which is locked by the separate keys of the check officers, where it remains until the *trial of the pix* by jury before the king or certain of his council, which usually takes place once every three or four years in the Court of Exchequer at Westminster.

The term journey weight is applied at the mint to the weight of certain parcels of coin, which were probably considered formerly as a day's work. The journey of gold is 15 troy pounds, which is coined into 701 sovereigns, or 1402 half sovereigns. A journey of silver weighs 60 lbs. troy, and is coined into 792 crowns, or 1584 half crowns, or 3960 shillings, or 7920 sixpences.

COINS. *See* Numismatics. Money.

COKE. The charcoal obtained by heating coal with the imperfect access of air, or by its distillation. The former is usually called *oven coke;* the latter *gas coke*, being abundantly produced in gas-works. The weight of coke usually amounts to between 60 and 70 *per cent.* of the coal employed. Coke is a valuable fuel for many purposes in the arts.

COL'CHICUM. (From Colchis in Armenia, where the plant is said to have abounded.) This term is generally applied to the cormus or bulb of the *Colchicum autumnale*, or *meadow saffron*, a plant common in this country, and largely collected for medical use. It was much employed formerly as a diuretic in dropsy; then fell into disuse; and more recently again largely prescribed for the cure of gout, it having been ascertained that the celebrated French remedy for gout called *Eau*

medicinale d'Husson was a tincture of colchicum. Its efficacy may probably be ascribed to the presence of a peculiar alkaloid, which has been termed *colchicia*. When the cormi are intended for medical use, they should be dug up in summer (July), and immediately cut into thin transverse slices, placed separately upon paper, and dried by a very gentle heat. The best preparation is the *wine of colchicum*, made by infusing an ounce and a half of the bulb prepared and dried as above, and coarsely powdered, in 12 ounces of sherry, for six or seven days, shaking it daily: then filter it for use. The dose is from 20 drops to 1 drachm, taken at bed-time in a little water.

COLCO'THAR. A red oxide of iron, being the residue of the distillation of green vitriol or sulphate of iron.

COLD. In Natural Philosophy. *See* HEAT.

COLD. In Medicine. *See* CATARRH.

CO'LEOPHY'LLUM. (Gr. κολεος, *a sheath*, and φυλλον, *a leaf*.) A term introduced into botany, to indicate a monocotyledonous structure, the young leaves being evolved from within a sheath, while those of Dicotyledons are always naked.

COLEO'PTERANS, *Coleoptera*. (Gr. κολεος, and πτερον, *sheath-winged*.) The name of the order of insects comprehending those in which the first pair of wings have the consistence of horn, and serve as defensive coverings to the second pair, or true wings, which are of large size, and are folded transversely when not in use.

By means of this mechanism the *Coleoptera* are enabled to burrow in the soil, or bore the trunks of trees, without injury to their delicate organs of flight, which are the true or second pair of wings; these being of ample size are peculiarly folded, being bent at nearly right angles, so as to pack up in small compass beneath the elytra or wing-covers when the beetle is at rest. In some species the membranous wings are wanting, but the elytra are always present; although in this case, as they are never required to be expanded for flight, they are generally soldered together by a straight suture at the middle line. In ordinary cases the inner straight margins of the wing-covers are simply but accurately applied to each other.

The *Coleopterans* are of all the orders of insects the most numerous, and the best known. Their singular forms, the brilliant and agreeable colours which many of them present, the large size of some of the species, the solid consistence of their teguments, which renders their preservation easy, and the regular series of affinities traceable through several of the groups, all combine to render them objects of particular interest and attention.

The head supports two antennæ of various forms, but almost always consisting of eleven joints. They have two compound eyes, but no ocelli. The mouth is composed of six principal pieces; of which four, called the mandibulæ and maxillæ, move transversely in pairs, while the remaining two are fixed, and close the mouth vertically. The uppermost of the two vertical pieces is called the *labrum*; the lowermost is termed the *labium*, and is itself subdivided into the *mentum* and *lingua*, and together with the maxillæ, or the lowest of the vertical pieces, supports a pair of articulated processes, called *palpi* or *feelers*.

The anterior segment of the thorax, or manitrunk, supports the first pair of feet, and greatly surpasses in extent the two other segments which form the alitrunk. The abdomen is sessile, and united to the trunk by a great part of its breadth. It is externally composed of six or seven wings.

The *tarsi* vary as to the number of their joints, in some *Coleoptera* having but three, in others four, in others five; modifications upon which Latreille founds his primary division of the order. *See* PENTAMERA, TETRAMERA, TRIMERA.

The *Coleoptera* undergo a complete metamorphosis. The larva resembles a worm; the head is encased in a firm horny substance; the mouth is analogous in the number and functions of its parts to that of the perfect insects; it has also generally six feet, but some species have instead only simple tubercles. When perfect the larva generally burrows in the earth, and excavates an oval cell, within which it undergoes its change into an inactive pupa; this is generally of a whitish colour, with the wings and legs folded upon the breast. The habitation and manner of life of these insects varies much, both in their immature and perfect stages. The affinities of the *Coleoptera* to the *Orthoptera* are of a closer and more manifest nature than can be traced between the *Coleoptera* and any other order of the mandibulate insects. The genus *Forficula* forms the intervening link. It was formerly placed by Linnæus at the end of the *Coleoptera*, and was subsequently referred by Latreille to the order *Orthoptera*; but now constitutes the type of an order apart and intermediate to these two. The absence in some ants of the wings, sting, and ocelli, has led Mr. Macleay to suspect that these *Hymenoptera* make an approach to the *Coleoptera*. Mr. Kirby would place the *Strepsiptera* in juxtaposition with the *Coleoptera*, observing that the metamorphosis in the former "being different from that of *Orthoptera* and *Hemiptera*, and nearer to that of the *Coleoptera*, this seems its most natural station, considered as an Elytrophorous order."

COLEO'PTILUM. (Gr. κολεος, *a sheath*, and πτιλον, *a feather*.) A term sometimes applied to the young leaves of Monocotyledons, from the circumstance of their always being developed within a sheath, while those of Dicotyledons are always naked. This is, however, a mistake both in fact and theory.

CO'LEORHI'ZA. (Gr. κολεος, *a sheath*, and ῥιζα, *a root*.) A term invented by Mirbel to denote the sheath within which the radicle of monocotyledonous plants is enclosed.

CO'LIC. (Gr. κωλον, *the colon*; one of the large intestines, to the seat of which the principal pain is generally referred.) There are many varieties of this complaint, and it arises from various causes, and exhibits different symptoms. The general indications of cure are to evacuate the bowels by the least irritating means, and, when the lower intestines are loaded, by the use of glysters; opiates and etherial remedies may be resorted to to allay spasms, and warm bath and fomentations are often necessary. There is a peculiar disease called the *painters' colic* or *dry bellyache*, which appears to arise from the absorption of lead into the system, and which therefore commonly attacks plumbers, painters, and makers of white paint and other colours and preparations in which lead is used; the persons employed also in the lead mines and furnaces are subject to it. It is often named from certain places in which it is peculiarly prevalent; as Poictou, Devonshire colic, &c. It begins with restlessness and uneasiness about the stomach, nausea, and obstinate costiveness. There is general spasm of the bowels, often accompanied by great pain, which is somewhat relieved by pressure; and this circumstance enables us to distinguish the complaint in question from inflammation of the bowels; into which, however, it runs, if not timely relieved by opiates, emollient glysters, warm bath, and gentle aperients, especially castor oil when it will remain on the stomach, by which the spasm is allayed and the bowels evacuated of their hardened and irritating fœces. This is the *acute* state of the disease; but it often occurs in a *chronic* form, in which case pains and constipation of the bowels are followed by ocsacional delirium, epilepsy, paralysis, especially of the hands, and wasting away of the muscles. This disease terminates fatally if not timely relieved, and above all the patient should be cautiously removed from all contact with lead, and allowed fresh air and a nutritious but not stimulating diet.

COLLA'PSE. (Lat. collabor, *I shrink down*.) A wasting of the body; or a sudden and extreme depression of its strength and energies.

CO'LLAR. (Lat. collæ.) In Architecture, an horizontal piece of timber connecting two rafters.

COLLAR. In Ornithology, the coloured ring round the neck of birds. In Malacology, the thickened secreting margin of the mantle in the testaceous Gastropods.

COLLAR, signifies a peculiar badge worn round the neck by knights of different orders. It consists of a gold chain, enamelled, &c., to which is attached the badge of the order of knighthood; and it is worn at court chiefly on state occasions, which are thence called *collar days*.

COLLARI'NO. (Fr. collarin.) In Architecture, that part of the Tuscan and Roman Doric columns on the upper part of the shaft encircling them like a small collar. The more proper name is an astragal.

CO'LLECT (Lat. con, *together*, and lego, *I read*), signifies, as the derivation of the word implies, a prayer *read together with* other parts of the Church of England service, either usually or on a particular occasion.

COLLECTA'NEA, is applied, in Literature, to a selection of passages made from various authors, usually for the purpose of instruction.

COLLE'CTORS. In Botany, dense hairs covering the styles of some species of *Compositæ*, &c.: and acting as brushes to clear the pollen out of the cells of the anthers.

CO'LLEGE. (Lat. collegium.) According to the primary meaning of the word, any society or number of persons bound together by the same laws or customs (*Collegæ, colleagues*). Among the Romans not only societies invested with a character resembling that of modern corporations, enjoying certain political rights in common (as the colleges of augurs, pontifices, &c.), were termed Collegia; but bodies of men who appear to have had no bond of union except common employment (as the collegia opificum, or colleges of the different trades) were also thus designated. Hence has originated the erroneous notion that the guilds of modern Europe were derived from similar institutions among the ancients, by attributing to the last-mentioned collegia a corporate character, which it is not sufficiently proved that they possessed; although some of these bodies, as we learn from the fragments of the lawyer Gaius, did in effect hold common property, and had their affairs administered by by-laws of their own. In England many corporate bodies are termed Colleges; *e. g.* the colleges of phy-

sicians and surgeons, of heralds, &c. &c. A college, in the academical meaning of the word, signifies a society established for academic purposes under royal or private foundation, endowed with revenues, and subject to a private code of laws. Where such a society possesses within itself all the means of instruction and the rights and faculties which are incident to a university, the terms University and College are in effect convertible, and indiscriminately used. Thus, Trinity College, Dublin, affords a specimen of an institution called indiscriminately by either title. On the other hand, the universities of Oxford and Cambridge are composed of a number of colleges united together under the same discipline and government, and in which those powers peculiarly belonging to a university are wielded by one class of authorities, the functions of the colleges superintended by another. The Scottish universities, not being in the strict sense of the words endowed societies (*i. e.* not possessing a regular body of fellows and scholars receiving stipends), cannot be properly termed collegiate bodies.

The early history of colleges is somewhat obscure; although there can be no doubt that they were originally founded, in the various universities of the middle ages, with similar objects and from the same charitable motives. The first students at these universities assembled together under no common bond of union, except that of academic study and discipline, and lodged as suited their own convenience. Next, hostels or boarding houses were established (in the first instance, it is said, by the religious orders for students of their own fraternities), in which the scholars lodged together under certain superintendence. Charitable individuals afterwards endowed these hostels, for the purpose of providing poor scholars with free lodgings. Finally, to these endowments were added (by gifts or bequests) stipends for all or a certain number of the scholars frequenting these inns or hostels; and thus the foundation of a college was completed. The distinction of language arising from ancient usages is still preserved at Oxford, where societies endowed for the maintenance of fellows and scholars are termed Colleges,—societies unprovided with such endowments, Halls. But at Cambridge there is no distinction between Colleges and Halls. At the university of Paris fifteen colleges, or more, are said to have been founded in the 13th century; and the whole number, in the course of time, amounted to eighteen greater and about eighty lesser. But these institutions assumed a different shape from that which they took in England. The greater colleges became appropriated to particular faculties, or departments of a faculty. Thus, for example, the Sorbonne was the college of the theological faculty; and, in process of time, the lectures and disputations of most of the faculties became confined to the walls of those colleges which were exclusively devoted to them. Hence the university became, in fact, a collection of academies for instruction in particular subjects, and its corporate character for purposes of education vanished altogether as early as the 15th century. (See *Malden on the Origin of Universities*, and the authorities there cited.)

The name and institution of colleges were derived by the English universities, together with most of their other peculiarities, from Paris; but their history is very different. The colleges now subsisting in both these universities were constituted by royal or private munificence; either as original foundations, or (more commonly) by the endowment of formerly subsisting halls or hostels with stipends for students. They were all formed on the same principle, consisting of a head (variously termed master, principal, provost, &c.); of a body of higher graduates (generally termed fellows); and another of inferior graduates (scholars), who, according to the terms of the several foundations, were or were not eligible as a matter of right to the fellowships. The colleges were thus founded simply for the purpose of assisting scholars in their progress through the university, not for that of conferring instruction. All those of Catholic foundation, it must be added, were intended to supply the church with ministers; hence the still subsisting regulations prohibiting the marriages of fellows. In the course of time independent members, *i.e.* members not upon the foundation nor sharing in the endowments, were admitted to reside within the walls of the colleges; and the task of superintending, and finally of instructing them, was gradually transferred from the university authorities to those appointed by and resident within the colleges. And, by the present constitution of our national universities, the only powers retained by the university as such are of a general character, as of conferring degrees and other honours, &c. &c.; while the function of education for the purpose of qualifying for those degrees has entirely passed into the hands of the colleges of which that university is composed, every member of the university being now, by usage which has acquired the force of law, also member of some college or hall. And, with respect to discipline and government, the power is shared between the university, which through its vice-chancellor and proctors exercises a general superintendence; and the colleges, which by their own officers maintain order within their own walls. A college, therefore, in the sense in which the term is applied at Oxford and Cambridge, has a double character,—1. as an endowed society; 2. as a house of education. In the first sense, the college is composed of the head, fellows, and scholars. It is under the government of the original laws framed by its founder, with such variations as in some cases time has introduced; but alteration is always jealously watched. According to the tenure of these statutes, the head is either chosen by the fellows from among themselves, or in some instances appointed by the crown or other authority. The fellows, again (who are mostly, but not universally, graduates who have passed the lowest degree, that of Bachelor of Arts), and the scholars, who are admitted when under-graduates, are either chosen from particular localities, schools, &c. &c., according to the will of the founder, or elected according to merit after free competition between members of the college or of the university at large. Every college is finally under the superintendence of a visitor, generally some high ecclesiastical functionary. 2. As a place of education, the college receives within its walls not only fellows and scholars, but also (in the great majority of instances) independent members, limited in number only by the extent of the lodging which it can afford; it being usual at Oxford (although not at Cambridge) that every student on entering the university should not only belong to a college or hall, but reside within its walls. The under-graduate members of the college are under the superintendence of the tutors. These are, in general, resident fellows, appointed by the head to perform this office. In some colleges each tutor has under his special control a certain number of under-graduates; in others the tutors divide among them, not the students, but the different branches of instruction which are to be communicated. Such is a very general outline of the system of English colleges; but each of these foundations is exclusively governed by its own laws and usages, and no comprehensive description will apply without exception to all. Oxford has nineteen colleges and five halls; Cambridge seventeen colleges or halls. In both universities the oldest are supposed to have existed from the middle of the 13th century; the greater part were founded between that period and the Reformation, but a few are of Protestant foundation.

CO'LLEGE OF JUSTICE. In Scottish Law, a term applied to the supreme civil courts, composed of the lords of council and session; together with the advocates, clerks of session, clerks of the bills, writers to the signet, &c. *See* Session.

CO'LLET. *See* Collum.

COLLIMA'TION. (Lat. collimo, *I aim at.*) The *line* of collimation, in a telescope, is the line of sight, or the straight line which passes through the centre of the object glass and the intersection of the wires placed in its focus. The *error* of collimation is the difference between the actual line of sight and the position which that line ought to have in reference to the instrument.

COLLIMA'TOR. Captain Kater gave the name of *floating collimator* to an instrument invented by him for ascertaining the horizontal point. It consists of a small telescope, furnished with cross-wires in its focus, and fastened horizontally on a flat iron float, which is made to swim on mercury, and which of course, when left to itself, will always assume one and the same invariable inclination to the horizon. If the cross-wires of the collimator be illuminated by a lamp placed in the focus of its object glass, the rays from them will issue parallel, and consequently be in a fit state to be brought to a focus by the object glass of any other telescope, in which they will form an image as if they came from a celestial object in their direction, *i.e.* at an altitude equal to their inclination. By transferring, then, the collimator still floating on a vessel of mercury from one side of a circular instrument to the other, we are furnished with two *quasi-celestial* objects, at precisely equal altitudes, or opposite sides of the centre; and if these be observed in succession with the telescope of a circle, bringing its cross to bisect the image of the cross of the collimator, the difference of the two readings on the limb will be twice the zenith distance of either; whence the horizontal or zenith point is immediately determined. Another form of the collimator has the telescope placed vertically, whereby the zenith point is directly ascertained. (*Phil. Trans.* 1828; *Pearson's Practical Astronomy*, vol. ii.)

COLLI'QUATIVE. (Lat. colliqueo, *I melt.*) Excessive evacuations are so termed, which appear to melt down the strength and substance of the body.

COLLI'SION. (Lat. collisio, from collido, *I strike against.*) In Mechanics, the action of one body impinging against or striking another with a certain degree of force. In order to explain the phenomena which take place when two bodies in motion impinge against each other, we suppose the bodies either perfectly non-elastic, or perfectly elastic, and that they move in a medium which offers no resistance. As none of these suppositions have place

exactly in nature, the results deduced from them must in practice undergo certain modifications.

In the case of non-elastic bodies, let us suppose, first, that the body A strikes against another body B, which is either at rest or is moving in the same direction with A toward C, but with a less velocity.

The body B presents an obstacle to the motion of A; part of the force of A must therefore be expended in overcoming the obstacle, that is to say, in causing B to move with a velocity equal to its own. But when the quantity of motion necessary for this purpose has been communicated, B no longer opposes the motion of A; so that both bodies have the same velocity after the shock. Now, since a body cannot impart force to another without losing precisely an equal quantity itself, the sum of the forces, or *moments*, must remain the same after as before collision; but it has just been shown that the velocities of both bodies are the same after the shock; therefore (this momentum being measured bv the product of the mass into the velocity) the sum of the moments is distributed between the two bodies in the proportion of their masses, and the common velocity is found by dividing the sum of the moments before the impact by the sum of their masses.

Let us next consider the shock of two bodies moving in opposite directions. If the forces by which they are animated are equal, they will destroy each other at the instant of collision; if they are not equal, the greater will destroy the smaller, and the two bodies will then move in the direction of that whose moment was the greater, and the two moments will be equal to the difference of the moments before the impact. In this case also the velocity after the impact is the same for both bodies, and equal to the difference of the moments divided by the sum of the masses, and the remaining force is distributed between the two bodies in proportion to their respective masses.

In the case of elastic bodies, the results are modified by a new force being brought into action. Let an ivory ball A strike against another B advancing in the same direction but with a less velocity. The first effect of the collision is to produce a momentary union of the two balls, and to compress or flatten the impinging surfaces; the next is the effort of the bodies to recover their figure, and when the elasticity is perfect (as it is here supposed to be) the compressed surfaces are restored with a force exactly equal to that by which they were displaced. This restoring force, produced by the elasticity, is called the *recoil*, and its effect is to double precisely the effect that would be produced if the bodies were non-elastic. When the balls A and B come into closest union, they take a common velocity, A losing exactly as much as B gains. But in recovering their figure, the loss of A's velocity and the gain of B's velocity are each doubled. In order, therefore, to obtain the actual velocities of the impact, we may estimate the velocities that would be gained or lost by each if non-elastic, and add or subtract this to or from the common velocity they would have upon the same hypothesis.

If the masses of the two bodies are equal, their velocities are interchanged. If only one of the equal bodies be in motion, it will come to rest after the impact, and the other will move forward in the direction in which the first was moving, and with the same velocity; if they move in opposite directions, each will return in the contrary direction with the velocity the other had. Whether the bodies be equal or unequal, the difference of their velocities, or their relative velocity, will be the same in amount both before and after the impact.

A result of this theory, which at first sight appears paradoxical, is, that when several elastic bodies increasing in magnitude are arranged in the same straight line, touching each other, and one smaller than the least of them strikes against the least, each will in turn be reflected, and communicate to the succeeding one a greater quantity of motion than it has itself. This increase of momentum is greatest when the masses of the bodies increase in geometrical progression.

In all cases of collision the state of the centre of gravity, whether at rest or in motion, remains the same after the impact as before. If it was at rest, it remains in that state; and if it was in motion, it continues to move in the same direction and with the same velocity, notwithstanding the impact. This is the case both in respect of non-elastic and elastic bodies; and it is a constant law in whatever manner the bodies act on each other, and whatever be their respective natures. (For a full and elementary explanation of this subject, see *Maclaurin's Account of Newton's Principia.*)

CO'LLUM. (Lat. collum, *the neck.*) That part of the axis of a plant whence the stem and root diverge. In the beginning it is a space which there is no difficulty in distinguishing, so long as the embryo or young plant has not undergone any considerable change; but in the process of time it is externally obliterated, so as to become a mere matter of theory.

COLLUTORIUM. (Lat. colluo, *I wash*, and so, *the mouth.*) A lotion for rincing the mouth.

COLLY'RIUM. (Gr. κωλυω, *I check*, and ῥους, *a defluxion.*) Lotions intended to check inordinate discharges. The term is now exclusively applied to *eyewaters*.

CO'LOBUS. (Gr. κολοβος, *mutilated.*) A genus of long-tailed Quadrumanes, or monkeys; so called, because the fore hands are deficient in, and, as it were, mutilated of, a thumb. In this respect the *Colobi*, which are exclusively limited to the African continent, resemble the spider-monkeys (*Ateles*) of South America: but they have not a prehensile tail to compensate for the imperfection of the hands; their long caudal appendage is, on the contrary, terminated by a tuft of hairs. The *Colobi* differ also from the *Ateles* in having five molar teeth instead of six on each side of each jaw, and in having cheek-pouches.

CO'LOCYNTH. (Gr. κωλον, *the colon*, and κινεω, *I move.*) This term is applied in the Materia Medica to the pith of bitter apple, the fruit of the *Cucumis colocynthis*, which is violently purgative. It is imported dried, and generally peeled, from Turkey: it is rarely used alone; but one of the most valuable purgatives is the *compound extract of colocynth*, which is a combination of this drug with aloes, scammony, cardamum seeds, and soap.

COLOCY'NTIN. The bitter purging principle of the *colocynth*.

CO'LON. (Gr.) This name is given to the greater part of the large intestines: the colon passes upwards towards the liver, forming the *transverse arch* which descends upon the left side, forming its *sigmoid flexure;* entering the pelvis, it passes into the *rectum*.

COLON. In Grammar. *See* PUNCTUATION.

COLONNA'DE. (Lat. columna.) In Architecture, a series of columns placed at certain intervals, called intercolumniations, from each other, varying according to the rules of art and the order employed.

COLONEL. The commander of a regiment or battalion of troops: he is the highest in rank of *field officers*, and immediately subordinate to a general of division. The word is of uncertain origin. The *lieutenant-colonel* is immediately under the colonel, assisting in his duties, and being his substitute when required.

COLONY. (Gr. αποικια, Lat. colonia.) Colonies are establishments formed in foreign countries by bodies of men who voluntarily emigrate from, or are forcibly sent abroad by, their mother country. Various motives have, at different periods, led to the formation of colonies. Sometimes, as in the case of most of the Greek colonies of antiquity, they were formed by citizens driven from their native country by the violence of political factions; sometimes, as in the case of the Roman colonies, they were formed for the purpose of bridling subjugated provinces: the latter, indeed, were a species of camps or military stations, forming, as it were, the advanced posts of that mighty army which had its head-quarters at Rome: and sometimes, again, as in the case of the Phœnician colonies, and of most of those established in modern times, they have been formed for commercial purposes, or in the view of enriching the mother country, by opening new markets from which she might, if she chose, exclude foreigners.

The nature of the connection that has existed between colonies and their mother countries has been exceedingly various. Most of the Greek colonies being founded by private adventurers, who received no assistance from the government of the parent state, were really independent; the duty which they owed to their metropolis being such only as is due to kinsmen and friends, and not that due by subjects to their rulers. The Roman colonies, on the other hand, being founded by the state for an important political purpose, always maintained an intimate connection with, and dependence upon, Rome. They formed the great bulwarks of the empire; nor was the conquest of any province ever supposed to be completed till colonies had been established in it, and roads had rendered it accessible to the legions. The colonies established for commercial purposes have generally been subjected to such regulations as were deemed most for the advantage of the parent state. Their growth has thus in many instances been retarded; and they have been rendered less serviceable to their founders than they would have been had they been treated with greater liberality.

The very narrow limits within which this article must be compressed make it necessary that we should limit our statements to a few remarks, having more particular reference to those questions of colonial policy most interesting to the English reader.

The advantages supposed to result from that monopoly of the colony trade which all modern countries possessed of colonies have endeavoured to enforce, seem to be altogether imaginary. The ties of kindred, and the identity of language, customs, and manners, give the merchants of the mother country great advantages, and enable them, provided their goods be about as cheap as those of

others, to supply the colonial markets in preference to every one else. But all attempts to establish a monopoly in favour of the mother country, by prohibiting the importation of the produce of other nations into the colony, are necessarily either useless or prejudicial, not merely to its interests, but even to those of the mother country. If the latter can produce the articles required by the colony as cheap or cheaper than others, she will command the supply of the colonial markets, without any interference whatever; and if she cannot do this, unless by excluding the cheaper products of others, then it is plain the goods sent to the colony can only be produced by diverting a portion of the capital and industry of the mother country into comparatively disadvantageous channels, or into businesses in which she is excelled by others: it is plain, too, that no artificial monopolies can be maintained, except in the case of small and easily guarded colonies. The British merchants have at present the supply of by far the greater part of the manufactured goods required by our North American possessions; because the goods they send to them are generally cheaper than those sent there by other parties. But were competitors capable of underselling our merchants to appear in the field, they would have very little difficulty indeed in depriving them of these markets. Cheap goods are sure to make their way through every barrier; and the frontier of our North American colonies is so very extensive, and the impossibility of guarding it so obvious, that the smallest saving in point of expence would occasion the clandestine introduction of prohibited goods in unlimited quantities. In such a case custom-house enactments are good for nothing. All the tyrannical regulations and sanguinary punishments of Spain and Portugal were unable to prevent their transatlantic possessions being deluged with the prohibited commodities of Britain, France, and Germany. The ability to supply it with comparatively cheap goods is the only means by which it is possible to preserve any market. It is this that secures for us at this moment the same superiority in the markets of the United States that we possessed in them when they were our dependencies; and the moment we lose this advantage we shall not merely lose their market, but, with it, the markets of *all* our colonies. Nothing, therefore, can in reality be more futile than to found colonies, or to retain them in a state of unwilling dependency, in the view of monopolising their trade. If we can undersell others, we shall command their markets without any sort of interference; and if we cannot do this, the attempt to force upon them comparatively dear goods is sure to be defeated; or, if, unhappily, it should have a partial success, it would be injurious alike to the mother country and the colony.

A colony might be advantageous, and might contribute to increase the wealth of the mother country, if it yielded a greater revenue than was required for its government and defence: but this is rarely the case. Most colonies require a heavy outlay on their first foundation; and when they attain to any considerable importance, all attempts to make them contribute directly to increase the income of the mother country are very apt to excite discontent, and probably even rebellion: an unfortunate attempt of this sort led, in fact, to the American war. To obviate all chance of any such disastrous event occurring in future, we have distinctly renounced all pretensions to make our colonies contribute any thing, unless it be towards defraying the expense of their local government and militia. All the troops and squadrons required for their protection and security are furnished gratuitously by England; and, instead of deriving any revenue from our colonial possessions, they cost us *annually*, in time of peace, a direct outlay of about 2,500,000*l*. (*Official Account*, 18th of August, 1836.) In time of war, or when dissatisfaction prevails in any important colony, the direct outlay may be twice or three times as great.

A colony may, however, be advantageous in a pecuniary point of view, even when it costs the mother country a considerable direct outlay, provided it afford great facilities to individuals for making fortunes, with which to return to the mother country. A large sum is annually brought in this way into England from India; but our colonial possessions are, in this respect, of little advantage. Few, comparatively, of those individuals who acquire property in the N. American colonies return to England; and but few situations under the colonial government give the means of acquiring fortunes.

If a colony enjoy a natural monopoly of any product or article in extensive demand, it is supposed that, by laying a heavy duty on its exportation, a considerable advantage may be made to accrue to the mother country: but this does not really appear to be the case. Ceylon possesses a monopoly of the trade in cinnamon; but the enormously high duty (3*s*. per lb.) laid on the article when exported has restricted the demand for it to the narrowest limits, and reduced its culture, and the revenue derived from it, to a comparatively trifling amount. Most of our readers have no doubt heard of the immense profits made by the Dutch on spices, of which the possession of the Moluccas gave them the monopoly. But these high profits were wholly a consequence of the limitation of the quantity sold; and to prevent a fall of price by an increase of the supply brought to market, the Dutch occasionally destroyed a portion of the produce! There is no longer, however, so much even as the shadow of a doubt that they were heavy losers by this oppressive and short-sighted policy. The sales were confined to an amount hardly sufficient to employ the capital even of a single merchant; and the total sum realized by the government is not supposed to have amounted to the tenth part of what it would have risen to had the trade been left free, under a moderate duty.

When a nation derives the whole or any considerable portion of any important article from abroad, it is necessarily exposed, especially when the supply comes from one or a few foreign countries, to the risk of more or less inconvenience, from an interruption of the friendly intercourse subsisting with such countries. When such important articles are furnished by a colony, their supply is comparatively secure; and, in such cases, colonial possessions may be very valuable. At this moment any interruption of the trade with the United States would most probably, by interfering with the supply of raw cotton, be productive of the most calamitous results; and there can be no doubt that if the whole, or any considerable part of the supply of cotton, were derived from a colony, it would be an important advantage. This, however, is not the case. It is not improbable but that, at some future period, India may yield abundant supplies of cotton; but at present the cotton she sends to Europe is neither considerable in amount nor of good quality.

It was long supposed that our colonies in the West Indies were peculiarly valuable from their furnishing us with a secure and abundant supply of sugar, an article now become a necessary of life, and yielding a very large revenue. We doubt, however, whether there were ever any good foundation for such an opinion; but, whatever may have been the case formerly, there is none now. Sugar is not produced in one or a few countries only; but is a staple product of almost all intertropical regions; and it is now largely produced even in the northern parts of Europe. (*See* SUGAR.) So far, indeed, is it from being true that we are indebted to our West Indian colonies for abundant supplies of sugar, that the fact is nearly the reverse. Foreign sugar is, and has long been, excluded from our markets by oppressive discriminating duties; and were these repealed, and the duties on all sugars placed on the same level, it is exceedingly doubtful whether we should continue to derive any considerable portion of our supplies of sugar from our sugar colonies in the west.

Great stress is frequently laid on the advantage of colonies established in unoccupied countries, in affording a field for the ready and beneficial employment of the surplus or unemployed population that occasionally abounds in old settled and densely peopled countries; neither can there be a doubt that this is of very material importance. But it is pretty obvious that, having founded a colony, it is unnecessary to retain it in a state of dependence if it wish to become free, to realize the advantage referred to. Labour, in such colonies, is always in great demand, and a regard for their own interests always disposes the colonists to give every fair facility to the immigration of labourers. Notwithstanding the advantages occasionally held out by the British government to encourage emigration to our North American colonies, the great current of emigration has always been directed to the United States; and, even of the emigrants that sail from this country for Canada, scarcely a fourth part remain in the province, but immediately leave it for the contiguous states of the Union. It is idle, therefore, to attempt to excuse the policy of attempting to retain colonies in a state of reluctant dependence on the mother country, on pretence of their affording a profitable outlet for poor or unemployed persons. The interest of the settlers will keep this outlet open, and will secure every real advantage that could, in this respect, be derived from the most complete colonial domination.

We beg, however, that it may not be supposed, from any thing now stated, that we regard the foundation of colonies as inexpedient; on the contrary, their establishment has been highly advantageous to this as it has been to most old settled countries in all ages. It is not to their foundation, provided they be placed in proper situations and judiciously managed, but to the needless interference with their government, the trammels imposed on their industry, the prevention of their free intercourse with other people, and the attempt to govern them after they are able and determined to govern themselves, that we object. A nation that founds a colony in an unoccupied country, or in a country occupied only by savages, extends by so doing the empire of civilization to, it may be, an indefinite degree. Such colony not only forms a desirable outlet for the redundant or unemployed population of the mother country, but it forms a new and rapidly increasing market for its products and those of other

countries. No one can doubt that Europe has been signally benefited by the discovery and civilization of America; but the advantages thence arising, how great soever, would have been incomparably greater, but for the various impolitic regulations imposed by the mother states on their colonies. The British colonies, though fettered in various ways, enjoyed a much greater degree of freedom than those of any other country; and, in consequence their progress, both before and since the æra of their independence, has been proportionally rapid. The colonies of Spain, on the other hand, though occupying the finest provinces, had their progress thwarted by the blind jealousy and short-sighted rapacity of the mother country, and were kept as much as possible in a state of pupilage. The government was entirely administered by natives of Old Spain; the colonists were carefully excluded from every office of power and emolument; one colony was prohibited from trading with another; and had foreigners presumed to settle amongst them, they would have been liable to capital punishment. In consequence their progress was very slow; and when at length they succeeded in throwing off the galling yoke of the mother country, they became, from their inexperience in self-government, a prey to all sorts of disorders. It is very questionable whether her South American colonies were of the least service to Spain; and it is, at all events, certain that they have not conferred either on her or on other countries a tenth part of the benefit they would have done had they been treated with greater liberality, and permitted freely to avail themselves of all the advantages of their situation.

The American war seems to have decided, in so far as experience can decide any thing, the question as to the policy of retaining colonies in a state of dependency that are determined to govern themselves. No colonies were ever reckoned half so valuable as those which now form the republic of the United States; and it was generally supposed that their emancipation would be decisive of the fate of Britain,—that her sun would then set, and for ever! But have we really lost any thing by that event? Has our trade, our wealth, or our power been in any degree impaired by the independence of the United States? The reverse is distinctly and completely the fact. The notion that we could have continued for any length of time to retain such rapidly growing countries in a state of dependence, or that we could have been advantageously united in a federal union with vast regions situated in another hemisphere, is too wild and extravagant to require examination. But notwithstanding its independence we have continued, and will necessarily continue in all time to come, to reap all the advantage we can reasonably claim as founders of this mighty empire in the wilderness. Englishmen will necessarily always command a preference in the American markets. And while we are disencumbered of the impossible task and enormous expense attending the government and defence of all but boundless countries 3,000 miles distant, our intercourse with them grows with their growth; and we are as much benefited and enriched by them as we should have been had they continued in the same state of dependency as Australia or the Cape of Good Hope.

The previous remarks are not, of course, meant to apply to such dependencies as Malta or Gibraltar. These are not colonies, but naval stations, necessary for the accommodation of our ships of war and merchantmen, and serving also as secure depôts for our produce. Every commercial and maritime nation that takes a just view of its real interests will always take care to possess itself of some such strong-holds.

Neither are the previous remarks meant to apply to the conquest and occupation of foreign countries, in the view of increasing national opulence and power. Such policy may be either good or bad, according to the peculiar circumstances affecting each particular case. Our remarks apply only to colonies strictly so called; that is, to the case of foreign territories, peopled principally or wholly by emigrants, or by the descendants of emigrants from the mother country, and not held as a mere military station.

Sometimes, in order to carry on a trade with a colony, it is necessary to give its products peculiar advantages in the markets of the mother country; and consequently at the expense and to the prejudice of the consumers in the latter. We rather incline to think that no small portion of our trade with the West Indies is forced in this way; and that were the discriminating duties on foreign sugar abolished, we should derive a considerable part of our supplies from other quarters. But whatever may be the case with the West India trade, this, at all events, is the case with the Canada trade. It employs a large number of ships and seamen, and seems, to a superficial observer, highly valuable. In truth and reality, however, it is very much the reverse. Two thirds and more of this trade is forced and factitious; originating in the oppressive discriminating duty of 45*s*. a load imposed on timber from the north of Europe, over and above what is imposed on that brought from a British settlement in North America! This obliges us to resort to Canada, whence we import an inferior article at a comparatively high price. The disadvantages of this impolitic system are numerous and glaring. To a manufacturing country, having a great mercantile and warlike navy, timber is indispensable; and yet, instead of supplying ourselves with it where it may be found best and cheapest, we load the superior and cheaper article with an exorbitant duty; and thus do the most we can to make our houses and ships be built and our machinery constructed of what is inferior and dear! But the mischief does not stop here. By refusing to import the timber of the north of Europe, we proportionally limit the power of the Russians, Prussians, Swedes, and Norwegians to buy our manufactured goods; while, by forcing the importation of timber from Canada, we withdraw the attention of its inhabitants from the most profitable employment they can carry on, — that is, from the cultivation of the soil, — and make them waste their energies in comparatively disadvantageous pursuits! Such, either in a less or a greater degree, is the uniform result of all attempts to interfere with the natural order of things, and to force a trade, whether with a colony or a foreign country matters not, that would not otherwise be carried on.

But the existing state of our relations with Canada affords other matter for serious, and not very pleasant reflection: that colony is not, and never has been, of advantage to England. Were the duties on Canada timber reduced to the same level as those on Baltic timber, we question whether it would be found to possess a single article that could be advantageously exported to this country, or that we might not buy cheaper and better elsewhere. It no doubt affords an outlet for emigrants, and is in so far useful; but in all other respects its occupation has always been, and will most probably continue to be, productive of little except loss. And even as respects emigration, it is, as already explained, by no means clear that the field would be at all narrowed by Canada becoming independent, or connected with the United States.

But useless as Canada has been to England in time past, the connection with it will, in all probability, become much more onerous in time to come. We shall not stop to inquire whether the Canadians have good grounds for the dissatisfaction that prevails so generally amongst them. It is enough to know that it exists; and that nothing but the presence of a large British army is able to maintain our nominal ascendency in that province. While this state of things continues, the prosperity of the colony must be at a stand; emigration to it will cease or be greatly narrowed; and the distresses in which the settlers will be involved will give additional strength to the party wishing to break off the connection with the mother country. The people of Britain would do well to reflect dispassionately on the state of the Canadian question. There are not, perhaps, a dozen men of sense in the empire who are not ready to admit that in some ten or twenty years Canada will be independent, or be incorporated with the United States. But if so, what should be our policy in the mean time? Are we resolved to maintain an army of 10,000 or 15,000 men in Canada? — to expend, directly and indirectly, some three or four millions a year in preserving a mere nominal ascendency in a colony our connection with which is really a loss? If such be our determination, it may be doubted whether we have profited much by the dear-bought experience afforded by the American war. National pride may prevent our relinquishing this costly and barren dominion; but good sense, and the most obvious views of expediency, would seem to suggest the policy of voluntarily anticipating what there is every reason to think must in the end necessarily happen, and of providing for the independence of Canada under a system of friendly and mutually beneficial relations.

The explanation given by Dr. Smith in the *Wealth of Nations* (book iv. cap. 7.) of the causes of the rapid growth and prosperity of colonies founded in advantageous situations, though impugned by Sismondi (*Etudes sur l'Economie Politique*, ii. cap. "Colonies") and others, seems to be consistent alike with principle and historical evidence. When a colony is founded in an uninhabited or but thinly peopled district, each colonist gets a large extent of the best land; he has no rent, and but few if any taxes to pay; and being able to procure supplies of manufactured articles from the mother country, or one equally advanced, he applies all his energies to agriculture, which under the circumstances is most productive. The demand for labour in such colonies is very great; for the high rate of wages, combined with the cheapness of the land, speedily changes the labourers into landlords, who in their turn become the employers of fresh labourers. In consequence population and wealth advance with unusual rapidity; and in some instances, as in that of the United States, they have continued for a lengthened period to go on doubling every twenty or five and twenty years!

But in stating that the facility of obtaining supplies of fertile and unoccupied land is the principal cause of the rapid progress of new colonies, it is not meant to affirm that it is the only cause. An advantageous situation for the prosecution of commercial pursuits, and great superiority in navigation, may enable a colony to advance at its outset, though without any considerable extent of territory, with even more rapidity than if it enjoyed an unlimited command of fertile land. This seems to have been the principal cause of the speedy extension of the Greek colonies in antiquity. The most famous of these, as Syracuse and Agrigentum in Sicily, Tarentum and Locri in Italy, and Ephesus and Miletus in Asia Minor, were amongst the principal emporia of the ancient world. They were all sea-port towns; were founded in the most advantageous situations for carrying on an extensive commerce, and owed, in fact, their wealth and greatness mainly to trade and navigation. Owing, however, to the limited extent of their territorial acquisitions, a consequence partly of the difficulty of subduing the indigenous population, and partly of the neighbourhood of other colonies founded by rival states, their power rested on no very broad or solid foundation; so that the fall of the capital city and the annihilation of the state were all but synonymous.

The colonies founded in modern times have been placed under very different circumstances. The countries in which they were planted were either so very thinly inhabited as to be almost deserts, or they were occupied by a feeble and inferior race unable to oppose any effectual obstacle to the diffusion of the colonists; so that the latter easily spread themselves over a large extent of country, and have had in general more of an agricultural than of a commercial character. But while this has given them greater strength, it has not, after the difficulties attendant on their first establishment were got over, in any degree impeded their progress, but the contrary. The most flourishing of the colonies of antiquity will not bear to be compared in respect of rapidity of growth, magnitude and power, with the United States; and the slower progress of the Spanish and Portuguese colonies is not owing to the colonists having distributed themselves over a wide extent of country, but to the oppressive interference of the mother country with their domestic arrangements, and the vexatious restrictions laid on their intercourse with foreigners.

A very great degree of equality prevailed among the free settlers in Greek colonies; and in consequence the lands accquired by the colonists were distributed amongst them in nearly equal portions. But in modern times it is very different. Owing to the vast extent and almost desert state of the countries in which they have been principally planted, the poorest individuals have generally succeeded in acquiring slips of land; while the superior class of colonists, or those who had influence with the colonial government, or with that of the mother country, frequently succeeded in getting grants of vast tracts of land, not in the view of cultivating, but of holding them till in consequence of the increase of population in the vicinity they had acquired a considerable value. These large reserves, by interrupting the communications between different parts of the colony, and increasing the difficulty and cost of conveyance, have frequently proved not a little injurious to its interests. But there are various ways in which an abuse of this sort might be obviated; and perhaps the best would be to apportion the land according to the available capital of the settlers, it being stipulated that no individual should receive above a certain number of acres, and that it should revert back to the public unless certain improvements were effected upon it within a specified time after the grant was made.

But not satisfied with attempting to put down an abuse of this sort, we are now told that all the difficulties incident to colonization have originated in the too great dispersion of the colonists; and that to obviate them, and to ensure to all new colonies the acme of prosperity, we have merely to compel the colonists to keep close together by exacting a high price for the surrounding waste or unoccupied land; in other words, by making the colony as like an old settled country as possible! Perhaps such a crude project was hardly worth notice. If, on the one hand, the price set on the waste land were inconsiderable, it would not prevent the purchase of large tracts of land on speculation, and the entailing on the colony all the disadvantages that have resulted from the making of injudicious grants; and if, on the other hand, the price demanded for the land were pretty high, it would go far to oppose an insuperable obstacle to the progress of the colony. Rich men do not leave their native country to expose themselves to the inconveniences and hardships attending the establishment of new settlements in the wilderness. This, if it be done at all, must be done in time to come as in time past, by individuals in straitened circumstances, and anxious to improve their fortunes. But to exact a high or considerable price for land from such persons would, by sweeping away the whole or a considerable portion of their capital, deprive them of the means of clearing and cultivating the land, and proportionally retard their progress and that of the colony. The plan of letting lands by fine is admitted by every one who knows any thing of agriculture to be one of the worst that can be devised; and this colonization project is bottomed on the same principle, and will no doubt be as pernicious.

It is said that in consequence of the exaction of a price for the land, and the concentration of the colonists, their employments, being more combined and divided, will be prosecuted with a great deal more success than at present. All this, however, proceeds on the false and exploded assumption that the colonists are not, like other individuals, the best judges of what is for their own advantage. Dr. Smith says truly that it is the highest impertinence for kings and ministers to attempt to direct private people *how* they should employ their capitals. But it is, if possible, a still greater impertinence to attempt to direct them *where* they shall employ them. A regard to their own interest will draw people sufficiently together; and to enact regulations in the view of concentrating them still more, is in every respect as contradictory and absurd as it would be to set about increasing the public wealth by regulating the sort of employments to be carried on, and the countries with which, and the commodities in which, to deal.

We have already sufficiently explained the principal cause of the rapid progress made by some of the Greek colonies: it should, however, be borne in mind that these colonies had great numbers of slaves, who carried on most part of the more common employments. Hence, in Syracuse or Tarentum, every rich individual might have as many obsequious servants as he pleased, and all sorts of luxurious accommodations were to be had in the greatest profusion. But in those modern colonies where slavery is abolished, the different ranks and orders of men are more nearly assimilated, less by the depression of the rich than by the elevation of the poor. What is wanted in refinement and attention is far more than compensated by the wellbeing and comfort of the lower classes.

It is a part of this new project, on the supposed excellence of which much stress is laid, that the sums got by the sale of lands in the colony are to be expended in defraying the expense attending the conveyance thither of labourers. This is a species of bait held out to tempt capitalists to buy land, by making them believe that though land be artificially dear, labour will be artificially cheap, and that on the whole they will be very well off! This, however, is merely attempting to repair an injury done the capitalists, by inflicting a still more serious injury on the labourers. In a colony where a large portion of the capital is swallowed up in the purchase of land, the demand for labour must be comparatively limited; and this limited market is to be glutted by throwing upon it crowds of paupers transported gratis from England! We say crowds of paupers; for few labourers aware of the facts of the case, who can afford to pay for a passage to the United States, will voluntarily go to a colony where land is to be artificially raised to a high price, and labour artificially reduced. The whole scheme seems, in fact, to be little else than a tissue of delusions and contradictions, and it says little for the discernment of the public that it should have attracted any notice.

It is true that the Americans sell their unoccupied lands; but they sell the richest and finest lands in the valley of the Mississippi at less than a dollar an acre, whereas we exact 5*s*. an acre for the worst land at the antipodes, or in that *terra incognita* called Southern Australia! If these regulations be intended to divert the current of voluntary emigration from our own colonies to the United States, they do honour to the sagacity of those by whom they were contrived, and there is not a word to be said against them; but in all other respects they seem to be as impolitic and absurd as can well be imagined. (For further information on this important subject, see *St. Croix, de l'Etat et du Sort des Anciennes Colonies;* the art. "Colony" in the *Encyclopædia Britannica;* and *M'Culloch's Commercial Dictionary*, and Edition of the *Wealth of Nations.*)

CO'LOPHON. In Bibliography, the postcript contained in the last sheet of an early printed work (before the introduction of title-pages), containing the printer's name, date, &c., is so termed; from a fanciful allusion to a Greek satirical proverb, in which the people of Colophon, in Asia Minor, are reproached with being always the hindmost.

COLO'PHONITE. A variety of garnet of a *resinous* fracture.

COLO'PHONY. (Gr. Κολυφωνια, the city whence it was first brought.) The dark-coloured resin which remains after the distillation of oil of turpentine.

COLO'SSAL. (From Colossus, a very large statue at Rhodes.) In the Fine Arts, a term applied to any work of art remarkable for its extraordinary dimensions. It is, however, more applied to works in sculpture than in the other arts. It seems probable that colossal statues had their origin from the attempt to astonish by size at a period when the science of proportion and that of imi-

tation were in their infancy. Colossal statues of the divinities were common both in Asia and Egypt. By the description of the palace or temple attributed to Semiramis it abounded with colossal statues, among which was one of Jupiter forty feet in height. In Babylon we learn from Daniel that the palaces were filled with statues of an enormous size, and in the present day the ruins of India present us with statues of extraordinary dimensions. The Egyptians surpassed the Asiatics in these gigantic monuments, considering the beautiful finish they gave to such a hard material as granite. Sesostris, according to history, appears to have been the first who raised these colossal masses, the statues of himself and his wife, which he placed before the temple of Vulcan, having been thirty cubits in height. This example was imitated by his successors, as the ruins of Thebes sufficiently testify. The taste for colossal statues prevailed also among the Greeks. The statue of Apollo at Rhodes, executed by Chares, a disciple of Lysippus, has indeed given this species of art the name it bears; and the great Phidias contributed several works of this order. The colossus at Tarentum by Lysippe was no less than forty cubits in height; and the difficulty of removing it, rather than the moderation of the conqueror, prevented Fabius carrying it off with the Hercules from the same city. But the proposition made to Alexander of cutting Mount Athos into a statue, in one of whose hands a city was to be placed capable of holding ten thousand inhabitants, whilst in the other he was to hold a vessel pouring out the torrents from the mountain, exceeds all others in history. Before the time of the Romans colossal statues were frequently executed in Italy. The first monument of this nature set up in Rome was one placed in the capitol by Sp. Carvilius after his victory over the Samnites. This was succeeded in after times by many others, of which those now on Monte Cavallo, said to be of Castor and Pollux, are well known to most persons. In modern times the largest that has been erected is that of S. Carlo Boromeo at Arona near Milan. This gigantic statue is upwards of sixty feet in height.

COLOSSE'UM. *See* AMPHITHEATRE.

COLO'STRUM. The first milk after delivery. A mixture of turpentine with the yolk of egg.

CO'LOUR. (Lat. color.) In Painting, that quality of a body which affects our sensation in regard to its hue. *Local colours* are those which are natural to a particular object in a picture, and by which it is distinguished from other objects. *Neutral colours* are those in which the hue is broken by partaking of the reflected colours of the objects which surround them. *Positive colours* are those unbroken by such accidents as affect neutral colours.

CO'LUBER. A Linnæan genus of serpents, including all those in which the subcaudal scale-plates or scutæ are arranged in pairs. This extensive group is now subdivided into numerous subgenera.

CO'LUM. A term, now obsolete, denoting that part of the ovarium from which the ovula arise; commonly called the Placenta.

COLU'MBA. (Lat. columba, *a pigeon*.) A genus of birds which form the transition from the Passerine to the Gallinaceous orders. They fly well; live in a state of monogamy; build their nests in trees or in the crevices and fissures of rocks; and lay but few eggs at a time, generally two; their tail is composed of twelve quill-feathers: so far the Columbæ resemble the Passerine birds. But their beak is vaulted; the nostrils perforated in a broad membranous space, and covered with a cartilaginous scale, which even forms a bulge at the base of the bill; the sternum is deeply and doubly notched; a dilated crop is developed from both sides of the œsophagus; the stomach is a true gizzard; and the lower larynx has only a single pair of muscles: all these important modifications of structure indicate the close affinity of the Dove tribe to the Gallinaceous birds. And it may be further remarked, that although the pigeons lay but few eggs at each brood, they breed frequently, and at short intervals. The male assists his mate in the business of incubation and rearing of the young, which are at first supported by a milky secretion prepared from the glandular coat of the crop, and regurgitated, together with the macerated grain. The Linnæan genus is subdivided into numerous but unimportant subgenera, characterized by the greater or less length of the bill, and the proportions of the feet and tail.

COLU'MBA NOACHI. (Noah's Dove.) A small constellation in the southern hemisphere, near the hinder feet of Canis Major, formed by Halley.

COLUMBA'RIUM. (Lat.) In Architecture, a pigeonhouse or dovecote. From the similarity the arched and square-headed recesses in the walls of cemeteries, which were made to receive the cinerary urns, were also called Columbaria.

COLU'MBIA. A bitter crystalline principle, obtained from colomba root.

COLU'MBIUM. A metal discovered by Mr. Hatchett in 1801, in a mineral from Massachusets in North America. It has since been found in a Swedish mineral called tantalite, but its ores are extremely rare. It is acidifiable, and hence the peroxide has been termed *columbic acid*.

COLUMELLIA'CEÆ. (Columellia, one of the genera.) An obscure natural order of shrubby or arborescent Exogens, inhabiting Mexico and Peru; distinguished from *Jasminaceæ*, to which order they have been referred, by having an adherent ovary, a perigynous disk, undivided stigma, and inferior capsule with polyspermous cells. Of its true affinity little is known.

CO'LUMN. (Lat. columna.) In Architecture, a member of an order whose section through the axis is usually a frustum of an elongated parabola. It is circular on every height of its plan, and consists of a base, shaft or body, and a capital. It differs from a pilaster, which is square on the plan. The use of the column is to support the entablature. *See* ORDER.

CO'LURES. In Astronomy, two imaginary great circles of the celestial sphere intersecting in the poles of the world; one passing through the equinoctial points of Aries and Libra, and the other through the solstitial points of Cancer and Capricorn. For this reason the first is called the *equinoctial*, and the second the *solstitial* colure. The name Colure, derived from Gr. κολουρος (cauda truncus, *imperfect*), is supposed to have been given to those circles because a portion of them is always concealed from view under the horizon. But this is the case with every other meridional circle as well as the colures.

CO'LZA, OIL OF. The oil expressed from the seed of the *Brassica oleracea*, a species of cabbage. Colza oil is much used in France and Belgium for burning in lamps and other purposes.

CO'MA. (Gr. κομη, *hair*.) The assemblage of branches forming the head of a forest tree. Also used to denote bracts that are empty and terminate an inflorescence, as in *Salvia horminum*.

COMA. (Gr. κωμα, *a swoon*.) Lethargy, or unnatural drowsiness; whence the term *comatose*.

CO'MA BERENI'CES. (Literally *Berenice's hair*.) A constellation of the northern hemisphere, between the tail of the Lion and Bootes. *See* CONSTELLATION.

COMB, or COOMB. A measure of corn, commonly four Winchester bushels.

COMB, or COMBE, in the western counties of England, signifies a small valley. The same ancient word of Celtic derivation is used in Wales (cwm), and in the Alps between France and Piedmont (combe), in the same sense.

COMBINA'TION. (Lat. con, and binus, *double*.) In Algebra, signifies the disposition or arrangement of any number of objects or symbols in all possible ways. The two principal problems that occur in the theory of combination are the following: — 1st, Any number of things with the number in each combination being given; to find the number of combinations. 2d, To find the number of alterations which any number of quantities can undergo when combined in every possible variety of ways. In the solution of the first problem we have to consider that in combining things by pairs, two things, *a*, *b*, admit of one combination only, viz. *a b*; three things, *a*, *b*, *c*, admit of three, viz. *ab*, *ac*, *bc*; four admit of six, viz. *ab*, *ac*, *ad*, *bc*, *bd*, *cd*; five admit of ten, viz. *ab*, *ac*, *ad*, *ae*, *bc*, *bd*, *be*, *cd*, *ce*, *de*. Generally, if n denote the number of things, the formula which expresses the number of all their combinations by pairs is $\frac{n(n-1)}{1\cdot 2}$. Thus, if $n=5$, then $\frac{5\cdot 4}{1\cdot 2}=10$; if $n=6$, then $\frac{6\cdot 5}{1\cdot 2}=15$ is the number of combinations.

When the things are combined by *threes*, the number of combinations that can be made out of a given number n, is $\frac{n}{1}\times\frac{n-1}{2}\times\frac{n-2}{3}$. If combined by *fours*, the number of combinations is $\frac{n}{1}\times\frac{n-1}{2}\times\frac{n-2}{3}\times\frac{n-3}{4}$, and so on.

The number of combinations of all sorts that can be made of n things (that is, by first taking the things one at a time, then taking them by twos, then by threes, and so on) is 2^n-1. Thus, all the possible combinations or selections that can be made of three things are $2^3-1=7$, viz. *abc*, *ab*, *ac*, *bc*, *a*, *b*, *c*.

The second problem requires us to take into account not only the different combinations of the things themselves, but also the order of their arrangement. Admitting this element of variation,

Two things may be varied by pairs in four ways: thus, *aa*, *ab*, *ba*, *bb*.

Three quantities, taken by pairs, may be varied nine ways; thus, *aa*, *ab*, *ac*, *ba*, *ca*, *bb*, *bc*, *cb*, *cc*.

Generally the number of variations by pairs which can be made of n things is equal to n^2; when taken by threes, the number of variations is n^3; when by fours, the number of changes is n^4, and so on. Hence the whole number of changes in n things, taken by *twos*, by *threes*, by *fours*,

and so on to n, is the sum of the geometrical series $n + n^2 + n^3 + n^4 \ldots\ldots + n^n = \frac{n^n - 1}{n-1} \times n$. Thus, if $n=5$, the number of possible changes is $\frac{5^5-1}{4} \times 5 = 3905$; and if $n=24$ (the number of letters in the alphabet), the theorem gives 1391724288887252999425128493402200, a number consisting of 34 digits. *See* PERMUTATION.

COMBINA'TION. In Law, may take place for the performance of any unlawful act, and is punishable before such act is executed. But the word has been commonly used in a particular sense; viz. that of a combination among workmen to demand wages at a particular rate; which was an unlawful act prior to the 6 G. 4. c. 129. repealing former statutes. Workmen are now at perfect liberty to form such combinations; but penalties are enacted by the statute against such as use threats or violence towards those who refuse to join in them. And the offence of administering unlawful oaths (whether preparatory to a combination among workmen, or for any other purpose) remains unaffected by the statute.

Combinations to raise wages, or "strikes," have formed for the last fifty years the most embarrassing difficulties with which British manufacturers, and the labouring classes themselves, have had to contend; and it can scarcely be said that the repeal of the combination laws in 1824 has produced much effect either to encourage or diminish them. On this subject we shall make an extract from a note, or rather a dissertation on "wages of labour," in Mr. M'Culloch's Edition of *Smith's Wealth of Nations*, in which the tendency of combinations to fetter commercial operations is set forth with a brevity and perspicuity no where surpassed.

"The repeal of the act against voluntary combinations in 1824 was a just and a wise measure. If any number of persons choose to combine to refuse to work, except for a certain amount of wages, or for certain hours per day, or week, to forbid them would seem to be a most oppressive interference with one of the distinguishing privileges of free labourers. It was found too that practically the laws against such combinations were good for nothing, and that, instead of putting them down, they gave them a secret character, and made them be easily perverted to other and more objectionable objects. But when workmen have power to refuse to employ themselves on terms of which they disapprove, they have got *all*, in this respect, to which they are entitled. None of them have any right to dictate to their fellows; or to say that because they object to certain stipulations in the terms offered by such and such employers, no one else shall be allowed to accept them. A pretension of this sort strikes at the very foundations of society; and if tolerated might enable juntos of designing individuals to inflict irreparable injury, not only on the employers of labour, but on the manufactures of the country, and consequently on the lasting interests of the labouring class. We need not, however, be surprised to learn that this is what numbers of workmen in various places have attempted to do; and that combinations have been formed, not for the legitimate purpose of refusing to work except on certain conditions, but for preventing other workpeople who may disapprove of, or not choose to insist on, these conditions, accepting the terms offered by their employers. The measures taken to enforce this most unjustifiable pretension have in some instances been of a very obnoxious description, and have evinced the existence of a very dangerous spirit. Nothing should be omitted that may serve to root out and suppress combinations for such illegal ends. They are completely subversive of that security essential to the prosecution of all industrious undertakings; and are, at bottom, as hostile to the interests of those that enter into them as they are to the interests of every one else." (For further details on this subject, see *A. Smith*, Book i. chap. 8.; *the Parliamentary Debates of the Year* 1824; *Torrens on Wages and Combinations*, London, 1834; *Edinb. Review*, vol. 39. 59.)

CO'MBRETA'CEÆ. (Combretum, one of the genera.) A natural order of shrubby or arborescent Exogens, all living within the tropics, and placed indifferently in the vicinity of *Santalaceæ* and *Elæagnaceæ*, or of *Onagraceæ* and *Myrtaceæ*. They all possess an astringency, and some are employed in dyeing. Some are polypetalous, some apetalous. They are especially distinguished by their convolute embryo.

COMBU'STION. This term is generally applied to the phenomena exhibited by burning bodies, and which depend upon the rapid union of the *combustible* with the oxygen of the air. The evolution of heat and light which attends this process announces intense chemical action; and we consequently find that combustion is always attended by the production of new compounds. *See* HEAT.

CO'MEDY. (From the Greek words κώμη, *a village*, and ᾠδη, *a song*; because the original rude dialogues, intermixed with singing and dancing, out of which the early Greek comedy arose, were sung by rustic actors at village festivals.) A species of drama, of which the characteristics in modern usage are, that its incidents and language approach nearly to those of ordinary life; that the termination of its intrigue is happy; and that it is distinguished by greater length and greater complexity of plot from the lighter theatrical piece entitled a farce. The original Attic comedy was a burlesque tragedy in form, in substance a satire on individuals, and founded on political or other matters of public interest. The modern comedy is derived from the new comedy of the Greeks, of which Menander and Philemon were the principal authors, and which has been preserved to us through the Latin imitations of Plautus and Terence. *See* DRAMA.

CO'MET. (Gr. κομητης, from κομη, *hair*.) The name given to a numerous class of celestial bodies belonging to the solar system. The luminous point which shines with greater or less brilliancy at the centre of a comet is called its nucleus. The nucleus is generally surrounded by a *nebulosity*, or luminous aurora. The train of light, of greater or less extent, with which most comets are accompanied, is called the *tail*. Formerly this name was only applied to the luminous train when it fell behind the comet in its diurnal motion; if it preceded the comet, it was called the *beard*; but this distinction has disappeared in modern works on Astronomy.

The ancients gave the name of comet to every nebulous star or meteor which was observed to pass successively through different constellations. Modern astronomers apply the name, notwithstanding the etymology, to stars which have neither nebulosity nor tail. According to them, the distinctive characters of a comet are, 1st, that it possesses a proper motion; 2d, that it traverses space in a curve so elongated that in the distant parts of its orbit it ceases to be visible. The proper motion distinguishes comets from those new stars which occasionally appear, and become extinguished without changing their place in the sky. The elongated form of the orbit establishes a distinction equally marked between the comets and the planets.

Orbits of Comets. — Some of the ancient philosophers regarded comets as simple meteors, engendered in the atmosphere. In order, however, to be convinced that they occupy a far more remote situation, it is only necessary to compare simultaneous observations at very distant places on the earth. Tycho Brahe was the first who showed that their true place is in the planetary regions: since the time of Tycho, it has been discovered that they revolve about the sun according to regular laws, similar to those which govern the planetary motions; and that their orbits are very elongated ellipses, having the sun in one of their foci.

Comets are only visible during the short time they are near the perihelia of their orbits. But an elongated ellipse, and a parabola having the same summit and focus, only begin to diverge sensibly at a considerable distance from the common summit. In order, therefore, to represent the different positions of a comet during the short time it is visible, we may in general without any inconvenience substitute a parabola for an ellipse. If it happens that the orbit cannot be represented by a parabola, we conclude that the ellipse is not very elongated. Now, by means of three positions of a comet seen from the earth, all the elements of its parabolic orbit may be determined. These elements are, 1st, the line of the nodes; 2d, the inclination of the orbit to the plane of the ecliptic; 3d, the perihelion distance, or least distance of the comet from the sun, expressed in parts of the earth's semidiameter; 4th, the instant of the passage through the perihelion; 5th, the longitude of the perihelion. When these elements are known, the path of the comet is completely determined; and it is only necessary, in addition, to indicate the direction of the motion, that is to say, whether it is in the order of the signs, or the contrary.

The proper motion of all the planets is performed from west to east in the order of the signs; comets, on the other hand, appear to traverse the heavens in all directions indifferently. Of 129 comets whose orbits have been determined, there are 68 whose motion is direct, and 61 whose motion is retrograde, and their orbits intersect the ecliptic at all possible angles. Out of the whole number there are only three whose returns to the sun in successive revolutions have been verified by observation. These are, 1st, Halley's comet, of which the period is about seventy-five and a half years; 2d, Encke's, whose period is about three and one third years; and 3d, Biela's, which performs its revolution in six years and about eight months.

Halley's Comet. — Newton was the first who submitted the motion of a comet to calculation, and pointed out a method of determining its orbit from three of its observed positions. Halley applied Newton's method to a great number of comets, of which the positions had been observed; and on comparing the resulting elements, per-

ceived that the comet which appeared in 1682 moved nearly in the same orbit as one which had been observed in 1607, and another which had been observed by Apian in 1531. As the interval between these successive apparitions was nearly the same, namely, about seventy-six years, the identity of the three comets appeared to Halley to be established, and he accordingly predicted its return in 1759. Clairaut, a celebrated French mathematician, computed the time at which it would arrive at its perihelion; and his results were confirmed by observation, the comet actually passing its perihelion within about a month of the time predicted.

The computation of the comet's return to its perihelion is a work of great difficulty and labour; for in consequence of the attractions of the larger planets, the path of the comet is considerably changed at each revolution, and all these changes or *perturbations*, as they are called, must be computed from the theory of gravitation.

The reappearance of this comet in 1835 was expected with great interest. Its perturbations in the previous revolution were calculated by Damoisean and Pontecoulant in France, and by Rosenberger in Germany, and the time of its perihelion passage fixed for the month of November in that year. Damoisean's calculation gave the 4th, Pontecoulant's the 7th, and Rosenberger's the 3d of the month. The comet, true to its appointed laws, became visible about the end of August, in the part of the heavens predicted; and it appears from the comparison of the numerous observations that were made of it, to have actually passed its perihelion on the 16th of November. The position of its orbit was such that it could scarcely be seen in Europe after the passage, on account of its proximity to the horizon; but it was then caught by the astronomers of the southern hemisphere, and continued to be observed by Sir John Herschel at the Cape of Good Hope till the end of March, 1836, when its increasing distance from the earth rendered it invisible. For some weeks it continued visible to the naked eye, but its splendour was not very remarkable.

Encke's Comet.—Two other comets have more recently been identified as having been seen in preceding revolutions about the sun. One of these is called Encke's comet, from Professor Encke of Berlin, who first computed its elliptic elements. Its orbit is very elongated, the eccentricity being nearly = ·845, and inclined to the ecliptic in an angle of about $13^\circ\ 22\frac{1}{3}'$. The period of its revolution is 1207 days, or about 3 and 1-3d years. Though this comet was not recognized as periodic till 1819, it had frequently been observed in previous revolutions—in 1789, 1795, 1801, and 1805. From the ellipse calculated by Encke, its return was predicted in 1822. On this occasion it was invisible in Europe, but was observed at Paramatta in New South Wales. In the subsequent returns of 1825, 1828, and 1832, it was observed in the principal observatories both in the northern and southern hemispheres. In comparing the intervals between the successive returns to its perihelion, it is found that the period of this comet is continually diminishing. This is exactly the effect that would be produced if it moved through a resisting medium; for the resistance, by diminishing the actual velocity, diminishes the centrifugal force, in consequence of which the solar attraction preponderates, and the comet is drawn nearer to the sun, and completes its revolution in a shorter time. Accordingly, as there appears no other way of accounting for the observed acceleration, it seems now to be the general opinion of astronomers that an ethereal medium pervades the regions of space, of sufficient density to affect the motions of comets, though so rare as to offer no sensible resistance to the denser masses of the planets, whose periods of revolution have continued exactly the same since the epoch of the first astronomical observations. If this medium really exists, the comet must ultimately fall into the sun, unless it is dissipated altogether; an event which seems not improbable, from the observed fact of its having been less conspicuous at each reappearance.

Biela's Comet.—The third periodic comet at present known was discovered by Biela, an Austrian officer then residing at Prague, in February, 1826; and by M. Gambart of Marseilles in April of the same year. It has been identified with comets observed in 1772, 1789, 1795, 1846, &c. It performs its revolution in 2461 days, in an ellipse inclined to the ecliptic, in an angle of $13^\circ\ 33'\ 15''$, having an eccentricity of 0·74701, its greater semi-axis being 3·56705. Its last apparition took place, in accordance with calculation, in 1839; and its next return will be in 1846. It is a small comet, having no tail, and presenting no appearance of a solid nucleus, but only a slight increasing density towards the centre; and small stars were seen through it. Its orbit, by a singular coincidence, nearly intersects that of the earth; and had the earth, at the time of the comet's passage in 1832, been a month in advance of its actual place, it would have passed through or very near the comet.

Effects of the Action of the Planets on the Orbits of Comets.—Comets in passing near the larger planets are drawn aside from their paths, and have their orbits sometimes entirely changed. In June, 1770, a comet was discovered by Messier; and as soon as three observations had been obtained, the elements of its parabolic orbit were determined. The comet continued visible for a long time, and it was found that the parabolic elements could not be made by any combination to represent the observations. It followed, therefore, that the orbit could not be a parabola. Lexell undertook the computation of an elliptic orbit, and found, in fact, that the comet was describing an ellipse, of which the greater axis was only equal to three times the diameter of the terrestrial orbit, and would consequently complete its revolution in about five years and a half. He accordingly predicted its return at the end of that period; nevertheless, the comet did not appear at the expected time, and, though very conspicuous in 1770, has never been seen since. On examining the catalogues, no trace was found of a comet describing the same orbit having been seen before. The question, therefore, occurred, in what manner was this mysterious appearance and disappearance to be explained? The solution was found in the disturbing influence of Jupiter. On submitting to calculation the action of this planet on the comet, it was found, in the first place, that in the year 1767, before the comet had approached Jupiter, the elliptic orbit which it described corresponded to a revolution, not of five, but of fifty years; and in the second place, it was found that in 1779, when getting beyond the sphere of attraction of the same planet, the orbit in which it then moved could only be described in twenty years. Previously to 1767 it moved in so wide an orbit that it could not be seen from the earth: the attraction of Jupiter threw it into the orbit in which it was observed by Messier. On a second approach to Jupiter, it was again deflected from its path, and thrown into an orbit in which it was invisible as at first.

Physical Nature of Comets.—Notwithstanding the attention which has been given to the observation of comets whenever they make their appearance, nothing whatever is known of their physical constitution; nor has any rational or even plausible explanation been offered of the voluminous appendage denominated the tail. The following remarks of Sir John Herschel on this subject are extremely interesting.

"The smaller comets, such as are visible only in telescopes, or with difficulty by the naked eye, and which are by far the most numerous, offer very frequently no appearance of a tail, and appear only as round or somewhat oval vaporous masses, more dense towards the centre; where, however, they appear to have no distinct nucleus, or any thing which seems entitled to be considered as a solid body. Stars of the smallest magnitudes remain distinctly visible, though covered by what appears to be the densest portion of their substance; although the same stars would be completely obliterated by a moderate fog, extending only a few yards from the surface of the earth. Whenever powerful telescopes have been turned on these bodies, they have not failed to dispel the illusion which attributes solidity to that more condensed part of the head which appears to the naked eye as a nucleus; though it is true that in some a very minute stellar point *has* been seen, indicating the existence of a solid body.

"It is in all probability to the feeble coercion of the elastic power of their gaseous parts by the gravitation of so small a central mass, that we must attribute this extraordinary development of the atmosphere of comets. If the earth, retaining its present size, were reduced by any internal change (as by hollowing out its central parts) to one thousandth part of its actual mass, its coercive power over the atmosphere would be reduced in the same proportion, and in consequence the latter would expand to a thousand times its actual bulk; and indeed much more, owing to the still further diminution of gravity by the recess of the upper parts from the centre.

"That the luminous part of a comet is something in the nature of a smoke, fog, or cloud, suspended in a transparent atmosphere, is evident from a fact which has been often noticed; viz. that the portion of the tail, where it comes up to and surrounds the head, is yet separated from it by an interval less luminous, as if sustained and kept off from contact by a transparent stratum, as we often see one layer of clouds laid over another, with a considerable space between. These, and most of the other facts observed in the history of comets, appear to indicate that the structure of a comet, as seen in section in the direction of its length, must be that of a hollow envelope, of a parabolic form, enclosing near its vertex the nucleus and head, something as is represented in the annexed figure.

This would account for the apparent division of the tail into two lateral branches, the envelope being oblique to the line of sight at its borders, and therefore a greater depth of illuminated matter being there exposed to the eye. In all probability, however, they admit great varieties of structure, and among them may very possibly be

bodies of widely different physical constitution." (*Astronomy; Cabinet Cyclopædia*, p. 304.)

From the same authority we extract the following statement respecting the actual dimensions of some of the most conspicuous comets: — "The tail of the great comet of 1680, immediately after its perihelion passage, was found by Newton to have been no less than 20,000,000 of leagues in length, and to have occupied only two days in its emission from the comet's body! — a decisive proof this of its being darted forth by some active force, the origin of which, to judge from the direction of the tail, must be sought in the sun itself. Its greatest length amounted to 41,000,000 leagues, a length much exceeding the whole interval between the sun and the earth. The tail of the comet of 1769 extended 16,000,000 leagues, and that of the great comet of 1811, 36,000,000. The portion of the head of this last comprised within the transparent atmospheric envelope which separated it from the tail was 180,000 leagues in diameter. It is hardly conceivable that matter once projected to such enormous distances should ever be collected again by the feeble attraction of such a body as a comet — a consideration which accounts for the rapid progressive diminution of the tails of such as have been frequently observed." (Ibid. p. 311.)

It is extremely probable that the comets are merely collections of gaseous matter, of which a part may be dissipated in space at every revolution; but further observations are wanted to make this hypothesis certain. In 1682 Halley's comet appeared as round and clear as Jupiter; in 1759 it was not visible to the naked eye; in 1836 it was again sufficiently visible, but it was then in a much more favourable position than in 1759.

In former times comets were regarded as preternatural appearances, betokening the displeasure of the superior powers, and accordingly viewed with the terror and apprehension naturally excited by harbingers of indefinite and unavoidable calamity. Since they have been discovered to be component parts of the solar system, their appearance excites no other interest than that which astronomers feel to determine their orbits, and to deduce from their physical aspects such conclusions as they are calculated to afford relative to the constitution of the universe.

COMETA'RIUM. An astronomical toy, intended to represent the motion of a comet about the sun. Any instrument capable of describing an elongated ellipse may be called a *cometarium*. *See* ELLIPTIC COMPASSES.

COMI'TIA. In Ancient History, the assemblies of the Roman people, which were of three kinds, distinguished by the epithets *Curiata*, *Centuriata*, and *Tributa*.

1. The Comitia Curiata were the assemblies of the patrician houses or *populus;* and in these, before the plebeians attained political importance, was vested the supreme power of the state. The name *Curiata* was given because the people voted *in curiæ*, each curia giving a single vote representing the sentiments of the majority of the members composing it; which was the manner in which the tribes and centuries also gave their suffrages in their respective comitia. After the institution of the Comitia Centuriata, the functions of the curiata were nearly confined to the election of certain priests, and passing a law to confirm the dignities imposed by the people.

2. The Comitia Centuriata were the assemblies of the whole Roman people, including patricians, clients, and plebeians, in which they voted by centuries. By the constitution of the centuries, these comitia were chiefly in the hands of the plebeians, and so served originally as a counterpoise to the powers of the comitia curiata, for which purpose they were first instituted by the lawgiver king Servius Tullius. These comitia quickly obtained the chief importance, and public matters of the greatest moment were transacted in them; as the elections of consuls, prætors, and censors, and the passing laws and trials for high treason.

3. The Comitia Tributa were the assemblies of the plebeian tribes. They were first instituted after the expulsion of the kings; and in them were transacted matters pertaining to the plebeians alone, as the election of their tribunes and ædiles.

CO'MMA. (Gr.) In Music, the smallest of all the subdivisions, being about the ninth part of a tone.

COMMA. In Grammar. *See* PUNCTUATION.

COMMA'NDER. In the Navy, otherwise called master, an officer next in rank above lieutenant, corresponding with major in the army.

COMMANDER-IN-CHIEF. The officer in whom is vested the supreme command of all the land forces of the British Empire. This officer is appointed by the ministry of the day, whose confidence he is supposed to enjoy, and he is assisted in the discharge of his duties by several subordinate officers, such as the adjutant-general, the quartermaster-general, &c. (see these terms), who are each at the head of a particular department.

COMMA'NDERY, or PRECEPTORY. According to the usages of some orders of Knights, a district attached to a manor or chief messuage under the control of a member of the order, who receives the income of that district arising from the estates of the order, taking out of it his own pension, and accounting for the rest.

COMMELINA'CEÆ. (Commelina, one of the genera.) A natural order of herbaceous Endogens, chiefly inhabiting the East and West Indies. Brown remarks that the order greatly differs from *Juncaceæ* both in habit and structure, and agrees better with *Restiaceæ*, having but little affinity with Palms; and Agardh adds, that it agrees with *Orchidaceæ* in the structure of the stamens and seeds, but in what respect he does not state. The species are very often mere weeds, but occasionally are beautiful flowering plants. A common example is the *Tradescantia virginica*.

COMME'NDAM. (Lat.) A term of the Canon Law. A person to whom custody of a void ecclesiastical benefice is committed by the superior, without the profits appertaining to it, was said to hold the benefice *in commendam*, i. e. *entrusted to his care;* but by various devices the restriction on the receipt of profits was evaded, and the holding benefices in commendam became a mode of enjoying pluralities. By the English law, no one can hold in commendam without license from the crown. An ordinary case is where clergymen promoted to bishoprics with insufficient revenues are allowed in this manner to retain the profits of livings.

COMME'NSURABLE. Quantities, in Geometry, are said to be commensurable when they have some common measure or divisor which divides each of them without leaving a remainder. Thus a yard and a furlong are commensurable magnitudes, because a foot is a measure or aliquot part of each of them, being contained in the yard three times, and in the furlong 660 times. Fractional numbers and surds are also said to be commensurable when they have a common measure of the same kind as themselves. Thus $\frac{2}{3}$ and $\frac{3}{4}$ are commensurable, being each divisible by $\frac{1}{6}$; and so are $2\sqrt{2}$ and $3\sqrt{2}$, being each measured by $\sqrt{2}$.

CO'MMENTARY. (Derived from the Latin verb comminiscor, *I call to mind.*) In Literature, a word used in different significations: — 1. In the same sense with memoirs, as a short narrative of particular events and occurrences, composed by an actor or spectator of those events with the professed object of calling back the circumstances to his own mind; *e. g.* the Commentaries of Cæsar. 2. Critical observations on the text or contents of a book. These are either in the form of detached notes, containing remarks on particular passages; or they are embodied in what is termed a running commentary, or series of remarks written and printed in a connected form.

CO'MMERCE (from *commutatio mercium*), is the exchange of one sort of produce or service for some other sort of produce or service.

Exchanges of this description have their rise in the nature of man and the circumstances under which he is placed, and their origin is coeval with the formation of society. The varying powers and dispositions of different individuals dispose them to engage in preference in particular occupations; and in the end every one finds it for his advantage to confine himself wholly or principally to some one employment, and to barter or exchange such portions of his produce as exceed his own demand, for such portions of the peculiar produce of others as he is desirous to obtain and they are disposed to part with. The division and combination of employments is carried to some extent in the rudest societies, and it is carried to a very great extent in those that are most improved; but to whatever extent it may be carried, commerce must be equally advanced. The division of employments could not exist without commerce, nor commerce without the division of employments: they mutually act and react upon each other. Every new subdivision of employments occasions a greater extension of commerce; and the latter cannot be extended without contributing to the better division and combination of the former.

In rude societies, the principal business of commerce, or the exchange of one sort of commodities for some other sort, is carried on by those who produce them. Individuals having more of any article than is required for their own use endeavour to find out others in want of it, and who at the same time possess something that they would like to have. But the difficulties and inconveniences inseparable from a commercial intercourse carried on in this way are so obvious as hardly to require being pointed out. Were there no merchants or dealers, a farmer, for example, who had a quantity of wheat or wool to dispose of, would be obliged to seek out those who wanted these commodities, and to sell them in such portions as might suit them; and having done this, he would next be forced to send to, perhaps, twenty different and distant places, before he succeeded in supplying himself with the various articles he might wish to buy. His attention would thus be perpetually diverted from the business of his farm; and while the difficulty of exchanging his own produce for that of others would prevent him from acquiring a

taste for improved accommodations, it would tempt him to endeavour to supply most things that were essential by his own labour and that of his family; so that the division of employments would be confined within the narrowest limits. The wish to obviate such inconveniences has given rise to a distinct mercantile class. Without employing themselves in any sort of production, merchants or dealers render the greatest assistance to the producers: they collect and distribute all sorts of commodities; they buy of the farmers and manufacturers the things they have to sell; and bringing together every variety of useful and desirable articles in shops and warehouses, individuals are able, without difficulty or loss of time, to supply themselves with whatever they want. Continuity is in consequence given to all the operations of industry; for, as every one knows beforehand where he may dispose to the best advantage of all that he has to sell, and obtain all that he wishes to buy, an uninterrupted motion is given to the plough and the loom. Satisfied that they will have no difficulty about finding merchants for their produce, agriculturists and manufacturers think only how they may improve and perfect their respective businesses. Their attention, no longer dissipated upon a variety of objects, is fixed upon one only. It becomes the object of every individual to find out machines and processes for facilitating the separate task in which he is engaged; and while the progress of invention is thus immeasurably accelerated, those who carry on particular businesses acquire that peculiar dexterity and *sleight of hand* so astonishing to those who live in places where the division of labour is but imperfectly established. Facility of exchange is, in truth, the vivifying principle, the very soul of industry; and no interruption is ever given to it without producing the most ruinous consequences.

The merchants, or dealers, collect their goods in different places in the least expensive manner; and by carrying them in large quantities at a time they can afford to supply their customers at a cheaper rate than the latter could supply themselves. Not only, therefore, do they, by enabling every employment to be carried on without interruption, and the divisions of labour to be perfected, add prodigiously to the powers of industry, and, by consequence, to the wealth of the community, but they also promote the convenience of every one, and reduce the cost of merchandising to the lowest limit. According as commerce is extended, each particular business becomes better understood, better cultivated, and carried on in the best and cheapest method: where it is far advanced, the whole society is firmly linked together; every man is indebted to every other man for a portion of his necessaries conveniences, and enjoyments; every thing is mutual, and reciprocal; and a large country becomes in effect, from the intimate correspondence kept up through the medium of the mercantile class, like a large city.

The annihilation of the class of traders would deprive society of all these advantages. The difficulties that would then be experienced in selling and buying would oblige every one to attempt, in so far as possible, directly to supply his own wants; the division of employments would be contracted on all sides, and Great Britain would gradually relapse into a state little, if at all, superior to its state at the Norman conquest.

The celebrated Italian economist, the Count di Verri, has defined commerce to be the conveyance of commodities from place to place (*trasporto delle mercanzie da un luogo a luogo*). This definition has been adopted by M. Say, who contends that commerce does not consist in exchanges, but in bringing commodities within reach of the consumers (*il consiste essentiellement à placer un produit à la portée de ses consommateurs*). But this is plainly to confound the means with the end; the preparations for an exchange with the exchange itself. The conveyance of commodities from place to place is necessary to enable commerce to be carried on; but unless they be conveyed in the view of being sold or exchanged for other commodities, and unless that exchange actually take place, there is no room or ground for considering the conveyance in the light of a commercial operation. It is obvious, too, that though the Count di Verri's definition were not erroneous in this respect, it is not sufficiently comprehensive. Suppose that a hat manufactory is established in Regent Street, and that a shop is attached to it, where the hats are sold; no one doubts that those employed in this shop are engaged in a commercial undertaking, and yet they have nothing to do with the carriage of commodities. Whatever, therefore, may be the particular sort of commerce carried on, whether the commodities have been brought from a distance or produced on the spot, its object and end is an exchange; when this end is not attained, no act of commerce can be said to have taken place.

The erroneous definition of commerce which M. Say has adopted has hindered him from rightly appreciating its influence. "In commerce," says he, "there is a genuine production, because there is a modification productive of utility and value. The merchant, after buying a commodity at its current price, sells it again at its current price; but the last price is greater than the former, because the merchant has brought the commodity into a situation which has really augmented its price, and the society is enriched by this augmentation." (*Cours d'Economie Politique*, t. ii. p. 213.) But though this be true, it is not the whole truth, nor even the greater part of it. Suppose that a hat-maker and a shoe-maker live in contiguous houses; if the one exchange his hats for the other's shoes society will not certainly gain much by the change in the locality of the commodities, but it will notwithstanding be materially benefited by the transaction; for, in consequence of the exchange, each tradesman will be able to confine himself to his own business: the hat-maker will not be obliged to waste his time in clumsy attempts to make his own shoes, nor will the shoe-maker be compelled to make his own hat. It is in this that the *peculiar* advantage of commerce consists. What an individual gives for anything is, speaking generally, the fair equivalent of what he gets. But the facility of exchanging allows every one, as has been already seen, to apply his entire time and energies to some one department; and in this way occasions the production of an incomparably greater quantity of all sorts of wealth than it would otherwise be possible to produce.

The mercantile class has been divided into two leading classes, — the wholesale dealers and the retail dealers. This division, like the divisions in other employments, has grown out of a sense of its utility. The wholesale merchants buy the goods at first hand of the producers; but instead of disposing of them to the consumers, they generally sell them to the retailers or shopkeepers, by whom they are retailed or distributed to the public in such quantities and in such a way as is most suitable for them. The interest of all parties is consulted by this division. Had the wholesale dealers attempted also to retail their goods, they could not have given that undivided attention to any part of their business so necessary to ensure its success. A retailer should be constantly at his shop; not merely that he may attend to the orders daily sent to him, but that he may learn all that transpires with respect to the situation of his customers, their wants, and their circumstances. But wholesale dealers being obliged to attend to what is going on in different and distant quarters, cannot give this minute attention to what happens in their immediate vicinity; and though they could, the capital required to carry on a wholesale business would not be sufficient for that purpose, were the business of retailing joined to it. Were there only one class of merchants, the capital and the number of individuals employed in commercial undertakings would not probably be less than at present; but the merchant, being obliged to apply himself principally to one department, would have to leave the chief share of the other to servants; a change which, as every one knows, would be productive of the most mischievous consequences.

There can, therefore, be no doubt that the separation in question has been highly advantageous. The classes of merchants, like those of artificers, are mutually serviceable to each other and to the public. Without this subdivision, commerce would have been impeded in its operations; particular branches of it would have been comparatively neglected; nor would any branch have been carried on with the same economy and attention with which all are now conducted.

In a highly civilized country like Great Britain, the trade in every commodity in considerable demand, as corn, sugar, tea, timber, &c., affords employment for a separate class of traders. But for all purposes of general inquiry, it is sufficient to consider commerce under three heads, viz.:—1. The Home trade, or that carried on between individuals of the same country; 2. Foreign trade, or that carried on between individuals of different countries; and, 3. The Colony trade, or that carried on between the inhabitants of any particular country and its colonists. We subjoin a few remarks upon each of these heads.

1. *Home Trade.* — It has been already seen that the varying capacities and dispositions of different individuals occasion the introduction of a division of employments, and the practice of exchange or barter. But the external circumstances under which different individuals are placed vary still more than their natural powers or tastes. One set inhabit a rich fertile plain, suitable for the growth of corn and other culmiferous crops. Another set inhabit a mountainous district, the soil of which is comparatively sterile, but which is well fitted for rearing cattle; another set are planted upon the margin of a river, or arm of the sea, abounding in every facility for carrying on the business of fishing; and so on. Now it is so obvious, that though the individuals belonging to any particular district had not established a division of labour amongst themselves, it would be highly for their advantage to establish one with those occupying other districts, the productions of which are materially different. When the inhabitants of Newcastle apply themselves principally to the coal trade, those of Essex to the raising of wheat, and those of the highlands of Scotland to the

raising of cattle and wool, each set avail themselves, in carrying on their employments, of the peculiar powers of production conferred by Providence on the districts they occupy; and by exchanging such portions of their produce as exceed their own consumption, for the surplus articles raised by others, their wealth and that of every one else, is immeasurably increased. It is in this *territorial division of labour*, as it has been happily designated by Colonel Torrens, that the main advantage of commerce consists. In commercial countries, each individual may not only enter at pleasure, on such pursuits as he deems most advantageous, but the entire population of districts and provinces are enabled to turn their energies into those channels in which they are sure to receive the greatest assistance from natural powers. Suppose England were divided into separate parishes, or even counties, surrounded respectively by Bishop Berkeley's wall of brass, and having no intercourse with each other, in what a miserable situation would we be! Instead of 1,500,000, London could not under such circumstances contain 15,000 inhabitants; and these would be exposed to numberless privations of which we have not the slightest idea. Unless the territorial division of labour were carried to some extent, the division of employments amongst individuals occupying the same district, could be but very imperfectly established, and would be of comparatively little use. It is only when one is able both to gratify his taste and to avail himself of the varying capacities of production given to different districts that the benefits of commerce can be fully appreciated, and that it becomes the most copious source of wealth as well as the most powerful engine of civilisation.

"With the benefits of commerce," says an eloquent writer, "or a ready exchange of commodities, every individual is enabled to avail himself to the utmost of the peculiar advantage of his place; to work on the peculiar materials with which nature has furnished him; to humour his genius or disposition, and betake himself to the task in which he is peculiarly qualified to succeed. The inhabitant of the mountain may betake himself to the culture of his woods, and the manufacture of his timber, the owner of pasture lands may betake himself to the care of his herds; the owner of the clay pit to the manufacture of his pottery; and the husbandman to the culture of his fields, or the rearing of his cattle; and any one commodity, however it may form but a small part in the whole accommodations of human life, may, under the facilities of commerce, find a market in which it may be exchanged for what will procure any other part, or the whole; so that the owner of the clay pit, or the industrious potter, without producing any one article immediately fit to supply his own necessities, may obtain the possession of all that he wants. And commerce in which it appears that commodities are merely exchanged, and nothing produced, is nevertheless, in its effects, very productive; because it ministers an encouragement and facility to every artist in multiplying the productions of his own art, thus adding greatly to the mass of wealth in the world, in being the occasion that much is produced."—(*Ferguson's Principles of Moral and Political Science*, vol. ii. p. 424.)

II. *Foreign Trade.*—The trade carried on between individuals of different countries is founded on precisely the same circumstances—the differences of soil, climate, and productions, on which is founded the trade between different districts of the same country. One country, like one district, is peculiarly fitted for the growth of corn; another for the cultivation of the grape; a third abounds in minerals; a fourth has inexhaustible forests; and so forth:—

> Hic segetes, illic veniunt felicius uvæ,
> Arborei fetus alibi, atque injussa virescunt
> Gramina. Nonne vides, croceos ut Tmolus odores,
> India mittit ebur, molles sua thura Sabæi?
> At Chalybes nudi ferrum, virosaque Pontus
> Castorea, Eliadum palmas Epiros equarum?
> Continuo has leges æternaque fœdera certis
> Imposuit natura locis.—*Georg.* lib. i. lin. 54.

Providence, by thus distributing the various articles suitable for the accommodation and comfort of man in different countries, has evidently provided for their mutual intercourse. In this respect, indeed, foreign trade is of far more importance than the home trade. There is infinitely less difference between the products of the various districts of the most extensive country, than there is between the products of different and distant countries; and the establishment of a territorial division of labour amongst the latter must therefore be proportionally advantageous.

"As the same country is rendered richer by the trade of one province with another; as its labour becomes thus infinitely more divided, and more productive than it could otherwise have been; and as the mutual interchange of all those commodities which one province has and another wants multiplies the comforts and accommodation of the whole, and the country becomes thus, in a wonderful degree, more opulent and more happy; so the same beautiful train of consequences is observable in the world at large,—that vast empire, of which the different kingdoms may be regarded as the provinces. In this magnificent empire, one province is favourable to the production of one species of produce, and another province to another. By their mutual intercourse, mankind are enabled to distribute their labour as best fits the genius of each particular country and people. The industry of the whole is thus rendered incomparably more productive; and every species of necessary, useful, and agreeable accommodation is obtained in much greater abundance, and with infinitely less expense."—(*Mills's Commerce Defended*, p. 38.)

But to enable the advantages of foreign commerce to be rightly appreciated, it will be proper to consider it under the following heads:—viz. 1. Its influence in supplying us with useful and desirable articles, of which we should otherwise be wholly destitute; 2. Its influence in multiplying and cheapening the peculiar productions of our own country; 3. Its influence in making us acquainted with foreign discoveries and inventions, and in exciting invention by means of competition and example; and, 4. Its indirect influence upon industry, by increasing the sources of enjoyment.

1. With respect to the first of these influences, or the effect of commerce in furnishing every people with commodities not otherwise attainable, it is too obvious and striking to require any lengthened illustrations. Great Britain is as abundantly supplied with native products as most countries; and yet any one who reflects for a moment on the nature and variety of the articles we import from abroad, must be satisfied that we are indebted to trade for a very large part of our superior accommodations. Tea, sugar, coffee, wine, and spices; silk and cotton, the materials of our most extensive manufactures; gold and silver; and an endless variety of other highly important articles, are sent to us by foreigners. And were the importation put an end to, what a prodigious deduction would be made, not from our comforts and enjoyments merely, but also from our means of supporting and employing labourers! If foreign commerce did nothing more than supply us with so many new products, it would be very difficult to overrate its value and importance.

2. But such is the beneficent influence of commerce, that while it supplies an endless variety of new productions, it multiplies and cheapens those that are peculiar to every country. It does this, by enabling each separate people to employ themselves, in preference, in those departments in which they enjoy some natural or acquired advantage, and by opening the markets of the world to their productions. When the demand for a commodity is confined to a particular country, as soon as it is supplied improvement is at a stand. The subdivision and combination of employments is, in fact, always dependent upon and regulated by the extent of the market. Dr. Smith has shown, that by making a proper distribution of labour among ten workmen, in a pin manufactory, 48,000 pins might be produced in a day; and since his time the number has been nearly doubled. But had the demand not been sufficient to take off this quantity of pins, the divisions and improvements in question could not have been made; and the price of pins would in consequence have been comparatively high. This principle holds universally. The most important manufacture carried on in Great Britain — that of cotton — is entirely the result of commerce. Supposing, however, that cotton wool had been a native product, we could never have made such astonishing advances in the manufacture had we been denied access to foreign markets. Notwithstanding the splendid discoveries in the machinery, and the perfection to which every department of the trade has been brought, the vast extent of the market has prevented its being glutted, and has stimulated our manufacturers and artizans to persevere with unabated ardour in the career of improvement. Our cotton mills have been constructed, not that they might supply the limited demand of Great Britain, but that they might supply the demand of the whole world. And in consequence of the extraordinary subdivision of labour, and the scope given to the employment and improvement of machinery by the unlimited extent of the market, the price of cottons has been reduced to less, probably, than a fourth part of what it would have been had they met with no outlet in foreign countries. The hardware, woollen, leather, and other manufactures, exhibit similar results. The access their products have had to other markets has led to important improvements in their production; so that, as was previously stated, commerce not only supplies us with a vast variety of new and desirable articles, but it also cheapens the staple productions of the country, and renders them more easily attainable by the great mass of people.

3. The influence of commerce in making the people of each country acquainted with foreign inventions and discoveries, and in stimulating ingenuity by bringing them into competition with strangers, is obvious and powerful. It distributes the gifts of science and art, as well as those of nature. It is the great engine by which the blessings of civilization are diffused throughout the world, the intercourse to which it gives rise making every one

acquainted with the processes carried on and the inventions made in the remotest corners of the globe. Were any considerable improvement made in any important art either in China or Peru, it would be very speedily understood and practised in England. It is no longer possible to monopolize an invention. The intimate communication that now exists amongst nations renders any important discovery, wherever it may be made, a common benefit. The ingenious machine invented by Mr. Whitney, of the United States, for separating cotton wool from the pod, has been quite as advantageous to us as to the Americans; and the inventions of Watt and Arkwright have added to the comforts of the inhabitants of Siberia and Brazil, as well as of England. The genuine commercial spirit is destructive of all sorts of monopolies. It enables every separate country to profit by the peculiar natural powers and acquired skill of all the others; while, on the other hand, it communicates to them whatever advantages it may enjoy. Every nation is thus intimately associated with its neighbours. Their products, their arts, and their sciences, are reciprocally communicated; and the emulation that is thus excited and kept up forces routine to give place to invention, and inspires every people with zeal to undertake, and perseverance to overcome, the most formidable tasks. It is not possible to form any accurate notions as to what would have been our state at this moment, had we been confined within our own little world, and deprived of all intercourse with foreigners. We know, however, that the most important arts, such as printing, glass-making, paper-making, &c., have been imported from abroad. No doubt we *might* have invented some of these ourselves; but there is not the shadow of a ground for supposing that we should have invented them all; and without foreign example and competition, we could hardly have carried any of them beyond the merest rudiments.

4. The influence of commerce upon industry, by its increasing the number of desirable articles, though not quite so obvious, perhaps, as the influences already specified, is not less powerful and salutary. Industry is in no respect different from the other virtues, and it were idle to expect it should be strongly manifested where it does not bring along with it a corresponding reward. In the early stages of society, before artificial wants have been introduced, and men are satisfied if they can avert the attacks of hunger, and procure an inadequate defence against the cold, industry is confined within the narrowest limits; and provided the mildness of the climate renders clothing and lodging of little importance, and the earth spontaneously pours forth an abundant supply of fruits, the inhabitants are immersed in sloth, and seem to place their highest enjoyment in being free from occupation. Sir William Temple, Mr. Hume, and some other sagacious inquirers into the progress of society have been struck with this circumstance, and have justly remarked that those nations that have laboured under the greatest national disadvantages have made the most rapid advances in industry.

But in civilized and commercial societies, new products and new modes of enjoyment, brought from abroad, or invented at home, stimulate the inhabitants to continued exertions. Their acquired tastes and the wants which civilization introduces, and custom and example render universal, become infinitely more numerous, and as urgent as the tastes or wants of those that are less advanced. The passion for luxuries, conveniencies, and enjoyments, when once excited, becomes quite illimitable. The gratification of one desire leads immediately to the formation of another. "The natural flights of the human mind are not from pleasure to pleasure, but from hope to hope." The happiness of a civilized nation is not placed in indolence or enjoyment, but in continued exertion; in devising new contrivances to overcome new difficulties; in extending still further the boundaries of science, and increasing their command over luxuries and enjoyments. The remark of the Abbe Mably is as true as it is forcibly expressed:—"*N'est on que riche? On veut être grand. N'est on que grand? On veut être riche. Est on et riche et grand? On veut être-plus riche et plus grand encore.*" (*Œuvres*, t. iv. p. 76.)

Without commerce this progress would never be realized. The commodities possessed by particular nations are but few, and may be attained with comparatively little labour. Generally speaking, a man may easily supply himself with corn, cloth, and beer; and if the utmost exertions of ingenuity and the most laborious efforts of industry could only furnish additional quantities of those articles, they would very soon cease to be made. Men do not practise industry and economy for their own sakes, but for the advantages that result from them; and the more, consequently, that these advantages are multiplied, that is, the greater the variety of wants they are made to supply, and of gratifications they are made to command, the greater will be the energy displayed in their prosecution. "*Le travail de la faim,*" as Raynal has well observed, "*et toujours borné comme elle; mais le travail de l'ambition croît avec ce vice* (*vertu?*) *même.*"

And hence the true way to render a people industrious is to endeavour to inspire them with a taste for the luxuries and enjoyments of civilized life; and this will be always most easily done by giving every facility to the cultivation of foreign commerce. The number of new articles, or, in other words, of new motives to stimulate, and new products with which to reward the patient hand of industry, is then prodigiously augmented. The home producers exert themselves to increase their supplies of disposable articles, that they may exchange them for those of other countries and climates; and the merchant, finding a ready demand for such articles, is stimulated to import a greater variety, to find out cheaper markets, and thus constantly to apply new incentives to the vanity and ambition, and consequently to the industry of his customers. Every power of the mind and body is thus called into action; and the passion for foreign commodities—a passion which some shallow moralists have ignorantly censured—becomes one of the most efficient causes of industry, wealth, and civilization.

IV. *Colony Trade.*—For some remarks on this head, the reader is referred to the article COLONIES.

Principle and Influence of Restrictions on Commerce.—The commercial intercourse carried on between the inhabitants of different districts of the same country, and those of different countries, is founded on the principle which prompts each member of the same family, or each inhabitant of the same village, to apply himself to some one business. It would therefore seem that that *freedom* of commerce which is universally admitted to be productive of the most beneficial consequences when established between the occupants of different districts of the same country must be equally beneficial when established between those of different countries. It appears to be generally believed, that to occasion a commercial intercourse, nothing more is necessary than to remove such legal or physical obstacles as may interpose to prevent it. But this is not by any means enough. A of Yorkshire does not sell to or buy from B of Kent, merely because there is nothing to hinder him from doing so; he must further believe that his interest will be promoted by the transaction: unless he do this, the utmost facility of exchanging will be offered to him in vain; nor will the finest roads or the speediest conveyances occasion the least intercourse. We neither buy nor sell for the mere pleasure of the thing. We do so only when we believe it will be a means of promoting some end, of procuring some peculiar advantage for ourselves that we could not so easily procure in any other way. If any one supposed he could better attain his object in entering upon a commercial transaction with some particular individual by entering upon a similar transaction with some one else, or by any other means, he would most certainly decline engaging in it. We may, and often do, make a false estimate of what is for our advantage; but its promotion is the mainspring of our actions; and it is it, and it only, that we have in view when we buy of a particular individual, or resort to a particular market, in preference to others.

Unless therefore it could be satisfactorily established that princes and rulers have a better understanding of what has a tendency to promote the wealth and industry of their subjects than themselves, it is difficult to see on what ground any restriction on the freedom of commerce is to be vindicated. The person who buys French wine or Polish corn, does so only that he may benefit himself: and the fair presumption is that he does what is right. Human reason is, no doubt, limited and fallible; we are often swayed by prejudice, and are apt to be deceived by appearances. Still, however, it is certain that the desire to promote our own purposes contributes far more than any thing else to render us clear-sighted and sagacious. "*Nul sentiment dans l'homme,*" says M. Say, "*ne tient son intelligence eveillée autant que l'interêt personnel. Il donne de l'esprit aux plus simples.*" The principle that individuals are, speaking generally, the best judges of what is most beneficial for themselves, is universally admitted to be the only one that can be safely acted upon. No writer of authority has latterly ventured to maintain the exploded and untenable doctrine, that governments may advantageously interfere to regulate the pursuits of their subjects. It is their duty to preserve order, to prevent one from injuring another; to maintain, in short, the equal rights and privileges of all. But it is not possible for them to go one step further, without receding from the principle of non-interference, and laying themselves open to the charge of acting partially by some, and unjustly by others.

"The statesman," says Dr. Smith, "who should attempt to direct private people in what manner they ought to employ their capitals, would not only load himself with a most unnecessary attention, but assume an authority which could safely be trusted not only to no single person, but to no council or senate whatever, and which would nowhere be so dangerous as in the hands of a man who had folly and presumption enough to fancy himself fit to exercise it." (*Wealth of Nations*, p. 200.)

In every discussion as to any point of public economy,

it is essential to bear in mind that the legislature abandons its duty, or rather acts in direct opposition to it, the moment it begins to legislate in the view of promoting the interest of particular classes. The question never ought to be, whether any proposed measure or regulation has a tendency to benefit agriculturists, manufacturers, or merchants; but whether its tendency be to benefit the public. Certain individuals or classes may be benefited by what is prejudicial to others; but it would be a contradiction to contend that a system of policy which enriches A by impoverishing B can be publicly advantageous; and it is upon this latter consideration that the attention of the legislature should always be fixed. Whatever has any tendency to increase the security of property, to perfect the divisions of labour, to stimulate industry and ingenuity, and to increase the wealth and comforts of *all* classes, deserves the encouragement of government. But when it goes further, and interferes to prohibit individuals from carrying on certain branches of trade that others may be promoted, it arrogates to itself that authority the assumption of which is so justly censured by Smith. Such prohibition is, in fact, quite subversive of the right of private property; for that right is violated, not merely when a man is unjustly deprived of any part of his fortune, but also when he is prevented from disposing of it in any way, not hurtful to others, he may think fit.

It does not therefore appear, considering this question on general grounds, that there is so much as the shadow of a foundation for those commercial restrictions that make so prominent a figure in the policy of all modern nations. If it could be shown that statesmen and ministers were the best judges of the means by which those subject to their authority might improve their condition, the case would be different. But no such pretension is set up, and, if it were, it would be universally scouted. We may safely leave the conduct of individuals to be determined by their own prudence and sagacity. They act under the most serious responsibility; and we have the best attainable security, the plain and obvious interest of the parties, that they will, in the peculiar circumstances under which they are placed, follow that course which is most advantageous for themselves, or, in other words, for the community. All systems of policy that would regulate the pursuits of private persons according to the views of government must be arbitrary and violent in their nature, and any attempt to act upon them could not fail to be productive of the most mischievous consequences. A wise government will confine its efforts to the maintenance of that order of things which nature has established. It will not mix itself up with the affairs of its subjects, but will leave them to pursue their own interest in their own way; to bring their industry and capital into the freest competition with those of others; and will interpose only when they swerve from the rules of justice. Freedom and security are all that is necessary to stimulate industry, and to insure the most rapid advancement in the career of improvement.

We cannot, however, feel any surprise that these principles should have been so widely departed from, and that commerce, and indeed most sorts of industry, should be everywhere subjected to restrictions and regulations. They originated in a comparatively unenlightened age, before the genuine sources of public wealth and the limits of proper interference on the part of governments had been explored and defined. The fallacies on which most of them are founded, however obvious they may now seem, were not speedily or easily detected; and, after their hollowness has been exposed, the return to a better system is a work of extreme difficulty. Every regulation affecting the employment of capital and industry, though always injurious to the public, is, for the most part, productive of advantage to a greater or smaller number of individuals. The moment that any change is proposed, these persons lay before government the most exaggerated representations of the injury that would result from the abolition or modification of the regulation; and not satisfied with this, they most commonly enlist a portion of the press into their service, and availing themselves of all the aid that sophistry and ingenuity can supply, labour to make the public believe that the regulation complained of is a national benefit, and that they are interested in its support! This device has very often been attended with the most complete success; and it is to this circumstance, more than any thing else, that the tenacity with which erroneous theories in commerce are supported is to be ascribed, and that sophisms, that have been again and again exposed, are put forward anew with as much seeming confidence as if they had never been questioned.

All the great branches of industry carried on in every country depend on peculiarities of soil or climate, or on the genius of the people, and not on custom-house regulations. What should we have to fear from the abolition of all prohibitions? We export the produce of every one of our principal manufactures, as cotton, wool, iron, leather, &c., to every market of the world; so that the possibility of our being injured by the admission of similar articles from abroad is quite out of the question. Admitting, however, that the abandonment of the protective system might force a few thousand workmen to abandon their employments, it is material to observe that *equivalent new ones* would, in consequence, be opened to receive them, and that the aggregate demand for their services would not be in any degree diminished. Suppose that, under a system of free trade, we imported a part of the silks and linens we now manufacture at home; it is quite clear, inasmuch as neither the French nor Germans would send us their commodities gratis, that we should have to give them an equal amount of British commodities in exchange: so that such of our artificers as had been engaged in the silk and linen manufactures, and were thrown out of them, would, in future, obtain employment in the production of the articles that must be exported as equivalents to the foreigner. It is idle, therefore, to pretend that the repeal or modification of a restrictive regulation can ever be a means of diminishing the demand for labour. We may, by giving additional freedom to commerce, change the *species of labour* in demand, and make it be employed more profitably, but we cannot lessen its quantity. Should our imports this year amount to ten or twenty millions more than they did last year, we shall, it is certain, have to pay them by exporting an equally increased amount of our peculiar products. And therefore if *exportation* be desirable, and the most ardent admirers of the restrictive system admit it to be such, *importation* must also be desirable, for the two are indissolubly connected; and to separate them, even in imagination, infers a total ignorance of the most obvious principles. Commerce, whether carried on between individuals of the same or of different countries, is founded on a fair principle of reciprocity; buying and selling are in it what action and reaction are in physics, *equal and contrary*. Those who will not buy from others render it impossible for others to buy from them. Every sale implies an equal purchase, and every purchase an equal sale. Hence *to prohibit buying is exactly the same thing, in effect, as to prohibit selling*. No merchant would ever export a single bale of goods were he prevented from importing a greater value in its stead. But it is impossible he can do this if foreign commodities be excluded. In whatever degree, therefore, an unrestricted trade might lead us to receive commodities from other countries, in the same degree it would render them customers for our commodities, would promote our manufactures, and extend our trade. To suppose that commerce may be too free, is to suppose that labour may be turned into too productive channels, that the objects of demand may be too much multiplied and their price too much reduced; it is like supposing that our agriculture may be too much improved, and our crops rendered too luxuriant.

It is often affirmed, though we believe without the least foundation for the statement, that had it not been for restrictions on importation, several manufactures that now furnish employment for a considerable population would most probably never have existed amongst us. But supposing this statement to be admitted, it would not form any valid objection to the principle now laid down. It is quite as much for the advantage of communities as of single families to respect the principle of the division of labour. The interests of every people will always be best promoted by addicting themselves, in preference, to those branches of industry in which they have a superiority over others; for it is by this means only they can ever fully avail themselves of their peculiar facilities of production, or employ themselves and their capital most beneficially.

When importation from abroad is restricted, that some new or incipient manufacture may be promoted, government assumes, though perhaps unconsciously, that it knows better than its subjects what is the most profitable line for them to engage in. Never was there an assumption more entirely unfounded. Individuals are always on the alert to find out what are the most advantageous businesses in which to embark; and though they sometimes, no doubt, form erroneous conclusions, the chances are ten to one in favour of their being right. Were it otherwise the number of well-advised and prosperous undertakings entered upon in all tolerably well-governed countries would not, as is the case, infinitely exceed those of a contrary description. But though it were different, the interference of government would not certainly abate the evil. However well intended, all attempts to introduce or extend some particular business cannot fail of being productive of immediate injury to others; and, should the object ever be realized, it would most probably not be found to be a national benefit, but the reverse. If, instead of directly producing linens, a manufacturer finds it more profitable to produce cottons or hardware, and to exchange these with the Germans for linen, how ridiculous would it be to attempt to promote the public interests by shutting out foreign linens, and compelling them to be produced at home! It is not disputed that the linen manufacture might be somewhat promoted by such a measure; but it admits of demonstration that other and more advanta-

geous businesses would sustain a corresponding depression. Governments may depend upon the fact, that their subjects are incomparably better informed with respect to these matters than they can ever be. It is not possible for them, do what they will, to interfere to encourage one set of producers, without at the same time, and by the same act, proportionally discouraging some other set. Their obvious duty is, therefore, to abstain from all interference with the legitimate pursuits of individuals. To the clamourers for protection they may always answer, that they would be happy to meet their wishes, provided they could do so without injuring others but that that being impossible, they feel themselves bound not to interfere, but to allow every one to reap the profit or abide the loss of the speculations into which he may enter.

We have not entered in this article into any investigations with respect to that great class of exchanges which consist in the rendering of labour or services for money or commodities. The laws by which they are governed may be more appropriately stated under the head LABOUR. It is sufficient here to observe, that prohibitions are to the full as injurious and inconsistent when applied to this description of exchanges as to the exchange of commodities.

Our object in this article has merely been to lay before the reader a brief view of the principles that govern commercial transactions, and of the mode in which commerce contributes to increase private and public opulence. To have entered into a detail of the various ways in which commerce may be facilitated, would have engaged us in discussions that would have added too much to the length of this article; and the reader is, therefore, referred for information on these points to the articles BANKS, COLONIES, EXCHANGE, MONEY, ROADS, WEIGHTS AND MEASURES, &c.

We subjoin some tables, derived from official sources, illustrative of the nature and extent of the commerce of Great Britain during the last few years: —

I. An Account of the Real or Declared Value of the principal Articles of British and Irish Produce and Manufacture exported in 1838.

Articles.	Declared Value, 1838.
	L.
Coals and Culm - -	484,305
Cotton Manufactures - - -	16,700,468
Yarn - - -	7,430,582
Earthenware - - -	670,985
Glass - - -	376,524
Hardwares and Cutlery - -	1,507,478
Linen Manufactures - -	2,919,719
Yarn - - - -	655,699
Metals; viz. Iron and Steel - -	2,530,903
Copper and Brass - -	1,226,258
Lead -	156,150
Tin, in Bars, &c. - -	103,230
Tin Plates - -	434,749
Salt - - - -	223,372
Silk Manufactures - - -	778,031
Sugar, Refined - - -	550,506
Wool, Sheep's or Lambs' - -	432,067
Woollen Manufactures - -	5,792,156
Yarn - - -	365,657
Total of the above Articles - -	43,338,839

II. Account of the Real or Declared Value of the various Articles of the Manufacture and Produce of the United Kingdom exported to Foreign Countries in 1828, and during each of the Eight Years ending with 1837; specifying their Value, the Countries to which exported, and the Value of those annually shipped for each.

Countries to which exported.	Exports.								
	1828.	1830.	1831.	1832.	1833.	1834.	1835.	1836.	1837.
	L	L.	L.	L.	L.	L.	L.	L.	L.
Russia - -	1,318,936	1,489,538	1,191,565	1,587,250	1,531,002	1,382,300	1,752,775	1,742,433	2,046,592
Sweden - -	42,699	40,488	57,127	64,932	59,549	63,094	105,156	113,308	101,121
Norway - -	53,582	63,926	58,580	34,528	55,038	61,988	79,278	79,469	72,413
Denmark - -	111,880	118,813	92,294	93,396	99,951	94,595	107,979	91,302	103,448
Prussia - -	179,145	177,923	192,816	258,556	144,179	136,423	188,273	160,722	131,536
Germany - -	4,394,104	4,463,605	3,642,952	5,068,997	4,355,548	4,547,166	4,602,966	4,463,729	4,898,016
Holland - -	2,142,736	2,022,458	2,082,536	2,789,398	2,181,893	2,470,267	2,648,102	2,509,622	3,040,029
Belgium - -					886,429	750,059	818,487	839,276	804,917
France - -	498,938	475,884	602,688	674,791	848,333	1,116,885	1,453,636	1,591,381	1,643,204
Portugal, Proper -	945,016	1,106,695	975,991	540,792	967,091	1,600,123	1,554,326	1,085,934	1,079,815
Azores -	27,940	23,629	41,638	77,920	54,430	63,275	49,717	53,574	56,405
Madeira -	39,802	38,444	38,960	28,038	33,411	38,455	40,082	52,168	46,044
Spain and the Balearic Islands - -	301,153	607,068	597,848	442,926	442,837	325,907	405,065	437,076	286,636
Canary Islands -	38,152	42,620	33,282	21,053	30,507	30,686	24,308	40,370	41,904
Gibraltar - -	1,038,925	292,760	367,285	461,470	385,460	460,719	602,580	756,411	906,155
Italy and the Italian Islands - -	2,176,149	3,251,379	2,490,376	2,361,772	2,316,260	3,282,777	2,426,171	2,921,466	2,406,066
Malta - -	239,458	189,135	134,519	96,994	135,438	242,696	136,925	143,015	103,680
Ionian Islands -	41,078	56,963	50,883	55,725	38,915	94,498	107,804	109,123	124,465
Turkey and Continental Greece (exclusive of the Morea) -	185,842	1,139,616	888,654	915,319	1,019,604	1,207,941	1,331,669	1,775,034	1,163,426
Morea & Greek Islds.	335	9,694	10,446	10,149	25,914	37,179	28,834	12,003	15,431
Egypt (Ports on the Mediterranean) -	35,302	110,227	122,832	113,109	145,647	158,877	269,225	216,930	220,080
Tripoli, Barbary, and Morocco -	13,745	1,138	426	751	2,350	14,823	29,040	29,322	54,007
Western Coast of Africa	191,452	252,123	234,768	290,061	329,210	326,483	292,540	467,186	312,938
Cape of Good Hope -	218,049	330,036	257,245	292,405	316,197	304,382	326,921	482,315	488,814
Cape Verd Islands -	5,856	1,710	215	- -	146	530	575	413	751
St. Helena -	31,362	38,915	39,431	21,236	30,041	31,615	31,187	11,041	9,645
Isle of Bourbon -	35,188	10,042	- -	- -	- -	7,091		- -	3,795
Mauritius - -	185,972	161,029	148,475	163,191	83,424	149,319	196,559	260,855	349,488
Arabia - -	- -	- -	- -	- -	- -	250	6,049	16,358	787
East India Company's Territories & Ceylon	4,256,582	3,895,530	3,377,412	3,514,779	3,495,301	2,578,569	3,192,692	4,285,829	3,612,975
China - - -	- -	- -	- -	- -	- -	842,852	1,074,708	1,326,388	678,375
Sumatra and Java -	189,200	162,102	285,296	150,606	471,712	410,273	353,892	234,852	313,791
Phillippine Islands -	300	71,220	39,513	102,284	185,298	76,618	129,743	51,778	33,808
New South Wales, Van Diemen's Land, and Swan River -	443,839	314,677	398,471	466,238	558,372	716,014	696,345	835,637	921,568
New Zealand, and South Sea Islands -	2,487	1,396	4,752	1,576	936	- -	2,687		
Ports of Siam -	- -	10,467	- -	- -	- -	19,742			
British North American Colonies -	1,691,044	1,857,133	2,089,327	2,075,725	2,092,550	1,671,069	2,158,158	2,732,291	2,141,035
British West Indies -	3,289,704	2,838,448	2,581,949	2,439,808	2,597,589	2,680,024	3,187,540	3,786,453	3,456,745
Hayti - -	248,328	321,793	376,103	543,104	381,528	357,297	365,798	251,663	171,050
Cuba & other Foreign West Indies -	569,728	618,029	663,531	633,700	577,228	913,005	787,043	987,122	891,713
United States of America - -	5,810,315	6,132,346	9,053,583	5,468,272	7,579,699	6,844,989	10,568,455	12,425,605	4,695,225
Mexico - -	307,029	978,441	728,858	199,821	421,487	459,610	402,820	254,822	520,200
Guatemala -	6,191	- -	- -	- -	3,700	30,366	15,244	764	78
Colombia - -	261,113	216,751	248,250	283,568	121,826	199,906	132,242	185,172	170,451
Brazil - -	3,518,297	2,452,103	1,238,371	2,144,903	2,575,680	2,460,679	2,630,767	3,030,532	1,824,082
States of the Rio de la Plata - -	312,389	632,172	339,870	660,152	515,362	831,564	658,525	697,334	696,104
Chili - -	709,371	540,626	651,617	708,193	816,817	896,221	606,176	861,903	625,545
Peru - -	374,615	368,469	409,003	275,610	387,524	299,235	441,324	606,332	476,374
Isles of Guernsey, Jersey, Alderney, and Man - -	329,428	344,036	324,634	317,496	335,934	360,665	351,612	318,609	330,017
Totals -	36,812,756	38,271,597	37,164,372	36,450,594	39,667,347	41,649,191	47,372,270	53,368,572	42,070,744

III. Account of the Quantities of the principal Articles of Foreign and Colonial Merchandise imported into, exported from, and retained for Consumption in the United Kingdom, with the Nett Revenue accruing thereon, during the Years ending 5th January, 1837 and 1838.

Description of Merchandise.	Quantities imported. 1836.	Quantities imported. 1837.	Quantities exported. 1836.	Quantities exported. 1837.	Quantity retained for Consumption. 1836.	Quantity retained for Consumption. 1837.	Nett Revenue. 1836.	Nett Revenue. 1837.
							L.	L.
Ashes, pearl and pot - cwts.	152,955	147,329	19,137	18,810	130,176	128,098	998	193
Barilla and alkali —	70,214	102,135	1,680	3,141	97,202	91,404	Gross rev. 9,678	Gross rev. 8,995
						Drawbcks& repayments.	5,532	4,019
Bark for tanning or dyeing —	772,119	786,730	3,345	8,003	784,819	781,113	4,146	4,976
Coffee, viz.: —							25,855	26,458
British plantation lbs.	18,877,912	15,184,413	108,493	329,017	17,532,731	17,138,158		
East India & Mauritius —	9,906,710	9,950,005	3,622,895	1,320,255	7,412,725	9,205,634	691,616	696,645
Foreign plantation - —	5,270,215	11,278,096	6,950,370	6,411,703	2,234	3,169		
Totals	34,054,837	36,412,514	10,681,758	8,060,975	24,947,690	26,346,961		
Cocoa - - - lbs.	2,788,224	2,853,000	332,587	933,276	1,130,168	1,416,613	11,165	13,922
Husks and shells - —	425,648	511,757	16,800	- -	364,144	481,170		
Cotton wool from foreign countries, viz.: —								
The United States of America - - lbs.	289,615,692	320,651,716						
Brazil - - - —	27,501,272	20,940,145						
Turkey and Egypt - —	5,426,721	7,881,540						
Other foreign countries —	6,734,413	4,616,829						
Cotton wool from British possessions, viz.: —								
East Indies and Mauritius - - lbs.	75,957,887	51,577,197						
British West Indies, the growth of - - - —	1,312,806	1,199,162						
British West Indies, imported from - —	401,531	396,540						
Other British possessions —	835	23,654						
Total quantities	406,959,057	407,286,783	31,739,763	39,722,031	363,684,232	368,445,035	430,006	450,658
Indigo - - - - lbs.	7,710,544	6,545,873	3,691,951	3,587,561	2,840,398	2,226,194	36,356	29,889
Lac dye - - - —	663,675	1,011,674	200,975	133,959	620,248	423,335	1,717	1,140
Logwood - - - tons	12,881	14,699	4,385	3,316	12,361	12,023	2,473	2,543
Madder - - cwts.	108,906	84,841	364	822	105,445	78,830	10,712	8,057
Madder roots - —	85,251	109,235	3	2	84,101	100,503	2,114	2,532
Flax and tow, or codilla of flax and hemp - —	1,529,116	1,000,865	16,789	6,970	1,511,428	993,654	6,441	4,234
Currants - - —	196,561	217,921	5,738	17,841	175,774	174,842	194,821	193,893
Lemons and oranges - chests	265,864	349,880	1,455	1,536	249,651	311,490	52,226	62,431
Raisins - - cwts.	182,286	169,590	36,496	11,526	156,194	152,162	117,095	114,095
Hats of straw - - No.	14,042	26,228	16,172	12,711	3,437	5,624	1,009	1,632
Platting of straw - lbs.	42,890	30,862	11,846	7,546	29,681	23,962	24,558	20,003
Hemp, undressed - cwts.	586,032	773,621	38,105	16,574	567,892	651,613	2,482	2,766
Hides, untanned, viz.: —								
Buffalo, bull, ox, cow, or horse hides - - —	352,061	338,652	37,795	46,649	330,214	290,739	45,769	36,482
Hides, tanned, viz.: —								
Buffalo, bull, ox, cow, or horse hides - - lbs.	70,410	87,678	32,305	19,903	63,010	63,895	794	814
Leather gloves - pairs	1,490,999	1,255,920	31,405	18,894	1,459,363	1,218,470	27,507	22,923
Molasses - - cwts.	528,306	582,283	1,600	1,641	657,082	592,019	295,645	266,324
Oil — Olive - - galls.	2,682,016	1,721,914	150,561	209,472	1,844,622	1,496,656	46,514	34,986
Palm - - cwts.	277,017	223,337	34,379	16,732	234,357	211,919	14,678	13,299
Train, spermaceti, and blubber - tuns	19,489	21,803	1,365	393	18,722	20,878	1,292	14,370
Saltpetre and cubic nitre cwts.	279,902	349,993	38,444	36,959	231,134	240,222	6,045	6,339
Flax and linseed - bushels	3,339,215	3,321,089	1,371	6,879	3,179,097	3,381,643	19,905	21,118
Silk, raw - - lbs.	4,453,081	4,146,481	113,600	345,971	4,239,254	3,520,105	18,072	15,454
Waste and knubbs - —	1,608,289	943,281	87,645	21,268	1,524,968	876,456	712	389
Cassia lignea - - —	837,413	984,674	633,083	760,141	89,396	105,485	2,242	2,642
Pepper - - - - —	7,724,932	5,291,993	4,151,569	4,768,860	2,794,491	2,625,075	99,134	65,621
Pimento - - - —	3,269,238	2,113,300	2,337,982	1,376,645	400,914	335,406	6,359	4,193
Sugar, viz.: —			Raw.					
West India - cwts.	3,600,517	3,305,238	278,098	448,582	3,488,399	3,954,810	4,184,165	4,760,565
East India and Mauritius —	720,997	912,967	Refined.					
Foreign - - - —	327,647	265,073	248,644	227,807				
Tallow - - - - —	1,186,364	1,314,649	18,709	52,375	1,314,085	1,289,514	207,789	203,977
Tea - - - lbs.	49,307,701	36,973,981	4,269,863	4,716,248	49,142,236	30,625,206	4,674,535	3,223,840
Timber, viz.: —								
Battens and batten ends, gt.hun.	17,247	15,983	80	128	15,677	14,451	152,596	133,806
Deal and deal ends —	69,318	72,832	1,022	946	68,300	66,651	647,581	580,570
Masts, 6 and under 8 inches in diameter - - No.	8,414	9,474	345	199	9,247	9,763	2,780	2,865
Masts, 8 and under 12 inches in diameter - —	3,381	3,628	268	160	3,291	3,444	2,119	2,313
Masts, 12 and upwards loads	2,649	4,273	35	19	3,200	4,077	3,443	4,571
Oak planks - —	3,046	1,968	- -	6	2,871	2,199	11,490	8,813
Staves - - gt. hund.	93,695	85,721	2,124	1,638	90,811	84,454	57,334	51,693
Fir, 8 inches square and upwards - loads	622,680	579,960	460	846	612,865	581,039	545,074	456,389
Oak, ditto - —	25,684	31,656	15	2	26,062	30,940	31,318	41,205
Unenumerated, ditto —	39,422	48,484	72	80	39,314	48,026	10,043	12,073
Wainscot logs, ditto —	4,212	5,593	- -	3	3,988	4,020	10,954	10,938
Tobacco, viz.: —								
Unmanufactured - lbs.	32,232,907	27,144,107	12,319,405	17,341,587	22,150,785	22,321,489		
Manufactured or cigars —	168,668	632,186	432,661	302,869	158,182	144,385	3,397,102	3,417,663
Snuff - - —	13,580	4,153	3,496	3,472	508	351		
Wool, sheep and lambs' —	64,239,977	48,379,708	613,707	2,831,352	60,366,415	42,515,899	189,524	118,168
Wine, viz.: —								
Cape - - imp. galls.	580,275	618,105	10,876	6,766	541,511	500,727	74,435	68,854
French - - - —	533,241	725,140	99,112	106,935	352,063	438,594	96,534	120,286
Portugal - - —	4,089,235	2,693,365	381,026	199,518	2,878,359	2,560,252		
Spanish - - —	3,164,244	2,802,585	645,822	492,345	2,388,413	2,278,263	1,622,994	1,497,957
Madeira - - - —	233,979	289,400	152,368	148,107	133,673	111,376		
Other sorts - - —	805,109	904,885	385,320	381,122	515,193	502,319		
Totals of Wine	9,406,083	8,033,480	1,674,524	1,334,793	6,809,212	6,391,531	1,793,963	1,687,097

IV. Account specifying the different Articles, and the Real or Declared Value of each, of the Produce and Manufacture of the United Kingdom, exported to Foreign Parts during each of the Three Years ending with 1837.

Species of Exports.	1835.	1836.	1837.
GREAT BRITAIN.	L.	L.	L.
Alum	1,359	3,898	2,761
Apparel, Slops, and Negro Clothing	494,861	604,863	533,301
Arms and Ammunition	407,490	411,286	289,142
Bacon and Hams	27,573	42,319	35,840
Beef and Pork, salted	104,782	136,898	119,117
Beer and Ale	225,641	264,560	268,235
Books, printed	148,098	178,034	147,430
Brass and Copper Manufactures	1,093,949	1,072,002	1,166,082
Bread and Biscuit	5,405	8,184	9,991
Butter and Cheese	178,657	205,858	179,073
Cabinet and Upholstery Wares	51,003	75,511	67,357
Coals and Culm	242,746	329,760	428,690
Cordage	79,541	84,475	73,231
Corn, Grain, Meal, and Flour	25,109	31,297	34,781
Cotton Manufactures	16,393,170	18,482,586	13,632,146
—— Yarn	5,706,563	6,120,326	6,955,936
Cows and Oxen	1,445	3,072	6,107
Earthenware of all sorts	539,990	837,493	563,082
Fish of all sorts	217,652	185,433	185,120
Glass of all sorts	636,928	551,599	475,995
Haberdashery and Millinery	516,775	681,980	414,687
Hardwares and Cutlery	1,831,766	2,270,630	1,460,404
Hats, Beaver and Felt	135,048	147,907	104,600
—— of all other sorts	27,437	41,753	46,290
Hops	16,616	11,788	10,547
Horses	99,465	98,302	75,215
Iron and Steel, wrought and unwrought	1,640,939	2,340,207	2,003,708
Lard	11,881	26,585	14,782
Lead and Shot	195,096	224,931	155,210
Leather, wrought and unwrought	278,978	316,322	250,308
—— Saddlery and Harness	73,348	93,388	87,037
Linen Manufactures	2,838,050	3,249,053	2,109,897
—— Yarn	216,635	315,608	415,726
Machinery and Mill-work	307,316	300,852	493,298
Mathematical and Optical Instruments	25,004	25,030	27,259
Mules	1,762	5,366	5,104
Musical Instruments	60,810	76,120	71,618
Oil, Train, of Greenland Fishery	39,074	5,836	5,700
Painters' Colours	169,861	210,811	151,307
Plate, Plate Ware, Jewellery, and Watches	231,900	338,869	257,726
Potatoes	5,954	4,915	7,030
Salt	142,412	171,463	190,444
Saltpetre, British refined	20,284	14,411	19,593
Seeds of all sorts	8,549	8,920	7,466
Silk Manufactures	973,479	916,777	503,653
Soap and Candles	248,803	276,222	230,835
Spirits	16,866	24,297	10,485
Stationary of all sorts	257,877	297,945	197,489
Sugar, refined	851,745	697,920	602,377
Tin, unwrought	32,290	61,847	74,657
—— and Pewter Wares and Tin Plates	381,068	387,528	371,518
Tobacco (manufactured) and Snuff	13,594	13,654	13,124
Tongues	2,422	3,599	3,744
Umbrellas and Parasols	45,462	62,336	39,464
Whalebone	12,960	10,550	6,347
Wool, Sheep's	387,834	323,549	185,350
—— of other sorts	45,080	39,967	10,076
Woollen and Worsted Yarn	309,091	358,690	337,140
Woollen Manufactures	6,836,735	7,636,117	4,654,397
All other Articles	1,034,142	1,293,932	1,113,069
Total real or declared Value of the Prod. and Manufac. of the U. K. exported from Great Britain to Foreign Parts L.	46,926,370	53,015,431	41,911,898
IRELAND, Total Exports from L.	445,900	353,141	363,010
Total from the United Kingdom L.	47,372,270	53,368,572	42,274,938

See the *Commercial Dict.*; see also the *Treatise on Commerce* by the same author, from which part of the above article has been abstracted.

CO'MMISSARY (Lat. committo, *I entrust*), is used in various ways as nearly synonymous with *deputy*. In military affairs, the parties who provide clothing, &c. for the army are styled *commissaries*; and the whole body of officers belonging to this department, the *commissariat*.

COMMI'SSION. In the Army. *See* ARMY.

COMMISSION. In the Navy, the title of the appointment or warrant of officers of the rank of lieutenant, and above to hold their office. The commission is signed by the lords commissioners of the Admiralty.

COMMISSION, in Law, an appointment, usually by warrant or letters patent to one or more as commissioners, to perform certain duties specified in the instrument. In this mode many of the highest judicial or ministerial functionaries of the realm are appointed; thus, the judges of the superior courts hold several commissions, as of oyer and terminer, gaol delivery, &c. And high offices of state, when not regularly filled, are often entrusted to commissioners for the time being, and said to be put in commission; thus the custody of the great seal is put in commission in the absence of a lord chancellor and lord keeper. The Treasury and Admiralty have of late times been usually entrusted to commissioners, no lord high treasurer or lord high admiral having been appointed. The Court of High Commission consisted of persons appointed under letters patent to examine into matters of ecclesiastical jurisdiction, under stat. 1 Eliz. c. 1. (abolished 16 Car. 1.) Magistrates or justices of the peace are appointed by means of a commission, occasionally renewed, commonly termed the commission of the peace.

CO'MMISSU'RÆ. A term applied in Anatomy to certain parts of the brain which cross from one of its sides to the other. *See* BRAIN. In Botany, it signifies the place of junction of two opposite carpels.

COMMI'TMENT. In Law, the sending to prison of one charged with any crime. It appears to have been the ancient usage that whoever could lawfully arrest a person for felony or treason could also send or bring him to the common gaol; but since the Habeas Corpus Act it is the uniform practice that offenders are committed by the warrant in writing of a justice of the peace. The privy council and secretary of state can also commit in cases of treason. A commitment in writing must declare the authority of him who makes it, and also the nature of the offence with which the party is charged.

COMMI'TTEE, in the language of Parliament, is either a committee of certain members, or a committee of the whole house. (*See* PARLIAMENT.) *Select committees* are bodies appointed by open nomination or by a peculiar mode of election for the transaction of business, either according to the standing orders, or by accustomed usage. All private bills are referred in the first instance to select committees. *Joint committees* in former times consisted of bodies deputed by the two houses, and met for the purpose of adjusting differences, sometimes after free conferences had failed. They were free from the forms observed in conferences. As in the latter, the Lords deputed only half the number of members sent by the Commons. They have been long disused.

CO'MMODORE. A naval officer having the temporary rank of rear-admiral; the senior captain of several ships is called the commodore by courtesy.

CO'MMON. (Lat. communis.) In Law, is the right which one person has of taking a part of the produce of land, while the whole property in the land is vested in another. Common of pasture is either, 1. *Common appendant*, which is the right of the tenant of a manor to pasture his beasts on the lord's waste; 2. *Common appurtenant*, annexed to land by grant or prescription; 3. *Common in gross*, a right severed from the land.

When a common is under pasture all those who have a right of pasturage may turn out on it a certain number of animals, according to the extent of the enclosed grounds which they cultivate. When the common consists wholly or partly of arable land, this arable land is formed into ridges, generally with a narrow riband or balk of turf between each ridge, or between each two or three ridges. The right of cultivating these ridges is distributed among the holders of the enclosed lands of the parish, according to the extent of their possessions; and in order that there may be no partiality, and that every one may have as much interest in preserving his neighbour's ridge as his own, the ridges which any individual has the right of cultivating do not lie together, but are distributed among the ridges of his neighbours.

CO'MMONABLE LANDS. A common in which the greater part of the land is arable.

CO'MMON-FIELD LANDS. When the whole of a common belonging to a parish is not in a ring fence, but lies in different places, these places are called common fields.

CO'MMON MEASURE. In Arithmetic, is a number which divides two or more other numbers without leaving a remainder.

CO'MMON PLEAS, or COMMON BENCH, COURT OF. In Law, was originally that branch or side of the *aula regia* in which civil causes between subjects were tried. It was separated and rendered stationary, while that portion of the court from which the King's Bench is derived followed the person of the king by a provision of Magna Charta. This court has concurrent jurisdiction with the other two superior common law courts (*see* COURTS, SUPERIOR) in personal actions and ejectments. But it retains exclusive jurisdiction over all other mixed, and all real actions or pleas of

land. These, however, have now nearly fallen into disuse. (*See* PLEADING.) The Court of Common Pleas has one chief and four puisné judges.

COMMON PRAYER BOOK. The name given to the collection of all the offices of regular and occasional worship according to the forms of the church of England. The basis of this book is to be found in the King's Primer, set forth in 1546 by Henry VIII., which was intended to convey instruction to the people in the most important parts of the church service; but contained little more than the Creed, Lord's Prayer, Commandments, and Litany. This Primer underwent two revisions and republications under Edward VI., whose second Liturgy approaches very near in its contents to that which exists at present. It was at that review that the Sentences, Exhortation, Confession, and Absolution were prefixed to the Daily Service; the Decalogue was introduced into the Communion Service; and certain remnants of the Romish customs were finally abolished, as the sign of the cross in confirmation and matrimony, the anointing of the sick, and the prayers for the dead.

On the accession of Elizabeth, another review of the Liturgy was instituted; but the alterations effected were little more than in the selection of the lessons. At the review in the reign of James I., after the conference with the Presbyterians at Hampton Court, no change of importance was introduced, except the addition of the explanation of the Sacraments in the Catechism. Again, when on the restoration of Charles II. a conference had been held with the Dissenters at the Savoy, the subject of the Common Prayer Book was reconsidered in convocation. The services for the 30th of January and 29th of May were then added, as also the Form to be used at Sea. A few trifling alterations were made also in the other services; but these were the last that have been effected. On the accession of William III. another revision took place, and a considerable number of alterations were proposed and supported by many of the bishops and clergy; but they were rejected by convocation, and have never since been revived by authority. The following is a chronological list of the revisions of the Prayer Book in which any alterations have taken place. It is taken from the *Rev. T. V. Short's History of the Church of England:* —

1546. The King's Primer.
1548. The Communion Service.
1549. First Liturgy of Edward VI.
1550. First Ordination Service.
1552. Second Liturgy of Edward VI.
1552. Second Ordination Service.
1560. Liturgy of Elizabeth.
1604. Alterations introduced by James I.
1633. Alterations introduced by Charles I.
1661. Last Revision; authorized Liturgy.

COMMONS, HOUSE OF. *See* PARLIAMENT.

CO'MMON TIME. In Music, that in which every measure or bar contains one semibreve, two minims, four crotchets, eight quavers, and so on.

CO'MMONWEALTH. *See* REPUBLIC.

COMMONWEALTH OF ENGLAND. In History, the form of government established in England on the death of Charles I. in 1649, and which existed during the protectorate of Oliver Cromwell and his son Richard, until the abdication of the latter in 1659. The substitution of a democratical for a monarchical form of government was provided for and enjoined by two successive charters. The first charter of the commonwealth was drawn up in December, 1653, by the *council of officers*, who, on the voluntary resignation of the parliament in the early part of the same year, had declared Cromwell "Protector;" it was styled the "Instrument of Government." The second charter, called the "Petition and Advice," was framed in May, 1657, by the parliament which the protector had assembled in the previous year. Under the first charter, as has been well observed, the English government may be classed among republics with a chief magistrate at its head; under the second, it became substantially a monarchy, and Oliver Cromwell from 1657 to the period of his death was de facto King of England. (*Hallam's Constit. History*, 421.) On the demise of Cromwell, the succession of his son Richard was at first cordially recognized; but soon afterwards discontents and cabals having sprung up in the country, his inability or disinclination to govern induced him to abandon the protectorship after a reign of eight months; and on the 29th of May, 1659, the restoration of the monarchy under the old *regime* was effected by the triumphal entry into London of Charles II. It would be out of place to give here a detailed view of the state of England during the commonwealth. Suffice it to observe, all authors have concurred in opinion, that, whatever were the defects of the home government, arising partly from the ambition of the protector, and partly from the stubbornness and opposition of his councils, the energy and decision which Cromwell maintained in every department of the state not only laid the foundation of England's maritime greatness, but raised her to a pitch of prosperity that has rarely, if ever, been equalled.

COMMU'NION, is used in various ways in the general sense of participation: — 1. A person is said to be in communion with a church, who declares his acquiescence in its doctrines and participates in its worship; and hence the term communion is used sometimes for a church. 2. Communion is confined emphatically to participation in the Eucharist. (*See* EUCHARIST.) 3. The Communion of Saints, an article of the Apostles' Creed, is variously explained.

COMMUTA'TION. In Astronomy, the angle of commutation of a planet is the angle formed at the earth by a straight line drawn from the earth to the sun and the orthographical projection on the plane of the ecliptic of the straight line which joins the earth with the planet. It is measured by the difference between the sun's longitude and the geocentric longitude of the planet.

CO'MMUTATION OF TITHES. *See* TITHES.

COMO'SE. Ending in a tuft or kind of brush.

COMPA'NION. The hut or covering over a ladder (or staircase) in a ship.

COMPANY (Fr. *compagnie*), in its most general sense, means any two or more individuals associated for any common object, whether of business or pleasure.

In its more limited sense, however, and that in which it is usually understood in this country, the term company means an association of individuals for the prosecution of some industrious undertaking. Such associations may be of very various descriptions, inasmuch as the terms of the association or partnership may be varied in an infinity of ways. Generally, however, they may be said to be either *private* or *public* companies; that is, according to the law of England, companies with not more than six partners and with more than six; and public companies may farther be divided into *joint stock* and *regulated* companies, and these again into *incorporated* and *unincorporated* companies.

I. The principle on which associations for industrious purposes are established is too obvious to require much illustration. All great results are brought about by co-operation, and could not be effected otherwise. Isolated man is comparatively feeble and helpless; the capacity of associating for a common purpose is, in fact, the main source of his power, and the principal distinction between him and the lower animals — *Quo alio fortes sumus quam quod mutuis juvamur officiis?* One man has capital without skill, and another skill without capital: if such persons act independently, they will be able to effect little or nothing; but if they combine their efforts, and the capital of the one be applied and directed by the skill of the other, the effect of their exertions will be incomparably greater. But this is not all. Many of the greatest and most important works undertaken in modern times could not have been attempted by one individual, how opulent or skilful soever. Some of them require a vast outlay; while the returns being frequently remote and contingent, no single individual, and, indeed, no small number of individuals, would be willing to put their fortunes to hazard by engaging in them. But such undertakings are readily and advantageously carried on by large associations; for, in that case, individuals being called upon only to subscribe comparatively small sums to the common stock, they can afford to lose them without, in most instances, suffering any material inconvenience; while the aggregate amount of the subscriptions may, notwithstanding, amount to a very large sum, and be adequate to the greatest undertakings. In fact, some of the most gigantic works ever entered upon either in this or any other country have been accomplished by the joint contributions of the subscribers of 100*l.* shares. It is true that wealthy individuals usually subscribe for a number of such shares; but this does not affect the principle of the system, which is to distribute the risk according to the ability of the individuals associated.

II. In *private* companies the business is usually conducted by one or more of the partners on the principles laid down in the deed of partnership. The rights and obligations of the partners as respects each other are, of course, mainly determined by this deed: as respects the public, the law regards the act of one partner as the act of the company; and each partner is bound, without any regard to the sum he has subscribed to the company's stock, to the whole extent of his fortune, for the debts and engagements of the firm. Certain formalities are necessary at the withdrawal of a partner; such as advertizing in the *Gazette*, and the sending of special information of the fact to all individuals in the habit of dealing with the company. *See* PARTNERSHIP.

III. *Public* companies may, as already stated, be either joint stock or regulated; and these again may be either incorporated or unincorporated.

1. By a joint stock company is meant a company the stock of which is subscribed by a certain number of persons in shares of a certain amount. Thus, supposing that a joint stock association is to be formed for carrying on the business of banking or insurance, for excavating

a dock or a canal, or for constructing a railway, and that its capital is to amount to 1,000,000*l.* to be subscribed in shares of 100*l.* each; any individual (unless exceptions be made in the conditions under which the company is to be formed) who can command 100*l.* may become a partner of this association, and will be registered in the company's books as the holder of a share of 100*l.* of the company's stock. It is customary, too, in the vast majority of instances, to allow individuals to transfer their stock or shares to others, who succeed to all the rights and obligations of their predecessors. The price which shares or portions of stock fetch in the market depends, of course, on the real or supposed state of the company's affairs: if it be known or supposed to be in a flourishing and prosperous condition, and paying a high interest or dividend on its stock, the latter may sell for 10, 20, 50, or 100 per cent. or upwards of advance; whereas if it be known or supposed to be in an unprosperous condition, its shares may not bring a third or a tenth part of what they originally cost.

The affairs of companies of this description are usually conducted by salaried officers, who are appointed by and act under the orders of a board of directors chosen by the company at large, according to the conditions in their deed of association. The partners in such companies are all individually liable, without regard to the magnitude of their stock or shares, for the entire debts and obligations of the company.

At common law no action can be raised by or against such companies without making all the shareholders parties to the action. But the obvious and insuperable inconveniences that would result from the enforcement of this rule have made it be enacted, by the 1st Victoria, cap. 73., that the crown may at pleasure grant to joint stock associations letters patent, authorizing them to sue and be sued in the names of particular officers of their own; without, however, unless government judge proper, incorporating the company, or affecting the liability of the different partners for its debts.

2. When joint stock companies are incorporated by royal charter, or by letters patent, the liability of the partners is limited to the amount of their stock, and they cease to be responsible beyond that amount. This is the case with some great joint stock associations; as the banks of England, Scotland, and Ireland; the East India Company, the Royal Exchange Assurance, and a few more. But government has hitherto been, and that for the best reasons, very chary of granting charters of incorporation. It is difficult, in fact, to imagine a case in which they ought to be granted. Individuals are always ready to embark, without stipulating for any restriction of their liability, in any scheme, however hazardous, that holds out any promise of even a moderate return. And this unlimited responsibility of the partners is, in all ordinary cases, the only security worth a pinch of snuff on which the public can ever rely for protection against the fraud or misconduct of the managers of joint stock companies.

The grand distinction between unincorporated and incorporated joint stock companies is, that in the case of the former, the law looks only to the individuals forming the association; while, in the latter, it looks only to the corporate body, and pays no attention to the individuals of which it is made up. On judgment against an Incorporation, execution can only pass on the corporate property; and supposing it to become insolvent, the partners can only, as already stated, be called upon to make good the amount of the stock of the incorporation standing in their names. But it is quite otherwise with an unincorporated joint stock company: should it become insolvent, the partners, to use the words of Lord Eldon, are severally liable for the whole debts and engagements of the company, even "*to their last shilling and their last acre.*"

We have already sufficiently explained (see art. BANKS) the advantages that would result from the periodical publication of the names of the partners in joint stock companies. The public are clearly entitled to know who the parties are that embark in such concerns. Nothing on which it would be prudent to place much reliance can be learned from prospectuses and professions. Without knowing who the partners really are, the public have no means of forming any fair estimate of the character of any association, or of the credit to which it may be justly entitled. But we doubt whether it would be prudent to carry interference with joint stock companies farther than this. It is excessively difficult, and in most cases quite impossible, to enforce such regulations in regard to such companies as would serve to disclose the real state of their affairs, provided they had an interest in concealing it; and it is needless to say, that the leading of the public to depend on regulations that cannot be carried into effect, is one of the most likely means that can be resorted to for the encouragement of imposture and fraud.

3. *Regulated companies* consist of a number of unconnected individuals or associations engaged in the same business or department of trade, under condition of their conforming to regulations laid down for their common guidance. Such companies have been mostly formed for the prosecution of the trade with distant and peculiarly situated countries. Their principle is not to exclude individual competition, but merely to make the different parties engaged in the trade observe the same general rules. Companies of this description were at one time common; but they have now mostly fallen into desuetude, though it be easy to imagine circumstances in which they might be advantageously revived.

4. *Civic companies*, of which there are many in the the city of London and other large towns, are in reality *guilds* or *fraternities*. Originally they consisted of the parties carrying on a peculiar trade or profession; and in most instances they gradually acquired the privilege of prescribing the conditions and limitations under which individuals not belonging to the fraternity might obtain leave to engage in its peculiar trade within the precincts of the city or borough to which it belonged. In more modern times, however, the injurious influence of such restrictions on the free exercise of industry became obvious; and in consequence the powers formerly exercised by civic companies or guilds over individuals not free of their society, who attempted to carry on the same trade, have been either wholly repealed or greatly modified. At present, therefore, the companies in question exist principally as charitable institutions, or as incorporated associations, having, in many instances, the management of large amounts of property appropriated for the use of their poorer brethren, or for some similar purpose.

CO'MPANY. In the Army, a body of men, forming one of the chief divisions of a battalion of infantry. In the guards and artillery, a company consists of 120 men, but in all other infantry regiments of 100. A company in the infantry corresponds to *troop* in cavalry regiments; and is under the inspection of a captain, a lieutenant, and an ensign, besides the non-commissioned officers; with the exceptions of the artillery, engineers, marines, and the rifle brigade, in which *second lieutenants* are substituted for *ensigns*.

COMPA'RISON, or SIMILE. In Rhetoric, appears to differ from Metaphor (which see) only in form; the resemblance being stated in the first case, implied in the second. This is the sense in which the term Comparison is used and defined by Aristotle, in his *Art of Rhetoric*. Frequently the same idea furnishes at the same time both comparison and metaphor; as in the following line, "They melted from the field as snow." The word "melted" is used by transferring the property of the snow to a multitude of individuals: so far, therefore, the phrase is a metaphor; but the additional words, "as snow," transform it into a direct comparison. Perhaps, however, it might be more correctly said, in this instance, that the predicate "melted" is transferred by the figure termed Hypallage from the *snow* to the *multitude*, both words being used as subjects in the same sentence. The comparison, being as it were a metaphor resolved and rendered more flowing and less concise, is more appropriate to poetry than to prose composition. In fact, the only figures of this description which are generally admissible in prose writing are illustrations; *i. e.* arguments drawn from analogy in the form of comparisons. (*See* ILLUSTRATION.) It will generally be found that in every language the earliest writers, especially the poets, are the most addicted to the use of comparisons and metaphors of a highly figurative and bold character, as is especially observable with respect to the sacred poets, and to Homer; while as language advances in cultivation the metaphor comes more and more into ordinary use, and forms, as it were, the basis of composition, while at the same time it gradually loses the energetic and poetical cast which at first distinguished it.

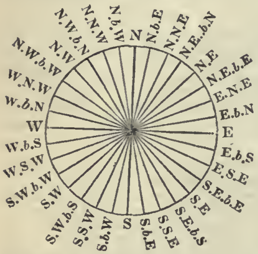
COMPARISON, DEGREES OF. Those varieties in the inflexions of adjectives which denote the degree in which a quality is possessed by a substance, either generally or in reference to one or more other substances. In English there are only two degrees of comparison, commonly named the comparative and the superlative. The first compares two conceptions only, as "John is *taller* than Charles." The second either compares one conception with a definite number of others, as "John is the *tallest* of all the four;" or expresses general superiority, as "the *fairest* of women."

COMPA'RTMENTS. (Ital. compartimenti.) In Architecture, the subdivisional parts of larger divisions for ornament, to which alone this term is properly applicable.

CO'MPASS. A name given to instruments contrived to indicate the magnetic meridian, or the position of objects with respect to that meridian. According to the purposes to which the instrument is chiefly applied, it becomes the *mariner's compass*, the *azimuth compass*, the *variation compass*, each particular application requiring some peculiarity of construction; but whatever modifications it may receive, the essential parts are the

same in all cases. These are a magnetized bar of steel, called the *needle*, having fitted to it at its centre a cap, which is supported on an upright pivot, made sharp at the point in order to diminish the friction as much as possible and allow the needle to turn with the slightest force. The *mariner's compass* has a circular card attached to its needle, which turns with it; and on the circumference of which are marked the degrees, and also the 32 *points* or *rhumbs*, likewise divided into half and quarter points. The pivot rises from the centre of the bottom of a circular box, called the compass box, which contains the needle and its card, and which is covered with a glass top to prevent the needle from being disturbed by the agitation of the air. The compass box is suspended within a large box, by means of two concentric brass circles or gimbals; the outer one being fixed by horizontal pivots, both to the inner circle which carries the compass box, and also to the outer box, the two sets of axes being at right angles to each other. By means of this arrangement the inner circle, with the compass box, needle, and card, always retain a horizontal position notwithstanding the rolling of the ship.

The notation of the mariner's compass is as follows:— The circumference being divided into the four quadrants by two diameters at right angles, the extremities of these diameters are the four cardinal points (cardo, *a hinge*), marked N., S., E., W. (north, south, east, west). Bisecting each of the quadrants, the several points of bisection are denoted by placing the two letters at the extremities of the quadrant in juxtaposition. Thus, N.E. (north-east) denotes the point which is half way between north and east; and so with N.W., S.E., S.W. (north-west, south-east, south-west). Let the octants next be bisected; the points of division are denoted by prefixing to each of the above combinations first the one, and then the other of the two cardinal points of which it is formed. Thus N.E. gives N.N.E.



and E.N.E. (north north-east, and east north-east); and so in respect of the others. Sixteen points have thus been named. Let the distances be again bisected; then each of the points so found is expressed by that one of the preceding points already named to which it is nearest, followed by the name of the cardinal point towards which its departure from the nearest points leads it, the two being separated by the letter *b*(by). Thus, the point half way between N. and N.N.E. is N. by E. (north by east); that which is half way between N.N.E. and N.E. is N.E. by N. (north-east by north), &c. The whole of the thirty-two points are thus distinguished, as in the figure.

The principal requisites of a compass are intensity of directive force, and susceptibility. The first of these is obtained by constructing the needle of the material and form best suited to receive and retain the magnetic virtue. A number of experiments on this subject were made by Coulomb, and more recently by Captain Kater, an account of which is given in the *Phil. Trans.* for 1821. Captain Kater found that the kind of steel capable of receiving the greatest magnetic force is shear steel; and that the best form is that of a lozenge or rhomboid (*fig.*), cut out in the middle, so as to diminish the extent of surface in proportion to the mass, it being found that the directive force of the needle, when magnetized to saturation, depends not on the extent of surface, but on the mass. Beyond a certain limit (about five inches) no additional power is gained by increasing the length of the needle; and needles exceeding a very moderate length are apt to have several consecutive poles, the effect of which is to produce a great diminution of directive force. On this account short needles, made very hard, are to be preferred.

Like many other of the most valuable arts of life, the origin of the compass is entirely unknown. By some writers it is ascribed to Flavio Gioja, who lived in the 13th century; yet Guyot de Provence, who lived a century earlier, speaks of the loadstone, to which he gives the name of *marinetti*, or mariner's stone, as useful to navigation. Others pretend that it was invented in France; but there seems to be no other reason for this supposition than the fact that from time immemorial the north point of the compass card has been distinguished and ornamented with a *fleur de lis*. For a reason of a different kind, but perhaps of the same degree of weight, Dr. Wallis and others have supposed the invention to belong to England, the name *compass*, which is given to the instrument by most European countries, being used in England to signify a circle. The term *bussola* in Italian, and *boussole* in French, has also been supposed to be derived from our term *box*, by which the compass is frequently designated. Gilbert, in his celebrated work *De Magnete*, affirms that Marco Polo brought the invention to Europe from China, about the year 1260. It appears very probable that the Chinese were acquainted with the directive property of the loadstone at an early period. Their method is to place it on a small piece of cork and set it to float on water. The art of communicating the magnetic virtue to steel, and suspending the needle on a pivot, is undoubtedly an European invention.

The *azimuth compass*, being intended to show the bearing of objects in respect of the magnetic meridian, has its circle divided merely into degrees, instead of the rhumbs used in navigation, and is provided with sights to allow the angles to be taken more accurately.

The *variation compass* is designed to exhibit the diurnal changes in the deviation of the magnetic from the true meridian; and the needle is generally made of much greater length than in the mariner's compass, in order to render minute variations more sensible. *See* MAGNETISM.

COMPITA'LIA. (Lat. compitum, *a street*.) A Roman feast celebrated in honour of the Lares and Penates. Under Tarquinius Superbus, it is said that human victims were sacrificed at this solemnity. The gods invoked at it were termed Compitales, as presiding over the streets.

CO'MPLEMENT. (Lat. compleo, *I fill up*.) What is wanted to complete or fill up some quantity or thing. Thus, the complement of an angle is what is wanted to make the angle a quadrant or 90°. Complement of a number is what is necessary to be added in order to make the number 1, or 10, or 100, or, in general, 1 with zeros. In Geometry, the complements of a parallelogram are the two spaces which, with the parallelograms about the diagonal, make up the whole parallelogram.

COMPLU'VIUM. (Lat.) In Ancient Architecture, an area in the centre of the Roman houses, so constructed that it might receive the waters from the roofs. It is also the gutter or eave of a roof.

CO'MPOSITE NUMBERS, in Arithmetic, are numbers which can be divided by some other number greater than unity. They are consequently opposed to *prime numbers*, which admit of no divisor. In Music, *composite numbers* are such as are composed by the multiplication of the prime integers, 2, 3, 5.

CO'MPOSITE ORDER. In Architecture, one of the five orders of architecture, and, as its name imports, composed of two others, the Corinthian and the Ionic. Its capital is a vase with two tiers of acanthus leaves, like the Corinthian; but instead of stalks, the shoots appear small and adhere to the vase, bending round towards the middle of the face of the capital; the vase is terminated by a fillet, over which is an astragal crowned by an ovolo. The volutes roll themselves over the ovolo to meet the tops of the upper row of leaves, whereon they seem to rest. The corners of the abacus are supported by an acanthus leaf bent upwards. The abacus resembles that of the Corinthian capital (*see* CAPITAL). In detail the Composite is richer than the Corinthian, but less light and delicate. Its architrave has usually only two fasciæ, and the cornice varies from the Corinthian in having double modillions. The column is ten diameters high. The principal examples of this order are the Temple of Bacchus at Rome, the arch of Septimius Severus, those of the Goldsmiths and of Titus, and that in the baths of Diocletian. The example here given is from the arch of Titus, which is considered a fine specimen of the order. *See* ORDER.

COMPO'SITÆ. In Botany, the largest of all known natural groups of plants; and so called because the old botanists who invented the name regarded the flower-heads as compound flowers. They answer to the *Syn-*

genesia polygamia of Linnæus, and are positively characterized by having capitate flowers, syngenesious anthers, and an inferior ovary with a single erect ovule. In the most recent account of this order, by M. De Candolle, nearly 8000 species are enumerated in about 900 genera, and the subject is not nearly exhausted; they exist all over the world where vegetation can develope, and are sometimes trees, although more generally herbaceous plants or shrubs. Among medical species, the chamomile, wormwood, southernwood, elecampane, and opium lettuce are conspicuous; of esculents, the order contains the artichoke, the Jerusalem artichoke, the lettuce, succory, and endive; and among ornamental plants, the aster, dahlia, coreopsis, sunflower, &c. But by far the greater part of this large assembly consists of species which are either weeds or of no known use. The reader who wishes to become acquainted with this order must consult *De Candolle's Prodromus Regni Vegetabilis*, vols. v., vi., and vii.

COMPOSI'TION. In Law, an agreement made between the owner of lands and the parson, with the consent of the ordinary and the patron, that such lands shall be discharged from the payment of tithes, by reason of some land or other real recompence given to the parson in satisfaction thereof. Such an agreement, since the 13 Eliz. c. 10., is not good for a longer term than three lives or twenty-one years. *Composition* signifies also the agreement between a bankrupt after his last examination and nine tenths of his creditors for the satisfaction of their claims, and has the effect of superseding the fiat of bankruptcy.

COMPOSITION. In the Fine Arts, that combination of the several parts, whereby a subject is agreeably presented to the mind, each part being subordinate to the whole. See INVENTION.

COMPOSITION. In Music, the art of disposing and arranging musical sounds into airs, songs, &c., either in one or more parts, for voices or instruments or both. Zarlino defines it to be the art of joining and combining concords and discords together, which are the matter of music.

COMPOSI'TION OF FORCES or MOTION. In Mechanics, signifies combining or uniting several forces or motions, and determining the result of the whole. If a body is solicited by two forces which act in the same direction, the *resulting* force, or *resultant*, is equal to the sum of both; that is to say, the effect produced is the same as would be produced by a single force acting in the same direction, and equal to their sum. If the two forces act in opposite directions, the resultant is equal to their difference, and the body will move in the direction of the greater. If the lines of direction of the two forces make an angle with each other, the resultant will be a mean force in an intermediate direction. Thus, if the two forces be represented in intensity and direction by the two sides of a parallelogram, then the resultant is represented in intensity and direction by the diagonal of the parallelogram which passes through the angle formed by those two sides.

COMPO'SITOR. (Fr. compositeur.) In Printing, the workman who arranges the types in lines and pages, and prepares them for being printed off.

COMPOSTE'LLA, ST. JAMES OF, or ST. JAMES OF THE SWORD. An ancient order of knighthood in Spain, the chief of the four military orders (Compostella, Calatrava, Alcantara, Manresa); probably founded either by Alphonso IX. of Castile (1158, 1214), or Ferdinand II. of Leon (1157, 1188). It originally began from the voluntary association of certain gentlemen to defend the great road leading to the celebrated shrine of St. James at Compostella. Pope Alexander III. gave the order its rules of government. The order possessed at one period eighty-four commanderies, with two cities and numerous burghs and villages. The knights take the vows of poverty, obedience, and conjugal chastity; to which they add a fourth, "to defend and maintain the immaculate conception of the Holy Mother of Jesus Christ."

CO'MPOUND INTEREST, is interest charged not only on the principal, but also on the interest forborne. Thus, if money is invested so that the interest is not paid as it becomes due, but successively added to the capital, the capital is said to accumulate at compound interest. Let $r =$ the amount of 1*l.* for 1 year; that is to say, $= 1$*l.* with its interest added to it; then the amount of 1*l.* at the end of 2 years will be r^2; at the end of 3 years, r^3; at the end of 4 years, r^4; and so on. The law of this country does not allow compound interest to be charged on money lent.

COMPRE'SSIBI'LITY. The quality of bodies in virtue of which they can be reduced to small dimensions. All bodies, in consequence of the porosity of matter, are compressible, though liquids resist compression with immense force.

CO'MPTONITE. A mineral found in ejected masses on Vesuvius; named after Lord Compton, who first brought it to England in 1818.

COMPURGA'TION. An ancient mode of trial both in civil and criminal cases. In the latter, by the law of the Saxons (which William the Conqueror confirmed in this respect, at least as to its main features), the accused party was allowed to clear himself by the oath of as many of his neighbours to his innocence as amounted in collective worth, according to the legal arithmetic of the Anglo-Saxons, to one pound (*see* WEREGILD), if he could in the first instance (being a villein) obtain the testimony of his lord that he had not been previously convicted. If otherwise, he was bound to undergo ordeal, or wage his law with a greater number of compurgators. Compurgation in criminal cases was abolished in general by Henry II.'s assizes, the ordeal being enforced in lieu of it. But it was retained as a special franchise in some boroughs, to which those assizes did not extend; and the last instances of it on record are to be found in the rolls of the hundred court of Winchilsea, in the reign of Henry VI. (See *Sir F. Palgrave on the British Commonwealth*.) A singular usage of the same description long remained in the ecclesiastical courts, by which convicted clerks, allowed their clergy and delivered up to the ordinary, were admitted to purge themselves by the oaths of compurgators, which was abolished by 18 Eliz. c. 7. Wager of law, in civil cases, lay in some personal actions only, and in incidental traverses in real actions (see *Blackstone*, lib. iii. c. 23.); and in these cases, although many technical difficulties prevent defendants from availing themselves of it, it is not yet abolished.

COMS, COOMS, COOMES, or CHIVES. The points of the radicles of malted grain, which after kiln-drying drop off during the process of turning. They are sold by maltsters under the name of malt dust, and are considered excellent manure.

CONCE'PTACLES. (Lat. conceptaculum, *a receiver*.) The cases containing the reproductive organs of such plants as ferns, in which they are produced from the back of the leaves, growing in the form of spots at the anastomoses, margins, or extremities of the veins, and then collectively called Sori. The conceptacles are also termed Capsules, Thecæ, and Sporangia.

CONCEPTA'CULUM. (Lat. *a receiver*.) A term in Botany, denoting a one-valved fruit opening longitudinally on one side, and distinct from the seeds. It is a folliculus without any attachment between the placenta and the ventral suture, as in Asclepias.

CONCE'PTION. (Lat. concipere, *to conceive*.) In Mental Philosophy, that faculty or act of the mind by which we combine a number of individuals together by means of some mark or character common to them all. We may observe, for instance, that equilateral isosceles and scalene triangles all agree in one respect, that of having three sides; and from this perceived similitude we form the conception *triangle*.

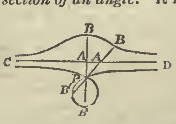
CONCERTA'NTE. (It. concentare, *to contrive*.) In Music, a term expressive of those parts of a musical composition that sing or play throughout the piece, as distinguished from those that play only occasionally in particular places.

CONCE'RTO. (It.) In Music, a piece composed for a particular instrument, which bears the greatest part in it, or in which the performance is partly alone and partly accompanied by other parts.

CONCE'TTI. (It.; rendered by English writers on rhetoric *conceits*.) Ingenious thoughts or turns of expression, points, jeux d'esprit, &c. in serious composition. In the 16th century, the taste for this species of brilliancy, often false and always dangerous, spread rapidly in the poetical composition of European nations, especially in Spain and Italy; where the name of *concetti* was applied rather in a good than a bad sense, the critical taste being much perverted. Tasso is not free from *concetti*. After his time they became offensively prominent in Italian poetry for a century afterwards: Marino and Filicaia offer strong examples. In France, the mode of concetti was equally prevalent in the 17th century, and was peculiarly in vogue with the fair critics of the Hotel Rambouillet, so well known by Moliere's "Précieuses Ridicules." In England, Donne and Cowley are instances of a style full of *concetti*.

CO'NCHIFERS. (Lat. concha, *a shell*, and fero, *I carry*.) A name applied by Lamarck, Schweigger, and Latreille to all mollusks which are protected by a bivalve shell.

CO'NCHOID. (Gr. κογχη, *a shell*, and εἶδος, *form*.) The name given to a curve invented by Nichomedes for the solution of the two famous geometrical problems of antiquity, — the *duplication of the cube*, and the *trisection of an angle*. It is constructed as follows: —



Let P be a given point through which any straight line is drawn to cut or meet another straight line C D given in position; if a segment AB (or AB′) of a given length be taken on either side of C D, the point B (or B′) will trace the conchoid. The curve has different forms, according to the different relative

positions of the point B with respect to the pole P and the given straight line C D. The conchoid is a curve of the fourth order, the equation between the rectangular co-ordinates (the origin being placed at A in the straight line perpendicular to C D) being $x^2 y^2 = (a^2 - y^2)(b + y^2)$, in which A B $= a$, and A P (perpendicular to C D) $= b$.

CONCHO'LOGY. (Gr. *κογχη, a shell,* and *λογος, a discourse.*) The science of shells: that department of Malacology which treats of the nature, formation, physiological relations, and classification of the hard parts or skeletons of the molluscous animals.

As Osteology, inasmuch as it relates to the nature, development, and physiological subserviencies of the skeletons of the vertebrate animals, is a science in the strict acceptation of the term, so also is Conchology under the like applications; but as no naturalist has yet conceived a classification of vertebrate skeletons independently of the softer organs of the body which they support and protect, and as, notwithstanding that the complex internal skeletons of the Vertebrates are closely related to their general structure and habits, the classification of these parts would not in all cases tally with the natural arrangement of the animals to which they belonged, therefore still less scientific must be a classification of shells merely, apart from a consideration of the molluscous animals by which they are secreted. For shells, instead of consisting, like bones, of living organized substance permeated by blood-vessels, absorbents, and nerves, are mere inorganic laminated, concretionary, or crystalline deposits of calcareous earth, more or less combined with albuminous matter: they are also formed in the skin, and are appendages to the dermal system, which in all classes of animals is the principal seat of variety. In many cases, therefore, there exists very little correspondence between the structure or even the presence of a shell and the general character of the organization of a mollusk; and the absence of uniformity between the condition of the shell in closely allied species is exemplified in the highest as well as the lowest classes of the molluscous sub-kingdom. The argonaut, the poulp (*Octopus*), the calamary, the cuttle-fish, and the spirula, all possess the same peculiar and highly developed organization; and in a classification founded on general structure, and expressive of the true affinities of its objects, they must rank in the same order of their class. But the shells of these mollusks present respectively the following conditions:—the first, a simple, external, light, elastic, subtransparent, but calcareous discoidal univalve; the second, two internal, friable, subtransparent styles, composed of hardened albumen; the third, an elongated, feather-shaped, horny plate; the fourth, an internal, compressed, oval, laminated, friable, calcareous mass; the fifth, an elongated, cylindrical, conical shell, twisted spirally in the same plane, divided into chambers by calcareous partitions, perforated by a siphon, and partly internal, partly external, in its situation. Now, in a system of Conchology, understood as the classification of shells in the abstract, these productions would necessarily be dispersed into five widely different groups; and in like manner, the small, thin, and flat plate, which is buried in the substance of the mantle of the slug, would be far removed from the large external spiral shell of the snail.

But no conchologist groups together his shells strictly and exclusively, according to their resemblances; all the testaceous productions of the Cephalopods, now that the real affinities of these mollusks are known, are arranged in the same group, notwithstanding their striking discrepancies of texture and form, and in their relative size and position to the bodies of their fabricators: so likewise with the shells or their rudiments of the air-breathing Gastropods, or of the Pteropodous Mollusca. In short, every purely conchological system must undergo modifications corresponding with the progress which is made in the knowledge of the true natural affinities of the molluscous animals; and the progress of Conchology is therefore essentially connected with that of *Malacology*, under which term an outline of the most approved classification of the Mollusca and their shells will be found.

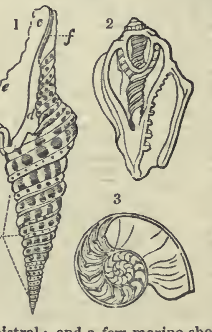
Under the present head will be briefly treated those points which relate to Conchology as a science; viz. the development, structure, configuration, and physiological subserviencies of shells.

The formation of a shell commences with the exudation of layers of albumen from the outer surface of the mantle or skin of the embryo mollusk, which is generally followed by the admixture of rhombic or prismatic crystalline particles of the carbonate of lime: and this first-formed shell of the embryo constitutes the nucleus of the shell of the mature mollusk. The nucleus is developed in most cases before the embryo quits the egg-coverings, but it is never "coeval with the first formation of the animal;" it is preceded by several distinct stages in the development of the embryo. The subsequent growth of the shell depends upon the deposition of fresh layers to the inner surface of the circumference of those previously formed; beyond which the new-formed layers extend in proportions which determine the figure of the future shell.

Sometimes the calcifying margin of the mantle extends outwards at an obtuse or right angle to the last-formed margin of the shell; and after having deposited a calcareous plate in this position, is retracted and absorbed, to be again similarly produced and extended after ordinary growth has proceeded to a certain extent. It is to this periodical growth of the mantle and plethoric condition of the calcifying vessels that the ridges on the exterior of the shell in the *Venus plicata* among Bivalves, and in the *Scalaria pretiosa* among Univalves, are due. Should the mantle, instead of being uniformly extended, send outwards a number of detached tentaculiform calcifying processes, these will form a row of spines corresponding in length and thickness to the soft parts on which they are moulded; and as the calcifying processes continue to deposit shelly material during the progress of their absorption, the spines, which were at first hollow, thus become solidified, and are soldered to the margin of the shell. This development of calcifying processes or filaments of the mantle and spines may likewise alternate with periods of the ordinary formation of the shell; and thus the exterior of the shell may become bristled with rows of spines, as in some species of *Spondylus*, and in the *Murex crassispina*.

The most simple form of shell is the cone, which may be much depressed, as in the genus *Umbrella;* or extremely elevated and contracted, as in the *Dentalium;* or of more ordinary proportions, as in the limpets (*Patellæ*). The apex of the cone is oblique and excentric; directed, in the limpets, the argonaut, and the nautilus, towards the head, but in most other mollusks towards the opposite extremity of the body. A shell may consist of one piece, as in the Inopercular Univalves; or of two pieces, as in the Opercular Univalves and most Bivalves; or of three pieces, as in *Terebratula;* or of four or more pieces, as in some of the *Pholades* and the Multivalves proper, or Chitons. With respect to the operculum, this part is sometimes calcareous, but it consists frequently of albuminous membrane only, or is *horny;* thus presenting the condition which the univalve shell itself presents in certain genera, as *Aplysia*, *Loligo*, &c.

The conical univalve shell is generally spirally convoluted; sometimes, as in the *Nautilus* (*fig.* 3.), in the same plane, more usually in an oblique direction, as in *fig.* 1 and 2. As a general rule, the spiral univalve, if viewed in the position in which its inhabitant would carry it if it were moving forwards from the observer, is twisted from the apex downwards, from left to right, the spire being directed obliquely towards the right (*a*, fig. 1., indicates the spiral turns of *Pleurotoma*). In certain genera, as *Clausilia*, *Physa*, the shell is twisted in the opposite direction: such shells are called "perverse," or sinistral. Some species of *Bulinus*, *Partula*, and *Pupa* are sinistral; and a few marine shells, as *Fusus sinistrorsus*, also exhibit the reverse of the ordinary disposition of the spire.



The part around which the spiral cone is wound is termed the "columella." This is sometimes simple, sometimes plicated, as in the *Voluta musica* (fig. 2.); it is also sometimes solid, sometimes hollow: when the latter, its aperture is termed the *umbilicus*. (*f*, fig. 1.) The opening forming the base of the spiral univalve is bounded by an inner lip *d*, and an outer lip *e*: the inner lip offers a smooth convex surface, over which the foot or locomotive disk of the mollusk glides to reach the ground.

In many Univalves, the aperture of the shell is entire; in others, it is broken by a notch, or perforated by one or more holes; or a portion of it is produced into a canal or siphon (*c*, fig.1); or it may present a pallial notch (*b*, fig.1.) opposite to the siphon). These modifications are important, on account of the constancy of their relation to certain conditions of the respiratory organs: thus the conchologist, in grouping together all the spiral univalve shells of which a part of the margin was either notched or produced into a grooved siphon, would really indicate a very natural tribe of Mollusca, every species of which he might be assured was aquatic and marine, and breathed by means of two gills having a pectinated structure, to which the water is conducted by a fleshy tube. Were a like correlation between the shell and its inhabitant to hold good in other families of Mollusca, the classification of shells

would then be a subject of much importance, and worthy the attention of the scientific naturalist: unfortunately, the reverse of this is frequently the case.

The part called the *operculum*, which is present in certain univalve mollusks, is a plate consisting of layers of sometimes calcified, sometimes uncalcified, albumen, attached to a disk at the back part of the foot, and forming, when this is retracted, a more or less perfect defence to the outlet of the shell.

Some opercula increase by the addition of matter to their entire circumference; and these are either concentric, as in *Bithynia* and *Paludina*, or excentric, as in *Ampullaria* and most of the Pectinibranchiate mollusks: other opercula grow by the addition of matter to part of their circumference; and these are either spiral or imbricated: in the latter, the layers of growth succeed each other in a linear series. No operculum presents an annular form. As the operculum sometimes varies in structure in species of the same genus, as, *e.g.*, of *Vermetus;*—since, moreover, this part is inconstant even as to its presence in species of the same genus, as in the Volutes, Cones, Mitres, and Olives; and as some genera in a natural family, as *Harpa* and *Dolium*, among the Buccinoids, are without an operculum, while the other genera of the same family possess that appendage, it obviously affords characters of very secondary importance in a scientific classification of the Univalve Mollusca. Much confusion indeed might have been introduced into the science of Malacology if the opinions of those conchologists who have proposed to classify shells from the modifications of the operculum had been much respected by naturalists.

True bivalve shells are peculiar to the Acephalous Mollusca; and their presence is constant, although they are in a few instances too small to cover the whole of the body, and in the ship-borers (*Teredo*) exist only as small instruments, limited to the function of excavating the burrows inhabited by these mollusks. But all the species in which the bivalve shell is inadequate to the protection of the whole of the body derive extrinsic defence by burrowing in sand, or stone, or wood; and they also commonly line their burrows with a layer of smooth and compact calcareous matter, forming a tube. This calcareous tube, in some cases, is of considerable size and thickness, as in the *Teredo gigantea* or *Septaria* of Lamarck. In the *Clavagella* one valve, and in the *Aspergillum* both valves, are soldered to this tube, which, in the latter, presents a peculiar modification of its exposed extremity, which resembles the end of the spout of a watering-pot. No two shells can present a greater contrast than do those of the *Placuna* and *Aspergillum;* yet the organization of their respective constructors is essentially the same. In a classification of shells, the calcareous tubes of the *Dentalium*, *Serpula*, *Aspergillum*, *Vermetus*, &c., would be associated in the same general group; but it needs only to observe how these products of animals, belonging not only to different classes, but to distinct primary divisions of the animal kingdom, are arranged in the cabinets of collectors, to be convinced that Conchology, as a classificatory science, apart from Malacology, no longer exists.

With regard to the structure and physiological relations of bivalve shells, it may be observed, first, that in all Acephalous Mollusca which breathe by distinctly developed lamellated gills (*Lamellibranchiata*), one valve corresponds to the left, the other to the right side of the animal; but in the Brachiopodous Bivalves, one valve is applied to the ventral, and the other to the dorsal aspect of the animal.

In all the Lamellibranchiate Bivalves which are free, the two valves are symmetrical, and the shell is termed *equivalve;* in all those which adhere by one of their valves to foreign bodies, this valve is deeper and larger than the unattached valve: such shells are termed *inequivalve*. Of those Acephalans which are attached to foreign bodies by means of a byssus, some, as *Tridacna*, *Saxicava*, and *Bysso-arca*, are equivalve, and both valves are notched, to form the hole for the passage of the byssus; while others, as the *Pectines*, *Aviculæ*, and *Peda*, are inequivalve, the byssus passing through a groove in the right valve.

Linnæus, who first introduced precision into the description of shells, defined several points requisite to be noticed in the outer and inner surface of a bivalve shell, but the prurient epithets, which his comparison of the bivalve selected for illustration induced him to attach to those parts, have been abandoned and changed. If the shell of the common cockle (*Cardium edule*) be examined, each valve will be seen to be produced into a conical prominence, bent towards, and nearly meeting at, that part by which the valves are joined together. These prominences are termed the *umbones*. The apex, or beak of the umbo, corresponds to the apex of the univalve shell, and is the point at which the development of the bivalve commences. When the apex is directed in the transverse plane of the shell, and so placed that a bisection of the shell in that plane through the apices shall divide the valve into two equal parts, the shell is termed *equilateral:* of this form the common scallop (*Pecten*) is an example. When, upon a similar division, a slight difference is observed in the two valves, the shell is termed *sub-equilateral;* but where the difference is well marked, it is an *inequilateral* bivalve. When the apex is bent, as is commonly the case, out of the transverse plane, it is always directed more or less towards the anterior part of the shell; if such a Bivalve shell as a *Cytherea* or *Isocardia* be held before the observer, with the umbones directed forwards and the hinge above,—in the position, in fact, in which the living animal would place itself if it were creeping forwards from the observer,—the right valve will of course correspond with the right hand of the observer, and the left with the left. (*Fig.* 4. is the left valve of a *Cytherea; a* is the upper or dorsal margin, *b* the lower or ventral margin, *c* the anterior, *d* the posterior margin, *e* the apex of the umbo, *f* the lunule.) Now, if a Bivalve in which the apices have a spiral twist, as an *Isocardia* or *Diceras*, be placed in the above position, and compared with the univalve shell of a *Concholepas* or *Purpura*, it will be seen that the left valve corresponds with the ordinary or dextral spiral Univalve, and the right valve to the perverse or sinistral Univalve. Instances, however, have been met with where the characters of the valves of the Bivalve were reversed, like the occasional exceptions in the "perverse" sinistral Univalves before mentioned.

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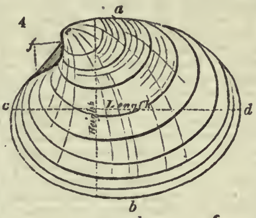

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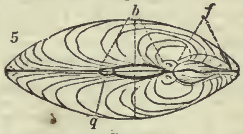

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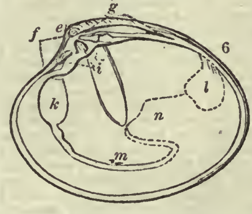


When the circumference or margin of one valve fits exactly at every part to that of its fellow, it is said to be "regular," or entire; but if it be notched at any part, so as not to come into contact with the corresponding part of the opposite valve, it is "irregular," or emarginate.

With respect to the outer surface of a Bivalve, the parts called *umbones* and *apices* have already been defined, and the upper or dorsal and anterior margins of the valve determined; if we continue our examination of the exterior surface of the Bivalve, we shall find, in most cases, anterior to the apices, a depression of variable extent and depth. This is the "lunule" (*f*, fig. 5.): it may be cordiform, or crescentic, lanceolate, oval, oblong, deep, superficial, &c. Behind the apices is another depression, longer and narrower than the lunule, and which is called the "fissure" (*g*, fig. 5.), and its margins lips. Behind the fissure there is sometimes a small depression, called the "suture" (*h*, fig. 5.). The general more or less convex surface of each valve is called the "venter," or belly, which terminates in the *limb*, circumference, or margin.

The most important part of the margin is that which is modified to form the joint or hinge upon which the two valves open and shut. This part is called the "cardinal edge," and generally presents certain prominences and depressions, the projections of one valve interlocking with the depressions of the other. The projections or "teeth," together with the cavities or "cardinal pits," are very regular in their formation in each genus and species of Bivalve. What is of more importance is, that every modification in the structure of the hinge is generally found to coincide with some recognizable and more or less important difference in the organization of the soft parts; so that conchologists have justly attached great value to the characters derivable from the hinge, especially for the purpose of generic distinctions. When the teeth are situate beneath the apex or centre of the hinge, they are called *cardinal;* when they are removed from the centre of the hinge, they are named *lateral teeth* (*i*, fig. 6.); when two only are present, one is called anterior, the other posterior; when there are three, they are distinguished respectively as the anterior, median, and posterior teeth; but when the hinge is composed of a great number of teeth, it is said to be "serial," as in *Arca*. The direct medium of union of the two valves is a dense fasciculus of elastic

albuminous fibres, generally of a brown colour, called the "ligament," or "elastic ligament." The fibres of this part are attached by their extremities to the two valves, which, in most cases, present a particular depression for their reception. The ligament is always so long as to prevent the actual closing of the valves, except when its elasticity is overcome by a certain force, as by that of the contraction of the adductor muscle or muscles: thus the inorganic power of elasticity is made the direct antagonist of a vital and muscular contraction; and as the patent condition of the bivalve shell is that which the exigencies of the animal most constantly require, it is assigned to a force which can act without ever causing fatigue, while the occasional or protective action of forcibly closing the valves is due to an action under the immediate control of the will or instinctive sensation. The modifications of the internal surface of a bivalve shell are, perhaps, the most interesting and important; as they relate immediately to the structure of the soft parts, and bespeak the general nature of the organization of the animal. Hence they afford the characters by which the habits and structure of an extinct genus may be to a great extent determined.

The adductor muscles leave well-marked impressions on the inner surface. If there be but one muscular impression on a valve, then it belongs to a "*monomyary*" or "unimuscular" Bivalve; and if neither valve of a fossil shell presenting this character have been immediately attached to foreign bodies, then the laws of co-existence warrant the inference that the constructor of such a Bivalve possessed a byssus, and the muscular organ called the foot; but that the foot was developed only to the extent adapted to serve as an instrument for moulding the soft fibres, and regulating the attachment of the byssus.

If each valve of a bivalve shell exhibit two muscular impressions, it proves the species to be "dimyary" or "bimuscular" (*k* is the anterior, and *l* the posterior muscular impression in the *Cytherea*, fig. 6.); if, moreover, there be a thin small muscular depression beneath the cardinal hinge, we have then an indication that the animal possessed a large foot, organized to serve as a locomotive or burrowing fleshy organ, the retractive muscle of which was inserted in the above depression. The line continued between the impressions of the two adductors indicates, by its depth and breadth, the development of the muscular margin of the mantle, and is called the *pallial impression* (*m*, fig. 6.). If this line be continued uninterruptedly, parallel with the margin of the valve, we may be assured that the animal was either without siphons, or had them of very small size; but if the pallial line be broken by an angular notch (*n*, fig. 6.) continued inwards before its junction with the posterior muscular impression, then it may be certainly inferred that the animal had well developed muscular tubes or siphons for respiration, with all the concomitant powers and habits. Thus the general organization of the soft and perishable fabricator of a bivalve shell may be as certainly determined by the evidence of its fossilized enduring case, as that of a vertebrate species by the structure of its skeleton. The more immediate affinities of the Bivalve are revealed by the modifications of the hinge.

It sometimes happens, however, that the whole of the internal or nacreous stratum of a fossil bivalve shell is destroyed, especially if it have been imbedded in porous chalk; and as the muscular impressions and the articular structure of the hinge are composed exclusively of the inner stratum of the shell, the means of determining the nature and affinities of the animal in that case are lost; and, unless the observer were acquainted with the texture and structure of the bivalve shell, he would run the risk of mistaking the part of a decomposed Bivalve for the whole of some nondescript "Acardian" species, as those Bivalves are termed in which the hinge is naturally wanting.

Each valve of a bivalve shell consists of two strata, distinct in texture and in their organs of formation: the internal stratum is deposited in nearly parallel layers, by the central and posterior parts of the mantle: it forms the smooth iridescent lining of the shell called "mother of pearl;" the outer stratum is secreted by the thick glandular margin of the mantle, and consists of conical fibres, resting obliquely by their apices, or narrower ends, upon the nacreous laminæ. The thickness of the two strata of the shell always preserves an inverse ratio, the outer one being thinnest at the *umbo*, and thickest at the margin; the inner one the reverse.

One hundred parts of oyster shell give—

Of carbonate of lime	98·3
Phosphate of lime	1·2
Insoluble animal matter	0·5
	100·0

Most univalve shells are composed of three strata, which consist of layers of rhombic or prismatic crystals, differently arranged in the adjoining strata. The chief difference of structure depends on the relative quantity of the animal to the earthy constituents of the shell.

Hunter discovered that the molluscous inhabitants of shells had the power of absorbing a part of the shell previously formed; a fact which has been confirmed by subsequent observers, and which gives rise, in several species, to singular modifications in the form and structure of the shell in the progress of growth. Another change of form is due to the physical decomposition or destruction of a part of a shell: this occurs to the apex of certain Univalves, after they have been evacuated by their original occupant, in the widening and lengthening the shell to accommodate it to an increase of bulk. Such shells are said to be "decollated," as in *Cerithium decollatum*, *Helix decollata*, &c. An analogous partial decomposition always obtains in many *Uniones* and *Anodontæ*, of which the "umbones" are then said to be "decorticated," the external coloured layer or bark of the shell being worn away. There is no general law or uniformity in the mode in which the inhabitants of either univalve or bivalve shells dispose of that part of their calcareous abode which they evacuate in the progress of their growth. In the decollated shells, the vacated spire is partitioned off by the formation of a thin nacreous plate; and its walls being thin and fragile, it is then broken away, as above described. In *Vermetus gigas*, the vacated portions of the tube are successively partitioned off, and a series of concave plates or septa developed; but the part of the shell thus divided into chambers, or "camerated," is retained. The *Spondylus varius*, among Bivalves, offers an analogous structure. In the pearly nautilus, the vacated portion of the shell is converted into a series of chambers by the development of calcareous septa in greater number and regularity than in any Gastropodous Univalves; and the partitions are perforated by a membranous tube or siphon, and the deserted chambers are converted, by the superaddition of this part, into a hydraulic machine, perfectly adapted to the habits and exigencies of the animal. The like structure, with various modifications, obtains in the extensive, but mostly extinct, race of "Siphoniferous" Cephalopods. In the argonaut, the vacated spire of the shell is not partitioned off, but is retained in full communication with the inhabited part, and made subservient to the reproductive economy of the species. In the *Magilus antiquus*, the posterior part of the shell, as it is deserted, is progressively filled up with a dense, solid, subtransparent crystalline deposit of carbonate of lime. A deposit of similar calcareous material, in a less degree, fills up the deserted spire of the shell in some species of *Cassis*, *Mitra*, *Triton*, &c.; and in the long "turreted" shells of the *Terebræ*, *Cerithiæ*, &c. the deposition of this dense material in the vacated apex is the preventative, instead of the cause, of decollation.

CO′NCLAVE. (Lat. con, *together*, and Gr. κλειω, *I shut up*.) The assembly of cardinals for the election of a pope. It begins the day following the funeral of the deceased pontiff. The cardinals are locked up in separate apartments, and meet once a day in the chapel of the Vatican (or other pontifical palace), where their votes, given on a slip of paper, are examined. This continues until two thirds of the votes are found to be in favour of a particular candidate. The ambassadors of France, Austria, and Spain have each the right to put in a veto against the election of one cardinal, who may be unacceptable to their respective courts.

CONCLU′SION. In Logic, that proposition which is inferred from certain former propositions, termed the premisses of the argument.

CO′NCORD. (Lat. concordia.) In Music, the relation of two sounds agreeable to the ear either in succession or consonance.

CONCO′RDANCE. (Lat.) A biblical index, in which all the leading words used in scripture are arranged alphabetically, and a reference made to the various places in which they occur, for the purpose of enabling the student to collate with facility one passage with another in the view of determining its meaning. The importance of this class of works was early appreciated, and a vast deal of labour has been expended in compiling them. Concordances have been made of the Greek Septuagint, the Greek Testament, the Latin Vulgate, and the English Old and New Testaments; a full list of which will be found in *Watt's Bibliotheca Britannica*, and in *Orme's Biblio. Biblica*. The first Concordance was compiled by Cardinal Hugues de St. Cher, who died in 1262. The best English Concordance is that of Cruden, which appeared in 1737, and still maintains its ground as an authority.

CONCO′RDAT. An agreement or convention upon ecclesiastical matters made between the Pope and some temporal sovereign, as that between Pius VII. and Bonaparte in 1802, by which the Roman Catholic religion was re-established in France; on which occasion the Pope recognized the new division of France into 60 sees, instead of the much greater number which had existed before the revolution, the payment of the clergy from the national revenues, and the appointment of the bishops by the

civil authority. Origiually the term was applied to agreements regulating mutual rights between bishops, abbots, priors, &c. The liberties of the French church were first established by the pragmatic sanctions of Saint Louis (1268), and Charles VII. (1439). In 1516 a concordat between Francis I. and Pope Leo X. divided the privileges of the church between them, and the king assumed the nomination of bishops. The states of Orleans restored their election to the chapters in 1560. The pragmatic sanctions were still considered as forming the base of ecclesiastical law in France down to the revolution.

CO'NCRETE. (Lat. concrescere, *to coalesce in one mass.*) In Architecture and Engineering, a mass composed of stone chippings or ballast cemented together through the medium of lime and sand, usually employed in making foundations where the soil is of itself too light or boggy, or otherwise insufficient for the reception of the walls. The employment of concrete in this country owes perhaps its introduction to Mr. George Semple, the engineer who erected the Essex bridge at Dublin, and who in 1776 published a Treatise on Building in Water; but there is no doubt it was well known at least to the Italian architects, if not to those of higher antiquity. The *riemputa* of Palladio, and the instructions in Alberti's 3rd Book, chap. viii., clearly point to what is now called concrete. The essential quality of concrete seems to be that the materials used should be of small dimensions, so that the cementing medium may act in every direction round them, and that the latter should on no account be more in quantity than is necessary for that purpose. Architects and engineers have much varied the proportions of lime and sand used. If the lime, which should be fresh and ground to powder, be good stone lime, such as that from Dorking, used in the neighbourhood of London, it will bear three or four times its measure by bulk of sand. These, and the ballast or gallots, as the stone chippings are called, should be thoroughly turned over and mixed together. If the foundations be wet, the mixture will want very little if any water; indeed sometimes the ballast only is wetted, and then covered over with the lime and sand. It is then filled into the barrows, and run on to be dropped from a stage into the foundations. This latter operation should be performed at as great a height as possible above the level of the trench, in order that the whole of the different particles of the composition may be compressed together so as to occupy the least possible space. The stones employed should not exceed the size of a common hen's egg. The mass very quickly sets and becomes extremely hard. On the top of it, which is kept as level as possible, a tier of what is called Yorkshire stone landings is laid, and very often throughout the lengths a chain of timber is buried in the footings, whose durability is requisite only while the work is settling; over the landings and timber thus laid, the latter, it is to be observed, occupying but a very small portion of the thickness of the footings, and quite buried in them, the walls are carried up.

CONCRETE TERM, in Logic, is so called when the notion derived from the view taken of any object is expressed with a reference to, or as in conjunction with, the object that furnished the notion; as "foolish," or "fool." When the notion is expressed without any such reference, it is called an abstract term; as "folly." (See *Whately's Logic*, p. 124.)

CONCU'SSION. (Lat. concutio, *I shake.*) A term generally applied to injuries sustained by the brain, independent of fracture of the skull, as from blows and falls. More or less insensibility, sickness, impeded respiration, and irregular pulse are the first symptoms; but these subside, and the sufferer often becomes more easy and collected; yet, although the symptoms apparently abate, dangerous inflammation may be going on, and a fatal termination ensue. In all accidents of this kind, where, as is commonly said, persons are *stunned*, the most cautious treatment should be adopted, and no time lost in obtaining skilful professional aid.

CONDENSA'TION. The rendering a body more dense, compact, or of greater specific gravity, by bringing its particles into closer union. The term is commonly applied to the conversion of vapour into fluid by distillation or otherwise. See GAS.

CONDE'NSER. An instrument for reducing an elastic fluid of a given mass into a smaller volume. The pneumatic condenser is a syringe by which a large quantity of air may be forced into a given space. It is constructed on the same principle as the air-pump; only the valves are disposed in the contrary order, that is, to open inward instead of outward.

CONDI'TION. In Law, has been defined in the most general sense, "A restraint annexed to a thing, so that by the non-performance the party shall receive loss, and by the performance advantage." It is most commonly used to signify a term whereon a grant is made: *e.g.* grant of an estate to A., on condition that the grantee shall pay such a sum on such a day, or else his estate shall cease. Conditions of this description may be implied by law: as, where tenant for life enfeoffs a stranger in fee simple, he forfeits his estate for the breach, as it is said, of the implied condition not to grant a greater estate than his own. Conditions are *precedent*, when an estate is gained on the performance of them; *subsequent*, when the condition is to be performed after the acquisition of the estate which is lost by its non-performance. But the distinctions between these two classes are numerous and minute. In general, where a condition is of such a nature that compensation can be made for its non-performance, equity will relieve the party breaking it from the consequences of the breach on making such compensation.

CONDI'TIONAL PROPOSITION, in Logic, is one which asserts the dependence of one categorical proposition on another: *e.g.* "If the wind changes, it will rain." The proposition from which the other results is termed the Antecedent; the resulting proposition the Consequent. A conditional syllogism is one in which the reasoning depends on a conditional proposition. It is of two sorts, constructive and destructive; as, 1. If A=B, then C=D; but A = B, therefore C = D. 2. If A=B, then C=D; but C is not equal to D, therefore A is not equal to B. The connection between the antecedent and consequent of a conditional proposition is termed the Consequence.

CONDOTTIE'RI. (It. *leaders.*) In Italian History, a class of mercenary adventurers in the 14th and 15th centuries, who commanded military bands, amounting to armies, on their own account, and sold their services for temporary engagements to sovereign princes and states. One of the earliest and most famous among those leaders was the Englishman Sir John Hawkwood, who commanded in various Italian wars about the time of our Edward III. The bands under command of the Condottieri were well armed and equipped. Their leaders had in many instances considerable military skill; but, as they took no interest in national contests, except to receive pecuniary advantages, the wars between them became a sort of bloodless contests, in which the only object of each party was to take as many prisoners as possible for the sake of the ransom. This singular system of warfare was only put an end to by the more serious military operations of the French, who invaded Italy under Charles VIII. Although many Condottieri acquired much honour as well as emolument, one only attained to high rank and independent power; this was Francesco Sforza, originally a peasant, who in 1451 made himself duke of Milan, and transmitted that sovereignty to his descendants.

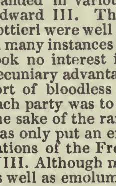
CONDU'CTOR. In Electricity. See ELECTRICITY.

CO'NDUIT. (Fr.) In Architecture, a passage of very narrow dimensions, usually subterranean, for the purpose of secret communication between apartments, many of which exist in ancient buildings. Also a pipe for the supply of water to any place.

CO'NDYLE. (Gr. κονδυλος, *a knuckle.*) The rounded head of a bone.

CONDY'LOPEDS, *Condylopoda.* (Gr. κονδυλος, and πους, *a foot.*) A name applied by Latreille to that subdivision of Encephalous articulate animals which have jointed feet: the Acephalous Cirripeds are excluded from this group, which consequently includes the Myriapods, Insects, Arachnidans, and Crustaceans.

CONE. In Geometry, a solid body, having a circle for its base, and terminating in a point, which is called its vertex. The cone may be described as follows: — Suppose a fixed point A without the plane of the circle B C D, and through the point A let a straight line A B indefinitely produced on both sides be drawn, and carried round the circumference of the circle B C D; the two surfaces A B C D and A *b c d* generated by this motion are the surfaces of two opposite or vertical cones. The circle B C D is called the *base* of the cone, and the straight line A O drawn from its vertex to the centre of the base is called its *axis*. If the axis is perpendicular to the plane of the base, the cone is said to be *right*; if the axis is inclined to the plane of the base, the cone is *oblique*. Some of the principal properties of the cone are the following:—The area or surface of a right cone, exclusive of its base, is equal to a triangle of which the base is equal to the periphery of the base of the cone, and altitude equal to the slant side of the cone; or equal to the sector of a circle whose radius is the side of the cone, and its arc equal to the circumference of the base of that solid. It is much more difficult to determine the surface of an oblique cone, which cannot be reduced to the measure of the sector of a circle. The solid contents of a cone, whether right or oblique, are equal to one third of a cylinder having the same base and altitude. The centre of gravity of a right cone is distant from the vertex $\frac{3}{4}$ of the axis. Sometimes the name cone is given to other solids than those whose surfaces are produced by the motion of a straight line about the circumference of a circle. It is applied generally to all bodies which can be formed in the same manner, assuming any curve whatever for the circumference of the base. The beautiful relation which connects the cone,



the sphere, and the cylinder, namely, that they are to each other in the proportion of 1, 2, and 3, was discovered by Archimedes.

CONE OF RAYS. In Optics, includes all the rays which fall from a luminous point, or from a single point of a luminous object, upon a given surface; for example, the object glass of a telescope.

CONFE'DERACY. (Lat. con, *together*, fœdus, *a league.*) In Politics, an alliance of independent states for a common object: sometimes also, but less properly, of individuals.

CONFEDERA'TION, THE GERMANIC, was formed at the congress of Vienna: the instrument by which it is constituted bears date June 8.1815. This union was framed to supply the want of the ancient imperial government, dissolved in 1806. The constituent members are thirty-four monarchical states and four free cities, which enter the confederation as equal and independent. The diet of plenipotentiaries, which forms the representative body of the league, is permanent, and sits at Frankfort-on-the-Maine. When this diet meets as a *general* assembly (plenum) six states, viz. Austria, Prussia, Bavaria, Saxony, Hanover, Wurtemberg, have four votes each; five other states three each; four two; the rest one; making seventy in all. But in the making of fundamental laws, admission of new members into the confederacy, and on religious questions, unanimity is required. In the *ordinary* assembly of the diet, the votes are so apportioned as to make only seventeen in all: this is the assembly in which propositions are discussed, which are decided without discussion in the plenum. This ordinary diet manages the general affairs of the confederation. Austria presides in both diets. The principal objects of the confederation are, the examination of disputes between its members; mutual protection; reciprocal assistance towards securing internal tranquillity; the establishment of constitutions of estates in all the states; the establishment of certain central courts of appeal; legal equality of Christian sects; an international community of civil rights in some points; and finally, the regulation of the condition of mediatized princes and states. *See* MEDIATIZATION.

CO'NFERENCE. In English Parliamentary usage, a meeting of certain delegated members of the two houses to discuss the provisions of a bill respecting which there is a disagreement between them; usually on the subject of amendments introduced by one and rejected by the other. The principal rules relating to conferences are, 1. That a conference must be demanded by that house which is in possession of the bill. 2. It is the privilege of the House of Lords to name the time and place at which the conference shall be holden. 3. The house which asks the conference must in its message clearly express the subject matter respecting which it is to be holden. 4. It is usual for the house desiring the conference to appoint a committee to draw up reasons to be offered in support of the measure which the house has adopted. These reasons are communicated by its managers (*i. e.* delegates) to those of the other house; and it is irregular for any member to go beyond these reasons, or to speak anything except by way of introduction to their delivery. 5. If the reasons alleged on both sides fail in producing agreement between the houses, what is termed a free conference is demanded; usually after two conferences have been holden without effect. In a free conference the managers are not tied down to follow a particular line of instructions (although they may have received such instructions from their house), but may discuss the provisions of the measure in a more liberal manner.

Conference has also been the frequent denomination of meetings of divines for ecclesiastical purposes. The conferences of Hampton Court (1604) and the Savoy (1660), between clergy of the church of England and Puritans and Presbyterians, are well known in English history. The annual meetings of Wesleyan preachers are styled conferences.

CONFE'SSION, AURI'CULAR (Lat. auricula, *ear*), is accounted by the church of Rome part of the sacrament of penance. It must be made to a priest, who is under solemn obligation not to reveal it; and must be of every mortal sin. The Roman Catholics cite several passages of scripture, particularly Matt. iii. 6., Acts xix. 18., and James v. 16., as indirectly establishing this usage; which, however, as an authorized practice of the church, does not appear to be older than about A.D. 1215. Confession is also prescribed by the Greek church. Among Protestants, the Lutherans for some time retained it; but confession to God alone is recognized in our church as preparatory to absolution. (See especially *Bingham, Orig. Eccl.* book xviii. c. 4.)

CONFESSION OF FAITH. A formulary setting forth the opinions held by a religious community. The most important documents of this nature published prior to the Reformation are the Apostles', the Nicene, and the Athanasian creeds. (See these arts.) Since that period the Romanists refer, 1. To the decrees and catechism of the council of Trent, as containing a complete exposition, accompanied by an elaborate defence, of their opinions; 2. To the Creed of Pius IV., published in 1564, which begins with a statement of the Nicene creed, and proceeds to declare briefly and explicitly the additional tenets of the Romish church; 3. The exposition of the Catholic faith by Bossuet, as having been sanctioned by the Pope, is considered of secondary authority.

The most authentic symbol of the Greek church is that which was drawn up in 1642 by Mogila, the metropolitan of Kiow. It was approved with great solemnity by the patriarchs and principal clergy of that communion.

The reformed churches have in almost all cases drawn up summaries of their peculiar tenets, and require their ministers to express their assent to them. The church of England requires subscription upon ordination to the Thirty-nine Articles, and the three articles of the 36th Canon which relate to the supremacy of the King, &c. The Book of Common Prayer and the Homilies are also authorized statements of the doctrine of this community.

The symbolic books of the Lutheran church are numerous: the principal are, the Confession of Augsburgh, drawn up by Melanchthon in 1530; the articles of Smalcald by Luther (1538); the Great and Little Catechisms of Luther (1529); and the Form of Concord (1579). The original symbol of the Scotch church is called the General Confession of the true Christian Faith, which was adopted by the King and nation, together with the Solemn League and Covenant, in 1581. A second was drawn up in 1660 by some of the principal ministers, in consequence of an order in parliament for that purpose. The Confession of the Westminster Assembly (in 1643) was declared in 1690 by an act of parliament to be the national standard of faith in Scotland.

In this country the imposition of formularies for subscription which are conceived in other than the words of scripture has frequently been made a ground of dissent and separation from the English church. The Presbyterians also and Independents have suffered many secessions upon this ground, which is maintained as a clear deduction from the Protestant principle of the right of private interpretation. It may be answered, that a church, like the Romish, which forbids private interpretation, might reasonably enough express its belief in the words of scripture, the meaning of which in its mouth would be sufficiently intelligible; but that a Protestant church, on the contrary, must paraphrase the language of the Bible to make itself understood, and that its alternative must be between a confession of this nature and none at all; and the impracticability of the latter course has been shown by the experience of several minor sects in this country and elsewhere.

CO'NFESSOR. (In Greek, ὁμολογητης.) In Ecclesiastical History, the title given to those who have undergone persecution for Christianity short of death. They were peculiarly honoured in the primitive church, together with the memory of those who had actually suffered (martyrs). *Cyprian*, Epist. 37. (See *Giescler's Eccl. Hist.* 1st Period, 2nd Division, ch. 3.)

CONFI'GURATION. In Astronomy, denotes the position which the planets occupy relatively to each other.

CONFIRMA'TION. The laying on of hands by the bishop, for the conferring of the grace of the Holy Spirit; a rite by which a person arrived at years of discretion takes upon himself the performance of the baptismal vow made for him by his sponsors. This ceremony is derived from the practice of the Apostles, of whom we read (Acts, viii. 16. xix. 16.) that after certain disciples at Samaria and Ephesus had been baptized, they laid their hands upon them, and the Holy Ghost came upon them. The descent of the Holy Ghost upon the Apostles themselves on the day of Pentecost is considered also as an example of confirmation succeeding baptism. In the early ages this ceremony seems to have been accompanied very generally with the unction of the forehead. This ceremony is retained by the Roman Catholics, who consider confirmation a sacrament.

CO'NFLICT OF LAWS. The opposition between the municipal laws of different countries, in the case of an individual who may have acquired rights or become subject to duties within the limits of more than one state. In the language of Mr. Burge (*Colonial and Foreign Law*, i. 5.), "the right or claim which is in contestation before a judicial tribunal may present a conflict between the laws of the country in which he was born, or had a domicile, or had taken up a temporary residence, or in which his property, the subject of the claim, was situated, or in which the act, instrument, or testament on which the claim is founded was executed, or in which the contestation takes place. In this conflict of laws it becomes an important branch of jurisprudence to ascertain which should be selected, and the principles on which the selection is to be made." The following are among the principal works on this subject: — *Rodenburg on the Conflict of Statutes*, an Essay appended to his treatise *De Jure Conjugum*; *Hortius, De Collisione Legum*; *Boullenois, De la Personnalité et de la Réalité des Lois*; the

American judge Story's treatise on the *Conflict of Laws;* and the above cited work of Mr. Burge, *Commentaries on Colonial and Foreign Laws generally, in their Conflict with each other and with the Law of England,* 4 vols. 8vo. Lond. 1837.

CO'NFLUENT. (Lat. confluens, *flowing together.*) Running together. Applied to eruptive diseases in which the pimples or pustules are not detached, but so numerous as to form confluent patches, or even to cover the whole surface of the body; hence the term *confluent small-pox.*

CONFO'RMITY, OCCASIONAL. The participation of one in any of the observances (more particularly sacraments) of a church from which he dissents. Much controversy existed among the English Dissenters, especially in the reign of Queen Anne, with respect to the lawfulness of occasional conformity.

CONGE'. (Fr.) In Architecture the same sort of moulding as the echinus or quarter-round; also a term used for the cavetto; the former being called the swelling congé, the latter the hollow congé.

CONGE' D'ELIRE. (Fr. *leave to choose.*) The king's writ or license to the dean and chapter to choose a bishop in the time of vacancy of the see; a mere formal proceeding.

CO'NGENERS. Species belonging to the same genus.

CONGE'STION. When there is an unnatural accumulation of blood in the capillary vessels of any part of the sanguiferous system, the organ in which it takes place, and the functions of which are disturbed, is said to suffer under *congestion:* it induces a morbid condition of the vessels of the part affected, which when once established is difficult of removal. Congestion of the brain, liver, or lungs is a frequent effect of fevers, though generally consequent upon a previous morbid condition of the organs.

CONGLO'MERATE. (Lat. conglomero, *I keep together.*) In Anatomy, glands which are made up of many small glands, the ducts of which unite into one, as the salivary glands, are so called. In Botany, the term is applied to flowers closely compacted upon one footstalk.

CONGLOMERATE. In Geology, a rock composed of pebbles cemented together by another mineral substance, either calcareous, silicious, or argillaceous.

CONGREGA'TION. (Lat. congrego, from con, *together*, and grex, *a flock.*) At Oxford and Cambridge the assembly of masters and doctors is so called, in which the ordinary business of giving degrees, &c. is transacted.

CONGREGATION. In Ecclesiastical language, properly an assembly of the people for the purpose of divine worship. Companies of religious persons, forming subdivisions of monastic orders, are styled in the church of Rome congregations. For an account of the congregations of cardinals at Rome, a species of committees for the transaction of business of the see of Rome, see *Enc. Metropol.* art. "Congregation." The "Congregation of the Lord" was an appellation assumed by the first Scotch Presbyterian Dissenters, in contradistinction to the Church of England, which they styled the "Congregation of Satan." They first came into notice in 1557, under the Duke of Argyle, and were at a later period led by John Knox.

CO'NGREGA'TIONALI'STS. A sect of Protestant Dissenters, who arose in this country as early as the reign of Queen Elizabeth, when Robert Brown maintained that every society of Christians meeting in one place for religious worship under its own laws and ministers formed a legitimate and independent congregation. The Congregationalists have been called from their founder Brownists, and in later times Independents. They form a powerful body in England, and are very numerous in America. Each congregation appoints its own ministers by vote, and can remove them at pleasure, and reduce them to the rank of laymen. They believe in the Trinity, predestination, total depravity, particular redemption, effectual grace and final perseverance; and maintain that every congregation of visible saints furnished with a pastor is under no other ecclesiastical jurisdiction whatever. (See *Neale's Hist. Puritans.*) The number of Independent congregations in England and Wales was stated in 1836 to be about 1840. (*M'Culloch's Statistical Account of the Br. Empire.*)

CO'NGRESS. (Lat. congredior, *I go together.*) In Politics, a meeting of the sovereigns of states, or their representatives, for the purpose of arranging international matters. The first general European congress was after the conclusion of the thirty years' war in Germany, at Münster and Osnabrück, 1648, which was followed by the peace of Westphalia. Remarkable general congresses have been — 1. of the Pyrenees, 1659; 2. of Aix-la-Chapelle, 1668; 3. Nimeguen, 1676; 4. Ryswick, 1697; 5. Utrecht, 1713; 6. Aix-la-Chapelle, 1748; 7. Teschen, 1779; 8. Paris, 1782; 9. Versailles, 1785; 10. the Hague, 1790; 11. Rastadt, 1797; 12. Erfurt, 1808; 13. Vienna, 1814, concluded at Paris, 1815; 14. Aix-la-Chapelle, 1818; 15. Troppau, 1820; 16. Laybach, 1821; 17. Verona, 1822.

CONGRESS is also the title of the national legislature of the United States of America. It consists of a house of representatives, and of a senate. The former is composed of members chosen every second year. The qualification of electors is the same with that required in their respective states for electors to the lower house in the state legislature. The number of representatives is apportioned according to the population of each state, and is altered every ten years, when the census is taken by authority. In making this estimate, the slave population is reckoned only at three fifths of its amount. There cannot be more than one representative for 30,000 free persons. The senate is composed of two members from each state: the senators are chosen for six years by the legislature of the state. The house of representatives chooses its own speaker: the vice-president of the United States is, ex officio, president of the senate. Bills for revenue purposes must originate in the house of representatives; but are liable to the proposal of amendments by the senate. The senate has the sole power of trying impeachments; but can only convict by a majority of two thirds of the members present, and its sentence extends only to removal from office and incapacitation for holding it. The regular meeting of congress is on the first Monday in December annually. Every bill which passes the two houses is sent to the president for approval or disapproval; in the latter case, he returns it, with his reasons, to the house in which it originated: if, on reconsideration, it is passed again by a majority of two thirds in each house, it becomes law. The powers of congress are strictly limited, and separated from those of the various state legislatures, by the constitution.

CO'NIC SE'CTIONS. In Geometry, lines formed by the intersections of a plane with the surface of a cone, which assume different forms, and acquire different properties, according to the different positions of the plane in respect of the axis of the cone. There are five species: —

1. If the cone be cut by a plane passing through its vertex, the common intersection of the conical superficies and the plane will be two straight lines meeting in the vertex.

2. If the intersecting plane be parallel to the base, or, in the case of the oblique or scalene cone, if it be so situated as to cut off from the vertex a cone similar to the original cone, the section will be a circle.

3. If the intersecting plane be parallel to a plane which touches the cone, the section will be a parabola.

4. If the intersecting plane pass through both sides of the cone, and is neither parallel to the base nor to the plane of a subcontrary section, the section will be an ellipse.

5. If the intersecting plane have such a position that, when produced, it meets the opposite cone, the section is a hyperbola.

These five are the only lines which can be formed by the common intersection of a plane and the surface of a cone, and they all equally arise from that intersection; but as the straight line and the circle form the peculiar subject of elementary geometry, their properties are usually treated apart; and the three last, namely, the parabola, the ellipse, and the hyperbola, considered as the curves especially designated by the term *Conic Sections.*

Some of the principal and distinctive properties of the curves are easily deduced from this mode of generation.

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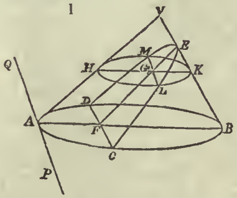

Let V A C B be the cone, and C D E the section made by a plane parallel to the plane which touches the cone in the line VA; then, by the definition, C E D is a parabola. Now let P Q be the intersection of the plane which touches the cone in V A with the plane of the base A C B; then P Q being a tangent to the circle A C B D, is perpendicular to A B, the diameter of that circle, and consequently C D, which is parallel to P Q, is also perpendicular to A B; therefore C F is equal to F D. In F E take any point G, through which let there pass a plane H L K, parallel to the base A C B, intersecting the plane C E D in the straight line L G M; then L M will be parallel to C D, and perpendicular to H K, and L G equal to G M. We have therefore, from the property of the circle, $CF^2 = AF \cdot FB$, and $LG^2 = HG \cdot GK$; therefore since by reason of the parallels V A and E F the line A F is equal H G, $CF^2 : LG^2 :: FB : GK$. But $FB : GK :: EF : EG$; therefore $CF^2 : LG^2 :: EF : EG$; consequently, since C F and E F are constant quantities, the ratio of LG^2 to E G (or of LM^2 to E G) is constant; whence we infer that in the parabola the square of any ordinate L G is equal to the rectangle of the corresponding absciss E G into a constant quantity. From this all the other properties of the curve may be deduced. It is in fact the common equation of the parabola. *See* PARABOLA.

For the ellipse and hyperbola, let E M F L be the section; through V draw a plane parallel to E M F L, and

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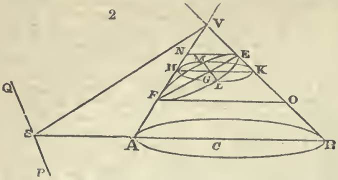

let P Q be its intersection with the plane of the base. Through C, the centre of the base, draw C S perpendicular to P Q, meeting the base in A and B. Let E F be the intersection of the plane E L M with the plane A V B, which passes through the axis of the cone; and in E F take any point G, through which let a plane H M K L be drawn parallel to the plane of the base, the line L M being its intersection with the plane E L M. Lastly, through the points E and F let E N and F O be drawn, meeting the opposite sides of the cone in N and O. Because of the similar triangles, we

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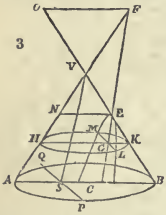

have E G : G K : : E F : F O,
and F G : G H : : F E : E N,
therefore E G·G F : G K·G H : : E F^2 : F O·E N.

Now E F^2 and the rectangle F O·E N are constant quantities, independent of the position of the point G; and G K·G H = G L^2 (L M being parallel to P Q, and therefore perpendicular to H K); consequently the rectangle E G·G F is to the square of G L in a constant ratio. This property furnishes an equation to the ellipse and hyperbola, from which all the properties of those curves may be deduced. *See* ELLIPSE and HYPERBOLA.

The mutual relations of all the curves to each other may be rendered sensible by supposing the plane V P Q to revolve about an axis passing through V parallel to P Q, and the intersecting plane E M L to accompany it in its revolution, always maintaining its parallelism. Suppose the revolution to commence when the plane V P Q is parallel to the base; in this position the intersection of the cone with E M L is a circle. When V P Q changes its position, and becomes inclined to the plane of the base, the section E M F L (*fig.* 2.) becomes an ellipse. As the plane V P Q continues to revolve, the ellipse becomes more and more elongated, till at length P Q touches the plane of the base (*fig.* 1.), when the curve, instead of returning into itself, exhibits two infinite branches, and passes into the parabola. The revolution continuing, the line P Q falls within the base of the cone (*fig.* 3.); the section E M L still presents infinite branches, but its axis E G now meets the opposite cone in F, the vertex of another section entirely similar and equal to E M L; whence the hyperbola has two pairs of branches, which, from the opposite cones, are called opposite hyperbolas. Suppose that in this position (while P Q falls within the base) the distance between the two planes V P Q and E M L is diminished; as the distance diminishes the curvature of the hyperbolic branches will also diminish; and when the distance vanishes the curvature vanishes, and the two branches pass into a system of two straight lines intersecting each other in the apex of the cone.

The sections of the cone were first studied by the geometricians of the school of Plato. They admitted, however, only the right cone into their geometry; and they supposed the section to be formed by a plane perpendicular to its side. Consequently the three sections were formed from three different cones, the angles at the vertex being right, acute, or obtuse. The parabola was produced from a right-angled cone, the ellipse from an acute-angled cone, and the hyperbola from an obtuse cone. Apollonius of Perga, according to Eutocius, was the first who showed that the three sections may be obtained from every cone, whether right or oblique, and whatever the the angle of its apex, the species of the curve depending on the different inclinations of the plane of the section to the cone itself. It has, however, been established that Archimedes, who flourished about forty years prior to Apollonius, was acquainted with the fact that the three sections may be derived from the same cone. Pappus, in his Mathematical Collections, ascribes to Apollonius the names by which the three sections are designated: the term *Parabola*, however, occurs in the writings of Archimedes.

Although the three curves were first noticed as resulting from the sections of the cone, they still decidedly belong to plane geometry; and their genesis may be defined, and all their properties investigated, without having any reference whatever to the solid. Accordingly many geometers, in modern times, have treated the curves as generated by the motion of points on a plane; and this method has undoubtedly the advantage of relieving the student from the difficulty of conceiving the positions and intersections of different planes, and following out the relations of the lines drawn on them, which become so complicated when represented on the same surface. Dr. Wallis of Oxford, and the celebrated De Witt, seem to have been the first who adopted this method, which has been followed by Dechales, De La Hire, Boscovich, Dr. Simson, and many others. The ancient mode of defining them from the sections of the cone is seldom adopted in the recent treatises.

Various definitions of the curves *in plano* have been proposed. The parabola is usually defined from this property, that the distance of any point in the curve from the focus is the same as its distance from the directrix. For the ellipse and hyperbola the property which has been most generally assumed as the definition is, that if any point be taken in the curve, and straight lines be drawn from it to the two foci, the sum of those lines in the case of the ellipse, and their difference in the case of the hyperbola, is a constant quantity. This property seems to have been chosen rather from considerations respecting the facility of the description of the curves by mechanical means, than from any peculiar advantage which it affords for the investigation of their other properties. It does not indicate the relationship of the three curves, and is in fact not applicable to the parabola, which has only one focus. On this account Boscovich selected a property which gives a definition applicable alike to all the three sections, and from which the general properties common to all of them are established by the same demonstration. It is this — a point and a straight line being given by position on a plane, another point which moves in such a manner in the same plane that its distance from the given point has to its distance from the given straight line a constant ratio, describes a conic section. When the constant ratio is a ratio of equality, the curve traced out by the moving point is a parabola; when a ratio of minority the curve is an ellipse, and when a ratio of majority an hyperbola. This general definition of the conic sections has also been adopted by Thomas Newton, Walker of Nottingham, and Professor Leslie, in their respective treatises.

The different properties of the conic sections may also be investigated by the modern algebraic analysis; and as all the curves are derived from the same cone, so all their equations are included in one general equation, of the second degree, between two variables. The equation of the second degree between the two variables x and y, in its most general form, is

$$A y^2 + B x y + C x^2 + D y + E x + F = 0,$$

which, by assigning certain values to the constant coefficients A, B, C, D, E, F, or assuming certain relations to exist among them, becomes the equation of an ellipse, an hyperbola, a parabola, a circle, or that of a system of two straight lines; and it may be demonstrated that whatever be the values of the coefficients, it can only express one or other of those curves. See *Biot's Essai de Géometrie Analytique; Hamilton's Analytical System of the Conic Sections;* or the *Traité Analytique des Sections Coniques, &c.* by the Marquis de l'Hopital.

The conic sections have acquired a remarkable interest in modern times on account of their use in natural philosophy and astronomy. A body projected in space, and urged by a central force which varies inversely as the square of the distance, must describe a conic section; and all the planets move in ellipses about the sun. The knowledge of the properties of the ellipse doubtlessly facilitated the discovery of the true nature of the planetary orbits; and hence it has been said, with some appearance of truth, that to the seemingly barren speculations of the Greeks relative to the sections of the cone we are indebted for the sublime theories of Kepler and Newton. A considerable number of the most interesting properties of the curves are demonstrated in the first Book of the *Principia*, where Newton has considered the method of solving this problem — Straight lines and points being given by position on a plane, to describe a conic section which shall pass through the given points and touch the given straight lines.

Treatises on the conic sections are exceedingly numerous; in fact there is no part of the mathematics which has been more studied by geometricians, both ancient and modern, than the properties of these curves. To the ancients they furnished an excellent field for the exercise of their elegant geometrical analysis; and the more difficult investigations of series for their quadrature and rectification have given occasion to some of the most elegant applications of the modern calculus. The following are some of the principal geometrical treatises — *Apollonii Pergæi Conicorum Libri Octo*, &c., Oxford,

1710, by Dr. Halley; Viviani's two works — 1. *De Maximis et Minimis Geometrica Divinatio*, 2. *De Locis Solidis Secunda Divinatio Geometrica; De La Hire's Sectiones Conicæ*, Paris, 1685; *Hamilton, De Sectionibus Conicis Tractatus Geometricus*, Dublin, 1758; *Simson's Treatise*, in Latin and English; *Robertson's* ditto; *A short Treatise on the Conic Sections*, by the Rev. T. Newton, Cambridge, 1794; *Walker's Treatise*, London, 1794; *Leslie's Treatise on Lines of the Second Order; A Geometrical Treatise on the Conic Sections* by Professor Wallace, Edinburgh, 1837, &c. &c.

CONI'DIA. (Gr. κονις, *dust*.) A term sometimes used in describing lichens, to denote the bodies which constitute the powdery matter called *soredia*, lying upon the surface of the thalli. By others they are called the *propagula*.

CONI'FERÆ. (Lat.) In Botany, a natural order of arborescent or shrubby Gymnosperms, inhabiting most parts of the world, and usually both resinous and evergreen. Their real organization was, for a long period, but little understood, until Brown discovered that the ovules of the entire order are naked. No other race of plants can be named of more importance to mankind than this, — first, for their resinous secretions, as turpentine, pitch, Canada balsam, &c.; and secondly, for their timber, which is used under the names of fir, pine, deal, cedar, sandarach, and many others. All the kinds of fir, cedar, juniper, pine, savin, cypress, and arbor vitæ, are species of genera belonging to this order, which appears from geological evidence to have existed in great abundance among the earliest vegetation that clothed the surface of our planet.

CONIRO'STERS, *Conirostres*. (Lat. conus, *a cone*, and rostrum, *a beak*.) A tribe of Insessorial birds or perchers, including those which have a thick robust conical beak, as the crows and finches.

CONISTE'RIUM. (Gr. κονιστηριον.) In Ancient Architecture, a room in the gymnasium and palæstra, wherein the wrestlers, having been anointed with oil, were sprinkled over with dust, that they might lay firmer hold of their antagonists.

CO'NITE. (Gr. κονις, *powder*.) A silicious carbonate of lime, found associated with certain zeolites, in the form of a white powder.

CONJOINT DEGREES. In Music, a term used of two or more notes which immediately follow each other in the order of the scale.

CONJOINT TETRACHORDS. In Music, two tetrachords or fourths, in which the same note is the highest of one and the lowest of the other.

CONJUGA'TION. (Lat.) In Grammar, is to verbs what *declension* is to substantives — the sum total of the inflexions which they admit, corresponding to the various circumstances of time or mood under which an action is conceived to take place.

CONJU'NCTION. In Grammar, that part of speech which expresses the relation of propositions or judgments to each other. *See* GRAMMAR.

CONJU'NCTIVE MOOD. That modification of the verb which expresses the dependence of the event intended on certain conditions. *See* GRAMMAR.

CONNARA'CEÆ. (Connarus, one of the genera.) In Botany, a natural order of shrubby or arborescent Exogens inhabiting the tropics, and only distinguished with certainty from *Leguminosæ* by the radicle being remote from the hilum: they approximate very closely to the Cæsalpineous section of *Leguminosæ*; but their want of stipules and regular flowers will usually be sufficient to distinguish them from the great mass of the Papilionaceous section.

CONNI'VENT. (Lat. conniveo, *I wink*.) A term used figuratively by botanists in describing the direction of organs, to denote a gradual inward direction, as in many petals. It is the same as converging.

In Anatomy, the term is applied to those valvular folds of the lining membrane of canals which are so disposed as to retard, while at the same time they permit, and, as it were, connive at, the passage of the contents of such canals as the "valvulæ conniventes" in the human intestine.

CO'NNOISSEU'R. (Fr. connoitre, *to know*.) In the Fine Arts, one who is versed in a knowledge of the fine arts. His qualifications are so numerous, that very few sound connoisseurs have appeared; and in nine cases out of ten these come under the description of a well-known Italian author of being "conoscitori senza cognizione."

CONOHE'LIX. A genus of shells, intermediate beween the *Cones* and *Volutes*.

CO'NOPS. (Gr. κωνωψ, *a gnat*.) A Linnæan genus of Dipterous insects, characterized by having an elongated, slender, pointed proboscis. It is at present subdivided into the genera *Bucentes*, *Prosena* and *Stomoxys*, *Myopa*, *Zodion*, and *Conops* proper: the larvæ of the latter subgenus are developed within the abdominal cavity of the humble bees, and other Hymenoptera.

CONSCIENCE, COURTS OF, and of REQUESTS, are courts for the recovery of small debts. The jurisdiction of these courts in London and other places arises out of various statutes, beginning with 1 J. I. c. 14., their original appointment having been by order in council under Henry VIII. The jurisdiction of the London Court of Conscience is extended by 39 & 40 G. III. c. 104. to the recovery of debts not exceeding 5*l*., and in Southwark and many other places by subsequent statutes.

CO'NSCRIPT. (Lat. conscribo, *I enroll together with others*.) *Patres Conscripti*, or *Fathers Conscript*, A title of the Roman senators; properly of those who were added to the senate subsequently to the expulsion of the kings.

CONSCRI'PTION. The compulsory enrolment of individuals for military or maritime service, taken from the population at large. The conscription, in the Roman commonwealth, was made not by lot, but by arbitrary selection by the consuls from among the bulk of the citizens when a levy was required. In France the conscription was established during the revolution, before which period the armies of that country had been recruited by voluntary enlistment. The word is first used in a law of 1798. According to the law as at present established, all citizens are liable to the conscription at the age of twenty. Each arrondissement has its contingent allotted to it out of the total number required for the service, and this number is filled up by lot from the youths liable to the conscription. There are, however, various claims for exemption recognised by the law. The legal duration of the service is seven years.

CONSECRA'TION. (Lat. sacer, *holy*.) The act of setting apart a person or thing to the service or worship of God: thus a newly built church is consecrated with certain ceremonies, varying in different communities. The admission of a bishop to his office is called his consecration.

CONSE'NTIAN GODS. A term by which the Latins distinguished their twelve chief deities — Juno, Vesta, Minerva, Ceres, Diana, Venus, Mars, Mercury, Jupiter, Neptune, Vulcan, and Apollo. The origin of these deities was Italian, and distinct from those of the Greeks; but as the literature of Rome took its tone and colour from Greece, so its mythology was mixed up with that of the latter country, those deities whose functions most resembled each other being confounded, till the above names became regarded as nothing more than the Latin appellations of the Greek divinities.

CONSE'RVATORY. In Horticulture, is a glazed structure, in which exotic trees and shrubs are grown in a bed or floor of soil. It is distinguished from an orangery by its having a glazed roof, while that of the latter is opaque; and from a greenhouse by the plants being planted in the free soil, and thus growing up from the floor, while in the greenhouse the plants are grown in pots placed on shelves, or on a stage or series of shelves, rising one above another. Above a century ago, for example, in the time of Evelyn, the term conservatory was applied to those garden buildings now called orangeries, and in modern horticulture employed only for the preservation of exotic plants, such as orange trees, &c., which are in a dormant state during winter. The greenhouse and the modern conservatory were then not in existence. They are exclusively employed for the preservation of plants which are in a growing state during winter. The largest conservatory in the world, at the present time (1841), is that erected at Chatsworth in Derbyshire, for palms and other tropical plants, which covers above an acre of ground, and is sixty feet high. There are very handsome conservatories for Cape and Australian plants at Alton Towers, and other places.

CONSIDERA'TION. In Law, is the material cause of a contract, without which it is not binding on the party. Consideration is said to be either expressed or implied. An express consideration is where the motive or inducement of the parties to the contract is distinctly declared by its terms; as where a man bargains to sell his land for 100*l*. It is implied, where an act is done, or a legal demand forborne, at the request of another, without an express stipulation: in which case, the law presumes an adequate compensation for the act or forbearance to have been the inducement of the one party, and the offer of the other; as where a person comes to an inn and makes use of it, intention to pay for the accommodation is presumed. Consideration is also either "valuable," that is, for money or an equivalent; or it is "of natural affection," certain degrees of relationship affording in some cases sufficient consideration for a gift.

CONSI'STORY. (Lat. consistorium, said to have been the private councillors of the Roman emperors.) An assembly of ecclesiastical persons; also certain spiritual courts are so called which are holden by the bishops in each diocese. At Rome the consistory denotes the judicial court constituted by the college of cardinals. The representative body of the reformed church in France is styled Consistory; a title and assembly originated by Calvin. There is now, or should be, according to law, a consistory for every 6000 Protestant souls, consisting of the pastor or pastors, and from 6 to 12 elders. The consistory names the pastor. There are now 88 reformed

consistories in France (not including the Lutheran churches).

CONSI'STORY COURT. The chancellor of every archbishop and bishop is the judge of this court in England, and a commissary is appointed for places remote from the consistory. *See* ECCLESIASTICAL COURTS.

CO'NSOLE. (Ital.) *See* ANCONES.

CONSO'LIDATED FUND. Down to 1816, the exchequers of Great Britain and Ireland were kept separate, certain portions of the public revenue arising in each kingdom being especially appropriated to the discharge of the interest on its own debts, and other peculiar purposes. But on January 5th, 1816, the separate exchequers were consolidated into one; and an act was at the same time passed consolidating certain portions of the joint revenue of Great Britain and Ireland into one fund, hence called the Consolidated Fund, and providing for its indiscriminate application to the payment of the public debts, civil lists, and other specified expenses of both kingdoms. Some portions of revenue are not included in this fund; but it embraces by far the largest part of the public income. Thus, in 1838, of a total nett income of 47,333,460*l.*, the consolidated fund included no less than 44,144,438*l.*: the expenditure on account of the peculiar charges to be defrayed by the fund during the same year amounted to 31,742,918*l.*, leaving a surplus of 12,401,570*l.* applicable to other objects. (*Fairman on the Funds*, 7th ed. p. 196.; *Parl. Paper*, No. 149. Sess. 1839, &c.)

CO'NSONANCE. (Lat. consonans, *sounding together*.) In Music, the agreement of two sounds simultaneously produced, the one grave and the other acute.

CONSONANT. *See* LETTER, VOWEL.

CO'N SORDI'NI. (Ital.) In Music, a direction to perform the passage, if on a pianoforte, with the dampers down, or on a violin with the mute on; it is usually written short, C. S.

CONSPIRACY. (Lat. conspiratio, *agreement*.) In Law, is in the strictest sense an agreement of two or more persons falsely to indict one, or procure him to be indicted, for felony; who, after acquittal, may have his writ of conspiracy. In a more general sense, many species of combinations to injure another are termed conspiracies; as to procure one to be arrested, to defraud under certain circumstances, &c. Conspiracy is an indictable offence; and two at least of the persons indicted must be found guilty to produce a conviction, as otherwise the offence is not proved against any one. Combinations of workmen to regulate the rate of wages, prior to the 6 G. 4. c. 129., were commmonly termed conspiracies.

CO'NSTABLE. A high officer in the monarchical establishments of the middle ages. (Lat. comes stabuli, *count of the stable*.) In France, the first dignitary under the crown, commander-in-chief and supreme military judge. In that country the office was abolished in 1627, as conferring powers too dangerous in the hands of a subject. In England the last permanent lord high constable was Edward Stafford, Duke of Buckingham, whose office was forfeited to the crown by his attainder in 1522; since which time it has only been occasionally conferred on particular emergencies. The title is supposed to have originated in the Lower Empire. (*Ducange*, *Gloss.*)

CONSTABLE. A constable is an officer particularly charged with the preservation of the peace, either within the hundred, where he is called high constable, or within the parish or tything, where he is called petty constable, and where he has generally superseded the tything-man. The duties of the high constable respecting the preservation of the peace are now merely nominal; but he is still of use to represent the hundred in certain legal actions, and to perform certain ministerial offices connected with the administration of justice, as, for instance, the return of jurors, which originally devolved upon the bailiff of the hundred. The functions of petty constable are still of great and daily importance. It is his business, in the first place, to interfere upon his own authority, and if necessary by apprehension of the offender, whenever a breach of the peace or other more serious offence is committed in his presence, or whenever he has sufficient information of a felony; and, in the next place, to execute all such warrants apparently and upon the face of them legal as shall be committed to his hands by competent authorities. He has a right, when impeded in the execution of his duty, to call upon bystanders for assistance, and has the power in case of sickness or disability to appoint a deputy to execute warrants in his stead. Constables were anciently appointed, and still might legally be so, by the jury of the leet; but high constables are now appointed either at quarter sessions or by the justices of the hundred out of sessions, and petty constables are annually sworn in to the office at quarter sessions for each parish upon presentment of the vestry; and the person so presented is compellable under the penalty of fine and imprisonment, except in recognized cases of disability or exemption, to serve the office. A *special* constable is a person appointed to act as constable upon a particular occasion; and any two magistrates have, in case either of actual or apprehended riot, the power of calling upon all persons who would be liable to serve as petty constables to act as special constables, and their refusal is punishable in the same manner as in the case of the former office. Constables are frequently appointed in pursuance of particular acts of parliament, as the police constables in London. (*Burn's Justice*, tit. "Constable;" *Viner's Abridgment.*)

CONSTELLA'TION. (Lat. con, *together*; stella, *a star*.) In order to distinguish with greater facility the different stars, it has been the practice of observers, from time immemorial, to separate them into groups or clusters, which have received the name of *constellations*, and been represented by the figures of men or animals, or other sensible objects to which they were fancied to have some resemblance. Hipparchus called them *Asterisms*; Aristotle and Hyginus, *Bodies*; Proclus, *Animals*; others, *Meteors*; but the term Constellation has been long established by general usage. The origin of these figures and names is involved in impenetrable obscurity. By most authors the twelve constellations of the zodiac are supposed to have been established about 1700 years before our era, either by the Egyptians or the Chaldeans. Dupuis supposes them to have had an incomparably more ancient origin, and that their names are significative of the climate of Egypt at the epoch when the solstice was in Capricorn; that is, about 15,000 before Christ. But even on this hypothesis, namely, that the names of the zodiacal constellations, or *signs*, as they are frequently called, are significative of the seasons, it may be supposed that reference was made to the sign opposite to the sun, instead of that which the sun occupied; in which case the origin of the names would be referable to an epoch preceding our era by about 2000 or 3000 years. This arises from the motion of the equinoctial points, which regress or go backward annually among the stars, accomplishing half a revolution in about 12,500 years.

Hipparchus was the first who constructed a catalogue of the stars from exact observations. It has been preserved to our own times in the *Almagest* of Ptolemy, and contains 1022 stars, distributed among 48 constellations; namely, 12 in the zodiac, 21 to the north of the zodiac, and 15 to the south. Stars which were not comprehended in any of the constellations (and it is evident that there must be many such) were called by a Greek term signifying *unformed*; that is, not entering into the *forms* of the constellations. Several have been added in modern times, as the stars of the southern heavens became better known. A much better idea may be formed of the figures and relative positions of the constellations by inspecting a common celestial globe, than from any description, however detailed.

The 48 constellations of Hipparchus are as follows:—

In the zodiac 12 — *Aries*, *Taurus*, *Gemini*, *Cancer*, *Leo*, *Virgo*, *Libra*, *Scorpio*, *Sagittarius*, *Capricornus*, *Aquarius*, *Pisces*.

In the northern hemisphere 21 — *Ursa Minor* (the Little Bear), *Ursa Major* (the Great Bear), *Draco* (the Dragon), *Cepheus*, *Bootes*, *Corona Borealis*, *Hercules*, *Lyra*, *Cygnus* (the Swan), *Cassiopeia*, *Perseus*, *Auriga* (the Waggoner), *Ophiucus* or *Serpentarius*, *Serpens*, *Sagitta* (the Arrow), *Aquila* (the Eagle), *Delphinus* (the Dolphin), *Equuleus* (the Horse's Head), *Pegasus*, *Andromeda*, *Triangulum* (the Triangle).

In the southern hemisphere 15 — *Cetus* (the Whale), *Orion*, *Eridanus*, *Lepus* (the Hare), *Canis Major* (the Great Dog), *Canis Minor* (the Little Dog), *Argo* (the Ship), *Hydra*, *Crater* (the Cup), *Corvus* (the Crow), *Centaurus*, *Lupus* (the Wolf), *Ara* (the Altar), *Corona Australis* (the Southern Crown), *Pisces Australis* (the Southern Fish).

To the above 48 constellations of Hipparchus, 12 near the south pole were added by Bayer, and represented in his *Uranometria*, the first edition of which appeared in 1603. These were, *Indus* (the Indian, or Indian Triangle), *Grus* (the Crane), *Phœnix*, *Apis* or *Musca* (the Bee), *Triangulum* (the Southern Triangle), *Avis Indica* (the Bird of Paradise), *Pavo* (the Peacock), *Pica Indica* (the Toucan), *Hydrus* (the Hydra), *Dorado*, *Piscis Volans* (the Flying Fish), *Chameleon*. The two constellations, *Coma Berenices* (Berenice's Hair) and *Antinous*, were formed by Tycho Brahé; the first comprehending some of Ptolemy's unformed stars near *Leo*, and the second of others near *Aquila*. They are given in the catalogue of Riccioli, published in his *Astronomy Reformed* in 1665.

In the *Planisphærium Stellatum* of Bartschius, published in 1624, the eight following constellations are found, and said to have been formed by the moderns in that part of the heavens which is visible in Europe — *Camelopardalis* (the Giraffe), *Tigris*, *Jordanus*, *Vespa* (the Wasp), *Columba Noachi* (Noah's Dove), *Monoceros* (the Unicorn), *Rhombus* (the Rhombus or Rhomboid), *Gallus* (the Cock). The same constellations are met with in the Celestial Charts of Royer, published in 1679, with the exception of *Gallus*. *Vespa* is also changed into *Lis* (the Flower-de-luce), and *Crux* (the Cross) added.

In the Charts of Hevelius, entitled *Firmamentum Sobiescianum*, and published in 1690, we find 10 new constellations — *Canes Venatici* (the Greyhounds, Asterion, and Chara), *Lacerta* (the Lizard), *Leo Minor* (the Little Lion, in place of *Jordanus*, mentioned above), *Lynx* (instead of *Tigris*), *Sextans* (the Sextant of Urania), *Scutum Sobiescianum* (Sobieski's Shield), *Triangulum* (the Little Triangle), *Vulpecula et Anser* (the Fox and Goose), *Cerberus*, and *Mons Mœnalus*.

To the above *Cor Caroli* (the Heart of Charles II.) was added by Flamsteed, and *Robur Carolinum* (the Oak of Charles) by Halley.

Notwithstanding the additions already made to the constellations in the southern hemisphere since the time of Ptolemy, Lacaille found so many clusters of unformed stars, while observing at the Cape of Good Hope, that he added to the list no fewer than 14 new constellations, to which he gave the following names — *Officina Sculptoria* (the Sculptor's Workshop), *Fornax Chymica* (the Chemical Furnace), *Horologium* (the Clock), *Reticulus Rhomboidalis* (the Rhomboidal Net), *Cœlum Scalptorium* (the Graver), *Equuleus Pictoris* (the Painter's Easel), *Pyxis Nautica* (the Mariner's Compass), *Octans Hadleianus* (Hadley's Octant), *Machina Pneumatica* (the Air Pump), *Circinus* (the Compass), *Quadra* (the Square), the *Telescope*, the *Microscope*, and *Table Mountain*. Some still more recent additions have been proposed, particularly by Bode; among which are the *Honours of Frederic*, the *Sceptre of Brandenburg*, *Herschel's Telescope*, &c.; but they do not seem to be generally used in astronomical catalogues.

If the question were to be asked, What good purpose can be served by this multiplication of arbitrary divisions and fantastic names? we apprehend that no very satisfactory answer could be given. Astronomers doubtless find it convenient to classify the stars under certain divisions; but when the number of divisions becomes so great as to be remembered with difficulty, the advantage disappears. The arbitrary nature of the divisions also leads to great inconvenience, inasmuch as they are liable to much uncertainty, and frequent change of boundary. Not only have the names in several instances been changed, but it seems to have been a common practice with astronomers and chart-makers to take stars from one constellation and give them to another, without any other rule than that of pleasing their own fancies. On this account it is frequently extremely difficult to identify stars (particularly in the southern hemisphere) in the different catalogues. It is to be wished that the whole of the constellations (excepting perhaps the 48 of Hipparchus and Ptolemy) were obliterated from our celestial charts and globes, and that observers in describing the places of the stars would confine themselves to a simple statement of their right ascensions and declinations, at least until some better arrangement and nomenclature shall have been devised and agreed upon.

CONSTI'TUENT ASSEMBLY. In French History, the first of the national assemblies of the revolution; elected in 1788 as the states-general, dissolved in 1791 after proclaiming the constitution of that year.

CONSTITU'TION. The collective body of the fundamental laws of a state; either contained in written documents, or established by prescriptive usage. Constitutions have been divided into three kinds by political writers: — 1. Those granted (octroyées) by monarchs to their subjects; 2. Those springing out of rights enjoyed independently by the people, or classes of the people, which in monarchical countries are recognised by the sovereign in his contract with the people; 3. Those founded on compact between sovereign powers, *i.e.* federal constitutions. In a certain sense, all states in which the power of a sovereign over his people, or classes of his people, is limited by law or legal usage in any particular, may be said to possess pro tanto a constitution; but, in ordinary language, only a government in which the power of legislation, or that of granting and withholding supplies to the sovereign, is vested in the people, or a body of representatives elected by them or by a class of them, is termed constitutional. Constitutions have again been divided into — 1. Those in which legislative power is exercised directly by the people (as in some small modern commonwealths, and in all the free states of antiquity); and, 2. Representative constitutions. The last again, as prevailing in modern Europe and America, has been divided historically into — 1. Those which have originated from compact between several independent interests, as the sovereign, clergy, nobles, and commons, in feudal kingdoms; 2. Those formed artificially, in modern times, on the model of the British constitution; which, although arising out of the same causes which produced the feudal constitutions, assumed in the course of time a different and more comprehensive character.

CONSTITU'TIONS. In Roman Law, decrees of regular authorities, as prætors, &c.; more particularly decrees of the emperors, whether by decree, edict, or letter.

CONSTITUTIONS, APOSTOLICAL. An ancient code of regulations respecting the doctrine and discipline of the church, said by some to have been promulgated by the Apostles, and collected by Clemens Romanus. They appear to have been at one time admitted into the canon of Scripture. Their authenticity has been a subject of much dispute. They have been printed together with the so-called Canons of the Apostles. (See *Cotelerii Patres Apostolici*, vol. i.; *Krabbe's Dissertations on the Apostol. Constitutions and Canons*, Hamb. and Gotting. 1829; *Gieseler, Eccl. Hist.* 1 Period, 3 Div. § 66.)

CONSTRI'CTOR. (Lat. constringo, *I squeeze*.) A name applied to the larger serpents, which overcome and destroy a struggling prey by throwing themselves round it in overlapping folds, and crushing it by their muscular force. The *Boa Constrictor*, properly so called, is a native of South America, having anal hooks, and a single row of subcaudal scutæ.

CONSTRU'CTION. (Lat. con, *with*, and struo, *I pile up*.) In Architecture, literally the building up from the architect's designs; but amongst architects it is more particularly used to denote the art of distributing the different forces and strains of the parts and materials of a building in so scientific a manner as to avoid failure and ensure durability.

CONSTRU'CTION OF EQUATIONS, in Algebra, is the representing of the roots of equations by means of the intersections of geometrical lines. The roots of any algebraic equation may be represented by the intersection of a straight line with a curve of the same dimensions as the proposed equation, the roots of the equation being the ordinates of the points of intersection. An equation of any degree may also be constructed by means of two curves, whose dimensions, multiplied together, produce the dimensions of the given equation. Thus, a quadratic equation may be constructed by the intersection of a straight line with a circle, or with any conic section; a cubic equation by the intersection of a straight line with a line of the third order; a biquadratic by the intersection of a straight line with a line of the fourth order, or by means of two conic sections.

CO'NSUBSTA'NTIA'TION. The term by which Luther expressed the opinion which he held upon the nature of the elements in the Eucharist, as distinguished from Transubstantiation, the doctrine of the Romanists. The latter assert, as the word they use implies, that the bread and wine are changed into the body and blood, and lose their former substance, although they retain its appearance miraculously to the senses. The Lutherans deny this change; but affirm that while the bread and wine do still remain in their natural substance, the body and blood are at the same time transfused into them, and thus that both are actually partaken of together. Calvin says, "I assert that the body of Christ is really (as the usual expression is), that is, truly given to us in the sacrament, to be the saving food of our souls — the Son of God offers daily to us in the holy sacrament the same body that he once offered in sacrifice to his Father, that it may be our spiritual food. If any one ask me concerning the manner, I will not be ashamed to confess that it is a secret too high for my reason to comprehend, or my tongue to express." A reformer of the English church would have said probably that the Romanist is decidedly in error, for the mystery that he maintains exceeds even the literal interpretation of the scripture language. Upon the truth of the Lutheran hypothesis he would decline to express an opinion, not denying the possibility of consubstantiation, but neither presuming to define the manner of Christ's presence in the elements; and he would rather recognize in the language of Calvin a right appreciation of the verity of our Saviour's expressions, and a just perception of the nature of a mystery.

CO'NSUL. In Politics, a public officer whose functions partake of the diplomatic and commercial characters. Such officers appear to have been first employed by the Italian republics, to protect their merchants engaged in trade in the cities of the Levant. The consuls of European states in that region, and in Africa, are at the present time officers of more importance than those established in the cities of Christendom; as they exercise, according to treaties, civil jurisdiction over the citizens of their respective states. In general, the consul is not regarded as a minister or diplomatic functionary, and is subject to the civil authorities of the place where he resides. A resident English merchant, acting here as consul of a foreign country, is not exempt from arrest on mesne process. English consuls are now under the regulations of stat. 6 G. 4., by which they are made salaried officers, and the fees which they are still allowed to take are specified. (See *M'Culloch's Com. Dic.*)

CO'NSULARS. The title given to Roman citizens who had been dignified with the office of consul, and consequently were honoured with a certain precedence in the senate.

CO'NSULS. The supreme magistrates of Rome after the expulsion of the kings. Their number was two, and the period of their office one year; but there was no re-

striction as to the number of times the same individual might be elected. The power of the consuls was nearly the same as that of the kings; *i. e.* they were the supreme executive officers, but had no legislative authority. In time of war it was highest; they then levied the armies, and led them in person against the enemy. The consuls were originally chosen only from the Patricians, but afterwards from the Plebeians also. The age required by law was 43 years; but besides this it was requisite to have passed through the inferior offices of quæstor, ædile, and prætor. They were elected at the Comitia Centuriata, some months before their entrance into office, which took place at different periods of the year at different times, but finally in January, during which interval they were termed *consules designati*, or appointed consuls. Soon after their entrance into office they cast lots about the provinces to fall to the share of each, the superintendence of which was conferred on them by the senate. Under the emperors the nominal office of the consulate was preserved, but its substantial power destroyed; the elections also became merely forms, the emperor appointing whom he pleased. Then too the custom was introduced of having several sets of consuls in one year; those admitted on the first day, however, gave their name to the year, and were distinguished from the others, who were termed *suffecti* (*i. e.* substituted), by the title *ordinarii* (*i. e.* regular). Persons also were sometimes dignified merely with the title without enjoying the office, and were then styled honorary consuls. Under Justinian (A. U. 1294) the year ceased to be denominated by the name of the consul.

CONSULS, in French History, were the persons (Bonaparte, Sieyes, and Ducos) to whom, after the dissolution of the Directory in November 1799, was entrusted the provisional government of the country, and at whose suggestion it was agreed that France should be permanently subjected to consular authority. According to the constitution framed on this suggestion, Bonaparte, Cambaceres, and Lebrun, called first, second, and third consuls, were elected by the conservative senate each for ten years, and invested with different degrees of authority. But the senate having passed various decrees curtailing the powers of the second and third consuls and augmenting those of the first, by which the government was gradually assimilated to a monarchy, after the lapse of four years and a half an easy transition was made from the consular to the imperial form; the title of emperor was substituted for that of consul; and the exercise of the sovereign authority, which indeed had been only nominally shared with his colleagues, delegated exclusively to Napoleon Bonaparte.

CO'NSULTA'TION (Lat.), in ordinary Legal language, is a meeting of the counsel engaged by a party to a suit, for the purpose of deliberating on the best mode of proceeding in the case.

CONSULTATION, WRIT OF. In Law, a writ granted by the king's court, whereby a cause which had been removed into such court by prohibition out of the ecclesiastical court is returned thither again. It is so called because it issues in consequence of the judges, on consultation, having found that the suggestion on which the prohibition was granted is false or not proved. *See* PROHIBITION.

CONSU'MPTION. (Lat. consumo, *I waste away*.) This term is commonly applied to a diseased state of the lungs, attended by emaciation, debility, cough, hectic fever, and purulent expectoration. It may be produced by a variety of causes; but hereditary disposition and scrophulous habit are leading causes which predispose to its most alarming form, namely, that which arises from tubercles in the lungs. Its first symptoms are cough; at first dry, but afterwards attended by mucous expectoration, difficult breathing, lassitude, and impaired appetite. These are succeeded by more copious expectoration of viscid or purulent matter, sometimes streaked with more or less blood; greater difficulty of breathing, pain in the side, especially on coughing or taking a full inspiration; and inability to lie with equal comfort upon both sides; the emaciation becomes more perceptible; and the pulse, at first not much affected, becomes full, hard, and quick; frequent flushings and fever of a remittent character ensue, attended by chills and red sediment in the urine, but the tongue is not much altered, and the mouth is usually moist; the bowels, at first irregular, become habitually relaxed; profuse perspirations, attended by extreme debility and rapid emaciation, follow; the legs swell; and the patient sinks, generally retaining the senses, and even in hope and spirits to the last. In the early treatment of this disease the tendency to inflammatory action must be most cautiously encountered by bleeding, cupping, or blisters; the bowels gently opened by saline aperients; and the cough and irritability quieted by opium, henbane, or hemlock, and by small doses of expectorants. Tonics and acids require to be given with the utmost prudence; and after all little except palliation can be effected. The diet must from the beginning be scrupulously attended to, and should be mild and nutritive, but not stimulant; and sometimes a temporary benefit results from change of air; but where the disease is once established its effect is uncertain, and it is in many cases worse than injudicious to advise change of climate. The inhalation of vapours of chlorine and iodine, in very minute quantity, has appeared to give in some cases a little temporary relief; in others it has proved decidedly mischievous; in none permanently useful; and we must with regret assume that there has been some mistake in the supposed cures of established and constitutional consumption. In its very early periods, change of country, diet, habit, and occupation will sometimes seem to suspend its progress; it has also been checked by other diseases, and not unfrequently it lies dormant in females who breed quickly; but at a later period it again shows itself, and proceeds to its fatal end.

CO'NTACT, ANGLE OF. In Geometry, the angle made by a curve line with its tangent. Euclid has demonstrated that the angle made by the circle with its tangent is smaller than any rectilinear angle, and that no straight line can be drawn between the circle and tangent without cutting the circle. Innumerable circles may, however, be made to pass between them. Formerly the angle of contact afforded geometers a fruitful source of metaphysical controversy. See an excellent account of the writings of Wallis, Peletarius, Clavius, Vieta, and others, on this subject, in the notes to *Camerer's Euclid*, Berlin, 1824.

CONTA'GION. (Lat. contagies.) The propagation of specific diseases from person to person. *Contagious poisons* communicate the property of producing similar poisons; the *small-pox* is a characteristically contagious disease. By some writers the term has been limited to diseases requiring *actual contact* for their communication; but contagious matter appears often transmissible by the air, hence the terms *immediate* and *mediate contagion*. Where diseases are propagated through the medium of the air, they are generally called *infectious*.

CONTE'MPT. In Law, disobedience to the rules, orders, or process of a court of competent authority. Contempt in court is punishable by fine or imprisonment: for contempt out of court an attachment may be granted. Contempt of the king's prerogative, by refusing to assist him in the exercise of his lawful authority, &c., is a high misprision or misdemeanor.

CO'NTEXT. (Lat. contextus.) The general series of a discourse; when we cite a particular passage, we mean by its *context* the parts immediately preceding and following it, which determine or affect its sense.

CONTINE'NTAL SYSTEM. In Modern History, the celebrated plan of the Emperor Napoleon for excluding the merchandise of England from all parts of the Continent. It was commenced by the decree of Berlin, issued 21st Nov. 1806, which declared the British islands in a state of blockade, and made prisoners of war all Englishmen found in the territories occupied by France and her allies. The blockade thus instituted was far from complete; and in the course of events licenses were expressly granted by the government for its evasion, and became a source of revenue. Some writers have affirmed that British commerce lost by this decree and those which followed it more than 60 millions sterling in 18 months; but this is an enormous exaggeration.

CONTI'NGENT. (Lat.) In Politics, the proportion (generally of troops) furnished by one of several contracting powers in pursuance of an agreement. The Germanic diet has fixed the *contingents* of the several states forming that confederacy to its army by the stipulations of 1814.

CONTI'NUAL PROPO'RTIONALS. Quantities are said to be continual proportionals, or in continued proportion, when the first is to the second as the second to the third, as the third to the fourth, and so on.

CONTI'NUED BASS. In Music, the same as thorough bass. It receives the name from its continuation through the whole of a composition.

CONTI'NUED FRA'CTIONS. In Arithmetic, a species of fractions first proposed about the year 1670 by Lord Brounker, President of the Royal Society, and improved by Dr. Wallis; but which have acquired their greatest value by their application, in the hands of the Continental mathematicians, to the solution of numerical equations, and of problems in the indeterminate analysis. Their nature will be most easily understood from a numerical example.

Let it be required to convert the fraction $\frac{108}{149}$ into a continued fraction. The value will not be altered by dividing both terms by the same number. Assume 27, which is contained in the numerator 108, and on dividing the denominator by it there will result the compound quotient $5\frac{14}{27}$. The given fraction therefore becomes $\frac{4}{5\frac{14}{27}}$, or $\frac{4}{5+\frac{14}{27}}$. Again, dividing the fraction $\frac{14}{27}$ by the greatest measure of its numerator, namely 7, it will be changed into $\frac{2}{3\frac{6}{7}}$, or $\frac{2}{3+\frac{6}{7}}$. Wherefore the original fraction is now transformed into $\frac{4}{5+\frac{2}{3+\frac{6}{7}}}$. It is, however,

more convenient to divide by such numbers as will render the numerators all units. Thus, let the fraction be $\frac{287}{992}$. Divide both terms by 287, and there results $\frac{1}{3\frac{131}{287}}$. Dividing again the terms of the last fraction by its numerator 131, there arises $\frac{1}{2\frac{25}{131}}$. Dividing again by 25, the fraction $\frac{25}{131}$ is converted into $\frac{1}{5\frac{6}{25}}$. Lastly, $\frac{6}{25} = \frac{1}{4\frac{1}{6}}$. Collecting all the fragments, we now get

$$\frac{287}{992} = \cfrac{1}{3 + \cfrac{1}{2 + \cfrac{1}{5 + \cfrac{1}{4 + \cfrac{1}{6}}}}}.$$

It is easy to see how the continued fraction is reconstructed into its equivalent simple fraction, by following the reverse process.

By decomposing a fraction in this manner a series of derivative fractions is obtained, which constantly approach to the true expression, and exhibit the successive approximate values in the lowest terms. Taking the last example, $\frac{287}{992}$: if we stop with the first term of the expansion, we find for the approximate value $\frac{1}{3}$, which is considerably too small; if we take in two terms, we find $\cfrac{1}{3+\cfrac{1}{2}} = \frac{2}{7}$, which is a little too large. Admitting three terms, we get $\cfrac{1}{3+\cfrac{1}{2+\cfrac{1}{5}}} = \frac{11}{38}$, which is again too little, but nearer the true value than the last. In this manner we approach nearer and nearer at every successive step; and it may be remarked, that the errors are alternately in excess and defect. (See *Leslie's Philosophy of Arithmetic; Euclid's Analysis Infinitorum;* and the *Additions* to the French translation of *Euler's Algebra*.)

CONTINU'ITY, LAW OF. A principle of considerable use in investigating the laws of motion, and of change in general, and which may be thus enunciated: — *Nothing passes from one state to another without passing through all the intermediate states.* Leibnitz claims the merit of having first made known this law; but in so far as motion at least is concerned, it is distinctly laid down by Galileo, and ascribed by him to Plato. But though a perception of its truth seems to have been felt long before, Leibnitz was certainly the first who applied the principle to test the consistency of theories, or supposed laws of nature. The argument on which he attempted to establish it *à priori* is, that if any change were to happen without the intervention of time, the thing changed must be in two different conditions at one and the same instant, which is obviously impossible. A remarkable application of the law of continuity was made by John Bernoulli in an Essay on the Laws and Communication of Motion, which gained the prize of the Academy of Sciences of Paris in 1724, to prove that perfectly hard bodies cannot exist; because, in the collision of such bodies, a finite change of motion must take place in an instant, an event which, by the law now explained, is impossible. This conclusion was objected to by D'Alembert and Maclaurin, who on account of it were disposed to reject the law of continuity altogether; but the difficulty is got over by supposing (which on various grounds is extremely probable) that there is no real contact, and that bodies begin to act on each other when their surfaces, or what seem to be their surfaces, are yet at a distance.

CONTO'RNIA'TI. In Numismatics, medals supposed to have been struck about the period of Constantine the Great and his immediate successors; they are of bronze, with a flat impression, and marked with peculiar furrows. (Ital. contorni, whence their name.) They bear the figures of famous emperors or celebrated men. Their object is uncertain; but they have been supposed to be tickets of admission to the public games of the circus in Rome and Constantinople.

CONTOUR. (It. contorno.) In the Fine Arts, the external lines which bound and terminate a figure. The beauty of contour consists in those lines being flowing, lightly drawn, and sinuous. They must be carefully and scientifically drawn, which cannot be effected without a thorough knowledge of anatomy.

CO'NTRABA'ND. (Ital. contra, *against;* bando, *an edict* or *proclamation.*) In Commercial language, goods exported from or imported into a country against its laws. *Contraband of war*, such articles as a belligerent has, by the law of nations, the right of preventing a neutral from furnishing to his enemy. Articles contraband of war are, in general, arms and munitions of war, and those out of which munitions of war are made; all these are liable to be seized: but very arbitrary interpretations have been affixed to the term by powerful states, when able to enforce them by arms. Thus provisions are held contraband of war when it is the object to reduce the enemy to famine. But with respect to these and other articles not in their nature contraband, it seems to be the practice that the belligerent should purchase them from the neutral for a reasonable equivalent, instead of confiscating.

CONTRABA'SSO. (It.) The largest of the violin species of string and bowed instruments, whereof it forms the lowest bass, usually called the double bass.

CO'NTRACT. In Civil Law, the term usually applied to such agreements, whether express or implied, as create, or are intended to create, a legal right, and corresponding liability; such right not attaching to the possession of the subject matter of the contract, except in equity, and that indirectly, but subsisting both in equity and law against the contracting party.

The conditions essential to the legal validity of a contract relate either to the competency of the parties, the sufficiency of the consideration or inducement, the nature of the thing contracted for, the fairness of the transaction, or, lastly, to the form of the agreement.

And, first, as to the competency of the parties. The party to be sued must have been at the time of the contract of sound mind, and, unless it was for the supply of necessaries, of full age; and if a woman, she must have been unmarried, subject as to the latter condition to some exceptions established either by local custom or by the doctrines of equity.

Secondly, as to the sufficiency of the consideration on the part of the person suing, — it must have been either future marriage since performed, or money, or something capable of being estimated in money; or some act, whether of performance or abstinence, whereby some undoubted advantage, though not capable of being exactly valued, accrues to the party sued.

Thirdly, the act contracted for must be neither contrary to written law, nor to public policy; and it must be beneficial to the party seeking either performance or compensation, or to some one on whose behalf he gave the consideration.

Fourthly, there must have been neither fraud (either by concealment or misstatement) nor compulsion on the part of the plaintiff in obtaining the agreement; and fraudulent acts subsequent to the agreement having reference to it are also sufficient to deprive the guilty party of all right under it. Some circumstances are in equity considered either as conclusive evidence of fraud, or as substantive acts of coercion, which are not strictly of such a nature, and are not so deemed at law.

Lastly, as to the form of the agreement. Where it relates to an interest in land of three years' duration or more, or to goods of the value of 10*l*. or upwards, unless there be earnest or delivery, or where it is an agreement as surety, or where it is upon marriage as a consideration, it must be in writing; though the want of a written instrument may be supplied in equity by partial performance, that is, by acts evidently done in pursuance of the alleged contract.

Contracts are sometimes implied either in the whole from the acts of the parties, as from the ordering of goods a contract to pay for them; or in part, and as incidental to the principal agreement, as, in the case of a lease, a contract by the tenant to use fairly and take due care of the thing leased. And at law some obligations not arising in any manner from contract are, as regards the mode of enforcing them, placed on the same footing as those which do arise from contract; the remedy, and not the right, being assimilated by statute.

Such are the general requisites to the validity of agreements; but at law the extent of the right and liability arising under them varies according to their form; agreements being there divided into those under seal, which are called agreements by specialty, and those not under seal, which are called simple contract or parol agreements, including not only such as are merely verbal, but such as are written and unsealed. The first sort alone are binding upon the land, and that only when the heir is named; and they possess this farther advantage over agreements by simple contract, that being executed as the *deed* of the contracting party, a sufficient consideration will always be implied in their favour, unless an insufficient one be actually stated on the face of them. Again, agreements both by specialty and simple contract are either to pay a sum certain actually stated in the agreement, or a sum uncertain to depend upon the value of the thing received; or they are agreements to perform certain acts. In the first case, the remedy is by action of debt either on bond or covenant, or upon simple contract, as the case may be. In either of the latter cases the remedy is by action for breach of covenant where the agreement is under seal, or by action of assumpsit where it is by simple contract; the relief given in each of the two last-mentioned sorts of action being compensation in damages for the injury accrued from non-performance of the agreement. *See* ACTION.

The remedy in equity, where there is any, is in all cases alike. — specific performance of the act agreed to be done; and such relief will be given to the same extent and against the same parties, whether the contracting party himself or his real or personal representatives,

without any distinction between agreements under seal and those which are not so.

But though courts of equity have jurisdiction in all cases of agreements, at least in all such as do not constitute an actual debt at law, yet the exercise of that jurisdiction is, subject to certain rules, a matter of discretion; for the reason that the denial of the equitable relief will not leave the party without some remedy, namely, that of damages at law: and on this account specific performance can only be obtained in equity in those cases where pecuniary damages would not afford to the disappointed party an adequate compensation. Thus such relief will not be granted in any of those cases where the inducement to the bargain or agreement was merely the expectation of profit, as it is in agreements for the sale or purchase of personal chattels; and other circumstances also are a bar to equitable relief, which are no defence to an action at law, as, for instance, the want of mutual liability, apparent laches, and indifference in following up the agreement; or particular consequences of collateral hardships arising to one party from actual performance; or the impropriety in equity of the agreement, as where performance would be a breach of trust. And on the other hand, though the equitable jurisdiction is founded upon a supposed legal right, there are cases in which the right having been lost at law, as by default in literal compliance with the terms of the agreement, will yet be enforced in equity.

Contract, Original or Social. In Politics, that which is supposed to exist ab initio, according to some theories of government, between the sovereign power and the subject. So prevalent was this doctrine at the period of the revolution of 1688, that the Convention Parliament pronounced James II. to have broken the "original contract between the king and the people." The original contract, with the reciprocity of rights and duties which it engenders, is clearly a supposition having no historical foundation in the annals of any people; but it is, nevertheless, the only hypothesis in which men can consistently proceed in framing a theory of government which shall satisfy at once the moral and economical wants of society.

CONTRADI'CTORY PROPOSITIONS. In Logic, are those which having the same terms differ in quantity and in quality. *Contrary Propositions* are two universals with the same terms, the one negative and the other affirmative. *See* Proposition.

CONTRA'LTO. (It.) In Music, the part immediately below the treble; called also the counter tenor.

CO'NTRAST. (Fr. contraste.) In the Fine Arts, an opposition of lines or colours to each other, so contrived that the one gives greater effect to the other. By means of contrast energy and expression are given to a subject, even when employed on inanimate forms. All art is indeed a system of contrast: lights should contrast with shadows, figures with figures, members with members, and groups with groups. It is this which gives life, soul, and motion to a composition.

CO'NTRATENO'RE. In Music, the same as *Contralto*, which see.

CO'NTRAVALLA'TION. (Lat. vallum, *trench*.) In Fortification, a trench guarded by a parapet, formed by the besiegers between their camp and the place besieged, to secure themselves and check the sallies of the garrison. The line of *contravallation* is thus, as the name implies, a sort of *counter* fortification.

CONTRO'L, BOARD OF, or BOARD OF COMMISSIONERS FOR THE AFFAIRS OF INDIA, is constituted under the authority of Mr. Pitt's celebrated Act, passed in 1783. It consists of such members of the privy council as his Majesty is pleased to appoint, of whom the two principal secretaries of state and chancellor of the exchequer always form three. The president is usually a cabinet minister. The controlling functions of the board consist in revising all despatches prepared by the court of directors and addressed to the governments in India. It also has the power of requiring the court to prepare despatches on a given subject, and revising and altering them. The board is divided into six departments,—accounts, revenue, judicial, military, secret political, and foreign and public. The names of the first four indicate their duties: the third has three subdivisions,—the secret departments, respecting confidential communications addressed (as the act prescribes) by the local governments to the secret committee of the court of directors, and vice versâ; the political, comprising general correspondence respecting native chiefs and states; the foreign, respecting foreign Europeans and Americans resorting to India. The public department takes charge of commercial, ecclesiastical, and other miscellaneous affairs. The salary of the president of the board is 3500*l*., that of a paid commissioner 1200*l*., of the secretary 1500*l*.

CONTRO'LLER. (Fr. controleur.) An officer appointed to control or oversee the accounts of other officers, and to certify whether the matters confided to his care have been controlled or examined. In England, there are several public functionaries of this title, as the controller of the mint, customs, stationery, &c.

CO'NTUMACY. (Fr. contumace, *stubborn*) In Scotch Ecclesiastical Law, a wilful disobedience to any lawful summons or judicial order. It is punished by imprisonment.

CO'NUS. (Gr. κωνος, *a cone*.) A term in Botany, denoting that form of inflorescence called a strobilus or cone, which is a spike, the carpels of which are scale-like, spread open, and bear naked seeds. Sometimes the scales are thin, with little cohesion; but they often are woody, and cohere into a single tuberculated mass.

Conus. The name of a Linnæan genus of *Vermes Testacea*, characterized by the conical form of the shell, the base of which is formed by the spire, which is accordingly flat, or very slightly projecting; the aperture is narrow and rectilinear, or nearly so, without any enlargement or plication. The genus is retained without subdivision, and forms part of the *Buccinoid* family of the Pectinibranchiate order of Gastropods in the system of Cuvier.

CO'NVENT. (Lat. conventus, from convenio, *I come together*.) A religious house, inhabited by a society of monks or nuns. *See* Monachism.

CONVE'NTICLE. (Lat., diminutive of conventus.) An assembly for the purpose of divine worship; first used in a contemptuous sense for the meetings of the followers of Wicliffe (stat. 2 H. 4. c. 15.), and since applied to the places of meeting of petty sects and of Dissenters in general in the Conventicle Act, 16 Car. 2., repealed by 52 G. 3. c. 155. Originally the word had no such peculiar application, but was used by the fathers and ancient writers for a church.

CONVE'NTION. In Political language, this name has been applied to assemblies of national representatives meeting on extraordinary occasions without being convoked by the legal authority. Two parliaments have been so called in English history. The first, that which met in April, 1660, and restored Charles II. to the throne—the Lords assembling by their own authority; and the Commons, by virtue of writs issued in the name of the keepers of the liberties of England, by the authority of parliament. The second, that which met in 1688, each house by its own authority, and on the summons of the Prince of Orange; which declared King James II. to have abdicated the crown, and transferred it to William and Mary. In French History, the name Convention is applied to that assembly which met after the legislative assembly had pronounced the suspension of the royal functions, in September, 1792, and proclaimed the republic at its first sitting. This body dissolved itself on the establishment of the Directory, in October, 1796. The Scottish assembly which met on the flight of James II. was entitled the Convention of Estates. In the United States, meetings of the people of separate states, by specially chosen representatives, to review and amend the state constitutions, have been termed Conventions.

Conve'ntion, Military. A treaty between military commanders concerning terms for a temporary cessation of hostilities; generally between a victor and a defeated general, for the evacuation of a district or position by the latter. Such, at least, were the two most celebrated conventions of modern times: that of Closter-Seven (1757), between the Dukes of Cumberland and Richelieu; that of Cintra (1808), between Junot and the English generals.

CONVE'RGENT-NERVED. A term used in describing the venation of leaves, to denote cases where the ribs form a curve and meet at the point, as in *Plantago lanceolata*.

CONVE'RGING SERIES. In Analysis, are series of which every succeeding term is smaller than the preceding, and which, consequently, tend to a certain limit. It is only converging series which admit of summation.

CO'NVERSE. In Geometry, a proposition is said to be the converse of another when the conclusion of the first being used as the supposition in the second, the conclusion of the second agrees with the supposition of the first. Thus, the fifth proposition of the first book of *Euclid* affirms that if the two sides of a triangle be equal, the angles at the base are equal; and the sixth affirms that if the angles at the base be equal, the two sides are equal. The sixth is therefore the *converse* of the fifth.

CONVE'RSION. In Logic, a proposition is said to be *converted* when the terms are so transposed that the subject is made the predicate, and vice versâ. All logical conversion is illative; *i. e.* the truth of the converse follows from that of the original. Conversion is either "simple" or "per accidens." Universal negatives (denoted by the sign E) and particular affirmatives (I) can be converted simply, retaining both quantity and quality: thus, "No virtuous man is a rebel;" "No rebel is a virtuous man." Conversion per accidens changes either quantity or quality. Universal affirmatives (A) are converted by changing the quantity; as. "All oaks are trees;" "Some trees are oaks." Particular negatives (O) by changing the quality, considering the negative as attached to the predicate instead of the copula: the proposition is

thus changed into I,—"Some poets are not learned;" "Some not learned (unlearned) men are poets." *See* PROPOSITION.

CO'NVERT. (Lat.) A person who changes his religion. Individuals, of what faith soever, who abandon their own creed and embrace Christianity are called *converts*, in contradistinction to *apostates*, applied generally to *Christians* who adopt another religion. History, both sacred and profane, has transmitted to us many instances of sudden conversion, in which the hand of a miraculous providence may clearly be traced. Among the most remarkable may be mentioned the conversion of 3000 Jews on the day of the Feast of Tabernacles, and that of Paul the apostle, the emperor Constantine, and Clovis, king of France.

CONVEY'ANCE. (From *convey*.) In Law, a deed which passes land from one to another. (*See* REAL PROPERTY, LAW OF.) *A conveyancer* is a lawyer, whose business consists in advising and preparing such deeds. It is not necessary to be called to the bar to practise as a conveyancer; but most conveyancers take that step soon after beginning their business, and frequently combine it with that of equity draftsmen.

CONVI'CTION. At Common Law, is the finding of one guilty of an offence by the verdict of a jury; and may take place where one is outlawed, or appears and confesses, or is found guilty on the inquest. (*See* JURY, VERDICT.) By various statutes summary proceedings, without the intervention of a jury, are authorized for the trial and conviction of minor offenders. Such are those before commissioners of excise, &c. for breaches of the revenue laws, and before justices of the peace for various disorderly offences. The party charged must be summoned to attend; and a conviction by a magistrate must be in writing, and should state the whole of the evidence for and against the defendant.

CONVOCA'TION. (Lat. convoco, *I call together*.) In English Ecclesiastical Law, the council of the church, derived, first, from the custom of the bishops assembling their diocesan clergy for the sake of considering spiritual matters; and, secondly, of the archbishops holding convocations of the clergy of a whole province. Convocations were first assembled in England under the king's authority by Edward I., who summoned them by their provinces, for the sake of obtaining subsidies from the clerical body. They met in each province in two houses — one of the suffragan bishops; the other of deans, archdeacons, and representatives of the inferior clergy. The taxation of their own body was withdrawn from convocation in 1664; and, on the other hand, the privilege of voting for knights of the shire was then conceded to ecclesiastics. As the power of enacting canons had been already virtually abolished by statutes of Henry VIII., Elizabeth, and Charles II., there now remained no business for convocation to transact; and it was only in the reigns of William III. and Anne, when attempts were made by the high church party to impart fresh activity to it as an ecclesiastical tribunal, that its meetings were attended with any historical importance. Since that period it has become customary to prorogue convocation every year immediately upon its assembling. The rights and history of the convocation are treated of at length in several writings of the learned Bishop Gibson, especially his *Synodus Anglicana*, Lond. 1702.

CONVOCA'TION, HOUSE OF, in the University of Oxford, is the assembly which enacts, amends, &c. laws and statutes; elects burgesses, many professors, and other officers, &c. It is composed of all members of the university who have at any time been Regents (*see* REGENTS), and who, if independent members, have retained their names on the books of their respective colleges. The power of convocation at Oxford to make statutes is limited: in the first place, the royal statutes cannot be explained or amended without royal license; and, in the next place, with respect to all other laws and statutes, no proposition can be entertained in convocation unless it has been first submitted to the hebdomadal meeting of heads of houses, by whom it must be in the first instance sanctioned or rejected.

CONVO'LVULA'CEÆ. (Convolvulus, one of the genera.) A natural order of herbaceous or shrubby Exogens, twining and producing a milky juice when wounded. They are very abundant in the tropics, and possess purgative qualities in their roots, depending upon a peculiar resin, of which scammony and jalap, yielded by the *Convolvulus Scammonia* and *Ipomœa purga*, may be taken as examples. Many of these plants are objects of striking beauty; some, which unfold their pure, white, magnificent flowers at night only, are called in tropical countries *Belle de Nuit*; others expand only beneath a warm and brilliant sunshine. The *Lignum Rhodium* of the old pharmacologists is produced by an upright bushy species, called *Breweria scoparia*.

CO'NVOY. (Fr. convoyer, *to conduct*.) In Navigation, the term applied to designate a ship or ships of war, appointed by government, or by the commander in chief on a particular station, to escort or protect the merchant ships proceeding to certain ports. Convoys are mostly appointed during war; but they are sometimes also appointed during peace, for the security of ships navigating seas infested with pirates. For an account of the various regulations and conditions relative to convoys, see *M'Culloch's Com. Dict.*

CONVOY, in the Military service, signifies a detachment of troops appointed to guard supplies of provisions, ammunition, or money, in their progress to a distant part of any country, or to an army in the field, against an attack which might be made upon them either by the peasantry or by parties of the enemy.

CONVU'LSION. (Lat. convello, *I pull together*.) A writhing and agitation of the limbs, and involuntary action of the muscles in general. The fits vary much in extent and violence, sometimes attacking the whole body, and at others confined to particular parts; in the former case the mind is affected, but it often remains in the latter undisturbed: they also vary in duration, lasting from a few minutes to some hours. They are sometimes preceded with dizziness, double or disturbed vision, and coldness, and are followed by great languor; but at others they come and go without much disturbance. Teething, worms, and overloaded bowels are common causes of convulsive attacks in children; and these are relieved by freely and timely lancing the gums, and by the administration of proper purges. In *puerperal convulsions* bleeding and opiates are the usual remedies; and in cases where convulsive attacks arise from violent affections of the mind, the exciting causes must be studiously avoided. Warm baths, bleeding, and nervine stimulants are the usual medical aids; and where there is difficulty of swallowing, a glyster, composed of half a pint of gruel with a drachm of tincture of opium and two drachms of tincture of assafœtida, has, in adults, proved eminently useful. Cold affusions often do harm. The after-treatment consists in the judicious use of tonics and nervous stimulants, and in avoiding all obvious exciting causes.

COO'LER. An apparatus used by brewers and distillers for cooling worts. The coolers generally consist of very shallow vessels exposing great surface, and placed in the high and airy parts of the brewery: the cooling is sometimes assisted by fans, which agitate the air over their surfaces. Worts are also occasionally cooled by causing them to traverse metal pipes, which are surrounded by a counter-current of cold water.

CO-O'RDINATES. (Lat. con, *together*, and ordino, *I arrange*.) In Analytical Geometry, the system of lines to which points under consideration are referred, and by means of which their position is determined. The position of a point on a plane is absolutely determined if we know its distances, measured in a given direction, from two straight lines given by position in the same plane. In like manner, the position of a point in space is determined by its distances from three straight lines given by position, provided any one of them be not in the same plane with the other two. The use of co-ordinates was introduced into geometry by Descartes, for the purpose of facilitating the investigation of the properties of curve lines. For the sake of convenience, they are generally chosen at right angles to each other, and are then called rectangular co-ordinates. In plane geometry, one of them is the *absciss*, and the other the *ordinate*. The geometry of three dimensions requires one absciss and two ordinates; the first horizontal, and the second vertical. The point from which they all proceed is the *origin of the co-ordinates*.

COPAI'BA or COPIVI BALSAM. An exudation from the *Copaifera officinalis*, a South American tree; it is a liquid resin, and yields by distillation a considerable quantity of a pungent volatile oil. A small teaspoonful taken twice a day in a glass of water proves diuretic, and is of use in the cure of gleet and the latter stages of *gonorrhœa*. A larger dose is aperient, and has been of service in the treatment of *hæmorrhoids*.

CO'PAL. (An American name applied to clear gums?) This substance is often improperly called *gum copal*. It is a peculiar resin, very difficultly soluble in alcohol; hard, brittle, and inodorous: its specific gravity varies from 1·04 to 1·13. It is the produce of the *Rhus copallinum* and of the *Elæocarpus copaliferus* of the East Indies: a third kind of copal is also brought from the Coast of Guinea. It is used in varnishes.

COPA'RCENARY. (Lat. con, and particeps.) In Law, an estate is said to be held in coparcenary, and the tenants termed coparceners, where it descends from an ancestor to two or more persons. Sisters are coparceners at common law; tenants in gavelkin by custom. No right of survivorship exists between coparceners. They may agree, or any one may force the rest to make partition.

CO'PING. (Sax. cop, *the head*.) In Architecture, the upper covering or top course of a wall, usually of stone, and wider than the wall itself, in order to let the rain water fall clear from the wall.

CO'PPER. (*Cuprum*, a corruption of *Cyprium*, from the island of Cyprus, whence it was formerly brought.)

This metal was known at a very remote period; and in the early ages of the world, before iron was in use, copper was the chief ingredient in domestic utensils and instruments of war. It is an abundant metal, and is found native, and in many ores; of these the most important are the varieties of *pyrites*, which are sulphurets of copper and iron. The richest mines are those of Cornwall. It occurs in veins, traversing the primary rocks of that county; it is chiefly transported to Swansea to be smelted, in consequence of the deficiency of coal in Cornwall. The ores are repeatedly roasted and fused to drive off the sulphur, and the oxide of copper is ultimately reduced by the joint agency of heat and carbon. Copper is distinguished by its colour. Its specific gravity is 8·6. It is ductile and malleable, and requires a temperature equal to about 2000° of Fahrenheit's scale for its fusion; that is, nearly a white heat. Exposed to air and moisture, copper gradually becomes covered by a green rust; heated red hot it absorbs oxygen, and is superficially converted into a black oxide, which is the basis of the principal salts of copper: it consists of 32 copper and 8 oxygen. It forms blue or green salts with the acids; of these the *sulphate of copper*, or blue vitriol, is a good example. The salts of copper are poisonous; and in consequence of the use of copper vessels for culinary purposes, food is sometimes contaminated by them. It is detected when in very minute quantities by the bright blue colour produced by the addition of liquid ammonia, and by a brown precipitate with ferrocyanate of potash. A clean plate of iron dipped into a solution containing copper becomes covered with the latter metal in a metallic state.

COPPERAS. Green vitriol, or sulphate of iron.

CO'PPERPLATE. In Engraving, a plate of copper highly polished on which an engraving is made.

CO'PPICE. Woods which are cut down at stated periods to be manufactured into poles, rods, stakes, faggots for fuel, bark for the tanner, or charcoal. When wood of this kind has no standard trees, it is called simply a coppice, or copse wood; but when it has standard trees interspersed through it, it is called a wood. When coppices are cut down for hoops, rods, and small stakes for manufacturing into crates, hoops, wicker hurdles, &c., the period at which they are cut varies from six to ten years, according to the soil. When they are cut down for poles for hops and similar purposes, the periodical cuttings are commonly between twelve and fourteen years apart; and when they are cut down chiefly for the sake of the bark, they are seldom cut oftener than from fourteen to twenty-one years. A country abounding in coppice wood generally abounds also in singing birds, which are comparatively rare in countries where all the woods are of the pine and fir tribe.

COPRO'PHAGANS, *Coprophaga*. (Gr. κοπρος, *dung*, and φαγω, *I eat*.) A section of Lamellicorn beetles which live in and upon the dung of animals.

CO'PULA. (Lat. *a bond or tie*.) In Logic, that part of the proposition which affirms or denies the predicate of the subject. The only true logical copula is the present tense of the verb *to be*, with or without the negative sign, "is" or "is not."

CO'PY. (Fr. copie.) In the Fine Arts, a transcript from an original work of art. When an artist copies his own work, it is called a *duplicate* or *double*.

COPY. In Printing, is the subject matter to be printed, whether it be an original work in manuscript or a reprint: in the first case it is termed manuscript copy, or written copy; in the second printed copy.

CO'PYHOLD. In Law, is a species of *customary estate*, said to be held by copy of court roll; *i.e.* where the tenant's title is evidenced by a copy of the rolls of a manor made by the steward of a lord's court. Customary estates are those which exist in real property subject to the custom of manors; and their peculiar characteristic is, that all alienations of them must be transacted, in part at least, in the lord's court, the ordinary mode of alienations being by surrender to the lord and admittance of the new tenant. The peculiar tenure called copyhold is derived from the tenure in *villain socage*, as it was termed, held formerly under a manor. This was in its origin a mere permissive tenure by serfs attached to the soil; and copyhold estates are still expressed in legal phraseology to be held "at the will of the lord by the custom of the manor." With respect to the incidents of dower, and other characteristics, they are frequently governed by the custom of the manor; but where this is not the case, they are under the same rules which govern the transmission and alienation of freehold property. By the Reform Act, copyholders for life, or a greater estate to the amount of 10*l*. per annum, are admitted to the exercise of the electoral franchise in counties. The best treatises on the law of copyholds are those of *Watkins* and *Scriven*.

CO'PYRIGHT. In Law, the right of property in a literary composition vested in the author. By 54 G. 3. c. 156. s. 4. the term of copyright in an author and his assignee extends to twenty-eight years absolutely, and for the life of the author if he survive that period. Neglect to enter a work at Stationers' Hall does not affect copyright. Every assignment of copyright must be in writing. The author or assignee of a pirated work has his remedy by action; or chancery will grant an injunction to restrain the sale of pirated copies, and produce an account of such copies printed and sold. The act above mentioned required that eleven copies of every work should be delivered at the expense of authors and publishers, on demand in writing, for the use of a few favoured public and private libraries in the United Kingdom; but by the 6 & 7 Will. 4. cap. 110. the number was reduced to five. In France, copyrights continue for 20 years after the death of the author. In most of the German states, they are perpetual; and to prevent spurious copies being introduced from other states, a late resolution of the Diet has declared that a copyright secured in one state is good in all. Both in England and on the Continent, various other compositions, such as engravings, etchings, prints, maps, charts, and sculpture of all kinds, receive from statute a protection analogous to that of literature.

CO'RACLE. A boat made of wicker-work covered with leather, used chiefly by the ancient Egyptians.

CO'RACOID. (Gr. κοραξ, *a crow*, and ειδος, *form*.) A name first applied to a small process of the blade-bone of apes and man, on account of its resemblance to the beak of a crow; and now extended to a large flattened bone passing from the shoulder-joint to the sternum in birds, reptiles, and monotremes, and of which the process above mentioned is the rudimental representative.

CORALLI'NA. A name applied by Linnæus to a genus or group of marine organized bodies of arborescent habit, with jointed stems, supported on a kind of root, divided into branches, which are likewise jointed. Neither pores nor polypes are distinguishable on the surface of these beings; their chief purpose in the economy of nature is to prepare during life, and precipitate by their decay, fine particles of carbonate of lime or chalk: they thus lend their aid to the Lithophytous corals in covering submerged land with the elements of a fertile soil, which the expansive subterranean forces may afterwards convert into dry land.

CORALLI'NES. The name commonly applied to the tubular or nudibrachiate order of Polyps which have an external jointed calcareous or horny covering: the true nature of these plant-like animals was discovered by our countryman Ellis. *See* TUBULIFERA.

CO'RBEILS. In Fortification, little baskets filled with earth, about a foot and a half high, and from eight inches to a foot in diameter, which are set on a parapet or elsewhere to afford cover from the fire of an enemy.

CO'RBEL. (From the Fr. corbeille, *a basket*.) In Architecture, a projecting bracket, often sculptured like a modillion, sometimes in the form of a basket, for the purpose of supporting a superincumbent object, also for receiving the springing of an arch. A *corbel table* is a projecting battlement, parapet, or cornice, resting on corbels.

CO'RCULUM. (Lat. cor, *the heart*.) An old name for what botanists now call the embryo of a plant. It was not, however, applied with much precision; for the plumula and radicle alone of such seeds as the bean and almond were called the corculum, while the term should have included the cotyledons also.

CO'RDATE. (Lat. cor, *the heart; literally heart-shaped*.) A term used in describing the general form of organs, to denote any thing having two round lobes at its base, the whole resembling the heart in a pack of cards; as the leaf of *Alnus cordifolia*.

COR'DIA'CEÆ. (Cordia, one of the genera.) A natural order of arborescent Exogens, inhabiting the tropics of both hemispheres. They are nearly allied to *Convolvulaceæ*, from which they are separated by their inverted embryo and drupaceous fruit. They were formerly associated with *Boraginaceæ*; but their plaited cotyledons and dichotomous style caused them to be removed. The flesh of the fruit is succulent, as seen in the Sebesten plums, the produce of the *Cordia myxa* and *Sebestena*; but otherwise they are of no value. It has been asserted that the wood from which the mummy cases of the Egyptians were made was that of *Cordia myxa*; but there is no doubt that it was really produced by *Ficus sycomorus*.

CO'RDON. In Fortification, a row of stones jutting out between the rampart and base of the parapet. A line of troops drawn round a town or tract of country, so as to prevent ingress or egress, is also called a cordon.

CO'RIA'RIA'CEÆ. (Coriaria, one of the genera.) A natural order of shrubby Exogens, inhabiting Chile, Peru, the south of Europe, and a few other places. Placed by De Candolle directly after *Ochnaceæ*; an order with which they no doubt agree in some respects, but they differ from them very essentially in being apocarpous. Some botanists consider them apetalous, and allied to *Phytolaccaceæ*; the question of their affinity is still unsettled. Their sensible properties are of a poisonous nature.

CORIA'NDER. The seed of the *Coriandrum sativum*. (Gr. κορις, *a bug*, the odour of the fresh plant resembling

that of the bug.) It is a native of Europe, cultivated on account of its seeds, which are occasionally used in medicine; they have a peculiar perfumed flavour, with some bitterness, and form one of the ingredients of *curry powder.*

CORI'NTHIAN ORDER. In Architecture, one of the five orders of architecture. The capital (*see* ARCHITECTURE) is a vase elegantly covered with an abacus, and surrounded by two tiers of leaves, one above the other; from among which stalks spring out, terminating at their summits in small volutes at the external angles and centres of the abacus. The capitals of the Tuscan, Doric, and Ionic orders appear added to the tops of the shafts; but the Corinthian capital seems to grow out of the column, varying in height from a diameter and one sixth of the lower part of the shaft to one diameter only; such last being the height of the capitals of the temple at Tivoli. The entablature of this order is variously decorated. The architrave is usually profiled, with three fasciæ of unequal height, though in some specimens there are only two. The frieze is often sculptured with foliage, and the cornice decorated both with modillions and dentils; the former having a sort of baluster front with a leaf under them; and the latter, which are cut into the body of the band, being occasionally omitted, as are sometimes even the modillions. The principal remaining ancient examples of the order at Rome are in the Temple of Mars Ultor, Portico of Severus, the Forum of Nerva, Temple of Vesta, Basilica of Antoninus, the Pantheon, &c. &c.

CORK. (Corrupted from Lat. cortex; Germ. kork.) The bark of the *Quercus suber*, a species of oak growing in the southern provinces of Spain, France, and Italy. When rasped cork is digested in water and alcohol, it leaves from 70 to 80 *per cent.* of insoluble matter, which has been called *suberine*, and which, by the continued action of nitric acid, is converted into *suberic acid.*

CO'RMUS. (Gr. *κορμός, a stem.*) In Botany, a short roundish rhizoma.

CORN. The seeds of certain grasses which have been immemorially used as food, for man or animals, are called corn; and those which are used exclusively or principally by man are called bread corns. The term corn is also sometimes applied to the seeds of other plants which may be ground into meal and used as food, such as the seeds of the buckwheat, the quinoa, and of certain leguminous plants, which, however, are more properly denominated pulse. The principal bread corns of temperate climates are wheat, rye, oats, and barley; those of warm climates are maize, rice, and millet; and those of cold climates oats and barley.

It may be worthy of remark, that all bread corns are annual plants, and from that circumstance far better adapted for universal cultivation than if they had been perennials, or even biennials. An annual plant may indeed be said to belong to no country in particular, because it completes its existence during the summer months; and in every part of the world there is a summer. Hence, we find the same corns ripening their seeds within the frigid and the torrid zone; and though the quality of barley and wheat grown in Lapland be far inferior to that grown in the south of Spain, or on the plains of India, yet it is still such as may be made into wholesome bread and invigorating fermented liquor. Had the bread corns been perennials, they must necessarily have lived through the winter in every country in which they were grown, as well as through the summer; and such of them as might have been adapted to the winters of cold climates, when taken to warm climates would have been so far weakened by being kept in a growing state throughout the year as in a few years to have ceased to exist; while the perennials of warm climates, such as the south of Spain and Italy, could not have lived through a single winter in Russia or Lapland. For the same reason, that is, because they are annuals, and require little more than to be sown and reaped, the bread corns are in an especial manner the domestic plants of man in an early stage of civilization. A people like the wandering Arabs, who live in tents, and change their encampments annually or oftener, may conveniently reap their crop, raise their tents, and carry their seed corn about with them, till they find a suitable spot where they can pitch their tents and take their next crop. This, however, could not be done by a people who, in addition to corn and pulse, depended for the food of themselves and cattle on the production of roots, such as the turnip and the potatoe; and these accordingly are plants characteristic of a settled people, in a higher degree of civilization and a greatly advanced state of agriculture. The capacity of any country for growing corn may be said to be according to the flatness of its surface, provided it be neither too hot nor too cold, too wet nor too dry. The perennial grasses and trees also grow better in plains than any where else; but they will thrive on the steep declivities of hills, which, if subjected to tillage in order to grow corn, would have the surface soil washed away by rains and thawing snows.

Value of the Produce of Corn. — In agricultural countries, not in a very high state of civilization, the culture of corn is the principal employment of the great bulk of the community; and in all considerable countries, how far soever they may be advanced in arts and refinement, its culture is always by far the most extensive as well as the most important branch of national industry. No great country, perhaps, ever existed, the population of which was so extensively engaged in manufactures and commerce as that of Great Britain. Still, however, we employ about a *third part* of our inhabitants in agriculture; and of these, fully three fourths are directly or indirectly engaged in the raising of corn. Unfortunately, there are no accounts, on which it would be safe wholly to rely, of the ordinary produce of corn either in this or any other great country. But, without pretending to peculiar accuracy, we are inclined to think that the present (1842) average growth of all sorts of corn in the United Kingdom may be safely estimated at about 64,000,000 quarters, of which about 55,000,000 may be consumed by man, and the lower animals. (See *post.*) Now supposing this estimate to be nearly accurate, and taking the average price of the different descriptions of corn at 35*s.* a quarter, the total value of the corn annually produced will amount to the sum of 112,000,000*l.* sterling, or to nearly or quite four times the total annual value of the cotton manufacture! This is sufficient to evince the paramount importance of agriculture as a source of wealth as well as a means of subsistence.

Corn Laws. — This superior importance of corn as an article of culture, and the dependence so generally placed upon it as an article of food, are the causes why the trade in it has been so very generally subjected to regulation. It is long even before the most enlightened portion of an instructed community become satisfied of the advantage of permitting the supply of corn or any indispensable article to be adjusted, like that of other less important things, by the unfettered competition of private individuals. It seems, at first sight, reasonable to suppose that the most likely way to secure plenty at home is to impose restrictions on exportation. But in truth and reality, this is very far from being the case. How fertile soever, no country that imposes restrictions on exportation need hope to escape perpetually-recurring scarcities; for wherever free exportation is prevented, the excess of supply that occurs in plentiful years being thrown wholly upon the home market depresses prices to such an extent as to be ruinous to the farmer: and thus, by injuring agriculture and lessening the quantity of land in corn, never fails to occasion a scarcity on the occurrence of a deficient harvest. In Great Britain, however, the policy has long been to give every facility to exportation, and even to lay restrictions on importation. This has arisen from our legislature being principally composed of individuals dependent on and connected with the land; and whose interest consequently has led them to endeavour to secure as high a price as possible for its produce. But it is needless to add that this policy is, if possible, even more objectionable than the other. Instead of being publicly advantageous, high prices are, in every instance, distinctly and completely the reverse. The less the sacrifice of money or of labour for which corn or any other article can be procured so much the better. But to make sure that the price of corn, or of any thing else, will be fixed at the lowest limit at which the required supply can be obtained, all that is necessary is to abolish all restrictions, whether on exportation or importation. Freedom is the parent of abundance, cheapness, and equality of price; restriction, of scarcity, dearness, and uncertainty. Any interference with the trade in corn, or with any other great department of trade, that has not the removal of natural or artificial restraints for its object, is not only inconsistent with the best established principles, but is sure to be pernicious. In this, as in all other things connected with national industry, the short and only safe rule is to leave individuals to pursue their own interest in their own way.

Our limits forbid our attempting to make any enumeration of the various statutes that have been passed at dif-

ferent periods for regulating the trade in corn. Down to the Revolution, the policy was to restrict exportation; but from that period the contrary policy has been pursued, and the legislature has pretty uniformly endeavoured to facilitate exportation, and to prohibit or fetter importation. It was not, however, till about 1770 that the restrictions on importation began to have much practical influence. But about that time, population having begun rapidly to advance, in consequence of the extraordinary impulse given to manufacturing industry by the inventions and discoveries of Watt, Arkwright, Wedgwood, and others, the price of corn in England began to rise above its price on the Continent; and from being an exporting we became an occasionally, or rather a pretty constantly, importing country. Had there been no restrictions on importation, our prices, it is plain, could not have exceeded those of the adjoining Continental states by a greater sum than might have been required to defray the cost of importing into this country. The restrictions, however, overturned this natural principle; and in deficient years added materially to the difference between our prices and those of the Continent. This difference attained to its greatest height during the late war, owing to the formidable difficulties it threw in the way of importation. During the last six years of that contest, prices in England (after allowing for the depreciation of the currency) were fully double their amount in the principal continental markets.

At the close of the war, in 1814 and 1815, the renewed intercourse with the Continent led to a great importation of corn, which occasioned such a sudden and heavy fall of prices as was productive of much severe distress amongst the farmers. Parliament endeavoured to obviate this by increasing the restrictions on importation, a device which had, in part, the anticipated effect. But since 1820, the influence of improved communications and of ameliorations in agriculture has been so very great, that, notwithstanding the vast increase of population, prices have been progressively falling, and were, in 1835, lower than in any previous year since 1787. Practically, therefore, the influence of the restrictions has been materially diminished, and a much greater effect is now usually ascribed to them in ordinary years than they really exert. No doubt, however, they tend materially to aggravate the scarcity and suffering originating in a deficient harvest, and are, therefore, highly objectionable.

The existing duty on foreign corn, or that imposed in the course of the present year (1842), by the act 5 Vict. 2 sess. cap. 14, is not invariable, but fluctuates according to the variations of price in the home market. It amounts to 20*s*. on wheat, when the price is at and under 51*s*. a quarter; and decreases, though not regularly, as the price rises, till the latter reaches 73*s*., when the duty is 1*s*. only. We subjoin the scale of duties on wheat: —

Average Price per Quarter.	Duty per Quarter.	Average Price per Quarter	Duty per Quarter.	Average Price per Quarter.	Duty per Quarter.
Under 51*s*.	20*s*.	58 — 59*s*.	14*s*.	66 — 67*s*.	6*s*.
51 — 52	19	59 — 60	13	67 — 68	6
52 — 53	18	60 — 61	12	68 — 69	6
53 — 54	18	61 — 62	11	69 — 70	5
54 — 55	18	62 — 63	10	70 — 71	4
55 — 56	17	63 — 64	9	71 — 72	3
56 — 57	16	61 — 65	8	72 — 73	2
57 — 58	15	65 — 66	7	73 and upwards	1

Corresponding duties are laid on barley, oats, and other species of grain.

This fluctuating scale of duty, though it be a material improvement on the previous scale, or that laid down by the act 9 Geo. 4. cap. 60, has like it, though in a less degree, the defect of adding to the risk and uncertainty incident to the corn trade; for, suppose a merchant orders a quantity of foreign corn when prices are at a certain level, if they fall before it arrives, he not only loses in consequence of the decrease of price, but is further charged with a corresponding increase of duty; whereas on the other hand, had the price advanced, he would have gained not merely by its increase, but by the fall in the rate of duty! The effect of this system is, therefore, precisely the reverse of what it should be were it founded on sound principles, inasmuch as it aggravates the loss arising from a bad, and increases the profit of a successful, speculation!

But in recommending the policy of a free trade in corn, we do not mean to contend that it would be either just or expedient always to admit of importation free of duty. In certain circumstances this may be the proper course, but not in all. No duty should ever be laid upon foreign corn on pretence of protecting British agriculture, as that is, in fact, taxing the other classes in order to secure a doubtful benefit for the agriculturists. But if agriculture be more heavily burdened than any other great department of industry carried on at home, a constant duty should be laid on corn from abroad, to balance the excess of duty falling on the agriculturists. This is not to favour the latter, but to do them justice. It has been denied that the British agriculturists are in this predicament; but were this the place for entering into such investigations, it would not be difficult to show that they are in fact more heavily taxed than the manufacturers or traders; and that, consequently, they are entitled to claim that a fixed and invariable duty be laid on all foreign corn when imported, corresponding to the excess of taxation by which they are affected. We believe, however, that a fixed duty of 5*s*. a quarter on wheat, and on other grain in proportion, would be more than adequate to meet all the claims of the agriculturists arising out of the peculiar pressure of the taxes to which they are subjected; and it is abundantly certain, that with such a duty, but little foreign corn would now be imported in ordinary years; and, consequently, that the agriculturists would sustain no real injury from the adoption of such a system. Those who may wish for further information as to the interesting topics now merely glanced at, and others we have not been able to notice, are referred to the article "Corn Laws," in the new edition of the *Encyclopedia Britannica*, the art. "Corn Laws" in the *Commercial Dictionary*, and the note on the same subject in M'Culloch's edit. of the *Wealth of Nations*, 1 vol. 8vo.

We subjoin an estimate of the quantity of corn used as food for man; and of the total quantity of corn produced and consumed in the United Kingdom, deduced from the data given in *M'Culloch's Statistics of the British Empire*, and the census of 1841.

	Quarters.
I. Consumed by man: —	
Wheat - - - -	15,000,000
Oats, rye, and maslin - - -	15,000,000
Barley for malting, &c. - -	6,000,000
Beans and pease as meal - - -	600,000
Total consumed by man - -	36,600,000
II. Consumed by the lower animals: —	
Corn (principally oats), used in the feeding of horses and other animals, in distillation, &c. - - -	18,000,000
Total consumed by man and the lower animals, &c. - - - -	54,600,000
To which add seed, 1-6th part -	9,100,000
Total growth of corn in the United Kingdom - - - -	63,700,000

Account of the Average Prices of British Wheat per Quarter, in England and Wales, since 1771, as ascertained by the Receiver of Corn Returns.

Years.	Wheat.			Years.	Wheat.			Years.	Wheat.		
	L.	*s.*	*d.*		*L.*	*s.*	*d.*		*L.*	*s.*	*d.*
1771	2	7	2	1795	3	14	2	1819	3	13	0
1772	2	10	8	1796	3	17	1	1820	3	7	11
1773	2	11	0	1797	2	13	1	1821	2	16	2
1774	2	12	8	1798	2	10	3	1822	2	4	7
1775	2	8	4	1799	3	7	6	1823	2	13	5
1776	1	18	2	1800	5	13	7	1824	3	4	0
1777	2	5	6	1801	5	18	3	1825	3	8	7
1778	2	2	0	1802	3	7	5	1826	2	18	9
1779	1	13	8	1803	2	16	6	1827	2	16	9
1780	1	15	8	1804	3	0	1	1828	3	0	5
1781	2	4	8	1805	4	7	10	1829	3	6	3
1782	2	7	10	1806	3	19	0	1830	3	4	3
1783	2	12	8	1807	3	13	3	1831	3	6	4
1784	2	8	10	1808	3	19	0	1832	2	18	8
1785	2	11	10	1809	4	15	7	1833	2	12	11
1786	1	18	10	1810	5	6	2	1834	2	6	2
1787	2	1	2	1811	4	14	6	1835	1	19	4
1788	2	5	0	1812	6	5	5	1836	2	8	6
1789	2	11	2	1813	5	8	9	1837	2	15	10
1790	2	13	2	1814	3	14	0	1838	3	4	7
1791	2	7	2	1815	3	4	4	1839	3	10	8
1792	2	2	11	1816	3	15	10	1840	3	6	4
1793	2	8	11	1817	4	14	9	1841	3	4	4
1794	2	11	8	1818	4	4	1				

CO'RNEA. (Lat. cornu, *a horn.*) The transparent membrane of a horny texture which forms the anterior part of the eyeball. In vertebrates it is simple: in insects it is subdivided into numerous hexagonal segments.

CO'RNET. (It. cornetta, *a small flag.*) A commissioned officer in a troop of horse, corresponding in rank with the ensign of a battalion of infantry. His duty is to carry the standard near the centre of the front rank of the squadron.

Cornet. In Music, a shrill wind instrument formed of wood, which appears to have been in use in the earliest times, and remained so till about the commencement of the 18th century, when it was displaced by the oboe.

CO'RNET-A-PISTONS. (Fr.) A brass wind musical instrument, of the French horn species, but capable of much greater inflexion from the valves and stoppers (pistons) with which it is furnished, and whence it derives its name.

CO'RNICE. (Fr. corniche.) In Architecture, the upper great division of an entablature (*see* Entablature), consisting of several members.

CORNS. Thickenings of the cuticle of the toes, of a

horny texture, arising from continued pressure over a projection of bone. One of the best and simplest remedies for this painful disorder is to wear upon the toe or part affected a piece of leather, spread with diachylon or other emollient plaster, and having a hole in it corresponding with the size of the corn. By this means all pressure upon the corn is avoided. (See *Sir B. Brodie's Lecture on Corns and Bunions*, *Medical Gazette*, 13th Feb. 1836.)

CO'RNSTONE. A provincial name for a species of red limestone.

CO'RNU AMMONIS. A name sometimes applied to the fossil shells called Ammonites.

CO'RNUA. (Lat. cornu, *a horn.*) In Zoology, hard and more or less elongated processes projecting from the head. The term is usually applied to such processes in the class Mammalia, in which they serve as weapons of offence and defence. These weapons consist either of bone, when they are called "antlers;" or of horn, or of bone and horn, or lastly of bone and hairy skin. The first kind of horns are peculiar to the deer tribe; the second to the rhinoceros; the third to the sheep, ox, and antelope tribes; and the fourth to the giraffe. The bony horns, antlers, ceràta, or *cornua solida*, as they are technically termed, during the whole period of their formation resemble the horns of the giraffe, inasmuch as they are covered with a hairy and highly vascular integument: the bony material of these processes is in fact secreted by the vessels of that integument, so that their co-existence is essential as long as growth proceeds. When their growth is completed, and the antlers have arrived at their characteristic size and figure (which in the elk and Wapiti deer are truly remarkable), the determination of blood to the parts gradually lessens; the vessels shrink; the circulation in the formative membrane is at length suppressed; and the tegument then shrivels, dries, cracks, and is rubbed off by the instinctive actions which the deer now almost ceaselessly performs with his newly acquired and consolidated antlers. The skin and periosteum of the head, once continuous with those of the antler, now terminate at an abrupt line at the base of the antler, from which a ridge of bone, or "burr," as it is termed, is developed, apparently for the purpose of defending the margin of the persistent integument; for when this is continued, as in the Munt-jac deer, half way up the antlers, the burr is developed immediately above its termination, or at the middle, and not at the base of the antlers. Some physiologists have conjectured that the use of the "burr" was to compress the vessels of the periosteum of the antler, and that its formation was deferred to near the completion of the antler: but observation shows that it commences at an earlier period of growth; and sound physiology teaches that the cessation, like the commencement of the growth of the horn, must be the result of deeper and more constitutional operations. The most remarkable fact in the economy of antlers is that they are shed and renewed annually, the fall of the horns being concomitant with the shedding of the hair. The attempts to assign the final cause of this phenomenon have not been very successful. In the axis deer, *e. g.* the bucks do not all shed their horns at the same time, but at different periods of the year. In the rein-deer the branches which project forwards from the base of the horn, or the brow antlers, are habitually used to scrape away the snow which conceals the lichens on which they principally feed. The female, therefore, needs antlers as much as the male, and she has them; but this is a rare and singular exception, for the females of other species of deer are destitute of these ornamental weapons. True horns, or those which consist either partly or entirely of horny material, are never shed. In the antelopes they are in almost all cases confined to the male, and their bony basis is generally solid; in sheep and oxen the horns are commonly present in both sexes, and the bony basis is hollow. The term *cornua cava* is, however, usually applied to all horns consisting of bone and horn, and reciprocally the ruminants having such horns are termed "hollow-horned." But this extension of the term seems to have arisen from a consideration of the external horny sheath alone, which is but a part, and that not the most essential, of the horn. The horn or horns of the rhinoceros consist of an agglutination of horny fibres, which are attached only to the integument; the integument adhering with more than usual firmness at this part to the roughened surface of the bone beneath. The horn of the rhinoceros differs from that of other mammalia in being situated upon the median line of the forehead; so that when there are two they are placed one behind the other, and not laterally and symmetrically, as in the ruminants.

A few ruminants have naturally two pairs of horns; and this was the case with a great extinct species, *Sivatherium*, whose remains have been discovered in the Himalayan mountainous regions, where the small *Antilope quadricornis* still exists. Horns are characterized in zoological descriptions according to their position, as *Cornua nasalia*, *frontalia*, *parietalia*, &c.: or according to their direction, as *Cornua prona*, turned forwards; *reclinata*, turned back; *incurva*, bent inwards; *vara*, bent outwards; *redunca*, with the apices curved forwards; *lyrata*, when they represent the horns of the ancient lyre; *gyrata*, when spirally twisted: or according to their period of existence, as *cornua perennia*, when they last the life-time of the animal; or *cornua decidua*, or *annua*, when annually shed: lastly, horns are termed *cornua ossea*, *cornua solida*, *cava*, according to their structure, as above described. For the peculiarities of the giraffe's horns, see GIRAFFE.

Certain species of many other classes have parts projecting from the head, analogous in form or structure to the cornua of the mammalia. The frontal protuberance of the emeu, hornbill, and helmeted curassow consists of bone covered with a sheath of horn; the kamichi or horned screamer is a still more remarkable example of a bird so armed. In reptiles we find horned toads, vipers, and iguanas. Fishes present divers simulations of true horns. In mollusca retractile feelers or eye-stalks are commonly called "horns," as in the snail; but the appendages which would come under the general definition of our present term arrive at their maximum relative size, variety, and singularity of form in the class of insects.

CO'RNUCO'PIA. (Lat. cornu, *a horn*, and copia, *plenty.*) In the Fine Arts, an ornament representing a horn, from which issue flowers, fruits, leaves, and the like. The origin of the cornucopia has been variously given. Some authors have traced it to the infant days of Jupiter, whose nurse, Amalthea, when one of her goats had broken off a horn against a tree, presented it to the god wreathed with flowers and filled with fruit. Hence it became the emblem of Plenty among the ancients, in which light it is regarded also by many modern nations. The cornucopia is found very frequently in the types of ancient coins, particularly upon those of Sicily. (See the medal of Arsinoe.)

CORO'LLA. (Lat. corolla, *a garland.*) That envelope of a flower which is placed next within the calyx. It is usually more richly coloured and larger than the latter, but is extremely variable in this respect. Owing to its being in many plants one of the most striking parts of the flower, it is much employed by botanists in their systematical arrangements, and by the French school has been taken as the means of forming fundamental characters of the subclasses in the great Dicotyledonous division; but there is no doubt that its importance for this purpose has been much overrated. Theoretically considered, the corolla is composed of modified leaves, with the ordinary organization of which its parts or petals correspond as much as can be expected of rudimentary organs; its physiological action is to absorb oxygen, without decomposing carbonic acid, in which respect it agrees with leaves in their morbid state in the autumn. The corolla has been described by Lamarck as a diseased state of the foliage.

CO'ROLLARY. (Lat. corollarium, signifying originally a gratuity or donation presented to a person over and above what was strictly his due.) In its mathematical sense, this word is used to designate a consequence drawn from some proposition already demonstrated without the aid of any other proposition. Thus, supposing it demonstrated that if a triangle have two equal sides, it has also two equal angles; it would then follow, as a corollary, that if the three sides of a triangle are equal, its three angles are also equal.

CORO'NA. (Lat.) In Architecture, the flat, square, massy member of a cornice, very frequently called the drip or larmier. Its situation is between the cymatium above and the bed moulding below, and its use to carry the water drop by drop from the building.

CORO'NA AUSTRALIS and CORONA BOREALIS. (The *southern crown* and *northern crown.*) Two of the old constellations of Ptolemy; the first in the southern, and the second in the northern hemisphere.

CORO'NA DENTIS. In Zoology, the exposed part of a tooth, which projects beyond the alveolus and gum.

CORONA'MEN. In Zoology, the superior margin of a hoof, called in veterinary surgery the coronet.

CO'RONARY. (Lat. corona, *a crown.*) Coronary vessels and ligaments are those which spread round certain viscera, bones, &c.

CORONA'TION. *See* KING.

CO'RONER (Lat. coronator), is the title of an office established in Saxon times, of which the holder was, as his name indicates, in a peculiar manner the officer of the crown, whose private rights of property, whether arising by escheat, wardship, or consisting in demesne, it was his business to maintain and superintend in the county for which he acted. Connected in some degree with this character is the more important if not the sole function which he now exercises: that of holding inquests on the bodies of such as either die or are supposed to die a violent death. (4 Edw. 1. st. 2.) For which purpose he is empowered to summon jurymen out of the neighbourhood, and witnesses. Should violent death be occasioned by any personal chattel, it is forfeited as a deodand to the crown; but juries are now in the habit of assessing a small sum of money in lieu of the

chattel or its full value. (*See* DEODAND.) The coroner was originally in some sort the colleague and assistant of the sheriff, and in his default might still act as sheriff in the execution of writs, which in such case would be directed to him. The coroner is still, as the sheriff was formerly, elected by the freeholders of the county; but the office, which was once strictly honorary, has lost much of the dignity which belonged to it, and is now held by persons, usually either surgeons or attorneys, whose object in accepting it is the profit to be derived from fees. There are generally several coroners in the same county. (*Jervis on Coroners.*)

CO'RONET, or CORO'NA. This word is employed by botanists to express certain appendages of the corolla, which are arranged within it in a circle, and which not unfrequently give a very peculiar appearance to the flower in which it is found. In the Narcissus it is a cup; in Symphytum it consists of five glandular narrow processes; in Asclepias it is a thick fleshy ring extended into bended lobes. In all cases the coronet is a modification of sterile stamens.

CO'RONET. In Heraldry, an inferior crown belonging to the British nobility. The figure of John of Eltham, second son of Edward II., who died in 1334, affords the earliest representation of this ornament. Barons do not appear to have borne them earlier than the reign of Charles II. The time at which the coronets of the present orders of nobility were respectively distinguished in the existing fashion cannot be ascertained.

CO'RONET-BONE. The second of the consolidated phalanges of the horse's foot.

CO'RPORAL. (Fr. caporal, from capo, *a hedd.*) A non-commissioned officer in a battalion of infantry immediately under the serjeant; his business is to place and relieve the sentinels, and at drill he has charge of a squad. In the ranks he does the duties of a private, but his pay is somewhat higher.

CORPORA'TION. (Lat. corpus, *body.*) A body politic or incorporate; consisting of a person or persons having power to take and grant, &c. to himself or themselves and their successors. Corporations, in English Law, are divided,—1. Into sole and aggregate. Sole corporations are such as consist of a single person who is constituted a corporation by law, for the purpose of enjoying certain advantages and incurring certain duties, transmissible to his successors. Such is the parson of a living in respect of his benefice; a bishop, in respect of the ecclesiastical rights and property of his see; the king, &c. Corporations aggregate are such as consist of more individuals than one, and are kept up by a perpetual succession of members. 2. Into ecclesiastical and lay. Parsons, bishops, deans and chapters, are instances of the former. The latter are again subdivided into civil and eleemosynary. Among the first are trading companies and municipal corporations; among the latter, hospitals, colleges in the universities, and similar establishments (which, however, were anciently esteemed eccelsiastical).

By the law of England, corporations are erected only with the king's consent, express or implied; and may exist by prescription, by letters patent, or by act of parliament. Bishops, parsons, &c., may indeed be said to exist as corporations by force of the common law; but some ancient municipal bodies, such as the corporation of London, are in a stricter sense corporations by prescription. Corporations by act of parliament may be created either expressly, or by implication; as, where a body is to take lands by succession, this constitutes them a corporation. But the ordinary mode by which they are erected is by the king's letters patent or charter of incorporation; persons exercising the power of founding corporations by a grant of their own (as the chancellor of the university of Oxford) being for this purpose only delegates of the king.

The chief incident of a corporation is the power of taking by succession. This power is, however, confined in the case of sole corporations to estates of freehold; corporations aggregate only can take goods and chattels by succession. Grants by a corporation aggregate must be by deed under their common seal, which is necessary to give validity to most of their acts. A corporation has essentially the power of making by-laws to bind its own members, which are valid so far as they are not contrary to the laws of the kingdom. Corporations ecclesiastical and eleemosynary may, moreover, be subject to rules or statutes imposed by the king or the founder; civil corporations only to the common law and their own by-laws. In aggregate corporations, the act of the majority is the act of the whole.

The common law capacity of corporations to take lands has been, however, materially narrowed by statute. Thus a devise of lands to a corporation by will is bad, except for charitable purposes. And, in consequence of the Statutes of Mortmain (*see* MORTMAIN), a corporation, whether lay or ecclesiastical, must now have a license from the king in order to purchase.

All corporations are said to be subject to visitation. The visitor of ecclesiastical corporations is the ordinary (*see* ORDINARY); the visitor of lay corporations is the founder. In eleemosynary corporations this right, therefore, is in the founder and his heirs, or in such person as he has appointed: in civil corporations, the king is visitor, and exercises that jurisdiction in the King's Bench; where alone misbehaviour of such corporations or their officers can be inquired into, chiefly by means of the processes termed *mandamus* and *quo warranto* (which see). A corporation is dissoluble, 1. By act of parliament; 2. In the case of an aggregate corporation, by the death of all its members; 3. By surrender of its franchises into the hand of the king; 4. By forfeiture of its charter through negligence or abuse of the franchise.

CORPORA'TIONS, MUNI'CIPAL. These bodies, which have acted so important a part in the history of modern Europe, originated in the Italian and provincial towns subject to the Roman sway. Under that empire the government of the towns was in many respects independent of the central authority, or only controlled by it in the last resort; and as the municipal institutions of the Romans remained undestroyed through the long period of the dark ages, the free cities which arose in the eleventh and twelfth centuries in Italy, France, and elsewhere, did in fact only preserve their ancient systems of internal policy in the new character of republican constitutions. (See especially *Savigny on Roman Jurisprudence in the Middle Ages.*)

In England we have no record of the internal constitution of our towns prior to the Saxon times, and during those times our information is extremely scanty and imperfect. The magistracy in Saxon towns appears to have been elective; that in Danish, hereditary. In Domesday Book we find in every town (eighty-two in all, in those parts of the record which remain to us) a certain number of persons mentioned as "burgesses;" a number sometimes equalling, sometimes falling far short of the houses enumerated. It has been supposed that at this early period all free inhabitants paying scot and lot were burgesses; a supposition which can neither be easily proved nor controverted. Boroughs at this period were exempt from the immediate jurisdiction of the sheriffs of the counties in which they were situate: they possessed their own hundred courts, leets, and view of frankpledge; but they were liable for various duties to the king, who was usually lord of the leet, *i. e.* exercised jurisdiction in the borough; and to the lord of the soil also, if there were any. It became usual after the Conquest for the king to let the fees and revenues thus due, together with the right of appointing the officers of justice, to the burgesses in general; and by this species of enfranchisement the borough became an independent municipality. But a free borough was constituted by having, in addition to those powers, exemption from the king's tolls, granted to its burgesses by royal charter. Such continued to be, in substance, the condition of English boroughs for several centuries. Burgess-ship was gained, either by residence simply, with payment of scot and lot, or, in some cases, by apprenticeship, constituting a title of admission to the guild merchant or trading community of the borough, which by degrees became identified with the borough itself; or, as in London, by admission into the guilds of the several trades, an alteration which appears to have taken place in that city as early as the thirteenth century.

During all this period no one seems to have doubted the capability inherent in the burgesses of a town, as a community, to take and enjoy lands, tolls, or other hereditaments, to themselves and their successors. But about the period of the reigns of Henry V. and VI., the increasing subtlety of our legal system, and more particularly the notions introduced by the study of the civil law, appear to have occasioned the custom of granting charters in a new form. It appears to have been thought that the power of holding lands in succession, and the right of suing and being sued by a common name, could not in strictness be enjoyed, except by a body constituted for those very purposes by the king's grant. Hence originated charters or letters of incorporation. These seem to have been first granted to eleemosynary foundations; afterwards, and first in the reigns before mentioned, they were granted to the men or burgesses of towns jointly with the mayor, bailiff, or other chief officer; and thus municipal corporations in the strict legal sense were first constituted.

But previously to this time it is probable that a great change had taken place, in most towns, in the character of the class of "men" or "burgesses" to whom these charters were granted. As the privileges of burgess-ship became more valuable, additional difficulties were thrown by the governing body in the borough in the way of its acquisition. While the old household right remained in some places, it was lost in others: in its stead, or by its side, arose the rights of freemen of a guild or trade; those of the holders of particular tenements, which alone were recognized as conferring on their occupant the title of burgess; those of freeholders in cities, counties of themselves, &c. And hence the variety of the old parliamentary franchise (*see* PARLIAMENT), as members of parliament were elected by the burgesses. Hence the

corporations, which were constituted by the charters of Henry VI. and Edward IV., were already very different bodies from the general mass of dwellers in a town. But close corporations, properly so called, were not established until the reigns of the Tudors, when the first "governing charters" were granted; that is to say, charters which, disregarding the old common law system, by which every burgess had a share in corporate rights, and the power of electing his magistrates, established special rules for the internal regulation of a borough. By these new charters the powers of municipal government were usually vested in a mayor and common council: the latter consisting of councillors and aldermen; the former of whom were selected in various ways, by the whole of the council or the aldermen; the aldermen mostly nominated by and out of the rest of the council. In these bodies the control over the town funds, the civil and criminal jurisdiction of the town, and police authority within its limits, became vested. The freemen, as well as the commonalty, thus ceased to be members of the governing body; but the former retained the extensive pecuniary advantages which in many places belonged to them.

The causes of this revolution, and of the gradual change by which the municipal bodies became more and more exclusive in their character, are chiefly to be found in the parliamentary franchise enjoyed by most of the corporate boroughs. When the House of Commons became an important body in the empire, the crown, as well as the noblemen and the powerful individuals to whose estates the boroughs were contiguous, had a strong and direct interest in controlling the nomination of members. This was much more easily effected by the agency of select bodies, such as the corporations, than by influencing the votes of an independent community. Hence, while in the larger places the corporation, usually devoted to the interest of its patron, exercised a decisive or a strong authority in controlling elections, in many smaller boroughs the elective franchise became in effect confined to the corporation itself, by means of the freemen who were closely associated with it. Thus the system of close corporations, established under the Tudors, acquired continually more strength and more exclusiveness: although the committee of privileges presided over by Mr. Serjeant Glanville, in the reign of James I., resolved that charters of the crown were inoperative so far as they assumed to alter the parliamentary franchise of a borough. The governing bodies in the previous reign seem also to have assumed in many places the power, which has been since so liberally exercised, of admitting to the rights of freemen, or burgesses, whom they pleased, either by free gift or purchase. The great bulk of the property of corporations, both that enjoyed by them to their own use, and that of which they were trustees for charitable purposes, seems to have been acquired after the first charters of incorporation were granted, and previously to the Revolution.

In the reign of Charles the Second, when the corporate bodies in the larger towns had become for the most part attached to the Whig interest, and hostile to the court, they were attacked by the crown through the famous writs of quo warranto. These were writs issued out of the King's Bench to the municipal bodies, to inquire by what right they exercised their jurisdictions and enjoyed their franchises; and the object was to contest the validity of the ancient charters, or at least to terrify them into surrendering them into the king's hands, and receiving new ones from him. Many such surrenders were actually made, and new charters granted: these, however, were recalled by a proclamation of James II., and the old ones regranted or revived; and this proclamation was allowed, after the Revolution, to have the force of law. A few boroughs, however, did not accept the restoration of their charters, and remained without a corporation. From the period of the Revolution little or no change of importance took place in the constitution of the towns or their governing bodies, until the passing of the Municipal Reform Act in 1835. By this act (5 & 6 W. 4. c. 76.) the municipal franchise is made uniform all over the kingdom. In order to enjoy it, an individual must have occupied a house, warehouse, counting-house, or shop, within the borough, for three years; and must have been rated to all poor rates in respect of such premises during the whole of such time; and must be enrolled on the burgess list, which is framed by the overseers of the parishes and revised every year by the mayor and assessors. He must also have resided within seven miles of the borough during that time. There are also provisions for the cases of successive occupancy and change of residence. These burgesses form the electoral body. They choose,—1. The councillors; of whom the number is limited by the act, according to the number of wards of which each borough consists (this number being also specified by enactment, and varying from one to sixteen). No person can be qualified as a councillor, or alderman, unless he is a burgess possessing a certain amount of property (1000*l.*), or a rating at 30*l.* per annum, in boroughs having four wards and upwards; 500*l.*, or 15*l.* per annum, in boroughs not having that number. One third part of the councillors go annually out of office. 2. The council, *i. e.* the mayor, existing aldermen, and councillors, jointly elect every year the aldermen from among the qualified burgesses; half of whom go out of office every third year. 3. The councillors and aldermen together elect out of their own united body the mayor, whose office is annual. The mayor, aldermen, and councillors together form the council. The town-clerk, treasurer, &c. are appointed by the council during pleasure.

With regard to existing rights, freemen are retained, so as to enjoy their rights of property and parliamentary franchise; but they can no longer be made by gift or purchase; and they must be inhabitants of the borough. The income arising out of the corporation property is to form a borough fund; which is to be applied, subject to existing claims, to the payment of salaries and other municipal expenses, prosecutions, maintenance of the gaol, &c. &c.; and if the fund be insufficient for these purposes, the council can impose a rate to supply the deficiency. Wherever a municipal corporate body, either sole or in conjunction with other persons, had lands, &c. in trust to charitable uses, the trusts are gradually transferred by this act to the new councils; but every corporation possessed of advowsons, or rights of nomination to benefices in the church, is required to sell such advowsons, &c. under the direction of the ecclesiastical commissioners. Where the watching of the town was regulated by local acts, these acts are repealed, and the corporation is directed in all places to appoint a committee for the purpose of superintending that duty; and wherever the lighting is not regulated by local acts, that also is placed under the management of the corporation.

With respect to jurisdiction, the council of every borough now having a separate court of quarter sessions, or desiring to attain one, may apply to the king to retain or to acquire it; on which the king may, if he pleases, appoint a recorder to be paid by the town, being a barrister of five years' standing. This officer is to hold the court of quarter sessions of the peace, in which he is to be sole judge. Borough courts of record are to be retained as heretofore, and those in which a barrister of five years' standing acts as judge have power to try personal actions to the amount of 20*l.* The king is empowered to grant a commission of the peace to all boroughs named in Schedule A of the act, and to such boroughs named in Schedule B as he shall see fit, on petition of their council. The mayor and recorder to be justices of the peace ex officio; the others named by the crown. The council also are directed, if they think fit, to petition for the appointment of salaried police magistrates in their borough, stating the salary which they are willing to pay; on which the crown will appoint such officer or officers, being barristers of not less than five years' standing. The history of municipal corporations has been often written, and generally with much party spirit and unfairness. Those who wish to study it in the only authentic records, viz. charters and other documents, will find the most abundant collection of them, chronologically arranged, in *Messrs. Merewether and Stephen's History of Boroughs*, 1836.

CORPU'SCULA VERMIFO'RMIA. (Lat. corpusculum, diminutive of corpus, *body*, and vermiformis, *worm-shaped.*) In Vegetable Anatomy, are synonymous with strangulated or necklace-shaped ducts, a kind of spiral vessel found chiefly in the knots and contracted parts of stems.

CORPU'SCULAR A'CTION. The power or influence which the minute particles, or atoms, or *corpuscles* of matter, exercise on each other, and which is the cause of all chemical changes.

CORPU'SCULAR PHILO'SOPHY. A system of physics in which all the phenomena of the material world are explained by the arrangement and physical properties of the corpuscles or minute atoms of matter. A doctrine of this sort was anciently taught in Greece by Leucippus and Democritus, and is described in the beautiful poem of Lucretius.

CO'RPUS JURIS. (Lat. *body of law.*) *Corpus Juris Romani*, the collection of the authentic works containing the Roman law as compiled under Justinian. The Corpus Juris comprehends the Pandects, the Institutes, the Code, and the Novels or Authentics, *i. e.* the later constitutions of Justinian; to which, in some editions, are added a few issued by his successors. M. Beck has lately published at Leipzig the most complete edition. There are likewise publications styled *Corpus Juris Canonici*, *Germanici*, *Feudalis*, &c.

CORRE'CTION. (Lat. corrigo, *I correct.*) In the Fine Arts. With the Italians the word, *correzione*, is used to denote an exact acquaintance with the different proportions of the parts of a body or design generally; but with us the term is applied to those emendations of inaccuracies or alterations of first thoughts, which they call *pentimenti*, to be seen under the surface of the finished picture, and which are accounted indications of its originality.

CORRECTING, in Printing, in the first instance, is to amend and put right the errors in the types that the compositor may have made, and any defects in his workmanship; in the next, it is the correcting of the proof sheets of a work by the author or editor, in the orthography, the punctuation, the language, and in making such alterations as may appear to him necessary. The following explanation of the marks which are in general use by printers for this purpose, with the annexed specimen, will enable a gentleman who has to superintend a work through the press to correct the proof sheets in a way that will be clearly understood by the printer, and will tend to promote correctness by preventing those mistakes that occasionally occur, owing to his not clearly comprehending the marks on the proof.

1. Where a word is to be changed from small letters to capitals draw three lines under it, and write *caps.* in the margin.

2. Where there is a wrong letter draw the pen through that letter, and make the right one opposite in the margin.

3. A letter turned upside down.

4. The substitution of a comma for another point, or for a letter put in by mistake.

5. The insertion of a hyphen.

6. To draw the letters of a word close together that stand apart.

7. To take away a superfluous letter or word the pen is struck through it and a round top *d* made opposite, being the contraction of *deleatur*, to expunge.

8. Where a word has to be changed to Italic draw a line under it, and write *Ital.* in the margin; and where a word has to be changed from Italic to Roman, write *Rom.* opposite.

9. When words are to be transposed three ways of marking them are shown; but they are not usually numbered except more than three words have their order changed.

10. The transposition of letters in a word.

11. To change one word for another.

12. The substitution of a period or a colon for any other point. It is customary to encircle these two points with a line.

13. The substitution of a capital for a small letter.

14. The insertion of a word, or a letter.

15. When a paragraph commences where it is not intended, connect the matter by a line, and write in the margin opposite *run on.*

16. Where a space or a quadrat stands up and appears, draw a line under it and make a strong perpendicular line in the margin.

17. When a letter of a different size to that used, or of a different face, appears in a word, draw a line either through it or under it, and write opposite *w.f.*, for wrong fount.

18. The marks for a paragraph, when its commencement has been omitted.

19. When one or more words have been struck out, and it is subsequently decided that they shall remain, make dots under them, and write the word *stet* in the margin.

20. The mark for a space where it has been omitted between two words.

21. To change a word from small letters to small capitals make two lines under the word, and write *sm. caps.* opposite. To change a word from small capitals to small letters make one line under the word, and write in the margin *lo. ca.* for lower case.

22. The mark for the apostrophe; and also the marks for turned commas, which designate extracts.

23. The manner of marking an omission, or an insertion, when it is too long to be written in the side margin. When this occurs it may be written either at the top or the bottom of the page.

24. Marks when lines or words do not appear straight.

The subjoined specimen when corrected would be as follows:—

ANTIQUITY, like every other quality that attracts the notice of mankind, has undoubtedly votaries that *reverence* it, not from reason, but from prejudice. Some seem to admire indiscriminately whatever has been long preserved, without considering that time has sometimes co-operated with chance: all perhaps are more willing to honour past than present excellence; and the mind contemplates genius through the shades of age, as the eye surveys the sun through artificial opacity. The great contention of criticism is to find the faults of the moderns, and the beauties of the ancients. While an author is yet living, we estimate his powers by his worst performances; and when he is dead, we rate them by his best.

To works, however, of which the excellence is not absolute and definite, but gradual and comparative; to works, not raised upon principles demonstrative and scientifick, but appealing wholly to observation and experience, no other test can be applied than LENGTH of duration and continuance of esteem.

Antiquity, like every other 1 *caps*
quality that attr~~r~~cts the notice
of ~~u~~ankind, has undoubtedly 3
votaries that reverence it, not *Ital*
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dice. some seem to admire
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been long pr~~o~~served, without
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times co-operated with chance:
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honour present than past ex- 9 *tr*
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contemplates genuis through 10 *iu*
the shades of age, as the eye
~~views~~ the sun through artificial 11 *survey*
opacity, the great contention 12 12
of criticism is to find the faults
of the moderns, the beauties 14 *and*
of the ancients. 15 *run on*

While an autor is yet living,
we estimate his powers by his
worst performances; and when
he is dead, To works, however, 18 *Break New Pa or ¶*
of which the excellence is not
5 gradual 4 but 1 absolute 2 and 3 defi- *tr*
nite and comparative; to works, 4
raised not upon principles de- 9 *tr*
monstrative ~~and scientifick~~, but 19 *stet*
appealing wholly to observa-
tion and experience, noother 20
test can be applied than length 21 *sm. caps*
of duration and continuance of
esteem. 22

we rate them by his best. 23

CORRESPO'NDENCE. (Lat. con, *with*, and respondeo, *I answer*.) In the Fine Arts, the fitting or proportioning the parts of a design to each other, so that they may be correlative, and that the same feeling may pervade the whole composition.

CO'RRIDOR. (Ital. corridoro.) In Architecture, a gallery or open communication to the different apartments of a house.

CORRO'SIVE SUBLIMATE. The bichloride of mercury, composed of 200 mercury + 72 chlorine. It is an acrid poison of great virulence: the stomach-pump and emetics are the surest preventives of its deleterious effects when accidentally swallowed; white of egg has also been found serviceable in allaying its poisonous influence upon the stomach. Its specific gravity is 52. It requires 20 parts of cold water, but only 2 of boiling water, for its solution. *See* Mercury.

CO'RRUGATE. (Lat. ruga, *wrinkle*.) In Zoology, the surface of an animal is so called when it rises and falls in parallel angles more or less acute.

CO'RSAIR. (Ital. corsaro.) A term used in the south of Europe and some other parts for a pirate or his ship. The corsairs of Barbary were commissioned by their princes to attack the merchant ships of hostile countries.

CO'RTES. (*See* States.) The old assembly of the estates in Leon, Castile, Arragon, and Portugal. These estates were framed, as elsewhere, of nobility, dignified clergy, and representatives of the towns. In Arragon they were presided over by a high officer, termed Justiza, with powers in some respects sufficient to control the monarch. The origin of popular representation in the cortes of the several kingdoms out of which that of Spain was finally formed is assigned to a date as early as the 12th century; but the deputies sent by the towns were irregularly summoned, frequently did not attend, and the numbers which appeared for each town frequently bore no proportion to the relative size of the different places. In the 14th century the power of the cortes seems to have been at its height, after which it gradually decayed, and under the government of Ferdinand and Isabella was reduced almost to a nullity. (See *Prescott's Ferdinand and Isabella*, vol. i.; *Hallam's Middle Ages*.) After the time of Philip II., the cortes of Spain were only occasionally convoked on the accession of kings, and their sittings were a mere form. In 1811, during the French invasion, they were convoked at Cadiz, and conducted the affairs of that kingdom during the war of independence. In 1814, Ferdinand VII. dissolved them, and declared all their decrees null. In 1820, the cortes met again, and adopted a new constitution; in 1821, the people of Portugal followed the same example: both constitutions were overthrown in 1823; the first by the French invasion, the latter by a counter revolution. The later events of Spanish and Portuguese history have again called these national assemblies into existence.

CORTI'CIFERS, *Corticiferi*. (Lat. cortex, *bark*, fero, *I carry*.) Those Polyps whose uniting fleshy substance is spread, like the bark of a tree, over a central calcareous or corneous axis.

CO'RTILE. (Ital.) In Architecture, an open quadrangular or curved area in a dwelling-house, surrounded by the buildings of the house itself.

CO'RTINA. (Lat. cortina, *a kind of table*.) A term used in describing Fungi, to denote that portion of the velum which adheres to the margin of the pileus in fragments.

CORU'NDUM. A crystallized or massive mineral of extreme hardness, and composed of nearly pure alumina; it is usually almost opaque, and of a reddish colour. It is allied to the sapphire.

CORVE'E. (French.) In Feudal Law, the obligation of the inhabitants of a district to do certain services, as the repair of roads, &c. for the sovereign or the feudal lord. Some species of corvée were performed gratis; others for a fixed pay, but generally below the value of the labour performed.

CO'RVUS. (Lat. *the raven*.) A Linnæan genus of birds, now the type of a family (*Corvidæ*), belonging to the Conirostral division of the *Passeres* of Cuvier; and including, with the Crows proper, the Rollers (*Coracias*) and Birds of Paradise (*Paradisea*).

Co'rvus. In Astronomy, one of Ptolemy's constellations, in the southern hemisphere.

CORYBA'NTES (Gr.) in Grecian Mythology, were the priests of Cybele; so called either from Corybas, the son of that goddess, or from the frantic gestures with which their devotions were accompanied; the term Corybantes signifying literally "shaking the head violently." They used to beat brazen cymbals in their sacred rites;

—— Acuta
Si geminant Corybantes æra. Hor. *Od.* I. 16. 8.

and their whole religious proceedings were characterized by such extravagant fanaticism as to have enriched the Greek language with several terms expressive of *madness* or *frenzy*.

CORYCE'UM. (Gr. κώρυκος.) In Ancient Architecture, an apartment in a gymnasium whose exact destination is not known.

CORYDA'LEA. An alcaline principle, from the *Corydalis tuberosa* and *Fumaria cava*.

CO'RYMBI'FERÆ. (Lat. corymbus, *a flat-headed kind of inflorescence*, and fero, *I bear*.) One of the divisions of the great group of *Compositæ* admitted by Jussieu. It comprehends those plants which, like the Chrysanthemum and the Aster, have the capitula furnished with a ray; and those others which, like Artemisia, although destitute of a ray, are similar to such plants in the majority of their characters.

CORY'MBUS. (Lat.) In Ancient Sculpture, the cluster of ivy leaves, berries, garlands, &c. with which vases were encircled.

Cory'mbus. In Botany, a form of inflorescence consisting of a central axis, developing lateral pedicels, the lower ones of which are so long that their flowers are elevated to the same level as that of the uppermost.

CORYPHŒ'NA. (Gr. κορυς, *a helmet*, and φαινω, *I show*.) A genus of spiny-finned fishes, so called from the head being crested like a helmet. It belongs to the Mackerel family (*Scomberoids*); and includes the true dolphin, or changeable coryphene (*Coryphœna hippuris*). The genus is now raised to the rank of a family, including, with *Coryphœna* proper, the subgenera *Centrolopus* and *Leptopodes*.

CO'RYPHŒ'US. (Gr. κορυφη, *summit*.) The leader of the chorus in ancient dramas; by whom the dialogue between the chorus and the other actors of the drama was carried on, and who *led* in the choric song.

CORY'ZA. (Gr. κορυζα.) A copious running from the nose.

CO'SECANT and COSINE. The secant and sine of the complement of an angle or arc; the prefix *co* being merely the abbreviation of *complement*, first introduced by Gunter.

COSME'TIC. (Gr. κοσμεω, *I adorn*.) Remedies to remove freckles and pimples from the face and to improve the complexion.

CO'SMICAL. (Gr. κοσμος, *the world*.) This word occurs frequently in the ancient astronomy, in which it is used to denote a particular position of a planet or star, at its rising or setting, in respect of the sun. A star is said to rise *cosmically* when it rises at the same instant that the sun rises; and to set cosmically, when it sets with the sun. Cosmical is opposed to *achronycal*, which signifies that a star rises at the instant the sun sets, and vice versâ. The cosmical and achronycal risings of a star are invisible to the naked eye, because the light of the sun in the horizon effaces that of the star.

COSMO'GONY. (Gr. κοσμος, *world*, and γονος, *birth*.) The science which treats of the origin of the universe. If we except the cosmogony of the Indians, the earliest extant is that of Hesiod, which is delivered in hexameter verse. The first prose cosmogonies were those of the early Ionic philosophers, of whom Thales, Anaximenes, Anaximander, and Anaxagoras are the most celebrated. In modern times, a Theory of the World has been produced by Burnet. We do not include in this list of cosmogonies the researches of modern geologists, or the systems to which they have led. They may be said to hold the same place in relation to the old cosmogoners, which the astronomer or the chemist occupies in reference to the astrologers and alchemists of ancient times.

The different theories which have been formed to account for the origin of the world may be comprehended under three classes: — 1st, Those which suppose the world to have existed from eternity under its actual form. Aristotle embraced this doctrine; and conceiving the existing universe to be the eternal effect of an eternal cause, maintained that not only the heavens and the earth, but all animate and inanimate beings are without beginning. 2d, Those which consider the matter of the universe eternal, but not its form. This was the philosophical system of Leucippus, Democritus, Epicurus, and indeed most of the ancient philosophers and poets, who feigned the world either to be produced by the fortuitous concourse of atoms existing from all eternity, or to have sprung out of the chaotic form which preceded its present state. 3d, Those which ascribe both matter and its form to the direct agency of a spiritual cause.

COSMO'GRAPHY. (Gr. κοσμος, and γραφω, *I write*.) The science which treats of the construction, figure, and arrangement of all the parts of the world; and therefore comprehends astronomy, geography, and geology.

COSMO'LOGY. (Gr. κοσμος, and λογος, *a discourse*.) *See* Cosmogony.

COSMO'POLITE. (Gr. κοσμος, and πολις, *a city*.) A citizen of the world: one who makes the world his country.

COSMORA'MA. (Gr. κοσμος, and ὁραω, *I see*.) A species of picturesque exhibition, consisting of a number of drawings, generally about eight or ten, which are laid horizontally round a semicircular table, and reflected by

mirrors placed opposite to them diagonally. The spectator views them through a convex lens placed immediately in front of each mirror. The pictures are illuminated by lamp light; but the lamps are so placed that they cannot be reflected by the mirrors, and are therefore invisible to the spectator.

COSS. When algebra was first introduced into Europe, it was called the *Rule of Coss;* probably from the Italian *Regola di Cosa*, the *Rule of the Thing;* the unknown quantity being termed *cosa*, the thing. Hence *Cossic Art, Cossic Numbers*, &c., found in some of the old authors.

COSSA'CKS. A people inhabiting those parts of the Russian empire which border on the northern dominions of Turkey, Poland, and the southern confines of Siberia. Both the name and origin of this people are involved in great uncertainty. They seem to have nothing Russian in their origin and character, and are probably a mixed Caucasian and Tartar race. They form a sort of independent republic, paying no taxes to Russia, but cheerfully contributing their numerous and valuable contingent of troops; and are well known as the most harassing light troops that ever exercised a predatory warfare in the train of any army.

Their dress is a short vest in the Polish style, large trowsers of a deep blue colour, and a black sheepskin cap. Their arms consist of a sabre, long spear, musket, a pair of pistols, and a long whip, which they apply to their enemy as well as their charger's back. They are mostly members of the Russian Greek Church, and are described as a hospitable, generous, and disinterested people. Their numbers have not been estimated for nearly a century, when they amounted to 955,228 males.

CO'STA. (Lat. costa, *a rib.*) A term formerly confined to that bundle of vessels which passes directly from the base to the apex of a leaf; but which is better extended to all the main veins which proceed directly from the base to the apex, or to the points of the lobes.

CO'STAL. (Lat. costa.) Belonging to the ribs.

CO'STARDMO'NGER. (From costard, *a large apple.*) An itinerant dealer in apples. The word is often written *costermonger*, and applied to hawkers and pedlars who sell fruit.

CO'STATE. (Lat. costa, *a rib.*) In Botany, a term applied in two ways, in describing the venation of leaves: either to indicate the presence of but one rib, as in most leaves; or in speaking of cases where three or more ribs proceed from the base to the apex of a leaf, and are connected by cross veins. The latter are frequently called nerves, or nervures. If a leaf has its ribs all distinct from the very base, it is called tricostate, quinquecostate, and so on; but if the ribs are united at the base in a distinct manner, the term becomes triplicostate, quintuplicostate, &c.

COSTATE. In Zoology, the surface of the whole or part of an animal is so termed when it has several broad elevated lines.

COSTS. In Law, the expenses to which parties are put in the prosecution and defending of actions. Costs are to be considered either as between attorney and client, *i. e.* the expenses and fees which the attorney is entitled to recover from his client; or as between party and party, *i.e.* that portion of the expenses to which a successful party has been put in his suit, which he is entitled in certain cases to recover from the unsuccessful one. Costs in the latter sense are not given by the common law. The statute of Gloucester (6 E. 1. c. 1. s. 2.) first enacted, that the demandant should recover from the tenant the cost of his writ, if successful; and that this provision should extend to all cases where a man recovers damages. By a liberal construction of this statute the costs of the writ are understood as the costs of the action, and its benefit is extended to plaintiffs in most cases where they would have been entitled to damages before that statute. In other cases, the plaintiff is not entitled to costs, unless they are expressly given by statute. In assumpsit, covenant, and debt, if the plaintiff have a verdict, but the damages or debt and damages be under 40*s*., the judge may deprive him of any more costs than damages by certifying to that effect on the record, under 43 Eliz. c. 6. s. 2. In actions for assault and battery, and trespass, wherever the damages given by a jury do not amount to 40*s*., the plaintiff (by several statutes) is allowed no more costs than damages, unless the judge shall certify that assault and *battery* was sufficiently proved; or, in trespass, that the title to land came in question. The certificate may be granted at the trial, or within a reasonable time afterwards. Where, out of several issues, some are found for the plaintiff and others for the defendant, the plaintiff is now only entitled to costs on those issues on which he may succeed, and the costs of the defendant's issues will be deducted from his. The defendant's right to costs rests also on several statutes, principally 23 H. 8. c. 15. Double and treble costs are given by some statutes in particular cases; and they follow by implication where double and treble damages are given. Double costs, in practice, mean single costs and one half their amount in addition: treble, the same, with one half of these last. Costs are *taxed* as between party and party by officers of the court; and recoverable by action, execution, or attachment. As between attorney and client, the attorney has a right of action for costs; but his bill is liable to taxation by officers of the court, under certain restrictions. Costs in equity are within the discretion of the court, except in certain cases; as where no answer is made to a bill exhibited, or an insufficient answer, &c.

COSTU'ME. (It.) In Painting and Sculpture, this word has become used chiefly as a term denoting the particular sort of dress suitable to the subject, according to the time in which the action is supposed to have taken place; but the word has a more general signification, inasmuch as it includes the keeping of all the accessories, ornaments, utensils, &c. of such forms and colours as historical knowledge proves them really to have possessed.

COTE' DROIT, COTE' GAUCHE. *See* DEPUTIES, CHAMBER OF.

COTERIE. An old French word, supposed to be derived from the Lat. quot, *how many*, signifying literally a society or company. In the 13th or 14th century, when merchants were about to embark in any commercial enterprise, they formed a coterie or company, each contributing his *quota* of goods or money, and deriving his *quota* of profit. But the term soon acquired a more extended signification, in which, however, the original meaning is still perceptible, being applied to any exclusive society in which interesting subjects (chiefly literary and political) are discussed, each member being supposed to contribute his *quota* or share of information for the general edification or amusement.

COTI'SE. (Fr. coté, *side.*) In Heraldry, a diminutive of the bend, being one half the width of the bendlet: generally borne in couples, with a bend or charges between them. A bend, fess, &c. between two cotises, is termed *cotised.*

CO'TTABUS. (Gr. κοτταβος.) A celebrated Greek game. It consisted in throwing wine from cups into little basins of metal suspended in a particular manner, or floating in a large vessel of water; so that dexterity might be shown in throwing it without spilling, in producing a particular sound, &c. The cottabus was so favourite a sport, that rooms were built expressly for its performance, styled *cottabeia.*

CO'TTAGE ALLO'TMENTS, are those portions of ground which are allotted to the dwellings of country labourers for the purpose of being cultivated by them as gardens. Sometimes these allotments are placed adjoining the dwellings, in which case they are more commonly called cottage gardens; but at other times they are placed at a distance from the cottage, and form small portions of a large enclosure; and to this kind of cottage garden the term allotment is more properly applied than to the other. The object in both cases is to afford resources to the cottager; and to enable him, by growing vegetables and roots of various kinds, not only to supply his own family, but to keep pigs, rabbits, poultry, &c. Such being the uses of cottage allotments, the advantage of each cottage having its garden surrounding it, instead of at a distance, is sufficiently obvious. In the latter case, the cottager must necessarily lose much time in travelling backwards and forwards from his house to his garden; and his wife and children will often be prevented from employing themselves in it. In such a garden he cannot grow fruits, because they would be comparatively unprotected; nor can it be worth his while to grow flowers in a place where they would not prove an ornament to his dwelling. On the supposition that the cottager has his pigstye close to his dwelling, the food for the pigs must be brought home from the allotment; and the manure made by them, which is one of the advantages of keeping pigs, must be carried out again. It is well known to all persons of any experience on this subject, that by far the most valuable part of the manure made by the cottager, such as soapsuds, &c., may be included under the term liquid manure; and this, when the allotment is at a distance, may be considered as entirely lost, the cottager being without either conveniences or time for carrying it out. In point of usefulness, therefore, a cottage allotment in a field, at the distance of a furlong or less from the cottage, is not worth half what it would be if adjoining the dwelling; while in point of enjoyment to the cottager, and of ornament to the roadside, it is hardly worth anything. A cottage allotment is therefore a miserable substitute for a cottage garden. On the other hand, the labourer who has a lease of a comfortable cottage surrounded by a garden, even if the latter should not be larger than the eighth part of an acre, has within his reach all the essentials of happiness possessed by the richest landed proprietor. He can grow good and wholesome vegetables and fruits; he may have his live stock of pigs, poultry, rabbits, and bees; he may ornament his house front, and the borders of his walk with shrubs and flowers; and he has the wages of his labour

for the purchase of those comforts and luxuries which his garden does not afford. In the culture and management of this spot, he has constant occupation of the most agreeable and useful kind for his leisure hours throughout the year; and, in short, whatever the farmer or country gentleman has on a large scale, he has on a small one. In quiet possession of this little garden, which he regards as his own, he learns to respect himself, acquiring at the same time a taste for accumulating property. The time, it is to be hoped, is not far distant when the humblest country labourer will possess such a cottage and garden; but it is necessary that the country labourer should acquire previously a taste for these comforts by seeing them possessed by others of his class; and for this we must look partly to the country labourers themselves, partly to the government for the establishment of a system of universal education which shall raise the taste of the humblest part of society, and partly to the humanity and sympathetic feeling of the landed proprietors; because it is to them we must look, in the first instance, for building the cottage and accompanying it with garden ground.

COTTON. (*Gossypium*, Lin.) A species of vegetable wool, the produce of the *Gossypium herbaceum*, of which there are many varieties. The kinds of cotton met with in the market are usually designated by the names of the places from which they are brought; but practically, they are all divided into the two great classes of *long and short stapled*. Its goodness depends on its colour, and the length, strength, and fineness of its fibre. Its price varies, according to quality, from 2*s*. to 4*d*. per lb. The general chemical characters of cotton are those of *lignin*. It is peculiarly susceptible of combination with certain metallic oxides or bases; whence the facility with which it is locally dyed, as in the process of *calico printing*.

COTTON MANUFACTURE. In modern times cotton has attained to an importance among vegetables second only to that of corn, and which could not have been so much as dreamed of in former ages. The manufacture of cotton wool into articles of use and ornament appears, indeed, to have been carried on in India from the remotest antiquity; but it has not made any very great progress in the East, and obtained no footing worth mentioning in Europe, till last century.

The truth is, that this manufacture, though it now affords employment and subsistence to many hundreds of thousands of persons in this and other countries, is almost wholly a consequence of discoveries and inventions made in Great Britain and the United States, since the middle of last century. Previously to that period the manufacture was everywhere confined within the narrowest limits. Owing to the difficulty of separating the wool from the seed, its price, so long as this operation had to be performed by the hand, was naturally high; while the cost of its spinning and weaving by the wheels and looms in use previously to 1760 added so much to its price, that cotton articles were suited only to the use and demand of the better classes of society; and it seems unreasonable to suppose that the manufacture should have been materially extended without a greatly increased facility of production. But in this respect the most signal and extraordinary improvements have been made. The *Jenny* invented by Hargreaves in 1767 enabled one individual to spin 80 or 120 threads with about the same facility that a single thread had been previously spun. The jenny, however, was fitted only to spin the softer descriptions of yarn or that used as *weft*, being unable to give the thread the firmness and hardness required in that used as *warp*. But this deficiency was soon supplied: the genius of Arkwright completed what Hargreaves had begun, by inventing the spinning frame,—that wonderful piece of machinery which spins any number of threads of any degree of fineness and hardness, leaving to man merely to feed the machine with cotton, and to join the threads when they break! Nearly at the same time that the spinning department was thus wonderfully improved, Dr. Cartwright, a clergyman of Kent, invented the power-loom, a machine which has already gone far to supersede weaving by the hand, and which will, no doubt, in the end bring about this desirable result. While these extraordinary inventions were being made, Watt was perfecting the steam-engine, endowing it with capacity to engrave a seal, to give motion to the most ponderous machinery, or to lift a ship like a bauble in the air; and was thus not only supplying the manufacturers with a new power applicable to every purpose, and easy of controul, but with one that might be placed in the most convenient situations, and amid a population trained to industrious habits.

Still, however, something more was necessary to complete this astonishing career of discovery. Without a vastly increased supply of the raw material at a lower price than it had previously brought, the inventions of Hargreaves, Arkwright, and Watt would have been of comparatively little value. Luckily, however, what they did for the manufacturers, Mr. Eli Whitney did for the cotton growers. This extraordinary person, a native of the southern states of America, invented a machine by which cotton wool is separated from the seed with the utmost facility and expedition. Previously to 1790 the United States did not export a single pound weight of raw cotton. In 1792 they exported the trifling quantity of 138,328 lbs. Whitney's invention came into operation in 1793; and in 1794, 1,601,760 lbs., and in 1795, 5,276,306 lbs. were exported! And so astonishing has been the growth of cotton in the interval, occasioned by this discovery and the discoveries made in England, that in 1838 the exports from the United States amounted to the prodigious quantity of 595,952,297 lbs.!

A cotton mill is, probably, all things considered, the most astonishing triumph of skill and ingenuity. All the various operations, from the carding of the wool to its conversion into a texture as fine almost as that of the gossamer, is performed by machinery. Each of the workmen at present employed in a cotton mill superintends as much work as could have been executed by 200 or 300 workmen 60 or 70 years ago, and yet, instead of being diminished, the numbers employed have increased even in a still greater proportion! It would be curious to investigate how many persons in the old and new worlds directly depend for subsistence on the inventions and discoveries of Hargreaves, Arkwright, Watt, Whitney, and the other founders and improvers of this great manufacture. They certainly amount to several millions; at the same time that there is hardly an individual in any country, how remote or barbarous soever, who is not indebted to them for an increase of comfort and enjoyment.

"It is impossible to estimate the advantage to the bulk of the people, from the wonderful cheapness of cotton goods. The wife of a labouring man may buy, at a retail shop, a neat and good print as low as 4*d*. a yard; so that allowing 7 yards for the dress, the whole material shall only cost 2*s*. 4*d*. Common plain calico may be bought for 2½*d*. a yard; elegant cotton prints for ladies' dresses sell at from 10*d*. to 1*s*. 4*d*. per yard, and printed muslins at from 1*s*. to 4*s*., the higher priced having beautiful patterns, in brilliant and permanent colours. Thus the humblest classes have now the means of as great neatness, and even gaiety of dress, as the middle and upper classes of the last age. A country wake in the 19th century may display as much finery as a drawing room of the 17th; and the peasant's cottage may, at this day, with good management, have as handsome furniture for beds, windows, and tables, as the house of a substantial tradesman 60 years since." (*Baines's Hist. Cotton Manufacture*, p. 358.)

Owing partly to our having had the start in the career of discovery, but more to our command of all but inexhaustible supplies of coal, so indispensable to the cheap and advantageous supply of steam as a moving power, and to the enterprise and invention of our capitalists, engineers, and workmen, we have continued to keep that lead in the manufacture we early acquired. At this moment it affords employment to not fewer than 1,500,000 individuals in this country; and constitutes, in fact, the grand source of our manufacturing prosperity, and the principal element of our commerce.

The following statements give a view of the progress of the manufacture in Great Britain: —

Account of the Imports of Cotton Wool, and of the official Value of the Cotton Goods exported from Great Britain in the following Years, from 1697 to 1764, both inclusive.

Years.	Raw Cotton imported.	Official Value of British Cotton Goods exported.	Years.	Raw Cotton imported.	Official Value of British Cotton Goods exported.
	lbs.	*L.*		*lbs.*	*L.*
1697	1,976,359	5,915	1730	1,545,472	13,524
1701	1,985,868	23,253	1741	1,645,031	20,709
1710	715,008	5,698	1751	2,976,610	45,986
1720	1,972,805	16,200	1764	3,870,392	200,354

The spinning jenny was invented in 1767, and Arkwright took out his first patent for spinning by rollers in 1769. The influence of these and numberless other inventions on the trade is exhibited in the following table: —

Years.	Cotton imported.	Cotton exported.	Years.	Cotton imported.	Cotton exported.
	lbs.	*lbs.*		*lbs.*	*lbs.*
1781	5,198,778	96,788	1810	132,488,935	8,787,109
1785	18,400,384	407,496	1811	91,576,535	1,266,867
1790	31,447,605	844,154	1812	63,025,936	1,440,912
1795	26,401,340	1,193,737	1813	50,966,000	
1800	56,010,732	4,416,610	1814	60,060,239	6,282,437
1805	59,682,406	804,243	1815	99,306,343	6,780,392

The subjoined statement, taken from the circular of Messrs. George Holt and Co., cotton brokers at Liverpool, dated the 31st December, 1840, gives a very complete view of all the more important particulars respecting the British cotton manufacture in the undermentioned years, from 1816 to 1840, both inclusive.

Statement of the Consumption, Exportation, &c. of the different Sorts of Cotton Wool, in and from Great Britain, in different Years, from 1816 to 1840, both inclusive.

Average Weekly Consumption.	1816.	1820.	1825.	1830.	1835.	1837.	1838.	1839.	1840.
Upland	-	2,918	3,713	5,452	5,896	4,438	5,505	5,464	5,346
Orleans and Tenessee	990	1,192	2,442	4.756	7,823	10,223	11,742	9,915	13,854
Sea Island	-	409	360	460	354	310	317	265	392
Total United States	4,036	4,519	6,515	10,668	14,073	14,971	17,564	15,644	19,592
Brazil	1,589	2,408	2,502	3,602	2,339	2,483	2,460	2,373	1,444
Egypt	-	-	891	508	446	779	781	518	540
East India	207	1,518	1,096	940	1,069	1,639	1,760	2,142	2,227
Demerara, West India, &c.	656	534	527	284	421	461	639	723	260
Total	6,488	8,979	11,531	16,002	18,348	20,333	23,204	21,430	24,063
Packages annually consumed	337,400	466,900	599,600	932,100	954,100	1,057,300	1,206,600	1,114,400	1,251,300
Average weight of packages consumed, in lbs.	263	258	278	298	333	346	346	343	354
Weekly consumption in packages, average 346 lbs.	5,122	6,945	9,634	14,320	18,348	20,333	23,204	20,764	24,063
Average weight of packages imported, in lbs.	256	249	270	300	331	347	350	348	365
Packages exported	29,300	28,400	72,800	33,400	102,800	123,400	103,300	117,300	119,700
Lbs. weight annually imported, in millions and tenths	93·9	143·9	222·4	2612	361·7	408·2	501·0	388·6	583·4
Lbs. weight consumed do.	88·7	120·3	166·8	2476	318·1	365·7	416·7	381·7	458·9
Lbs. weight in ports, 31st of Dec. do.	19·2	110·5	107·0	914	73·3	82·1	110·1	98·5	162·9
Lbs. weight in Great Britain, do.	-	127·0	115·5	·1188	89·6	115·6	160·9	125·8	207·0
Average price per lb. of uplands in Liverpool	18½*d.*	11½*d.*	11·6*d.*	6·9*d.*	10½*d.*	7*d.*	7*d.*	7⅜*d.*	6*d.*
Do. do. Pernams	26*d.*	15½*d.*	15·1*d.*	8½*d.*	14·1*d.*	9¾*d.*	9·375*d.*	10*d.*	9¼*d.*
Do. do. Surats	15¼*d.*	8½*d.*	8·9*d.*	5*d.*	7½*d.*	4·85*d.*	5*d.*	5¾*d.*	4⅝*d.*

N. B. — Messrs. Holt and Co. estimate the average weight of the packages imported in 1840 at 333 lbs. per bag Upland; 415 lbs. Orleans and Alabama; 330 lbs. Sea-Island; 171 lbs. Brazil; 215 lbs. Egyptian; 342 lbs. East Indian; and 166 lbs. West Indian.

We subjoin, from *Burns's Glance*, — a tabular statement, annually published at Manchester, and admitted to be drawn up with great care, — an account of the cotton spun in Great Britain and Ireland in 1838, and how that spun in England was disposed of, with several other interesting particulars.

Statement of Cotton spun in England, Scotland, and Ireland, in 1838; showing the Quantity of Yarn produced, and how that spun in England was disposed of.

	Number of Bags consumed.	Average Weight of Bags in lbs.	Total Weight in lbs.	Weekly Consumption of Bags, describing each sort.
Great Britain.				
American cotton	938,168	373	349,936,664	18,041·36
Brazil ditto	147,392	171	25,204,032	2,834·24
Egyptian ditto	40,273	284	11,437,532	774·25
East India ditto	94,468	363	34,291,884	1,816·36
West India ditto	16,519	316	5,220,004	317·35
Total number of bags consumed	1,236,820	346	426,090,116	23,785
Allowed for loss in spinning, 1¾ oz. per lb.			46,603,606	
Total quantity spun in England and Scotland			-	379,486,510
Deduct quantity spun in Scotland			- -	34,823,466
Total quantity spun in England in 1838			- -	344,663,044
How disposed of.				
Exported in yarn during the year			113,753,197	
Ditto in thread			2,362,983	
Ditto in manufactured goods			120,784,629	
Estimated quantity of yarn sent to Scotland and Ireland			6,875,952	
Exported in mixed manufactures, not stated in the above-named articles, consumed in cotton banding, healds, candle and lamp wick, waddings, flocks, calender bowls, paper, umbrellas, hats, and loss in manufacturing goods			16,753,000	
Balance left for home consumption and stock, 1st January, 1839			84,133,283	344,663,044
Ditto ditto ditto 1838			63,657,902	
Ditto ditto ditto 1837			43,486,686	
Ditto ditto ditto 1836			49,932,800	
Ireland.				
Gross weight of cotton spun in Ireland in 1838			4,412,860	
Allowed for loss in spinning, 1¾ oz. per lb.			482,656	
Total quantity of yarn spun in Ireland in 1838			3,930,204	

In 1832 the quantity spun was 222,596,907 lbs., giving a weekly supply of 4,280,709 lbs. Mr. Burns estimates the quantity spun per spindle, per week, at 8¼ oz., making the total number of spindles employed in England and Wales, in 1832, 7,949,208. Those employed in Scotland, during the same year, are estimated, in the same way, at 381,020. Mr. Burns further calculates the number of looms employed in England and Wales, in 1832, at 203,730. The consumption of flour in the manufacture is much greater than any one not pretty well acquainted with it would readily suppose. The average quantity required for each loom is estimated at 4 lbs. per week; making the total annual consumption in England and Wales, in 1832, 42,301,584 lbs., or 215,824 barrels of 196 lbs. each!

The places whence the supply of raw cotton is derived, and the quantity furnished by each, are seen in the following table: —

Account of the Quantities of Cotton Wool imported into the United Kingdom during the Seven Years ending with 1838; specifying the Quantities brought from different Countries, the Total Quantities exported, and the Quantities left for Consumption. — (Compiled from *Parl. Papers.*)

Countries.	1832.	1833.	1834.	1835.	1836.	1837.	1838.
Cotton wool from foreign countries, viz. —	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
United States of America - -	219,756,753	237,506,758	269,203,075	284,455,812	289,615,692	320,651,716	431,437,888
Brazil - - - - -	20,109,560	28,463,821	19,291,396	24,986,409	27,501,272	20,940,145	24,464,505
Turkey and Egypt - - - -	9,113,890	987,262	855,167	5,738,966	5,426,721	7,881,540	5,412,478
Other foreign countries - - -	598,048	1,696,108	2,260,852	5,207,389	6,734,413	4,616,829	4,759,688
Cotton wool from British possessions, viz. —							
East Indies and Mauritius - -	35,178,625	32,755,164	32,920,865	41,474,909	75,957,887	51,577,197	40,230,064
British West Indies, the growth of - -	1,708,764	1,653,166	1,672,211	1,495,517	1,312,806	1,199,162	928,425
Ditto, ditto, imported from -	331,664	431,696	624,314	319,753	401,531	396,540	600,931
Other British possessions - -	35,221	162,862	47,545	24,208	8,735	23,654	16,606
Total quantities imported - -	286,832,525	303,656,837	326,875,425	363,702,963	406,959,057	407,286,783	507,850,577
Quantities exported - - -	18,027,940	17,363,882	24,461,963	32,779,734	31,739,763	39,722,031	30,644,469
Left for consumption - - -	268,804,585	286,292,955	302,414,462	330,923,229	375,219,294	367,564,752	477,206,108

Account of the Exports of Cotton Goods and Yarn from the United Kingdom in 1837; specifying the Quantity and declared Value of those shipped for each Country.

Countries to which exported.	White or Plain Cottons.		Printed or Dyed Cottons.		Hosiery and small Wares.	Twist and Yarn.		Total Declared Value.
	Yards.	Declared Value.	Yards.	Declared Value.	Declared Value.	Pounds.	Declared Value.	
		L.		L	L.		L.	L.
Russia - - -	980,779	40,203	145,760	7,590	9,106	24,108,593	1,612,956	1,669,855
Sweden - - -	62,939	1,717	48,552	1,850	708	734,336	55,060	59,335
Norway - - -	164,634	4,081	347,809	9,964	1,682	197,700	10,474	26,201
Denmark - - -	45,992	1,033	71,569	1,369	88	57,470	2,870	5,357
Prussia - - -	- -	- -	- -	- -	- -	4,924	502	502
Germany - - -	14,203,855	294,378	28,967,374	713,771	162,263	34,272,607	2,177,823	3,348,235
Holland - - -	16,382,581	341,448	11,588,241	322,400	50,205	15,993,072	1,386,388	2,100,441
Belgium - - -	865,339	32,271	1,998,160	72,528	102,233	67,397	8,752	215,784
France - - -	1,169,753	23,683	1,269,924	35,529	93,768	94,707	31,364	184,344
Portugal, Proper - -	15,966,118	268,189	15,748,216	369,712	21,084	323,262	23,612	682,597
Azores - -	541,605	11,789	731,946	18,740	838	17,840	786	32,153
Madeira - -	519,315	8,255	649,954	12,767	1,068	1,358	78	22,168
Spain and the Balearic Islands -	151,380	4,047	205,986	5,694	221	687	45	10,007
Canaries - -	471,917	10,763	435,599	12,234	924	1,071	63	23,984
Gibraltar - - -	13,956,830	310,777	12,681,183	375,367	17,271	225,939	14,729	718,144
Italy and the Italian Islands -	24,976,414	526,881	17,631,057	481,915	40,910	8,775,028	477,882	1,527,588
Malta - - -	1,108,032	21,638	562,773	17,364	2,208	176,260	9,729	50,939
Ionian Islands - - -	1,497,260	26,314	841,686	19,955	790	297,980	14,303	61,362
Morea and Greek Islands -	9,054	256	67,794	2,664	33	1,800	100	3,053
Turkey - - -	23,727,096	482,438	9,423,139	288,230	2,297	3,527,538	180,225	953,190
Syria and Palestine -	5,140	330	-	- -	- -	- -	- -	330
Egypt - - -	5,559,900	107,125	693,240	23,207	349	660,700	41,372	172,053
Tripoli, Tunis, Algiers, and Morocco - - -	2,928,580	41,552	253,009	4,892	407	- -	- -	46,851
Western Coast of Africa -	607,843	15,783	4,365,569	119,540	391	2,982	395	136,109
Cape of Good Hope - -	2,293,943	54,567	3,136,936	80,483	9,389	9,314	899	145,338
St. Helena - - - -	18,816	519	5,326	141	19	- -	- -	679
Mauritius - - -	3,053,808	78,395	2,237,689	73,556	7,749	10,400	468	160,168
East India Company's territories and Ceylon -	46,366,175	1,040,018	17,847,458	488,231	30,444	8,478,021	602,293	2,160,986
Sumatra, Java, and other Islands of the Indian Sea - -	5,952,848	144,962	2,620,300	97,620	5,931	127,620	7,858	256,371
Philippine Islands - -	473,370	10,075	613,421	17,695	1,115	- -	- -	28,885
China - -	8,519,245	193,075	2,445,178	79,300	1,012	1,873,965	103 908	377,295
New South Wales, Van Dieman's Land, and other Australian Settlements - - -	1,275,348	36,561	1,335,325	44,889	15,809	13,625	781	98,040
British North American Colonies -	6,319,864	161,392	7,950,884	222,001	39,068	260,732	14,307	436,768
British West Indies - -	19,695,492	417,580	17,998,452	465,449	43,812	55,549	4,487	931,328
Hayti - - -	1,246,463	28,421	1,612,897	53,270	2,751	- -	- -	84,442
Cuba and other Foreign West Indian Colonies - -	6,798,705	148,024	11,966,502	293,865	11,608	6,250	309	453,806
United States of America -	5,471,788	187,585	12,010,067	407,237	117,572	219,712	13,359	725,753
States of Central and South America:								
Mexico - -	2,713,901	55,651	4,227,065	143,805	13,339	2,654,867	144,489	357,284
Columbia - -	1,436,553	32,630	2,675,164	58,136	4,085	188,283	12,488	107,339
Brazil - -	25,387,191	436,192	23,380,427	551,258	26,987	560	48	1,014,485
States of the Rio de la Plata - - -	10,923,196	207,714	9,260,258	237,557	18,818	5,734	364	464,473
Chili - -	7,825,718	150,492	9,356,806	240,267	18,217	- -	- -	408,970
Peru - - - -	3,655,774	88,013	5,641,351	165,804	14,300	- -	- -	268,117
Isles of Guernsey, Jersey, Alderney, Man, &c. - -	833,704	38,975	159,360	4,334	21,323	7,255	376	65,008
Totals - -	286,164,256	6,085,789	245,209,407	6,642,200	912,192	103,455,138	6,955,942	20,596,123

Manchester, or rather Lancashire, is the grand seat of the English cotton manufacture; and next to it Cheshire, Nottinghamshire, the West Riding of Yorkshire, and Cumberland are its principal seats. Glasgow and the surrounding district is the seat of the manufacture in Scotland. In Ireland it is principally confined to Belfast; but there it is of very limited dimensions, and is said to be rather on the decline.

With the exception of those employed in hand-loom weaving, the condition of the labourers employed in the cotton trade is eminently satisfactory. It has not only made a vast addition to the field of employment, but it has increased the comforts of those engaged in it. The stories once so current as to the cruelties practised upon and the hardships endured by the children and young persons employed in cotton factories were, though not wholly without foundation, grossly exaggerated; — they never, indeed, existed in the first-class mills; and since the system began of excluding children under 9 years of age, limiting the hours of employment, and appointing inspectors, abuses have been wholly put an end to.

The value of the cotton manufacture of Great Britain is greater than that of all Europe besides. And provided tranquillity be maintained at home, and we continue to be exempted from that political agitation that is the bane of industry and the curse of every country in which it prevails, we have nothing to fear from foreign competition. Our natural and acquired advantages for the prosecution of manufactures and trade are vastly superior to those of every other country; and though foreigners do excel us in a few departments, and may come to excel us in others, so that the character and species of

the manufacture may in consequence be partially changed, there is not so much as the shadow of a foundation for supposing that its amount will be at all affected. On the contrary, it is all but certain it will continue to augment with the augmenting wealth and population of the innumerable nations with which we have commercial relations.

It is impossible to frame any accurate estimate of the total value of the cotton goods and yarn annually produced in Great Britain. In the *Commercial Dictionary* they are estimated at about 34,000,000*l.*, and we are inclined to think that this is not far from the mark. Mr. Baines, in his elaborate work on the History of the Cotton Manufacture, gives the following estimate of the number of people employed, and the value of the manufacture.

Estimated Yearly Value of the British Cotton Manufacture.

		£
Wages of		
237,000 *	operatives engaged in spinning and power-loom weaving - -	6,044,000
250,000 †	hand-loom weavers, at 7*s.* per week each - - - - -	4,375,000
45,000	calico printers, at 10*s.* per week each -	1,170,000
159,300 ‡	lace workers (including 100,000 employed in embroidery, and 30,000 in mending, pearling, drawing, and finishing) - - - -	1,000,000
33,000	makers of cotton hosiery - -	505,000
	Bleachers, dyers, calenderers, fustian-cutters, machine-makers; makers of steam-engines, cards, rollers, spindles, shuttles, looms, and reeds; smiths, joiners, builders of all classes, mill-wrights, carriers, carters, warehouse-men, &c. &c.; say - - -	4,000,000
Raw material (spun in 1833) 283,675,200 lbs.¶ at 7*d.* per lb.	- - - -	8,244,693
Profits of capital, sums paid for materials of machinery, coals, flour for dressing, and other outgoings ‖	- - - -	6,000,000
		£ 31,338,693

In the *Commercial Dictionary* the capital employed in the manufacture is estimated at 34,000,000*l.*; which Mr. Baines thinks is very moderate.

COT'TUS. (Gr. *κοττη, a head.*) A genus of spiny-finned fishes; so called on account of the large size of the head. It includes two British species, viz. the Father-lasher (*Cottus bubalis*), and the Sea Scorpion (*Cottus scorpio*); both of which are dreaded by fishermen on account of the painful and dangerous wounds which they inflict by means of the spines with which the gill-covers are armed.

COTYLE'DON. (Gr. *κοτυλη, a hollow.*) In Botany, the seminal leaf of a plant. This organ forms a part of the embryo, and is what nourishes the plumula and radicle at their first period of development, before they are able to subsist upon the organizable matter absorbed by the latter from the earth. Exogenous plants have generally two cotyledons, Endogenous as generally one only; but there are exceptions in both cases. The latter class of plants seldom elevate their cotyledon above ground, and never convert it into a green leaf-like body, but usually leave it behind them within the integuments of the seed; the former frequently raise their cotyledons above the soil in the form of small green leaves, as in the garden radish; but there are very numerous exceptions to this, as in the pea, the oak, the chesnut, &c.

COTYLE'DONS. (Applied by Aristotle to designate the sucking-cups of the arms of the Dibranchiate Cephalopods.) In Comparative Anatomy, the cup-shaped vascular productions of the chorion in Ruminants, serving the office of a placenta, are so called.

COTY'LIFORM. (Gr. *κοτυλη, a cup.*) A term used in describing the general form of organs to denote a rotate figure with an erect limb.

COUCH. A layer or heap of barley, moistened and prepared for malting; also the name of that part of the malting floor on which the barley is spread out.

COUCHANT. (Fr.) In Heraldry, a term applied to a beast when represented as lying on the ground.

COU'CHING. In Agriculture, clearing land from couch grass (*Triticum repens*), which is effected by first pulverizing it, and then, in very dry weather, collecting the couch by harrows, or by a horse rake, such as that used for collecting stubble, and which so applied is called a couch rake.

Cou'ching. One of the operations to restore vision in cases of *cataract:* it consists in depressing the opaque lens, so as to remove it out of the axis of vision.

COUGH. This term is applied to a spasmodic action of the respiratory organs, occasioning a sonorous expulsion of air from the lungs: it is very commonly symptomatic of other affections; and some nosologists have considered that it is always so, and never idiopathic. Many cases of cough depend upon the extension of *catarrh* to the trachea and bronchiæ, which become loaded with mucus or phlegm, the efforts to expel which constitute coughing. Others are perhaps referable to a vitiated secretion; and others to imperfect action of the absorbents, by which the natural mucous secretion remains and accumulates in the air vessels, and by evaporation becomes inspissated and irritating; this appears to be one of the causes of the dry cough to which old people are subject. The treatment of catarrhal cough consists in allaying irritation by demulcents, such as mucilaginous drinks and lozenges, which, acting upon the glottis, sympathetically affect the trachea and its ramifications: amongst these extract of liquorice, and lozenges made of it and equal parts of gum tragacanth, are very effectual. Stimulants and full diet are to be avoided, and inflammatory symptoms carefully guarded against; for these are not unfrequently brought on by the violence of a cough. It is not unfrequently necessary to call in the aid of sedatives, expectorants, and aperients. Amongst the former small doses of Dover's powder, or of equal parts of it and extract of henbane, are very serviceable; and it is not uncommon to observe a troublesome cough disappear after a brisk dose of physic. An emetic will also sometimes effect its cure; so that coughs have been by some considered as symptomatic of a vitiated state of stomach and bowels. Where a cough periodically returns at night, and is not inflammatory, a dose of laudanum sufficient to induce sound sleep will often, as it were, break the habit and relieve it. Sedatives, conjoined with stimulating expectorants, such as squills, ammoniacum, benzoic acid, &c., are often effectual in relieving the coughs of old age; and in these, and what are called nervous coughs, much relief is experienced by administering mild opiates in the form of lozenges, so that they may pass gradually over the neighbourhood of the affected part, in consequence of the slowness with which they are dissolved in the mouth and swallowed: lozenges of sugar, liquorice, or tragacanth, with about two grains of extract of poppies in each, are useful in such cases. Where coughs are symptomatic of inflammatory action, of asthma, &c., they often require modes of treatment which have more particular reference to their exciting causes.

COU'LTER. (Lat. culter, *the coulter of a plough.*) In Agriculture, an iron blade or knife inserted into the beam of a plough, for the purpose of cutting the ground and facilitating the separation of the furrow-slice by the ploughshare. *See* Plough.

COU'MARIN. A crystalline odoriferous principle extracted from the tonka bean, which is the seed of the *Coumarouna odorata.*

COU'NCIL. In Church History, an assembly of prelates and other spiritual persons for the regulation of ecclesiastical matters. Such councils are either national, or œcumenical; the latter being those in which the whole body of the clergy throughout the world is represented, and are convened for the settling of points of universal interest.

The Roman Catholics hold that the decision of œcumenic or general councils are infallible, and for the most part allow their superiority to the popes themselves. This superiority was first asserted at the Council of Pisa, in which the two reigning anti-popes were deposed; and confirmed by the proceedings of those of Constance and Basil. Since that time the popes have been very unwilling to convene a general council, and that of Trent is the only one that has assembled in later times.

The Protestants allow the authority of general councils in matters which do not contradict Scripture, and attach great importance to the four first councils; viz. of Nice, Constantinople I., Ephesus, and Chalcedon. But they maintain that a general council can only be called by a

* Mr. Stanway, from the Returns of the mill-owners, ascertained that 67,819 mill operatives in England received 141,635*l.* 5*s.* 7¾*d.* as wages for a month of four weeks: at the same rate, 237,000 mill operatives, the number in the United Kingdom, would earn 6,434,453*l.* per year. But, as wages in Scotland are 10 per cent. and in Ireland 15 or 20 per cent. lower than in England, and as two weeks' wages in the year ought to be deducted for holidays, the amount of wages paid will be about 6,041,000*l.*

† In my estimate of the *number* of weavers I have not reckoned the winders, draw-boys, &c. who assist them, and who must amount to a great many thousands; but, in the supposed average of their *wages*, I include those earned by the assistants of the weavers as well as by the weavers themselves. The sum of 7*s.* per week for the *gross* wages of all the hand-loom weavers is, I am convinced, a fair estimate. The calculation is for 50 weeks in the year.

‡ The wages paid to the women and children employed in embroidery, mending, &c. the lace, must be extremely low. Mr. Felkin estimates the whole value of the lace manufactured in England at 1,850,650*l.*; deduct the cost of the yarn, 635,000*l.*, and there remains the sum of 1,215,650*l.*; of which, probably, 1,000,000*l.* consists of wages to the work-people.

¶ The quantity stated by Burns in the *Commercial Glance.*

‖ "I adopt this sum from Mr. M'Culloch, thinking it a moderate estimate."

temporal prince, which prerogative is assigned by the Romanists to the pope.

Their infallibility they strongly deny, and appear to reduce that assumption to an absurdity by asking —

1. What is the proof of infallibility existing in the church at all?

2. Supposing it to exist, how can it be shown that the church has been truly represented in any council? Or,

3. How can it be shown that the infallibility resides in a bare majority rather than the minority, when a difference of opinion prevails?

COU'NCIL, PRI'VY. The principal council belonging to the king of England. In its origin it appears as a small permanent committee, or minor council, consisting of members selected by the king himself out of the great council of the kingdom. The latter body is supposed to have been originally composed of all the immediate tenants of the crown; and it was occasionally summoned as late as the reign of Ric. II., and seems then to have comprised nearly all the prelates, nobles, and bannerets of the kingdom, "*et autres sages.*" When the privy council was formed out of it has not been ascertained. It appears in early rolls of parliament as the permanent or continual council; and as its powers under the Plantagenet kings were very extensive, so parliament exercised considerable influence in controlling the appointment of its members, although always vested in the crown as an essential prerogative. The privy council under these sovereigns usually consisted of the five great officers of state, the two archbishops, and from ten to fifteen other individuals, spiritual or temporal. It sat continually as a court, both to expedite the executive part of the administration, and to provide equitable relief in cases submitted to it, thus controlling the courts of common law. (See *Sir F. Palgrave's Essay on the Original Authority of the King's Council*, 1834; and the Preface to the *Records of the P. C.*, edited by Sir H. Nicolas.) There were also under the Tudors councils, portions of the privy council, exercising like powers in various parts of England. The increasing power of parliament on the one hand, and the extended equitable jurisdiction of the lord chancellor on the other, gradually encroached upon the ancient dignity and importance of both the councils. The decline in power of the privy council was, however, extremely gradual. The Star Chamber and Court of Requests, dissolved in the reign of Charles I., were both committees of the privy council. By stat. 16 C. 1. its direct jurisdiction in England in civil cases was taken away.

Privy councillors are made by the king's nomination, without patent or grant. Their number, having greatly increased under the Tudor princes, was restricted by Charles II. to thirty; but soon became indefinite again, and has so continued. But no privy councillors attend except such as are specially summoned. The privy council continues in office six months after the demise of the crown, unless sooner dissolved by the successor. The separation of the functions of the privy council from the more important political duties of the cabinet council seems to have been chiefly effected in the reign of W. III.

The jurisdiction of the privy council is of several sorts: 1. The king in council may issue proclamations binding on the subject, if consonant to the laws of the land. He issues also orders in council for the temporary regulation of various matters relating to trade and international intercourse. 2. The privy council has power to inquire into offences against government, and commit offenders to take their trial according to law. 3. Appellate jurisdiction in the last resort from all his Majesty's dominions, except Great Britain and Ireland, is vested in the privy council. By 3 & 4 W. 4. c. 41. a judicial committee of the privy council is constituted, to which are entrusted appeals from the prize and admiralty courts, and courts in the plantations abroad, and all other appeals which might before have come before the king in council. The judicial committee may direct feigned issues to be tried at common law. The lord president of the council is the fourth great officer of state. The office must probably have been cotemporaneous with the origin of the council itself; but the title is comparatively recent. It was created by Hen. VIII., and revived by Charles II. in favour of the Earl of Shaftesbury.

COU'NCIL OF STATE. A political and judicial body of very indefinite powers in the French monarchy, both before and since the Revolution.

COU'NSELLOR. (Lat. consiliarius.) In Law, a person retained by a client to plead his cause, who is also said to be of counsel for him. For the regulations by which the admission to practise as a counsellor is restricted in England, see BARRISTER.

COUNT. (Lat. comes, *a companion*; or according to a fanciful conjecture of some etymologists, from comedere, *to eat with*, because the holders of this dignity had the privilege of dining with the emperor.) A title of dignity in most of the continental states of Europe, equivalent in rank to the British earl and the German *graf*. This title has been in existence since the time of Augustus, who is said by Dion Cassius to have thus designated all the officers of his household. Under the Lower Empire and the first two races of the Frank kings, this title of count was given to officers of various degrees, and was at first attached to the office, and not to the person; but in the progress of time, when feudalism had introduced inheritance instead of election as a fixed rule in succession, it became subject to the same law as the higher titles of kings and dukes, and conferred hereditary privileges on its possessor. (*See* FEUDALISM.) The term count has in most of the states where it is in use degenerated into a mere title, to which no political importance is attached. "In the Papal states it may be bought for no considerable sum, and in most of the German states the sovereign may confer it as a mark of honour or esteem." Though the title count has never been introduced into Britain, the wives of earls have from the earliest period of its history been designated as *countesses*. (For further information on this subject, see *Dutillet's Recueil des Rois de France*.)

COUNT. In Law. *See* DECLARATION.

COU'NTERFORT. (Fr. contre, *against*, and fort, *strong*.) In Architecture, a buttress or pier built against and at right angles to a wall to strengthen it.

COU'NTERGUARDS, in Fortification, are small ramparts with parapets and ditches, to cover some part of the body of a place. They are generally made before the bastions, sometimes before the ravelins.

COU'NTERMARK. In Numismatics, a stamp frequently seen on ancient coins, often obliterating a large part of the impression. The countermark is generally a figure or inscription; and some antiquaries have considered that their use was to augment the value of the money; others, that it was only struck on money taken from an enemy.

COU'NTERPART. In Law, when the parts of an indenture are interchangeably executed by the several parties, that part which is executed by the grantor is termed the original, and the rest are counterparts. If each part is signed by all parties, they are duplicate originals.

COU'NTERPOINT. (It. contrapunto.) In Music, a composition of several parts. The name originated in the circumstance of the notes being formerly placed one against or over the other, and without any stems.

COU'NTERPROOF. In Engraving, an impression obtained from another impression while it is yet wet from a copper plate, in which the design is in the same direction as in the plate itself. They are made chiefly for investigating the state of a plate; and of some prints the counterproofs are more valuable than the prints, where the drawing from the picture has not been reversed on the copper.

COU'NTERSCARP. In Fortification, the slope or *talus* of the exterior side of the ditch, towards the country. The interior slope is called *escarpe*. Sometimes the whole covert way, with its parapet and glacis, are termed *counterscarp*.

COU'NTERSIGN. In Diplomatics, the signature of a public officer to the charter of a king, prelate, &c. by way of certificate. "Obtulit," "recognovit," "relegit et subscripsit," are common additions, in charters of the middle ages, to the name of the countersigner.

COU'NTER-TE'NOR. In Music. *See* TENOR.

COU'NTY. A county is in England that district of territory which was anciently subject to the government of an earl or ealdorman, from whose Latin title *comes* the term is derived. The Saxon word corresponding to county was shire, meaning division, which is therefore not applied to such counties as were originally distinct sovereignties; such as Kent, Essex, Sussex, Middlesex, Suffolk, Norfolk.

The division of the kingdom into counties, which, in common with many other of our earlier institutions, is commonly attributed to Alfred, though it was probably of a date far anterior, was in ancient times chiefly of use in marking the limits of different jurisdictions. To each county belonged a county court, which it was the duty of the thanes and other freeholders to attend and do suits at, though it seems the thanes only took part in the administration of justice. Such court was originally held by the earl and bishop, the latter assisting in respect of the ecclesiastical jurisdiction belonging to the court; or in their absence by the sheriff, upon whom the right to preside in the county court, either in person or by deputy, as well as the other civil functions of the earl, have long since devolved. Considered in its judicial character, the county court was the great court baron or civil court of the county, and was originally competent to the trial of almost all civil actions arising within such county. The criminal jurisdiction belonging to the county, which is now vested in the magistrates at quarter sessions, was anciently exercised by the sheriff in his tourn (*see* title TOURN). The boundaries of a county serve also to mark the limits of the jurisdiction, both civil and criminal, which other courts or judges exercise within each county severally by commission from the crown (*see* VENUE); and within which limits also are

confined the ministerial functions of the sheriff as executor of the writs awarded by either of the great courts.

The division into counties is also for some purposes, particularly that of representation in parliament, political; and it is in the county court that the election of members of parliament takes place, and that other political acts of the men of the county are done; for county meetings convened and presided over by the sheriff are, properly speaking, holdings of the county court. What has been said of counties in England applies without qualification, save as to the time of the institution; to Wales, and, with very little qualification, to Ireland and Scotland; the most important point of difference being the greater extent of the jurisdiction and power of the sheriff in the latter country. There are in England 40 counties, in Wales 12, in Scotland 32, and in Ireland 32.

A County Palatine, of which description there are now two in England, viz. Durham and Lancaster, is a county in which all jura regalia, *i. e.* the whole rights of sovereignty in judicial matters, belonged to the earl of such county; but these privileges are now reduced to the possession of courts of their own, corresponding in number and jurisdiction to the King's courts at Westminster, whose jurisdiction is not excluded by theirs, and whose writs may be so framed as to run within the limits of the county palatine.

COU'NTY COURT. The County Court properly so called is a court baron, not of record, for civil causes, held by the sheriff in each county. This court can only hold pleas where the debt or damage is under 40*s*., except by virtue of the writ called of *justicies*, which is a special precept to the sheriff to do justice between parties in the same manner as it might be done in the courts of Westminster. Causes are removed out of this into the higher courts by writ of recordari. (For the extension of the powers of the sheriff by statute to try personal actions of greater amount, see SHERIFF; *Read's County Courts; Greenwood on Courts; Watson's Sheriffs.*)

COUNTY RATE. *See* RATE.

COU'PLED COLUMNS. In Architecture, columns half a diameter apart. *See* ARÆOSYSTYLOS.

COU'PLING BOX. A strong iron cylinder, by which the shafts of machinery are connected.

COURIERS. (Fr. courir, *to run.*) A name given in ordinary language to the bearers of public despatches or private intelligence by express. The institution of persons to convey intelligence with celerity and regularity is coeval with the earliest history of civilized nations. By the Persians they were styled *αγγαροι*, by the Greeks *ἡμεροδρομοι*, and by the Romans *cursores;* and the duties of the ancient couriers seem to have been wholly analogous to those of the moderns, and were performed chiefly on horseback; though the original derivation of the name would lead to an opposite supposition. In the middle ages couriers were known by the appellation trottarii, or *trotters;* and hence perhaps originated the English term *running footmen*, of whom history makes mention in the 17th and 18th centuries.

COURSE. (Lat. cursus.) In Architecture, a continued level range of stones or bricks of the same height throughout the face or faces of a building. *See* BOND.

COURSE OF CROPS. The rotation or succession in which crops follow one another, in a prescribed course of cropping. The rule is to follow a crop grown for its seeds or roots by one grown for its leaves or stems.

COU'RSERS, *Cursores*. (Lat. curro, *I run.*) An order of birds, including those which are disabled from flight by the restricted development of the wings, but which possess superior powers of running from the compensating size and strength of the legs: the ostrich, rhea, casowary, emeu, and apteryx are examples of this order.

COU'RSES. The lower square sails, as the foresail and mainsail.

COU'RTESY. (Fr. courtoisie, Ital. cortesia.) It was at the courts of princes and great feudatories that the minstrels and troubadours of the middle ages especially delighted to exercise their art; and it was there, also, that the peculiarities of chivalrous life and manners were chiefly exhibited. Hence courtesy was a general term, expressive of all the elegance and refinement which the society of those times had attained; in fact, it was synonymous with all the gentler parts of chivalry itself: and it is in this sense that it is used both by the early trouvères and romancers, and also by poets of a later age, when affecting the use of chivalrous language, as in the first lines of the great poem of Ariosto:—

> Le donne, i cavalier, l' arme, gli amori,
> Le *cortesie*, l' audaci imprese io canto.

The transition from this wider meaning to that in which it is now employed is obvious enough. It may be sufficient to refer to the very ingenious theories of Signor Rossetti respecting the secret meaning attached to this (among other) words of frequent occurrence in the poems of the Italian canzonieri of the thirteenth and fourteenth centuries. (*Inferno di Dante*, 1827, vol. ii. p. 430, &c.)

COURT PLASTER. Black silk varnished over with a solution of isinglass, which is often perfumed with benzoin.

COURTS OF JUSTICE, are divided by the rules of English law into courts *of record* and *not of record.* The former have power to make up their acts and judicial proceedings in the form technically called a *record*, as evidence of their judgment. All courts having power to fine or imprison are said to be impliedly courts of record; but this seems questionable.

The courts termed Superior are divided into those of Law, Equity, Ecclesiastical, Maritime, Prize or International, and Courts of Appeal and Error. They are,—

Three Superior Courts of Common Law (*see* COURTS, SUPERIOR), being—

1. The Court of King's Bench. *See* KING'S BENCH.
2. The Court of Common Pleas. *See* COMMON PLEAS.
3. The Court of Exchequer. *See* EXCHEQUER.

Four Superior Courts of Equity (*see* CHANCERY), being—

4. The High Court of Chancery.
5. The Rolls Court.
6. The Vice-Chancellor's Court.
7. The Equity side of the Court of Exchequer.
8. The Ecclesiastical Courts. *See* ECCLESIASTICAL COURTS.
9. The Court of Admiralty. *See* ADMIRALTY.
10. The Prize Court. *See* ADMIRALTY.
11. The Courts of Bankruptcy. *See* BANKRUPTCY.

The Courts of Error and Appeal are—

12. The Exchequer Chamber, from the Superior Common Law Courts. *See* EXCHEQUER CHAMBER.
13. The Privy Council, and Judicial Committee of the Privy Council, which are Courts of Appeal from the Ecclesiastical Courts, Admiralty, and also from the decisions of various Colonial Judicatures.
14. The High Court of Parliament. *See* PARLIAMENT.

Inferior Courts are numerous, both of record and not of record; being for the most part local jurisdictions of very various extent and authority. To these belong the Courts of Conscience and Requests, Courts Baron, Hundred Courts, Borough Courts, and County Courts, in which the sheriff presides.

COURTS, SUPERIOR. The three superior common law courts of England are the Court of King's Bench, of Common Pleas, and of the Exchequer. For the origin and history of each court, and its peculiar jurisdiction, see those separate heads.

For several centuries, by means of various admitted fictions, these three courts have exercised a concurrent jurisdiction in all personal actions (*see* ACTIONS); and the practice of all three is, in material points, the same. They sit, during term, at Westminster. The different branches of jurisdiction of the three superior courts are, 1. That of the full court in *banc*, during term only, when four judges sit together in each; 2. Of the Practice or Bail Court (created by the 1 W. 4. c. 70. s. 1., which as yet has been brought into operation in the King's Bench only, in which a single judge disposes of some less important matters of business); 3. Of a single judge at chambers, where also points of minor importance in the conduct of a cause are decided and directions given; 4. Of the master or prothonotaries, officers to whom various matters of fact, as computations, &c., are referred; 5. Of the judge at Nisi Prius and on the circuit, for the trial of issues in fact; 6. Of the sheriff in each county, who may be considered as an officer of the superior courts for the purpose of trying issues directed to him under 3 & 4 W. 4. c. 42.

The course of proceeding in the superior courts is either formal or summary. Formal proceeding, in personal actions, is the regular course of a trial, whether the issue, or question tried, be one of fact or law. The party complaining, or plaintiff, having brought the defendant into court in person, or constructively, by preliminary *process*, entitles his *declaration*, or the form of statement of his grievance (*see* PLEADING), as of one of the three courts, the same in which the writ for commencement of the action is said to be *returnable*. The defendant then pleads; and all the subsequent pleadings, or preparatory statements in writing, are entitled of the same court: in which also the record, or parchment roll containing the authentic entry of the whole proceeding, is made up. The question eventually raised between the parties will turn out to be either of law, or of fact. The former, being raised on what is termed a *demurrer* (*see* PLEADING), is argued at Westminster before the full court, and the judgment in law is conclusive of the issue. If the question be of fact, it must be tried by a jury. If the pleadings are dated at London or in Middlesex, as in *local* actions they must be if the question arise in those districts, and as in *transitory* actions they

may be in all cases (*see* PLEADING), the jury will be summoned accordingly, and the case tried before a judge of the court in which the action is brought, at *nisi prius* (see that head), either during term or in the sittings after term. If, on the other hand, the date, or *venue*, as it is termed, be in any other county, the parties proceed to trial at the assizes (the plaintiff bringing down the record from Westminster, by which means it is in his option to proceed to trial or not). In this case a jury is summoned in like manner before the judges of assize, by virtue of their commission of oyer and terminer. In some special cases, trial at bar is granted on application; in which case the cause is tried by a jury before the full court, at such time as the court may fix for convenience. If a party imagines himself to have grounds for being dissatisfied with the result of a trial, as, that the judge has summed up the evidence improperly to the jury, or that material testimony has been illegally rejected, he may move the court at Westminster for a new trial, or to set aside the verdict, according to the circumstances of the case; and such motion is made before the full court in term. On the issue of the trial judgment is awarded, declaring that the plaintiff either has, or has not, entitled himself to the remedy prayed; and costs are given with the judgment; after which the successful party may sue out execution, unless there be an appeal by writ of error, which only lies on matter of law arising on the face of the proceedings.

Summary proceedings are of very miscellaneous character; and are by affidavit, motion, rule *nisi* (*i. e.* unless cause is shown against the rule on a certain day; when, if no cause, or insufficient cause, is shown, the rule is made absolute; and if made absolute, followed by demand of performance, and this performance enforced by means of attachment for contempt of court). By these means the courts have extensive authority to give directions and enforce conditions during the progress of a suit. Among summary proceedings may also be enumerated the leave given, on motion, to amend various formal defects in pleadings.

COURT BARON. A Court Baron, so called either from the lord or baron who presided over it, or from the freemen, in ancient times also called barons, who were its suitors and judges, was a court, having its origin apparently in notions of a patriarchal jurisdiction, properly and in the first instance incident to every manor, in which it was held by the lord of the manor or his steward, who, assisted by the freeholders of the manor, there decided on the purely civil controversies which arose between them. A court baron also belonged to every hundred and county (see those titles); and in many cases also to particular franchises or lordships, which might include several manors. Courts baron, from the inferiority of their judges, and from the defects of their jurisdiction, which a party might defeat by removal of the cause to a higher tribunal, have long fallen into disuse; except in manors of ancient demesne, where the jurisdiction was, and in some respect still is, in the first instance exclusive, the lord of such manors having once been the king; and except in manors containing land of copyhold or customary tenure. *See* COPYHOLD.

COURT-MARTIAL. A court for trying and punishing the military offences of officers and soldiers. Courts-martial, in our law, are bound by the same rules and principles of evidence as courts of law. Their jurisdiction is conferred by the Mutiny Act (1 W. & M.), which is annually renewed. The crimes cognizable by them are designated by the Mutiny Act and Articles of War. The persons liable to martial law are officers, soldiers, and persons serving with the army in the field; and receiving pay as a soldier subjects the receiver to it; but officers on half-pay are not liable. The judgments of courts-martial are open to the disapprobation of the king or his commanders-in-chief; and are likewise liable to reversal by the Court of King's Bench. The acts of a court-martial, like those of other courts instituted by statute with particular powers, may become the subject of application to the courts at Westminster for a prohibition. *Naval courts-martial* have their jurisdiction defined by the thirty-six articles of war, embodied in 22 G. 2. c. 23. and 19 G. 3. c. 17., and are composed of admirals, captains, and commanders. (See *M'Arthur on Courts Martial; Kennedy on C. M.; James, Collection of Proceedings of C. M.* 1820; *Tytler on Military Law.*)

COU'SSINET. (Fr. *a cushion.*) In Architecture, the crowning stone of a pier, or that which lies on the capital of the impost and under the sweep. Its bed is level below and inclined above, receiving the first rise or spring of the arch or vault. This word is also used for the ornament in the Ionic capital, between the abacus and echinus or quarter round, which serves to form the volute, and is thus called because its appearance is that of a cushion or pillow seemingly collapsed by the weight over it, and bound with a strap or girdle called the baltheus.

COVE. An inlet on a rocky coast. It is a term nearly synonymous with *harbour;* the word cove being generally, though not always, used when the indentation on the coast is too shallow or narrow to admit first-class vessels.

CO'VENANT. In History, the famous bond of association adopted by the Scottish Presbyterians in 1638. It was framed on the model of a similar declaration, which had been twice solemnly subscribed in the early period of the Reformation: but in more violent language, and with more specific obligation to support the kirk, together with a prohibition and abjuration of the Anglican liturgy and articles. The founders of the Solemn League and Covenant were Alexander Henderson, leader of the clergy, and Archibald Johnston of Wariston, an advocate. (See *Laing's History of Scotland*, vol. iii.) A new religious covenant between the two kingdoms was framed in 1643, and taken by the English House of Commons and assembly of divines at Westminster. Charles II. subscribed the Scottish covenant on his coronation in 1651; but on his restoration it was declared null by act of parliament, and burned by the common hangman. It formed, however, the watch-word and bond of union of the discontented party, or Covenanters, as they were called, in the rebellions of his reign.

COVENANT. In a theological sense, a promise made by God to man upon certain conditions: the two grand distinctions of which are emphatically designated the Old and New Covenant or Testament; in each of which certain temporal or spiritual benefits are promised to man upon the performance of duties therein pointed out.

COVENANT. In Law, is an engagement under seal to do or to omit a direct act. Covenants are of many different species, as, in fact and in law, implied and express, &c.; and, according to their subject matter, or express stipulation, they are binding respectively on the heirs, executors, and assigns, or executors and assigns only, of the covenantor.

COVENANT is also a form of action, which lies where a party claims damages for breach of a covenant or contract under seal.

COVENA'NTERS. The great body of the Scottish people, at the era of the Reformation, adopted the presbyterian faith and polity as established by Calvin at Geneva, and as introduced into Scotland by Knox, and recommended and enforced by his eloquence. As presbyterianism was thus closely associated in their minds with their deliverance from what they regarded as the degrading authority of popery, the people of Scotland have ever been distinguished for their cordial and unflinching adherence to this new faith. But though it was the object of public veneration, it never succeeded in gaining permanently either the affection or countenance of the court. On the contrary, the successive monarchs by whom Scotland was governed from the Reformation in 1560 till the final establishment of presbytery as the national church in 1690, regarded it with disfavour, and did all in their power, either by open persecution, or by private intrigue, to undermine and destroy it. They regarded it, being a republican hierarchy, as incompatible with royal authority; and James VI. declared that "presbytery and monarchy could no more agree than God and the devil." But though, owing to royal favour, episcopacy, or "black prelacy," as it was contemptuously called by the presbyterians, occasionally predominated, it was as often superseded by presbytery. The latter, after having been for some time displaced by prelacy, gained the superiority in 1592; from which time till 1606 it was established as the national religion. At this latter period, however, episcopacy obtained the mastery, which it enjoyed for upwards of thirty years. But though this polity, being favoured by the influence of the court, so long maintained the ascendency, it continued as obnoxious as ever to the great body of the Scottish people. Indeed, so obnoxious was it known to be, that, though episcopacy legally prevailed, it was thought prudent for some time nominally and formally to rule the church by means of the ecclesiastical judicatories peculiar to presbytery. But the people were not so easily deceived; nor could any consideration induce them either to forego the ecclesiastical polity which was so dear to them, or look on its rival with the least degree of toleration or favour. Matters at length came to a crisis on this subject. Charles I. having introduced that arbitrary judicatory in matters religious and ecclesiastical, the High Commission Court, and having attempted to introduce the Book of Canons and the Liturgy or Service Book, the public voice was aroused, and public indignation was generally and unequivocally expressed, particularly in Edinburgh, where a very serious tumult took place (July, 1637) on a Sunday, on occasion of an attempt being made (according to royal proclamation) to read the liturgy in the church of St. Giles. Supplications against the liturgy issued from almost every quarter of the country, from all classes of the people, and from the great majority of municipal corporations, and were carried by the principal men of the kingdom to be presented to the privy council. These supplications were not attended with the success which it was hoped they would have experienced. But the

supplicants or the public were not to be driven from their purpose. The supplicants, who had flocked to Edinburgh in great numbers, could not long remain there. But the most effectual means were adopted to keep up an organized opposition to the royal procedure in this matter. Four *tables*, as they were called, were formed. One table consisted of nobility, another of gentry, a third of clergymen, a fourth of burgesses; thus representing all ranks and classes of the people. There was also a general table, composed of representatives from the four subordinate tables, which received suggestions from these, and decided on what steps it was necessary to adopt. One of the first acts they passed was the production of the *Covenant;* and hence all those who either then or afterwards subscribed it or gave in their adherence to it, were denominated *Covenanters.* (*Baillie's Letters*, i. *passim; Laing's Hist. of Scotland*, iii.; *Cook's Hist. of the Church*, iii.; *Acts of General Assembly.*)

The origin of the Covenant in Scotland may be traced to the Reformation, during the progress of which it was renewed several times; and it evidently had a reference to the covenants so frequently adopted by the children of Israel, and by which they bound themselves to adhere to that religion which the Almighty had established among them.

The Covenant to which we at present more immediately refer, is in many respects a renewal of the Covenant which was subscribed in the year 1580, 1581, and 1590, but so modified and enlarged as to embrace the circumstances under which the church was placed at the interesting crisis under review. It inveighed not merely against popery, as the former Covenant had done, but "against the danger of the true reformed religion (that is, the presbyterian faith and polity as established in 1592), of the king's honour, and of the public peace of the kingdom, by the manifold innovations and evils" so generally prevalent. The subscribers also profess, and "before God, his angels, and the world, solemnly declare, that, with their whole heart, they agree and resolve all the days of their life constantly to adhere unto and to defend the foresaid true religion." "We promise and swear," to use their own words, "by the great name of the Lord our God, to continue in the profession and obedience of the foresaid religion; and that we shall defend the same, and resist all these contrary errors and corruptions, according to our vocation, and to the uttermost of that power that God hath put in our hands, all the days of our life." (*Vide* the *National Covenant* appended to the *Westminster Confession of Faith*, p. 483. edit. 1815.)

These expressions, however unequivocal or strong, are not more energetic than others in the same document. They showed that the persons by whom they were uttered were in earnest, and that nothing could satisfy them but the abolition of the High Commission Court, and the revocation of the canons and liturgy; in other words, the total and unconditional abrogation of prelacy. They insisted on the questions that existed between them and the king being immediately submitted to a free General Assembly of the Kirk, and to parliament.

Meanwhile the tables invited all the supplicants to repair from the country to attend a solemn meeting, which was to be held in Edinburgh in honour of the Covenant The supplicants having obeyed the summons, the Covenant (1st March, 1638) was solemnly subscribed and sworn, amid prayers and with uplifted hands, by the nobility, gentry, clergy, and burgesses; by thousands of all classes, of both sexes, and of every age. Nor was this all. Commissioners were immediately despatched with copies of it throughout Scotland; and in a few weeks every district of the country, with some partial exceptions, submitted to the Covenant.*

The nation was now divided into two parties,—the *Covenanters*, a name originally imposed by their adversaries, and the *Non-Covenanters;* the latter being a small, feeble, and scattered body. (*Baillie's Letters; Livingstone's MS. Life.*)

Charles, seeing the formidable position assumed by the Covenanters, and the influence which they possessed, was at length willing to recal the liturgy and the canons, and to make considerable concessions for the sake of peace. But it was too late: no compromise could now be accepted; nothing would satisfy the Covenanters but the extirpation of prelacy: nothing that fell short of this would be at all listened to. Nay, so far did they carry their condemnation of the bishops, that they had not only preferred an accusation against them as the authors of the innovations, but had, meanwhile, applied for an interdict, prohibiting them from having a seat in the privy council. The prelates, indeed, finding that they were the object of public odium, and that their influence was nearly gone, voluntarily withdrew from the council. The king, after much temporizing and intrigue, found himself obliged, however reluctantly, to agree to the meeting of the General Assembly on the terms which the Covenanters had proposed,—namely, that lay-elders should, as in the best days of presbytery, be recognized as constituent members of the inferior ecclesiastical courts, and eligible as members of assembly; that not only should the bishops, the former official moderators (presidents) of presbyteries, not be replaced, but that these dignitaries might be legally prosecuted by the Assembly, and their usurpations restrained, if not their order entirely suppressed. (*Ib.*)

The Assembly accordingly met at Glasgow in November, and continued its sittings (for thirty days) as its inalienable right, even though the royal commissioner, the Marquis of Hamilton, had meanwhile declared the meetings dissolved. It embraced in the list of its members the most eminent of the nobility and gentry as lay-elders. It not only annulled the canons, liturgy, the High Commission Court, and other innovations, but it abolished episcopacy itself, and declared it as having been from the first both illegal and unscriptural. Of the prelates, fourteen in number, of whom the Scottish hierarchy had consisted, eight were excommunicated, four deposed, and the remaining two merely suspended from their ecclesiastical functions. Nor did the Assembly stop here; for, while it abolished prelacy, it re-established presbytery as it had existed previously to the late innovations, with all the privileges, liberties, powers, and jurisdictions which it had formerly enjoyed. (*Acts of Assembly*, 1638.)

The proceedings of this Assembly, particularly its contemptuous and summary mode of dealing with the favourite hierarchy of the king, could not be agreeable to Charles. These proceedings were, on the contrary, so obnoxious to him that, on the Supplication voted at the conclusion of its meetings being presented to him, he expressed himself as deeply offended, and declined to return any answer to it. "When the Covenanters," says he, "have broken my head, they will put on my cowl." This injudicious conduct on the part of the king brought matters to a crisis. Both parties prepared for war; a step, however, which the Covenanters, who always professed the greatest loyalty, adopted with reluctance. So devoted, however, were the people to what they regarded as a righteous cause, that the expense on the side of the Covenanters, who included in the list of their adherents almost every individual in Scotland, was defrayed by a general voluntary assessment. In raising both men and money the clergy took an active part; and contributions for carrying on the war were levied by them from their respective flocks to an extent scarcely credible. "We sent from Stranraer," says John Livingstone, then minister of that parish, "our fourth fencible man, viz. 15 men. The town was but little and poor; all the yearly rent was estimated at 2000 merks Scots * * *. I propounded to my flock the condition of the army, and desired they would prepare their contribution to be given after sermon; at which time we got 45*l.* sterling," or nearly the half of the whole income of the place. (*MS. Life*, p. 34.) Nor was the spirit which pervaded the army less interesting or enthusiastic than that which characterized the whole body of the Covenanters. "Every company," says an eyewitness, "had fleeing at the captain's tent door a brave new colour, stamped with the Scottish arms, and the motto, *For Christ's Crown and Covenant*, in golden letters." (*Baillie*, i. 174.) Every regiment was attended by a chaplain. "I carried myself," says Dr. Baillie, who attended the army in the capacity of a chaplain, "as the custom was, a sword and a couple of Dutch pistols at my saddle." "Our soldiers grew in experience of arms, in courage, and favour daily. Every one encouraged another: the sight of the nobles and their beloved pastors daily raised their hearts. The good sermons and prayers, morning and evening, under the roof of heaven, to which their drums did call them for bells, the remonstrances very frequent of the goodness of their cause, of their conduct hitherto by a divine hand, made them as resolute for battle as could be wished." "Had you lent your ear, in the morning, or especially at even, and heard in the tents the sound of some singing psalms, some praying, and some reading scripture, ye would have been refreshed." (*Ib.*)

Such was the spirit under the influence of which the Covenanters waged and carried on the war with their sovereign. Of the hostilities that ensued it is unnecessary here to give a farther account than to say, that the Covenanters, though they gained the only battle that was fought, lost no time in making proposals of peace. These proposals were accepted by the king; and a treaty was concluded (June, 1639) four months after the commencement of the war. Of this treaty the most important clause was,

* So pertinaciously was subscription of the Covenant insisted on, that no student could enter college, or take a degree there, and no person could be admitted to the Lord's Supper, without having first subscribed this obligation. Not only were such persons as professors and teachers, but every human being of whatever rank, bound to subscribe under the risk of "all ecclesiastical censure." Those "suspected of papistry" were summoned before the church courts, with a view of inducing them to sign the Covenant; and if they refused, they were ordered to be proceeded against and tried as disaffected persons. Every university, synod, presbytery, and parish were obliged to have each a copy of the Covenant in 4to., "with some blank paper, whereupon every body may be obliged to sign." Subscription of the *Solemn League and Covenant*, afterwards to be spoken of, was prosecuted with almost equal zeal. (*Acts of Assembly, apud annos* 1639-48.)

that, as the king would not ratify the enactments of the Assembly of Glasgow, and as the Covenanters would not annul them, a free General Assembly should be held in the ensuing month of August, and a parliament immediately afterwards; to the decision of which courts every dispute between the contending parties was to be referred. This Assembly met accordingly; and its proceedings, as might have been expected, were exactly of the same character as those of the former: and yet, such was the progress of public opinion, that the Earl of Traquair, the royal commissioner, not only did not refuse to ratify them, but consented to subscribe that obnoxious bond, the Covenant, which was ordained, under the penalty of ecclesiastical censure, to be subscribed by all ranks. The members of the privy council, besides, gave to the Covenant the sanction of their authority, and attached their signatures to it. (Ib.)

The proceedings of this Assembly were, if possible, more obnoxious to Charles than those of its predecessor; and afraid lest the parliament, which had already met, should exhibit a similar spirit, he lost no time in proroguing it. But nothing could now arrest the march of public sentiment; and in the parliament, which met in June 1640, in direct opposition to the wishes of the king, who had determined to prorogue it, every enactment of the General Assembly respecting the Covenant and the presbyterian faith obtained the sanction of that supreme court, and became the law of the land.

Thus the Covenanters, after an arduous struggle of three years, saw their object fully gained; namely, their favourite ecclesiastical polity established, and the validity and authority of the Covenant recognised by the legislature. Their history from this date (which will be found more at length under the article PRESBYTERIANS) becomes that of the presbyterian church in Scotland, and is interwoven with the annals of their country. Charles, offended with the triumph of the Covenanters, again declared war against them; but after a short campaign, unfavourable to the royalists, peace was restored (1641) The king having, meanwhile, alienated the affections of his English subjects, and a civil war having, in consequence, broken out, the Covenanters, on the repeated and urgent application of the parliament of England, made common cause with them, and took up arms for the third time against royal authority. But along with a civil league the Scots succeeded (1643) in carrying a religious covenant, known in history under the name of the *Solemn League and Covenant;* an obligation which was long revered in both divisions of the island, and the main object of which was to accomplish uniformity of religious doctrine and church government in both kingdoms. Nor was this object long in being, so far, attained: a presbytery, as it existed in Scotland, having obtained the sanction of the famous Assembly of Divines met at Westminster (1643-9), and having been afterwards ratified by the English parliament, was recognised as the national church of both portions of the empire. Presbytery, however, was introduced into England rather as an experiment than a permanent institution. Besides, it was not systematically adopted except in London and Lancashire; and it rapidly declined, having been, to a considerable extent, superseded by Independency. But at the Restoration episcopacy triumphed over both these forms, and has since prevailed as the established church in England. (*Solemn League and Covenant* appended to the *Westminster Confession of Faith*, edit. 1815; *Acts of General Assembly; Wodrow, Baillie, Laing.*)

Though the presbyterians had, meanwhile, differed somewhat in opinion as to some public matter, and though they were not all equally zealous in favour of the Covenant, yet the importance of this obligation was never lost sight of. On the martyrdom of Charles I. the Scots refused to recognise the right of his son, Charles II., to the throne, till he consented to subscribe the Covenant, and to guarantee and uphold the presbyterian church. Cromwell, though he allowed them the free exercise of their religion, never was the object of their affections and confidence, inasmuch as he was a sectary, and a friend to toleration, which latter they had uniformly condemned. But the Protector, while he tolerated the presbyterian faith, deprived it of some of its most valuable attributes. He not merely interdicted the meetings of the General Assembly*, but prohibited the tender of the Covenant or any similar obligation, and divested some of the ecclesiastical penalties, such as excommunication, of their terrors by depriving them of their civil effects. But a worse fate yet awaited the Covenant. At the Restoration, not only was episcopacy restored and presbytery superseded as the national church; but by a sweeping act, called the *Act Rescissory*, passed in 1661, all the parliaments that had been held since 1640 were declared null and void; thus rendering invalid those acts, in confirmation both of the Covenant and of presbytery, to which the late king had assented, and which Charles II. himself had sworn to maintain. From this period the Covenant may date its decline. It continued, indeed, to be regarded as sacred by perhaps the most valuable, if not the most numerous, portion of the clergy and people, — of those who would submit to no compromise, and who, in consequence, were the objects, during the reigns of Charles and his brother James, of the most ruthless persecution. Nay, so far did some of these parties carry their opinions, that they did not regard any person entitled to homage as king unless he had "covenanted," or affixed his signature to the Covenant. The party by which such a principle was professed are known in history under the name of Cameronians; a body which, though now much reduced both in numbers and importance, and who have moderated or changed their sentiments on this subject as well as on others, still exist in Scotland as a distinct religious sect. (*See* CAMERONIANS.) At the Revolution, when presbytery was revived in Scotland and established as it now obtains, no mention was made of the Covenant either in the General Assembly or inferior courts. It seems to have been allowed to fall into desuetude, no steps having been taken with regard to it. It now exists only as a matter of history; though, as just said, the Cameronians may be regarded as the successors and descendants of the Covenanters of the 17th century. (Ib.)

* The General Assembly had met annually from the year 1638 to 1649 inclusive. It sometimes met without having the sanction of the king, or without his majesty being represented in it, as is usual, by a commissioner. Not merely the Covenanters, but Presbyterians in general, laid it down as a principle, that the church courts are, in matters ecclesiastical and religious, independent of civil authority, and irresponsible to it. Accordingly, in 1638, the Assembly continued its sittings even after it had been dissolved by the royal commissioner. Cromwell in 1653 caused the General Assembly, then sitting, to be summarily dismissed, and interdicted its meeting in future. In this instance, the Assembly had implicitly to obey. This judicatory did not again meet till after the Revolution. (*Baillie's Letters*, ii. 369-70.)

CO'VERTS. In Ornithology. "The lesser coverts" (*tectrices primæ*) are small feathers which lie in several rows on the bones of the wings. The "greater coverts" (*tectrices secundæ*) are the feathers that lie immediately over the quill-feathers and the secondaries. "The under coverts" are the feathers that line the inside of the wings.

CO'VERTURE. In Law, the legal condition of a married woman. *See* MARRIAGE, LAW OF.

CO'VERT WAY, or COVERED WAY. In Fortification, a road or space of ground on the outer edge of the ditch, level with the adjacent country, and ranging all round the works. It is usually about 30 feet broad, and is protected by the glacis. Sometimes it is called the corridor.

CO'VEY. An old bird with her young ones; but generally used to designate a number of partridges or other game. It also in some countries signifies a cover for game.

CO'VIN. In Law, a compact between two or more, to deceive or prejudice others in certain cases; as, if tenant for life or in tail conspire with another party, to the intent that such party may recover lands held by the tenant to the prejudice of him in reversion.

COW'HAGE, COWITCH. This term is generally applied to the hairs or spiculæ which cover the seed pods of the *Mucuna pruriens*, a climbing perennial plant, which is a native of the East and West Indies. An electuary formed by dipping the pods into treacle, syrup, or despumated honey, and then scraping them, has long been used as a vermifuge; but it is often a very troublesome remedy, from the excessive itching which it produces when it touches the unprotected skin, and there are other more effectual means of expelling worms.

COW'-KEEPER. A person whose business it is to keep a stock of cows for supplying the public with milk and cream. The principal cow-keepers of the metropolis have their establishments in the suburbs, where they are connected with pasture fields, in which the animals are turned out a portion of every day throughout the year, excepting when the ground is covered with snow, or when it rains very hard. The cows are fed in the house with grains, mangold wurzel, hay, tares, and other kinds of nourishing food; and as the animals get air and exercise, their milk may be considered wholesome. There are many cow-keepers, however, in the metropolis, who keep only a few cows in confined back houses, and even in dark cellars; and, while they feed them with rich food, give them no exercise at all: hence the milk of such cows cannot be considered as wholesome.

COW POX. This disease was proposed in the year 1798 as a substitute for, and preventive of, the small pox by Dr. Jenner; and subsequent experience, as well as the extent to which the inoculation of it, or *vaccination*, as it is called, is carried throughout the civilized world, furnish well-grounded hopes of the ultimate extinction of one of the severest visitations of the human race. Small bluish vesicles, surrounded by inflammation, elevated at the edge and depressed in the centre, and containing a limpid fluid, occasionally appear upon the teats of the cow, the animal being at the same time somewhat indisposed: a similar disease is transferable under certain circumstances to the hands of the milkers; and persons who had so received it were found to be in many instances unsusceptible of small pox, both natural and inoculated. There is a disease of the horse's heel called

grease, which appears to have produced similar effects upon the hands of farriers, and is perhaps the origin of the cow's disease: but it is from the latter animal that the *matter* is most certainly effective, and from which it is transferred to the human race, where it produces similar pustules; and the fluid of these may again be transferred with the same effects from one human subject to another. Whether by continuous circulation through human subjects the *virus*, as it is called, gradually loses its preventive efficacy, is an important question, and one upon which there are differences of opinion; but it would probably be more safe if more frequently derived from its original source upon the cow's teat. It seems useless here to discuss the various objections which have been raised, and the suspicions which have been thrown out against the permanent efficacy of this preventive, since the most extended and unbiassed experience of the most skilful observers seems amply to have proved that *when the pustule has gone through its regular stages*, the person is afterwards, during the whole period of life, unsusceptible of natural and of inoculated small pox, the exceptions to this statement being so few as either to be referable to imperfect vaccination, or to idiosyncracy; and though it is not pretended that cases of small pox after vaccination are as rare as of small pox after small pox, yet it is well known that the latter do occur, and, in short, that there is no rule without exceptions. In doubtful cases vaccination should always be repeated; and as no inconvenience results from a repetition of its inoculation, and the disease is not infectious by effluvia, it may be performed at certain intervals, or may even be tested as to its efficacy by *variolous* inoculation; although to the latter there are certainly serious objections, if we look to its ultimate extermination. In inoculating patients for the cow pox the matter should be taken from a healthy child, at about the 6th or the 8th day, at which time the pustule is well formed; and it should be immediately transferred upon the point of the lancet from the pustule to the arm, and inserted by a small oblique puncture under the cuticle, one place in each arm being quite sufficient. If this direct mode cannot be followed, the virus intended for inoculation may be transferred between two pieces of plate glass, one of which is slightly indented for its reception; when slid over each other they are air-tight, and the edges may be secured by a strip of moist gold-beaters' skin or very thin bladder. If it is necessary to moisten the virus, this should be done with as small a portion as possible of tepid water, not exceeding the temperature of 100°. Lancet points which have been *armed*, as it is called, cannot be long depended upon, and are apt to be rusted and to irritate the arm. About the third day after inoculation the puncture generally becomes red and elevated, but the periods of its incipient progress are very uncertain; it then continues to enlarge and become vesicular; and is in full perfection about the eighth or ninth day, at which period also the surrounding circle of inflammation or *areola* is at its height. About the eleventh or twelfth day this declines, and the centre of the pustule becomes brown, and gradually dries up into a dark-brown circular scab, depressed in the centre. During the progress and scabbing off of the pustule great care should be taken to avoid all external injury; all irregularities in its progress should also be carefully watched; and if much inflammation comes on spontaneously two on or three days after inoculation, and especially if suppuration ensues, the probability is that the operation has failed; and in all cases where there is the least doubt the inoculation should be repeated, although, if one of the pustules has gone through the above described progress, the failure or irregularity of the other is of no consequence. The cow-pock is seldom attended by any symptoms requiring medical aid; but generally there is a slight drowsiness and febrile symptoms, with some restlessness, and occasionally sickness, about the second and third days; but these symptoms are immaterial to the preventive efficacy of the virus, which can only be judged of by the appearance and progress of the pustules, to which therefore it is necessary to pay close attention.

COW'RIES. (Germ. kouri.) Small shells brought from the Maldives, which pass current as coin in smaller payments in Hindostan, and throughout extensive districts in Africa: 100 are equivalent to a penny.

COY'POU. A Rodent quadruped; the *myopotamus* of geologists. *See* Nutria.

CRAB. *See* Cancer.

CRA'BRO. (Lat. crabro, *a hornet.*) A genus of Hymenopterous insects, belonging to the section *Aculeata* or sting-bearers, and to the subsection *Fossores* or burrowers. The hornet (*Crabro vulgaris*) is the type of this genus, which is now raised to the rank of a family (*Crabronidæ*), including two groups of subgenera. In one of these groups all the species have their fore-legs provided with strong spurs, for the purpose of excavating in decayed wood, or burrowing in sand, to form cavities in which their eggs are deposited; the insects of the other section have the fore-legs unarmed, and form no burrows, but deposit their eggs in the nests of other species. The true hornets (*Crabro*) excavate their retreat in wood, and feed their larvæ with the caterpillars of small moths found upon the oak, as well as with flies.

CRA'DLING. (Sax. cpaðel.) In Architecture, the timber ribs in arched ceilings and coves to which the laths for the plaistering are nailed.

CRAFT. *See* Trade and Vessel.

CRAG. A provincial name applied in Norfolk and Suffolk to certain accumulations of gravel.

CRAMP. Spasmodic or involuntary contraction of some of the muscles, often attended with great pain; it is common in the muscles of the leg and foot, especially after any extraordinary exertion of them, and is sometimes brought on apparently by irritation in the stomach of indigestible food. When cramp seizes the calf of the leg, it usually goes off upon placing the limb in an erect posture and rubbing the affected part: those subject to it find much relief by applying opiate liniments. If it arises from indigestion, or from indulgence in acescent drinks or champagne, mild bitters with magnesia, taken at bed time, will generally prevent its recurrence.

Cramp. (Dutch kramp.) In Architecture, a piece of metal, bent or dovetailed at each end, for the purpose of holding two blocks of any material firmly together.

CRANE. (Sax. cpan.) In Mechanics, a machine for raising heavy weights, and depositing them at some distance from their original place; for example, raising bales from the hold of a ship, and depositing them on the quay. A jib or transverse beam, inclined to the vertical in an angle of 40° or 50°, is constructed, which, by means of a collar, turns on a vertical arbor. The upper end of the jib carries a fixed pulley, and the lower end a cylinder, which is put in motion by a wheel and pinion, or cog wheel, or merely with a handle. The weight is made fast to a rope which passes over the pulley and is wound round the cylinder. On turning the cylinder, the weight is raised as far as necessary; the jib is then turned on its arbor till the weight is brought immediately over the spot where it is to be deposited; when, by withdrawing the moving power, it is allowed to descend by its own gravity. Cranes may be constructed of immense power. They are generally turned by human force; sometimes, however, by a steam engine.

CRA'NGON. (Gr. κραγγη, *a cray-fish.*) The name of the genus of Macrourous Crustaceans, including the common shrimp (*Crangon vulgaris*, Fabr.) This species abounds most on sandy coasts, and is caught by means of a large open net fixed to the end of a long stick.

CRANIO'LOGY. *See* Phrenology.

CRA'NIUM. (Gr. κρανιον, *the skull.*) Sometimes applied to the entire bony compages of the head of the vertebrate animals; but, in Human Anatomy, is restricted to that portion of the skull which surrounds the brain.

CRANK. A mechanical contrivance for changing a revolving into an alternate motion. An iron axis is bent in some part of its length out of its rectilinear direction. As the axis turns the bent part describes the circumference of a circle, and gives a reciprocating motion to a piston or rod attached to it.

Crank. (Germ. krank, *sick.*) In Nautical language, a ship is said to be *crank*, when by the form of its construction, or by want of a sufficient quantity of ballast or cargo, or by being loaded too much above, it is incapable of carrying sail without being exposed to the danger of oversetting.

CRAPE. A species of gauze made of raw silk woven without crossing; it is stiffened with gum-water.

CRASSULA'CEÆ. (Crassula, one of the genera.) A natural order of herbaceous or shrubby Exogens, growing in hot, dry, and exposed situations; remarkable for the succulent nature of their stems and leaves. They have an affinity with *Penthorum* and with *Illecebraceæ*, through *Tillæa*; and possess refrigerant abstergent properties, mixed at times with a good deal of acridity.

CRA'TER. (Gr. *a large cup* or *bowl*, used in antiquity during a repast, for holding mixed wine and water.) The mouth of a volcano, which see.

CRAYO'NS. Coloured cylinders used for drawing upon paper; they are usually made of a fine pipe-clay, coloured with metallic pigments or carmine. Crayons containing plumbago are styled *solid lead pencils*.

CREAM. (Fr. crême.) A semifluid yellowish substance which collects on the surface of milk, and which is made into butter by the process of churning. When the milk of any animal is allowed to stand for some time it spontaneously undergoes certain changes; this substance rises to the surface, and forms a thin stratum, which is called cream, and which consists chiefly of oily particles; while the milk below, which of course is thinner than it was before the cream separated from it, is of a pale bluish colour, and consists of curd, coagulum, or the matter of which cheese is made. When cream is kept for some days it gradually becomes thicker, and partially coagulated; and if put into a linen bag and suspended from the ceiling of a cool room, it will acquire the consistence of cheese; and this is one among other modes of making cream cheeses. When cream is shaken

by churning it is resolved into its component parts, and hence we have butter and buttermilk. In order to make butter it is not always necessary that the cream should be separated from the milk; but whether separated or not, the process is facilitated by allowing the liquid to stand for some time, during which a part of the sugar contained in the serum is changed into an acid, which shortens the process of churning by facilitating the separation of the butter from the milk. When either cream or milk is churned without having previously become sour, the process is much more tedious; and sometimes, from causes not easily accounted for by the dairymaid, it is unsuccessful, and the milk is said to be bewitched. The true cause, however, is the want of acidity; because it has been found that the addition of a small portion of vinegar will dissolve the charm, and cause the almost immediate appearance of butter. Cream, when separated from milk and kept still it has become acid, is frequently mixed with milk newly drawn from the cow; and this eaten with sugar is one of the most delicious preparations of the dairy. Costorphin cream, so called from a village of that name in the neighbourhood of Edinburgh, is made by putting the milk of three or four days together with the cream into a vessel, and allowing it to remain there till it has become sour and coagulated. The whey is then drawn off and fresh cream added; and when it is brought to table it is eaten with sugar, and in the strawberry season with that fruit. Devonshire cream is simply sour curd, or sour cream eaten with fresh milk, or fresh cream, with or without the addition of sugar. Devonshire scalded or clouted cream is milk and cream heated to the boiling point, and suffered to cool, when the cream will be found to have separated from the milk, and when skimmed off may either be made into butter or eaten with fresh cream and sugar. Common clotted cream is simply milk and cream in a coagulated state, and sour. When the clotted cream is broken and stirred, and the whey drawn off, the mass may be turned into cheese by artificial pressure, by which the whey is separated instantaneously; or by suspending it in a porous bag, in a cool airy situation, when it will be separated by degrees. *See* Butter, Cheese.

CREDE'NTIALS, LETTERS OF. The instrument in the form of a letter, from one monarch to another, which constitutes the evidence of the title of a minister at a foreign court to the power which he exercises. There are two sorts of credentials: the one sealed, drawn up and countersigned by the minister of foreign affairs; the other open, signed only by the king. Unless the minister be mentioned expressly in his credentials as an ambassador, he has only a right to the observances due to foreign ministers of inferior rank.

CRE'DIT, in Political Economy, is a term used to express the lending of wealth, or of the means of acquiring wealth, by one individual or set of individuals to another. The party who lends is said to give credit, and the party who borrows to obtain credit. Hence credit may be defined to be the acquisition by one party of the wealth of another in loan, according to conditions voluntarily agreed on between them.

Very exaggerated notions are commonly entertained of the influences of credit; but, in fact, all operations in which credit is given or acquired resolve themselves into a new distribution of wealth already in existence. The "magical" effect that is every now and then ascribed to credit is quite imaginary. A party who purchases goods payable at some future date obviously acquires the command of so much of the capital of the seller of the goods as their value amounts to, in the same way that a party who discounts a bill acquires the command of a corresponding portion of the capital of the discounter. Wealth is not created by the issue of bills; and all that their negotiation does is to transfer already existing property from one individual or party to another.

In the great majority of cases loans are made by individuals who wish to retire from business, or who have more capital than they can advantageously employ, to individuals entering into business, or who wish to extend their concerns and to acquire a greater command of capital. The probability is, that capital will be more likely to be efficiently employed by the latter than by the former class of persons; and the advantage of credit, in a national point of view, consists in that circumstance. Loans made to prodigals or spendthrifts, or to individuals who expend them on unprofitable undertakings, are, in so far, publicly injurious; but, speaking generally, these bear but a very small proportion to the other class of loans, or those made to individuals by whom they are advantageously expended.

Public credit is the phrase used to express the trust or confidence placed in the state by those who lend money to government.

The interest or premium paid by the borrowers to the lenders depends on a great variety of circumstances,— partly on the rate of profit that may be made by the employment of capital at the time, partly on the duration of the loan and the security for its repayment, and partly on the facilities given by the law for enforcing payment. The only way, indeed, in which a government can advantageously interfere to encourage credit is by simplifying the administration of the law, and by giving every facility for carrying the conditions of contracts into effect.

CRE'DITOR. *See* Bankruptcy.

CREED. Any brief summary of Christian belief; but more especially either of the three confessions commonly called the Apostles', Nicene, and Athanasian. The term is derived from the word credo, *I believe;* in like manner as paternoster, avemaria, &c., are prayers named from the first word of these formulas in the Latin tongue.

CREEK (Sax. crecca, said to be derived from the Lat. crepido), is a shore or bank on which the water beats, running in a small channel from any part of the sea. It is also applied to any part of a large river which is resorted to as a harbour or landing place by small craft. In the United States, the term creek is used as synonymous with our English words brook or rivulet.

CREEL. A kind of basket; such, for instance, as is used by anglers.

CRE'MOCA'RPIUM. (Gr. κρεμαω, *I suspend*, and καρπος, *fruit.*) A two to five-celled inferior fruit, the cells of which are one-seeded, indehiscent, dry, perfectly close at all times, and when ripe hanging separate from a common axis, as in umbelliferous plants.

CREMO'NA. A general designation of the violins made at Cremona in Italy, during the 17th and 18th centuries, chiefly by the family Amati. (*See* Violin.) Cremona is also a name erroneously given to a stop in the organ; being nothing more than a corruption of krumhorn, an ancient wind instrument, which it was originally designed to imitate.

CREO'LE. (In Spanish Criollo.) A name given to the descendants of whites born in Mexico, South America, and the West Indies; in whom the European blood has been unmixed with that of other races. The various jargons spoken in the West India islands by slaves, &c. are called Creole dialects.

CRE'OSOTE, or KREASOTE. A colourless, transparent, oily liquid, separable from wood-tar: it appears to be the principle to which the antiseptic power of wood-tar, smoke, and crude pyrolignous acid is owing. Hence its name, from κρεας, *flesh*, and σωζω, *I save.*

CRE'PITUS. (Lat.) The crackling noise which is produced upon pressing cellular membrane when it contains air.

CRESCE'NDO. (It.) In Music, a direction to the performer to increase the volume of sound from soft to loud; marked thus $<$.

CRE'SCENT (Lat. cresco, *I increase*), in Heraldry, is a bearing in form of a half moon. When the horns are turned towards the chief or upper part of the shield, it is called *crescent*, in contradistinction to the terms *increscent* and *decrescent;* in the former of which the horns are turned to the right, and in the latter to the left side of the shield. The crescent is frequently used to distinguish the coat armour of a second brother or junior family from that of the principal branch. As is well known, the crescent, or, as it is usually designated, the *crescent montant*, has become the symbol of the Turkish empire, which has thence been frequently styled the Empire of the Crescent. This symbol, however, did not originate with the Turks. Long before their conquest of Constantinople the crescent had been used as emblematic of sovereignty, as may be seen from the still existing medals struck in honour of Augustus, Trajan, and others, and it formed from all antiquity the symbol of Byzantium. On the overthrow of this empire by Mohammed II., the Turks, regarding the crescent which every where met their eye as a good omen, adopted it as their chief bearing; and it has continued ever since to decorate their minarets, their insignia, their dress, and in short every thing appertaining to their empire. Crescent has also been applied to three orders of knighthood: the first of which was instituted by Charles I., king of Naples and Sicily, in 1268; the second by René of Anjou, in 1448; and the third by the sultan Selim in 1801, two years after the battle of Aboukir. The last-mentioned order is still in existence, and is remarkable for the fact that none but Christians are eligible for admission.

CRE'ST. (Lat.) In Heraldry, the ornament affixed to the helmet, being a personal or hereditary device. Warriors bore insignia peculiar to themselves in this manner among the classical ancients. The earliest instance of the heraldic crest in England is said to be that of Edmund Crouchback, Earl of Lancaster (about 1280). The crest is, in modern blazonry, a figure placed upon a wreath, coronet, or cap of maintenance, which surmounts the coat of arms. It is not unfrequently a repetition of some bearing in the shield itself; as, the crest of Castile is a castle.

CRETA'CEOUS. (Lat. creta, *chalk.*) Composed of chalk. In Geology, the *cretaceous group* of rocks includes the upper strata of the secondary series, immediately below the tertiary deposits, and resting upon the oolitic group. (See *Fitton*, in *Geol. Trans.*, 2d Series, vol. iv.)

CRE'TINS. A name applied in the Valais and elsewhere to a class of idiots, who are also generally afflicted with *goitres*, which see.

CRIB. Sometimes applied to a rack for hay or straw for cattle, and sometimes to a manger for corn or chaff; also to a small enclosure in a cow-house or shed for calves or sheep.

CRIB-BITING. Biting the manger or crib; a bad habit among horses, brought on by uneasiness occasioned by diseases of the teeth, or by roughness in the person who currycombs them.

CRI'BBLE. A coarse sieve, or screen, for sifting sand, gravel, or corn; the term is also applied to a sort of coarse meal.

CRI'COID. (Gr. κρικος, *a ring*, and ειδος, *appearance*.) Annular or ring-shaped. A cartilage of the larynx is hence called the *cricoid cartilage*.

CRI'NO. A cuticular disease, supposed to arise from the insinuation of a *hair-worm* under the skin of infants.

CRINOI'DEANS, *Crinoidea*. (Gr. κρινον, *a lily*, and ειδος, *appearance*.) A name given by Miller to an extinct family of Echinoderms, having a radiated, lily-shaped disc, supported on a jointed stem. When this stem is cylindrical, the species are termed *Encrinites*; when it is pentagonal, *Pentacrinites*. See those words.

CRI'SIS (Gr. κρισις, *a decision*), may be defined, in its most extended signification, as a decisive point in any important affair or business; but it is used more particularly in a political sense, to denote a certain conjuncture of affairs in which, from what cause soever it may have originated, the ordinary operations of government are so fettered or deranged as to lead to some important change in the policy or institutions of a country. Like many expressions of similar import, the phrase "political crisis" admits of an almost endless variety of shades of meaning, being applicable at once to a change of ministry, the abolition of a constitution, a revolutionary insurrection, and the dethronement of a sovereign. Hence this expression will be better interpreted by the feelings, predilections, or prejudices of each individual, than by any definition of which it is susceptible. In France, a "crise politique," as it is called, is synonymous with the terms *coup d'etat*, *emeute*, *revolution*, *insurrection*, &c. In Medicine, certain symptoms which announce a favourable or an unfavourable termination of a disease are called *critical symptoms*, and the period at which they show themselves the *crisis* of the disease. In the progress of fevers these symptoms have been supposed to show themselves at certain definite periods, which therefore have been called *critical days*.

CRI'TICAL PHILO'SOPHY. The metaphysical system of Kant is sometimes so termed, from his famous work, the *Kritik der Reinen Vernunft* (Criticism of Pure Reason). *See* KANTIAN PHILOSOPHY.

CRI'TICISM (Gr. κρινω, *I judge*), has been defined "the art of judging with propriety concerning any object, or combination of objects." In a somewhat more limited, but still extensive meaning, its province is confined to literature, philology, and the fine arts; and to subjects of antiquarian, scientific, or historical investigation. In this sense, every branch of literary study, as well as each of the fine arts, has its proper criticism as an appendage to it. The elements of criticism depend on the two principles of Beauty and Truth, one of which is the final end or object of study in every one of its pursuits: Beauty, in letters and the arts; Truth, in history and the sciences. The office of criticism, therefore, is, first to lay down those forms or essential ideas which answer to our conception of the beautiful or the true in each branch of study; and, next, to point out by reference to those ideas the excellences or defects of individual works, as they approach or diverge from the requisite standard in each particular. Thus, historical criticism teaches us to distinguish the true from the false, or the probable from the improbable, in historical works; scientific criticism has the same object in each respective line of science; while literary criticism, in a general sense, has for its principal employment the investigation of the merits and demerits of style or diction, according to the received standard of excellence in every language; and, in poetry and the arts, criticism develops the principles of that more refined and exquisite sense of beauty which forms the ideal model of perfection in each. Taste is the critical faculty; that perception of the beautiful in literature and the arts, for the acquisition of which, perhaps, some minds have superior natural powers than others, but which can in no instance be fully developed except by education and habit. (*See* ÆSTHETICS.) Among the classical ancients, the criticism of Beauty was carried to a high degree of perfection. Less encumbered with a multitude of facts and things to be known than ourselves, their minds were more at leisure, and more sedulously exercised in reflecting on their own notions and perceptions; hence the astonishing progress which they made in the fine arts; and hence, in literature, they valued more the beauty of the vehicle in which sentiments were conveyed, and the moral or poetical beauty of those sentiments themselves, than the objective branches of study which it is the principal purpose of literature, in our days, to convey easily and precisely to the mind. And as the criticism which antiquity has left us consists almost wholly of such as relates to literature and the arts (in history they had, as far as we know, few critical spirits, in the sciences almost none), the name is still confined, in its most popular signification, to those provinces of research. The criticism of Truth is of later growth; but as it is regulated for the most part by similar rules and principles, and as minds which possess the faculty of judgment in a high degree in the one are generally capable, if exercised, of forming right apprehensions in the other, they may be considered as nearly allied in the more essential respects. For although it is true that in scientific investigation great knowledge of the individual subject is required to constitute a critic, and in the fine arts the most gifted mind will require much education and practice to judge of beauty; yet it is equally true in both of these branches of study, however widely differing from each other, that knowledge alone (except perhaps in purely abstract science, in respect of which the name of criticism seems hardly applicable) will not make the critic, and that the habit of discriminating and judging correctly is a distinct faculty or compound of faculties in the mind. Among a host of works which may be consulted with advantage on this subject, are *Blair's Lectures on Belles Lettres; Campbell on Rhetoric; Whately on Rhetoric; Knight and Alison on Taste; Laharpe, Cours de la Litterature; La Cretelle, Traité de la Rhetorique; Horn and Menzel's History of Polite Literature;* and *Schlegel's Miscellaneous Essays*, &c. *See* BELLES LETTRES and RHETORIC.

Criticism, in a more limited sense, is a branch of belles-lettres. Essays written for the purpose of commending or discommending works in literature or the arts, and pointing out their various merits and defects, are works in the critical department. Thus the term "periodical criticism" is used to express the body of writing contained in the various works under the name of magazines, reviews, &c., which are periodically published in most literary countries.

CRO'CKETS. (Fr. crochet, *a hook*.) In Gothic Architecture, ornaments resembling curved and bent foliage running up on the edge of a gable or pinnacle. They are of two varieties: the earliest are formed by a simple curve turning downwards, as in the gables and spires of Lincoln cathedral; the later have the point of the leaf returned and pointing upwards. Sometimes animals are substituted in the place of leaves.

CRO'CODILES. (Gr. κροκοδειλος.) A name first applied by Herodotus to the crocodile of Egypt, because that animal resembled a small lizard of the same name (*Stellio* of the moderns), which is now known in Greece under the name of *Koslordylus*. The Egyptian and other species of crocodile were confounded by Linnæus under the name of *Lacerta crocodilus*; but the crocodiles are distinguished from all other Saurian reptiles, or *Lacertæ* of Linnæus, by the following characters:—They have a long and powerful tail, which is flattened in the vertical direction, to serve as the principal means of propelling the body through water with the swiftness required in the pursuit of fish, which form the principal prey of the crocodile. The extremities are short, and comparatively of little use in aquatic progression, except in guiding and changing the direction of the motion, for which purpose they are always webbed or half-webbed. The fleshy tongue is attached by its entire marginal circumference, as in most fishes, to the inner side of the lower jaw, and is not extensible, as is the case in all true lizards. The teeth are simple, conical, sharp-pointed, large, lodged in distinct sockets, and arranged in a single row; which structure and disposition are in relation with the carnivorous habits of the crocodile. Lastly, the intromittent organ of the male is single.

To these essential differences between the crocodiles and lizards may be added the following characters, which are common to all the crocodiles:—

1. The fore-feet have five toes; the hind-feet four toes.
2. Three toes only on each foot are armed with claws; so that there are two toes in front and one behind which have no claws.
3. The whole of the tail and the upper and under parts of the body are covered with square scutæ or plate-scales; and the greater number of those on the back are traversed longitudinally by a more or less prominent ridge.
4. The sides of the body are covered with small round scales.
5. The ridges on the scales of the tail form at its base two prominent lateral series, or dentated keel-like crests, which converge and blend into one at the posterior part of the tail.
6. The tympanum or drum of the ear is protected by two moveable flaps.
7. The eyes are provided with three eyelids.
8. Two little pouches containing a substance of a musky

odour. Their anatomy also affords some characters which are common to all the species, and very well distinguish their skeleton from that of other Saurians. The ventricles of the heart do not intercommunicate. The vertebræ in the cervical region support a series of spurious ribs, which are directed backwards, and the extremities of each overlapping the next in succession prevent the animal from turning the head to the side. This structure, it will be seen, is in admirable accordance with the aquatic habits of these large piscivorous reptiles; since, in order to displace the fluid medium through which they move, it is essential that the head should be firmly locked to the trunk. It is for this reason that the vertebræ immediately behind the head in fishes bear ribs; and the cervical vertebræ of the whale, although they accord in their number and in the absence of ribs with those of other mammalia, are modified so as to answer the same end as the costo-cervical vertebræ of crocodiles and fishes, being compressed from before backwards, and anchylosed sometimes into a single piece.

CROFT. A small field adjoining the dwelling house and kitchen garden. The term is also sometimes applied to common field lands.

CRO'MLECH, or CROMLEH. In British Antiquities, large flat stones laid across others in an upright position; very commonly found in parts of Wales, in Devonshire and Cornwall, and other exposed districts of England, as well as in some continental countries. Cromlechs are generally supposed by antiquaries to have been constructed to serve as altars. According to some (see *Fosbrooke's Encyclopædia of Antiquities*, 508.) there is a difference between the cromlechs of the Britons and those of nations of Germanic descent; the former being inclined stones, perhaps for the purpose of allowing the blood shed in sacrifice to run off; the latter thick round stones, standing on small hillocks and covering caves.

CROP OUT. A mining and geological term, expressing the rising up or exposure at the surface of a stratum or series of strata.

CROPS, ROTATION OF. *See* AGRICULTURE.

CRO'SIER. The staff of an archbishop, surmounted by a cross, and thereby distinguished from the pastoral staff or crook of a bishop. This staff, according to Polydore Virgil, was given to bishops wherewith to chastise the vices of the people; and was called *baculus pastoralis*, in respect of their pastoral charge and superintendence over their flock, as well as from its resemblance to the shepherd's crook. Many authors contend that the crosier is derived from the *lituus* or augural staff of the Romans.

CROSS. (Lat. crux.) A gibbet made of two pieces of wood laid upon each other at any angle. Originally, it was nothing more than a tree; but it afterwards assumed a variety of forms, of which the following are the most usual examples, × ⊤ †. The cross was used as a very general instrument of punishment by almost all the nations of antiquity, from the earliest period of their history. Among the Syrians, Jews, Egyptians, Persians, and especially the Carthaginians, it appears to have been the usual military punishment (*Val. Max.* ii. 7.; *Herod.* iii. 125—159.); and that it was not unknown to the Greeks, the crucifixion of 2000 Tyrians by Alexander after his capture of their city abundantly testifies (*Quin. Cur.* 44.; *Just.* 18. 3.) But in no part of the ancient world was this punishment so generally resorted to as in the Roman empire. Under the early monarchical government of Rome, it extended indiscriminately to every rank (*Liv.* i. 26.); but latterly it came to be regarded as the most infamous of deaths, and, save in cases of sedition, was inflicted only on slaves or the vilest malefactors. The disgust and horror in which this punishment was held by the Romans is evident from the expressive epithets applied to it by Cicero, "crudelissimum et teterrimum" (*most foul and brutal*), as well as from the phrases used synonymously with the instrument of punishment itself; such as "arbor infelix," "infame lignum," &c. From the multiplicity of conflicting details respecting the punishment of the cross, it is clear that there was but little uniformity observed in carrying it into effect. By the Roman law the culprit, or, as he was called, the *cruciarius*, was scourged previously to the crucifixion either in the prætorium, or on the way to the place of execution. On his arrival there he was stripped of his garments, and then either nailed by the hands and feet to the cross, or, as sometimes happened, only fastened to it by ropes. In order to hasten death, it was the practice to break the legs or to pierce the body of the sufferer with a spear or other sharp instrument; but this was not always done; and instances have occurred of persons, who after being suspended for some considerable time on the cross, were taken down and survived. By the Jewish law, it was ordained, that the body of the culprit should be removed from the cross on the day of his execution; but the Romans frequently allowed it to hang till it dropped piecemeal to the ground and nothing remained. "Suffixorum corpora crucibus," says Seneca, "in suam sepulturam defluunt." In general, the cross was erected near some great road or highway, in order to indicate more distinctly the ignominy of the culprit and the severity of his death.

After Jesus Christ had, by an unjust sentence, suffered on the cross, and by his death made atonement for the transgressions of mankind, the cross, from being an object of horror, became, as it were, the symbol of the Christian world, and in the end came to be regarded even with superstitious veneration. Constantine, from respect for these feelings, abolished the punishment of crucifixion throughout the Roman world.

The Apostles make use of the term cross as expressive of the sufferings to which the faithful must submit in attestation of their belief, which they liken figuratively to those of our Saviour in his death. Tertullian says that the early Christians were accustomed on every occasion of daily life, *frontem crucis signaculo terere*, to make the sign *with the fingers upon the forehead*. This extravagant profuseness in the use of a symbol naturally led to superstition; and the cross appears to have become the object of actual adoration as early as the 4th century, when that practice is made a reproach against the Christians by Julian. The allegation of the later Romanists, that it is not the wood of the cross, but Christ figuratively present, that is worshipped by them, appears to have been put forward occasionally at this time, but sometimes not without reproof from the ecclesiastical authorities. In the Romish church there are certain festivals observed to this day in memory of circumstances connected with the cross; as the Invention or Discovery and the Exaltation of the Cross: the former commemorates the supposed discovery of the true cross by the Empress Helena, the latter its restoration to Calvary by Heraclius.

CROSS. In Heraldry, an ordinary, formed by lines drawn palewise and fesswise, inclosing (if bounded by the escutcheon) one fifth of the shield, or one third if charged. A cross gules is termed the cross of St. George. A plain cross is one the extremities of which do not reach to the circumference of the escutcheon, but are "couped," or cut off in a straight line. There are many other kinds of crosses not reaching the circumference of the escutcheon known in heraldry; the following are only a few, most commonly used in bearings:—A *cross crosslet* is one crossed on each arm. Such a cross between four plain crosses is termed a Jerusalem cross. A *cross flory* has three points at each end. A *Maltese cross* has arms increasing in breadth towards the end, with double points. A *cross fitchy* has the lower limb pointed, as if to fix in the ground. A *patriarchal cross*, the insignia of patriarchs or archbishops, is plain, having two bars, the upper smaller than the lower. A *cross moline* terminates in representations of the ends of the fer-de-moulin, or milrind. It is the difference of the eighth son of a family.

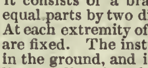
CROSS. An instrument formerly used in surveying for laying out perpendicular lines, but now seldom employed. It consists of a brass cross or circle, divided into four equal parts by two diameters at right angles to each other. At each extremity of these diameters perpendicular sights are fixed. The instrument is mounted on a staff to fix it in the ground, and its use is to find the point in a given line or direction through which a straight line drawn to an object at some distance will be perpendicular to the former line.

CRO'SS-BOW. A weapon used for shooting with, before the invention of fire-arms. All weapons having the bow attached to a stock were called cross-bows; and some of the larger sort were furnished with instruments for bending the bow.

CRO'SS-BREED. The offspring of parents of two different breeds.

CRO'SSES, STONE, in Architectural Antiquities, are of various descriptions, according to the occasion or purpose of their erection. They are said to have originated in the practice of marking the Druid stones with a cross, at the period of the conversion of the Celtic tribes to Christianity. *Preaching crosses* are generally quadrangular or hexagonal, open on one or both sides, and raised on steps. They were used for the delivery of sermons in the open air; such was the famous Paul's Cross in London. *Market crosses* are well known. *Weeping crosses* were so called because penances were finished before them. *Crosses of memorial* were raised on various occasions; sometimes where the bier of an eminent person stopped on its way to burial, in attestation of some miracle performed on the spot: such are the well-known crosses of Queen Philippa. Crosses served also as land-marks; they are especially set up for this purpose on the lands of the Templars and Hospitallers.

CROSSE'TTES. (Fr.) In Architecture, the returns on the corners of door cases or window frames; called also ears, elbows, ancones, prothyrides. In architectural construction, they are the small projecting pieces in arch stones which hang upon the adjacent stones—*a*, *a*, *a*, *a*.



CRO'SS-FURROW. A furrow or open trench cut across other furrows to intercept the water which runs

along them, in order to convey it to the margin of the field where it may find its way to an open ditch or some other general drain.

CRO'SS-STONE. So called from the intersection of its crystals. It is a species of *harmotome*, found in great beauty at Andreasberg. (*See* ANDREASBERGOLITE.) It is composed of 49 *per cent.* of silica, 16 alumina, 18 baryta, and 15 water.

CRO'TALUM. (Gr. κϱοταλον.) An ancient kind of castanet, used by the Corybantes or priests of Cybele. This instrument must not be confounded with the modern *crotalo*, a musical instrument used chiefly by the Turks, and corresponding exactly with the ancient cymbalum.

CRO'TALUS. (Lat. crotalum, *a castanet* or *rattle.*) A genus of poisonous serpents, including those which are furnished with a rattle at the extremity of the tail.

CRO'TCHET. (Fr. crochet.) In Music, one of the notes or characters of time, equal to half a minim.

CRO'TCHETS, in Grammar, more frequently called *brackets*, are certain marks or hooks in which words or phrases are included thus [ ], by way of distinguishing them from or of illustrating the context.

CRO'TON OIL. The expressed oil of the seeds of the *Croton tiglium;* formerly called *Grana tiglia*, and *Molucca grains*. The tree is a native of Ceylon, and of Malabar and the Molucca Islands. Its seeds are very purgative; and their expressed oil so drastic, that a single drop will often prove violently operative, completely emptying the bowels and exciting a copious watery secretion from them. The most active form for its exhibition is made into a pill with bread crumb: it may also be rubbed with a little mucilage of gum arabic, and given in a liquid form; but it always requires much caution in its administration.

CROUP. An inflammation of the larynx and trachea, accompanied by difficulty of breathing and cough, and by a peculiar shrillness of voice and wheezing; there is also generally more or less expectoration of purulent and filmy matter, which is thrown out upon the affected part and continually threatens suffocation. This disease is most common in infants, and in children from three to nine years old; it is of rare occurrence, in its acute form at least, after twelve years of age. In the successful treatment of this distressing and dangerous disease, every thing depends upon promptitude in the application of remedies calculated to subdue the local inflammatory action. This is to be done either by leeches to the region of the trachea, by cupping, or by bleeding in the jugular vein; by the cautious application of external irritants of rapid action, such as a piece of lint dipped in strong acetic acid, which, however painful, is sometimes of service; by blisters, and by the exhibition of large doses of calomel: there is a difference of opinion as to the employment of emetics. The inhalation of steam is useful where it can be resorted to, but in young children it is impracticable. In *spasmodic croup* the wheezing and sense of suffocation appear to depend upon spasmodic action of the larynx or epiglottis: like the former it attacks infants and children, but comes on and goes off very suddenly, returning at intervals, during which the patient is comparatively easy. In weakly and irritable children it sometimes appears a consequence of teething. An emetic, calomel purges, warm bath, diaphoretics, and a blister, are the leading remedies; bleeding should be avoided. There is a kind of croup which sometimes attacks children of weakly constitutions, and which appears symptomatic of irritation in the stomach and bowels, for it is relieved by purging, and disappears as the constitution improves. Another form of this disease is called *chronic croup*. It is attended by cough and the expectoration of tough mucus, sometimes apparently membranous or tubular, occasioning difficulty of breathing and suffocation. This disordered state of the trachea and bronchial membranes may occur at all periods of life: it is relieved, and often cured, by using the inhaler with warm water, by expectorants with small doses of sedatives and mercurials, and by occasional purging.

CROWN. (Lat. corona.) In Heraldry. Among the ancients, and especially in the Roman republic, crowns were presented to citizens as marks of distinction for valiant or otherwise meritorious exploits. From this usage the crown has been adopted as a bearing by modern heralds. Nine species of the crown are enumerated in heraldry; some of which, however, have not been introduced into modern arms, and are only known from the description left of them by the ancients:—1. The Eastern Crown, imitated from that which appears on coins of Greek oriental sovereigns, and borne by those who have distinguished themselves in the East: the East India Company's arms have this crown. 2. The Triumphal Crown, which, after being borne by Julius Cæsar, became the Crown Imperial. 3. The plain Circlet or Diadem. 4. The Obsidional Crown, given among the Romans to those who had performed exploits in the defence of fortified places. 5. The Civic Crown, for saving the life of a citizen. 6. The Crown Vallary, to soldiers who had first entered the enemy's trench. 7. The Mural Crown, to soldiers distinguished in besieging armies. 8. The Naval Crown, common in English coats of augmentation. 9. The Crown Celestial.

CROWN. In Architecture, the uppermost member of the cornice; called also *corona* and *larmier*.

CROWN or DEMESNE LANDS (*Terræ Dominicales*). The lands, estates, or other real property belonging to the crown or sovereign. These were anciently very extensive in this and most other European countries. The rents and other payments arising from them formed during the middle ages an important part of the revenue of our English kings; and they still form an important part of the revenue of several Continental sovereigns. These lands have been acquired by various means, such as purchase, succession, forfeiture, &c. Having been regarded for a lengthened period as the private property of the crown, and as being consequently at the free disposal of the sovereign for the time being, but little providence has been displayed in their management. A grant of crown lands was, indeed, the ordinary method in which our sovereigns used formerly to gratify their favourites; and, in consequence of the magnitude and improvidence of such grants, the crown estates in this country have been reduced within very narrow limits. Parliament frequently interposed to check this profusion, but without effect till after the Revolution, when the lavish grants of crown lands, made by William III. to the Bentinck and other families, occasioned so much dissatisfaction that the practice was put an end to. This was done by the act 1 Ann, st. 1. cap. 7., which declared that all future grants or leases of lands from the crown for a longer term than 31 years, and of houses for a longer term than 50 years, should be void.

The crown estates, forests, manorial rights, &c. not granted away, have now become, in consequence of arrangements to that effect, the property of the public; and are administered by a department specially appropriated to that purpose, called the "Woods and Forests." Their total nett revenue in 1838 amounted to 388,642*l*., collected at an expense of 10¾ per cent. Of late years a considerable extent of crown lands, consisting of old forests and chaces, have been enclosed and planted with forest trees, with a view to the supply of timber for the navy.

Certain lands, manorial rights, &c., with the sum paid as commutation for the loss of the tin duties, are the private property of the prince of Wales, as duke of Cornwall; and when there is no prince of Wales, of the crown.

CRU'CIBLE. (Lat. crucio, *I torment;* because, in the language of old chemistry, the metals were tortured by fire to yield up their various virtues.) A vessel, generally made of very refractory earthenware, in constant use in the chemical laboratory for performing fusions of metals and other substances.

CRUCI'FERÆ. (Lat. crux, *a cross;* the flowers being in the form of a Maltese cross.) A natural order of Exogens, inhabiting most temperate countries. They are allied to *Capparidaceæ*, but differ in their tetradynamous stamens; and also to *Papaveraceæ* and *Fumariaceæ*, but are distinguished by their seeds, and having no albumen. They are characterized essentially by their deviation from the ordinary symmetry observable in the relative arrangement of the parts of fructification of other plants. Linnæus divided this order into *Siliquosæ* and *Siliculosæ*, from the forms of their fruits; but more recently divisions have been founded upon the nature of the plicature of the cotyledons, and the position of the radicle with respect to them. They possess universally antiscorbutic and stimulant properties, combined with an acrid flavour; and their seeds uniformly abound in a fixed oil,—properties of which cress, mustard, and rape may be taken as representatives.

CRU'CIFIX. The figure of Christ upon a cross; also a cross with the figure of Christ upon it.

CRUDE. (Lat. crudus.) In Painting, a term applied to a picture when the colours are rudely laid on, and do not blend or harmonize.

CRUISE. (Germ. kreutzen, *to cross.*) A voyage within certain limits, for the purpose of meeting with enemy's ships, pirates, &c., or for mere exercise.

CRU'OR. (Lat. *gore.*) The red coagulum of the blood, which appears as the blood cools.

CRU'PPER. A roll of leather put under a horse's tail, and connected with the saddle by a strap and buckle, for the purpose of preventing the saddle from being cast forward on the horse's neck by the action of riding.

CRU'RAL. (Lat. crus, *the leg.*) Relating to the leg, or shaped like a leg or root.

CRUSA'DES. (Lat. crux, *cross.*) In the European History of the Middle Ages, wars undertaken by confederacies of chiefs and soldiers with a religious object. Those which were engaged in by great part of the nations of Europe for the recovery of Palestine from the infidels are more frequently denoted by this peculiar name. The term Crusade is derived from the sacred symbol of the cross, which was borne by the warriors engaged in it over their arms: the colour of the cross often served to designate the nation of the soldier; as, the white cross on a red ground, France; the red cross on a white

ground, England. The principal crusades for the conquest of Palestine were—1. The first, A. D. 1096, excited by the preaching of Peter the Hermit and the encouragement of Pope Urban II., in which Godfrey of Boulogne headed the Christians, who made themselves masters of Jerusalem and great part of Palestine. 2. The second, A. D. 1142, in which Conrad III. of Germany and Louis VII. of France led armies to complete the conquest of Palestine, but without success. 3. The third, A. D. 1189, was occasioned by the capture of Jerusalem by sultan Saladin; Frederic II. of Germany, Philip Augustus of France, and Richard Cœur de Lion of England were the chief among the confederate monarchs: the capture of Acre was almost the only fruit of this great expedition. 4. The fourth crusade was conducted by the King of Hungary, Andrew II., in 1217. 5. The fifth was conducted by Frederic II. of Germany (Barbarossa), who recovered Jerusalem, but for a short time. 6. The sixth, A.D. 1248, by Saint Louis king of France, against Egypt, but without success. Among other wars which have been at various times denoted by the name of Crusades, that against Raymond count of Toulouse and his heretical vassals the Albigeois, of which the first leader was the famous Simon de Montfort, is the most memorable. (*See* ALBIGENSES.) Whether the Crusades exercised a beneficial influence on the state and condition of society, is a question which has long engaged the attention of the learned; and, as is the case with every subject of a purely speculative character, different opinions have been entertained respecting it at different times. In the seventeenth century, when the question came first to be agitated, these extraordinary expeditions were generally regarded as having been in the highest degree favourable to the intellectual, commercial, and political interests of the world; but in the succeeding century there arose a host of inquirers, at the head of whom was Voltaire, less dazzled by the brilliancy which romance had thrown around these enterprises than the philosophers of the preceding age, by whom they were represented as mere ebullitions of superstition, fanaticism, and barbarism, which, how strongly soever they agitated the surface of society, in no degree contributed to its permanent improvement. And it was not until Robertson published the introduction to his *Charles V.*, in which he expressed his conviction that the Crusades had exercised a most favourable influence over the progress of freedom and the advancement of the human mind, that a check was given to these unfavourable views, and that the interest and importance formerly attached to the Crusades began to be revived. With the view of stimulating inquiry into this grand historical question, the French Institute, in the year 1806, with its usual enlightened spirit, proposed it to the learned of all countries as a subject of general competition; and the prize was awarded jointly to the essays of Heeren and Choiseul d'Aillecourt, which have since been published. These essays form the groundwork of the more elaborate researches of Michaud, and of the numerous other treatises upon this subject with which the literature of France, England, and Germany has since been inundated; and along with all the most recent discussions upon this question, which it has been our fortune to see, manifest a singular coincidence of opinion respecting the tendency of the Crusades, which, in spite of some strong drawbacks and disadvantages, they consider as having materially contributed to the revival of European learning and civilization. There are few disputed subjects of which it is more difficult to form a correct estimate than the influence of the Crusades, whether we regard the distant period when they took place, the insufficiency of contemporary history, the different phenomena and consequences by which they were accompanied in different countries, or, above all, the difficulty of assigning to these enterprises their own peculiar effects, amid the multiplicity of other causes, more powerful, perhaps, though less apparent, which were then operating on society. As our limits necessarily preclude us from entering upon this interesting inquiry, we must content ourselves with merely glancing at the chief arguments which have been adduced on both sides of the question. Some of those who maintain that the Crusades exercised a beneficial influence over the interests of society, scruple not to trace to them the origin of almost all the civilization which modern Europe at present enjoys. But those who take a more reasonable view of the matter, reckon among the advantages which resulted from these enterprises the general intercourse which they tended to establish between nations that might otherwise have long remained strangers to each other; the removal of international contentions and prejudices, which the union of nearly all the European states in pursuit of a common object tended to effect; the impulse which they gave to commercial enterprise throughout the world, more especially in Italy, and subsequently to the revival of literature and the fine arts in that country; the general diffusion of more liberal modes of thinking and acting on political and religious questions; and finally the breaking up of the feudal system, which, as is alleged, laid the foundation of the civil liberty at present enjoyed by all the communities of Europe. On the other hand, those who advocate the negative side of the question allege that the Crusades were begun in folly, prosecuted without skill, and ended in defeat. They caused, it is maintained, a waste of life and labour beyond example, without any advantageous return. For two centuries they afflicted almost every family in Europe with the most painful privations; and withdrew the attention of its inhabitants from the peaceful pursuits of industry to marauding expeditions undertaken in a spirit of religious fanaticism, and evincing in their conduct a disregard for the most obvious principles of justice. Agriculture, commerce, arts and education, were neglected by all ranks, under a general distemper of the imagination, which represented the recovery of the Holy Land from the possession of infidels as the most sacred and urgent of duties. In this Quixotic attempt, they sacrificed the flower of successive generations, and the strength and ornament of their respective countries. It is contended too by those who take this view of the matter, that the absence of the principal sovereigns from their kingdoms gave full scope to all sorts of faction and disturbance at home; and that though the power of some of the greater barons was broken by the debts and obligations they contracted during these expeditions, the anarchy inseparable from the feudal system was greatly augmented, and the progress of good government greatly retarded. Without attempting to determine the precise degree of weight that should be attached to these conflicting statements, it is abundantly clear that there has been, on both sides, a vast deal of exaggeration; and though it be obviously absurd to ascribe to the Crusades the superior wealth, civilization, and freedom of modern Europe, it is at the same time sufficiently clear that their beneficial influence, in various respects, countervailed to a considerable extent the impoverishment, anarchy, and war in which they involved the greater part of Europe and Asia. In addition to the prize essays already referred to, the reader may consult the elaborate and important work of *Michaud, l'Histoire des Croisades*, and his *Bibliographie des Croisades;* with *Wilken's Geschichte der Kreuzzüge; Haken's Gemälde der Kreuzzüge;* the art. "Croisades" in the *Encyclopédie des Gens du Monde*, &c. &c.

CRU'SCA, ACCADEMI'A DELLA. *See* ACADEMY.

CRU'STA. (Lat.) In Gem Sculpture, a gem engraved for inlaying on a vase or other object.

CRUSTA'CEANS, *Crustacea*. (Lat. crusta, *a hard covering*.) A class of free articulate animals, with articulated limbs, a branchial respiration, and a dorsal ventricle or heart.

CRY'OLITE. (Gr. κρυος, *ice*, λιθος, *stone*.) A rare mineral from Greenland. It is a double fluoride of sodium and aluminum. It readily fuses in the flame of a candle, whence its name.

CRYO'PHORUS. (Gr. κρυος, and φερω, *I bear*.) The frost-bearer or carrier of cold; an instrument contrived by Dr. Wollaston for freezing water by its own evaporation. (*Philos. Trans.* 1813, p. 71.)

CRYPT. (Gr. κρυπτω, *I hide*.) In Architecture, the under or hidden part of a building. It is used also to designate that part of the ancient churches and abbeys appropriated to the monuments of deceased persons. (See *Dugdale's Monasticon*.)

CRY'PTA. (Gr. κρυπτω.) In Botany, the round receptacles for secretion present in the leaves of some plants, as in the orange and myrtle.

CRY'PTÆ. (Gr. κρυπτω.) Little rounded excrescences, in which the minute ramifications of the arteries terminate in the cortical part of the kidneys.

CRYPTOGA'MIC PLANTS (Gr. κρυπτος, *concealed*, and γαμος, *marriage*), are those which never produce flowers or sexes, but which are multiplied without the aid of sexual intercourse. Linnæus gave them their name, upon the supposition that they in fact do possess sexual organs, although he was unable to discover them; and since his time Hedwig and others have endeavoured to show that sexes do exist in them, although in a concealed and anomalous state. In fact, it appears that in *Marchantianæ*, Mosses, *Jungermanniaceæ*, and some others, the reproductive organs are of two sorts, and it is not altogether unreasonable to call the one male and the other female; but at the same time it must be confessed that if such parts are rightly named, they are exceedingly dissimilar to the organs so called in Phanerogamic plants, and that the utmost which can be conceded to them is, that one contains a male principle and the other a female principle. From the recent observations of Agardh, Morren, Leveillé, Klotzsch, and others, it is not improbable that two such principles exist, although in a state of intimate intermixture, even in plants like *Fungi* and *Algæ*. The principal natural orders of Cryptogamic plants are *Ferns, Mosses, Equisetaceæ, Lycopodiaceæ, Characeæ, Hepaticæ, Lichens, Algæ*, and *Fungi*. In these orders we have the greatest variation in the organ of vegetation, some of the ferns forming trees 50 or 60

feet high, while many *Algæ* and *Fungi* are vesicular and microscopic. Among the latter, vegetable life approaches so nearly to that of animals that distinctions fail, and it is no longer possible to say that locomotion is the peculiar property of the one and fixation that of the other; for in numerous *Algæ* the seeds have an undoubted spontaneous power of motion in water until they begin their growth as young plants. Cryptogamic plants are connected with Gymnosperms through *Lycopodiaceæ* and *Equisetaceæ*, with Rhizanths through Fungi, and perhaps with Endogens by tree ferns; they do not appear to have any immediate relation to Exogens.

CRYPTO'GRAPHY. (Gr. κρυπτος, and γραφω, *I write.*) Also termed *Polygraphy* and *Steganography.* The art of writing in a manner intelligible only to those admitted into the secret of the method, either by conventional signs (cipher), or by other contrivances.

CRY'PTO PORTICUS. In Ancient Architecture, a concealed portico; also one that for coolness is enclosed on every side. Some of them were sunk some way into the ground.

CRY'STAL, *Crystallus.* (Gr. κρυσταλλος, *ice.*) This term was originally applied to those beautiful transparent varieties of silica, or quartz, known under the name of *rock crystal.* When substances pass from the fluid to the solid state, they frequently assume those regular forms which are generally termed crystals.

CRY'STALLINE LENS. The *lens* of the eye, placed in a depression upon the anterior part of the vitreous humour. *See* EYE.

CRY'STALLIZATION, *Crystallography.* (Gr. κρυσταλλος, *a crystal*, and γραφω, *I describe.*) The doctrine of the relation of crystalline forms, and of the origin and structure of crystals. Natural as well as artificial crystals occur in an infinite variety of forms; but they may generally be referred to some primary figure, of which these varieties may be regarded as modifications. The structure of crytallized bodies is most easily illustrated by reference to natural crystals, but the theory applies to all crystallized bodies; it assumes the existence of some definite primary figure, which by various truncations may be modified into its secondary forms.

The varieties of calcareous spar may be referred to as presenting one of the easiest illustrations of the mechanical texture of crystals, and of the modifications of which a definite primary figure is susceptible. Calcareous spar occurs in more than a hundred different forms, all of which, by careful mechanical division, are reducible to an *obtuse rhomboid*, whose faces are inclined to each other at angles of 105° 5′; this, therefore, is called the *primary form* of calcareous spar.

The *secondary forms* are presumed to be derived from the primary forms in consequence of *decrements* of particles taking place upon the edges, or angles, or both, of the primary form. Thus, if the primary form were a cube, it might be reduced to a secondary octahedron by decrements, or *truncations*, in the direction of the planes produced by the removal of its solid angles; and by a similar operation a primary octahedron might become a secondary cube.

The doctrine of the relations and conversions of these forms is, properly speaking, a branch of solid geometry; but its practical applications to chemistry have in fact rendered crystallography a subsidiary branch of those departments of science. By a careful examination of the forms and modifications and texture and fracture of crystals, the chemist and mineralogist are in many cases enabled to determine their nature or composition; and in some cases a strict examination of such forms may supersede analysis, or other more circuitous methods.

When we attempt by cautious mechanical means to dissect a crystal, we find that it will only yield kindly and afford smooth surfaces when broken or divided in certain directions. A *cube* of fluor spar, for instance, will only give way under such circumstances in the direction of its solid angles or corners; and pursuing the division in such directions an octahedron will be the resulting figure; and each slice which is removed may be further divided into octahedra and tetrahedra. The new and smooth surfaces resulting from this division or *cleavage* of the crystal are called its *cleavage planes*, the line produced by the meeting of two planes is called the *edge* of the crystal, and the meeting of any two lines or edges forms a *plane angle.* A *solid angle* is produced by the meeting of three or more plane angles. Different crystallographers have assumed various primitive forms as the bases of their respective *systems of crystallization.* Hauy assumed six (*Traité de Mineralogie*); Mr. Brooke enumerates fifteen primary forms (*Familiar Introduction to Crystallography*); and almost each author upon this subject has adopted different views as regard the number of fundamental forms and the modes of derivation of secondary figures. In Germany the system of crystallography of Mohs is pretty generally adopted. (See Haidenger's Translation of *Mohs' Mineralogy.*) But any detailed account of these different systems and theories would be inconsistent with our present object. It may be observed, however, that the *theory* of crystallization is greatly simplified by assuming all secondary forms as resulting from the aggregation of primary spherical or spheroidical molecules. (See a paper on this subject by Dr. Wollaston, in the *Philosophical Transactions for* 1813; and Mr. Daniell's interesting confirmations of the hypothesis in the first volume of the *Quarterly Journal of Science and the Arts.*)

The process of crystallization is resorted to for many useful and important purposes in the chemical arts: it is the principal means by which various saline products are obtained in a state of purity; for, in the act of crystallization, they throw off foreign substances and acquire definite composition. It is thus, for instance, that nitre is purified for the manufacture of gunpowder; and that the common and other salts with which crude nitre is contaminated are got rid of, a *crystal* of nitre being of necessity a definite compound of 54 parts of nitric acid combined with 48 of potassa. Nitre furnishes an instance of what is termed an *anhydrous* crystal; it retains none of the water in which it had been dissolved, and from which it is deposited. There are, however, many salts, the crystals of which are *hydrous;* and in such cases the quantity of water which they contain always bears a certain definite quantitative relation to the elements of the salts. Sulphate of magnesia, for instance, or Epsom salt, forms prismatic crystals, which always contain 51·2 per cent. of *water of crystallization:* they are constituted of 20 parts of magnesia, 40 of sulphuric acid, and 63 of water.

CTE'NOBRA'NCHIATA. (Gr. κτεις, *a comb*, and βραγχια, *gills.*) A name substituted by some naturalists for *Pectinibranchiata;* applied by Cuvier to that order of Gastropods which breathe by means of pectinated gills.

CTENOI'DES. (Gr. κτεις, and ειδος, *form.*) A name given by Agassiz to one of his orders of fishes, characterized by scales composed of layers with pectinated or toothed posterior margins. These combs overlapping one another give a rough feel to the skin: the scales are horny or bony, without enamel. The Ctenoid order includes the following families:—*Chetodontes*, *Pleuronectes*, *Percoides*, *Polyacanthes*, *Scienoides*, *Sparoides*, *Scorpenoides*, *Aulastomes.*

CU'BATURE, is the measurement of the contents of a solid body, or finding a cube equal to it.

CUBE. (Gr. κυβος, *a die.*) In Geometry, a solid body bounded by six equal squares. The cube is one of the five regular Platonic bodies, which, being placed beside each other, fill up the space about a point. It is also called the *hexaedron*, on account of its six sides. The *duplication* of the cube, or the finding of the side of a cube containing exactly twice as much matter as another given cube, was a celebrated problem among the geometers of antiquity, but which cannot be solved by means of the straight line and circle, the only lines which the ancients admitted into their geometrical constructions. (*See* DUPLICATION OF THE CUBE.) In arithmetic, *cubes*, or *cubic numbers*, are numbers formed by the multiplication of any number into itself twice: thus 8 and 27 are cubes; the first being equal to $2 \times 2 \times 2$, and the second to $3 \times 3 \times 3$.

CU'BEBS. The berries of the *Piper cubeba*, or *Java pepper.* They have a bitter and aromatic flavour, and contain volatile oil and resin: they are stomachic; and given in a dose of from one to two drachms in powder, two or three times a day, have proved curative in certain forms of *gonorrhœa.*

CU'BIC EQUA'TION. In Algebra, is an equation which involves the *cube* or third power of the unknown quantity. Like equations of any other degree, cubic equations are either *pure* or *adfected:* the pure containing only the cube of the unknown quantity; and the adfected containing the square or simple power, or both, of that quantity. A pure cubic equation is of this form, $x^3 = a$; where a is any number whatever, positive or negative, and the value of x is found by extracting the cube root of the number a by the usual arithmetical rule.

It might seem, at first sight, that the only value which x can have in the equation $x^3 = a$ is $x = \sqrt[3]{a}$; but on further consideration it will be seen that there are two more values of x, or at least two other sets of symbols by which the value of x may be represented, which equally satisfy the equation. On substituting n^3 for a, the equation becomes $x^3 = n^3$, or $x^3 - n^3 = o$; but $x^3 - n^3$ is resolvable into the two factors $(x - n) \times (x^2 + x\,n + n^2)$, therefore the equation is satisfied either by making $x - n = o$, or $x^2 + x\,n + n^2 = o$. The first gives $x = n$; and on solving the quadratic $x^2 + x\,n + n^2 = o$, the following values of x result, namely, $x = \frac{1}{2}(-n + \sqrt{-3\,n^2}) = \frac{1}{2}\,n\,(-1 + \sqrt{-3}$, and $x = \frac{1}{2}\,(-n - \sqrt{-3\,n^2}) = \frac{1}{2}\,n\,(-1 - \sqrt{-3})$. The three roots of the equation $x^3 - n^3 = o$ are therefore $x = n$, $x = \frac{1}{2}\,n\,(-1 + \sqrt{-3})$, $x = \frac{1}{2}\,n\,(-1 - \sqrt{-3})$; and this conclusion is easily verified by raising each of these three expressions to the cube, or by multiplying all three together: in either case the result will be n^3. It may be remarked that the first expression only for x is real, the two latter are imaginary,

A complete cubic equation has the form $x^3 + A\,x^2 + B\,x + C = o$, where A, B, and C denote known quantities, positive or negative. Now it is always possible, by assuming $x = y - \frac{1}{3} A$, to transform an equation of this form into another in which the second term shall be wanting, and which shall have the form $y^3 + a\,y + b = o$; the coefficients a and b of this last equation being also known, and depending on those of the former equation. If, therefore, we can succeed in finding the value or values of y from this equation, those of x will also become known in consequence of the equation $x = y - \frac{1}{3} A$.

In order to discover the roots of the equation $y^3 + a\,y + b = o$, suppose y to be composed of two parts, u and v, or assume $y = u + v$. The equation then becomes by substitution,

$$\left.\begin{array}{r} u^3 + 3\,u^2\,v + 3\,u\,v^2 + v^3 \\ + a\,u + a\,v \\ + b \end{array}\right\} = o;$$

which, as it contains two indeterminate quantities, may be divided into any two parts at pleasure. Let it be resolved into the two,

$$u^3 + v^3 + b = o,$$
$$3\,u^2\,v + 3\,u\,v^2 + a\,u + a\,v = o.$$

The last of these is the same as

$$(3\,u\,v + a)\;(u + v) = o,$$

which may be satisfied either by making $u + v = o$, or $3\,u\,v + a = o$. But the supposition that $u + v = o$ is inadmissible, since $u + v = y$; for if we suppose $y = o$, then on account of the original equation, $y^3 + a\,y + b = o$, it would be necessary to suppose also $b = o$, which is inconsistent with the hypothesis. To determine u and v, therefore, we have only the two equations,

$$u^3 + v^3 + b = o, \quad 3\,u\,v + a = o;$$

the first of which gives $u^3 + v^3 = -\,b$, and the second $u\,v = \frac{1}{3}\,a$, whence $u^3\;v^3 = \frac{1}{27}\,a^3$. On substituting in the first of these two last equations the value of v^3 deduced from the second, we find $u^3 + \frac{a^3}{27\,u^3} = -\,b$, from which u^3 is obtained by the solution of a quadratic. The solution gives $u^3 = -\frac{1}{2}\,b \pm \sqrt{\frac{1}{27}\,a^3 + \frac{1}{4}\,b^2}$; whence, and from the equation $u^3 + v^3 = -\,b$, $u^3 = -\frac{1}{2} b + \sqrt{\frac{1}{27} a^3 + \frac{1}{4} b^2}$, $v^3 = -\frac{1}{2}\,b - \sqrt{\frac{1}{27}\,a^3 + \frac{1}{4}\,b^2}$, $u = \sqrt[3]{-\frac{1}{2} b + \sqrt{\frac{1}{27} a^3 + \frac{1}{4} b^2}}$, $v = \sqrt[3]{-\frac{1}{2}\,b - \sqrt{\frac{1}{27}\,a^3 + \frac{1}{4}\,b^2}}$; but $y = u + v$, therefore

$$y = \sqrt[3]{-\tfrac{1}{2} b + \sqrt{\tfrac{1}{27} a^3 + \tfrac{1}{4} b^2}} + \sqrt[3]{-\tfrac{1}{2} b - \sqrt{\tfrac{1}{27} a^3 + \tfrac{1}{4} b^2}}.$$

Having obtained a value of y in terms of a and b, which satisfies the equation $y^3 + a\,y + b = o$, that equation is resolved; but, as in the case of pure cubic equations, two other values of y may be found, each of which also satisfies the equation. For the sake of abridging, let $P = -\frac{1}{2}\,b + \sqrt{\frac{1}{27}\,a^3 + \frac{1}{4}\,b^2}$, $Q = -\frac{1}{2}\,b - \sqrt{\frac{1}{27}\,a^3 + \frac{1}{4}\,b^2}$; and let also $p = \frac{1}{2}\,(-1 + \sqrt{-3})$, $q = \frac{1}{2}\,(-1 - \sqrt{-3})$; then $u^3 = P$, and $v^3 = Q$; and in consequence of what was shown above u and v have each these three values:

$$u = \sqrt[3]{P}, \quad u = p\,\sqrt[3]{P}, \quad u = q\,\sqrt[3]{P}, \qquad (m)$$
$$v = \sqrt[3]{Q}, \quad v = p\,\sqrt[3]{Q}, \quad v = q\,\sqrt[3]{Q}. \qquad (n)$$

To determine in what manner these equations must be combined in order to give the corresponding values of y $(= u + v)$, we must recollect that $u\,v = \frac{1}{3}\,a$; but $P\,Q = \frac{1}{27}\,a^3$, or $\sqrt[3]{P\,Q} = \frac{1}{3}\,a$; therefore $u\,v = \sqrt[3]{P\,Q}$. But it is obvious that $p\,q = 1$; in order therefore to preserve these relations, we must combine the first of the equations (m) with the first of (n), the second of (m) with the third of (n), and the third of (m) with the second of (n). Hence the three values of $u + v$, or y, are $y = \sqrt[3]{P} + \sqrt[3]{Q}$, $y = p\,\sqrt[3]{P} + q\,\sqrt[3]{Q}$, $y = q\,\sqrt[3]{P} + p\,\sqrt[3]{Q}$.

The first of these three formulæ was invented by Nicholas Tartalea and Scipio Ferreus independently about the same time; but having been first published by Cardan, is generally known by the name of *Cardan's Rule*.

In applying the above formula for the resolution of a cubic equation, it is necessary to extract the square root of the quantity $\frac{1}{27}\,a^3 + \frac{1}{4}\,b^2$. Now, as a and b may have any values whatever, if it happen that a is negative, and such that $\frac{1}{27}\,a^3$ is greater than $\frac{1}{4}\,b^2$, the quantity $\frac{1}{27}\,a^3 + \frac{1}{4}\,b^2$ becomes negative, and the extraction of its square root impossible. This circumstance gives rise to what is termed the *irreducible case*, and long continued to puzzle algebraists, the three roots of the equation appearing all under an imaginary form. It has been found, however, from a more profound analysis of the nature of equations, that in this case (that is, when a is negative, and $\frac{1}{27}\,a^3$ greater than $\frac{1}{4}\,b^2$) all the three roots are real, notwithstanding their imaginary form. In fact, every equation of the third degree must have at least *one* real root: when the irreducible case occurs, *all* the roots are real; in the other case, one root is real, and the other two imaginary.

CUBI'CULUM. (Lat.) In Ancient Architecture, strictly a bed room; but with the Romans applied in a more extended sense to the balcon or tent provided to cover the emperors at the public shows.

CU'BIT. (Lat. cubitus.) In Architecture and Sculpture, a linear measure of the ancients, equal to the length of the arm from the elbow to the extremity of the middle finger, usually considered about eighteen English inches. The geometrical cubit of Vitruvius was equal to six ordinary cubits.

CU'BITUS. The fore arm; the larger bone of which is called the *os cubiti*. This term is said to be derived from cubo, *I lie down*, from the ancient custom of leaning on that part of the arm when in the recumbent posture at meals.

CU'CULINÆ. A name given by Latreille to a family of bees, distinguished by the absence of the femoral plates for transporting pollen, and which are consequently compelled to resort to the combs of other bees in order to deposit their eggs: hence they may be regarded, like the cuckoo, as a kind of parasite.

CU'CULUS. (Lat. cuculus, *a cuckoo*.) A most interesting genus of Passerine birds, belonging to that group which is characterized by having the toes situated two before and two behind (*Zygodactyli*); and so named from including as the typical species the common European cuckoo (*Cuculus canorus*). The cuckoo is a migratory bird; it arrives in England in the month of April for the purpose of breeding. It differs from almost every other bird in not constructing a nest, nor under any circumstances hatching its own eggs; but deposits them in the nests of other birds, as the hedge-sparrow. The unfledged young have a remarkable instinct, which impels them to unceasing efforts to expel their helpless companions from the nest, which they effect by pushing them in the hollow of their back to the verge of the nest, and tilting them over, until they at length monopolize all the care and provision of the foster-parent. The young cuckoos of the year do not leave this country till the month of September.

CUCU'RBITA'CEÆ. (Cucurbita, one of the genera.) A natural order of Exogens, inhabiting the hot countries of both hemispheres. They are placed by Auguste de St. Hilaire and De Candolle between *Myrtaceæ*, to which they appear to have little affinity, and *Passifloraceæ*, to which they are so closely allied that they differ only in the sinuous stamens, unisexual flowers, inferior fruit, and exalbuminous seeds. St. Hilaire also insists upon their affinity with *Onagraceæ*, with which, including *Combretaceæ*, they agree in some respects. The order is one of the most useful in the vegetable kingdom, comprehending the melon, the choco, and the various species of gourd; all valuable as the food of man. Colocynth is the pulp of *Cucumis colocynthis*, which is so drastic as to be classed by Orfila among his poisons. The root of *Bryonia* possesses a powerful purgative property, but is said to become wholesome if properly cooked; and the perennial roots of all the order appear to contain similar bitter drastic virtues: especially of the *Momordica elaterium*, which has an active poisonous principle called *elatine*.

CUIRA'SS. (Fr. cuir, *leather*.) A covering for the breast; originally, as the name denotes, of leather, also of quilted linen, cloth, &c. The cuirass of plate-armour succeeded the hauberk, hacqueton, &c. of mail, about the reign of Edward III.; and from that period the surcoat, jupon, &c., which were usually worn over the coat of mail, began to be laid aside. From that period the cuirass or breast-plate continued to be worn, and was the last piece of defensive armour laid aside in actual warfare. There were cuirassiers in the English civil wars, and in the French service nearly to the end of the 17th century: after this period, the cuirass was generally laid aside, until it was again employed by some of Napoleon's regiments, and it is now, in most services, worn by some regiments of heavy cavalry.

CUISSES, CUISSOTS, CUISSARTS, &c. In Plate Armour, the pieces which protected the front of the thigh.

CULDE'ES. A religious order, whose origin is attributed to St. Columba, an Irish monk of the 6th century, who evangelized the western parts of Scotland, and founded a famed monastery in Iona. The word is probably contracted from *cultores Dei*. See *Jamieson's Hist.*

CU'LEX. (Lat. *a gnat*.) A Linnæan genus of insects, having the common gnat (*Culex pipiens*, L.) for its type; but now raised to the rank of a family (*Culicidæ*), including the genera *Megarhina, Sabethes, Œdes, Aropheles*, and *Culex* proper: the two latter are British.

CU'LINARY VEGETABLES. Plants cultivated in gardens, and sometimes in fields, for culinary purposes. They may be classed as—leaf plants, such as the cabbage tribe, spinaceous plants, salads, pot and sweet herbs; stalk plants, such as asparagus, tart rhubarb, sea kale, &c.; roots, such as the turnip, carrot, potato, &c.; seeds, such as the pea and bean; fruit, such as the cucumber, gourd, &c.; and the entire plants, such as the onion, leek, mushroom, &c. They may be otherwise arranged as—the

cabbage family; the leguminous family; esculent roots; spinaceous plants; aliaceous plants; asparaginous plants; acetarious plants; pot herbs, sweet herbs, plants used in tarts and confectionary, and edible fungi.

CULI'NUS. A term introduced by Linnæus to denote the stem of *Graminaceæ*, which has a peculiar organization. The term is now used by few writers.

CU'LLET. The term given to broken glass brought to the glass house for the purpose of being melted up with fresh materials.

CULM. A provincial synonym of *anthracite*. Mineral carbon, glance coal, columnar coal, are terms also applied to this species of coal, of which Kilkenny coal furnishes an example.

CULM. In Agriculture, the stem of grasses.

CULMINA'TION. (Lat. culmen, *the top*.) The passage of a celestial body over the meridian, or the highest point of its diurnal circle.

CULTIVA'TOR. An implement of the horse-hoe kind, chiefly used in working fallows. It consists of a frame, sometimes of wood and sometimes of iron, into which a number of coulters, or tines, are introduced; which, when the instrument is drawn along lands already ploughed, penetrate to the bottom of the furrow, and thoroughly pulverize the soil. One of the best of these implements for using on a large scale is Finlayson's harrow; but it requires six horses to work it properly. On a small scale, and for working with two horses between rows of plants, Wilkie's grubber is an excellent implement; as is that known as Kirkwood's cultivator.

CU'LTRATE. (Lat. culter, *a ploughshare*.) Coulter-shaped, as when a body is straight on one side and curved on the other.

CU'LVERT. An arched channel of masonry built beneath the bed of a canal, for the purpose of conducting water under the canal. If the water to be conveyed has nearly the same level as the canal, the culvert is built in the form of an inverted siphon, and acts on the principle of a water pipe. This word also signifies any arched channel for water under ground.

CU'LVERIN. A cannon equal to an 18-pounder; a *demy-culverin* is a 9-pounder.

CU'MIN SEED. The seed or fruit of the *Cuminum cyminum*. It is imported from Sicily and Malta. It forms an ingredient in *curry powder*, and in some kinds of cheese; it has also been used medicinally, but is unimportant. It has a very peculiar odour, and a bitter and aromatic taste. In poultices and plaisters, it is supposed to promote the dispersion of indolent tumours. Some of the Roman poets allude to its power of producing pallor and languor.

CU'NEATE. (Lat. cuneus, *a wedge*.) An animal or part is so called which has the longitudinal diameter exceeding the transverse, and narrowing gradually downwards.

CU'NEIFORM LETTERS, called *Keilschriften* by the Germans. (Lat. cuneus, *a wedge*.) The name given to the inscriptions found on old Babylonian and Persian monuments, from the characters being formed like a wedge. This species of writing, as it is the simplest, so it is the most ancient of which we have any knowledge; and though it is difficult to say by whom or in what country it was invented, its use was common to the Medes, Persians, and Assyrians, at the most remote periods of their history. It should seem, however, that the peculiarity of its form caused it to be employed, like the hieratic character of the Egyptians, chiefly in monumental inscriptions, there being another mode of writing in use better calculated for ordinary purposes; and Mr. Rich conjectures that it fell into disuse soon after Alexander's conquest of Persia, when neither the Persians nor the Babylonians had any monuments to erect or events to record. The native princes, says that ingenious traveller, who wrested the throne of Persia from his feeble successors, adopted the Greek language and character in their coins and inscriptions; and all recollection of the cuneiform writing must have perished during the long period in which they held the sceptre of Iran.

About seventy years ago, a few specimens of inscriptions existing at Persepolis having found their way into Europe, the attention of the learned was directed to the subject; and many German philologists, at the head of whom was the celebrated Tychsen, applied themselves to the task of deciphering and translating these inscriptions with an unrivalled energy and enthusiasm. It was not, however, till the commencement of the present century, when Dr. Grotefend of Hanover engaged in the pursuit, that the mystery in which this species of writing had for so many centuries been involved began to be cleared up, and the foundation laid of a more satisfactory and philosophical mode of explication. As might be expected on a subject on which so much wing may be given to the imagination, the most diverse and extraordinary theories have been propounded respecting it, many of them supported by ingenious reasonings, and displaying great learning and research; but as the general opinion inclines to regard Dr. Grotefend's theory as based on the most solid foundation, and as the most likely to lead to important results, we shall limit ourselves to giving a brief summary of his views. According to him this mode of writing is formed of two radical signs,—the wedge and the angle,—susceptible, however, of about thirty different combinations; and consists of three varieties, distinguished from each other by a greater or less complication of the characters. It is of Asiatic origin; is written from right to left, like the Sanscrit; differs from the ancient Egyptian hieroglyphics, inasmuch as it is alphabetic, not ideographic; and, finally, with a few considerable modifications, forms the basis of most of the Eastern languages. The views of Dr. Grotefend received striking confirmation from the researches of Mr. Rich, whose valuable Memoirs, enriched at they are with numerous inscriptions found at Babylon and Persepolis, cannot fail to give considerable impulse to the prosecution of this intricate study. A full exposition of this species of writing would prove one of the most valuable accessions to modern literature, as it would throw a flood of light upon many points of the manners, customs, and civil polity of many Eastern nations now enveloped in the most profound obscurity, and rescue their ancient history from the gross fictions by which it is disfigured in the modern literature of Persia. But upon this subject we are far from entertaining very sanguine hopes. Apart from the collateral benefits which have flowed from the prosecution of this study, and which have exhibited themselves chiefly in the greatly increased desire that exists throughout Europe to obtain a knowledge of the Eastern languages, the only direct results by which it has been hitherto followed may be stated to be the translation of a few minor inscriptions, and the establishment of a canon so extremely arbitrary, that it is very problematical if the labours of others in the same field can be materially benefited by it. To all who have read the paper of Dr. Grotefend addressed to the university of Göttingen two years ago, in which all that has been done on this subject is exhibited with much perspicuity, it must be matter of painful regret to observe that the immense amount of labour and learning expended upon it has been attended by such incommensurate results; and a study which has proved so unproductive even to its most enthusiastic disciple will scarcely be found to improve in the hands of others, who, whatever be their qualifications, can never be expected to surpass the gentleman in question either in learning, ingenuity, or devotion to the subject. For further information on this subject, the reader is referred to *Rich's Memoirs*, which contain innumerable specimens of the cuneiform writing.

CU'NONIA'CEÆ. (Cunonia, one of the genera.) A natural order of arborescent or shrubby Exogens, inhabiting South America and the East Indies; allied so very intimately to *Saxifragaceæ*, that they are only distinguished by their arborescent habit and interpetiolar stipules. The bark of some species is used for tanning leather.

CU'PEL. A shallow earthen vessel, somewhat of a *cup* shape, generally made of bone earth. It is used in the assays of the precious metals, which are fused upon a cupel with lead. Cupellation means the refining of gold or silver upon a *cupel*.

CU'PID. (Lat. Cupido.) The Roman name of the Grecian god of love Eros (Ἔρως). There were three divinities, or rather three forms of the same deity, with this appellation (*Cic. de Nat. Deor.* 3. 23.); but the one usually meant when spoken of without any qualification was the son of Mercury and Venus. Like the rest of the gods, Cupid assumed different shapes; but he is generally represented as a beautiful child with wings, blind, and carrying a bow and quiver of arrows, with which he transpierced the hearts of lovers, inflaming them with desire. Among the ancients he was worshipped with the same solemnity as his mother Venus; his influence pervaded all creation, animate and inanimate; and vows and sacrifices were daily offered up at his shrine. Statues of Cupid formed among the ancients great objects of *vertu*. Praxiteles is said to have derived great honour from his statues of this divinity; and in his orations against Verres, Cicero has given celebrity to one statue of Cupid by this artist, which formed an object of peculiar veneration to the Thespians.

CU'POLA. (It.) In Architecture. *See* DOME.

CU'PPING. (From the *cup shape* of the glasses used in its performance.) In this operation a cup-shaped glass is used, into which the large flame of a spirit lamp is momentarily introduced, so as to expel a great part of its air by dilatation; it is then instantly applied to some part of the body, which is forced into it by the external pressure; and on removing the glass a circular red mark is left, from the propulsion of the blood in the small vessels of the part: this is called *dry cupping*. It is generally followed up by making a number of incisions in the part by means of an instrument called a *scarificator*, from which the blood oozes, and from which a considerable portion may be drawn by again applying the cupping glass. Cupping, when well performed, is not a very painful or disagreeable operation, and is an excellent mode of local

blood-letting. When the operator is not dexterous, it is not only painful, but often dangerous in its consequences. The bleeding may generally be easily stopped by a piece of lint or soft rag; but this should be looked after, as instances have occurred of persons bleeding to death from the wounds of a scarificator.

CUPULI'FERÆ. (Lat. cupa, *a cup.*) A natural order of arborescent or shrubby Exogenous plants, inhabiting all temperate and some hot climates. They are distinguished by their amentaceous flowers and peculiarly veined leaves from all European trees; and from other plants by their apetalous superior rudimentary calyx, fruit enclosed in a husk or cup; and by their nuts, which contain but one cell and one or two seeds, in consequence of the abortion of the remainder. These plants are akin to *Betulaceæ* and *Salicaceæ*, from which they are distinguished by the presence of a calyx and the veining of the leaves. They are nearly allied to *Urticaceæ;* but differ in their many-celled ovary, pendulous ovules, and superior calyx. This order comprehends the oak, hazel, beech, chestnut, and hornbeam,—well known valuable forest trees.

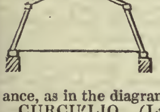
CURACO'A. A liqueur which derives its name from the island of Curacoa: it is prepared in great perfection by the Dutch. It derives its flavour from Seville orange peel, with a small quantity of cinnamon and mace.

CURASSOW. *See* CRAX.

CU'RATE. (Lat. curare, *to take care.*) Properly an incumbent who has the cure of souls; now generally restricted to signify the spiritual assistant of a rector or vicar in his cure. Curates form the lowest order of the clergy; and are divided into two classes, perpetual and stipendiary. "Perpetual curates are such as are appointed to the churches of those parishes in which the tithes were appropriated to some monastery before the statue 4 H. 4. making it necessary to endow a vicar, or which had from some cause or other escaped its operation;" or they are such as officiate in some chapel: in either of which cases, their salary is usually paid by some fixed payment, or by a portion of the tithes appropriated for their maintenance at the foundation of the chapel. Stipendiary curates are such as are appointed by the vicar or rector to officiate at their churches in their stead. The salary of stipendiary curates is defrayed by the party who appoints them; and by the 57 Geo. 3. c. 90. it must in no case be under 90*l.*; and where the population of the parish amounts to 500, with certain restrictions, 150*l.* (See *M'Culloch's Stat. Brit. Empire*, vol. ii. 280. 2d ed.)

CURA'TOR (Lat.), in a general sense, signifies a person who is appointed to take care of any thing. Among the ancient Romans, there were officers in every branch of the public service to whom this appellation was given: thus we read of *Curatores frumenti, viarum, operum publicorum, Tiberis*, &c. &c.; *i. e.* persons who distributed corn, superintended the making of roads and the public buildings, or were conservators of the river. — Curator, in the Civil Law, is the guardian of a minor who has attained the age of fourteen. Before that age, minors are under a tutor. The guardianship of persons under various disabilities, and of the estate of deceased or absent persons and insolvents, is also committed to a *curator*. This title is derived from the ancient Romans, by whom, as was remarked above, it was given to various officers who acted as superintendents of different departments of the public service. In learned institutions, the officer who has charge of libraries, collections of natural history, &c. is frequently styled curator.

CURB ROOF. (Fr. courber, *to bend.*) In Architecture, a roof in which the rafters, instead of continuing straight down from the ridge to the walls, are at a given height received on plates, which in their turn are supported by rafters less inclined to the horizon, whose bearing is, through the medium of the wall-plate, directly on the walls. It presents a bent appearance, as in the diagram, whence it derives its name.



CURCU'LIO. (Lat. curculio, *a weevil.*) A Linnæan genus of Coleopterous insects, now the type of an extensive family, — *Curculionidæ*, or weevils belonging to the Tetramerous section of the order. The prolongation of the anterior part of the head, in the form of a proboscis or snout, at once distinguishes the insects of the present family from all other beetles. The number of the *Curculionidæ* may be imagined when it is stated that entomologists have found it necessary to distribute them into nearly three hundred subgenera. They are all vegetable feeders, and include some of the most dangerous enemies to the vegetable stores of mankind.

CU'RFEW. (From the French couvre-feu, in modern Latin ignitegium.) The practice of tolling the church bell at eight or some other hour in the evening, to warn people to extinguish their fires, was a very common one in the middle ages. It is difficult to say on what foundation the common tradition, that William the Conqueror introduced it from Normandy to prevent the English from assembling in the evening to plan schemes of rebellion, rests. Lord Lyttleton, in his *Life of Henry II.*, discusses the question. It is more probable that the Conqueror enforced a very common police regulation. The real reason of the curfew was to prevent fires. The custom of ringing the evening or curfew bell is still retained in many places. (See *Brand's Popular Antiquities*, vol. ii. p. 136, 137.)

CU'RIA. (Lat.) In Ancient Architecture, a court, council, or senate house.

CU'RIES, *Curiæ*. A subdivision of the Roman patrician tribes, each of which were divided into ten *curies*. Three *curies* probably contained originally ten houses (*gentes*) each. These houses were similar to the Scottish clans, in which, though the bond of union was supposed to be that of common blood, yet in reality there was no consanguinity between many of the component families.

CURL. A disease in potatoes, in which the leaves on their first appearance appear curled and shrunk up; and consequently, as they do not present a sufficient surface to the light to elaborate the sap in a sufficient manner for carrying on the growth of the plant, it never acquires strength, and either dies, or produces very imperfect tubers. The cause of the disease in the first instance is generally supposed to be the unhealthy state of the set; but something also may be owing to bad management and improper soil.

CU'RRANT. The fruit of two species of *Ribes;* namely, *R. rubrum*, which furnishes the common red and white currants; and the *R. nigrum*, which produces the black currant. The currants of the grocers' shops are the dried berries of a small species of grape cultivated in Zante, Cephalonia, and Ithaca; and in the Morea in the vicinity of Patras. Notwithstanding the heavy duty of 22*s.* 2*d.* per cwt. with which this commodity is burdened, they are largely imported into the British empire, The entries of currants for home consumption amounted at an average of the two years ending 1838 to 193,827 cwt., producing an annual revenue of 189,192½*l.*

CU'RRENCY. (Lat. curro, *I run.*) In Political Economy, a term sometimes used to express the collective amount of the money, and of the bills, cheques, and other substitutes for money, employed in selling or buying, or in the distribution of commodities and services among the different ranks and orders of the community.

CU'RRENT (Lat. curro.), denotes in its most general sense the progressive movement of any object; but it is applied chiefly to the progressive movement of fluids, especially of air, electricity, and water.

Currents in the ocean arise from various causes, either occasional or constant. They may be occasioned by an external impulsion, for example a gale of wind; from a difference in the temperature of different parts of the sea; from the inequality of evaporation, the melting of the polar ice, or in short any cause tending to disturb the hydrostatic equilibrium. It is difficult in many cases to trace their causes, or to give any satisfactory theory of their existence; but on account of their importance to navigation they have been observed, especially of late years, with great care. Among those which have a permanent or general character, there are two which are very remarkable. The first is that of the tropical waters westward round the globe, and the second that which constantly flows from each pole towards the equator. The tropical or westerly current is chiefly confined within the zone extending to about 30° on each side of the equator, and its velocity is estimated by Humboldt at about nine or ten miles a day. In the Atlantic it separates into two branches: one of which forms the *gulf stream;* and the other flows along the coast of Brazil, and passes through the Straits of Magellan. The gulf stream flows northward through the middle of the Atlantic, till it reaches the Cape Verd Islands; it then passes through the Caribbean Sea, between Cuba and the peninsula of Yucatan, sweeps round the Gulf of Mexico, and rushes out by the Bahama Channel; then, spreading out to a greater breadth, it continues its course along the shores of the United States to Newfoundland, where it is deflected eastward by a current setting in from Baffin's Bay; and, passing the Azores and Canary Islands, returns in a great measure into itself. Its breadth is 51 leagues in the Bahama Channel, and velocity from 3 to 5 miles an hour. (*Murray's Geography*, p. 186.) The polar currents flow constantly from the poles towards the equator, though it is evident that their sources must be supplied by currents in a contrary direction. Their existence is proved by the great masses of ice which are carried every year from the polar seas to tropical latitudes. Oceanic currents, by carrying with them the temperature of the regions whence they flow, contribute in no small degree to modify the temperature of the atmosphere, and give a character to the climate of the countries to which they are contiguous. On the parallel of New York Humboldt found the temperature of the gulf stream 72° of Fahrenheit, while out of the current the heat of the ocean at the surface was only 63°. The current which flows

along the eastern coast of Africa, and doubles the Cape of Good Hope in a stream 130 miles broad, is from 7° to 8° warmer than the contiguous sea. The existence of *under currents* in the ocean is suspected rather than proved. For currents in the atmosphere, *see* WINDS.

CU'RRYING. (Fr. corroyer.) The art of dressing skins after they are tanned, for the purposes of the shoemaker, saddler, and harness-maker, &c.; or of giving them the necessary smoothness, lustre, colour, and suppleness. The operation of currying is performed in two ways; either upon the flesh, or on the hair, or, as it is technically called, the *grain;* and consists chiefly of four processes, which require great experience and dexterity. The reader will find in Dr. Ure's *Dictionary of Arts, &c.* a full account of this curious operation, accompanied by a wood cut illustrative of the singular tools and manipulations which it requires.

CU'RSITORS. (Lat. curro, *I run.*) Officers in the Court of Chancery, whose duty it is to make out original writs. They are called also clerks of the course (clerici de cursu); and are 24 in number, forming a peculiar corporation. Cursitor Baron is the name of an officer in the Court of Exchequer, who administers the oath to all high sheriffs, under sheriffs, bailiffs, and all the functionaries of the customs.

CURTAI'L STEP. (Lat. curtus, *short.*) The lower step in a flight of stairs ending at its outer extremity in a scroll. Perhaps taking its name from the step curling round like a cur's tail.

CURTA'NA. The sword (as it is called) of Edward the Confessor, which has its edge blunted as an emblem of Mercy. It is carried between the swords of justice temporal and justice spiritual; and borne before the kings of England at their coronation.

CU'RTATE DISTANCE. A term employed in astronomy to denote a planet's distance from the sun reduced to the plane of the ecliptic. The curtate (or shortened) distance is therefore equal to the true distance multiplied by the cosine of the planet's heliocentric latitude.

CU'RTESY or COURTESY OF ENGLAND, in Law, is the right of a husband who has married a wife seised in fee simple or fee tail general, or heiress in special tail, and has issue male or female born alive, and which by possibility may inherit, to hold her lands after her death for his life. (*See* MARRIAGE, LAW OF.) Thus, four things are said to be necessary to give an estate by the curtesy, — marriage, seisin of the wife, issue, and death of the wife.

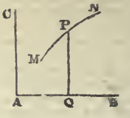
CU'RULE MAGISTRACIES, in Ancient History, were those of the greatest dignity in the Roman state; and were distinguished from all others by the privilege enjoyed by the persons who held them of sitting on ivory chairs (*sellæ curules*) when engaged in their public functions. The curule magistrates were the consuls, prætors, censors, and chief ædiles; which last, on account of this privilege, were called curule ædiles, to distinguish them from the plebeian.

CU'RVATURE. The continual flexure or bending of a line from the rectilinear direction. The curvature of a circle is greater in proportion as the radius is smaller; and the curvature of any other curve at a given point is measured by comparing it with a circle which *osculates* it, or forms with it a contact of a particular kind at that point. (*See* OSCULATING CIRCLE, and RADIUS OF CURVATURE.) The determination of the curvature of curve lines requires the aid of the differential calculus.

CURVE. In Analytical Geometry, a line of which no three consecutive points are in the same direction or straight line. The general theory of curve lines, and of the figures bounded by them, forms an extensive and important part of mathematical science, and in fact properly constitutes what is called the high or transcendent geometry. It will easily be understood, however, that the curves which form the object of geometrical speculation are those only of which the succession of points observes a regular law, capable of being expressed by a mathematical formula; not those which are formed irregularly by the hand, for example, like letters in writing.

Although the ancient geometricians had bestowed some attention on the subject of curve lines, and in addition to the conic sections had investigated some of the properties of a few other curves, as the cissoid, the conchoid, particular kinds of spirals, and perhaps others whose names may have been forgotten; yet their researches had only led them to the knowledge of a small number of particular propositions deduced from a laborious consideration of the circumstances of each individual case, and not admitting of extended application. The general methods of investigation which the modern geometer can apply with so much greater advantage are owing to the progress of algebra, and the happy invention by Descartes of the method of defining curves by algebraic equations.

Let M N be a curve, and A B, A C two straight lines in the same plane, to which all its points are referred; then A B and A C are the axes of the curve. Take a point P in the curve, and draw P Q parallel to A C; the line A Q is called the absciss of the point P, and is denoted by x; and P Q the ordinate, and denoted by y.



Now if for any given value of A Q a corresponding value of P Q can be assigned, that is, if P Q can be expressed in terms of A Q and known quantities, that expression is called the equation of the curve, and all its properties can be thence deduced by means of algebraic transformations without any reference to the diagram.

The first use of this method of defining curve lines by means of an equation between the absciss and ordinate is to enable us to divide them into classes, of which all the individuals have some properties in common. Descartes divided them into two great classes, — *geometrical* and *mechanical.* It is now usual to indicate the same distinctions by the terms *algebraic* and *transcendental.* Algebraic curves are those in which the relation between the absciss and the ordinate is expressed by an algebraic equation: transcendental curves are those in which the relation between x and y is not expressed by an algebraic, but by a differential equation; that is, by an equation between dx and dy. There is still a class which may be regarded as intermediate between these two; namely, *exponential* curves, or those in the equation of which one or both of the unknown quantities enters as an exponent. Such, for example, is the equation $y = a^x$.

In order to form an idea of a curve of which the equation is given, it is necessary to suppose the equation resolved; that is to say, that the value of y is found in terms of x and given numbers. This being found, we take all the positive values of x from 0 to + infinity, and also all the negative values to − infinity. The corresponding ordinates or values of y will give all the points of the curve; the positive ordinates being taken on one side of the axis of the abscissa, and the negative on the opposite side.

Algebraic curves are divided into different classes or orders, according to the degree of the equation which expresses the relation between their co-ordinates. Straight lines are denominated lines of the *first order,* because the equation of a straight line being of the form $0 = A + Bx + Cy$, is only of one dimension; that is to say, it contains no powers or products of the variables x and y. Lines of the second order are those of which the equation rises to two dimensions. The general form of this equation is,

$$0 = A + Bx + Cy + Dx^2 + Exy + Fy^2;$$

and the curves which it includes are the conic sections; that is, the circle, the ellipse, the hyperbola, and the parabola. These curve lines are the simplest of all, because lines of the first order are not curves; hence they are sometimes called *curves of the first order.* Following out the analogy, lines of the *third,* or those whose equation rises to the third degree, are *curves of the second order,* and so on.

The dimension of the equation of a curve line is not altered by changing the origin or position of its co-ordinates, or in making any transformation of its axes. It follows, therefore, that a line of the nth order can never be intersected by a straight line in more than n points, because the ordinates can never have more than n real values. This follows from the general theory of equations; and in fact all the properties of any curve line being deducible from its equation, a complete theory of algebraic equations of any degree includes the theory of lines of that order. In this way it is proved that all lines of any order of which the number is uneven have necessarily at least two infinite branches; for in this case one at least of the co-ordinates is raised to an uneven power in the equation — for example, the 3d, the 5th, &c.; and therefore will have at least one real value, whatever value (which may be increased *in infinitum,* positively and negatively) may be given to the other co-ordinate.

We have mentioned that the lines of the second order include only the circle and the conic sections. Newton, in his *Enumeratio Linearum Tertii Ordinis,* reckons 72 *species* of lines of the third order, or curves of the 2d degree. As the order is more elevated the number of *genera* and species becomes more numerous. The subdivisions into genera and species are, however, founded on some arbitrary properties, and consequently are not made uniformly by different authors. Cramer, in his *Analyse des Lignes Courbes,* found fourteen different genera of curves of the third order; and Euler (*Introductio in Analysin Infinitorum*) sixteen. The whole number of curves belonging to this order has been supposed to amount to some thousands.

Curves of Double Curvature.—Hitherto we have spoken only of curves on a plane; but if they are traced on surfaces which are not plane, they will have a double curvature; that which belongs to the line itself, and that of the surface on which it is traced. In order to investigate the properties of a curve of this sort, it must be supposed to be projected on two different planes perpendicular to each other; the projections will be two ordinary curves having a common axis and different ordinates. One of these curves will be defined by an equation between x and y, and the other by an equation between x and z; so that the

equation of a curve of double curvature is composed of two equations, each containing two variables, of which one is common to both equations, and taken on the line of intersection of the two planes of projection.

Curve Surfaces. — A curve surface is represented algebraically by an equation containing three variables; for example, x, y, and z. It is geometrical when its equation is algebraic, and expressed in finite terms; and mechanical when the equation is differential, and not algebraic. Curve surfaces are also classed according to the dimensions of the variables in their equations. When the variables are only of the second degree, the surfaces are of the second order; when the variable co-ordinates rise to the third degree, they are surfaces of the third order, and so on.

The most complete treatise on the theory of curve lines is that of Cramer, *Introduction à l'Analyse des Lignes Courbes;* but more or less on the subject is contained in every work treating of the application of algebra to geometry. For curve surfaces, and curves of double curvature, the student may consult Lacroix's large work, *Traité du Calcul Differentiel et du Calcul Integral;* or the *Application de l'Analyse à la Géométrie* of Monge.

CUSCUTA'CEÆ. (Cuscuta, one of the genera.) A very small natural order of Exogens, consisting of but one genus, inhabiting all the quarters of the globe, and related to *Convolvulaceæ;* but distinguished by the imbricate corolla, which does not fall off after flowering, the spiral embryo, and the parasitical habit. Common dodder, a curious thread-like twining plant, found on heaths, belongs to the order.

CUSP. (Lat. cuspis, *point.*) In Astronomy, expresses the points or horns of the moon. In geometry the word is used to denote the point or corner formed by two parts of a curve meeting and terminating there.

Cusp. In Architecture, a term applied by Sir James Hall, in his *Origin of Gothic Architecture*, to the spear-shaped ornaments appended to the several points of trefoil, quatrefoil, &c. arches; but this term, it is to be observed, has not been generally adopted by architects.

CUSPA'RIA BARK. *See* Angustura.

CU'SPIDATE. (Lat. cuspis.) In Botany, a term used in describing the apex of a body, when it gradually tapers into a rigid point. It is also used sometimes to express abruptly acuminate, as the leaf of many *Rubi.*

CU'STARD APPLE. A term applied in the West Indies to the fruit of the *Anona reticulata.*

CU'STOM (Fr. coutume), in Law, signifies generally a right or law not written, but established by long usage. To render a custom valid it has been said that the following qualities are requisite: — 1. Antiquity; *i.e.* that it shall have been used as far back as time of legal memory, that is, the first year of Richard I. 2. Continuance without interruption; 3. Without dispute. 4. It must be reasonable; and 5. Certain. 6. Compulsory. 7. Customs must be consistent with each other. Customs in derogation of the common law must be construed strictly. General customs, relating to all England, are determinable by the judges; but local customs by a jury. An exception to this rule is to be found in the *Custom of the City of London*, which, if questioned, is established by certificate of the mayor and aldermen; with the exception of those customs from which the corporation itself claims a benefit. *Customs* (*coutumes*), in the law of France, were the laws relating both to moveable and immoveable property peculiar to different districts of the kingdom before the Revolution. Districts governed by customs were commonly termed *pays coutumiers*, in contradistinction to the remainder of the realm, which being under the civil law was termed *pays de droit Romain.* The pays coutumiers embraced all the north of France. The valid coutumes were estimated at 140 *general*, or comprehending districts, and 360 *local*, belonging to towns and places; but the enumeration was not exact. The *coutume de Paris* was the most important of all; and it was a generally recognized principle that when a case was unprovided for by local custom, that of Paris was to be applied in aid. Works containing the customary law of a particular district are styled *Coutumiers.*

CU'STOMARY FREEHOLD, in Law, is a superior kind of copyhold; the tenant holding, as it is expressed, by copy of court roll, but not at the will of the lord. *See* Copyhold.

CU'STOMS. (Lat. portoria.) In Finance, duties charged on the importation or exportation of certain commodities; that is, on their being brought into, or sent from, a country. Such duties were levied in antiquity, and form an important part of the revenue of this and most other modern states. Down to the æra of the Revolution, customs duties were charged indiscriminately on most commodities, whether exported or imported; but since the epoch in question they have been almost exclusively laid on imported articles; those laid on exports being, in most instances, imposed rather to check or prevent the exportation of the articles, than in the view of raising revenue.

Were this the proper place for such investigations, it might be easily shown that moderate customs duties are about the least exceptionable of all taxes. They are collected with the greatest possible facility, involving no inquiry into the circumstances of individuals, as is the case with taxes on income or property; nor any interference of any sort with the processes carried on in the arts, as is the case with certain excise duties. By allowing imported goods to be lodged in bonded warehouses, under the joint locks of the king and the importer, the revenue is protected, without its being necessary for the importer to pay the duties till the goods be withdrawn for consumption; so that but little additional capital is required to be at the command of the importing merchant because of the articles in which he deals being subject to duties, and but little addition is consequently made to the price of the goods on account of the profits accruing to the dealers on the duties.

Customs duties should not be carried to such a height as to give any overpowering stimulus to smuggling. They then contradict and defeat the very purpose for which they are intended. Our finance ministers have not, however, been sufficiently alive to this obvious consideration. There can be no articles better fitted to bear customs duties than tobacco and spirits; but the duties with which they are loaded are so extravagantly high, that they occasion a great deal of smuggling, with its accompanying crime and demoralization, and would certainly be a good deal more productive, were they effectually reduced. The existing duties on brandy and geneva are, perhaps, the very worst in our tariff; but they would be about the very best, were they reduced from 22*s*. 6*d*. to 8*s*. or 10*s*. a gallon.

We subjoin an account of the gross and nett amount of the customs duty collected in each of the great divisions of the United Kingdom in 1837 and 1838.

	Gross Receipt, 1837.		Gross Receipt, 1838.		Nett Receipt, 1837.		Nett Receipt, 1838.	
	L.	*s.*	*L.*	*s.*	*L.*	*s.*	*L.*	*s.*
England	19,321,324	15	19,585,250	15	17,471,469	10	17,734,405	17
Scotland	1,626,291	19	1,666,399	0	1,402,920	6	1,326,000	18
Ireland	1,945,849	3	1,951,507	17	1,682,169	7	1,693,776	0
Total	22,893,465	17	23,203,157	12	20,556,559	3	20,754,182	15

CU'TICLE. (Lat. cutis, *skin.*) In Anatomy, the scarf skin. The exterior membranous covering of the body. In its chemical characters it resembles nail, quill, &c., and has the properties of a condensed form of albumen.

Cu'ticle. In Botany, the thin vesicular membrane that covers the external surface of vegetables, and adheres firmly to the cellular substance beneath it. It acts in plants as a means of preventing a too rapid perspiration, and is furnished with respiratory openings called stomata.

CU'TLERY. A term used to designate all kinds of sharp and cutting instruments made of iron or steel, as knives, forks, scissors, razors, &c. The principal seat of the manufacture of British cutlery is Sheffield; and the articles made there are held in the highestest imation in all parts of the world. *See* Hardware.

CU'TTER. A vessel with one mast and a bowsprit, of considerable breadth in proportion to her length. The distinction between a cutter and other vessels of one mast, which are called sloops, is, that in the cutter the jib, has no *stay* to support it.

CU'TTING. An excavation made through land, to conduct a road through it on a level lower than that of the surrounding land. *See* Railroad.

CYA'NIC A'CID. A compound of 26 cyanogen + 8 oxygen = 34 cyanic acid.

CY'ANITE. (Gr. κυανος, *blue.*) A massive and crystallized mineral. It has a pearly lustre, is translucent, and of various shades of blue: it is a silicate of alumina, with a trace of oxide of iron. Only found in primitive rocks.

CYA'NOGEN. (Gr. κυανος, and γιγνομαι, *I am produced;* because it is an essential ingredient of Prussian blue.) Cyanogen is a gas of a strong and peculiar odour, resembling that of rubbed peach leaves; it is obtained by heating *cyanuret of mercury.* Under a pressure of between 3 and 4 atmospheres it becomes a limpid liquid. It extinguishes a taper, is highly poisonous and unrespirable, and burns in contact of air with a rich purple flame. Water absorbs between 4 and 5 times its volume of the gas. It is composed of carbon and nitrogen in the proportions of 12 carbon + 14 nitrogen = 26 cyanogen; it is therefore a bicarburet of nitrogen. Mixed with oxygen it explodes by the electric spark, and is resolved into carbonic acid and nitrogen gas. It combines with hydrogen to produce the *hydrocyanic* or prussic acid: it forms with the metals *cyanurets* or *cyanides.*

CYANO'METER. (Gr. κυανος, and μετρον, *measure.*) An instrument contrived by Saussure for determining the deepness of the tint of the atmosphere. A circular band of thick paper or pasteboard is divided into 51 parts, each of which is painted with a different shade of blue, decreasing gradually from the deepest blue

formed by a mixture of black, to the lightest formed by a mixture of white. The coloured zone is held in the hand of the observer, who notices the particular tint which corresponds to the colour of the sky. The number of this tint, reckoned from the lightest shade, marks the intensity at the time of observation.

CYANO'SIS. (Gr.) In Medicine, the blue disease. A blueness of the body occasionally arises from malformation of the heart. The whole of the body, and especially its exposed parts, becomes a blue or lead colour, in consequence of the administration of nitrate of silver.

CY'ANU'RETS. Compounds of cyanogen. When Prussian blue is boiled in water with red oxide of mercury, and the solution filtered, it yields white or pale buff crystals of *cyanuret of mercury*.

CYANU'RIC ACID. A crystallizable acid, obtained by decomposing urea by heat.

CYBE'LE (Gr. Κυβήλη), in Mythology, was originally the Phrygian goddess of the earth. When her worship was introduced among the Greeks, they confounded her with Rhea, as did the Latins with their Ops. Her rites, like those of the Asiatic deities, in general were celebrated with great excitement; her priests, who were called Galli, Corybantes, Curetes, &c., running about with howlings and clashing of cymbals.

CY'CADA'CEÆ. (Cycas, one of the genera.) In Botany, a very small natural order of arborescent Gymnosperms, inhabiting the tropics of Asia and America. They were formerly referred by Linnæus to the Palms; but in 1825 Brown showed the analogy between *Cycadaceæ* and *Coniferæ*, and hence their present station. Adolphe Brongniart also proved the affinity by finding the vessels contained in the wood of both orders to be, as he says, of the same structure. The only remarkable quality in the order is the production of a kind of sago by the soft centre of *Cycas circinalis*.

CY'CLANTHA'CEÆ. (Cyclanthus, one of the genera.) In Botany, a natural order of Endogens, inhabiting the tropics of the western hemisphere, and allied to *Pandanaceæ*, from which their plaited leaves and spiral flowers divide them.

CY'CLAS, SINGLETON, &c. An article of dress worn both with and without defensive armour, which came into fashion about the reigns of Edward II. and III. in England. It was a mantle or surcoat without sleeves, of silk, cloth, &c., reaching to the knees before and to the calves of the legs behind. It was succeeded by the japon or gyppon, a shorter kind of surcoat.

CY'CLAS. (Gr. *κυκλος, a circle.*) A genus of freshwater air-breathing Gastropods or snails, so named on account of the more or less rounded circumference of the shell in all the species. Of these the following are natives of Britain: — the river cycle (*Cyclas rivicola*, Leach), the largest species of which is not uncommon in the smaller streams communicating with the Thames; the horny cycle (*C. cornea*, Lam.), common in ditches near Battersea; cupped cycle (*Cyclas calyculata*, Drap.); lake cycle (*Cyclas lacustris*, Drap.).

CY'CLE. (Gr. *κυκλος.*) The revolution of a certain period of time which finishes and recommences perpetually. Cycles were invented for the purposes of chronology, and for marking the intervals in which two or more periods, of unequal length, are each completed a certain number of times, so that both begin again exactly in the same circumstances as at first. The cycles used in chronology are three; the *cycle of the sun*, the *cycle of the moon* or *Metonic cycle*, and the *cycle of indiction*.

The *cycle of the sun*, or solar cycle, is a period of time after which the same days of the week recur on the same days of the year. If the number of days in the year were always the same, this cycle could only contain seven years; but the order is interrupted by the intercalations. In the Julian calendar the intercalary day returns every fourth year, and the cycle consequently contains $4 \times 7 = 28$ years; after which period the Dominical letters return in the same order, or the first day of the year and of every month falls again on the same day of the week. The origin of this cycle is unknown; it is supposed to have been invented about the time of the Council of Nice (325); but the first year of the first cycle is placed by chronologists nine years before the commencement of the Christian era. Hence the year of the cycle corresponding to any given year in the Julian calendar is found by the following rule: — *Add nine to the date, and divide the sum by twenty-eight; the quotient is the number of cycles elapsed, and the remainder is the year of the cycle.* Should there be no remainder, the proposed year is the 28th, or last of the cycle. In the reformed calendar this rule can only apply from century to century; for the order is interrupted by the omission of the intercalary day every hundredth year, and is not restored till the end of four hundred years. *See* DOMINICAL LETTER.

The *cycle of the moon* is a period of 19 solar years, after which the new and full moons fall on the same days of the year as they did 19 years before. This cycle was invented by Meton, a celebrated astronomer of Athens, and the chronological period which he founded on it is celebrated in history under the name of the *Metonic cycle*. The Metonic cycle contained exactly 6940 days, which exceeds the true length of 19 solar years by nine and a half hours nearly. On the other hand, it exceeds the length of 235 lunations, or synodic revolutions of the moon, by seven hours and a half only. The framers of the ecclesiastical calendar, in adopting this period, altered the distribution of the lunar months, in order to accommodate them to the Julian intercalation; and the effect of the alteration was that every three periods of 6940 days was followed by one of 6939. The mean length of the cycle was therefore $6939\frac{3}{4}$ days, which agrees exactly with 19 Julian years. A table, therefore, showing the days of the new and full moons for 19 years, would serve to show the days of these phenomena for any year whatever when its number in the cycle is known. The number of the year in the cycle is called the *golden number;* either because it was so termed by the Greeks, who, on account of its utility, ordered it to be inscribed in letters of gold in their temples, or more probably because it was usual to distinguish it by red letters in the calendar. The cycle is supposed to commence with the year in which the new moon falls on the 1st of January. This happened in the year preceding the commencement of our era; hence to find the number of any year in the lunar cycle, or the golden number of that year, we have this rule: — *Add one to the date, and divide by nineteen; the quotient is the number of cycles elapsed, and the remainder is the year of the cycle.* Should there be no remainder, the proposed year is the last or 19th of the cycle.

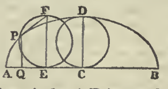
Cycle of indiction, or *Roman indiction*, a period of 15 years; not astronomical, like the two former, but entirely arbitrary. Its origin and the purpose for which it was established are alike uncertain; but it is conjectured that it was introduced by Constantine the Great, about the year 312 of the common era, and had reference to certain judicial acts that took place under the Greek emperors at stated intervals of 15 years. In chronological reckoning, it is considered as having commenced on the 1st of January of the year 313. By extending it backwards to the beginning of the era, it will be found that the 1st year of the era corresponded with the 4th of the cycle. In order, therefore, to find the number of any year in the cycle of indiction, we have this rule: — *Add three to the date; divide the sum by fifteen, and the remainder is the year of indiction.* *See* CALENDAR.

CY'CLIC CHORUS. The chorus which performed the songs and dances of the Dithyrambic Odes at Athens. They derived their name from the circumstance of their dancing round the altar of Bacchus in a circle (*κυκλος*), and were thus distinguished from the square (*τετράγωνος*) choruses of tragedy.

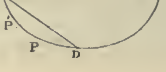
CY'CLIC POETS. (Gr. *κυκλος.*) This term was applied to a succession of Epic poets who followed Homer, and wrote merely on the Trojan war and the adventures of the heroes immediately connected with it, keeping, as it were, to one circle (*κυκλος*) of subjects. None of their works have come down to us.

CY'CLOBRA'NCHIANS, *Cyclobranchiata.* (Gr. *κυκλος*, and *βραγχια, gills.*) The name of an order of hermaphrodite Gastropodous Mollusks, including those in which the branchiæ consist of little tufts or pyramids attached in a circular arrangement to the inner surface of the margin of the mantle.

CYCLOI'D, or TROCHOID. (Gr. *κυκλος*, or *τροχος, wheel;* and *ειδος, form.*) In Geometry, one of the transcendental curves, described by a point P in the circumference of a circle which rolls along an extended straight line A B until it has completed a revolution. Some of the properties of the curve are obvious from this definition. The line A B, which is called the base of the cycloid, is equal to the circumference of the generating circle; and CD, which is the axis of the cycloid, is equal to the diameter. In any position E P F of the generating circle, A E is equal to the arc E P, A Q the absciss = A E − Q E = arc E P − sine EP, and PQ the ordinate = 1 − cosine of E P.



It is also easy to prove that the whole length of the cycloid A D B is equal to four times C D, and the whole area or space between the curve and its base triple that of the generating circle. A portion of the curve D P, counted from its summit, is double of F P, the supplemental chord of the arc E P; and F P is also a tangent to the cycloid at P. The curve has many other remarkable properties which have been discovered by more recondite investigations. Its *involute*, or the curve formed by unfolding a thread or flexible line from its convex side, is a cycloid equal and similar to the original. If a heavy body descends by the force of gravity in an inverted cycloid, the velocity which it acquires is exactly proportional to the length of the cycloidal arc P D; so that from whatever point (P, P′) it may begin to fall, it will arrive at the lowest point D



in precisely the same time. If a body is to descend by the force of gravity from a point A to another point D not in the same vertical, it will accomplish the passage in a less time by describing the cycloid A P D than by moving in the straight line A D, or in any other path whatever. *See* BRACHYSTOCHRONE.

The cycloid may be made to assume an endless variety of forms by placing the tracing point not in the circumference of the generating circle, but without or within it, though still in the same plane. When the tracing point is without the circle, the curve has its base shortened, and is called the *curtate* or *contracted cycloid*. If the point is within the circumference, the curve is called the *prolate* or *inflected cycloid*.

Few curves have afforded finer scope for the exercise of modern geometry than the cycloid. Its properties successively engaged the attention of Roberval, Fermat, Descartes, Pascal, Slusius, Wren, and Wallis. Huygens rectified the curve so early as 1657; and having afterwards discovered its isochronism, or the remarkable property that all bodies gliding along it will descend from any point in the same time, and likewise that it produces a similar cycloid by its development, he applied these discoveries to the improvement of the pendulum, and showed how a perfectly synchronous vibration could be procured, theoretically at least, by causing a flexible rod to vibrate between cycloidal cheeks. Its property of being the line of swiftest descent was discovered by John Bernoulli in 1697.

CYCLOI'DES. (Gr. κυκλος.) A name given by Agassiz to one of his orders of fishes, the species composing which have scales composed of simple layers with smooth margins, but often ornamented on their exterior surface with different figures impressed upon all the layers: these are of horn or bone without enamel; the scales of the lateral line, instead of being flat, are funnel-shaped; the contracted part applied against the disk of the scale forms the tube by which the mucus exudes which covers the fish. The families included in the *Cycloid* order are, *Labroides*, *Muges*, *Atherines*, *Scomberoids*, *Gadoids*, *Gobioids*, *Murenoids*, *Lucioids*, *Salmonoids*, *Clupeoids*, and *Cyprinoids*.

CY'CLOPÆ'DIA. (More correctly *Encyclopædia*, from the Greek words ἐν κύκλῳ παίδεια; *instruction in a circle*.) A work containing definitions or accounts of the principal subjects in one or all departments of learning, art, or science. Its arrangement may be either according to divisions into the various sciences, &c., or the subjects may be arranged and treated in alphabetical order. The *Encyclopédie Françoise*, or *Dictionnaire Encyclopédique*, and the *Encyclopædia Britannica*, have been the most celebrated works of this species; but the earliest appears to be the *Lexicon Technicum* of Harris, published in 1706. The great French work, the *Encyclopédie Methodique*, consists, not of one, but of a series of encyclopedias or dictionaries. *See* DICTIONARY, ENCYCLOPÆDIA.

CYCLO'PEAN. An epithet applied to certain huge structures the remains of which are found in many parts of Greece, Italy, and Asia Minor, the architecture of which was totally different in style from that which prevailed during the historical ages. The epithet originated in the Grecian tradition that assigned these edifices to the gigantic strength of the Cyclops. It is most probable that they were really raised by the Pelasgians, the predecessors or ancestors of the later Greeks; and a gradual progress may be traced in them from the extreme of rudeness to a degree of symmetry that indicates an approach to the elegance of Grecian architecture.

CYCLO'PES. (Gr. κυκλος, *circle* and ωψ, *eye*.) In Mythology, a race of gigantic beings fabled by the Greeks to dwell in Sicily, where they assisted Vulcan in forging the thunderbolts of Jupiter. They had only one eye, round, and situated in the centre of the forehead. The most celebrated among them was Polyphemus, whose exploits have formed a prolific theme for the poets of antiquity. His attachment to the nymph Galatea, is happily described in an idyl of Theocritus; and the 9th book of the *Odyssey* contains a graphic account of his savage propensities, and of the loss of his eye by the stratagem of Ulysses.

CYCLO'SIS. (Gr. κυκλος.) A term applied by Schultz to that general motion of latex or the vital fluids of plants, which passes through vessels of a peculiar kind, and which are diffused through the system of plants without interruption; in distinction to *rotation*, or the movement of fluids in separate cells, as in Chara, Valisneria, &c. According to this physiologist, the phenomenon of cyclosis is confined to the highest forms of vegetation, while that of rotation is characteristic of the more imperfect orders of plants.

CY'CLOSTO'MA. (Gr. κυκλος, and στομα, *a mouth*.) A genus of air-breathing Gastropods or snails; so called on account of the circular form of the aperture of the shell. *Cyclostoma elegans* and *Cycl. productum* are both natives of England.

CY'CLOSTO'MES, *Cyclostoma* (Gr. κυκλος, and στομα *a mouth; round-mouthed*.) A tribe of cartilaginous fishes, including those in which the mouth is surrounded by a circular lip, forming a large sucker, as in the lamprey.

CY'GNUS. (Lat. *the swan*.) In Astronomy, one of the old constellations in the northern hemisphere.

CY'GNUS. In Ornithology. *See* SWAN.

CY'LINDER. (Gr. κυλινδω, *I roll*.) In Geometry, a solid which may be conceived to be formed by the revolution of a rectangular parallelogram about one of its sides. The surface of a cylinder, not including the two ends, is equal to the rectangle formed by multiplying the circumference of its base into its altitude; and the solid content is equal to its altitude multiplied into the area of its base. The cone, the sphere, and the cylinder have a remarkable relation to each other, first discovered by Archimedes: namely, that the cone is one third of the cylinder, having the same base and altitude; and the inscribed sphere two thirds of the cylinder; or the cone, the sphere, and the cylinder are to each other as the numbers 1, 2, and 3.

CYLI'NDROID. (Gr. κυλινδρον, *cylinder*, and ειδος, *form*.) A solid which differs from a cylinder in having ellipses instead of circles for its ends or bases.

CY'MA, or CYMATIUM. (Gr. κυμα, *a wave*.) In

Architecture, a moulding, taking its name from its contour resembling that of a wave, being hollow in its upper part, and swelling below. Of this moulding there are two sorts: the cyma recta,

just described; and the cyma reversa, whose upper part swells, whilst the lower is hollow. By the workmen these are called ogees.

CYMA. (Gr. κυημα, *a fœtus*.) In Botany, a form of inflorescence consisting of a solitary flower seated in the axilla of dichotomous ramifications, as in *Sambucus*. This term is also sometimes improperly used, in place of coma, to express the head of a forest tree.

CY'MBALS. (Gr. κυμβαλον, from κυμβος, *hollow*.) Brass musical instruments of percussion, played in pairs by striking one against the other. They are circular, about six or eight inches diameter, attached to leather mountings, by which they are held. Cymbals are musical instruments of great antiquity, though there is considerable doubt as to who was the inventor. They were employed by the Greeks in the festivals of Cybele and Bacchus, and indeed by nearly all the nations of antiquity. The cymbals and the *crotola* (which see) were used together.

CY'MBIUM. In Natural History, a name given by many writers to a kind of sea-shell, commonly called the gondola. It belongs to the genus *concha globosa*, or *dolium*.

CYNA'PIA. A crystallizable alkaline base obtained from the *Æthusa cynapium*.

CY'NARA'CEÆ. (Cynara, one of the genera.) In Botany, one of the divisions of the great group of *Compositæ*, admitted by Jussieu. It contains the thistle, the artichoke, and similar plants, having their capitula surrounded by a hard spiny or lacerated involucrum, and long equal tubular florets with an inflated limb. They are also called *Cynarocephalæ*.

CYNAROCEPHALÆ. *See* CYNARACEÆ.

CYNARRHO'DIUM. (Gr. κυων, *a dog*, and ῥοδον, *a rose*.) In Botany, a fruit with distinct ovaria, and hard indehiscent pericarpia enclosed within the fleshy tube of the calyx, as in *Rosa*.

CY'NICS. A sect of philosophers among the Greeks, so called from their snarling humour, and their disregard of the conventional usages of society; the name being derived from κυων, *a dog*. It is difficult to give any satisfactory account of the tenets of this sect, as during all the period of its existence it was in a state of constant fluctuation, and, like most of the philosophical systems of antiquity, derived its character and complexion from the peculiar temperament and disposition of those who embraced it. But amid all the follies and incongruities by which it was disfigured, and which exhibited themselves chiefly in a contemptuous neglect of all science and art, and of all the comforts and charities of life, it is impossible not to admit that its grand aim was to inculcate the love of rigid virtue and a contempt of pleasure. On this point the testimony of Horace,—himself a zealous adherent of the school of Aristippus, the very opposite of the cynical sect,—even were there no other, must be held to be conclusive; and, according to his opinion, the aim of the cynical philosophy was to induce every man to become

Virtutis verae custos, rigidusque satelles.

This sect was founded by Antisthenes, a disciple of Socrates, who sought to imitate his master in carelessness of outward splendour and contempt of riches; but his indifference to these things soon degenerated unhappily into a love of ostentation, shown by a display of poverty. Thus he and many of his followers rejected not only the conveniences but the common decencies of life, and lived in rags and filthiness; while they sneered bitterly at the rest of the world, instead of endeavouring to teach it to cultivate the pure reason of which they professed themselves to be the only followers. Of this sect was the

famous Diogenes, whose meeting with Alexander the Great is too well known to require being noticed in this place.

CY'NIPS. (Gr. κυω, *I am pregnant.*) A Linnæan genus of Hymenopterous insects, belonging to that section which has not a poisonous sting. The ova of this genus are deposited in living trees, and the irritation excited by their presence gives rise to the formation of the excrescences called galls.

CY'NOMORIA'CEÆ. (Cynomorium, one of the genera.) In Botany, a natural order of Rhizanths, at present but little known. One species is a native of Malta, and was formerly supposed to possess great medicinal powers as an astringent: it figures in old officinal catalogues under the name of *Fungus melitensis*.

CY'NOSA'RGES. A sort of academy in the suburbs of Athens, situated near the Lyceum; so called from the mythological story of a white dog (κῦνος αργου), which, when Diomus was sacrificing to Hercules, the guardian of the place, carried off part of the victim. Besides possessing several temples erected in honour of Hercules, Alcmene, and other mythological personages, it was chiefly famed for its gymnasium, in which foreigners or citizens of half blood used to perform their exercises; and as being the place where Antisthenes instituted the sect of the cynics, and taught his opinions.

CY'NOSURE. (Gr. κυων, *a dog*, and ουρα, *a tail.*) Literally the tail of a dog, applied by some philosophers to the constellation Ursa Minor, by which the ancient Phœnicians used to be guided on their voyages: whence it has been borrowed by the language of poetry, in which it signifies "a point of attraction:"

> Where perhaps some beauty lies,
> The cynosure of neighbouring eyes. *L'Allegro*, 79.

CY'NTHIUS and CY'NTHIA. In Mythology, surnames given by the ancient poets to Apollo and Diana; from Cynthus, a mountain of the island of Delos, on which they are fabled to have been born. (*Virg.*, Eclog. 6.3. *Hor.*, Od. III. 28.)

CYPERA'CEÆ. (Cyperus, one of the genera.) A natural order of Endogens, inhabiting the marshes, ditches, streams, &c. of all countries. They closely resemble *Graminaceæ;* but are distinguished from them by the stems being solid and angular, not round and fistular, and by there being no diaphragms at the articulations. They approach *Juncaceæ* and *Restiaceæ*, but are known at once by the sheaths of their leaves not being split. The entire order has lately been re-arranged by Nees Von Esenbeck and Kunth. Their sensible properties are unimportant. *Carex arenaria* affords one of the European substitutes for sarsaparilla.

CYPHE'LLÆ. (Gr. κυφος, *a tubercle.*) A term used in describing lichens, to denote pale tubercle-like spots on the under surface of the thallus.

CY'PHER, or CIPHER. In Diplomatic affairs, "an occult manner of writing, legible to those only who possess the key or secret." This art, in a variety of forms, has been more or less practised in every civilized country; and has been cultivated by the moderns in particular to such a degree as to have acquired the importance of a distinct science, under the names *Cryptography*, *Polygraphy*, *Stenography*, &c. To give a general exposition of the principles of the art, it would be necessary to enter into minute details inadmissible in a work of this kind; but the reader will find in *Rees's Cyclopædia* a full and learned disquisition on the subject.

CY'PHONISM. (Gr. κυφων, *an instrument of punishment.*) A species of punishment frequently resorted to by the ancients, which consisted in besmearing the criminal with honey, and then exposing him to insects. This punishment was carried into effect in various ways, but chiefly by fastening the sufferer to a stake, or extending him on the ground with his arms pinioned.

CYPRÆ'A, *Cowry*. The name of a Linnæan genus of the *Vermes Testacea*, characterized by a subovate smooth shell, with a linear aperture extending from one end of the shell to the other, and transversely furrowed or dentated in the mature state. The genus is retained without subdivision, and forms part of the *Buccinoid* family of the Pectinibranchiate order of Gastropods of the system of Cuvier.

This genus is remarkable for the difference of form which exists in the young and old states of the shell: in the former the lip is thin, and the aperture wide, but the mantle is progressively developed until its lobes extend over the columella on the one side and the lip on the opposite side of the aperture, covering them with successive layers of nacreous shell, and at length diminishing the aperture to a narrow linear form. One species of cowry (*Cypræa moneta*, L.) is commonly used by the natives of certain parts of Africa and other semi-barbarous nations as a medium of monetary exchange.

CYPRI'NUS. (Lat. cyprinus, *a carp.*) A Linnæan genus of abdominal fishes, now the type of a family of Malacopterygians in the system of Cuvier, and of Cycloid fishes in the system of Agassiz; including the genus *Cyprinus* proper, or carps; *Barbus*, or barbels; *Gobio*, or gudgeons; *Tenca*, tenches; *Abrama*, breams; *Leucisens*, minnows; *Cirrhinus; Labes; Catastomus;* and *Gonorhynchus.*

CY'PSELA. (Gr. κυψελη, *a bee-hive.*) In Botany, one-seeded, one-celled, indehiscent fruit, with the integuments of the seed not cohering with the endocarp: in the ovarium state evincing its compound nature by the presence of two or more stigmata; but nevertheless unilocular, and having but one ovule. Usually called an *Achenium.*

CYRE'NIANS. The philosophers of a school founded at Cyrene, a Grecian colony on the northern coast of Africa, by Aristippus, a disciple of Socrates. They held, with the Epicureans, that pleasure was the only good and pain the only evil, and were not at such pains as the latter to prove that the first could only attend on virtuous conduct; they also differed from them in not considering absence from pain of itself to be a pleasure of the highest order. But though these philosophers held that pleasure should form the ultimate object of pursuit, and that it was only in subserviency to this that fame, friendship, and even virtue are to be desired, still there were many points in their philosophy calculated to command general sympathy. It is impossible not to admit that, with all the defects of the system, its object, as Dryden says in reference to Horace, is to render us happy in relation to ourselves, agreeable and faithful to our friends, and discreet, serviceable, and well-bred in relation to those with whom we are obliged to live and converse. Perhaps the best view of the philosophy of this sect is to be obtained from the Satires and Epistles of Horace, in which the versatility of disposition, politeness of manners, and knowledge of the world that distinguished the Cyrenians, are set forth with great clearness, and with all the ardour of an enthusiastic disciple. The grand principles of Aristippus are thus happily described in the couplet —

> Omnis Aristippum decuit color et status et res,
> Tentantem majora, fere præsentibus æquum:

and the poet's own partiality for this system of philosophy, and its accommodating character, are thus exhibited: —

> Nunc in Aristippi furtim præcepta relabor,
> Et mihi res non me rebus subjungere conor.

CY'RTANDRA'CEÆ. (Gr. κυρτος, *crooked*, and ανηρ, *a male;* Cyrtandra, the name of one of the genera.) A natural order of Monopetalous Dicarpous Exogens, inhabiting the tropics, and closely allied to *Gesneraceæ*, *Bignoniaceæ*, and *Pedaliaceæ;* from the former differing only in never producing an inferior ovary, their deeply lobed placentæ, their siliquose fruit, and the want of albumen; from *Bignoniaceæ*, by their habit, their minute apterous seeds, one-celled ovary, with two double parietal placentæ; from *Pedaliaceæ*, in nothing except their minute indefinite seeds, and the membranous not woody texture of the fruit and placentæ.

CY'STIBRA'NCHIANS, *Cystibranchia*. (Gr. κυστις, *the bladder*, and βραγχια, *gills.*) A family of Isopodous *Crustaceæ*, comprehending those which have the branchiæ lodged in vesicular cavities.

CY'STIC OXIDE. (Gr. κυστις.) A species of urinary calculus, composed of a peculiar animal matter.

CY'STICS, *Cystica*. (Gr. κυστις.) Rudolphi thus denominates the order of Entozoa in which the body is terminated by a cyst peculiar to one individual or common to many. The hydatid in the brain of sheep, and the parasite which produces measly pork, are examples of this order.

CYSTI'TIS. (Gr. κυστις.) Inflammation of the bladder.

CY'STOCE'LE. (Gr. κυστις, and κηλη, *a tumour.*) A hernia or rupture formed by a protrusion of the bladder.

CYSTO'TOMY. (Gr. κυστις, and τεμνω, *I cut.*) The operation of cutting into the bladder for the extraction of a stone or other extraneous substance.

CYTHERÆ'A. In Mythology, a name given to Venus, from the island Cythera, where she was worshipped with peculiar veneration. (*Ovid. Fast.* iv. 285.)

CY'TINA'CEÆ. (Cytinus, one of the genera.) In Botany, a natural order of Rhizanths inhabiting the south of Europe, the Cape, and Guinea. They are very little known, and have no sensible properties of importance. Pelletier says that Cytinus has the property of precipitating gelatin without containing tannin.

CYZICE'NUS. In Ancient Architecture, a large hall decorated with sculpture; and so called from the inhabitants of Cyzicus, who were celebrated for their magnificence in building.

CZAR, ZAR, or TZAR. A title given to their monarch by several Sclavonic tribes. In Russia, Ivan II. adopted in 1579 the title of Czar of Moscow. The eldest son of the czar was termed Czarovicz; but after the death of Alexis, the murdered son of Peter I., this title was no more used, until revived by Paul I., in 1799, in favour of his second son, the late grand duke Constantine. The consort of the emperor of Russia is styled *Czarina.*

D.

D. The fourth letter in the Hebrew alphabet, and those derived from it, is the medial of the order of dentals or palato-dentals; and is susceptible of various interchanges, particularly in the German and English languages. As an abbreviature, D has several significations; thus, D. stands for Doctor, — M. D. Doctor of Medicine, — D. D. Doctor of Divinity, &c. Among Roman writers, D. is used for Divus, Decimus, Devotus, Diebus, &c. D. M. in the Roman epitaphs signifies Diis Manibus; but, on other occasions, Deo Magno, or Diis Magnis. As a Roman numeral, D signifies five hundred: in this case, it is more correct to write IↃ.

D. In Music, the note on the third line in the bass or F clef, on the fourth space in the tenor clef, on the third space in the counter-tenor clef, and on the fourth line in the treble or G clef.

DA CA'PO. (It.) In Music, usually written short, D. C. An instruction to the performer in such airs as end with the first strain, that the song must be begun again and ended with the first part.

DA'CELO. One of those generic terms which Dr. Leach framed by transposing the letters of the name of the typical or Linnæan genus from which the species so designated were dismembered; in the present case, the word is obtained from *Alcedo*, and is applied to a large Australian species of Passerine bird, nearly allied to the kingfisher.

DACRYO'MA. (Gr. δακρυω, *I weep.*) A disease of the lachrymal duct of the eye, by which the tears are prevented passing into the nose, and therefore trickle over the face.

DACTI'LIOGLYPH. (Gr. δακτυλιος, *a ring;* and γλυφω, *to engrave.*) In ancient gem sculpture, the inscription of the name of the artist on a gem.

DACTILIO'GRAPHY. (Gr. δακτυλιος, and γραφω, *to write.*) In gem sculpture, the science of gem engraving.

DA'CTYL. (Gr. δακτυλος, *the finger.*) The name of a metrical foot in Greek and Latin poetry, consisting of a long and two short syllables; as in the word *cārmĭnă*. In the English and German languages, where accent determines quantity, the word dactyl means an accented followed by two unaccented syllables; as in *quantity, liebliche.*

DA'CTYLI. Priests of Cybele in Phrygia; so called, according to Sophocles, because they were five in number, thus corresponding with the number of the fingers (δακτυλοι), from which the name is derived. Their functions appear to have been similar to those of the Corybantes and Curetes, other priests of the same goddess in Phrygia and Crete.

DA'CTYLO'LOGY. (Gr. δακτυλος, *a finger*, and λογος, *discourse.*) The art of spelling words by placing the fingers in such positions as to signify the letters of the alphabet.

DACTYLO'PTEROUS. (Gr. δακτυλος, and πτερον, *a wing or fin; finger-finned.*) A fish is said to be so when the inferior rays of its pectoral fin are partially or entirely free. The term *Dactylopterus* has been applied by Lacepede to a genus of Gurnards, remarkable for the great expansion of their pectoral fins. The most common and best known species of this genus inhabits the Mediterranean, and is the *Trigla volitans* of Linnæus, or the flying gurnard. It is sometimes confounded with the true flying fish (*Exocœtus*).

DA'DO. (It. *a die.*) In Architecture, the die, or that part in the middle of the pedestal between the base and cornice. It takes its name from being a cube like a die.

DÆ'DALUS. In Fabulous History, the great grandson of Erechtheus king of Athens, is celebrated as the most ancient statuary, architect, and mechanist of Greece. To him is ascribed the invention of the saw, the axe, the plummet, and many other tools and instruments; and to such a degree did he excel in sculpture, that his statues are fabled to have been endowed with life. For the alleged murder of his nephew he was obliged to quit Athens, whence he repaired to Crete, then under the sway of Minos, by whom he was favourably received. Here he constructed the famous labyrinth, on the model of the still more famous one of Egypt; but having assisted the wife of Minos in an intrigue with Taurus (*see* MINOTAUR), he was, by a strange fatality, confined to this very labyrinth along with his son Icarus. By means, however, of wings, which he formed of linen or feathers and wax, Dædalus and his son contrived to make their escape. The former pursued his aërial journey, and arrived safely in Sicily; but the latter having soared too near the sun, in consequence of which the wax that fastened the wing was melted, dropped into and was drowned in the sea (thence called the *Icarian*). In Sicily Dædalus continued to prosecute his ingenious labours, and lived long enough to enrich that island with various works of art. From the plastic powers of Dædalus, the ancient poets used to regard his name as synonymous with *ingenious*, as in the phrase *Dædaleum opus;* and in a somewhat similar sense Lucretius applies it to the earth, in order to describe its vernal vegetation, —

> —— tibi suaves Dædala tellus
> Submittit flores.

A few years ago the name of Dædalus, which had been appropriated by various artists in the history of Grecian art, was assumed by the constructors of some ingenious automata, in memory of the grand impressions which the works of Dædalus had produced.

DA'GON. (Heb. דג, dag, *a fish.*) One of the principal divinities of the ancient Phœnicians and Syrians, and more especially of the Philistines. The origin, attributes, and even the sex of this divinity, are all wrapt in the most profound obscurity; but the sacred writers concur in assigning to him such a degree of authority as must place him on a level with the Jupiter of the Greeks and Romans. The reverence in which he was held by the Philistines, and the remarkable circumstances attending his downfall, will be found fully detailed in Judges, c. 16., and 1 Samuel, c. v.; but we cannot refrain from transferring to our pages Milton's graphic sketch of the leading features of his history: —

> —— Next came one
> Who mourned in earnest when the captive ark
> Maimed his brute image, head and hands lopt off
> In his own temple, on the grunsel edge,
> When he fell flat, and shamed his worshippers:
> Dagon his name, sea monster, upward man
> And downward fish; yet had his temple high
> Reared in Azotus, dreaded through the coast
> Of Palestine, in Gath and Ascalon,
> And Accaron and Gaza's frontier bounds.

The *Samson Agonistes*, as is well known, exhibits the great importance of this divinity; and the

> —— solemn feasts,
> With sacrifices, triumph, pomp, and games,

celebrated to his honour by the Philistines.

DAGUE'RROTYPE. The name given to a process lately introduced by Daguerre, an ingenious French artist, by which the images from the lens of a camera obscura, as is supposed, are fixed on metal plates. It has been our good fortune to see several of the productions of this surprising discovery, and we regret that words cannot convey the impression they made on us. With the exception of local colour, they present nature herself to the spectator. The qualities of objects are so clearly expressed that silk could not in the representation be mistaken for satin, nor marble for plaster. The sky is given with as different an expression of quality from stone as that substance is from the ground on which it stands. The productions we saw were nearly uniform in size, being about 10 inches by perhaps 6 or 7; and notwithstanding the small space within which the views are confined, we could by means of a lens count the strands in a rope. This extraordinary discovery must not be confounded with that of an ingenious gentleman (Mr. Talbot) of this country, in which what in nature is in light becomes a dark space in the representation, and the parts that are dark are exhibited in masses of light. In Daguerre's discovery the objects are lighted as they are in nature, with all the sparkling effects which the sun scatters on them: the intensity of tone in the foregrounds is balanced by the aërial effects in the distances; in short, the only step wanting to rival the original is to impart to these self-created pictures that which the father of colour, the sun, bestows upon all things beneath him, namely, colour. Mr. Talbot's process has been made known by a paper read before the Royal Society, and some have called his specimens Photogenic pictures. *See* PHOTOGENIC.

DAI'RY. (Dey, *milk*, obsol. Eng.) An apartment in a house, or a separate building, for the purpose of holding milk, and manufacturing it into butter, cheese, or other dairy produce. On a small scale, where butter only is made from milk, the dairy may be a room in the north side of the dwelling-house; or it may form one of the offices connected with the kitchen court. The requisites for the room to contain the milk are — an equal temperature throughout the year, viz. between 48° and 55°; sufficient ventilation to carry off all bad smells and impurities in the air; and the exclusion of flies and other insects. An equable temperature is maintained by thick or by hollow walls, and by double windows. In winter the temperature is somewhat raised by the warm milk, and in summer it is cooled to the degree required by ventilation and the evaporation of water poured on the floor. The ventilation is effected by opening the glazed sashes of the windows, and supplying their places by wire shutters; and indeed one of the best modes of arranging the windows of a dairy is to have wooden shutters outside for closing in the most severe weather in winter; next a fixed frame of wirework to exclude the flies; and within this, at three or four inches distance, the glazed sash, which should be made to open. A dairy on a large scale is most conveniently arranged as a detached building; in which case, it contains a milk-room, a churning-room, and a dairy scullery, or place for

scalding the utensils. If cheese is to be made, a room will be required for the cheese press, and another for drying the cheeses.

The quantity of milk raised in the vicinity of London for the supply of the inhabitants, and the revenue derived from the sale of it, show the importance of this article. In his valuable work on cattle, their breeds, &c. "Mr. Youatt estimates the number of dairy-cows, at present kept in London and its environs, at 12,000; affording, on Mr. Middleton's hypothesis, an annual supply of 38,400,000 quarts of milk. Now, as milk is sold by the retailers at from 3*d*. to 4*d*. a quart, after the cream is separated from it, and as the cream is usually sold at from 2*s*. 6*d*. to 3*s*. a quart, and there is reason to suspect that a good deal of water is intermixed with the milk, we should hardly be warranted in estimating that the milk, as obtained from the cow, is sold at less than 5*d*. a quart, which gives 800,000*l*. as the total price of the milk consumed in the city and its immediate vicinity." (*M'Culloch's Statistics*, 2d ed. vol. i. p. 490.)

DA'IS. (Fr.) In Architecture, the platform or raised floor at the upper end of a dining hall, where the high table stood; also the seat with a canopy over it for those who sat at the high table.

DALMA'TICA. A long white gown with sleeves; worn by deacons in the Roman Catholic church over the *alb* and *stole*. It was imitated from a dress originally worn in Dalmatia, and imported into Rome by the emperor Commodus, where the use of it gradually superseded the old Roman fashion of keeping the arms uncovered. A similar robe was worn by kings in the middle ages at coronations and other solemnities.

DA'MAGE-FEASANT. In Law, a beast is said to be so, when found in another person's ground without his leave or licence; in which case the tenant may distrain or impound it: but at his own peril, if the accident have happened through his own negligence in not repairing the fences of his close. Possession, without title, is sufficient to empower the tenant to distrain damage-feasant. Proper notice is, however, to be given; and if the owner of the estate tender amends, it is unlawful to detain them.

DA'MAGES. (Lat. damna.) In English Law, the recompence awarded by a jury to a plaintiff, in certain forms of action, for the loss or *damage* he has sustained by the injury committed by the defendant. At *common law*, damages are recoverable in personal and mixed actions. In actions upon the case, trespass, &c., a certain amount of damages, sufficient to cover all the hurt really sustained by the plaintiff, is alleged or *laid* in the declaration; and it is the duty of the jury to inquire the real amount of damages, and assess it accordingly. In the action of debt, where the amount due is something certain, the damage laid is now merely nominal, for the injury supposed to be done by the detention of the debt; the jury, therefore, award a nominal sum only. Damages are also allowed in actions upon a variety of statutes, and sometimes double or treble damages; in which case the plaintiff is entitled to twice or three times the amount awarded by the jury.

DA'MASK. (From *Damascus*, where it was anciently made.) A woven fabric produced by a particular construction and management of the loom, in which are represented various figures of flowers, fruit, leaves, &c. The chief seat of this manufacture is Dunfermline in Fifeshire, and Lisburne and Ardoyne near Belfast. The best damasks are of linen; those of cotton are cheaper, but less elegant and durable.

DAMASKEE'NING. The art of inlaying iron and steel with gold and silver, originally practised at Damascus in Syria.

DAMA'SSIN. A species of woven damask with gold and silver flowers.

DAME (probably a corruption of the Lat. domina, *a mistress*), was formerly a title of honour, and is still used in the English law to denote the wife of a knight or baronet. Dame was also the designation of nuns of the Benedictine and certain other ancient orders.

DA'MPER. An iron plate sliding backwards and forwards in a groove, and so arranged as to enlarge or contract, and occasionally close the chimneys of furnaces, steam-boilers, &c. so as to increase or diminish the draught of air through the fire, and consequently regulate the intensity of the combustion.

DAMPS. (Germ. dampf, *vapor*.) The noxious exhalations of mines and excavations. The carburetted hydrogen of coal mines is called *Fire Damp*; carbonic acid is termed *Choke Damp*.

DA'NCING (Germ. tanzen), may be defined to be a graceful movement of the figure, accompanied by gestures and attitudes indicative of certain mental emotions, and by measured steps in harmony with a piece of music arranged for the purpose. The great antiquity of dancing is attested by history, both sacred and profane. It consisted at first, probably, of nothing more than gesticulation and moving in a procession; in which sense it formed part of the celebration of the religious rites of the ancient Hebrews and Egyptians. But the Greeks, who are confessedly indebted to the Egyptians for the elements of their religion and literature, though these were afterwards refined by them to such a degree as nearly to obliterate all traces of their origin, soon polished and improved these sacred rites, and introduced them into all the festal ceremonies of which their elegant mythology was composed. In this they were, as usual, imitated by the Romans. If we believe Scaliger, the early bishops of the church were styled *præsules*, because (as the word literally implies) they led off the dance at their solemn festivals; and this practice continued in the church till the 12th century. Almost every country can boast of national dances peculiar to the inhabitants; which it is rare to see so well performed when adopted by others. Of these the best known to us are the *tarantella* of the Neapolitans, the *bolero* and *fandango* of the Spaniards, the *mazourek* and *krakowiaque* of Poland, the *cosaque* of Russia, the *redowac* of Bohemia, the *quadrille* and *cotillon* of France, the *waltz* and *gallopade* of Germany, and the *reel* of Scotland.

DA'NEGELT. A tribute of twelve pence laid by the Danes upon the Anglo-Saxons upon every hide of land throughout the realm.

DA'NNEBROG. An ancient Danish order of knighthood, supposed to have been founded in 1219; revived in 1693, and re-constituted in 1808.

DANS. Small trucks or sledges used in coal mines.

DA'PHNE. (Gr. Δαφνη.) In Grecian Mythology, a nymph of Diana, the daughter of the river god Peneus. She was beloved by Apollo; but she resisted all his attempts to excite in her a mutual attachment, and at last betook herself to flight. On being hotly pursued by the god, she invoked the earth to swallow her up, when her prayer was granted, and she was immediately changed into a laurel tree, which was ever after sacred to Apollo, and regarded as the symbol of fame and glory. (*Ovidi. Met.* l. x.)

DA'PHNIA. A genus of the Entomostracous or lower-organized Crustaceans, belonging to the order *Branchiopoda*, and the section *Lophyropoda*. The most common species and type of this genus, *Monoculus pulex* of Linnæus, is a favourite and interesting microscopic object. Its body is compressed, oval, and inclosed in a large bilobed carapace; the two lobes being connected together along the back and open below, resembling a bivalve shell. The head is prolonged into a snout, and provided with a single central compound eye. The chief organs of swimming are the modified antennæ, which have a long basal joint, supporting two jointed branches beset with long bristles. It is by the sudden contraction of these organs that the little animalcule propels itself through the water by a series of jerks. The true legs are ten pairs, very small, having a respiratory vesicular organ attached to the second joint; the first eight pairs have the terminal joint dilated and hairy. The eggs are incubated in a kind of marsupial pouch, situated towards the dorsal aspect of the lower end of the body: in five days the young are excluded. The *Daphnia pulex* is extremely prolific; and as it assumes a rose-red colour in summer time, the swarms which abound in stagnant water often impart to it so deep a colour as to give rise to a suspicion and popular belief that it is occasioned by blood.

DA'RIC. A Persian gold coin (so called by the Greeks, from Darius, the name of several Persian sovereigns), having upon the obverse an archer crowned and kneeling upon one knee, and on the reverse a quadrata incusa, or deep cleft. The weight of the daric is about 130 grains.

DAROO' TREE. The *Ficus sycamorus*, or Egyptian sycamore.

DA'RTER. Certain web-footed birds of the Pelican family are so called. *See* PLOTUS.

DASH. (Etym. uncertain.) In Music, a small mark, thus ', denoting that the note over which it is placed is to be performed in a short and distinct manner.

DA'SYPRO'CTA. (Gr. δασυς, *hairy*, and πρωκτος; Lat. anus.) The subgeneric name applied by Illiger to the *Agouti* and *Acouchi*, which before were included in the great genus *Cavia* of Linnæus.

DA'SYPUS. (Gr. δασυς, and πους, *a foot*.) A name originally and very appropriately applied by the Greeks to the hare, but transferred by Linnæus to the genus including the Armadillos. This genus is subdivided in modern systems into *Dasypus* proper, *Tatusia*, and *Priodon*. The remains of a gigantic extinct animal of the armadillo kind has recently been discovered in South America, and called *Glyptodon*. See that word.

DA'SYURE. (Gr. δασυς, and ουρα, *a tail; hairy-tailed*.) The name of a genus of Carnivorous Marsupials, comprehending those which have hairy tails combined with digitigrade feet, and a dental formula of—incisores $\frac{8}{6}$, canini $\frac{2}{2}$, molares spurii $\frac{4}{4}$, molares veri $\frac{8}{8} = 42$.

DA'TA. (Lat. *things given*.) A term used in geometry to denote certain things or quantities determined by the conditions of the problem, and at the same time known or assignable. According to Simson (Preface to *Euclid's Data*), a thing is said in general to be given which is either actually exhibited or can be found out;

that is, which is either known by hypothesis or can be demonstrated to be known; so that in the analysis or investigation of a problem, from the things that are laid down to be known or given, by the help of known propositions other things are demonstrated to be given, and from these other things are again shown to be given, and so on, until that which was proposed to be found out in the problem is demonstrated to be given. When this is done the problem is solved, and its composition is made and derived from the compositions of the data which were made use of in the analysis.

In the language of the ancient mathematicians, geometrical quantities are given in *species*, *magnitude*, or *position*. Thus, a triangle is given in *species* when its three angles, or the ratios of its sides, are known. A straight line is given in *magnitude* when we know its length, or the area of a triangle of which the three sides are given. And lastly, a line is given in *position* when we know its inclination to another given line. The *Book of Data*, ascribed to Euclid, is the first in order of the ancient treatises on the geometrical analysis. There are numerous editions of this work. Those of Simson and Horsley are the best.

DATE. In Diplomatics, the notation of the time and place of the delivery or subscription of an instrument. The word is derived from the common formula at the foot of instruments, "datum" or "data," *given* at such a place and time. Dates of time are distinguished into definite and indefinite. The former mark specially the year, and sometimes the month, day, &c.; the latter only contain a general reference to some period of time. Thus many instruments of the earlier part of the middle ages are dated only "*Regnante Domino nostro Jesu Christo;*" and very often the date contained only mention of the reigning prince, without reference to the years of his reign. Definite dates are various in ancient charters and deeds. The Christian Greeks dated generally, down to the fall of Constantinople, by the year of the world; beginning their year at the 1st of September. The date used in the oldest Latin charters is commonly that of the Indiction (*see* INDICTION), which is also frequently added in the Greek. The Christian era (under the several names of year of grace, of the incarnation, of the reign of Christ, of the nativity, &c. &c.) began to be in common usage in royal charters in France about the reign of Hugh Capet; in Spain and Portugal not until the 13th and 14th centuries. In England, the Saxon kings frequently dated by the incarnation; but deeds and charters under the Plantagenet kings generally bear the year of the reigning prince.

DA'THOLITE, or DATOLITE. A mineral composed of silica, lime, and boracic acid; a borosilicate of lime. It occurs in Norway, in the Tyrol, and in the Hartz. It becomes opaque when heated.

DA'TIVE CASE. (Lat. dativus, from do, *I give.*) That inflexion of a noun which denotes participation in the action of the verb which accompanies it. *See* GRAMMAR.

DATU'RIA. The poisonous principle of the *Datura stramonium.* It belongs to the class of crystallizable alkaloids.

DAU'PHIN. The well-known title of the heir apparent to the crown of France, before the Revolution, was that of the counts or lords of Vienne in Dauphiné, from the 12th century, or an earlier period: its origin cannot be ascertained. From the last male of that ancient house the title passed to his heirs, the house of Burgundy; and from them to the family of La Tour Dupin, of whom Humbert II. surrendered his principality in 1349 to Charles, grandson of Philip of Valois: from which period the principality of Dauphiné continued to be the apanage, and the title of Dauphin the appellation, of the king's eldest son. The name of the province is derived from the title of its lords.

DA'VIT. A piece of timber used in managing the anchor.

DA'VITE. A name given to a fibrous sulphate of alumina found in a warm spring near Bogota, in Columbia.

DAVY'NE. A white or brown crystallized mineral found in cavities of some of the lapideous masses ejected by Vesuvius.

DAY (Lat. dies; Germ. tag.), in its most common acceptation, denotes the interval of time during which the sun remains above the horizon; and is opposed to *night*, which denotes the time the sun is below the horizon. In this sense it is sometimes called the *artificial day*. But the term day is also generally used to denote the time in which the earth makes a complete revolution with respect to the celestial bodies, and consequently expresses different intervals, according as the body with which the earth's rotation is compared is fixed or moveable.

The *Astronomical* or *Solar Day*, called also the *Apparent Day*, is the time that elapses between two consecutive returns of the same terrestrial meridian to the centre of the sun. Astronomical days are not of equal length, for two reasons: 1st, the unequal velocity of the earth in its orbit, in consequence of which the apparent daily motion of the sun is greater in winter than in summer; and 2d, the obliquity of the ecliptic, in consequence of which the sun's apparent daily motion in right ascension (that is, in the plane of the earth's equator) is less at the equinoxes than at the tropics. The astronomical day commences at noon, and is counted on, through the 24 hours, to the noon following.

The *Civil Day*, or *Mean Solar Day*, is the time employed by the earth in revolving on its axis, as compared with the sun, supposed to move at a *mean* rate in its orbit, and to make 365·2425 revolutions in a mean Gregorian year. In this mode of reckoning time, the days are all of the same length; and noon, or any given hour of the civil day, sometimes precedes and sometimes comes after apparent noon, or the corresponding hour of the astronomical day. Most nations, at least in modern times, have agreed in placing the commencement and termination of the civil day at mean midnight.

The *Sidereal Day* is the time that elapses between two successive culminations of the same star. This interval of time has always remained of the same invariable length, as is proved by the most ancient astronomical observations. It is divided into 24 sidereal hours; and these are again subdivided into sidereal minutes and seconds. This mode of reckoning time, during the day, is now universally adopted by astronomers in their observatories; although the commencement of the day is still determined by the apparent culmination of the sun.

DE'ACON. (Gr. *διακονος, a minister or servant.*) A minister of religion, holding, in Protestant churches, the lowest degree in holy orders. The first appointment of deacons is mentioned in Acts vi., where the Apostles direct the congregation to look out seven men of honest report, upon whom they may lay their hands. Their office at this time seems to have been chiefly the care of the poor and the distribution of the bread and wine in the love feasts. We learn, however, from the example of Philip, Acts viii., that they also had authority to preach. In the English church it is customary to require a candidate for deacon's orders to have completed his 23d year. As a deacon he is not capable of holding any benefice, and may only officiate as a curate, chaplain, or lecturer. It is generally understood that a deacon may not read the Absolution: he may not administer the sacrament alone, but in assisting the priest may offer the cup to the communicants.

DEAD BEAT. In Clock-work (called also *dead scapement*, or *scapement of repose*), a peculiar kind of scapement invented by Mr. George Graham about the year 1700, with a view to lessen the effect of the wheel work on the motion of the pendulum; and acquired its name from the circumstance that the seconds' index stands still after each drop, whereas the index of a clock with a *recoiling* scapement is always in motion, hobbling backward and forward. *See* HOROLOGY.

DEAD LIGHTS. Strong wooden posts or shutters put over the glass windows of the cabin in bad weather, as a defence against the sea.

DEAD RECKONING. A term used in navigation to express the estimation that is made of a ship's place without having recourse to observation of the celestial bodies. It is made by observing the way she makes by the log, and the course on which she has been steered, making allowance for drift, leeway, &c.

DEAD WATER. The water that closes in with a ship's stern.

DEA'FNESS. An imperfection of the sense of hearing, arising from a variety of causes, some of which are inexplicable and incurable, and others ascertainable and susceptible of relief or entire removal. When the organ of hearing is imperfect in its functions, either at birth or in childhood, dumbness or imperfect articulation attends it; for speech is an imitative faculty, and an infant born deaf, cannot attempt those motions of the organs of voice which gradually attain perfection by practice: he consequently becomes incapable of communicating his ideas through that medium.

The external ear, though tending by its form and situation to improve and perfect the sense of hearing, is in no way necessary; for it may be cut off without producing deafness. A common cause of deafness arises out of imperfections or obstructions in the passage leading from the external ear down to the membrane of the tympanum. This passage is partly cartilaginous and partly bony; and from its oblique direction it is difficult so to see into it as to ascertain the seat or cause of the obstruction. In some persons, however, when placed in a proper position, so that the sunshine or other strong light may be properly directed into it, a little management enables us to examine nearly its whole extent. In some cases of congenital deafness this passage is closed by a membrane, which, if near the external orifice, is easily detected, and may be divided or removed; but, if deeply seated, it may escape observation till the child attains a certain age, or should begin to talk: for till that time the deafness of infants often passes unobserved. Under these circumstances, and where the malformation exists in both ears,

the child will be dumb as well as deaf; for although the organs of speech may be perfect, if those of hearing are inert he is incapable of imitating sounds: in this case, therefore, a timely operation may effect the double benefit of giving both hearing and speech. Where the passage to the tympanum is more extensively obliterated or malformed, the cases become of course more complicated, but yet often admit of entire cure by a skilful and timely operation.

The presence of foreign bodies in the aural passage is a common cause of imperfect hearing, and sometimes it is obstructed by accumulations of hardened wax. These causes of deafness may in most cases be relieved or removed by syringing the ear with warm water, which should be forcibly injected, and so directed as to reach the membrana tympani. Insects or worms in the ear may be washed out in the same way, or killed by the introduction of a few drops of olive oil, or of camphorated oil.

Another cause of deafness is deficient secretion of wax, occasioning a dryness of the tube of the ear. It is relieved by greasy applications, and by the cautious use of stimulants, such as olive oil, to which a few drops of oil. of turpentine, or of compound camphor liniment, or of spirit of ammonia, have been added.

In cases of inflammation of the tympanum followed by suppuration, more or less deafness ensues, dependent upon the extent of the mischief going on, and requiring prompt, and generally antiphlogistic treatment: the pain, especially at the outset of the disorder, is often intense, and the discharge purulent and often offensive.

Lastly, hardness of hearing often appears to depend upon imperfection in the functions of the auditory nerve, and from obstructions in the Eustachian tube. The deafness that attends a violent cold is frequently dependent upon the latter cause, and goes off as the secretions of the part return to their natural state.

DEAL. (Sax. delan, *to divide.*) In Architecture, the small thicknesses of timber into which a piece of timber of any sort is cut up; but the term is now improperly restricted in its signification to the wood of the fir tree cut up into thicknesses in the countries whence deals are imported, — viz. Christiana, Dantzic, &c. Their usual thickness is three inches, and their width nine. They are purchased by the hundred, which contains 120 deals, be their thickness what it may, and reduced by calculation to a standard thickness of one inch and a half, and a length of twelve feet. *Whole deal* is that which is one inch and a quarter thick, and *slit deal* is half that thickness.

DEAN. (Lat. decanus.) An ecclesiastical dignitary in cathedral and collegiate churches, being the head of the chapter of canons or prebendaries, and forming together with them a council to advise the bishop in the affairs of his see. (*See* CHAPTER.) In England there are, properly speaking, three classes of ecclesiastical presidencies to which the title dean belongs; deans rural, deans of cathedrals, and deans in peculiars. Rural deans were originally beneficed clergymen appointed by the bishop to exercise a certain jurisdiction in districts of his diocese remote from his personal superintendence. They seem to have been equivalent in many respects to the chorepiscopi of the early church, and many parts of their office are now discharged by the archdeacons. By degrees this office fell into disuse; and though rural deans are still occasionally employed in visitations, to examine into the state of repair of churches, and performance of divine service, their functions have for many years become almost obsolete. Deans of cathedrals have already been noticed. The third species of deans, or deans in peculiar, are those of "particular parishes and churches, or rural districts that have jurisdiction within themselves, and are not under the ordinary of the diocese." These peculiars are of different kinds; and their functions consist sometimes of jurisdiction united to spiritual cure, as the dean of Battel in Sussex, and sometimes of jurisdiction only, as in the case of the Dean of the Arches, London.

DEATH WATCH. *See* ANOBIUM.

DE'BACLE. (Fr. debacler, *to unbar.*) A rush of waters, breaking down all opposing barriers, and carrying away and dispersing the broken fragments of rocks.

DEBE'NTURE. A custom-house certificate entitling the exporter of goods to a drawback or bounty. Also, an instrument in use in some government departments, by which government is charged to pay to a creditor or his assigns the sum found due on auditing his accounts.

DEBRI'S. (Fr.) In Geology, the fragments of rocks, &c.

DEBT, in Law, is a species of contract, whereby a *chose in action*, or right to a certain sum of money, is mutually acquired and lost: usually divided into debts of record, debts by special contract, and debts by simple contract. A debt of record is a sum which appears to be due, by the evidence of a court of record; such as debt on judgment or recognizance. Debt by specialty is where a sum is acknowledged to be due, or becomes due, by instrument under seal; such as a covenant, bond, &c. Both these species of debts, being contracted by a man or himself and his heirs, attach on his lands and tenements, and bind them in the hands of his heir or devisee. Debt by simple contract is either by parole or by written obligation unsealed; within which class fall bills of exchange and promissory notes.

DEBT is also a personal action of contract, in which the plaintiff seeks the recovery of a debt; *i. e.* a *liquidated* or certain sum of money alleged to be due to him. *See* ACTION.

DEBT, NATIONAL. *See* NATIONAL DEBT.

DEBUT (Fr.), in its most general acceptation, is applied to the commencement of any undertaking, or to the first step made in a public career; but it is confined more particularly to the language of the theatre, in which it signifies the first appearance of an actor, or his first appearance on any particular stage.

DE'CADE. (Lat. decas, from Gr. δεκα, *ten.*) A word used by some old writers in a general sense for the number ten, or an enumeration by tens; but more peculiarly appropriated to the number of books into which the history of the Roman Empire by Livy is divided, each division consisting of ten books or *decades*. It was also the name given to the space of ten days, which in the French republican calendar was substituted for the ordinary week. The tenth or last day was termed *decadi*. Thus, except in bissextile years, the whole number of decades was thirty-six and a half: the days of the half decades, falling at the close of the year, were at one time called *sansculottides*, and afterwards *complementary;* and dedicated respectively to Virtue, Genius, Labour, Opinion, and Recompence.

DE'CAGON. (Gr. δεκα, *ten*, and γωνια, *an angle.*) A geometrical figure, having ten sides and ten angles. If the sides and angles are all equal, the figure is a regular decagon, and inscribable in a circle. Euclid, in the Fourth Book of his *Elements*, shows that the side of a regular decagon is equal to the greater segment of the radius of the circumscribing circle divided by a medial section, or so that the rectangle contained by the whole radius and one of the parts is equal to the square of the other part; consequently, if we denote the radius by r, and the side of the decagon by s, we shall have the proportion $r : s :: s : r - s$; whence $s^2 + rs = r^2$, and by solving the quadratic $s = \frac{1}{2} \cdot r\,(\sqrt{5} - 1)$. If the radius is unit, $s = \frac{1}{2} \cdot (\sqrt{5} - 1) = \cdot 618034$; and the area $= 7 \cdot 694209 \times s^2$, or 7·694209 of the square of the side.

DE'CALOGUE. (Gr. δεκα, *ten*, and λογος, *discourse* or *catalogue.*) The commandments which were delivered by God to Moses upon Mount Sinai (Exod. xx.) That their number was understood by the Jews to be ten appears from Exod. xxxiv. 28.; but they differed from us in the manner of dividing them, considering our two first as one, and separating the last into two. The same method is adopted by the Romish church, professing to follow the authority of St. Augustine. (See *Catechism. ad Parochos.*)

DE'CA'MERON. (Gr. δεκα, *ten*, and ἡμερα, *day.*) The name given by Boccaccio to his celebrated collection of tales: they are supposed to be narrated in turn, during ten days, by a party of guests assembled at a villa in the country to escape from the plague which raged at Florence in 1348.

DECA'NDROUS. (Gr. δεκα, and ανηρ, *a male.*) A plant having ten stamens.

DECANTA'TION. The pouring off a clear liquid from its subsidence or residue; it is often resorted to in the chemical laboratory instead of filtration, the clear supernatant liquor being poured or syphoned off from precipitates, which may thus be repeatedly washed or edulcorated, so, as to free them from all soluble matters.

DECAPITA'TION. (Lat. decapitare, *to behead.*) A mode of punishment of great antiquity, having been practised by the Jews, Greeks, and Romans, and some other ancient nations. Among the Continental nations of modern times, it has long been the ordinary punishment inflicted on all capitally convicted criminals. During the early period of English history, it was the usual mode of punishing felons; but it afterwards became a punishment appropriated only to criminals of the highest rank, and even to this day it is considered as the most honourable death which a capital offender can undergo. The last instance of the infliction of this punishment in England occurred in 1745, soon after the rebellion in Scotland had been quelled.

DE'CAPOD, *Decapoda.* (Gr. δεκα, and πους, *a foot; ten-footed.*) A name applied by Dr. Leach to a tribe of Cephalopods, including those which have ten locomotive and prehensile appendages proceeding from the head; two of which are always longer than the rest, and are called tentacles. Also applied by Cuvier to designate an order of Crustaceans, comprehending those which have ten thoracic feet.

DECA'PTERY'GIANS, *Decapterygia.* (Gr. δεκα, *ten*, and πτερυξ, *pinion.*) A name given by Schneider to an artificial division of fishes, including those which have ten fins.

DE'CARBONIZATION OF CAST IRON. This process is resorted to in order to convert cast iron into

steel, or by a further decarbonization to reduce it to the state of malleable iron; hence, many articles which were formerly exclusively manufactured of wrought iron are now cast, and afterwards decarbonized, such as horse-shoes, &c.; and in other cases various cutting instruments are cast, and afterwards brought to a proper hardness by a similar process. The articles to be decarbonized are packed in finely powdered hæmatite, or native oxide of iron, and exposed for a sufficient time to a high red heat. It is often necessary to mix iron filings or turnings with the hæmatite: these substances, thus applied, gradually abstract the excess of carbon in cast iron, and reduce it to a state analogous to that of steel; or, by a longer continuance of heat, to that of soft iron. In some cases, however, the process seems rather to affect the texture and mechanical properties than the composition of the iron, and is therefore more analogous to annealing.

DE'CASTYLE. (Gr. δεκα, *ten*, and στυλος, *a column.*) In Architecture, a building having ten columns on a front or flank.

DE'CASYLLA'BIC, having ten syllables. In the German and English languages the ordinary heroic verse is decasyllabic; but a short syllable is sometimes added at the end by way of variety, and this, in consequence of the structure of those languages, takes place more frequently in the former than the latter. In the Italian heroic verse the eleventh syllable is almost uniformly added, and hence it is more properly to be termed an *hendecasyllabic*. In French versification the decasyllabic line is appropriated to light compositions, especially tales.

DECE'MBER (Lat. decem, *ten*), was the tenth month in the calendar of the ancient Romans, who began the year with March.

DECE'MVIRI. (Lat. *ten men.*) Properly any body of ten men appointed for particular purposes. But that which is especially known by this name was the commission elected from the Roman patricians in the 302d year after the foundation of the city, and invested with all the supreme powers of the state, for the purpose of drawing up a body of laws founded, according to Roman tradition, on the most approved institutions of Greece. They presented to the people a number of laws engraved on ten tables, containing a summary of the privileges to be enjoyed by the people, and the crimes to be punished, &c. At the same time they informed the people that their plan was incomplete; and accordingly a new commission, to which the plebeians were admitted, was appointed for the next year, with the same powers; the result of which was the addition of two more tables to the former ten, thus making up the famous twelve tables, which were the foundation of all Roman law in subsequent times. The second decemvirate did not demean itself with the same moderation as the first, but sought to prolong its power, and at the same time proceeded to some violent acts of despotism, which so exasperated the people as to make its dissolution necessary.

Besides these extraordinary commissions, there was a body of decemviri chosen for judicial purposes, to preside over and summon the centumviri, and to judge certain causes by themselves. There were likewise decemviri appointed from time to time to divide lands among the military.

DECE'PTIVE CA'DENCE. In Music, a cadence in which the final close is avoided by varying the final chord.

DECI'DUOUS. (Lat. decido, *I fall off.*) In Zoology, a term applied to parts which have but a temporary existence, and are shed during the life-time of the animal, as certain kinds of hair, horns, and teeth.

Deci'duous is applied, in Botany, to plants whose leaves fall off in the autumn, in contradistinction to evergreens.

DE'CIMAL ARI'THMETIC, is the common system of arithmetic, in which the scale of numbers proceeds by tens. *See* Arithmetic.

DE'CIMAL FRACTIONS, are fractions which have for their denominator 10, 100, 1000, &c., or in general some power of 10. The use of decimal fractions is merely an extension of the ordinary scale of arithmetical notation. Setting out from the unit's place, the first figure to the left (in the expression of any whole number) denotes so many tens, the second to the left so many hundreds, the third so many thousands, and so on; so that in the number 765, for example, each unit of the 6 is the tenth part of each unit of the 7, and each unit of the 5 a tenth of each unit of the 6. In like manner, in the expression of a decimal fraction, setting out from the unit's place, the first figure to the right expresses so many tenth parts, the second to the right so many hundredth parts, the third so many thousandths, and so on; so that each figure, as before, expresses parts, which are each ten times smaller than those expressed by the figure immediately preceding. By expressing fractions in this manner, the operations of addition, subtraction, multiplication, and division are exactly the same as in integer numbers.

In order to distinguish the integral from the fractional part of a numerical expression, a point or comma is placed between them. Various marks have been used for this purpose at different times; but the point is now most commonly employed, and, according to the practice of Sir Isaac Newton, it should always be placed near the top of the figure, thus 2·46, which prevents it from being confounded with the ordinary marks of punctuation.

Decimal fractions appear to have been introduced by Regiomontanus, about the year 1464; but Stevinus was the first who wrote an express treatise on the subject in his *Practique d'Arithmetique*, published in 1582. They are now universally employed in all arithmetical calculations; and it is much to be regretted that a decimal division of weights, measures, money, &c. has not been adopted in all civilized countries, by which the reduction of fractional parts from one scale to another would be obviated, and all the applications of arithmetic to the ordinary purposes of life greatly simplified. A subdivision of weights and measures on this principle was adopted in France at the time of the Revolution, but has not been imitated by other countries.

DECIMA'TION. (Lat.) In Roman History, the selection by lot of one man out of every ten, who was put to death as an example to, or satisfaction for, the rest. If an army, legion, or century, as the case might happen, had quitted its post, raised a mutiny in the camp, or otherwise failed in its duty, it was assembled before the general; the lots were cast into an urn; as many were drawn as formed the tenth part of the number of the offenders, and the unlucky drawers were put to the sword. This practice has been occasionally recurred to in modern times; as by the Spanish general Cuesta, after the battle of Talavera.

DECLAMA'TION (Lat. declamatio), signified, among the ancients, the art of speaking indifferently upon both sides of a question: a species of intellectual exercise resorted to by the rhetoricians of Greece and Rome, as the best means of acquiring facility in public speaking. In modern times the meaning of *declamation* is different in different countries. In Germany, and in most parts of the Continent, it is often used in a sense nearly synonymous with *recitative*. In France and England, especially the latter, it is sometimes applied to any grand oratorical display, either in the pulpit, at the bar, in the senate, or on the stage, in which the voice, gesticulation, and the whole delivery of the speaker are in perfect keeping with the subject matter of his address. But it is employed most usually in a disparaging sense, to indicate the use of forced emphasis, inflated language, and violent gestures to withdraw the attention of the auditors from the weakness or fallacy of the reasoning. *See* Eloquence.

The Romans employed the term *declamare* only in the sense of *to plead* or *practise at the bar*, as in the verse of Horace (*Epis*. 2. 2.), —

Dum tu declamas Romæ;

but that they at the same time assiduously cultivated the art of declamation in the sense of recitation, is evident from the following couplet, in which Martial has happily illustrated the great importance of a good delivery: —

Quem recitas meus est, O Fidentine, libellus;
Sed male quum recitas, incipit esse tuus.

DECLARA'TION. In Law, a legal specification, on record, of the cause of action, by a plaintiff against a defendant. *See* Pleading.

DECLE'NSION. (Lat. declinatio, from declino, *I deflect.*) In Grammar, the changes of termination in nouns, corresponding to the various relations in which substances are conceived to stand. *See* Case and Grammar.

DECLINA'TION CI'RCLES, are small circles of the sphere, parallel to the equator, in which the stars perform their apparent diurnal revolutions.

DECLINA'TION OF A CELESTIAL BODY, is the angular distance of the body north or south from the equator, and is measured on the great circle which passes through the centre of the body and the two poles, and is consequently perpendicular to the equator. The place of a star in the heavens is determined by means of its *right ascension* and *declination*; the *right ascension* being the angular distance, measured on the equator, between the first point of Aries and the point in which the meridian of the star intersects the equator. Right ascension and declination thus correspond to longitude and latitude on the surface of the earth. In the analytical theory of the planets it is often necessary to define the place of a planet or comet with reference to the ecliptic, or plane of the earth's annual motion; and the early astronomers unfortunately adopted for this purpose the terms *longitude* and *latitude*, which, as the same terms are appropriated to terrestrial objects in a different sense, is the cause of considerable embarrassment to beginners. The student of astronomy must therefore remember that in speaking of celestial objects, declination and right ascension have

reference to the *equinoctial*, or plane of the earth's diurnal rotation; while *latitude* and *longitude* refer to the *ecliptic*.

The declination of a star is said to be *north* when the star is north of the equator, and *south* when the star is south of the equator.

DECLINA'TION OF THE MAGNETIC NEEDLE. The axis of a magnetic needle, that is, the straight line which joins its poles, does not coincide with the astronomical meridian, but deviates from it more or less, sometimes towards the west, and sometimes towards the east. This deviation is called the *Declination of the Needle*.

It was formerly imagined that the magnetic needle, when freely suspended, took a direction exactly north and south at all places on the earth; and Columbus is said to have been greatly astonished when he observed, in his memorable voyage for the disoovery of the New World, in 1492, that the needle of his compass did not point to the true north. The same fact was observed by Sebastian Cabot about the year 1500; but notwithstanding its great importance to mariners, the first tables showing the amount of the declination at various places were only prepared in 1599 by the Dutch navigators at the orders of the Prince of Nassau. In 1622, Gunter, professor of geometry at Gresham College, made the important discovery that the declination is not constant. He found it to be 6° 13′ to the east at London in that year; whereas in 1580 it had been observed by Robert Norman to be 11° 15′ also to the east.

The following table of observations, made at Paris, will be sufficient to give an idea of the changes which the declination of the needle has undergone at different epochs:—

Years.	Declination.	Years.	Declination.
1580	11° 30′ East.	1805	22° 5′ West.
1618	8 0	1813	22 28
1663	0 0	1814	22 34
1678	1 30 West.	1817	22 19
1700	8 10	1819	22 29
1767	19 16	1822	22 11
1780	19 55	1824	22 23
1785	22 0	1825	22 22

From this table it appears that since 1580 the declination has varied more than thirty degrees. In 1663 it vanished. From the date of the first observations till 1820, it has advanced progressively westward; but since that time it appears to have assumed a retrograde movement towards the east. (*Pouillet, Elemens de Physique*, t. i. p. 462.)

DECOLLA'TION. (Lat. de, *off*, and collum, *the neck*.) A word synonymous with *beheading;* used chiefly in reference to the decapitation of John the Baptist, to the festival instituted by the Romish church in his honour, and to the celebrated picture of Mabuse (*Walpole's Anecdotes of Painting*, vol. i. p. 82.), which represents this subject. This word is used by Fabyan so far back as the year 1350.

DECOMPOSITION, CHEMICAL. When compounds are resolved into their elements, or when the chemical constitution of substances is altered, they are said to be decomposed; and when, in this operation, new products are formed, such products are called the *results of decomposition*. Thus, *ammonia* is the result of the decomposition of most animal substances; *carburetted hydrogen gas* is the result of the decomposition of pit-coal, &c.

Chemists use the terms *simple* and *compound*, or *single* and *double* decomposition, to distinguish between the less and more complicated cases. When a compound of two substances is decomposed by the intervention of a third, which is itself simple, or which acts as such, the case is one of simple decomposition: water, for instance, is a compound of oxygen and hydrogen. When the metal potassium, which is a simple body, is thrown into it, it is decomposed; the hydrogen is liberated in the form of gas, and the oxygen combines with the potassium to form potassa. Such a case is often tabularly represented as follows; and the annexed numbers are the *equivalents* of the acting bodies, or the respective weights which are required for perfect decomposition.

Water 9. { Hydrogen 1.
Oxygen 8 + potassium 40. }

Potassa 48.

This shows that when 9 parts by weight of water are decomposed by 40 parts of potassium, 48 parts of potassa (or oxide of potassium) are formed, and 1 part of hydrogen liberated.

When two new compounds are produced, the result is called *double* or *complex* decomposition. Thus, when potassa (composed of potassium and oxygen) and hydrochloric acid (composed of hydrogen and chlorine) react upon each other, chloride of potassium (composed of chlorine and potassium) and water (composed of hydrogen and oxygen) are the results. These, with their respective *equivalents*, are shown in the following diagram.

Water 9.

Hydrochloric acid 37. { Hydrogen 1 + oxygen 8.
Chlorine 36 + potassium 40. } Potassa 48.

Chloride of potassium 76.

This table, therefore, shows that 37 parts by weight of hydrochloric acid and 48 of potassa produce, by mutual decomposition, 76 parts of chloride of potassium and 9 of water.

A knowledge of the mutual decomposing powers of different substances, or, in other words, of their relative affinities, constitutes the skill of the practical chemist. See in reference to this subject the articles AFFINITY, EQUIVALENTS, and the general article on CHEMISTRY.

DECO'MPOSI'TION OF FORCES. In Mechanics, signifies the same thing as the *Revolution of Forces*. Any force whatever may always be decomposed or resolved into several others, the resultant of which is equal to the given force. For example, a force represented in intensity and direction by the diagonal of a parallelogram, may be resolved into two others of which the intensities and directions are respectively represented by the sides of the same parallelogram. *See* COMPOSITION OF FORCES.

DECO'MPOSI'TION OF LIGHT. The separation of a beam of light into the different rays which exhibit the prismatic colours. *See* LIGHT.

DE'CORATION. (Lat. decorare, *to adorn*.) In the Fine Arts, adornment, ornament, embellishment. It is a combination of ornamental objects, which a desire for variety brings together in all sorts of forms for embellishing those subjects which are the objects of art. The decoration of any work should be confined strictly to the development of impressions which the mass itself is intended to create; its object being merely to multiply the relations it has, by presenting new images which spring from the original bare design. Decoration in all the arts, except on particular occasions, should be used with a sparing hand. Once commenced it becomes difficult to know when to cease.

DECOY. A device by which aquatic birds, chiefly ducks, are enticed from a river or lake, up a narrow winding canal or ditch, which, gradually becoming narrower, at last terminates under a cover of net work of several yards in length. The birds are enticed by the smoothness of the turf on the margin of the canal, which tempts them to leave the water, and begin to dress their plumage. When so engaged at some distance up the canal, they are suddenly surprised by the decoy man and his dogs, who have been concealed behind a fence of reeds; and having again taken the water, they are driven up by the dogs till they enter within the net work which terminates the decoy, and are then readily caught.

DECRE'E, *Decretals*. (Lat. decerno, *I decide*.) Decreta or decrees, in the Civil Law, are the decisions of emperors on cases submitted to them, forming a part of their constitutions. Decretals were the decrees of popes, having the same authority in canon law as decrees in civil. They retained this authority in most Catholic countries until the 14th century. Several compilations of them are in existence. The false decretals of Isidore, a spurious collection framed with a view to extend the papal power, profess to contain the decrees of popes during the first three centuries: they were forged in the 9th.

DECREE. In Law, the judgment of a court of equity on any bill preferred. Either party may petition the court for a re-hearing, before it is signed and enrolled. After that form has been gone through, a bill of review may be had upon apparent error in judgment on the face of the decree. It may also be appealed against in the House of Lords. In Scottish law, various legal judgments and sentences are styled *decreets*.

DE'CREMENT. (Lat. decresco, *I decrease*.) The small part by which a variable quantity becomes less and less. It is opposed to *increment;* but these terms are now seldom used by mathematicians.

DECRE'PITATION. (Lat. decrepito, *I crackle*.) The crackling noise which common salt and many other substances make when thrown into the fire.

DECU'RION. The Latin name for the commander of ten men. A military decurion was a cavalry officer, who originally commanded ten soldiers, or one third of a turma; but afterwards the same name was preserved, though the command was extended to the whole turma. Municipal decurions were magistrates in the municipal towns, answering to senators at Rome. In later times also certain officers of the imperial household used this title; as decurions of the chamberlains, &c.

DECUSSA'TUS, *Decussate*. Applied to the arrangement of bodies in pairs that alternately cross each other; as the leaves of many plants.

DEDICA'TION. (Lat.) In Literature, a complimentary address to a particular person, prefixed by an author to his work. Dedications arose out of the dependent situation in which authors have too frequently been placed in reference to their powerful or wealthy patrons; and, at no very distant time, were often rewarded by pecuniary presents. The custom of dedicating works was in use at a very early period. The brightest ornaments of Roman literature, Horace, Virgil, Cicero, and Lucretius, were among the number of those who practised it. At the period of the revival of letters in Europe, few works were published without dedications; many of which are remarkable for their elegance and purity of style, and from the interesting matter which they contain are of far more value than the treatises to which they are prefixed. But the practice became gradually perverted; and many of the authors of the succeeding generations employed them chiefly with the view of securing the patronage of the great. Dedications were most abused in France under Louis XIV., and in England from 1670 to the accession of George III. Dryden was a great dedicator, and Johnson wrote dedications for money. Corneille got 1000 louis d'ors for the dedication of *Cinna*. Some of the most beautiful dedications with which we are acquainted are those prefixed to the different volumes of the *Spectator*, by Addison; and in more recent times the poetical dedications with which each canto of Sir Walter Scott's *Marmion* is prefaced. A complete history of dedications would prove a valuable accession to modern literature, as they would throw a flood of light upon the history, character, and attainments of many distinguished persons which are now involved in obscurity. A few such works are in existence; but they are only accessible to the learned. See *De Dedica. Lib. vet. Lat.* by Walch. (Leip. 1715.) *Commenta. de Dedica. Lib.* by Tacke. (Wolfenbüttel, 1733.)

DE'DIMUS POTESTA'TEM. In Law, a writ or commission given to one or more private persons, for the speeding an act appertaining to a judge or some court. When the commission of the peace is renewed, a writ of dedimus potestatem is issued out of chancery, directed to some ancient justice, to swear in a justice newly inserted.

DEED. A deed, in Law, is a writing sealed and delivered by the parties. If made by one party only, it is termed a deed poll; if by several, an indenture. The formal parts of a deed of conveyance are, first, the date and names of the parties; secondly, the recitals, in which the intention of the parties and former transactions with reference to the same property are recounted, so far as necessary; then the operative part. This expresses, first, the consideration for which the deed is made (which for many sorts of deeds is now merely nominal); then the conveyance by and to the several parties; then the parcels, or description of the tenements and their legal adjuncts; then what is termed the habendum, beginning with the words "to have and to hold," expressing the quantity of estate conveyed; then the declaration of uses, which limits or modifies the enjoyment to one or more parties, according to the stipulations previously made; then the declarations of trusts, if any, that is, of equitable interests created in the property; and lastly, the covenants for title. These covenants stand in the place of the ancient warranty, a clause by which the grantor warranted and secured to the grantee the thing granted; arising out of the feudal custom, whereby if a lord had thus warranted a fief, and the tenant was afterwards evicted, the lord was bound to recompense him with another fief of equal value. The covenants relating to the title secure to the grantee a pecuniary compensation for any damage he may suffer contrary to their stipulations. Besides the covenants for title, such as may be demanded by the peculiar circumstances of the case, — as in a lease the covenants for repairing, payment of rent, &c., — covenants in general, when broken, give the covenantee an action for damages against the covenantor; or if he be dead, against his executor or administrators to the extent of his personal property in their hands; or if the covenant be with him, his heirs and assigns, the remedy extends to the heir or grantee of the covenantee.

Lastly, the conclusion of a deed contains its execution and date. It must be signed and sealed by the grantor; and also by the grantee, if any engagement or covenant is entered into by him. It is usual for witnesses to attest the deed; but this is not necessary, unless where a power having been given to be executed by deed the terms of the power require such attestation. There are several species of deeds; some having effect at common law, others under the Statute of Uses; some creating an estate termed original or primary; some enlarging, restraining, transferring, or extinguishing estates already created, which are called secondary or derivative.

DEER. The English generic name for the ruminating quadrupeds with deciduous horns, or antlers; which appendages form, in fact, the essential character of the genus *Cervus* of Linnæus. (*See* CORNUA.) Deer are anatomically distinguished from other ruminants by the absence of a gall bladder

The species of deer may be primarily divided into two groups, of which one includes those with antlers more or less flattened, the other those with rounded antlers. The elk (*Cervus alces, L.*) is the most characteristic species of the first group, and forms the type of the subgenus *Alces* of modern systems. It equals or exceeds the horse in bulk; has a short body, with a still shorter neck, raised on long stilt-like legs. The muzzle is long, broad, and overhangs the mouth like a square-shaped lapel: it is very muscular, and is of essential service to the animal in detaching the lichens and mosses from the trunks of trees and other places within its easy reach. The long legs of the elk particularly adapt it to the marshy and swampy forests which it chiefly frequents, in the northern parts of both the European and American continents. The antlers of the elk appear first in the form of *dags* or unbranched pointed stems; these are succeeded by a stem or *beam* supporting a few short branches. At five years he puts up antlers in the form of a triangular plate, supported on a pedicle, and notched along the outer margin. Afterwards the bony plate increases in its expanse, and the points between the notches are developed into long branches or *snags*, of which a single antler sometimes sends off as many as fourteen; and the pair will then weigh about fifty pounds. The female elk goes with young rather longer than eight months.

The rein-deer (*Cervus tarandus*) differs from the rest of the genus in the presence of antlers in both sexes, and in the great development of the *brow-antlers*, or branches which extend forwards over the forehead from the base of the beam. The antlers are retained through the winter; and, as it is understood that the brow-antlers are used to detach the frozen snow, which at that season covers the *lichen rangiferinus*, and other species on which the rein-deer feeds, the necessity of the singular exception in favour of the female rein-deer becomes obvious. Her antlers are, however, always smaller than those of the male. The rut takes place in mid-winter, and the period of gestation is about six months: as in most other species of deer, one fawn is produced at a birth. The rein-deer is a native of the most northern parts of Europe and America. To the Laplander it serves all the ordinary offices of the beast of draught, and supplies him with the rich variety of nutriment, clothing, and useful implements, which man in more favoured climes obtains from other species of the valuable order of Ruminantia.

The third species of deer referable to the flat-horned group is that which the ancients termed *platiceros*, and which now forms the ornament of the English park; the fallow deer (*Cervus damas*, Linn.). In the technical language of the hunter, the male fallow deer is called a "buck," the female a "doe," and the young a "fawn." The buck-fawn of the second year, which is characterized by having simple dags, is a "pricket." In the third year a brow-antler is put forth, and the young buck is termed a "sorel." In the fourth year he is a "sore," and the summit of the beam presents a bifid expansion. At the fifth year the expanded summit of the beam is formed, and begins to develop snags, and the fallow deer is then a "buck of the first head." At each subsequent year the branches of the expanded beam increase in length to a certain period, after which they lose their size and regularity. The period of gestation in the fallow doe is eight months.

Of the species of deer of which the beam of the antler gives a rounded form in section, the red deer (*Cervus elaphus*) and the roe-buck (*Cervus capreolus*) are indigenous species.

The male red deer, in the language of "the noble art of venerie," is called a "hart," and the female a "hind." She goes with young about a week longer than the fallow doe; and brings forth in May a single fawn, rarely two. The young of both sexes are at first styled "calves." The male differs from that of the fallow deer in putting up at six months a pair of rudimental antlers, in the form of cylindrical knobs, called "bossets." In the second year they assume the condition of "dags," and the wearer is called a "brocket." In the third year two or three branches or "tynes" are developed, and the young deer becomes a "spayad." In the fourth year the summit of the beam expands into the crown or "surroyal," and the deer is now distinguished by the name of "staggard." In the fifth year the term "stag" is applied to him in a limited and technical sense. At the sixth year he is a "hart," and his designation is not afterwards changed; but at this period he is particularly distinguished as a "hart of ten," and is not considered fair game till his seventh year, when the hart is said to be "palmed" or "crowned," in reference to the full development of his antlers. The antlers or "attire" are shed very soon after pairing; at this period, when the hart has "lost his attire," he retreats to the shadiest or most unfrequented part of his range. New antlers begin to grow very soon after the old ones are shed, and they are completed in the month of August. The skin, or "velvet," which protected the vascular periosteum during their growth now dries, and is rubbed off against trees or any resisting body;

this act is technically called "burnishing." The harts during this period form a peculiar and distinct association. The hinds form another group, and go also into retirement with their calves, to which they attend with a high degree of instinctive maternal solicitude. The "brockets," and the "brockets' sisters," constitute a third association.

The roebuck is the smallest species of European deer; the male is monogamous, and the female brings forth two fawns. In our own island they are now confined to the Scottish mountains.

The largest species of round-antlered deer in America is the *Wapiti* (*Cervus strongyloceros*); that of Asia is the great *Rusa* (*Cervus hippelaphus*), which is noticed in the writings of Aristotle. In South America there is a singular group of small deer, called prickets or brockets, on account of the antlers never being developed beyond the simple condition of "dags," such as characterize the brocket age of the red deer.

DEFÆCA'TION. (Lat. de, and fæx, *dregs*.) The separation of the dregs and impurities of liquors.

DEFAMATION. *See* LIBEL.

DEFAU'LT. (Fr. défaut.) In Law, is in a general sense the omission of any act which a party ought to do in order to entitle himself to a legal remedy. Such is, for example, non-appearance in court on a day assigned. If a plaintiff in an action make default in appearance, he is non-suited; if a defendant, judgment by default passes against him. Suffering judgment by default is taken for an admission of the contract alleged by the plaintiff.

DEFEA'SANCE. In Law—1. A collateral deed, made at the same time with a deed of conveyance, containing conditions on the performance of which the estate created by the deed of conveyance may be defeated. 2. A defeasance on a bond, recognizance, or judgment recovered, is a condition which when performed defeats a bond, &c. (*see* BOND), contained in or indorsed on the instrument itself.

DEFE'CTIVE FIFTH. In Music, an interval containing a semitone less than the perfect fifth. It is also called semidiapente, and flat, lesser, or diminished fifth.

DEFE'NDER OF THE FAITH. (Fidei Defensor.) A title bestowed on Henry VIII. of England by Pope Leo X. on the occasion of that monarch's publishing his writing against Luther. When at the Reformation Henry suppressed all the monasteries and convents in England, the pope deprived him of this title; but in the thirty-fifth year of his reign, it was confirmed by parliament, and it has been since constantly assumed by the sovereigns of England.

DE'FERENT. (Lat. defero, *I carry away*.) In the Ptolemaic system of the universe the planets move in circular orbits, the centres of which are carried round in the circumferences of other circles. These secondary circles are called the *deferents*, as carrying the orbits; those in which the planets move being the epicycles. The system of epicycles and deferents was invented by Hipparchus for the purpose of explaining the eccentricities, perigees, and apogees of the planets. *See* EPICYCLE.

DEFI'CIENT NUMBERS, in Arithmetic, are numbers such that the sum of their aliquot parts is less than the numbers themselves. Thus, 8 is a deficient number; because its aliquot parts, 1, 2, 4, when added together, make only 7. In like manner the number 16 is deficient, its parts being 1, 2, 4, 8, the sum of which is 15.

DEFILADING. *See* FORTIFICATION.

DEFI'LE. In Fortification, a narrow way, through which troops can pass only in *file*, or a small number abreast.

DE'FINITE PROPORTIONALS. In Chemistry. *See* ATOMIC THEORY and EQUIVALENTS.

DEFINI'TION (Lat.), literally laying down a boundary, signifies, in Logic, an expression which explains any term so as to separate it from every thing else, as a boundary separates fields. By the schoolmen definitions are divided into *nominal* and *real*, according to the *object accomplished* by them, whether to explain merely the meaning of the word or the nature of the thing; and, on the other hand, they are divided into accidental, physical, and logical, according to the *means employed* by each for accomplishing their respective objects, whether it be the enumeration of attributes, or of the physical or the metaphysical parts of the essence. (*Whately's Logic*, pp. 141-2.)

DEFLAGRA'TION. (Lat. deflagro, *I burn*.) A chemical term applied to sudden and rapid combustion: when a mixture of charcoal and nitre is thrown into a red hot crucible it burns with a kind of explosion, or *deflagrates*.

DEFLE'CTION OF THE RAYS OF LIGHT. When a luminous ray passes very near an opaque body it is *deflected*, or bent from its rectilinear course, towards the surface of the body, and the deflection is greater in proportion as the distance of the ray from the body is less. This phenomenon was first observed by Grimaldi, and was carefully examined by Newton, who gave it the name of *diffraction*.

DE'FTER-DAR, literally *Book-keeper*. The title given by the Turks to the chancellor of the exchequer and his two coadjutors or deputies in the finance department.

DEGLUTI'TION. (Lat. de, and glutio, *I swallow*.) In Physiology, the act of swallowing food. This operation is performed by mechanism of the most extraordinary and complicated kind, in which the consentaneous actions of the various muscles of the tongue, the soft palate, the pharynx, the larynx, and the œsophagus or gullet, are concerned, partly by voluntary and partly by involuntary impulse.

There are, as it were, four openings at the back part of the mouth, three of which, during deglutition, must be perfectly but temporarily closed; whilst the fourth, namely, that through which the food is to pass towards the stomach, must be open and without impediment. The openings which are to be closed are those which communicate with the nose, with the ears, and with the lungs; but, as far as the latter is concerned, it follows of course that respiration can only be suspended for a very short time, and that therefore the moment the morsel is swallowed, or has passed over the larynx, the communication between it and the nose must again be free.

When food is properly masticated, a sufficient quantity is collected upon the tongue, which is then so pressed against the palate by a muscular action proceeding from the tip of the tongue backwards as to propel it towards the pharynx, or upper end of the gullet; at this moment the soft palate, previously hanging like a pendulous veil at the back of the mouth, is drawn into a horizontal position, so as to form a continuation, as it were, of the bony part of the palate, and at the same time to close the nasal canals. No sooner does the portion to be swallowed reach the pharynx, than it is embraced, as it were; while the base of the tongue, the os hyoides, and the larynx are raised forward to meet it, and hurry it over the opening of the glottis towards the œsophagus. The instant the larynx is raised the glottis is firmly closed; and as soon as the morsel has passed over it the larynx descends, the epiglottis is raised, and the glottis opens again to allow air to enter the lungs. Thus it is, therefore, that the food is limited to the direction of the œsophagus, and neither passes into the nasal canals, nor into the Eustachian tubes, nor into the larynx, all the concurrent actions in this period of the act of deglutition being simultaneously and involuntarily performed. By the contraction of the pharynx the morsel is delivered into the œsophagus, and propelled by the muscular structure of that tube towards the stomach. In the upper part of the œsophagus, the fibres relax immediately after the passing of the food, but the inferior portion remains contracted for some moments after the food has entered the stomach.

The due admixture of saliva with the food, and the lubrication of the various and complicated parts over and through which the food passes, by mucous secretion, tend materially to facilitate the progress of the alimentary pellet.

DEGRE'E. A distinction of rank in universities: in its proper use denoting a certain amount of proficiency in the faculty or science of which it is entitled; but, by modern usage, frequently conferred either of right to members of the university of sufficient standing, or merely as an honorary distinction. The origin of degrees at the universities of Paris and Bologna, the two most ancient in Europe, appears to have been only the necessary distinction between those who taught and those who learnt. The former were styled (such was at least the case at Paris) doctors or teachers, and masters, as a token of respect, indiscriminately. At what time the distinction between these two degrees arose we cannot ascertain; but about the middle of the 13th century we find, at Paris, doctors and masters simply as graduates, and not necessarily connected with the business of teaching; those who were so being called regent masters, or simply regents. (*See* REGENT.) The degree of bachelor, the lowest in the several faculties, is certainly of French origin; from whence it has been argued that the whole system of academical titles is so likewise. Degrees still continue to bear the same names, and, with some variation, the same relative academical rank, in most European countries; but the mode of granting them, and their value at different universities as tokens of proficiency, vary greatly. At Oxford and Cambridge degrees are given in arts, divinity, law, medicine, and music; but among all these the lowest degree in arts, viz. that of bachelor (B. A.), is the only one conferred on a substantial examination, and the only one which is attained by proceeding through a regular academical course of study. The higher degrees in arts, and those in the other faculties, are attained simply by residence and the performance of a few unimportant exercises. Honorary degrees, in the English universities, are generally conferred in civil law.

A considerable difference of opinion exists upon the question how far the possession of degrees forms a valid test of ability to exercise any of the learned professions; and though at first sight nothing might appear more preposterous than to question the necessity of some such test being exacted from those to whom the lives and fortunes of millions of human beings are in a peculiar manner

intrusted,—physicians and lawyers, — still there are many who maintain that "degrees have always been, and must continue to be, utterly worthless." Among those who entertained this opinion may be mentioned Dr. Smith; whose sentiments on this subject, though pretty distinctly indicated in the *Wealth of Nations*, are fully detailed in a letter to Dr. Cullen, which the reader will find in Mr. M'Culloch's edition of that work, 1 vol. 8vo. But those who wish to see this question fully examined in all its bearings, should consult a note, or rather dissertation, "On the Value and proper Mode of conferring Literary and Scientific Degrees," in the same edition of the work now referred to, in which the author contends that it is not against the principle of degrees, so much as the mode of conferring them, that the chief objections may be urged. The value of a degree, it is there contended, must always depend on the disinterested character of the parties who confer it. Now, when it is remembered that, till very recently, in every university, those in whom was vested the privilege of granting degrees are the identical parties engaged in preparing the candidate for receiving them, who are thus, as it were, called upon to form an estimate of their own handiwork, it will be sufficiently obvious that the system hitherto pursued in awarding academical distinctions must be wholly inadequate as a test of literary or scientific merit. This being the case, it might seem almost unaccountable that so little success should have attended the many efforts that have been made to place the granting of degrees on a sounder and more satisfactory footing, were it not matter of notoriety that to divert into a new channel the current of popular feelings or prejudices which has been flowing for ages in a particular direction is almost impracticable, even after the benefits of the change have been clearly and unequivocally demonstrated. Some such ideas as to the inadequacy of degrees appear to have been entertained a few years ago in many of the German states. There the bare possession of a degree was formerly sufficient to authorize members of the legal or medical profession to engage in the exercise of their several duties; but a change has been since effected, which has at once infused new life into the educational establishments of the country, and has been attended with great advantage to all classes of the people. This change consists in the establishment of boards composed of gentlemen eminent for their attainments, and wholly unconnected with the business of education, whose duty it is to ascertain by a rigid examination the qualifications of those who have already obtained degrees in the faculties of law and medicine, and thus to determine whether the degree has been properly conferred; and unless the diploma obtained at the university be stamped with the authority of these different boards, the possessor of it is prohibited from engaging in the exercise of his profession. In this way the degree, which was formerly regarded as the *aim* or *end* of the student's ambition, is now looked upon simply as a *means* of attaining it, inasmuch as it confers no direct privileges, and does not necessarily secure professional honour or emolument, though it form the sole passport to both. A somewhat similar course relative to the granting of degrees was adopted in this country on the establishment of the London University; with this peculiarity, that while in Germany the different faculties of the universities retain the privilege of conferring degrees, which, however, are of little value, unless confirmed by the authority of the boards alluded to, in the London University this right is vested in the board to the entire exclusion of the professors. Whether this system will work well remains yet to be seen; but, to use the words of Mr. M'Culloch, "if we mistake not, its formation will mark the commencement of a new era in the history of education."

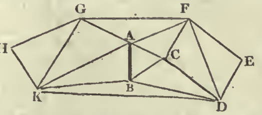
Degree. In Algebra, a term applied to equations to denote the highest power of the unknown quantity. Thus, if the index of the highest power of the unknown quantity is 4, the equation is said to be of the fourth degree.

Degree, in Geometry and Trigonometry, is the 360th part of a circumference, or of four right angles. Every circle, whether great or small, is considered as divided into 360 parts or *degrees*, each degree being subdivided into 60 minutes, and each minute into 60 seconds. This division of the circle has been employed since the most remote ages. It is not certainly known what gave occasion to the adoption of the arbitrary number 360; but it most probably had reference to the space described by the sun in one day in performing his annual revolution in the ecliptic, the number 360 being taken instead of 365, as being more convenient for arithmetical operations on account of its containing a great number of divisions. The Chinese divide the circle into 365¼ equal parts; so that the sun describes daily an arc of one Chinese degree. An attempt was made by the French philosophers, at the period of the Revolution, to introduce into works of science a division of the circle better adapted to our decimal arithmetic (the quadrant or right angle being divided into 100 degrees, the degree into 100 minutes, and so on); but though the system was adopted by some writers of the first order of merit (for example, Laplace in the *Mécanique Céleste*), and extensive tables were computed for the purposes of astronomical calculation, it never came into general use, and now appears to be entirely abandoned. It may be remarked, that a division of this sort was recommended long ago by some of the most eminent mathematicians, Stevinus, Wallis, Briggs, Gellibrand, Newton, and others.

Degree. In Grammar. *See* Comparison.

DEGRE'E OF LATITUDE, on the surface of the earth, is the distance an observer must advance along the meridian, to the north or south, in order to produce a variation of one degree in the altitude of the pole. Ever since it was discovered that the earth is round, the exact measurement of a degree of the terrestrial meridian has been a problem of extraordinary interest, inasmuch as it leads directly to a knowledge of the earth's dimensions. In modern times the problem has acquired a still greater importance, in consequence of the discovery of the earth's ellipticity; for it is by the comparison of the lengths of meridional degrees at different latitudes that we are enabled to ascertain accurately the true figure of the earth, which enters as an element into many of the most interesting inquiries of physical astronomy.

When we consider the great irregularities of the actual surface of the earth, and that the length of a degree depends on the radius of the circle on which it is measured, it will readily appear that terrestrial degrees at different places, if measured on the external surface, must be exceedingly unequal. In order to obviate the effects of superficial irregularities, and to reduce all the degrees to the same radius, the surface of the sea is supposed to be continued all round under the continents, and it is to this surface or level that all the measurements must be referred. This being understood, the general principle on which the measurement of degrees of the terrestrial meridian must be accomplished are readily perceived. Two stations being assumed on the same, or nearly the same meridian, the distance between them must be found with great exactness in feet, yards, or some known linear measure. Having ascertained the itinerary distance, the latitude of each of the stations must be determined; the difference of the two latitudes is the length of the celestial arc intercepted between the two stations; and by comparing this with the terrestrial measure, the number of yards or feet corresponding to a degree becomes known. It is evident that, in order to obtain a result of any value, all these operations must be executed with the greatest care and precision. An error of a single second in the celestial arc corresponds to about 100 feet on the ground, and a long series of astronomical observations must be made to obtain the latitude of any place true to a second. On this account it is necessary to measure an arc of considerable length, two or three degrees at least; because the error in the determination of the latitudes is the same, whether the arc be long or short, and in the case of a long arc its influence becomes less sensible. But the exact measurement of a line extending two or three degrees on the surface of the earth, by the direct application of rods or chains, is perhaps altogether impracticable, on account of the irregularities of the ground and many other circumstances which render an operation of this sort, when carried on even for a few miles, an affair of great difficulty. Hence it becomes necessary to have recourse to other methods. A level piece of ground is selected near the meridional arc proposed to be measured. On this a straight line A B is traced in any direction, and its length accurately found by the application of rods of metal, or sometimes of wood or of glass. The ground adjoining the arc to be measured is then formed into triangles by means of signals, C,D,E,F,K, erected at convenient distances, or on remarkable points of the country; and the angles which the signals make with each other determined by a theodolite or other appropriate instrument. The sides A C and B C are then deduced from the measured base A B, and thence successively the sides of the other triangles; and in this manner the whole distance between the stations which form the terminal points of the arc is determined by a series of trigonometrical calculations. The reductions for differences in the levels of the signals must next be applied, and also for their altitude above the level of the sea; and it is obvious that these reductions cannot be made without having at least an approximate knowledge of the dimensions of the earth, and without making some hypothesis respecting its figure, though the dimensions and figure of the earth are elements that can only be deduced from the measurement and comparison of degrees.



From this general description it will be readily inferred that the measurement of terrestrial degrees depends on astronomical operations of very great nicety, and that the

attempts made in ancient times could lead only to rude approximations with respect to the dimensions of the earth, supposing its figure to be spherical. Eratosthenes, who lived in the 3d century before Christ, is the first with the detail of whose operations we are acquainted who undertook to determine the length of a meridional arc on correct principles. Having observed the difference of the sun's altitude at the summer solstice at Alexandria and Syene in Upper Egypt, and having found, by means with which we are unacquainted, the itinerary distance between the two places, he inferred the circumference of the earth to be 250,000 stadia, and consequently the length of a degree 694⅓ stadia. Posidonius, some time after, measured in a similar manner the arc between Alexandria and Rhodes, and inferred the length of the degree to be 666⅔ stadia. Ptolemy, in his Geography, assigns 500 stadia as the length of a degree of the meridian; but as we are unacquainted with the precise value of the stadium, we cannot form any correct idea of the approximation attained in these ancient measures. In the 9th century, the Arabian caliph Almamoun ordered a degree to be measured on the plains of Mesopotamia. His mathematicians arrived at the exact value given by Ptolemy; a circumstance which, as it could scarcely have happened if they had operated independently, has led to the suspicion that they merely adopted the conclusion of the Greek astronomers. In modern times the measurement of terrestrial degrees has been justly regarded as of the greatest scientific importance. About the middle of the 16th century, Fernel made a rough measurement of the distance between Paris and Amiens by counting the revolutions made by his coach wheel, and concluded the length of the meridional degree to be 364,960 English feet. Norwood, in 1635, measured the distance between London and York, and found the length of the degree to be 367,176 feet. But the first who employed the method of triangulation for obtaining the length of a terrestrial arc was Snell, a native of Holland. The application of the telescope to instruments for measuring angles, by Picard, was an invention which gave a far greater accuracy and certainty to operations of this kind than could before be attained; and the discovery by Richer of the flattened form of the earth at the poles, and the consequent inequality of the meridional degrees, invested the subject with a new and unexpected interest. In the year 1735, the Academy of Sciences of Paris, to decide the important question of the spheroidal form of the earth, resolved that two arcs of meridian, the one at the equator and the other as near the pole as possible, should be measured with all the accuracy which the improved state of astronomy admitted of. Accordingly, Bouguer, Godin, and Condamine were despatched to Peru; Maupertuis, Clairaut, Lemonnier, and some other associates, to Lapland,— for the execution of this purpose. The latter party accomplished their mission, and returned to Paris within 16 months; Bouguer and his companions had to contend with great difficulties and hardships, and were detained not less than ten years. The result was, that the length of the degree of the meridian at the equator, reduced to the level of the sea, was found to be 56,753 toises, or 362,912 English feet; and in Lapland, under the parallel of 65½°, to be 57,437 toises, or 36,729 feet, exceeding the former by 684 toises.

Since these memorable expeditions several arcs of meridian have been measured in different countries, and all the results concur in proving that the degrees increase in length as we proceed from the equator to the pole, agreeably to the theory of hydrostatic equilibrium, which requires an accumulation of matter in the equatorial regions of the earth, in order to counterbalance, by its attraction, the effect of the centrifugal force of rotation. Lacaille, in 1751, measured a degree at the Cape of Good Hope; and the result is interesting on account of the locality, as no other operation of the kind has yet been undertaken in the southern hemisphere. In the same year an arc was measured in the Roman states by Maire and Boscovich; another by Liesganig in Hungary in 1762; one in North America by Mason and Dixon in 1764; and one by Beccaria in Piedmont in 1777; but the results cannot be regarded as entitled to much confidence in comparison of those obtained from the more extensive and accurate operations that have been since executed in France and England, and also in India. The French philosophers, in 1792, having chosen for the unit of their new system of weights and measures a fractional part of the terrestrial meridian, it was resolved to measure the arc extending through the whole of France from Dunkirk to Barcelona. This splendid undertaking was confided to two astronomers of the highest eminence, Mechain and Delambre, by whose spirited exertions it was carried through in the face of obstacles of the most formidable kind, arising from the political state of the country at that time. Every precaution that profound theory or eminent practical skill could suggest was adopted to secure the accuracy of the results. In 1806 the triangulation was extended from Barcelona through Spain to the coasts of the Mediterranean; and subsequently, after the death of Mechain, who fell a victim to his exertions, by Biot and Arago to the Balearic Isles. The whole, thus extended from Dunkirk on the north to Formentera on the south, comprehends 12° 22′. The English arc, connected with the trigonometrical survey of the kingdom, which has been carried on since 1790 under the direction of the Board of Ordnance, reaches from Dunnose in the Isle of Wight to Burleigh Moor in Yorkshire; nearly 4 degrees. Though no doubt is entertained that the result of this measurement is of a high degree of accuracy, it must be confessed that our confidence arises rather from the great excellence of the instruments employed than the science or skill of those to whom the operations were entrusted. It is deserving of remark that both the French and English arcs present this anomaly, that when portions of them taken at particular places are considered separately, the length of the degrees appears to increase on going southward. Two arcs of meridian have been measured in India. The first extends only a degree and a half; but the second is the longest which has been measured in any country, and includes about 16 degrees. It was begun, and about 10° executed, by Colonel Lambton; and the remainder was conducted by Captain Everest. The details of Colonel Lambton's operations are given in the *Asiatic Researches* (vols. viii. to xiii.); those of Captain Everest, in his *Account of the Measurement of an Arc of the Meridian between the Parallels of* 18° 3′ *and* 24° 7′. London, 1830.

Some portions of meridional arcs have more recently been measured in Europe; but as our limits will not permit us to enter into further details, we shall content ourselves with giving the following table of the results of those which appear to be deserving of confidence:—

No.	Meridional Arcs.	Amplitude or length of Arc.	Latitude of middle point.	Length of Degree in English feet.
1.	Arc measured by Bouguer, recomputed by Delambre - - -	3° 7′ 3′	1° 31′ 0″ S.	362,809
2.	First Arc measured in India by Col. Lambton, from Trivandeporum to Paudree - -	1 34 56	12 32 21 N.	362,988
3.	Second Indian Arc by Col. Lambton and Captain Everest, from Punnae to Kulliampoor -	15 57 59	16 8 22	363,040
4.	French Arc from Dunkirk to Formentera by Mechain and Delambre -	12 22 12	44 51 ·	364,644
5.	English Arc from Dunnose to Burleigh Moor -	3 57 13	52 35 45	365,032
6.	Arc measured in Hanover by Gauss, from Gottingen to Altona - -	2 0 57	52 32 17	365,301
7.	Arc measured in Lithuania by Struve, from Jacobstadt to Hockland	3 35 5	58 17 37	365,377
8.	Arc measured in Sweden by Svanberg, from Maltorn to Pahtawara -	1 37 20	66 20 11	365,697

In the above table the numbers are exhibited as if the whole arcs had been measured at once, and the latitudes only observed at each extremity; but in fact, in the three long arcs, latitudes were observed at several intermediate stations, and consequently so many more independent measures obtained. Thus the second Indian arc consisted of five partial arcs, the French of six, the English of three, and Struve's of two; so that there are in the whole *twenty* independent determinations of the meridional degree. Combining the results of these twenty measurements by methods well known to mathematicians so as to deduce the most probable mean values, the dimensions and ellipticity of the earth are found to be as follows:—

	English feet.		Miles.
Equatorial diameter - -	41,843,330	=	7924·87
Polar diameter - -	41,704,788	=	7898·63
Difference of diameters - -	138,542	=	26·24
Ellipticity, or difference of diameters divided by greater - -	$\frac{1}{302{\cdot}026}$		

Assuming these as the true elements of the earth's magnitude and figure, the following table is calculated, showing the length of a degree of the meridian at every 10th degree of latitude. The formula from which the calculation is made is the following:— Let a be the equatorial semidiameter of the earth, e the ellipticity, l the latitude of the place, and d the length of a degree at the latitude l; then $d = a\,(1 - e + 3\,e \sin^2 l)\ 3600 \sin.\ 1''$.

Latitude.	Length of Degree in English feet.	Latitude.	Length of Degree in English feet.
0	362,734	50	364,862
10	362,843	60	365,454
20	363,158	70	365,937
30	363,641	80	366,252
40	361,233	90	366,361

DEGREE OF LONGITUDE, on the earth, is a degree of the equator, or of any of its parallel circles. If the earth is a regular spheroid of revolution, the circles parallel to the equator, and consequently the degrees of those circles, must diminish regularly as their distance from the equator increases, according to a law derived from the nature of the ellipse. Hence, if we know the measured lengths of a degree of two or more small circles in different latitudes, we are in possession of data sufficient to determine the diameters and ellipticity of the earth. The measurement of degrees of longitude, therefore, in reference to the determination of the earth's figure, is of equal importance with the measurement of degrees of the meridian, and has accordingly been executed in various instances. The geodetical operations required in the one case are the same as in the other; but on account of the great difficulty of determining the astronomical longitudes with the necessary accuracy, the results have never been regarded as equally satisfactory. Supposing the equatorial diameter of the earth, as indicated by the meridional degrees, to be 41,843,330 English feet, and the ellipticity $= \frac{1}{302{\cdot}026}$, the following table shows the length of a degree of longitude at every tenth degree of latitude.

Latitude.	Degree of Longitude in English feet.	Latitude.	Degree of Longitude in English feet.
0	365,152	50	235,171
10	359,640	60	183,029
20	343,263	70	125,254
30	316,493	80	63,612
40	280,106	90	0

DEGRE'ES. In Music, the small intervals of which the concords or harmonical intervals are composed.

DEHI'SCENT. (Lat. dehisco, *I gape.*) A term applied to those fruits which separate regularly round their axes, either wholly or partially, into several pieces.

DEIFICATION. *See* APOTHEOSIS.

DEI GRATIA (*by the grace of God*). A Latin formula, usually inserted in the ceremonial description of the title of a sovereign. It was used originally by the clergy.

DEILE'PHILA. (Gr. δειλη, *evening*, and φιλεω, *I love.*) A subgenus of hawk-moths (*Sphingidæ*) belonging to the crepuscular or evening tribe of Lepidopterous insects. They are characterized by wings entire and acute; antlia rather elongated; antennæ short, and clubbed in the male. One species, *Deil. celerio*, feeds upon the vine.

DEINOTHE'RIUM. (Gr. δεινος, *terrible*, θηριον, *wild beast.*) The name of a fossil genus of gigantic Pachyderms, chiefly remarkable on account of its enormous tusks, which projected downwards from the lower jaw instead of the upper, as in the elephant and walrus.

DE'ISM, or THEISM. (Lat. Deus; Gr. Θεος, *God.*) Belief in the existence and attributes of God, coupled with disbelief in any express revelation of his will. There exist various shades of opinion among Deists, which the reader will find pointed out in Clarke's learned work on the *Attributes*; but general usage has assigned this word a meaning synonymous with *sceptic* or *freethinker:* hence it is regarded as a term of reproach. In its original acceptation, *theist* was directly opposed in meaning to *atheist;* but these terms are now frequently, though very incorrectly, employed without distinction to designate an *unbeliever in Christianity.*

DEJEUNER. (Fr. *breakfast.*) A term wholly naturalized in almost all the languages of modern Europe, not excepting the English, signifying the morning meal. The materials of which it is composed vary of course with the climate and usages of different countries; but it is worthy of remark that in France itself this term is rapidly losing, if indeed it has not already lost, its original acceptation, being used, particularly by the fashionable world, as synonymous with the English *luncheon.*

DEL CREDERE COMMISSION. In Mercantile Law, a term derived from the Italian (credere, *to trust*), which denotes a commission granted by a merchant to a factor to dispose of goods; the factor, for the consideration of an additional per-centage, agreeing to guarantee the solvency of the purchaser. *See* FACTOR.

DE'LEGATES, COURT OF. Formerly the highest ecclesiastical court of appeal in England: in ordinary cases composed of three common law judges and three civilians; in special cases a fuller commission is sometimes issued. In case of a division of opinion, or where no common law judge is in the majority, a commission of adjuncts was issued. Appeal lay to it from the archiepiscopal courts. Its powers are transferred by 2 & 3 W. 4. c. 92. to the privy council.

DELEGA'TION. In the Civil Law, the act by which a debtor transfers to another person the duty to pay, or a creditor makes over to a third party the right to receive payment.

DELFT WARE. A coarse species of porcelain, originally manufactured at Delft in Holland, whence its name.

DE'LIAN PROBLEM. *See* DUPLICATION OF THE CUBE.

DE'LICACY. (Lat. deliciæ.) In the Fine Arts, minute accuracy as opposed to strength or force: slenderness of proportion, great finish, and softness are its characteristics.

DELIQUE'SCENCE. (Lat. deliquesco, *to melt down.*) When certain saline substances are exposed to air, they absorb so large a quantity of moisture as to run down into a liquid state, or *deliquesce.*

DELI'RIUM TRE'MENS. A disease of the brain, resulting from the excessive and protracted use of spirituous liquors; it is therefore almost peculiar to drunkards. It begins with excessive irritability, loss of sleep, frightful dreams and visions, and a multiplicity of the ordinary delusions of insane persons, ending in furious madness. The hands are usually, but not always, tremulous. By careful treatment, and more especially by the judicious use of opium, patients have recovered from this disease; but, for obvious reasons, it is difficult to manage, and subject to relapses. Bleeding should in almost all cases be, if possible, avoided.

DE'LITE'SCENCE. (Lat. delitescere, *to lie hid.*) In Surgery, when a tumour very suddenly and unexpectedly subsides, it is said to terminate in *delitescence.*

DE'LPHI, ORACLE OF; so called from Delphi, the capital of Phocis, the most famous of all the oracles of antiquity, sacred to Apollo. The origin of the oracle at Delphi is wrapt in obscurity. By some authors it is ascribed to chance; but many incline to believe that it owed its origin to certain exhalations, which, issuing from a cavern on which it was situated, threw all who approached it into convulsions, and during their continuance communicated the power of predicting the future. Be this as it may, these exhalations were soon invested with a sacred character; and as their reputation extended, the town of Delphi insensibly arose around the cavity from which they issued. The responses were delivered by a priestess, called Pythia, who sat upon a tripod placed over the mouth of the cavern; and after having inhaled the vapour, by which she was thrown into violent convulsions, gave utterance to the wished-for predictions, either in verse or prose, which were then interpreted by the priests. Originally the consultation of the oracle was a matter of great simplicity; but in process of time, when the accuracy of the predictions became known, a series of temples, each more magnificent than its predecessor, was erected on the spot. Immense multitudes of priests and domestics were connected with the oracle; and to such a height of celebrity did it attain, that it wholly eclipsed all the other oracles of Greece.

The position of the oracle was the most favourable that could well be imagined. Delphi formed at once the seat of the Amphictyonic Council and the centre of Greece, and, as was universally believed, of the earth. Hence, in every case of emergency, if a new form of government was to be instituted, war to be proclaimed, peace concluded, or laws enacted, it came to be consulted, not only by the Greeks, but even by the neighbouring nations; and thus the temple was enriched by an incredible number of the most valuable presents and the most splendid monuments, and the town of Delphi rose to be one of the most wealthy and important of the cities of Greece.

As it was well known that the riches of all Greece were concentrated in the temple at Delphi, this sacred repository became frequently an object of plunder. But in spite of all the rapacity to which it was exposed, the oracle continued to utter its responses long after the seat of empire had been transferred from Greece to Rome; and it was only when Constantine the Great removed the sacred tripods to adorn the hippodrome of his new city, that the responses of the oracle ceased to be delivered. For a view of the characteristics of oracles in general, and the influence which they exercised over the nations of antiquity, see the article ORACLE.

DE'LPHIN. In Literary History, a name given to the edition of the Latin classics, prepared and commented upon by thirty-nine of the most famous scholars of the day, at the suggestion of Louis XIV., for the benefit of the young prince (in usum Delphini) under the superintendence of Montausier his governor, and his preceptors Bossuet and Huet.

DELPHI'NIA. A vegetable alkaline base, obtained from the seeds of the *Delphinium staphisagria*, or stavesacre.

DELPHI'NUS. (Lat. *a dolphin.*) The *Dolphin*, one of the ancient constellations of the northern hemisphere.

DELPHINUS. This term is restricted in modern Zoology to those species of Cetacea which have teeth in both jaws, all simple, and almost all conical. They are the most carnivorous in proportion to their size. The Linnæan genus *Delphinus* is now subdivided into *Hyperoodon*, of which the great bottle-nose dolphin is the type; *Delphinapterus*, represented by the beluga; *Phocæna*, represented by the common porpesse; and *Delphinus* proper.

DE'LTA. The Greek letter Δ; and, in antiquity, the lower portion of Egypt, comprised between the E. and W. branches of the Nile and the sea, was from its resemblance to the above letter called the Delta. And hence if any large river, before it enters the sea, diverges and forms two sides of a triangle, the sea being the base, the strand or alluvial land included by the three lines is called a *delta;* as the delta of the Rhone, the Danube, Ganges, &c.

DELTO'ID. Of the shape of the Greek letter delta, Δ. The term is used in anatomy and botany.

DE'LUGE. (Lat. diluvium.) In the 1656th year after the creation (according to ordinary chronology), in the 600th year of the life of Noah, and on the 17th day of the second month (November, according to some commentators), the waters began to rise upon the earth. They appear to be represented as swelling upwards by some upheaving force (the fountains of the great deep were broken up), and descending also in continual rain for forty days and nights. All the mountains "that were under the whole heaven" were covered; "all flesh perished that moved on the earth," with the exception of Noah and his family, and the animals which entered with him into the Ark. The waters remained 150 days; and then "returned from off the earth continually:" and the Ark rested on Ararat on the seventeenth day of the seventh month; and on the first day of the first month of the following year "the face of the ground was dry," but not completely drained of the water for nearly two months longer. Such is a very concise abridgment of the account of this great catastrophe contained in the 7th and 8th chapters of Genesis. Two subjects connected with it require a brief discussion:—the parallel traditions of ancient mythology; and the confirmation which the Mosaic account has been supposed by some to receive from the discoveries of modern geological science, which others have represented as directly opposed to it.

As to the first, the belief in the destruction of mankind by a deluge in the earliest times, and of the escape of one individual and family under circumstances resembling those recorded in sacred history respecting Noah, is a remarkable feature in the traditions of a great variety of nations. The Fo-ki of the Chinese, the Satyavrata of the Indians, Xisuthrus or Seisithrus among the Assyrians, Deucalion and Ogyges among the Greeks,—all present striking features of analogy to the patriarch of scripture: even the Mexicans had their traditional deluge. These fragments of early belief are collected very copiously in the third volume of *Bryant's Ancient Mythology*. (See also *Russell's Connexion of Sacred and Profane History*, vol. ii.) It is undoubtedly true that some of these deluges may have been local inundations only; as, for example, the natural features of the Thessalian plain seem to account conclusively for the tale of Deucalion. Still the universality of these traditions, and their general agreement as to circumstances, seem to point to some common source of information.

With regard to geological theories of the deluge, it is perhaps the safest and wisest course to acquiesce in the general principle, that as scripture was given for a very different purpose than that of conveying physical knowledge, so the endeavour to torture its brief language into exact accordance with our discoveries, real or imaginary, in that branch of inquiry, is both vain and unreasonable. But since much controversy has been expended on the subject, it may be worth while to observe, that in the instance of the deluge, the chief difficulties have arisen not from any endeavour of infidel writers to confute scripture by the aid of geology, but through the over eagerness of the advocates of religion to seize on each hasty generalization made in the progress of an advancing science, in order to press it into the service of their own opinions. Thus the cause of revelation has been defended by physical arguments where no defence was called for; and these arguments have been necessarily abandoned afterwards by those who advanced them. We need not here speak of the notions which have been propounded by speculative geologists respecting the proximate causes of the deluge; such as Burnet (*Telluris Theoria Sacra*), Newton, &c.; and Dr. Geddes, whose ingenious theory is, that it was produced by a sudden increase of the central heat expanding the volumes of water supposed to be contained in cavities of the globe, breaking up its surface from within, and then submerging it under an inundation of *hot* water. More general interest has been excited by the imaginary proofs which from time to time geology has been supposed to furnish of the *fact* of a universal deluge. Thus the discovery of fossil shells in inland strata, and near the summits of the highest mountains, was at one time offered as conclusive evidence; and some infidel writers were reduced to the absurd shift of representing them as *lusus naturæ*, or accounting, like Voltaire, for those found on the Alps by supposing them to have been thrown away by pilgrims on their journey! But when, in the course of discovery, it was known that these fossil relics are to be found scattered through an infinite variety of solid strata formed apparently by partial deposition, one reposing beneath another, so as to form the whole superficial crust of the globe, the impossibility of considering them as the results of any great convulsion became evident, and the argument founded on them fell to the ground. A similar instance of over hasty conclusion has been exhibited in more recent times. Some geologists imagined themselves to have discovered proofs of a general convulsion, attended by a rapid passage of water over the surface of the whole earth, at a period subsequent to the deposition of the last tertiary strata. This notion is to a certain extent countenanced by Cuvier (*Theory of the Earth*, Dr. Jameson's translation, pp. 11. 13. &c.), and by Dr. Buckland (*Reliquiæ Diluvianæ*, 1823.); and it is unfortunate that Dr. Sumner (*Records of the Creation*) should have adopted it as the foundation of an argument in favour of revelation. For more recent investigations have shown that it is impossible to distinguish these supposed traces from those of local disturbance.

On the whole, the question may perhaps be summed up thus: many writers (Cramer, Von Hoff, &c.) have contended that the scriptural deluge was local only, extending over the then inhabited portion of the earth; but if it is to be regarded as universal, and the expressions of the Bible taken in their literal sense, geology (in its present very imperfect state) affords us no insight into the possible *causes* of such a convulsion. But on the supposition of its having been produced by a sudden miraculous interference with the order of nature, no such information was to be expected from science. Neither does geology afford any distinct *evidence* of a universal deluge; but, looking at the manner in which that deluge is recorded to have taken place, and the short period of its duration, it is difficult to see how any permanent results which it may have produced *could* be distinguished from those of the innumerable local inundations of which the surface of the earth furnishes such manifest testimony. The points of contact between natural science and revelation are in reality few or none; it is the jealousy of believers on the one hand, and the cavils of scepticism on the other, which have given rise to the very unmeaning controversies which exist upon the subject.

DE'MAGOGUE. (Gr. δημος, *people*, and αγωγος, *leader*.) One who directs or leads the people in political matters. In its original acceptation it was considered as a most honourable designation, having been applied to Solon, Demosthenes, and in fact to many of the most illustrious characters of antiquity; but it is now almost invariably used in a bad sense. The oldest and most satirical of all portraits of the demagogue is traced by Aristophanes in his play of the *Knights*, in the character of Cleon.

DEMA'ND. In Political Economy. *See* SUPPLY AND DEMAND.

DEMARCA'TION. (Fr.) A term used to designate the line or boundary by which one object is separated from another. The word was first introduced in 1493, when Pope Alexander VI., in order to put an end to the disputes which prevailed between the crowns of Spain and Portugal relative to their Indian discoveries and conquests by virtue of his pontifical authority drew through the ocean an imaginary line, by which the dominions of both parties were defined; and thus originated the expression *line of demarcation*. It is only in this phrase that the word is employed to this day in all the languages of Europe.

DEMES'NE. (Lat. terra dominicalis.) In Law, originally that portion of the lands belonging to a lord which was held in his own occupation. Hence it is sometimes used to distinguish those parts of a manor which the lord has in his own hands, or those of lessees at rack-rent, from those which are in the hands of freeholders and copyholders. *See* ANCIENT DEMESNE.

DEME'TER. (Doric Gr. δα, *the earth*, and μητηρ, *a mother*.) The Greek appellation for Ceres (quod vide).

DE'MI. (Fr.) A word signifying *half*, frequently used in the composition of English words, being equivalent to the Latin *semi*.

DE'MIDITO'NE. (Gr. διτονος.) In Music, a minor third. *See* THIRD

DE'MIGODS. A general appellation of the inferior divinities of Greece and Rome, more particularly of such of the mixed offspring of divinities and mortals as were afterwards deified. Of these the number was almost incredible; and though their worship was not cultivated with such veneration or solemnity as that of the superior gods, it prevailed to a greater or less extent in every quarter of the ancient world, and formed a large part of the heathen mythology.

DE'MILUNE, in Fortification, is a work placed before the curtain.

DE'MIQUAVER. In Music, a note equal in duration to half a quaver.

DE'MITINT. In Painting, a tint representing the mean or medium between light and shade; by some called a *half tint*.

DEMIU'RGUS, *Demiurge*. (Gr. δημιουργος, from δημος, *people*, εργον, *work*.) In the original sense of the word, as used by classical authors, an artificer employed

in ordinary handicraft. In the language of Platonist writers, it denotes an exalted and mysterious agent, by whose means God is supposed to have created the universe. Hence the Demiurgus, or Logos, as the same imaginary agent is termed in the *Timæus* of Plato, is identified by the Platonizing Christians with the second person in the Trinity.

DEMO'CRACY. (Gr. δημος, *people*, and κρατεω, *I govern.*) A government is usually termed a democracy in which the whole of the people, or a large proportion of it, exercises sovereignty either directly or by representatives. According to some political writers, the term is strictly appropriate only where "a majority of the adult males" share in the government. In Aristotle's view of governments, democracy is a perversion of the imaginary system, which he terms Politeia, or commonwealth par excellence; in which the majority are supposed to govern for the good of the whole, while in democracy they govern for their own. *See* REPUBLIC.

DE'MOGO'RGON. (Gr. δαιμων, *a demon*, and γοργος, *terrible.*) In Mythology, a mysterious divinity of antiquity, of whose origin, attributes, and history no satisfactory account can be given, in consequence of the obscurity in which they are enveloped. By some writers he is regarded as the author of creation; others consider him to have been a famous magician, to whose spell all the inhabitants of Hades were subjected; but all concur in viewing him as an object rather of terror than of worship: hence in the *Paradise Lost* (Book 2.), Milton speaks of

> ——— the dreaded name
> Of Demogorgon.

For further information the reader is referred to one of the most learned works of any age or country, the *Dictionnaire de Trevoux*.

DE'MOISELLE. In Zoology. *See* GRINDAE.

DE'MON. (Gr. δαιμων, *a spirit.*) The existence of invisible beings of superior powers and intelligence to mankind, though inferior to the Deity, has been an article of belief among all heathen nations. They have varied, however, in the dispositions they have assigned to them. The Greeks, from whom we derive the term in Scriptural language, applied it originally to the deified spirits of departed heroes, whom they supposed to have some influence in promoting the good of mankind, and considered therefore as objects of adoration. The manner, however, in which demons are represented in Scripture as evil spirits inflicting injury on men at the suggestion of the Father of Evil, is conformable to the oriental notion upon such points; except, indeed, that in the Scriptures the general supremacy of God, who suffers evil to exist, is maintained, in opposition to the eastern dogma of the eternal and equal conflict of the good and the evil principles. The early fathers indulged in much speculation upon these subjects; but in modern times the literal interpretation of the agency of demons as referred to in Scripture has been frequently called in question. The demons, like the fairies and goblins of other mythologies, are represented with various characters of beneficence, malice, and wanton mischief. They were sometimes distinguished by the names Cacodemon and Agathodemon (from κακος, *bad*, and αγαθος, *good*), according as their influence was evil or beneficent.

DEMO'NIACS. Persons possessed by or under the influence of demons or devils, of whom mention is made in some passages in the New Testament. Some divines have supposed that such influence was permitted to the powers of evil at one particular time for the greater manifestation of our Lord's authority in rebuking them: but it is certain that the idea of demoniacal possession was very ancient among the oriental nations; and those to whom it seems incredible that it should have been grounded on fact, must be content with interpreting such passages of Scripture as a concession to the opinions and feelings of the Jewish people.

DEMONO'LOGY. (Gr. δαιμων, *deity* or *dæmon*, and λογος, *discourse.*) The belief in an intermediate race of beings, between deity and humanity, has been a prevalent feature in almost every popular creed; and all tradition or speculation respecting it may be said to fall under the general term of Demonology. Among the early oriental nations, especially the Persians and Egyptians, the science of astronomy appears to have been essentially connected with this branch of superstition; the heavenly bodies were honoured as dæmons or celestial intelligences. This ancient belief appears to have had much influence on the Jewish rabbinical writers; and out of it, connected with what is revealed to us in the Old Testament of the existence and attributes of angels, they framed their peculiar mythology.

The Greek word δαιμων, *dæmon*, is said to be derived from δαημων, *knowing* or *intelligent*. In the earliest monuments of the language, its signification is vague and uncertain. In Homer it generally signifies a deity: δαιμονιον is anything godlike, wonderful, which may have been communicated or inspired by a deity; but, in the *Odyssey*, some traces are to be found of the meaning "fortunate" or "unfortunate" attached to the word. In Hesiod, however, we have an express mythological account of the dæmons,—as spirits, in a state between mortality and divinity, peaceful and favourable to man: he describes them as of different orders. The mortals who lived in the golden age have become dæmons of the first rank; those of the silver age have inferior honours, and are mortal, although their life is prolonged to a length of many hundreds of human generations. The heroes form a still inferior class of intermediate spirits. In popular language, when hero-worship became widely spread in Greece, the word hero and dæmon were used without much distinction; but the more recondite difference appears to have been this,—the hero was the departed worthy himself, such as he had once lived on earth; the dæmon was his immaterial part, converted into a sort of abstract principle,—a spiritual agent of good or evil, favourable or unfriendly to mankind. It is in this sense also that the inferior deities themselves are designated as dæmons. Thales is said to have defined more accurately the difference between gods, heroes as the souls of deceased mortals, and dæmons properly so called; and in Plato's theology the dæmons occupy an important place—as intermediate spirits, closely watching over, directing, and recording the actions of mortals. By later writers they were divided into many classes: some ministers of punishment and revenge, some freeing from evils already befallen (λυσιοι), some warding off their approach (αλεξικακοι), &c. It was in Egypt and Syria, under the Ptolemies and Seleucidæ, that the Grecian philosophy and mythology came in contact with those of the Rabbis; and from that union a new mixed system of dæmonology took its origin. Hence, in the Greek of the New Testament, the word δαιμονιον is taken, without addition or qualification, as an evil spirit, and rendered by our translators "devil."

Analogous to the dæmons of the Greeks were the genii of the Romans; but there were peculiar and characteristic features about the belief in the latter which show it to be of a different origin, probably derived from the Etruscans, who, as some antiquarians believe, drew their mythology from the ancient source of Samothrace. The genii of the Romans were an innumerable host of spirits: every man, house, or city had an attendant genius. The genius of every mortal is mortal as himself; accompanies him into life, and conducts him in all its vicissitudes. In this sense, the genius was a favourable companion: to enjoy the good things of life is represented as "indulging" or gratifying the genius; abstaining from them, as "defrauding" him. Wine and flowers are appropriate offerings to him. But he is also "vultu mutabilis, albus et ater:" he is the companion of the mischances as well as the pleasures of life; unless, as the difficulty appears sometimes to have been solved, the individual had his *pair* of genii, good and bad. And this latter should appear to have been the popular belief among the Etruscans, as far as we can collect it, in a subject where all is vague and indistinct; and it is impossible accurately to separate the abstract creations of philosophers and poets from the substantive objects of general belief. The Etruscans represented the evil genius as a dark and frightful figure, attending a mortal on one side, who is protected or followed on the other by a child or youth—the usual emblem of the good genius. The genius is often represented on vases and in ancient paintings as a winged figure; and a genius holding a torch downwards is the emblem of death.

The dæmons of the middle ages were simply fallen angels or devils, according to the sense of the word in the New Testament; and hence demonology, in the language of modern writers, generally signifies the history of the supposed nature and properties of such evil spirits, and of the modern superstition respecting compacts between them and mankind. *See* MAGIC, WITCHCRAFT.

DEMONSTRA'TION (Lat. demonstro, *I show*), was used by the old writers to signify "any manner of showing either the connection of a conclusion with its premises, or that of a phenomenon with the asserted cause; but it now means, in philosophical language, only that process by which a result is shown to be a necessary consequence of the premises from which it is asserted to follow, on the supposition that those premises are admitted, either as matter of fact, or of intuitive evidence, or of previous demonstration." Demonstration is also used in ordinary language as synonymous with *proof:* thus it is often said that "evidence amounts to demonstration."

DEMONSTRATIONS, in a Military sense, are manœuvres practised for the purpose of misleading the enemy.

DE'MOS. (Gr. δημος.) In Ancient History, a borough or ward; an Attic word, denoting one of the districts into which Attica was divided, and which in early times were bound together by the ties of common blood, but were not united closely into one nation till the time of Theseus, who fixed on Athens as the nucleus of the state.

DEMU'RRAGE. In Mercantile Law, the delay which a merchant makes in loading or unloading a ship, beyond the time specified in his charter-party, or other agreement with the owners; in which it is usually stipulated that

he shall pay at a certain rate per diem for such extra time, which payment is also termed demurrage.

DEMU'LCENTS. (Lat. demulceo, *I soothe.*) Medicines which sheathe and defend sensible parts from the action of irritating matters; they are chiefly mucilaginous substances, such as gum, starch, &c.

DEMU'RRER. (From the Lat. demoror, *I delay.*) In Law, an issue between plaintiff and defendant on matter of law. It confesses that the facts are true as stated by the opposite party, but denies the legal consequences inferred by the opposite party from these facts. Demurrers are either general or special. (*See* PLEADING.) Demurrers in equity are of the same nature with those at law. Demurrer may be also to an indictment in criminal cases.

DEMY. *See* PAPER.

DENA'RIUS. A Roman silver coin worth ten asses originally, and afterwards considered equal to eighteen asses, when the weight of the latter coin was reduced to one ounce.

Originally the denarius was $\frac{1}{100}$ of a pound of silver, but its weight varied. Its value is considered equal to $7\frac{3}{4}d.$ of English money.

There was also a gold denarius equal in value to wenty-five silver ones.

DENDRO'DOA. (Gr. δενδρον, *a tree*, and ωον, *an egg.*) The name of a subgenus of Ascidians, or fixed tunicated Mollusks, suggested by the ramified form of the ovarium; but this structure is not peculiar to the species included in the genus so designated.

DE'NDROMYS. (Gr. δενδρον, and μυς, *a mouse.*) A South African genus of Rodentia, nearly allied to the true mice, but differing in the habits of the species, which frequent the branches of trees, in which they construct their nest and bring forth their young.

DE'NDROPHIS. (Gr. δενδρον, and οφις, *a serpent.*) A genus of harmless serpents of the great family of Colubers, remarkable for their long and slender body.

DE'NIZEN. (Welsh dinassdyn, *man of the city.*) In Law, an alien born, who has received ex donatione regis letters patent to make him an English subject. He may take lands by purchase and devise; but cannot enjoy offices and trusts, &c., or receive a grant of lands from the crown.

DENOMINA'TOR. A term used in Arithmetic, in speaking of fractions, to denote the number of parts into which the unit or whole is divided. Thus, for example, in the fraction $\frac{7}{12}$ (seven twelfths) of a foot, 12 is the denominator, and indicates that the unit or one foot is divided into 12 equal parts; and 7, the numerator, shows how many of these parts are to be taken. The denominator always indicates unity, for the whole is equal to all its parts. A fraction may always be regarded as a whole number, whose unit is a part of the primitive unit, which part is expressed by the denominator. Thus, in the fraction $\frac{7}{12}$ of a foot, the foot is supposed to be divided into *twelfths* or inches; and $\frac{7}{12}$ expresses the same thing as 7 inches, or the particular unit, an inch, taken seven times.

DENOU'EMENT. (Fr.) A term completely naturalized in England; used to designate the development of the plot or story in a novel or play, and in short in every department of literature.

DE'NSITY (Lat. densus, *thick*), is used in Physics to denote the quantity of matter which a body contains under a given or determinate surface; for example, a cubic foot. The quantity of matter in any body is called its mass, and is measured by the weight of the body, to which it is always proportional. Hence the density of any body is great in proportion as its weight is great and its volume small; or, the density of bodies are directly as their masses, and inversely as their volumes. It follows also from the definition, that if two bodies have the same volume, their densities are directly as their masses or weights; and that if two bodies have the same mass or weight, their densities are respectively in the inverse ratio of their volumes. The density of a body is also proportional to its specific gravity.

DE'NTAL FO'RMULA. (Lat. dens, *a tooth.*) A notation used to signify the number and kind of teeth of a mammiferous animal, and usually forming the main element in its generic character. Thus the cats, or genus *Felis*, are characterized by incis. $\frac{6}{6}$; canin. $\frac{1}{1},\frac{1}{1}$; præmol. $\frac{2}{2},\frac{2}{2}$; mol. $\frac{2}{1},\frac{2}{1} = 30$; which signifies that they have six incisores in both the upper and the lower jaw; one canine tooth on each side of both jaws; two præmolares, or false molares, on each side of each jaw; two true molares on each side of the upper, and two on each side of the lower jaw. The dental formula of man is — incis. $\frac{4}{4}$; canin. $\frac{1}{1}$; præmol. $\frac{2}{2},\frac{2}{2}$; molares, $\frac{3}{3},\frac{3}{3} = 32$.

DENTA'LIUM. A genus of Mollusks inhabiting elongated univalve shells, resembling an elephant's tusk in miniature, whence the name.

DE'NTATE. (Lat. dens.) In Zoology, the margin of a part of an animal is so termed when it is cut into teeth whose sides are equal, or nearly so.

DENTA'TUS. (Lat. dens.) Toothed; applied to the margins of bodies furnished with sharp teeth with concave edges.

DE'NTES (Lat. *the teeth*), properly so called, are parts peculiar to the vertebrate animals, composed of gelatin, hardened principally by the phosphate of lime, and are fixed to the bones of the mouth. They serve to catch, kill, hold, pierce, cut, or crush the objects of food, and are variously shaped accordingly. Substances composed of softer material, generally horn, perform the analogous offices in the invertebrate animals, and are generally called teeth; horny material is substituted for teeth in a few fishes, in chelonians, birds, whales, and the *Ornithorhynchus paradoxus*.

In fishes the teeth may be situated on the intermaxillary, maxillary, mandibular, palatine, vomerine, pterygoid, hyoid, or pharyngeal bones; in a few instances they are implanted in sockets or "alveoli," or they may be fixed to an osseous base which is attached by ligamentous substance to the oral bones; but most commonly they are immediately anchylosed, or joined by a direct continuation of bony substance, to the bones themselves which encompass the mouth.

In reptiles the teeth may be found on the palatine, pterygoid, or vomerine, as well as on the maxillary and intermaxillary bones. They are generally anchylosed, or confluent with the substance of the jaws; but in the plesiosaurs and crocodiles are implanted in sockets.

In mammals the teeth are confined to the maxillary and intermaxillary bones, are always implanted in sockets, and in this class only may be so fixed by more than one fang or root.

Teeth generally consist of three distinct substances; viz. ivory, enamel, and bone, or cæmentum, also called crusta petrosa.

The texture of the ivory is minutely tubular, that of the cæmentum of combined tubules and cells; and the earthy material is arranged principally in these cavities, which have definite arrangement and proportions in each species of animal. The enamel consits of hexagonal filamentary crystals.

In the human subject the teeth are called, according to their figure, "incisors," "canines," "bicuspids," and "molars;" the same terms have been transferred to the teeth of the mammalia generally, except that those which are analogous to the bicuspids in man are called "præmolars," or spurious molars. A tooth is divided into a crown, a neck, and a fang or fangs.

The vascular bodies concerned in their development are called "pulp" and "capsule:" the ivory or body of the tooth is formed by the former, the enamel and cement are due to the latter organ.

In most cases when the pulp has secreted as much ivory as forms the full-sized crown of the tooth, it begins to diminish in size; and as it continues to exercise its function during the progress of its absorption, a gradually decreasing fang is the result: when the absorption of the pulp, instead of being general, proceeds from two or three parts, a corresponding number of fangs are extended from the crown. But sometimes the pulp retains its full size and activity during the lifetime of the animal, in which case the part of the tooth lodged in the socket presents the same size and form as the protruded crown, of which it is a direct continuation. The fore teeth of the rat, beaver, and other rodents are familiar examples of these constantly growing teeth. But this is not the only mode in which excessive wear and tear of the teeth is provided for. In the elephant when one grinder is worn down it is pushed out, and replaced by a second of subsequent formation; these successional teeth, or "dents de remplacement," as they are termed by the French anatomists, are formed in the elephant, each in a cavity at the back part of the jaw, behind the tooth which they are destined to succeed. In other animals again, the teeth which suit the size of the jaws when young are pushed out by others which are proportioned to the size of the full-grown jaws; these, which are termed "permanent teeth," succeed the "deciduous teeth" in the vertical direction, being developed in the substance of the jaws above the deciduous teeth in the upper, and below the deciduous teeth in the lower jaw. As the deciduous series of teeth are generally developed in the mammalia at the period when the young animal is suckling, they are commonly called "milk" teeth; but as in some rodents deciduous teeth are formed and shed before birth, they might be termed "uterine" teeth. Thus teeth may succeed each other in the horizontal or vertical direction. In the human subject all the deciduous teeth are succeeded vertically; but the additional teeth follow each other from behind forwards. In mammalia a tooth has not more than one successor in the vertical direction, but in reptiles and fishes there may be many such.

It is a singular but constant fact, that in mammalia the permanent molar always presents a more simple crown

than the deciduous one which it has replaced; thus, in man, the quadricuspid milk grinders are succeeded by the permanent bicuspides.

DE'NTILS. (Lat. dentes, *teeth.*) In Architecture, small square blocks or projections in the bed mouldings of the cornices in the Ionic, Corinthian, Composite, and occasionally Doric orders. Their breadth should be half their height; and, according to Vitruvius, the intervals between them should be two thirds of their breadth. In the Grecian orders they are not used under modillions.

DE'NTIRO'STRES. (Lat. dens, and rostrum, *a beak.*) The name of a tribe of Insessorial birds, characterized by having a notch and tooth-like process on each side of the margin of the upper mandible. In connection with this organization the Dentirostral birds manifest rapacious habits, and prey on smaller and weaker birds. The butcher-birds belong to this tribe.

DENTI'TION. (Lat. dens.) The cutting of the teeth. At birth the teeth consist of pulpy rudiments buried in the gum; and it is not till the third or fourth month that they begin to assume shape and hardness. At this period children generally become fretful; the saliva flows copiously, and they are fond of biting upon any thing hard and cold; the gums become turgid; there is more or less fever, frequently a cough; and a rash appears, commonly called the *red gum.* These symptoms generally subside in the course of a fortnight or three weeks, and the child remains tolerably free from uneasiness till the seventh or eighth month, when the gums become tender; and often so much so, at some particular spot, that the slightest touch or pressure produces extreme pain: the gums become more red and swollen, but paler at the upper part, which, just before the tooth appears, becomes blistered. During these periods an increased flow of saliva and a lax state of bowels are favourable symptoms; but where the local irritation is considerable, the gums should be freely lanced, and any excessive diarrhœa should be very cautiously checked: small doses of magnesia, or of chalk julap with dill water, and occasionally with a little powdered rhubarb, will generally be sufficient for this purpose. When involuntary motions of the jaws and face, or more general convulsions ensue, and are not relieved by the loss of blood which generally follows proper lancing of the gums, or where there is drowsiness and oppressed respiration, a leech or two to the temples, and a small blister to the back of the neck, or behind the ear, must be promptly resorted to; and any sluggishness of bowels prevented, or even anticipated, by a little calomel and rhubarb, or some other active purge. Very mild opiates, very cautiously administered, may afterwards prove necessary; but the administration of these in any form to young children requires the utmost caution, and syrup of poppies and other soothing remedies should never be entrusted to the nurse. The period of teething in children cannot be too scrupulously watched over, as the irritation which then ensues seems not unfrequently to lay the foundation of water in the head, especially where there is a predisposition to that disease.

DENUDA'TION. (Lat. denudo, *I lay bare.*) In Geology, the removal of part of the land, so as to lay bare inferior strata.

DENUDA'TUS. (Lat.) Naked. In Botany, applied to the polish or texture of bodies, and denoting the reverse of hairy, downy, or any similar term.

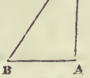
DEO'BSTRUENTS. Medicines which remove obstructions. The term is often used in reference to the removal of glandular complaints.

DE'ODAND. (Lat. Deo dandum, *to be given to God.*) At Common Law, every personal chattel which has been the immediate occasion of the death of a human being is forfeited to the king on the finding of a coroner's inquest; to be applied as alms by his almoner. Where a thing not in motion is the cause of death, it has been held that the part only which was the immediate cause is forfeited; as the wheel of a cart, where a man meets his death by climbing on the wheel at rest and falling from it: if in motion, the whole; as, the whole cart, where the wheel goes over him. However, juries have for a long time past taken on themselves to assess a sum of money, as the value of the thing forfeited; which has become in practice very arbitrary, and usually, but not always, trifling. In this way coroners' juries have to a certain extent usurped a power which the principle of the law by no means entrusts to them; viz. of imposing a fine where they believe negligence to have caused death. By 3 & 4 W. 4. c. 99. s. 29. coroners are to make out and transmit to the treasury an account of deodands.

DEONTO'LOGY. (Gr. δέον, *due*, and λόγος, *discourse.*) The science of duty; a term assigned by the followers of Jeremy Bentham to their own doctrine of ethics, which is founded on the tendency of actions to promote happiness. (See *Bentham's Deontology, init.*; also Mr. Whewell's Preface to *Sir James Macintosh's Dissertation on Ethics*, Edinb. 1836; and art. ETHICS in this work.)

DEPA'RTMENT. (Fr. departir, *to divide.*) In Geography, a territorial division of the kingdom of France. Before the first revolution, France was divided into 37 generalities, or governments, each of which was subdivided according to local custom into districts, bearing various names; and the laws regulating property in each were subject to extremely complicated varieties. The plan of a new division into more convenient portions was first conceived by the Constituent Assembly in 1787, and carried into effect in 1790. Mirabeau proposed the formation of 120 departments; but the actual number formed was 80, afterwards increased by subdivision to 83. M. Belleyme, geographical engineer, was the chief agent in the work. In tracing the limits of the departments, the subsisting divisions of provinces and generalities were maintained to a certain extent; but the chief object was to render them nearly equal on an average repartition of size and population, so that the more populous departments are in general smaller; but the division is by no means uniform. The names of the departments are chiefly taken from rivers, mountains, or other well-known geographical objects. In 1808, the number was increased by conquest to 127, including 12 for the colonies. These last were subsequently retrenched; but in 1811, when the empire extended from Rome to Hamburg, the total number was 130. At present France has 86 departments. Each is administered by an officer named by the government with the title of Prefect, and subdivided into *arrondissments* and *cantons.*

DEPA'RTURE. A nautical term, used to denote the distance a ship has gone to the east or west of the meridian from which she departed. The difference of meridians being first found in degrees, the departure must be estimated by the number of miles in a degree of the parallel of latitude where the ship is. In *Mercator's Sailing*, the departure is represented by the base A B of a right-angled plane triangle, A B C; of which the angle at C opposite the base is called the *course*, and the hypothenuse B C is the *distance sailed.* Hence the theorem for finding the departure: — As radius is to the sine of the course, so is the distance run to the departure.



DEPHLEGMA'TION. The operation of freeing spirit of wine and certain other fluids from the water which they usually contain. A very strong and pure spirit is often said to be highly *dephlegmated.*

DEPHLOGISTICA'TION. (Lat. de, *down*; and Gr. φλογιστος, lit. *burned up.*) A term applied by the older chemists to certain processes by which they imagined that phlogiston was separated from bodies. They regarded oxygen as common air deprived of phlogiston, and hence called it *dephlogisticated air.*

DEPI'LATORY. (Lat. de, *from*, and pilus, *hair.*) Any application which removes hair from any part of the body. The celebrated Turkish Depilatory is a mixture of 7 parts of quicklime and 1 of orpiment. The latter ingredient is probably useless; for when powdered quicklime is made into a thin paste with water, and applied by a camel-hair pencil to any part till it produces a tingling or burning sensation, on wiping it off with a wet sponge the hair, especially if it be soft and delicate, is removed with it.

DEPLOY. (Fr. deployer, *to expand.*) In the art Military, the expansion of a body of troops previously compacted in column, so as to present a larger front; generally for the purpose of performing some evolution, or of forming into line, or of directing an attack in some quarter least expected by the enemy.

DEPORTA'TION. In French law, a punishment equivalent to transportation in English. It is ranked as third in degree; after capital punishment, and condemnation to the galleys or public labour (travaux forcés) for life. Deportation for political offences was a common punishment at one period during the French revolution; especially after the fall of Robespierre and his party. It was then usually executed by conveying the criminals to Cayenne in South America.

DEPOSI'TION. In Law, the testimony of a witness, put down in writing, in answer to interrogatories legally exhibited for that purpose. In the court of chancery such depositions form the established medium of proof; and the interrogatories are exhibited, in London by the examiners, in the country by commissioners appointed for that purpose. Depositions in civil actions, in the courts of common law, are regulated by the stat. 1 W. 4. c. 22. By 7 G. 4. c. 64. the examination of the prisoner and witnesses before a magistrate on a charge of felony must be taken down in writing, and returned to the court. If duly taken, these depositions are evidence at the trial under certain restrictions.

DEPO'T (Fr.), is used to designate a place where all sorts of military stores and provisions are kept, or where recruits are received and trained. It is also applied to that portion of a regiment which remains at home when the rest is ordered upon foreign service.

DEPRE'SSED. (Lat. deprimo, *I depress.*) In Zoology, the whole or part of an animal body is so called when its vertical section is shorter than the transverse.

DEPRE′SSION OF EQUATIONS, in Algebra, is the reduction of equations to a lower degree, by dividing them by one or more of their component factors. It is only in a few cases that equations, whose roots are unknown, can be thus depressed. 1st, When some particular relation subsists between two (or more) of the roots; for example, if an equation contain equal roots these may be found, and the equation reduced as many dimensions lower as there are equal roots. 2d, If two roots of an equation be of the form $+a$, $-a$, differing only in their signs, they may be found, and the equation depressed. 3d, If the equation is reciprocal, that is to say, such that its form is not changed by changing x into $\frac{1}{x}$, then it is susceptible of depression. The methods by which these classes of equations are depressed are to a certain point to be regarded as a branch of the transformation of equations, since the general object of the theory is to make the solution of an equation depend on the solution of another more simple. (See *Bourdon's Algebra.*)

DEPRE′SSION OF THE HORIZON, or DIP OF THE HORIZON, in Nautical Astronomy, denotes the depression or dipping of the visible horizon below the true horizontal plane, and which arises from the circumstance that the eye of the observer is not placed on the same level with the surface of the sea, but at some distance above it. Hence in observing the altitude of the sun or a star above the horizon with the sextant, the altitude appears greater than it really is. Let $a =$ the radius of the earth, and $x =$ the height of the eye above the horizon; then the cosine of the angle of depression $= \dfrac{a}{a+x}$. At the height of 10 feet this amounts to about three minutes of a degree.

DEPUTA′TION (Lat.), is applied to a certain number of persons selected from a company or body, and appointed to lay before a sovereign, an assembly, a minister, or other public functionary, a statement of the views of the selecting party relative to any question, or to prosecute any affair in their name.

DE′PUTIES, CHAMBER OF. The lower of the two legislative chambers in France. The right of election to the Chamber of Deputies is in persons of 25 years of age, paying 200 francs of direct contributions; *i. e.* the land tax, personal tax, door and window tax, and a few others: officers in the army and navy, and members and correspondents of the Institute, are only required to pay 100 francs. The list of electors is made out by the mayors of the communes annually, and revised by the prefect; subsequent claims are judged by the prefect in council, and, in the last resort, by the Cour Royale. There are 459 members of the chamber, each elected by a separate electoral college: the election is by ballot. To be eligible to the chamber, the candidate must be thirty years of age, and pay 500 francs of direct taxes. The total number of electors in 1838-39 amounted to 197,598. The duration of the chamber is triennial.

The Chamber of Deputies is divided into nine bureaux; which are renewed every month. To these bureaux questions are referred by the chamber; as well laws proposed by the king or the house of peers as propositions of individual members. The bureaux report on the question, after separate discussion in each, before the general discussion in the chamber begins. Except in case of dissolution, measures commenced in one section pass on to the next in the same stage in which they have been left. The vote on a proposed law is secret, on any other proposition open.

The "coté droit," "coté gauche," and the "centres," form the three grand divisions of which the Chamber of Deputies is composed. When the three chambers of the States-General of 1789 were consolidated into one by the designation of the National Assembly, the most distinguished members of the aristocratic and republican parties were in the habit of sitting together, for the purpose of communicating more easily with one another: the former occupied the benches to the right, the latter those to the left of the president's chair; while the centre benches, or those fronting the president's chair, were filled by those who held various intermediate shades and modifications of opinion. This custom remains in force at the present day, and nothing can exceed the nicety with which each variety of political opinion is grouped in the French representative assembly. The coté droit, or the side to the right of the president's chair, is occupied by those members who incline to favour the royal prerogative; the coté gauche, on the other hand, is set apart for those who are more in favour of popular ascendency; while those members who, with considerable difference of opinion among themselves, generally support the ministers, occupy the "centres" (centre droit et centre gauche), which may thus be termed the ministerial benches. But, it has been judiciously remarked, "as in every great political party there are shades of opinion, some being more warm and violent, and others more moderate, discriminating, or cautious, so both the coté droit and the coté gauche are generally subdivided into three sections each. The more zealous royalists take their seats at the outer extremity of their side of the house towards the president, and are styled the "extrême droit;" the ultra liberals sit on the corresponding seats on the opposite or left side, and are styled the "extrême gauche." For a more minute view of this arrangement, and an account of the various changes which these different divisions have undergone, see the *Encyclopédie des Gens du Monde*, and the *Penny Cyclop.* art. "Coté Droit."

DE′RBYSHIRE SPAR, *Fluor Spar*. It is of various colours; and the large nodules, which are peculiar to Derbyshire, are often beautifully veined, and admit of being turned in the lathe into vases and small columns. A fine variety of this spar occurs in Cumberland, in cubic crystals of a pale sea-green colour. The cube is the most common form of the crystals of fluor; but it also occurs in octohedra, some fine specimens of which have been found associated with galena in the mine of Beer Alston upon the Tamar. It consists of fluorine and calcium.

DERM. (Gr. δερμα, *skin.*) The true or organized layer of the tegumentary covering of animals. It is composed of a close and irregular network of whitish fibres, consisting of condensed cellular tissue, whence it is also termed "corium," and is every where traversed by capillary arteries and veins, absorbents and nerves; and, in the mammalia, with the roots of the hairs and the ducts of the sudorific follicles: it is covered with the "rete mucosum" and "epiderm." The derm is of considerable thickness in the rhinoceros, hippopotamus, elephant, &c.; whence the name "Pachyderma," applied to the order containing these and allied quadrupeds.

DERMA′PTERANS, *Dermaptera.* (Gr. δερμα, and πτερον, *a wing; skin-winged.*) An order of insects dismembered from the *Orthoptera* of Latreille, and including those which have the elytra wholly coriaceous, and always horizontal; the two membranous wings are folded longitudinally, and the tail is armed with a forceps. This order is represented by a single Linnæan genus, — viz. *Forficula*, or earwig; insects which are common in damp places, and often found in numbers under stones, and beneath the bark of trees: they do much damage in gardens by preying upon the fruit. The English common name, and also the French, "pierce-oreille," relate to a habit absurdly attributed to these insects of penetrating the ears.

DE′RMATOBRA′NCHUS. (Gr. δερμα, and βραγχια, *gills.*) A genus of Gastropods, or snails, in which the branchiæ consist, as in *Scyllæa*, of ramified productions of skin.

DERMATO′LOGY. (Gr. δερμα, and λογος, *a discourse.*) A treatise or history of the skin and its diseases.

DERME′STES. (Gr. δερμα, and εσθιω, *I eat; skin-devourers.*) The name of a Linnæan genus of Clavicorn Coleopterous insects, noted for their ravages on dead animal substances, especially the preserved skins of animals, and which are consequently the pests of a museum. The old genus *Dermestes* is subdivided in modern entomology into several subgenera. The "bacon-beetle" (*Dermestes lardarius*) is the type of that to which the term *Dermestes* is now confined.

DE′RMOBRA′NCHIATES, *Dermobranchiata.* (Gr. δερμα, and βραγχια, *gills on the skin.*) The name of a family of Gastropods, comprehending those which respire by means of external branchiæ or gills, having the form of membranous plates, filaments, or tufts.

DE′RMOSKE′LETON. (Gr. δερμα, and σκελετόν, *the dried remains of a body, or the skeleton; skin-skeleton.*) A term applied to the coriaceous, crustaceous, testaceous, or osseous integument, such as covers most invertebrate and some vertebrate animals; it serves more or less completely the offices of protecting the soft parts of the body, and as a fixed point of attachment to the moving powers.

DE′RRICK, in Nautical language, used in a variety of meanings, but chiefly for a tackle used at the outer quarters of a mizen-yard, consisting of a double and single block connected by a fall.

DE′RVISE. (From a Persian word signifying *poor.*) The name of certain classes of religious persons among the Mohammedans of Turkey and Asia. They live partly in monasteries, partly alone, either stationary or wandering; and belong to a great variety of orders, of which there are thirty-two (it is said) within the Turkish empire only. It is impossible to determine the period to which the origin of the dervises is to be referred. As in most other countries, there has existed in Persia from time immemorial a class of enthusiasts, who, impressed with the conviction that poverty is the only passport to virtue, and that the privations of this world will be commensurately compensated in the world to come, have voluntarily renounced all the comforts, luxuries, and charities of this life, and devoted themselves entirely to religious exercises. In most instances, however, such enthusiasts have been more famed for the theory than the practice of sanctity; and the dervises do not appear to form an exception to the rule. Their public religious

exercises are disfigured by the grossest fanaticism and buffoonery; and their private life is said to be marked by great hypocrisy and licentiousness. (*D'Herbelot, Bibl. Crit.*)

DESCANT. (It. descanto.) In Music, composition in several parts. It is either *plain*, which consists in the orderly placing of many concords answering to simple counterpoint; *figurate* or *florid*, wherein discords are employed; or *double*, where the parts are so contrived that the treble or any high part may be made the bass, and the contrary.

DESCE'NT. In Law, if a person die seised in fee-simple, otherwise than as a joint tenant (see *post*), of lands or tenements which he has not disposed of by will, they will descend to his heir. Such seisin is either actual possession or virtual; as, possession by the tenant of a chattel interest, whose possession is always held to be the same with that of the remainderman, or reversioner, who is to succeed him. If a person have become possessed by purchase of lands or tenements in fee-simple, of which, from the nature of the estate, he cannot obtain seisin (as a remainder expectant on a particular estate of freehold), these likewise descend to the heir in case of his intestacy. It is well known that by the common law of England the rules of descent were different from those obtaining in other countries; that a direct lineal ancestor could in no case inherit from his descendant; that brothers and sisters of the half blood, *i. e.* sprung from another mother, or from another father, were also excluded from the succession. These rules have now (by 3 & 4 W. 4. c. 106.) been wholly removed or modified; so that the law of descent recognizes in succession the following heirs: — 1. The eldest or only son, or his issue. 2. The younger son, or his issue. 3. The daughter, or, if more than one, all the daughters as *coparceners* (see *post*) and their issue; such issue claiming *per stirpes*, not *per capita*, *i. e.* claiming only the share of their respective mothers. 4. In default of lineal descendants, the nearest lineal ancestor now succeeds, in preference to any person who would have been entitled to inherit either by tracing his descent through such lineal ancestor, or in consequence of there being no descendant of such lineal ancestor; *e. g.* a father inherits before a brother, a grandfather before an uncle, &c. 5. In default of father, brothers, or sisters of the whole blood and their issue, then the inheritance devolves on the eldest brother or sister of the half blood by a different mother, the half blood following the same rule where the inheritance devolves on the descendant of any other ancestor. 7. On failure of male ancestors on the paternal side and their descendants, female paternal ancestors and their descendants. 8. On failure of these, the mother, her ancestors, — first male, then female, — and their respective descendants. 9. The half blood follow always next after any relation in the same degree of the whole blood and his issue, if the common ancestor be a male; next after the common ancestor, if a female: so that the brother by the half blood on the part of the mother inherits next after the mother. Descent is always traced from the first purchaser; but the last owner is presumed to be the first purchaser unless the contrary can be proved. In some particular localities the custom of gavelkind prevails, by which all the sons inherit equally from the father. By the custom of borough English, the youngest son is heir. Bastards cannot inherit, nor can an alien; but a natural-born subject may derive his title (under certain restrictions) through alien ancestors.

DESCENT, in Mechanics, is the motion of a body towards the centre of the earth caused by the attraction of gravity. The following are the laws of *descent* of bodies: —

1st. Heavy bodies, in an unresisting medium, fall with a uniformly accelerated velocity.

2d. When the action of gravity is uniform, the space passed over in a given time is exactly half that which would be passed over in the same time by the velocity acquired at the end of the time if continued uniformly.

3d. The spaces passed over in different times are proportioned to the squares of the velocities, or the squares of the times.

4th. The time of the oblique descent of a body down any chord of a circle, drawn from the uppermost or lowermost point of the circle, is equal to the time of descent through the diameter of the circle.

5th. The times of descent through all arcs of the same cycloid are equal.

6th. It is found by experiment that a heavy body near the surface of the earth, when allowed to descend by its own gravity, falls through $16\frac{1}{12}$ feet in the first second of time; consequently, by the 2d law, it acquires a velocity in that time which would carry it through 32 feet in a second, if gravity ceased to act. See ATTRACTION, ACCELERATION.

DESCRI'PTION (Lat. descriptio), in Rhetoric, is used to designate such a strong and lively representation of any object as places it before the reader in a clear and satisfactory light. The execution of this task, as is universally admitted, is attended with great difficulty, and requires no ordinary powers. Indeed, such is the importance which some critics of eminence attach to the possession of this quality, that they have erected it into a standard whereby to estimate the productions of genius in every department of literature; and though such a test may seem somewhat arbitrary, yet when we consider the powers indispensably requisite to form a good description, we shall not be surprised to find that amid the galaxy of brilliant productions in other departments with which our literature is adorned, there are so few authors who have attained eminence in this. A good description, according to Dr. Blair, is simple and concise; it sets before us such features of an object as on the first view strike and warm the fancy; it gives us ideas which a statuary or a painter could lay hold of and work after them — one of the strongest and most decisive trials of the real merits of description. Hence among the qualities essentially necessary, and without which, indeed, even mediocrity is unattainable in this walk of literature, are an eye conversant with nature in all her aspects, a strong imagination wherewith to catch her grand and prominent features, and great simplicity and clearness of style to transmit the impression unimpaired to the imagination of others.

There is no species of composition, prose or poetical, into which description does not enter in some shape; but the term has been borrowed from literature generally, and applied more particularly to those poetical productions which are devoted exclusively to the description of nature, such as Milton's *Allegro* and Thomson's *Seasons*. Hence, although Shakespeare may with great justice be styled a descriptive poet, from the exquisite descriptions of nature with which his unrivalled plays are interspersed; yet as his chief excellence lies in pourtraying the character and passions of man, he does not fall, properly speaking, within this category. By no writer, either of antiquity or modern times, was the faculty of description possessed in a more eminent degree than by Sir Walter Scott. All his delineations of natural scenery are executed with an unrivalled fervour of imagination; while at the same time they are marked by such traits of character and truth that every object is brought distinctly before the mind, and might without difficulty be transferred to canvass by the artist's pencil. Under the head "Descriptive Poetry," in *Blair's Lectures on the Belles Lettres*, the reader will find an admirable account of the characteristics of this species of composition, with a critical notice of the most celebrated descriptive poets of all ages and countries.

DESCRI'PTIVE GEO'METRY. A term first employed by Monge, and subsequently by other French geometers, to express that part of science which consists in the application of geometrical rules to the representation of the figures, and the various relations of the forms of bodies, according to certain conventional methods. It differs from ordinary perspective, inasmuch as the design or representation is made in such a manner that the exact distance between the different points of the body represented can always be found, and consequently all the mathematical relations resulting from the form and position of the body may be deduced from the representation.

In the descriptive geometry, the situation of points in space is represented by their orthographical projections on two planes, at right angles to each other, called the *planes of projection*. It is usual to suppose one of the planes of projection to be horizontal, in which case the other is vertical; and the projections are called horizontal or vertical, according as they are on the one or the other of these planes.

According to this system, any point whatever in space is represented by drawing a perpendicular from it to each of the planes of projection: the point on which the perpendicular falls is the projection of the proposed point. As contiguous points in space form a line, so the projections of those points, which are also contiguous, form a line in the same manner, which is the projection of the given line. Hence as two projections only are required for the determination of a point in space, they are also sufficient for the determination of any curve whatever, whether of single or double curvature.

The same mode of representation cannot be employed with regard to surfaces; for as the projections of the contiguous points of a surface cover a continuous area on both planes of projection, there is nothing to indicate that any particular point on one of the planes of projection corresponds to one point more than another on the second plane, and consequently that it belongs to one point more than another in space. But if we conceive the surface which is to be represented to be covered with a system of lines succeeding one another according to a determinate law, then, by projecting these lines on each of the two planes, and marking the correspondence of the one projection with the other, the projections of all the different points of the surface will have an evident dependence on

each other, and the surface will be rigorously and completely determined.

Some elemenatry surfaces may, however, be represented in a much more simple way. The plane, for example, is completely defined by the straight lines in which it intersects the two planes of projection. These lines are denominated the *traces* of the plane. A sphere is also completely defined by the two projections of its centre, and the great circle which limits the projections of its points. A cylinder is defined by its intersection (or trace) with one of the planes of projection, and by the two projections of one of its ends. A cone is represented by its intersection with one of the planes of projection and the two projections of its summit.

The most immediate application of descriptive geometry is the representation of bodies, of which the forms are susceptible of a rigorous geometrical definition. Sculpture, architecture, painting, and all the mechanical arts, the object of which is to give to matter certain determinate forms, borrow from descriptive geometry their graphical procedures, by the aid of which all the parts of an object are faithfully represented in relief before the object itself is executed. But it was chiefly in consequence of its application to civil and military engineering, and to fortification, that this branch of geometry received a distinctive appellation, and was considered of so much importance as to form one of the principal departments of study in the Polytechnic school of France. The best systematic works written on the subject are those of Monge, Hachette, Vallée, and Leroi. A good general idea of the methods of procedure may be obtained from the small work of Lacroix, *Complément des Elémens de Géométrie.*

DE'SERT. (Lat. desertum.) A term generally used to designate an uninhabited place or solitude; in which sense, as has been judiciously remarked, it is equally applicable to the fertile plains watered by the Maranon, and the sandy wastes of Lybia, but applied more particularly to the vast sandy and stony plains of Africa and Asia. In every region of the globe plains are to be found of greater or less extent, which, though marked by strong features of resemblance in their grand outlines, exhibit with the different latitudes in which they are placed a corresponding variety of character, and according to the distinguishing peculiarities of each are known by different appellations. Thus we have the *steppes* of Europe, the *deserts* of Asia and Africa, the *savannahs* of the Mississippi and the Missouri, and the *pampas* and *llanos* of South America. (See these different articles.)

The most striking feature of Africa consists of its immense deserts, which have in all ages presented to the speculations of the geographer objects highly worthy of attention. Of these the chief is the *Sahara*, or *the Desert*, so called by way of eminence. This prodigious zone of sand stretches, with few interruptions, from the shores of the Atlantic to the confines of Egypt, and comprehends in its length and breadth a superficies of about 2,200,000 square miles. The sand raised by the burning wind called the simoom is frequently in a state of motion, and as it sweeps along in its career of desolation bears a strong resemblance to the waves of a tempestuous sea. This immense expanse, however, is by no means a uniform surface of loose sand. In many parts the dreary waste is broken by low hills of naked sandstone, or by tracts of arid clay, and occasionally it is enlivened by verdant isles or *oases*, which serve as resting places for the caravans that traverse these dismal regions. (*Traill's Physical Geog.*) But for these *oases*, indeed, the Sahara would be wholly impassable. It presents, says Malte Brun, no traces of a beaten path; and the caravans that traverse it, directing their way by the polar star, describe a tortuous road in order to profit by the oases, which are represented as brilliant with vegetation, but which probably owe a great part of their reputation to the contrast they form with the absolute barrenness of the desert.

As we have elsewhere remarked (*see* CAMEL and CARAVAN), the camel is the sole medium of the communication between those countries which are separated by extensive deserts. In the beautiful and expressive metaphor of eastern speech, it is "the ship of the desert;" and in truth it is the only ship by which the wilderness can be navigated with certainty and safety.

The great deserts of Africa are only separated from those of Asia by the valley of the river Nile and the Red Sea. But upon this subject we cannot refrain from transferring to our columns the remarks of Dr. Traill, who has sketched with a masterly hand the grand outlines of the Asiatic deserts. "Soon after quitting the Nile, the traveller by the route of Suez encounters sand, which is continued into the centre of Arabia, where it forms the desert of Nedsjed, extending to the valley of the Euphrates. The sandy zone then inclines northward, enters Persia, and forms the saline deserts of Adjemi, Kerman, and Mekran; it is turned north-east by the valley of the Indus, passes through Caubul and Little Bukharia, till it joins the vast deserts of Cobi and Shamoo, which occupy so large a portion of Central Asia between the Altalan and Mustag chains, and reach to the confines of China. The sandy zone, thus traced throughout the breadth of the ancient continent from Western Africa to the 120° of east longitude, has been computed to cover an area of 6,500,000 square miles; but the Asiatic portion of this tract includes many chains of mountains and fertile valleys. It is characterized by the occurrence of arid wastes of sand or clay, sometimes with saline incrustations on the surface, and is remarkably deficient in considerable rivers: except the Nile, the Euphrates, the Indus, and the Oxus, there are no large rivers in a region which embraces almost a fourth part of both Africa and Asia. This portion of Central Asia forms a series of elevated plains 6000 miles in length from east to west. Some of these plains, says Humboldt, are covered with herbage; others produce only evergreen saliferous plants, with fleshy and jointed stems; but a great number glitter from afar with a saline efflorescence that crystallizes in the semblance of lichens, and covers the clayey soil with scattered patches like new-fallen snow." (*Physical Geog.* pp. 21, 22.) Under the head MIRAGE will be found some account of the so called singular optical illusion so often seen in the desert.

In Scripture, the term desert bears a wholly different interpretation from that usually attached to it in profane writings. It has been fully shown by Reland (*Palest.* l. i. p. 375.) that the Hebrew מדבר (midbar), the ἐρῆμος of the Greeks, and the *desertum* or *solitudo* of the Latins bear no analogy to each other; the first being appropriated almost exclusively to those thinly peopled districts of the Holy Land which yielded pasturage for cattle, and were remarkable at once for their beauty and the luxuriance of their vegetation.

DESE'RTER. (Lat.) An officer, soldier, or sailor, who absents himself from his post without permission, and with the intention not to return. The crime of desertion has in all ages and countries been regarded with peculiar detestation. In Greece and Rome, the deserter, during war, suffered death; during peace, was deprived only of civil rights: a sound and enlightened distinction. The military code of Great Britain inflicts "death or such other punishments as may be adjudged by a general court-martial" on deserters; thus leaving a proper discretionary power for the exercise of lenity in cases where the motives to the crime may bear the most favourable construction.

DESICCA'TIVES. (Lat. de, and siccus, *dry*.) In Materia Medica, applications which dry up the secretion of membranes, ulcers, &c.

DESIDERA'TUM (Lat. *wished for*), is used to signify something wanted to improve or perfect any art or science, or to promote the advancement of any object or study whatsoever.

DESI'GN. (Fr. dessin.) In all the Arts, the idea formed in the mind of an artist on any particular subject, which he endeavours to transfer to some medium for the purpose of making it known to others. It is sometimes loosely and improperly used synonymously with drawing.

Every work of design is to be considered either in relation to the art that produced it, to the nature of its adaptation to the end sought, or to the nature of the end it is destined to serve; thus its beauty is dependent on the wisdom or excellence displayed in the design, on the fitness or propriety of the adaptation, and upon the utility of the end. The considerations of design, fitness, and utility, have become the three great sources of beauty of form. This beauty frequently arises from the combined power of these expressions.

Every work of art supposes unity of design, or some particular end proposed by the artist in its structure or composition. In forms considered simply as expressive of design, the only possible sign of unity of design is uniformity or regularity, by which the productions of chance are distinguished from those of design; and without the appearance of this, variety becomes confusion. In every beautiful work of art, we are not satisfied with mere design, — we must have elegant design, of which the grand feature is variety; it is this which in general distinguishes beautiful from plain forms, and without it uniformity is dull and insipid.

The arts of design are usually considered those of Painting, Sculpture, and Architecture; to which, under their several heads, the reader is referred for further information.

DESI'GNA'TOR. (Lat.) In Roman Antiquities, a species of master of the ceremonies, whose duty it was to assign to each person his proper place in the theatres and at the other public spectacles. Officers with this appellation were employed among the Romans on every occasion of public display, and in all domestic solemnities whether of a joyful or mournful character. But the chief occupation of the *designator* consisted in arranging and marshalling the funerals of distinguished persons; and in this capacity he was attended by a troop of inferior officers, all arrayed in black, whose part it was, among other duties, to keep off the crowd, like the lictors of the magistrates. In his brief and elegant description of the

insalubrity of Rome during the autumnal season (*Epis.* i. 7.), Horace thus graphically introduces the designator and his attendants: —

—— dum ficus prima calorque
Designatorem decorat lictoribus atris.

DE'SPOT. (Gr. δεσπότης, *master*.) A name applied to sovereign princes possessing absolute authority. The well-known address of the slave to Hippolytus, in *Euripides* — "O king, for it is fitting to call only the gods despots" (*masters*) — shows the distinction which the republican spirit of the Greeks took between the two titles. The later Greek emperors took the title of despot: which was afterwards, about the eleventh century, given to the son or nearest relation of the reigning prince.

DE'SPOTISM. In Politics, absolute and irresponsible government by a single individual or despot. In popular language, all governments are called despotical that are administered by one individual whose decisions are not controlled by any representative assembly or recognized subordinate authorities. Thus, we are in the habit of saying that the emperors of Austria and Russia and the king of Prussia are despotical or absolute sovereigns; meaning by this, that all legislative and executive measures seem to proceed from their free will. But the abstract idea of despotism goes farther than this; and means a government by a single individual with unlimited power over the lives and fortunes of his subjects. The prophet Daniel, in his description of the Babylonian monarch Nebuchadnezzar, has given what is perhaps the best account of this species of government. "All people, nations, and languages, trembled and feared before him: whom he would he slew, and whom he would he kept alive: whom he would he set up, and whom he would he put down." (Chap. v. 19.)

But though this gives a vivid idea of what is understood by a pure depotism, it can be regarded only as a popular, or rather poetical account, of a government where the sovereign is possessed of great power. The truth is, that a purely despotical government never had, and never can have, any existence in fact. How absolute or despotical soever, all sovereigns must conduct their government so as to procure the concurrence and support of a large, or, at all events, a powerful portion of their subjects. A despot is, after all, merely an individual, and becomes quite powerless when those masses of individuals, in whom the ability to coerce others really resides, disapprove of his proceedings. The prætorian bands in antiquity, the janissaries of Constantinople, and the grenadiers of Petersburg, must, at least, be led by opinion. But though the sanction of the instruments employed in his government be indispensable to the existence of a despot, it is but seldom that he dares trust to it only. The most absolute and tyrannical of the Roman emperors, when they wished to get rid of any obnoxious individual, dared not to order him to be executed, but were obliged to suborn false evidence, and to proceed against him according to legal forms: and so it is in all countries. Were the most absolute sovereign of whom we have any certain accounts openly to seize on the property of any individual in his dominions, or to put him to death without being able to assign some apparently satisfactory grounds for doing so, the foundations of his power would be shaken to the very centre; and the repetition of such conduct would most likely occasion his deposition. The strength of absolute governments, when they embark in oppressive courses, depends on their being able to conceal or pervert the real facts of the case, so that the victims of their tyranny may be made to appear to be the victims of their justice. We may be assured that no ruler of any country emerged from the merest barbarism ever could, for any considerable period, openly commit on his own responsibility any gross injustice towards any considerable portion of his subjects. Those who have done so have rarely, if ever, failed to expiate their folly and tyranny by some signal punishment.

Neither the government of Prussia nor Austria, nor even that of Russia, can be justly called despotical. Their rulers are controlled to a very great extent by the force of public opinion; and are influenced by a much more lively feeling of responsibility than the sovereigns of limited monarchies, or of countries in which the legislative functions are divided. It is this fear of their subjects that makes them so anxious, by laying restrictions on the freedom of the press, to conceal their conduct, or to obtain a favourable judgment upon it. There can be no despotism, nor any considerable approach towards despotical government, where the press is free and the people instructed; and it is to their influence in securing the freedom of the press, and consequently in enlightening public opinion, and making the bulk of the people acquainted with their *real* interests, that the advantage of representative assemblies and of a popular form of government is mainly to be found.

DESQUAMA'TION. (Lat. squama, *scale*.) The separation of layers or scales from the skin or bones.

DESSE'RT. A word of doubtful etymology, signifying the last service at dinner, consisting of fruits and confections, &c. The modern dessert is probably equivalent to the *mensæ secundæ* of the Romans. If we believe Congreve, the term came into use among the French about the commencement of the 17th century, and was soon adopted into and naturalized in most of the European languages. In all the countries of Europe the splendour of the dessert has ever since the period of its introduction kept pace with the progress of refinement and civilization, and by many *gastronomes* the qualities and arrangement of a dessert are looked upon as the most valid test of all that is Attic in taste and refined in elegance.

DESTE'MPER. (Fr. détrempe.) In Painting, a preparation of opaque colour ground up with size and water, used in scene painting. This species of painting is also called, when practised on a small scale, *body colour painting*. Destemper painting differs from fresco painting in that the latter is performed while the walls are still wet, whilst the former requires that they should be dry.

DE'STINY. (Lat. destinare, *to appoint*.) An inevitable necessity depending upon a superior cause. This doctrine has, under a variety of names, been embodied in almost all the religious systems of antiquity; and even in modern times, with a few modifications, it has been largely adopted by many sects of the Christian church. (*See* PREDESTINATION, NECESSITY.) Destiny was called by the Romans *Fatum* (*see* FATES), and by the Greeks Αναγκη, *Necessity*, or Μοιρα, *a Part*, as if it were a chain or necessary series of things indissolubly linked together. According to many of the heathen philosophers, destiny was a secret and invisible power or virtue, which with incomprehensible wisdom regulated all the occurrences of this world which to human eyes appear irregular and fortuitous. The Stoics, on the other hand, understood by destiny a certain concatenation of things, which from all eternity follow each other of absolute necessity, there being no power able to interrupt their connection. (*Rees's Cyclo.*) To this invisible power even the gods were compelled to succumb. Jupiter and Venus are represented by the poets as vainly attempting to withdraw Cæsar from his impending fate; but, as Seneca observes, it is thus that the Ruler of all things, in writing the book of destiny, has prescribed the limitation of his own power: "Scripsit fata; sed sequitur, semper paret."

DESTRU'CTIVE DISTILLA'TION. A term applied to the distillation of organic products at high temperatures, by which the ultimate elements are separated or evolved in new combinations. The destructive distillation of coal is resorted to for the production of gas, and that of bone for the production of ammonia, and of wood for the formation of vinegar.

DETA'CHED. (Fr. detaché.) In Painting, a term applied to all objects in a picture which appear to stand out from those by which they are surrounded. It arises from a due knowledge of aërial and linear perspective.

DETA'CHMENT (Fr. detachement), in Military language, is a certain number of squadrons of cavalry and battalions of infantry, selected from the main body of an army for the purpose of being employed in some particular duty, such as in *foraging*, *escorting*, &c.

DETA'ILS. (Fr. detail.) In the Fine Arts, the parts of a work as distinguished from the whole as a mass. They must always be so kept under as not to interfere with the general effect of the work; neither must they be overlaboured, lest, instead of aiding, they embarrass the work of which they form parts.

DETE'NTS, in Clock-work, are the stops which lock and unlock the machinery in striking.

DETE'RGENTS. (Lat. detergo, *I wipe away*.) Medicines which remove viscidity, and cleanse sores.

DETE'RMINATE PRO'BLEM. In Geometry, is a problem which admits of one solution only, or a limited number of solutions; and is opposed to an *indeterminate problem*, which admits of an indefinite number of solutions.

DETERMINA'TION OF BLOOD. In Medicine and Surgery, when there is apparently a more copious and rapid flow of blood to any part, it is said to suffer under a determination of blood; as to the brain, liver, &c.

DE'TINUE, in Law, is a personal action of contract, and lies where a party seeks to recover goods and chattels, or deeds and writings, detained from him.

DE'TONATING TUBE. A stout glass tube used in the chemical laboratory for the detonation of gaseous bodies. It is generally, as represented in the annexed cut, graduated into centesimal parts, and perforated by two opposed wires, for the purpose of passing an electric spark through the gases which are introduced into it, and which are confined within it over water or mercury. When a detonating tube is used over either of these fluids, the smallest possible quantity of explosive gas should be introduced into it, as in consequence of the expansion which ensues, a portion is apt to be forced out at the moment of the explosion. The tube, when used, should be firmly held; a spring is sometimes substituted for the grasp of the hand, but it is inconvenient.

DETONA'TING POWDER. A term applied in

Chemistry to fulminating mercury and silver, and to other compounds which suddenly explode when struck or heated. Some of these compounds have lately been much used for the ignition of gunpowder in percussion locks.

DETONA'TION. When chemical combination or decomposition is sudden and attended by flame and explosion, it is often said to be effected by *detonation*. If a mixture of hydrogen gas and oxygen be inflamed by the electric spark or by a taper, it burns rapidly and with explosion, and is said to *detonate*. When a grain or two of phosphorus is mixed with chlorate of potassa and struck with a hammer, the mixture detonates.

DETRI'TUS. A geological term applied to deposits composed of various substances which have been comminuted by attrition. The larger fragments are usually termed *debris;* those which are pulverized, as it were, constitute *detritus*. Sand is the detritus of siliceous rocks.

DEUCA'LION. One of the most famous personages of antiquity, the son of Prometheus, and king of Thessaly. The story of the deluge with which Thessaly was inundated during his reign, the preservation of Deucalion with his wife Pyrrha, and the mode by which, in compliance with the injunction of the oracle, they repeopled the world, are too well known to require being dwelt upon in this place. The grand features of the flood of Deucalion, which, as recorded by Ovid and other writers of antiquity, bear so striking a resemblance to the scriptural account of the deluge, are common to the history or the traditions of almost all nations, how remote or barbarous soever. The great Indian poem, *Mahabarada*, for instance, contains a graphic description of a flood, by which, with two exceptions, the whole human race was overwhelmed; and M. Humboldt found on the banks of the Orinooko a similar tradition, which had prevailed among the barbarous natives from time immemorial. In that beautiful ode dedicated to Augustus (Book 1, 2.), in which richness of imagery and elegance of language vie with the loftiest tone of morality, Horace thus alludes to the flood of Deucalion: —

> Terruit gentes, grave ne rediret
> Sæculum Pyrrhæ nova monstra quæstæ,
> Omne cum Proteus pecus egit altos
> Visere montes, &c.

The date assigned to Deucalion by Eusebius is 1541 B.C., by the Parian marbles seven years earlier; but many of the statements concerning him are so obscure, while others are so manifestly mythological, as to leave considerable doubts of his having ever existed. *See* DELUGE.

DEUS EX MACHINA. A scholastic expression, borrowed from the stage. In conformity with the mythological belief of the age, the tragic poets of Greece, and especially Euripides, instead of bringing about their catastrophe by natural means, often resorted to a more convenient expedient — the intervention of a divinity. But when any such intervention, contrary to the maxim ot Horace,

> Nec deus intersit nisi dignus vindice nodus,

took place without an adequate cause, it was injurious to scenic effect; and hence the expression *deus ex machina* originated, the divinity in such a case being nothing more than a *machine*. This expression has also been applied by analogy to those philosophers who, unable to solve a difficulty by ordinary means, have immediate recourse to the aid of a supernatural power.

DEU'TERONOMY. The name given to the last book of the Pentateuch. The term is composed of two Greek words, δευτερος, *second*, and νομος, *law;* and is equivalent to the *Mischna* of the Hebrews, who thus designated the book of Deuteronomy, from its containing a recapitulation of the laws and ordinances scattered over the other books of Moses. *See* PENTATEUCH.

DEUTEROPA'THIA. (Gr. δευτερον, *second*, and παθος, *disease*.) A sympathetic affection of any part; as a headache from an overloaded stomach, or sickness from an injury of the head.

DEU'TOXIDE. A term applied in Chemistry to certain compounds containing *one* atom or prime equivalent of base in combination with *two* of oxygen; in this sense the word is synonymous with *binoxide*. It is sometimes indiscriminately applied to the second degree of oxidizement of which bases are susceptible.

DE'VIL. (Gr. διαβολος, *an accuser*), lit. one "who accuseth us before God day and night." (Rev. xii. 10.) The word bears the same sense as Satan, and is applied in the New Test. to the evil principle, the adversary of man referred to throughout the books of the Old and New Test. under various names and titles, as Satan, Lucifer, Belial, Apollyon, Abaddon, the Man of Sin, the Tempter; and described as an angel who fell from heaven with many inferior spirits, being cast down from thence by God for his pride and rebellious spirit. From that time he is said to have had permission to try and tempt mankind, in which he succeeded in the persons of our first parents, thereby introducing sin and sorrow into the world. He is represented in Job and Zechariah as standing in the presence of the Lord, seeking permission to tempt men. It is manifest that the character herein attributed to the Devil is identical with that of the Evil Principle in the Gnostic and Manichean philosophy, and in the oriental system of religion generally; excepting, indeed, that the scriptures always maintain the inferiority of the evil to the good; but it may also be reasonably inferred that it was held by the Jews anterior to their captivity in Babylon, and the contact into which they then came with the Magian superstitions. Although the serpent who tempted Eve in Paradise is not expressly said to be this Satan or Devil, nor is he at all mentioned by name by Moses, yet the character of the Evil Principle is there vividly delineated; he is also characteristically mentioned in the Psalms, the Book of Job, and the Chronicles.

DEVI'SE, or DEVICE. (Fr. deviser, *to invent, will*, or *imagine*.) In Heraldry, the term Devise is popularly used in the same sense as armorial bearings (which see); but it is more strictly employed to signify a symbol, consisting of a representation of some visible object, and in many instances a motto appropriate to it, used, not by way of heraldic bearing, but according to the fancy of the inventor: sometimes for the motto alone. Monograms are also a species of device. From the word *deviser*, in its ancient signification of *to will*, is derived the Norman French *devise*, a bequest of real property by testament, which is still retained in our law.

DEVISE, in Law, is a gift of lands by a last will and testament. Lands held in fee-simple became devisable, where not so by special custom, by the statute 34 & 35 H. 8. c. 5. By 3 & 4 W. & M. c. 14. devises were made void against specialty creditors. Estates pur auter vie are devisable by stat. 29 C. 2. c. 3. A will of lands formerly only operated on those lands of which the testator was possessed at the time of publishing it. (*See* WILL.) In a devise, the words are, in general, more liberally construed than in alienation by deed. But by the recent Statute of Wills (1 Vic. c. 26.) every will is held to speak, both as to real and personal property, as if executed immediately before the death of the testator.

DEW. (Germ. thau, *moisture*.) The deposition of water from the atmosphere, occasioned by cold. The phenomena of dew have been considered by all writers on meteorology, from Aristotle downwards; but they were first successfully investigated by the late Dr. Wells, who gave the true theory of the meteor in an admirable essay on the subject, first published in 1814.

The circumstances which influence the production of dew are the following: — Dew is never abundant except during calm and serene nights. It is, however, frequently observed in small quantities both on windy nights, if the sky is clear, and on cloudy nights, if there is no wind; but it is never seen on nights both cloudy and windy at the same time. If, in the course of the night, the weather, from being calm and serene, should happen to become windy and cloudy, not only will no more dew be formed, but that which has been already formed will disappear, or at least diminish considerably. In calm weather, if the sky be partially covered with clouds, more dew will appear than if it were entirely covered, but less than if it were entirely clear. A slight motion of the air is rather favourable than otherwise to the formation of dew. On two nights equally calm and serene, the quantities of dew deposited may be very unequal. If rain has fallen recently, it will be formed in abundance; on the contrary, very little will be formed in nights otherwise favourable, if the weather has been dry for some time previously. In general, whatever tends to increase the quantity of moisture in the atmosphere will contribute to render the deposition of dew more abundant. Dew is commonly more plentiful in spring and autumn than in summer; the reason is, that the differences of the temperatures of the day and night are greater in the former seasons of the year than in the latter. It is always most copious on those clear and calm nights which are followed by misty or foggy mornings; the formation of the fog showing that the atmosphere had previously contained much moisture. Dew has been observed to be unusually plentiful on a clear morning succeeding a cloudy night. The notion that dew is only formed in the morning and evening is incorrect; bodies are covered with dew at all hours of the night, provided the sky be serene. In this country dew probably begins to appear upon grass, in places shaded from the sun during clear and calm weather, soon after the heat of the atmosphere has declined; that is, three or four hours after midday. Grass is frequently felt to be moist, in dry weather, several hours before sunset; but, on the other hand, dew is scarcely ever known to be present in such quantity upon grass as to exhibit visible drops before the sun is very near the horizon, or to be very copious till some time after sunset. Other circumstances being equal, less dew is formed during the first half of the night than during the second, although the air at midnight has already lost a certain portion of its moisture.

Polished metals are, of all bodies, those which attract the least quantity of dew. This property of metals is sufficiently remarkable to have led some respectable philosophers to affirm that they are never wetted by dew.

Dr. Wells, however, observed it to form on gold, silver, copper, tin, platina, iron, steel, zinc, and lead; but when dew does form on these metals, it commonly only sullies the lustre of their surfaces; and even when it is sufficiently abundant to gather into drops, these are almost always small and indistinct. Dew which has been formed upon a metal will often disappear, while other substances in the neighbourhood remain wet; and a metal which has been purposely wetted will often become dry, though similarly exposed with bodies that are contracting dew. This inaptitude of the metals to attract dew is communicated to bodies of a very different nature which touch or are near them: for example, wool laid upon a metal will acquire much less dew than an equal quantity laid upon grass in the immediate vicinity; and, conversely, bodies on which the metals are laid have an influence on the quantity of dew which the latter will attract. The metals do not all resist the formation of dew with the same force. Dr. Wells one night saw platina distinctly dewed, while gold, silver, copper, and tin, though similarly situated, were entirely dry; and he several times saw these four metals free from dew, while iron, steel, zinc, and lead were covered with it.

Difference in the mechanical state of bodies, though the other circumstances be similar, has an effect on the quantity of dew which they attract. Thus, more dew is formed upon fine shavings of wood, than upon a thick piece of the same substance. It is chiefly for a similar reason that fine raw silk, fine unwrought cotton and flax, were found by Dr. Wells to attract somewhat more dew than the wool he employed, the fibres of which were thicker than those of the other substances just mentioned.

The quantity of dew which is precipitated on bodies does not depend solely on their nature and constitution, but also on the situation in which they are placed with regard to surrounding objects. As a general principle, it may be affirmed that whatever tends to diminish the portion of the sky which can be seen from the place which the body occupies, diminishes the quantity of dew with which the body will be covered.

Of the Cold connected with the Formation of Dew.—The temperature of grass covered with dew is always lower than that of the surrounding air. On calm and clear nights, Dr. Wells very frequently found the grass 7, 8, or 9 degrees, and on one occasion 14 degrees, colder than the air about 4 feet above the ground. He also observed that in places sheltered from the afternoon sun, but still open to a considerable portion of the sky, the difference between the temperature of the grass and the air begins to be sensible as soon as the heat of the atmosphere begins to diminish. In analogous circumstances, a similar coldness continues on grass, in still and serene mornings, for some time after the rising of the sun. In cloudy nights, particularly if there was wind, the grass was never much colder than the air; sometimes it was even warmer: but in calm weather, very high clouds, though sufficiently extensive and dense to conceal the sky, would yet frequently allow of the grass being several degrees colder than the air. If the night became cloudy, after being very clear, the temperature of the grass immediately became higher. The temperature of metals sometimes falls from 2 to 4 degrees below that of the surrounding air; when this takes place, other bodies, such as wool, swan-down, the leaves of plants, &c., are considerably colder than the atmosphere. The substances which are most easily covered with dew are those which are cooled down the quickest when exposed to a clear sky. Of all substances tried by Dr. Wells, swan-down exhibited the greatest cold; in general, the most productive of cold are the filamentous and downy. Snow, also, is one of those bodies which acquires a temperature very considerably lower than the atmosphere.

Theory of Dew.—Dr. Wells's experiments show that the most perfect analogy subsists between the faculty which bodies possess of attracting moisture from the atmosphere, and the other property which they have of acquiring, in calm and clear nights, a temperature much below that of the surrounding air. But is the cold which is observed on bodies covered with dew the cause or the consequence of the precipitation of the fluid? The latter opinion was maintained by Dr. Wilson of Glasgow, in a paper on hoar-frost inserted in the first volume of the *Transactions of the Royal Society of Edinburgh*. But it has been clearly established by Dr. Wells that the cold is the cause of the dew; for he found, 1st, that in certain circumstances bodies would become colder than the air without being dewed, whence it is obvious that the cold could not be the effect of the dew; and, 2d, that when dew was formed, its quantity and the degree of cold that appeared with it, at different times, were very far from being always in the same proportion to each other. He also invariably found that bodies became colder before dew began to appear on them. The formation of dew is therefore a phenomenon precisely of the same kind as the precipitation of moisture which takes place on the outside of a vase into which a liquid colder than the air is poured. But this is a phenomenon of which the most complete and satisfactory explanation has been given. It is well known that atmospheric air, at every different degree of temperature, can contain only a determinate quantity of water, and that the quantity is greater as the temperature is higher. Conceive then a stratum of air coming into contact with a solid body colder than itself: the contact cools it down to a lower temperature, and immediately a portion of its water is precipitated. A second stratum of air succeeds the first, is cooled down in its turn, and abandons that portion of its moisture which its decreased temperature does not permit it to retain. The phenomenon is repeated with great rapidity, and in a short time the *cooling* body is covered with small drops, or even a continuous sheet of moisture. As soon as it was proved that bodies exposed to the clear sky acquire a temperature lower than that of the atmosphere, the origin of the moisture with which their surfaces become covered could not be mistaken.

In order to render this theory complete, it only remains to explain the cause why bodies, when exposed to the sky in clear and calm nights, become colder than the surrounding atmosphere. Since the laws of the radiation of heat were established by the experiments of Sir John Leslie and Count Rumford, the rationale of this phenomenon has been well understood. During calm and serene nights, the upper parts of the grass radiate their heat into the regions of empty space, from which they receive back no heat in return; its lower parts, from the smallness of their conducting power, transmit little of the earth's heat to the upper parts, which at the same time receiving only a small quantity from the atmosphere, and none from any other lateral body, must remain colder than the air, and condense into dew its watery vapour, if this be sufficiently abundant, in respect of the decreased temperature of the grass.

This explanation is grounded on the hypothesis of M. Prevost of Geneva respecting the constant radiation of heat by bodies in contact with the atmosphere, even at the time when they are exposed to the influence of bodies warmer than themselves: but the hypothesis has not been universally admitted; and Sir J. Leslie, on the contrary, ascribes the effect to the descent of cold air from the upper regions of the atmosphere. "The application of the æthrioscope," he remarks, "has not only ascertained the existence, but measured the intensity, of the cold pulses which are at all times darted downwards from the successive strata of air, though often partially intercepted by clouds, or more completely obstructed by low fogs. It may be computed that in fine bright evenings those cold pulses, rained from the sky, are sufficient alone to depress the temperature of the ground, according to the seasons, sometimes eight degrees, but generally about three degrees of Fahrenheit's scale. The blades of grass, thus chilled from exposure, cool in their turn the damp air which touches them, and cause it to drop its moisture." (*Ency. Brit.*, art. "Dew.") The theory of Dr. Wells has also been examined by Mr. Blackadder, in the *Edinburgh Philos. Journal*, Nos. XXI., XXVII., and XXVIII.; and more recently by Van Roosbroek of Leyden in his *Théorie de la Rosée*, Rotterdam, 1836.

It may be added, that among all the phenomena connected with the formation of dew, there is not one which does not admit of a satisfactory explanation on the principle established by Dr. Wells; namely, that dew is never deposited on the surface of bodies till they have been previously cooled down by their radiation towards space.

DEW'BERRY. The fruit of the *Rubus cæsius*, so termed from the resemblance of the bloom or waxy secretion upon it to dew.

DEW POINT. The degree indicated by the thermometer when dew begins to be deposited. It varies with the degree of the humidity of the atmosphere.

DEXIA'RIÆ. A family of Dipterous insects, which subsist chiefly on the juices of flowers. The typical genus is *Dexia*, Mirgen; the other genera included in the family are *Zeuxia, Dinera, Scotiptera, Rutila Gymnostyla, Omalogaster*, and *Prosena*.

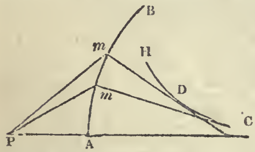
DE'XTRINE, in Chemistry, means the soluble or gummy matter into which the interior substance of starch globules is convertible by *diastase*, or by certain acids. It is remarkable for the extent to which it turns the plane of polarization to the *right* hand, whence its name. The term is also applied to starch which by exposure to heat has been rendered soluble in cold water.

DEY. (Derived by some from the Turkish daï, *a maternal uncle.*) A Turkish title of dignity, given to the governors of Algiers (before the French conquest), Tunis, and Tripoli. The dey is chosen for life from among the chief authorities of the place, with the approbation of the Turkish soldiery. At Tunis the equivalent title of *bey* is more usually substituted for *dey*. This term is admitted by all philologists to be of very great antiquity; though it is impossible to assign any precise date to its introduction. The reader will find in *Ersch and Gruber's Encyclop.* much valuable information respecting this title, and the regencies in which it is in use.

DIABE'TES. (Gr. δια, *through*, and βαινομαι, *I pass.*)

An immoderate flow of urine. There are two varieties of this disorder: the one is merely a superabundant discharge of ordinary urine, and is termed *diabetes insipidus;* in the other the urine has a sweet taste, and contains abundance of a peculiar saccharine matter: it is called *diabetes mellitus.* This disease usually attacks persons of a debilitated constitution towards the decline of life, and generally without any obvious cause. Thirst and a voracious appetite are its first symptoms; the urine gradually increases in quantity; and then there is a sense of weight and uneasiness in the loins, emaciation, œdematous legs, and hectic fever. The quantity of urine which is voided sometimes far exceeds that of liquid and solid food taken together; so that it has been supposed that the solids of the body are, as it were, melted down, and flow off in the form of water and sugar. In diabetes mellitus the quantity of saccharine matter is generally such, especially where the disorder has been of long standing, as materially to increase the specific gravity of the urine; and this accordingly forms a useful criterion of the state of the disease, for whatever tends to diminish the specific gravity of the urine is at the same time diminishing its saccharine contents: an hydrometer therefore is useful in determining this point. The specific gravity of healthy urine does not exceed 1020, and contains about 380 grains of solid matter in the pint; that of diabetic urine sometimes attains a specific gravity of 1040 to 1050; in which case, as appears from Dr. Henry's table (*Medico-Chirurgical Transactions*, vol. ii.), it contains from 766 to 960 grains of solid matter in the pint. The cause of this disease is unknown; but it has been shown that there are no traces of sugar in the blood of persons who are voiding it abundantly by urine; so that the idea of its formation in the stomach, and subsequent separation in the kidneys, is untenable. Nor has dissection thrown much light upon the subject, for in some cases no morbid state of the viscera is observed; in others, however, the kidneys are flabby, pale, and enlarged, or more vascular than they should be: the lacteals are also sometimes thickened, and the mesenteric glands enlarged. There are very few cases on record of the cure, or even of the relief, of confirmed diabetes. Where it is symptomatic of hysteria, dyspepsia, or hypochondriasis, the usual remedies for those affections are useful; but where it is *idiopathic*, and saccharine, nothing has proved decidedly serviceable. Strict abstinence from vegetable food of every kind, and the free exhibition of opium, are the only plans which have held out hopes of success; but there are very few cases upon record in which these seem to have been permanently successful.

DIACAU'STIC CURVE (Gr. δια, *through*, and καιω, *I burn*), in the higher Geometry, is the *caustic by refraction.* It is generated as follows:—If rays Pm issuing from a luminous point P be refracted by the curve A m B, so that the sines of incidence are to the sines of refraction in a given ratio, the curve C D H, which touches all the refracted rays, is called the *diacaustic.* or caustic by refraction. *See* CAUSTIC.



DIA'CHYLUM, or DIACHYLON. (Gr. δια, and χυλος, *juice.*) A celebrated plaister of former days made of the juices of several plants; the term is still retained, and applied to common plaister, made by boiling hydrated oxide of lead with olive oil.

DIACO'DIUM. (Gr. δια, and κωδια, *a poppy.*) A preparation of the poppy. Syrup of white poppies was formerly called *syrup of diacodium.*

DIA'COPE. (Gr. δια, and κοπτω, *I cut.*) A genus of spiny-finned fishes of the perch tribe, allied to *Serranus;* but distinguished by a notch at the lower part of the preoperculum, to which a projecting tubercle is adapted.

DIACOU'STICS. (Gr. δια, and ακουω, *I hear.*) That branch of physics which treats of the properties of sound refracted in passing through media of different densities. *See* SOUND

DIACRI'TIC MARKS. (Gr. διακρινω, *I distinguish.*) In Palæography, marks used to distinguish letters between the forms of which much similarity exists. Thus *n* and *u* are distinguished in German running hand by the mark ◡ over the latter letter.

DIADE'LPHOUS. (Gr. δια, and δελφυς, *a womb.*) A term applied to stamens the filaments of which have coalesced into two masses, as in Fumaria and many leguminous plants.

DI'ADEM. (Gr. διάδημα, from δεω, *I bind.*) Originally a fillet wound round the temples, probably imported into Greek costume from the East. It was the symbol of royalty among various oriental nations. The diadem of Bacchus, from the representation in ancient statues, &c., was a broad band, which might be unfolded so as to form a veil. Constantine the Great was the first Roman emperor who used the diadem; after his time, it was set with rows of pearls or precious stones.

DIÆ'RESIS. (Gr. διαιρεω, *I divide.*) In Grammar, the resolution of a diphthong, or a contracted syllable, into two syllables: as, in Latin, auraï for auræ, &c.; and, in English, the resolution of the last syllable of participles by giving a sound to the final *e:* belovëd, cursëd. &c. *See* METAPLASM.

DIAGNO'SIS. (Gr. διαγιγνωσκω, *I distinguish.*) The art of distinguishing one disease from another. The characteristic symptoms of diseases, by which they are recognized, are termed their diagnostic symptoms.

DIA'GONAL. (Gr. δια, *through*, and γωνια, *angle.*) A straight line drawn through a figure, joining two opposite angles. The term is chiefly used in geometry, in speaking of four-sided figures; but it is also properly applied with reference to all polygons of which the number of sides is not less than four. Euclid uses the term *diameter* in the same sense; but modern geometers use *diameter* only when speaking of curve lines, and *diagonal* when speaking of angular figures.

DI'AGRAM. (Gr. διαγραμμα; from δια, through, and γραφω, *I write.*) The figure or scheme drawn for the illustration of a mathematical proposition, or the demonstration of any of its properties. It is also used in other branches of science, and in the fine arts, for the general purposes of illustration.

DI'AGRAPH. (Gr. δια, and γραφω, *I describe.*) A name given by the French artists to a recently invented instrument used in perspective. For a minute description of its properties we beg to refer the reader to the *Encyclopédie des Gens du Monde*, and to the paper of M. Gavard, the inventor, recently published at Paris.

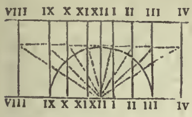
DI'AL, or SUN-DIAL. (Lat. dies, *day.*) An instrument for showing the hour of the day by means of the sun's shadow. The invention and use of sun-dials are of the highest antiquity. According to Herodotus, the Greeks learned the use of them from the Chaldeans; and the first of which history makes mention is the hemisphere of Berosus, who is supposed to have lived about 540 years before Christ. The sun-dial and the clepsydra were the only instruments known to the ancients for the measurement of time.

In constructing a sun-dial, the object is to find, by means of his shadow, the sun's distance at any time from the meridian. When this distance is known, the hour is also known, provided we suppose the sun's apparent motion to be uniform, and that during the whole course of a day he moves in a circle parallel to the equator. Neither of these conditions is, in fact, accurately fulfilled, but the error which this gives rise to is of small amount; and it is, moreover, sufficiently obvious that the use of a dial is not to indicate the hour with astronomical precision, but merely to give such an approximation as is necessary for the purposes of civil life.

Dials are usually constructed on an immoveable surface, and admit of an infinite number of different constructions, all depending on the nature of the surface and its position with regard to the equator of the earth. The general principles, however, are the same in all, and depend on the simplest elements of geometry and astronomy. The first part that claims attention is the *style* or *gnomon*, or axis of the dial, which is usually a cylindrical rod, or the edge of a thin plate of metal. The style must be directed perpendicularly to the terrestrial equator; in which direction it may be considered, on account of the smallness of the earth's diameter in comparison of the distance of the sun, as coinciding with the axis of the diurnal rotation; consequently the plane which passes through the style and its shadow on the surrounding surfaces, and which always passes through the centre of the sun, will be an hour plane, and turn with the sun as the sun turns round the style by the effect of the diurnal motion. All that remains to be done, in addition, is to discover, and describe, for the different hours of the day, the intersections of this variable hour plane with the surface on which the dial is to be constructed. On these intersections the shadow of the style will be projected every day at the same hour; because at the same hour the sun must have returned to the same hour-plane, although his distance from the equator may be different.

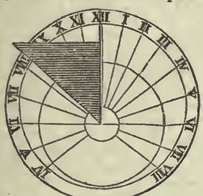
From these considerations it is manifest that the whole theory of dialling is comprehended in the solution of this general problem:—"Twelve planes all intersecting each other in the same straight line, and making with each other equal angles of 15°, being given in position; to find the intersections of those planes with any surface whatever, also given in form and position." The surface which intersects the hour planes may be of any kind whatever, but for obvious reasons it is generally a plane; and when its position with respect to the common intersection of the hour planes (which is the style of the dial) and to any one of those planes is given, the *traces* or intersections, which are in this case all straight lines, are the hour lines on the dial, and easily calculated by the ordinary rules of trigonometry or geometry.

According to the position of the plane of the dial with respect to the horizon of the place, the dial is *horizontal*, *vertical*, or *inclined*. The simplest case of all is that in which the plane of the dial is parallel to the axis of the earth (or passes through the poles) and perpendicular to the meridian of the place. In this case the style is also parallel to the plane of the dial, and the hour lines are parallel straight lines, whose distances from the meridian, or twelve hour line, are respectively proportional to the tangents of the angles which the hour planes make with the plane of the meridian.



Let d be the shortest distance of the style from the plane of the dial; then the distance of the hour line of XI and I from the hour line of XII is equal to $d \times \tan. 15^\circ$. The distance of the hour line of X and II from XII is $d \times \tan. 30^\circ$; the distance of IX and III is $d \times \tan. 45^\circ$; and so on, the hour line of XII being the intersection of the plane of the meridian in which the style is with the plane of the dial. This is called a *Polar Dial*.

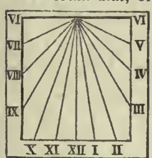
The most common construction is the *Horizontal Dial*, or that in which the plane of the dial is parallel to the horizon, and consequently makes with the style an angle equal to the latitude of the place. At the equator, this is the same as the polar dial, which has just been described; but at all other places, the hour lines intersect each other in the point in which the style intersects the plane of the dial, which point is called the centre, and the angles they make with one another, or with the XII hour line, depend on the latitude.



Their respective positions are computed from this theorem: — As is the radius to the sine of the latitude, so is the tangent of the hour from noon (reckoning 15° to the hour) to the tangent of the hour angle at the centre. Or, putting $h =$ the hour from noon, $l =$ latitude of the place, and $x =$ the hour angle at the centre of the dial; then the formula for computing the hour lines is $\tan. x = \tan. h \sin. l$, the radius being unit. From this formula the following table is computed, showing the angles which the different hour lines of a horizontal dial make with the meridional line, at the latitude of London, or $51\frac{1}{2}^\circ$.

MORNING.	AFTERNOON.		
XI	I.	11°	51′
X.	II.	24	19
IX.	III.	38	3
VIII.	IV.	53	35
VII.	V.	71	6
VI.	VI.	90	0

After the horizontal dials, the construction most frequently employed is that in which the plane of the dial is vertical; for example, when fixed on the wall of a house. In this case, the positions of the different hour lines depend on the latitude of the place and on the aspect of the dial; that is to say, its position with respect to the meridian. If the dial is perpendicular to the meridian, it is a *south dial*, or *north dial*, according as it faces the south or north. (The vertical south dial is represented in the annexed figure.) When not perpendicular to the meridian, the vertical dial is said to be *declined*. The formula for the hour lines of a south vertical dial differs from that for a horizontal dial in no respect excepting that the sine of the latitude is changed into the cosine, the cause of which will be obvious, when it is considered that the plane of the dial in passing from the horizontal to the south vertical direction preserves its inclination to the different hour planes unaltered; while the angle which it makes with the style, or the axis of the earth, is the complement of the angle it made with the same line in its former position.



Let y, therefore, be the hour angle at the centre of the dial; and putting, as before, $h =$ the hour from noon, and $l =$ the latitude, the formula for the south vertical dial is $\tan. y = \tan. h \cos. l$; whence it follows that a horizontal dial constructed for any given latitude will be a south vertical dial for any place of which the latitude is the complement of the latitude of the former place, — a property which was discovered by the Arabians. The hour lines of the vertical north dial are found exactly in the same way as those of the south dial.

When the face of the vertical dial is exactly east or exactly west, its plane is in the meridian, and consequently parallel to the vertical plane in which the style is. The hour lines, therefore, as in the polar dial, are all parallel to each other. Let d be the height of the style above the plane of the dial, h' the hour from 6 o'clock, and x the distance of that hour line from the hour line of VI, which is the intersection of the prime vertical with the plane of the dial; then $x = d \tan. h'$: the same formula as was given for the polar dial.

When the vertical dial does not face directly one of the four cardinal points, it is called a declining vertical dial, and the investigation of the hour lines is somewhat more complicated.

Let l denote the latitude of the place,
d the declination of the dial, reckoned from the east towards the south,
h the hour angle from noon,
y the hour line angle on the dial.

Find these two auxiliary quantities, viz. an angle P, and the tangent of an angle Q (of which only the logarithm is required), such that

$$\tan. P = \frac{\sin. l \tan. d}{\text{rad.}}; \quad \tan. Q = \frac{\cot. l \sin. P}{\sin. d};$$

then, the forenoon hours on the west declining dial, and the afternoon hours on the east, will be found from the formula

$$\tan. y = \frac{\tan. Q \sin. h}{\cos. (x + P)};$$

and the morning hours on the east declining dial, and the afternoon hours on the west, by the formula

$$\tan. y = \frac{\tan. Q \sin. h}{\cos. (x - P)}.$$

The formulæ which have now been given are sufficient to enable any one who has a slight knowledge of logarithmic computation to trace the hour lines of any one of the dials which has been described with great facility. It is therefore unnecessary to explain the *geometrical* methods of construction by the rule and compasses, which are besides less accurate, and more liable to be misunderstood. Of the mechanical operations necessary to be executed, such as fixing the style and placing the plane of the dial in the true vertical or horizontal position, it is unnecessary to speak, as they will readily suggest themselves to any one who has a clear conception of what is required to be done. The only thing that requires explanation is the method of finding the meridian line without having recourse to any of the more delicate operations of astronomy. The method generally practised is as follows: — Assume a point in the plane of the dial through which it is intended the meridian line shall pass. With this point as a centre, describe several concentric circles; then fix a pin or wire in the same point, perpendicular to the plane, and of such a length that the extremity of the shadow shall fall within the circles (or some of them) at midday. Observe the time when the extremity of the shadow reaches some one of the circles in the forenoon, and mark the point where it crosses the circle. In the afternoon mark the point where it again crosses the same circle, and divide the arc between the two points thus marked into two equal parts; the straight line which joins the point of bisection with the centre is the meridian line required. For greater security, the passage of the shadow over several circles may be marked; and if the points of bisection of the different arcs do not lie in the same straight line with the centre, a point must be chosen which occupies a mean position among all the others, and the straight line passing through it may be regarded as the true meridian. This method is sufficiently accurate for the purposes of a dial. Two plummets suspended over the meridian line will indicate the plane of the meridian in space. Its intersection with any vertical plane may be found by the eye.

It will be observed that the time indicated by a dial is *solar* time or *true* time, and agrees with *mean* time, or that which is shown by a well-regulated clock, only on four different days of the year. In order to find the mean time from the dial, it is necessary to apply a correction called the *Equation of Time*. (See the term.)

It has been supposed that the style is formed by a wire, or the straight edge of a thin plate; but a slit in a plate properly placed, allowing a line of light to pass, will evidently answer the purpose. Sometimes a small hole is preferred; and the hour lines, instead of being described on a plane surface, are sometimes described on the surface of a sphere, or a cylinder or a cone. The reader may find a description of some curious dials in Brewster's edition of *Ferguson's Lectures*. For the history of dialling, see *Delambre*, *Astronomie Ancienne*, tome ii.; *Montucla*, *Histoire des Mathematiques*, tome i. The writers on the subject are very numerous. For a concise and perspicuous treatise we may refer to the article in the *Encyclopedia Britannica*.

DI'ALECT. (Gr. διαλεκτος, from διὰ, signifying *division*, and λέγω, *I speak*.) In the philosophical sense of the word, any variety of a common language. Hence German, English, Swedish, &c. are all strictly said to be dialects, as coming all of them from the same original

stock. Commonly, however, we limit the application of the term dialect to the varieties of a national language; and speak of the dialects of English, French, &c. In Greek the four dialects (Doric, Ionic, Æolic, Attic) were the four written varieties of the language, each possessing a literature of its own. In this respect no modern tongue presents a parallel to the Greek; inasmuch as, in all, one dialect has been arbitrarily adopted as the standard of polite writing and conversation, and the written works which are extant in the other dialects are regarded merely as exceptions to the general rule.

DIALE'CTICS. (Gr. διαλέγομαι, *I converse or debate.*) This name was originally used by Plato as synonymous with metaphysics, or the highest philosophy. Strictly speaking, it can only be regarded as a preparatory discipline for such investigations, or at most as a scientific method of prosecuting them. The most splendid examples of dialectical subtilty that exist are to be found in the *Dialogues* of Plato, especially in those entitled *Parmenides, the Statesman and Sophist.* Aristotle expresses himself with some contempt of dialectics. It is certain, however, that its own logic owes its existence to the dialectical exercises of the Platonic schools; and that it may, in one point of view, be regarded as a body of canons and directions for their legitimate use. (*See* PLATONIC PHILOSOPHY.) In modern times various systems of dialectics have been propounded in different countries; but by no philosophers, either ancient or modern, has this science been more successfully cultivated than by the Germans, who, among a host of other names more or less distinguished, can boast of a Fichte, Kant, Leibnitz, Hegel, Schelling, and Schlegel, as the propounders each of a peculiar dialectical system.

DIA'LLAGE. (Gr. διαλλαγη, *difference.*) A mineral of a foliated structure easily divisible in *one* direction, its natural joints and fractures exhibiting a very *different* lustre and appearance.

DI'ALLING LINES, or SCALES. Graduated lines on rules or circles to facilitate the construction of dials. They usually consist of two lines of tangents and a line of latitudes. Such contrivances are of no great use; the readiest and best method is to compute the angles of the hour lines from the trigonometrical formulæ: when the angles are known, they can be set off by means of a scale of chords, or by any of the other methods employed in practical geometry.

DIA'LOGISM. (Gr. διαλογος, from δια, *through*, and λογος, *speech.*) In Rhetoric, a mode of writing which consists in the narration of a dialogue; *i.e.* in which the conversation of two or more persons is reported, without their being actually introduced as personages speaking; in which, therefore, the sentence is framed or governed by the third person instead of the first. A speech by a single person, or the species of conversation held by a person with himself (thinking aloud), when reduced into the narrative form, is also, although somewhat incorrectly, termed by French literary writers dialogism.

DI'ALOGUE. (Gr. διάλογος.) In Literature, a composition or part of a composition in the form of a conversation between two or more persons. The dialogue was the form most generally adopted by the ancients for the conveyance of instruction, and was considered equally applicable to the most grave and philosophical, and to the most ludicrous and comical subjects. Thus it was adopted by Plato, Cicero, and Lucian, with equal success. Plato chose this form for the conveyance of his philosophical sentiments; because real conversation had been the mode by which his master, Socrates (who left no writing), gave instruction to the Athenians. In the *Dialogues* of Plato, Socrates is himself introduced as the chief interlocutor. Among modern writers the philosophical dialogue has been frequently employed for the same purpose, more especially by the French, to whose language and mode of thought it should seem to be peculiarly suited. Among other eminent persons of that country who have enriched its literature with this species of composition are, Fenelon; Paschal, in his *Provincial Letters;* Bouhours, in his *Entretiens d'Ariste et d'Eugène;* Fontenelle, in his *Dialogues of the Dead*, and *Plurality of Worlds;* Galiani, *Sur le Commerce des Grains*, &c. In England this method of composition has been less frequently practised; and, perhaps, with the exception of Berkeley and Hurd, has rarely succeeded in the hands of those who attempted it. Both the Germans and Italians have attempted to impart a knowledge of their different philosophical systems in this manner. Among the latter may be mentioned Machiavelli and Algarotti; and among the former Lessing, Mendelssohn, Schelling, and Herder; though the labours of none of these distinguished persons in this department of literature are so important as to require any particular notice in this place. It has long been a question of dispute as to the class of subjects for the discussion of which this mode of writing is chiefly adapted, and upon this point various opinions have been entertained. Upon this question it is not our intention to enter; but we cannot refrain from citing here the opinion of a gentleman as to its peculiar fitness for conveying philosophical instruction, whom few will venture to gainsay on such subjects. "There are some subjects," says Mr. Hume, "to which dialogue writing is peculiarly adapted, and where it is preferable to the direct and simple method of composition. Any point of doctrine which is so *obvious* that it scarcely admits of dispute, but at the same time so *important* that it cannot be too often inculcated, seems to require some such method of handling it; where the novelty of the manner may compensate the triteness of the subject, where the vivacity of conversation may enforce the precept, and where the variety of lights presented by various personages and characters may appear neither tedious nor redundant. Any question of philosophy, on the other hand, which is so *obscure* and *uncertain* that human reason can reach no fixed determination with regard to it, if it should be treated at all, seems to lead us naturally into the style of dialogue and conversation. Reasonable men may be allowed to differ where no one can reasonably be positive; opposite sentiments, even without any decision, afford an agreeable amusement; and if the subject be curious and interesting, the book carries us in a manner into company, and unites the two greatest and purest pleasures of human life, study and society."

The dramatic dialogue differs from the philosophical, inasmuch as its subject is one of action. The whole of modern dramas is dialogue, with the exception of occasional monologue or soliloquy. (For a learned account of the *dialogue*, see the *Encyclo. des Gens du Monde.*)

DIA'METER. (Gr. δια, *through*, and μετρον, *a measure.*) A straight line passing through the centre of a geometrical figure, as that of a circle, ellipse, or hyperbola. Many figures have diameters, though they have, properly speaking, no centres; in this case, the diameter is the straight line which bisects all the parallel chords. Some geometers extend this definition, and apply the term diameter to the curve lines which pass through the points of bisection of all the parallel chords of other curves. In this sense every curve has a diameter. In astronomy the *apparent diameters* of the celestial bodies are estimated by the number of seconds in the angles they subtend at the eye. The apparent diameter (which is measured by the micrometer), compared with the distance of the body, gives its *real* diameter; for the distance of the sun or a planet is to its real diameter, as radius to the sine of the angle subtended by the apparent diameter of the body.

DIAMETER. In Architecture, the measure across the lower part of the shaft of a column, which is usually divided into sixty parts, called minutes, and forms a scale for the measurement of all the parts of an order.

DI'AMOND. (A corruption of *adamant;* from Gr. α priv., and δαμαω, *I conquer*, from its extreme hardness and difficulty of fracture.) The most valuable of the precious stones. Diamonds were originally discovered in Bengal, and in the Island of Borneo. About the year 1720 they were found in Brazil. They always occur in a detached state in alluvial soil. The primitive crystalline form of the diamond is a regular octahedron, of which there are numerous modifications. Diamonds are found of all colours: those which are colourless, or which have some very decided tint, are most esteemed; the latter, however, are rare. Those which are slightly discoloured are the least valuable. The diamond is the hardest known substance, and can only be polished by its own dust or powder. The art of splitting or cutting and polishing this gem, though probably of remote antiquity in Asia, was first introduced into Europe in 1486 by Louis Berghem of Bruges, who accidentally discovered that by rubbing two diamonds together their surfaces might be abraded. They are cut chiefly into two forms, *rose* and *brilliant:* the latter have the finest effect, but require the sacrifice of a larger portion of the gem; so that the weight of an ordinary polished diamond often does not exceed half that of the rough gem. The largest known diamond is probably that mentioned by Tavernier, in possession of the great mogul: it was found in Golconda in 1550; is of the size of half a hen's egg, and said to weigh 900 carats. Among the crown jewels of Russia is a magnificent diamond, weighing 195 carats: it is of the size of a pigeon's egg, and was purloined from a brahminical idol by a French soldier; it passed through several hands, and was ultimately purchased by the Empress Catherine for the sum of 90,000*l.* and an annuity of 4000*l.* Perhaps the most perfect and beautiful diamond hitherto found is a brilliant brought from India by a gentleman of the name of Pitt, who sold it to the regent Duke of Orleans for the sum of 100,000*l.* It weighs about 136 carats, or 544 grains.

That the diamond is combustible, was first proved by the Florentine academicians in 1694, who found that when exposed to the heat of the sun concentrated in the focus of a large lens, it burned away with a blue lambent flame. The *products* of its combustion were first examined by Lavoisier in 1772, who showed that when it was burned in air or oxygen it produced carbonic acid: subsequent experiments have shown that nothing but carbonic acid is thus formed; and hence it is proved that the diamond is charcoal or carbon in a pure and crystalline form.

DIA'NA. In Mythology, the Latin name of the goddess known to the Greeks by the name of Artemis (Ἄρτεμις), the daughter of Jupiter and Latona, and sister of Apollo. She was the virgin goddess of the chase, and also presided over health. The sudden deaths of women were attributed to her darts, as those of men were to the arrows of Apollo. In later times she was confounded with various other goddesses, as Hecate, Lucina, Proserpina, and Luna. In the two last of these characters she was said to appear in the nether world and in heaven respectively, while on earth she assumed the character of Artemis; whence she was called the three-formed goddess. Her power and functions in these characters have been happily expressed in the couplet —

> Terret, lustrat, agit, Proserpina, Luna, Diana,
> Ima, suprema, feras, sceptro, fulgore, sagitta.

She was generally represented as a healthy active maiden in a huntress's dress, with a handsome but ungentle expression of countenance. The homage rendered to Diana was so extensive that the silversmith who remarked that she was worshipped in all Asia and the world, can scarcely be accused of exaggeration. A catalogue of the various places where temples were erected in her honour would comprise every city of note in the ancient world. Among others may be mentioned Ephesus, Abydos, Heraclea, Aulis, Eretria, Samos, Bubastus in Egypt, Delos (whence she was termed Delia), and Mount Aventine at Rome. But of all her temples, that at Ephesus was the most celebrated. It was erected at the joint expense of all the states of Asia; and according to the accounts of ancient authors, it must have surpassed in splendour all the structures of antiquity, and fully deserved to be regarded as one of the wonders of the world. A small statue of the goddess, or, as she was termed by her votaries, the "Great Diana of the Ephesians," which was commonly supposed to have been sent from heaven, was here enshrined and adorned with all that wealth and genius could contribute. The fate of this temple is well known. On the day that Alexander the Great was born, it was set on fire by Eratostratus (*Val. Max.* 8. 14.), from a morbid desire to transmit his name even with infamy to posterity. This edifice was afterwards rebuilt on a plan of similar magnificence; and it remained in full possession of its wealth and reputation till the year 260 A. D., when it was completely destroyed during an invasion of the Goths.

DIA'NA, TREE OF. A name given by the old chemists to the crystallized silver which is separated when mercury is put into a solution of nitrate of silver.

DIA'NDROUS. (Gr. δις, *double*, and ανηρ, *a man*.) A term applied to any plant having but two stamens.

DIAPA'SON. (Gr. δια, *through*, and πας, *all*.) In Music, an interval used by most authors to express the octave of the Greeks. By one of the boldest metaphors with which we are acquainted, Dryden has beautifully availed himself of this expression in the well-known stanza of his first Ode to St. Cecilia's Day: —

> From harmony, from heavenly harmony,
> This universal frame began;
> From harmony to harmony
> Through all the compass of the notes it ran,
> The diapason closing full in man.

For an account of the diapason in the organ pipes, see ORGAN.

DIAPE'NTE. (Gr. δια, and πεντε, *five*.) In Music, an ancient term signifying a fifth.

DI'APER. A woven linen ornamented with patterns, and used for towels and table linen; it sometimes resembles an inferior kind of damask. It is said to have been originally manufactured at Ypres in Flanders; whence the term d'Ypres, corrupted into diaper.

DIA'PHANOUS. (Gr. δια, and φαινω, *I shine*.) A term applied to bodies which permit the light to pass through their substances. It is the synonyme of translucent. A body which allows the forms of objects to be seen through it is transparent.

DIAPHO'NICS. (Gr. δια, and φωνη, *sound*.) The doctrine of refracted sound. *See* SOUND.

DIAPHORE'SIS. (Gr. διαφορεω, *I carry through*.) A perspiration; hence also *diaphoretics*, medicines which promote perspiration.

DI'APHRAGM. (Gr. δια, and φραττω, *I divide*.) This term is applied to the straight calcareous plate which divides the cavity of certain shells into two parts only; its more common signification relates to the muscular and tendinous partition which separates the chest from the abdomen in mammalia.

DI'APHRAGMATI'TIS. Inflammation of the diaphragm, or of its peritonæal coats. The treatment is the same as that of pleurisy and peritonitis.

DIARRHŒ'A. (Gr. διαῤῥεω, *I flow through*.) A purging or looseness of the bowels. There are several varieties of diarrhœa, depending upon different causes, and consequently requiring in many instances distinct modes of treatment. In general it is necessary first to remove offending and irritating matters from the bowels by means of aperients; rhubarb, from its astringent tendency, is the purgative usually employed; afterwards astringents with warm aromatics, and the occasional addition of some form of opium, are prescribed and continued till the inordinate laxity of the bowels is quelled. Where diarrhœa is connected, as it often is, with excess of acidity in the stomach, magnesia, chalk, or carbonated alkalis are united to the other remedies.

DIARTHRO'SIS. (Gr. *articulation*.) The moveable connection of bones.

DI'ARY. (Lat. diarium, literally *a daily allowance;* from dies, *a day*), signifies properly a note-book or register of daily occurrences, in which the writer has a principal share, or which have come under his own observation, or have happened in his own time. The term *diary* is equivalent to the French *journal*, the Italian *diario* and *giornale*, and the German *Tagebuch*.

DIASCHI'SMA. (Gr. διασχιζω, *I cleave*.) In Music, an interval consisting of two commas.

DI'ASPORE. A laminated mineral, composed of 80 alumina, 18 water, 3 oxide of iron. A small fragment decrepitates when heated, and is dispersed in numerous fragments; hence its name, from the Gr. διασπειρω, *I scatter*.

DI'ASTASE. (Gr. δια, and ιστημι, *I set*.) A peculiar substance generated during the germination of barley, wheat, &c., which tends to accelerate the formation of sugar during the fermentation of worts. It is precipitated from infusions of bruised malt by alcohol. It is the principle which by its reaction on starch tends to develop sugar in the processes of germination and malting.

DI'ASTEM. (Gr. διαστημα.) In Ancient Music, a simple interval as distinguished from a compound one; to which latter was given the name of a *system*.

DIASTE'MA. (Gr.) In Zoology, the vacant space occurring in the dental series by the absence of the canine or laniary teeth.

DIA'STOLE. (Gr. δια, and στελλω, *I stretch*.) The dilatation of the heart and arteries.

DI'ASTYLE. (Gr. δια, and στυλος, *a column*.) In Architecture, that mode of arranging columns in which the intercolumniation or space between the columns consists of three diameters, or according to some of four diameters.

DIATE'SSARON. (Gr. δια, and τεσσαρα, *four*.) In Ancient Music, the interval of a fourth.

DI'ATHE'RMAL, or DIATHERMANOUS. (Gr. δια, and θερμη, *warmth*.) A term applied to certain substances, such as transparent pieces of rock salt, &c., which suffer radiant heat to pass through them, much in the same way as transparent or *diaphanous* bodies allow of the passage of light.

DIA'THESIS. (Gr. διατιθημι, *I dispose*.) A particular state of constitution predisposing to certain diseases: such as inflammatory, nervous, and putrid diathesis; uric diathesis, in which there is excess of uric acid thrown off by the kidneys; gouty diathesis, &c.

DIA'TONI. (Gr. δια, and τονος, *an extension*.) In Ancient Architecture, the angle stones of a wall, which were wrought on two faces, and which, from stretching beyond the stones above and below them, made a good bond or tye to the work.

DIATO'NIC. (Gr. δια, and τονος, *a tone*.) In Music, a term denoting the natural scale of music, which proceeding by degrees includes both tones and semitones. It includes the intervals formed by the natural notes, as well as those produced in transposing the natural.

DIAZENE'TIC. (Gr. διαζευγνυμι, *I separate*.) In the Ancient Greek Music, a term applied to the tone disjoining two fourths, one on each side of it, and which joined to either made a fifth.

DIAZO'MA. (Gr. δια, *through*, and ζωμα, *a cincture*.) In Ancient Architecture, the landings or resting places which encircled the amphitheatre at different heights, like so many bands or cinctures; whence the name.

DI'BBLE. In Agr. and Hort., a cylindrical piece of wood from one to two inches in diameter, and from 1 ft. to 2 ft. in length, having a cross handle at one end, and brought to a conical point at the other, for the purpose of making holes in the ground to receive plants or seeds. Dibbles which are used for planting potatoes or beans are commonly from two to two and a half feet in length, with a peg inserted near the ground in order that the operator may press it in with his foot.

DIBO'THRIANS, *Dibothri*. (Gr. δις, *twice*, βοθριον, *a pit; two-pitted*.) The name of a division of tape-worms, including those *Bothriocephalans* which have not more than two pits or fossæ on the head.

DIBRA'NCHIATES, *Dibranchiata*. (Gr. δις, and βραγχια, *gills; two-gilled*.) The name of the order of Cephalopods which includes those with two gills, and which are also characterized by having three distinct hearts; an apparatus for secreting and emitting an inky fluid; cephalic arms, never exceeding ten in number, solid, and supporting acetabulæ; and in short all the chief characteristics which are usually ascribed to the entire class of Cephalopods. The same term (*Dibranches*) is applied

by Latreille to an order of the class *Cirripedia*, comprehending those species which are similarly characterized by having two gills.

DICASTE'RIUM. (Gr. δικη, *justice*.) In Ancient Architecture, the name of a tribunal or hall of justice in Athens.

DICE COAL. A species of coal easily splitting into cubical fragments.

DICERA'TES, *Dicerata*. (Gr. δις, *double*, and κερας, *horn; two-horned*.) A name applied by De Blainville to a family of the order *Paracephalophora Polybranchiata*, comprehending all such Gastropodous Mollusks as have two tentacles on the head. The term *Diceras* was previously applied by Lamarck to a fossil genus of Bivalves.

DICHO'TOMOUS, *Dichotomus*. (Gr. διχοτομος.) Signifies the division of an object by repeated bifurcation, so that the branches are always in pairs.

DICHO'TOMY. An artificial system, in which natural objects are arranged according to the above mode of division.

DI'CHROISM. (Gr. δις, *double*, and χρωμα, *colour*.) A term in Optics, used to designate a property possessed by several crystallized bodies of appearing under two distinct colours according to the direction in which light is transmitted through them. Thus the muriate of palladium appears of a deep red colour along the axis, and of a vivid green when viewed in a transverse direction. Sir D. Brewster states (*Optics*, *Cab. Cyclopedia*) that in examining this class of phenomena, he found them to depend on the absorption of light, being regulated by the inclination of the incident ray to the axis of double refraction, and on a difference of colour in the two pencils formed by double refraction.

DICO'LOPHUS. (Gr. διχα, *separately*, and λοφος, *a crest*.) The name of the genus of wading birds (*Grallatores*), including the *cariama*, which is characterized by a tuft of feathers projecting from the crown of the head in two directions.

DICOTYLE'DONS. (Gr. δις, *double*, and κοτυληδων, *a seed-leaf*.) One of the primary classes of the vegetable world, consisting of all those plants that have their embryo furnished with two cotyledons, or with a greater number arranged on the same plane. These plants are also called Exogens.

DICTA'TOR. In Ancient History, a Roman magistrate appointed on special occasions to supersede the consuls. The first dictator was elected some years after the expulsion of the kings, on the occasion of a war with the Latins, while a dangerous sedition was feared at home; but the period is very uncertain. Dictators were appointed also for mere ceremonial objects, as for holding comitia. But the purposes for which the dictator was appointed differed so materially at different times, and the opinions of later historians respecting the extent of his authority are so conflicting and unsatisfactory, that more obscurity still exists upon this subject than almost any other within the compass of Roman antiquities. According to Niebuhr, the object aimed at in the institution of the dictatorship was to evade the Valerian laws, and to re-establish the unlimited authority of the patricians over the plebeians; for the appeal to the commonalty granted by these laws was from the sentence of the consuls, and not from that of this new magistrate. But this unlimited power did not extend over the patricians. The form of their election was precisely similar to that of the kings, who were appointed by the senate, while their authority was confirmed by a decree of the curies. Originally the dictator continued in office only six months; but at a later period this salutary rule was neglected. Sylla and Julius Cæsar, the last dictators, were nominated perpetual dictators; the former in the year 81 B.C., the latter after the battle of Pharsalia. The title was subsequently offered to Augustus by the people, but declined; and it was never afterwards assumed by the Roman emperors. An officer called magister equitum, appointed sometimes by the dictator, sometimes by the senate, and sometimes by the people, was always in attendance on the dictator. (See *Niebuhr's Rom. History*, and *Ersch and Gruber's Encyclo.*)

DI'CTIONARY (Mod. Lat. dictionarium), either signifies a collection of words in one or more languages, with their peculiar significations, arranged in alphabetical order; or it may be applied in a more extended sense to any work which professes to communicate information on an entire subject, or an entire branch of a subject, under words or heads digested in order of the alphabet. Hence dictionaries may be said to be of two sorts, — of *words*, and of *facts* or *things*; in the former sense the term *dictionary* being equivalent to *lexicon*, in the latter to *encyclopædia*.

Dictionary of words. — The ancients have left us no monuments of this species of literature; and, with a few brilliant exceptions, all the attempts that took place at the early period of the Christian era, and during the middle ages, are comparatively incomplete. It was not till after the invention of printing, when a taste for the classic literature of antiquity became general, that some laborious men, in the view of elucidating the Greek and Roman authors, and of facilitating the investigations of others, undertook the task of compiling dictionaries. Under the head LEXICON will be found a succinct notice of the chief performances in this department of literature; and we shall here restrict ourselves to the remark, that the history of ancient, and, with a few modifications, of modern lexicography, presents the singular phenomenon, that it is only when the language of a country is on the decline, or at all events has attained such a degree of perfection as to be apparently unsusceptible of further improvement, that dictionaries begin to be compiled. "No one," says an able writer, "thinks of writing a dictionary till the language he intends to illustrate has become a study;" and this is seldom the case till the age of its purity and vigour has gone by, till the phraseology of its original authors has become in some degree obsolete, and the caprice or ignorance of later writers has diversified or corrupted the significations of words. In modern times the honour of possessing the best dictionaries belongs to Italy, France, and England. These are the *Vocabulario degli Academici della Crusca*, extended in the latest editions to 6 vols. fol.; the *Dictionnaire de l'Académie Française*, 2 vols. 4to., to which a supplementary volume has been recently added; and *Johnson's Dictionary*, 2 vols. fol. 1755; — works unrivalled in plan and execution, and which, notwithstanding the cavillings of certain philologists, will long remain standards in their respective languages. The Spaniards also possess a dictionary of considerable reputation, entitled *Diccionario de la Lengua Castellana, compuesto por la Real Academia Espanola*, 6 vols. fol. 1726; but the Germans, perhaps from the cause above adverted to, that the resources of their language have, as is universally admitted, not yet been adequately developed, do not possess any dictionary of acknowledged authority.

Dictionaries of facts or things are of two species; being either devoted to separate or single branches of science, art, or literature, or embracing the whole circle of the arts and sciences. Of the former, the *Historical and Critical Dictionary* of Bayle, and the *Dictionnaire de la Bible*, by Dom Calmet, may serve as specimens; and of the latter, the *Encyclopédie Française*, and the *Encyclopædia Britannica*. That the idea of comprising all the sciences in a single work was not unknown in antiquity is evident from the expression εγκυκλιος παιδεια, which was used to signify such a course of instruction as should embrace all the sciences. The earliest approximation to this species of literature is to be found in the work of Varro, *Rerum Hum. et Divin. Antiquitates*, of which nothing remains but the title; and in the *Historia Naturalis* of Pliny, who has embodied in that work all the results of his multifarious studies and vast erudition. But the term *Encyclopædia* is said to have been first applied to works of this description by some of the Arabian writers of the middle ages, and particularly by Alfarabius, whose general treatise on the sciences is still preserved under this designation. Towards the close of the 16th and the commencement of the 17th centuries, there appeared in Europe several similar treatises with the same title, of which the most celebrated was that of Alstedius, in 2 vols. fol.; but none of these productions can be properly termed dictionaries or encyclopædias, being merely collections of treatises resembling rather such works as *Kett's Elements of General Knowledge*, &c., than corresponding to the modern notion of an encyclopædia. The strongest resemblance to the works in question is presented by the *Lexicon Universale Historicum Sacrum et Profanum* of Hofmann, 1677, in 2 vols. fol., and followed in 1683 by a supplement of equal extent; the form of which, at least, has served for a model to nearly all succeeding dictionaries or encyclopædias. (*Penny Cyc.*) It might perhaps be preposterous to assert that Hofmann borrowed the notion of his *Lexicon* from Bacon's theory of the *Encyclopædian Tree*, as set forth in the *Novum Organon* (Leyden, 1650); but, as M. Guizot has observed, there can be little doubt that the great abundance of dictionaries and encyclopædias which the whole of Europe has since witnessed is in some degree owing to that eminent philosopher's *Classification Complete et Raisonnée* of human knowledge.

The subjoined list contains a selection of the most valuable productions in this department of literature which have appeared since that time, arranged according to the place and date of their publication.

Great Britain.

1. Lexicon Technicum, or Universal Dictionary of the Arts and Sciences, 2 vols. fol.; the first published 1704, the second in 1710. A supplementary vol. was afterwards added.
2. Chambers's Cyclopædia, 2 vols. fol. 1728. This work was extended in a 7th edit. to 4 vols. fol. 1778-85, by Dr. Rees, who afterwards re-edited the work in 45 vols. 4to. (See *infrà*.)
3. An Univ. History of Arts and Sciences, &c., by Dr. De Coetlogon, 2 vols. fol. 1745.

4. Barrow's New and Universal Dictionary of Arts and Sciences, 1 vol. fol. 1751; with a suppl. vol. 1754.
5. A New and Complete Dict. of Arts and Sciences, by a Society of Gentlemen (commonly called Owen's Dictionary, from the name of the publisher), 4 vols. 8vo. 1754.
6. The Complete Dict. of Arts and Sciences, 3 vols. fol. 1766, by the Rev. Ben. Croker, Dr. Thos. Williams, and Sam. Clark.
7. Encyclopædia Britannica, 3 vols. 4to. 1771. The fifth edition of this work, completed in 1814, was extended to 20 vols.; and a supplement in 6 vols., under the editorship of Mr. Napier, added in 1824. A seventh edition of this work, in which the supplement is incorporated, is now in course of publication under the same editor; and will be completed during the present year.
8. The English Encyclopædia, 10 vols. 4to. 1795-1803.
9. The Cyclopædia, commonly known by the name of Rees's Cyclopædia, 1802-19. 45 vols. 4to.
10. British Encyclopædia, 6 vols. 8vo. 1807-9.
11. Encyclopædia Londinensis, 24 vols. 4to. 1810-29, by John Wilkes.
12. Brewster's Edin. Encyclop. 18 vols. 4to. 1810-30.
13. Pantalogia, or New Dict. of Arts and Sciences, 12 vols. 8vo. 1813-16. By Mason Good, Gregory, and Bosworth.
14. Burrowe's Modern Encyclopædia, 10 vols. 4to. 1816.
15. Encyclopædia Edinensis, 6 vols. 4to. 1816.
16. Encyclopædia Perthensis, 23 vols. roy. 8vo.; completed in 1816.
17. Encyclopædia Metropolitana, 1818. Not yet completed.
18. Oxford Encyclopædia, 6 vols. 4to. 1828; to which a supplement in 1 vol. was added in 1831.
19. The London Encyclopædia, 24 vols. 8vo. 1826.
20. Partington's British Cyclopædia, 10 vols. 8vo. 1833-36.
21. Penny Cyclopædia, large 8vo. 1833, now in course of publication.

France.

1. Dictionnaire Universel Français et Latin, known by the name Dictionnaire de Trévoux, 1704. 3 vols. fol. The fifth and last edition, Paris, 1771, was augmented to 8 vols. fol.
2. Encyclopédie, ou Dictionnaire raisonnée des Sciences, des Arts, et des Métiers, par Diderot et d'Alembert, 35 vols. fol. 1751-80. The original series consisted of 28 vols., of which 11 were plates. A supplement of 5 vols. was afterwards added, one of which consisted of plates; besides a "Table Analytique" of the whole work, compiled by M. Monchon, in 2 vols. A variety of encyclopædias of more or less reputation was published in France immediately after the "Encyclopédie" of Diderot and D'Alembert; but as they are all, to a greater or less extent, mere abridgments of, or compilations from, this great work, we do not think them worthy of notice in this catalogue.
3. Encyclopédie, ou Dictionnaire Universel raisonnée des Connaissances humaines, par le Professeur de Felici. Yverdun, 1770-75. 42 vols. 4to.; besides a sup. of 6 vols. 4to.
4. Encyclopédie Méthodique, &c., 1782, 1832, 201 vols. 4to., including 47 vols. of plates. In this work every art or science is treated of in a separate volume or series of volumes; so that it forms in fact a collection of dictionaries.
5. Dictionnaire des Sciences et des Arts, par Lumier, 3 vols. 8vo. 1805.
6. Encyclopédie Moderne, &c., par M. Courtin, 1823, &c. 24 vols. 8vo.
7. Encyclopédie des Dames, par une Société des Dames, Paris, 1821, &c.
8. Dictionnaire de la Conversation et de la Lecture. Paris, 1834-9. 52 vols. 8vo. or 104 livraisons.
9. Encyclopédie des Gens du Monde. Paris, 1833, &c. Of this valuable and popular work 30 parts or 15 vols. 8vo. have already appeared, bringing it down to letter I.

Germany.

1. Grosse vollständige Universal Lexicon, von Zedler, 1732-50, 64 vols. 8vo.; with a sup. Another edition was published 1751-54 in 4 vols. fol. Halle and Leipsig.
2. Deutsche Encyclopedie, &c., 1778-1804, by Koester and Roos. Of this work 23 vols. 4to. appeared, bringing it down to letter K.
3. Economische Encyclopedie, by Krunitz, Floerke, and Korte, 1774, 1828. 148 vols. 8vo. Berlin.
4. Conversations Lexicon, 1796-1809, 6 vols. 8vo.; besides a sup. of 2 vols. The 6th edition was completed at Leipsig, 1824, in 10 vols., with 2 of a sup.; since that time there have appeared several editions of this work materially augmented. An English translation of it, with the addition of much valuable information, was completed at Philadelphia, in 13 vols. 8vo. 1820-33, under the superintendence of Dr. Liebner; and a republication of this American work, with considerable improvements, has been recently completed at Glasgow, in 6 vols.
5. Allgemeine Encyclopedie der Wissenschaften und Künste, von Ersch und Gruber, 1818, &c. Leipsig. 65 vols. 4to. of this work have already appeared. It is divided into sections, of each of which A, H, and O are the commencement.
6. Gehler's Physicalisches Wörterbuch, neu bearbeitet von Brandes, Gmelin, Horner, Muncke, Pfaff. 9 vols. 8vo. Leipsig, 1825-40. As the title implies, it is confined to general physics, and physical astronomy; but its great value renders it worthy of a place in this catalogue.
7. Haus-Lexicon, or Vollständiges Handbuch praktischer Lebens-kentnisse für alle stände, 8 vols. 8vo. Leipsig, 1835-37.
8. Damen Conversations Lexicon, 10 vols. small 8vo. Adorf, 1835-38.

Besides these, there are no fewer than 19 Encyclopædias of greater or less extent in course of publication in Germany; but it has not been our fortune to see any of them, with the exception of the Conversations Lexicon der Gegenwart, which forms a species of supplement to the Conversations Lexicon above specified.

Italy.

1. Dizionario Scientifico ex Curiosa, Sacra, Profana, by G. P. Pinati. 10 vols. fol. Venice, 1746-51.
2. Encyclopedia Italiana. Naples, 1788.
3. Encyclopedia Methodica Critica Ragionnata delle belle Arti, by Pietro Zani. Parma, 1818-20.

But another branch of the same encyclopædian tree, which, as already remarked, yielded such brilliant fruits in the hands of Ducange, Bayle, and Calmet, has taken deep root in Europe, and more especially in this country, and has greatly contributed to the diffusion of knowledge; viz. the compilation of dictionaries appropriated to separate branches of literature, science, or art. A mere catalogue of these would swell this notice to a size wholly incompatible with our limits, as there is scarcely a department of human knowledge in which works of this class have not been published within the last fifty years. It is not our intention to enter upon a discussion of the positive or comparative merits of the works referred to, though there exist perhaps few more fertile fields for criticism; but, if we take into consideration the extreme difficulty of compiling a good dictionary, and the acquirements essential to the individual who undertakes it, we shall not be surprised if but a few only of the vast number of dictionaries with which the literature of this and other countries is inundated be respectably executed. It may be true that the qualities of brevity, precision, and distinctness, without which no work of this class is even tolerable, do not belong to the highest order of intellect; though they are, perhaps, quite as rarely to be met with as its more showy attributes; but it is easy to see that to give interest to a work of this nature, and to present the reader with satisfactory information in a perspicuous and compendious form, a more than ordinary share of ability is indispensable. Montesquieu said of Tacitus that he abridged all, because he knew all. But though a thorough knowledge of the subject be indispensable, that is not enough to enable an individual to make a good dictionary. He must be able to split it into its elements; to treat each part as if it were separate and independent, and the reader wished to study it only; and at the same time to preserve all the parts in due subordination to each other, and to the plan of the work. The judgment, tact, and variety of research and learning, to say nothing of the labour, necessary to give permanent interest and real value to a work of this sort in any of the great departments of human knowledge, may be more easily imagined than described; and hence the extreme fewness of such works. But even the inferior class of dictionaries have many recommendations; and though mostly compiled at second-hand from other works, and with but little unity of plan or execution, still, if they be *tolerably accurate and precise*, they cannot fail to be of great utility. We are aware, indeed, that this position has been denied; and that it has been contended that the general prevalence of dictionaries has exercised a baneful influence upon the literature of the age, inasmuch as, by making people satisfied with the information which they contain, they tend to generate a taste for superficial learning, and thus, by discouraging all reference to more elaborate treatises, strike at the root of original thought and profound erudition. Those, however, who adopt this line of argument, quite overlook the main objects which dictionaries are calculated to serve. Such arguments would have some weight had it been ever contemplated that the mathematician should study mathematics, the philosopher philosophy, the divine theology, or any professional man the subjects that form the basis of his profession, in a dictionary only. But this is by no means the case. The grand object aimed at in such works, is to place within the reach of persons engaged in the business of active life a mass of well-digested, accurate, and readily accessible information upon subjects not connected

with their own immediate pursuits, such as it might be exceedingly difficult for them to procure elsewhere; while even to the learned, or to those who have access and leisure to refer to more extensive depositories of human knowledge, they serve as convenient manuals or reference books. But upon this subject we cannot do better than transfer to our columns an eloquent passage from the elaborate paper of M. Guizot on *encyclopædias* (Paris, 1826), to which we beg to refer the reader for a clear and learned exposition of the merits of this species of literature. "Parlerai-je enfin de leur utilité commune et pratique, de l'abondante instruction, des innombrables enseignemens qu'elles fournissent, et qui s'appliquent à tant de circonstances, à tant de besoins de la vie? Dans les grandes villes, au milieu de toutes les facilités, de toutes les richesses de la société humaine, on oublie trop qu'une multitude de familles independantes, aisées, dont le travail n'absorbe point le temps ni les facultés, vivent dans une situation toute différente, celles-ci à la campagne, celles-lá dans de petites villes, éloignées de toutes ces ressources de la science et de l'industrie qui se pressent autour de nous. C'est là qu'on apprend à connaître le prix de cette science domestique qui se transporte en quelques volumes dans la solitude la plus profonde. Sans doute elle est incomplete et fautive; on se trompe souvent dans l'application qu'on en fait; mais, à tout prendre, elle éclaire et dirige plus souvent encore; elle diminue les embarras, les ennuis de l'isolement; elle rassure les imaginations; elle établit enfin, entre des milliers d'individus dispersés et les grands foyers de la science, une sorte de lien intellectuel dont l'importance et les effets se laissent difficilement apprecier." Such, then, being the purposes contemplated by works of this class, and such the acknowledged benefits that accrue from them, so far from the number and variety of works which have been published in the course of the last and present century under the title of dictionaries and encyclopædias, occasioning any surprise, we are almost warranted in anticipating that, owing to the gradual progress of human knowledge, the progressive augmentations to the stock of polite literature, and the number and rapidity of the inventions and discoveries which are constantly enriching the arts and sciences, this species of publication will continue to increase, and that, in a word, the literature of every country will gradually assume more and more of the dictionary form.

DI'CTUM. (Lat. *something said.*) A word used in common parlance to signify the arbitrament or award of a judge.

DI'CTYOTHE'TON. (Gr. *δικτυον, a net,* and *τιθημι, I place.*) In Ancient Architecture, masonry worked in courses like the meshes of a net. Also open lattice work for admitting light and air.

DIDA'CTIC (Gr. *διδασκω, I teach*), in the schools, signifies every species of writing, whether in verse or prose, whose object is to teach or explain the rules or principles of any art or science. Thus to this class of literature belong the writings of Aristotle on grammar, poetry, and rhetoric; Longinus's Treatise on the Sublime; and the *Institutiones* of Quintilian, &c. But the term has been borrowed from scholastic phraseology, and appropriated more exclusively to all poetical writings devoted to the communication of instruction on a particular subject, or of a reflective or ethical character, thence called *didactic poetry*. Were this the place for such investigations, it might be easily shown that the *didactic* must have been among the first species of poetical composition; and that the writings of the earliest poets of whom profane history makes mention, such as Orpheus and Linus, might with propriety be classed under this category. But be this as it may, this species of poetry has been in use from a very remote period, and there is scarcely any nation in which it has not taken root. Among the most celebrated poems of this species may be reckoned in ancient times that of Lucretius, *De Rerum Naturâ*, in which the Epicurean system of philosophy is explained; Virgil's *Georgics*, which has almost always served as a model to the didactic poets of succeeding ages; and Horace's *Art of Poetry;* and in more recent times, Pope's *Essays on Criticism* and *Man;* Du Fresnoy's *Art of Painting* (see Mason's translation in the Literary Works of Sir J. Reynolds); Vida and Boileau's *Art of Poetry;* Akenside's *Pleasures of the Imagination;* Armstrong's *Art of Preserving Health;* Somerville's *Chace;* Dyer's *Fleece;* Young's *Universal Passion,* &c. The reader will find in Blair's *Lectures*, vol. iii., a full exposition of the nature and characteristics of this species of poetry, and a critical notice of the most famed didactic poems of all ages and countries.

DIDA'CTYLE. (Gr. *δις, double,* and *δακτυλος, the finger; two-fingered, or two-toed.*) This epithet is applied to various animals, as to the ruminants among quadrupeds (by Klein), to the ostrich among birds; to the amphiuma, an amphibious reptile with two digits on each extremity; and to certain insects, as the *Pterophorus didactylus* and *Gryllotalpa didactyla.*

DIDASCA'LIA. (Gr.) A term in use among the Greek writers of antiquity, and till within the last century among almost all the nations of modern Europe, applied to the representation of dramatic pieces, or to critical notices of the stage, and of every thing appertaining thereto. The only paper with this designation, now in existence, is, as far as we know, that published at Frankfort, which enjoys a large circulation.

DI'DORON. (Gr. *διδωρον.*) In Ancient Architecture, a brick whose length was one foot, and its breadth one half its length.

DIDE'LPHYS. (Gr. *δις, double,* and *δελφυς, womb.*) A generic name originally applied to the opossum, and all other quadrupeds which like it have a duplicature of the integument of the abdomen forming a pouch, in which the prematurely born young are received, protected, and nourished, as in a second womb, until their growth is advanced to a stage corresponding to that of the new-born young in the ordinary mammalia. In modern systems the term is, singularly enough, restricted to that group of Marsupials in which there are certain species deficient in the abdominal pouch. The genus *Didelphys*, or true opossums, are characterized by the following dental formula — incisores $\frac{10}{8}$, canini $\frac{2}{2}$, molares spurii $\frac{6}{6}$, molares veri $\frac{8}{8}$, = 50; and by having the hinder foot provided with a thumb, and a prehensile tail.

DI'DUS. The generic name for the dodo or dronte. Birds of this kind were discovered by the Portuguese in 1499 on the island now called Mauritius, where they were afterwards observed by the Dutch in 1598, and in the early part of the following century. Original figures of the bird are given in *De Bry* (*Quinta pars Indiæ Orientalis, &c.*, MDCI.); by Clusius, in his *Exotica*, 1605; by Herbert, in his *Travels*, 1634; by Bontius (Piso's edition, 1658); and by Savery, in his celebrated picture of "Orpheus charming the Beasts," now in the museum at the Hague. The last figure is the best; it was painted, as were the other figures of exotic species in the same picture, from studies of the living animals preserved at that time in the celebrated menagerie of Prince Maurice of Nassau. It is highly probable that the same dodo was the subject of the painting of which the one now in the British Museum is a copy.

Besides this pictorial evidence there exist a head and a foot of the dodo in the Ashmolean Museum at Oxford, and a foot of the dodo in the British Museum. The following is Willoughby's translation of the original description of this extinct bird by Clusius: — "The dodo is called by Clusius *Gallus gallinaceus peregrinus*, by Nieremberg *Cygnus cucullatus*, by Bontius *Dronte*. This exotic bird, found by the Hollanders in the island called by the Portuguese *Cygnæa* or *Cerne*, that is the Swan Island, and Mauritius Island by the low Dutch, of thirty miles compass, famous especially for black ebony, did not exceed a swan in bigness; but was of a far different shape, for its head was great, covered as it were with a certain membrane resembling a hood; besides, its bill was not flat and broad, but thick and long, of a yellowish colour next the head, the point being black. The upper chap was hooked; the nether had a bluish spot in the middle, between the yellow and black part. They reported that it is covered with thin and short feathers, and wants wings, instead whereof it hath only four or five long black feathers; that the hinder part of the body is very fat and fleshy, wherein for the tail were four or five small curled feathers, twirled up together, of an ash colour. Its legs are thick rather than long, whose upper part, as far as the knee, is covered with black feathers; the lower part, together with the feet, of a yellowish colour; its feet divided into four toes, three (and those the longer) standing forward, the fourth and shortest backward, all furnished with black claws. After I had composed and writ down the history of this bird, with as much diligence and faithfulness as I could, I happened to see in the house of Peter Pauwius, primary professor of physic in the university of Leyden, a leg thereof cut off at the knee, lately brought over out of Mauritius his island. It was not very long from the knee to the bending of the foot, being but little more than four inches, but of a great thickness; so that it was almost four inches in compass, and covered with thick set scales; on the upper side broader, and of a yellowish colour; on the under (or back side of the leg) lesser and dusky. The upper side of the toes was also covered with broad scales, the under side wholly callous. The toes were short for so thick a leg; for the length of the greatest or middlemost toe to the nail did not much exceed two inches, that of the other toe next to it scarce came up to two inches; the back toe fell something short of an inch and a half; but the claws of all were thick, hard, black, less than an inch long; but that of the back toe longer than the rest, exceeding an inch. The mariners in their dialect give this bird the name *Walgh-vogel*, that is, a nauseous or yellow bird; partly because after long boiling the flesh became not tender, but continued hard and of difficult concoction (excepting the breast and gizzard, which they found to be of no bad relish), partly because they could get many

turtle-doves, which were much more delicate and pleasant to the palate. Wherefore it was no wonder that in comparison of those they despised this, and said they could be well content without it. Moreover they said that they found certain stones in its gizzard; and no wonder, for all other birds as well as these swallow stones to assist them in grinding their meat." Thus far Clusius.

Now, with respect to the parts of the bird which still remain to us, we infer that the head, from the sudden rising of the cranium above the face, and the form of the anterior extremity of the lower jaw, as also from the nostrils being covered with an arched scale, did not belong to a vulture or any other Accipitrine bird; while in the presence of the cere at the base, and the forward position of the nostrils, it resembles the rhea and apteryx among the Struthious birds. The apteryx, however, deviates more from the typical *Struthionidæ* in the shape of the bill and position of the nostrils than does the dodo. With respect to the foot in the British Museum, this differs from that of the vultures in the form and disposition of the tarsal scales, in the shortness of the middle toe, and the bluntness and straighter figure of the claws; while in all these respects it agrees with the foot of the apteryx and the Gallinaceous order. So that even those naturalists who, like Mr. Gray of the British Museum, still reject the evidence in proof of the Struthious nature of the dodo, and deny its existence at any period, are compelled to imagine that the bird represented in the original figures above quoted was made up by joining the head of a bird of prey to the legs of a Gallinaceous bird. The analogies of ornithology, however, by no means sanction the rejection of the multiplied, and, if we except Leguat's narrations, consistent evidence, of the actual existence of the Struthious dodo. Whoever inspects the painting by Savery, above mentioned (which seems hitherto to have escaped the attention of the naturalists who have written on the dodo), must feel a conviction that its original was no factitious or artificial specimen. Neither the head nor the feet still preserved in our museums can be referred to an albatross, a penguin, a vulture, or any other known existing species; while they closely correspond (allowing for the absence of the horny sheath of the bill) with the original figures of the dodo. We have therefore no hesitation in concluding that in other respects those figures are equally faithful representations of the extinct Struthious form in question. Such also appears to be the conclusion to which the learned writer of the article "Dodo" in the *Penny Cyclopedia* arrived; in whose words we shall conclude the present notice:—"If the picture in the British Museum and the cut in Bontius be faithful representations of a creature then living, to make such a bird a bird of prey, a vulture in the ordinary acceptation of the term, would be to set all the usual laws of adaptation at defiance. A vulture without wings! How was it to be fed? And not only without wings, but necessarily slow and heavy in progression on its clumsy feet. The *Vulturidæ* are, as we know, among the most active agents in removing the rapidly decomposing animal remains in tropical and intertropical climates; and they are provided with a prodigal development of wing to waft them speedily to the spot tainted by the corrupt incumbrance. But no such powers of wing would be required by a bird appointed to clear away the decaying and decomposing masses of luxuriant tropical vegetation—a kind of vulture for vegetable impurities, so to speak; and such an office would not be by any means inconsistent with comparative slowness of pedestrian motion."

DIDY'NAMOUS. (Gr. δις, *twice*, and δυναμις, *power*.) A term applied to flowers having four stamens, of which two are short and two are long.

DIE (Fr. dé), in Coinage, is the instrument by which the impressions are given upon the various denominations of coin. The following is an outline of the *die manufacture*, as conducted in her Majesty's mint:—The engraver selects a forged plug of the best cast steel of proper dimensions for his intended work; and having carefully annealed it, and turned its surfaces smooth in the lathe, proceeds to engrave upon it the intended device for the coin; the Queen's head, for instance. When this is perfect the letters are put in, and the circularity and size duly adjusted; it is then hardened, and is termed a *matrix*. Another plug of soft steel is now selected; and the matrix being carefully adjusted upon it, they are placed under a very powerful fly-press, and two or three blows so directed as to commence an impression of the matrix upon the plug; this is then annealed, and the operation repeated till the plug receives a perfect impression of the work upon the matrix. This impression is of course in *relief*, the original work upon the matrix being indented, and produces what is termed the *punch*. This, being duly shaped in the lathe, is hardened, and is employed in the production of impressions in soft steel or *dies*, which being properly turned and hardened, are exact *fac-similes* of the original matrix, and are used in the process of *coinage*. When a pair of dies are made of good steel duly hardened and tempered, and are carefully used, they will sometimes yield from two to three hundred thousand impressions before they become so far worn or injured as to require to be removed from the coining presses.

DI'ERESI'LIS. A term invented by Mirbel to denote a many-celled superior fruit; the cells being dry, indehiscent, few-seeded, and cohering by a common style round a common axis—Ex. *Malva*.

DIE'SIS. (Gr.) In Music, an interval less than a comma. The harmonical diesis is the difference between a greater and a less semitone.

DI'ET. (Lat. dies, *a day*; Germ. Reichstag.) A name given to the principal national assembly in many countries of modern Europe.

By the usage of the *German Empire*, two diets were summoned every year by the emperor, besides such as were convoked on extraordinary occasions. There were three chambers—1. That of the electors (*see* ELECTORS). 2. That of the sovereign princes, divided into two spiritual and four temporal benches. The counts of the empire voted collectively in four benches or divisions, and not as individuals; the prelates and the abbots in two. 3. The chamber of the imperial cities, divided into the Rhenish and the Swabian benches. The diets, together with the emperor, exercised the prerogatives of sovereignty. A decree of the diet was termed a recess of the empire. The diet of the modern Germanic Confederation is a meeting of plenipotentiaries, permanently assembled in the city of Frankfort-on-the-Maine. There are two diets: one termed *plenum*, in which the thirty-eight sovereign members of the confederacy have seventy votes divided between them; the other the lesser or ordinary, in which their votes amount together only to seventeen. In the latter assembly propositions are brought forward and discussed, which are decided in the other without discussion. On some fundamental questions unanimity is required, in order that any proposition may be adopted; in other cases a majority of two thirds is necessary. Austria presides in both diets, and has the casting voice in the lesser.

The diet of Hungary is composed of the king (Emperor of Austria) and the estates. The latter consist of the higher clergy, the magnates, the two courts of appeal, and two representatives from each chapter, county, city, and privileged district. They are divided into two chambers, called tabulæ.

The diet of Switzerland is composed of the representatives of the cantons, and manages such affairs as by the federal constitution are exempted from the jurisdiction of those several independent states. It is held every two years, alternately at Zurich, Berne, and Lucerne, which are termed the presiding cantons (vorort). The schultheiss or governor (chief executive magistrate) of the presiding canton is landamman of Switzerland for the time being. Each canton has one vote in the diet.

From a very remote period, down to 1832, Poland enjoyed a national assembly, or *diets*, which were of two sorts, *ordinary* and *extraordinary*. The ordinary diet was held every two years, and usually at Warsaw; though it was expressly enacted that every third meeting should be convened at Grodno, in Lithuania. The duration of its sitting was restricted to six weeks, and could not, under any pretext, be protracted beyond this period. The diet was composed of a selection from the nobility, who formed what was called the senate, and of the deputies returned by each of the palatinates and districts of the country. The number amounted to about 400. The period of its meeting was fixed by the king, who presided over its deliberations; except during an interregnum, when the business of summoning the diet devolved on the archbishop of Guesna. The *extraordinary* diets differed from the *ordinary* chiefly in this, that there was no stated period for the former being summoned together, that they were convoked only to listen to propositions from the throne, and lasted only four days.

As is well known, the throne of Poland was not hereditary, but elective; and, on the occasion of choosing the sovereign, the Polish diets were held in the open country, and were attended by all the nobility on horseback, armed and equipped as if for battle. On this subject the reader is referred to a work of great ability, by De la Birardière, entitled *Histoires des Dietes de Pologne, pour les Elections des Rois, depuis* 1572 *jusqu'en* 1674 (8vo. Paris, 1679). *Dietines* was the name given to the particular assemblies of the Polish nobility in which deputies were elected to serve in the ordinary diets, and to represent the wishes and interests of their constituents. In these dietines every gentleman possessing an estate of three acres had the right of voting, and every deputy was chosen by the majority of suffrages. (See *Dunham's History of Poland*.)

DIET DRINK. Alterative decoctions taken in considerable quantities; such as decoction of sarsaparilla, sassafras, dandelion, &c. *Lisbon diet drink* nearly resembles the compound decoction of sarsaparilla of the London Pharmacopœia.

DIETE'TICS. (Gr. διαιτᾳειν, *to nourish*.) That part of medical science which relates to the diet or ordinary food. *See* DIGESTION and FOOD.

DIEU ET MON DROIT. (Fr. *God and my right.*) The motto of the royal family of England. It was first assumed by Richard I., to intimate that he held his sovereignty from God alone, and not in vassalage to man; and it should seem that it fell into desuetude among the immediate successors of that prince, and remained so till the reign of Edward III., by whom it was revived when he first claimed the crown of France. Since that period, if we except the reigns of Elizabeth, William III., and Anne, the first and last of whom used the motto "Semper eadem," and the second, though only in his private capacity, "Je maintiendray," *Dieu et mon droit* has always formed the royal motto of England.

DI'FFERENCE. In Logic, one of the predicables. It is that particular quality which distinguishes the subject from all others, when contemplated from that point of view in which we are then regarding it; and is said, logically, to be part of the essence of the subject. The genus, together with the difference, is said logically to make up the species; the species, with the difference, to make up the lower species, or the individual: — *e.g.* To the genus metal add the difference "susceptible of magnetic attraction," and we obtain the species iron, which is distinguished from all other metals by the existence of that peculiarity. *See* LOGIC.

DI'FFERENCE, in Arithmetic and Algebra, is the excess of one quantity over another, or that which remains when one quantity is taken from another quantity of the same kind. In the higher mathematics the theory of *Finite Differences* forms an extensive branch of analysis, which is usually explained in treatises on the Differential and Integral Calculus. (See the treatises of Euler, Bossut, Lacroix, &c.; or the Appendix by Sir J. Herschel to the English translation of Lacroix's smaller work.)

DI'FFERENCES. In Heraldry, devices borne on the escutcheon to indicate the part of a family to which the bearer belongs. This has been effected by various methods, — at present by what are termed brisures, marks of filiation, or of cadency; being small charges placed conspicuously in the shield. The eldest son bears a label of three points; the second, a crescent; the third, a mullet; the fourth, a martlet; the fifth, an annulet or small ring; the sixth, a fleur-de-lys; the seventh, a rose; the eighth, a cross moline; the ninth, a double quatrefoil. The family of the second son repeat these differences on their own paternal mark of filiation: — *e.g.* the second son's first son bears a crescent ensigned with a label, and so on of the rest. Females do not bear differences.

DIFFERE'NTIAL (diminutive of Difference), in the higher Mathematics, denotes a quantity infinitely small, or less than any assignable magnitude. *See* DIFFERENTIAL CALCULUS.

DIFFERE'NTIAL CALCULUS. The name by which one of the most important branches of the higher mathematics is usually designated.

In confining ourselves to a very general view of the subject, it may be said that the object of the differential calculus is to find the ratios of the differences of variable magnitudes, on the supposition that these differences become *infinitely small;* an hypothesis which gives rise to considerable abbreviations in the general calculation of differences. But it is here necesssary to attend to the particular signification in which the terms *infinite, infinitely small,* are used in the language of the calculus. Every magnitude which forms the subject of mathematical reasoning is susceptible of augmentation or of diminution without limit. We may therefore always conceive a quantity to become so great as to exceed any finite assignable quantity of the same nature as itself; or so small as to be less than any finite assignable quantity also of the same nature as itself: in the former case the quantity is said to be infinite; in the latter, infinitely small. In this sense it is obviously not necessary to attribute a real and physical existence to an infinitely great or infinitely small quantity: it is sufficient to imagine that if we attribute to any quantity which enters into a question a value as great or as small as we please, there always exists, beyond this limit, a quantity of the same kind still greater or still smaller, and which in this sense is infinitely great or infinitely small in comparison of any other finite quantity of the same kind. So that a finite magnitude may be regarded as nothing, or zero, in comparison of one infinitely great; and an infinitely small magnitude as nothing, or zero, in comparison of a finite magnitude.

The infinitely small quantities which come under consideration in the differential calculus are called *differentials.* The differential of a magnitude or variable function is expressed by writing the letter d before the magnitude or function: thus dx signifies the differential of the variable magnitude x, $d\,(xy)$ the differential of the product of the two variables x and y, and so on. Instead of using the letter d, the English mathematicians formerly indicated the *fluxion* of a quantity (which is equivalent to the differential) by placing a dot over it; thus $\dot{x}$ represented the fluxion of x, and $\overline{\dot{x}\,y}$ that of the product $x\,y$; but this notation was found in the progress of the calculus to be inconvenient, and has been disused by all the modern writers. The letter d was introduced by Leibnitz, and it has been adopted by all the Continental writers since the origin of the calculus as the symbol of differentiation.

The principles upon which the doctrine of infinitesimal quantities can be best established have been the subject of much dispute among mathematicians, and various methods of deducing the fundamental theorems have been proposed, of which the principal are — the *differential method* of Leibnitz, the Newtonian *method of fluxions*, Newton's *method of prime and ultimate ratios* followed in the *Principia*, D'Alembert's *method of limits*, Lagrange's *method of derivation*, and Landen's *residual analysis*. The principles and general procedure of Leibnitz's method (which, properly speaking, is the differential calculus) may be explained as follows: —

The differential of a variable quantity may be defined to be the infinitely small difference between two successive states of the same variable, and the object of the calculus is to find this differential for all possible cases; that is to say, for all the possible functions of the proposed variables, such as x, y, z, &c., of which the particular differentials are expressed by dx, dy, dz, &c. Before explaining how this is done, it is necessary to examine into the distinction that must be made between the operation by which an ordinary or finite difference is found, and that to which we must confine ourselves when the difference is infinitely small, or a differential. If we consider the proposed system or function in any two determinate states different from each other, the difference of the two values of the same quantity taken in the two states will be determinate, and consequently cannot be supposed as small as we please, so that no part of its expression can be omitted; but if the two states of the function approach indefinitely near each other, the difference of the two values of the same variable may be rendered as small as we please. It then becomes a differential, and is in fact nothing more than the ordinary difference simplified by the suppression of the quantities which in its expression may be regarded as infinitely small in comparison of the other quantities of which it is composed. Such is the general principle of differentiation. (Carnot, *Reflections sur la Métaphysique du Calcul Infinitésimal*, Paris, 1813.)

From this general principle it follows evidently that in order to differentiate a quantity, or any function whatever of a quantity, or of several combined quantities, which function we shall represent by $\varphi\,(x, y, z, \&c.)$, it is only necessary to consider it in its second state; that is to say, when x, y, z, &c. having become respectively $x + dx$, $y + dy$, $x + dz$, &c., the function itself becomes $\varphi\,(x + dx, y + dy, z + dz, \&c.)$; to subtract the primitive value of the function from its value thus increased, which will give for the finite difference of the proposed function

$$\varphi\,(x + dx, y + dy, z + dz, \&c.) - \varphi\,(x, y, z, \&c.);$$

and, lastly, to pass from this difference to the differential by neglecting those quantities which in the development are infinitely small in comparison of those to which they are to be added, or from which they are to be taken away. This general rule will be better understood by showing its application to some particular examples.

1. Let it be proposed to differentiate the sum $a + b + x + y$, composed of constant and variable quantities. According to the general formula, the constants a and b have no differential; and those of x and y are dx and dy respectively; therefore the differential of the proposed sum, that is, $d\,(a + b + x + y)$ is $a + b + (x + dx) + (y + dy) - (a + b + x + y)$, which becomes on reduction $dx + dy$. Hence, *the differential of any sum whatever of constants and variables is equal to the sum of the differentials of the variables alone.*

2. Let it be required to differentiate $x - y$. Here we have $d(x - y) = (x + dx) - (y + dy) - (x - y)$; or after reduction, $d\,(x - y) = dx - dy$; whence the differential of the difference of any two variables is equal to the difference of their differentials.

3. Let it be proposed to differentiate the product $x\,y$ By the formula we have $d\,(x\,y) = (x + dx)\,(y + dy) - x\,y = x\,dy + y\,dx + dx\,dy$; but it is necessary to remark that the last term $dx\,dy$ is infinitely small in comparison of each of the two others, as will be evident on dividing it by either of them, for the quotient is obviously an infinitely small quantity. The third term must therefore be neglected; whence the formula becomes $d\,(xy) = x\,dy + y\,dz$. In like manner $d\,(xyz) = xy\,dz + xz\,dy + yz\,dx$; and so on for the differential of the product of any number of variable quantities.

4. Let it be proposed to differentiate the fraction $\frac{x}{y}$. By the general formula the difference will be $\frac{x + dx}{y + dy} - \frac{x}{y}$; which being reduced to a common denominator, becomes $\frac{y\,dx - x\,dy}{y^2 - y\,dy}$; and on leaving out the quantity $y\,dy$, which is infinitely small in comparison of y^2 with which it is joined, we have $d\,\frac{x}{y} = \frac{y\,dx - x\,dy}{y^2}$

5. Let it be proposed to differentiate the function x^m. In this case the general formula gives $(x + d\,x)^m - x^m$. Expanding $(x + d\,x)^m$ by the binomial theorem, we get $(x^m + m\, x^{m-1}\, d\,x + \frac{1}{2}(m-1)\, x^{m-2}\, d\,x^2 + \&c.) - x^m$, or $m\, x^{m-1}\, d\,x + \frac{1}{2}(m-1)\, x^{m-2}\, d\,x^2 + \&c.$, for the difference. But $d\,x^2$ being infinitely small in comparison of $d\,x$, the term into which it enters as a factor (and all the succeeding ones which are multiplied by $d\,x^3$, $d\,x^4$, &c.) must be rejected. We have therefore simply, for the differential, $d\,x^m = m\, x^{m-1}\, d\,x$. It will easily be understood that m may be any quantity, whole or fractional, positive or negative.

6. Let it be proposed to differentiate the expression a^x, in which a is a constant quantity, and x a variable exponent. According to the general principle the differential is $a^{x + dx} - a^x$, or $a^x \cdot a^{dx} - a^x$, or $a^x(a^{dx} - 1)$. Assume $a = 1 + b$, and we shall have $a^{dx} = (1 + b)^{dx}$; whence by the binomial theorem,

$$a^{dx} = 1 + d\,x\,b + d\,x\,b^2\,\frac{d\,x - 1}{2} + d\,x\,b^3\,\frac{(d\,x-1)\,(d\,x-2)}{2\cdot 3}$$

+ &c.; and as the quantity $d\,x$, being infinitely small in comparison of the finite numbers 1, 2, 3, &c., must be rejected, the equation, on transposing the first term of the second member, becomes

$$a^{dx} - 1 = d\,x\,(b - \frac{b^2}{2} + \frac{b^3}{3} - \frac{b^4}{4} + \&c.)$$

Substituting this value of $a^{dx} - 1$ in the expression $a^x(a^{dx} - 1)$, and writing $a - 1$ instead of b, we have for the differential of the proposed function

$$d\,a^x = a^x\,d\,x\left((a-1) - \tfrac{1}{2}(a-1)^2 + \tfrac{1}{3}\,(a-1)^3 - \&c.\right)$$

Or, making the constant factor (which is the Napierean logarithm of the number a) = M,

$$d\,a^x = \mathrm{M}\,a^x\,d\,x.$$

7. Let the proposed function be log. y. Make $x = \log. y$; then $d\,x = d \log. y$; and by the general definition of a logarithm, we have always, whatever may be the value of a, the base of the system, $y = a^x$. Hence $d\,y = d\,a^x$; and substituting for $d\,a^x$ its value M $a^x\,d\,x$, given in the last paragraph, we have $d\,y = \mathrm{M}\,a^x\,d\,x$. Substituting, therefore, y for a^x, and $d \log. y$ for $d\,x$, we find ultimately

$$d \log. y = \frac{d\,y}{\mathrm{M}\,y}.$$

8. Let it be proposed to differentiate sin. x, x being an arc of a circle of which the radius is 1. By the general principle d sin. x = sin. $(x + d\,x)$ − sin. x; whence, by the common trigonometrical formula, d sin. x = sin. x cos. $d\,x$ + cos. x sin. $d\,x$ − sin. x. Now if we recollect that $d\,x$ is an infinitely small arc, it will be obvious that its cosine differs from unity only by an infinitely small quantity, which therefore must be rejected. The formula consequently becomes d sin. x = sin. x + cos. x sin. $d\,x$ − sin. x = cos. x sin. $d\,x$. Again, $d\,x$ being infinitely small, it differs from its sine only by an infinitely small quantity, which must therefore be rejected. Hence sin. $d\,x = d\,x$, and we have

$$d \sin. x = \cos. x\,d\,x.$$

By the same process of reasoning we find d cos. x = − sin. $x\,d\,x$, and d tan. $x = \dfrac{d\,x}{\cos.\,x^2}$. It is unnecessary to give more examples; the method of applying the general principle is obvious.

Hitherto we have considered the system of variable quantities in two successive states only; but it may be considered successively in two, three, four, or any number of consecutive states, all differing infinitely little from each other. This consideration gives rise to successive *orders* of differentials, derived from each other by a continued repetition of the same operation. By differentiating a function of any variable quantities we obtain a derivative function, in which the corresponding quantities differ infinitely little from their values in the original function. Another differentiation gives a second derivative function, and so on; so that we obtain as many successive orders of differentials as operations are performed. But it is to be remarked, that the infinitely small differences between the quantities in the first derivative system and the corresponding quantities in the original function, are not the same as the infinitely small differences between the quantities in the second derivative system and the corresponding quantities in the first; and those between the second and third systems are again different from those between the first and second. Hence it follows that these differentials are themselves variable, and consequently, like all other variable quantities, have their differentials. If therefore we retain the symbol d as the characteristic of the differential of any species of variable, the expression $d\,d\,x$ will denote the quantity by which $d\,x$ is augmented in passing from the first derivative state to the second, exactly in the same manner as $d\,x$ represents the increase of x in passing from the original to the first derivative state. In like manner $d\,d\,d\,x$ will express the augmentation which $d\,d\,x$ receives in passing from the second system to the third, and so on.

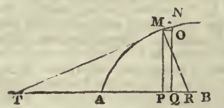
The quantities $d\,x$, $d\,d\,x$, $d\,d\,d\,x$, &c. are called the first, second, third, &c. differentials of x. In the same manner, $d\,y$, $d\,d\,y$, $d\,d\,d\,y$, &c. are the first, second, third, &c. differentials of y. Instead of writing $d\,d\,x$, $d\,d\,d\,x$, &c., it is usual to write $d^2\,x$, $d^3\,x$, &c. And this notation is not merely preferred on account of the abbreviation; it is absolutely necessary in many cases for the sake of carrying on the investigation when many successive differentials of the same variable are necessary to be considered. But these symbols must be carefully distinguished from $d\,x^2$, $d\,x^3$, &c., which are likewise abbreviations, but which at the same time denote real powers of $d\,x$, signifying respectively $d\,x\,d\,x$, $d\,x\,d\,x\,d\,x$, &c.; and they must also be distinguished from the quantities $d\,(x)^2$, $d\,(x)^3$, &c., which are the differentials of the powers x^2, x^3, &c. of x, while $d\,x^2$, $d\,x^3$, &c. are the powers of the differentials.

From these considerations it follows that the differentials of all orders are differentiated in the same manner as any other variable, and consequently no particular rules are required for this purpose. For example, the differential of $x\,y$ is $x\,d\,y + y\,d\,x$; and on differentiating this differential, we find $d\,x\,d\,y + x\,d^2\,y + d\,y\,d\,x + y\,d^2\,x$. Differentiating a third time, we get, on adding the similar terms, $3\,d\,x\,d^2 y + 3\,d\,y\,d^2\,x + x\,d^3\,y + y\,d^3\,x$, and so on.

In the application of the calculus, it is very important to observe, that when different variables are connected by equations we are always at liberty to assume the differential of one of the variables to be constant; and this constant differential then becomes a term of comparison, and serves to regulate all the others. For instance, in considering a curve line, we may suppose the successive infinitely small increments of the absciss to be all equal; in this case $d\,x$ is invariable, and consequently $d^2\,x = 0$. But the increments of the ordinate, which correspond to these equal increments of the absciss, are not equal, and consequently the differentials of $d\,y$ (or $d^2\,y$) are not zero; and the law according to which $d\,y$ varies in passing from one point to another, while $d\,x$ remains constant, is precisely that which will make known the nature of the curve. In other words, the nature of the curve will be determined by the relations between the successive differentials $d\,y$, $d^2\,y$, $d^3\,y$, &c. of the variable y.

Having now endeavoured to explain the general principles of the calculus, we shall give a few examples of its application to the theory of curve lines, the first subject to which it was applied by its inventors.

Let A M N be a curve line, which we may regard as a polygon of an infinite number of sides. Let one of these sides M N be produced till it meet the axis A B in T, and draw M P perpendicular to A B; then M T is the tangent and T P the subtangent. Through N, the other extremity of the side M N, draw N Q parallel to M P, and draw M O parallel to A B. Now, since M N is supposed to be infinitely small, M P and N Q are infinitely near each other; consequently M O is the differential of the axis A P = x, and N O the differential of the ordinate M P = y; whence M O = $d\,x$, and N O = $d\,y$. But the two triangles M N O and M T P are similar, therefore N O : O M : : M P : P T; that is, $d\,y : d\,x : : y :$ P T; whence P T = $y\,\dfrac{d\,x}{d\,y}$, an equation giving the value of the subtangent, and consequently the position of the tangent itself. It therefore only remains to determine the value of $y\,\dfrac{d\,x}{d\,y}$ from the equation of the curve. As an example, let it be required to find the subtangent of the commom parabola, the equation of which is $y^2 = a\,x$, a being the semiparameter of the axis. Differentiating the equation of the curve, we get $2\,y\,d\,y = a\,d\,x$; whence $\dfrac{d\,x}{d\,y} = \dfrac{2\,y}{a}$, and the subtangent $y\,\dfrac{d\,x}{d\,y} = \dfrac{2\,y^2}{a}$. Substitute in this expression $a\,x$ for y^2, and we have subtangent = $2\,x$, a well-known property of the parabola.



The position of the normal is found in a similar manner. Draw M R through M perpendicular to M T and meeting A P in R; then M R is the normal, and P R the subnormal. Because T M R is a right angle; therefore P R : P M : : P M : P T; that is, P R : $y : : y : y\,\dfrac{d\,x}{d\,y}$, consequently the subnormal P R = $y\,\dfrac{d\,y}{d\,x}$. Let the curve, for example, be an ellipse, the equation of which is $b^2\,x^2 + a^2\,y^2 = a^2\,b^2$, the co-ordinates being referred to the centre. The differential of this equation is $2\,b^2\,x\,d\,x + 2a^2\,y\,d\,y = 0$, whence we find $\dfrac{d\,y}{d\,x} = -\dfrac{b^2\,x}{a^2\,y}$; and consequently the subnormal $y\,\dfrac{d\,y}{d\,x} = -\dfrac{b^2}{a^2}\,x$.

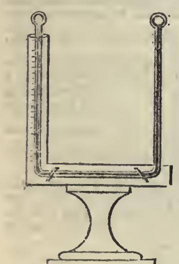
The differential calculus applies with like facility to the determination of the radii of curvature and the involutes of curve lines, to the finding of maxima and minima, in-

vestigations respecting series, and numerous other inquiries; in all of which it affords a singular facility in resolving questions, the solutions of which without its aid could only be obtained with great labour and difficulty.

The differential calculus was invented by Leibnitz; but reduced to a systematic form, and greatly extended, by the two celebrated brothers James and John Bernoulli. Some years, however, before Leibnitz fell on the discovery, the method of *fluxions*, with which the differential calculus agrees in every respect excepting its notation and the manner in which the principles are usually explained, had been invented and applied by Newton. This circumstance gave rise to a dispute, which was long carried on with great acrimony, between the mathematicians of England on the one hand, who put forward the claims of Newton for the honour of the invention, and those of France and Germany on the other, who gave the merit of it to Leibnitz. It was established beyond doubt that Newton was in possession of his method before it had been thought of by Leibnitz: the only question, therefore, was whether Leibnitz received such hints or information respecting the nature of Newton's method as were sufficient to guide him to its discovery. Of this there is no evidence, and extremely little probability; accordingly mathematicians have long agreed in recognizing the claim of Leibnitz to be regarded as an independent inventor. The notation introduced by Newton was followed generally by British mathematicians till some years after the beginning of the present century; but that of Leibnitz and the Bernoullis is now universally adopted.

DIFFERENTIAL COEFFICIENT, in Analysis, is the ratio of the differential of any function of a variable quantity to the differential of the variable. Let x and y denote two quantities related to each other by the equation $y = a x^2 + b x + c$, then y is a function of the variable x; the differential coefficient is $\frac{d y}{d x}$; and we have $\frac{d y}{d x} = 2 a x + b$. It is to be observed that the differential coefficient is not to be considered as an algebraic fraction, but merely a symbol, showing (in the present instance) that the function y has been differentiated with respect to x, and of which the two parts $d y$ and $d x$ have no independent meaning.

DIFFERENTIAL THERMOMETER. An ingenious instrument, of great use in experimental philosophy, for measuring very small differences of temperature; invented and first applied by Sir John Leslie, though the idea of an instrument of the same kind seems to have long before suggested itself to Sturmius. The differential thermometer is described by Leslie, in his *Experimental Inquiry into the Nature and Propagation of Heat*, nearly as follows: — Two glass tubes of unequal lengths, each terminating in a hollow ball, and having their bores somewhat widened at the other ends, a small portion of sulphuric acid tinged with carmine being introduced into the ball of the longer tube, are joined together by the flame of a blow-pipe, and afterwards bent into nearly the shape of the letter U; the one flexure being made just below the joining, where the small cavity facilitates the adjustment of the instrument, which, by a little dexterity, is performed by forcing with the heat of the hand a few minute globules of air from the one ball into the other. The balls are blown as equal as the eye can judge, and from four tenths to seven tenths of an inch in diameter.



To one of the legs of the thermometer a scale is attached; and the liquid contained in the tube is so disposed that it stands in the graduated leg opposite the zero of the scale, when both balls are exposed to the same temperature. From this construction of the instrument, it is easy to see that it is affected by the difference only of heat in the two balls. As long as both balls are of the same temperature, whatever this may be, the air contained in the one will have the same elasticity as that contained in the other; and consequently the intercluded coloured liquid, being thus pressed equally in opposite directions, must remain stationary. But if, for instance, the ball which holds a portion of the liquor be warmer than the other, the superior elasticity of the confined air will drive it forwards, and make it rise in the opposite branch above the zero, to an elevation proportional to the excess of elasticity or of heat. Sulphuric acid is chosen as the liquor best adapted to the purpose; because it is not vaporizable, and consequently does not by its vapour affect the pressure of the air above it. The carmine is used to render it more easily visible.

DIFFRA'CTION. In Optics, a species of deviation or inflexion which the rays of light undergo in passing very near the extremities of any opaque body. This phenomenon was first observed by Grimaldi, who described the principal appearances with sufficient accuracy; but it was Newton who first attempted to explain its cause by the general properties of light. His experiments are detailed in the last book of his *Optics*. In order to exhibit the phenomena of refraction, let a beam of solar light, reflected horizontally, be admitted into a dark chamber through a small round hole, and received on the white horizontal wall. If the hole has a sensible diameter, the image of the sun thrown on the wall will suffer no sensible alteration of colour; but if we place in the axis of the beam of light, and at a distance of 5 or 6 feet from the hole through which it is admitted, a metallic plate, having a puncture made in it by the point of a very fine needle, and intercepting all other light than that which passes through the puncture, the appearance on the wall will no longer be a circular spot of white light only; it will be surrounded with several concentric coloured rings, covering a space far exceeding in extent that which the solar beam would have occupied if the rays of which it was composed had followed their rectilinear direction. It is obvious therefore, both from the colours and the space occupied by the light, that the different rays have been reflected or bent in different degrees, and in a manner quite analogous to what takes place when light passes through a glass prism. By substituting a very narrow slit for the puncture in the metallic plate, or several punctures or slits very close to each other, and arranged in a certain manner, some of the most beautiful phenomena of optics are exhibited. The phenomena of diffraction have been much studied of late years, as affording a test by which to try the truth of the rival theories of light. At present the result is in favour of the theory of undulation, inasmuch as it has afforded a satisfactory explanation of all the phenomena without exception. *See* LIGHT.

DIFFU'SION OF GASES. When two gaseous bodies which do not act chemically upon each other are mixed together in any relative proportions they gradually diffuse themselves through each other; so that after a sufficient time has elapsed for the purpose, whatever may have been their relative densities, they are found intimately blended: the heavier gas does not fall, nor does the lighter one float. Dalton, therefore, has appropriately represented gaseous bodies as acting as *vacua* to each other. Professor Graham's researches have lately thrown much new light upon this subject, and he has determined the laws of *gaseous diffusion* by a series of well conceived experimental inquiry. (See *Graham's Elements of Chemistry*, vol. i. p. 71.; and *Quarterly Journal of Science*, N.S., vol. v.)

DIGA'MMA. (Gr. δις, *double*, and γαμμα (Γ), so called from its representing two gammas, one set above another, thus, F.) The name given to the form of that letter in the ancient Greek alphabet which corresponds in appearance generally to the Latin F.

A mere outline of the controversies that have prevailed among the learned respecting the form and power of the digamma, the mode of its pronunciation, and the purposes which it served in the early language of Greece would occupy more space than our prescribed limits admit of; and we must content ourselves with referring the reader to the article "Digamma" in the *Encyc. Metrop.*, and Ersch and Gruber's *Allgem. Encyc.*, in which the discussions on this subject display great learning and research. This letter appears to have occupied the sixth place in the alphabet, and was most prevalent in the Æolic dialect; though some grammarians contend that it was common to all the dialects of Greece in their more ancient mode of pronunciation. It has often been expressed by B, and sometimes by, Γ, Δ, Θ, Φ, and X; and it is now almost universally considered to have had the force of F, V, or the English W. As the Latin language approximated more nearly to the Æolic than to any of the other Grecian dialects, the use of the digamma is very prevalent in many Latin words, and the facility with which it was there interchanged for V, both at the commencement and in the middle of words; will be at once apparent from the following examples: — Gr, εαρ, *spring*, Æol. Fεαρ, Lat. ver; Gr. ἑσπερος, *evening*, Æol. Fεσπερος, Lat. vesperus; Gr. οινος, *wine*, Æol. Fοινος, Lat. vinum; Gr. ωον, *an egg*, Æol. ωFον, Lat. ovum, &c. (See Kidd's edition of *Dawe's Miscellanea Critica*, pp. 175—335.; and *Buttmann's Greek Grammar*.)

DIGA'STRIC MUSCLE. (Gr. δις, and γαστηρ, *belly*.) A double muscle, situated externally between the lower jaw and mastoid process; it is attached to the *os hyoides* in the human subject at the middle of its course. It pulls the lower jaw downwards and backwards; and when the jaws are shut it draws the larynx, and with it the pharynx, upwards in the act of swallowing.

DI'GEST. Several compilations of the Roman Law have been so called; but the best known is that which was made by order of the emperor Justinian. It is also

termed the Pandects, from the Greek words παν, *all*, and δεχεσθαι, *to receive;* signifying the general nature of the collection. The care of this great compilation was entrusted by the emperor to Tribonian, with seventeen associates. It was completed in three years, and published A.D. 533. It contains the best decisions and opinions of former jurists, collected, it is said, from more than two thousand volumes; and follows the same arrangement as the code of the same emperor, which had appeared in 529. The Pandects of Justinian, according to the commonly received story, were neglected in the Eastern Empire shortly after the decease of that emperor, and were wholly lost in the West until the accidental discovery of a MS. at Amalfi in 1130. But this tradition is now generally believed to rest on no solid foundation. *See* LAW, CIVIL. (See also *Gibbon*, cap. 44.; *Savigny on the Roman Law.*)

DIGE'STER. A strong iron or copper vessel with a tightly adjusted lid, furnished with a safety valve, in which bodies may be subjected to the action of high-pressure steam.

DIGE'STION. The general process by which food is converted into *chyme* in the stomachs of animals, and by which it is rendered fit for the production of *chyle*, and ultimately of *blood*. The term digestion is also more generally applied to the entire functions of the intestinal canal. The phenomena of digestion, though exclusively chemical, are also under the immediate influence of vitality, and are consequently perfectly different from any changes which the food suffers out of the body; hence the unsatisfactory conclusions of the older physiologists, who considered attrition, fermentation, and similar mechanical and chemical processes as sufficient to account for the extraordinary changes that are produced. It has been clearly ascertained that the influence of the nervous system is essential to the due performance of the functions of the stomach; and that when the brain, or the nerves that supply that viscus, are either injured or divided, digestion is either impaired or altogether suspended, and the food then ferments and putrefies instead of digesting. It has been said that the transmission of a current of electricity through the nerves is equivalent to their connection with the brain, and that under such circumstances the stomach, notwithstanding the division of its nerves, continues its functions; but these, and other statements in which electricity is said to be equivalent to the nervous and cerebral agency, require much more extended experimental proofs than they have hitherto received, before they can be admitted as true interpretations.

DIGESTION. In Surgery, this term was formerly applied to the treatment by which wounds or ulcers were brought into that state in which they form healthy pus: the remedies or applications promoting this object were termed *digestives*.

DI'GGING. The operation of moving earth with a spade. In gardens where the soil is loose the main object of digging is to mix the soil by burying the surface and bringing what is below to the top, and in that case a spade with a large blade may be used; but in digging firm ground spades can only be used which have narrow blades, as these may be more easily made to penetrate the ground.

DI'GIT (Lat. digitus, *finger*), in Arithmetic, signifies one of the ten symbols, 0, 1, 2, 3, &c., by which all numbers are expressed. By astronomers the term is used in speaking of eclipses, to denote the twelfth part of the diameter of the sun or moon. Thus, the eclipse is said to be of ten digits, if ten parts out of twelve of the diameter are concealed. It is convenient to employ this mode of defining the magnitude of an eclipse.

DIGITA'LIA. A vegetable alcaloid, procured from the leaves of the digitalis. *See* FOXGLOVE.

DI'GITIGRADES, *Digitigrada*. (Lat. digitus, *a digit;* gradior, *I walk.*) The carnivorous quadrupeds, which walk on the extremities of their digits. An artificial group of *Carnivora* is so called in the system of Cuvier.

DI'GLYPH. (Gr. δις, *twice*, and γλυφω, *I carve.*) In Architecture, a projecting face with two panels sunk thereon.

DI'GNITARY, in the Canon Law, signified originally a person who held an ecclesiastical benefice or dignity, which gave him some pre-eminence above mere priests and canons. To this class exclusively belonged all bishops, deans, archdeacons, &c.; but it now includes all the prebendaries and canons of the church.

DIGRE'SSION (Lat. digredi, *to diverge*), signifies any details introduced into a work, which are either altogether foreign from the immediate subjects of which it treats, or not absolutely necessary to the progress or development of the story. It will at once be perceived from this definition that, as a general rule, digressions are to be carefully avoided, from their tendency to withdraw the attention of the reader from the chief points of the story or the question under discussion. There are, however, some departments of literature in which the use of digressions is not only admissible, but even advantageous. On this subject, however, no definite rules can be laid down for the guidance of the author; but there can be little doubt that if introduced properly and without effort, managed with good taste, and confined within reasonable limits, digressions have the effect of relieving the mind from the fatigue of a too long sustained attention, and of imparting life and interest to a subject that may be naturally dry and uninteresting. The Essays of Montaigne exhibit more clearly than any similar productions with which we are acquainted, the admirable uses to which digressions may be turned in the hands of a master. Many of the writings of Sterne, but more especially his *Tristram Shandy* (which contains an eulogium upon digressions), supply the happiest examples of their effects; and in our times *The Doctor, &c.*, of which five volumes have already been published, owes its principal attractions to the digressions with which the story is interlarded. *See* EPISODE.

DIGRESSION, in Astronomy, denotes the apparent distance of the inferior planets Mercury and Venus from the sun. Mercury is never seen at a greater distance than about 28° from the sun; this is called its *greatest digression:* but on account of the great eccentricity of the planet's orbit, the limit is subject to considerable variation. The greatest digression of Venus is about 47½°, and it admits of a variation only amounting to about 2° 48′ between its extreme values. When the digression of an inferior planet attains it maximum, the visual ray along which it is seen is a tangent to the orbit, and the planet appears for some days nearly stationary. The term *elongation* is also used to denote a planet's apparent distance from the sun; but *elongation* is applied indifferently to any planet, whereas *digression* is usually confined to the two inferior ones.

DILA'PIDATION, chiefly in Ecclesiastical Law, is where an incumbent of a benefice suffers the parsonage house or outhouses to fall down or be in decay for want of necessary repairs, or commits any wilful waste of the inheritance of the church. Proceedings against an incumbent for dilapidations must be in the spiritual court. Against his executors, the remedy is either by proceeding in that court, or the successor may have an action of debt or on the case for damages at common law.

DILATA'TION. *See* EXPANSION.

DILE'MMA. (Gr. δις, *twice*, and λῆμμα, *an assumption; a twofold assumption.*) In Logic, a species of argument in the form of a complex conditional syllogism. (*See* SYLLOGISM.) It has been divided by logical writers into — 1. The simple constructive dilemma, in which the major premiss contains several antecedents all with the same consequent; the minor premiss grants that some one of these antecedents is true; and the conclusion infers that the common consequent is true: *e.g.* If A is B, C is D; and if X is Y, C is D; but either A is B or X is Y, therefore C is D. 2. The complex constructive dilemma, in which the several antecedents have each a distinct consequent; and it being granted that one antecedent is true, it follows that one consequent is true: *e.g.* If A is B, C is D; and if X is Y, E is F; but either A is B or X is Y, therefore either C is D or E is F. 3. The destructive dilemma, properly so called, has several antecedents with each a different consequent; and by denying the consequents disjunctively (*i.e.* denying that one or the other consequent is true) in the minor premiss, we proceed in the conclusion to deny the truth of one or the other antecedent: *e.g.* If A is B, C is D; and if X is Y, E is F; but either C is not D or E is not F, therefore either A is not B or X is not Y. Every dilemma may be reduced into two or more simple conditional syllogisms.

In the ordinary sense of the word, a dilemma is an argument in which two or more propositions are pressed upon the mind in such a manner that by granting which we will we are compelled to infer the same conclusion. One of the most celebrated dilemmas is that of the philosopher Protogoras in reference to his pupil Euathlus; for an account of which we beg to refer the reader to the *Athenian Letters*, vol. i. p. 149.

DI'LETTA'NTE. (It.) A term wholly naturalized in France, England, and Germany; signifying an amateur, chiefly of music, but also of the kindred sciences. There has existed in England, since the year 1760, a society called the *Dilettanti Society*, which was originally instituted by gentlemen who had travelled in Italy, simply for social purposes, and for perpetuating in each other's company the pleasure they had derived from their residence in that classic country: but its objects soon become materially extended; and it has acquired universal celebrity by the liberality with which it has devoted its funds to the purposes of science and art. The society still exists, and meetings of it are occasionally held. Some of the most famous travellers in Greece and Asia Minor, among whom we may mention Chandler, have been sent out at the sole expense of the Dilettanti Society; and many works illustrative of the art and science of the classic regions of antiquity, which would otherwise in all probability never have seen the light, have under their auspices been given to the world.

DI'LIGENCE. In Scottish Law, a general term, comprehending the process of law by which persons, lands, or effects are seized in execution or in security for debt

It is divided into that against the *heritage*, that against the *moveables*, and that against the person of the debtor; of each of which there are several species. (*See* INHIBITION, ADJUDICATION, POINDING, SEQUESTRATION, HORNING.) Diligence is also the name of the warrants issued by courts for enforcing the attendance of witnesses, or the production of writings.

DILLENIA'CEÆ. (Dillenia, one of the genera.) In Botany, a natural order of chiefly arborescent Exogens inhabiting the hotter parts of the world. Allied to *Magnoliaceæ;* from which they are distinguished by their want of stipules, and the quinary arrangement of the parts of fructification. They differ from *Ranunculaceæ*, to which they are also akin, in their persistent calyx and habit, and are universally characterized by the presence of an aril. Their properties are generally astringent.

DILL SEED. The seed of the *Anethum graveolens*, or *common dill*. This plant is grown for the supply of the medical market with seeds: they are warm aromatics, with something of the caraway flavour, and yield *dill water* and an essential oil when distilled with water. Dill water is a useful remedy in flatulency and gripes of children.

DI'LUENTS. (Lat. diluo, *I wash away.*) Water and aqueous drinks, which increase the secretion of urine and the perspiration, and appear to dilute the fluids of the body, are medically spoken of as *diluents*.

DILU'VIUM. (Lat.) The accumulations of gravel, &c. supposed to have been the consequence of the deluge.

DI'MERANS, *Dimera*. (Gr. δις, *two*, μηρος, *thigh.*) The name of a section of Coleopterans, comprehending those which have apparently only two joints in each tarsus; this structure, however, does not in point of fact exist, there being always a third rudimental tarsal joint.

DIMI'NISHED INTERVAL. In Music, one that is defective or short of its just quantity by a lesser semitone.

DIMINUE'NDO. (It.) In Music, an instruction to the performer to lessen the volume of sound from loud to soft, usually marked thus >.

DIMINU'TION. (Lat. diminutio.) In Music, a division of a large note into smaller ones; as a semibreve into two minims, four crotchets, &c.

DIMINU'TION. In Architecture, the gradual decrease of the diameter of a column as it rises. *See* ENTASIS.

DIMI'NUTIVE (Lat.), in Grammar, is applied to words which, by the addition of one or more syllables to those from which they are derived, soften the meaning or diminish the force and effect thereof. Every language is in a greater or less degree susceptible of diminutives; but in this respect, as is well known, the Italian language surpasses all those both of ancient and modern times.

DI'MITY. A cotton cloth of a thick texture, and generally striped or otherwise ornamented in the loom; it is chiefly used for articles of female dress, and for bed furniture or window curtains, and is very rarely dyed.

DIMYA'RIAS, *Dimyariæ*. (Gr. δις, *twice*, μυων, *a muscle.*) All those bivalves or conchifers are so called which have two distinct and separate adductor muscles, and consequently two corresponding muscular impressions on each valve.

DI'OCESE. (Gr. διοικησις, *a government.*) The territorial extent of a bishop's jurisdiction, embracing several parœciæ or parishes. As in early times the Christian converts were most numerous or most easily collected into a congregation in large towns, so in these towns did the bishop reside and minister to the faithful in his church, assisted by his priests and deacons. When the number of believers required the accommodation of additional temples, or congregations were formed in the neighbouring villages, the bishop was wont to appoint priests for their service, and the districts inhabited by these subsidiary congregations would become the parishes of his diocese.

DI'ODON. (Gr. δις, and οδους, *a tooth; two-toothed.*) The name of a genus of Plectognathic fishes with undivided jaws, each with a single and continuous dental plate.

DIONY'SIA. (Gr. τὰ Διονυσια.) In Ancient History, the festivals of Dionysus or Bacchus, but more particularly those that were celebrated in Attica, which were three in number, distinguished by the following titles:— 1. The Country Dionysia (τὰ κατ' ἄγρους). 2. Those in Limnæ (a part of the city of Athens, where they were held), which were also called Lenæan (τὰ ληναῖα, from λῆνος, *a wine-press*), or Anthesteria (Ανθεστήρια, from Anthesterion, the name of the Attic month corresponding to our January, in which they were celebrated); and 3. The Great Dionysia (τὰ μέγαλα). At all of these festivals the chief amusements consisted in the representation of stage plays; but the last was most celebrated, as then, before the face of all Greece, the great tragic contests were held, no expense being spared to render the decorations and accompaniments as splendid as art could make them: for on these exhibitions a great portion of the revenues drawn from the tributary states was expended, besides the private property of the persons appointed to superintend them, they being not only under the protection of the state, but a principal object of its care. (See *Bœckh's Public Economy of Athens.*)

DIOPHA'NTINE ANA'LYSIS. A branch of algebra, which treats of certain classes of indeterminate questions relating to square and cube numbers, rectangular triangles, &c. The name is derived from Diophantus, a mathematician of Alexandria, who is supposed to have lived in the third century of our era, and who examined and resolved a great number of questions of this nature in his celebrated treatise on arithmetic. Of this work, which exhibits the state of algebra among the Greeks, there are two editions: one by Bachet at Paris, in 1621; the other at Toulouse, in 1670, which is enriched by some valuable notes of Fermat. The following example will serve to illustrate the nature of the Diophantine problems; the object of which, in general, is to find commensurable numbers that satisfy conditions which may be satisfied by an infinity of indeterminate numbers. Suppose it were required to find three numbers, such that the sum of the squares of the two first is equal to the square of the third; that is, to find x, y, and z, such that $x^2 + y^2 = z^2$. The solution may be as follows:—Let $z = x + u$, then $z^2 = x^2 + 2xu + u^2$, and $x^2 + y^2 = x^2 + 2xu + u^2$, or $y^2 = 2xu + u^2$, whence $x = \frac{y^2 - u^2}{2u}$. Now we may choose for y and u any numbers we please, so that $y^2 - u^2$ is divisible by $2u$ (which will be the case if we make $u = 1$, and y any odd number whatever). For example, if we suppose $y = 3$, and $u = 1$, we have $x = 4$, and $z = x + u = 5$; so that the three numbers are 3, 4, and 5. Since $x^2 + y^2 = z^2$, it is obvious that x and y may represent the two sides of a right angled triangle, of which z is the hypothenuse. The student of the indeterminate analysis will find this subject very fully and perspicuously treated in the second volume of *Euler's Algebra*.

DIO'PSIS. (Gr. δια, *through*, and ωψ, *an eye.*) The name of a genus of Dipterous insects, remarkable for having the eyes and antennæ situated at the extremity of slender horny peduncles rising from the sides of the head, and equalling, in some species, the entire length of the body.

DIO'PTRICS. (Gr. διοπτρον, *something transparent;* from δια, *through*, and οπτομαι, *I see.*) A branch of Optics, of which the object is to investigate and explain the effects of the refraction of light when it passes through different media, as air, water, glass, &c. Its principal application is to the construction of telescopes and microscopes, and other instruments which require the use of refracting lenses. The term is not much used by modern writers on optics, the phenomena to which it refers being treated under the general head of *Refraction*. *See* LENS, LIGHT, OPTICS, REFRACTION.

DIORA'MA. (Gr. δια, *through*, and ὁραω, *I see.*) A mode of painting or scenic representation, invented by two French artists, Daguerre and Bouton, and recently brought forward as a public exhibition in all the principal cities of Europe.

The peculiar and very high degree of optical illusion produced by the diorama depends upon two principles; the mode of exhibiting the painting, and the manner of preparing it. With respect to the first of these, the spectator and the picture are placed in separate rooms, and the picture viewed through an aperture, the sides of which are continued towards the picture, so as to prevent any object in the picture room from being seen excepting the painting itself. Into the room in which the spectator is placed no light is admitted excepting what comes through this aperture from the picture; he is thus placed in comparative darkness, and also (which contributes to the effect) at a considerable distance from the picture. The picture room is illuminated from the roof, which is glazed with ground glass; and the picture so placed that the light falls on it at a proper angle to be reflected towards the aperture. The roof, which is invisible to the spectator, is provided with an apparatus of folds or shutters, by which the intensity of the illumination may be increased or diminished at pleasure, and so modified as to represent, with great effect and accuracy, the different *accidents* of light and shade, or the changes of appearance depending on the state of the atmosphere; as bright sunshine, cloudy weather, or the obscurity of twilight.

The second principle consists in painting certain parts of the picture in transparency, and admitting a stream of light upon it from behind, which, passing through the picture, produces a brilliancy far surpassing what could be obtained by illuminating the picture in the ordinary way, and renders the relief of the objects represented much stronger and more deceptive. Hence, the diorama is peculiarly adapted for representing architectural objects, as the interiors of cathedrals, &c.

In order to render the exhibition more attractive, it is usual to present more scenes than one. This may of course be effected by removing one picture and substituting another; but with a view to prevent the illusion from being impaired by the accidents incidental to scene-shifting, a different method is sometimes resorted to. In the diorama in the Regent's Park, the room in which the spectator is seated is a rotunda about 40 feet in diameter, which turns round a vertical axis by means of machinery placed under the floor. There are two pic-

ture rooms contiguous to each other, each containing a view; and when the scene is to be changed, the rotunda is turned round until the aperture in front of the spectators, which was first opposite to the opening into one of the picture rooms, is placed directly opposite the opening into the other. This contrivance, however, it will be observed, is independent of the principles peculiar to the diorama.

DIOSCOREA'CEÆ. (Dioscorea, one of the genera.) A natural order of Endogens, inhabiting the tropics, and agreeing with *Simlacea* by the genus *Tamus*, in having an inferior fruit; but differing from it by the threefold character of inferior ovary, capsular fruit, and the albumen having a large cavity. The mealy tubers of Dioscorea, under the name of *yams*, form an important food in all tropical countries.

DIP, in Magnetism, is the angle which a magnetic needle makes with the plane of the horizon, when poised on its centre of gravity and at liberty to turn in the vertical plane. *See* DIPPING NEEDLE.

DIP. In Geology, when strata are inclined, the angle which they make with the horizon is called the angle of *dip* or inclination, and the point of the compass towards which they slope is called the *dip of the strata*.

DIP OF THE SEA HORIZON. The apparent angular depression of the visible horizon, caused by the height of the spectator above the surface. To find it, multiply the square root of the height in feet by 1·063; the result is the dip in minutes (of a degree) and decimals. The actual dip observed is generally less than the true or abstract dip by $\frac{1}{14}$ on the average; but this is again affected by the temperature of the sea: when the sea is warmer than the air the horizon appears lower than its place by theory, and the contrary when the sea is the colder.

DI'PHTHONG (Gr. δις, *double;* and φθεγγομαι, *I sound*), has usually been defined to be a double vowel, or the union of two vowels pronounced together, so as only to make one syllable. If, however, this definition be more narrowly examined, it will be found to be deficient in two of the most essential qualities of a good definition — precision and accuracy. If, says Mr. Walker, a diphthong be two vowel sounds in succession, they must necessarily form two syllables, and therefore by the very definition cannot be a diphthong: if it be such a mixture of two vowels as to form but one simple sound, it is improperly called a diphthong; nor can any such simple mixture exist. Perhaps the best definition of a diphthong, although even that is far from embracing all the peculiarities of this class of letters, is to be found in *Smith's Scheme for a French and English Dictionary*, to which we beg to refer the reader.

DI'PHYANS, *Diphyes.* (Gr. δις, *two*, and φυη, *an offspring.*) A family of *Acelaphans*, comprehending those singular species in which two distinct individuals are always conjoined, one being lodged in the concavity of another.

DI'PLOE. (Gr. διπλοω, *I double.*) The horny or spongy substance between the tables of the skull.

DIPLO'MA. (Gr. διπλωμα, from διπλος, *double.*) Every sort of ancient charter, donation, bull, &c. is comprehended by writers on diplomatics under the name diploma. The term is derived from the earliest charters of donation with which we are acquainted, those of the early Roman emperors having been inscribed on two tablets of copper joined together so as to fold in the form of a book. Writings of earlier date than the fifth century are generally on leaves of the papyrus, or *Biblos Ægyptiaca;* those of a later period, on parchment. The form and character of the diploma granted by the sovereigns, prelates, nobles, &c. of modern Europe, varied from age to age; and the knowledge of these variations forms an important branch of the science of diplomatics.

DIPLO'MACY, in its most restricted sense, is used to express the art of conducting negotiations or arranging treaties between nations by means of their foreign ministers, or written correspondence; but, in its most extended signification, it embraces the whole science of negotiation with foreign states as founded on public law, positive engagements, or an enlightened view of the interests of each. But, upon this subject, we cannot do better than embody in our pages some remarks from the Introduction to Marten's *Manuel Diplomatique*, in which a distinct view is exhibited of the importance and main objects of diplomacy.

Diplomacy, says that able statesman, must be placed in the foremost rank of the useful sciences. The fate of nations, in the present state of the world, depends greatly on their relations with others; and these again are materially influenced and determined by the nature of their foreign policy, that is, by the success with which they have cultivated and applied the principles of this science. Diplomacy embraces —

1. The law of nations, by which the relations of one state with another are determined both in peace and war.
2. The political principles of individual states, as deduced from a regard to their peculiar interests; and a knowledge of the way in which these interests may be reconciled with, and made subservient to, the law of nations.
3. An acquaintance with the privileges and duties of diplomatic agents.
4. The conduct of negotiations, or the course to be pursued in treating of the interests of different states.
5. The moral and physical statistics of each power.
6. The political and military history of the states having diplomatic relations; and the projects, tendency, and policy of their respective governments.
7. The various systems of government, supremacy, concession, retention, equilibrium, centralization, confederacy, &c., that may be brought into operation.
8. The art of composing diplomatic despatches.

To this multifarious information the diplomatist should unite the powers of calculation and application peculiar to strong minds,—the "tact des convenances," which may be felt, but cannot be expressed, — circumspection, address, and perfect integrity. The combination of these various qualities will procure for the diplomatist such a character for sagacity, rectitude, and straightforwardness, as will sooner or later obtain for him an ascendency over the minds of others, and give great weight to his opinions.

It must be remembered that the diplomacy of every nation is more or less within the range of casualties; being subject to the versatility inseparable from human affairs, the fickleness and passions of man, and the uncertainty of events; — an unlooked-for death, a change of ministry, treacherous designs, undue influence from any quarter, a false calculation, corruption, — each of these causes may change the policy or course of a government; and this will more or less affect every other government, in proportion to the extent of its influence. In addition to these numerous causes of variation, if ambitious projects be entertained by any great power, diplomacy becomes still more intricate and difficult. Every state desires to be protected against the storm which its rulers imagine they can prognosticate, and of whose bursting they are apprehensive. Again, we must remark that the schemes of a government, how admirably soever contrived, have often miscarried, either from subordinate persons or those intrusted with putting them in execution having misapplied or misunderstood the instructions of their superiors.

From what has been said, it will be easily understood that, in diplomacy, false estimates are frequently formed of the merits of original plans or designs from looking at their results only. The diplomatist is of course exempted from all responsibility in regard to operations mixed up with the events of war; he is answerable only for the success of his projects under the conditions on which he proposed them.

A diplomatist of moderate capacity, if favoured by circumstances, may accomplish much more than the man of genius who has to contend with adverse fortune; but this difference of success makes no change in their relative ability, and those acquainted with the circumstances readily discriminate between sagacity and accident.

Diplomacy has been practised in substance ever since mankind have been formed into independent states, though it is difficult to ascertain the precise period at which the term came into use. The system, however, of the regular and uninterrupted residence of foreign ministers during peace at the European courts, as at present practised, is said to have originated with the Cardinal de Richelieu. Before that time embassies had been only sent on special occasions, but attended with much greater show and retinue than has been the fashion in modern times; while the substantial business of states at the neighbouring courts was transacted by agents of a lower stamp and character. Diplomatic agents are now ranked, in Europe, in the following order, according to the regulations of the Congress of Vienna: — 1. Ambassadors; 2. Envoys extraordinary and ministers plenipotentiary; 3. Ministers resident; 4. Chargés d'affaires; 5. Secretaries of legation and attachés: the latter, however, have no precise diplomatic character, and are only considered by courtesy as attached to the legation.

Among the best works on this important subject are the *Traité complet de Diplomatie, ou Theorie generale des Relations exterieures des Puissances de l'Europe*, par M. le Comte de Garden (Paris, 1833), 3 vols. 8vo.; and *De Wicquefort's Ambassadeur et ses Fonctions* (Ed. Opt.), 1746, 12 vols. 4to. See also the *Manuel Diplomatique*, by Von Marten (Paris, 1825); *Flassan's Hist. Gen. et Raisonn. de la Diplom. Française*, 7 vols. (Paris, 1811); and Von Marten's (senior) *Grundriss einer Diplom. Geschichte der Europ. Staatshandel, &c.* (Hamburg, 8vo).

DIPLOMA'TICS. The science of deciphering ancient writings, assigning their date, &c. The name is derived from *diploma*, which see. Writings of earlier date than the fifth century were mostly on the leaves of the papyrus, or *Biblos Ægyptiaca*. Parchment appears to have been first generally used in that century; and the oldest documents bearing the character of diplomas which we possess do not extend to a higher antiquity. Not long after the general adoption of parchment, a variety of substances and colours began to be used in

writing, as vermilion, purple, gold and silver; but this sumptuous fashion did not long remain in use. The science of diplomatics teaches the different styles and forms adopted in ancient public documents; the titles, rank, &c., of public officers whose names are subscribed to them; the knowledge of the materials used in writing in different ages, of the different characters used in successive periods and in various countries; and the several kinds of diplomas or public instruments.

This science is said to owe its origin to a Jesuit of Antwerp, named Papelroch, who devoted himself arduously to the research and exposition of old diplomas about the year 1675; but the honour of having reduced it to a science, and established it on a sure and more satisfactory foundation, is due to Mabillon, whose learned work, *De re Diplomatica*, was given to the world in 1681. The principles laid down by Mabillon, however, were more fully developed about the middle of last century, in one of the most elaborate works of which the literature of any nation can boast, the *Nouveau Traité de Diplomatique;* and which has left little to be done by subsequent labourers in this field beyond the duty of translation, compilation, or abridgment. From the above statement of the objects of this science, it will be at once perceived that it is of immense utility. It has greatly facilitated the researches of the historian, the politician, the divine, the political economist; and has contributed to the elucidation of points in the history of nations which might otherwise have been for ever buried in obscurity. We subjoin a list of the most important works on this interesting science, arranged according to the date of their publication; from which it will be seen that the French and Germans have prosecuted this science with an energy and enthusiasm to which, considering its vast importance, our national literature presents a most humiliating contrast. Besides the work of Papelroch above referred to, entitled the *Propylæum*, there are, Mabillon, *De re Diplomatica*, 6 vols. fol. (Paris, 1681), to which a supplementary vol. was added in 1704; *Historia Diplomatica*, by Maffei, 4to. (Mantua, 1727: this work may be regarded as merely a supplement to Mabillon); *Chron. Waltheri Lexicon Diplom.* 3 vols. fol. (Gotting. 1745-7); Heumann von Teutschenbrunn, *Commenta. de re Diplom. Regum, &c.*, 4to. (Nuremberg, 1745); *Nouveau Traité de Diplomatique*, by the Benedictine monks Toussaint and Tassin, 6 vols. 4to. (Paris, 1750-65.); *De Vaine's Diction. Raisonnée de Diplomatique*, 2 vols. 8vo. (Paris, 1774: this work is intended chiefly to aid beginners in the science); Gatterer, *Abriss der Diplomatik*, 8vo. (Götting. 1798); *Schœnemann's Prolusio de finibus Artis Diplom. Pract. Regundis;* and his *Versuch eines Vollständ. Systems der Allgem. besonders ältern Diplomatik*, 8vo. (Götting. 1802).

DIPLONEU'RANS, *Diploneura.* (Gr. διπλος, *double*, and νευρον, *nerve.*) A name applied by Rudolphi to that division of the animal kingdom comprehending the species which have two nervous systems, viz. the ganglionic or sympathetic, and the cerebro-spinal; the series so designated corresponds with the *Vertebrata* of Cuvier.

DIPLO'PIA. (Gr. διπλος, *double*, and οπτομαι, *I see.*) Double vision. This affection occasionally is symptomatic of nervous irritability, worms, indigestion, hysteria, &c.

DIPLO'PTERA. (Gr. διπλος, *double*, and πτερον, *a wing; doubled wing.*) The name of a division of Aculeate Hymenopterous insects, comprising those species of wasp which have the upper wings folded or doubled up longitudinally when at rest.

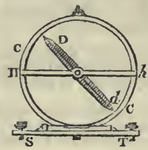
DIPLO'ZOON. (Gr. διπλος, *double*, ζωον, *an animal; double animal.*) The name of a very singular parasitic worm, which infests the gills of the bream, and which appears to be formed of two distinct bodies united in the middle, so as to present the appearance of a St. Andrew's cross, each half of the animal containing precisely the same organs; viz. an alimentary canal, a sanguiferous and a generative system.

DIPNEUMO'NEANS, *Dipneumoneæ.* (Gr. δις, *twice*, and πνευμων, *a lung; two-lunged.*) A term applied to a section of spiders (*Araneidæ*), including those which have only two pulmonary sacs.

DI'PPEL'S OIL. An empyreumatic oil, produced during the destructive distillation of bone.

DI'PPER. A name commonly given to the water-ouzel and other species of the genus *Cinclus.*

DI'PPING NE'EDLE. An instrument for showing the direction of the magnetic force of the earth. It is a magnetic needle, furnished with an axis at right angles to its length, and passing as exactly as possible through its centre of gravity, about which it moves in a vertical plane. When a needle thus mounted is placed any where not on the magnetic equator, it *dips*, or points downwards; and if the vertical plane in which it moves coincides with the magnetic meridian (which is always known by means of a variation compass), the position which it assumes shows at once the direction of the magnetic force; and the intersection of two or more directions, found by making the experiment at different places, indicates the place of the magnetic pole. Though the principles on which the dipping needle acts are abundantly simple, its practical construction is found to be exceedingly difficult. It must be accurately balanced on its axis; the axis must be placed exactly horizontal; the friction must be diminished to the utmost extent possible; and the adjustments can only be made when the needle is perfectly free from magnetism, and also secured from the effects of the magnetic influence of the earth. It must be subsequently magnetized, and during this process much care is required to guard against derangement. The simplest construction is represented in the annexed figure. The needle D *d* consists of a flat oblong piece of steel, tapering to a point at both ends, and having a slender cylindrical axis passed through its centre of gravity. The axis moves freely in circular holes made in the lateral horizontal bars H *h*, which support a vertical circle C C, graduated for the purpose of showing the inclination of the needle to the horizon. The stand S T, to which the circle is fixed, is provided with levels, and adjusted to horizontality by means of screws. But in the most improved form of construction of the dipping needle, the axis, instead of being a cylinder, is a knife edge, resting perpendicularly, like the supports of a pendulum, on two agate planes. A needle thus supported, however, must necessarily make small oscillations; consequently it must be so adjusted that when it points in the direction of the magnetic force, the knife edges may be perpendicular to the agate planes. The mean value of the angle of the dip must therefore be known previously to its construction; but it is the best adapted, on account of its delicacy, for ascertaining the minute variations of the dip at the same place. The angle of the dip, like that of the variation, changes its value even at the same place, following of course the motion of the magnetic poles, which, from the observations made by Scoresby, Parry, Ross, and others in high latitudes, appear to have a motion westward, the annual amount of which is about 11′ 4″. In the summer of 1831, Commander Ross, in an excursion from the vessel in which his party were so long detained in the polar seas, reached a spot on the continent of North America, which had been calculated to be the position of the magnetic pole. There he found the dip of the needle to be 89° 59′, within one minute of the vertical; and compass-needles suspended in the most delicate manner possible exhibited no polarity whatever. The latitude of this spot is 70° 5′ 17″ north, and its longitude 96° 46′ 45″ west. (For a description of some other forms of the dipping needle, see *Brewster's Treatise on Magnetism.*)



DIPSA'CEÆ. (Dipsacus, one of the genera.) In Botany, a natural order of herbaceous Exogens, chiefly inhabiting the south of Europe and a few other countries. Nearly allied to *Compositæ;* but differing in their stamens being distinct, and their ovule pendulous. They are distinguished from *Calyceraceæ* in the latter having connate anthers and alternate leaves; and from *Valerianaceæ* by their capitate flowers, and the presence of albumen. Their properties are unimportant. *Dipsacus fullonum* is employed mechanically, for the sake of its hard stiff bracts, in the process of dressing woollen cloths.

DI'PSAS. (Gr. *a viper.*) This term has been applied by Laurenti to a genus of Colubrine serpents; and by Dr. Leech to a genus of fresh-water Bivalves, intermediate to *Unio* and *Anodonta.*

DIPTERA'CEÆ. A natural order of arborescent Exogens, only found in India and the Indian Archipelago, very near to *Elæocarpeæ;* but distinguished by the petals not being fringed, and in the want of albumen. They are also allied to *Malvaceæ* in the contorted æstivation of the corolla and the crumpled cotyledons; but differ in the stamens being either distinct or partially combined, their long, narrow, 2-celled anthers, and pendulous ovules. Blume traces an affinity with *Guttiferæ* in their resinous juice, compound superior ovary, drupaceous fruit, numerous long anthers, irregular coloured calyx, and single exalbuminous seed; but from this order the stipules and the æstivation of the corolla abundantly distinguish them. The order is chiefly marked by the enlarged foliaceous unequal segments of the calyx investing the fruit. To it belongs the camphor tree (*Dryobalanops camphora*), which also yields the camphor oil of Borneo and Sumatra, and a timber called sal, the best and most extensively used in India; while other species yield pitch.

DI'PTERAL. (Gr. διπτερος, *double-winged.*) In Architecture, a temple which had a double range of columns on each of its flanks.

DI'PTERANS, *Diptera.* (Gr. διπτερος.) An order of insects having for their main and most conspicuous character two wings only corresponding to the anterior pair, and two short clubbed appendages, called *halteres* or balancers, and which seem to be the rudiments of the posterior pair in four-winged insects. The Dipterans are also distinguished by having the mouth in

the form of a sucker, composed of from two to six lancet-shaped elongated scales, inclosing a canal upon the upper surface of a fleshy tongue or proboscis. The larvæ or maggots of the Dipterous insects have frequently a membranous head; and always have the stigmata, or breathing pores, confined to the second and terminal segments of the body. In some species, as the blow-fly, the eggs are hatched within the body of the parent; in others, as the forest-fly (*Hippobosca*), the larva undergoes its metamorphosis in the parent's body, and the young are excluded in the form of *pupæ*.

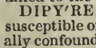
DIPTERY'GIANS, *Dipterygia*. (Gr. δις, *twice*, and πτερυξ, *a fin; two-finned*.) A family of fishes comprehending those which have but two fins.

DI'PTYCH. (Gr. δίπτυχον, *twofold*.) Among the Romans, a tablet of wood, metal, or other substance, used for the purpose of writing, and folded like a book of two leaves: when the book consisted of several leaves, it was termed πολύπτυχον, or *manifold*. The diptychs of antiquity were employed especially for public registers. The sacred diptycha of the Greek church were double catalogues, containing on one side names of the living, on the other those of the dead, which were rehearsed during the office.

DI'PUS. (Gr. δις, and πους, *a foot*.) The general name for the Jerboas or Rodent animals, in which the hind-legs are disproportionately developed, and chiefly serve for locomotion. The numerous species referable to the Linnæan genus are now divided into the subgenera *Alactaga, Gerbillus, Dipus* proper, &c.; and form the family *Dipodidæ*: the *Gerbilli*, however, are more nearly allied to the *Muridæ*.

DIPY'RE. (Gr. δις, and πυρ, *fire*; i.e. a mineral doubly susceptible of the action of fire.) This mineral was originally confounded with *picnite*. It is found in the Western Pyrenees. When heated before the blowpipe, it first becomes phosphorescent, and then fuses: characters by which it is distinguished from picnite. It occurs in white or reddish white transparent or translucent crystals, of a prismatic form; its specific gravity is 2·63. It is hard enough to scratch glass. It is a silicate of alumina and lime.

DI'RECT. (Lat. dirigo.) In Music, a character used



at the end of a staff, to direct the performer's notice to the succeeding note at the beginning of the following staff.

DIRE'CTOR. A common surgical instrument: it is generally made of silver, and resembles a grooved probe. Its use is to direct the knife, and protect the parts underneath from its edge or point.

DIRECTORS. In Commerce, the name given to the individuals composing the board of management of a joint stock company; as the Bank of England, the E. I. Co., &c.

DIRE'CTORY. In French History, the name given by the constitution of 1795 to the executive body of the French republic. It consisted of five individuals, called directors, who were selected by the council of elders from a list of candidates presented by the council of five hundred. One of these directors retired every year, and was succeeded by another elected on the same principle. To the Directory was entrusted the superintendence of the home and foreign departments, the finances and the army, and the appointment of the ministers of state and other public functionaries. Its policy was at first moderate and conciliatory; but after a short interval it had recourse to measures which produced wide-spread dissatisfaction, and it was at length overthrown on the ascendency of Bonaparte after an existence of four years. (For the history of the Directory, see *Memoires de Gohier*, Paris, 1824.)

DIRECTORY, signifies also a book containing the names of the inhabitants of a town, arranged in alphabetical order, together with their places of abode, &c. It is likewise applied to a book containing directions for public worship, or other religious services.

DIRE'CTRIX. In Geometry, the name given to a certain straight line perpendicular to the axis of a conic section; and it is a property of these curves that the distance of any point of the curve from the directrix is to the distance of the same point from the focus in a constant ratio. The term is also sometimes applied generally to any line, whether straight or curved, which is required for the description of any curve.

DIRGE. (A contraction of *dirige*, used in the old formula of the Catholic service for the dead—*Dirige, Domine, Deus*.) A funeral song or hymn.

DISABI'LITY, in Law, signifies a state which renders a person incapable of enjoying certain legal benefits; as, the state of an alien renders him incapable of taking lands, that of infancy of making valid contracts, and so forth. Disability, it is said, may happen in four ways; by the act of the ancestor, of the person, of God, or of the law.

DISC, or DISK. (Lat. discus.) In Astronomy, the face of the sun, moon, or a planet, such as it appears to us projected on the sky. The forms of the celestial bodies being spherical, their projections are circular planes.

DISCHA'RGE. (Fr. discharger.) In Architecture, a term used to signify the relief or distribution of a weight or load to be borne; thus *discharging arches* are those used in any wall over a lintel to discharge the lintel of the weight which would be otherwise borne by it.

DISCI'PLE. (Lat. discipulus.) Literally, one who learns the principles of any science or liberal art from another; but the term is used in a eulogistic sense, more particularly to signify the followers of any renowned teacher or philosopher, whose spirit they have imbibed along with a knowledge of his peculiar tenets.

DI'SCIPLINE (Lat.), signifies, primarily, instruction or government; but it is applied figuratively to a peculiar mode of life, in accordance with the rules of some profession or society. It is also used to designate the punishments employed in convents, and those which enthusiasts undergo or inflict upon themselves by way of mortification.

DI'SCIPLINE, BOOK OF, in the Church of Scotland, is a common order, drawn up by the General Assembly in 1650 for the reformation and uniformity to be observed in the discipline and policy of the church. In this book episcopal government is set aside, Kirk sessions are established, the observance of saints' and other holy days is condemned, and other regulations for the internal government of the church are prescribed. It is called the First Book of Discipline.

DISCIPLINE, MILITARY. The obedience to and exercise of the laws of military men and matters: bravery may gain a battle, but the final event of war is essentially dependent upon discipline. "Discipline is the right arm of a general, and *money* is his shield."

DISCIPLINE OF THE SECRET, or DISCIPLI'NA ARCA'NI. A name given by theological writers to a system supposed to have been in force in the primitive church, by which its most important and mysterious doctrines were concealed from the mass of believers, and fully developed only to a select class. When at the beginning of the Reformation the Roman Catholics were urged with the silence or ambiguity of the fathers of the first four centuries upon many principal points of their doctrine, they met the objection by declaring it to be the constant custom of the primitive church, enjoined by the apostles themselves (for which they quoted 1 Cor. iii. 1, 2.), to throw a veil of mystery, or preserve entire silence, upon all such awful and incomprehensible subjects. The opinions of Protestants upon this question have certainly been far from uniform; but all allow probably that in the 4th century the practice alluded to was prevalent: the usage of the 3d is more equivocal, and there are few who attach any weight to the defence set up by their adversaries by appealing to the two first.

The following we are disposed to consider a fair representation of the subject.

The apostles and evangelists say very little directly and systematically concerning the principal doctrines of Christianity. We may suppose that in their private teaching they were more express, and that some particulars assumed a more definite shape from their connection with apostolic tradition, than would have been the case had they been derived to us from the language of the Holy Scriptures merely. But the comparatively private and temporary occasions of the writings of most of the apostles may account for this want of precision, without supposing that they purposely concealed their ultimate conclusions. The one or two passages upon which a contrary opinion is grounded certainly refer only to the spiritual progress of a believer, and not to any advance in the knowledge of forms and results. The writings of the Fathers of the first two centuries may, we believe, be pronounced entirely clear of any passage which can fairly be appealed to by the advocates of the Disciplina. In the third Clemens of Alexandria is considered to furnish the strong-hold of the theologians of that party; but although he makes a very marked and accurate distinction between the perfect and imperfect Christian, he founds it not upon superior knowledge of the doctrines, but upon an advance in purity and spiritual conduct. This is what he denominates true gnosticism, which he is at great pains to distinguish from the spurious and heretical; and even herein he appears to be speaking only from his own individual notions, or at least from those only of the Alexandrian school of theology, and not from any recognized opinions and usages of the church.

It is to be observed that the primitive church was wont to make some trial of the candidates for baptism, causing them to pass through a course of religious instruction, in which they were led by certain steps from the elemental to the more complete knowledge of their duties preparatory to that initiatory ceremony. This is no more than would be practised even now in the case of an adult convert; but such cases in these times are extremely rare, and hardly admit of a definite formal custom. But in the first four centuries the conversion of adults was the most prominent object of Christian solicitude: it was this that most drew the attention of the church; it was this therefore which naturally became the subject of formal ceremonics and practices. Accordingly in process of time, when the clergy began to feel the strength of their position, and to cherish the ambitious views which were prompted by it, this practice was an instrument fitted to their hands.

They made a mystery of that which was before only a second step in knowledge, and excited the awe or curiosity of their hearers by checking themselves ostentatiously when hovering on the borders of a doctrinal subject, with such phrases as ἴσασιν οἱ μεμυημένοι, *the initiated understand me*, &c.; and probably, by the rhetorical flourishes with which they screened their real meaning, deceived themselves, or at least posterity, into the exaggerated notions whose shape and system were finally confirmed at the Council of Trent.

DISCLAI'MER, in Law, is a plea containing an express denial or renunciation of some claim which has been made upon or by the party pleading. It is more especially taken for the denial, by an alleged tenant, of his tenancy. Such disclaimer is punishable at common law by the forfeiture of the land, if, on writ of right *sur disclaimer* brought, the lord succeed in proving the tenancy.

DI'SCOBOLES, *Discoboli*. (Gr. δίσκος, *a quoit;* βάλλω, *I throw*.) Those who played at quoits (*discus*) in antiquity. In Ichthyology, this word is applied to a family of pectoral or subbrachian fishes; comprehending those which have the ventral fins confluent, and forming a suctorious disc beneath the throat.

DI'SCOID. (Gr. δισκοειδής.) This term is applied to those univalve shells of which the whorls are disposed vertically on the same plane, so as to form a disc; as in the *pearly nautilus* and *planorbis*.

DISCONTI'NUANCE. In Law, an injury to real property, which consists in the keeping out the rightful owner of an estate by a tenant whose entry was at first lawful, but who wrongfully retains the possession afterwards: as, where tenant in tail makes a feoffment in fee-simple for life or in tail. In this case the heir in tail, remainder-man, or reversioner, is put to his writ: so alienations made by husbands seised in right of their wives, or by ecclesiastics seised in right of their church, work a species of discontinuance.

DI'SCORD. (Lat. discordia.) In Music, the relation of two sounds which the ear receives with displeasure, whether used in succession or consonance.

DISCO'RDIA. In Mythology, a malevolent deity, daughter of Night, and sister of Erinnys, the Parcæ, and Death. She is represented as having been banished from heaven by Jupiter, on account of the broils she perpetually occasioned. This was the goddess who, from disappointment at not being invited to the marriage of Thetis and Peleus, threw into the midst of the assembly the golden apple, with the inscription *detur pulchriori* (*let it be given to the fairest*); which, as is well known, occasioned the famed contest between the goddesses Juno, Minerva, and Venus, and ultimately led to the Trojan war, and the destruction of Troy. The ancient poets represent this divinity with a pale and ghastly look, a dagger in her hand, and her hair entwined with serpents; and Milton graphically describes her as

Discord, with a thousand various mouths.

DI'SCOUNT. An allowance made for the payment of money before it is due, and is equivalent to the interest of the principal sum diminished by the discount during the time that must elapse before the money becomes payable. The proper meaning of discount, and the rule for computing it, will be best understood from an example. Suppose the rate of interest to be 4 per cent., and that A holds a bill of 104*l.* payable a year hence. Suppose, also, that B has a sum of 100*l.* in hand, which he wishes to lay out at interest for one year. At the end of the year A's bill becomes due, and he receives 104*l.* B also receives back for principal and interest 104*l.* It is therefore clear that if at the commencement of the year A had given B his bill, and received from B his 100*l.*, neither party would have gained or lost by the transaction. Hence a bill of 104*l.*, payable a year hence, interest being 4 per cent., is equivalent to 100*l.* in hand; and the difference between the amount of the bill and its present value, viz. 4*l.*, is the discount. Now the discount on 104*l.* having been found, the discount on any other sum is found by simple proportion. If we observe that 4 is the rate per cent. of interest, and that 104*l.* is the present worth plus the discount, the truth of the following rule for the computation of discount will be apparent:—"As 100*l.* with the rate per cent. added is to the rate per cent., so is the principal sum to the discount." This rule supposes the time of payment to be one year; if it is less or more, the result must be diminished or increased in proportion to the time. Bankers and mercantile people, however, instead of computing discount in this correct way, reckon it in the same manner as simple interest, by which, in large transactions, they obtain a very considerable advantage. At 4 per cent. interest is 1 in 25, whereas discount is only 1 in 26.

DISCO'URSE. (Lat. discurrere, *to discuss*.) In Rhetoric, signifies in its widest acceptation a series of sentences and arguments arranged according to the rules of art, with the view of producing some impression on the mind or feelings of those to whom it is addressed. In Logic, this term is applied to the third operation of the mind, commonly called reasoning. *See* LOGIC.

DISCO'VERY. In Law, the act of revealing or disclosing any matter by a defendant in his answer to a bill in Chancery. *See* CHANCERY.

DISCRE'TE PROPO'RTION (Lat. discretus, *separated*), in Arithmetic, is a proportion in which the ratio of the antecedents to the consequents is different from the ratio of the consequent of the first pair of terms to the antecedent of the second. Thus, the proportion 2 : 3 : : 4 : 6, is a discrete proportion; for the ratio of 2 to 3, or of 4 to 6, is different from the ratio of 3 to 4. Discrete is therefore opposed to *continual*, a continual proportion being that in which the ratio of every two contiguous numbers is the same throughout; thus, 2 : 4 : : 8 : 16.

DISCRE'TE QUANTITY. A term applied to quantities of which the component parts have a separate and distinct existence. Thus, numbers are discrete quantities, being composed of separate units.

DI'SCUS. (Gr. δίσκος.) The ancient quoit, which consisted of a heavy circular mass of iron, sometimes perforated in the middle. In the ancient game, the players did not try to hit a mark, but to throw the quoit to the greatest possible distance. There is a discus preserved in the Cabinet of Antiques at Paris, in which holes are provided for the thumb and fingers. The practice of throwing discs is mentioned by Homer among the sports which occurred at the funeral of Patroclus; and Pindar celebrates Castor and Iolaus as skilful launchers of the discus.

DISCU'TIENT. (Lat. discutio, *I destroy*.) Remedies which repel or resolve tumours.

DI'SDIAPA'SON. (Gr. δὶς, *twice*, and διαπασῶν, *through all*.) In Music, two octaves or a fifteenth.

DISEA'SE. (Dis, and ease.) Any morbid state of the body generally, or of any particular organ or part of the body, is called a *disease*. By medical writers the term *disease* is defined as implying "a deviation from the natural and healthy actions of the whole system or of any individual part;" and they are in the habit of designating certain forms of disease by the following terms, namely: — *Acquired*, which are not congenital or hereditary, but derived from causes evidently operating after birth. *Acute*, which are severe, but of comparatively short duration. *Asthenic*, attended by manifest depression of the vital powers. *Chronic*, which are of long duration. *Congenital*, which are born with the individual. *Constitutional*, which more or less affect the whole system. *Contagious;* this term should be confined to those diseases only which are communicable from one to another by *contact*, either personal or intermediate: it is presumed, for instance, that the plague is a truly contagious disease, and that it can only be transferred from one individual to another by actual bodily contact, or through the medium of bedclothes or articles of apparel. The term "contagious disease" is, however, often misapplied to those which are *infectious*, or communicable through the medium of the atmosphere. *Endemic*, diseases which are either peculiar to particular places, or which are especially prevalent in certain districts only. *Epidemic*, diseases which are generally diffused over a whole country; they may generally be traced to atmospheric causes, and are commonly of an infectious character: influenza and cholera often prevail in this way. *Exanthematous* are those diseases which are accompanied by an eruptive fever, such as measles, small-pox, &c. *Hereditary* diseases are such as prevail in families, and are transmitted by parents to their offspring; gout and scrofula furnish examples. *Idiopathic* or *primary* diseases are those which are not dependent upon or symptomatic of others; certain affections of the head, for instance, may arise immediately from disease of the brain, or they may be mediately connected with disordered states of the stomach: the former are idiopathic, the latter *symptomatic*. *Intercurrent* diseases are those which arise in individuals from incidental causes during the prevalence of endemic or epidemic sickness. *Intermittent* diseases are marked by a regular cessation and recurrence of symptoms; the patient, during the interval, being, to all appearance, free from disorder: the various forms of ague are characteristically intermittent. *Local* diseases are opposed to those which are constitutional; they are presumed to be limited to some particular organ: the term "chronic disease" is sometimes misapplied in this sense. *Malignant* diseases are those which are of a highly dangerous and intractable character, and the symptoms of which are generally very formidable from the first; various forms of fever, rapidly depressing the vital energies, are said to assume a malignant type: hence also the term *malignant*, as generally applied to the Asiatic cholera. Local diseases are frequently malignant, such as cancer and ill-conditioned ulcers: all these are opposed to the *mild* forms of the same maladies. *Periodical*, diseases which recur at fixed periods, as in autumn, winter, &c. *Puerperal*, diseases incident to women soon after child-birth. *Specific* diseases are those which are marked by some disordered vital action not belonging to disease in general, but peculiar to the

individual case. *Sporadic* diseases are those arising from adventitious causes affecting the individual. *Sthenic* diseases are marked by the activity of the vital powers, directly opposed to those which are asthenic.

DISINFECTING LIQUOR. Solution of chloride of soda, or of chloride of lime.

DISJU'NCTIVE PROPOSI'TION, in Logic, is a proposition compounded of two or more categorical propositions, so stated as to imply that some of them must be true: — thus, " Either A = B, or C = D." A disjunctive, in which the two propositions are not naturally connected together in such a manner as to warrant their being proposed as alternatives, is nugatory and absurd in sense, although not incorrect in logical form. If one or more of the categorical antecedent propositions be denied, we infer that the remaining one, or, if there are more than one, some one of those remaining, is true: *e. g.* " Either A = B, or C = D; but A is not equal to B, therefore C = D." A poem is either good, bad, or indifferent: but it is not good; therefore, it is bad or indifferent. There are different forms of the *disjunctive syllogism*, founded on the disjunctive proposition.

DISK. In Botany, a term applied to certain bodies or projections, situated between the base of the stamens and the base of the ovarium, but forming part of neither, and taking a variety of forms. The disk is usually supposed to consist of rudimentary stamens, since an anther has been noticed to grow from that of *Pæonia moutan*, and in other cases manifest indications are observable of a tendency to assume the form of those organs.

DISLOCA'TION. (Lat. dislocare, *to put out of place.*) A surgical term, synonymous with *luxation.* " When the articular surfaces of bones are forced out of their proper situation, they are said to be dislocated or luxated. A considerable share of anatomical knowledge is required to detect the nature of these accidents; and it is much to be lamented that students neglect to inform themselves sufficiently upon the subject. (See *Sir A. Cooper's Surgical Essays*, i. p. 2.)

DISO'MUM. (Lat.) In Ancient Sculpture, a tomb made for the reception of the remains of two persons.

DI'SPART, in Gunnery, is the difference between the semidiameter of the base ring at the breech of a gun and that of the ring at the swell of the muzzle.

DISPE'NSARY. A place where medicines are made up and distributed; but used more generally for a charitable institution, where the poor are supplied with medicines and advice. Institutions of this nature are of comparatively recent origin; though they are now to be met with in every town of any importance both in this country and on the Continent. In London there are one or more dispensaries in each district; and to every dispensary there are always attached one or more physicians, surgeons, and apothecaries, whose duty it is respectively to prescribe and dispense medicines to the poor, and to visit them in their own houses in the event of their being too ill to attend personally at the institution. In most cases dispensaries are supported by voluntary contributions.

DISPENSA'TION. In Law, a licence granted by the bishop to a clergyman within his diocese to omit some particular of his duty; as, to hold two or more benefices, or to reside out of his parish. The name is peculiar to ecclesiastical law, and was formerly applied to the licences granted by the papal authority for several purposes; as, to marry within the prohibited degrees, &c.

DISPE'NSATORY. A word synonymous with Pharmacopœia (which see); signifying a book which describes the history, preparation, and composition of medicines.

DISPE'RSION. In Optics, a term used to denote the angular separation of the constituent rays of light when decomposed by the prism. In consequence of the unequal refrangibility of the different rays, a beam of light admitted through a small hole or slit in the shutter of a darkened room, and refracted by passing through a prism, forms an elongated image or spectrum; the red rays, which are the least refracted, occupying one end of the spectrum, and the violet rays, which suffer the greatest refraction, occupying the other end. The rays therefore, after refraction, are no longer parallel; so that the *index* of refraction (or the ratio of the sine of incidence to the sine of refraction) is different for each ray; and the difference of the indices for the extreme rays is called the *dispersion* of the light.

Sir Isaac Newton, who first examined the prismatic colours, was led by some imperfect experiments to suppose the dispersion proportional to the refraction; but it was soon discovered that although the colours in spectra formed by prisms of different substances are always arranged in the same order, they do not occupy the same relative lengths, — a prism of flint glass, for example, giving proportionally less red and more violet than a prism of crown glass; and that substances, for which the index of refraction of the middle ray of the spectrum is nearly the same, produce spectra of different lengths, or different amounts of dispersion. It is on this property namely, the irrationality of the refractive and dispersive powers of different substances, that the methods of forming achromatic lenses depend: had the supposition of Newton been correct, it would have been impossible to produce an image by refraction unaccompanied by the prismatic colours. *See* ACHROMATISM.

The difference between the indices of refraction of the extreme rays of the spectrum formed by a prism of any substance is called the *coefficient of dispersion* with respect to that substance, or simply the *dispersion;* and the *dispersive power* is the quotient which is obtained by dividing the coefficient of dispersion by the mean index of refraction diminished by unity. The *mean index* is that of the ray which corresponds to the middle of the spectrum. As these terms are of frequent occurrence in scientific works, we shall illustrate the definitions by an example. According to Sir D. Brewster, the index of refraction of diamond for the extreme violet ray is 2·467, and for the extreme red ray 2·411; the difference of these two indices is ·056, which, therefore, is the coefficient of dispersion for diamond. Again, the mean index, or mean of the above two numbers, is 2·439, which diminished by unity becomes 1·439; therefore the dispersive power of diamond is ·056 divided by 1·439, or ·0388.

For a table of the dispersive powers of a great number of different substances, see *Brewster's Optics*, in the *Cabinet Cyclopedia;* but we may remark, that as this table appears to have been constructed before the discovery of Fraunhofer's method of determining the indices of refraction by means of the dark rays in the spectrum, it rests on data subject to great uncertainty. *See* REFRACTION; also LIGHT, OPTICS, and SPECTRUM.

DISPLUVIA'TUM. (Lat.) In Ancient Architecture, a place in which the rain is conveyed away in two channels. A cavædium displuviatum, according to Vitruvius, was an open court exposed to the rain.

DISPOSI'TION. (Lat. dispositio.) In Architecture, one of the six essentials of the art. It is the arrangement of the whole design by means of ichnography (plan), orthography (section and elevation), and scenography (perspective view); and differs from distribution, which signifies the particular arrangements of the internal parts of a building.

DISQUISI'TION. (Lat.) An inquiry into the nature and properties of any problem, question, or subject, in the view of gaining or communicating correct information respecting it.

DISSE'CTION. (Lat. disseco, *I cut asunder.*) Signifies literally the cutting to pieces of any organized body with a view to elucidate its structure and functions. *See* ANATOMY.

DISSE'ISIN. In Law, a species of wrongful ouster or putting out of him who is seised of the freehold in lands: it is either *single disseisin*, or *disseisin by force*, more properly termed *deforcement.*

DISSE'NTERS. Persons who dissent on religious grounds from the usages and formula of the established church in England. Roman Catholics, however, are generally referred to as a distinct class, and the term Dissenters applied to Protestants only.

The first dissenters from the church of England were the Puritans, who, at the beginning of the reign of Elizabeth, complained of the use of the surplice, the sign of the cross in baptism, and some other relics, as they esteemed them, of popery. The laws of Elizabeth, however, required their attendance at church under severe penalties; and no opportunity was allowed them, even though they held episcopacy itself in abhorrence, of forming separate sects or congregations. Perhaps the first distinct sect of dissenters were the Brownists, who adopted very extreme opinions on the subject of church government, and against whom the punishment of death was enacted, as denying the queen's supremacy in ecclesiastical matters. On the accession of James an attempt was made by the puritanical party within the church to obtain a relaxation in some points of doctrine and discipline; but the conference at Hampton Court, which was convened upon that occasion, separated without effecting more than a few trifling alterations in the services. The penal laws continued in force, and Dissenters were not recognized as a distinct body by the state. They may be said to owe their origin in this sense to the assembly of divines convened by authority of parliament at Westminster in 1643, when a body of 120 clergymen and 30 laymen met and established the Presbyterian forms of doctrine and government, as set forth in the book called the *Directory*. The Independent party did not entirely accede to this settlement, and created some disturbances during the Protectorate. At the Restoration, the Presbyterian clergy were ejected on St. Bartholemew's-day, 1662, by the Act of Uniformity, which re-established the Liturgy, and was attended with some circumstances of aggravation and harshness. Two thousand non-conforming clergy were thereby ejected from their benefices. The Corporation Act, requiring attendance on the sacrament preparatory to accepting municipal offices, was also passed at the beginning of this reign; and the Test Act followed, which

excluded Dissenters in like manner from all places of trust and profit under government. These laws were repealed by 9 G. 4.; and Dissenters are now required only to make a declaration, according to the form of the act, that they will not exercise any influence they may possess by virtue of such office to injure or weaken the church by law established. The Act of Toleration (1 W. & M.) had long since abrogated the penal laws of Elizabeth against Dissenters, excepting Papists and such as deny the Trinity.

DISSE'PIMENTS. In Botany, the partitions that are formed in ovaria by the united sides of the cohering carpella, and which separate the inside into cells; also called *septa*.

DISSERTA'TION. (Lat.) An oral or written examination of any question or subject under some general or particular view. Perspicuity, simplicity, and methodical arrangement are the most essential qualities of a good dissertation.

DI'SSIDENTS. In modern European History, a term applied in Poland to those dissenters from the established religion (Catholic) who, under the old republic, were allowed the free exercise of their faith; including Lutherans, Calvinists, and Greeks, but excluding various minor sects. Their rights were fixed by the Religious Peace (pax dissidentium) of 1573, but they were infringed upon in the 18th century by various princes. They were supported in demanding the repeal of these restrictions by Russia and Prussia (in 1766), and hence those powers acquired one of their favourite pretexts for interference in the affairs of the Polish nation. Their rights were restored in 1775, with some exceptions; but after the Russian conquest they were placed on the same footing with the Catholics.

DI'SSONANCE. (Lat. dissonans, *discordant*.) In Music, a false consonance or concord. The same as discord.

DISTE'MPER. A disease of the dog. The distemper in dogs is commonly considered as a catarrhal disorder, and in general a running from the nose and eyes is one of the first and leading symptoms; it is usually accompanied by a short dry cough, and succeeded by wasting of the flesh and loss of strength and spirits. The nasal defluxion, which is at first watery, becomes after some days, or perhaps weeks, mucous and purulent, loading the eyes and obstructing the nostrils; the cough becomes more distressing, and is attended by an effort compounded of coughing and vomiting; the listlessness, wasting, and loss of appetite also increase.

If the disease be virulent, symptoms of affection of the brain are its frequent concomitants, attended by fits, and great debility and paralysis of the extremities, or by convulsive twitchings resembling St. Vitus's dance; and such is the induced irritability of the animal at this period, that an angry menace, or the sight of another dog in a fit, will often bring one on; and fondling and encouraging a dog under these primary attacks will shorten their duration, or altogether check them. If they continue, and increase in violence and frequency, they commonly prove fatal. "When the epileptic fits," says Mr. Blaine, "have gained their full hold on the dog, a partial or total mental alienation takes place; when total, the poor brute is often perfectly phrenitic; he waters and dungs unconsciously; he tears up the ground, bites every thing around him, and not unfrequently himself also. When the fit is over, he shakes himself, and looks and acts as usual, unless the attacks have been very violent and long-continued, when they leave him greatly exhausted and dispirited." In some of these attacks the dog walks round and round, unconscious of every thing about him. In such cases, the unfortunate animal is often supposed to be mad, and is frequently sacrificed accordingly; "but the suddenness of the seizure ought to inform the looker-on of the total impossibility of its being *rabies*, which is always in the worst cases marked with some recollection, some knowledge, and which never exhibits the indiscriminate fury which characterizes epilepsy."

Inflammation of the lungs is by no means an unfrequent consequence of distemper; and the bowels are always more or less affected by diarrhœa and dysenteric discharges, often indicating ulceration of the intestinal canal, and accompanied by bloody mucus and extremely offensive evacuations.

Protracted cases of distemper are sometimes attended by a pustular eruption on the abdomen and chest, accompanied sometimes by an hepatic affection, called by sportsmen, the *yellow disease*, from its giving the whole surface of the body a yellow hue: these are almost always fatal symptoms.

The danger and fatality of this disease depend upon so many causes that it is extremely difficult to prognosticate the results; young dogs and puppies seldom survive, and it is generally fatal to weakly and delicate dogs, and more so in town than in the country. Early in the disease a single fit is not alarming; but one or more fits in the advanced stages are seldom followed by recovery: impatience of light, red eyes, pneumonic attacks, and obstinate diarrhœa, are all bad symptoms; and spasmodic twitchings, a yellow tinge of the skin, and a pustular eruption, are in almost all cases the forerunners of death.

Laxatives, emetics, and occasional bleeding, are the leading remedies in the early stage of this disease; obstinate diarrhœa should be checked by astringents; and warm bathing, and anti-spasmodics must be resorted to to quell the violence of the fits.

The distemper is communicated by the contact of the diseased catarrhal secretion, and it may also be given by its inoculation; inoculation has indeed been proposed as a mitigation of the disorder, and it has been asserted that vaccination is a preventive. But it has been proved by Mr. Blaine that vaccination is quite inefficacious; and that inoculation with the matter of distemper is equally inefficient in mitigating the complaint, even when it is borrowed from the mildest forms. Many dogs, indeed, which have taken the disease by inoculation have had it with peculiar severity, and several have sunk under it. (See *Blaine's Canine Pathology*.)

DISTEMPER. In Painting. *See* DESTEMPER.

DI'STICH. (Gr. διστιχον.) A couplet of verses. In the Greek, Latin, and German languages, distich is applied to pieces of poetry consisting of two lines, in hexameter and pentameter verse.

DISTICHI'ASIS. (Gr. δις, *twice*, and στιχος, *a row*.) A double row of eyelashes, the innermost of which excite a constant irritation of the eye. The term *trichiasis* is generally applied to this malformation.

DI'STICHOUS. (Gr.) A term applied to the arrangement of organs in two rows, the one opposite to the other, as the florets of many grasses.

DISTILLA'TION. (Lat.) The evaporation and subsequent condensation of liquids by means of a *still* and *refrigeratory*, or of a *retort* and *receiver*.

The discovery of the art of distillation is generally ascribed to the alchemists; but it was doubtlessly known in more remote ages to the Arabians, and by them probably derived from nations further east.

The process of distillation, though in continual use in the chemical and pharmaceutical laboratory, is carried on upon the most extensive scale for the production of ardent spirits in the *distilleries*. Under the words ALCOHOL, BRANDY, FERMENTATION, WINE, &c. will be found some details bearing upon the nature, sources, and production of spirituous liquors; in the present article, therefore, we shall limit ourselves to an outline of the different processes which are more exclusively conducted in the British distillery.

There are two distinct operations in the production of ardent spirits: the one is the conversion of certain vegetable principles into alcohol; and the other, the separation of the alcohol from the other substances with which it is necessarily blended during its production.

The vegetable principle which is essential to the formation of alcohol is *sugar;* and this is sometimes used *directly*, as where molasses and analogous saccharine products are subjected to immediate fermentation; or it is *indirectly* obtained by subjecting amylaceous grains to certain processes, by which the starch they contain is first converted into sugar, and then that sugar afterwards alcoholized.

In our distilleries the latter alternative is adopted; and various kinds of grain, but chiefly barley, wheat, and rye, with more or less malt, are subjected to the operation of *mashing*. For this purpose the ground grain and the bruised malt are duly mixed, and infused under constant agitation in a proper quantity of hot water in the *mash-tun;* the wort is then run off, and fresh water added, till the soluble materials of the grain are extracted.

In this way the mixed worts or *wash* is obtained, which is afterwards to be subjected to fermentation; but in the distillery the operator is not, as in the brewery, left to his own judgment or convenience, but enforced to conform to the excise laws, which are of a very peremptory and often of a very unscientific character. By these laws the distiller is restricted in the density of his worts to specific gravities between 1050 and 1090; and in Scotland, between 1030 and 1075. It is presumed that at those specific gravities, which are called 50 and 90, and 30 and 75, the actual quantity of saccharine or saccharifiable matter contained in each barrel (or 36 imperial gallons) amounts respectively to from $47\frac{1}{4}$ lbs. to 85 lbs., and from 28 lbs. to $79\frac{3}{10}$ lbs. When the wash above alluded to is adjusted as to density, it is run into the fermenting vats, where, mixed with a small quantity of yeast, it is subjected to the process of fermentation, which continues from six to ten or twelve days, the time required for its completion varying with the mass of liquid and with the temperature of the atmosphere.

During mashing, as well as during fermentation, the starch passes into sugar, and the sugar into alcohol; the consequence of which is that the wash gradually decreases in density or *attenuates;* and as soon as this attenuation has reached its maximum, which may be determined by

the hydrometer, it should be distilled, in order to prevent the access of acetous fermentation.

In all large distilleries there are two sets of stills: one for the purpose of distilling from the wash a weak spirit, technically called *low wines;* and the other for redistilling (or *rectifying*) the low wines. In these distillations there passes over along with the first and last portions of the spirits a peculiar volatile oil of a disagreeable flavour and odour, and rendering the weaker spirit milky. These portions are called *faints*, and are carefully turned into separate receivers as soon as the appearance of the runnings from the worm end indicates their presence.

The quantity of alcohol which may be obtained from a given quantity of sugar will depend upon the skill and care with which mashing, fermentation, and distillation have been respectively conducted; theoretically, 100 pounds of sugar are convertible into about 51 of alcohol and 49 of carbonic acid. The quantity of alcohol to be procured from different kinds of grain will also depend upon the same causes, and upon the quantity of sugar, and of starch and gum convertible into sugar, which each may contain. According to Hermstædt 100 pounds of starch should yield 35 pounds of real alcohol; and 100 pounds of the following grains should yield the following quantities of spirit of the specific gravity of 0·9427; that is, of spirit containing 45 per cent. of real alcohol; namely, wheat 40 to 45 pounds, rye 36 to 42, barley 40, oats 36, buckwheat 40, maize 40.

Sometimes malt only is used in the distillery, in which case the distiller calculates in obtaining two gallons of whiskey of proof strength from each bushel of malt.

What is meant by the term *proof spirit* will appear obvious from the following extract from a report of a committee of the Royal Society respecting the improvement of the hydrometer. "With regard to the substance *alcohol* upon which the duty is to be levied, there appears to be no reason, either philosophical or practical, why it should be considered as *absolute* (that is, *pure*). A definite mixture of alcohol and water is as invariable in its value as absolute alcohol can be. It is also invariable in its nature; and can be more readily and with equal accuracy identified by that only quality or condition to which recourse can be had in practice, namely, *specific gravity*. A *diluted alcohol* is that, therefore, which we recommend as the only exciseable substance; and as on the one hand it will make no difference in the identification, and on the other will be a great commercial advantage, it is further recommended that the standard be very nearly that of the present proof spirit. The proposition, therefore, of your committee is, that *standard spirit* be that which, consisting of alcohol and water alone, shall have a specific gravity of 0·92 at the temperature of 62° Fahrenheit. This standard is rather weaker than the old proof spirit in the proportion of nearly 1·1 gallon of the present proof spirit per cent. But this difference is trifling compared with the convenience resulting from the adoption of the specific gravity 0·92, instead of that of the present proof spirit, which is 0·918633. It may be interesting hereafter to ascertain what proportion of *absolute alcohol* enters into the composition of the recommended standard spirit, but the point possesses not the slightest practical importance in reference to the present question."

The *proof spirit* of commerce, and that of the Pharmacopœia, is generally stated to be of the specific gravity of 0·920 at 62°, and is considered as a mixture of *equal weights of absolute alcohol of the specific gravity of* 0·791 *at* 60° *and of water*. The *rectified spirit* of commerce, or rather that of the Pharmacopœia, is directed to be of the specific gravity of 0·838 at 60°, and may be regarded as a mixture of about 82 parts of absolute alcohol and 18 of water.

The inquisitorial regime, observes Dr. Ure, imposed by law upon our distilleries might lead a stranger to imagine that our legislators were desirous of repressing by every species of annoyance the fabrication of the fiery liquid which infuriates and demoralizes the lower population of these islands. But, alas! credit can be given them for no such moral or philanthropic motive. The necessity of the exchequer to raise a great revenue, created by the wasteful expenditure of the state on the one hand, and the efforts of fraudulent ingenuity on the other, to evade the payment of the high duties imposed, are the true origin of that regime. Examinations in distilleries are constantly making by the officers of excise. There is a survey at six o'clock in the morning, when the officers take their accounts and gauges, and make calculations which occupy several hours. At ten o'clock they again survey, going over the whole premises, where they continue a considerable time, frequently till the succeeding officer comes on duty; at two in the afternoon another survey takes place, but not by the same people; at six in the evening the survey is repeated; at ten there comes another survey by an officer who had not been engaged in any of the previous surveys of that day. He is not relieved till six o'clock next morning. In addition to these regular inspections, the distilleries are subject to frequent and uncertain visits of the surveyor and general surveyor. "We are never," says Mr. Smith, the eminent distiller of Millbank, "out of their hands."

There can be no doubt that all the operations of our distilleries would be susceptible of infinite improvement by an alteration in the excise laws. As these at present stand, the duty is charged from calculations — 1. On the quantity and density of the wash; 2. On the quantity and density or strength of the low wines, or first products of distillation; 3. Upon the quantity and strength of the spirit, or, in other words, of the alcohol actually produced. It is presumed, in reference to the wash, that the alcohol which it will afford by fermentation will be directly as its density (without reference to the nature of the matter which it holds in solution). In low wines, and in the spirits, the proportion of alcohol is inversely as the density, and the duty is charged in conformity with experiments upon the composition of mixtures of alcohol and water of different densities.

Nothing need be said here of the mode of judging of the value of the wort by its attenuation during fermentation, nor of the fallacies to which the different operations are liable, and we are well aware of the danger and difficulties of meddling with so important a branch of the revenue; but it is impossible for any scientific person to visit our distilleries without at once seeing much that is susceptible of safe and effectual alteration; or to peruse the multitudinous documents, and the evidence which has been brought before the commissioners of revenue inquiry and before parliamentary committees, bearing directly or indirectly upon this subject, without an anxious wish that some remedy should be found for the evils which are there set forth. In every point of view two things seem highly desirable, and apparently not unattainable; the one is that the materials employed as sources of spirit, and the mode of conducting the operations of the distillery, should be, as far as possible, entirely unshackled; the other (a necessary consequence), that the duty should be levied upon the ultimate product at the worm end; or, in other words, upon the quantity of absolute alcohol actually produced, and that the charge should be made in reference to that alone.

In reference to further details regarding the operations of the distillery and their influence upon the revenue, the reader is referred to ***Dr. Ure's Dictionary of Arts and Manufactures***, art. "Distillation;" and to ***M'Culloch's Dictionary of Commerce***, art. "Spirits," which is enriched with numerous tables. See also the article SPIRITS in this work.

DI'STOMA. (Gr. δις, *twice*, and στομα, *mouth.*) The name of a genus of Trematodous intestinal worms, including those which have two suckers or organs of adhesion, of which the anterior alone is a true mouth; and the posterior or larger disc is situated on the ventral aspect of the body, a little way behind the mouth.

DISTO'RTION. (Lat. distorqueo, *I turn awry.*) An unnatural deviation of shape or position of any part of the body, producing visible deformity.

Some distortions are exclusively dependent upon disordered actions of the muscles or nerves, or both; certain kinds of lameness, for instance, arise from a want of due sympathy between the flexor and extensor muscles, or from an unnatural contraction of one or more muscles in consequence of the inefficiency of their opponents; hence various paralytic distortions, squinting, wry neck, and some forms of what is termed club-foot.

The most common cause of distortion, however, is disease of the bones, which, being sometimes deficient in their hardening or earthy principle, are incapable of supporting the weight of parts which they are designed to bear, or of sustaining pressure or muscular action, without more or less flexure. Of this kind is the disease called *rickets* (from ῥαχις, *the spine*), in which it has been presumed, though erroneously, that the vertebræ are the chief seat of the mischief. Besides rickets, there are other cases of curvature of the spine, the causes of which are by no means very obvious, more especially those of the *serpentine* or *lateral* curvature, which is not unfrequent among delicate girls in the higher and middling classes of life, though of very rare occurrence among the lower orders. This disease is usually observed about the ninth or tenth year, and the symptoms are generally traced in the following order:—1. The child makes frequent attempts to prevent the dress falling off one shoulder; 2. One shoulder appears higher than the other; 3. One of the collar-bones, or one side of the breast-bone, appears fuller than the other; 4. One hip appears to project; 5. One leg appears shorter than the other; 6. There is a peculiarity in the manner of walking, one foot being swung round and the shoulder thrown forward. When the girl reaches the age of twelve or thirteen (for this disease is *very rare* in boys), she becomes evidently twisted, and the spine is found to have assumed a serpentine form. In reference to the treatment of this kind of distortion, it appears that very opposite methods have been successful; thus, some patients have been confined for months to the same position; another violently exercised; another

shampooed and acupuncturated; a fourth relies on artificial supports, such as stays and bandages; a fifth is leeched or blistered; and many are told to attend only to the general health. The truth is, that distortion may depend upon different causes, and different remedies may be required in its different stages of progress. The serpentine curvature of the spine generally originates in muscular debility; and therefore, at its commencement, is appropriately treated by attention to the general health, by proper exercises and tonics. As the disease, however, proceeds, the muscles and ligaments acquire a certain form, and then artificial supports may be appropriately resorted to. In a yet more advanced stage, the vertebræ themselves become altered in form; and hence the spine may require to be stretched, and kept so during a considerable part of the twenty-four hours, so as to allow the bones to resume their natural form. When the ribs and sternum have become much displaced and misshapen, methods of compressing and remodelling them must be adopted; and lastly, when what is called *anchylosis*, or permanent bony deformity, has taken place, palliations and preventives of further mischief can alone be resorted to.

In all cases where there is a tendency to distortion, its early progress should be watched with the utmost solicitude, and *preventive means* steadily and perseveringly adopted. When a girl is eight or ten years old, she should not be confined to the school room, and to a walk once or twice a day, but she should be induced by amusing and romping games to use active exercise, and especially such as brings the muscles of the trunk into play; she should not be kept long at the piano-forte, and her chair should be made so as to support her. If she has a tendency to lean to one side, she should be allowed to learn her lessons in a recumbent posture, and not constantly admonished to "hold herself up." By attention to these simple rules at a very early period of this tendency to distortion, its further progress may be possibly prevented; but if the girl becomes listless, lounging, and pallid, appearing awkward in her gait, and the clothes slip off of one shoulder, the spine is probably becoming distorted; and in this case she should not be allowed to sit erect without using some artificial support, such as an arm-chair, or chair crutch, and she should read always lying down; while by the help of proper stays and a belt support should be given to the loins, while the upper part of the chest is left free. No shoulder-straps, collars, or back-boards should be used to push in the projecting shoulder, unless the loins be at the same time supported; for in the majority of cases a sinking of the lumbar part is the cause of the inequality of the shoulders. The child should, in this stage of the disorder, be a good deal in the open air; not walking sedately, but, if possible, skipping about; and when she comes in, should not lounge on a chair, but lie down; or if out-of-door exercise is inadmissible, she should play at battledore and shuttlecock, and use a skipping rope. But whatever exercise be used, it should never be carried to fatigue. The child should sleep on a firm hair mattress, with scarcely any pillow; she should have good nourishing diet; occasional warm aperients and alkaline tonics may be proper; and cold bathing or sponging. By scrupulously following up the preceding plan, the general health is improved, and the tendency to distortion often diminished; but constant care for months, and even years, can alone ensure its removal. Where the spine has acquired a decided twist, a variety of mechanical contrivances, and many different plans of treatment, have been proposed and used with more or less success, with a view of correcting the deformity, or preventing its increase and improving the figure. For an account of these we must refer to the authors who have expressly treated upon these subjects, and especially to the sensible tract of the late Mr. John Shaw, from which we have abridged the preceding remarks.

There is another kind of distortion, differing entirely from the preceding; namely, *angular curvature* of the spine. It generally proceeds from scrofulous ulceration of the bodies of the vertebræ; it is attended with paralysis of the lower extremities, and is often fatal. Similar disease often occurs in the other bones and joints of the body.

There are a variety of deformities resulting from other causes than those above adverted to; namely, from gout, rheumatism, and various chronic and local affections, which, however, do not come under the general term of *distortions:* nor can we properly refer to this head a variety of real deformities which are chiefly the consequence of dress and fashion; such as those which result from wearing stays, bandages, ill-made and tight shoes, and the like.

DISTRA'CTILE. In Botany, a term invented by Richard to denote a connective which divides into two unequal portions, one of which supports a cell and the other not, as in *Salvia*.

DISTRE'SS, in Law, is the taking of a personal chattel out of the possession of a wrongdoer into the custody of the party injured, to procure satisfaction for the wrong committed.

Distress may be had for various kinds of injuries, and as a means of enforcing process, or the performance of certain acts in various cases. But the most usual injury for which a distress may be taken is that of non-payment of rent. Distress for rent is said to be incident to the reversion; so that it may be taken for rent reserved upon a gift in tail, lease for life, years, &c., though there be no clause of distress in the deed, if the reversion is in the party distraining. Distresses are to be of things valuable, wherein some one has a property. But various species of personal chattels are exempt from distress, especially the utensils and instruments of a person's trade and profession, if in actual use, otherwise they are not privileged. All distresses for rent must be made by day, and on the premises; but if any tenant fraudulently removes goods from off the premises, the landlord may within thirty days seize such goods wheresoever found, unless they are sold for a valuable consideration before the seizure. Persons who distrain for rent may sell the distress for payment of rent in arrear, if the tenant or owner fails to replevy, with sufficient security, within five days after taking the distress and giving the tenant notice of the cause. In this case the constable is bound to assist; the goods are to be appraised by two sworn appraisers; and the overplus, if any, left in the constable's hands for the use of the owner.

DI'STRICT. A territorial division. This term was formerly used in France, and particularly in the year 1790, when by the law of 16th Feb. the whole country was divided into 555 districts; and it is still common to many of the Continental states. The county of Lincoln is divided into three districts; Lindsey, Kesteven, and Holland. These divisions are of great antiquity, and in all probability owe their origin to the distinct natural features by which they are characterized.

DITHYRA'MBIC ODE. (Gr. διθυραμβος.) A species of Greek lyrical poem in honour of Bacchus, which derived its name from Dithyrambus (Διθυραμβος), one of the appellations of that deity: a word of uncertain meaning and etymology. The style of this poetry was very bold, often passing into bombast; so much so indeed as to become proverbial for the latter quality. The most celebrated Dithyrambic writer was Pindar; none of whose compositions in this line, however, have come down to us, or indeed any other known poems of this class. In modern times the term is indiscriminately employed to designate odes of an impetuous and irregular character. *See* ODE.

DI'TONE. (Gr. διτονος.) In Music, an interval consisting of two tones.

DI'TRIGLYPH. (Gr. δις, *twice*, τρεις, *three*, and γλυφω, *I carve.*) In Architecture, an arrangement of intercolumniations in the Doric order, by which two triglyphs are obtained in the frieze between the triglyphs that stand over the columns.

DI'TTO, in Book-keeping, more usually contracted into *Do*, signifies *the same* as that which precedes it. It is derived from the Italian word *ditto*, signifying *the said*.

DI'TTY. (Fr. ditie.) A word of great antiquity in the English language, signifying most usually a simple or pastoral song. Thus Milton says—

> Meanwhile the rural ditties were not mute,
> Tempered to the oaten flute;
> Rough satyrs danced, &c.

Shakespeare, Dryden, and many of the old classic English writers, have repeatedly given importance to this word.

DIURE'SIS. (Gr. διουρησις, *a discharge of urine.*) An excessive flow of urine. *See* DIABETES.

DIURE'TIC, signifies literally any thing which increases the secretion of urine. The term is usually applied to certain medicines which act specially upon the kidneys, such as squills, turpentine, and some of the neutral salts; and it frequently happens that during an inordinate flow of urine derived from such causes watery fluids are absorbed from other parts, and, as it were, transposed to the kidneys: upon this principle is founded the use of diuretics in dropsy. There are some alteratives which operate as diuretics, especially when they are taking a favourable operation upon the system: this seems especially to be the case with sarsaparilla. Water and other diluents and liquids, when taken in excess, also operate as diuretics; as far, at least, as mere increase in the flow of urine is concerned.

DIU'RNAL (Lat. dies, *a day*), is the name given to the book containing those canonical hours of the Roman Catholic breviary which are to be said during the day. It is intended especially for the clergy of the Romish church, and consists generally of four volumes, one for each season of the year.

DIU'RNALS. (Lat. diurnus, *by day.*) A tribe of Raptorial birds, including those which fly by day and have lateral eyes: also a family of Lepidopterous insects, which have a similar period of activity.

DIVA'N. A word common to many of the eastern languages, signifying in Turkish the audience-chamber of the vizier, or supreme judicial tribunal. The divan of

the caliphs was a court for the relief of petitioners, over which those monarchs presided in person. The Turkish divan, as is well known, is the great council of the empire.

It would seem that the earliest acceptation in which this word was employed is that of a muster-roll or military day-book; and we find it used, especially by the ancient Arabs, who borrowed it from the Persians, to signify a collection of poems by one and the same author, arranged in alphabetical order; thus we hear of the Divan (*i.e.* the collected poems) of Sadi, the Divan of Halfiz, &c. The word *divan* is also among the Turks a common appellation for a saloon or hall which serves for the reception of company, for the transacting of business, or for occasional repose; hence in all probability the term is employed in all modern languages to signify a sofa.

DIVA'RICATE. (Lat. divarico.) In Zoology, when the divisions of a part spread out widely.

DIVE'RGENT. (Lat. divergo.) In Zoology, when the branches form a right angle with the stem; as the snags of certain antlers, the divisions of certain Polypiaries, &c.

DIVE'RGING. In Botany, used in describing the venation of leaves, to denote the angle which is formed by the midrib and one of the primary veins, when it is between 20° and 40°.

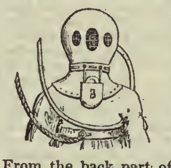
DI'VIDEND. (Lat. divido, *I divide.*) In Arithmetic, the number or quantity given to be divided. Dividend, in Commerce, is the name given to the payment made to creditors out of the estate of a bankrupt, and to the annual interest payable upon the national debt and other public funds.

DIVINA'TION. (Lat.) The art of foretelling future events. A singular and ever-active feeling of curiosity has in all ages induced mankind to cast an anxious look towards futurity in the desire of penetrating its mysteries, originally either by serious reflections on the past, by a comparison of the past with the present, or by inferences more or less satisfactorily deduced from the probable occurrence of events. But mankind did not rest here: since the remotest period of antiquity, divination formed a regular science, intimately allied to religion, and furnished with peculiar rules and regulations, more or less skilful and ingenious in proportion to the state of civilization of the people by whom it was practised. But of all the nations of antiquity there were none who, notwithstanding their great learning and refinement, cultivated the science of divination with such enthusiasm as the Greeks and Romans. Independently of their credulity with regard to auguries and oracles, which may be termed the higher class of divination, the most trifling incidents supplied them with the occasion to indulge in this propensity; and there was nothing in the wide range of human affairs from which they did not derive tokens of futurity. To enumerate all, or even the chief objects of divination among the ancients, would far exceed our prescribed limits. Under the different heads, as BELOMANCY, NECROMANCY, &c., the reader will find a notice of the principal of them; and for the rest he may consult with advantage Cicero, *De Divinatione*. *See* ORACLE.

DIVINE RIGHT, THE, OF KINGS. In Politics, means the absolute and unqualified claim of sovereigns on the obedience of the people; insomuch that, although they may themselves submit to restrictions on their authority, yet subjects endeavouring to enforce those restrictions by resistance to their unlawful acts are guilty of a sin. This doctrine, so celebrated in English constitutional history, has been asserted on very different grounds. Hobbes (*De Civ.*) deduced the absolute authority of kings from the supposed social contract, whereby men parted absolutely with their natural rights in exchange for protection. But the fashionable political writers and theologians of the times both of Charles I. and II. (in the latter reign, Sir Robert Filmer, author of the *Patriarcha*, may be more especially cited, on account of his having been directly answered by Leslie), maintained that government had an existence before property, and before any supposed social contract could take place; that it originated in the patriarchal sway, which was succeeded by the regal, and that no other was authorized by Scripture. See also the *Convocation Book* of 1603; Archbishop Leslie on the *Power of the Prince;* Sherlock's *Case of Resistance to Supreme Powers*, 1684; Mackenzie's *Jus Regium*, 1683. The same principles were practically adopted by the Jacobites, when they maintained the divine right of the expelled sovereign, and afterwards of his descendants, by hereditary title. As to the views of modern high church divines on the subject, see *Dr. Pusey's Sermon on the 5th of November*, 1837. *See* NON-RESISTANCE.

DI'VING. The art of descending in water. Independently of the valuable native productions which are found at the bottom of the sea, such as pearls, coral, sponges, &c., the treasure which is so frequently carried down in wrecked vessels makes it an object of importance to be able to descend to the bottom and remain there long enough to execute the operations necessary to recover it. But without the assistance of some mechanical apparatus, it is extremely little that even the most practised divers can perform. A minute and a half, or two minutes, is the longest time that a diver, in general, can remain under water. Besides, on account of the loss of weight in water, the power which a man can exert is extremely small, unless borne down by a load which would entirely prevent him from rising again to the top. For these reasons, numerous projects have been brought forward to assist the natural powers of the body, and render diving an art of more extensive utility. In all these projects, the principal object aimed at is to supply the diver with fresh air and light, and leave him the free use of his arms, and the power of walking within a moderate range at the bottom. Borelli contrived an apparatus which he called a diving bladder; the bladder being of brass or copper, about two feet in diameter, to contain the diver's head, and fastened to a goat skin covering exactly fitted to the shape of the head. An apparatus of this kind was successfully used by Mr. Deane on the west coast of Scotland, at Spithead, and at Donaghadee, where he brought up an immense number of dollars and various other articles from a vessel which had been wrecked there more than thirty years before.

The principal part of Mr. Deane's apparatus consists of a helmet of thin sheet copper, which covers the head of the diver, large enough to admit of free motion, and furnished with three eye-holes, covered with glass protected by brass wires. The helmet comes pretty well down over the breast and back, and is fastened by rivets to a water-proof canvass jacket so tightly that no water can penetrate. A leather belt passes round the diver, to which are attached two weights, one before and the other behind, each about 40 lbs. The belt is supplied with a buckle in front, which, in case of any accident happening, can be instantly undone. The diver is supplied with fresh air, by means of a flexible water-proof pipe, which



enters the helmet, and communicates with an air-pump, wrought above in the barge from which he descends. This pipe passes under the left arm of the diver, and enters the back of the helmet, being so contrived that the fresh air is made to impinge on the glasses; which in a great measure prevents their being dimmed by the moisture of the breath. From the back part of the helmet there is also led an eduction pipe, to allow the escape of the breathed air. A signal line passes under the right arm to communicate with attendants at the surface. The diver descends from the side of the vessel, either by means of a rope or wooden ladder, loaded at the lower end, the weight being kept at a little height above the ground. When the diver descends to the bottom, the weight is let down, and the rope allowed to become slack, to prevent the motion of the boat from obstructing him. His motion is rendered steady by heavy weights attached to his feet; and he carries a line in his hand, that he may, when necessary, guide himself back to the rope. A waterproof dress covers his body entirely; and he is thus enabled to remain under water five or six hours at once, all the while perfectly dry. (See *Popular Encyclopædia*, art. "Diving.")

DIVING BELL. An apparatus, by means of which persons are let down and enabled to remain under water, and execute various operations; such as levelling or clearing the bottoms of harbours, preparing a foundation for buildings, bringing up sunken materials, &c. The principle of the diving bell depends on the impenetrability of atmospheric air, and may be illustrated by a very familiar experiment. Bring the edge of an inverted tumbler, or any close vessel, to the surface of water, and, keeping the mouth horizontal, press it down in the water. It will be seen that, though some portion of water ascends into the tumbler, the greater part of the spacer emains empty, or only filled with air; and any object placed in this space, though surrounded on all sides with water, would remain perfectly dry. In fact, the quantity of air remains the same, but is compressed into a smaller volume, in proportion to the depth to which it is made to descend. Now, if we conceive a vessel of wood or iron, sufficiently capacious to hold several men, to be suspended by a chain, and lowered by means of weights attached to it to any moderate depth under water, it is evident that they may remain there for a considerable time, and perform any operation that could be executed on land in the same confined space. The machine, however, as thus described, is liable to two great defects, which must be obviated by other contrivances before any great advantage can be derived from it. In the first place, as the air by its compressibility allows the water to enter the lower part of the bell, the dry space is not only diminished, but the bottom on which the bell rests, and where the operations are to be carried on, is also covered with water to a proportional depth. In the second place, the air within the bell, by repeated respiration, soon becomes mephitic, and unfit to support life; so that it is necessary to elevate the apparatus after short intervals, to admit a fresh supply.

It is not known at what period the diving bell was invented. Beckman, in his *History of Inventions*, mentions that at Toledo, in the sixteenth century, two Greeks, in the presence of the emperor Charles V. and several thousand spectators, let themselves down under water in a large inverted kettle with a burning light, and rose again without being wet. George Sinclair, the author of *Satan's Invisible World Displayed*, in his work entitled *Ars Nova et Magna Gravitatis et Levitatis*, mentions some attempts that were made, about the year 1665, to raise, by means of a diving bell, the treasure from the ships of the Invincible Armada that went to the bottom near the Isle of Mull in the Hebrides, and describes the kind of bell that was employed. But, on account of the defects to which we have alluded, the diving bell continued to be of very little use till the time of Dr. Halley, who contrived a means of introducing fresh air into the bell while under water, and of allowing the mephitic or breathed air to escape. The bell he made use of he describes as having been of wood, containing about 60 cubic feet in its concavity, and of the form of a truncated cone, whose diameter at the top was three feet, and at the bottom five. This was coated with lead, so heavy that it could sink empty, and the weight so distributed about its bottom that it could only descend in a perpendicular direction. In the top a clear glass was fixed, to let in the light from above, and a cock to let out the air that had been breathed. To supply the air to the bell he caused a couple of barrels, of about 36 gallons each, to be cased with lead so as to sink empty, each of them having a bung-hole in its lowest part, to let in the water as the air in them condensed on their descent, and to let it out again when they were drawn up full from below. To a hole in the uppermost part of the barrels a trunk or hose was fixed, long enough to fall below the bung-hole, and kept down by a weight, so that no air could escape by the hose till its end was raised up. The barrels thus prepared were let down by the side of the bell. A man stationed on a stage suspended from the bell was ready to take up the hose; and, as soon as their ends were brought to the surface of the water in the barrels, all the air that was included in the upper parts of them was blown with great violence into the bell, while the water entered at the bung-holes below and filled the barrels. By means of this contrivance the air was not only kept fresh, but another great advantage was gained; namely, that by admitting a sufficient quantity of it the whole of the water was expelled from the inside of the bell, and the bottom of the sea laid dry.

By means of this contrivance for the admission of fresh air, it was now possible to remain for any length of time under water; but the use of the apparatus was still found to be attended with some inconveniences, and even considerable danger. The divers within the bell having no power over it, its rising or sinking depends entirely upon the people at the surface of the water; and as the bell, even when in the water, has a considerable weight, there is always a possibility of the chain by which it is raised breaking, which would inevitably be attended with the destruction of the divers. Another danger, still more to be apprehended, is, that if the mouth of the bell in its descent should come upon a sunken ship, or a rock projecting abruptly from the bottom, it might be overset before any signal could be given to those above. These defects were obviated by the very ingenious contrivances of Mr. Spalding of Edinburgh. In order to avoid the risk of being upset when the bell descends on a rocky or uneven bottom, he suspended a considerable weight, which he called a *balance weight*, below the bell, by a rope passing over a pulley fixed in the inside; and the other weights attached to the bell being so adjusted that they could not sink it without the balance weight, as soon as the latter rested on the ground the bell remained suspended in the water. In case of the mouth of the bell being caught by any obstacle, the balance weight is immediately lowered, till it rests on the bottom; and as the bell, when thus relieved, is buoyant, the divers, having disengaged it from the rock, have it in their power either to descend by pulling in the rope, or by allowing it to run to ascend to the surface. Another contrivance of Mr. Spalding deserves mention. He divided the bell into two compartments, the one above the other, and communicating by means of a stopcock. The divers are stationed in the lower one, and the weights are so adjusted that when the cavity above is empty the bell is buoyant; when it is filled with water, the bell sinks. Immediately above the partition are some slits in the sides of the bell; and at the top is an orifice, which can be opened or shut at pleasure. Suppose now, this orifice being open, the bell is required to be lowered; as it descends, the water enters at the slits, and the air escapes by the orifice. When the apparatus is entirely under water, and the cavity consequently completely filled, let the orifice be shut. The bell will now continue to descend; but if the stopcock communicating with the upper compartment be opened, the air will rush from the under to the upper, and displace a quantity of the water, and the apparatus will be lightened by the whole of the water so displaced. The divers have it thus in their power to regulate the descent or rise as they please. By admitting a certain quantity of air into the upper cavity, the descent of the bell is arrested; by admitting a greater quantity it becomes buoyant, and rises to the top. This method of constructing the diving bell has not, however, been adopted.

The greatest improvement on the diving bell, since that of Halley, was made by the celebrated Mr. Smeaton, and consists in forcing down a continued stream of air by means of an air pump through a flexible tube; and this plan is now always adopted. In the year 1788, Mr. Smeaton constructed a diving bell to be used in the operations then contemplated at Ramsgate harbour on a new and improved plan. Instead of a bell-shaped vessel sunk by weights, his apparatus consisted of a square chest of cast iron, four and a half feet long, four and a half feet high, and three feet wide, affording sufficient room for two men under it. It was cast of such a thickness that its own weight was sufficient to sink it; and its thickness was greatest near the mouth or lower part, to prevent it from being easily overset. This construction of the diving bell gave the men within it no power of raising or sinking it; but as the apparatus was made to be used at a place where the nature of the bottom was known, this advantage was not considered of great consequence; and, in fact, it is found by experience that it is better to leave the bell to be entirely guided from above. On account of the facility with which water conveys sound, the strokes of a hammer on the inside of the bell can be heard at a great distance; and the sound coming through the water has a peculiar character, which cannot be mistaken. By previous arrangement any directions can be given in this manner. For instance, one blow may denote more air; two, stand fast; three, heave up; four, lower down, and so on. With these successive improvements, the diving bell is found to be a most important machine in all great operations to be performed under water. It was used with great advantage by Mr. Rennie in the construction of the various harbours he projected; and it has recently been successfully employed in deepening the Clyde between Glasgow and Greenock, and improving the navigation of the river. See the article "Diving Bell," in the new edition of the *Encyclopedia Britannica*.

DIVI'NING ROD. *See* RABDOMANCY.

DIVI'SIBILI'TY. The property which all bodies possess of being separable into parts. It was a question formerly much agitated among philosophers, whether matter is divisible *in infinitum*; or whether a certain term does not exist beyond which the particles are reduced to simple atoms incapable of further division. The question is incapable of direct solution, and fortunately is of no importance to science; but the extent to which the actual subdivision of bodies has been carried in many cases in the arts may well be considered as prodigious. "In the gilding of buttons, 5 grains of gold, which is applied as an amalgam with mercury, is allowed to each gross; so that the coating left must amount to the 110,000th part of an inch in thickness. If a piece of ivory, or white satin, be immersed in a nitro-muriate solution of gold, and then exposed to a current of hydrogen gas, it will become covered with a surface of gold hardly exceeding in thickness the ten-millionth part of an inch."

"The solution of certain saline bodies, and of other coloured substances, exhibits a prodigious subdivision and dissemination of matter. A single grain of the sulphate of copper, or blue vitriol, will communicate a fine azure tint to five gallons of water. In this case the copper must be attenuated at least ten million times; yet each drop of the liquid may contain so many coloured particles, distinguishable by our unassisted vision. Odours are capable of a still wider diffusion. A single grain of musk has been known to perfume a room for the space of twenty years. Animal matter likewise exhibits in many instances a wonderful subdivision. The milt of a codfish when it begins to putrefy has been computed to contain a billion of perfect insects, so that thousands of these living creatures could be lifted on the point of a needle. But the infusory animalcules display in their structure and functions the most transcendent attenuation of matter. The *Vibrio undula*, found in duck weed, is computed to be ten thousand million times smaller than a hemp seed. The *Vibrio lineola* occurs in vegetable infusions, every drop containing myriads of these oblong points. The *Monas gelatinosa*, discovered in ditch water, appears in the field of a microscope a mere atom endued with life, millions of them playing like sunbeams in a single drop of liquid." (*Leslie's Natural Philosophy.*)

DIVI'SION. (Lat. divido, *I divide.*) One of the four fundamental rules of arithmetic, the object of which is to find how often one number is contained in another. The number to be divided is the *dividend*, the number which divides is the *divisor*, and the result of the division is the *quotient*. Division is the converse of multiplication.

DIVI'SION. In Music, a dividing or separation of the interval of an octave into a number of lesser intervals.

DIVI'SION, in Logic, is the enumeration of several things signified by a common name; thus, tree is said

to be divided into oak, ash, elm, &c. A common term may be divided in several ways, according to the various points of view in which it may be regarded for the purpose of qualification. Thus a bookbinder may divide books into folios, quartos, &c.; a librarian into theological, historical, &c.

Division, in the art Military, signifies generally a certain proportion of an army, consisting of cavalry and infantry together or separately, that is, under the order of a brigadier or other general officer; but, in a more restricted sense, it is applied to any number of men on military duty detached from an established body, as a division of artillery, pioneers, &c. The divisions of an army are the number of the brigades and squadrons of which it consists; the divisions of a battalion are the several platoons into which a regiment or battalion is divided either in marching or firing. (*James's Mil. Dict.*)

DIVO'RCE. (From the modern Latin word divortiare, *to turn or put away.*) The Jewish law of divorce is founded on the directions given in the 24th chapter of Deuteronomy; but the permission therein contained is subject to many obstacles and formalities in modern practice. In Greece, in classical times, the practice of divorce seems to have varied in different states; at Sparta it appears to have been unusual, in Athens great facilities were afforded by the law. In republican Rome great strictness in this branch of morals prevailed for a long period, although parties were less impeded in pursuing a divorce by the difficulties imposed by the law than by public opinion. But in the later period of the republic, and under the emperors, divorce became extremely common, and was obtained with equal ease by either sex. Our Saviour's declaration to the Pharisee, in the 19th chapter of St. Matthew, became the foundation of the law on this subject in Christian countries, and divorces were consequently allowed in one particular case only; but after the Roman church had erected matrimony into a sacrament, they became, as they now are in Catholic countries, wholly impossible: the only dissolution of marriage being in cases where it is void ab initio. In most Protestant countries, the facility of divorce has been so much restored in latter times as to approximate to the heathen practice. In England divorce *a vinculo matrimonii*, on the ground of adultery, can only be obtained by act of parliament; divorce *a mensâ et toro*, commonly termed separation, by sentence of the spiritual court. *See* Marriage, Law of.

DO. In Music, a syllable used by the Italians instead of *ut*, than which it is by them considered more musical and resonant.

DOCE'TÆ. (Gr. δοκειν, *to seem.*) One of the earliest heretical sects; so called from the reality of our Lord's incarnation, and considering him to have acted and suffered only in appearance. Some divines have conceived that the express declarations of the nature of Christ in St. John's writings were specially directed against these opinions.

DO'CIMA'STIC ART. (Gr. δοκιμαζω, *I prove.*) The art of assaying minerals or ores, with a view of determining the quantity of metal which they contain.

DOCK. (Probably from the Gr. δεχομαι, *I receive.*) An artificial basin for the reception of ships. Docks are of two sorts, wet and dry: the former are used for the purpose of loading and unloading a ship's cargo out of the influence of the tide, and are constructed with gates, which when shut keep the ship constantly afloat at low water; the latter are intended for the building, repairing, or examination of ships, which are admitted into them at flood tide, and are so called because they are either left *dry* by the ebbing of the sea, or rendered so by the use of great flood gates or of pumps. The reader will find in the *Commercial Dictionary* a full account of all the docks of Great Britain, with remarks on their utility, history, &c. A *naval dock* is a place provided with all sorts of naval stores, timber, and all the requisite machinery for ship-building. The principal naval docks of Great Britain are Portsmouth, Plymouth, Chatham, Sheerness, Woolwich, and Deptford. It is in these docks, and particularly the three first, that ships of war are laid up in time of peace.

DOCKET, DOCQUET, or DOGGETT (Lat. documentum), in Law, is an abridged entry of an instrument or proceeding on a small piece of paper or parchment. Exemplifications of decrees in chancery, fiats in bankruptcy, and other instruments, are thus *docketed* for purposes of reference.

DO'CTOR, or TEACHER. This title of learned distinction was first adopted in the twelfth century. The degree of Doctorate, succeeding and superior to that of Master in European universities, was first conferred at Bologna; by the university of Paris, in 1145, on Peter Lombard; in England, it is supposed, in the reign of King John. Before this time, if the appellation of Doctor was used, it was only in its plain sense of "teacher," and as synonymous with master. The degree of Doctor is conferred, in the English universities, in each of the three faculties of divinity, law, and medicine, — but not in that of arts, — and in the science of music. The Continental degree of Doctor of Philosophy is unknown among us.

Do'ctor. A thin plate of steel used in scraping the colour or mordant off the copper plates employed in calico printing; the term is probably a corruption of the word *abductor*.

DO'CTORS' COMMONS, is the popular name for the courts and offices occupied by the body incorporated in 1768 under the title of "The College of Doctors of Law exercent in the Ecclesiastical and Admiralty Courts," and which are situate on the southern side of St. Paul's Churchyard. The college consists of a president (the dean of the arches for the time being), and of those doctors of law who having regularly taken that degree in either of the universities of Oxford or Cambridge, and having been admitted advocates in pursuance of the rescript of the Archbishop of Canterbury, have been elected fellows of the college in the manner prescribed by the charter. *See* Courts, Ecclesiastical.

DO'CTRINAIRES. In Politics, a cant word, originally applied in France to a section of politicians who occupied a place, in the first chambers after the restoration of 1815, between the deputies of the centre, who generally supported ministers, and the extreme left, which always opposed them. The chief men of this party were systematic writers and speakers on government, who sought to establish a frame of constitution somewhat more resembling that of England than any which has hitherto subsisted in France. The nickname given to them implied that they were considered by the public as theorists: they were, in fact, the same class which Napoleon used to term Ideologists. They supported the Duc de Cazes when in office; afterwards they were generally in opposition until 1830, since which time several of their leaders have held office at different times. Royer Collard, De Broglie, the young Baron de Stael, Guizot, &c., were among the chief public men commonly called Doctrinaires; but this, like other party nicknames, has been, and is, employed in a very arbitrary manner.

DO'CTRINE (Lat. doceo, *I teach*), signifies, in its most extended sense, any thing that is taught either as a matter of faith or practice; and accordingly the term is applied more particularly to various theories that have been embraced and enforced in philosophy and religion: hence we hear of St. Augustine's *doctrine* of grace, Newton's *doctrine* of colours, &c.

DO'CUMENTS. (Lat. doceo, *I teach.*) In Law, written instruments adduced for the purpose of evidence. *See* Evidence.

DO'DECADA'CTYLUS. (Gr. δωδεκα, *twelve*, and δακτυλος, *a finger.*) The portion of the small intestines called *duodenum*, its length being about the breadth of twelve fingers: this at least may be the case in some animals to which the dissection of the earlier anatomists, who gave this name, was limited.

DODE'CAGON. (Gr. δωδεκα, and γωνια, *an angle.*) A regular polygon of 12 equal sides. If the side of a dodecagon be represented by 1, the area is $=3 \times (2 + \sqrt{3})$ $= 11{\cdot}196$ nearly. In general, the area of the figure is equal to the square of its side multiplied by the constant number 11·196.

DO'DECAHE'DRON. (Gr. δωδεκα, and ἑδρα, *seat.*) One of the five Platonic bodies or regular solids; its surface being composed of 12 equal and regular pentagons. The surface of a dodecahedron is found by multiplying the square of its side or linear edge into the number 20·64578; and its solidity by multiplying the cube of its side by 7·66312.

DODECA'NDROUS. (Gr. δωδεκα, and ανηρ, *a male.*) Any plant having twelve stamens.

DODECA'STYLE. (Gr. δωδεκα, and στυλος, *a column.*) In Architecture, a building having twelve columns on a front or flank.

DODO'NA. In Antiquity, the seat of the most ancient, and one of the most celebrated oracles of Greece, sacred to Jupiter. By some writers its origin is attributed to Deucalion, who is said to have built the town of Dodona where it stood; but according to the traditions of the priestesses of the temple, it was founded by a dove, which, perching on the branch of an oak, recommended in a human voice that a temple should be erected to Jupiter in that place. The situation of the oracle was in an extensive forest, the oaks of which are said to have been endowed with the gift of prophecy; and the oracles were most frequently delivered by three priestesses, who expounded the will of the divinity. That the responses of this oracle were received with singular veneration, may be inferred from the number of votaries by whom it was frequented, and the costly presents which adorned the temple and its precincts. This oracle continued to utter responses till the time of Augustus, when it ceased. (*Strabo*, vii.) *See* Oracle.

DO'DRANS. (Lat.) A measure equal to about nine inches, being the space between the end of the thumb and of the little finger when both are fully extended. It is about equal to the *palm*.

DOG. *See* Canis.

DO'G BELTS. A term used in some coal mines for a strong broad piece of leather round the waist, to which a chain is attached, passing between the legs of the men drawing the dans in the low works.

DOG DAYS. *See* Canicular Days.

DOGE. (Probably a corruption of the Lat. dux, *a leader.*) The title of the supreme executive magistrate in the republic of Venice. The origin of this office dates as far back as 697; when, owing partly to the dissensions and intrigues that resulted from the annual election of the seven tribunes by whom the affairs of Venice had been previously administered, and partly to so divided an authority being found inadequate to the conduct of the rapidly increasing powers of the state, the Venetians resolved to replace the tribunes by a single chief magistrate, who should hold office for life. This magistrate, whom they called *the Doge*, was clothed with almost regal authority. In him was vested the power of convoking assemblies, of declaring war or concluding treaties; of commanding the armies of the state; of appointing the military tribunes and the judges; of hearing appeals and deciding definitively on all matters at issue; of collecting the citizens in their different islands, and in the quarters or districts of Venice, for the purpose of choosing their parish priests or bishops; of judging all matters concerning the clergy in all causes, both civil and criminal; and of awarding ecclesiastical punishments, investing the bishops, and installing them in their churches. (*And. Dandolo apud Gallicioli. Chron.* i.) But notwithstanding these apparently vast powers which were vested in the doge at the first institution of the office, the slightest glance at the history of Venice, which for more than eleven centuries, with a few interruptions, continued to be governed by doges, will abundantly prove that though the Venetians allowed four centuries to elapse before they attempted to fix the bounds or control the exercise of the sovereign authority by any legal enactments, they never ceased to regard with jealousy the chief magistrate of their own appointment and approval, and at last succeeded in limiting and restricting his power, so as to render him a mere state pageant of the *grand* council, in which resided the supreme executive authority. The history of the doges is so incorporated with that of the Venetian republic as to be wholly inseparable from it; and a bare outline of the various phases which they exhibited during a career unrivalled for duration and brilliancy in the annals of human society, would be incompatible at once with our limits and the design of this work. The reader will find ample information on this subject in *Daru's Histoire de la République de Venise* (8 vols. 8vo. Paris); the *Quarterly Review*, vol. 31.; and *Edinburgh Review*, vol. 46. (*See* Bucentaur.) *Doge* was also the title given to the chief magistrates of Genoa, who were elected from the senatorial body. The doges of Genoa held office originally for life, as at Venice; but from 1528 down to 1797, when that form of government was abolished by the French, they remained in office only two years, and their authority was exceedingly circumscribed.

DO'GMA. (Gr. δοκειν, *to seem.*) Literally a conclusion founded upon experience. In Theology, *dogma* has been defined to be a fundamental article of belief derived from acknowledged authority, and is usually applied to what are considered as the essential doctrines of Christianity, deduced either from the Scriptures or from the fathers of the church. (*See* Theology.) There are, however, many other *dogmas* peculiar to the different sects into which Christianity is divided. Thus the bulls and decretals of the pope, together with all the councils both of earlier and later times, are regarded by the Roman Catholics with as much veneration as the authority of the Scriptures and the holy fathers. The Greek church, on the other hand, acknowledges the authority only of the earlier councils, in addition to that of the Scriptures and the fathers; and the Lutheran and other Protestant churches have embodied their dogmas in their respective confessions of faith and other ecclesiastical standards. *Dogmatic theology*, as this branch of divinity is called, in contradistinction to moral and scholastic theology, forms an important object of study in many of the Continental universities. In the Protestant universities of Germany, there are chairs set apart for the history of *dogmas*, or, as it is termed, *Dogmatik*; in which the origin and nature of the dogmas of the various Christian sects are examined, and the merit of the arguments by which they are supported respectively canvassed. Among the ancient physicians, the *dogmatists* founded their practice upon conclusions or opinions drawn from certain theoretical inferences, which they conceived might be logically defended or proved. At present a dogmatist is one who is fond of strong assertions not always founded upon correct reasoning.

DO'G STAR. A name popularly given to *Sirius*, a star of the first magnitude, in the constellation *Canis Major* (the Greater Dog), and the brightest fixed star in the firmament.

DO'GWOOD. A name applied to two different plants: in England to any of the shrubby species of *Cornus*; in the West Indies to the *Piscidia erythrina*. The former are of little interest, except as ornamental shrubs; the latter is a powerful narcotic, the real value of which in medicine has still to be determined.

DOLA'BRIFORM. (Lat. dolabra, *a hatchet.*) In Zoology, when a whole or part is shaped like a hatchet, as the foot of certain Bivalves.

DO'LCE. (It.) In Music, an instruction to the performer that the music is to be executed softly and sweetly.

DO'LERITE. A trap-rock composed of augite and felspar.

DOLICHO'TIS. (Gr. δολιχος, *long*, and ους, *an ear.*) The name applied by F. Cuvier to the subgenus of Cavies, to which the Patagonian hare (*Cavia Patachon.*) belongs.

DOLLAR. *See* Money.

DO'LOMITE. Magnesian marble, or granular magnesian carbonate of lime. Named after Dolomieu.

DO'LPHIN. This term is applied, in common language, to two inhabitants of the ocean of widely different habits and organization: by naturalists it is generally used to signify the dolphin of the ancients, which is a cetaceous mammal of the genus *Delphis* of Linnæus; by poets it is applied to the coryphene (*Coryphæna Hippurus*, Linn.), a fish long celebrated for the swiftness of its swimming, and the brilliant and beautiful colours which it successively assumes in the act of death.

DOM (Lat. dominus, *a lord*), in the middle ages, was a title originally possessed by the pope, and at a somewhat later period by the dignitaries of the Roman Catholic church. In more recent times, it formed a distinguishing title of certain monastic orders, such as the Benedictines, &c.; and it appears to have been equivalent to the *don* of the Spaniards, the *von* of the Germans, and the *de* of the French. Mabillon and Calmet are always spoken of as Dom Mabillon and Dom Calmet.

DOMAI'N (Lat. dominicum, from dominus, *lord*; in legal language, *demesne*), signifies properly that portion of the territorial possessions of a lord which he retains in his own occupation. Thus, the lands retained in possession of the crown, and not granted out to the great feudal lords, were styled domaines in France. *Ancient demesne*, in English law, is a peculiar tenure by which certain lands are held of the crown, being such as are evidenced by Domesday Book to have been in the possession of King Edward the Confessor.

DOME. (Lat. domus.) In Architecture, the spherical or other figured concave ceiling over a circular or polygonal building. A *surbased* or *diminished dome* is one that is segmental on its section; a *surmounted dome* is one that is higher than the radius of its base. The forms of domes are various, both in plan and section. In the former, they are circular and polygonal; in the latter, we find them semicircular, semi-elliptical, segmental, pointed, sometimes in curves of contrary flexure, bell-shaped, &c. The oldest cupola on record is that of the Pantheon at Rome, which was erected under Augustus, and is still perfect. We here subjoin a list of the domes whose dimensions entitle them to notice.

Domes.	Feet diam.	Feet high.
Pantheon at Rome - - -	142	143
Duomo at Florence, Sta. Maria del Fiore - - - - -	139	310
St. Peter's at Rome - - -	139	330
St. Sophia at Constantinople - -	115	201
Baths of Caracalla (Ancient) - -	112	116
St. Paul's, London - - -	112	215
Dome of the Mosque of Achmet -	92	120
Chapel of the Medici - - -	91	199
Baptistery at Florence - - -	86	110
Church of the Invalids at Paris - -	80	173
Minerva Medica at Rome - -	78	97
Madonna della Salute, Venice - -	70	133
St. Geneviéve at Paris (Pantheon) -	67	190
Duomo at Sienna - - -	57	148
Duomo at Milan - - - -	57	254
St. Vitalis at Ravenna - - -	55	91
Val de Grace at Paris - - -	55	133
St. Mark, Venice - - - - -	44	

DO'MESDAY BOOK (*Liber Judiciarius*, or *Censualis Angliæ*), according to Hume, the most valuable piece of antiquity possessed by any nation, was framed by order of William the Conqueror (1031-6), and contains a general survey of most of the lands in England, their extent in each district, their proprietors, tenures, value; the quantity of meadow, pasture, wood, and arable land which they contained; and, in some counties, the number of tenants, cottagers, and slaves of all denominations who lived upon them. It consists of two volumes; one in fol., the other in 4to.: the former comprehending 31 counties, the latter those only of Essex, Norfolk, and Suffolk. The counties of Northumberland, Cumberland, Westmoreland, and Durham, were not comprehended in this survey, probably on account of their then wild uncultivated state. Nor does Lancashire appear under its proper name; but Furness and the north-

ern part of that county, as well as the south of Westmoreland and part of Cumberland, are included within the West Riding of Yorkshire. Though in several respects the information contained in Domesday Book is inaccurate and defective, still in a variety of interesting particulars it serves admirably to illustrate the ancient state of England. The publication of Domesday Book was undertaken by order of Geo. III. in 1767, and was completed, under the superintendence of Mr. Abraham Farley, in 1783. The original is deposited in the Chapter House at Westminster, where it is open to inspection. Sir H. Ellis has published a useful introduction and index to it. Two volumes of Records supplementary to Domesday Book, framed for a similar purpose, and of a nearly contemporary date, were published in 1816 by the Commissioners upon the Public Records. The term Domesday is of doubtful origin: the first syllable seems derived from doom, *judgment*.

DO'MICILE. In Law, the place where a person has his home. Personal property, on the decease of the owner, is distributable according to the law of the country in which he was domiciled at the time of his death; not according to the law of the country in which the property is situate. Residence for forty days constitutes a domicile as to jurisdiction in Scotland.

DOMI'NICAL LETTER. For the purpose of exhibiting the day of the week corresponding to any given day of the year, the framers of the ecclesiastical calendar denoted the seven days of the week by the first seven letters of the alphabet, A, B, C, D, E, F, and G; and placed these letters in a column opposite to the days of the year, in such a manner that A stood opposite the 1st of January or first day of the year, B opposite the 2d, and so on to G, which stood opposite the 7th; after which A returns to the 8th, and so on through the 365 days of the year. Now if one of the days of the week, Sunday, for example, falls opposite to E, Monday will be opposite F, Tuesday G, Wednesday A, and so on; and every Sunday through the year will be represented by the same letter E, every Monday by F, and so on. The letter which represents Sunday is called the *Dominical Letter*, or *Sunday Letter*. As the number of days in the week and the number in the year are prime to each other, two successive years cannot begin with the same day; hence the Dominical Letter changes every year. This mode of representing the days of the week has now fallen nearly into desuetude, and the initial letter of the name of the day is placed in our almanacs opposite the day of the month.

DOMI'NICANS. Friars of the order of St. Dominic, instituted at the beginning of the 13th century. *See* art. ORDERS, MENDICANT.

DO'MINO. (Ital.) A long loose cloak of black silk, furnished with a hood removeable at pleasure, and worn chiefly at masquerades by persons of both sexes by way of general disguise. *See* MASQUERADE.

DON. (Lat. dominus.) A Spanish and Portuguese title, which the king, the princes of the blood, and the highest class of the nobility prefix to their names. The ladies of rank have the predicate donna. The title was originally equivalent to that of knight.

DO'NATISTS. A religious faction, which arose in Africa in the beginning of the 4th century in opposition to Cecilianus, bishop of Carthage. The Numidian bishops were indignant at a slight received from him at the time of his consecration, and declared him informally appointed, on account of their absence from the ceremony. They also accused him of unworthy conduct during the Diocletian persecution. There are two persons of the name of Donatus celebrated as leaders of this party. Their cause was heard before several councils (those of Arles, Milan, and Carthage), in all of which they were pronounced schismatics. The Donatists, however, continued to be a powerful faction for more than 100 years, and raised at various times great wars and commotions. The name of Circumcelliones was given to the numerous bands of country people of the lowest ranks who took up arms in their cause. St. Augustin was most successful in bringing public opinion to bear against the Donatists.

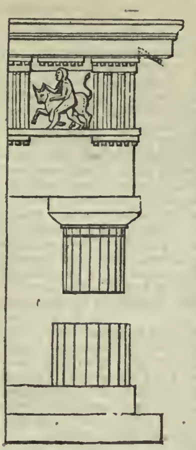
DO'NATIVE, in Law, is a benefice merely given and collated by the patron, without presentation or induction.

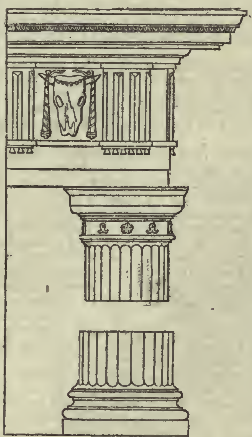
DO'NJON, or DUNGEON. Originally a fortress on a hill: from the Celtic dun, *height*. The central building or keep of an ancient castle; frequently raised on an artificial elevation.

DOOR (Sax. ðoꞃ, Gr. θυρα.) In Architecture, the gate or entrance of a house. The *door frame* is the surrounding case into and out whereof the door shuts and opens. It consists of two upright side pieces or posts and a head, generally fixed together by mortices and tenons, and wrought, rebated, and beaded.

DORA'DO. (Span. *gilt*.) A southern constellation, formed by Bayer; called also sometimes the Sword-fish.

DO'RIC ORDER. In Architecture, one of the five orders. The true origin and birthplace of this order is not satisfactorily known. The example here given is from the temple of Theseus at Athens. The principal points in which the Grecian differs from the Roman Doric are, that it stands at once on the pavement of the building, without socle, tori, or fillets; and that it presents a more pyramidal section than the other, from the great diminution given to it. Its flutes too are never deeply sunk; the capital has no astragal, but only some small annulets to separate it from the shaft. The entablature is so subdivided that the architrave and frieze are each more than a third of its height, the remainder being given to the cornice, which has a band under the mutulus. The mutulus projects forward under the corona, over which is generally placed an ovolo fillet, with another larger ovolo and fillet thereover. The column is usually five or six diameters high. The principal examples of the order are in the Parthenon, temple of Theseus, Propylæum, portico of the Agora at Athens, the temple of Minerva at Sunium, one at Corinth, temple of Apollo and portico of Philip in the Isle of Delos, &c. &c. The Roman Doric varies considerably from that above described. From the diagram it will be seen that the triglyphs are always placed over the centre of the column, and the metopæ should always be an exact square. It follows thence that the intercolumniations are always regulated by the triglyphs. Sometimes it is placed on a plinth, at other times on a pedestal sparingly decorated with mouldings. Though it occasionally, as in this example, has an Attic base, it is more commonly used with only a torus and astragal. The capital is formed with a neck and astragal under the ovolo, and a cymareversa and fillet on the abacus. The only pure ancient example of this order is that of the theatre of Marcellus at Rome. The flutes are without fillets between them, as in the Grecian Doric, and are twenty in number. Of the moderns, by far the most successful in his profile of the order, which they have made what may be called Italian Doric, is Palladio, from whom the example here given is selected.





DORI'PPE. A genus of the short-tailed Decapod Crustaceans, belonging to the tribe *Notopoda*. The species of this genus exist at great depths in the sea, and it is probable that they use the small feet, which are directed towards the back, to cover themselves with foreign bodies for concealment: they have been found in the Mediterranean, Adriatic, and Indian seas.

DO'RMER. (Lat. dormio, *I sleep*.) In Architecture, a window placed on the inclined plane of the roof of a house, whose frame is placed vertically on the rafters.

DO'RMITORY. (Lat. dormio, *I sleep*.) In Architecture, a large sleeping apartment capable of containing many beds.

DO'RNOCK. A stout figured linen, named after the town in Scotland where it was originally manufactured.

DORSIBRA'NCHIATES, *Dorsibranchiata*. (Lat. dorsum, *back*; branchiæ, *gills*.) A name given by Cuvier to an order of Anellidans, or red-blooded worms, comprehending those which have the gills projecting from the middle part of the back or sides of the body. The Nereis, or sea-centipede, is an example of this order.

DORT, SYNOD OF. An assembly of Protestant divines convoked at Dort in 1618-19, by the States-general, under the influence of Maurice, Prince of Nassau, in which the tenets of the Arminians on the five points

relating to election, redemption, original sin, effectual grace, and perseverance, were condemned by the adherents of Calvinism. This national synod consisted of thirty-eight Dutch and Walloon divines, five professors from different universities, and twenty-one lay elders; but besides these there were ecclesiastical deputies present from most of the states of the United Provinces, and from the churches of the Palatinate, Hesse, Switzerland, Bremen, England, and Scotland. This synod was opened on Nov. 13. 1618, and continued till May 29th in the following year, during which period it held 180 sessions; but long before these sessions had come to a close, the Arminians were pronounced guilty of pestilential errors, and condemned as corruptors of the true religion. For minute details of the proceedings of this celebrated synod, the reader may consult *Brandt's History of the Reformation in and about the Low Countries* (London, 1720-22), and the usual authorities in ecclesiastical affairs. It was at this synod that the project of obtaining a translation of the Bible into Dutch was first started. The execution of this task was entrusted to some of the most learned men of the time; and after the lapse of 19 years their labours were given to the world in what has been since known as the *Dort Bible*. (See *Townley's Illustrations of Biblical Literature*.)

DOSI'THEANS. The name of a religious sect which sprung up in the first century of the Christian era. Their principal tenets consisted in believing in the divine mission of their leader, Dositheus, from whom they derived their name, and in rejecting the authority of the prophets by denying their inspiration. This sect remained in existence till the 4th century; but with regard to its history, there exists but little authentic information.

DOTTREL. *See* Numerius.

DOU'BLE BASS. *See* Contrabasso.

DOU'BLE STARS. *See* Stars, Double.

DOUBLOO'N. *See* Money.

DOUCHE. (Fr.) A jet or current of water directed upon some part of the body. An apparatus for this purpose is to be found in most bathing establishments. Steam or vapour is also sometimes applied in the form of douche.

DO'VECOT. A structure for keeping tame pigeons; the only essential difference between which and a common poultry-house is, that the entrance for the birds must be raised to a considerable height from the ground, because pigeons fly higher in the atmosphere than most other birds.

DO'VER'S POWDER. A compound of ipecacuanha, opium, and sulphate of potash. It is the *pulvis ipecacuanhæ compositus*, or compound powder of ipecacuanha of the present Pharmacopœia. Ten grains, which is the average dose, contain one grain of opium and one of ipecacuanha. It is an excellent sedative and sudorific.

DO'VE-TAIL. (From its spreading like a pigeon's tail.) In Architecture, a joint used by carpenters in connecting two pieces of wood by letting one piece into the other, in the form of the expanded tail of a dove. It is the strongest method of joining masses, because the tenon or piece of wood widens as it extends, so that it cannot be drawn out, because the tongue is larger than the cavity through which it would have to be drawn. The French call this method *queue d'hironde*, or swallow's tail.

DOW'AGER (Fr. douairière), seems to signify a widow who either enjoys a dower from her deceased husband, or who has property of her own brought by her to her husband on marriage (dowry), and settled on herself after his decease. In the language of etiquette the term is applied to a widow lady, to distinguish her from the wife of her husband's heir having the same title.

DOW'ER (Lat. dotarium, from dos), in Law, is defined to be the estate for life a widow acquires in a certain portion of her husband's real property after his death. Dower by the common law entitles her to a third part of all the lands and tenements of which the husband was seised in fee-simple or fee-tail at any time during the coverture. Hence this species of dower could not be affected by the husband's conveyance of the lands, unless by fine or recovery in which the wife joined, or by his devise. But the law in this respect has undergone material alterations by the provisions of the 3 & 4 W. 4. c. 105. Dower by custom varies in different districts. There were other obsolete species of dower, now abolished by the statute already mentioned. A married woman may be deprived of her right to dower by attainder of her husband for treason, or herself for treason and felony; by divorce a vinculo matrimonii; by elopement from the husband and living with an adulterer, which incapacity may be removed by reconciliation with the husband. In order to prevent the inconveniences occasioned by this right, which materially impeded the conveyance of property, various modes of *barring*, i.e. defeating, the right to dower were invented by legal ingenuity. Of these the most usual in practice was and still is the limitation of a separate estate (commonly, although incorrectly, called a jointure) to the wife on marriage. This estate must be "a competent livelihood of freehold for the wife, of lands and tenements, to take effect in profit or possession presently after the death of the husband, for the life of the wife at least." This mode of barring dower derives its efficacy from the provisions of the Statute of Uses, 27 H. 8. c. 10. But now by 3 & 4 W. 4. c. 105. dower may be barred by a simple declaration in the deed by which land is conveyed to the husband, or in any deed executed by him; or by declaration in his will, or by any devise of real estate to her.

DOWLAS. A coarse kind of linen.

DOWNS, have been defined to be banks or elevations of sand which the sea gathers and forms along its shores, and which serve it as a barrier. The word is derived from the Celtic *dune*, which see. The term is also applied to large tracts of poor naked hilly land which serve chiefly for the grazing of sheep, thence called Down sheep. Downs is the name given to the well-known road for shipping in the English Channel, which possesses excellent anchorage, and in time of war forms the place of rendezvous for the English navy.

DOW'RY, although often confounded with *dower*, has a different meaning; namely, the *dos mulieris* or marriage portion brought by the wife to her husband. The word, however, has no legal signification.

DOXO'LOGY. (Gr. δοξα, *glory*; λογος, *discourse*.) A form of praise or glorification. The greater and lesser Doxologies, as they are distinguished by the liturgical writers, are the hymn sung by the angels at the Nativity, "Glory be to God on high," &c.; and the shorter form, "Glory be to the Father," &c. The last clause in the Lord's Prayer, as it is recorded by St. Matthew, the genuineness of which has been sometimes questioned, is also frequently called the Doxology.

DRACHM. There are two drachms in our system of weights; namely, the avoirdupois drachm, which is the sixteenth part of the avoirdupois ounce; and the apothecaries' drachm, which is the twelfth part of the troy ounce, and equivalent to sixty troy grains: the latter drachm is the only one which is retained in common use.

DRA'CHMA. (Gr. δραχμή.) An Athenian silver coin of the value of six oboli, or about 7¾*d.* of our money. Other Greek states had *drachmæ* of different values, but the above is that generally referred to. There was also a weight of this name nearly equivalent to 2 dwt. 7 gr. troy weight.

DRA'CO. (Lat. *the Dragon*.) One of the ancient constellations in the northern hemisphere.

DRA'CO MITIGA'TUS. An alchemical name of *calomel*: corrosive sublimate was probably called *draco* or the dragon.

DRACO'NIN, or DRACINA. The colouring matter of the resin called *dragon's blood*.

DRA'GOMANS. The interpreters attached to European embassies or consulates in the Levant. The dragoman of the Sublime Porte is an important Turkish officer, who forms the medium of communication between his own government and the embassies of foreign countries.

DRA'GON. (Gr. δρακων.) In Fabulous History, one of the most famous mythological creations of antiquity and the middle ages. The position which this being occupies in fabulous history presents one of the most singular phenomena of the human mind, as its existence was firmly accredited among the ancients of almost every nation, both in the eastern and western regions of the earth. It occurs in the sacred allegories of the Jews, and in the legends of the Chinese and Japanese; and the pages of the classic poets of Greece and Rome teem with representations of the dragon. Thus the dark retreats of their gods and their sacred groves were defended by dragons; the chariot of Ceres was drawn by them; and a dragon kept the garden of the Hesperides. In Scandinavian mysteries, the dragon was the minister of vengeance under their vindictive gods (see *Grimm's Deutsche Mythologie*); and the ancient Britons, enslaved in the trammels of Druidic superstition, entertained a similar notion of its nature. (*Rees's Cyclopædia*.) The allegory of the Dragon has even found a place among many nations who have embraced Christianity. In the the Book of Revelations (chap. 20.), the angel is represented as laying "hold on the dragon, that old serpent, which is the devil;" and hence in painting and statuary the triumph of Christianity over infidelity and heathenism is sometimes represented by a dragon pierced or trampled under foot. This representation forms also the attribute of different saints in the legends of Christianity, more especially of St. Michael, St. George, and St. Margaret the Martyr. The dragon of antiquity was a species of monstrous serpent with wings and feet; and he seems to have possessed many qualities in common with the most famed terrors of ancient Greece, such as the

Gorgons and hydras and chimæras dire,

with which he was in all probability intimately allied.

Dragon. In Zoology, this term is applied to a genus of small Saurian reptiles, characterized by two lateral aliform productions of the skin supported upon the first

six pairs of ribs; which, instead of bending round the thorax, are elongated and directed outwards for that purpose.

DRA'GON BEAM. In Architecture, an horizontal piece of timber on which the hip or angle rafters of a roof pitch. It is framed into a short diagonal piece, which ties the plates at the internal angles of a roof.

DRA'GON FLY. A common name for the Neuropterous insects belonging to the genus *Agrion* or *Lobellula*.

DRAGONNA'DES. (Fr.) The name given to the persecutions instituted by Louis XIV. and his successor against the French Protestants, from the coercive measures (parce qu'on y employait les *dragons*) which were put in force to effect their conversion.

DRA'GON'S BLOOD. A deep red resin used in colouring varnishes; it is the produce of the *Pterocarpus draco*, and is imported from India.

DRAGOO'NS (Fr. dragon; probably from the Lat. draconarius, *the bearer of a standard upon which was represented the figure of a dragon*), is the name given to a species of cavalry trained and armed to act either on foot or on horseback, as emergencies may require. The origin of this species of troops has been ascribed by Pere Daniel to the Marechal de Brissac; but there can be but little doubt that a sort of soldiers answering exactly to the definition above given of dragoons was in use among the ancient Romans. At present dragoons form part of the military force of all the powers of Europe. The first regiment of dragoons in this country was raised in 1681, and called the Royal Regiment of Dragoons of North Britain, now the *Scots Greys*. In England, this species of troops is of two sorts,—*Dragoons* simply, and *Dragoon guards;* the difference between them consisting in this, that the accoutrements and horses of the latter are somewhat heavier than those of the former. *See* CAVALRY.

DRAI'NING. The art of freeing the surface of the soil from superfluous water, considered with reference to cultivated vegetables, and the health of man and animals. Water may become superfluous by being collected in the natural hollows on the surface, and thus forming bogs; by being retained in the surface stratum, in consequence of a retentive subsoil; or by oozing through a moist subsoil to the surface stratum, in consequence of supplies from subterraneous sources. Water collected in bogs, or marshy places, remains there, because it has no natural outlet, neither by an opening or hollow along the natural surface, nor by the porosity of the subsoil, in consequence of which the water might sink into it and disappear. The obvious mode of draining in the first case is by a trench or drain, so deep as to draw the water from the lowest parts of the hollow, bog, or marsh. Where water is retained in the surface soil in consequence of a retentive subsoil, as in the case of clays and many loams, the most effective mode is to cut a number of small drains parallel to and at short distances from one another; and by the tops of these drains reaching within an inch or two of the bottom of the surface soil, which in cultivation is turned over by the plough, they absorb the superfluous water that passes through this soil and carry it off. Or, should the land be in pasture, the tops of the drain should be brought within an inch or two of the grassy surface, so as to intercept the water, both oozing laterally from the surface soil, and vertically from among the leaves of the grass. It may be observed also that pasture lands on this description of retentive soil may be more readily drained when laid into ridges, and an underground drain formed under each furrow or surface drain. This, however, is not essential; and though furrows or surface drains would be no deformity in field culture, yet in lawns and parks the appearance of furrows would destroy the continuity and evenness of surface, which in lawns is one chief source of beauty. To drain the surface soil, where it is supplied by water from the subsoil, requires some knowledge of the strata of which the subsoil is composed. In general the strata composing the subsoil lie over one another in a direction more or less approaching to horizontal; and when the natural inclination of the surface is everywhere parallel to this strata beneath, the water, if it oozes out of the subsoil at all, will generally do so equally throughout the subsoil; and in such cases numerous drains at no great distance are required to carry it off, precisely as in the case of draining soils with retentive subsoils. But when the line of surface does not correspond with the line of substrata, but intersects this line, then water will generally be found oozing out at the line of intersection, technically called the cropping out of the strata. The quantity of water which will issue from these sections or croppings out of broken strata will depend on a great variety of circumstances, into which it is unnecessary here to enter; because in all cases the mode of draining is the same, viz. that of forming a drain parallel to the line of the fracture of the strata. This drain in some cases is not required to extend the whole length of the line of fracture; because if the strata have a double inclination, so as it were to conduct the water to one angle or point, a drain at that angle or point will carry off the whole of the superfluous water contained in the strata. The subsoil in some cases is composed of strata in a nearly vertical position, and in others of strata alternately depressed and elevated, so that a section through them would form a serpentine line; and sometimes the subsoil is composed of strata the layers of which have been broken up and jumbled together. All these, and other cases, are to be drained in one or more of the above described modes; that is, accumulated water, whether in the soil or above it, is to be let off by cuts or drains made at the lowest points of accumulation; and surface soil saturated with water, whether from greater atmospherical supplies than can be carried off by evaporation or can sink into the subsoil, or whether it arise from sources in the subsoil, is to be carried off by numerous drains close to one another, and the tops of which are within a few inches of the cultivated soil, or of the permanent clothing of grass or other herbage.

DRA'MA (from the Greek word δρᾶμα, *an action or thing done;* derived from the verb δραω, *I act or do*), has been defined a species of poem in which the action or narrative is not related, but represented. The invention of the drama is one of those which should seem to proceed most naturally from the ordinary customs and feelings of men. There is a species of dramatic action which seems almost instinctive; we naturally imitate the tone and gestures of others in reciting their sayings or adventures, or even in adopting their sentiments. Yet some nations appear never to have taken the farther step of doing, methodically and with design, what all do involuntarily. In the accounts which we possess of the ancient Egyptians, for example, we have no trace of their having possessed dramatic representation. But among a great number of tribes, wholly independent of each other, we find something approaching to the dramatic art intermingled with their common or solemn customs, and generally connected with religious observance. This was especially the case in Greece, whence the name and substance of the drama have been chiefly derived by the modern European nations.

The history of the development of the dramatic art in Greece is well known: its elements were found in the religious festivals celebrated from the earliest ages in that country. The feasts of Bacchus in particular had sacred choruses or odes; these were afterwards intermixed with episodic narrations of events in mythological story, recited by an actor in the festival with gesticulation: thence again, the next step was to introduce two actors with alternate recitation; and thus were produced tragedy (τραγωδιά, *the song of the goat*, from the animal which was led about in those festive processions); and comedy (κωμωδιά, *the village song*), which differed from the former in that the dialogue of the interlocutors was satirical, and not mythological. The early Greek tragedy was a dramatic representation of some scenes or events recorded in the national traditions, the actors personating those who played a part in these events, together with a chorus or band of singers, representing such persons as might naturally be supposed to have been bystanders at the occurrence (captive women, old men, or counsellors, &c.), who sang at intervals, during the representation, hymns to the gods, or songs appropriate to the scenes passing in representation: while the Attic comedy, in its first invention, must be regarded as a parody on tragedy, in which the personages were either real characters introduced for the purpose of satire, or ludicrous personifications. Æschylus, the oldest tragic writer (with the exception of Phrynichus, his cotemporary), carried the Greek drama at once to nearly its highest state of perfection. Sophocles and Euripides introduced additional actors into the dialogue (which at first admitted only two at the same time), and turned the naked recitals of events which form the substance of the plays of Æschylus into something more nearly resembling the modern idea of a plot, with contrasted characters and incidents leading to the accomplishment of a main action. Many tragic writers, the whole of whose works have been lost, flourished after Euripides in Athens and Alexandria; but they do not seem to have altered the character of the art which they received from their predecessors. The fate of comedy was different: the old Attic comedy was a political or philosophical satire in action, which in form was a burlesque on the tragedy. Afterwards, passing through the intervening stage of the middle comedy, of which we know little, the art acquired in the new comedy of Menander and Philemon a character somewhat approaching to that in which it is at present cultivated; a narrative in representation of scenes and incidents in ordinary life of a light or ludicrous character.

The dramatic art among the Greeks aimed at producing an impression upon the spectators by three different means; which, according to modern phraseology, we may denominate poetical effect, dramatical effect, and theatrical effect. The poetry of the Greek drama was of the highest order; but it forms a topic to be considered apart. Dramatical effect is the proper subject of the dramatic art; and, in judging of the efforts of the Greek mind in this direction, we are assisted not only by the

study of the dramatic poems which we possess, but by the rules of criticism delivered to us by Greek authors, and especially by Aristotle. From these it appears that the parts or characteristics of a tragedy, essentially divided, were held to be the fable or story, the manners, the style, the sentiment, the music, and the diction: that the fable should consist of an entire action, namely, one principal event and the auxiliary events; and that the proper emotions to be excited by the action are terror and pity: that its parts of quantity, according to the division of form, were the prologue, being that part of the tragedy which precedes the parode or first entry of the chorus; the episode, being all those several parts which are included between the several choral odes; the exode, the part which follows the last choral ode; and the chorus itself, or the intervening odes, which also admit of various subdivisions. Formally considered, the arrangement of the old comedy nearly resembled that of tragedy; in the new, the chorus was altogether omitted. The unity of action was a remarkable characteristic of the Greek drama, although widely different from that peculiar quality which modern critics have characterized by the name: it should rather be termed unity of subject, inasmuch as in many of our remaining tragedies, and especially those of Æschylus, there is little or no trace of what we term a plot, *i.e.* a main incident at which we arrive through subordinate incidents tending to its accomplishment. The unity of time, —viz. that the imaginary duration of the action should not exceed twenty-four hours; and that of place,—namely, that the scene in which the events occur should be the same throughout,—are inventions of French critics, not warranted by the remains of Greek art, in which both are not unfrequently violated; but, although not rules of Grecian discovery, they are easily rendered applicable to the simple and severe form of the Greek tragedy.

In considering the theatrical effect of the Greek drama, we must remember that the tragedies were originally religious solemnities; the theatre, a vast building open at the top, calculated for the accommodation of several thousand spectators; the scene, &c. proportionally large. Dramatic representations were, at Athens, the offering of wealthy men to the people: he who contributed the expenses of the entertainment was said, εἰσάγειν, to bring in the play; the poet who produced it, διδάσκειν, to teach it, *i.e.* teach the actors to perform it. A complete representation consisted of four pieces by the same author; a trilogy, or three tragedies, narrating successive events in the same series of mythological tradition; and a fourth piece, termed a satyric drama, of which the chorus consisted of satyrs, and the mythological subject was treated in a manner approaching to burlesque. The features of the actors were exaggerated by masks, their height increased by dress, their powers of voice aided by acoustic contrivances, in order to suit the colossal dimensions of the theatre. The whole vocal part was rhythmical; the choral odes were sung, and accompanied by the choric dance, in which the actors composing the chorus took part, subjected to very peculiar rules: the narrative part of the performance was spoken in a peculiar modulated voice, resembling probably the recitative of the modern opera. As to the metrical character of the ancient Greek drama, the metre used in the dialogue was the iambic trimeter, varied occasionally with the anapæstic and trochaic, chiefly where the other dramatis personæ conversed with the chorus, or the members of the chorus itself took part in the action; the choral odes were composed in a great and very artificial variety of metre.

Latin Drama.—The early Etruscans possessed dramatic representations, whence the Romans derived some peculiar national entertainments (*see* MIMI); but, with this slight exception, their drama consisted merely in the first instance of translations, afterwards of close imitations of the Greek. Accius and Pacuvius transferred to the Roman stage the tragedy of the three Attic poets; Plautus and Terence the new comedy of Menander. Of these writers Terence is the only one who appears to have deviated, and that slightly, into original invention: in the degeneracy of the Roman empire even this adscititious taste ceased to be cultivated, and the theatres were entirely occupied by farcical buffoonery, or shows and sports on a gigantic scale. Among an infinite variety of works which treat of the classical drama, may be cited the first volume of *Schlegel on Dramatic Art and Literature.* A catalogue of them will be found at the end of the 4th edition of the *Theatre of the Greeks*, Cambridge, 1836. See also *Edin. Rev.*, vol. 49.

Chinese Drama.—Before proceeding to the dramatic art of modern Europe, derived as it is from that of Greece, two oriental nations may be noticed which possess a national drama of their own. In China, theatrical entertainments form one of the most popular amusements, and theatrical writing has been cultivated from a very early period. The Chinese drama comprises pieces which we should term both tragical and historical plays, tragicomedies, and comedies both of intrigue and of manners; together with abundance of low, pantomimic, and farcical representations. In their regular drama, however, there appears to be less of what we should term connected than of successive action: many of them are, as it were, dramatized memoirs or biographies of individuals, real or fictitious; the representation of some is said to require ten days. It is remarkable that, of all national dramas, the Chinese appears to be the only one in which we can trace no original connection with religious observance. (*Morrison, Horæ Linicæ; Abel Remusat; Memoirs of the Acad. des Inscriptions*, &c.)

Hindoo Drama.—The Hindoo plays which now exist are written for the most part in Sanscrit, although not a living language at the period when they were composed; mixed, however, with other dialects, which, according to Hindoo critics, are respectively appropriate to different parts of a play. They seem to have been appropriated to the entertainment of learned persons, and acted only on solemn occasions. They are few in number; about sixty only are known: some containing long mythological narratives, others much complicated incident of a domestic character, in a strain of tragedy alternating with comedy, like the romantic drama of modern Europe. The dramatic art appears to have flourished in India during a period of several ages, ending about the 14th or 15th centuries of our era. Dramatic criticism was also much cultivated; and the most minute and artificial rules are laid down by Hindoo commentators as to the conduct of a piece, the requisite ethics, the formal arrangement, and the characters which must be introduced. The Hindoo drama is so widely different from the Greek or Chinese, that it must be regarded, like them, as a spontaneous offspring of national genius. (*Wilson's Specimens of the Theatre of the Hindoos*, 2 vols. 8vo. 1835.)

Modern European Drama.—For many centuries after the downfall of the Roman empire, the dramatic art appears to have been entirely lost. Its first revival in the middle ages was owing to the solemnities of the church, into which dramatic interludes were introduced in various countries of western Europe, representing at first events in biblical history or the lives of the saints, and afterwards intermingled with allegorical fantasies. (*See* MYSTERIES, MORALITIES.) The framers of these early pieces were monks, and the monks were the only preservers of classical learning; but whether we can infer from these facts that the idea of these rude representations was suggested or their details improved by classical associations, it is not easy to pronounce. At the period of the revival of literature, however, the dramatic art was called nearly at once into life in the four principal countries of western Europe; Italy, France, Spain, and England. In the two first of these countries it arose simply classical, and unmixed with any original conceptions, or with the sentiments and fashions of the middle ages; in the two last it partook largely of both, and was also immediately derived from the mysteries and moralities above mentioned: hence, in a historical view, arose the distinction, so elaborately explained by modern critics, between the classical and romantic drama.

Italian Drama.—Originated in close imitation of classical models. The *Sofonisba* of Trissino (1515) is not absolutely the oldest Italian play, but the first which served as a model for subsequent composers. Rucellai and many others followed in the same track; Bibbiena, Machiavel, Ariosto, as closely imitated the model of the Terentian comedy. The pastoral drama of the 16th century, of which Tasso and Guarini were the most celebrated writers, furnished the first novelty in this branch of literature; but these are rather poetical than dramatical compositions. The true national theatre of Italy arose in the 17th century, in the musical drama (opera), to which Metastasio, early in the 18th, communicated all the charms of poetry; but since the period of that writer, the operatic part of the dramatic art has again been wholly disconnected from the literary, and the words only serve as vehicles for the music. While the higher classes were devoted to the opera, the lower found their national amusement in the commedie dell' arte; comedies performed by masqued characters, which gradually became fixed in the well-known persons of Harlequin, Pantaloon, Brighella, &c., who improvised their parts: Goldoni, in the middle of the 18th century, succeeding in establishing a regular comic drama in possession of the stage; while his rival, Gasparo Gozzi, took up the commedie dell' arte as models, and founded upon them a series of amusing extravagances. But since the period of these two spirited writers comedy has fallen almost completely into disrepute. At the end of the 18th century Alfieri, a bold and severe genius, produced tragedies in which the ancient classical form (with the exception of the chorus) was again reverted to, instead of the French imitations of it which had long been current in Italy as well as the rest of Europe; and several dramatic poets have since appeared, who have adopted the same model. (*Ginguené, Litterature Italienne; Tiraboschi; Walker on Italian Tragedy*, 1799; *On the Revival of the Drama in Italy*, 1805; *Riccoloni, Hist. of the Ital. Theatre.*)

French Drama.—The early French tragic writers, from the beginning of the 16th century down to Corneille in the

middle of the 17th, produced nothing but unsuccessful and somewhat barbarous imitations of the Greek tragedy. The first pieces of this kind represented on the French stage had prologues and choruses. Corneille had studied and loved the Spanish drama; and without introducing much of its varied form and incident, he transfused a portion of its boldness and romantic sentiment into the French theatre, together with a power of energetic declamation peculiarly his own. Racine, on the other hand, was a pure admirer of antiquity; but with a taste and delicacy of feeling which until his time had been very rarely found to accompany classical knowledge. The French tragedy grew up with these two great writers as models, and Boileau as its legislator. A peculiar and rigorous system of criticism was introduced, affecting both the form and the substance of dramatic writing; and this system became established in the minds of the French public, as the natural and not the conventional rule of beauty. It would be impossible to enter into an examination of the rules of the French drama; suffice it to say, that they banished from the tragic stage all except heroic characters and passion; required perfect simplicity of plot, uniformity of language, and, in addition, the observance of the before-mentioned technical unities of place and time. These rules have ever since been scrupulously followed, without deviation, on the regular French stage, and many of the greatest names in dramatic literature have voluntarily subjected themselves to their restraints. The French comedy, however, is infinitely more national and characteristic than the French tragedy: it originated in that of Spain, and was carried at once to a high degree of perfection by Molière, — rejecting the extravagance of the Spanish drama, confining itself within certain definite limits governed by analogy to those established for tragedy, and retaining satire instead of adventure as its leading principle. Since that period the French comic stage has been, beyond all contradiction, not only the best, but the model from which that of all other nations has been wholly derived. Of the present state of the French drama it is difficult to speak with precision; but the national or regular stage seems to be every day losing in popularity, while the attempts to establish a new one on what is termed in France the romantic model have hitherto met with very partial success. (*Laharpe, Cours de Littérature; Correspondance de Grimm*, passim; *Voltaire, Discourse on Tragedy; Schlegel.*)

Spanish Drama. — Spain commenced her literary career more independent of foreign aid than any other country. Her dramatic art appears to have originated as early as the 14th century; which produced satirical pieces in dialogue, and one complete dramatic romance by an unknown author (*La Celestina*), in addition to the mysteries and miracle plays, which were exhibited in Spain even more plentifully than elsewhere. The early Spanish comedies of the 16th century were conversations, like eclogues, between shepherds and shepherdesses; with occasional interludes of negroes, clowns, and Biscayans, the favourite subjects of popular jest. But the Spanish drama owed to one great author, Lope de Vega, what our own owed to his contemporary, Shakspeare, — a rise at a single bound from insignificance to great richness and variety; he created, moreover, nearly all its numerous divisions, and has left examples of each. The name comedy, in the early Spanish stage, implied no ludicrous or satirical representation, but simply a play of adventure. Comedias divinas, or spiritual comedies, were subdivided into lives of saints, and pieces of the holy sacrament (autos sacramentales): the comedies of human life into heroic, answering to the tragedy of our early English dramatists, although even less regular in form; and comedies of domestic adventure (comedias de capa y espada, — of cloak and sword). Besides these, the interludes which were played between the prologue and the piece (sayneteres) possess a distinct character as literary compositions. Almost all pieces have one favourite invariable character, the gracioso or buffoon. Calderon, a greater poet than Lope, and his equal in dramatic power, is the only other great name in the Spanish drama. Subsequent writers may all be classed as imitators either of their own older poets, or of the favourite dramatists of the French school. (*Bouterweck's Hist. of Sp. Literature; Quart. Rev.*, vol. 38.; *Sismondi, Lit. du Midi de l'Europe; Schlegel.*)

English Drama. — For the semi-religious representations out of which the English drama arose, *see* Mystery and Morality. One of the latter, *The New Custom*, was printed as late as 1573; by which time several regular tragedies and comedies, tolerably approaching to the classical model, had appeared. But a third species of exhibition soon took possession of the stage, the historical drama, in which the successive events of a particular reign or portion of history were represented on the stage; and, together with it, arose the English tragedy and comedy. Our first dramatic poets (those before Shakspeare) were scholars; hence they preferred the form of the ancient drama, the division into acts, &c. But they were also writers, who strove for popularity with the general class of their countrymen; hence, instead of imitating classical simplicity, and confining themselves to a peculiar cast of diction and sentiment removed from the ordinary course of life, they invented a species of composition which intermingled poetical with ordinary life and language. Comedy, again, became in their hands a representation of adventures, differing from those of tragedy only by ending generally in a happy instead of an unhappy exit, and not materially either in the characters or language. Thus the distinctions which they established between tragedy, comedy, and tragi-comedy, are little more than adventitious; and the Shakspearian drama, properly considered, must be looked on as a miscellaneous compound, in which actors, language, and sentiments, of a character far removed from those of ordinary life, alternate with those of a low and even a burlesque character. There is no tragedy of Shakspeare in which comic scenes and characters are not introduced: there is only one comedy (*The Merry Wives of Windsor*) without some intermixture of sentiment approaching to tragic. It continued to be the chief national literature, as well as the favourite national amusement, down to the period of the civil wars, when the opinions and legislation of the prevailing party put a stop to dramatic representation altogether. During the interval thus created the old English art was unlearned altogether, and the new drama, on the model of the French, introduced almost at once on the return of Charles II. and his courtiers from the Continent. The distinction between tragedy and comedy was then first substantially recognized: the former confined to heroic events and language, the latter to those of ordinary life. But tragedy, subjected to foreign rules, ceased entirely to flourish: and Otway, the last writer of the old English drama, who wrote partly on the ancient model, although after the Restoration, is also the last tragic poet of England who still occupies the stage; with the exception of Rowe, and of a few authors of that peculiar species of composition, the domestic tragedy, in which the distresses and melancholy events of common life are substituted for those of an heroic character. Comedy, on the other hand, obtained possession of the national taste and stage; and although the charm of poetry and romantic adventure, which had belonged to the old drama under either name, was denied to the modern comedy, it soon attained a high degree of excellence as well as popularity. The last comedies in verse were written shortly after the Restoration; since which time, with the exception of a few insulated attempts to revive the older form, it has been entirely framed on the French model. The main element of a modern comedy is satire; but it admits of a subdivision into comedy of intrigue and comedy of manners, — the former being chiefly directed to the development of a plot, the latter to the delineation of manners; although these qualities ought, properly speaking, to be united to constitute a good play. The most distinguished of our dramatic writers in the former line are, amongst many, Congreve, Vanbrugh, Farquhar, Colman, Sheridan: in the latter, the writings of Shadwell and Foote, perhaps, afford the most remarkable instances of that less popular form of comedy which almost neglects the interest of plot, and confines itself to a satirical representation of prevailing vices and follies. (See *Edin. Rev.* vol. 38.; *Prolegomena to Malone and Boswell's Shakspeare; Hazlitt's Lectures; Coleridge's Remains; Collier, Hist. of Eng. Dramatic Poetry.*)

German Drama. — The modern German drama is founded on the old English model; and, although the last in order of time, has risen to a high degree of excellence, the stage in Germany being incomparably more national and popular at the present time than in other European countries. While France, England, and Spain have to look back two hundred years for those names which form the glory of their dramatic literature, Lessing, Schiller, and Goethe are writers only of the past generation.

DRAMATU'RGY. (Gr. δϱαμα, and εϱγον, *work.*) The science or art of dramatic poetry and representation: a word used by German writers.

DRAM TIMBER. *See* Baulk.

DRA'PERY. (Fr. draperie.) In Painting and Sculpture, the clothing applied to the human figure. *See* Casting of Drapery.

DRA'STIC MEDICINES. (Gr. δϱαστικος, *effective.*) A term chiefly applied to purgatives and some other remedies which are rapid and powerful in their operation.

DRAUGHT OF WATER. The depth of the lowest point of the ship: as the keel is seldom exactly horizontal, the draught of water is taken forward and aft. A ship of the largest size draws nearly 30 feet.

DRAW'BACK. In Political Economy. When a duty is laid on an article produced in a country that is suitable for the foreign market, it is usual, on its being entered for exportation, to remit or pay back the duty to the exporter; and hence the technical phrase drawback. The policy of a measure of this sort is, in most cases, obvious. It is rarely for the public advantage to impose a duty on an article about to be exported; the inevitable effect of such duty is, by proportionally increasing the price of the article, to lessen the foreign

demand for it; and its probable effect is, in most instances, entirely to exclude it from the foreign markets. Except in a few rare cases, one country has seldom so great an advantage over others in the production of commodities as would justify the imposition of a duty on their exportation, without incurring an extreme risk of making them be supplied from some other quarter. This, however, is a result to be deprecated in every point of view. And hence in every case in which the exporting country has no ascertained or decided superiority over others in the production of commodities on which duties are laid at home, there can be no question as to the expediency of drawbacks. These must not, however, exceed the amount of duty charged; for when they do this, the excess becomes, in fact, a bounty.

DRAW′ING. (Sax. ðraᵹan, *to draw along.*) In the Fine Arts, the art of representing any object by means of lines circumscribing its boundaries. Drawing is of course the foundation of every thing in art, including within it a knowledge of perspective, anatomy, and proportion, and when acquired giving, as Sir Joshua Reynolds observes, "a proportionable power of drawing correctly what we imagine." The human figure is the principal, perhaps the only object, upon which a student should be first employed; for he who can correctly draw that will not be at a loss in representing any thing else he may wish. Sir Joshua observes, that he who endeavours to copy nicely the figure before him, not only acquires a "habit of exactness and precision, but is continually advancing in his knowledge of the human figure; and though he seems to superficial observers to make a slower progress, he will be found at last capable of adding (without running into capricious wildness) that grace and beauty which is necessary to be given to his more finished works, and which cannot be got by the moderns, as it was not acquired by the ancients, but by an attentive and well compared study of the human form."

DREAMS (Germ. Träume), may be defined to be those trains of ideas which occupy the mind, or those imaginary transactions in which it is engaged, during sleep. Dreams constitute some of the most curious phenomena of the human mind, and have in all ages presented to philosophers a subject of most interesting investigation. The theory of dreams embraces two distinct classes of phenomena, *physical* and *psychological*: the former relate to the question as to how the body is affected in a state of sleep (*see* Sleep), how the body in that state affects the mind, and how this affection operates to the production of the phenomena of dreams; the latter comprehend an inquiry into the laws which regulate the train of ideas that occur during sleep, and the mode in which these laws operate, together with an examination of certain psychological appearances peculiar to that state. To both these classes of phenomena the attention of some of the most distinguished philosophers, both of antiquity and of modern times, has been directed; and much labour and ingenuity have been expended in endeavouring to ascertain the origin and nature of dreams, and to account for the various phenomena by which they are accompanied. To give even an outline of the various theories that have been propounded on this subject, would be wholly incompatible with our limits. The system of condensation on which works of this species must be constructed is, as will be easily understood, but little suited for metaphysical disquisitions, in which, to use a remark of Horace, brevity so easily degenerates into obscurity; but in the present instance this is perhaps the less to be regretted, for of all those speculative questions which are said to lie beyond the reach of human inquiry, there is none on which the opinions of philosophers are more conflicting and unsatisfactory than the theory of dreams. Among a multitude of other *efficient* causes, dreams have been ascribed to direct impressions on the organs of sense during sleep, — to the absence of real impressions on the senses, — to a disordered state of the digestive organs, — to a less restrained action of the mental faculties, — to the suspension of volition while the powers of sensation continue, — and to the succession and unequal relaxation and cessation of the different senses at the commencement and during the time of sleep. (*Encyc. Edin.*) From the remotest period of antiquity, dreams have also been ascribed to supernatural agency. The records of history, both sacred and profane, abound in instances of dreams which it is impossible to account for on any other hypothesis than that of a supernatural interposition; and, as has been well observed, though there can be no doubt that many dreams which have been considered supernatural, as revealing facts and scientific truths, may now be explained by means within our own knowledge, it can just as little be doubted that many well authenticated dreams are utterly inexplicable by ordinary or natural means. This belief in the supernatural character of dreams is common to every nation in a greater or less degree; but it prevails more especially in the countries of the East, where, from time immemorial, there has existed a class of persons whose peculiar occupation consists in the interpretation and explanation of dreams. Those who wish for comprehensive details on this subject may consult the writings of Aristotle, Lucretius, Democritus, &c.; and, among ourselves, of Locke, Newton, Hartley, Baxter, Beattie, and Stewart; and still more recently, those of Abercrombie and Macnish, which are extremely valuable for the numerous instances of extraordinary dreams with which their theories are illustrated. The *Penny Cyclopædia*, also, contains an article upon dreams, which exhibits great metaphysical acumen. (See *The Royal Book of Dreams.*)

DRE′DGING MACHINE. A machine for clearing out or deepening the beds of navigable rivers, harbours, canals, &c., by the removal of deposited matters.

DRE′SSING. A term applied to gum, starch, and other articles used in stiffening or preparing silk, linen, and other fabrics.

DRE′SSINGS. In Architecture, mouldings round doors, windows, and the like.

DRIFT, in Navigation, is the angle which the line of a ship's motion makes with the meridian, when she is driven by the wind or waves and not governed by the helm. It also signifies the distance to which she is carried in a given time in that direction.

Drift. (Sax. ðrifan.) In Architecture, the horizontal force which an arch exerts with a tendency to overset the piers.

DRILL. In Mechanics, a small instrument of steel for perforating metals or hard substances. Its action is produced by communicating to it a very rapid rotation by means of a *drill-bow.*

Drill. In Agr., a machine for sowing agricultural seeds in rows; sometimes worked by the hand alone, and sometimes by the addition of a horse.

DRILL HUSBANDRY. In Agr., the cultivation of arable land, by sowing the crops in rows; the advantage of which is, that it admits of destroying the weeds, and stirring the soil in the intervals between the lines of plants. As this mode of cultivation requires some implements and machines not in use in the commoner kinds of farming, and as it is besides better adapted for some soils than for others, it is not so generally used as the obvious advantages attending it would lead us to expect.

DRIP. In Architecture, the same as Corona, which see.

DRI′PPING EAVES. (Dan. dripper, *to drop.*) In Architecture, the lower edges of a roof wherefrom the rain drips or drops to the ground.

DRI′VING NOTES. In Music, such notes as connect the last note of one bar with the first of the following one, so as to make only one note of both. They are also used in the middle of a measure, and when a note of one part terminates in the middle of the note of another, in which case it is called *binding* or *legature.* Driving notes are also called *syncopation,* when some shorter note at the beginning of a measure or half measure is followed by two, three, or more longer notes, before any other occurs equal to that which occasioned the driving note to make the number even; for instance, when an odd crotchet succeeds two or three minims, or an odd quaver two or more crotchets.

DROITS OF ADMIRALTY. The perquisites resulting chiefly from the seizure of the property of an enemy at the commencement of a war, and attached to the office of lord-high-admiral, or to the crown when that office is vacant. These perquisites were originally vested in the sovereign, to enable him to provide for the expense of defending the realm, and clearing the seas of pirates; and their value and importance will be at once perceived from the following brief statement. In 1798, one ship which had been captured brought 55,000*l.*; in 1800, another brought 65,000*l.*; in 1804, one captured ship was worth 105,000*l.*; and in 1806, several taken at once netted 155,000*l.* During the last war, also, the Dutch ships at one seizure brought 1,030,000*l.*; the Spanish ships, 2,200,000*l.*; and so large were the sums made at one and the same moment in this rich fund, that the crown one year, after paying many hundred thousands to captors, and large sums to different branches of the royal family, gave a million out of the residue to the public service. (*Edin. Rev.* vol. xxxiii. p. 482.) By the civil list introduced on the accession of William IV., it was arranged that all the droits of admiralty which might accrue during his reign should be paid into the exchequer for the benefit of the public service; and the civil list of her present Majesty has made no alteration in that arrangement. *See* Prize Money

DRO′MEDARY. *See* Camelus.

DROPS. (Sax. ðroppan.) In Architecture, the frusta of cones in the Doric order, used under the triglyphs in the architrave below the tœnia. They are also used in the under part of the mutuli or modillions of the order. In the Greek examples they are sometimes curved a little inwards on the profile.

DROP SERENE. (Lat. gutta serena.) *See* Amaurosis.

DRO′PSY. (Gr. ὕδωρ, *water.*) An unnatural collection of watery fluid in any part of the body. When it

takes place in the cellular membrane, it constitutes *anasarca;* when in the cavity of the abdomen, *ascites;* in the cavity of the cranium, *hydrocephalus;* in the scrotum, *hydrocele;* in the uterus, *hydrometra;* and in the chest, *hydrothorax*. Dropsy may arise from a variety of morbid actions, either of the secerning or absorbing vessels. When the fluid which lubricates the internal surfaces and cavities of the body is secreted in excessive quantity, or is not adequately removed by the absorbents, it may so accumulate as to constitute the various forms of this disease; it may therefore arise out of excessive as well as of defective action; it may also result from a variety of other causes connected with organic lesion or derangement, both vascular and nervous. The treatment of dropsy will of course vary with the cause of the disease: it sometimes requires depletion, and at others tonics; and local accumulation of fluids is often susceptible of removal by remedies which stimulate the absorbents to increased action, or which excite the excretories of the intestines or promote the flow of urine. Dropsy is a common symptom of a broken constitution and failure of the powers of life.

Dro'psy. In Botany, a disease peculiar to succulent plants, arising from an excessive introduction of water into the system. It produces rapid rottenness, and can only be stopt by destroying all the parts affected by it, and exposing the individual to a very dry atmosphere.

DROSO'METER. (Gr. δροσος, *dew*, and μετρον, *measure*.) Any instrument for measuring the quantity of dew that collects on the surface of a body exposed to the open air during the night. The first instrument for this purpose was proposed by Weidler. It consisted of a bent balance which marked in grains the preponderance which a piece of glass of certain dimensions, laid horizontally in one of the scales, had acquired from the settling and adhesion of the globules of moisture. A simpler and more convenient drosometer would be formed on the principle of the rain gauge; and in order to facilitate the descent of the dew down the sides of the funnel into the tube, a coat of deliqueate salt of tartar may be spread over the shallow surface. Dr. Wells, in making his celebrated experiments on dew, exposed a small quantity of wool to the open sky, and the differerence in its weight when laid down and taken up showed the quantity of moisture it had imbibed in the interval.

DROW'NING. When a person is submerged under water, suffocation ensues, not in consequence of the access of water to the windpipe or lungs, but merely from the exclusion of air, the mechanism of the glottis, or upper portion of the windpipe, being such as to prevent, by the spasmodic closure of the epiglottis, the entrance of more than a very trifling and accidental quantity of water. Under these circumstances, however, an attempt is made to inspire, which is followed by the reaction of expiration, and consequently a little air is thrown out, and the residuary quantity in the lungs still further diminished; access of oxygen to the blood is therefore effectually cut off, the aëration of the blood is prevented, and venous blood circulates in the arterial system, the right side of the heart becoming loaded with it, and the pulmonary vein returning it to the right cavities of that organ. The consequences of the non-aëration of the blood thus ensuing upon the vital functions is their suspension and rapid extinction; so that in the course of four or five minutes after the access of air has been cut off death ensues, although some of the organic functions may and do continue for a much longer period. When therefore a person has been perfectly submerged in water for the space of five minutes, perfect insensibility ensues, and the functions upon which life more immediately depends cannot be restored.

In consequence, however, of the struggles made by a drowning person, and of their chances of occasional gasps of air, and of the varying quantity of air which the lungs may contain, we must not despair of the possibility of resuscitation, even when the body has been for fifteen or twenty minutes in the water, although it must be confessed that after four or five minutes' submersion the chances of recovery are very remote.

The state of alarm and agitation into which persons falling into the water, and who cannot swim, are thrown, and their ignorance in general of the means which should be resorted to upon such an emergency, as well as want of presence of mind to adopt them, lead to neglect of those obvious measures by which immediate dangers might be averted. They should endeavour to recollect that the specific gravity of the human body when the lungs are filled with air, is less than that of water, and that consequently the body has, under such circumstances, a natural tendency to float; and that if the head can then be so placed as to keep the mouth or even the nostrils above water, respiration may be continued. They should also remember that by a forced inspiration a much larger quantity of air may be drawn into and retained in the lungs than in a common or natural inspiration; and that therefore the blood will continue longer aërated, and consequently a longer period will elapse before a second attempt at inspiration need be made, and before insensibility or the cessation of the vital functions will ensue. If, for instance, while breathing as usual, we suddenly hold our breath, we shall find ourselves forced to make an inspiration in the course of from a quarter to half a minute; but if we previously make two or three forced respirations, so as to cleanse the lungs in the first instance of foul air, and then take a forced inspiration, we shall be able to hold breath for more than a minute, and sometimes even for two minutes. It is upon this principle, that skilful divers are enabled to remain under water for a period that sometimes appears almost incredible; and if the depth of water be considerable, and the air supplied from a diving bell, its degree of condensation or diminished bulk will of course enable a given volume to oxygenate the blood more effectually than the same volume at common atmospheric pressure.

Such, then, is an outline of the physiology of drowning; it naturally leads to the important question as to the most effective means of restoring suspended animation in such cases. It of course follows from what has been said, in the first place, that not a moment is to be lost in getting the body out of the water, and removing it with the utmost speed to any place where further means can be resorted to; and now air should be thrown into the lungs, and artificial respiration should be attempted with as little loss of time as possible, for till the blood has an opportunity of being aërated, the return of the vital functions is of course impossible. The body should also be immediately stripped of the wet clothes, which should be cut off or otherwise removed with the utmost speed; and warm blankets should be at hand as wrappers, and warm towels for rubbing and drying the body. Artificial respiration, together with warmth and friction, carefully, however, and moderately employed, are the first and most essential remedies. Much has been said of the advantage in these cases of electricity; and, if possible, it should certainly be resorted to: slight shocks should be passed through the region of the diaphragm, the heart, and along the course of the spine; and various forms of the magneto-electric machine seem particularly well adapted to these purposes. The truth is, that the means to be adopted in all these cases are few and simple; but unless they are immediately at hand, and instantly available, they will fail, even under the most favourable circumstances. Yet, where even a glimmering of hope remains, they should, even under unfavourable circumstances, be as speedily and completely as possible resorted to; for there are on record extraordinary cases of resuscitation, when every thing appeared to militate against a successful issue.

But in these cases it is not only important to know what to do, but also what to avoid. Nasal stimulants, such as ammonia, aromatic vinegar, and other pungent and volatile applications, should be avoided: they can be of little use under the most favourable circumstances, and in the most judicious hands; and if unskilfully employed, may do infinite mischief. The warm-water bath is a bad substitute for warm air and friction; it interferes with the latter, and with the use of electricity, and places the body in a constrained and unfavourable position. In these days it is scarcely necessary to point out the extreme absurdity of holding the body with the head downwards, to allow the water to run out by the mouth, or the still more dangerous use of tobacco, especially of the injection of tobacco smoke,—means calculated to put the life of a healthy person in jeopardy, and every way suited to render all attempts at the restoration of suspended animation ineffectual.

DRU'GGET. A coarse and flimsy woollen texture, chiefly used for covering carpets. It was formerly extensively employed as an article of clothing by the poorer classes, more especially of females; but this and similar fabrics are now almost wholly superseded by cotton goods, which induce greater cleanliness, and are less liable to retain infectious and contagious poisons.

DRU'IDS. The priests of the Celtic inhabitants of ancient Gaul and Britain. Our classical information respecting them is chiefly derived from Julius Cæsar; Strabo, Tacitus, Pliny, Lucan, and other authors, have also left us particulars respecting them. On those slender foundations very extensive superstructures have been raised by the imagination of English and French antiquaries. The classical name of Druid was derived by the Latins from δρυς, an oak; but is more probably of Celtic origin. The doctrine of the Druids was not committed to writing, but retained by memory in the form of verses; of which the Welsh Triads are supposed, with some probability, to retain the form and vestiges. There appears to have been much of fraud and vulgar delusion mixed up in the religious rites which they practised. The gods whom they worshipped, according to classical writers, were Jupiter (Taranis), Apollo (Belenus), Mars (Hesus), and several others, whom they believed to be the same with personages of the Grecian mythology. The sacrifice of human victims is uniformly represented as a part of their worship. Their places of worship were chiefly conse-

crated groves, of one of which Lucan has given a fine description in the second book of his *Pharsalia*. The rock-altars, cromlechs, cist-vaens, and other relics of antiquity, which are scattered over the surface of parts of England and France, are attributed by antiquaries for the most part to the Druidical age. Claudius and other Roman emperors issued severe edicts against the Druids, but did not succeed in extirpating them. This was only effected by the general introduction of Christianity; and some suppose that the celebrated Culdees of Scotland and Ireland were converted Druids.

DRUM. (Dan. tromme.) In Architecture, the upright part of a cupola either above or below a dome. The same term is used to express the solid part or vase of the Corinthian and Composite capitals.

DRUM. In Music, an instrument of percussion, formed by stretching a piece of parchment over each end of a cylinder formed of thin wood, or over the top of a cauldron-shaped vessel of brass; the latter is hence called a kettle drum. The large drums which are beaten at each end are called double drums, and are used chiefly in military bands. Kettle drums are always used in pairs; one of which is tuned to the key note, the other to the fifth of the key. It is principally used for military purposes, especially for exciting the soldiers under the fatigue of march or in battle. The drum is supposed to be an eastern invention, and to have been brought into Europe by the Arabians, or perhaps the Moors. The kettle drum, the bass drum, and tambourine, are common in the East.

DRUM OF THE EAR. *See* EAR.

DRUPE. In Botany, a one-celled, one or two-seeded, superior, indehiscent fruit; the outer coat is soft and fleshy, and separable from the inner or endocarpium (stone), which is hard and bony: the whole proceeding from an ovarium, which is perfectly simple. The peach, plum, apricot, cherry, are examples of this.

DRY. (Sax. ðriȝ.) In Painting, a term applied to a painting wherein the outline is too strongly marked, and the colours of the objects do not unite with those by which they are surrounded. In sculpture it is used in speaking of a work wherein there is a want of luxuriousness and tenderness in the forms.

DRY'ADS. (Gr. δρυς, *an oak*.) In the Heathen Mythology, a kind of imaginary female deities whom the ancients believed to inhabit the woods and groves.

DRY DISTILLATION. This term is applied to the distillation of substances *per se*, or without the addition of water: thus if we put wood into a retort or other distillatory apparatus, and subject it to heat, it yields tar, vinegar, water, and various gaseous and other matters, which are called the products of its *dry* or destructive distillation.

DRY'ING OIL. This term is generally applied to linseed and other oils which have been heated with oxide of lead; they are the bases of many paints and varnishes.

DRY ROT. A disease which attacks wood, rendering it brittle, and destroying the cohesion of its parts, is known by this name. It occurs among the timbers of ships, where it sometimes commits the most serious damage, and in damp ill-ventilated houses. It is usually ascribed to the attacks of fungi, especially to such as *Polyporus destructor* and *Merulius lachrymans*, whose filamentous spawn or thallus appears upon the surface, overspreading it like a tough thick skin of white leather; and there is no doubt of its being often connected with the appearance of such fungi. But dry rot is certainly, in some cases, to be identified with the presence of fungi of a more simple kind than those just mentioned; especially of such as belong to or resemble the genus *Sporotrichum*.

The destruction of timber by such plants is effected in part by the disintegration of the tubes of the weed, in consequence of the introduction between them of the fine filamentous spawn of the fungi, and in part by the dampness which is thus conveyed to the interior of the wood, where it soon produces decomposition. It is not, however, certain that dry rot is always caused in this manner; on the contrary, the term appears to be frequently applied to cases of spontaneous decomposition of timber without the presence of fungi, or when the appearance of the latter takes place long after the commencement of the disease.

When dry rot produced by fungi has once made its appearance, there is no means of arresting its progress without removing the whole of the diseased and neighbouring parts; and even then it will probably again break out, unless means can be taken to introduce a circulation of fresh air among the parts liable to the affection. For if timber is allowed to remain in a damp situation, and in the dark, it affords so favourable a nidus for the seeds of fungi, that they are almost certain to vegetate upon it; unless some means have been previously taken to render the timber permanently unsuited to their growth. This end appears to have been attained by Mr. Kyan, who has obtained a patent for pickling timber, as a preventive of the dry rot, and who employs for this purpose a solution of corrosive sublimate. This salt of mercury is a well-known vegetable poison: if any animal jelly, upon which fungi will quickly appear in the form of mouldiness, is mixed with a minute quantity of corrosive sublimate, no fungi will in that case be produced; so that both theory and experience are in favour of Mr. Kyan's process. It is not improbable that the progress of dry rot might even be arrested in the buildings where it occurs, if the timbers could be got at and well washed with the same solution.

Although dry rot generally fixes itself upon timber, it will also attack any form of vegetable matter. The paper hangings of rooms, chiefly composed of cotton and linen thread, are occasionally overrun in houses which have been long shut up and neglected; and the mildew which destroys the strength of canvass is only another form of dry rot, the appearance of which is altered by the special circumstances under which the fungus is developed, or by the species of the fungus itself.

DRY'SALTER. A dealer in salted or dried meats, and in the materials used in pickling, salting, and preserving various kinds of food; hence drysalters usually sell a number of saline substances and miscellaneous drugs.

DRY'STOVE. A glazed structure for containing the plants of dry arid climates; such as the cactuses, mesembryanthemums, aloes, and other succulents of Africa.

DU'ALISM. A name given to those systems of philosophy which refer all existence to *two* ultimate principles. Dualism is a main feature in all the early Greek cosmogonies, and is that which distinguishes them from the eastern speculations on similar subjects, which mostly regard all things as *emanating* from a single principle. The dualistic hypothesis was, doubtless, originally suggested by the analogy of male and female in animal existence. The earliest forms under which the theory appeared are, as might be expected, rude in the extreme. The Orphic poets made the ultimate principles of all things to be Water and Night; by others Æther and Erebus, Time and Necessity, are severally deemed worthy of this distinction. (*Brandis, Gesch. der Phil.* i. p. 71.; *Arist. Metaph.* xix. 3.) The ancient Greek and Roman mythology was evidently constructed on this principle. (See *Varro, De Re Rustica*, i. 2.) In its more philosophic form, the dualistic theory was maintained among the ancients by Pythagoras and many of the Ionian school; among the moderns, chiefly by Descartes. (*See* arts. IONIC PHILOSOPHY, CARTESIAN PHILOSOPHY.) It may be expressed generally as the assumption of the coeternity and simultaneous development of the formative with the formed, of the *natura naturans* with the *natura naturata*. So the system of philosophy which regards matter and spirit as distinct principles is a species of dualism, as opposed to materialism.

In Theology, the doctrine of the two sovereign principles of good and evil (*see* MANICHEISM) is also dualistic; and the high Calvinistic theory may be said to be a species of dualism, viz. that all mankind are divided, in the eternal foreknowledge of God, and by his arbitrary decree, into two classes, — tne elect and reprobate.

DU'AL NUMBER, in Grammar, is the name given to that form of the verb and substantive by which, in the ancient Greek, Sanscrit, and Gothic, and the modern Lithuanian languages, *two* persons or things are denoted, in contradistinction to *plural*, which expresses an indefinite number of persons or things. For full discussions on the nature and peculiarity of the dual number, see *Buttmann and Matthäi's Greek Grammar*; see also the *Penny Cyclop.*, and the authorities there referred to.

DU'BBING OUT. A term used by plasterers to signify the bringing of an uneven surface to a plane by pieces of tiles, slate, plaster, or the like.

DUCAT, DUCATOON. *See* MONEY.

DUCK. *See* ANAS.

DUCKBILL. *See* ORNITHORHYNCHUS

DUCTI'LITY. (Lat. duco, *I draw*.) A property of certain bodies, in consequence of which they can be *drawn out* at length without suffering any interruption of the continuity of their constituent particles. The term ductility is frequently confounded with malleability, or that property of bodies through which different forms can be given to them by pressure or percussion. In general ductility depends, in a greater or less degree, on the temperature. Some bodies, wax for example, are rendered ductile by a small degree of heat; while glass requires a violent heat before it acquires ductility. Some of the metals — for example, gold, silver, lead, &c. — are ductile under all known temperatures.

"The ductility of some metals far exceeds that of any other substance. The goldbeaters begin their operations with a riband an inch broad and 150 inches long, which had been reduced, by passing it through rollers, to about the 800th part of an inch in thickness. The riband is cut into squares, which are disposed between leaves of vellum, and beat by a heavy hammer till they acquire a breadth of about three inches, and are thus extended to ten times their former surface. These are again quar-

tered, and placed between the folds of goldbeaters' skin, and stretched out by the operation of a lighter hammer to the breadth of five inches. The same process is repeated, sometimes more than once, by a succession of lighter hammers; so that 376 grains of gold are thus finally extended into 2000 leaves of 3·3 inches square, making in all 80 books, containing each of them 25 leaves. The metal is consequently reduced to the thinness of the 282,000th part of an inch, and every leaf weighs rather less than the fifth part of a grain. A particle of gold, not exceeding the 500,000th part of a grain, is hence distinctly visible to the naked eye."

"It has been asserted that wires of pure gold can be drawn of only the 4000th part of an inch in diameter; but Dr. Wollaston, by an ingenious procedure, has lately advanced much farther. Taking a short cylinder of silver, about the third part of an inch in diameter, he drilled a fine hole through its axis, and inserted a wire of platinum only the 100th part of an inch thick. This silver mould was now drawn through the successive holes of a steel plate, till its diameter was brought to near the 1500th part of an inch; and consequently the internal wire, being diminished in the same proportion, was reduced to between the 4000th and 5000th part of an inch. The compound wire was then dipped in warm nitric acid, which dissolved the silver, and left untouched its core, or the wire of platinum. By passing the incrusted platinum through a greater number of holes wires still finer were obtained, some of them only the 30,000th part of an inch in diameter. The tenacity of the metal, before reaching this limit, was even considerable; a platinum wire, of the 18,000th part of an inch in diameter, supporting the weight of a grain and a third." (*Leslie's Elements of Nat. Philosophy.*)

Glass, when well softened by the fire, becomes as ductile as soft wax, and may be spun out into threads of greater fineness than any hair, and which bend and wave like hair in the wind. The method of producing these threads is exceedingly easy. Two workmen are employed; the first holds the glass over the flame of a lamp; the second applies a hook to the metal in fusion, which, when drawn back, brings with it a thread of glass, still adhering to the mass; the hook is then fitted on the circumference of a wheel, which, being turned round, draws out the thread, and winds it about its rim. Some of these threads are scarcely larger than that of a silkworm, and are surprisingly flexible.

DUCTS. Those membranous tubes in the internal anatomy of plants which have conical or rounded extremities; their sides being marked with transverse lines, or rings, bars, or dots, arranged spirally, and being incapable of unrolling.

DU'EL (Lat. duellum, *a conflict between two individuals;* in the original use of the Roman word, *between two states*), signified originally a trial by battle resorted to by two persons as a means of determining the guilt or innocence of a person charged with a crime, or of adjudicating a disputed right; but in more modern times it is used to signify a hostile meeting between two persons, arising from an affront given by one to the other, and for the purpose (as is said) of affording *satisfaction* to the person affronted.

The practice of the duel, as a private mode, recognized only by custom, of deciding private differences, seems to be of comparatively recent date, and descends by no very direct transmission from the ancient appeal to the judicial combat as a final judgment in legal disputes. That it originated with the feudal system is abundantly clear, if it were only from the fact that in Russia, where that system was never known, the custom of the duel was unheard of, until introduced by foreign officers even within the memory of the present generation. But it is certain that many antiquarian writers have confused together two very different institutions: the *appeal to arms*, as an alternative for the trial by ordeal or by compurgators, appointed by traditionary usage from the earliest periods of Germanic history; and the *voluntary challenge or defiance*, resorted to for the purpose of clearing disputes involving the honour of gentlemen. This last custom was first elevated to the dignity of an established institution by Philip le Bel of France, whose edict regulating the public combat between nobles bears the date of 1308: the best comment on which may be found in the spirited and accurate representation, by Shakspeare, of the quarrel between Mowbray and Bolingbroke.

The duello, in this its high and palmy state, when favoured by princes and tolerated by the church, became the subject of many fantastic regulations, partly framed on the imaginary code of chivalry, and partly on the precepts of the civil law. Thus, in a curious treatise on this subject by Dario Attendoli, an officer of the Italian wars (printed in 1565), we find it laid down that not less than twenty days must elapse between the receipt of a cartel or challenge and the answer; because such was the time required to elapse, in civil suits, between the plaintiff's charge and the defendant's first pleading. Three, four, or five months must then be allowed to the champions for preparation. The combat must take place in lists, and under the eyes of the sovereign authority of the city selected by the challenger. The strictest equality of rank must be observed between the parties; a rule which appears to have been tolerably well attended to, and must have saved the shedding of much unnecessary blood. But, while every precaution was taken to render such duels not easily to be engaged in on light grounds, it was part of the same code that they should be carried through in serious earnest. In another curious Italian book of problems concerning the duel (of the same date), the question is put, "Whether a prince will do well or ill in separating two champions, when both shall be so weakened by loss of blood as to appear unable to continue the combat?" and resolved in the negative. And if the vanquished had his life spared him, he was bound to consider himself the prisoner of his conqueror, and devoted to his service, until released by death or by positive permission; although Attendoli intimates that, in his opinion, the limitation of thirty years, according to the maxims of the civil law, ought to apply to this servitude.

The particular regulations of these Italian laws of honour are of the most curious and pedantic minuteness. Attendoli has favoured us with several common precedents of challenges and answers. The commencement of the cartel, "per injuria di fatti," for injury in deeds, runs as follows: — "I, M., having been by thee, N., enormously beaten with a stick (superchievolmente con un bastone percosso) at Rome, on the —— ultimo, after an evil fashion, from behind, I not being aware of thee, and in time of peace, say to thee that thou hast done basely and wickedly, and as a traitor and vile cavalier." To this cartel are appended the signatures of four witnesses, who affirm themselves to have been present at the administering of the bastinado. The cartel was to be publicly placarded in the streets; as was also the answer, or, if the adversary declined the combat, a statement of his refusal. In this latter case, it was debated whether it were not allowable to hang up a likeness of the person declining to fight; but this singular species of posting, although we are told it was not uncommon, is reprobated as unbecoming a gentleman. The distinctions as to persons are not less amusing. (See *e.g.* question 3d of the Book of Problems in the treatise of Attendoli above referred to.)

The fashion of the public duel seems never to have prevailed to any extent in England. Although the ancient Judicium Dei was so interwoven with our laws that, at a comparatively late era, the whole court of Common Pleas would occasionally adjourn in full term to Smithfield or Bankside, to see the long-contested intricacies of a "writ of right" brought fairly to issue in a match at singlestick; yet the stern necessity of washing out affronts in blood, whether in open or private quarrel, does not seem to have been strictly adhered to until the latter part of the reign of Queen Elizabeth. Then the the imaginations of the young nobles of the court, heated with the favourite study of chivalry, readily adopted the sanguinary practice of foreign realms. At this period appeared the famous *Treatise of Honour* of Vincentio Saviolo — a fierce and punctilious Italian, a fencing master by profession, bred in the wars of Italy, and deeply versed in the science of the public duello, then a favourite theme of reminiscence, although no longer known in practice, as will be presently shown. This little work, published in 1594, — now little known to us, save by the famous quarrel in Shakespeare's *As You Like It*, concerning the cut of the courtier's beard, which seems intended as a parody on some parts of it, — appears to have been adopted by the gallants of the time as a standing book of reference in all cases of supposed insult. Saviolo resolves all quarrels into the lie, — that is, he supposes the original insult to be followed, either expressly or impliedly, by a regular series of replies and retorts, until one or the other party is reduced to give the lie direct; which, like the phrase "stupid youth" (*dummer junge*), in some German universities, was immediately followed by the appeal to arms.

> That ordinary commotioner the lie,
> The father of most quarrels in this climate,

appears to have been raised to this "bad eminence" by Francis the First, the great guide of his day in matters of chivalry, who first gave it as his opinion, that the lie could under no circumstances be brooked by a man of honour. Attendoli holds that the virtue of the insult lies mainly in the word lie; and that any circumlocution, however plain, greatly deprives it of its effect. This, however, Saviolo stoutly denies; and maintains that an imputation on the veracity of a party, in whatever words it may be couched, is equally deserving of resentment. The lie, being a matter of so great importance, became the subject of much nice distinction; insomuch that a note to *Dr. Moore's Essay on Duelling* informs us, that they enumerated thirty-two different ways of giving the

lie in the latter part of the sixteenth century. Saviolo, however, contents himself with the division into the lie direct and lie circumstantial; each of which he subdivides into general and special; besides a fifth sort, which he calls "fictitious" or "sham" lies. These, he says, seem to have originated from the custom that he who receives the lie direct, or last retort, being of necessity the challenger, has the choice of weapons; to gain which advantage it was not unusual for one who sought a quarrel to address his enemy with, "If you say I am a scoundrel, you are a liar;" by which means they supposed that the latter was put to the necessity of making a direct reply. In opposition to this notion, Vincentio shows divers honourable devices by which an ingenious duellist, when assailed in this manner, may retort on his adversary, so as to throw the burden of the last word on him. Paris de Puteo, a Neapolitan lawyer, is said to have practised chiefly in this branch of business, and to have answered cases on the point of honour put to him from all parts of Europe.

Yet, however extravagant the foolery of these early writers may seem on a matter of such serious nature, it must be confessed that, retaining as they did much of the old opinion, refined into a sentiment, respecting the immediate interposition of God in the judicial combat, the true point of honour was far safer in their hands than in the less scrupulous ones of the professed duellists of modern times. Saviolo does not hesitate earnestly to inculcate on his pupil the duty of maintaining no cause except that which he seriously believes to be just and true, and of submitting to any humiliation rather than fight in defence of a falsehood. A fine, although somewhat extravagant illustration of this chivalric principle, may be found in the old play of *A Fair Quarrel*, by Middleton and Rowley. Captain Ager, the hero of the piece, is saluted by his colonel on the occasion of some dispute with the appellation of "son of a whore." A challenge follows, and time and place are fixed; but the captain cannot satisfy his conscientious honour without repairing to his mother, and acquainting her, although indirectly, with the provocation he has received. She, suspecting his meaning, and fearing for his life, in a moment of weakness falsely intimates the imputation to be a true one. The captain's mind is instantly made up—he will not fight in a bad quarrel; but, for his mother's sake, he will not divulge the reason. His two seconds arrive, and he hears, with seeming equanimity, their expostulations, and at last their insults, declaring that although he is ready to follow them to the field, he will not fight a stroke. But, being branded on that account by his adversary with the epithet "coward," he thankfully seizes on the opportunity afforded him by this fresh insult; draws in "a fair quarrel," and overthrows his opponent.

In 1547, Henry II. of France issued an edict absolutely prohibiting the judicial or public combat. This decree was produced by the death of his favourite, La Chataigneraye, in consequence of wounds received in the lists in the presence of Henry himself. By a curious coincidence, the abolisher of one of the grand institutions of the feudal ages was destined, in his own person, to be the cause of the disuse of another: he was slain in a tournament, and that knightly exercise was no longer practised at courts after that melancholy event. The public duel survived some time longer in Italy, as may be seen by the dates of the treatises quoted above. Its abolition in France was by no means followed by the good effects which the statesmen of those days probably anticipated from it. Debarred from public conflict, the gentlemen of France were at the same time freed from its manifold restraints; and private duels, conducted with a ferocity and sanguinary spirit hitherto unheard of, became prevalent to the most astonishing degree. The wars of religion, prosecuted with a degree of bitterness perhaps unexampled in the history of any nation, added public causes of dispute to those of an hereditary and personal nature. Even the ordinary laws of honour, which seem inseparable from the practice, were neglected. We find in Brantome, that there were duellists who prided themselves on the advantages which they had taken of their antagonists, and were not esteemed the less in society for having done so. Not only had individuals and families their quarrels; we are told that there were regiments in the same service, of which the officers were bound to fight one another whenever they met. The duellist seems to have usurped, with the fair sex, the attentions usually paid to the soldier. We have the testimony of Lord Herbert of Cherbury, himself a vain and cold-blooded quarreller, for the honour in which the ladies of France held the brave Balagny—an ordinary man, in a threadbare doublet and grey breeches, with neither figure, wit, nor fortune to recommend him; but whose testimonials consisted in the fact of his having killed eight or nine of his friends in single combat.

It was about the reign of Henry III. also, that the sanguinary custom of the seconds taking part in the quarrel of their principals seems first to have become established, a custom which only gradually wore out in the beginning of the last century. When such bloody practices were rife in all parts of France, we are scarcely tempted to doubt the extraordinary assertions we find in the writers of those days,—that one hundred and twenty gentlemen were killed in duels, in a single French province, in six months; that in the reign of Henry IV. four thousand fell in two years; that this strange species of mania cost France more gentle blood than thirty years of civil war. Henry IV. issued edicts against duelling; Louis XIII. proceeded against it at one time with such severity, that we are told that wounded duellists were dragged at once from the field to the gibbet; but this unwarrantable violence, as usual in such cases, had no effect. The evil at length produced a remedy by its own excess. In the minority of Louis XIV. the Duke de Nemours, a prince of the blood, fell, with two of his four seconds, in a quarrel with another grandee of the court. After this deplorable event, many noblemen and gentlemen of undoubted courage entered into a voluntary compact to abstain from duelling. Louis XIV., when of age, approved of their resolution, and seconded it by several edicts. To the honour of this prince, it should be remembered that during the whole of his life he laboured firmly and temperately to correct this abuse, and with no ordinary success. This he effected, not merely by the force of laws, but by exhibiting in his own demeanour, and encouraging in his courtiers, that mixture of dignity with gentleness which most readily turns away wrath and repels insolent familiarity. One of his expedients, however, it must be admitted, seems to our modern ideas not very likely to attain the object proposed. This was the establishment of a court of chivalry,—the members of which were the marshals of France,—which was to decide on all questions in which a gentleman might conceive his honour to be involved. It is said that this singular sort of arbitration was at first very efficacious; although in Mercier's time (the reign of Louis XVI.) he tells us (as we might naturally suppose) that a person who should have resorted to the court to redress an insult would only have incurred ridicule, in addition to the disgrace of not personally resenting it. Various laws relating to the duel have been since made in France, but have fallen into disuse for the most part. Whether slaying in a duel be murder, is a point on which there has been a continual conflict between the courts of cassation and the royal courts since 1817, when it was raised in the case of De Poligny and Rosay. But the legal question is of comparatively small importance, from the licence assumed by juries in that country. A civil action lies on behalf of the friends of the slain man.

In England, the first attempt made to introduce legislative enactments in aid of the common law for repressing of duels is said to have taken place in 1713; when, after the celebrated duel of Duke Hamilton and Lord Mohun, a bill for that purpose was brought into the Commons, but lost on the third reading. A provocation or challenge to fight is a high misdemeanor. In Scotland, as late (we believe) as the middle of the 16th century, licences for duelling were granted by the crown, and formed a source of revenue: death in a duel without licence was murder. (See *Pitcairn's Criminal Trials*.) The new codes of Bavaria and Prussia contain a number of provisions, with perhaps too much minuteness of distinction, against duels, challenges, &c. The common punishment is imprisonment for a shorter or longer term.

See as to duels, in addition to former works on the subject, *Fougeroux de Campigneulles, Histoire des Duels*, 3 vols. 8vo. 1834; in which most authorities are collected, although it is a compilation including many anecdotes, &c. of no authenticity. For modern legislation on the subject, the article "Duel," in *Ersch and Gruber's Encyclopædia*, may be consulted with advantage.

DUE'NNA. (Span. dueña.) The chief lady in waiting on the queen of Spain. In a more general sense, it is applied to a person holding a middle station between a governess and companion, and appointed to take charge of the junior female members of Spanish and Portuguese families.

DUE'T. (Lat. duo, *two*.) A piece of music composed for two performers, either vocal or instrumental.

DUGO'NG, or DUYONG. The name of a herbivorous cetaceous animal, characterized by two large permanent incisive tusks in the upper jaw, and four molar teeth above and below, the grinding surface of which exhibits a rim of cementum surrounding a slight excavated centre of ivory. The upper lip is beset with numerous strong bristles, and similar ones are found more sparingly scattered over the body. The anterior extremities are fin-like, and without nails. The caudal fin is broad, and of a crescentic figure. One species (*Halicore Indicus*, Cuv.) inhabits the seas of the Indian Archipelago. A second dugong has been recently discovered in the Red Sea (*Halicore tabernaculi*, Ruppel), but which is at most only a variety of the preceding. The fabled mermaid seems to have been founded on the dugong.

DUKE. (From the Latin dux, *leader or commander*.)

The title of Duke is said to have originated in the usages of the Lower Empire, where it was given to the military governors of provinces. From thence it was borrowed by the Franks, who adopted, in many respects, the titles and distinctions of the empire. Charlemagne is said to have suffered it to become obsolete, but the emperor Louis created a duke of Thuringia in 847. In course of time, according to the usual progress of feudal dignities, the title became hereditary. In Germany the dukes became the chief princes of the empire; this title being proper to all the secular electors, and to most of the greater feudatories. In other countries their dignity became merely titular. In Italy and France dukes form the second rank in the nobility, being inferior to princes: in England they form the first. The title was not known in the latter country until the reign of Edward III.; and the word dux is used by writers before that period as synonymous with count or earl. In the eleventh year of the latter monarch the dignity of Duke of Cornwall was bestowed on his eldest son, Edward the Black Prince. In the year 1351, his third son, John of Gaunt, Earl of Lancaster, was created Duke of Lancaster for life, furnishing the next instance of this dignity. In neither of these instances, nor in any subsequent one, according to Sir H. Nicolas (*Introduction to the Peerage*, vol. i. p. lxxvii.), was the dignity thus created a dukedom by tenure: it has always remained a personal title only, and descendible according to the limitations of the charter.

DULCAMA'RA. (Lat. dulcis, *sweet*, and amarus, *bitter*.) The common woody nightshade, the stalk of which is used in medicine to furnish a decoction which is somewhat narcotic and diuretic, and has a very peculiar bitter-sweet flavour. It has been recommended in chronic rheumatism, and as an alterative in some cutaneous cases, but is not much depended upon.

DU'LCIMER. (Etym. uncertain.) A musical instrument, of what description is unknown, but probably of the wind species, in use among the Jews.

DU'MBNESS. (*Aphonia* of medical writers; from α, privative, and φωνη, *voice*.) This term is generally applied to persons who are either born deaf, or become so in early infancy; the consequence of which is that the organs of speech have never been called into due action, their functions being at first imitative in respect to sounds, and the numerous muscles of the tongue, glottis, &c. concerned in speech remain inactive; for persons who even in very early life become deaf are not rendered dumb, the organs of speech having been once called into activity, and having acquired their peculiar powers and consentaneous actions. Dumbness may also arise from injury to the lingual nerves, or from great general or local debility; in which case blisters, stimulants, tonics, and other remedies may be resorted to for the restoration of speech. It is remarkable that the loss of the tongue, and even of part of the palate, does not necessarily occasion dumbness: this has happened from disease, and among barbarous nations the tongue was occasionally extirpated; yet cases are on record showing that even under such circumstances speech was more or less perfectly retained; and there is an account in the *Memoires de l'Academie des Sciences* for 1718 of a girl who was born without a tongue, and yet acquired the faculty of speech. The case of Margaret Cutting, related in the *Philosophical Transactions* (1742) by Dr. Parsons, may also be consulted in reference to this subject.

DU'MUS. In Botany, a low and much-branched shrub.

DUNES. (Ang. Sax. *low hills*.) Hills of moveable sand, which are met with along the sea coast in various parts of Great Britain, Ireland, and the Continent. The mode of their formation and progress is exceedingly curious. In various districts the sea deposits on the beach a quantity of fine sand, which is carried forward by the wind till it meets with some obstruction in the shape of large stones, roots of trees, or other obstacles, when it gradually accumulates into mounds or hillocks, "whose general appearance, size, and distribution depend on those of the obstacles to which they owe their existence." When these mounds have attained a certain elevation they are urged forward upon the land; for, as Cuvier observes, "le même vent qui éleve le sable du rivage sur la dune jette celui du sommet de la dune à son revers opposé." The direction which they take depends chiefly on that of the wind; and their inroads upon the land are attended by the most destructive effects. One of the departments of France, the Landes, has been nearly overwhelmed by their progressive advance. The quantity of moveable sand which the sea annually deposits on that coast has been estimated at upwards of 3,000,000 square feet, and its annual progress inland at about 72 feet. In that department the dunes advance in a north-easterly direction; and it has been calculated, with apparently sufficient exactness, that unless their progress be arrested, they will have reached Bordeaux in 1500 years. During the violent hurricanes which frequently occur in these regions, the whole mass of sand of which the dunes are composed appears to be in agitation; and such is the rapidity with which they then advance, that entire villages, fields, and gardens are almost instantaneously engulphed, and the aspect of whole districts changed within four and twenty hours. The progress of the dunes, however, as already remarked, is in general slow and steady. Thus the town of Mimizan, after struggling for more than the fourth part of a century against their encroachments, is now almost buried beneath them; and such have been their destructive effects upon a village of Britanny, that nothing is visible of it except a small part of the church steeple. As will be easily imagined, the means of arresting the progress of the dunes forms a most interesting and important inquiry. For this purpose various measures have been recommended; but by far the most efficient means hitherto adopted consists in planting close together, so as to form, as it were, a line of defence against the sand, such trees and shrubs as are known to thrive in a barren soil. This process, wherever it has been tried, has been found not only to fix the dunes, but at the same time to form a simple and secure barrier against all further encroachment of the sand.

DU'NKERS. A Christian sect, which formed itself into a society under peculiar rules in Pennsylvania in the year 1724. The origin of their name is unknown. They practise abstinence and mortification, under the idea that such austerities are meritorious in the sight of God, and effective, first in procuring their own salvation, and further in contributing to that of others. They form a society strictly connected within itself, and hold love feasts in which all assemble together; but their devotions and ordinary business are carried on in private, nor do they recognize a community of goods. They also deny the eternity of future punishments; conceiving that there are periods of purgation, determined by the sabbath, sabbatical year, and year of jubilee, which are typical of them.

DU'NNAGE. Any light or loose material, as wool, &c., used as a bed in the stowage of heavy articles.

DUODE'CIMAL. (Lat. duodecim, *twelve*.) Proceeding by twelves. The term is given to a rule or operation of arithmetic, by which the contents of any surface or solid are found by multiplying together its linear dimensions, expressed in feet, inches, and lines, and is consequently much used by artificers in finding the contents of their work. The rule is also called cross multiplication, from the manner in which the operation is usually performed, and which is as follows: Suppose it were required to find the superficial content of a plank 12 feet 9½ inches long, and 3 feet 7 inches broad. Set down the two dimensions under each other, placing feet under feet, inches under inches, &c., and for the half inch put down its equivalent 6 lines, as in the following example: —

$$\begin{array}{rrr}
12 & 9 & 6 \\
3 & 7 & \\
\hline
38 & 4 & 6 \\
7 & 5 & 6\frac{1}{2} \\
\hline
45 & 10 & 0\frac{1}{2} \\
 & 12 & \\
\hline
 & 120\frac{1}{2} &
\end{array}$$

Now, since the feet are conceived to be units of measure, the inches are so many 12ths of unity, and the lines so many 12ths of a 12th, or 144th parts of unity. The units consequently form the first column, the 12ths the second, and the 144ths the third. Multiplying therefore the first line by 3 feet or 3 units, we get 38 feet, 4-12ths of a foot, and 6-144ths of a foot. Next, multiplying the upper line by 7-12ths, we get first the 6 lines or 6-144ths, multiplied by 7-12ths, equal to 42-1728ths, which is equal to 3½-144ths. Then the 9-12ths multiplied by the 7-12ths give 63-144ths, which added to the 3½ make 66½-144ths, or 5-12ths and 6½-144ths; therefore 6½ is placed in the third column, and the 5-12ths carried on. Lastly, the 12 units multiplied by the 7-12ths give 84-12ths, which added to the 5-12ths make 89-12ths, and this is equal to 7 units or feet and 5-12ths; consequently 7 is placed in the first column and 5 in the second. Adding the two products together, we get 45 feet, 10-12ths of a foot, and ½-144ths of a foot. But in square or superficial measure the 144th part of a foot is an inch; and 10-12ths = 120-144ths; consequently the result of the operation is 45 sq. feet and 120½ sq. inches.

The operation is itself much simpler than the description or explanation, which is found embarrassing to beginners; it would therefore, perhaps, be better to reject the rule altogether from elementary books of arithmetic; and, regarding the inches and lines as parts of a foot, to perform the operation by the ordinary rule of *practice*.

DUODE'CIMO. (Lat.) A book is said to be in *duodecimo* (abbreviated 12mo.), when every sheet being six times folded makes twelve leaves or twenty-four pages.

DUODE'NUM. (From duodenus, *consisting of twelve*.) The commencement of the intestinal canal, forming a division, which in some animals is about as long as the breadth of twelve fingers. This term, introduced by the older anatomists, is still applied to that portion of the intestines, though the measure is generally inapplicable.

DU'PLICATE RATIO, is the ratio of the squares of two quantities, or the square of their ratio. Thus the ratio

of a^2 to b^2 is the duplicate of the ratio of a to b. If there be three quantities in continued proportion, the first is to the third in the duplicate ratio of the first to the second: — thus if a, b, c be continual proportionals, that is, if $a : b :: b : c$, then a is to c in the duplicate ratio of a to b.

DUPLICA'TION OF THE CUBE. A celebrated problem of the ancient geometry. While a plague was desolating Athens, a deputation was sent to consult the oracle of Apollo at Delos, who returned for answer that the plague would cease when they had doubled the altar of the god. The altar was cubical, consequently the problem was to find the side of another cube of twice the solid contents. As this problem requires the solution of a cubic equation, it cannot be solved by plane geometry; but Hippocrates of Chios reduced it to another; namely, the insertion of two mean proportionals between two given straight lines, a problem which several of the ancient geometers, particularly Archimedes, Eutocius, Pappus, and Nicodemes, discovered methods of constructing by means of the higher curves. Among the modern geometers who have not disdained the same inquiry, are the illustrious names of Newton and Huygens. See *Montucla, Histoire des Mathematiques*.

DU'PPER, or DUBBER. A globular short-necked vessel made of buffalo's hide, in which castor oil is imported from India. Each dupper holds about 80 lbs. of oil.

DU'RA MATER. A thick membrane enveloping the brain and adhering to the inner surface of the cranium. *See* BRAIN.

DURA'MEN. (Lat.) The fully formed central layers of the wood of Exogenous trees; what is called in common language the heart wood. It is only the sapwood solidified by the introduction of various secretions into the interior of the cells or tubes of which such wood is composed.

DU'RESS (Lat. duritas, *hardship*), in Law, is such constraint, either actual or by threats occasioning a reasonable fear, as will invalidate legal acts done by a party suffering it. Duress of imprisonment must be by illegal imprisonment. Duress per minas, by threats, is interpreted to mean such threats as occasion fear of life or limb.

DUTCH GOLD. Copper, brass, and bronze leaf is known under this name in commerce; it is largely used in Holland for ornamenting toys and paper.

DUTCH SCHOOL. In Painting, this school, generally speaking, is founded on a faithful representation of nature, without attention to selection or refinement. The ideas are usually low, and the figures local and vulgar. Its merit lies in colouring and drawing with extreme fidelity what was before the eye of the artist. The pothouse, the workshop, or the drunken revels of unintellectual boors, seem to have furnished its principal subjects. The great appearance of reality infused into its productions induced Hagedora to call it the School of Truth. Notwithstanding its deficiency in all that tends to raise the mind, it has gained an unspeakable lustre from its great head, Rembrandt van Rhyn, to whose name may be added those of De Leide, Heemskirk, Polemburg, Wouvermans (an exception to our general observations), Gerard Dow, Mieris, and Vandevelde, &c.

DUU'MVIRI. A general appellation, among the ancient Romans, given to any magistrates elected in pairs to perform any function or class of functions. The chief Duumviri were the Duumviri Sacrorum, to whom were entrusted the care and the interpretation of the Sibylline books. The Duumviri Municipales had almost consular power in the municipal cities. The Duumviri Navales were officers appointed to man, equip, and command the Roman navy.

DWA'RFING TREES. Dwarf trees may be produced in three different ways: by grafting on dwarf slow-growing stocks, as, for example, the pear on the quince; by planting in pots of small size filled with poor soil, by which the plant is starved and stunted; and by causing a portion of the extremity of a branch to produce roots, and then cutting it off and planting it in a pot or box of poor soil. This last is the Chinese method, and is thus performed: — The extremity of a branch two or three feet in length, in a fruit or flower-bearing state — for example, the points of the branches of a fir tree bearing cones, or of an elm bearing blossom buds — being fixed on, a ring of bark is taken off at the point where it is desired that the roots should be produced. The space thus laid bare is covered with a ball of moist clay, which is kept moist by being covered with moss, which is occasionally watered. In the course of two or three months in some trees, and of a year or two in others, roots are protruded into the ball of clay. The branch may then be cut off below the part from whence the roots have been protruded, and the branch being planted in a pot of poor soil, and kept sparingly supplied with water, it will remain nearly in its present state for many years; producing leaves, and perhaps flowers, annually, but never shoots longer than a few lines.

DWARF WALL. (Sax. ðpeorh.) In Architecture, a low wall, not so high as the story of a building in which it is used.

DY'EING. The object of this beautiful art is to fix certain colouring matters uniformly and permanently in the fibres of wool, silk, linen, cotton, and other substances. There are a few dyeing materials which impart their colour to different stuffs without any previous preparation, and these have been technically termed *substantive colours;* by far the greater number, however, of colouring materials, only impart a fugitive tint under such circumstances, and require that the stuff to be dyed should undergo some previous preparation, in order to render the colour permanent; that is, capable of resisting the action of air, light, and water. The substance applied with this intention is called a *base* or *mordant*, and must posesss an affinity for the fibre of the stuff on the one hand, and for the colouring materials on the other. The mordant often effects another important object; that of changing or exalting the colour at the same time that it fixes it. The principal mordants are aluminous earth and oxide of iron, and these are usually applied in the state of acetates. As an instance, we may mention the mode of dyeing calico red by means of *madder*, a decoction of which, if applied to the unprepared goods, would only give them a dirty red tinge, neither agreeable nor permanent. If the calico be previously passed through a weak solution of acetate of alumina, and then dried at a high temperature, and afterwards washed, a portion of the alumina is retained in chemical combination with the fibre of the calico; and when thus prepared and submitted to the action of a hot decoction of madder, and again washed, it comes out of a fine red, which is fixed in consequence of the attraction of the alumina for the peculiar principle which gives colour to the madder. If the mordant be oxide of iron instead of alumina, the colour which is then produced is purple; and various shades and colours are obtained by mixing mordants, by using more or less of them, and by applying the coloured solutions in various states of concentration. Sometimes articles are dyed by a similar precipitation of coloured metallic oxides in the fibre; thus yellow is obtained by passing cloth impregnated with acetate of lead through a solution of chromate of potash: a double decomposition ensues, and yellow chromate of lead is precipitated in and combined with the vegetable or animal fibre. Blues are produced by passing the goods previously mordanted with iron through an acidulated solution of ferrocyanate of potash; these are generally called *chemical colours*, though not in fact more so than the others. Scarlet is exclusively produced by the colouring matter either of the cochineal or of the lac insect, which is fixed by oxide of tin, or by alumina, and heightened by the action of tartar.

The chemical principles of the art of *calico printing* are the same as those of dyeing, but the details are more difficult and complicated; and in consequence of the combination of a great variety of colours upon the same ground, the process is sometimes extremely refined and intricate; so that a rich, varied, and pleasing pattern, thus effectively produced, may be considered as a triumph of practical skill over theoretical difficulties, which is scarcely rivalled, and certainly not excelled, in any other of the arts. It is obvious that calico printing is in the abstract a topical dyeing; and much discrimination and taste are requisite in the contrivance of the pattern, its general design, and the colours in which it is exhibited. In this art the mordants, and sometimes the colours, are applied either by *blocks*, upon which the pattern is designed in relief, or by *copper plates*, which are engraved, or by *cylinders* or rollers. If the aluminous mordant be printed by one block and the iron mordant by another, and a mixture of the two by a third, and the piece thus prepared be then passed through a madder bath, and properly cleansed and bleached, the colour will only adhere to the mordanted places, and it will be red where the aluminous earth only has been applied, purple with the mixed mordant, and black with the iron; if the same three mordants be used with a decoction of quercitron bark, the resulting colours will be yellow, olive, and brown; and in this way a great variety of colours may be produced. Sometimes copperplate and block printing are combined; a fine running pattern being printed by the plate or cylinder over the whole surface, which serves as a groundwork, and upon which other figures are printed by blocks. Sometimes the mordant and colour are both applied at once by means of a block, and rendered fixed and permanent by exposing the goods for some time to steam. Some beautiful effects are also produced by printing the pattern upon a mordanted ground with some substance which will *resist* the colour, and so produce a white pattern upon a coloured ground. The same effect is sometimes brought about by *discharging* the colour by the topical application of certain bleaching materials.

DYKE, or DIKE. When a mass of unstratified or igneous rock, such as granite, trap, or lava, appears as if injected into rents and fissures in the stratified rock, so as to intersect the strata, it is called a *dyke*. *Dyke* is also the name given to a mound of earth, stones, or other materials, intended to prevent low land from being inundated by the sea, &c.; as the dykes of Holland.

DYNA'MICS (Gr. δυναμις, *force or power*), signifies literally the doctrine of force or power; but as force or power is known to us in no other way than by its effect, that is, by the *motion* which it produces in the body on which it acts, and is measured by that motion, dynamics may be defined to be the science which treats of the motion of bodies. It is, however, usually restricted to those circumstances of motion in which the moving bodies are at liberty to obey the impulses communicated to them; the opposite cases, or those in which the bodies, whether by external circumstances, or by their connection with one another, are not at liberty to obey the impulses given, being comprehended in the science of *mechanics*. Thus, the motion of a stone falling freely to the ground, or of a celestial body in its orbit, belongs to dynamics; while that of a body descending an inclined plane would properly belong to mechanics.

The theory of varied motions, and of the accelerating forces which produce them, is founded on two general laws: 1st, That all motion impressed on a body is by its nature uniform and rectilinear; and 2nd, That different motions impressed either simultaneously or successively on the same body, are compounded in such a manner that the body is found at every instant in the same point of space in which it would have been found in consequence of the combination of the motions had they existed separately. Thus, if a body be acted on by two forces at the same instant, one of which acting alone would cause it to move uniformly over A B, and the other acting alone would cause it to move over A C at right angles to A B in the same time; the velocity of the body in the one of these directions will not be changed by the force impelling it in the other. With regard to the first of these laws, it is evident that a body in motion, not subjected to the action of any new force, will continue to move in the prolongation of the straight line in which it moves at any given instant, since there is no reason why it should deviate from its rectilinear direction rather to one side than the other; but the uniformity of its motion cannot be asserted *à priori*: it is only by induction and experience that we come to be persuaded that the velocity with which any body is impressed will not diminish of itself, nor the body finally come to rest unless it is impeded by some external causes. The second law, which involves the theory of the *composition of forces*, has been demonstrated by several mathematicians, particularly Daniel Bernoulli, D'Alembert, Laplace in the *Mécanique Céleste*, and Poisson in his excellent *Traité de Mécanique*; but all these demonstrations are too difficult to be accounted elementary.

The science of dynamics is due entirely to the moderns, and its foundations were laid by the celebrated Galileo. Before him no one had considered the forces which act on bodies, excepting in the case of equilibrium; and although the acceleration of falling bodies, and the curvilinear motion of projectiles, had been attributed to the constant action of terrestrial gravity, no one had yet succeeded in determining the laws of these common phenomena. Galileo first made this important step in advance, and thereby opened a new and boundless field for the progress of mechanics. Huygens added to Galileo's theory of the acceleration of falling bodies the theories of the motion of pendulums and of centrifugal forces, and thus prepared the way for the great discovery of universal gravitation. In the hands of Newton mechanics became a new science; and the discovery of the infinitesimal calculus at length enabled geometers to express all the laws and circumstances of the motion of bodies by analytical equations. The investigation of the forces which produce the phenomena of the material world, or of the mutual action of the different parts of matter on each other, now form indeed the principal object of mathematical studies. The best systematic treatises on Dynamics are to be found in *Lagrange's Mécanique Analytique*, and *Poisson's Traité de Mécanique*. Of late years several valuable elementary treatises have appeared in our own language. See FORCE, MECHANICS, MOTION.

DYNAMOMETER. (Gr. δυναμις, *power*, and μετρον, *measure*.) An instrument for measuring power of any kind, as the strength of men and animals, the force of machinery, the magnifying power of a telescope, &c. An instrument for measuring animal force was invented by Mr. Graham many years ago, and afterwards improved by Desaguliers; but as it consisted of wooden works, it was too heavy and bulky to be conveniently used for ordinary purposes. Leroy, of the Academy of Sciences of Paris, proposed a dynamometer, which consisted merely of a tube of metal of ten or twelve inches in length, placed vertically on a stand, and containing a spring in its interior, which indicated by its compression the amount of the force applied. This instrument was in fact the same in principle as the common spring balance.

The most convenient dynamometer is that of Regnier, which is described in Cahier 5. of the *Journal de l'Ecole Polytechnique*. It consists of an elliptical steel spring of about 12 inches in circumference, and the force is applied either by pressing the two vertices of the axis minor against each other, or by drawing in opposite directions the two ends of the axis major. In both cases the sides of the spring are made to approach each other; and thus they move an index which marks the degree of approximation on a semicircular scale. By means of this machine the mean force is ascertained which a man can exert with the right hand, or with the left, or with both together, and in various positions of his body. Some interesting results relating to the average strength of men at different ages, and of different weights and sizes, have been deduced by M. Quetelet of Brussels from numerous experiments with this dynamometer. See STRENGTH OF ANIMALS.

DYNA'STIDÆ. (Gr. δυναστης, *a master*.) A family of beetles, including the giants of the Coleopterous order. They are remarkably powerful insects, excavating burrows in the earth and in putrescent timber, upon the latter of which they principally feed.

DY'NASTY. (Gr. δυνάστεια, from δυνάστης, *a lord or chieftain*.) A race or family of sovereigns in succession.

DYSÆSTHE'SIA. (Gr. δυς, an adverb signifying in composition *badness* or *difficulty*, and αισθανομαι, *I feel*.) Impaired sense of touch.

DY'SENTERY. (Gr. δυς, and εντερα, *bowels*.) A disease of the bowels, endemic in many climates in the autumnal months, and frequently arising from marsh miasma, bad diet, exhaustion and fatigue: its symptoms are loss of appetite, sickness, pain about the bowels, and a frequent ineffectual desire to evacuate their contents, which when passed are mucous, fetid, and bloody, with small indurated lumps. It is often accompanied by intermittent and remittent fever, especially in hot and damp countries. In this country dysentery is generally a mild disorder, and not infectious; and is commonly cured by gentle aperients, such as castor oil, or salts and manna, to cleanse the bowels, and opiates to allay irritation. The chronic symptoms which remain are treated with mild tonics, especially vegetable bitters, such as infusion of calumba, angustura, or cascarilla. The contagious dysentery of camps, attended by remittent or typhoid fever, is an alarming and fatal disease; its treatment requires much consideration and skill, and consists in judiciously meeting the various symptoms as they arise. Aperients, diaphoretics, and nauseants, succeeded by tonics, are leading remedies; and the febrile symptoms must be treated according to their inflammatory or putrid tendency.

DYSPE'PSIA. (Gr. δυς, and πεπτω, *I digest or concoct*.) Indigestion. This is a complaint from which few entirely escape, which assumes an infinite variety of shapes and symptoms, and which arises from many causes. In the higher ranks of society, and amongst the luxurious and opulent, it is a common consequence of over eating, or of indulgence in difficultly digestible or over-stimulating food, or of want of due exercise and general bodily and mental exertion. In others it results from mental anxiety and labour associated with a sedentary life; from the fatigues of business, or the influence of debilitating passions. In the lower orders it is the constant result of indulgence in spirituous liquors, combined in many instances with want of proper food, the means which ought to be applied to procuring it being disposed of in the gin shop.

The symptoms of dyspepsia vary, therefore, in the different grades of life. The epicure loses his relish for the most refined dishes, becomes bloated, plethoric, heavy, and perhaps apoplectic; the lady of fashion suffers from headaches, flatulence, occasional giddiness, and dimness of sight; she becomes indolent, capricious, and full of fancies, or, as the old physicians used to say, she has the *vapours*; the studious man feels the intensity of his mind blunted, loses his appetite, or at least all enjoyment of meals, sleeps ill, and dreams much, gets whimsical and discontented with himself and his friends, and becomes a *hypochondriac*; the lower classes at first take their glass of gin or of rum because they find it a cheap stimulant, little thinking of the misery they are laying up for future years; this stimulant soon becomes habitual, and they not only feel miserable and heartbroken without it, but the single glass soon loses its efficacy, and the dose must be gradually increased till they degenerate into regular tipplers, the aspect and characters of whom it were needless to describe, as they may be daily and hourly studied in those hells of temptation and iniquity, the gin shops of London, — where it is curious and instructive, but humiliating and alarming, to witness the various grades of mental and bodily disease in the men, women, and even children, who there immolate to Satan.

Complicated as are the symptoms of dyspepsia, and numerous as are the remedies and modes of treatment proposed for its relief or cure, they really resolve themselves into a few simple rules. In the majority of cases, *abstinence* is the first and most essential step: the epicure must abstain from the luxuries of the table, eat and drink with moderation, rise betimes, and use due exercise; the woman of fashion must revert to regular hours, that is,

the night and the day must be employed as intended by nature, and not in inverted order; the philosopher and the scholar must occasionally, and often frequently and assiduously, divest themselves of their mental labours, and resort to amusements and occupations of a more trivial character. Those among the lower orders who have once acquired the habit of dram drinking are incurable; for such is the depression of mind and body, and such the gnawing restlessness that want of the accustomed stimulus occasions, that without it they become miserable and inconsolable, and usually fall a sacrifice to mental or bodily disease, or to both combined: here, therefore, prevention is the only cure. The medical treatment of dyspepsia generally resolves itself into that of such of its particular symptoms or consequences as are most prominent; the inactivity of the bowels is to be opposed by proper aperients properly administered; the debilitated stomach to be strengthened by mild tonics, antacids, and stimulants; the mental symptoms often yield to the same treatment, and often require local depletion, or diffusible stimulants, such as ammonia and ether; and lastly, change of air, of scene, and of occupation are often indispensable, under which head sea bathing and courses of mineral waters may be included. The above observations are of course inapplicable to all cases of dyspepsia resulting from structural disease, which, though often an effect, is also a frequent cause of symptoms of indigestion; indeed, such are the sympathies of the stomach that it is apt to be affected by any aberration from health.

DYSPHA'GIA. (Gr. δυς, and φαγω, *I eat.*) Difficulty of swallowing. Paralysis, stricture of the œsophagus, enlarged tonsils, relaxed uvula, a debilitated state of the muscular coat of the pharynx and œsophagus, spasm of the organs concerned in deglutition, inflammation, are among some of the leading causes which occasion difficulty of swallowing; it is also an attendant upon hysteria, hypochondriasis, tetanus and trismus, and hydrophobia. The treatment will depend upon the prevailing cause, and is noticed under other articles.

DYSPNŒ'A. (Gr. δυς, and πνεω, *I breathe.*) Difficulty of breathing. This is generally a symptomatic affection, and commonly attends upon various morbid affections of the lungs, heart, &c. It occasionally happens that persons in full health are seized with an attack of difficulty of respiration; where this occurs in nervous irritable habits it generally goes off by perfect quiet, with the help of a little ether or ammonia; if in full habits, bleeding is sometimes requisite. Persons who are subject to these attacks should keep themselves as quiet and tranquil in body and mind as possible, and should avoid excess of food and wine, and even all stimulating diet. A recumbent posture, and sudden change of air, — as going out of a warm into a cold room, or into the open air, — will often relieve an accidental attack of dyspnœa.

DYSU'RIA. (Gr. δυς, and ουρον, *urine.*) Dysury. Difficulty in voiding the urine. A common symptom in cases of gravel, inflammation of the urinary organs, spasm, and stricture. The nature of the relief must depend upon the exciting cause.

E.

E. The fifth letter in the Hebrew alphabet, and in those derived from it. In the Latin language it is often interchanged with *i* and *o*; and in the Greek with *a*, *o*, and occasionally *u*. In most languages *e* admits of great variety in its pronunciation, and, in French and English particularly, surpasses every other letter of the alphabet in this quality: as a Latin numeral E signifies 250 —

E quoque ducentos et quinquaginta tenebit.

E. In Music, the third note or degree of the diatonic scale, corresponding to the *mi* of the French and Italians. In the bass clef it is that on the third space of the staff, in the tenor on the first space, in the counter tenor on the fourth line, and in the treble clef that on the first line.

EA'GLE. In Ornithology. *See* Aquila, Falconidæ.

Ea'gle. In History, the symbol of royalty; as being, according to Philostratus, the king of birds. Hence, in the Scriptures, a Chaldæan and Egyptian king are styled eagles. The eagle was borne as a standard by many nations of antiquity. The first who assumed it, according to Xenophon (*Anab.* i. 10.), were the Persians, from whom (in all probability through the medium of the Greeks) it was borrowed by the Romans at an early period of their history, but first adopted as their sole ensign in the consulate of C. Marius. (*Plin.* x. 4.) Previously to that period they had used as standards wolves, leopards, eagles, and other animals, indifferently, according to the humour of their generals. The Roman eagles were gold or silver figures in rilievo, about the size of a pigeon; and were borne on the tops of spears, with their wings displayed, and frequently with a thunderbolt in their talons. When the army marched the eagle was always visible to the legions; and when it encamped the eagle was always placed before their *prætorium* or tent of the general. The eagle on the summit of an ivory staff was also the symbol of the consular dignity. In modern times Napoleon caused the tricolor flag, which at the outbreak of the first French Revolution had become the standard of France, to be surmounted with an eagle; and thus constituted it the standard of the consular and imperial armies. From this circumstance, and from the almost unprecedented career of victory so long pursued by the French under this standard, the expression *eagles of Napoleon* is often used metaphorically to designate the *armies* under his command. After the battle of Waterloo the eagle was superseded in France by the fleur de lys, the ancient emblem of the Bourbon race. Eagles are frequently found on ancient coins and medals; where, according to Spanheim, they are emblematic of divinity and providence, but according to all other antiquaries of empire. They are most usually found on the medals of the Ptolemies of Egypt and the Selucidæ of Syria. An eagle, with the word *consecratio*, indicates the apotheosis of an emperor.

Eagle. In Heraldry, a bearing of frequent occurrence, and particularly assumed by sovereigns as the emblem of empire, from having been borne on the legionary standard of the ancient Romans. The eagle of Russia is *or*, with two heads displayed, sable, each ducally crowned of the field; the whole imperially crowned, beaked, and membered, gules. The eagle of Austria is also displayed with two heads; the Prussian eagle has one only. The Americans have adopted an eaglo of a peculiar species belonging to their continent as the device of the Union, which is impressed on their gold coins.

EA'GLE, BLACK. A Prussian order of knighthood, founded in 1701; united with the order of the Red Eagle, or order of Sincerity, instituted by the Margraves of Bayreuth.

EA'GLE STONE. A term applied by the old pharmaceutists to globular clay ironstone, which they called *lapis ætites.*

EA'GLE WOOD. A fragrant wood, used by the Asiatics for burning as incense. The Malayan name is *Agila*, whence the Portuguese name *Pao d'Agila.*

EAR. (Germ. ohr.) The external ear is formed of a pliant cartilage covered by a thin skin, and having appropriate nerves and muscles; its various cavities and projections have received distinctive names from the anatomist. The curved and irregular passage which leads to the inner ear is called the *meatus auditorius*, and

in the adult is more than an inch in length; it is lined with a peculiar secretion called *cerumen.* The *tympanum* separates the external from the internal ear; it is closed by a membrane called the *membrana tympani* or *drum of the ear*, upon the inner surface of which a nerve called the *chorda tympani* ramifies, and to the centre of which is affixed the process of a little hammer-shaped bone, called the *malleus*, and which, together with the *incus*, the *os orbiculare*, and the *stapes*, forms a chain of communication between the *tympanum* and the *fenestra ovalis:* these small bones are supplied with appropriate muscles. The *vestibule* is a small cavity in the petrous portion of the temporal bone, having a little spiral cavity called the *cochlea* connected with it, and three cylindrical cavities, or tubes, bent in a semicircular form, two of which are horizontal and one vertical. These cavities contain a liquid; and in them the auditory nerve, which proceeds from the fourth ventricle of the brain, ramifies and terminates. It is obvious that vibration of the tympanum, occasioned by undulations of the air, may be communicated through the bony chain above mentioned to the fluid in the vestibule, and thence to the acoustic nerve; but any further uses of this extraordinary and complicated mechanism are beyond our knowledge. In the annexed diagram *a* represents the external ear, *b* the external meatus, *c* the tympanum, *d* the malleus, *e* the incus, *f* the stapes, *g* the semicircular canals, and *h* the cochlea.

EA'RINGS. Small ropes fastened to cringles (loops) in the upper corners, and also to the *leeches* of sails, for the purpose of fixing the leeches of the sail to the yard. The first or head earings fix the corners of the sail permanently, the second are used only in reefing.

EARL. A title of dignity, derived from the Anglo-Saxons. It denoted at first any person of noble race (see *Palgrave's Rise of the E. Commonwealth*); and there seem to have remained in popular language traces of this ancient use of the name down to a late period. Afterwards some of the Saxon earls were hereditary, and some official governors of extensive districts. After the Conquest, the title of earl was used by the English to express the French title of count (in Latin comes); to which again the word graf (identical in origin with the English reeve) furnishes an equivalent in Germany. Hence the wife of an earl is still styled countess. In writings earlier than the age of Stephen, the Latin word consul is also used as synonymous. It has been supposed (and the explanation is supported by Mr. Cruise, *On Dignities*, p. 17.) that the dignity of an earl was originally annexed to the possession of a certain tract of land, and that there were three sorts of earldoms — one, when the dignity was annexed to the possession of a whole county with *jura regalia*, in which case the county was a county palatine, as Chester, Pembroke, and Durham; the second, where the earl had no possession of the county, and no advantage from it, but the third penny or third part of the sum arising from pleas in the county court; the third, where a tract of land was granted to hold as a county, "per servitium unius comitatus." But this is an opinion open to controversy; and it may be doubted whether there are any settled principles as to the creation or descent of earldoms earlier than the reign of Edward III., when they were granted by letters patent to the earl and the heirs of his body. Earldoms, like baronies, gradually became converted from territorial to merely titular honours. These two were the only titles in the English peerage, until the creation of the duchy of Cornwall in the 11th year of Edward III. (See *Nicolas's Synopsis of the Peerage of England*.)

EARL MA'RSHAL OF ENGLAND. One of the great officers of state, who regulates all great ceremonies, takes cognizance of all matters relating to honour, arms, and pedigree, and superintends the proclamation of peace or war. The court of chivalry, *curia militaris* (now almost forgotten), was formerly under his jurisdiction: he is still at the head of the herald's office, or college of arms. Camden, in his discourse concerning the etymology, antiquity, and office of earl marshal, alleges that it was first introduced in the reign of Richard II., who conferred it on Thomas Mowbray, Earl of Nottingham, his predecessors having been styled only *Marshals* of England. Various limitations have been made in the grants of this office from time to time; but it is now hereditary in the family of Howard, and enjoyed by its head, the Duke of Norfolk.

EA'RNEST (Lat. arrhæ; Fr. arrhes), in Law, is a part of the subject of a contract, as money or goods, transferred, in order by such delivery to pass the property in the whole, or in some other way to confirm the contract. By the Statute of Frauds, 29 C. 2. c. 3., no contract for sale of goods of the value of 10*l*. or more is good unless in writing, or unless such earnest be given or taken.

EA'R RINGS. (Germ. ohrringe.) Well-known ornaments worn by women, and sometimes by men, in all ages and countries. They have assumed an endless variety of forms; but consist generally at present of a simple ring, to which are attached pendant jewels, such as pearls, diamonds, or other precious stones. In the middle ages they were termed *pendants*, to which article the reader is referred for full information.

EARS. In Architecture. *See* CROSETTES.

EAR SHELL. *See* HALIOTIS.

EARTH. (Germ. erde, Lat. terra.) The name of the planet which we inhabit. It is the third in order from the sun, its orbit embracing the orbits of Mercury and Venus, but being within the orbits of all the other planets. The earth is endowed with a double motion: first, a motion of rotation about an axis passing through its centre; and secondly, a motion of revolution about the sun. It is the first of these motions which produces the phenomena of day and night, and the apparent diurnal revolution of the celestial bodies. The time in which the earth's rotation is performed is measured by the interval which elapses between two transits of the same fixed star over the meridian of any place; and this interval is always precisely the same, for astronomers have proved that it cannot have varied so much as three times the thousandth part of a second since the date of the first astronomical observation, that is to say, during the last two thousand years. It is called the *sidereal day*, and forms a perfectly uniform measure of time.

The revolution of the earth about the sun is performed in an elliptic orbit, which lies all in one plane, and has the sun in one of the foci. The eccentricity of the orbit, or the distance of the foci from the centre, is 0·01679 parts of the mean distance of the earth from the sun; so that if we take the mean distance for unity, the greatest distance of the sun is 1·01679, and the least 0·98321. The mean distance is nearly 95 millions of miles. The motion of the earth in its orbit is not uniform; being most rapid when it is at its *perihelion*, or point nearest the sun, and slowest at its *aphelion*, or greatest distance from the sun. This inequality of the angular motion of the earth about the sun gives rise to an inequality in the lengths of the *apparent* solar day, which is the interval of time between the successive transits of the sun over the same terrestrial meridian. If the earth moved uniformly in its orbit, accomplishing its annual revolution in the same time it does, the interval between any two consecutive transits of the sun over the same meridian would always be the same. This interval is called the *mean solar day*. The time in which the earth performs a revolution in its orbit, with respect to the fixed stars, or points in absolute space, is 365·2563612 mean solar days, or 365 days, 6 hours, 9 minutes, 9·6 seconds. This is called the *sidereal year*.

The plane which contains the earth's orbit is called the plane of the *ecliptic*. The axis of the earth's diurnal rotation is not perpendicular to the plane of the ecliptic, but makes with it an angle of 66° 32′ 4″; whence the *equator* of the earth is inclined to the ecliptic in an angle of 23° 27′ 56″. This inclination, which is called the *obliquity of the ecliptic*, gives rise to the phenomena of the seasons. In fact, as the two planes intersect always at the centre of the earth, it is evident that if, while the earth is carried round its orbit its axis of rotation remains always parallel to itself, the sun must rise above the equator during one half of the revolution, and fall below it during the other. Now this is what takes place: — the earth's axis of rotation preserves its parallelism, or points always towards the same star; and the sun in consequence at one period of the year is 23° 27′ 56″ to the north of the equator, and at the opposite season of the year is precisely the same distance to the south of it. The straight line formed by the intersection of the planes of the equator and ecliptic does not preserve the same position on the ecliptic; it has a slow motion *westward*, or contrary to the order of the signs, and retreats at the rate of 50·1″ annually; so that when the sun appears to return to the equator the sidereal revolution has not been quite completed: there remains an arc of 50·1″. The time in which the sun, or, to speak correctly, the earth, describes this arc is 20 minutes, 19·9 seconds; consequently the periodical return of the seasons is shorter by 20 m. 19·9 sec. than the true sidereal revolution of the earth round the sun. But the revolution of the seasons forms what is called the *equinoctial* or *tropical* year; which, therefore, is equal to 365·2422414 mean solar days; or 365 d. 5 h. 48 m. 49·7 sec.

The figure of the earth is that of an oblate spheroid of revolution, the axis of the poles being to the diameter of the equator in the ratio of 301 to 302. The equatorial diameter is nearly 7925 English miles, and the polar diameter about 7898 miles. (*See* DEGREE.) The mean radius of the earth is 3956 miles. Hence, supposing the earth to be a sphere, its whole surface would contain about 196,663,000 square miles.

The knowledge of the true figure and dimensions of the earth has been obtained by a combination of the results of mathematical theory with the actual measurement of degrees, and observations of the length of the seconds' pendulum at different places on its surface. As a great portion of the surface of the earth is covered by the sea, the general figure must be such as will satisfy the conditions of hydrostatic equilibrum. If the earth were fluid, and had no motion of rotation, its figure would be that of a sphere; but the rotation gives rise to a force which tends to cause every particle to recede from the axis, and which is proportional to the distance of the particle from the axis. Hence the attraction of the whole mass on any particle is to a certain extent counteracted by the centrifugal force of rotation, and the attraction is most diminished at the equatorial parts, where the distance from the axis is the greatest. Hence, in order that equilibrium may be restored, an accumulation of matter must take place round the equator, so that the mass will bulge out in that region, and become flattened at the poles. These theoretical considerations only render the spheroidal form of the earth probable; but they are fully confirmed by experiments of different kinds. If the earth is an oblate spheroid of revolution, the force of gravity at its surface must increase on going from the equator towards the poles; and the increase must be exactly proportional to that of the square of the sine of the latitude. Now it has been found by swinging an invariable pendulum at a great number of places, that the increase of gravity from the equator to the poles does follow this law. Anomalous results, indeed, appear; but they are only such as might be expected *à priori* from local irregularities of the surface, which, however, bear a much smaller proportion to the whole mass of the earth than the protuberances on the skin of an orange to its diameter. Another method of determining the exact form of the earth is by measuring the length of degrees of the meridian. Supposing the meridian to be an ellipse, the degrees of latitude must

become longer and longer as we recede from the equator, and the augmentation must be proportioned to the square of the sine of the latitude. This has likewise been found, by numerous measurements undertaken for the purpose, to hold true; so that theory and experiment fully concur in proving the general form of the earth to be that of an oblate spheroid of revolution.

On account of the large proportion of the earth's surface which is covered with water, and the comparatively small height to which the dry land rises above the level, it is evident that the figure of the earth cannot deviate much from that which is required for the hydrostatic equilibrium. It is computed that the proportion of water to land over the whole surface is as 2 to 1; that is to say, two thirds of the whole surface is covered with water, the surface of which must be in equilibrium. The altitude of the highest mountains on the earth above the level of the sea is supposed to be about 26,000 feet, or nearly five miles. But the mean radius of the earth, as we have already stated, is nearly 4000 miles; consequently the greatest superficial inequalities do not exceed the 800th part of the radius. In general they amount to but a small part of this quantity.

The *mass* of the earth compared with that of the sun is nearly as 1 to 355,000. Its mean density, which has been ascertained by observing the effect of mountains in deflecting the plumb-line from the perpendicular (ATTRACTION OF MOUNTAINS), and by experiments on the attraction of leaden balls, is to that of water as $5\frac{1}{2}$ to 1. The centrifugal force at the equator is to that of gravity as ·00346 to 1; and the force of gravity there is such that bodies fall through $16\frac{1}{12}$ feet in the first second of time. If the rotation of the earth were 17 times more rapid, the centrifugal force at the equator would be just equal to the attractive force, and bodies would have no weight.

From a knowledge of the form of the earth, and of its mean density, we are enabled to form some conjecture respecting its interior constitution. Newton demonstrated that if the earth were a homogeneous mass, or of equal density throughout, the ratio of its polar to its equatorial diameter would be that of 230 to 231; that is, the ellipticity would be $= \frac{1}{231}$. But the ellipticity found from the actual measurement of degrees is, as we have seen, considerably less than this fraction; consequently the earth is not homogeneous. Huygens, on the other hand, adopting the hypothesis that the density increases regularly from the surface to the centre, at which point it is infinite, found the ratio of the diameters to be that of 578 to 579. The true compression considerably exceeds that given by this ratio; and therefore, since it lies between the results of the two hypotheses, we infer that the density increases towards the centre, but that the density at the centre is not infinitely great.

Considering that the mean density of the whole earth is only about five and a half times that of water, and that the materials of which the crust of the earth is composed are all compressible in a greater or less degree, so that even at no very great depth the density of the different substances must be greatly increased by the mere pressure of the superincumbent materials, some philosophers have supposed that the effects of pressure must be counterbalanced by the expansive force of a great heat subsisting in the interior of the earth; and others that the earth is not solid, but merely a hollow shell of inconsiderable thickness. It has been calculated that at the depth of 35 miles, air, subjected to the pressure of a column of matter of the mean density of that at the surface of the earth, would acquire the density of water; that at the depth of 173 miles, water itself, which is eminently incompressible, would acquire the density of marble; and at the centre, marble would have a density 119 times greater than at the surface. But the comparatively small mean density of the mass proves that none of these effects take place. The hypothesis which supposes the earth to be hollow in the interior, is contrary to every analogy; and as it can be demonstrated from astronomical considerations that the density must increase in descending from the surface to a depth equal at least to one fourth of the radius, it is infinitely probable that this density continues to increase even to the centre; but that a very high temperature exists in the interior of the earth, in consequence of which the materials resist the effects of the condensation due to the pressure to which they are subjected. The principal arguments which have been brought forward to prove the high temperature of the interior parts of the earth, or the central heat, are drawn from the following circumstances: —

1. The form of the earth, nearly spherical, and flattened at the poles of rotation, together with the regular disposition of the materials about the centre in elliptic layers, proves that it must have originally existed in a fluid, if not an aëriform state; so that the constituent molecules must have had free liberty to obey the forces arising from their mutual attraction and from the position of the whole mass, and arrange themselves in the position of equilibrium. But there is no other agent than heat to which we can attribute the fusion of such substances as compose the greater part of the exterior crust of the earth. 2. The phenomena of volcanos, hot springs, and earthquakes, receive a very simple explanation on the hypothesis that the nucleus of the earth still remains in a state of fusion, and that the consolidation of the exterior crust still proceeds, though at an extremely slow rate. 3. The fact, which now appears to be fully established, that a sensible increase of temperature takes place as we descend from the surface (in deep mines for example), after passing the depth at which the influence of the solar heat ceases to be felt, furnishes a direct proof of a very high temperature in the interior of the earth. Much uncertainty exists as to the rate at which this increase takes place; but the mean results of a number of experiments made in the deep mines of Cornwall, and different parts of France and Germany, gives an increase of 1° of Fahrenheit's thermometer for every 15 yards of vertical descent, after passing the stratum of constant temperature. Admitting this rate of increase, and supposing it to be continued to the centre, the intensity of heat at the centre will be expressed by 3500° of Wedgewood's pyrometer. The temperature of 100° of Wedgewood, which is sufficient to fuse the lavas and the greater part of the known rocks, would be found at the depth of 125 miles; but M. Cordier, who, in the *Memoirs of the Royal Academy of Sciences of Paris* (volume for 1827), has collected a great number of facts relative to this subject, is of opinion that the phenomena warrant the conclusion that the mean thickness of the solid crust of the earth does not exceed 60 miles.

In order to explain the primitive fluidity of the earth, which it is necessary to admit in consequence of its figure and the law of the diminution of gravity from the poles to the equator, a different hypothesis has been proposed, and had numerous partisans. It consists in supposing a primitive dissolution of all the materials of the earth in a liquid, such as water. But if we consider that the fluidity of all bodies, even of liquids, is an effect of heat; that it is necessary to suppose not merely a partial fusion of the exterior crust, but of the whole mass of the earth; and that the weight of all the water on the globe does not probably amount to a 50-thousandth part of that of the solid materials, the insufficiency of this hypothesis will be apparent.

In whatever manner the earth may have taken its existing form, there are abundant proofs that its surface has been the theatre of many great revolutions. The masses of sand and gravel, and beds of limestone composed of shells and corals, which are found in the interior of continents, and even to the summits of the highest mountains, plainly show that the present land was once immersed deep under the waters of the ocean. The remains of animals and plants belonging to tropical countries, found in the highest latitudes, indicate an entirely different disposition of climates from that which now exists. The appearances of the mineral strata, twisted, and dislocated, and broken asunder, also afford undeniable evidence that the changes which have taken place on the surface of the earth have not all been brought about by the silent action of the causes which we see in daily operation, but by the operation of some violent force which has shaken the globe to its very centre. Whether these convulsions have been produced by an internal or external force; by the action of a central heat heaving up the solid crust of the earth, and raising mountains from the depths of the ocean; or by the collision of a comet, changing the axis of the earth's diurnal rotation, destroying the pre-existing equilibrium, and carrying the waters towards the new equator, — can never be any thing more than matter of speculation and conjecture. All that science makes known on the subject is, that since the time of the first recorded astronomical observations, that is to say, during the last two thousand years, the poles of the earth have been at precisely the same points on its surface as at the present day. *See* GEOGRAHY, PLANET.

EARTH. In Agriculture, earths are distinguished from soils by their being without organized matter in their composition. Though scarcely any such earths are found on or near the ground's surface, yet the distinction is of use in speaking of soils. Thus we say a soil, the basis of which is earth, of sandstone, or of chalk, &c.

EARTH. In Chemistry this term is applied to certain insoluble metallic oxides of abundant occurrence in rocks and soils, such as silica and alumina. Lime, magnesia, baryta, and strontia have been called *alkaline* earths, their action on vegetable colours being similar to that of the alkalis.

EARTHENWARE. *See* POTTERY.

EARTH NUTS, are various subterranean substances produced by plants. In England the name is given to the nut of *Conopodium flexuosum*, an umbelliferous plant; in Egypt to the round tuber of *Cyperus rotundus*, and other species of the same genus; in China to the subterranean pods of *Arachis hypogæa*, a leguminous plant; and in other countries to similar pods produced by the genera *Voandzeia*, *Amphicarpæa*, &c.: or to the small tubers of Cyperaceous plants.

EARTHQUAKE. One of the most formidable phenomena of nature. As the name implies, it consists of a vio-

lent agitation of the earth, accompanied by various other phenomena more or less singular and destructive in their effects, but by no means uniform in character, as the following enumeration of concomitant circumstances, gleaned from the accounts of various earthquakes that have occurred in ancient and modern times, will sufficiently evince. Earthquakes are usually preceded by a general stillness in the air, and an unnatural agitation of the waters of the ocean and of lakes. The shock comes on with a deep rumbling noise, like that of a carriage over a rough pavement, or with a tremendous explosion resembling a discharge of artillery or the bursting of a thunder cloud; and sometimes heaves the ground perpendicularly upwards, and sometimes rolls it from side to side. The single shocks of an earthquake seldom last longer than a minute, but they frequently follow one another at short intervals for a considerable length of time. During these shocks large chasms are made in the ground, from which sometimes smoke and flames, but more frequently stones and torrents of water, are discharged. In violent earthquakes, these chasms are sometimes so extensive as to overwhelm whole cities at once. In consequence of these shocks, also, whole islands are frequently sunk and new ones raised; the course of rivers is changed; seas overflow the land, forming gulfs, bays, and straits; sometimes disrupting the land into islands, and sometimes joining them to the continent.

There is no portion of the earth's surface, whether it be land or water, that is not more or less subject to earthquakes; and records of their destructive effects have been transmitted to us through every age. The first earthquake particularly worthy of notice was that which, in A.D. 63, destroyed Herculaneum and Pompeii. In the fourth and fifth centuries, some of the most civilized parts of the world were almost desolated by these awful visitations. Thrace, Syria, and Asia Minor, according to contemporary historians, suffered most severely. On the 26th of January, A.D. 447, subterranean thunders were heard from the Black to the Red Sea, and the earth was convulsed, without intermission, for the space of six months; and in Phrygia, many cities and large tracts of ground were swallowed up. On the 30th of May, A.D. 205, the city of Antioch was overwhelmed by a dreadful earthquake, and 250,000 of its inhabitants are said to have been crushed in its ruins.

In the year 1346, Asia Minor and Egypt were violently shaken; and in the following year severe earthquakes were experienced in Cyprus, Greece, and Italy.

In 1692, the island of Jamaica was visited by a terrible earthquake, in which enormous masses of earth were detached from the Blue Mountains; and vast quantities of timber, hurled from their flanks, covered the adjacent sea, like floating islands. It was during this earthquake that the city of Port Royal, with a large tract of adjacent land, sunk instantaneously into the sea. In the following year great earthquakes occurred in Sicily, which destroyed Catania and 140 other towns and villages, with 100,000 of their inhabitants.

Since the records of history, there have been no earthquakes equal in intensity to those which ravaged different parts of the world in the eighteenth century. Passing over the convulsion which in 1746 nearly laid waste Lower Peru, and those by which in 1750 the ancient town of Concepcion in Chili was totally destroyed, we come to 1755, when the city of Lisbon was almost wholly destroyed by one of the most destructive earthquakes which ever occurred in Europe. It continued only six minutes; but such was the violence of the convulsion, that in that short space upwards of 60,000 persons are said to have perished. The phenomena that accompanied it were no less striking. The sea first retired and laid the bar dry; it then rolled in, rising fifty feet or more above its ordinary level. The largest mountains in Portugal were impetuously shaken from their very foundations; and some of them opened at their summits, which were split and rent in a wonderful manner, huge masses of them being thrown down into the subjacent valleys. But the most remarkable circumstance which occurred at Lisbon during this catastrophe was the entire subsidence of the new quay, called Cays de Prada, to which an immense concourse of people had fled for safety from the falling ruins. From this hideous abyss, into which the quay sunk, not one of the dead bodies ever floated to the surface; and on the spot there is now water to the depth of 100 fathoms. This earthquake excited great attention from the incredibly great extent at which contemporary shocks were experienced. The violence of the shocks, which were accompanied by a terrific subterranean noise, like the loudest thunder, was chiefly felt in Portugal, Spain, and northern Africa; but the effects of the earthquake were perceived in almost all the countries of continental Europe, and were even experienced in the West Indies, and on the Lake Ontario in North America. Ships at sea were affected by the shocks as if they had struck on rocks; and even at some of the Scottish lakes, Loch Lomond in particular, the water, without the least apparent cause, rose to the perpendicular height of two feet four inches against its banks, and then subsided below its usual level. During the next twenty years, various earthquakes occurred in different parts of the world, attended with more or less destructive consequences. In 1759, Syria was agitated by violent earthquakes, the shocks of which were protracted for three months, throughout a space of 10,000 square leagues, and levelled to the ground Accon, Saphat, Balbeck, Damascus, Sidon, Tripoli, and many other places. In each of these places many thousands of the inhabitants perished; and in the valley of Balbeck alone, 20,000 men are said to have been victims to the convulsion. In 1766, the island of Trinidad and great part of Columbia were violently agitated by earthquakes. In 1772, the lofty volcano of Papandayang, the highest mountain in Java, disappeared, and a circumjacent area, fifteen miles by six, was swallowed up. In 1783, the north-eastern part of Sicily and the southern portion of of Calabria were convulsed by violent and oft-repeated shocks, which overthrew the town of Messina, and killed many thousands of its inhabitants, as well as many persons in Calabria. In the same year the islands of Japan, Java in 1786, Sicily and the Caraccas in 1790, Quebec in 1791, and the Antilles and Peru in 1797, were violently agitated by convulsions of this kind.

Since the commencement of the present century, various earthquakes have occurred both in the Old and New World. In 1811, violent earthquakes shook the valley of the Mississippi, by which lakes of considerable extent disappeared, and new ones were formed. In 1812, Caraccas was destroyed, and upwards of 12,000 of its inhabitants buried in the ruins. In 1815 the town of Tombora, in the island of Sumbawa, was completely destroyed by an earthquake, which extended throughout an area 100 miles in diameter, and destroyed 12,000 persons. In 1819, a violent earthquake occurred at Cutch, in the Delta of the Indus, by which, among other disastrous consequences, the principal town, Bhoog, was converted into a heap of ruins. In 1822, Aleppo was destroyed by an earthquake. In the same year Chili was visited by a most destructive earthquake, from which the coast for 100 miles is stated to have sustained an elevation of from two to four feet, while about a mile inland from Valparaiso it was raised from six to seven feet. In 1827, Popayan and Bogota suffered severely from earthquakes, during which vast fissures opened in the elevated plains around the latter city. In 1835, the town of Concepcion, in Chili, was entirely demolished by an earthquake. In 1837, the countries along the eastern extremity of the Mediterranean, especially Syria, were violently agitated by an earthquake, which caused great damage to the towns of Damascus, Acre, Tyre, and Sidon, and entirely destroyed Tiberias and Safet. Such are some of the most violent earthquakes that have occurred within the period of authentic history. The reader will find in *Poggendorf's Annalen* lists of the different earthquakes that have taken place within the last twenty years; and from these it will be observed that scarcely a month elapses without being signalized by one or many convulsions in some part of the globe. Shocks of earthquakes have at different times been felt in various parts of Britain, and more particularly in Scotland; but they have all fortunately been so insignificant, compared to those which have been experienced in other countries, that we shall refrain from entering into any details respecting them.

But though history supplies us with so large a catalogue of well-authenticated earthquakes, it is surprising that so little was done by the ancients either in investigating their causes or noticing their effects. It is only within the last century and a half, says Mr. Lyell, since Hooke first promulgated his views respecting the connection between geological phenomena and earthquakes, that the permanent changes effected by these convulsions have excited attention. Before that time the narrative of the historian was almost exclusively confined to the number of human beings who perished, the number of cities laid in ruins, the value of property destroyed, or certain atmospheric appearances which dazzled or terrified the observers. The creation of a new lake, the engulphing of a city, or the raising of a new island, are sometimes, it is true, adverted to, as being too obvious or of too much geographical interest to be passed over in silence. But no researches were made expressly with the view of ascertaining the amount of depression or elevation of the ground, or any particular alterations in the relative position of sea and land; and very little distinction was made between the raising of soil by volcanic ejections, and the upheaving of it by forces acting below. The same remark applies to a very large proportion of modern accounts; and how much reason we have to regret this deficiency of information appears from this, that in every instance where a spirit of scientific inquiry has animated the eye-witnesses of these events, facts calculated to throw light on former modifications of the earth's structure are recorded. Upon these questions, however, it is not our present intention to enter, as they will be more appropriately treated of under the heads GEOLOGY

and VOLCANO; to which articles we must refer the reader for an account of the various theories that have been maintained in regard to the origin or cause of earthquakes, as well as for a view of the grand permanent changes which these convulsions have produced on the surface and in the internal structure of the earth's crust. See *Bakewell's Introduction to Geology; Lyell's Geology; Traill's Physical Geography;* and *Phillips's Geology.*

EA'RWIG. *See* DERMAPTERA FORFICULA.

EA'SEL. (Germ. esel, *an ass.*) In Painting, a wooden frame used for supporting a picture during the progress of its execution.

EA'SEL PIECES. In Painting, pictures whose size is small enough to be painted on an easel.

EA'SEMENT. In Law, a convenience which one man has of another, his neighbour, by grant or prescription. Easements were included in the Roman law under the title servitutes; such are a way over the lands of another, or a water-course.

EAST. (Germ. Ost.) The point of the horizon at which the sun rises at the time of the equinoxes; or the point determined by a perpendicular to the meridian drawn towards the quarter of sunrise. The *east* is one of the four *cardinal points* of the compass.

EA'STER. (Germ. Ostern.) The festival which is held in commemoration of our Lord's resurrection. The term seems to be derived from a Saxon word signifying *rising.*

The Jews celebrated their passover, in conformity with the directions given them by Moses, on the 14th day of the month Nisan, being the lunar month of which the 14th day either falls on, or next follows, the day of the vernal equinox. In the year of our Lord's crucifixion this fell on a Friday: the resurrection, therefore, took place on the first day of the next week, which from thence is denominated the Lord's day. The primitive Christians in their desire to celebrate this anniversary fell into two different systems. The Western churches observed the nearest Sunday to the full moon of Nisan, taking no account of the day on which the passover would be celebrated. The Asiatics, on the other hand, following the Jewish calendar, adopted the 14th of Nisan upon which to commemorate the crucifixion, and observed the festival of Easter on the third day following, upon whatever day of the week that might fall; hence they obtained the name of Quartodecimantes: the former appealed to the authority of St. Peter and St. Paul, the latter to that of St. John.

The dispute which took place upon this point in the 2d and 3d centuries of our era is remarkable, as connected with perhaps the first event which can be brought to bear upon the question of the primacy of the Roman bishop; and it is the more interesting as both parties are accustomed to claim it as a testimony in favour of their own views. Victor, bishop of Rome, wrote an imperious letter to the Asiatic bishops, requiring their conformity to the Western rule; which was answered by Polycrates, bishop of Ephesus, in the name of the rest, expressing their resolution to maintain the custom handed down to them by their ancestors. The Roman bishop thereupon broke off communion with them; but he was rebuked by Irenæus of Lyons, and it was agreed by his mediation that each party should retain its customs. Such continued to be the practice till the time of Constantine, when the Council of Nice determined the matter by the following canons:—

1. Easter must be celebrated on a Sunday.
2. This Sunday must *follow* the 14th day of the paschal moon; so that if the 14th day of the paschal moon falls on a Sunday, then Easter must be celebrated on the Sunday following.
3. The paschal moon is that moon of which the 14th day either falls on, or next follows, the day of the vernal equinox.
4. The 21st day of March is to be accounted the day of the vernal equinox.

The new moons, it is necessary to observe, are those of the ecclesiastical calendar, which are determined arbitrarily (by the lunar cycle in the Julian calendar, and by means of the table of epacts in the Gregorian); so that the above rules define Easter without ambiguity. The new moons of the calendar are in general one or two days, sometimes even three days, *later* than the astronomical or true new moons; and the 14th day of the moon is accounted the full moon, although the opposition takes place more frequently on the 16th day. *See* CALENDAR, EPACT.

EAST INDIA COMPANY. A famous joint stock association originally established to carry on the trade between this country and the East Indies, or rather with the countries to the eastward of the Cape of Good Hope. It was constituted by royal charter in 1600, and continued, notwithstanding repeated efforts to open the trade, to enjoy the exclusive privileges originally conceded till 1688. At that period the power of the crown to restrain the freedom of trade without the sanction of parliament having been denied, a rival association obtained an act of parliament in its favour; but after a variety of negotiations, which it is unnecessary to specify, the two corporations were joined in 1702 under the name of "The United Company of Merchants trading to the East Indies;" an appellation which has been continued to the present day. In 1708 the United Company was secured by parliament in the exclusive privilege of trading to all places eastward of the Cape of Good Hope to the Straits of Magellan; and this privilege, with some modifications, was confirmed and prolonged by successive acts of parliament down to 1814. By the act 53 Geo. 3. c. 133., passed in 1813, the East India Company's charter was renewed for twenty years; but it then received some important modifications, by which a restricted intercourse was permitted to all British merchants with the whole of the Company's Indian possessions; the monopoly of the trade between England and China being, however, retained in the hands of the East India Company. These concessions paved the way for the act of 1833, by which, though the Company's charter was prolonged till 1854, not only was the monopoly of the China trade abolished, but an end wholly put to the Company's original character of a commercial association.

But it is not as a commercial association so much as a great territorial power, that the East India Company has become so distinguished. The first establishments of the English in India, as of other European nations, arose out of the alleged necessity of providing armed factories or strongholds, where the adventurers might warehouse their goods, and reside in safety for the purpose of carrying on their intercourse with the natives; but the factories speedily degenerated into fortifications, and the garrisons into armies. For a while the power of the English and French was pretty nearly balanced in India; but the talents and victories of the famous Lord Clive gave us a decided superiority over every competitor, foreign or native, and extended our sway over some of the largest and finest portions of the Mogul empire. The policy of Clive, whether it were really approved by the succeeding governors-general of our Indian dominions, or were forced upon them by necessity, has, some few short intervals excepted, been steadily followed up; and with such signal success, that our Indian empire comprizes at present the whole of Hindostan from the Himalaya Mountains to Cape Comorin, with a population of above 120 millions!

The most exaggerated accounts have been at all times current in Europe of the extraordinary wealth of India, and of the importance of the commerce with that part of the world. After the victories of Lord Clive, the most sanguine expectations began to be entertained, not only of a vast increase of trade with India, but that we should draw from her an immense amount of surplus revenue, or tribute. Perhaps it is not going too far to say that these expectations have been entirely disappointed. Great abuses existed in the government of the Bengal provinces when conquered by Clive; the servants of the East India Company making large fortunes by the oppression of the natives and the ruin of the country. But, notwithstanding the eradication of the abuses in question, the immense additions that have since been made to our empire, and the oppressive taxes laid on the natives, it is not very clear that England has hitherto derived any direct revenue from India. The distance of the country, and the totally dissimilar language and customs of the people, are very great obstacles to our governing it with the economy necessary to make it yield any considerable amount of surplus revenue. The East India Company always contended that the profits made by their monopoly of the China trade were necessary to enable them to conduct the government of India. But, though there are strong grounds on which to impeach the accuracy of this statement, still it is abundantly clear that the surplus revenue we have derived from India, supposing there has been any such, has been comparatively inconsiderable; and quite trifling, indeed, compared with our own anticipations, and with the notions entertained by others of its magnitude.

Until 1815 and 1816, when the continued fall in the price of cotton goods, caused by the astonishing discoveries and inventions of Arkwright, and the other founders and improvers of the cotton manufacture, enabled us to export cottons to India and to undersell the natives, the trade between this country and India was of the most limited description. Previously to the opening of the trade in 1813-14 the total amount of the exports of all sorts, including the important item of military stores, by the East India Company and by private traders in the Company's ships, did not amount to 1,400,000*l.* a year; and even on this a considerable loss is believed to have been incurred! But such has been the increased demand for British cottons, that the value of those exported to India amounts, at present, to above 2,500,000*l.* a year, and the whole of our exports to her to near 4,000,000*l.* Even this, considering the vast extent of India, is but a trifling export; it is, in fact, less than half the amount of our exports to the United States.

The restricted amount of our commerce with India may, perhaps, be in some degree ascribed to its having

been so long monopolized by the East India Company. But this will not explain the small surplus of Indian revenue; for, however ill fitted to serve as a commercial engine, the East India Company has governed India with singular discretion; and has made the most praiseworthy efforts to enforce economy in all departments of the administration, and to appoint the best men to all situations of power and emolument in that country. The patronage of India has always been less jobbed and abused than that of England; and there are few governments that have made more vigorous exertions to repress abuse, and to protect the rights of their subjects.

Under the act 3 & 4 W. 4. c. 85., to which we have alluded above, for continuing the charter till 1854, the functions of the East India Company have been rendered wholly political. She is to continue to govern India, with the concurrence and under the supervision of the Board of Control (*see* Control, Board of) nearly on the plan laid down in Mr. Pitt's act, in 1784, by which the Board of Control was constituted. All the real and personal property belonging to the company on the 22d of April, 1834, is vested in the crown, and is to be held or managed by the company in trust for the same; subject, of course, to all claims, debts, contracts, &c. already in existence, or that may hereafter be brought into existence by competent authority. The company's debts and liabilities are all charged on India. The dividend, which is to continue at 10½ per cent., is to be paid in England out of the revenues of India; and provision is made for the establishment of a *security fund* for its discharge. The dividend may be redeemed by parliament, on payment of 200*l*. for 100*l*. stock, any time after April, 1874; but it is provided, in the event of the company being deprived of the government of India in 1854, that they may claim redemption of the dividend any time thereafter upon 3 years' notice. (3 & 4 *Will*. 4. c. 85.)

Company's Stock—forms a capital of 6,000,000*l*., into which all persons, natives or foreigners, males or females, bodies politic or corporate (the Governor and Company of the Bank of England only excepted), are at liberty to purchase, without limitation of amount. Since 1793, the dividends have been 10½ per cent., to which they are limited by the late act.

General Courts.— The proprietors in general court assembled are empowered to enact by-laws, and in other respects are competent to the complete investigation, regulation, and control of every branch of the company's concerns; but, for the more prompt despatch of business, the executive detail is vested in a court of directors. A general court is required to be held once in the months of March, June, September, and December, in each year. No one can be present at a general court unless possessed of 500*l*. stock; nor can any person vote upon the determination of any question who has not been in possession of 1000*l*. stock for the preceding 12 months, unless such stock have been obtained by bequest or marriage. Persons possessed of 1000*l*. stock are empowered to give a single vote; 3000*l*. are a qualification for two votes; 6000*l*. for three votes; and 10,000*l*. and upwards for four votes. There were 2003 proprietors on the company's books in 1825; of these, 1494 were qualified to give single votes; 392, two votes; 69, three votes; and 48, four votes. Upon any special occasion, 9 proprietors, duly qualified by the possession of 1000*l*. stock, may, by a requisition in writing to the court of directors, call a general court; which the directors are required to summon within 10 days, or, in default, the proprietors may call such court by notice affixed upon the Royal Exchange. In all such courts the questions are decided by a majority of voices; in case of an equality, the determination must be by the treasurer drawing a lot. Nine proprietors may, by a requisition in writing, demand a ballot upon any question, which shall not be taken within 24 hours after the breaking up of the general court.

Court of Directors.— The court of directors is composed of 24 members, chosen from among the proprietors, each of whom must be possessed of 2000*l*. stock; nor can any director, after being chosen, act longer than while he continues to hold stock. Of these, 6 are chosen on the second Wednesday in April in each year, to serve for 4 years, in the room of 6 who have completed such service. After an interval of 12 months, those who had gone out by rotation are eligible to be re-elected for the ensuing 4 years. Formerly, no person who had been in the company's civil or military service in India was eligible to be elected a director until he had been a resident in England two years after quitting the service; but this condition no longer exists; and all civil or military servants of the company in India, supposing they are otherwise eligible, may be chosen directors immediately on their return to England, provided they have no unsettled accounts with the company; if so, they are ineligible for 2 years after their return, unless their accounts be sooner settled. (3 & 4 *Will*. 4. c. 85. § 28.) The directors choose annually, from amongst themselves, a chairman and a deputy-chairman. They are required by by-laws to meet once in every week at least; but they frequently meet oftener, as occasion requires. Not less than 13 can form a court. Their determinations are guided by a majority. In case of an equality, the question must be decided by the drawing of a lot by the treasurer: upon all questions of importance, the sense of the court is taken by ballot. The company's officers, both at home and abroad, receive their appointments immediately from the court, to whom they are responsible for the due and faithful discharge of the trust reposed in them. The patronage is, nevertheless, so arranged, as that each member of the court separately participates therein.

Secret Committee. — The principal powers of the court of directors are vested in a secret committee, forming a sort of cabinet or privy council. All communications of a confidential or delicate nature between the Board of Control and the company are submitted, in the first instance at least, to the consideration of this committee; and the directions of the board, as to political affairs, may be transmitted direct to India, through the committee, without being seen by the other directors. The secret committee is appointed by the court of directors, and its members are sworn to secrecy.

The territorial possessions of the East India Company are divided into the three presidencies of Bengal, Madras, and Bombay, at each of which the executive government is administered by a governor and three councillors, the governor of the Bengal presidency being at the same time governor-general of India. In their several presidencies, the governors and their councillors possess the privilege of enacting and enforcing laws; subject, however, in some cases, to the concurrence of the supreme court of judicature, and, in all cases, to the approval of the court of directors and the board of control.

We copy the following tables of Revenue, &c. from Mr. M'Culloch's *Statistics*, vol. ii. p. 519.

An Account of the Total Annual Revenues and Charges of the British Possessions in India under the East India Company, from 1809-10 to 1829-30; showing also the Nett Charge of Bencoolen, Prince of Wales Island, and St. Helena, the Interest paid on account of Debts in India, and the Amount of Territorial Charges paid in England. —(*Parl. Papers*, No. 22. Sess. 1830, and No. 306. Sess. 1833.)

Years.	Total Gross Revenues of India.	Total Charges in India.	Nett Charge of Bencoolen, &c.	Interest on Debts.	Territorial Charges paid in England.			General Result.	
					Cost of Political Stores.	Payments, Pensions, &c.	Total.	Surplus Revenue.	Surplus Charge.
	L.	*L.*	*L.*	*L.*	*L.*	*L.*	*L.*	*L.*	*L.*
1809—10	16,464,391	13,775,577	203,361	2,159,019	190,128	867,097	1,057,225	- -	730,791
1810—11	16,679,198	13,909,983	199,663	2,196,691	217,703	901,688	1,119,391	- -	736,530
1811—12	16,605,616	13,220,967	168,288	1,457,077	154,998	922,770	1,077,768	681,516	
1812—13	16,459,774	13,659,429	201,349	1,491,870	193,784	1,184,976	1,378,768	- -	271,634
1813—14	17,228,711	13,617,725	209,957	1,537,434	64,257	1,148,156	1,212,413	651,182	
1814—15	17,231,191	14,182,454	204,250	1,502,217	129,873	1,064,223	1,194,596	147,677	
1815—16	17,168,195	15,081,587	225,558	1,584,157	81,903	1,199,952	1 281,885	- -	1,004,992
1816—17	18,010,135	15,129,839	205,372	1,719,470	194,374	1,071,176	1,265,550	- -	310,096
1817—18	18,305,265	15,844,964	219,793	1,753,018	81,941	1,094,701	1,176,642	- -	689,152
1818—19	19,392,002	17,558,615	210,224	1,665,921	133,162	1,150,378	1,280,540	- -	1,323,305
1819—20	19,172,506	17,040,848	142,049	1,940,327	265,055	1,150,391	1,415,446	- -	1,466,164
1820—21	21,292,036	17,520,612	220,043	1,902,585	228,058	1,072,106	1,300,164	348,632	
1821—22	21,753,271	17,555,668	207,816	1,932,835	202,735	1,175,149	1,377,884	979,068	
1822—23	23,120,934	18,083,482	154,761	1,694,731	204,147	1,354,960	1,559,107	1,528,853	
1823—24	21,238,623	18,902,511	257,276	1,652,449	395,276	758,590	1,153,866	- -	727,479
1824—25	20,705,152	20,410,929	279,277	1,460,433	414,181	1,166,078	1,580,259	- -	3,025,746
1825—26	21,096,960	22,346,365	214,285	1,575,941	740,728	1,076,504	1,817,232	- -	4,856,857
1826—27	23,327,753	21,424,894	207,973	1,749,068	1,111,792	1,318,102	2,429,894	- -	2,484,076
1827—28	22,818,184	41,778,431	272,014	1,958,313	805,016	1,255,125	2,060,141	- -	3,250,715
1828—29	22,692,711	19,298,622	250,794	2,121,165	449,603	1,517,802	1,967,405	- -	945,275
1829—30	21,662,310	18,300,715	213,304	3,007,693	293,873	1,454,867	1,748,740	- -	608,142

ABSTRACT VIEW of the Revenues and Charges of India for the Years 1831-32, 1832-33, 1833-44, and (by estimate) 1834-35.

	Revenue.			
	• 1831-32.	1832-33.	1833-34.	1834-35.
	L.	*L.*	*L.*	*L.*
Bengal - -	9,474,084	9,487,778	8,844,241	5,445,100
Agra - -	- -	- -	- -	3,657,900
Madras - -	3,222,155	2,969,956	3,235,233	3,301,982
Bombay - -	1,401,916	1,497,308	1,600,691	1,503,782
Total revenues of India -	14,198,155	13,955,642	13,680,165	13,908,764
Deficiency of ordinary revenue - -	207,581	264,332	- -	578,336
	14,405,736	14,219,374	13,680,165	14,487,100

	Charge.			
	1831-32.	1832-33.	1833-34.	1834-35.
	L.	*L.*	*L.*	*L.*
Bengal - -	7,535,170	7,687,228	7,018,449	6,749,293
Agra - -	- -	- -	- -	581,800
Madras - -	3,239,261	3,174,347	3,258,995	3,076,404
Bombay - -	2,060,498	2,034,710	1,968,045	1,905,749
Total Charges in India - -	12,834,929	12,896,285	12,245,489	12,313,246
Charge on account of St. Helena -	94,152	95,553	91,641	10,986
Charge on account of India in England - -	1,476,655	1,227,536	1,293,637	2,162,868
Total charges of India - -	14,405,736	14,219,374	13,680,767	14,387,100
Surplus of ordinary revenue -	- -	- -	49,398	
	14,405,736	14,219,374	13,680,165	14, 4 870

N.B. The Company realized in 1834-35 the sum of 10,679,223*l.* by the sale of commercial assets. The debts of the Company in India on the 30th of April, 1834, amounted to 34,463,483*l.*, bearing an interest of 1,754,545*l.* a year. — (*Parl. Paper*, No. 380. Sess. 1836.)

We subjoin the following table, exhibiting the extent and population of India, which we copy from the second edition of Mr. Hamilton's *Indian Gazetteer*. Some later accounts have been published as to the population of particular provinces; but we believe that this is the most accurate statement that has hitherto been framed, embracing the whole country.

	British Square Miles.	Population.
Bengal, Bahar, and Benares - - - - -	162,000	39,000,000
Additions in Hindostan since A. D. 1765 - - - - -	148,000	18,000,000
Gurwal, Kumoon, and the tract between the Sutuleje and Jumna - -	18,000	500,000
Total under the Bengal presidency - - - -	328,000	57,500,000
Under the Madras presidency - - - - -	154,000	15,000,000
Under the Bombay presidency - - - - -	11,000	2,500,000
Territories in the Deccan, &c., acquired since 1815, consisting of the Peishwa's dominions, &c., and since mostly attached to the Bombay presidency - - -	600,000	8,000,000
Total under the British government - - -	553,000	83,000,000
BRITISH ALLIES AND TRIBUTARIES.		
The Nizam - - - - -	96,000	10,000,000
The Nagpoor Raja - - - - - -	75,000	3,000,000
The King of Oude - - - - -	20,000	3,000,000
The Guicowar - - - - -	18,000	2,000,000
Kotah, 6,500; Boondee, 2,500; Bopaul, 5,000 - - -	14,900	1,500,000
The Mysore Raja - - - - -	27,000	3,000,000
The Satara Raja - - - - -	14,000	1,500,000
Travancore, 6,000; Cochin, 2,000 - - - - -	8,000	1,000,000
Under the Rajas of Jondpour, Jeypoor, Odeypoor, Bicancere, Jesselmere, and other rajpoot chiefs, Holcar, Ameer Khan, the Row of Kutch, Bhurtpoor, Macherry, and numerous other petty chiefs, Seikes, Gonds, Bheels, Coolies, and Catties, all comprehended within the line of British protection - - - - -	283,000	15,000,000
Total under the British government and its allies - -	1,103,000	123,000,000
INDEPENDENT STATES.		
The Nepaul Raja - - - - -	53,000	2,000,000
The Lahore Raja (Runjeet Singh) - - - -	50,000	3,000,000
The Ameers of Sinde - - - -	24,000	1,000,000
The dominions of Sindia - - - -	40,000	4,000,000
The Cabul sovereign, east of the Indus - - -	10,000	1,000,000
Grand total of Hindostan - - -	1,280,000	134,000,000
INDIA BEYOND THE GANGES. — *British Acquisitions in* 1824 *and* 1825.		
Countries south of Rangoon, consisting of half the province of Martaban, and the provinces of Tavoy, Ye, Tenasserin, and the Mergui isles - - -	12,000	51,000
The province of Arracan - - - - -	11,000	100,000
Countries from which the Burmese have been expelled, consisting of Assam and the adjacent petty states, occupying a space of about - - -	54,000	150,000
Total - - - - -	77,000	301,000

EASY. The sea phrase for a ship that moves over the sea without jerking or straining.

EAU DE COLOGNE. A perfumed spirit originally prepared at Cologne, and principally used as a perfume; though many imaginary medical virtues have also been ascribed to it. Various recipes have been published for the preparation of eau de Cologne, some of them extremely complicated. (See *Ure's Dictionary of Arts and Manufactures*, art. "Eau de Cologne.") The following affords a good imitation of the original article:—Take of alcohol one pint; of the oils of bergamot, orange-peel, and rosemary, each one drachm; of bruised cardamom seeds one drachm; orange-flower water one pint; distil one pint from a water-bath.

EAU DE LUCE. A strong solution of ammonia, scented and rendered milky by the addition of a little mastic and oil of amber. It is considered an effective remedy in India against the bites of poisonous snakes.

EAVES. (Fr. eaux.) In Architecture, the lowest edges of the inclined sides of a roof which project beyond the face of the wall so as to throw the water off therefrom, that being their office.

EBBING OF THE TIDE. The reflux of the tide. *See* TIDE.

EBENA'CEÆ. (Ebenus, one of the genera.) A natural order of shrubby or arborescent Exogens chiefly inhabiting the tropics. They are allied to *Oleaceæ*, with which they agree in the placentation of their seeds; but are distinguished by their alternate leaves, and axillary usually unisexual flowers. They are more closely related to *Aquifoliaceæ;* but differ in the number of their stamens and in their divided sexes. Some species are remarkable for the hardness and blackness of their wood, known under the name of ebony and iron wood; others, as the *Kaki* of China, yield an eatable fruit; all are beautiful objects when growing.

E'BIONITES. An ancient sect (referred by Mosheim to the second century), who believed in Christ as an inspired messenger of God, but considered him to be at the same time a mere man, born of Joseph and Mary. They maintained also the universal obligation of the Mosaic law, and rejected the authority of St. Paul. The origin of their name is uncertain, some deriving it from that of their supposed founder; others deduce it from a Hebrew word signifying *poor*, and suppose the title to be given to them in reference either to the *poverty* of the class to which they mostly belonged, or the *meanness* of their doctrine. (See *Gieseler's Eccl. Hist.* b. i. c. 3.)

E'BONY. *See* EBENACEÆ.

EBULLI'TION. (Lat. ebullitio, *bubbling up.*) The motion produced in a liquid by its rapid conversion into vapour.

ECCHYMO'SIS. (Gr. εκχεω, *I pour out.*) The extravasation of blood into the cellular membrane which results from blows and bruises.

ECCLE'SIA. (Gr. εκκλησια.) In Ancient History,

the great assembly of the Athenian people, at which every free citizen might attend and vote. This assembly, though nominally possessed of the supreme authority of the state from the earliest times, yet having no fixed times of meeting, was but seldom convened at all; so that the archons, who were elected from the body of nobles or eupatridæ, had virtually the whole management of the state. But the regulations of Solon, which appointed it to meet regularly four times in every period of thirty-five days, besides extraordinary occasions on which it might be convened, called it into active energy. Solon, however, restricted the subjects discussed in the Ecclesia to such as had before passed through the senate of five hundred; but when the democratic spirit of after times prevailed, this rule was not at all strictly observed. The magistrates who had the management of these assemblies were the Prytanes (*see* PRYTANES), the Prohedri (*see* PROHEDRI), and Epistates (*see* EPISTATES). The first of these sometimes convened the people, and hung up in a conspicuous place a programme giving an account of the matters to be discussed. The *Prohedri* proposed to the people the subjects on which they were to decide, and counted the votes. The *Epistate*, who presided over the whole, gave the liberty of voting, which might not be done before his signal was given.

The forms of their proceedings were as follow: — First, an expiatory victim was sacrificed, and his blood carried and sprinkled round the bounds of the assembly. Then the public crier demanded silence, and invited all persons above fifty years of age to speak; after that, any one who pleased. After the subject was discussed, they proceeded to vote on the crier's demanding of them, "whether they would consent to the decree proposed to them?" The votes were commonly given by show of hands, but on some occasions by ballot. When the suffrages had been examined and their numbers declared, the *Prytanes* dissolved the assembly. In order to incite the people to attend the Ecclesia, a small pay of one or three oboli was given for early appearance; and a rope, rubbed with vermilion, was carried through the Agora, to mark such as lagged behind, who were accordingly fined.

ECCLE'SIA'STES. One of the canonical books of the Old Testament, so called from the Greek word signifying a preacher. Solomon is generally supposed to be the author of this book, though various opinions have been entertained on the subject; and indeed the whole question of its author, date, and design is involved in such difficulty, "that the labours of critics and commentators serve rather to perplex than to assist the inquirer." (*Holden on Eccles.*)

ECCLE'SIA'STIC. Something pertaining to or set apart for the church; in contradistinction to *civil* or *secular*, which regards the world. Ecclesiastics are persons whose functions consist in performing the service or in maintaining the discipline of the church. *See* CLERGY.

ECCLESIASTICAL COURTS. The ordinary Ecclesiastical Courts in England and Wales are, beginning with the lowest, —

1. The Peculiar Courts, which are very numerous; Royal, Archiepiscopal, Episcopal, Decanal, Sub-decanal, Prebendal, Rectorial, and Vicarial; with jurisdiction frequently extending only to a single parish, and sometimes limited only to a part of the matters usually subject to ecclesiastical cognizance.

2. The Archdeacon's Court, generally subordinate, with an appeal to that of the bishop.

3. The Courts of Commissaries, especially appointed by the bishop.

4. The Diocesan Court of every bishop within his respective diocese.

5. The Provincial or Archiepiscopal Courts.

These, in the province of Canterbury, which contains twenty-two dioceses, are —

(1.) The Court of Peculiars, which takes cognizance of matters arising in some particular deaneries.

(2.) The Prerogative Court. This court has authority in the matter of all wills or administrations of property left by persons having *bona notabilia*, that is, personal estate to a certain amount, within several dioceses of the province. It grants administration to the effects of all such persons dying intestate, and probate of wills.

(3.) The Court of Arches, or Supreme Provincial Court of Appeal. It also may take original cognizance of causes, by letters of request from the inferior courts; and it has a separate jurisdiction of its own in suits for legacies.

The province of York, including four dioceses besides that of Sodor and Man, has two courts; the Prerogative Court, and the Chancery or Court of Appeal.

A suit is commenced in the Ecclesiastical Courts by a process, sued out by the party complaining, and served on the other party by an officer of the court. The party cited may appear either in person or by his proctor, who discharges duties similar to those of the attorneys in common law courts. A party disobeying citation may be pronounced contumacious, and imprisoned by an attachment out of the lord chancellor's court.

In case the party cited appear to show cause against his citation that the court has no jurisdiction, or that he is not amenable to it, this preliminary objection is heard upon petition and affidavits. If the judge decide against the defendant on the question of jurisdiction, the latter may apply to the courts of common law for a prohibition.

If the cause proceed to trial, the plaintiff's first statement of facts is termed, in criminal cases, *articles*; in testamentary causes, an *allegation*; in other civil proceedings, a *libel*. Every subsequent plea in all cases is called an allegation; and every allegation is divided into separate heads or articles; so that witnesses are produced and examined, not as to the whole allegation, but as to such special facts as may be within their knowledge. Where a plea has been admitted, a certain time, or *term probatory*, is allowed to the party making it to examine his witnesses.

The witnesses are either brought to London, or examined in the country by a commission. The depositions are taken in private, and in writing, by the examiners of the court; who, on view of the allegations, examine the witnesses by such questions as they judge most proper to elicit the truth. The cross-examination is conducted by means of interrogatories, delivered by the adverse party to the examiner, and by him addressed to the witness. The examinations are kept secret until publication passes; after which either party is allowed to except, by a plea called an exceptive allegation, to the credit of an adverse witness.

When the cause is heard, the judge first peruses and carefully considers all the pleas and evidence, and then hears the case argued by counsel. Judgment is given in open court; and execution enforced by the compulsory process of *contumacy*, *significavit*, and *attachment*. Such is a very general view of the ordinary process of these courts.

If either party be condemned in costs, the other party's bill is taxed by the registrar. But the costs due by a party to his own proctor cannot be recovered in this court, and must be sued for by an action at law.

The law of the Ecclesiastical Courts is administered by men associated, as a distinct profession, for the practice of the civil and canon laws. They are incorporated as "the college of doctors of law." Every advocate must have taken that degree in the university of Oxford or Cambridge. From the college of advocates the archbishop selects the judges of the provincial courts.

The jurisdiction of these courts may be considered as threefold: — 1. In causes of a purely spiritual nature pertaining to the discipline of the church; 2. In mixed causes, partaking of a spiritual and civil nature; 3. In causes of a purely civil nature.

1. The first of these branches arises out of the natural power exercised by every church to correct its communicants by censures and discipline submitted to. Under this class falls the cognizance of offences committed by the clergy themselves by neglect of duty, immoral or heretical delinquencies, suffering dilapidations, &c.; also by laymen, in brawling and other indecent conduct in churches and churchyards, in neglecting to repair churches, in cases of incest, incontinence, defamation. All these, except the last, are termed "causes of correction." The punishments inflicted are monition, penance, excommunication, suspension *ab ingressu ecclesiæ*, and (in the case of clergymen) suspension from office and deprivation. In the case of laymen a great part of this jurisdiction has fallen into disuse; and the real penalty, whenever a cause is tried, consists, for the most part, in the payment of costs by the guilty party. The terrors so long attached to the process of excommunication (the only one by which ecclesiastical courts can enforce a sentence), are now matter of history. By the common law a person excommunicated was incapacitated from any legal act, and was, moreover, on certificate from the bishop, liable to imprisonment until reconciled to the church; but now, by the statute 53 George 3. chapter 127., the writ de contumace capiendo is substituted for the old writ de excommunicato capiendo in cases of contempt; and in the few cases in which excommunication is still pronounced as a sentence the court is empowered to assign a term of imprisonment, not exceeding six months. 2. Causes of a mixed description are suits for tithes, church rates, seats in churches, and faculties; which concern the temporals or external possessions of the church. The subtraction of tithes or other ecclesiastical dues may be complained of in the Ecclesiastical Courts; but if any question of law arises on the defence, as where modus or prescription is relied on against a claim of tithe, either party may apply for a *prohibition* from the King's Bench, as the Ecclesiastical Court has not authority to decide the point of law. Suits of this description are consequently of rare occurrence. The Ecclesiastical Court exercises jurisdiction to enforce the payment of church rates; but where the amount to be recovered does not exceed 10*l.*, and the validity of the rate is undisputed, two justices may enforce payment by distress. 3. Exclusive property in a seat in the body of the

church can be claimed only in virtue of a faculty, that is, a grant from the ordinary (or immediate ecclesiastical superintendent); or of a prescription, that is, immemorial usage, presumed to be founded on a faculty. But the courts of common law interfere, — 1. Where the pew is claimed as annexed to a house; 2. In all cases of prescription, in which a prohibition will be granted to remove the cause from the ecclesiastical tribunal in order to have the prescription tried by a jury. Causes of a purely civil nature, although in their origin supposed to possess something of a spiritual character, are testamentary and matrimonial. And these constitute the bulk of the business transacted in our Ecclesiastical Courts. The jurisdiction of these courts over wills is of very ancient date in England; while it either ceased at an early period or was never held valid in other Christian countries. The distribution of the personal effects of persons who died intestate was entirely at the discretion of the ordinary. This is one of the rights confirmed to the prelates by Magna Charta. The absolute power of the ordinary was first limited by Edward I., in whose reign he was compelled to discharge the intestate's debts; and in the reign of Edward III. he was obliged to divide them, by means of administrators, among the kindred of the deceased, in proportions which were finally determined by the Statute of Distributions. *See* Administration.

As a natural consequence of their power to distribute intestates' effects, the bishops acquired a jurisdiction over wills, both to determine their validity, and to decide disputes respecting bequests of personal property; hence arose the *granting probate of wills*, and suits for legacies. (*See* Will.) The courts of common law exercise exclusive jurisdiction over all testamentary devises of real estate; the ecclesiastical courts possess a similar power over bequests of personal estate; but courts of equity have no authority to determine the validity of a will of any description of property. Hence, in a devise of land, a judge and jury determine on vivâ voce evidence; in a bequest of personalty, the judge of the ecclesiastical court on depositions reduced into writing; and when the will relates both to real and personal estate, there may be a double trial and conflicting determinations.

Matrimonial causes form the next and most important branch of ecclesiastical jurisdiction. (*See* Marriage, Law of.) Directly, the ecclesiastical courts have the sole cognizance of the validity of a marriage; but indirectly, the common law courts assume this jurisdiction whenever the question arises in a civil or criminal proceeding before them.

ECCLE'SIA'STICUS. An apocryphal book, composed, as is generally supposed, by Jesus the son of Sirach, and admitted by the Romish church into the canon of the Old Testament. This book was originally written in Syro-Chaldaic, and consists chiefly of meditations relating to religion and the general conduct of human life. It displays but little regard for methodical arrangement; but the style is so highly poetical, and the sentiments so profound, that Addison (*Spectator*, No. 60.) has pronounced it one of the most brilliant moral treatises on record.

ECCOPRO'TICS. (Gr. ἐκ, *out*, and κοπρος, *excrement*.) The term formerly applied to mild aperient medicines.

E'CHEA. (Gr. ἠχεω, *I sound*.) In Ancient Architecture, sonorous vases of metal or earth in the form of a bell, used in the construction of theatres for the purpose of reverberating the sound of the performer's voice. They were distributed between the seats; and are described in the fifth book of Vitruvius, who states that Mummius introduced them in Rome, after the taking of Corinth, where he found this expedient used in the theatre.

E'CHELON (Fr.), in the art Military, signifies the position of an army, when its divisions are so formed as to be behind one another in the form of steps.

ECHI'DNA. In Grecian Mythology, the daughter of Geryon and the sea-nymph Callirhoe, or of Tartarus and Gaia; a monster that devoured travellers: parent, according to Hesiod, of those well-known terrors of ancient Greece, — Cerberus, the Hydra, the Sphinx, and the Nemean lion. Hence some suppose the name to represent a sort of general type of monsters and terrific phenomena.

Echi'dna. In Zoology, a name proposed by Cuvier for a genus of Australian quadrupeds, having the general form of an ant-eater, but covered with spines. The *Echidna*, like the *Ornithoryhnchus*, deviates in a remarkable manner from the typical structure of the mammalia in general in the organization of the generative and osseous systems, and forms with it a family or order called *Monotrema*. (See that word.) In the male of the *Echidna*, as in the *Ornithorhynchus*, the hind foot is armed with a curved spur, perforated like the fang of a viper by the duct of a poison gland, whence probably the reason for the name. Among the colonists of Australia, the *Echidna* is generally known by the name of the porcupine. It frequents sandy localities, lives in burrows, and feeds on ants and other insects, which it entraps by means of a long and adhesive tongue.

ECHINA'TUS, in Botany, signifies bristly.

ECHI'NOCO'CCUS. (Gr. ἐχινος, *a spine*, and κοκκος, *a cyst*.) A genus of Hydatids or Cystic Entozoons, of which one species (*Echin. hommis*) is recorded by Rudolphi as infesting occasionally the human subject.

ECHI'NODERMS, *Echinoderma*. (Gr. ἐχινος, *a hedgehog*, and δερμα, *skin*.) A name applied to a class of Invertebrate animals, which have a crustaceous or coriaceous integument, most commonly armed with tubercles or spines.

ECHINO'PORA. (Gr. ἐχινος, *a spine*, and πορος, *a pore*.) A subgenus of *Madrepores*. See that word.

ECHI'NUS. (Gr. ἐχινος.) The generic name of the sea-urchins, which constitute the type of the class *Echinoderma*. The Linnæan genus is now subdivided into many subgenera; some of which have their names compounded of Echinus and some other word, as *Echinobrissus, Echinocidaris, Echinoclypeus, Echinoconus, Echinocorys, Echinocyamus, Echinodiscus, Echinoampas, Echinometra, Echinoneus, Echinorodon*, &c.

Echinus. In Architecture, the same as the ovolo or quarter round, though the moulding is only properly so called when carved with eggs and anchors. (*See* Anchors.) It is the shell or husk of the chesnut, though the ornament does not seem to bear much resemblance to it.

E'CHO. (Gr. ἠχω, *sound*.) A sound reflected from a distant surface, and repeated to the ear. When sound in its passage through the atmosphere meets an obstacle, the molecules of air in vibration are reflected in the same manner as elastic bodies, and communicate to the contiguous molecules a vibratory motion, which is propagated in the direction determined by the inclination of the opposing surface to the original direction in which the sound reaches it, the angle of incidence being equal to the angle of reflection. Though echo is a simple consequence of the reflection of sound, several conditions must be fulfilled before it can be produced. In the first place, it is necessary that the ear be situated in the line of the reflection; and in order that the person who emits the sound may himself hear the echo, this line must be perpendicular to the reflecting surface, at least if there is only one reflecting surface; but if there are several such surfaces properly disposed, the sound may be brought back by a series of successive reflections to the point from which it emanated. In the second place, it is necessary that the opposing surface be at a certain distance from the ear; for if the direct and reflected sound succeed each other with great rapidity, they are in some measure confounded, and the echo cannot be distinguished. Hence large rooms and vaulted caves have a strong *resonance*, but no echo is produced by them; the proximity of the walls rendering it impossible to distinguish the reflected sounds.

Observation proves that sound passes through the atmosphere at the rate of about 1125 feet in a second; hence a person placed at half that distance, or 512 feet from the reflecting surface, would hear the echo exactly one second after the sound was emitted by him, and the echo would repeat as many distinct sounds as the ear can distinguish in a second. The utmost number of sounds which any ear can distinguish in a second perhaps does not exceed ten; hence the least distance of the reflecting surface from the point whence the sound is emitted must be about 50 feet, in order that an echo may be produced.

Every thing which is capable of reflecting sonorous pulses may cause an echo; whence the wall of a house, or the rampart of a city, a wood, rocks, or mountains, produce echos. Unless, however, the surface which reflects the sound is of considerable extent, the echo will be too feeble to be heard. A certain degree of concavity in the surface, by which several diverging rays of sound are collected and concentrated at the point where the echo is audible, if not absolutely essential, is at least highly favourable to the production of echos. It is a property of the ellipse that every sound proceeding from one of its foci, and impinging against the curve, is reflected into the other focus; whence two persons placed in the two foci of an elliptic chamber may converse with each other in a whisper, and their voices not be heard by those who are in the other parts of the room. Hence also walls or buildings approaching to the elliptic form return sounds with great distinctness and force. In the whispering gallery of St. Paul's, the faintest sound is conveyed from one side of the dome to the other, but is not heard at any intermediate point. In Gloucester cathedral a gallery of an octagonal form conveys a whisper 75 feet across the nave. Some echos are remarkable for their frequency of repetition. An echo in Woodstock Park repeats 17 syllables by day and 20 by night. Southwell (*Phil. Trans.* 1766) describes an echo in the Simonetta palace, near Milan, which repeated the report of a pistol 60 times. In *Birch's History of the Royal Society*, an account is given of an echo at Rosneath, near Glasgow, that repeats a tune played with a trumpet three times, completely and distinctly.

Echo, in Architecture, is a term often applied, though improperly, to certain vaults and arches, usually of an elliptic or parabolic form, made for the purpose of producing artificial echoes.

ECHO'METER. In Music, a sort of scale or rule, marked with lines, which serve to measure the duration of sounds, and to ascertain their intervals and ratios.

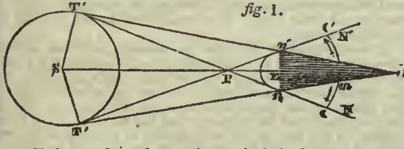
ECLE'CTICS. (Gr. ἐκλέγω, *I pick out.*) Those philosophers who endeavour to select from the systems of various schools those doctrines alone which are true, and to present these in the form of an entire whole. An eclectic spirit, it is evident, can only arise at a period of some maturity in philosophical speculation. Whether or not it is to be regarded as an evidence of the decay of original power in the age in which it appears, must depend on the less or greater coherence in the system when completed. In one sense of the word, Plato and Aristotle may be regarded as eclectics. They both availed themselves largely of the labours of their predecessors. Plato, in particular, comprehended in his scheme of philosophy the whole of more than one foregoing system; as the doctrine of Heraclitus of the perpetual flux of sensible objects, and the consequent uncertainty of sensible impressions. But in the hands of these great thinkers the *discerpta membra* are reunited, and endued with a principle of vitality as constituent parts of a harmonious whole. The same cannot be said of others who have adopted a similar method; especially of most of those to whom the term *eclectic* has been more peculiarly applied. These philosophers lived chiefly under the Roman empire. The most celebrated among them may be said to have been Epictetus (A. D. 90) and Plutarch. The latter, in particular, a man of great and various endowments, may yet be taken as a striking instance of a false eclecticism. His great object, in his philosophical writings, seems to have been to reconcile the profound speculations and pure morality of the philosophers with the fanciful inventions and the gross theology of the poets and priests of Greece, Italy, or Egypt.

A far more favourable specimen of the eclectic spirit has been afforded us in modern times in the person of M. Victor Cousin, without doubt the most able and ingenious thinker of modern France. See his *Lectures on the Hist. of Philosophy*, in which eclecticism is presented under its fairest guise, and vindicated with the utmost vigour of style and acuteness of thought.

ECLI'PSES (Gr. ἔκλειψις, from ἐκλείπω, *I faint away or disappear*), taken in a general sense, are those phenomena which exhibit the obscuration of astronomical luminaries, and may be divided into two kinds, in reference to the circumstances under which they are presented; viz. 1. When the obscuration is caused by an interception of the light received by the luminary from the sun; as in the cases of eclipses of the moon, eclipses of Jupiter's satellites, &c. 2. When the obscuration is caused by an interception, either totally or partially, of the light transmitted from the luminary to the spectator; and this kind consists of eclipses of the sun, occultations of stars and planets by the moon, and the transits of Mercury and Venus over the disc of the sun.

The most popular and generally interesting objects are the eclipses of the sun and moon; and their causes and aspects will here deserve some explanation. The earth and moon being opaque bodies are illuminated by the sun; and, just as we observe with small opaque bodies on the surface of the earth which are within the range of ocular examination, they cast their shadows in directions which are opposite to the sun. As the figures of the bodies are nearly spherical, and as the sun is the largest, it is plain that these shadows must be very nearly of a conical form. The moon is eclipsed when it becomes involved in the shadow of the earth, and so deprived of the light it is accustomed to receive from the sun; and this can take place only at the time of full moon, or when the moon is in opposition to the sun. Let S represent the

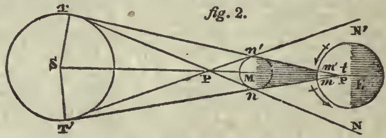
fig. 1.



sun, E the earth, and $n' t n$ its conical shadow, into which the rays of the sun do not enter. This shadow must evidently be a portion of the larger cone T t T′ which envelops both bodies. Suppose the plane of the paper to be the plane of the ecliptic, or the plane in which the earth moves round the sun, and let ☾ ☾′ represent a portion of the path of the moon round the earth, the arrows indicating the direction of her motion. Conceive also by means of cross tangents T P ☾, T′ P ☾′ the two opposite and circumscribing cones T P T′, ☾′ P ☾ to be drawn. The latter of these cones, ☾′ P ☾, is called the *penumbral cone;* and the space N n n' N′, projected beyond the earth, is called the *earth's penumbra*. It is evident that any position within this penumbra is at least partially deprived of the light of the sun; for if we imagine a spectator to be in that position, it is obvious that the interposition of the earth would act as a partial screen and obscure a portion of the sun's disc from his view. It is also evident that a greater portion of the disc of the sun would be hidden from this supposed spectator as his position approaches nearer to the earth's shadow; and that if we suppose him to enter the shadow, he will become totally deprived of the light of the sun, the disc of the sun in this case being entirely hidden by the intervention of the earth. From this observation it follows that as the moon advances in the penumbra from ☾ to m her disc will receive less and less light from the sun, and its brightness will gradually diminish; also, as soon as a portion of the moon's disc enters the shadow, that portion becomes totally deprived of the light of the sun, and is, in other terms, darkened or eclipsed. If in the course of the eclipse only a part of the moon's disc enters the earth's shadow, it is called a *partial eclipse;* but if the moon is totally darkened by the whole disc entering the shadow, it is called a *total eclipse*. It is to be understood in the diagram that the orbit of the moon, or the path she describes round the earth, is not in the plane of the ecliptic or the plane of the paper, but inclined to it at an angle always greater than 4° 57′ and less than 5° 21′. This is the reason why eclipses of the moon do not happen at every full moon, for they can only take place when the moon's elevation above the ecliptic at full moon happens to be less than the semidiameter of the section of the earth's shadow through which she passes. In the course of a year there may be three eclipses of the moon, which is the greatest number that can happen; but there must always necessarily be two.

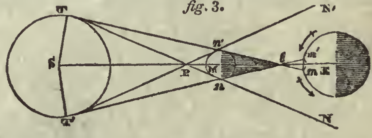
At the time of new moon, or when the moon is between the sun and the earth, her shadow or penumbra may fall on the disc of the earth at certain places, and prevent either all or part of the light of the sun from reaching those places on the earth's surface. This circumstance produces the phenomenon of a total or partial eclipse of the sun, which is limited to the portion of the earth on which the moon's shadow or penumbra happens to fall. The shadow of the moon does not always reach so far as the earth. In the two following diagrams, annexed by way of illustration, the former represents the case in which it does reach, and the latter represents the case in which it

fig. 2.



does not reach, the surface of the earth. The shadow of the moon in the first diagram falls upon a portion of the earth's surface between m and m'; and the inhabitants, if any, of that portion, will evidently, from what has been said before, have the sun's disc wholly covered by the intervention of the dark body of the moon, and therefore

fig. 3.



have presented to them a *total eclipse of the sun*. But in the second diagram, where the shadow of the moon does not reach the earth, if we suppose the dark conical shadow $n t n'$ to be produced into the small opposite cone $m t m'$ meeting the surface of the earth, it will be obvious, after a slight consideration, that any supposed spectator within this latter cone, or any inhabitant of the portion $m m'$ of the earth, will perceive the dark body of the moon wholly within the disc of the sun, and intercepting only an interior part of his light; the unobscured part of the sun which circumscribes the disc of the moon will consequently present the appearance of a beautiful luminous ring or annulus, and the eclipse exhibiting this aspect is commonly called an *annular eclipse* of the sun; the cone $m t m'$ may be similarly called the *annular cone*. It does not always occur, during the progress of an eclipse of the sun, that either the dark shadow of the moon or the annular cone will fall on the earth's surface, and it very rarely happens that either of them will fall on any defined spot, such as London or Edinburgh. For the occurrence of an eclipse on the earth, it is only necessary that the moon's penumbra N n n' N′ shall be projected against a portion of the terrestrial surface, as an inhabitant of that portion will at least have a part of the disc of the sun intercepted by the moon. When neither the moon's shadow nor the annular cone meets the earth in the course of an

eclipse, and consequently only a part of the sun's disc is obscured to terrestrial vision, it is called a *partial eclipse of the sun*, and in that respect it is similar to a partial eclipse of the moon. If in the two diagrams we suppose, as before, the plane of the paper to be the plane of the ecliptic, the position of the moon must not necessarily be considered to be in that plane. The north pole of the earth will be directed upwards at an angle of about 23° 28′, and the arrows will represent the direction in which the earth revolves about its axis; the moon proceeds round the earth in the same direction, and carries her penumbra across the earth's surface with a much greater velocity than the earth's rotation. It follows, therefore, that the arrows indicate also the direction in which the phenomena of the eclipse pass geographically over the earth, viz. from west to east; and that different places will have the eclipse at a later or earlier time, according as they are more to the east or west. Eclipses of the sun occur more frequently than eclipses of the moon. In the course of each year there must be two at least in some parts of the earth; but there cannot possibly be more than four,—a number that sometimes, though very seldom, happens.

Calculation of Eclipses of the Sun and Moon.—It is here chiefly intended to explain methods by which the times of beginning and ending of any phase or appearance may be predicted for a particular place on the earth. For these calculations it is necessary, first, to ascertain the longitudes and latitudes of the sun and moon by means of the solar and lunar tables. Those of the sun may be determined from the revised tables of Carlini, which form the supplement to the *Milan Ephemeris* for the year 1833; and those of the moon may be calculated from the tables of Burckhardt or Damoiseau. With the help of the tables, the hourly variations of the same quantities, as well as the horizontal parallaxes and semidiameters of both bodies, are to be calculated. The results so found will be elements from which the phenomena of the eclipse may be determined for any stated place on the earth; but their computation is necessary only for eclipses that occur at remote periods, since all these calculations are accurately executed and registered in the *Nautical Almanac*, a work regularly published three or four years in advance. The positions are there likewise reduced to the plane of the equator, so as to determine the places of the bodies by their right ascensions and declinations, which are more readily applicable to the calculation of *all* the circumstances of an eclipse; besides, the right ascensions and declinations of the moon are given with the utmost precision for every hour, which adds considerably to the facility of these calculations. It will here be the more generally useful and interesting, therefore, to describe methods by which, with the use of the *Nautical Almanac*, the circumstances of an eclipse may be predicted, as it will appear from any given spot on the earth's surface.

In the diagram (*fig.* 1.) join E m, E ☾, S n, and denote

E mn = the moon's horizontal parallax, by P,
E S n = sun's —— by π,
T n S = sun's semidiameter, by σ;

then the angle M E m is the semidiameter of the section of the earth's shadow traversed by the moon, as it would be seen from the centre E; and the angle M E ☾ is the similar semidiameter of the penumbra. To determine the semidiameter of the section of the shadow, we have mEt = Emn − Etm = Emn − (SnT − nSt) = Emn + nSt − SnT; that is, the semidiameter of the shadow = P + π − σ. This value, however, is affected by the atmosphere of the earth, which absorbs those rays of the sun that would pass near to the surface, and thus makes the shadow of the earth to appear sensibly larger. To take this effect into account, it is the usual practice of astronomers to increase the value given by the preceding expression by one-sixtieth, or to add as many seconds as there are minutes in the radius of the section. The actual formula employed in this calculation is therefore

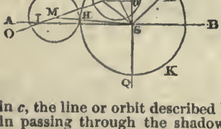
$$\text{Semid. of shadow} = \frac{61}{60}(P + \pi - \sigma).$$

By adding to this the angle m E ☾ = mn ☾ = T n T′ = 2σ, we have also,

$$\text{Semid. of penumbra} = \frac{61}{60}(P + \pi - \sigma) + 2\sigma.$$

Let the circle H H′ K represent the section of the earth's shadow through which the moon passes during the eclipse; P Q a portion of the circle of declination which passes through the centre S and the north and south poles, P being towards the north, and S towards the south; A B a portion of the parallel of declination, which also passes through S; O R, intersecting P Q in c, the line or orbit described by the centre of the moon in passing through the shadow; M her position when

Fig. 4.



she first comes into contact with the shadow, and begins to be eclipsed at H; m her position at the middle of the eclipse, or time of greatest obscuration; and M′ her position at leaving the shadow when the eclipse ceases. In the figure, for the sake of convenience, the shadow is supposed to be fixed; and hence the motion of M is not considered to be the entire motion of the moon, but the motion with which she passes through the shadow, or, as it is called, the relative motion of the moon. This relative motion is equal to the difference between the motion of the moon and that of the shadow. But as the centres of the sun and shadow must always be in opposite points of the sphere, as seen from the centre of the earth, the motion of the shadow will be just the same as that of the sun.

At any assumed time T, near to the time of opposition, let a be the position of M, and draw ab parallel to A B; at this instant let α denote the difference between the right ascensions of the moon and shadow; also let x = Sb, and y = ab. Then, from what has preceded,

Right ascension shadow = right ascension ☉ ± 12ʰ.

Declination shadow = declination ☉ with a contrary name.

α = right ascension shadow − right ascension ☾
x = declination ☾ − declination shadow
= declination ☾ + declination ☉.

But as $ab = y$ may be considered to be part of a parallel of declination, and as α is the spherical angle it subtends from the pole, it is evident that $y = \alpha \times$ cos. ☾'s declination. We must therefore first calculate the following quantities:—

Right ascen. shadow = right ascen. ☉ ± 12ʰ.
y = (right ascen. shad. − that of ☾) × cos. ☾'s dec.
hourly mo. y = (hor. mo. ☾'s right ascen. − that of ☉) × cos. ☾'s dec.
x = ☾'s dec. + ☉'s dec.
hourly mo. x = hor. mo. ☾'s dec. + hor. mo. ☉'s dec.

It will be here observed that hourly mo. y denotes the decrease of y, while hourly mo. x denotes the increase of x, in one hour.

If i denote the angle c I S or m S c, which is the inclination of the relative orbit O R with the parallel A B, we find also,

$$\tan. i = \frac{\text{hourly mo. } x}{\text{hourly mo. } y}$$

$$\text{hourly motion in the orbit } o\text{R} = \frac{\text{hourly mo. } y}{\cos. i}.$$

Again, in the right-angled triangle abS, knowing the sides Sb = x, and ab = y, we calculate the angle aSb and the distance Sa. The difference of the angles aSb, mSc, gives the angle aSm; and in the right-angled triangle aSm, knowing also the side aS, we find the other two sides am, Sm, the latter of which is the nearest distance of the centres of the moon and shadow. The distance S M, at the beginning or ending of the eclipse, is found by adding the semidiameter of the moon to that of the shadow; hence, in the triangle M S m, knowing also the side Sm, we find the side Mm = mM′; and by subtracting and adding the value of am, before found, we get the distances Ma, aM′. Knowing therefore these distances, and the hourly motion in the orbit O R, we find the times employed by the moon in traversing them: the former of these times, subtracted from the time originally assumed at which the elements were taken, will therefore give the time of the beginning of the eclipse; and, similarly, by adding the latter, we get the time at which the eclipse will terminate. The times thus found will be for the meridian of Greenwich, and will require reducing for the longitude of the place.

To those who are not familiar with algebraical operations, a rough sketch of the figure, drawn by the hand, will indicate most distinctly the way in which the several angles and lines ought to be combined in the process of the calculation.

For an eclipse of the sun the relative positions of the sun and moon are not independent of the observer's position, like those of the moon and the earth's shadow. In the calculation of an eclipse of the sun, we must first apply the effects of the relative parallax to the right ascension and declination of the moon to get her exact position with respect to the sun, as she will appear to a spectator at the place for which the calculation is proposed to be made. (See the article PARALLAX.) By subtracting and adding the hourly motions, given in the *Nautical Almanac*, we obtain the values of the quantities for an hour before and after the time of conjunction in right ascension. Then, after calculating and applying the effects of parallax to the moon, we find the quantities x, y, in the same manner as for an eclipse of the moon, only substituting the sun in place of the sections of the earth's shadow. The half differences of the quantities so computed for an interval of two hours will show their apparent hourly motions; and with these the remaining calculation, for either time, is precisely the same as has already been described for an eclipse of the moon. It is only further to be observed, that as the apparent relative motion of the moon is not

very uniform, the results will be most accurate when they are close to the times assumed. If a very accurate calculation of the beginning or ending be required, it will, for this reason, be necessary to repeat the calculation for a single assumed time close to the occurrence of the phase; and for this purpose we may adopt the hourly motions in the first calculation. In these cases, greater accuracy is to be obtained by interpolating the right ascensions and declinations from the running ephemeris than by inferring them from the list of elements.

ECLI'PTIC. In Astronomy, the great circle of the heavens which the sun appears to describe in his annual revolution. It has been called the *ecliptic*, because eclipses only happen when the moon is in the same plane, or very near it. The ecliptic, from time immemorial, has been conceived to be divided into twelve equal parts, called *signs*, — Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricornus, Aquarius, Pisces. But the signs of the ecliptic are not to be confounded with the *signs of the zodiac*, which denote the places occupied by certain constellations, and consequently never alter their position in the heavens. The signs of the ecliptic denote merely arcs of 30°; and as they are reckoned from the intersection of the equator and ecliptic, which is not a fixed point, their limits are not, in all ages, determined by the same stars.

The ecliptic is the circle to which longitudes and latitudes in the heavens are referred, as right ascensions and declinations are referred to the earth's equator.

The angle which the plane of the ecliptic makes with the plane of the equator is called the *obliquity of the ecliptic*. It is to the oblique position of these two planes that we owe the vicissitudes of the seasons. If the equator coincided with the ecliptic, the days and nights would always be equal at all parts of the earth, and there would be no summer or winter.

The obliquity of the ecliptic at the present time (Jan. 1. 1840) is 23° 27′ 36·52″. (*Nautical Almanac.*) This quantity, besides being subject to a periodic variation of about 18″, arising from the nutation of the earth's axis, is affected by a *secular* inequality, of which the period is not ascertained. By comparing the observations of the present times with those made in former ages, it is found that the obliquity has continued to undergo a slow progressive diminution, the rate of which appears to be about 45″ in a century, amounting to a fourth of a degree since the time of Hipparchus. The planes of the ecliptic and equator have consequently been approaching each other during the last 2000 years; but though mathematicians have not yet ventured to assign the limit of this approach, it cannot exceed a certain small quantity; and, after a few thousand years more, the two planes will begin again to recede. The diminution of the obliquity is caused by the action of the other planets, particularly Venus and Jupiter, on the earth; in virtue of which action the plane of the earth's orbit is drawn, as it were, nearer to the planes of these two planets. *See* NUTATION, and PRECESSION OF THE EQUINOXES.

ECLIPTIC DIGITS. *See* DIGITS.

ECLIPTIC LIMITS, are the greatest distances at which the moon can be from her nodes, in order that an eclipse of the sun or moon may happen. When the moon is within those limits at the time of the new or full moon, an eclipse certainly happens; but when the moon is beyond those limits, an eclipse cannot happen. The limits for an eclipse of the sun are about 17°, and for an eclipse of the moon about 12°.

E'CLOGUE. (Gr. ἐκλόγη, *a selection.*) In the original meaning of the word, the select or choice pieces of an author; or extracts collected out of former works, such as were termed in Latin *excerpta*. It is not known how this title was originally given to the pastoral poems of Virgil; but from the circumstance of their being so named, the word eclogue in modern usage is applied to that species of poetry. The persons who are introduced conversing in eclogues, or whose adventures are recounted in them, are shepherds; that is, for the most part, imaginary personages, whose sentiments, and the external circumstances among which they live, belong rather to an ideal age of gold than to the realities of modern life; and their loves constitute the main and proper subjects of the eclogue. Nevertheless various writers (Gay, &c. among ourselves) have endeavoured, but with little success, to give an air of greater reality to pastoral poetry, and give their rustics more of the costume and diction of actual clowns; but the result has been a species of burlesque, not at all answering to our conceptions of pastoral poetry; nor can we easily imagine that the personages of Theocritus, although the earliest and therefore the simplest of pastoral poets, are correct resemblances of the Sicilian rustics among whom the writer lived. The eclogues of Virgil are of various descriptions: some of them only have the true character of pastorals; others contain occasional poems on public and private events of the day, very slightly enveloped in the pastoral costume. The characteristics of this species of poetry, as assumed by the moderns, are, first, the representation of nature in soft and quiet scenes of cultivation; secondly, a slightly dramatic turn either of action or narration; thirdly, characters whose sentiments and language are confined within certain peculiar limits: thus, any strong emotion, virtue, or vice, would be an unfit topic for a pastoral poet to dwell upon. Among ourselves, Spenser, Philips, and a few others, may be named as pastoral poets in the strict sense of the word; others, as Milton in his *Lycidas*, have assumed the pastoral costume in order to convey a very different class of ideas. It is worthy of remark, that this species of composition is among those which have wholly disappeared in the present day: we have had no pastoral poet since Gay and Collins; and Gesner, in Germany, is the latest author who has acquired any degree of celebrity in this line. *See* IDYLL, BUCOLIC.

ECO'NOMY, POLI'TICAL. *See* POLITICAL ECONOMY.

ECTHY'MA. (Gr. εκθυω, *I break out.*) An eruption of pimples or small pustules common in young persons after having overheated themselves, or eaten indigestible and greasy things. Analogous eruptions are seen upon infants, especially those who are ill-nursed. Proper diet, mild aperients, especially small doses of rhubarb and magnesia, generally carry them off.

ECTRO'PIUM. (Gr. εκτρεπω, *I evert.*) An unnatural eversion of the eyelids, arising from tumefaction of the inner membrane, or from a contraction of the skin covering the eyelid.

ECZE'MA. (Gr. εκζεω, *I boil out.*) An eruption of the skin frequently observed in irritable habits, and sometimes mistaken for the itch: it is not pustular, but consists of small vesicles, often forming patches or blotches, and producing, as they die off, a desquamation of the cuticle. Alteratives and cooling local applications are the remedies usually resorted to for the relief of this complaint.

E'DDA. The ancient collection of Scandinavian poetry in which the national mythology is contained. There are two Eddas: the older is believed to have been reduced to writing, from oral tradition, in Iceland, between A.D. 1050 and 1133. It was recovered and published in Denmark in 1643. The new Edda, supposed to have been composed 200 years after the former, is an abridgment of it, with a new arrangement of its parts. It was translated by Resenius in 1640, and is thence called the Resenian Edda. The authenticity of these monuments of an early age has been doubted in recent times, but the latest researches of critics (the brothers Grimm and others) seem to go far towards establishing it. (See the *Penny Cyclopædia.*)

E'DDY (Sax. ed, *water*, and ea, *backwards*), is the water of a stream or tide which, in consequence of striking against some obstacle, is thrown backwards, and runs in a direction opposite to that of the general current. More frequently, however, the term is used to denote the whirling or circular motion caused by the meeting of two opposite currents; and, in this sense, it is also applied to a similar motion of the atmosphere. *See* WHIRLPOOL, WHIRLWIND.

EDE'NTALS, *Edentata*. The name of an order of Mammals, including those genera in which the dental apparatus is more or less incomplete: the incisive teeth are almost always deficient.

E'DICT. (Lat. edico, *I speak out.*) An instrument signed and sealed by a despotic prince to serve as a law to his subjects. In ancient Rome, the ordinances of the magistrates, but especially of the two prætors, *prætor urbanus* and *prætor peregrinus*, were so called. Previously to the time of Augustus, the grand principles of Roman law were exceedingly ambiguous and undefined; and to remedy this defect in some measure, the prætors used to publish, on their accession to office, *edicts* or rules for regulating the practice of their courts, as well as for their own guidance in the decision of doubtful cases. A jurisdiction, however, thus vague and arbitrary in its nature being constantly abused, it was enacted by the Cornelian Law (B.C. 56), that the prætor of the year should be compelled to adhere to the spirit and letter of his first proclamation. The edicts of the preceding prætor were not binding on his successor. If the latter confirmed them, they were styled *edicta vetera* or *tralatitia;* in contradistinction to *edicta nova*, those framed by himself. (*See* PRÆTOR.) Under the emperor Hadrian, a digest of the best decisions of the prætors from the earliest times was made by Sylvius Julianus, collected into a volume called *Edictum Perpetuum*, or Perpetual Edict, ratified by the emperor and senate, and fixed as the invariable standard of civil jurisprudence.

The *Edict of Milan* was a proclamation issued by Constantine after the conquest of Italy (A.D. 313), to secure to the Christians the restitution of their civil and religious rights, of which they had long been deprived, and to establish throughout his extended dominions the principles of a wise and enlightened toleration.

The most famous edict of modern history is the Edict of Nantes, issued by Henry IV. in 1598, to secure to the Protestants the free exercise of their religion. This act, after continuing in force nearly a century, was repealed

by Louis XIV.; and, as is well known, its revocation led to a renewal of the persecutions and bloody scenes which previously to the issuing of this edict had been enacted against the Protestants. The depopulation caused by the sword was also increased by emigration. Above half a million of her most useful and industrious subjects deserted France, and exported, together with immense sums of money, those arts and manufactures which had chiefly tended to enrich the kingdom. About 50,000 refugees passed over into England; and there can be little doubt that their representations of the cruelties perpetrated by the King of France tended to excite the suspicions of the English against their own Roman Catholic sovereign, and in some degree accelerated the advent of the Revolution of 1588. *See* HUGUENOTS.

In the French law, the term *edict* has a wide signification, being applied equally to the most momentous and the most trifling proclamations of the government.

E'DINGTONITE. A mineral found near Dumbarton in small greyish-white translucent prisms, composed of silica, alumina, lime, water, and probably some alkali.

EDI'TION (from the Latin verb edere, *to give out or publish*), means simply the (indefinite) number of copies of a work printed at one time, before the types are distributed by the compositor. Any one who prepares for publication the writings of another is said to edit them, and is called the *editor*. In literary language, since the invention of printing, the *editor* of a work revises, adds notes, prepares for the press, &c. &c.: the *publisher* is the bookseller who negotiates the sale of the impression. Sometimes (but especially in classical works) the edition goes generally by the name of the printer or publisher, sometimes by that of the editor. Thus, we have the Aldine and Elzevir Classics, &c., the houses of Aldus and Elzevir having been concerned both in printing and publishing; while *Bentley's Horace*, *Heyne's Homer*, &c., are so denominated from the name of the *editor*. In bibliographical works, *editio princeps* signifies the earliest printed edition of an author; *editio optima*, that which is generally regarded as the best, &c.

E'DITORS, are of different species:—1. Those who merely republish a text, or content themselves with adding notes and commentaries to it. 2. Those who superintend the publication of a work, receiving the manuscripts from one or more contributors; seeing that the object of the work is attained, that the language is correct, the illustrations appropriate, and the facts accurately stated, and that all the parts of the work are properly adjusted and made subordinate to each other.

E'DRIOPHTHA'LMA. (Gr. ἑδϱαιος, *fixed*, and ὀφθαλμος, *an eye*.) The name under which the Malacostracous Crustaceans with sessile eyes are grouped together.

EDUCA'TION (Lat. educare), in its most extended signification, may be defined, in reference to man, to be the art of developing and cultivating the various physical, intellectual, and moral faculties; and may thence be divided into three branches—physical, intellectual, and moral education. This definition is by no means complete; but it is used merely as indicative of the manner in which this subject has generally been discussed. Under physical education is included all that relates to the organs of sensation, and the muscular and nervous system. Intellectual education comprehends the means by which the powers of the understanding are to be developed and improved, and a view of the various *branches of knowledge* which form the objects of instruction of the three departments into which we have divided education. Moral education embraces the various methods of cultivating and regulating the affections of the heart.

The wide extent of this subject, and the infinity of collateral questions with which it is mixed up, would prevent us from entering into any details respecting it, even if the difficulty of communicating any satisfactory information upon so boundless a theme within our limits did not preclude us from the attempt. The influence which education has exercised in humanizing the world is universally acknowledged. Its importance has been recognized by philosophers and legislators in every age; and by all the nations, both of antiquity and modern times, which have become distinguished in history, it has been regarded as the chief element in the attainment and promotion of civilization. The reader will find, in the writings of Plato, Plutarch, and Quintilian, among the ancients, and in modern times of Locke, Rousseau, Basedow, Niemeyer, Rehberg, Cousin, &c., a view of the chief systems that have been proposed or adopted in reference to this subject; and for an account of the comparative merit of the different systems, and the innumerable controversies that have been maintained in regard to them, he may consult the *Edin.* and *Quar. Reviews*, passim, and the other periodical publications of England.

EDU'LCORA'TION. (Lat. edulcoro, *I purify* or *sweeten*.) A chemical term applied to the cleansing of substances, especially pulverulent precipitates, by the repeated affusion of water, so as to remove all soluble matters, and render them free from taste and smell.

EFFE'CT. (Lat. efficio.) In the Fine Arts, that quality in works of art whose nature is to give particular efficacy to other qualities, so as to bring them out and to attract the eye of the spectator.

EFFECT. *See* KEEPING.

EFFE'NDI. A Turkish word signifying *lord* or *superior*; applied to legal, ecclesiastical, or other *civil* functionaries, in contradistinction to *aga*, the name by which high *military* personages are designated. *See* REIS EFFENDI.

EFFERVE'SCENCE. (Lat. effervesco.) The escape of gaseous matter from liquids, as in the act of fermentation. All liquids from which bubbles of gas rapidly escape, so as to resemble boiling, are said to effervesce.

E'FFIGY. (Lat. effigies.) In Painting and Sculpture, the representation of an individual.

EFFLORE'SCENCE. (Lat. effloresco, *I flower*.) The spontaneous crumbling down of transparent crystals in consequence of the loss of water.

EFFLU'VIUM. (Lat. effluo, *I spread abroad*.) The vapours arising from putrefying matters.

EFFU'SION. (Lat. effundo, *I pour out*.) In Surgery, the escape of a fluid from the vessel naturally containing it; thus when the chest is wounded blood may be effused into the cavity of the pleura, and in injuries of the head blood may be effused upon the brain.

EGEON. *See* PONTOPTULUS.

E'GERAN. A variety of garnet found near Eger in Bohemia.

EGG. (Germ. ei.) The ovum of birds and oviparous animals. The changes which the hen's egg undergoes during incubation have been described by Sir E. Home in the *Philosophical Transactions* for the year 1822 (page 339.), and illustrated by a beautiful series of plates after Bauer's drawings: the same volume also contains a valuable paper by Dr. Prout on the same subject, but chiefly in reference to the chemical changes of the egg during that process. The specific gravity of new-laid eggs at first rather exceeds that of water, varying from 1080 to 1090; but they soon become lighter, and swim on water, in consequence of evaporation through the pores of the shell. When an egg is boiled in water, and suffered to cool in the air, it loses about 32 hundredths of a grain of saline matter, together with a trace of animal matter and free alkali. The mean weight of a hen's egg is about 875 grains, of which the shell and its inner membrane weigh 93·7 grains, the *albumen* or white 529·8 grs., and the yolk 251·8 grs. The shell contains about 2 *per cent.* of animal matter and 1 *per cent.* of the phosphates of lime and magnesia, the remainder being carbonate of lime, with a trace of carbonate of magnesia. When the yolk of a hard-boiled egg is digested in repeated portions of strong alcohol, there remains a white residue having the leading characters of albumen, but containing phosphorus in some peculiar state of combination: the alcoholic solution is yellow, and deposits a crystalline fatty matter, and when distilled leaves a yellow oil. The albumen of the egg contains sulphur. The use of the phosphorus is to yield phosphoric acid to form the bones of the chick; but the source of the lime with which it is combined is not apparent, for it has not been detected in the soft parts of the egg, and hitherto no vascular communication has been discovered between the chick and the shell.

The trade in eggs is of great value and importance; the number of eggs imported into this country from various parts of the Continent, for the year ending Jan. 5. 1839, was 83,745,723; and the gross amount of duty received for the same was 29,111*l*.

E'GLANTINE. (Fr. eglantier.) The old English name of the sweet-briar rose. The term is improperly applied by Milton to the honeysuckle.

EGYPTIAN ARCHITECTURE. *See* ARCHITECTURE.

EGYPTIAN BEAN. The fruit of the *Nelumbium speciosum* has been so called: it has been regarded as the forbidden bean of the disciples of Pythagoras.

EGYPTIAN PEBBLE. A species of agate or jasper.

EI'DER-DUCK. The species of duck tribe so called is one of the largest and most valuable of the *Anatidæ*, and, from certain modifications of the beak and sternum, constitutes the type of a subgenus, called *Somateria*. The common eider (*Somateria mollissima*) frequents in great numbers the Orkneys, Hebrides, and Shetland isles. It is defended from the cold of the dreary northern coasts by the development of an unusual quantity of the finest down beneath the dense exterior plumage, which is equally well adapted to form an impenetrable barrier to the wet. The down of the eider constitutes its chief value, as it combines with its peculiar softness, fineness, and lightness so great a degree of elasticity that the quantity of this material which might be compressed and concealed between the two hands will serve to stuff a coverlet.

As the female plucks from her own body a quantity of her finest down to line her nest, the Orcadians avail themselves of this instinct, and take an early opportunity to rob the nest of both eggs and down. She then begins to lay afresh, and envelops her eggs with another layer of down; and if this be removed, the male is said to contribute his own down when the female can afford no

more. Lastly, when the brood of ducklings is hatched, the nest is again visited and the down removed. Thus a considerable quantity of the valuable material furnished by the eider-duck is obtained independently of that which is plucked from the slaughtered birds. Besides the down and eggs, the islanders turn the skins and flesh of the eiders to profit; while these birds cost them no expense, as they feed entirely on sea-weed and other natural productions of the ocean.

EISTE'DDFOD. (Welsh, from eistedd, *to sit.*) The assemblies or sessions of the Welsh bards were so termed. (*See* BARD.) They were held, according to Pennant (*Tour in Wales*), at different places for the minstrels of their respective neighbourhoods; at Caerwys, at Aberfraw in Anglesea, and Mathravel in Powys. The judges were appointed by commissions from the Welsh princes, and after the Conquest from the English kings. The last was issued in 1568. But the Gwynnedigion and Cambrian Societies have lately revived the old custom; and annual meetings for the recitation of prize poems, and for performances on the harp, are now held under the name of Eisteddfod.

EJE'CTMENT, in Law, is a personal action in the form of trespass, in which a tenant for years claims damages for his expulsion from land demised to him; and it has become the usual form of trying questions of right to real property by a singular fiction. The party claiming land or its appurtenances not in his possession is the real plaintiff, through the means of a fictitious tenant (the celebrated John Doe), who complains of being ejected from his farm by the defendant. The defendant justifies by disputing the plaintiff's title to let the land; and if the plaintiff succeeds, he recovers not only *nominal* damages for his ejectment, but also *the land itself* for the term of Doe's supposed demise, and in fact for the term of his own right.

ELÆAGNA'CEÆ. (Elæagnus, one of the genera.) A natural order of shrubby arborescent Exogens inhabiting the entire northern hemisphere down to the equator, having leprous leaves, superior fruit, tubular calyx, and apetalous flowers. They are distinguished from *Thymelaceæ* by the ovule being erect, from *Proteaceæ* by the valvate calyx and the dehiscent fruit of the latter, and from *Santalaceæ* by the superior ovary. The berries of some species are eaten in Persia and Nipal.

ELÆOTE'RIUM. (Greek. ἔλαιον, *oil.*) In Ancient Architecture, an apartment in the ancient baths wherein the bathers anointed themselves after leaving the bath.

ELAI'DIN. A fatty matter produced by the action of nitric acid upon certain oils, especially upon castor oil.

ELAI'N. (Gr. ἔλαιον, *oil.*) That portion of fat or oil which retains a liquid state; it may be pressed out of hog's lard and other solid fats, and separated from oils by exposing them to cold and subsequent pressure.

ELAIO'DIC ACID. (Gr. ελαιον, and ειδος, *form.*) One of the compounds produced during the saponification of castor oil.

E'LAOLITE. (Gr. ελαιον, and λιθος, *stone.*) A brittle mineral, of a greasy lustre, crystalline in its texture, of various shades of grey, green, and red, and composed of silica and alumina, with about 18 *per cent.* of potash. It is found in Norway, and when *chatoyant* is sometimes used for ring stones.

E'LAPS. A subgenus of vipers. *See* VIPERA.

ELA'SMOTHE'RIUM. (Gr. ελασμος, *a plate*, and θηρ, *a beast.*) The name of an extinct Pachydermatous animal, which forms the type of a new genus, characterized by the laminated structure of its teeth, and intermediate between the horse and rhinoceros.

ELASTI'CITY. (Gr. ἐλαστη, *a spring;* from ελαυνω, *I draw.*) In Physics, that property which certain bodies possess of recovering their primitive form and dimensions after the external force by which they have been dilated or compressed or bent is withdrawn.

The theory of elasticity must be deduced from some hypothesis respecting the constitution of matter. The simplest and most general view which can be taken of the subject is, that all matter is composed of indefinitely small parts or *molecules* acted upon by attractive and repulsive forces. The attractive forces result from the action of the molecules on each other; the repulsive forces from the caloric with which the molecules are combined. From the combined action of these two forces, the attraction of matter and the repulsion of caloric, the different forms of matter and its varied physical properties may be explained.

This view of the constitution of bodies supposes that the molecules are not in contact, but at a certain distance from each other, which, though it is to be regarded as infinitely small in comparison of any distance appreciable by our senses, admits nevertheless of increase and diminution. When a body is in a state of rest, the opposite forces which any two of its contiguous molecules exercise on each other are in equilibrium. The energy of the forces also depends on the distance between the two molecules, or, in mathematical language, is a function of that distance. If the distance be increased within the limits of the action of the forces, both forces are diminished; and if the distance is diminished, both are increased, but not in the same proportion. If the interval at which the two forces balance each other be diminished, the repulsive force becomes stronger than the attractive force, and the two molecules are repelled from each other: on the contrary, if the distance be increased, the attractive force acquires the superiority, and the molecules are drawn towards each other.

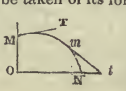
Let us now suppose a solid body, of which all the molecules are in a state of equilibrium, to receive the impression of an external force. The operation of the force is to produce a change in the distances of the molecules at the surface, in consequence of which the equilibrium is disturbed, and the molecules thrown into a state of vibration. This vibration is communicated to the interior molecules; and the body, under the action of the external force, undergoes a certain change of form. The molecules at the surface, which receive the impulse, transmit it to those in the interior of the body, and are reacted on by them with an equal force. In this manner the action is propagated through the whole mass, until it is destroyed by another exterior force, or by the resistance of an obstacle to the motion of the body itself.

From this hypothesis respecting the constitution of matter, analytical expressions may be deduced to represent the motions or the equilibrium of the molecules of a body acted upon by an external force which is not so great as to exceed the limits of its elasticity, or to produce a change in the distance of the molecules greater than the radius of the sphere of molecular action. These equations contain a numerical coefficient, which is constant for the same body, but variable for different bodies: and which has no influence on the law of elasticity, though it serves to measure its effects. It is therefore called the *modulus* of elasticity, or *coefficient* of elasticity; and is of the same nature and order of magnitude as the cohesive resistance which bodies oppose to rupture on being crushed, and may therefore be expressed as so many pounds acting on a square inch of surface. The modulus of elasticity for each particular body must be determined by experiment, and has only been ascertained in a few instances.

Elasticity is perfect when the body exactly recovers its primitive form, after the force by which it is bent or compressed or dilated has been removed, in the same time as was required for the force to produce the alteration. This perfect elasticity is, however, not found in any of the bodies of nature; the aëriform fluids or gases are those whose elasticity approaches the nearest to it. Hard bodies, even tempered steel and ivory, possess it in a less degree; in fluid substances the elastic force is greatly diminished; and in soft bodies, as butter, moist clay, it entirely disappears. In solid bodies the elastic force is, in general, diminished by use, or by a long-continued application of a straining force. A bow which has been long bent, or a spring which has been long compressed, will not entirely recover its original form. In many cases the elasticity of a body can be augmented by producing a closer aggregation of the molecules. The metals, for example, are rendered more elastic by hammering them cold, or by alloys. Iron and steel acquire a greater elasticity by *tempering;* that is, by producing a sudden contraction of their volumes when they have been expanded by heat.

The principal phenomena of elastic bodies are the following: — 1. That an elastic body (the elasticity being supposed perfect) exerts the same force in endeavouring to restore itself as that with which it was compressed or bent. 2. The force of elastic bodies is exerted equally in all directions, but the effect chiefly takes place on the side on which the resistance is the least. 3. When an elastic solid body is made to vibrate by a sudden stroke, the vibrations are performed in equal times, to whatever part of the body the stroke may be communicated. Thus, sonorous bodies always emit sounds of the same pitch; and the difference of the pitch depends on the greater or less frequency of the vibrations of the sonorous body. 4. A body perfectly incompressible cannot be elastic, therefore bodies perfectly solid can have no elasticity; and hence, also, the small degree of elasticity belonging to the liquids which are eminently incompressible. *See* COLLISION, PERCUSSION, STRENGTH OF MATERIALS; also ATMOSPHERE, HYDRODYNAMICS, PNEUMATICS, and VAPOUR.

ELA'STIC CURVE. In Mechanics, the figure assumed by an elastic plate or lamina, one end of which is fixed horizontally in a vertical plane, and the other loaded with a weight which tends by its gravity to bend the plate. This was the manner in which the curve was conceived to be formed by James Bernoulli, who first investigated its properties; but a more general view may be taken of its formation. Let the lamina M N be fixed



at the point M in such a manner that, however it may be bent, the direction of the tangent M T shall be constant; and let it be submitted to the action of any number of forces acting in the same plane, which will be the plane of the curvature. Let P be the resultant of all the forces acting

in the direction O M, the axis of y, and Q the resultant of all those acting in the direction O N, the axis of x; and let the distances of the directions of the forces P and Q from the axes of the co-ordinates be respectively p and q. The curve at any point m, the co-ordinates of which are x and y, is kept in equilibrio by the action of three forces, namely, P and Q, which are exerted in turning the lamina round the point m, and the elasticity E, which may therefore be considered as acting in the direction perpendicular to $m\ t$, the tangent at m. But the action of P on the point m is equal to the product of that force by its distance from the ordinate of m parallel to its direction, which distance is $p-x$. The action of P is therefore equal to $P\ (p-x)$; and, in the same manner, the action of Q is equal to $Q\ (q-y)$. Hence, since the elasticity is equal to the sum of these two, we have the equation

$$P\ (p-x) + Q\ (q-y) = E.$$

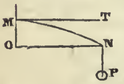
It is now necessary to make a hypothesis respecting the manner in which the elasticity E varies from point to point in the curve. The law usually assumed is, that the force of elasticity at any point is proportional to the tension, or inversely as the radius of curvature at that point; hence if r denote the radius of curvature, and E be the elasticity at the point where $r = 1$, the general equation of the elastic curve becomes

$$P\ (p-x) + Q\ (q-y) = \frac{1}{r}\ E.$$

Let $f'x = \frac{d\,y}{d\,x}$, and $f''x = \frac{d^2\,y}{d\,x^2}$; then, by the known expression for the radius of curvature, we have $\frac{1}{r} = \frac{f''\,x}{(1+f'x^2)^{\frac{3}{2}}}$.
The differential equation of the curve therefore becomes

$$P\ (p-x) + Q\ (q-x) = \frac{E\,f''\,x}{(1+f'\,x^2)^{\frac{3}{2}}}.$$

To take a simple case, let us suppose the lamina so



situated that the tangent M T is parallel to the axis O N, in which situation the force Q vanishes; and also let the force P be that resulting from the gravity of a weight suspended from the extremity N of the lamina; then, if $l =$ the length of the lamina, we shall have

$$P\ (l-x) = \frac{E\,f''\,x}{(1+f'\,x^2)^{\frac{3}{2}}}.$$

Let us further suppose the curvature to be very small, in which case, $f'\,x = \frac{d\,y}{d\,x}$ will be very small, so that its square may be neglected. We have then, on substituting for $f''\,x$ its value,

$$P\ (l-x) = E\,\frac{d^2\,y}{d\,x^2}.$$

The integral of this is

$$P\ (l\,x - \tfrac{1}{2}\,x^2) = E\,\frac{d\,y}{d\,x};$$

and a second integration gives

$$y - k = \frac{P}{2 \cdot 3\,E}\ (3\,l\,x^2 - x^3),$$

k being a constant, and equal to the distance O M.

The elastic curve is the same as that which a perfectly flexible line would form itself into, if supported at its two extremities and loaded with a fluid of uniform density filling the whole cavity of the curve; or it is the figure assumed by a spider's thread fixed at its extremities and blown by the wind.

E'LATER. (Gr. ελατηρ, *leaper*.) A Linnæan genus of Coleopterous insects, now the type of an extensive family of the Serricorn Coleoptera. The *Elateridæ* may be distinguished from the other Serricorn beetles by the presence of a strong, short, and often slightly curved spine, projecting from the posterior margin of the prosternum, and of a depression just above the origin of the second pair of legs adapted for the reception of the preceding spine. An *Elater* may be recognized on a distant view from the particular use to which it puts the above described sternal modifications. If a beetle be seen to fall upon its back, and instead of making the ordinary attempts to set itself upon its legs, bends its head towards its tail, raising this part, and then suddenly springing into the air, and repeating the action until it has fallen upon its feet, such a beetle may be recognized at once as a species of one or other of the numerous subgenera of the *Elateridæ*. This leap is due to the rebound occasioned by the sudden disengagement of the sternal spine from its socket. One of the species of *Elater* proper (*Elater noctilucus*) is the common fire-fly of the tropical parts of America. Its luminosity is emitted by two round convex yellow spots situated at the sides of the thorax. The *Elateridæ* generally are vegetable feeders; the larvæ devour decayed timber; the perfect insects feed on flowers or other soft and living parts of vegetables.

ELA'TERES. In Botany, the loose spiral fibres that are contained, together with the sporules, in the conceptacles of *Jungermaunia* and *Morchantia*.

ELATE'RIUM. (Gr. ελαυνειν, *to stimulate*.) This substance, commonly called *extract of elaterium*, is obtained from the fruit of the *Momordica elaterium*, or *squirting cucumber*, which, if gathered a little before it ripens and the juice gently expressed, deposits a green sediment, which is collected and dried. In the dose of from one eighth of a grain to a grain, good elaterium operates as a drastic purge, bringing away from the bowels a large quantity of watery secretion; it is seldom prescribed except with a view of diminishing the collection of fluid in cases of dropsy.

Elaterium. In Botany, a term invented by Richard to denote that kind of fruit which is found in *Euphorbia*, consisting of three or more carpels, consolidated when young, but bursting with elasticity when ripe.

E'LBOW. The sea phrase for the half twist in the cables by which the ship is moored, caused by her *swinging* the wrong way. (*See* Hawse.) Also a term for a sudden turn in a line of coast or course of a river.

ELBOWS. (Sax. elboga.) In Architecture, the upright sides which flank any panelled work, as in windows below the shutters, &c.

ELCA'JA. An Arabian tree, the fruit of which is emetic, and is employed in an ointment for the cure of the itch: it is the *Trichilia emetica* of botanists.

E'LDERS. Certain laymen who, according to the constitution of the Presbyterian church, form a council of which the minister is the moderator, and discharge the functions of a spiritual court. They also assist the minister in the management of the concerns of the parish, attending to the interests of the poor, like the deacons of the primitive church. Among the Jews, elders were those persons most distinguished for age, rank, and wealth, who formed the council of the people. *See* Presbyters.

EL DORA'DO. (Span. *the golden region*.) The name given by the Spaniards to an imaginary country, supposed in the 16th century to be situated in the interior of South America, between the rivers Orinoco and Amazon, and, as the name implied, abounding in gold and all manner of precious stones. After the Spanish conquest of Mexico and Peru, the most exaggerated accounts of the wealth and riches of the newly acquired territory were circulated and believed. A new region was fabled to exist far surpassing the wealth and splendour of Peru; expeditions were fitted out for the purpose of discovering it; and though all such attempts proved abortive, the rumours of its existence continued to be believed down to the beginning of last century. The term has now passed into the language of poetry, in which it is used to express a land of boundless wealth and felicity, like the ancient Elysium or the Mohammedan Paradise. (See a learned article on "Sir Walter Raleigh" in vol. lxxii. of the *Edin. Review*, which contains a *resumé* of all the speculations that have been entertained upon this subject.

ELEA'TIC PHILOSOPHY. A system owing its origin to Xenophanes, a native of Elea (in Latin *Velia*), who lived about the year B.C. 530. The most celebrated of his followers were Parmenides and Zeno, also natives of Elea. The dialectical character of the principal systems of antiquity may be said to owe its existence to the Eleatics. The tendency of their speculations was the direct contrary of that which distinguishes the Ionic school. While the latter fixed their attention on outward nature, and strove to discover the laws which regulate its progress, Xenophanes and his disciples confined their thoughts to what they conceived to be the only objects of real knowledge — the ideas of God, or Being as it is in itself. The world of succession and change, which they designated under the title of *that which becomes* (τὸ γιγνόμενον), they held to be utterly vain and illusory; the very conception of change itself seeming to them to involve a contradiction. Time, space, and motion they regarded as mere phantasms, generated by the deceiving senses, and incapable of scientific explanation. They were consequently led to distinguish between the pure reason, the correlative of Being, and in one sense identical with it, and opinion or common understanding, the faculty which judges according to the impressions of sense. Parmenides, in particular, was the author of a philosophical epic, the two books of which treated respectively of these two modes of thinking. For a full account of all that can be gathered from remaining fragments of this rigid system of rationalism, the reader must consult the German writers on the subject; in particular Brandis and Ritter, in their histories of philosophy. Frequent allusion is made both by Plato and Aristotle to the Eleatic doctrines, the authors of which are mentioned by both those philosophers in terms of evident respect and veneration. Plato has made their system the subject of a whole dialogue, entitled the *Parmenides*; perhaps the most striking specimen of dialectic subtlety which Grecian philosophy affords. Many valuable remarks on the nature and influence of the Eleatic doctrines are to be met with in Mr. Thirlwall's *History of Greece*, vol. ii. c. 12.

ELECA'MPANE. The vulgar name of the *Inula*

Helenium. It is an aromatic bitter, and was formerly regarded as expectorant; whence the monkish line,

Enula campana reddit præcordia sana.

A coarse candy, composed of little else than coloured sugar, is sold under the name of elecampane.

ELE'CT. (Lat. electus.) Some functionaries are so termed during the period between their appointment and some act which is necessary to ratify it; as, a bishop after election and before consecration.

ELE'CTION, in Law, is when a man is left to his own free choice to take or do one thing or another, which he pleases; as, where a man has two forms of action by which he may recover his right, it is within his election to choose that according to which he will proceed; or where, as in some cases, he has an election between several parties, against any of whom he may prosecute his suit. Where there are coparceners of lands, on partition the eldest sister has the election.

ELE'CTION, in Theology, is the choice made by God of certain individuals of the human race to enjoy peculiar privileges and blessings. In the Old Testament election is spoken of as national, not individual. The Jews were the chosen people of God (Deut. iv. 37., Is. lxv. 9., and in passages too numerous to be cited). And that the "elect" or chosen of God, of whom the inspired writers of the Epistles speak, and to whom they often address themselves, are in some instances only persons called to partake in the benefits of the Christian dispensation, appears to be admitted on all hands (1 Pet. i. 1, 2.; 1 Pet. ii. 9.). But an opinion arose from very early times in the church, that in other passages (Rom. ix. 18. 24., Eph. 1, &c.) the election spoken of is a predetermined choice, not to the immediate blessings of the covenant, but to eternal life; that God, by arbitrary will, selects a number of persons without respect to foreseen faith or good works, and infallibly ordains to bestow upon them eternal happiness through the merits of Christ. This doctrine is of course opposed to that of universal redemption; namely, that every man is enabled (if he will) to obtain salvation through those merits. It is certain that the doctrine of election — something resembling which is attributed to the Basilidians, Valentinians, and other early heretics — cannot easily be traced in the writings of any father of the church before Augustine, who embraced it with all the ardour of his eager disposition, but appears to have varied much in his opinions respecting it. It is most rigidly laid down in his treatise *De Dono Perseverantiæ*. Calvin, in modern times, was its great reassertor, and declared it in a dogmatical manner: "We were elected from eternity, before the foundation of the world, from no merit of our own, but according to the purpose of the divine pleasure." (*Inst.* iii. c. 15. s. 5.) It became a fundamental article of belief in Calvinistic churches. The synod of Dort was expressly convened to vindicate the doctrines of election and predestination against Arminian tenets (1615). The language of the Church of England, on this as on other controverted points, admits of a variety of interpretations; but during the prevalence of Calvinism in the higher clergy, and especially in the university of Cambridge, under Archbishop Whitgift, an attempt was made to define her tenets more strictly. The Lambeth articles, agreed to in 1595 by a portion of the clergy, assert that "God from eternity hath predestinated certain men unto life, certain he hath reprobated." But these were never authentically received by the church. *See* CALVINISM, PREDESTINATION.

ELECTIVE AFFINITY signifies the order of preference, as it were, in which substances combine; thus, if nitric acid be added to a mixture of lime and magnesia, it will *elect* or choose to combine with the lime in preference to the magnesia. *See* AFFINITY, CHEMICAL.

ELECTIVE GOVERNMENTS are those in which all functionaries, from the highest to the lowest, are chosen by the suffrages of a greater or less number of citizens. Of these the government of Athens in antiquity, and in modern times that of the United States, will serve as examples. When the functionaries of an elective government are chosen by a very great number, it is identical with a democracy; and when by a comparatively small number, either with an aristocracy or an oligarchy.

ELE'CTORS. (Germ. chur- or kur-fürsten.) Those princes of the old German empire who had a voice in the election of the emperor. These were originally (A. D. 1256) seven: Mentz, Treves, and Cologne, — ecclesiastical; and Bohemia, Brandenburg, Saxony, and the Elector Palatine, — lay; but to these Bavaria was added soon after their institution. In 1692 this dignity was conferred on the dukes of Brunswick-Luneburg, who were afterwards styled electors of Hanover; and, at different periods during the last century, on the princes of Salzburg, Wurtemberg, Baden, and Hesse Cassel. But on the dissolution of the German empire in 1806, the title of elector was merged in that of king, grand duke, &c. &c., by all the German states except Hesse Cassel, whose sovereign is still designated elector. The electors had various privileges, both general and special.

ELE'CTRIC FISHES. The species of the class *Pisces* are so called which have the power of discharging electric shocks; the most remarkable are the *Torpedo*, *Gymnotus*, and *Silurus*, or *Malapterurus electricus*.

ELECTRI'CITY. (Gr. ηλεκτρον, *amber;* the substance in which the property of attracting light substances after friction was first observed.)

This truly extraordinary power of matter, independent of the interest that always belonged to it, has of late years acquired much importance from its influence over chemical phenomena, and its connection with those of magnetism. When a clean glass tube is rubbed with the dry hand, or with a piece of silk, it attracts and repels any light substances, — such as feathers, bran, or little pieces of paper, — which are brought near it; a stick of sealing wax rubbed upon dry flannel exhibits the same appearances, and, to a superficial observer, seems to be exactly in the same state as the glass; and they are said to be electrically *excited*. But, on more close examination, it is found that when light bodies are *attracted* by excited glass, they are *repelled* by excited sealing wax, and *vice versâ*, so that the glass and wax are said to be in *opposite electric states;* and hence the terms *vitreous* and *resinous* or *positive* and *negative* electricity. But these two states are always coexistent: thus when glass is rubbed by silk the glass becomes positive, but the silk becomes negative; and in the case of sealing wax rubbed by flannel the wax is negative, but the flannel is positive.

A similar excitation of electricity is seen in an infinity of other cases; as when we rub a cat's back with the hand, or when a piece of silk riband is drawn briskly between the fingers, or a sheet of paper rubbed with India-rubber, or a metal rod with a silk handkerchief. These, and other extraordinary phenomena connected with them, are hypothetically referred to the presence of a peculiar form of matter called the *electric fluid;* it is supposed to appertain to all matter, but to become evident only when in redundance or deficiency. When glass is rubbed with silk the equilibrium of the electric fluid is disturbed, the silk imparts it to the glass; and hence the former, losing electricity, becomes *minus* or negative, and the latter, acquiring electricity, becomes *plus* or positive. This is commonly called "Franklin's Theory," having been proposed and defended by that celebrated electrician. Others have assumed the existence of *two fluids* as essential to the explanation of electrical phenomena; both equally subtile, elastic, and universally diffused, and each highly repulsive as to its own particles, and attractive of those of the opposite kind. Electrical quiescence is referred to the combination of these fluids, and their consequent mutual neutralization; and electrical excitation is the consequence of either being free or in excess. It is supposed that they are separated by friction, and by all those other causes which give rise to the appearance of free electricity. Either of these hypotheses may be adopted as facilitating the explanation of electrical phenomena, and as conferring meaning on terms which would otherwise be unintelligible: of the two the simplest, or that which refers the phenomena to one fluid, is perhaps the most generally applicable. Both are apparently equally consistent with facts; but the existence of any *fluid*, or form of matter, as the cause of electrical phenomena, is at best extremely problematical.

There are two series of distinct phenomena presented by electrified bodies: the one seems to result from the accumulation of electricity upon the surfaces of bodies; they are commonly included under the term *electricity of tension*, and are well exhibited by the common electrical machine and its prime conductor. It affects all neighbouring bodies, and they are thrown by it into a polar electrical state by what is termed *induction:* it has a tendency to pass off in sparks through the air, or gradually to escape from points. The thunder storm furnishes a magnificent specimen of this state of electricity. The other state of sensible electricity is that exhibited by *electricity in motion;* as when a current of electricity is passing through a wire or other conducting medium: in this case a vast *quantity* of electricity may be concerned in the phenomena without any apparent *intensity;* but, whilst the current is continuous, it produces magnetic phenomena of a most extraordinary character; and, when the perfect conductor is broken by the intervention of certain other media, they suffer in some cases chemical decomposition, and in others become heated, and even ignited. The phenomena of electricity in motion are best exhibited by the Voltaic apparatus.

In all electrical experiments remarkable differences are observed in respect to the transfer of the electric fluid through different bodies: some, such as the metals, allow its free and nearly unimpeded passage through their substance; while others receive and retain it more superficially, such as glass, resin, and other substances which exhibit attractive and repulsive powers when rubbed. Hence the division of bodies into *conductors* and *non-conductors*.

Many most important electrical phenomena depend apparently upon *induction*, a subject which has been ably

studied by Faraday. (*Phil. Trans.*) We shall here enter into such details only as are required to render some of the principal terms employed in discussing electrical phenomena intelligible.

If P + represent a metallic sphere in a highly positive electric state, and N P a metallic *conductor* in its vicinity *insulated* upon a glass stem; it will be found that the extremity N of N P is *negative*, whilst the other extremity P is *positive*, and that these opposite electricities are greatest at the extremities of the conductor, and gradually diminish towards the centre line C, which is neutral. This extraordinary state of excitation in N P is entirely dependent upon the proximity of P+; for if P+ be withdrawn, N P loses all appearance of electricity; and the degree of excitement in it is directly proportional to the extent to which P+ is excited, and (within certain limits) to its nearness to N; so that fluctuations in the electricity of N P will be observed in proportion as P+ is brought towards or removed from N, provided they are not brought into *contact*, and that no *spark* passes. These phenomena have been theoretically explained upon the supposition that the free electricity in P+ disturbs the equilibrium of the natural electricity of N P, and by repelling it from N to P leaves the former *minus* and the latter *plus*. Or, if we assume the existence of two electric fluids, then the free positive electricity of P+ *repels* the positive fluid of N P and *attracts* its negative fluid, throwing it into an *electro-polar* state. If N P, instead of being insulated, be connected by its extremity P with the ground, the accumulation at P is prevented whilst N retains its deficient or negative state; or, upon the other theory, the positive fluid at P is neutralized by a supply of negative fluid from the earth; and if, after having effected this by momentarily touching N P with the finger, we suddenly remove P+, the insulated conductor N P will be left with an excess of negative electricity.

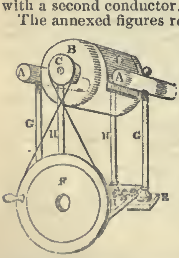
It will be obvious from the above statement that when light bodies, especially if they be conductors, are attracted by electrified surfaces in their vicinity, they are thrown by induction into opposite electrical states; and when the hand is brought near the excited conductor of the electrical machine, it becomes negative, and remains so till the equilibrium is restored by the passage of a spark; which phenomenon is supposed to be the result of the combination of the two electric fluids.

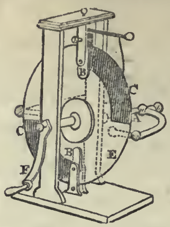
Many important phenomena of electrical accumulation are explained by reference to the principles of induction, and among them the action of the *Leyden jar* or phial. A thin glass jar or bottle, A, is coated inside and out, to within three or four inches of its mouth, with some conducting substance; tin foil, being especially convenient for the purpose, is generally used; and a metallic rod projecting a few inches from the aperture, and surmounted by a brass ball, B, communicates with the interior coating.

When the ball is applied to the prime conductor of the electrical machine, and the outer coating communicates with the ground, the interior acquires a positive and the exterior a negative charge; and on making a communication by means of a conductor between the inner and outer coatings, the electricities are annihilated with the production of a bright spark and explosion, and by a most disagreeable sensation, called the *electric shock*, if the body be made part of the *circuit*. When several jars are so arranged that their interior and exterior coatings are all separately connected, the assemblage constitutes the *electrical battery*.

In the common *electrical machines*, electricity is excited by the *friction* of the plate or cylinder of glass upon the cushions or rubbers; and the glass becomes positive, and communicates the same state to the opposed conductor, generally termed the *prime conductor* of the machine; the rubber becomes negative, and is sometimes connected with a second conductor.

The annexed figures represent the two common forms of the electrical machine. The first is the *cylinder* machine, commonly called Nairne's machine. B is the glass cylinder, which is made to revolve upon its axis by the multiplying wheels F, C, the necessary friction for the electric excitation being produced by the cushion and silk flap D. A A are the positive and negative conductors: the latter, bearing the cushion, is adjusted as to its requisite pressure upon the cylinder by the screw at E. The conductors are respectively supported and insulated by the glass pillars G G, which should be coated with lac varnish; and the axis of the cylinder rests upon the pillars H H, which are also of glass. The second figure represents the *plate* machine, usually termed Cuthbertson's machine, in which A is the prime conductor, borne by a stout glass stem which is attached to the frame of the machine. B B are the upper and lower pairs of cushions, by which, together with the silk flaps C C, the necessary friction is obtained. E is the disk of plate glass which is made to revolve upon its axis by the winch F. In this machine, as the cushions or rubbers are not insulated, the negative electricity cannot be separately accumulated or exhibited, as in the cylinder machine.





There are many other and highly important causes of electric excitation than those above adverted to; such as contact of different metals (*see* GALVANISM), chemical action (*see* VOLTAIC ELECTRICITY), change of temperature (*see* THERMO-ELECTRICITY), and magnetism (*see* MAGNETISM and ELECTRO-MAGNETISM).

ELE'CTRO-CHEMISTRY. That branch of chemical science describing the especial applications of electricity as a chemical agent.

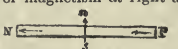
ELE'CTRODE. (Gr. ηλεκτρον, and ὁδος, *a way*.) The surfaces by which electricity passes into and out of other media have been called by Mr. Faraday *electrodes*. The term has also sometimes been derived from ηλεκτρον, *amber*, and ειδος, *like*, and applied to substances which, like amber, become electric by friction.

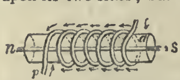
ELE'CTRO-DYNA'MICS. (Gr. ηλεκτρον, and δυναμις, *power*.) The phenomena of electricity in motion.

ELE'CTROLYTE. (Gr. ηλεκτρον, and λυω, *I set free*.) Substances susceptible of direct decomposition by the action of the electric current: hence, also, the verb *electrolyze;* i.e. to resolve compounds into their elements by the agency of electricity. Faraday has shown that in many supposed cases of electrolysis, the evolution of elements is the consequence of a secondary action; the sulphur, for instance, which is thus evolved at the negative pole from sulphuric acid, is the result of the evolution of hydrogen at that pole; in all cases of true electrolytic action sulphur appears at the anode.

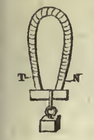
ELECTRO-MAGNETISM. When a current of electricity is traversing any substance, or when electricity is in motion, magnetism is at the same time developed. This fact was first observed by Professor Oersted of Copenhagen, and has become the source of an important series of discoveries included under the above term. The excitation of magnetism depends upon *quantity* of electricity, and is best observed in the wire which closes the voltaic circle, especially of one or more pairs of large plates. If a magnetic needle be brought near a wire through which an electric current is passing, it will immediately deviate from its usual position, and assume a new one, dependent upon the relative position of the needle and the wire. On placing the electric wire *above* and parallel to the magnet, the pole next the negative end of the battery always moves to the west; and when the wire is placed *under* the needle, the same pole turns to the east. When the electric wire is on the same horizontal plane with the needle, no declination takes place; but the magnet shows a disposition to move in a vertical direction, the pole next the negative side of the battery being depressed when the wire is to the west of it, and elevated when it is to the east.

The magnetic phenomena of a wire transmitting electricity are such as appear to depend upon the circulation of magnetism at right angles to the electric current, so that if N P represent the wire transmitting a current of electricity in the direction of the horizontal darts, a current of magnetism will be established in the direction of the vertical dart, appearing to move round the axis of the electric current; hence the term *vertiginous* or rotary magnetism, applied to these phenomena; and hence the motion of the pole of the magnet round the electric wire, or of the electric wire round the pole of the magnet, when they respectively are so arranged as to be able to move freely in any direction. If a steel needle be placed in contact with the electric wire, and parallel to it, it acquires opposite magnetisms upon its two sides; but if it be placed at right angles to the connecting wire, it becomes polar, and permanently magnetic. If the electric wire be twisted into a spiral, and the steel needle placed within it (as in the cut), it is retained there, and becomes a more powerful magnet in consequence of the repetitions and direction of the electric and magnetic currents, as will be evident from the annexed figure, where *a* represents a glass tube with the

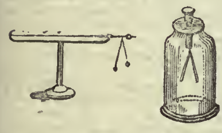




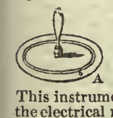
wire n p conveying the electric current twisted round it; the darts at the ends of which show the ingress and egress of the electricity, and the transverse darts the direction of the magnetic current. If the cylinder round which the wire conveying the electric current is twisted be of steel, it becomes a permanent magnet; if of pure soft iron, it becomes a temporary magnet, so long as the electric current is in motion, and s and n are powerfully opposed poles. If the bar be bent, as in the annexed cut, a powerful horse-shoe magnet is obtained when the ends p n of the copper wire twisted round it are connected with the voltaic circle; and a single pair of plates is sufficient for the purpose.



ELECTRO'METER. (Gr. ηλεκτρον, and μετρον, *a measure.*) An instrument for ascertaining the presence and intensity of electric excitation. The simplest form of electrometer consists of two very small pith balls suspended from a small conductor by very fine wire or thread; upon the principle that bodies similarly electrified repel each other, these *diverge* upon the reception of very minute quantities of electricity. Two thin slips of gold leaf are also similarly applied; and, to prevent the influence of the agitation of the air upon them, they are suspended in any convenient way under a glass shade. The other forms of electrometers generally act upon the same principle, being respectively adjusted to the varying degrees of quantity and intensity.



ELECTRO'PHORUS. (Gr. ηλεκτρον, and φερω, *I carry.*) This instrument consists of a flat smooth cake of resin A, which is rendered negatively electrical by friction; a plate of brass with a glass handle is then placed upon it, and becomes electropolar by induction. The brass plate, having been touched by the finger whilst lying upon the resin, is afterwards lifted off by its glass handle, and gives a spark of positive electricity. The same operation maybe indefinitely repeated. This instrument is sometimes a convenient substitute for the electrical machine, and is elegantly applied to inflame a jet of hydrogen gas in *Volta's inflammable air lamp.*



ELE'CTROPO'LAR. A term applied to conductors, one end or surface of which is positive, and the other negative; a state which they commonly exhibit when under the influence of induction.

ELE'CTROSCOPE. (Gr. ηλεκτρον, and σκοπεω, *I see.*) An instrument for rendering electrical excitation apparent by its effects. The gold leaf electrometer, and other similar arrangements, are *electroscopes.*

ELE'CTRUM. (Gr. ηλεκτρον.) A term applied by the ancients to various substances; but especially to the substance now called amber, or to a certain metallic alloy consisting of four parts of gold and one part of silver. (See *Pliny*, lib. xxxiii. and xxxvii.)

ELE'CTUARY. (Lat. electuarium.) This term is generally applied to powders which are mixed up with syrup, so as to be of about the consistency of treacle. The *confections* of the present Pharmacopœia are substituted for the former electuaries.

ELE'DONE. (Gr. ελεδονη.) A name applied by Aristotle to a genus of Malakia or Cephalopods having a single row of suckers on each arm, and without any musky odour; it is applied in modern zoology to the same genus.

E'LEGANCE. (Lat. elegantia.) In the Fine Arts, a quality indicating grace and lightness, but especially the latter. In painting and sculpture it greatly depends on good selection and delicacy of execution, and these again upon taste. Heaviness, and leanness or extreme lightness, are the boundaries between which elegance is a mean.

ELE'GIT (Lat. *he has chosen*), in Law, is a writ of execution, which lies for one who has recovered debt or damages; or upon a recognizance in any court against one not able in his goods to satisfy the same, directed to the sheriff, commanding him to make delivery of a moiety of the party's land, and all his goods except beasts of the plough. The creditor holding the moiety of the land until satisfaction is termed tenant *by elegit.*

E'LEGY, is the name given in modern times to a species of poetical composition of a mournful character. But though this signification of the term tallies with its etymology (Gr. ε, and λεγειν, *to cry alas*), the expression *elegy* among the Greeks, with whom it originated, and among the Romans, by whom it was assiduously cultivated, had a much wider signification. Thus among the former it embraced equally the warlike verses of Tyrtæus, the melancholy effusions of Mimnermus, and the moral and political aphorisms of Theognis and Solon; and among the latter it comprehended the miscellaneous themes of Ovid, Propertius, Tibullus, and Catullus. The form of verse in which it was composed was the alternate hexameter and pentameter. (*See* PENTAMETER.) In modern times almost all the nations of Europe have practised this species of composition; but if we except the *Elegies* of Hammond, Milton's *Lycidas*, and Gray's *Elegy* among ourselves, and Matthisson's *Elegie* among the Germans, it does not appear with great success.

E'LEMENTS. The old chemists applied this term to certain imaginary principles or essences of matter; such as fire, water, earth, and air. The elements of the alchemists are salt, sulphur, and mercury. The term element is now used as synonymous with *simple* or *undecompounded body;* that is, a substance which we cannot resolve into simpler forms of matter. The present list of *elements* includes all the *metals*, and the following substances — oxygen, chlorine, iodine, bromine, fluorine, hydrogen, nitrogen, sulphur, phosphorus, carbon, selenium, and boron; amounting in all to fifty-four, exclusive of the imponderable forms of matter. *See* EQUIVALENTS, CHEMICAL.

E'LEMI. The resinous exudation of the *Amyris elemifera*, brought from the West Indies: it yields a volatile oil on distillation. It is used in ointments, giving them a gently stimulating character, and adding to their viscidity. The *compound elemi ointment* of the Pharmacopœia is a good preparation of this kind, and resembles the *yellow basilicon* of old pharmacy.

ELE'NCHUS. *See* SOPHISM.

ELEPHANTI'ASIS. A disease which chiefly affects the legs and feet, which become rough, scaly, and swollen, and have been compared to the feet of the elephant: the skin gets thick, unctuous, and insensible, and the limb occasionally attains an enormous size.

E'LEPHANT, WHITE. A Danish order of knighthood of great antiquity: the number of knights is limited to thirty, besides members of the royal family.

E'LEPHAS, or ELEPHANT. (Gr. ελεφας, *an elephant.*) The generic name of the most gigantic of existing quadrupeds. They are characterized essentially by having grinders composed of alternating vertical plates of ivory, enamel, and cæmentum, and two tusks in the upper jaw: they are also the only living Mammalia which have a proboscis or trunk longer than the head. It is inferred from the structure of the skull that the extinct Mastodons, which have grinders of a more simple structure, also possessed a long proboscis; and accordingly Cuvier includes the genus *Elephas* and *Mastodon* in a particular family of Pachyderms called *Proboscidians.* Of the true genus *Elephas* there are two living and a greater number of extinct species. The Indian elephant (*Elephas Indicus*, Cuv.) differs from the African species in its greater size, in the skull being higher in proportion to its length, and with a more concave forehead. The Indian elephant has also comparatively smaller ears; the skin is of a paler brown colour; and it has four nails on the hind feet instead of three. The elephant will breed in confinement; its period of gestation is twenty months and some days. It brings forth one young at a birth, which derives its nourishment from two nipples placed on the inner side of the setting in of the fore-legs. The perpendicular height of the Indian elephant, measured from the top of the shoulder, has not been found to exceed ten feet six inches: the ordinary height is from seven to nine feet. The Indian elephant varies as to the length of the tusks; their ends only are visible externally in the females, and there is also a race (Mooknah) in which they are straight and short in the males. In other races the males have the tusks long and curved, especially in that called "Dauntelah." The anecdotes of the docility, sagacity, and tenacious memory of the elephant are numerous and generally known. The characteristics of the African elephant may be inferred from the account of those of the Indian species. It is usual to describe it as having a forehead convex instead of concave; but the projection is caused by the nasal bones, which are higher placed than in the Indian species; and the true front is in reality concave in the African species, but in a less degree than in the Indian. The chief external character of the African elephant is his huge ears. It is a remarkable fact that no African nation has ever subdued the elephant, or made it available for any useful purpose. For an account of the fossil elephants, see MAMMOTH.

ELEUSI'NIAN MYSTERIES. The secret religious rites performed every year in honour of Ceres and Proserpine at the Attic town of Eleusis. To these mysteries all Greeks of both sexes, if unpolluted by crime, were admitted; and as persons thus initiated were considered to be peculiarly under the protection of the gods and to enjoy their favour, it was a privilege much sought after. It has been thought that many passages of ancient classical writers refer in a covert manner to these mysteries, and the doctrines disclosed in them: thus, the whole sixth book of the *Æneid* has been interpreted by Warburton and others as an allegorical exposition of them, a notion controverted by Gibbon in one of his early works. *See* MYSTERIES.

ELEVA'TION. (Lat. e, *from*, and levo, *I raise.*) In Architecture, a geometrical representation of a building measured vertically in respect of the horizon; by the an-

cient architects called the orthography. It is only in this sense that it is technically used by architects; in general terms it is the height of a building above the ground.

Elevation, in Astronomy, denotes the angular height or the altitude of a celestial object above the horizon. Thus, *elevation of the pole* denotes the arc of the meridian intercepted between the pole and the horizon.

Elevation, in Perspective, is sometimes used for the scenography or perspective representation of the whole object or building.

E'LEVATOR. A surgical instrument for raising depressed portions of the skull.

ELFS, or FAIRIES. Imaginary beings, honoured more particularly by the northern nations, in whose mythology they occupy a prominent place. They were divided into two classes — the good and the bad; and their exploits have given rise to a multiplicity of delightful stories. (See *Midsummer-Night's Dream:* and *Grimm's Deutsche Mythologie*, p. 259.) *See* Fairies.

E'LGIN MARBLES. A collection of ancient bas reliefs, statues, &c., which were chiefly decorations of the Parthenon at Athens, and are now deposited with some additions at the British Museum. Mr. Harrison, a northern architect of great abilities, suggested to Lord Elgin in 1797, at the period of his nomination to the embassy at Constantinople, the removal of these celebrated works. But it was not till some time after Lord Elgin's arrival that the ministers of the Porte were prevailed on to allow him to detach any portion of the marbles; and about eighty cases arrived in England in 1812. In 1816 the collection was purchased by government under a recommendation of a committee of the House of Commons at, if we rightly recollect, the sum of 35,000*l*. They are without question the finest productions of sculpture in the world.

EL'IMINA'TION. (Lat. elimino, *I put out.*) A term used by writers on algebra to denote that operation by which any number n of equations being given, containing n unknown quantities, a single equation is deduced from them containing only one unknown quantity; so that, by resolving this equation, we find the value of the unknown quantity it contains, and thence, by successive substitutions, the values of all the other unknown quantities. To eliminate a quantity is therefore to cause that quantity to disappear from an equation.

ELIQUA'TION. (Lat.) The separation of two metals by fusion.

ELI'SION. (Lat. elido.) In Grammar, the cutting off or suppressing of a vowel at the end of a word, for the sake of euphony or the measure of the verse. The use of the *elision* was confined chiefly to the languages of Greece and Rome.

ELI'XIR. (Arab.) A term applied in old pharmacy to certain essences or tinctures: a mixture of an aromatic tincture with sulphuric acid was called *elixir of vitriol*. The alchemists applied the term *elixir* to various solutions employed in the art of transmutation.

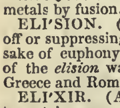
ELK. *See* Cervus.

ELLA'GIC ACID. An acid obtained by Braconnot from gall nuts, and differing from the gallic acid: the term is derived from the word *galle*, reversed.

ELLI'PSE. (Gr. ελλειψις, *defect.*) One of the conic sections, produced by cutting a cone by a plane passing obliquely through its opposite sides. (*See* Conic Sections.) The ancient Greek geometers gave this name to the figure, because, among its other properties, one is, that the squares of the ordinates are less than the rectangles under the respective abscissa and the parameter, or differ from them in *defect*.

Though the ellipse was first suggested to geometers from considering the sections of the cone, it may be defined in various ways, and all its properties investigated without any reference to the solid. We subjoin some of these definitions, which are, in fact, so many different properties of the ellipse.

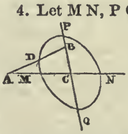
1. If two points F and f be given in a plane, and a point D be conceived to move around them in such a manner that the sum of the two distances D F and D f is always the same, the point D will describe upon the plane an ellipse A D B. The points F and f are the *foci* of the ellipse; and the point C, which bisects the distance between the foci, is its centre. The line A a is the *major* or *transverse axis;* and B b, which passes through the centre, and is perpendicular to A a, is the *minor* or *conjugate* axis. From this definition it is obvious how the curve may be described mechanically. Having fixed two pins F and f in the plane, let the ends of a thread be fastened to the two pins; then, moving a style or pencil within the thread, so as to keep it always stretched, the point of the style will describe the ellipse.



2. Let F be a given point, and M N a straight line given in position; if another point D move on the same plane so that its distance D F from F shall have always to the perpendicular D E, or its distance from the given line M N, the constant ratio of two given lines X and Y, of which X is less than Y, the point D will describe an ellipse. The line M N is called the *directrix*, and its distance from the centre C is such that C G is a third proportional to C F and C A. It is obvious that F A is to A G in the given ratio of X to Y.

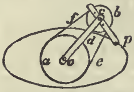
3. It is also a property of the ellipse that the rectangle under A H and H a is to the square of the ordinate H D in the ratio of the square of C A to the square of C B. From this property the common algebraic equation of the ellipse is derived. Let C A $= a$, C B $= b$, C H $= x$, and H D $= y$; then A H·H a : H D^2 : : $a^2 : b^2$, that is, $(a - x)(a + x) : y^2 : : a^2 : b^2$, or $a^2 - x^2 : y^2 : : a^2 : b^2$, whence $y^2 = \frac{b^2}{a^2}(a^2 - x^2)$. This equation may be put under the following elegant form, $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$.

4. Let M N, P Q be two straight lines intersecting each other in C; then if a straight line B A of a given length be carried along the two straight lines M N, P Q, any point D in A B (or in A B produced) will describe an ellipse the centre of which is at C. It is on this principle that elliptic compasses and lathes for turning ovals are constructed.



5. If a moving or generating circle roll along the concave circumference of a fixed circle in the same plane, and the radius of the former be half that of the latter, any given point in the plane of the generating circle, within or without it, will describe an ellipse. This very remarkable property of the ellipse, by which the curve is shown to be an epicycloid, was applied by Professor Wallace of Edinburgh to the invention of an ingenious instrument for describing an ellipse by continued motion. The construction of the instrument is as follows:—

"a and b are two wheels, the axes of which turn in holes c o, near the ends of the connecting bar d. One of the wheels b must be just half the diameter of the other a, which may be of any size, and a band e f goes round them outside; an arm c p is attached to the wheel b, and admits of being lengthened or shortened by sliding along its surface in a socket which may be any where on the wheel. Suppose now that the wheel a is fixed or kept from turning, and that the bar d is turned round the centre o, carrying at its other extremity the wheel b; the action of the band e f will then turn this wheel round its centre c; and while the bar makes one revolution round the centre of the fixed wheel, the other wheel will make two revolutions about its centre, and the point p in the sliding bar will describe the ellipse." (*Wallace's Conic Sections.*)



6. The ellipse is the curve in which the planets perform their revolutions about the sun, and its properties enter into almost every investigation connected with physical astronomy. In these investigations it is found most convenient to define the curve by means of an equation between the *radius vector*, that is, a line drawn from the focus to the curve, and the angle which it makes with the transverse axis. This is called the *polar equation* to the ellipse, and is found as follows:— Let F D the radius vector (see the first diagram) $= r$, C A $= a$, C F the eccentricity $= e$, and the angle A F D, which is called the *anomaly* $= \phi$; then $r = \frac{a^2 - e^2}{a + e\cos.\phi}$.

It is a property of the ellipse, that if a circle be described upon either axis, and from any point of that axis an ordinate be drawn both to the circle and ellipse, then the ordinate of the circle is to the ordinate of the ellipse as that axis to the other axis. Hence the whole area of the circle is to the whole area of the ellipse in the same proportion, and consequently the area of an ellipse is a mean proportional between the areas of the two circles described upon its transverse and conjugate axes. Hence, to find the area of an ellipse, multiply the two axes together, and multiply the product by ·7854. *See* Circle.

The whole length of the periphery of an ellipse is expressed by the following series:

$$2\pi\left(\overline{1} - \frac{1}{2^2}e^2 - \frac{1^2 \cdot 3}{2^2 \cdot 4^2}e^4 - \frac{1^2 \quad 3^2 \cdot 5}{2^2 \cdot 4^2 \cdot 6^2}e^6 - \frac{1^2 \cdot 3^2 \cdot 5^2 \cdot 7}{2^2 \cdot 4^2 \cdot 6^2 \cdot 8^2}e^8, \&c.\right)$$

where 2π denotes the circumference of the circle described about the greater axis, and e is the eccentricit that is, $e^2 = 1 - b^2$, b being the semi-axis minor, and the semi-axis major being unit.

ELLI'PSIS. (Gr. ἐλλείπω, *I omit.*) In Grammar and Rhetoric, the omission of a word or part of a sentence, which is left to be supplied by the imagination of the hearer or reader.

ELLIPSOID. (Gr. ελλειψις, and ειδος, *form.*) A geometrical solid, of such a nature that every section of it made by a plane produces an ellipse.

ELLIPSOID OF REVOLUTION, called also the *Spheroid*, is the solid generated by the revolution of an ellipse about its lesser axis.

ELLIPTIC COMPASSES. An instrument for describing an ellipse by continued motion. An instrument of this kind has been described under ELLIPSE. Various contrivances for effecting this purpose are described in the *Exercitationes Mathematicæ* of Schooten.

ELLIPTI'CITY of the TERRESTRIAL SPHEROID. A term used by Clairaut and other writers on the figure of the earth, to denote the deviation of the earth's form from that of a sphere. Clairaut employed the term to denote the difference of the two axes divided by the smaller: most other writers understand by it the difference of the axes divided by the greater. Thus, let $a =$ the equatorial diameter, b the polar diameter, $e =$ the ellipticity; then $e = \frac{a-b}{a}$, whence $b = a\ (1-e)$.

ELM. A valuable genus of trees, confined to the colder parts of the northern hemisphere, but common to both the old and new world. Most of the species are trees of considerable size, and produce a timber useful for many common purposes in which great strength and durability are not required; but some of them are small bushes of no known value. In Great Britain there are several species in a wild state, the most valuable of which are called the Welsh, the Hertfordshire, the Huntingdon, and the smooth-leaved; in other countries of Europe and Asia many peculiar species exist, but they have been little examined by botanists. The elm is valued for the rapidity of its growth, its hardiness, and its capability of thriving in poor soil unfit for tillage. The word seems to be an alteration of ulmus, its Latin name.

ELOCU'TION (Lat. eloquor, *I speak out*), signified originally, as the derivation of the word imports, the art of choosing and adapting words and sentences to the ideas to be expressed; but it is more frequently employed to denote the just and graceful management of the voice, countenance, and gesture in speaking; in which sense it is synonymous with what is termed a *good delivery* or *pronunciation*. *See* DECLAMATION, ELOQUENCE.

E'LOGE. (Gr. ευλογια, Ang. *eulogy*.) A term applied in France to the panegyrical orations pronounced in honour of illustrious deceased persons, and particularly of members of the Royal and other academies. Formerly the secretaries of the various French literary institutions used to compose and pronounce the *éloge*; but this duty is now performed by the new member elected in the room of the deceased. This practice is no doubt open to censure; but it has been the means of giving to the world many interesting biographical sketches, which would never otherwise have appeared. *Eloge* is also applied to any species of biographical writing in which praise predominates over censure, and has been much cultivated by French and Italian authors.

ELONGA'TION, in Astronomy, is the apparent distance of a planet from the sun. The greatest elongation of Mercury amounts to about $28\frac{1}{2}$ degrees, and that of Venus to about 47° 48′. With regard to the superior planets, the elongation may have any value from 0 to 180°.

E'LOQUENCE. (Lat.) The art of clothing the thoughts in the most suitable expressions, in order to produce conviction or persuasion. In its primary signification, eloquence (as indeed its etymology implies) had reference to public speaking alone; but as most of the rules for public speaking are applicable equally to writing, an extension of the term naturally took place; and we find even Aristotle (*Rhe.* book iii.), the earliest systematic writer on the subject whose works have come down to us, including in his treatise rules for such compositions as were not intended for public recitation. A still wider extension of the term was contended for by the ancient rhetoricians, who included under it all kinds of literary productions (such as treatises on law, logic, &c.), and whatever might be necessary to illustrate and explain them. In the following observations, we shall confine ourselves chiefly to the etymological meaning of the word, and shall give a brief sketch of the history, the objects, and the divisions of eloquence. The invention of eloquence is ascribed by the Egyptians and the fables of the poets to the god Mercury; but no certain account can be given when or by whom this art first began to be cultivated. If we may judge from the eulogiums which Homer pronounced upon Ulysses and Nestor for their attainments in eloquence, it must have been very early in high esteem among the Greeks. But though, from time to time, there arose in Greece many distinguished writers upon eloquence, it does not appear that the practice of the art was combined with the theory for public purposes till the time of Pisistratus, who owed to his rhetorical acquirements his elevation to the throne. Passing from Pericles (the next in order to Pisistratus), who was distinguished at once as a general, a statesman, and an orator, we find many eminent names during the Peloponnesian war immortalized for their eloquence by the pen of Thucydides. In the succeeding age arose the school of rhetoricians, or sophists, as they are called, who endeavoured to graft upon eloquence the subtleties of logic; and among the earliest and most eminent of this school were Gorgias, Isocrates, and Isæus, of whose publicly delivered orations there are still ten extant. It was in this age that Grecian eloquence attained its highest perfection by the genius of Demosthenes, to whom the palm has been conceded by the unanimous consent of ancient and modern times. Various are the writers that have endeavoured to point out the beauties of Demosthenes; but by none are the peculiar qualities and distinguished properties of his style more vigorously and happily (though briefly) pourtrayed than by Hume, who, throwing aside his usual calm and dispassionate manner, thus describes it:—"It is rapid harmony exactly adjusted to the sense: it is vehement reasoning without any appearance of art: it is disdain, anger, boldness, freedom, involved in a continued stream of argument; and of all human productions, the orations of Demosthenes present to us the models which approach the nearest to perfection." After this period, Grecian eloquence declined rapidly; and though in the following ages there flourished among others Hermagoras, Athenæus, Apollonius, Cæcilius, and Dionysius, their names have been almost without exception rescued from oblivion by a work, which may be regarded as the last expiring ray of Grecian eloquence — the incomparable treatise of Longinus on the Sublime.

In consequence of the all-absorbing spirit for military glory with which the ancient Romans were animated, it was long before they found leisure to appreciate the advantages of eloquence; and even so late as the year of the city 592, when, by the industry of some Greeks, the liberal arts began to flourish at Rome, the senate passed a decree banishing all rhetoricians from the country. But a few years afterwards, when Carneades, Critolaus, and Diogenes were sent as ambassadors from Athens to Rome, the Roman youth were so charmed with the eloquence of their harangues, that the study of oratory formed thenceforth a branch of a liberal education. Men of the highest rank were now seen teaching and learning respectively the art of eloquence; and such was the impetus given to this study, that it made the most rapid advances, and was at last crowned by the appearance of Cicero, to whom critics have concurred in assigning a rank inferior only to that of Demosthenes. That many illustrious orators existed at Rome prior to the age of Augustus, we learn from the work of Cicero, *De Claris Oratoribus*. In this treatise Cicero, in detailed notices and liberal eulogiums, has given immortality to the very men whose works were thrown into obscurity by the splendour of his own: as Quintilian says of Menander and *his* predecessors — atque ille quidem omnibus ejusdem operis auctoribus abstulit nomen, et fulgore quodam suæ claritatis tenebras obduxit. The mighty scale on which every thing was conducted at Rome, and the enormous interests so frequently at stake, were never so wonderfully exhibited as in the age of Cicero; and the unparalleled exigency found or created in him a talent for profiting by its advantages or coping with its difficulties. In the succeeding ages of the Roman empire, the despotic character of the government checked the growth of the rhetorical art; but the names of Tacitus, Quintilian, and Pliny are an earnest of what might have been achieved in this arena, had circumstances permitted the development of their talents.

During the middle ages, though the practice of eloquence may, as far as we know, be said to have lain dormant, the theory formed part of the scholastic study, as may be seen from the old doggrel hexameter, which served to fix the monastic studies in the memory—

"Gramm. (Grammatice) loquitur; Dia. (Dialectice) vera docet;
Rhet. (Rhetorice) verba colorat."

With regard to the early history of eloquence in England, there are found, indeed, the names of several distinguished men who in former times directed the resolutions of our parliament; but no pains were taken to preserve their speeches; and, as Hume observes, the authority which they possessed seems to have been owing to their experience, wisdom, or power, more than to their talents for oratory. It was not until the close of the last century (a period which, it may be said, Hume did not live to see), that an era arose in the history of British eloquence, which the genius of Chatham, Pitt, Burke, Fox, and Sheridan has consecrated and immortalized.

We can only allude to the history of eloquence in other countries. The little opportunity afforded for a display of forensic or senatorial eloquence by the different governments of Germany has almost entirely checked its growth in that country; and the same remark is applicable to Italy, Spain, and Portugal; all of which, however, have been rich in the eloquence of the pulpit. The only two countries in the world whose orators can be put in competition with those of Britain, are France and America. To the pulpit oratory of the former, the illustrious names of Bossuet, Bourdaloue, and Massillon have given enduring celebrity; while the popular character of their respective institutions, has formed a host of forensic and senatorial speakers worthy a prominent place among the orators of antiquity, and modern times. The pulpit orators of England are too well known to be noticed here.

The elements of eloquence are usually comprised under the four following divisions — *invention*, *disposition*, *elocution*, and *delivery*. The first has reference to the character of the thoughts or ideas to be employed; the second to their arrangement (usually called the *parts* of a discourse, — consisting of the *exordium* or *introduction*, the *narration*, the *proposition* the *proof* or *refutation*, and the *peroration:* see these terms); and the third and fourth have respect to words, style, utterance, action, &c.

The Greeks divided discourses according to their contents, as relating to precept (λογους), manners (ηθη), and feelings (παθη), and as therefore calculated to instruct, to please, and to move. The Romans distinguished three kinds of eloquence: — the demonstrative, occupied with praise or blame, and addressed to the judgment; the deliberative, which acts upon the will by persuasion or dissuasion; and the judicial or forensic, which was used in defending or attacking — a division originally laid down by Aristotle, *De Rhetorica*. In our own times, a division somewhat similar has been made; and the bar, the senate, and the pulpit are the three grand theatres for the exhibition of oratory. With regard to the distinguishing characteristics of these three kinds of eloquence, the reader will find ample information on this head by consulting Blair, or *Campbell's Philosophy of Rhetoric*. The following is a summary of their views. In popular assemblies, the great object to be effected by the orator is persuasion: the speaker aims at determining his audience to adopt some line of conduct, as good, fit, or useful; and in order to accomplish this object, he must address himself to all the principles of action in human nature, — to the passions, to the heart, as well as to the understanding. At the bar, on the other hand, it is not persuasion, but conviction, that the orator aims at producing. There it is not the speaker's business to persuade the judges to what is good and useful, but to show them what is just and true. Hence it is chiefly to the understanding that his eloquence is to be addressed. Hence, also, the eloquence of the bar is considered by most rhetoricians of a more limited kind than that of popular assemblies. In many instances, however, the eloquence of the bar has a much wider scope than such writers have conceded, and the trial by jury admits of the most impassioned appeals to be found in the annals of modern eloquence. With regard to the eloquence of the pulpit, though it appears at first view to be possessed of many qualities advantageous to oratorical display, such as the dignity and sublimity of the subject, the large and mixed audience, and the leisure of the speaker for premeditation, these will be found to be counterbalanced by many disadvantages; *e.g.* the triteness of the subject, and the difficulty experienced by the speaker to excite attention. Besides, at the bar, or in the senate, the orator addresses passions which are forbidden ground to the preacher; and if at any time the latter makes an incursion into those regions, he is in danger of assuming a tone inconsistent with the dignity and the charity of his profession. The fierce invective, the terrible crimination, the bold and unexpected retort, the cutting sarcasm, the cool and dignified irony, on the one hand, — and, on the other, the skilful flattery, the exquisite artifice, with which the baser as well as the nobler passions of the audience are wrought into a subservience of the purpose of the orator; all these fall more or less within the province of the bar and the senate, but are beyond the sphere of the pulpit orator. With all these restrictions, however, the subject to which pulpit eloquence may be addressed are sufficiently extensive to admit of great oratorical display; and as to convince the intellect and force the unwilling homage of the reason, as well as to awaken the conscience and to arouse the imagination, are the objects of preaching, the pulpit orator may, by the choice of his subject, at one time be argumentative and ratiocinative at another declamatory and impassioned.

It is admitted on all sides that, in modern times, eloquence has not been invested with so much importance, or cultivated with so much care as among the ancients. For the cause of this alleged inferiority of modern as compared with ancient eloquence no satisfactory reason has been hitherto assigned, and even Hume has confessed his inability to solve the problem. Perhaps one cause of the ascendency of the ancient orators lies in the difference of the means employed in ancient and modern times to gain the consent of the audience. Among the ancients, the most violent and passionate expressions, accompanied by what Cicero calls the "supplosio pedis," and the "percussio frontis vel femoris," were not only admissible, but were even necessary, in order to produce an effect upon the audience. Among the moderns, such violence of gesture, except on the stage, would excite nothing but laughter. Those orators are now-a-days more esteemed who aim at convincing the understanding than at captivating the feelings; and this is a characteristic that pervades every species of modern eloquence. Again, if we look to the peculiarities of ancient law, the tribunals of justice, and the legislative assemblies of the Greeks and Romans, we may perceive, perhaps, the superior arena of the ancients. The great scope for eloquence in ancient times, as has been observed by an able writer in the *Quarterly Review*, arose from a circumstance that with us would be considered a vice — the blending of the legislative with the judicial powers. When the legislature is employed, as in England, in establishing, from the contemplation of a whole class of cases, a general principle for deciding on every future case that may be referable to that class; and when the judicial power is only occupied in ascertaining to what previously established legal class any particular case belongs, and what the decision of the law is regarding that class: in this state of things, there is scope, indeed, for the exercise of the most useful and respectable powers of eloquence, — the clear, strong, and elegant development of ratiocination, and of the information and the views of a comprehensive mind; and this is all. But when, as was the case in Greece and Rome, the written laws are few and vaguely expressed; when the judges exercise an undefined equitable jurisdiction, in the application of which they are not bound by any regulation of their predecessors; still more, when the tribunal is invested with a direct legislative power, the question is no longer to be decided by argument and the application to general principles alone, but the individual passions and interests of the judges are let loose; and then all the higher and more perilous faculties of the orator are called forth to rule in this war of elements, and direct the storm as may suit his purpose, — whether to sweep away falsehood and oppression, or to bear down the barriers of truth, law, and justice. (See *Whately's Rhetoric; Campbell's Rhetoric; Cicero, De Oratore;* and the works already mentioned.)

ELUTRIA'TION. (Lat. elutrio, *I cleanse*.) The separation of substances by washing them in large quantities of water, so that the heavier particles fall to the bottom, and the lighter ones, remaining some time suspended, are gradually deposited in a finely divided state.

ELYDO'RIC PAINTING. (Gr. ἔλαιον, *oil*, and ὕδωρ, *water*.) In Painting, a species of painting with a vehicle composed of oil and water, invented by M. Vincent of Montpetit. Its object is to add the fresh appearance of water colours and the extreme finish of miniature painting to the mellowness of oil colours. Not, however, having seen any specimen of it, we are unable to state from our own knowledge whether those objects have been attained.

ELY'SIUM, or the ELYSIAN FIELDS. (Gr. ηλύσια πέδια.) In Mythology, the region to which the souls of the virtuous were said by the poets to be transported after death. They are variously represented as a part of the infernal realms, or islands situated in the Western Ocean beyond the Columns of Hercules. The enjoyments of the blessed spirits in this abode were held to consist in the same pursuits that were their delight on earth, carried on in a calmer and happier climate: beautifully described in the well-known passage (*Odyss.* iv. 563.) —

Αλλα σ' ες ηλυσιον πεδιον και πειρατα γαιης, &c.

Thus admirably rendered by the late A. Moore: —

> Thee to the Elysian plains, earth's farthest end,
> Where Rhadamanthus dwells, the gods shall send:
> There mortals easiest pass the careless hour;
> There neither winter comes, nor snow, nor shower;
> But ocean ever, to refresh mankind,
> Breathes the shrill spirit of the western wind.

A tract on the coast of Campania was also termed the *Elysian Fields*.

E'LYTRUM. (Gr. ελυτρον, *a sheath*.) The superior or first pair of wings in four-winged insects are so called when they are of a coriaceous and hardly flexible texture, and serve as a protective covering to the second pair; as in beetles.

EMANATION, SYSTEM OF. In Philosophy. *See* PANTHEISM.

EMA'NCIPA'TION. (Lat., from mancupo, *I sell*, or deliver over the tangible property in any thing.) By the ancient Roman law, the son stood in the relation of a slave to the father. By a fiction of that law, the son might be freed from this relation by being three times sold (mancipatus) by the father. Hence the enfranchisement of the son derived from this ceremony the name of emancipation. In course of time, various modes of emancipation, both tacit and express, became recognized by the Roman jurisprudence. The word, in countries following that law, signifies the exemption of the son from the power of the father, either by express act, or by implication of law. By the present civil law of France, majority (and with it emancipation) is attained at 21 years of age; and the marriage of a minor emancipates him. (See *Code Civil*, lib. 1. ch. 3.) In ordinary language, emancipation is used in a general sense to signify the enfranchisement of a slave, or the admission of particular classes to the enjoyment of civil rights.

EMA'RGINATE. In Zoology, when the margin of a part is broken by an obtuse notch, or the segment of a circle.

EMARGI'NULA. A subgenus of Gastropodous Mollusks, dismembered from the genus *Patella* of Linnæus, and characterized by a shell of a simple conical form, but

having a narrow fissure extending from the margin to near the summit.

EMBA'LMING. (Lat. balsamum, *balm.*) A process adopted by the ancient Egyptians, chiefly for the preservation of dead bodies from putrefaction. The term is derived from the use of balsamic substances in the operation; in addition to these, saline substances and tanning materials seem also to have been used. *See* MUMMY. (See *Granville*, in *Phil. Trans.*; and *Pettigrew upon Mummies.*)

EMBA'NKMENT. In territorial improvement, an embankment is a mound of earth or a wall, or a structure composed partly of a wall and partly of a bank of earth, to protect lands from being overflown by rivers or the sea. Embankments appear to have been coeval with the culture of corn crops; because these, it appears, were first grown on the alluvial soils which border large rivers, and to protect the crops from the overflowing of these rivers after heavy or long-continued rains, the cultivator would naturally throw up a bank of earth. This appears to have been done in Egypt at the most remote period of which there is any record. In modern times, embankments are employed, not merely to protect lands under cultivation, but to enclose land that is occasionally overflown by rivers or the sea, and render it fit for the purposes of husbandry. This has been done to a greater extent in Holland than in any other country. There are also immense embankments in Italy, particularly in Lombardy. In Britain, we have the embankments of the Thames near London, which have been in existence since the time of the Romans; many in Lincolnshire, formed during the time of Cromwell, and some of them many centuries before; and one of the most recent is that at Tre Madoc in Caernarvonshire, by which upwards of 4000 acres were recovered from spring tides, and in great part rendered fit for the plough. Embankments are attended with immense expense; but as the soil gained or protected is generally of the best quality, a judicious embankment is commonly considered as paying about the same rate of interest as a landed estate.

EMBA'RGO. A restraint or prohibition imposed by the public authorities of a country on merchant vessels or other ships, to prevent their leaving its ports. Embargoes are usually imposed only in time of war, or in apprehension of an invasion; in which cases the government employs the ships under embargo in armaments, expeditions, and transportation of troops, &c. When it is found necessary to stop the communication of intelligence between any two places, an embargo is laid upon all ships, both foreign and under the national flag.

E'MBASSY. *See* AMBASSADOR.

E'MBER DAYS, in the Romish calendar, are certain fasts appointed by Pope Calixtus for imploring the blessing of the Almighty on the fruits of the earth, and upon the ordinations performed in the church at these times. They occur four times a year, or once in each of the four seasons; being the Wednesday, Friday, and Saturday after the first Sunday in Lent, after the Feast of Pentecost or Whitsunday, after the festival of Holy Cross on the 14th of September, and after the festival of St. Lucia on the 13th of December. The weeks in which the ember days fall are called *ember weeks.* The word *embers* signifies ashes, which the primitive Christians strewed on their heads at these solemn fasts.

EMBERI'ZA. (Lat.) The name of a genus of Passerine birds, characterized by having the upper mandible narrower than the under one, with the edges turned inwards, and with a hard knob on the palate: the entire bill has the usual short strong conformation of the *Conirostral* tribe of Passerine birds. It is now the type of a family, subdivided into minor genera, under the name of *Emberizidæ* or Buntings.

EMBE'ZZLEMENT, in Law, is a felony, consisting of the same class of acts which would in any other case amount to larceny, when committed by one employed as a clerk or servant, and by virtue of his office, on the goods and chattels of his employer.

E'MBLEM. (Gr. εμβλημα; from εν and βαλλειν, *to throw in.*) Literally, *something inserted.* This term has various significations; but it is used most frequently in English to signify a figurative representation, which by the power of association suggests to the mind some idea not expressed to the senses. In Bibliography, books consisting of a series of plates, containing emblematic subjects, with explanations, generally in verse, in Latin or modern languages, are termed books of emblems. They were fashionable in the latter half of the sixteenth century. The best known is the *Emblemata Alciati*, by André Alciat, a French lawyer, which went through many editions.

EMBOLI'SMIC (Gr. εμβαλλω, *I insert*), in Chronology, signifies the same thing as *intercalary*, and is chiefly applied to the additional months required to fill up the lunar cycle. *See* CYCLE and EPACT.

EMBO'SSING, *Embossment.* (Fr. bosse, *a protuberance.*) In Architecture and Sculpture, the raising or forming in rilievo any sort of figure, whether performed with a chisel or otherwise. It is a kind of sculpture, in which the figures rise from the plane on which they are formed; and as they are more or less prominent, they are said to be in alto, mezzo, or basso rilievo.

EMBOUCHU'RE (Fr.), signifies the mouth of a river; it is used also for the mouth-piece of a musical instrument.

EMBRA'CERY. (Norm. Fr. embraserie.) In Law, the offence of endeavouring to corrupt or influence a jury; punishable by fine and imprisonment.

E'MBRASU'RE. In Fortification, an opening made in the wall or parapet of a fortified place, or breast-work of a battery, through which the guns are fired. The embrasures are usually made about two and a half feet wide at the interior extremity, and eight or nine feet at the exterior; and the sole or lower surface is at the height of about two and a half feet above the platform on which the carriage of the gun is placed; but their forms and dimensions are of course varied, according to their position relatively to that of the point against which the fire is to be directed.

E'MBROCATION. (Gr. εμβρεχω, *I moisten.*) A fluid application to any part of the body when painful or inflamed.

EMBROI'DERY. (Fr. broderie.) The name given to the art of working figures on stuffs or muslin with a needle and thread. All embroidery may be divided into two sorts, embroidery on *stuffs* and on *muslin*: the former is used chiefly in church vestments, housings, standards, articles of furniture, &c., and is executed with silk, cotton, wool, gold and silver threads, and sometimes ornamented with spangles, real or mock pearls, precious or imitation stones, &c.; the latter is employed mostly in articles of female apparel, as caps, collars, &c., and is performed only with cotton. In Germany this division is indicated by the expression *weisse* (*white* or muslin), and *bunte Stickerei* (*coloured* or cloth) *embroidery.* The embroidery of *stuffs* is performed on a kind of loom or frame; that of *muslin* by stretching it on a pattern already designed. The modes of embroidering stuffs or muslin with the common needle are extremely various; but a minute description of these processes would be as difficult as it would be uninteresting to the general reader. They consist for the most part of a combination of ordinary *stitches*; but no limit can be assigned to their number or variety. The art of embroidery was well known to the ancients. As early as the time of Moses we find it practised successfully by the Hebrews; and long before the Trojan war the women of Sidon had acquired celebrity for their skill in embroidery. At a later period, this art was introduced into Greece, probably by the Phrygians (by some considered as the inventors); and to such a degree of skill did the Grecian women attain in it, that their performances were said to rival the finest paintings. In our own times the art of embroidery has been cultivated with great success, more especially in Germany and France; and though for a long period it was practised only by the ladies of these countries as an elegant accomplishment, it is now regarded as a staple of traffic, and furnishes employment for a large portion of the population. In England also it appears to have taken deep root, as it now forms an accomplishment of which almost every lady is in possession. About seven years ago a great impetus was given to the cultivation of this art, both on the Continent and in England, by the invention of a machine which enables a female to execute the most complex patterns with 130 needles, all in motion at once, as accurately as she could formerly do with one. But as no account of this remarkable invention which we might give could be intelligible without the aid of illustrations, which would be out of place in this work, we must refer the reader to *Dr. Ure's Dictionary of Arts, &c.* for full information respecting it. One such machine with 130 needles is estimated to perform daily the work of 15 hand embroiderers employed in the ordinary way. Many of them are now mounted in Germany, France, and Switzerland; and in Manchester there is one factory where they do beautiful work. (See the *Art of Needle-work*, edited by the Countess of Wilton. Lond. 1840.)

E'MBRYO. (Gr. εμβρυον, from βρυω, *I bud forth.*) In Botany, a fleshy body occupying the interior of a seed, and constituting the rudiment of a future plant. It is divided into three parts;—viz. a plumula or growing point, a radicle or root, and a cotyledon or cotyledons. It is the vegetable fœtus; and is so tenacious of life under particular circumstances, that there are well-attested instances of its having preserved its vitality much beyond 1000 years. The term is also applied to the fœtus in utero before the fifth month of pregnancy, because its growth has been compared to the budding of a plant.

EMBRYO'TOMY. (Gr. εμβρυον, *the fœtus*, and τεμνω, *I cut.*) The operation of cutting the fœtus out of the womb.

E'MERALD. (Fr. emeraude.) A mineral of a beautiful green colour, which occurs in prismatic crystals, and is much valued for ornamental jewellery. The finest are obtained from Peru. It consists of 65 silica, 16 alumina, 13 glucina, about 3 oxide of chromium (which is the colouring matter), and a trace of lime. (*Vauquelin.*) The mines from which the ancients obtained emeralds are said to have existed in Egypt, near Mount Zabarah. (*Caillaud.*)

EME'RITI. (Lat.) The name given to the soldiers and other public functionaries of ancient Rome, who had retired from their country's service. On these occasions the parties were entitled to some remuneration, resembling our *half-pay;* but whether it was a grant of land or of money has not been accurately ascertained.

EME'RSION. (Lat. emergo, *I sink.*) In Astronomy, the reappearance of the sun, moon, or planets, or of a star, from behind the celestial body by which it has been eclipsed. The phenomena of *immersions* and emersions are of considerable use in determining the longitudes of places.

E'MERY. (From Cape *Emeri* in the island of Naxos.) A variety of corundum; amorphous, compact, and generally opaque. It is characterized by excessive hardness; and its powder is used for cutting and polishing glass, gems, and all hard substances: it scratches and wears down nearly all minerals except the diamond.

EME'TICS. (Gr. εμεω, *I vomit.*) Medicines which occasion vomiting. The only vegetable emetic in general use is *ipecacuanha*, from ten to twenty grains of which is a dose; the chief mineral emetics are the *tartrate of antimony and potash*, or *emetic tartar*, *sulphate of zinc*, and *sulphate of copper*. When it is merely wished to evacuate the contents of the stomach in cases where it is disordered by improper food, twenty grains of ipecacuanha in an ounce of water is a safe and good emetic; it generally operates in ten to twenty minutes, and its action may be assisted by chamomile tea or warm water. At the beginning of fevers or inflammatory disorders, an emetic is often advantageously administered, and then ten or fifteen grains of ipecacuanha with half a grain or a grain of emetic tartar in an ounce and a half of water is to be preferred: the perspiration which the vomit induces should be kept up by remaining in bed, and by warm drinks or other proper remedies. Where poisons have been swallowed, the stomach is often insensible to these means, especially where large doses of opium are concerned; and then half a drachm of sulphate of zinc or of sulphate of copper may be dissolved in three ounces of warm water, and a third part of the solution taken every ten minutes till it operates. In such cases, however, the stomach-pump is principally to be relied upon. When emetics are given in small doses, they produce *nausea*, and to this extent they have proved useful in restraining hæmorrhage of the lungs and stomach. Emetics should be avoided in all plethoric habits, and where there are any symptoms announcing fulness of the vessels of the head; in hernia, in the advanced stage of pregnancy, and in active inflammations. They should also be given with the utmost caution to young children; and when given, ipecacuanha should be resorted to. Old chronic pains and obstinate rheumatism are sometimes relieved by an emetic.

EME'TIC TA'RTAR. A triple salt, composed of oxide of antimony, potassa, and tartaric acid. It is soluble in eighteen parts of cold and in three of boiling water. In the dose of from half a grain to two grains it operates as a powerful emetic and sudorific; in smaller doses, it acts upon the bowels, and is diaphoretic.

E'METINE. A substance discovered in 1817 by Pelletier in ipecacuanha. It is white, pulverulent, and bitter; easily soluble in hot water and alcohol, and intensely emetic. It exists in ipecacuanha to the amount of about 16 *per cent.*, and appears to be the sole cause of its emetic property.

EMIGRA'TION. (Lat.) Migration is the movement of an individual or a number of people from one place of residence to another; emigration, their abandonment of their former home; immigration (a word of modern coinage), their settlement in their new one. Emigration is, in modern times, chiefly regarded in the light of a mode of relieving a country or district labouring under excess of population. The prejudices which formerly existed against it, on account of the loss of inhabitants thus sustained by a country, have long been removed, both by severe necessity, and by the progress of economical knowledge. The power of reproduction in the human race is so great, that the vacuum occasioned by any practicable amount of emigration is speedily filled. It was long ago observed that those provinces in Spain from which the most constant emigration to America was going on (Biscay, Asturias, &c.) were among the best peopled. The subject of emigration, considered in an economical light, has been amply discussed by Sir W. Horton (1825, &c.), by Col. Torrens, and by Mr. G. Wakefield (*on Colonization*, 1830, in which there are some curious calculations as to the effect produced on the movement of population by the emigration of a comparatively small number of marriageable persons: England and America, 1837). Emigration from our islands has for two centuries been chiefly directed to North America; of late years, the Cape of Good Hope and Australia have begun to absorb a small portion of our surplus population. In 1831, a government commission on emigration was formed, with a view to the regulation of the practice; by which officers were appointed both at home and in the North American colonies to watch over the interests of emigrants and furnish them with necessary information. With reference to Australia, they established, for the first time, the useful principle of disposing of the public lands by sale, in order to form a fund for emigration. The following table, showing the number of emigrants who have left the United Kingdom from 1825 to 1837 inclusive, is taken from the *Journal of the London Statistical Society*, i. 159.

1825 - 14,891	1830 - 56,907	1835 - 44,478
1826 - 20,900	1831 - 83,160	1836 - 75,417
1827 - 28,003	1832 - 103,140	1837 - 72,034
1828 - 26,092	1833 - 62,527	
1829 - 31,198	1834 - 76,222	In all - 694,969

Of these there went, in 1837,

29,884 to the North American colonies.
36,770 to the United States.
326 to the Cape of Good Hope.
5,054 to the Australian colonies.

The number in the same year from England was 40,502
—— Scotland - 4,779
—— Ireland - 26,753

The control of this important department is now (1841) transferred to three officers, entitled Commissioners of Colonial Lands and Emigration.

E'MINENCE. A title of honour borne in Europe by various dignitaries at different times; but appropriated to cardinals by a papal decree of the year 1630.

E'MIR. (In Arabic, *chief* or *lord.*) The khalifs took the title of *Emir-al-Mumenin*, — chief or commander of the Faithful. The title is now given by prescriptive usage to those who are considered to descend from Mohammed, by his son-in-law Ali and daughter Fatima (*see* SCHERIF, a title having the same application). But when joined to another word expressive of a particular command or office, it is a common title of dignity; as, *Emir-al-Omrah*, — a title given by the Turks to viziers and pachas, &c. *See* MIRZA.

EMME'NAGOGUE. (Gr. εμμηνιος, *monthly*, and αγω, *I move.*) Medicines which promote the menstrual evacuation.

EMO'LLIENTS. (Lat. emollio, *I soften.*) Medicines which are supposed to relax the living animal fibre.

E'MPEROR (Lat. imperator), was originally merely the title of a Roman general; but, on the fall of the republic, it was particularly applied to the head of the state. The authority of the Roman emperors was formed principally by the combination of the chief offices of the old republic in a single person; besides which, some extraordinary powers were conferred. Thus, Octavius held the titles of emperor, proconsul, and tribune, pontifex maximus or high priest; and was invested with perpetual consular authority, and also that of the censorship. Besides this, he was termed prince of the senate, and Augustus, which designation descended to his successors; but he was much more moderate in his use of titular dignities than his successors, contenting himself with substantial power. The provinces of the empire were divided between the senate and emperor, who appointed their governors, distinguished by the respective titles of proconsul and proprætor; but this division threw all the armies into the hands of the latter, as he took for his share the frontier provinces. The emperors appointed their own successors, who were dignified with the title of Cæsar, and in later times enjoyed a share in the government. Dioclesian first divided the care of the empire with a second Augustus in the person of Maximian, and each of these colleagues associated with himself a Cæsar. After the court was removed to Constantinople, the old titles and forms of the republic vanished by degrees, and the emperors assumed the style of oriental princes.

Charlemagne assumed the title of emperor after his coronation at Rome; and from his time this title (in German *kaiser*) was claimed exclusively, in western Europe, by the rulers of Germany. On the dissolution of the German empire in 1805, the title passed to the emperor of Austria, and, in the same year, Napoleon assumed it in France: the czars of Russia claimed it in the reign of Alexander.

E'MPHASIS. (From the Greek preposition εν, and φημι, *I speak.*) In Elocution, the stress laid on particular words or syllables in the pronunciation of a sentence, in order to express or enforce a meaning. It is divided by some writers into emphasis of force, which we lay on almost every significant word; and emphasis of sense, which we lay on particular words, to distinguish them from the rest of the sentence.

EMPHYSE'MA. (Gr. εμφυσαω, *I inflate.*) A collection of air in the cellular membrane, rendering the part tense and elastic, and crepitating when pressed.

EMPHYTE'USIS. (Gr. εμφυτευσις, from φυτον, *a plant;* a contract conveying the right of cultivation.) In the Civil Law, a contract by which houses or lands are given to be possessed for ever, or for a long term, on condition they shall be improved, and a small annual rent or pension (*canon emphyteuticus*), either in money, grain, or

any other thing, reserved and made payable to the grantor as a recognition of his paramount title. The grantor is said to retain the *dominium directum*, the grantee to acquire the *dominium utile*. The Scottish grant in feu-farm resembles the emphyteusis. From this word (pronounced in the lower age of Latinity emphytefsis) it is supposed that fief (fevodum, feodum) is derived.

E'MPIRE. (Lat. imperium.) Originally the territory or extent of land under the command and jurisdiction of an emperor. The dominions under the sway of ancient Rome were the first to which the term empire was applied: they consisted of two grand divisions,—the Empire of the East, or, as it was afterwards called, the Lower Empire; and the Empire of the West. The former admitted of various subdivisions in reference to the different dynasties to which it was subject; and the latter became, about the end of the 9th century, the German or Holy Roman Empire. In all these cases the sovereign or chief person in the empire was named the emperor. But the term empire has in several instances been employed to designate *a large extent of dominion*, without reference to the title of the ruler or sovereign of a country: thus we hear of the empire of Persia, Hindostan, &c. The dominions of the Queen of England are invariably designated the British Empire; and the epithet "imperial" is officially prefixed to the parliament of the United Kingdom. The term empire was applied from 1804 to 1814 to the dominions of France, including all the countries then incorporated with it by the conquests of Napoleon.

EMPI'RIC. (Gr. εμπειρικος.) One whose knowledge is founded on experience. The empiric school of medicine was opposed to the *dogmatic*; it appears to have originated with Serapion of Alexandria. The empirics considered the foundation of medical science to rest upon experience, derived either directly from experiment or from chance and imitation. They were, however, a pretending, and generally ignorant sect; so that the term empiric is generally applied to quacks and pretenders, without reference to its strict etymology, which should have limited it to the study of medicine, in accordance with the principles of Lord Bacon's philosophy.

EMPLE'CTON. (Gr. εμπλεκω, *I entangle*.) In Architecture, a method of constructing walls, in which, according to Vitruvius, the front stones were wrought fair, and the interior left rough and filled in with stones of various sizes.

EMPO'RIUM. (Gr. εμποριον.) A Greek word wholly naturalized in England, signifying a city or place where great commercial transactions are made. This word has been in use in England upwards of three centuries.

EMPROSTHO'TONOS. (Gr. εμπροσθεν, *forwards*, and τεινω, *I draw*.) A spasmodic action of the muscles, by which the body is involuntarily drawn forwards.

EMPYE'MA. (Gr. εν, *in*, and πυον, *pus*.) A collection of purulent matter in the cavity of the thorax. This is an occasional termination of pleurisy, and is attended by difficulty of breathing and inability to lie on the side opposite that which is affected; an external swelling is sometimes perceptible, and the matter has occasionally been let out by making an opening between the sixth and seventh ribs.

EMPYRE'AL AIR. Oxygen gas.

EMPYREU'MA. (Gr. εμπυρευω, *I kindle*.) A burned odour. Hence, the oils obtained by distilling various organic substances at high temperatures are called *empyreumatic oils*.

EMU. A three-toed Struthious bird, peculiar to Australia, differing from the *rhea* of South America in the extreme shortness of its wings, and from the cassowary of Java in the absence of the horny projection on the head.

EMU'LGENT. The artery and vein of the kidney are so called.

EMU'LSION. (Lat. emulgeo, *I milk*.) A milky liquid; as *almond emulsion*.

EMU'NCTORIES. (Lat. emungo, *I drain off*.) The excretory ducts of the body.

E'MYDINES, *Emydina*. A section of Chelonian reptiles or tortoises, having the genus *Emys* as the type.

EMY'DO-SAURIANTS, *Emydo-sauria*. (Gr. εμυς, and σαυρος, *a lizard*.) The name of an order of the class *Reptilia*, including the tribe of Crocodiles (*Crocodiliens*, Cuv.), which form part of the order *Sauria* of the *Règne Animal*.

ENA'LIOSAU'RIA. (Gr. εν, *in*, ἁλς, *the sea*, and σαυρος, *a lizard*.) A name applied to the entire group of extinct Saurians, in the organization of which paddles, like those of the whale or turtle, were combined with the head and trunk of a crocodile. *See* Ichthyosaur, Plesiosaur.

ENA'MEL. (Fr. enemail.) A semitransparent or opaque glass. Common glass fused with oxide of tin is converted into enamel. It is often variously coloured.

ENAMEL OF TEETH. *See* Teeth.

ENAMEL PAINTING. (Fr. en email.) In Painting, the art of painting with vitrifiable colours on thin plates of metals which are melted on to it. This art is of extremely high antiquity; it was practised by the Egyptians to a considerable extent, and by the Etruscans from the time of Persenna. After lying dormant, or at least in little vogue, for centuries, it was renewed in Italy under the pontificate of Julius II. The various colours used are prepared from oxides of different metals, melted with some vitrescent mixture laid on with a fine brush, the medium being oil of spike or some other essential oil; and it is not difficult to conceive, says Mr. Aikin, "how much the difficulties of this nice art are increased, where the object is not merely to lay a uniform coloured glazing on a metallic surface, but also to paint that surface with figures and other designs that require extreme delicacy of outline, accuracy of shadowing, and selection of colouring. The enamel painter has to work, not with actual colours, but with mixtures which he knows from experience will produce certain colours after the operation of the fire." This work requires several firings. The outline is first burnt in, after which the parts are filled up gradually with repeated burnings to the last finishing touches.

ENARTHRO'SIS. (Gr. εν, *in*, and αρθρον, *a joint*.) The ball and socket joint.

ENCA'MPMENT, in Military affairs, signifies the position occupied for an indefinite period by an army, with all its artillery, stores, baggage, &c., either for the purposes of exercise or warfare.

ENCANTHIS. (Gr. εν, *in*, and κανθος, *the angle of the eye*.) A small tumour or excrescence growing from the inner angle of the eye.

ENCA'RPUS. (Gr. εν, and καρπος, *fruit*.) In Architecture, the festoons on a frieze, consisting of fruits, flowers, leaves, &c.

ENCAU'STIC PAINTING. (Gr. εν, and καυστικος, *burning*.) In Painting, a method of painting used by the ancients, the precise mode of executing which is by no means sufficiently explained. From Pliny's account, it seems that the colours were made up into crayons through a medium of wax, and, the subject being previously traced with a metal point, were melted on the picture as they were used. The picture being finished, a varnish of melted wax was spread over all. The colours thus not only obtained considerable brilliancy, but the work was also protected from the weather. It was lastly well polished. The attempts to revive this art, which, after all, if we may draw our conclusion from Pliny's account, seems to have been but a clumsy process, have not been attended with success.

ENCE'PHALOCE'LE. (Gr. εγκεφαλος, *the brain*, and κηλη, *a tumour*.) Hernia of the brain. There are two kinds of this disease: one occurs in young infants, before the skull is completely ossified; the other presents itself after the destruction of a part of the skull in consequence of disease, accident, or the operation of the trepan.

ENCE'PHALON. (Gr. εν, *in*, and κεφαλη, *the head*.) The brain. The contents of the cranium.

ENCHA'NTMENT. The name given to the charms or ceremonies to which magicians have recourse in the practice of their art. It is derived from the Lat. in, and cantare, *to sing*; and is so called because the formulæ used in magic were usually written in verse and designed to be sung. *See* Magic, Demonology.

ENCHASING. *See* Chasing.

ENCHIRI'DION. (Gr. εγχειριδιον, from ἐν, *in*, and χειρ, *the hand*.) In Literature, a brief and useful compilation; a *manual*. The ethical treatise of Epictetus is termed his *Enchiridion*.

ENCLI'TICS. *See* Particles.

E'NCRINITES. *See* Crinoideans.

ENCYCLOPÆ'DIA. *See* Cyclopædia, Dictionary.

ENCY'STED. A term applied to tumours which are inclosed in a sac or cyst.

ENDE'CAGON, or UNDECAGON. (Gr. ενδεκα, *eleven*, and γωνια, *angle*.) A plane geometrical figure bounded by eleven sides. If the sides are all equal, and the length of each be supposed = 1, the area of the figure is 9·36564.

ENDE'MIC. (Gr. εν, *amongst*, and δημος, *the people*.) A disease peculiar to a certain class of persons, or to a certain district. Thus agues or intermittent fevers are endemic in low countries,—the *goitre* in the Alps, the *plica Polonica* in Poland. *See* Epidemic.

E'NDOCA'RPIUM. (Gr. ενδον, *within*, and καρπος, *fruit*.) A term invented by Richard to denote the inner coat or shell of a fruit.

E'NDOGENS. (Gr. ενδον, and γεινομαι, *I grow*.) One of the primary classes of plants, so called because their stems grow by successive additions to the inside. They are usually known by the veins of their leaves running parallel with each other, without branching or dividing. Grasses, lilies, the asparagus, and similar plants belong to this class, which in warm countries contains trees of large size, such as palms and screw pines.

ENDOPHY'LLOUS. (Gr. ενδον, and φυλλον, *a leaf*.) A term invented by Dumortier to denote the young leaves of Monocotyledons, from their being évolved within a sheath, while those of Exogens are not so enclosed.

ENDOPLEU'RA. (Gr. ενδον, and πλευρα, *the side*.) In Botany, the internal integument of a seed.

E'NDORHI'ZÆ. (Gr. ενδον, and ῥιζα, *a root.*) A term invented by Richard for the embryo of Monocotyledons, in which the radicle has to rupture the integument at the base of a seed prior to entering into the earth, appearing as if it came from within the mother root.

ENDORSEMENT. *See* EXCHANGE.

E'NDOSI'PHONITES. (Gr. ενδον, *internal;* σιφων, *a tube.*) A genus of extinct Cephalopods, with chambered convolute discoidal shells, having the siphon placed at the inner side of the turns, as in the Spirula. The *Endosiphonites* characterize the slate rocks of the Cambrian system, and have not yet been observed in the Silurian formation.

ENDOSMO'SE. (Gr. ενδον, and ωσμος, *impulsion.*) The transmission of gaseous bodies, or vapours or liquids, through membranes or porous substances from without inwards.

ENDOSPE'RMIUM. (Gr. ενδον, and σπερμα, *seed.*) A term invented by Richard to denote the albumen of seeds.

E'NDOSTOME. (Gr. ενδον, and στομα, *the mouth.*) The passage through the inner integument of a seed immediately below the part called the foramen.

ENDOTHE'CIUM. The fibrous cellular tissue lining an anther.

ENDOW'MENTS. *See* FOUNDATION.

ENEID. *See* ÆNEID.

ENE'MA. (Gr. ενιημι, *to inject.*) A medicine injected into the rectum. A clyster.

ENFEOFFMENT. *See* FEOFFMENT.

ENFILA'DE. A term used in military language to denote a fire of artillery or musketry in the direction of the enemy's line. A trench or parapet is said to be *enfiladed* when guns are so placed that the shot can be fired into it in a direction parallel to its length.

ENFRA'NCHISEMENT (Fr. franchise, *freedom or right*), in Law, is the act of incorporating a person into any society or body politic; as where one is made a citizen or free burgess of a town corporate. In feudal usage, a villein was said to be enfranchised when he was made free by his lord; and hence is derived the popular signification of the term. For enfranchisement of land, see COPYHOLD.

ENGA'GED COLUMNS. In Architecture, columns attached to walls, by which a portion of them is concealed; they never stand less than one half out from the walls.

ENGA'GEMENT, signifies either a battle by sea or land; but it is applied more frequently to the former, being synonymous with *action.* An engagement between two ships is called simply an *action:* between fleets a *general action.* As the object is to get possession of the enemy if possible, efforts are made either to disable him by cannonading, or, as is the practice of the English, to board him at once. The conquered vessel strikes (hauls down) her colours, which are afterwards replaced by those of the enemy hoisted over them.

E'NGINE, in Mechanics, is used to denote generally any kind of machine in which two or more of the simple mechanical powers are combined together.

ENGINE'ERING. (Fr. engine.) Strictly, the art of managing engines; but latterly applied in a more extended sense, not only to that art, but to all manufacturing and building operations in which engines are used. It is divided into two branches, Military and Civil.

Military engineering, as a science, implies a knowledge of the construction and maintenance of fortifications, and all buildings necessary in military posts; and hence includes a thorough instruction on every point relative to the attack and defence of places. The science also embraces the surveying of a country for the various operations of war, and consequently an acquaintance with mathematics and facility in drawing. When at a siege the engineer has surveyed a place, he reports to the commander the weakest places, and those in which approaches may be made with most success. He draws the lines of circumvallation and contravallation; marks out the trenches, places of arms, batteries, and lodgments; and in general directs the workmen in these operations. He should possess a practical and theoretical knowledge of gunnery. In regard to the marine branch of military engineering, it requires of course a general acquaintance with the construction of vessels, jetties, moles, and other buildings of that description.

Civil engineering, as its name imports, does not include those branches above named which specially belong to the art of war; but relates to the forming of roads and bridges, railroads, the construction of machinery for all purposes, the formation of canals, aqueducts, harbours, drainage of a country, &c. Till the year 1760, civil engineering was little cultivated in England as a distinct occupation; at that period, manufactures began to be extended by the enterprise, the capital, and science of a number of individuals eminent for their deep knowledge and persevering industry. New and more appropriate situations were chosen for carrying them on than the small towns in which they had been seated, and where combinations and corruption made the wages of the workman extravagant. Internal navigation was consequent upon this change: communication from harbours to warehouses, and the converse, as well as facility of transport from factory to factory, became absolutely necessary. Hence a system of canal navigation and aqueducts, which perhaps will not be entirely superseded even by the more modern railroad. Previous to the above period, a few jetties and piers of defence were thrown out in our seaports, affording to the mariner little better protection than nature herself: they have since become harbours of refuge; some of them are capable of holding large navies. The application of the steam engine to almost every purpose, independent of its importance in manufactures, has smoothed the difficulties formerly experienced in forming works under water, and has now made rapid strides towards superseding all animals of draught. To give the faintest outline of the science of practical engineering would be to write treatises on mathematics, mechanics, hydraulics, hydrostatics, and the other branches of natural philosophy: the reader must therefore seek for information under the separate heads of science involved in it.

ENGLAND, CHURCH OF. The period at which Christianity was first preached in this country has not been settled with any certainty; but there was certainly a British church existing in the island at the time of the mission of Augustine, in the year 597, to convert the Saxons. The British church, however, at that time, had shared the fate of the general British population, and had been pent up by the pressure of the heathen invaders within narrow limits at the extremities of the island. It can hardly be thought to have retained sufficient vigour to have effected the conversion of the barbarians, and would probably have died out but for the seasonable reinforcement from Rome. If such be the case, we must allow that Christianity in Britain owes at least its second foundation to the Romish see; but this foundation took place at a comparatively pure age, and possibly the influence of the uncontaminated religion of the Britons may have had its effect in preserving to the Saxons a very modified form of popery. Certain it is, as has been shown from existing homilies by Anglo-Saxon prelates, that some of the principal novelties of the Romanists were unknown to or repudiated by the English church, at least up to the time of Edward the Confessor.

The intercourse with France, which began to take place in that reign, and the superstitious temper of the monarch, prepared the way for the introduction of the Roman power: it was furthered by the necessities of the usurpers William and Stephen. Under Henry II. royalty took the alarm, and a fierce struggle took place, in which the papal authority was eventually victorious. Under John, the triumph of Romanism was completed, when the crown of England was actually given into the hands of Innocent III. But at that very time the seeds of the Reformation were being sown among the lowest classes: sects of strolling fanatics were constantly appearing and passing away; misguided themselves, but drawing the attention of the people to the errors of the church; and at length, under the impulse given by the learning of Wiclif, taking a definite and lasting shape under the name of the Lollards. A general reformation in opinion was almost at hand, when Henry VIII. threw off the supremacy of the Pope. But while he encouraged the reformers by that step, he checked them by severe enactments upon points of belief; and, as far as he is concerned, it may be doubted whether he at all assisted the development of the Reformation. The Church of England was first reformed by law on the accession of Edward VI.; but many points of doctrine and discipline were left untouched; and the enactments of Elizabeth, by which its whole constitution was finally settled, followed rather than preceded the expressed convictions of the nation. (For the variations that have since taken place in the services of the church, see art. COMMON PRAYER.) The government of the Church of England is episcopal, and the bishops sit in the House of Lords by virtue of the temporal baronies into which their benefices were converted by William the Conqueror. This constitution was subverted on the success of the Great Rebellion, and presbyterianism established in its stead; but the episcopal form was restored in 1660 with the return of Charles II.

ENGLISH ARCHITECTURE. We have already, under the article ARCHITECTURE, given a general view of the rise and progress of Gothic architecture. Our purpose in this place is to enter into details respecting its subdivisions in this country. Without disrespect to the later writers who have differently arranged and named the styles, we think none more convenient than that used by the Rev. Geo. Millers (in his description of the cathedral church of Ely) for giving the reader a succinct and satisfactory view of some of the examples which England affords. We propose, therefore, to subdivide the styles into five periods: — 1*st Period*, or *Anglo-Saxon*, which may be comprised from A. D. 600 to 1066, that is, from the conversion of the Saxons to the Norman Conquest; 2*d Period*, or *Norman*, from 1066 to nearly 1200, comprising the reigns of William I., William II., Henry I., Stephen, Henry II., and Richard I.; 3*d Period*, or *Early English*, from 1200 to 1300, or during the reigns of John, Henry III., and Edward I.; 4*th Period*, or *Ornamented English*, 1300

to 1460, comprising the latter portion of the reign of Edward I., that of Edward II., Edward III., Richard II., Henry IV., Henry V., and Henry VI.; *5th and last Period*, or *Florid English*, by some called the *Tudor Style*, from 1460 to the dissolution of the religious houses in 1537, comprising the reigns of Edwards IV. and V., Richard III., Henrys VII. and VIII.

Ducarel, in his *Norman Antiquities*, enumerates the churches in England anterior to the Norman Conquest; among which appear those of Stukely in Bucks, Barfreston in Kent, and Avington in Berks. Other examples are to be found in Waltham Abbey; the transept arches of Southwell, Notts; the nave of the abbey church of St. Alban, Herts; nave of St. Frideswide, Oxford, &c. The principal characteristics of this the *First Period* are,

(1)

arches (1) of semicircular form, frequently quite plain, occasionally decorated with various sorts of mouldings, both on the face and soffit; often double, triple, or quadruple, each projecting beyond the face of the other, with a moulding on the semicircular edge or arris, and resting on columns. The *columns* are always single, and on the plan circular, hexagonal, or octagonal; placed on a square plinth, and so low in proportion to their height as to be not more than 3½ diameters high. The shafts are sometimes ornamented with spiral fluted or other work. The capitals are indented, or rather engrailed, with fissures of different lengths and forms variously sloped off, or hollowed out towards the top. (2) They are often decorated with rude imitations of volutes and leaves, being exceedingly varied in their composition. — *Windows*, semicircular-headed, extremely narrow, being sometimes not more than six or eight inches wide to a height of little more than three feet, and splayed or levelled off on the inside through the whole thickness of the wall. — *Walls* of great thickness, without external buttresses.—*Ceilings* open-timbered, with a few specimens of vaulting in crypts. — *Ornaments* very sparingly used, except to capitals and shafts of columns. — *Plan* rectangular and parallelogrammic, being usually divided into a body and chancel separated by an ornamented arch. The chancel occasionally as broad as the nave, and at the eastern part ending in a semicircle. In large churches there is a nave and two side aisles, the latter being divided from the former by ranks of columns; but no transepts appear till the latter part of the period, that is, about 970, when they were generally adopted, with a square tower over their intersection with the nave of the church, and rising a little above the roof. At this date also towers began to appear at the west end, for the reception of bells. The churches of this period were of small dimensions, and it seems doubtful whether they were ever higher than one tier of arches with a range of windows above.

(2)

Of the *Second Period*, or *Norman Style*, many more examples remain than of those in the *First Period*; as in the nave, aisles, transept, and west front of Tewkesbury; the nave and west front of Malmsbury; Wimborn minster; Dunstable; St. Cross in Hampshire; Romsey in the same county, &c. Also in the cathedrals of Ely; western towers, and nave, choir, and round tower, called Becket's Crown, at Canterbury; nave and choir at Norwich; transept and choir at Hereford, chapterhouse at Chester; presbytery at Chichester; transept at Peterborough, &c. The characteristics of this style are, *arches*, generally semicircular, as in the diagram (3) here given of the nave of Gloucester cathedral, and of much larger dimensions than those of the preceding periods; their ornaments less minute. They are sometimes without ornament at all, and their soffits are always plain. In the second tier two small equal arches are comprised under one larger one, with a column between, from which they spring, thus (4): — In the third tier there are generally three together, the central one being higher and wider than those on the sides, and usually opened for a window. The three, however, only occupy a space equal in width to the lower arch. The arches, which serve for the decoration of entrance doorways, are richly ornamented with mouldings, foliage, representations of men and animals of grotesque forms fantastically put together. The pointed arch began to creep in about the end of this period, though but sparingly; and it may sometimes be seen capriciously intermixed with the semicircular arch, and alternating with it: when these appear they are usually sharp-pointed. — *Columns*. These are of large diameter compared with their intervals; the shaft is circular, hexagonal and sometimes octagonal on the plan; fluted, lozenged, reticulated, and otherwise sculptured. Sometimes they are square on the plan, and then they are accompanied by portions of columns or pilasters applied to them. Sometimes four columns are connected together, with or without angular pieces. They are much higher in proportion to their diameters than the Saxon columns above described; and though their capitals are not unfrequently quite plain, they are more commonly decorated with a species of volute, or with plants, flowers, leaves, shells, animals, &c. The bases stand on a strong plinth adapted on its plan to the shape of the combined forms. — *Windows*. These are still narrow, and semicircular-headed; but they are higher, and often in groups of two or three together. — *Ceilings* always of timber, except in crypts; in which they are vaulted with stone, with plain groins, frequently moulded, and with ornamented edges; but they are universally without tracery: the White Tower of London, however, affords an example of a centre aisle covered with vaulting.—The *walls* are of extraordinary thickness, with but few buttresses, and those of small projection, usually without ornament. — The *ornaments* employed were, the chevron or zigzag moulding (5); the embattled frette (6); the triangular frette (7); the nail head (8); the billet (9); the cable (10); the wavy (11); the nebuly (12); and some others. Many of these were used in the preceding period, as well as many which have received no names. Ranges of small arches also appear; these rest on brackets, sometimes with carved heads, along the upper part of a building, just below the eaves or battlement, and have received the name of a corbel table. (13) — *Plans* in this period are always with transepts and a tower at the intersection, rather loftier than before, and without spires; there are usually tiers of arches one above the other, and the eastern ends are semicircular. Though much of the Saxon style is retained, there is, from the larger dimensions of the edifices of this period, a much more impressive air of magnificence than has hitherto appeared. Indeed, the larger dimensions alone have by some been thought to be the only criterion for distinguishing the Norman and Saxon styles; but this cannot be depended on, inasmuch as many of the former buildings are of small extent.

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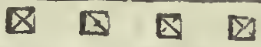
(8) 

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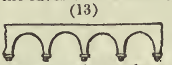

The *Third Period*, or *Early English Style*.—It was not till towards the close of the reign of Stephen, that the first transition from the Anglo-Norman style appears to have taken place. As we have before hinted, it is discoverable in the arch, which, from being semicircular, became pointed; a circumstance, though often investigated by antiquaries, still in obscurity. There is, however, another remarkable feature exhibited in the transition; the transformation, namely, of single massive pillars into clusters of small ones. Specimens of this style may be seen in the conventual edifices of Westminster Abbey, Tintern Abbey in Monmouthshire, Ripon and Beverley minsters in Yorkshire; and in the cathedral of Lincoln, the nave and arches beyond the transept; in York, the north and south transepts; in Wells, the tower and western front; in Ely, the presbytery; in Oxford, the chapterhouse; in Worcester, the transept and choir; and in Salisbury throughout. The characteristics of the style are, *arches* sharply pointed, and lofty in proportion to their span. In the upper tiers two or more are comprised under one, and finished with trefoil (14), or cinquefoil (15) heads, instead of points. — The *columns* (16) on which the arches rest are extremely slender in respect of their height, and usually consist of a central shaft surrounded by several smaller ones. The base assumes the general form of the cluster, and the capital is often decorated with foliage of extremely elegant formation. —*Windows* tall, narrow, and shaped at top like the head of a lancet; hence some writers, among whom Dallaway, have called this style the *lancet* Gothic. They are divided by one or at most two plain mullions, finished at their upper extremities with some simple ornament, such as a trefoil. —*Roofs* are high-pitched, and the *ceilings* vaulted, affording the first examples of arches with cross springers only, which, after a short period, diverged into many more, rising from the capitals of the columns, and almost overspreading the whole of the vaulting; the longitudinal line which reigned along the apex of the vault being decorated with bosses of flowers, figures, and other fancies.—The *walls* now lessen in thickness; but they are strengthened externally with buttresses, leaning as it were against them, for the purpose of counteracting the thrust exerted by the vaults

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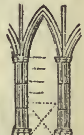

of the ceilings, which the walls and piers could not by their own gravity resist. The buttresses are, moreover, aided in their office by being surmounted with pinnacles, adorned with crockets at their angles, and crowned with a finial flower. — The *ornaments*, though numerous, are simple and elegant. The mouldings have not the variety found in the preceding period, being usually cut into a combination of leaves and flowers, placed commonly round the sides of arches, and especially of windows; but the columns are sometimes completely, as it were, embroidered with them. The spandrels of the arches are often covered with trefoils, quatrefoils, cinquefoils, roses, mullets, bosses, pateræ, &c. The pinnacles of shrines are high and acutely formed, often with niches under them containing statues; similar niches are also frequently used on the west and eastern fronts, their heads being extremely sharp. These ornaments, however, are not so profusely used in large as in small edifices, or in parts added to old ones. — The *plans* are generally similar to those of the *Second Period;* but the towers rise to a great height, and lanterns and lofty spires are very frequent accompaniments to the structure. In the transition from the second to the third style, it will naturally occur to the reader that the architect left one extreme for another, though it has been contended that the latter has its germ in the former. Be that as it may, the period of which we are now speaking was undoubtedly the germ of the succeeding styles by no very forced or unnatural relationship.

The *Fourth Period*, or *Ornamented English Style*.—Examples of this style are, the Chapel of Merton College, Oxford; New College Chapel in the same city; St. Stephen's Chapel, Westminster, so injured by the conflagration of the houses of parliament as to be now no longer in existence; St. Mary's, in York; choir of Tewkesbury, in Gloucestershire; Magdalen College, Oxford; Eton College Chapel, Bucks; and the Beauchamp Chapel at Warwick: also in the cathedrals of Exeter; nave and choir of

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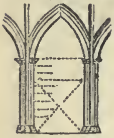

Litchfield throughout; naves of Worcester and York; spire and tower of Norwich; spire of Salisbury; nave and choir of Bristol; the Lady Chapel and Louvre at Ely; choir of Gloucester; Bishop Beckington's additions at Wells and at Lincoln, from the upper transept to the great east window. Its *characteristics* are, that the *arches* are less acute, changing in form, and more open. (17) In the *columns* the central and detached shafts are now brought into one general combination.— The *windows* are not only larger, but divided into several lights by a number of mullions, which constantly branch out at the top into leaves, flowers, wheels, fans, and numberless other forms. Though, however, these expanded considerably during the reigns of the two first Edwards, they grew narrower and sharper in proportion to their height during the reign of Edward III., when the head was often formed of lines scarcely curved above the haunches. The eastern and western windows were of large dimensions, and their glass splendidly painted. — The *ceilings* were constructed with vaulting of very highly decorated parts, whose principal ribs, spreading out from their springings on the imposts, covered the whole surface with tracery, much subdivided, and ornamented with beads, bosses, and a multitude of other devices, which were elaborately painted and gilt. — The *ornaments* are not so pure in line as in the previous style; but they are more varied and studied. Niches covered with tabernacles, for the reception of statues, every where abound; tiers of ornamental arches; pinnacles, not so lofty and tapered, but adorned with leaves and crockets, with much sculpture, painted and gilt, constantly occur; as also screens, carved stalls, panelled ceilings, and other ornaments in carved and painted wood.

The *Fifth Period*, being the *Florid English* or *Tudor Style* (18), is very completely exhibited in Henry the Seventh's Chapel at Westminster, King's College Chapel

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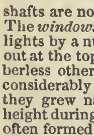


at Cambridge, and St. George's Chapel at Windsor,—edifices well known to most persons in this country. Examples are to be found also in the Lady Chapel of Gloucester Cathedral, Alcocke's Chapel at Ely, the exterior of the choir at Winchester, the Lady Chapel at Peterborough, and the north porch at Hereford. In the Tudor style, it seems as though this species of architecture having culminated, was now destined to set in a blaze of uncontrolled splendour of ornament. Simplicity was superseded by the dazzle of minute decoration, which was exhausted by the caprice of its inventors. It has therefore as well received the name of *Florid*, as its other name of *Tudor;* the latter from having been introduced and carried to its utmost pitch during the power of the family of that name. Its *arches* are universally flat and wide in proportion to their height.—The *windows* are much more open than in the last, flatter at the top, divided in the upper parts by transoms, which are almost constantly crowned with miniature embattled work.—The *ceiling* spreads out into such a variety of parts that the whole surface seems covered with a web of delicate sculpture or embroidery thrown over it; and from different intersections of this ribbed work clusters of pendent ornaments hang down, as Mr. Millers observes, like "stalactites in caverns." The *flying buttresses* are equally ornamented, and the external surfaces of the walls are one mass of delicate sculpture. The *ornaments*, as may be deduced from what we have above noticed, are lavish and profuse: fretwork, figures of men and animals, niches and tabernacles, accompanied with canopies, pedestals, and tracery of the most exquisite workmanship, carried this style to the summit of splendour, and perhaps had no small share in producing the extinction it was doomed to undergo.

The beautifully timber-framed roofs, of which many examples still exist, appear to have originated, as applied to great halls, about the reign of Edward III. About 1400 they were employed in churches, wherein prior to that date stone vaulting appears to have been more common. The Norman castles had their keeps and halls vaulted with stone, as was the case in those in North Wales built by Edward I.

Our limits preclude us from adverting to many fine specimens of ecclesiastical architecture in Scotland; but the abbeys of Melrose and Kelso, founded by David I., as well as those in Dryburgh and Jedburgh, all in Roxburghshire, show that the art was carried to as great perfection north of the Tweed as in the southern parts. Roslin and Holyrood Chapels, for richness and variety of ornamental carvings (the first erected by Sir William St. Clair), cannot be exceeded. Its plan is without parallel in any other specimen of the fifteenth century. The latter was finished by James, the second of that name, in 1440; and is a beautiful specimen, with flying buttresses, more ornamented than any even in England.

It would be impossible here to enumerate the palaces and private Gothic buildings of this country, of which parts still exist in the remains of the ancient palace at Westminster, Eltham, Kenilworth Castle, Hampton Court, and in many other places. A desire to renew it has appeared in this country of late years; but we doubt whether such will be attended with success. The habits of the people, one of the principal stimulants in architectural style, seem to us rather out of joint for the purpose. The following list exhibits the dimensions of the different cathedrals in England, rearranged from the Rev. Mr. Dallaway's *Discourses upon Architecture*.

Total Internal Length in Feet.		Internal Breadth of Transept.	Choir.		
			L.	B.	H.
Old St. Paul's - -	500	248	165	42	88
Winchester - -	545	186	138	—	78
Ely - - -	517	178	101	73	70
Canterbury - -	514	154	150	74	80
York - -	498	222	131	—	99
Lincoln - -	498	227	—	—	—
Westminster - -	489	189	152	—	101
Peterborough - -	480	203	138	—	78
Salisbury - -	452	210	140	—	84
Durham - -	420	176	117	33	71
Gloucester - -	420	144	140	—	86
Chichester - -	401	131	100	—	—
Norwich - -	411	191	165	—	—
Litchfield - -	411	88	110	—	67
Worcester - -	410	130	126	—	74
Exeter - -	390	140	131	—	69
Wells - - -	371	135	106	—	67
Hereford (ancient) -	370	140	105	—	64
Chester - -	348	—	—	—	—
Rochester - -	306	122	156	—	—
Carlisle - -	213	—	137	71	—
Bath - - -	210	126	—	—	—
Bristol - -	175	128	100	—	—
Oxford - -	154	102	80	—	37½

ENGRAILMENT. The ring of dots round the edge of a medal.

ENGRAVING. (Sax. ᵹnafan, *to dig.*) The art of producing by incision or corrosion designs upon blocks of wood, plates of metal, or other materials, from which impressions or prints upon paper or other soft substances are obtained by pressure. Engraving, as an art, seems to have nearly the same relation to design and painting as typography bears to written language; and its utility and great importance must be obvious to every one from its capability of giving a boundless circulation to representations of the most valuable examples of the arts and of objects connected with science. By some authors it is placed among the representations called monochromes (μονοχρώματοι). Xylography, or wood-engraving, was the earliest method practised; but its origin is involved in obscurity. If we might rely on Du Halde (*Description, &c. de l'Empire de la Chine*, 4to. 1736), it is possible that it was known in China 1120 years before Christ; though we think its invention is of a much later period, as the Chinese were not acquainted with the art of making paper till 95 B.C. It has been stated that this art was introduced into Europe from China, through the intercourse of the

Venetian merchants with its inhabitants; for it is proved that engraving on wood had been practised in that part of Italy which borders on the Adriatic as early as the 13th century. The first wood engravings in Europe of which any thing is known with certainty were executed in 1285, by a brother and sister of a noble family of the name of Cunio. They represent the actions of Alexander; and though doubts of their authenticity are expressed by Heinecken, Mr. William Young Ottley, the author of the elegant and learned *History of Engraving*, to which we are much indebted, thinks otherwise. But for the accidental discovery by a Venetian architect of the name of Temanza of a decree of the magistracy of Venice, in 1441, we might have been without positive proof of the practice of the art in Italy previous to 1467, and the Germans might still have continued to claim the honour of its introduction into Europe. This decree, dated 11th October, 1441, states in substance that the art and mystery of making cards and printed figures had fallen to decay, owing to their extensive importation; and in order that the native artists might find encouragement rather than foreigners, it was ordered that no work of the said art, printed and painted on cloth or paper, — viz. altar-pieces or images and playing cards, and whatever other work of the said art is done with a brush and printed, — should be allowed to be brought into the city, on pain of forfeiting the works, besides a pecuniary penalty. This decree plainly indicates that wood engraving was practised in Venice as early as the commencement of the fifteenth century. In Germany and the Low Countries, the early block books seem to have existed as early as 1420, and to have given Guttenburg the hint for using moveable types. At Rome, in 1467, a work intituled *Meditationes Johannis de Turrecremata*, issued from the press of Ulric Han, embellished with wood engravings, in which the design and execution of an Italian artist are evident. The decorations of the work of Valturius by Matteo Pasti, of Verona, published five years afterwards, exhibit considerable spirit and accuracy; and before the end of the fifteenth century the art had been carried to great perfection, as may be proved by the delicacy and purity with which the designs are engraved in the celebrated Hypnerotomachia of Colonna. (*See* ARCHITECTURE.) At this period, however, the discovery of copper-plate engraving had been made, and to this the more ancient art yielded place. Maso Finiguerra, a goldsmith and sculptor of Florence, and pupil of Masaccio, about the middle of the fifteenth century, seems from the most authentic accounts to have been the person to whom the world is indebted for the discovery. In his time, and for a considerable period previously, it was the practice to decorate church and other plate with works in *niello*, which were designs hatched with a steel point upon gold or silver, then engraved with the burin, and run in, while hot, with a composition called niello, — a compound of silver, lead, copper, sulphur, and borax, which was more easily fusible than silver, and of a black colour. The superfluous part of this niello which remained above the surface of the plate was then rubbed off with scrapers, and cleaned away with pumice-stone, leaving the engraved design on the plate with all the effect of a print. In order to preserve copies of their designs, the artists were in the habit before filling the design with the niello to take impressions of the plates with earth, over which liquid sulphur was poured, and from which, when cold, the earth was removed. But Finiguerra carried his practice beyond this; for with a mixture of soot and oil he filled the cavities of the engraving, and by pressing damp paper upon it with a roller, obtained impressions on the paper, having, as Vasari says, all the appearance of drawings done with a pen, "venivano come disignate di penna." Bartsch, in his *Essay on the History and Discovery of the Art of taking Impressions from Engravings*, prefixed to the thirteenth volume of his work *Le Peinteur Graveur*, very unwillingly admits the invention to have originated with Finiguerra, though he claims for the Germans the merit of applying it to practice for the multiplication of copies of pictures, &c.; but to this the opposing arguments of Mr. Ottley are so powerful that we apprehend the subject is not likely to be again mooted. Finiguerra was followed by Baccio Baldini, a goldsmith of Florence, who, according to Vasari, employed Sandro Botticelli to design for him. Mr. Ottley doubts, however, the inference that might be drawn from this passage; and indeed it does not appear likely that such an artist as Botticelli could have resigned himself to employment in such works as Baldini would be constantly requiring. Baccio's works were numerous, and are of course much sought after by collectors. Botticelli, a painter of eminence as well as an engraver, was a native of Florence, where he was born in 1437. He is spoken of with praise by Vasari, and especially for his picture at San Pietro Maggiore, of the Assumption of the Virgin: among the works he engraved from his own designs are subjects illustrative of Dante, and a number of prints of prophets and sybils. His death occurred in 1515. Contemporary with him flourished Antonio del Pollajuolo, and rather later Gherardo and Robetta, who advanced the art; though it was still dry in execution, and more to be admired for correctness of drawing and design than for any attempt at relief or effect. There can be no doubt that at this period the art was practised at Rome, though the Venetian state and other parts of the north of Italy furnished a more abundant supply of artists; — of whom Francesco Squarcione, Andrea Mantegna, Girolamo Mocetto, Marcello Fogelino, Montagna, Bramante the architect, Altobello, Gio. Bat. del Porto, Giovanni Maria, and Giovanni and Antonio de Brescia were among the most eminent. The works of Mantegna exhibit great marks of improvement on the Florentine school, and are characterized by a vigour and facility of execution which might naturally be expected, considering the rapid strides towards perfection made in the other arts.

In Germany and the Low Countries the art of engraving had made extraordinary progress during the fifteenth century; and the name of Martin Schoen or Schongauer must not be forgotten. This artist, who was also a painter and goldsmith, was the father of the German school of engraving. He was a native of Culmbach in Franconia, and born about 1420. He began the practice of the art when it was in its infancy, and succeeded in carrying it to a great degree of perfection. His death occurred at Colmar in 1486. Vasari relates that Michael Angelo, when young, was so pleased with a print by Schongauer, representing St. Anthony tormented by devils, that he copied it in colours. Albert Durer, the most celebrated of the early engravers of Germany, was born at Nuremburg, in 1471. Skilled in many arts, and a painter of no ordinary powers, it is astonishing that, in a life not exceeding fifty-eight years, he should have succeeded so eminently in that of engraving that he has even hardly been surpassed. On copper as well as wood his works exhibit specimens of executive excellence, which the experience of centuries has not been able to surpass. Durer is supposed to have been the inventor of the art of etching, at least no etchings are known before those which are extant from his hand. Of the works he has left, which are very numerous, his wood engravings are the most free and masterly. Following Albert Durer were Aldegrever his pupil, Hans Beham and his brother Bartholomew, Altdorfer, Binck, Goerting, Penz, and Solis. Hans Holbein, who, according to some was a native of Basle, and according to others of Augsburg, besides acquiring celebrity as a painter is known as an engraver on wood, executed many pieces; the best known and most remarkable of which are the fifty-three prints called the "Dance of Death," first published about 1530. Of the Dutch and Flemish schools Lucas van Leyden must be considered the head. Born in 1494, at the place whence he derives his name, he was the contemporary and friend of Albert Durer; to whom, though inferior in design, he was superior in composition. His works, which were both on wood and copper, are few in number. The Low Countries furnished a host of engravers, among whom we think it unnecessary to name more than the Sadelers; Bloemart, who laid the foundation of the principles upon which lines become capable of expressing quality, colour, and chiaroscuro, which the French engravers afterwards improved; Goltzius and his pupils; Muller; and Lucas Kiliau: the three last, though they handled the graver with great freedom and dexterity, fell into boundless absurdity and extravagance, which, however, were tempered and corrected by Mathieu and Saenredam. In the beginning of the seventeenth century the two Bolswerts appeared, whose style was much improved by the instructions of Rubens. Vosterman, Pontius, and Peter de Jode the younger were of this school, which is distinguished for the success and correctness with which it transferred the picture to the copper. Rembrandt, notwithstanding all his faults and absurdities, claims a special notice in this place as an engraver. The Descent from the Cross, and the print called the "Hundred Guilder Print," are extraordinary efforts of art. His portraits and landscapes are full of nature, expression, and character; and it is difficult to say whether he is more successful in his sunshine effects, than in the sober solemn twilight with which his varied subjects are enveloped. Vandyke has left a few specimens of etchings worthy of his name. Jegher, Lutma, and above all the family of the Vischers, exhibited great excellence in the art, which continued to advance under the hands of Waterloo, Jacob Ruysdael, and Paul Potter; the last of whom, in his etchings of animals, displayed a scientific acquaintance with drawing and anatomy till his time unpractised.

We must now return to close the brief account of the Italian school, in which the appearance of Marc Antonio Raimondi forms the most splendid era. Born at Bologna about 1488, he became the pupil of Raibolini, an artist of that city. His master in the art of engraving is, however, unknown. We first hear of him at Venice, whither Albert Durer went to institute proceedings against him for pirating his prints, which had been copied by Raimondi with such wonderful accuracy that they were sold for the originals. But the proper sphere for Marc

Antonio was Rome, whither he soon bent his steps. There his merit soon gained him the friendship and esteem of Raffaelle, then in the plenitude of his glory, by whom he was employed to engrave from his designs. His first plate from a design by Raffaelle was the Lucretia, soon after which he executed the Judgment of Paris. His engravings after this master are very numerous; and though free from the blandishments of style, chiaroscuro, and local colour which the art has received since his time, such was his knowledge of drawing, such the beautiful character that pervades his works, that he is entitled to the highest rank in the art to which excellence has ever attained. Strutt considers him one of the most extraordinary engravers that ever lived. His school attracted to Rome artists from all parts; among whom may be enumerated Marco de Ravenna, Giulio Bonasoni, Agostino de Musis, Enea Vico, and Nicolo Beatrici. Some of the German artists whom we have named above — viz. Beham, Penz and James Binck — resorted to Rome for the benefit of his instructions. On the death of Raffaelle, he executed engravings of some of the works of Giulio Romano. His last print, the Battle of the Lapithæ, is dated 1539. Some of the principal pupils of Marc Antonio have already been named; to them may be added Georgio Grisi, commonly called Mantuanus, and others of his family. Many of the Italian painters were extremely successful in engraving, among whom Titian etched many landscapes; but none cultivated the art with more success than Agostino Caracci, who studied under Cornelius Cort, a Dutch engraver, born at Hoorn in 1536. His design and execution are equally to be admired; and had he but concentrated his lights more, and attended to local colour, he would have been exceeded by none. In the seventeenth century Della Bella, Callot (who, though born in France, belongs to the Italian school), Guercino, Salvator Rosa, and Claude continued the reputation of the art. At the latter end of this century was born Antonio Canaletti, originally a scene painter, like his father Bernardo. His etchings opened an entirely new field in architectural engraving, and may be considered almost if not quite the first in which fine sparkling effects of light are introduced, and in which the darkest shadows partake of the transparency and clearness which nature herself exhibits. Piranesi, who was born in Venice, and died in 1770, appeared about the middle of that century: he was one of the most surprising architectural engravers that have ever existed, whether we consider the astonishing power or number of his works. His use of the etching needle surpassed all that has been done before or since; and in our own time Volpato of Florence, who, besides his other works, engraved almost all the celebrated performances of Canova with a delicacy, grace, and correctness of the first order.

The French school commenced about the middle of the sixteenth century with Noel Garnier, who was followed by many clever artists; but till the time of Louis XIV. it cannot be said to have been highly distinguished. At that epoch we have Gerard Edelinck, who, though born at Antwerp, belongs properly to the French school, and Gerard Audran. The former of these, who worked entirely with the graver, carried what is called colour in engraving to a much greater degree of perfection than had ever before been practised. His facility was amazing, and portrait and history were equally the subjects of his burin. The name of Audran, not less from the circumstance of the family having produced six engravers, than for Gerard Audran, who engraved the well-known Battles of Alexander after Le Brun, is conspicuous in the history of the art; his name, however, will descend to posterity with greater lustre from his engravings after the Italian school, and particularly those of Nicolo Poussin. Gerard Audran was born at Lyons in 1640, and died in Paris in 1703. John Audran, the last of the family who exercised the art, and nephew of Girard, died in 1756. Nanteuil, the three Drevets, of whom Peter was the most eminent, Le Clerc, Chereau, Cochin, Beauvais, Simonneau Dupuis, and many other masters belong to this period; but Balechon and Wille, towards the middle of the century, outstripped all that had been done by their predecessors. Wille was a German; but his residence having been chiefly at Paris, he is always ranked among the French engravers. His extraordinary powers in imitating the qualities of objects, and particularly of satin, the smoothness of effect he produced, and his extraordinary clearness in the use of the graver, entitle him to a place of the first rank in the French school, which, since the age of Louis XIV., has been more distinguished for its great mechanical skill, than for grace, correctness, and beauty in the higher departments of the art.

Till the middle of the seventeenth century England was indebted to foreign artists for the embellishment bestowed upon the typographical works she produced, as well as for such engravings, either in history, portrait, or landscape, as the taste of the nation required. Among the artists who visited England and made it their permanent or temporary residence were the Passes, Vaillant, Hondius, Vosterman, Hollar, Blooteling, Dorigny, and several others. Payne, who died about 1648, and Faithorne, who executed many historical pieces and portraits in a masterly manner, were the earliest English engravers deserving mention. William Faithorne, son of the last named, was eminent as one of the earliest mezzotinto engravers; a species of engraving of English invention, if the editor of *Wren's Pacentalia* can be relied on, and discovered, according to him, by his eminent relation, Sir Christopher Wren. This invention, which is usually attributed to Prince Rupert, is claimed by Heineken for Lieutenant-Colonel Siegen, who was a Hessian officer, from whom Heineken says Prince Rupert learned the secret, which he brought to England on his return with Charles II. After the two Whites, father and son, appeared Vertue, who was born in 1684. He was the scholar of Vandergucht, and from the numerous works he brought out must have been an artist of great industry and facility. The larger portion of his labours was confined to portraits. Vertue died in 1757, and left behind him a History of Painting and Painters in England, which was published by Horace Walpole in 4 quarto volumes. The works of Pond and Knapton can only be mentioned as continuing the history, though occasionally they possess some spirit; but Vivares, a Frenchman by birth, belonging, however, to the English school, and indeed the founder of it in landscape engraving, has shown in his engravings from the pictures of Claude talents, the precursors of that pre-eminence in landscape engraving which this country has not only improved upon but exclusively possessed. Woollett carried execution to a far greater extent than Vivares, uniting with that engraver's spirit all the elegance, clearness, and delicacy of the French school; and to these Woollett superadded every beauty that mechanical skill could effect. John Browne was a contemporary worthy of Woollett, whose works after Salvator, Both, and others are well executed. Sir Robert Strange distinguished himself by his great mechanical skill, whence resulted beautiful execution, by the breadth he preserved in the effects he copied, and by the delicacy he imparted to flesh in a manner that has never been equalled. His principal engravings are from the Italian painters, especially Titian, Guido, and Corregio, and reflect great honour on the English school, which since his time has never been deficient in producing artists of the first class. Strange was a native of one of the Orkney Islands, where he was born in 1721, and died in 1792. Since his time the names of artists of talent might be here supplied to a very great extent: we shall merely mention those of Basire, Bartolozzi, Rooker, Heath, Byrne, Bromley, Lowry, Earlom, Raphael, Smith, &c. In the present day the demand of prints for the embellishment of books has produced talent which perhaps might be more nobly employed in works of a higher order. In the enumeration of masters it will be seen that the name of Hogarth does not find a place, — for which our reason is that his engravings partake more of the nature of pictures transferred at once to copper, often without proceeding through the intermediate stage.

Engraving on Wood, or Xylography.—In this branch of the art the material used is a block of box or pear-tree wood, cut at right angles to the direction of the fibres, its thickness being regulated by the size of the print to be executed. The subject is drawn on the block with a black-lead pencil, or with a pen and Indian ink, taking care that the whole effect is represented in the lines so drawn. The whole of the wood is then cut away, except where the lines are drawn, which are left as raised parts; in which point it is that this mode of engraving differs so essentially from copper-plate engraving, wherein the lines are cut out or sunk in the metal, instead of being raised from it. The impressions from wood blocks are taken in the same manner as from printing types.

Engraving on Copper is performed by cutting lines representing the subject on a copper-plate by means of a steel instrument ending in an unequal-sided pyramidal point, such instrument being called a graver or burin, without the use of aquafortis; which mode will be seen below, under the art. ETCHING. Besides the graver there are other instruments used in the process; viz. a scraper, a burnisher, an oil stone, and a cushion for supporting the plate. In cutting the lines on the copper the graver is pushed forward in the direction required, being held in the hand at a small inclination to the plane of the copper. The use of the burnisher is to soften down lines that are cut too deep, and for burnishing out scratches in the copper: it is about three inches long. The scraper, like the last, is of steel, with three sharp edges to it, and about six inches long, tapering towards the end. Its use is to scrape off the burr raised by the action of the graver. To show the appearance of the work during its progress, and to polish off the burr, engravers use a roll of woollen or felt called a rubber, which is put in action with a little olive oil. The cushion, which is a leather bag about nine inches diameter filled with sand for laying the plate on, is now rarely used except by writing engravers. For architectural subjects, or in skies, where a series of parallel

lines are wanted, an ingenious machine was invented by the late Mr. Wilson Lowry, called a ruling machine, the accuracy of whose operation is exceedingly perfect. This is made to act on an etching ground by a point or knife connected with the apparatus, and bit in with aquafortis in the ordinary way.

Etching is a species of engraving on copper or other metals with a sharp-pointed instrument called an etching needle. The plate is covered with a ground or varnish capable of resisting the action of aquafortis. The usual method is to draw the design on paper with a black-lead pencil; the paper being damped and laid upon the plate, prepared as above, with the drawing next the etching ground, is passed through the rolling press, and thus the design is transferred from the paper to the ground. The needle then scratches out the lines of the design; and aquafortis being poured over the plate, which is bordered round with wax, it is allowed to remain on it long enough to corrode or bite in the lines which the etching needle has made. Etching with a dry point, as it is called, is performed entirely with the point without any ground, the burr raised being taken off by the scraper. Etching with a soft ground is used to imitate chalk or black-lead drawings. For this purpose the ground is mixed with a portion of tallow or lard, according to the temperature of the air. A piece of thin paper being attached to the plate at the four corners by some turner's pitch and lying over the ground, the drawing is made on the paper and shadowed with the black-lead pencil. The action of the pencil thus detaches the ground which adheres to the paper, according to the degree to which the finishing is carried: the paper being then removed, the work is bit in in the ordinary way. *Stippling* is also executed on the etching ground by dots instead of lines made with the etching needle, which, according to the intensity of the shadow to be represented, are made thicker and closer. The work is then bit in. *Etching on Steel* is executed much in the same way as in the process on copper. The plate is bedded on common glazier's putty, and a ground of Brunswick black is laid in the usual way, through which the needle scratches. It is then bit in, in the way above described.

Mezzotinto Engraving.— In this species of engraving the artist, with a knife or instrument made for the purpose, roughs over the whole surface of the copper in every direction, so as to make it susceptible of delivering a uniform black, smooth, or flat tint. After this process the outline is traced with an etching needle, and the lightest parts are scraped out, then the middle tints so as to leave a greater portion of the ground, and so on according to the depth required in the several parts of the work.

Aquatinta Engraving, whose effect somewhat resembles that of an Indian-ink drawing. The mode of effecting this is (the design being already etched) to cover the plate with a ground made of resin and Burgundy pitch or mastic dissolved in rectified spirit of wine, which is poured over the plate lying in an inclined position. The spirit of wine, from its rapid evaporation, leaves the rest of the composition with a granulated texture over the whole of the plate, by which means a grain is produced by the aquafortis on the parts left open by the evaporation of the spirit of wine. The margin of the plate is of course protected in the usual way. After the aquafortis has bitten the lighter parts they are *stopt out*, and the aquafortis is again applied, and so on as often as any parts continue to require more depth. Formerly the grain used to be produced by covering the copper with a powder or some substance which took a granulated form, instead of using the compound above mentioned; but this process was found to be both uncertain and imperfect. In the compound the grain is rendered finer or coarser, in proportion to the quantity of resin introduced. This mode of engraving was invented by a Frenchman of the name of St. Non, about 1662. He communicated it to Jean Baptiste le Prince; who died in 1781, from whom it was acquired by Paul Sandby, who introduced it through the medium of Mr. Jukes into England. It has been practised in this country with much greater success than elsewhere.

Etching on Glass.— The glass is covered with a thin ground of beeswax: and the design being drawn with the etching needle, it is subjected to the action of sulphuric acid sprinkled over with pounded fluor or Derbyshire spar. After four or five hours this is removed, and the glass cleaned off with oil of turpentine, leaving the parts covered with the beeswax untouched. This operation may be inverted by drawing the design on the glass with a solution of beeswax and turpentine, and subjecting the ground to the action of the acid.

Engraving on Stone, or *Lithography* (λιθος, *a stone*, and γραφειν, *to write or draw*). A modern invention, by means whereof impressions may be taken from drawings made on stone. The merit of this discovery belongs to Aloys Senefelder, a musical performer of the theatre at Munich about the year 1800. The following are the principles on which the art of lithography depends: — First, the facility with which calcareous stones imbibe water; second, the great disposition they have to adhere to resinous and oily substances; third, the affinity between each other of oily and resinous substances, and the power they possess of repelling water or a body moistened with water. Hence, when drawings are made on a polished surface of calcareous stone with a resinous or oily medium, they are so adhesive that nothing short of mechanical means can effect their separation from it, and whilst the other parts of the stone take up the water poured upon them, the resinous or oily parts repel it. Lastly, when over a stone prepared in this manner a coloured oily or resinous substance is passed, it will adhere to the drawings made as above, and not to the watery parts of the stone. It was formerly thought that this country did not possess a sort of stone like that of Germany suitable to the purposes of lithography; this, however, is now known to be erroneous, as the neighbourhood of Bath abounds with it, being the white *lias*, which lies immediately under the blue. It is also found in Scotland. The ink and chalk used in lithography are of a saponaceous quality: the former is prepared in Germany from a compound of tallow soap, pure white wax, a small quantity of tallow, and a portion of lamp-black, all boiled together, and when cool dissolved in distilled water. The chalk for the crayons used in drawing on the stone is a composition consisting of the ingredients above mentioned, but to it is added when boiling a small quantity of potash. After the drawing on the stone has been executed and is perfectly dry, a very weak solution of vitriolic acid is poured upon the stone, which not only takes up the alkali from the chalk or ink, as the case may be, leaving an insoluble substance behind it, but it lowers in a very small degree that part of the surface of the stone not drawn upon, and prepares it for absorbing water with greater freedom. Weak gum water is then applied to the stone, to close its pores and keep it moist. The stone is now washed with water, and the daubing ink applied with balls as in printing; after which it is passed in the usual way through the press, the process of watering and daubing being applied for every impression.

There is a mode of transferring drawings made with the chemical ink on paper prepared with a solution of size or gum tragacanth, which being *laid on the stone and passed through the press* leaves the drawing on the stone, and the process above described for preparing the stone and taking the impressions is carried into effect.

In Germany many engravings are made on stone with the burin, in the same way as on copper; but the very great inferiority of these to copper engravings makes it improbable that this method will ever come into general use.

Perhaps one of the greatest advantages of the art of lithography is the extraordinary number of copies that may be taken from a block. As many as 70,000 copies or prints have been taken from one block, and the last of them nearly as good as the first. Expedition is also gained, inasmuch as a fifth more copies can be taken in the same time than from a copper-plate: and as regards economy the advantage over every other species of engraving is very great.

Zincography.— This art, which is of very recent introduction in this country (so much so, indeed, that but few specimens are as yet to be seen), is similar in principle to lithography, the surface of the plates of zinc on which it is executed being bit away, leaving the design prominent or in relief. We have seen some beautiful examples of this art, but varying little in their appearance from those of stone engraving.

ENGRO'SSING. The writing of a deed over fair, and in proper legible characters. Among lawyers it more particularly means the copying of any writing upon parchment or stamped paper. In statute law, engrossing means the buying up of large quantities of any commodity in order to sell it again at an unusually high price. *See* FORESTALLING.

ENHARMO'NIC SCALE. In Music, a scale in which the modulation proceeds by intervals less than semitones; that is, by quarter tones, having two dieses or signs of raising or lowering the voice.

ENI'GMA. (Gr. αινιγμα.) A proposition put in obscure or ambiguous terms to puzzle or exercise the ingenuity in discovering its meaning. In the present day, the enigma is only a jeu d'esprit, or a species of amusement to beguile a leisure hour; but formerly it was a matter of such importance that the eastern monarchs used to send mutual embassies for the solution of enigmas. Every one remembers the enigma which Sampson proposed to the Philistines for solution; and the still more famous enigma of the Sphinx (quod vide), the source at once of the elevation and the misfortunes of Œdipus. About the 17th century the enigma, which had been for centuries neglected as a species of literary display, again came into favour; and in France particularly it was cultivated with so much zeal, that several grand treatises were dedicated to its history and characteristics. The best enigmas with which we are acquainted were written by Schiller, and have been incorporated in his works. Even in the present day the periodical literature of France and Germany does not disdain this species of writing; though, as was before observed, it is now employed gene-

rally for amusement, and rarely to convey moral instruction.

ENLI'STMENT, in Military and Naval affairs, means a voluntary engagement to serve as a private soldier or sailor, either for a fixed or unlimited period. Unlike the armies of the Continental nations, whose ranks are generally supplied by conscription, the troops of the British army in all its departments, whether of the line, artillery, or East India Company, are obtained by voluntary enlistment. About a century ago, it was usual to engage recruits for the period of three years; but the present practice is to enlist either for an unlimited period, as during the continuance of a war, or for certain defined numbers of years, which vary in the different classes of troops. For the infantry the period is seven years; for the cavalry ten years; for the artillery twelve years; and for the East India Company for an unlimited time or twelve years, provided the recruit be upwards of eighteen years of age, otherwise the difference between his age and eighteen years is added to each period. (*Penny Cyclo.*) By an act passed in 1819, called the Foreign Enlistment Act, no British subject was allowed to enter foreign service without permission from the crown; and though this act was recently suspended for three successive years in favour of the troops raised in this country for the service of the Queen of Spain, it is once more in full operation.

The navy of Great Britain is also manned by voluntary enlistment; though in time of war, or on other great emergencies, impressment (quod vide) is often resorted to for obtaining adequate supplies. The period of engaging to serve in the navy was, by an act passed in 1835, limited to five years; after which the sailor is entitled, under certain beneficial restrictions, to his discharge, with the privilege, however, of re-enlisting for a similar period.

E'NNEAGON. (Gr. ἐννεα, *nine*; γωνια, *angle*.) A plane geometrical figure bounded by nine sides. When the figure is regular and the side supposed $=1$, the area is 6·18182.

ENNEA'NDROUS. In Botany, having nine stamens.

ENNUI', a French term wholly naturalized in England, signifies a kind of listlessness or inaptitude for mental exertion; or it may be more scientifically defined as that uneasiness or languor which prevails during the absence of mental impressions. The Italian word *noja* corresponds to the French *ennui*.

ENRO'LMENT (in legal orthography, more properly, Inrolment), signifies in law the registering or entering of any document or lawful act in the rolls of the chancery, or superior courts of common law, or in the records of the quarter sessions. Such inrolment is rendered necessary in different cases by statute; as a deed of bargain and sale in order to pass lands must be inrolled in one of the courts of record at Westminster, or by the clerk of the peace in any county, by 27 H. 8. c. 16. Every deed before it is inrolled is to be acknowledged to be the deed of the party before a master in chancery, or a judge of the court in which it is inrolled.

ENSE'MBLE. (Fr.) In the Fine Arts, a term denoting the masses and details considered with relation to each other.

E'NSIGN. The national flag carried by a ship. Men of war carry a red, a white, or a blue ensign, according to the colour of the flag of the admiral in command of the station. Ships do not display their ensigns at sea, except in meeting strangers, on which ships show their national ensign. In harbour the ensign is not shown before 8 A.M., nor after sunset.

The ensign hoisted with the upper corner (or in British ships the *union* of the crosses of St. George and St. Andrew) downwards, is the signal of distress.

The English ensign is a red, white, or blue flag, having the union in the upper corner next the mast.

E'NSIGN. The lowest commissioned officer, subordinate to the lieutenants, in a regiment of infantry. An ensign is appointed to each company, and the junior ensigns carry the colours of the regiment. In the artillery and in the rifle brigade a second lieutenant takes the place of an ensign.

ENTA'BLATURE. (Fr. entablement.) In Architecture, the whole of the parts of an order above the column. The assemblage is divided into three parts: the architrave, which rests immediately on the column; the frieze next, over the architrave, being the middle member; and the cornice, which is the uppermost part. The first and last are variously subdivided in the different orders. *See* ORDER.

ENTAI'L. *See* FEE TAIL.

E'NTASIS. (Gr. ἐντασις.) In Architecture, a delicate and almost imperceptible swelling of the shaft of a column, to be found in almost all the Grecian examples, adopted to prevent the shafts being strictly frusta of cones. This refinement, which is alluded to in the second chapter of the third book of *Vitruvius*, was first observed in execution by Mr. Allason in 1814 in the Athenian edifices.

ENTE'LECHY. (Gr. ἐντελέχεια; from ἐντελὴς, *perfect*, and ἔχω, *I hold*.) A peripatetic term, invented by Aristotle in order to express an object in its complete actualization, as opposed to merely *potential* existence (τὸ δυνάμει ὂν). *See* ARISTOTELIAN PHILOSOPHY.

ENTELMI'NTHA. (Gr. ἐντος, *within*, and ἕλμινς, *a worm*.) A name synonymous with *Entozoa*, and applied to the same heterogeneous group of invertebrate animals. *See* CŒLELMINTHA and STERELMINTHA.

ENTERI'TIS. (Gr. ἐντερα, *the intestines*.) Inflammation of the bowels. This disease is frequently occasioned by incautious exposure to cold, by acrid substances or hardened fæces in the bowels. Its symptoms are, pain over the abdomen; thirst, heat, and excessive restlessness and anxiety; sickness; obstinate constipation; and a hard, small, and quick pulse. The pain increases as the disease proceeds, especially about the navel; there is great difficulty in voiding the urine, which is small in quantity and high-coloured; and the abdomen is so tender as not to endure the slightest pressure. It often terminates in a few hours in mortification of a part of the intestinal canal; in which case the pain suddenly ceases, the belly becomes tumid, the pulse sinks rapidly, and the countenance acquires a peculiar ghastliness: it also proves fatal during the inflammatory stage. Favourable symptoms are, a gradual diminution of pain and of tenderness on pressure, natural evacuation by the bowels, moist skin, equal and firm pulse, and a copious discharge of urine depositing abundance of red sediment. This is a disease which requires prompt and decided treatment, more especially as relates to bleeding, which should be carried as far as the strength will allow upon the first accession of the inflammation. Leeches should be applied over the abdomen, and the patient should be put in a hot bath, or fomented with hot water: the lower bowels should be evacuated by a glyster of castor oil and gruel; and small doses of saline purgatives, or of calomel and cathartic extract, should be administered to clear the bowels. The stomach, however, is very apt to reject these remedies, and sickness should be avoided: it must be quelled by the effervescing draught, with a very few drops of tincture of opium. In some cases pretty large doses of calomel and opium have been given with success. When the urgent symptoms give way, and the bowels have been cleared, diaphoretic saline medicines and gentle aperients may be used, and a mild nourishing diet allowed; but great care is requisite in ascertaining that all relics of the inflammatory action are got rid of, and that it is not lurking in some one spot in a chronic form.

E'NTEROCE'LE. (Gr. ἐντερα, *the bowels*, and κηλη, *tumour*.) A hernia or rupture, the contents of which are a portion of intestine.

ENTERODE'LA. (Gr. ἐντερα, and δηλος, *manifest*.) The name given by Ehrenberg to a section of his class *Polygastrica*, comprehending those which have a complete alimentary canal terminated by a mouth and anus.

E'NTEROEPI'PLOCE'LE. (Gr. ἐντερα; ἐπιπλοον, *the omentum*; κηλη, *tumour*.) A hernia or rupture containing both intestine and omentum.

ENTERO'LOGY. (Gr.) A treatise on the bowels.

ENTHYME'ME (Gr. ἐν, and θυμος, *mind*; something understood in the mind and not expressed), in Logic, is commonly defined to be an argument having one premiss expressed, the other understood. (*See* LOGIC, SYLLOGISM.) This is the character under which the universal form of reasoning, or syllogism, generally presents itself in connected writing. For example, the following argument, if drawn out in the correct logical form, would stand thus, "All tyrants deserve death; but Cæsar is a tyrant, therefore Cæsar deserves death." But in the rapid diction of oratory, or poetry, it would probably be expressed either, "All tyrants deserve death, therefore so does Cæsar;" in which case the minor premiss, "Cæsar is a tyrant," is suppressed: or, "Cæsar is a tyrant, therefore he deserves death," by suppressing the major premiss. Instances may be cited in which the enthymeme consists merely of one of the premisses expressed, while both the other premiss and the conclusion are to be supplied by a rapid exercise of thought. Thus in the well-known words, "But Brutus says he was ambitious, and Brutus is an honourable man," the last of these propositions contains a complete argument, — "what honourable men say is to be believed: Brutus is an honourable man, therefore what Brutus says is to be believed."

ENTOMO'LOGY. (Gr. ἐντομα, *insects*, and λογος, *a discourse*.) The science of insects: the history of the organization, habits, properties, and classification of those articulated animals which are distinguished by the presence of antennæ and of breathing organs, composed of ramified tracheæ with or without air-sacs. The name insect, from its etymological signification of an animal insected or divided into sections, is applicable to the greater part of the Articulate sub-kingdom, but is now restricted to those species characterized as above. The presence of highly developed organs for breathing air, together with peculiar and complex organs of sensation, is associated, as might be expected, with active powers of locomotion; and most insects, besides having articulated

members for terrestrial progression, for leaping or climbing, swimming or diving, are endowed with wings, and are capable of rapid and extensive flight. The power of traversing space is given in greater fulness and perfection to the class of insects than to any other created beings on our planet. A peculiar condition of the breathing organs, and a peculiar animal tissue (chitine), which combines great strength, elasticity, and levity, coexist in insects, and in insects only. If, therefore, the highest of living created animals contain the characteristic structures of all lower forms, as some transcendental anatomists assume, then man is not the acmé or apotheosis of animal organization; for neither anastomosing tracheæ nor a particle of chitine is present in his system; nor does he possess a thousandth part of the locomotive energies of certain insects.

Those insects which have more than six articulated legs, and have the segments of the trunk free, without distinction of thorax and abdomen, which undergo no other metamorphosis than acquiring an increased number of segments after exclusion from the egg, and which lastly possess neither compound eyes nor wings, are separated by some zoologists as a distinct class, under the name *Myriapoda*, which see.

In the Hexapod insects, the body is divided into a head, thorax, and abdomen; the head supports a pair of antennæ, and contains a pair of compound, and often also simple eyes; the mouth is provided with a labium, labrum, mandibulæ, and maxillæ; the labium and maxillæ also support peculiar feeling organs, called palpi. Sometimes these parts of the mouth, which are termed collectively trophi, or oral organs, are distinct, and adapted to mastication: the insects thus characterized constitute an extensive primary division of the class termed *Mandibulata*. Those insects in which the trophi are so modified as to form an instrument of suction are included in the primary division called *Haustellata*.

The Hexapod insects were divided by Linnæus into the following orders:—

1. *Coleoptera*. Wings four, the upper pair hard, with a straight suture. Ex.: Beetles and earwigs.
2. *Hemiptera*. Wings four, the upper pair moderately hard and incumbent. Ex.: Bugs, locusts, tree-hoppers, plant-lice, &c.
3. *Lepidoptera*. Wings four, covered with scales. Ex.: Moths and butterflies.
4. *Neuroptera*. Wings four, membranaceous; anus unarmed. Ex.: Dragon-flies, May-flies, &c.
5. *Hymenoptera*. Wings four, membranaceous; anus aculeate. Ex.: Bees, ants, saw-flies, &c.
6. *Diptera*. Wings two; halteres two, in place of the posterior wings. Ex.: Flies.
7. *Aptera*. Wings none. In this order Linnæus included not only true Apterous insects, as fleas, but also centipedes, spiders, crabs, lobsters, &c.; or the articulate animals now forming the classes *Myriapoda*, *Arachnida*, and *Crustacea*.

There is not, perhaps, any class of the animal kingdom which has been the subject of more numerous and various attempts at classification than that of insects. We have just seen that Linnæus adopted the locomotive system as the basis of his method. Fabricius, his pupil, proposed a system founded on modifications of the structure of the mouth. Latreille endeavoured to form a natural classification of those most numerous animals from a consideration of their entire organization. His latest system is as follows:—

Sub-class I. *Aptera*. No wings; simple eyes in most.

A. No metamorphosis, but simple moulting, without a season of torpidity; mouth in some a simple sucker, in others mandibulate.

Order 1. *Thysanura*.

2. *Anoploura* (or *Parasita*).

B. A complete metamorphosis, larvæ apodal; pupæ torpid; mouth haustellate, composed of an articulate sheath containing three setæ, with two scales at their base; body much compressed; the species saltatory and parasitic.

3. *Aphaniptera* (or *Siphonaptera*).

Sub-class II. *Ptilota*. Wings, but sometimes not developed as such; two compound eyes, to which in many are added simple eyes.

A. Two wings covered by two elytra, either crustaceous or coriaceous.

a. Mandibles and maxillæ; elytra of the same consistence.

4. *Coleoptera*.
5. *Dermaptera*.
6. *Orthoptera*.

b. No mandibles nor maxillæ; mouth haustellate, composed of an articulate sheath, including four setæ; elytra membranous at their extremity in most.

7. *Hemiptera*.

B. Wings four, or two; not covered by elytra.

a. Mandibulate; wings four, membranous, and generally transparent; a small scale (tegulum) at the base of the two anterior wings.

8. *Neuroptera*.
9. *Hymenoptera*.

b. Haustellate; wings scaly; tegula large, and thrown back.

10. *Lepidoptera*.

c. Two wings; haustellate.

11. *Strepsiptera* (or *Rhipiptera*).
12. *Diptera*.

For the characters of the above orders see the articles under their respective denominations.

ENTOMO'PHAGA. (Gr. ἐντομα, *insects*, and φαγω, *I eat*.) A tribe of Marsupial quadrupeds, characterized by having three kinds of teeth — viz. incisors, canines, and molares — in both jaws, and the intestinal canal provided with a moderate-sized cœcum. The Opossums (*Didelphys*), Bandicoots (*Perameles*), and the genera *Myrmecobius* and *Chæropus* are associated to form this group; and feed principally, though not exclusively, on insects.

E'NTOMO'STRACANS. (Gr. ἐντομος, *incised*, and ὀστρακον, *a shell*.) A division of the class *Crustacea*, including those species which are covered with a thin horny tegument in the form of a shell, and consisting of one or two pieces.

ENTOZO'A. (Gr. ἐντος, and ζωον, *an animal*.) A name given to an extensive series of low-organized invertebrate and generally vermiform animals, of which the greater part are parasitic on the internal organs of other animals. They have colourless blood, circulated in the higher organized species in a closed system of vessels, without an auricle or ventricle; they have no respiratory organs, no articulated members for locomotion, no organs of sense. The digestive system consists either of tubes or cavities excavated in the parenchymatous texture of the body, and without an anal outlet; or of a tube with both oral and anal orifices freely suspended in an abdominal cavity. A filamentary nervous system has been recognized in the higher organized Entozoa, occasionally complicated with a ganglion near the mouth; the generative system is unisexual, hermaphrodite, or diœcious. (For the classification of the Entozoa, see INTESTINALIA.) The species of Entozoa known to infest the human body are the following:—*Ascaris vermicularis*, *Ascaris lumbricoides*, *Tricocephalus dispar*, *Bothriocephalus latus*, *Tœnia solium*, in the alimentary canal; *Distoma hepaticum*, in the gall-bladder; *Acephalocystis endogena*, *Echinococcus hominis*, in the substance of the liver, in the omentum and cavity of the abdomen; *Filaria bronchialis*, in the bronchial glands; *Strongylus gigas*, in the kidney; *Spiroptera hominis* and *Strongylus spiniger*, in the urinary bladder; *Polystoma pinguicola*, in the ovarium; *Trichina spiralis*, in the voluntary muscles; *Cysticercus cellulosæ*, *Filaria medinensis*, and *Filaria oculi*, in the cellular tissue.

ENTREPOT. In Commerce, the name given in France and some other countries to a warehouse or other place where goods brought from abroad may be deposited, and from whence they may be withdrawn for export to another country, without payment of any tax or duty. An entrepôt is, therefore, synonymous with what is called a free port on the Continent, and in this country with a *bonded warehouse;* that is, a warehouse in which foreign products are stored under the joint locks of the king and the importer: if such products be entered for home consumption, they are free of duty till their entry; and if they be re-exported to a foreign country, they are exempted from all duty, and merely pay a small sum as warehouse rent. In popular language, however, the word entrepôt is frequently employed to designate a sea-port or commercial town which exports the produce of a considerable adjacent territory, and imports the foreign articles required for its supply. But its correct signification is that given above.

E'NTRESOL. (Fr.) In Architecture. *See* MEZZANINE.

ENTRO'PIUM. (Gr. ἐν, *in*, and τρεπειν, *to turn*.) A turning in of the eyelashes and eyelid, so as to irritate the ball of the eye.

E'NTRY, in Law, signifies the taking possession of lands and tenements where a man has title of entry. It is also used for a writ of possession. Entry is either actual, made by the party or his attorney; or an entry in law, by continual claim. Remedy by entry takes place in cases of abatement, intrusion, and disseisin; not on discontinuance or deforcement.

E'NVELOPE. In Fortification, a mound of earth, raised to cover some weak part of the works. Envelopes are sometimes raised in the ditch of the place, sometimes beyond it; and are in the form of a single parapet, or a small parapet bordered by another.

E'NVOYS, ORDINARY and EXTRAORDINARY, belong to the second order of diplomatic ministers. They are inferior in rank to ambassadors, properly so called; the chief difference between them being that the latter are held to represent the interests of their sovereign as agents, the former his person. *See* AMBASSADOR.

E'OCE'NE. (Gr. ἠως, *the morning*, and καινος, *recent*.) In Geology. "This period we shall call *Eocene*, because

the extremely small proportion of living species contained in these strata indicates what may be considered the first commencement or *dawn* of the existing state of the animal creation. To this period the formations first called tertiary, of the Paris and London basins, are referable." (*Lyell, Geology*.)

E'OLIPILE. *See* ÆOLIPILE.

EPA'CRIDA'CEÆ. (Epacris, one of the genera.) A natural order of shrubby Exogens, chiefly natives of Australia; they differ from *Ericeæ* chiefly in the structure of the anther, which is one-celled and destitute of appendages. The fruit of *Lissanthe sapida*, and a few other species, is eaten under the name of the Australian cranberry; otherwise there is no plant of any known use in the order, which, however, contains many beautiful species of the genera *Epacris*, *Lysinema*, *Sphenotoma*, *Styphelia*, and *Dracophyllum*.

E'PACT (Gr. ἐπακτος, *added or introduced*), in Chronology, denotes the moon's age at the end of the year, or the number of days by which the last new moon has preceded the beginning of the year. The common solar year consists of 365 days, and the lunar year of only 354 days: the difference is therefore 11; whence, if a new moon fall on the 1st of January in any year, the moon will be 11 days old on the 1st day of the following year, and 22 days old on the 1st of the third year. The numbers 11 and 22 are therefore the *epacts* of those years respectively. The addition of 11 to the last epact gives 33 for that of the succeeding or fourth year; but as the lunar month never exceeds 30 days, the epact cannot exceed 30; whence 30 is deducted from 33, and the epact is reduced to 3. Of the thirty days thus rejected an *embolismic* or *intercalary* month is formed, which, consequently, occurs every third year of the lunar cycle, and gives 13 lunar months to that year. In like manner the epacts of all the succeeding years of the lunar cycle are obtained; that is to say, by adding successively 11 to the epact of the former year, and rejecting 30 as often as the sum exceeds that number, the leap years being taken account of by adding one day to each lunar month which contains the 29th of February. Supposing, therefore, the epact of the first year of the cycle to be 11, the epacts of all the 19 years of which the cycle is composed will be as follows: — 11, 22, 3, 14, 25, 6, 17, 28, 9, 20, 1, 12, 23, 4, 15, 26, 7, 18, 29. But the order is interrupted at the end of the cycle; for the epact of the following year, formed in the same manner, would be 29 + 11 — 30 = 10, whereas it ought obviously to be 11, to correspond with the moon's age, all the circumstances being now supposed to be the same as they were at the commencement of the previous cycle. In order to understand this, it is necessary to remember that the lunar cycle of the ecclesiastical calendar is composed in the following manner:—The lunations are supposed to consist of 29 and 30 days alternately, or the common lunar year of 354 days; and, in order to make up 19 solar years, six embolismic or intercalary months of 30 days each are inserted in the course of the cycle, and one of 29 days at the end. Hence it follows that after adding 11 to the epact of the 19th year of the cycle, we must reject 29 instead of 30, in order to have the epact of the following year, or the first year of the following cycle.

This method of forming the epacts is adapted to the Julian calendar, and might be continued indefinitely, if the Julian intercalation were followed without interruption, and the lunar cycle, defined as above, had corresponded exactly with the lunar motions. But the intercalation is subject to correction, and the cycle is not quite exact. Hence the epacts must occasionally be adjusted; and, generally speaking, an alteration is made on the last year of each century. In the ordinary tables of the church calendar the epacts are therefore given only for a single century; but as the Gregorian calendar now in use defines precisely the length of the year, tables, though somewhat more complicated, have been formed, which show the epacts of every future year in all time to come. They may even be found by means of an algebraic formula of no great perplexity. (See the article "Calendar" in the *Encyclopedia Britannica*.) The epacts were invented by Luigi Lilio Ghiraldi, more frequently styled Aloysius Lilius, a physician of Naples, and author of the Gregorian Calendar, for the purpose of showing the days of the new moons, and thence the moon's age on any day of the year, and consequently of regulating the church festivals. It is only in ecclesiastical computations that the epacts are ever employed; in civil affairs the civilized portion of mankind have long since laid aside the use of the lunisolar year, and regulated time entirely by the sun. In the calendar of the Church of England, Easter and the other moveable feasts are determined in the same manner as in the old Romish calendar, excepting that the golden numbers are prefixed to the days of the *full moons*, instead of the days of the new moons. The epacts are consequently not used. It is desirable that the custom of reckoning time by the moon, which had its origin in ignorant ages, were abandoned, and the civil year adopted for every purpose. *See* CALENDAR.

The following table shows the epacts corresponding to each year of the lunar cycle during the present century. The year of the cycle is what is usually called the golden number, which is found by the following rule: — Add 1 to the date (or year), and divide the sum by 19; the quotient will be the number of cycles elapsed since the commencement of the era, and the remainder the golden number. *See* GOLDEN NUMBER.

Table of Gregorian Epacts.

Golden Number.	Epact.	Golden Number.	Epact.	Golden Number.	Epact.
I.	0	VIII.	17	XV.	4
II.	11	IX.	28	XVI.	15
III.	22	X.	9	XVII.	26
IV.	3	XI.	20	XVIII.	7
V.	14	XII.	1	XIX.	18
VI.	25	XIII.	12	I.	0
VII.	6	XIV.	23		

EPA'NALE'PSIS. (From the Greek preposition ἐπι, and ἀναλαμβανω, *I take up*.) In Rhetoric and Composition, a figure by which the word which begins the sentence is repeated at the end of it: "Judge not, that ye be not judged."

EPAU'LE. In Fortification, the shoulder of the bastion, or the angle made by the face and flank.

EPAU'LEMENT. A side work hastily raised to cover the cannon or men: also used for a demi-bastion, consisting of a face and flank; or for the redoubts made on a right line.

EPAULETTES. (Fr.) Distinguishing ornaments worn both by military and naval officers. In the different armies of the German states ensigns are not allowed to wear epaulettes; and hence the phrase "to obtain epaulettes," is synonymous with "to become a lieutenant." In the British army all officers with the rank of captain upwards wear two epaulettes; all under that rank only one.

EPENE'TIC. (Gr. ἐπαινετικος, from ἐπαινος, *an encomium*.) The laudatory or "encomiastic" species of oratory: a branch of the Epideictic, according to the division of Aristotle's *De Rhetorica*. *See* PANEGYRIC.

EPE'NTHESIS. A figure of grammar, by which one or more letters are inserted in the middle of a word; as in the Latin *rettulit* for *retulit*. *See* METAPLASM.

EPHEBEI'UM. (Gr. ἐφηβος, *a youth*.) In Ancient Architecture, the building appropriated for the wrestling and exercises of youth till they had, on their arrival at manhood, the right to enter the gymnasium.

EPHE'BI. (Gr. ἐφηβοι, signifying *arrived at the age of puberty*.) Applied particularly to the Athenian youth between the ages of eighteen and twenty years.

EPHE'MERANS, *Ephemerinæ*. (Gr. ἐφημερος, *daily*.) A family of Neuropterous insects, having the genus *Ephemera* as the type. They are called day-flies, from the enjoyment of their last stage of existence being generally limited to twenty-four hours.

EPHE'MERIS. (Gr. ἐφημερις; ἐπι, *upon*, and ἡμερα, *day*.) An astronomical table showing the places of a celestial body for every day at noon. Ephemerides (the plural) of the planets are computed and published annually for most of the principal observatories of Europe. The most celebrated of these are our own *Nautical Almanac*, the French *Connaissance des Tems*, and the Berlin *Jahrbuch*.

EPHEMERIS, in Literature, is a collective name for reviews, magazines, and all kinds of periodical literature.

EPHIA'LTES. (Gr. ἐφαλλομαι, *I leap upon*; from the sensation of something leaping upon the breast.) The nightmare. This affection, consisting of horrid dreams, with a sensation of great pressure upon the body, and of fruitless endeavours to escape and call for help, is generally symptomatic of indigestion, or of over-distension of the stomach. For its relief opening medicine, and sometimes an emetic, are often required, and careful abstinence from all that promotes dyspepsia, especially supper eating.

E'PHOD. (Heb.) A species of ornament worn by the Hebrew priests. The ephod worn by the high priest, says Calmet, was richly composed of gold, blue, purple, crimson, and twisted cotton; and upon the part which came over his shoulders were two large precious stones, upon which were engraven the names of the twelve tribes of Israel, six names upon each stone. The ephods worn by the ordinary priests were of fine linen. (See *Exod.* xxxix.)

E'PHORI. (Gr. ἐφοροι.) In Ancient History, the title of a class of magistrates common to many of the Dorian states of Greece, but more particularly known in reference to the political constitution of Sparta. The Spartan ephors were five in number, and were elected annually from the body of the ruling caste, and not from any particular tribe. They originally seem to have exercised a jurisdiction over the Spartans in their civil concerns, the

limits of which it is not easy to define; but their power increased by degrees, till it became supreme in the state. Besides their judicial authority, they exercised a control over the functions of the kings and the senate, and sometimes recalled the former from their foreign expeditions, and demanded an account of their proceedings. The executive power likewise was almost wholly in their hands.

E'PIC. (Gr. ἔπος, *a verse.*) A poem of an elevated character, describing generally the exploits of heroes. This species of poetry claims a very ancient origin, and is universally allowed to be the most dignified and majestic to which the powers of the poet can be directed. There are various theories regarding the character of an epic poem; and while some critics claim this title exclusively for the *Iliad* and *Odyssey* of Homer, the *Æneid* of Virgil, and the *Paradise Lost* of Milton, others — and particularly the Germans — embrace in the catalogue of epic writers Scott, Byron, Pope, Moore, and Campbell. Epic poetry has often been compared to the drama; and the essential difference between them is, that description is the province of the former — action of the latter. The emotions which epic poetry excite are not so frequent and violent as those produced by dramatic composition; but they are more prolonged, and more developed by actual occurrences; for an epic poem embraces a wider compass of time and action than is admissible in the drama. History has generally supplied the best epic writers with themes; but a close attention to historical truth in the development of the story is by no means requisite. Fiction, invention, imagination, may be indulged in to an almost unlimited extent; provided always the poet be careful to preserve what the critics call unity, *i. e.* provided his work embrace an entire action, or have a beginning, a middle, and an end. This is the distinguishing characteristic of the great epic poems. The object of the *Æneid*, for instance, is the establishment of Æneas in Italy; and amidst all the ramifications of the poem, the great object is kept steadily in view, and every digression from the subject is made powerfully and directly conducive to the progress and development of the tale. According to Aristotle, who has been implicitly followed by Blair, the essentials of an epic poem consist in the recital of some great event in a poetical form, — the contrivance of a plot important in itself, and instructive in the reflections which it suggests, filled with suitable incidents, enlivened with a variety of characters and descriptions, and maintaining throughout propriety of character and elevation of style. But besides these essential ingredients in epic poetry, there are also what may be termed *accidentals*, in which none of the great epic poems are deficient. These are a prescribed and lengthened march, formal addresses, sustained pomp, episodes, and machinery. About the necessity and use of machinery (the introduction of supernatural beings) in an epic poem there are various opinions. The French critics consider it as essential to the constitution of an epic poem, alleging that no poem, though possessed of every other requisite, has any pretension to be ranked in the epic class unless the main action be carried on by supernatural beings. "On peut dire," says Bossu, "en un mot qu'il faut user de machines partout, puisque Homere et Virgile n'ont rien fait sans cela." To be convinced of the error of this critic, we have only to ask ourselves what it is, in the writings of Homer and Virgil, that pleases us most? Assuredly, as an ingenious writer has remarked, it is not the councils of Olympus, the wiles of Juno and Venus, or the "animis in cœlestibus iræ" (how beautifully soever these are all pourtrayed), that awake a chord of sympathy, even after a lapse of two thousand years, in the breast of every one who reads them; but it is the knowledge of human nature, and the pictures of human feeling which these poems display, that have made them a "κτημα εις αει,"— a work for all time, a possession for eternity. In a word, upon this head we may say, that while, on the one hand, the *observance* of all these rules regarding machinery *alone* will never constitute an epic poem; so, on the other, the absence or violation of them in the hands of a man of genius will never deprive it of that character.

If the epic is the highest, it is also the most difficult style of poetical composition, and that in which mediocrity is least endurable; and hence few of the writers of epics on the classical model have obtained a high reputation as national poets in any language. Virgil is the earliest imitator of Homer whose epic has been preserved, and the most successful. The other Greek and Latin epic poets contain passages of great beauty; but their poems, as wholes, are of an inferior order. In the English language we have only two epics which can be said to form part of the national literature, and those only in part framed on the classical model: the *Paradise Lost* and *Regained* of Milton. French epics, including even the *Henriade* of Voltaire, so famous in its time, have no place among the chefs-d'œuvre of the national literature. Of the great Italian poems, only one (the *Jerusalem Delivered* of Tasso) fulfils the conditions of an epic. The poem of Dante, however sublime in style, has no unity of event or action: those of Ariosto, and the other Romanzieri, form a class distinguished from the epic by the mixture of the serious and ludicrous. The *Italia Liberata* of Trissino is simply pedantic. The old German and Spanish national poems, — the *Romance of the Cid*, and the *Niebelungen-Lied*, especially the latter, which is closely confined to the conduct of one great action, — although the work of writers unskilled in classical literature, deserve the title of epic as truly as those of Homer. There is a brief but masterly exposition of the origin and distinguishing characteristics of epic poetry in the *Penny Cyclopædia*, with reference to the chief German authorities on this subject.

EPICA'RIDANS, *Epicarides.* (Gr. ἐπι, *upon*, and καρις, *a shrimp.*) A family of Isopodous or equal-footed Crustaceans, which are parasitic upon shrimps.

EPICE'DIUM. (Gr. ἐπι, and κηδος, *grief.*) In Poetry, an elegiac poem on the occasion of a funeral solemnity in honour of some deceased person.

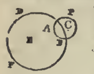
EPICRA'NITIS. (Gr. ἐπικραινω, *I finish.*) In Ancient Architecture, a tile forming the cyma of the cornice. The angular stone forming the vertex of the pediment was called the angular epicranitis. The term is used in the celebrated Athenian inscription brought to this country by Dr. Chandler, and now in the British Museum.

EPICURE'ANS. Followers of the tenets of Epicurus, a philosopher who lived from B. C. 337 to B. C. 270, and taught during the latter half of his life at Athens. The name of Epicurean has become the general designation of those who, either theoretically or practically, make pleasure the chief end of life and the standard of all virtue. Of the genuine doctrines of Epicurus himself we have notices in the work of Diogenes Laertius, who has preserved to us fragments of his very voluminous writings: but for these remains we should be at a loss, amid the conflicting statements of his friends and enemies, how to judge of his character as a man and a philosopher. The private character of Epicurus has, we doubt not, been unjustly aspersed; it will be found, however, on a careful examination of his system, that his merits as a philosopher have been as undeservedly extolled. Epicurus was the first philosophical teacher who deserted the lofty idea of science which Plato and Aristotle had striven to develop. Truth is, with him, no longer an object worth pursuing for its own sake, but only in so far as it contributes to the peace of mind of its possessor. Hence, though he retains the threefold division of philosophy into ethics, physics, and dialectics (in Epicurean language, canonic), he assigns the two latter a place subordinate to the first, and bestows on them a cursory and heedless mode of treatment.

We should greatly wrong Epicurus if we represented the gratification of the sensual appetites to be the object proposed by him to the wise man. The happiness which he regards as the true end of existence is rather a species of quietism, in which the philosopher, protected by his knowledge from all fear of injury from the powers of nature, and by the laws from the assaults of his fellow-creatures, holds himself open to all the pleasurable sensations which the temperate indulgence of his ordinary appetites, the recollection of past enjoyments, and the anticipation of future, are sufficient abundantly to furnish. In order to support his imaginary wise man in this tranquillity, he deemed it necessary to show that the apprehensions which beset mankind, of death, of the power and anger of the gods, and the like, are wholly unfounded. For this purpose he made use of the physical doctrine of Democritus; a system of atomic materialism, which makes all existences to arise from the concourse of minute particles of matter — the soul among the number, which is consequently, at the moment of death, resolved into its constituent elements. The mental philosophy of Epicurus was of a similar stamp: all our mental powers are resolved into sensation, immediate or recollected; and sensation, under both its forms, consists in the influx of certain extremely fine films, which are perpetually, as it were, sloughed from external objects, and find their way through the organs of sense to the soul. The gods of the Epicureans bear no relation to any part of their system: they are beings sprung, like men, from the concourse of atoms, and differing from them only in their superior blessedness and tranquillity, shown in their entire aloofness from the care and government of the world. The followers of Epicurus were numerous, especially among the Romans. Little more, however, than their names are recorded; with the exception of Lucretius, who, in his well-known poem, *De Rerum Naturâ*, illustrates and defends the physical and religious tenets of his master. In modern times, Gassendi, an atomic philosopher of the 17th century, has published an able statement of the Epicurean system, under the title of *Syntagma Philosophica Epicuri.* (See also *Diogenes Laërtius, Vit. Phil.* l. x.; and Cicero's philosophical writings generally: also *Ritter, Gesch. der Philos.* b. x. And for a list of the Epicureans, *Fabricii Bibliotheca Græca*, vol. iii. ed. Harles.)

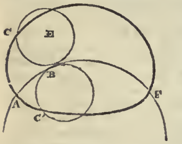
EPICY'CLE (Gr. ἐπι, *upon*, and κυκλος, *circle*), in the Ancient Astronomy, is a circle having its centre on

the circumference of another circle. It was a favourite axiom of the Greek astronomers, that all the celestial motions must be circular and uniform. The phenomena of the stations and retrogradations of the planets were apparently inconsistent with this supposition; and in order to explain them, Apollonius of Perga imagined the ingenious apparatus of *epicycles* and *deferents*. He supposed



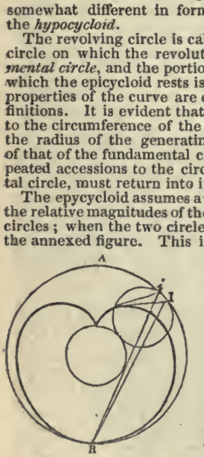
the planet P to move uniformly in the small circle or *epicycle* P A B, the centre of which is carried uniformly forward along the circumference of the large circle or *deferent* C D F, of which the earth occupies the centre E. Hipparchus, having discovered the eccentricity of the solar orbit, supposed the motions to be performed in eccentric circles. Ptolemy, the celebrated founder of the system which astronomers followed till the days of Copernicus, adopted the hypotheses both of Apollonius and Hipparchus; that is, he supposed the earth E to be placed at a small distance from the centre of the deferent circle (which consequently was called an eccentric), and the planet to move uniformly in the epicycle, the centre of which also moves uniformly in the deferent. By means of these suppositions, and by assigning proper ratios (determined by observation) between the radius of the deferent and the radius of the epicycle, and also between the velocity of the planet in its epicycle and the velocity of the centre of the epicycle on the deferent, he was enabled to represent with considerable accuracy, indeed with all the accuracy which the observations of that time required, the apparent motions of the planets, and particularly the stations and retrogradations which formed the principal object of the researches of the ancient astronomers. As a first step towards connecting the two sciences of astronomy and geometry, the system of epicycles does infinite honour to its inventors; and it ought to be borne in mind that it was never given out by Ptolemy as any thing else than a mere hypothesis for representing the apparent celestial motions, or, as he expresses it, for *saving* the appearances.

E'PICY'CLOID (Gr. επικυκλος, and ειδος, *form*), in Geometry, is a curve line which is generated by the revolution of a point in the circumference of a circle which rolls on the circumference of another circle either externally or internally. Thus, let the circle whose centre is E touch the circle A B F at the point A, and roll along the outside of the circumference; the point of original contact C, carried round till it return again to the circumference at F, will trace an epicycloid. If the circle revolve on the inside of the circumference, the curve traced out by the point C' will still be of the same kind, though somewhat different in form. This is sometimes called the *hypocycloid*.



The revolving circle is called the *generating circle*, the circle on which the revolution is performed the *fundamental circle*, and the portion of the fundamental circle on which the epicycloid rests is called its *base*. Some of the properties of the curve are easily deduced from these definitions. It is evident that the whole base A F is equal to the circumference of the generating circle; and when the radius of the generating circle is any aliquot part of that of the fundamental circle, the epicycloid, after repeated accessions to the circumference of the fundamental circle, must return into itself at the same point A.

The epycycloid assumes a variety of forms, according to the relative magnitudes of the fundamental and generating circles; when the two circles are equal, its form is that of the annexed figure. This is one of the caustic curves; for rays of light, issuing from a luminous point R in the circumference of a circle R I A, and reflected from any points I *i* in the circumference, are tangents to the curve; consequently all the reflected rays intersect in the curve which is thus traced out by the assemblage of brilliant points. When the radius of the generating circle is only half that of the fundamental circle, the exterior epicycloid forms the caustic of parallel rays. In this case the interior epicycloid becomes a straight line, the point C tracing out the diameter of the fundamental circle.



It is a remarkable property of epicycloids, that when the diameter of the generating circle is any aliquot part of the diameter of the fundamental circle, they are algebraic curves; and the whole epicycloidal circuits are capable of being expressed geometrically in terms of the diameters of those circles. Thus, let the radius of the generating circle be 1, and the radius of the fundamental circle n; then the length of the complete arc of the exterior epicycloid is expressed by the formula $8\left(\frac{n+1}{n}\right)$, and of the interior epicycloid by $8\left(\frac{n-1}{n}\right)$. In this case also the epicycloidal spaces, or areas, are expressible in terms of the areas of these circles; the surface of the exterior epicycloid being $\frac{3n+2}{n}$ times, and that of the interior epicycloid $\frac{3n-2}{n}$ times the area of the generating circle In all cases the epicycloid, as above defined, is rectifiable; but when the tracing point is not situated in the circumference of the generating circle, but any where in its plane within or without it, the curve is of a different nature, and the above properties no longer hold true. In this case the exterior curve is usually called the *epitrochoid*, and the interior the *hypotrochoid*.

The epicycloid was invented by the celebrated Danish astronomer Romer, the discoverer of the progressive motion of light, who proposed this curve, about the year 1674, as the proper form of the teeth of wheels, in order to destroy the friction. Newton, in the first edition of the *Principia*, gave its rectification; and Halley, in the *Philosophical Transactions*, No. 218., showed how its quadrature depends on that of the generating circle. The other principal properties of the curve were discovered and demonstrated by John Bernoulli.

The term *epicycloid* is applied to other curves than the above, but described in an analogous manner. If the revolving circle forms a constant angle with the plane of the fundamental circle, the curve traced out is called a *spherical epicycloid*. If an ellipse is made to roll on another ellipse, the generating point traces an *elliptic* epicycloid, &c.

EPIDE'MIC. (Gr. επι, *upon*, and δημος, *people*.) An infectious or contagious disease, which attacks many people at the same period and in the same country, "rages for a certain time, and then gradually diminishes and disappears, to return again at periods more or less remote." Thus influenza, scarlet fever, measles, &c., frequently appear as *epidemics;* that is, are found to prevail in certain parts of a country, while the adjacent districts are wholly free from their ravages. It is essential to the medical notion of an *epidemic* that it be of a temporary, in contradistinction to a permanent character. It differs from *endemic*, inasmuch as the latter class of diseases are of a permanent nature, and prevail only among certain people, and in certain districts.

EPIDE'RMIS. (Gr. επι, and δερμα, *the true skin.*) In Anatomy, the cuticle or scarf skin. It is an albuminous membrane.

EPIDERMIS. In Botany, the cellular integument, or the exterior cellular coating of the bark, or leaf, or stem of a plant. It is composed of cells compacted together into a stratum, varying in thickness in different species, and is often readily separable by gentle violence. It is believed to be intended by nature as a protection of the subjacent parts from the drying effects of the atmosphere.

E'PIDOTE. (Gr. επιδιδωμι, *I increase.*) A mineral which has received a great variety of names. It occurs crystallized, massive, and granular; its usual colours are various shades of green; its structure is generally fibrous. It is a triple silicate of alumina, lime, and iron. It occurs in most parts of Europe, in America, and in the East Indies. "L'épidote emprunte même des dimensions de sa molécule un caractère particulier; il consiste en ce que l'un des côtés de la base de cette molécule est plus étendu que l'autre, en sorte que cette base est un parallélogramme allongé, au lieu que dans les autres substances (actinote, amphibole, &c.) la figure de la base est d'un nombre. C'est de cette espèce *d'accroissement* que j'ai tiré le nom *d'épidote*." (*Hauy.*)

EPIGÆ'OUS. (Gr. επι, *upon*, and γη, *the earth.*) In Botany, a term used in describing the situation of bodies to denote any one growing close to the earth.

EPIGA'STRIC REGION (Gr. επι, and γαστηρ, *the stomach*), is that part of the abdomen which is over the stomach. It is also called the epigastrium.

E'PIGE'NESIS. In Physiology. *See* EVOLUTION.

EPIGLO'TTIS. (Gr. επι, and γλωττα, *the tongue.*) An oval cartilage at the root of the tongue, which closes upon the superior opening of the larynx; its superior extremity is loose, and elevated by its own elasticity: it closes the aperture of the larynx when the tongue is drawn back in the act of deglutition. Its base has a ligamentous attachment to the base of the tongue, the thyroid cartilage, and the os hyoides.

EPI'GONI. (Gr. επι, in the sense of *after*, and γιγνομαι, *I am born.*) The collective appellation of the sons of the seven Greek princes who conducted the first war against Thebes without success. The war subsequently undertaken by the Epigoni to avenge the defeat of their forefathers is celebrated in history. Their capture of Thebes forms the theme of Wilkie's epic poem, the *Epi-*

goniad, which was published about the middle of the last century, and procured for its author great reputation.

E'PIGRAM. (Gr. ἐπίγραμμα, *an inscription.*) In Poetry, a short poem or piece in verse, which has only one subject, and finishes by a witty or ingenious turn of thought; or, to use a more general definition, an interesting thought represented happily in a few words.

The first of these definitions, although tolerably correct as to the modern epigram, differs, as it will be seen, widely from the original sense of the word in Greek. The Greek epigram was, in the first instance, a short collection of lines actually inscribed on a monument, statue, fountain, &c.; and the word was thence transferred to such short poems as might serve for inscriptions: of such the collection termed the *Greek Epigrams* is almost wholly composed. Their general characteristic is perfect simplicity, and the seemingly studied absence of that *point* which characterizes the modern epigram. They are almost wholly in one form of metre, the elegiac.

In the poetry of classical Rome, the term epigram was still somewhat indiscriminately used to designate short pieces in verse; but the works of Catullus, and still more the well-known collection of the *Epigrams of Martial*, contain a great number which present the modern epigrammatic character; and Martial has, in fact, afforded the model on which the modern epigram has been framed. In this class of composition, and especially where the turn of thought is satirical, the French writers have been far more successful than those of any other nation; and the term "piquant" seems expressly invented to designate the peculiar force of those epigrammatic sallies of fancy of which their literature is full. (See Dr. Johnson's learned *Essay on Epigrams.*)

E'PIGRAPH (Gr. επιγραφω, *I inscribe*), also termed *Motto*. In Literature, a citation from some author, or a sentence framed for the purpose, placed at the commencement of a work or of its separate divisions.

EPI'GYNOUS. (Gr. επι, *upon*, and γυνη, *a female.*) A term used in botany to denote any organ growing upon the summit of the ovarium.

E'PILEPSY. (Gr. επιλαμβανω, *I seize upon.*) This disease is also called the *falling sickness*, from the suddenness of its attack. It is attended by convulsive stupor and frothing at the mouth. It comes on by fits, which after lasting a certain time go off, generally leaving a degree of lassitude and drowsiness. Where epilepsy is symptomatic of irritation in the primæ viæ, from worms, or indigestible and noxious food or poisons, or when it arises from the suppression of long-accustomed evacuations, the treatment is sufficiently obvious; so also in cases where it results from a blow, wound, or fracture, or from diseased bone, it may be relieved by proper surgical aid. Plethoric habits require lowering, and debility indicates the use of tonics. The disease, however, is always indicative of something essentially wrong in the nervous system; and where it arises from hereditary disposition, or comes on about the age of puberty, where the fits are frequent, and cannot be referred to any apparent cause, an unfavourable opinion must be formed respecting its termination, which, if not in apoplexy, is commonly in mental alienation or imbecility. Yet, the most unpromising cases have in a few rare instances ended well; that is, they have not recurred after violent pains, or eruptive disorders. It sometimes happens that certain symptoms precede the attack; and among them a sense of coldness proceeding from some part of the body towards the head, and called *aura epileptica*, with palpitation, flatulency, and slight stupor, are the most common. In such cases a brisk emetic, a large dose of opium and ether, a cold bath where it may be ventured upon, or any thing which produces a sudden shock upon the system, has prevented the fit. The most effective remedial treatment seems to be that which is directed to the diminution of nervous irritability by sedatives and tonics: among the former opium, ether, henbane, hemlock, and more lately morphia and strichnia, have been recommended; and as tonics bark, quinia, cascarilla, valerian, and some metallic salts, such as sulphate of iron, zinc, or copper, arseniate of potash, or the arsenical solution, and especially nitrate of silver; but the chance of permanently disfiguring the patient by the leaden hue which this last salt often communicates to the skin, should induce practitioners to be most scrupulous in the selection of this remedy. It is said that a violent scald or burn, or great alarm, as from a fire, a fall, and such accidents, have sometimes relieved the system of this horrible complaint; and hence perhaps the superstitious notions which have attached to its cure by charms.

During an epileptic fit, nothing can be done for the relief of the sufferer except taking care that he does not injure himself, and relieving him of any part of his dress which may tend to compress the vessels of the head; the paroxysms, however, are most frequent in the night.

E'PILOGUE. (Gr. επιλογος.) In Dramatic Poetry, the closing address to the audience at the end of a play.

EPI'PHANY. (Gr. επιφανης, *manifest.*) A church festival, signifying the manifestation of Christ, and referring to the appearance of the star which announced our Saviour's birth to the Gentiles. It is observed on the 5th of January, being the twelfth day from Christmas.

EPIPHONE'MA. (Gr. επι, *upon*, and φωνεω, *I speak.*) In Rhetoric and Composition, a short reflection added by way of corollary, or passing remark, to the end of a course of narrative or reasoning.

EPI'PHORA. (Gr. επι, *upon*, and φερω, *I bear.*) In Rhetoric, the emphatic repetition of a word or series of words at the end of several sentences or stanzas. The finest instance of this figure with which we are acquainted in modern oratory occurs in Fox's defence of himself and his measures in the House of Commons after the dissolution of the Coalition Ministry. Anaphora is a similar repetition at the beginning of several sentences.

EPI'PHORA. A disease occasioned by a superabundant secretion of tears.

EPIPHY'LLOUS. (Gr. επι, and φυλλον, *a leaf.*) In Botany, something inserted upon a leaf.

EPI'PHYSIS. (Gr. επι, *upon*, and φυσις, *nature.*) A process of a bone separated at first by a layer of cartilage from that to which it is attached.

EPIPLOCE'LE. (Gr. επιπλοον, *the omentum*, and κηλη, *tumour.*) A hernia or rupture formed by a protrusion of the omentum.

E'PIPLOON. (Gr.) The *omentum*.

EPISCE'NIUM. (Gr. επι, *upon*, and σκηνη, *a scene.*) In Ancient Architecture, the upper order of the scene in the theatre.

EPI'SCOPACY. (Gr. επισκοπος, *an overseer.*) The government of a church by three distinct orders of ministers — bishops, priests, and deacons. The nature of the argument upon which this constitution is best defended will be most clearly seen in a quotation from Mr. Short's *History of the English Church*. Speaking of the points at issue between the Presbyterians and the Church party in the reign of Elizabeth, he says, "Were there three distinct orders in the primitive church? and if so, was the right and office of ordaining peculiar to the highest of these?" He then proceeds to argue thus: — "In the apostolical history, as contained in the New Testament, these questions are not clearly answered, and there is much indistinctness about the names of bishop and priest or elder; but if we suppose, by way of hypothesis, that there were bishops, priests, and deacons, we shall find no statements which cannot be easily reconciled with the supposition. As we proceed with ecclesiastical history, those same traces become more decisive, till we find that at an early period the questions are both answered in the affirmative; and we infer, therefore, that unless it can be shown that a change in this particular took place, we may presume that the same ecclesiastical constitution existed from the time of the apostles. A Presbyterian might argue that in the apostolical history of the New Testament there is nothing which militates against the hypothesis of the two orders only, at least nothing which proves the point; that St. James might have been the chief elder, the moderator of the church of Jerusalem; that Titus and Timothy might have held no higher office than that of dean in a cathedral church, or archdeacon in a diocese; and that as the presbytery had the power of ordaining, they, as its superintendants, were directed by St. Paul to set all things in order. But then this hypothesis does not account for the introduction of episcopacy, without even a hint from the historians that any alteration in the church government was effected. When to this it is added, that there never existed a church without episcopacy till the Reformation, the proof seems as strong as moral proof can be that it is most probable that episcopacy is derived from the times of the apostles." He adds in a note — "The argument concerning the name of bishop is frequently mistaken. There is no doubt that ἐπίσκοπος is equivalent to πρεσβύτερος in the New Testament; but then the terms used in the New Testament for bishop are ἀπόστολος, or ἄγγελος. The concession, therefore, of the use of the name ἐπίσκοπος proves nothing. The Presbyterian is forced to say, that the order equivalent to that of the apostles does not now exist in the church, and to explain ἄγγελος by *the chief pastor of the church.* So that the argument from the names is rather in favour of episcopacy." It will be observed that this defence mainly relies upon the argument from antiquity and immemorial usage; and this is the authority to which the episcopalian always pays the highest regard when the Scriptures do not appear to be decisive. But the Presbyterians and Independents very generally take a different ground, and argue in the words of Dr. Maclaine, the translator of Mosheim — "that Christ, by leaving this matter undetermined, has of consequence left Christian societies a discretionary power of modelling the government of the church in such a manner as the circumstantial reasons of times, places, &c. may require; and therefore the wisest government of the church is the best and the most divine; and every Christian society has a right to make laws for itself, provided that these laws are consistent with charity and peace, and with the fundamental doctrines and principles of Christianity."

E'PISODE. In Poetry. From the Greek ἐπεισόδιον,

which in its original sense denotes those parts of a classical drama which are between the entrances, εἴσοδοι, of the chorus; and thence, by analogy, has the signification which has adhered to the derivative word in modern use,— an incidental narrative or digression in a poem, more or less connected with the main plot, but not essential to its development.

EPISPA'STIC. (Gr. επισπαω, *I draw upon.*) A term applied to substances which raise a blister upon the skin.

E'PISPERM. (Gr. επι, *upon*, and σπερμα, *a seed.*) In Botany, the testa or integuments of a seed.

EPI'STATES. (Gr. επιστατης.) The title of the presidents of the two great councils of the Athenians, viz. the Ecclesia and the senate of the Five Hundred. They were both respectively elected from the number of the prohedri of the ecclesia and senate, and their office only lasted one day. The latter of these two officers had the post of the greatest trust, as in his hands were placed the keys of the citadel and public treasury.

E'PISTA'XIS. (Gr. επισταζειν, *to drop from.*) Bleeding at the nose. In young persons, and where it is produced by accidental causes, this is of no consequence; unless, indeed, it should be very profuse, and then the topical application of cold and of styptics, especially a strong solution of alum, or a plug of lint properly introduced, will check it; but when it occurs frequently in advanced life, and is independent of nasal disease, it is apt to indicate an alarming fulness of the vessels of the head. It is also a dangerous omen in disorders of great debility, and more especially in putrid fever.

EPISTHO'TONOS. (Gr. επισθεν, *forwards*, and τεινω, *I bend.*) A spasmodic affection, in which the body is bent forwards.

EPI'STLE. (Gr. ἐπιστολη.) The use of this word is now confined in our language to the designation of those written addresses by apostolical writers to their Christian brethren which are contained in the canon of Scripture: a few others, either spurious or of high antiquity, although not recognized among inspired writings, are also so denominated. The Epistles of St. Paul, and others contained in the volume of the New Testament, are not arranged according to their date, but, in all probability, according to the views which those who arranged the canon entertained of the relative importance either of the writings themselves, or of the parties to whom they are addressed Thus the Epistles of St. Paul to the different churches, and the Catholic Epistles of St. John (*i.e.* addressed to the universal church), are ranked before the Epistles of those saints to individual Christians. An exception to this rule is to be found in the Epistle to the Hebrews, which is placed last among those of St. Paul, and seems to have been admitted into the canon at a comparatively recent period. The practice of reading a portion of an Epistle in the service of the church is extremely ancient, and said to be noticed by Justin in his *First Apology*.

E'PISTY'LIUM. (Gr. επι, *upon*, and στυλος, *a column.*) In Architecture, the same as *architrave*, which see.

E'PITAPH. (Gr. επι, and ταφος, *a tomb.*) Literally an inscription on a tomb. As has been well observed, inscriptions in honour of the dead are perhaps as old as tombs themselves; though they were by no means bestowed in such profusion in ancient as in modern times. Among the Greeks, for instance, this honour was paid only to the tombs of heroes, as in the case of Leonidas and his gallant comrades. (*Her.* vii. 228.) The Romans were the first to deviate from this course. Every Roman family who consecrated a tomb to their relations had the privilege of inscribing an epitaph thereon; and as their tombs were usually situated on the highway, the attention of passers-by was sought to be arrested by the words "sta viator;"—the formula with which all their epitaphs were prefaced. But how much soever the epitaphs of the ancient Greeks and Romans differed in point of number, there were three qualities which they possessed in common—brevity, simplicity, and familiarity; qualities which a modern critic, Boileau, has pronounced to be indispensable in this species of writing.

At what period sepulchral inscriptions came into use in England, has not been precisely ascertained; though there can be little doubt that this practice was introduced by the Romans at the period of their invasion of Britain. During the first twelve centuries of the Christian era, the monumental inscriptions of this country were all written in Latin. About the 13th century, the French language was adopted, and continued to be used for this purpose till the middle of the 14th century; at which time monumental inscriptions in the vernacular tongue became common, though the clergy and learned of that time, as might have been expected, still preferred the Latin, as their more familiar idiom. The modern English, French, and German epitaphs, of which several collections have been made, are infinitely more numerous than those of any time or nation, and exhibit every variety of style and sentiment; from the most chaste and majestic gravity, impressive tenderness, and laconic terseness, to the most puerile epigrammatic conceits, pointed satire, and heraldic prolixity. It would be out of place here to give specimens of all the various kinds of epitaphs included in this category; but we cannot refrain from citing, in illustration of our assertion, one or two instances, exhibiting each in an eminent degree the different characteristics of the class to which it belongs.

Epitaph on the Countess of Pembroke, by Ben Jonson.

Underneath this sable hearse
Lies the subject of all verse;
Sidney's sister, Pembroke's mother:
Death, ere thou canst find another
Good and fair and wise as she,
Time shall throw a dart at thee.

Epitaph on Robespierre.

× Passant, ne pleure point mon sort;
Si je vivais, tu serais mort!

× Passer-by, weep not for me,
Were I alive thou wouldst not be.

Epitaph on a French General.

Siste, viator; heroem calcas!
Stop, traveller; thou treadest on a hero!

E'PITHALA'MIUM. (Gr. ἐπιθαλαμιον.) A nuptial song, sung by a chorus of boys and girls when the bride and bridegroom entered the bridal chamber, and again on the first morning after the marriage. This was the custom in Greece, which was somewhat varied at Rome, where the chorus consisted of girls only, who sang before the door of the nuptial chamber till midnight. The most perfect examples of this species which antiquity has left us are by Theocritus and Catullus.

E'PITHET (Gr. ἐπίθετον, *something imposed upon another*), in Rhetoric and Composition, denotes a term employed in an adjective sense to express an attribute or quality of another substantive term. The abundance and the propriety of epithets form peculiar characteristics of various poetical styles. In the strict rhetorical sense, epithets are only such adjectives as convey a notion already implied in the noun substantive itself, and add nothing to the sense. Thus, the "glorious" sun is a mere epithet; while the "rising" or the "setting" sun would, as conveying some additional idea into the sense of the passage, not be considered as epithets. The former sort, however, are sometimes called in disparagement by writers on rhetoric "otiosa," or idle epithets.

EPITI'THIDES. (Gr. επι, and τιθημι, *I place.*) In Architecture, the crown or upper mouldings of an entablature.

EPI'TOME. (Gr. επιτέμνω, *I cut short.*) In Literature, an abridgment: a work in which the contents of a former work are reduced within a smaller space by curtailment and condensation. In the later classical period, extending through the declining age of the Western Empire, the practice of epitomizing the writings of older writers, especially in history, became very prevalent; and while some regard the works of Justin, Eutropius, and similar writers as having preserved to us much historical knowledge which would otherwise have been lost, others have maintained that these laborious compilers have done great disservice to literature, inasmuch as the voluminous works which they abridged being superseded by their more popular and cheaper compendia, in an illiterate age, have from that cause for the most part perished. *See* Abridgment.

EPIZO'ANS, *Epizoa*. (Gr. επι, *upon*, and ζωον, *animal.*) The name of a class of parasitic animals, which chiefly infest fishes, and of which the Linnæan genus *Lernæa* is the type.

E'POCH. (Gr. ἐποχη, from επεχω, *I stop.*) In Chronology, a fixed point of time from which dates are numbered, or at which a new computation begins. It is consequently the commencement of an æra. *See* Æra.

E'PODE. (Gr. επωδος, *something added to the ωδη, or ode.*) In the strophic choruses of the Grecian drama, the last portion following the strophe and antistrophe is so called. The name of *Epodes*, applied to a book of Horace's poems, merely signifies additional or supplementary odes.

EPOPEE. *See* Epic.

E'POPT. (Gr. εποπτης, *inspector.*) A functionary of the Eleusinian Mysteries, which see.

EPROUVE'TTE. In Gunnery, a machine for proving the strength of gunpowder. A small gun is attached to a frame, which is suspended from a horizontal rod, about which it oscillates like a pendulum. On the gun being fired, the recoil causes the frame to swing; and the force of the recoil is measured by the angle which the frame describes. In this manner the relative strength of different sorts of gunpowder is ascertained.

E'PSOM SALT. Sulphate of magnesia; formerly obtained by evaporating the water of certain springs at Epsom in Surrey.

EPU'LIS. (Gr. επι *upon*; οὖλα, *the gums.*) A small tubercle on the gums.

EPULO'TIC. (Gr. επι, and οὐλη *a scar.*) Applications which promote the skinning over of sores; hence the *epulotic ointments* of old pharmacy.

E'QUANT, in the Ptolemaic Astronomy, denotes a circle which was conceived to be described in the plane of the deferent or eccentric, for regulating and adjusting certain motions of the planets, and reducing them to easier calculation.

EQUA'TIONS, ALGEBRAICAL. An algebraical equation is an expression of equality between two quantities involving the ordinary symbols of algebra in any manner whatever. The "Theory of Algebraical Equations" forms an important subject or department of analysis, and is always understood to embody the discussion of equations when presented in their most convenient form for solution; and its great object is to develop the properties and to evolve the values of the real and imaginary roots. The equations are supposed to be cleared from radicals, and are classed in degrees according to the highest exponent of the unknown quantity.

Thus, if x denote the unknown quantity, and c_0, c_1, c_2, c_3, &c. the given numbers or coefficients;

$c_1 x + c_0 = 0$ is a *simple equation*, or an equation of the *first* degree;

$c_2 x^2 + c_1 x + c_0 = 0$ is a *quadratic*, or an equation of the *second* degree;

$c_3 x^3 + c_2 x^2 + c_1 x + c_0 = 0$ is a *cubic equation*, or an equation of the *third* degree;

$c_4 x^4 + c_3 x^3 + c_2 x^2 + c_1 x + c_0 = 0$ is a *biquadratic equation*, or an equation of the *fourth* degree, &c. &c.

And $c_n x^n + c_{n-1} x^{n-1} \ldots + c_2 x^2 + c_1 x + c_0 = 0$ is an equation of the nth degree.

We shall here consider two or three of the most important and useful general properties of an equation of the nth degree.

The complete solution of every equation of the nth degree must always comprise as many as n roots, real and imaginary, the imaginary roots being of the forms $p + q\sqrt{-1}$, $p - q\sqrt{-1}$. When a real root is substituted for x in the equation, the involved terms must counteract one another, and cause the result to vanish; and when an imaginary root is substituted for x in the equation, both the real and imaginary portion of the result must separately vanish. If the substitution of $p + q\sqrt{-1}$ causes both the real and imaginary parts to vanish, it is evident that the substitution of $p - q\sqrt{-1}$ will have the same effect, since the result will only differ from that of the former in the imaginary terms having changed all their signs. It follows from this remark that if an equation possesses a root of the form $p + q\sqrt{-1}$, it must likewise possess a corresponding imaginary root of the form $p - q\sqrt{-1}$. The roots $p + q\sqrt{-1}$, $p - q\sqrt{-1}$ are called a pair of imaginary roots; and as these roots must thus enter equations in pairs, every equation must have an even number of impossible roots, or else none at all.

Suppose the roots of an equation to be all real, and let them be denoted by $r_1, r_2, r_3 \ldots$ &c.; then the equation will in all cases be produced by multiplying together the factors $x - r_1$, $x - r_2$, $x - r_3$, &c. The equation may therefore be put in the form,

$$(x - r_1)\,(x - r_2)\,(x - r_3) \ldots \&c. = 0 \ldots \text{(A)}.$$

If, however, the equation likewise contains pairs of imaginary roots, $p + q\sqrt{-1}$, $p - q\sqrt{-1}$, $p' + q'\sqrt{-1}$, $p' - q'\sqrt{-1}$, &c., it will also embody the factors $(x - p - q\sqrt{-1})\,(x - p + q\sqrt{-1})\,(x - p' - q'\sqrt{-1})\,(x - p' + q'\sqrt{-1})$ &c.; or $\left((x - p)^2 + q^2\right)\left((x - p')^2 + q'^2\right)$ &c.; and will consequently take the form,

$$(x - r_1)\,(x - r_2)\,(x - r_3) \ldots \left((x - p)^2 + q^2\right)\left((x - p')^2 + q'^2\right) \ldots \&c. = 0 \ldots \text{(B)}.$$

The equation, when thus put in the form (A) or (B), is evidently satisfied when x is made equal to any one of the roots $r_1, r_2, r_3 \ldots p + q\sqrt{-1}$, $p - q\sqrt{-1}$, $p' + q'\sqrt{-1}$, $p' - q'\sqrt{-1} \ldots$ &c.; and the idea is very clearly conveyed how an equation of the nth degree may be fulfilled by n different roots, determined by equating the factors severally with *zero*.

If the factors of (A) be incorporated by actual multiplication, we shall derive expressions for the coefficients of the equation in terms of its roots. The operation will be as follows:

$$\begin{array}{l}
x - r_1 \\
x - r_2 \\
\hline
\begin{array}{r|l}
x^2 - r_1 & x + r_1 r_2 \\
- r_2 &
\end{array}
\end{array}$$

$$\begin{array}{l}
x - r_3 \\
\hline
\begin{array}{r|r|l}
x^3 - r_1 & x^2 + r_1 r_2 & x - r_1 r_2 r_3 \\
- r_2 & + r_1 r_3 & \\
- r_3 & + r_2 r_3 &
\end{array}
\end{array}$$

$$\begin{array}{l}
x - r_4 \\
\hline
\begin{array}{r|r|r|l}
x^4 - r_1 & x^3 + r_1 r_2 & x^2 - r_1 r_2 r_3 & x + r_1 r_2 r_3 r_4 \\
- r_2 & + r_1 r_3 & - r_1 r_2 r_4 & \\
- r_3 & + r_2 r_3 & - r_1 r_3 r_4 & \\
- r_4 & + r_1 r_4 & - r_2 r_3 r_4 & \\
& + r_2 r_4 & & \\
& + r_3 r_4 & &
\end{array}
\end{array}$$

By continuing the process we infer, generally, that for any equation in which the highest power of x has the coefficient unity, the coefficient of the second term is equal to the sum of the roots with the sign changed; that of the third term is equal to the sum of the products of every two roots; that of the fourth term is equal to the sum of the products of every three roots with the sign changed, &c. &c.; and the last term c_0, unaccompanied by x, is equal to the continued product of all the roots, with the proper algebraic sign when the degree of the equation is even, but with the sign changed when the degree is odd.

The consideration of an equation resolved into its simple factors (A) also, amongst other useful matters, suggests the method of eliminating a known root from an equation so as to descend to another equation of the next less degree, which contains the remaining roots. If r_1 be the known root, it is only necessary to divide the equation by the factor $x - r_1$; and in this operation the occurrence of no remainder will assure us that r_1 is in reality a true root of the equation. It will therefore be an advantage to ascertain a systematic plan by which the process of division by such a factor may be performed with facility. To preserve generality, suppose m to be any number that either may or may not be one of the roots of the equation,

$$c_n x^n + c_{n-1} x^{n-1} + c_{n-2} x^{n-2} \ldots + c_2 x^2 + c_1 x + c_0 = 0.$$

And on the equation being divided by $x - m$, suppose the quotient to be

$$c'_{n-1} x^{n-1} + c'_{n-2} x^{n-2} \ldots + c'_1 x + c'_0.$$

Then the actual work of the division will stand thus:

$$\begin{array}{l}
x - m\,\big)\, c_n x^n + c_{n-1} x^{n-1} + c_{n-2} x^{n-2} + \&c. \big(c'_{n-1} x^{n-1} + c'_{n-2} x^{n-2} + \&c. \\
\qquad c'_{n-1} x^n - m c'_{n-1} x^{n-1} \\
\hline
\qquad\qquad c'_{n-2} x^{n-1} + c_{n-2} x^{n-2} \\
\qquad\qquad c'_{n-2} x^{n-1} - m c'_{n-2} x^{n-2} \\
\hline
\qquad\qquad\qquad c'_{n-3} x^{n-2} + \&c.
\end{array}$$

By equating the several subtractions we hence derive the following relations for determining the coefficients c'_{n-1}, c'_{n-2}, &c.; viz.

$$\begin{aligned}
c'_{n-1} &= c_n \\
c'_{n-2} &= c_{n-1} + m c'_{n-1} \\
c'_{n-3} &= c_{n-2} + m c'_{n-2}, \ \&c. \\
c'_0 &= c_1 + m c'_1
\end{aligned}$$

and the remainder, $p = c'_0 + m c'_0$.

Thus it appears that the coefficient of the pth term of the depressed equation is successively found by adding m times the coefficient of the preceding term to the pth term of the original equation. As an example, let it be required to divide the equation $3x^3 + 3x^2 - 48x + 60 = 0$ by $x - 3$.

$$\begin{array}{lrrrr}
\text{Coefficients proposed,} & 3 & +\ 3 & -\ 48 & +\ 60 \\
 & & +\ 9 & +\ 36 & -\ 36 \\
\cline{2-5}
 & \multicolumn{3}{r|}{3x^2 + 12x - 12} & +\ 24 \\
 & \multicolumn{3}{r|}{\text{Quotient.}} & \text{Remainder.}
\end{array}$$

Again, let it be required to divide the same equation by $x - 2$.

$$\begin{array}{lrrrr}
\text{Coefficients proposed,} & 3 & +\ 3 & -\ 48 & +\ 60 \\
 & & 6 & +\ 18 & -\ 60 \\
\cline{2-5}
 & \multicolumn{3}{r|}{3x^2 + 9x - 30} & 0 \\
 & \multicolumn{3}{r|}{\text{Quotient.}} & \text{Remainder.}
\end{array}$$

Here the existence of no remainder points out 2 to be a root of the proposed equation, and $3x^2 + 9x - 30 = 0$, or $x^2 + 3x - 10 = 0$ to be the depressed equation containing the other two roots, which are therefore 2 and -5.

This expeditious method of dividing an equation by a simple factor may be employed with advantage in transforming an equation into another, whose roots shall differ from those of the former by any given quantity. Let the proposed equation be

$$c_4 x^4 + c_3 x^3 + c_2 x^2 + c_1 x + c_0 = 0.$$

Suppose that $x = x' + r$, and the substitution of this value instead of x will manifestly give a transformed equation, the roots of which will be less than those of the former by the quantity r; and this transformed equation will be of the form,

$$c_4 x'^4 + c'_3 x'^3 + c'_2 x'^2 + c'_1 x' + c'_0 = 0.$$

Now, if $x - r$ be put for x', this must return to the original equation; and hence the proposed equation is the same as $c_4 (x - r)^4 + c'_3 (x - r)^3 + c'_2 (x - r)^2 + c'_1 (x - r) + c'_0 = 0$. The following process of successive division,

which may be rapidly executed by the foregoing rule, thus furnishes a simple method of arriving at the sought coefficients:

$$\begin{array}{l}
x-r)\overline{c_4(x-r)^4+c'_3(x-r)^3+c'_2(x-r)^2+c'_1(x-r)+c'_0} \\
x-r)\overline{c_4(x-r)^3+c'_3(x-r)^2+c'_2(x-r)+c'_1} \mid \text{rem. } c'_0 \\
x-r)\overline{c_4(x-r)^2+c'_3(x-r)+c'_2} \mid \text{rem. } c'_1 \\
x-r)\overline{c_4(x-r)+c'_3} \mid \text{rem. } c'_2 \\
\quad\quad c_4 \mid \text{rem. } c'_3
\end{array}$$

Example: Let it be required to transform the equation $x^4+5x^3+4x^2+3x-105$ into another, whose roots shall be 2 less than those of the proposed equation.

	c_3	c_2	c_1	c_0
1	+ 5	+ 4	+ 3	− 105 (2
	2	+ 14	+ 36	+ 78
1	+ 7	+ 18	+ 39	− 27 = c'_0
	2	+ 18	+ 72	
1	+ 9	+ 36	+ 111 = c'_1	
	2	+ 22		
1	+ 11	+ 58 = c'_2		
	2			
1	+ 13 = c'_3.			

The transformed equation is therefore $x'^4+13x'^3+58x'^2+111x'-27=0$. If the several addends be suppressed and performed mentally, the operation will be reduced to the following:

1	+ 5	+ 4	+ 3	− 105 (2
	+ 7	+ 18	+ 39	− 27
	+ 9	+ 36	+ 111	
	+ 11	+ 58		
	+ 13			

It is on the principle of this operation that Mr. Horner has founded his general method of evolving the numerical value of a real root of an equation, which consists in similarly diminishing the equation by the successive digits of the root.

Some of the most useful properties of equations are here annexed.

1. If the real roots of an equation, ranged in the order of their magnitudes, be $r_1, r_2, r_3 \ldots$, r_1 being the greatest, r_2 the next in magnitude, &c.; and if a number a greater than r_1 be substituted for x, the result will be positive; if a number b, in magnitude between r_1 and r_2, be substituted for x, the result will be negative, &c., and so on with alternate signs.

2. No equation can have a greater number of positive roots than there are changes of sign from + to − and from − to +, in the terms or coefficients of its expression; nor can it have a greater number of negative roots than of permanencies of sign in the same terms.

3. Let p and q be any two numbers, such that q with its sign is greater than p with its sign; then, if an equation in x has m real roots comprised between p and q, the transformed equation in $(x-p)$ will have *at least m* variations more than the transformed equation in $(x-q)$.

4. For conciseness let $X=0$ denote any equation, and let the differential coefficient $\frac{dX}{dx}$ be denoted by X_1; then will the real roots of the equation $X=0$ be limits to those of the equation $X_1=0$; that is, the roots of the latter equation, taken in the order of magnitude, will fall severally *between* those of the original equation.

5. Assuming the same notation as in the last, the greatest common measure of the two expressions X, X_1, equated with *zero*, will determine the values of all *equal* roots that may be repeated in the equation $X=0$; if there be *no common measure*, the roots will be *all unequal*.

A very important theorem has been recently discovered by M. Sturm, by which we are enabled, without fail, to ascertain, by a direct process, the nature and situation of all the real roots of an equation. It is as follows: Let $X=0$ be any equation whose coefficients are real, and whose roots are unequal; and let X_1, as before, be the differential coefficient, $\frac{dX}{dx}$, of x. Let the operation of finding the greatest common measure of X and X_1 be performed; and in the several remainders which successively arise in the course of the process change all the signs from + to −, and from − to +. Suppose now that in the several resulting expressions,

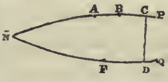
$$X,\ X_1,\ X_2,\ X_3 \ldots\ldots X_m$$

two numbers, p, q, such that $p<q$ be successively substituted for x, the results will furnish two series of signs; and, according to Sturm's theorem, the difference between the number of variations of algebraic sign in the first series and that of the second will always express *exactly* the number of real roots of the proposed equation comprised between p and q. If $-\infty$ and $+\infty$ be taken for p and q, the *total number* of real roots may thus be immediately ascertained.

For a demonstration of this remarkable theorem, see *Young's Treatise on Equations.*

EQUATION OF TIME, in Astronomy, denotes the difference, expressed in mean solar time, between the true or apparent right ascension of the sun and its mean right ascension. It may be popularly defined as the difference between the times indicated by an accurately constructed sun-dial and a well-regulated clock.

The equation of time arises from the combined operation of all the causes which tend to produce inequalities of the sun's motion in right ascension. The first of these is the eccentricity of the solar orbit, in consequence of which the sun's motion in longitude is unequal. The second is the obliquity of the ecliptic, in consequence of which the arcs of the ecliptic and equator, counting from the intersection of these circles to the meridian, are in general unequal. The third cause of the equation of time arises from the perturbations of the moon and planets, which sensibly affect the sun's motion in longitude. The different parts of the equation of time are collected and computed in the following manner: — Let N P represent the ecliptic, N Q the equator; and let N be the intersection of these circles, or the first point of Aries.



Take N A to represent the mean motion of the sun in any given time T, reckoning from the vernal equinox; then, if the sun advanced equably in the ecliptic, his place at the time T would be at the point A. But suppose that in consequence of the eccentricity of the orbit he would have advanced to B; then A B is what is called the equation of the centre. Suppose, further, that by the combined action of the planets during the time T he is carried forward to C; then the *true* arc of the ecliptic described by the sun is N C. Now, if we put

l = N C, the sun's true longitude,
m = N A, the sun's mean longitude,
e = A B, the equation of the centre,
p = B C, the effect of the perturbations,

there will result the equation $l=m+e+p$. Through C let the arc C D be drawn perpendicular to the equator; the point D will be that point of the equator which passes the meridian at the same time with the sun. If we now make r=N C−N D; then r is the *reduction to the ecliptic*, and the sun's *true* right ascension is $l-r$ = N D. Let N F = N A = m; then F is the point of the equator which the sun would occupy at the instant he occupies the point A in the ecliptic if he moved uniformly in the equator, and N F is the sun's *mean* right ascension. The mean sun would consequently pass the meridian with the point F, whereas the true sun passes it with the point D; therefore at the instant of true noon, when the points C and D are on the meridian, the mean sun is at the distance D F from the meridian. But D F = N D − N F $=l-r-m$ $=e+p-r$, which is the equation of time expressed in an arc of a circle. To convert it into mean solar time, we must multiply by 24 hours (corresponding to 360 degrees); therefore, representing the equation of time by t, we have

$$t=\tfrac{1}{15}(e+p-r).$$

This equation still requires to be corrected for the effect of nutation. The variation of the mean longitude resulting from the nutation is expressed by the formula 18″ sin. (360°− moon's node) = 18″ sin. N; and this reduced to the equator is 18″ sin. N cos. ω (ω being the obliquity of the ecliptic). Consequently the effect on the equation of time, being the difference of the variations on the ecliptic and equator, becomes 18″ sin. N (1 − cos. ω). But 18″ (1 − cos. ω) being reduced to time, becomes 0·09925 seconds; therefore, including the correction for nutation, the equation of time becomes finally

$$t=\tfrac{1}{15}(e+p-r)+\text{sin. N}\times 0{\cdot}09925 \text{ sec.}$$

The last term of this expression is very small, amounting when greatest to less than the tenth of a second, and is therefore scarcely sensible. The part depending on the perturbations is also very small, and can scarcely exceed two seconds. The principal parts, therefore, are the two depending upon the eccentricity and obliquity; and these were known in the time of Ptolemy.

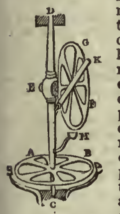
The equation of time is at its maximum about the beginning of November, when it amounts to about 16 min. 16 sec.; and is subtractive, that is to say, the clock is faster than the dial by that quantity. At four times in the year the equation vanishes, or the clock time and dial time agree. This happens about the 25th of December, the 16th of April, the 16th of June, and the 1st of September. But these epochs, depending on the longitude of the sun's perigee, are subject to some variation. The equation is given in the *Nautical Almanac* for every day of each year.

EQUATOR. In Astronomy, the great circle of the celestial sphere, of which the plane is perpendicular to the axis of the earth's diurnal motion. It is called the equator, because when the sun is in its plane the days and nights are exactly equal all over the world. The equator divides the sphere into the northern and southern hemispheres and the apparent diurnal motions of all the celes-

tial bodies are performed in circles which are parallel to it. The right ascensions are measured on the equator; and the declinations on circles which intersect it at right angles. The equator, in the heavens, is often styled the *equinoctial*.

In Geography, the equator is the great circle of the terrestrial sphere which is every where equally distant from the two poles, and divides the earth into the northern and southern hemispheres. Terrestrial *longitudes* are measured on the equator, or some one of its parallel circles; commencing from some arbitrary point, which different nations assume variously, most of them adopting the meridian which passes through their capital city or principal observatory. *Latitudes* are counted from the equator along the meridian.

EQUATO'RIAL. An astronomical instrument, contrived for the purpose of directing a telescope upon any celestial object of which the right ascension and declination are known, and of keeping the object in view for any length of time, notwithstanding the diurnal motion.



For these purposes, a principal axis C D, resting on firm supports, is placed parallel to the axis of the earth's rotation, and consequently pointing to the poles of the heavens. On this polar axis there is fixed, near one of its extremities, a graduated circle A B, the plane of which is perpendicular to the polar axis, and therefore parallel to the earth's equator. This circle is called the *equatorial* circle, and measures by its arcs the hour angles, or differences of right ascension. The polar axis is pierced at E F, and penetrated by the axis of a second circle G H, at right angles to it. The axis of the second circle has consequently no connection with any external support, but is sustained entirely by the polar axis. The plane of the second circle G H, which is called the *declination* circle, and carries the telescope K, is thus in all positions at right angles to the plane of the first or equatorial circle A B. Now it is easy to conceive, from this general description, that when the telescope is pointed to a star, the angle between the direction of the telescope and the polar axis is equal to the polar distance of the star; consequently, when a motion is given to the polar axis without altering the position of the telescope on the declination circle, the point to which the telescope is directed will always lie in the small circle of the heavens coincident with the star's diurnal path; and hence, if the motion communicated to the polar axis be just equal to the earth's diurnal rotation, the star will remain constantly, and as long as we please, in the field of the telescope, at least while above the horizon. In many observations this is indispensable, and it is an advantage which attaches to no other instrument. The polar axis may be moved by a peculiar kind of clock machinery, adjusted to sidereal time; and the best and largest equatorials are now furnished with such an apparatus. Besides relieving the observer from the fatigue of turning the instrument, the motion thus given is perfectly equable, and all those jerks avoided which, when the instrument is turned by the hand, often prove fatal to an observation. (For the method of adjusting the equatorial, see a paper by Professor Littrow of Vienna in the *Memoirs of the Royal Astr. Society*, vol. ii. p. 45.)

E'QUERRY. (Fr. ecuyer.) In the British Court, a subordinate officer under the master of the horse. The chief equerry is also styled clerk marshal, with a salary of 500*l*. per an. There are also four equerries in ordinary, whose salary is 300*l*. a year, and an equerry of the crown stable. A queen consort has three equerries.

E'QUIA'NGULAR FIGURE. (Lat. æquus and angulus.) In Geometry, a figure of which all the angles are equal among themselves, as is the case with all the regular polygons. Two figures also of the same kind, having each angle of the one equal to a corresponding angle of the other, are said to be *equiangular*, although when considered separately they may not be equiangular figures.

EQUILA'TERAL BIVALVE. A shell is so called when a transverse line drawn through the apex of the umbo bisects the valve into two equal and symmetrical parts.

EQUILA'TERAL FIGURE, in Geometry, is one that has all its sides equal to each other. Equilateral figures inscribable in circles are necessarily equiangular; but the converse does not always hold true. When the number of sides is odd, the equiangular figure inscribable in a circle is always equilateral; but when the number of sides is even, they may either be all equal, or one half equal to each other, and the other half equal to each other, though not to the former, the two sets being placed alternately.

EQUILA'TERAL HYPERBOLA, is that which has the two axes equal to each other, the asymptotes forming a right angle. See HYPERBOLA.

EQUILI'BRIUM. (Lat. æquus, *equal*, and libra, *balance*.) In Statics, results from the simultaneous action of several forces on a body, or material point, when they reciprocally destroy each other's action, so that the body or point, though free to move, remains at rest. Two equal forces, acting in contrary directions, destroy each other; and when a body submitted to the action of several forces remains at rest, it is necesary that the resultant of one part of the forces be exactly equal and opposite to the resultant of the remainder, or that the resultant of the whole be nothing. The science of equilibrium is thus founded entirely on the composition of forces. *See* STATICS.

EQUILIBRIUM. (Lat.) In the Fine Arts, the just poise or balance of a figure or other object, so that it may appear to stand firmly. Also the due equipoise of objects, lights, shadows, &c. against each other by some striking feature. This quality is obvious in the works of nature, as well in the human form as in landscape. In the latter, for instance, the sun is generally the medium of producing it by strong contrasts of light and shadow. In architecture, the same means are employed to produce the most striking effects, on the theory of which Le Roy has ably written.

EQUILIBRIUM. In Politics. *See* BALANCE OF POWER.

E'QUIMU'LTIPLES. The products of quantities multiplied by the same numbers. For example, $5\,a$ and $5\,b$ are equimultiples of a and b; and $m^2\,n\,p$ and $m^2\,n\,q$ are equimultiples of p and q. Equimultiples of quantities have to each other the same ratio as the quantities themselves.

EQUINO'CTIAL. (*See* EQUINOX.) The great circle formed by the intersection of the plane of the earth's equator with the sphere of the heavens. This term is chiefly met with in the older books of astronomy, the term *equator* being now generally given to the same circle. *See* EQUATOR.

EQUINOCTIAL POINTS. The two opposite points of the celestial sphere, in which the ecliptic and equator intersect each other; the one being the first point of Aries, and the other the first point of Libra. The equinoctial points do not retain a fixed position relatively to the stars, but retrograde or move backwards from east to west with a slow motion, equal to about 50 seconds yearly requiring 25,000 years to accomplish a complete revolution. This motion is called the precession of the equinoxes.

E'QUINOX (Lat. æquus, and nox, *night*), in Astronomy, is the time at which the sun passes through the equator in one of the equinoctial points. When the sun is in the equator the days and nights are of equal length all over the world, whence the derivation of the term. This happens twice every year; namely, about the 21st of March, and the 22d of September: the former is called the *vernal* and the latter the *autumnal* equinox. The equinoxes do not divide the year into portions of equal length; for in consequence of the sun being at his greatest distance from the earth during the summer months, and his angular motion in his orbit being consequently slower, the interval from the vernal to the autumnal equinox is greater than that from the autumnal to the vernal. In other words, the sun continues longer on the northern than on the southern side of the equator. At the beginning of the present century, the difference amounted to 7 days 16 hours and 51 minutes. The summer in the northern hemisphere is consequently longer than in the southern by this quantity; and to this circumstance some meteorologists ascribe, in part at least, the higher temperature that is found to prevail in the northern hemisphere under the same parallel of latitude.

E'QUIPAGE (Fr. equipper), in ordinary language, signifies the carriage, horses, and liveries which indicate the fortune or rank of any gentleman when he appears abroad. — *Equipage*, in marine affairs, signifies the crew of a ship, together with all a ship's furniture, masts, sails, ammunition, &c. In the art military, it denotes all sorts of utensils and artillery, &c., necessary for commencing and prosecuting with ease or success any military operation.

E'QUISETA'CEÆ. (Equisetum, one of the genera.) A natural order of Gymnosperms, inhabiting the ditches and rivers of most parts of the world. They have no decided affinity with any known order, but are more like flowering plants than flowerless; and therefore are best considered as a degeneration of *Coniferæ*, to which they have so much resemblance, rather than as a race in affinity with ferns, with which they have no resemblance. They have no medicinal qualities; but for economical purposes are useful for polishing furniture, owing to the quantity of silex contained in their epidermis. They are considered by the farmer, who calls them horsetails, as a sign of heavy, bad, wet land.

E'QUISE'TIC ACID. A peculiar acid, discovered by Braconnot existing, combined with magnesia, in the *Equisetum fluviatile*.

E'QUITANT. In Botany, a term used in describing the vernation of leaves, to denote that they overlap each other parallelly and entirely, without any involution, as the leaves of Iris. They seem as if they bestrode each other in opposite directions, whence the name.

E'QUITES. In Ancient History, a class of Roman citizens, commonly represented by the English word

knights, but not answering in all respects to its meaning. The origin of the Equites was the body of Celeres, instituted by Romulus; and they originally consisted of those who were rich enough to serve in war on horseback, but afterwards they became a distinct order. They were chosen promiscuously from the patricians and plebeians whose age was above 18 years, and fortune, at least towards the end of the republic, not less than 400 sestertia, or 3229*l*. The badges of the equites were a golden ring and a robe with a narrow purple border; and to them were appropriated the fourteen rows of seats in the theatres next the orchestra, where the senators sat. This body disputed with the senate the privilege of forming the jury who assisted the prætor in trials; but, after repeated transfers of this office from one to the other, it was finally shared between both. The equites also furnished the farmers of the public revenue, or *publicani;* but though they had enjoyed this privilege under the republic, it was only during the empire that they looked to such offices as their birthright. Cicero affirms that the flower of the Roman chivalry, the ornament of Rome, the strength of the empire, lay in these engrossers of the public revenue: "florem equitum Romanorum, ornamentum civitatis, firmamentum reipublicæ, publicanorum ordine contineri." (See *Niebuhr's Roman History.*)

E'QUITY. (Lat. æquitas.) In Jurisprudence. In the words of Blackstone (*Comm.* i. 61.), "Since in laws all cases cannot be foreseen or expressed, it is necessary that when the general decrees of the law come to be applied to particular cases, there should be somewhere a power vested of defining those circumstances which (had they been foreseen) the legislator himself would have expressed." In the same view, Grotius defines equity, as "Correctrix ejus in quo lex propter universalitatem deficit" (*De Æquitat.* i. s. 12.); and distinguishes it from the dispensing power, which does not mitigate law, but dispenses certain persons from the obligation of it. Puffendorf considers it under two heads,—as declaring a case to be excepted out of the general provisions of a law; and as deciding omitted cases on which the law does not pronounce at all. (*Elements*, i. 22, 23.) The necessity of some power to modify and apply, with allowances for particular cases, the strict rules of law, is necessarily felt in every jurisprudence, and provided for in different ways. Thus in ancient Rome the prætor, "juvare, supplere, interpretari, mitigare, jus civile potuit; mutare vel tollere non potuit." (*Digest*, l. i. t. 1. 7.) So, in English law, the judges have constantly assumed the authority to pronounce cases to be within the "equity," as it is termed, of statutes or rules, when they are not within its words; as, for example, action of waste given by the Statute of Gloucester against tenant for life "or years" is extended by equitable construction against tenants who hold for a year or half a year only. But the word equity, in English jurisprudence, is now more properly applied to a separate body of law, created and sustained on the strength of precedents, and administered by tribunals distinct from the common law courts of the country. The separation of equity from law originated in the necessity which has already been spoken of; but from the circumstance of the former being administered by a different class of functionaries, it has by degrees assumed this distinct shape and substance. By seeking relief in equity is now meant, not so much applying for a mitigation of the strict rules of law, as seeking a remedy before a tribunal having a jurisdiction either concurrent with the courts of law or (in some cases) exclusive, but exercising it according to a different process and on different principles. The origin of this peculiar system is to be traced, in part, to the system of uses (*see* USE, TRUST); in part to the obvious advantages resulting from the examination of the parties, and compelling discovery on oath in cases of fraud, account, &c.; and to the power, gradually acquired by equity judges, of compelling the specific performance of contracts where courts of law could only award damages for their breach; in part, also, to the peculiar functions imposed by statute and usage on the lord chancellor as guardian of infants, idiots, and lunatics, superintendent of charities, &c. The general view of the system of equitable jurisprudence as at present existing is given in the articles CHANCERY and TRUST. (See *Blackstone's Commentaries*, vol. iii.; *Fonblanque on Equity; Mitford's Pleadings in Chancery.*)

EQUI'VALENTS, CHEMICAL. A term introduced into chemistry by Dr. Wollaston to express the system of definite ratios in which substances reciprocally combine, referred to a common standard of unity. If we assume hydrogen as unity, it being the substance which combines with others in the smallest relative weight or proportions, then all other substances may be represented by certain multiples of that unit, expressed with sufficient precision for all ordinary purposes by whole numbers. (*See* ATOMIC THEORY and AFFINITY.) Thus, upon this system the equivalent number of oxygen will be 8, and that of water will be 9, for 8 oxygen + 1 hydrogen = 9 water; and the equivalent of potassium will be 40, and of potassa or oxide of potassium 48, for 40 potassium + 8 oxygen = 48 potassa. Upon the same principle the equivalent of hydrochloric acid, which is a compound of chlorine and hydrogen, is 37, for it consists of 1 part by weight of hydrogen and 36 of chlorine; or, in other words, of an atom of hydrogen = 1 + an atom of chlorine = 36. The equivalent of sulphur is 16: to form sulphuric acid one atom of sulphur = 16 combines with 3 atoms of oxygen $(8 \times 3) = 24$; hence the equivalent of an atom of sulphuric acid is $16 + 24 = 40$. These equivalents are often expressed by certain abbreviations, termed *chemical symbols;* which, as far as single equivalents of the simple substances are concerned, are represented, together with their equivalent numbers, in a table in the article CHEMISTRY.

E'QUIVALVE. A bivalve is so called when its two valves are of similar size and form.

EQUI'VOCAL TERM. In Logic, a term which has several significations, applying respectively and equally to several objects. A word is generally said to be employed equivocally where the middle term is used in different senses in the two premises (*see* SYLLOGISM); or where a proposition is liable to be understood in various senses, according to the various meanings of one of its terms.

EQUU'LEUS (Lat.), called also *Equiculus* and *Equus Minor*. The *Little Horse;* one of Ptolemy's constellations in the northern hemisphere.

EQUULEUS was also the name given in antiquity to a species of rack used in extorting confessions. It was originally practised on slaves, but at a later period it was employed against the Christians.

E'QUUS. (Lat. *a horse.*) The generic name of the quadrupeds with a single digit and hoof on each foot, as the *horse, ass*, and *zebra*. Of these species the horse is the largest, most docile, most valuable, and most widely distributed over the globe. Of the Mammalia which existed on the earth's surface during the tertiary periods of geology, the horse is one of the few which have been preserved to the present epoch; and in the American continent, where it once became extinct, along with the Mastodon and Megatherium, it now again ranges wild in vast troops, the descendants of the war horse introduced by the European discoverers and conquerors of the so called "new world."

The first record of the taming and application of the horse to the purposes of man is in Genesis, 19.; in which it is written, that when Joseph transferred his father's remains from Egypt to Canaan, "there went up with him both chariots and horsemen." The period when the horse is thus indicated as a beast both of draught and burden, is calculated to have been 1650 years before the birth of Christ. Horse and chariot races formed part of the Olympic games in Greece, 1450 years B. C.

The wild horses which inhabit the steppes of Tartary are supposed to be, like those that traverse the pampas of South America, descendants of certain individuals which had escaped from the thraldom of man. The best of the wild Asiatic races are those which inhabit Tscherkessi, Abassi, and the northern slopes of the Caucasian range. The principal varieties which Pallas indicates in the Asiatic horse are, first, the "moustachoed horse," characterized by numerous strong bristles on the upper lip; the "woolly horse," a Russian variety, covered with a crisp woolly hair, and common among the Baschkirs; a naked or hairless horse, not uncommon amongst the Krim Tartars, who keep it always clothed; lastly, the variety delineated by Johnston, in which a woolly mane is continued from the neck along the middle of the back to the tail, and which Pallas saw among the Buracti.

The wild horses appear to be free from nearly all those diseases to which the domestic breed are prone. They are generally of a pale or greyish brown colour, with brown mane and tail, a whitish muzzle, changing to black about the mouth. They are less than the domestic breed; with a larger head; longer legs; larger ears, with the apices sub-reflected; the forehead is more convex above the eyes; the hoofs are contracted and sub-cylindrical (*ungulæ contractæ, subcylindraceæ*); mane sub-erect, less lax than in the domestic horse; the coat, in winter, looser and sub-undulated along the back (*in dorso sub-undulatum*); the tail not very large. They recognize the presence of man at a great distance when he approaches them to windward, and fly from him with wonderful speed; they prefer sunny slopes, and avoid forests and steep places. They do not wander beyond the 50th degree of north latitude. Wild stallions attracted by domestic mares are often taken and killed.

The first change which domestication works upon the form of the wild horse is to increase the bulk of his trunk as compared with his head and limbs. This change is beautifully exemplified in the Arabian, which we must regard as an early, if not first remove, from his wild neighbours of the more northern deserts, and which the Bedouin still hunts for the sake of their flesh. The head is not only proportionally smaller, but is remarkable for the breadth and squareness of the forehead, the shortness and fineness of the muzzle, the prominence and brilliance of the eye, and the smallness of the ears. The body is still somewhat light, and narrow at the forepart;

but the shoulder is superior in its formation to that in any other breed. The Arabian seldom stands more than 14 hands 2 inches. The "Barb," so called from its native country, Barbary, is somewhat smaller than its near ally the Arabian; it seldom exceeds fourteen hands and an inch; the shoulders are flat, the chest round, the legs rather long, and the head small and very beautiful. The Barb is remarkable for its fine and graceful action; but though it is superior to the Arabian in its general form, it has not its untiring spirit or its speed. Our most valuable English varieties of the horse date from the introduction of, and interbreeding with, the Barb and Arabian.

We have no means of ascertaining the nature or peculiarities of the horses which the ancient British charioteers managed with such dexterity in their destructive charges through the disciplined troops of Cæsar. They must have been subsequently modified by crossing with the Roman horses. King Athelstan received from Hugh Capet of France several German running horses; William the Conqueror and his followers introduced the Spanish horse, with the blood of the Barb. The first Arabian horse is recorded to have been introduced in the reign of Henry I.; and a greater admixture of Arabian blood was a natural consequence of the return of the Crusaders. King John devoted especial attention to the improvement of his stud; and he imported one hundred choice stallions of the Flanders kind. The size and strength required to carry the warrior clad in the heavy armour of those days led to the frequent introduction in subsequent reigns of the large and heavy war horses of the Low Countries. Afterwards, when the nobles derived their amusements more from the sports of the turf and field, they were induced to cross their stately and heavy breed of war horses with those of lighter structure and greater speed; the latest improvement seems to have been derived from a direct intermixture of the pure Arabian.

The principal varieties or breeds of English horses are — The hackney or road horse. "He should be," Mr. Youatt observes, "a hunter in miniature; with these exceptions: His height should rarely exceed fifteen hands and an inch. He will be sufficiently strong and more pleasant for general work below that standard. He should be of a more compact form than the hunter, of more bulk according to his height. It is of essential consequence that the bones beneath the knee should be deep and flat, and the tendon not *tied in*. The pastern should be short, and less oblique or slanting than that of the hunter or race horse. The foot should be of a size corresponding with the bulk of the animal, neither too hollow nor too flat, and open at the heels. The forelegs should be perfectly straight; for a horse with his knees bent will from a slight cause, and especially if overweighted, come down. The back should be straight and short, yet sufficiently long to leave comfortable room for the saddle between the shoulders and the *huck* without pressing on either. Some persons prefer a hollow-backed horse. It is generally an easy one to go. It will canter well with a lady; but it will not carry a heavy weight, or stand much hard work. The road horse should be high in the forehead, round in the barrel, and deep in the chest."

The origin of the better kind of *coach horse*, says Mr. Youatt, is the "Cleveland bay," confined principally to Yorkshire and Durham, with Lincolnshire on one side and Northumberland on the other, but difficult to meet with pure in either county. The Cleveland mare is crossed by a three-fourth or thorough-bred horse of sufficient substance and height, and the produce is the coach horse most in repute, with his arched crest and high action.

There is, or rather was, a breed called, from its round punchy make, the *Suffolk punch*. "It stood from fifteen to sixteen hands high, of a sorrel colour; was large-headed, low-shouldered, and thick on the top; deep and round-chested; long-backed; high in the croup; large and strong in the quarters; full in the flanks; round in the legs, and short in the pasterns. It was the very horse to throw his whole weight into a collar, with sufficient activity to do it effectually, and hardihood to stand a long day's work." This valuable breed is now nearly extinct: it is thought to have been produced from the Norman stallion and the Suffolk cart mare. Excellent carriage horses are obtained by crossing the Suffolk breed with a good hunter.

The best dray horses are produced from the Suffolk punch crossed with the Flanders.

The breed of English racers is traced authentically to an Arabian stallion introduced into this country by a Mr. Darley, and hence called the "Darley Arabian." Anterior to this period the pedigree of a racer can rarely be carried back beyond some obscure reference to an Eastern horse. The Darley Arabian was the sire of Flying Childers, and the great grandsire of Eclipse. Eclipse was remarkable for the very great size, obliquity, and lowness of his shoulders; the shortness of his forequarters; his ample and finely proportioned quarters, and the swelling muscles of his fore-arm and thigh. He was, moreover, what is termed a thick-winded horse, and puffed and roared so as to be heard at a considerable distance; yet he never had an opponent on the turf sufficiently fleet to put his full speed to the test. Eclipse died at the age of twenty-five years, having begot the extraordinary number of three hundred and thirty-four winners.

Another stream of Eastern blood was introduced into the swelling veins of our thorough-bred horses by a beautiful Barb, called the Godolphin Arabian.

The hunter, a favourite English variety, includes as much of the blood and high breeding of the racer as is compatible with the power and endurance demanded by the chase. The author of the excellent work on the horse in the *Library of Useful Knowledge*, thus describes the good points of a hunter: — "The first property of a good hunter is, that he should be light in hand. For this purpose his head must be small; his neck thin, especially beneath; his crest firm and arched; and his jaws wide. The head will then be well set on. It will form a pleasant angle with the neck, which gives a light and pleasant mouth."

The more extreme varieties which we have in England are the ponies and Galloways: of these the Sheltie or Shetland pony is the most diminutive; it rarely exceeds nine hands high, and sometimes does not reach seven and a half. His strength is proportionally far greater than his size; he is perfectly docile, and will fatten on the hardest fare.

The dental character of the horse, and of the genus *Equus*, is thus expressed in zoology: —

Incisors $\frac{6}{6}$, Canines $\frac{1 \cdot 1}{1 \cdot 1}$, Molares $\frac{6 \cdot 6}{6 \cdot 6} = 40$; *i. e.* it has six incisors or nippers in the front of both the upper and lower jaws, one tusk or canine, and six molars or grinders, on each side of both jaws. They appear in the following order: — The two middle incisors, and the two anterior grinders, come into place at about a week after birth; the third grinder in the course of the first month; the two adjoining incisors before the end of the sixth week; the two outer incisors between the sixth and ninth month; making the six incisors above and below, and completing what is termed the colt's mouth. There are also two very small deciduous canines developed about the sixth month; the fourth grinder generally makes its appearance at the end of the first year; and thus the formula, incisors $\frac{6}{6}$, molares $\frac{4 \cdot 4}{4 \cdot 4}$, is characteristic of the yearling foal. A fifth grinder makes its appearance at the end of the second year; and now commences the displacement of the first set, and the protrusion of the second or permanent set of teeth. The deciduous teeth are lost in the order of their acquisition; the two middle incisors of both the upper and lower jaws are displaced *between the second and third years;* the first and second deciduous grinders are shed at two years and eight months. A *three-year old* colt has the permanent middle incisors above the gum, but not on a level with the adjoining deciduous incisors; they are also characterized by a large and deep groove containing a black substance traversing transversely the working edge of the crown of the tooth; the *sixth grinder is also coming into place.* At *three years and a half* or little later the adjoining deciduous incisors are shed, and their large successors begin to peep above the gum; the small lateral incisors are diminished in size and much worn. This gives a very characteristic condition to the mouth.

At *four years* the sixth grinder has attained the level of the others; the permanent tusks begin to appear; the second permanent incisors have come into place, and are marked with a deep fissure extending quite across the edge of the crown; the corresponding mark in the middle incisors is worn wider and fainter; the third deciduous grinder is shed. The external incisors are shed *between four and a half and five years.* At *five years* their permanent successors are in place, with a long deep mark on the inner side of the edge of the crown. The corresponding mark is much worn in the middle incisors, and to a less degree in the adjoining ones. The tusks are about an inch in length. At *six years* the mark or fissure on the middle incisors is worn away, but a discolouration on the part remains; the mark in the adjoining incisors is shorter, broader, and fainter; and the lateral incisors present the edges of the enamel in a more regular state, and evidently worn; the tusks are an inch in length and pointed; the third permanent grinder has taken its place in the dental series. At *seven years* the mark is worn away on the four middle incisors in both jaws, and in progress of obliteration in the lateral incisor: the apex of the canine or tusk is blunted. At *eight years* the mark is gone from all the lower incisors, and they cease to afford any indication of the subsequent age of the horse. The tusks are rounded off; the marks remain longer on the incisors of the upper jaw. Of course the marks are obliterated in proportion to the friction to which

the teeth are subject; they are sooner lost in a stall-fed horse than in one at grass; they are prematurely worn away in the crib-biter.

The age of a horse being always calculated from the 1st of May, it is very difficult to determine whether an animal be a late foal of one year or an early one of the next. A horse may be made to appear older than he really is by premature extraction of the deciduous teeth; or younger by imitating artificially the natural marks of the incisors after they have been obliterated by attrition; but these frauds are readily detected when all the concomitant conditions of a horse's mouth are scanned by the practised eye.

Owing to the premature labour to which the horse is in general condemned in this country, and to the present rapid rate of travelling, he has rarely a chance of living out his natural term of existence. A well-used horse may last between thirty and forty years. Mr. Percival gives an account of a barge-horse that died in his sixty-second year. Mr. Youatt quotes the record of another horse that received a ball in his neck at the battle of Preston in 1715, and which was extracted at his death in 1758.

ERA. *See* Æra.

ERA'SED, in Heraldry, signifies any thing forcibly torn off, leaving the edges jagged and uneven; as, a lion's head erased, &c.

ERA'STIANS. The followers of Erastus, a German divine; a sect which obtained some notoriety in England in the time of the civil wars. They referred the punishment of all offences, civil or religious, to the civil magistrate; and asserted that the church had no power to enforce any acts of discipline, nor to refuse the communion of the Lord's Supper to any one who desired it.

E'RATO. (Gr. ερως, *love.*) In Ancient Mythology, the muse who presided over love poetry. (See *Callimachi Epigramm.*) She is frequently confounded with Terpsichore; and in the 7th Book of the *Æneid* she is invoked by Virgil as synonymous with Calliope.

E'REBUS. (Gr. Ερεβος.) According to the classic mythology, the son of Chaos and Darkness, who dwelt in the lowest part of hell, which is frequently called by his name.

ERETHI'SMUS. (Gr. ερεθιζειν, *to excite.*) This term is generally applied to a peculiarly irritable state of constitution, which occasionally results from the use of mercury, and in which there is great depression of strength and irregularity of pulse, anxiety, paleness, and tremors.

E'RGOT, or CLAVUS, is a disease of the rye, produced by the attack of fungi which take possession of the ovary and destroy it, producing in its room a long, black, hard, hornlike body. It is remarkable for the specific stimulating effects it produces upon the uterus, on which account it is much employed in cases of difficult parturition.

ERICA'CEÆ. (Erica, one of the genera.) A natural order of shrubby Exogens, inhabiting the Cape of Good Hope and many other places. It differs from *Vaccinaceæ* and *Campanulaceæ* in the superior ovary; from *Epacridaceæ* in the anther being two-celled; from *Pyrolaceæ* and *Monotropaceæ* in the structure of the seeds, and in habit; and from all the orders represented by *Scrophulariaceæ* and *Gentianaceæ* in the number of the cells of the ovary agreeing with the lobes of the calyx and corolla. Their general qualities are astringent and diuretic, some few being poisonous. The *Arbutus*, *Andromeda*, *Kalmia*, *Rhododendron*, *Azalea*, all well known shrubby plants of great beauty, belong to this order.

ERI'CHTHIANS. *See* Erichthus.

ERI'CHTHUS. (Gr. ηρι, *early*, and χθων, *the earth.*) A genus of long-tailed Decapod Crustaceans, inhabiting the tropical ocean. These crustacea are remarkable for the delicate and often transparent and colourless character of their large and undivided thoracic shield or carapace, which always is terminated anteriorly in a styliform rostrum: they have no moveable rostral plate, and the gills are in general very small and simple, and sometimes wholly inconspicuous. The genus thus characterized is now subdivided into *Squillerichthus*, *Almia*, and *Erichthus* proper; and the whole are included under the family name of *Erichthians*, or *Erichthidæ*, which in the natural system ranks next to the *Squillidæ*, or sea mantises.

ERI'DANUS. (The river Eridanus.) One of the ancient constellations in the southern hemisphere, first mentioned by Aratus.

ERINA'CEUS. (Lat. erinaceus, *a hedgehog.*) A genus of useful insectivorous Mammals, of which our common hedgehog is a well-known and unmeritedly persecuted species. The teeth are small, and form a series of sharp bristling points, well adapted for the crushing of beetles, or cracking the back-bone of a snake; but quite inadequate to the purpose of self-defence against larger carnivorous quadrupeds. Nature has, however, provided the hedgehog with a compensatory coat of armour, thickly bristled over with strong elastic spines, and capable of being drawn by powerful cutaneous muscles over every part of the body. When the hedgehog thus puts himself in a defensive attitude, he resembles a bristled sphere; and is capable of enduring hard blows or heavy falls without suffering material injury.

Mr. Bell says, in his excellent history of British quadrupeds, "The strength and elasticity of this covering is such, that I have repeatedly seen a domesticated hedgehog in my own possession run towards the precipitous wall of an area, and without hesitation throw itself off; and contracting at the same instant into a ball, in which condition it reached the ground from a height of twelve to fourteen feet, after a few moments it would unfold itself and run off unhurt."

As the food of the hedgehog consists almost entirely of cold-blooded animals, which in our climate almost entirely disappear from the scene of nature in the winter season, the hedgehog must have starved if he had not been endowed with the singular property of subsiding into a state of suspended animation during the period of famine. In order, however, to preserve the low temperature which he then possesses, he prepares in some retired hole a soft nest of moss and leaves; and thus passes his winter "undisturbed by the violence of the tempest, and only rendered still more profoundly torpid by the bitterest frost." All the store of nutriment which he carries with him to his place of hybernation is a thick layer of fat about his viscera and beneath his skin, which is slowly absorbed, as the little waste of his inactive life requires, and more rapidly during the first few days of his resuscitation in spring. The female produces from two to four young ones in the summer; they are blind, and covered with soft and flexible spines. The hedgehog has thirty-six teeth. The intermaxillary bones contain six teeth, of which the two anterior are longer than the rest, placed wide apart, directed obliquely downwards with a slight convergence. The six upper incisors are opposed to six below, of which the two anterior ones have the same disproportionate size as the corresponding ones above. Of the remaining teeth the four posterior ones on each side of both jaws are large, multicuspidate, true molares. The intermediate teeth are small, with two fangs, and represent the spurious molares.

E'RIOCAULO'NEÆ. (Eriocaulon, one of the genera.) A natural order of Endogens, inhabiting the marshes of most parts of the world: usually combined with *Restiaceæ*. It is composed of herbaceous plants, with their flowers growing in close heads, and contains no species of any known use.

ERIO'METER. (Gr. εριον, *wool*, and μετρον, *a measure.*) An optical instrument proposed by the late Dr. Young for measuring the diameters of minute particles and fibres, by ascertaining the diameter of any one of the series of coloured rings they produce. "The eriometer is formed of a piece of card or a plate of brass, having an aperture of about a fiftieth of an inch in diameter in the centre of a circle about half an inch in diameter, and perforated with about eight small holes. The fibres or particles to be measured are fixed in a slider; and the eriometer being placed before a strong light, and the eye assisted by a lens applied behind the small hole, the rings of colours will be seen. The slider must then be drawn out or pushed till the limit of the first red and green ring (the one selected by Dr. Young) coincides with the circle of perforations, and the index will then show on the scale the size of the particles or fibres." (*Brewster's Optics*, *Cabinet Cyclopædia.*)

ERI'PHIA. (Gr. εριφος.) A genus of short-tailed or Brachyurous Crustaceans, including the *Cancer spinifrons*, Herbst.; *Cancer conagra*, Fabr.; and other later discovered species.

ER'MINE. ("This," says Gwillim, "is a little beast less than a squirrel, that hath his being in the woods of the land of *Armenia*, whereof he taketh his name.") In Zoology, a species of *Mustela*, or stoat, differing from the common weasel in being about one third larger, and in having a somewhat broader head and a longer tail. In the summer season the upper part of the head, neck, and body, and the greater part of the tail, are of a pale reddish brown colour; the under parts white, with a very slight tinge of yellow; tip of the tail black, and somewhat bushy. In the winter the whole of the body becomes white, slightly tinged with yellow; but the black termination of the tail is permanent. The fur is closer and finer at this season, especially in the colder latitudes, from which countries the ermine affords one of the most beautiful and valuable of furs. When made up the tails are inserted one to each skin, at regular distances, and in the quincunx order; and thus arranged the ermine fur forms the distinctive doubling of the state robes of sovereigns and nobles, as well as of their crowns and coronets.

Ermine. In Heraldry, one of the furs used in blazonry. It represents the skin of that animal white, spotted or timbered with black. *Ermines* is black, spotted or timbered with white. *Erminites* differs from ermine in having the side hairs of the timberings red. *Erminois* is the same as ermine, except that gold is substituted for the white. *Pean* is black, timbered with gold.

ERO'DED. (Lat. erodo, *I gnaw.*) In Zoology, when

a part has its edges irregularly jagged, as if gnawed or eaten.

ERO'TIC (Gr. ἐρως, *love*), is an epithet applied generally to all that relates to the passion of love. Thus whatever excites that passion, or depicts its effects, is termed *erotic*. In a more confined sense, this appellation has been conferred on a certain class of Greek and Latin authors, both in prose and poetry, of whose writings love formed the principal theme. Of these the most distinguished are Achilles Tatius, Heliodorus, Anacreon, Sappho, Ovid, Tibullus, Propertius, &c. (See the learned work entitled *Scriptores Erotici Græci, cura Mitscherlichii.*)

E O'TOMA'NIA. (Gr. ἐρως, and μανια, *madness.*) Mental aberration, supposed to be occasioned by the passion of love.

ERPETO'LOGY, more properly *Herpetology*. (Gr. ἑρπετος, *a reptile*, and λογος, *a discourse.*) The branch of zoological science which specially treats of the class *Reptilia*. This class of animals is characterized by having a heart so constructed as to transmit to the lungs a part only of the circulating mass of blood which it receives from the systemi veins, the remainder being sent again to the body without having been purified in the lungs. There thus results a less amount of reaction of oxygen upon the blood than takes place in Mammalia, and consequently a lower grade of animal heat, and an inferior activity of muscular contraction; but, as the proportion of venous blood transmitted by the heart to the general system varies in different reptiles with the various modifications of the heart, there is a corresponding difference in the manifestation of their vital phenomena.

As reptiles are thus exempt from the office of preserving the temperature of a circulating fluid many degrees warmer than that of the external atmosphere, they have no need of teguments adapted to retain heat; and are accordingly naked, or covered with scales or hard bony plates. Their brain is very small, and without the great commissures. The lungs serve more or less as reservoirs as well as decomposers of the atmospheric air; and thus with a certain degree of independence of the general circulation, the reptiles are enabled to remain much longer under water than either birds or mammalia. Some species, indeed, have in addition to their lungs gills for breathing water, either during their immature state, or throughout life, and thus are truly amphibious. With a cold blood, low respiration, low sensation, and sluggish habits, is associated an extraordinary power of endurance of abstinence and bodily injury.

Reptiles are either oviparous, or ovoviviparous: they do not incubate. They present a great variety of forms, and constitute altogether a much less natural group than either birds or mammals. The character which Cuvier has assigned to the *Reptilia* would not seem to distinguish them from certain fishes with highly developed air bladders, without the additional statement that the organ of smell in the class *Reptilia* is situated in a canal communicating both with the cavity of the mouth and the external surface.

Cuvier divides, after Brongniart, the reptiles into four orders, viz.: —

The *Chelonia* (tortoises and turtles); of which the heart has two auricles, and the body is supported on four legs, and inclosed between two plates or shields formed by the ribs and sternum.

The *Sauria* (lizards and crocodiles); of which the heart has two auricles, and the body, supported on four legs, is covered with scales.

The *Ophidia* (slow-worms and serpents); of which the heart has two auricles, and the body is without legs.

The *Batrachia* (frogs, toads, newts, &c.); of which the heart has but one auricle, and the body is naked, and supported on four, or in a few cases two legs. Most of these pass, as they advance to maturity, from the condition of a fish breathing by gills to that of a quadruped breathing by lungs. Some, however, never lose their gills.

Such are the characters assigned by Cuvier (in 1829) to his primary divisions of the class *Reptilia*, but they are not a true expression of the organization of the groups so distinguished. The *Batrachia*, for example, have since been proved to have two auricles, although not so distinct externally as the other reptiles. Some of Cuvier's *Sauria*, again, have two distinct ventricles; whilst the rest have but one, like the *Chelonia* and *Ophidia*. The crocodiles, alligators, and gharrials are the higher organized *Sauria* here alluded to; and since they differ also from the *Lacertine Sauria* in having a simple undivided tongue and intromittent organ, and a well-marked modification of the tegumentary system, they deserve to rank as a distinct order, at the head of the class *Reptilia*. This order has been termed by Merrem *Loricata;* for the skin, in fact, instead of being covered by imbricated scales, is strengthened and protected by several rows of flattened and generally elliptical bones, developed between the cuticle and true skin, and often supporting a longitudinal crest; these bones or scutæ are situated chiefly along the back part of the neck, body, and tail.

Another order of *Reptilia* is clearly indicated by the remains of several large or even gigantic species now extinct, in which the extremities were modified to serve as fins on the plan of the paddles of the *Cetacea*. These reptiles are chiefly referable to the genera *Ichthyosaurus* and *Plesiosaurus;* they were marine, and of predaceous habits, and constitute the order *Enaliosauria*.

The *Chelonia* form a third and very natural order.

Those *Saurians* of Cuvier which have a heart composed of a single ventricle and two auricles, which have a bifid tongue and double intromittent organ, and which have a scaly and generally imbricated covering, form a fourth order of reptiles, to which the term *Squamata* has been given.

The *Ophidia* of Cuvier constitute the fifth order of reptiles. Some naturalists have proposed to unite the serpents with the lizards in the same order, on account of the gradual transition traceable in different genera from one to the other group; but the class of reptiles, by parity of reasoning, ought to be merged in that of fishes; and the naturalists who favour the blending of the tetrapodal with the apodal reptiles seem to forget that an order is a conventional division, a group of convenience, and not an entity circumscribed by nature. To separate the *Batrachia* as a distinct class from the *Reptilia*, seems to be an error in the opposite extreme. The viviparous four-footed salamander, breathing air by membranous lungs, and circulating blood by a biauricular heart, is thus placed in a distinct class from the four-footed lizard, without any essential difference in the pulmonary or sanguiferous systems to warrant the separation; the only differences that can be urged for such a step are a modification of the tegumentary covering, and a greater development and later continuance of the temporary branchial apparatus, of which traces are met with in the embryos of all the air-breathing Vertebrata; and a modification of the reproductive system. The naked integument; the presence of external gills in the young state; the almost simultaneous fecundation, sometimes without intromission, of numerous ova, — may be grounds for regarding the *Batrachia* or *Amphibia* as a subclass, or a group somewhat higher than an order; but seem not to warrant their separation from the scaled reptiles as a distinct class, as a group equivalent among Vertebrata to that of birds or mammals. For the subdivisions of the above orders see LORICATA, ENALIOSAURIA, CHELONIA, SQUAMATA, OPHIDIA, BATRACHIA, and also AMPHIBIA.

E'RPETON. *See* HERPETON.

ERRA'TA. (Lat.) The term applied to the faults that have escaped in the impression, or, as the case may be, in the composition of a work; usually inserted in a list either at the commencement or the end of the book. This manner of indicating typographical errors is coeval with the art of printing itself. Various dissertations have been devoted to this subject; among others may be mentioned that of Lindenberg, *De Erroribus Typographicis*, which, although of a somewhat impracticable nature, contains many ingenious observations.

E'RROR. In Law, a writ of error is one which authorizes the judges of a superior court to examine a record on which judgment has been given in an inferior court on an allegation of error in pleading a process, &c., and to affirm or reverse the same. It is the common remedy for erroneous judgments in courts of record. Error lies from inferior courts of record, and from the Common Pleas, to the King's Bench; from each of the three superior courts to the judges of the other two sitting in the Exchequer Chamber; from the Exchequer Chamber, and in certain cases directly, to the House of Lords. It lies in criminal as well as civil cases. Writ of error must be brought within twenty years. Correctly speaking, it is applicable only for the reversal of judgments on account of errors in law, and not of fact.

ERSE. The name given by the English and Scots to the dialect of Celtic spoken by the inhabitants of the Highlands of Scotland. The term is evidently another form of the word Irish. The people speaking the Erse tongue call themselves *Gael* (written, but not pronounced, *Gaidheal*), and their language *Gaelig*. The inhabitants of the low country of Scotland, it is remarkable enough, they call *Gall*, a term which they occasionally apply also to any stranger. England in the Erse language is called *Sasson*, meaning Saxony, and the people and language *Sassonach;* the latter being often called *Beurla*, which means speech in general, and in this case "the language" *par excellence*. The Irish are called by the Scots Highlanders *Gael*, like themselves, with the distinction of belonging to Erin, or Ireland. For the Welsh and their country there appear to be no names known to the Erse language. The Erse or Gaelic has been asserted to be one of the dialects of that Celtic or Gaulish language which is once supposed to have pervaded nearly the whole western portion of Europe, including France, Spain, and Britain. For such an hypothesis, however, there is no good evidence; and all analogy is wholly opposed to the supposition that a people so rude, so divided, and so scattered as the inhabitants of Europe were 2000 years ago, should

have had a common language. The great probability, on the contrary, is that in such times there were in Europe, as there are now in America, in Hindostan, and in the great group of the Oriental Archipelago, *many* languages; a few so closely connected as to amount only to dialects of each other, but the greater number either differing wholly, or agreeing only in a few words, — communicated possibly through the medium of religion, or adopted for convenience by the rest from one tribe or nation, which through good fortune or favourable position had obtained the start in civilization. The languages supposed to be of the Celtic stock, and of which we have sufficient evidence either by remains or as living tongues, are the Welsh, the Bas Breton or Armorican, the Irish, the Erse or Gaelic, the Manks or language of the Isle of Man, the Cornish, and the Basque or language of the provinces of the same name in Spain. An examination of these appears to prove the truth of the theory we have now suggested. The Welsh and Armorican are but dialects of the same language, and the same observation holds true of the Irish and Erse. These languages agree respectively with each other, not only in grammatical structure, but in that numerous class of words which constitutes the groundwork of every language; viz. prepositions, adverbs, conjunctions, with such verbs, adjectives, and nouns as are of most frequent and familiar use. The Irish and Erse so nearly resemble each other, that after a short familiarity with the pronunciation, the Irish and Scots Highlanders have no difficulty in understanding each other; and the same is said to be the case with the Welsh and Bas Breton. On the other hand, the languages of the two latter are wholly unintelligible to the first, and *vice versa*. The Manks is but a dialect of the Irish or Erse, and the now extinct Cornish was unquestionably a dialect of the Welsh. As to the Basque, long supposed to be a Celtic tongue, a careful examination of it by the late Baron William Humboldt showed not only that it bore no resemblance to the Welsh, the Irish, or their dialects, but that it had nothing in common with any known language, ancient or modern.

Respecting the causes which produced a similarity between the languages of Wales and Britany we possess some historical evidence. In the fourth and fifth centuries the Welsh, or people speaking the Welsh language in Britain, emigrated in great numbers to the opposite shore of the Continent, driven from their own country by the tribes of the northern part of the island. Their number was so considerable that they acquired a superiority over the native population of the part of Gaul where they settled, and succeeded ultimately in imposing on it their own name and language. A similar emigration from Ireland, although we have no historical record of it, probably propagated the name and language of the Irish, with their manners, customs, and traditions, over the poor and mountainous portion of Scotland which is now the site of the Gaelic or Erse language. It does not necessarily follow, in this case, that the Highlands of Scotland were without inhabitants when the Irish colonists or conquerors planted themselves there. A primitive race of inhabitants no doubt previously existed, whose name and language were lost in the strength and multitude of the invaders that occupied their country, as happened in America as the result of a British invasion, and in Britain itself as the result of a Saxon one. It may perhaps be said, in this instance, that the emigration is as likely to have taken place from the Highlands of Scotland to Ireland, as from Ireland to the Highlands; but the answer to such a supposition is obvious, viz. that conquest is more likely to have proceeded from an extensive and fertile country to a poor one destitute of resources, than from the latter to the former.

Although we have stated that between the Irish and Gaelic on one hand, and the Welsh and Armorican on the other, there is no such connection as would imply an identity of origin, there is still much evidence exhibiting an early and frequent communication, and probably to some extent even an intermixture of races, originating in an unsettled and stirring period of the history of the inhabitants of Europe; in such a state of society, in short, as produced within the memory and knowledge of history the migrations and invasions of the Gauls, and of the Cimbri and Teutones. The similarity of language to which we now allude bears no inconsiderable resemblance to that which is ascertained to exist between most of the languages of the great Oriental Archipelago and Pacific Ocean, and which has been satisfactorily traced from Madagascar to Gaster Island. We may take as an example the numerals, which, with few exceptions, are the same in the Irish, Erse, Welsh, and Armorican, just as they are in many, although not in all, the languages of the innumerable nations and tribes occupying the scattered islands which lie between Asia and Australia north and south, Africa, and America west and east. But the numerals, it should be recollected, are not essential and indispensable portions of rude language; but, on the contrary, as much comparatively recent inventions as an alphabet, or the Arabian system of notation; and indeed an invention, particularly when carried to the length to which it has been in this case, implying a very considerable advancement in early society. The system is, as usual, decimal; and although it contains evidence of rude attempts at local and less perfect plans, is obviously of single origin. It reckons by ten up to twenty, and then counts by scores up to a hundred. Thus nineteen is "one and nine," and expressed by the very same words in all the languages. The word for twenty in the two classes of languages differs. Thirty is expressed by the circumlocution of "one score and ten," forty by "two scores," and fifty by "two score and ten," &c. One hundred is expressed by the same term in all the languages; and it is the utmost limit of native enumeration, for a thousand and the numbers above it are borrowed from the Latin. In the example of the numerals, then, we discover, what might be looked for, evidence of considerable simplicity and even rudeness in these Celtic languages.

Of the four languages now spoken of, the Welsh appears to be that which was longest and most cultivated. It was unquestionably a written language in the 10th century; and the perfect alphabet, by which every sound in it is invariably expressed, consisting of sixteen radical and twenty-seven derivative characters, forming in all forty-three letters, is still preserved. The Erse or Gaelic was the least cultivated; and until late years even the Bible which was used in the Highland churches was no other than the Irish. It first attracted notice after the publication in the English language of the poems of Ossian, said to be derived from it about the middle of the last century. These, it was pretended, were translated from manuscripts in the translator's possession; but such poems in a written form, it is now sufficiently known, never had any existence, either in the Irish or Gaelic language. Although not committed to writing, or rather not handed down in writing, these poems, committed to memory and handed down from one bard or story-teller to another, still exist in the Highlands of Scotland, and in a dress not remote from that in which they were rendered by Macpherson into English. Their scene is sometimes laid in Scotland, but more frequently in Ireland. In short, they are the Iliad and Odyssey of the Celtic race of the two islands, handed down by tradition only,— what the poems of Homer were in all likelihood to the Greeks themselves, before the art of writing was known to them. The Erse, although a rude and uncultivated language, is a nervous and manly one, both as to expression and sound, and well suited to poetry, whether sublime or tender. The range of its sounds is very great; for it possesses twelve vowels, and no less than eighteen diphthongs and triphthongs, with forty-one consonants, including aspirates. Many of the consonants are guttural; and of these, as well as of the vocalic sounds, there are several utterly unpronounceable by a stranger: the attempts made to express such a variety of sounds by the Roman alphabet are, of course, both awkward and imperfect. As to the grammar, that of the Gaelic is of complex structure, implying a primitive language which has undergone little change by admixture with other tongues.

ERYSI'PELAS. (According to etymologists, from the Gr. *ερυεσθαι*, *to spread*, and *πελας*, *near*—spreading over the neighbouring parts; but the derivation is doubtful.) Called also *Saint Anthony's Fire*, that saint having miraculously cured it. This disease usually commences with fever, followed by an eruption of a very red colour, sometimes vesicular, and attended by tumefaction. It commonly attacks the head and face, and is at its height from the third to the sixth day; but its duration and progress are very variable in different individuals. The fever which attends this form of erysipelas is more or less inflammatory, and at first cooling diet and aperients are required; and the local irritation and itching may be quelled by cooling lotions, or by sprinkling the part with a puff of hair powder, which is sometimes singularly soothing to the sufferer. From the eighth to the twelfth day, the eruption scabs or scales off. If sickness, shiverings, and delirium attend the height of the disorder, an unfavourable termination may be anticipated. Sometimes suppuration occurs, especially of the eyelids and scalp. The greater number of cases of this disorder have a tendency, in their latter stages, to debility; and bark, or sulphate of quinine, with other tonics, are indicated. But where inflammatory symptoms run high, aperients and diaphoretics must be persevered in; and blistering, and even cupping, are necessary.

Where erysipelas is attended with typhoid symptoms, it is dangerous from the beginning; and wine, bark, ammonia, and other stimulants, are usually prescribed.

In that form of erysipelas which attacks different parts of the body in successive patches aperients, diaphoretics, and alteratives are useful; but in every case of this disease, lotions and ointments should be used with the utmost caution, and warm or cold water, and milk and water, are generally the best applications. There is a variety of erysipelas which attacks infants, and which is sometimes alarming from its gangrenous or suppurative tendency. Erysipelatous inflammation is also often a sequel of surgical operations, especially in crowded and ill-

ventilated hospitals, where it sometimes spreads among the patients to a very alarming extent. Cleanliness, ventilation, fumigation, and, above all, the removal of the affected persons to a better air, are the only chances of eradication.

ERYTHE'MA. (Gr. ερυθρος, *red.*) All *rashes*, as they are commonly called, and rednesses of the skin, attended by marked constitutional affection, and very mild forms of *erysipelas*, come under this denomination.

ERY'THRIC ACID, applied by Brugnatelli to a *red* substance obtained by the action of nitric on uric acid.

ERY'THROGEN. A peculiar substance, discovered in 1821, by M. Bizio of Venice, in the gall-bladder of a person who died of jaundice. It was a green tasteless liquid, which became *deep purple* in nitric acid and ammonia, and when heated in the air produced a purple vapour; hence its name, from ερυθρος, *red.* He supposes it identical with the colouring matter of the blood.

ERYTHRO'NIUM. A name originally given to the metal since called *Vanadium*, from the *red* colour of its acid.

E'RYX. (Gr.) A genus of serpents with a short obtuse tail and a single series of subcaudal scutæ, as in Boa; but having both the abdominal and caudal scutæ much narrower, and the anal hooks inconspicuous.

E'SCALADE. (Fr.) The scaling of a fortification by means of a ladder is so called.

ESCAPA'DE. (Fr.) A term almost naturalized in England, signifying any impropriety of speech or behaviour of which an individual is unconscious.

ESCA'PEMENT, in Clock and Watch-work, is the name given to that part of the mechanism by which the circulating motion of the wheels is converted into a vibratory motion, as that of the pendulum of a clock or balance of a watch. Various contrivances are employed for this purpose, depending on different mechanical principles, as the *dead-beat* escapement, the *lever* escapement, the *duplex* escapement, the *detached* escapement, &c. *See* HOROLOGY.

ESCA'RP (Germ. scharf, *sharp*), in Fortification, signifies any thing high and precipitous. Sometimes it is used to denote the side of the ditch next the place; in which case it is opposed to *counterscarp*, which denotes the side next the country. In a fortress, the escarp is the exterior surface of the revetment wall supporting the rampart.

ESCA'RPMENT. In Geology, the steep face often presented by the abrupt termination of strata where subjacent beds "crop out" from under them. The two most extensive lines of hill which traverse the centre and south of England are formed by the escarpments of the oolite and chalk formations respectively. The first extends through Yorkshire, the West of Lincolnshire, Rutland, Northampton, Warwick, Gloucester, Somerset, Dorset; being bounded throughout on the N. W. by the outcrop of the *lias* formation. The latter commences in Yorkshire, rises again in Norfolk, and extends through Cambridge, Hertford, Bucks, Oxford, Berks, Wilts, and Dorset, in a parallel line to the former.

E'SCHAR. (Gr. εσχαρα, *the crust of a scar produced by burning.*) When a living part has been burned, it becomes hard, rough, and of a grey colour, forming what is properly called an eschar: it is a slough produced by fire or caustics. The English *scar* is evidently derived from this term.

ESCHARO'TICS. Applications which form eschars. The term is generally applied in surgery to mild caustics.

ESCHE'AT, in Law, happens when tenant in fee-simple dies without having left any heir to the land, and without having incurred a forfeiture to the crown (as for treason). This case arises on sentence of death for murder; but not for other felonies, which, since 54 G. 3. c. 145., leave the power of disposition of his estate after death to the offender. In this case the land goes to the lord of the fee. There is no escheat of equitable estates.

E'SCROW. (Fr. ecreu, *scroll.*) In Law, a deed delivered to a third party, to be the deed of the party making it upon a future condition when a certain thing is performed, until which it has no effect as a deed.

E'SCUAGE, or SCUTAGE. (Either derived from scutum, *a shield*, or the same word signifying a piece of money; which latter denomination of coin, indeed, perhaps originates in the fact of money having been levied under the name of this tribute.) A pecuniary satisfaction, paid in lieu of military service by tenants in chivalry. There have been doubts among our antiquarian lawyers whether escuage were, properly speaking, a tenure in itself, or merely an incident to tenure; but the latter is probably its proper character. Littleton says, that tenant by homage, fealty, and escuage is tenant by knight service. The assessment of escuage was uncertain in amount, and, by Magna Charta and 25 Ed. 1., could only be taken by assent of parliament. Escuage, together with the other appendages of military tenures, was abolished by 12 C. 2. c. 24.

ESCU'RIAL, or EL ESCURIAL. A royal palace of Spain, about twenty-two miles from Madrid, at the foot of the Carpentani mountains, which divide the two Castiles. It was commenced by Philip II., from two motives — the dying injunction of his predecessor Charles V., who was desirous that a tomb should be constructed for the royal family of Spain; and the other to erect a monument surpassing all triumphant arches and similar buildings, to commemorate the famous victory of San Quintin, won on the festival of St. Lawrence, to whose intercession the king attributed his success. Its foundations were laid in 1563; Giovanbatista of Toledo being the architect who planned and continued to superintend the building till his death in 1567, when his pupil Giovanni d'Herrera carried on and finished it. As an architectural composition it is unworthy to be attributed, as it has been, to Bramante, Pellegrini, or Vignola. They as well as others may have given designs for it, but such were not selected. It is considered by Spaniards as entitled to be called the eighth wonder of the world; and numberless fables are told about the number of its doors, windows, and columns, as well as its cost having been twenty-four millions of ducats, though the expense of erecting it was not quite one fourth of that sum. The whole pile comprises a magnificent monastery, which was given to the fathers of San Girolamo; of a college, a seminary, and a royal palace. In plan the form resembles a gridiron, the instrument of martyrdom of St. Lawrence, of which that part used for the royal palace is supposed to represent the handle. It is internally disposed into fifteen courts of various dimensions, the largest whereof are ornamented with porticoes and galleries; and the material employed is a species of granite. The principal façade, looking towards the west, is 740 feet long, and 60 feet high to the cornice. Towers flank the façade at each angle of the edifice 200 feet high. The masses are much cut up by the division of the principal façade into no less than five stories of windows. The elevation to the east is 1100 feet long, and that to the south 580 feet long. The church of the monastery is 364 feet long, 230 feet wide, and 170 feet high; and is divided and supported by piers 53 feet distant from each other. From the centre a cupola rises of good form exteriorly, but clumsily composed inside. Its diameter is 66 feet, and from the pavement to the top of the cross the height is 330 feet. The pantheon here is a crypt under the high altar of the church, and is used as the place of sepulture of the Spanish royal family. On extraordinary occasions it is lighted by a superb lustre. The staircase leading to this mausoleum has fifty-nine steps, divided by one landing; at the sides of which are two bronze statues, — one of Human Nature stripping herself of the illusions of the crown and sceptre, the other of Hope. On the two inferior landings are two doors, — one leading to the vault, where are laid the remains of the infants and infantas, and queens who have had no issue; the other to the chamber, 36 feet diameter and 38 feet high, where the remains of the kings are deposited. The whole of the building is profusely ornamented, particularly with paintings from the best masters of Italy, Flanders, Spain, and Germany. The adjacent buildings are worthy of so august a pile. Attached to the monastery by an arched gateway is an edifice called the Campagna, which has two galleries, each 100 feet long and 20 feet wide. This was built by Francesco de Mora, the successor of Giovanni d' Herrera. Here are the hospitals, granaries, pantries, and other offices; here also are the gardens, which from being seated on the acclivity of a hill appear hanging. The garden on the south side of the monastery is 8000 feet in circuit. Adjoining the eastern and northern façades is a spacious gallery or esplanade surrounded by a parapet. On this side are the quarters for the guards, the riding school, the aqueduct, &c. &c. Beyond the outer buildings is the Fresnada, about half a league to the east. This villa is surrounded by a wall, and contains courts, gardens, meadows, fountains, trees of all sorts, lakes with islands, fisheries, &c. Here also is a church of fine and simple form, by Francesco de Mora. In 1773 many works were executed at the Escurial for the infants Don Antonio and Don Gabriele by Villaneuva, the then architect of the palace; indeed from the time of Philip II. all his successors have made some additions to this superb edifice, which, like the the original fabric, contain great beauties and great defects.

ESCU'TCHEON, or ESCOCHEON. In Heraldry, a shield on which arms are emblazoned: derived from the French écu or écusson, Italian scudo, Latin scutum. The favourite shape for the purpose of heraldry is that commonly called the Norman shield; but women, daughters of parents entitled to coat-armour, bear their father's arms on a lozenge-shaped shield. The points of the escutcheon are the parts named in order to express the local position of the charges borne on the field. (*See* CHARGE.) They are nine in number. *Escutcheon of pretence* is the shield on which a man carries the arms of his wife; in England only borne if she is an heiress, and he has children by her. It is borne in the centre of his own shield, and generally of the same shape. *Inescutcheon*, an escutcheon borne also within the shield in the middle of the coat (but smaller than an escutcheon of pretence), or in chief. It is a species of ordinary.

ESOTE'RIC, opposed to *Exoteric.* (Gr. εσω, *within*, εξω, *without.*) Much dispute has prevailed among the

learned as to the precise import of this distinction. By some it was thought that the ancient philosophers had a set of mysterious doctrines which they communicated only to the more enlightened of their disciples, and another more popular doctrine which they promulged to the multitude. In the case of Aristotle, to whose writings the distinction properly applied, this opinion is, to a certain extent, well founded; except so far as regards the suspicion of intentional concealment implied in it. The exoteric or *published* writings of that philosopher appear to have been written in the form of dialogues, all of which are lost. His esoteric works, we gather from the synonymous term *acroamatic* (*ἀκροᾶσθαι, to hear*), were not intended to supersede the necessity of oral instruction to render them intelligible. This agrees well enough with the brevity, the frequent repetitions, and the perplexed arrangement of the works of Aristotle which survive. (See *Ritter*, *Gesch. d. Ph.* b. ix. c. 1.)

E'SPALIER. In Horticulture, a substitute for a wall on which to train fruit trees, and sometimes ornamental shrubs. The objects are to expose the foliage of the plants more perfectly to the light, to prevent the branches from being blown about by the winds, and to economize space by confining them within definite limits. The espalier is either constructed of wood or iron; and commonly of two horizontal rails joined by upright rods, six or eight inches apart. The most elegant and economical structure of this kind at present in use is a double espalier formed of hoop iron posts in the shape of the letter A, twenty inches wide at bottom, and six or seven feet high, at which height the hoops meet in a point. Through the hoop iron posts wires are inserted horizontally at six inches apart, and drawn quite tight; the result of which is a double surface on which to train the trees. (See *Loudon's Suburban Gardener*, p. 232.)

ESPA'RTO. (Span.) A species of rush; the *Stipa tenacissima* of botanists. It is found in the southern provinces of Spain. It is made into cordage, much used in the Spanish navy; and is platted for other purposes, such as mats, shoes, &c.

ESPLANA'DE, or GLACIS. In Fortification, the sloping of the parapet of the counterscarp or covered way towards the open country.

ESQUI'RE, *Ecuyer*, *Escudero*. (In Latin, armiger.) A well-known title of rank; derived from the French écu, Lat. scutum, *a shield*. Some suppose that it has its origin from the Scutarii, a sort of soldiery in the Roman armies; others derive it from equus, *a horse*, and suppose that esquire and equerry denoted orignally the same thing, viz. *a groom*. But it is generally supposed to have belonged to the shield or armour bearers (armigeri) attached to the person of knights. This office, in the times of chivalry, was honourable, and generally borne by persons of good family. Hence the term esquire became gradually appropriated, in England, to a rank above the simple gentleman and below the knight. Younger sons of peers (now called Honourables), their eldest sons, eldest sons of knights, sheriffs of counties, serjeants at law, justices of the peace, and doctors of divinity, are esquires by virtue of their respective rank or office. Heads of ancient families are considered esquires by prescription; and hence has originated the use of the word, in the present day, as a common addition to the names of all those who live in the rank of gentlemen. The king creates an esquire, by putting round his neck a silver collar of *ss*; to which ceremony was formerly added the putting on of a pair of silver spurs.

E'SSAY. In Literature, an attempt; a species of composition. In general, this title is given to short disquisitions on subjects of taste, philosophy, or common life. In this sense it has been applied to periodical papers, published at regular intervals under a collective name, by one or more writers, containing remarks on topics of the day or on more serious subjects. From the appearance of the *Tatler*, in the beginning of the last century, which was chiefly written by Sir Richard Steele, this species of literature continued to be a favourite in England for seventy years, and many similar series of essays were produced; the best of which are united in one collection under the name of *The English Essayists*. The most celebrated of these works was the *Spectator*, to which Addison was the best contributor; and next to it the *Rambler*, published and almost wholly written by Samuel Johnson. The title of essay has been also adopted, by way of indicating diffidence in the completeness of their work, by various authors of more extended performances; as by Locke (*Essay on the Human Understanding*).

E'SSENCE. (Lat. essentia, from esse, *to be or exist.*) In Philosophy, a scholastic term, denoting what the Platonists called the idea of a species. The school philosophers give two significations of the word essence: the first denoting the whole essential perfection of a being, and consequently its entity, with all its intrinsic and necessary attributes taken together; the second denoting the principal or most important attributes of any thing. The essences of things were held by many to be uncreated, eternal, and immutable. *See* METAPHYSICS.

E'SSENCE D'ORIENT. A term applied to a pearly-looking matter found principally at the base of the scales of the *bleak*, a small fish of the genus *Cyprinus*: it is used to line the interior of glass bubbles or beads, as in the manufacture of artificial pearls.

ESSE'NES. A sect among the Jews in the time of our Saviour, of whom an account is preserved to us by Josephus and Philo, though they are not mentioned in Scripture. They were few in number, and lived chiefly in solitude, taking no part in public affairs, but devoting their lives to contemplation. There were indeed two classes of them, distinguished as the practical and contemplative, who differed in the degree of strictness and austerity which they observed. They believed in the immortality of the soul, and held the Scripture in the highest reverence; interpreting it, however, after an allegorical system of their own. (See *Blackwood's Mag.*, 1840.)

ESSE'NTIAL OILS, or VOLATILE OILS. Under this term are included all those peculiar compounds obtained by distilling vegetable substances with water, and which pass over along with the steam, and are afterwards condensed in the liquid or solid form. They appear to constitute the *odorous* principles of vegetables. Their specific gravity fluctuates on either side that of water: they are very sparingly soluble in water, and these solutions constitute the *medicated waters*; rose, peppermint, and other waters being such solutions of the respective essential oils. They dissolve in alcohol and form *essences*, many of which are used as perfumes. When these oils are pure, they evaporate from paper when held before the fire; but if adulterated with fixed oils, they leave a greasy stain, and seldom dissolve perfectly in alcohol. The more expensive of these oils are frequently adulterated with the cheaper ones, and this fraud can only be detected by an experienced nose. Their chief use is in perfumery, on account of their odour, and in medicine they form valuable stimulants. They are inflammable, and are, with few exceptions, compounds of hydrogen, oxygen, and carbon. The essence of turpentine, of lemons, and a few others, are *hydrocarbons*.

ESSOI'GN. In Law, an excuse for one who is summoned to appear and answer an action or perform suit in a court, &c., by reason of sickness or other prevailing cause. The first return day in every term was called the essoign day, because the court sate on it to take essoigns; *i. e.* excuses for such as did not appear according to the summons of the writ. The essoign day seems to be done away with by the effect of the statutes 11 G. 4., 1 W. 4. c. 70., and 1 W. 4. c. 3.

ESTA'BLISHMENT. *See* FOUNDATION.

ESTABLISHMENT OF THE PORT. A term used by writers on the tides, to denote the interval between the time of high water at any given port and the time of the moon's transit immediately preceding the time of high water, when the moon is in syzygy; that is, at the new or full moon. This interval is influenced by local circumstances, and consequently different at different places. *See* TIDES.

ESTAFE'TTE. (Span. estafeta.) Applied originally to military couriers, but now used in all the countries of modern Europe to signify an *express*. The difference between a courier and an estafette consists in this, that while the former must deliver the despatches, &c. entrusted to him personally at the place to which they are addressed, in the latter the despatches, letters, &c. to be forwarded are consigned to the care of postillions, who are changed with every relay of horses successively till they arrive at the place of their destination.

ESTA'TE, in common parlance, is applied to the landed property held by individuals; and a man is said to be of good or of small estate, according to the magnitude of his landed property.

Estates vary exceedingly in size and value in most parts of England. The largest estate in the kingdom may be worth 100,000*l.* or upwards a year; and there are estates of most inferior degrees of magnitude, down to the annual value of 40*s.*! In some counties property is more, and in others it is less, subdivided. In Cheshire, the East Riding of Yorkshire, and one or two other counties, there are comparatively few small proprietors; but the latter predominate in most parts of the West of England, in the North, and generally throughout the country. On the whole, we believe it may be safely affirmed, that by far the largest portion of the kingdom is parcelled into properties of less than 1000*l.* a year. It is not difficult to account for the prevalent misconceptions on this point. Though few in number, the owners of large estates engross the attention of common observers, and hinder them from fixing their eye on the mass of obscure, petty landowners, that constitute the great bulk of the class. Dr. Beeke, whose authority as to such matters is deservedly high, estimated the total number of proprietors in England and Wales at 200,000; and supposing the gross rental of the kingdom to be 30,000,000*l.* a year, the average annual income of each, in his capacity of landlord, will be only 150*l.*! and seeing that a few have much more, it follows that many must have good deal less. Hence it is

that few lead a more laborious life, or are more under the necessity of abstaining from luxurious indulgences, than the owners and occupiers of small landed properties. Nothing, in fact, can be a greater mistake than to suppose, as is generally done, that the landowners are an extremely opulent and an extremely indolent body. These may be the characteristics of a few individuals amongst them; but it would be quite as wide of the mark to affirm that they are generally applicable to the entire class, as that they are generally applicable to the classes of manufacturers and traders. (See *M'Culloch's Statistics*, vol. ii.)

ESTATE FOR LIFE, in Law, is a freehold interest in lands and tenements, whether enjoyed for the life of the tenant, or for the life of another party (in which latter case it is termed an estate pur auter vie). This species of interest includes estates granted for an uncertain period limited within the duration of a life; as, for instance, an estate granted to a widow during her widowhood. An estate for life is created wherever lands or tenements are given by means adequate to the conveyance of a freehold, without any express limitation of an estate. If tenant for life convey an estate greater than his own by feoffment, fine, or recovery, he forfeits his estate; but if he does so by any of those conveyances which are termed innocent, he creates an estate determinable on his own death. With respect to estates pur auter vie, it is observable that formerly, when lands were given to A. for the life of B., if A. or A.'s assignee happened to die in B.'s lifetime, the estate belonged to the first person who could take possession, termed an *occupant*; but if given to A. *and his heirs* for the life of B. on the same event, A.'s heir succeeded as special occupant. Now, by the Statute of Frauds (29 C. 2. c. 31. s. 12.), estates pur auter vie are devisable; and, if there be no special occupant, they go to the executors or administrator of the deceased.

ESTATE FOR YEARS. In Law, an estate limited for a term of years, or other determinate time, in lands, tenements, or hereditaments, is a chattel or personal interest; and, on the death of the owner, devolves, like other personal property, on his executors or administrator. An estate for years is properly created or *demised* by an instrument termed a lease; which, at common law, has not full operation until the entry of the tenant. It may also be created by declaration of use, or by devise in a will; and may be made either to commence immediately, or on a future day and event: in which latter case, unless there be any particular estate to support it as a remainder, it is called an *interesse termini*, until the time arrives for its reduction into possession. Covenants between the lessor and lessee, relating to the land (which are usually inserted in the lease), are said at common law to run with the land: they pass, along with the term of years, to a party to whom the lessee conveys it by assignment; but the lessee's covenants do not pass to a party to whom he conveys part of the term by underlease. A tenancy from year to year is a species of estate for years.

ESTATE OF INHERITANCE. In Law, an estate in fee-simple or fee-tail. (See these articles; and REAL PROPERTY, LAW OF.)

ESTATES, POLITICAL. *See* STATES.

ESTIVA'TION. A term applied to the parts of a flower when unexpanded: it is used, in connection with various adjectives, to express the manner in which sepals or petals are rolled up before the flower unfolds.

ESTO'PPEL. In Law, an impediment or bar to a right of action, arising from a man's own act, or that of one to whom the party estopped is privy. As, if a party is bound by a particular name in an obligation, and afterwards sued by that name on the same obligation, he is estopped, *i.e.* forbidden in law to say in abatement that he is misnamed; as he cannot say contrary to that which he has admitted by his own deed. All parties to a deed are estopped to say any thing against what is contained in it; and privies are also bound.

ESTRE'AT. In Law, the extract, copy, or note of some original writing or record, and especially of fines and amercements; entered on the rolls of the court, to be levied by its bailiff or other officer. Fines to the king are estreated into the Court of Exchequer. Estreats are made out in that court by the remembrancer for the lord treasurer, and received from him by the clerk of the estreats, who writes them out to be served for the king, &c. Provision is made for the due return, estreating, and levying of fines, &c. in the superior and some other courts by 3 & 4 W. 4. c. 99.

ES'TRICH. The commercial name of the fine down of the ostrich.

ES'TUARY. *See* ÆSTUARY.

ETÆ'RIO. In Botany, an aggregate fruit, having the ovaries distinct, pericarp indehiscent; either dry upon a fleshy receptacle, as the strawberry; or dry upon a dry receptacle, as the ranunculus; or fleshy upon a dry receptacle, as the rubus: the parts being achenia or small drupes.

ET CÆTERA, usually expressed by the sign *&c.* means *and so on.*

ETCHING. *See* ENGRAVING.

ETCHING NEEDLE. An instrument of steel with a fine point, for tracing outlines, &c. on the copper plate.

ETE'RNITY. An attribute of the Deity, the existence of whom is without beginning or end. It is the immediate consequence of the self-existence which we attribute to him. Being the cause of all things, he is himself independent of any cause.

Eternity being infinite, is inconceivable by our finite understandings; at the same time, we cannot imagine an infinite being to exist without it. There is a distinction made between an *anterior* and a *posterior* eternity. The latter belongs to creatures whom God proposes to preserve for ever; the former to himself alone. We suppose God to exist without parts, and also without succession. It is an inconsistency in atheism to suppose a succession of generations from an anterior eternity: nothing that is successive can be actually infinite and eternal.

ETESIAN WINDS. *See* WINDS.

E'THAL. A substance formed during the saponification of spermaceti. Chevreul derived the name from the first syllables of *ether* and *alcohol*, on account of its analogy to those liquids in point of composition.

E'THER. (Gr αιθηρ) In Chemistry, this term is applied to a highly volatile, fragrant, inflammable, and intoxicating liquid, produced by distilling a mixture of equal weights of sulphuric acid and alcohol. When these liquids mutually act on each other, a series of complicated changes ensue, which terminate in the conversion of alcohol into ether. Ether, like alcohol, may be regarded as a compound of hydrocarbon and water; and if alcohol be considered as consisting of *one* equivalent of olefiant hydrocarbon = 14, and *one* of water = 9, ether may be regarded as constituted of *two* of olefiant hydrocarbon $(14 \times 2) = 28$, and *one* of water = 9: hence, the equivalent of alcohol being $14 + 9 = 23$, that of ether will be $14 \times 2 = 28 + 9 = 37$; and the process of etherification may be stated to consist in the abstraction from alcohol of one half of its elemental water. By some, ether is regarded as the oxide of a peculiar hydrocarbon, which they term *ethule*, composed of 4 equivalents of carbon and 5 equivalents of hydrogen; and alcohol must in that case be considered as hydrate of ether.

Ether, or, as it is often called, to distinguish it from analogous products obtained by the intervention of other acids, *sulphuric ether*, is a limpid colourless fluid, of an agreeable odour, and a hot pungent taste. Its specific gravity is about 0·713, though that of the shops is usually heavier; it boils at about 98°, and freezes at the low temperature of 46° below 0°. The specific gravity of etherial vapour compared with atmospheric air is as 258 to 100. Ether is sparingly soluble in water, which takes up about a tenth of its bulk; it dissolves in all proportions in alcohol. The principal use of ether is in medicine. When taken internally, it is stimulant; and it is sometimes applied externally, by reason of the cold produced during its evaporation, as an ingredient in refrigerating lotions.

ETHE'RIA. (Gr. αιθω, *I shine.*) A genus of Lamellibranchiate Dimyary Bivalves, with a large ventral muscular plate or foot, as in the *Uniones*; but having their shell adherent, as in the oyster, to foreign bodies; the hinge is toothless, irregular, undulated, and callous; the ligament external, but penetrating in a pointed form into the interior of the shell. The term *Etheria* has also been applied by Rafinesque to a genus of Macrourous Crustacea.

E'THERIN. A name applied by some chemists to quadrihydrocarbon; that is, to an hydrocarbon 1 atom or equivalent of which is constituted of 4 atoms of carbon and 4 of hydrogen. It is obvious that such a compound may be regarded as the base of ether; its equivalent would be $6 \times 4 = 24 + 4 = 28$.

E'THICS. (Gr. ηθος, *custom, moral character*.) The science the object of which is to determine what ought to be in relation to voluntary action, and to those dispositions, faculties, or affections of mind which tend mediately or immediately to voluntary action. It has been our aim throughout the present work, in all articles relating to abstract or speculative subjects, especially to such as have been matter of long controversy, rather to present our readers with a history of the opinions which have been held by others, and to direct them to the works in which those opinions are maintained with the greatest ability, than to give a systematic account of what appeared to us the correct view of the particular department of inquiry before us. The definition with which we preface this article may appear to be in some degree a deviation from this our practice, inasmuch as it contains by implication a decision of certain questions in the science before us, which some of our readers may consider to be still "sub judice," besides including the use of terms to which it has been asserted by certain modern writers on ethics that no intelligible meaning can be attached. Our answer is, that we can conceive of no definition, not including the terms in question, or their equivalents, which shall justify us in assigning to the science of ethics an independent existence, or, by consequence, in giving to

the word which designates it a distinct place and a separate treatment. Whether the words "ought" and "voluntary" have any meaning or not, must appear from the sequel: it is enough for our present purpose that the majority of moralists have believed them to possess one.

There is no subject within the limits of speculation concerning which controversy has been waged with greater vehemence, with the exception, perhaps, of theology, than that of ethics. We have not far to search for the general reasons of this fact. Besides being a science of pre-eminent interest to those who unite high moral feeling and a concern for the interests of their kind with a capacity for speculation, it is a science also the treatment of which is peculiarly liable to be affected by the moral nature and habits of those who take it in hand. Without taking upon us to assert that to be a good ethical writer it is necessary to be a good man, we think that the history of speculation justifies us in the belief that a partial or confined view of moral science indicates, for the most part, a corresponding excess or defect in the moral qualities of the person holding it; at least where such peculiarity cannot be traced either to imperfect intellectual qualifications, or to singularly unfavourable circumstances of time, place, or education. Systems which have sprung up under such influences commonly expire with the circumstances which called them into being. The youthful student may indeed be attracted by the ingenuity or confounded by the subtlety with which they have been maintained; but, with a person of sound mind, who has access to writers of larger and deeper views, they cannot long maintain a place in his understanding, much less in his practical habits. We have introduced these remarks, partly as our justification for omitting from this article all notice of such systems as those of Epicurus in ancient, and Hobbes, Helvetius, and Mandeville in modern times; and partly as an introduction to what we shall make the central point of our observations—an account of the controversy which at present divides ethical speculators in England. We allude, it will be perceived, to the dispute which has for some time prevailed between the respective partizans of what have been called the "utilitarian" and "sentimental" schools. Those who are acquainted with the most recent records of opinion which have been published on both sides of this controversy will see reason to wonder at two things: at the very small real discrepancy between the parties engaged; and at the singular vehemence with which they disclaim all community of opinion, and strive to establish a difference which does not exist, or to exaggerate one which does. An historical examination of the origin and growth of the two schools will in a great degree explain these two facts; inasmuch as it will show that the difference between the disputants is one rather of feeling and habit than of pure theory. It will also serve as a thread whereon to hang such notices of past systems as it was necessary to give, in order to impart to this article the same historical character with that possessed by the articles on similar subjects which occur during the course of this work. We shall thus have an opportunity of communicating to our readers by far the most of what is really important in English ethical speculation; and in the attempt which we shall make to show the essential incompleteness of both theories, and to indicate the true central point from which the science of morals ought to be viewed, we shall be enabled to introduce an account of some of the leading features which distinguished the systems of antiquity. We begin with those whom we have named the sentimental moralists.

The most eminent of these have been men who have devoted their attention chiefly or entirely to what may be called empirical psychology; that science, namely, which determines the sequences of mental phenomena, and their dependence on each other in the relation of cause and effect; in one word, to the *physics* of the mind. In this department of science the most fruitful discovery that has been made is what is commonly named the Law of Association. This law, according to which Hobbes and Condillac attempted to account for the origin of our perceptive and intellectual faculties, was applied with better success by Hartley to the analysis of our emotive principles. The moral sentiments, the ultimate source of which Hutchison held to be benevolence, and Adam Smith sympathy, Hartley sought still lower, in the simple capacity of organic pleasure and pain. From these original elements are formed, by successive or co-ordinate processes of association, the feelings of sympathy, gratitude, resentment, shame, and the like; and, as the last and most perfect formation, the faculty of moral approbation or disapprobation. This theory, which must not be, as it frequently is, confounded with the selfish theory, is that which the celebrated dissertation of the late Sir James Mackintosh, prefixed to the *Encyclopædia Britannica*, is intended to illustrate. It is in reference to the successive stages of development of the associative principle that this elegant work is alone valuable. Its author may be considered as ending the series of sentimental moralists; in which, in addition to the names given above, may be inserted that of Dr. Thomas Brown. The result of their speculations is, that they have established the existence of a moral faculty in man, as a fact of natural history; a fact, also, which holds a distinct and defined place in a physical theory. It is, as we shall see, by no means an insignificant circumstance that, of the five names we have enumerated, two were physicians by profession, and one had dedicated great part of his youth to the study of practical medicine.

The reputed father of the "utilitarian" moralists is the celebrated Jeremy Bentham. The labours of this unquestionably powerful thinker were principally devoted to the sciences of legislation and jurisprudence; to which, also, much of the attention of those who profess themselves his followers or admirers has been directed. It is only as auxiliary to these sciences that Mr. Bentham has handled the subject of morality. The most complete account of the utilitarian principle is to be found in Mr. Austin's work on jurisprudence. This principle is thus enunciated:—"The morality or immorality of an act consists in the beneficial or pernicious consequences resulting from it; the morality or immorality of an agent, in the goodness or badness of his intention, the goodness or badness of the intention being determined by the nature of the consequences which are foreseen, or might be foreseen, as resulting from the act." Here, we are told, we must carefully distinguish between *intention* and *motive;* between foresight of the consequences of an action, and the state of mind which causes the action. To quote an instance used by the acute author of a recent work named *A Fragment on Mackintosh*,—"A man, to save his family from starving, wires a hare on my estate. My first impulse is to throw him into jail. Before I determine to do so, however, I consider the misery which I shall bring on the man himself, and the state of want, wretchedness, and probable demoralization, into which I shall plunge his family. In spite of these foreseen consequences, I resolve to prosecute him. Here my *motive* is the preservation of my game, my *intention* the production of misery and vice in a multitude of my fellow-creatures. The immorality of this act manifestly consists in the intention; the motive is neither moral nor immoral." Having given this preparatory illustration, we shall extract from the same work what is there denominated "A list of the requisites of a moral act." These are—"1. *The motive.* There is no act without a motive; but the motive is in itself neither moral nor immoral. 2. *The volition.* There is no act which is not willed; but the act of willing is neither moral nor immoral. 3. *What is called the external act;* to wit, *the bodily part or motive.* That, like the motive, is in itself neither moral nor immoral. The same bodily operation is indifferently a part of every sort of act. It is, however, a necessary part of every act. 4. *The consequences of the act.* An act which has no consequences that are materially either beneficial or hurtful is not called a moral act. That alone receives this denomination which has consequences material to some one or more human beings. 5. *The expectation of the beneficial consequences in the mind of the agent* 6 This is not all: it is not enough to make an act moral that the agent expects from it beneficial consequences to somebody; it is further necessary *that he have no reason to expect from it evil consequences equivalent* to any other body; that is, in other words, that he have *a conviction of its general utility.*"

In order to obviate an objection to the principle so enunciated,—viz. that it supposes a laborious calculation of consequences to precede every moral action,—Mr. Austin, in the work to which we previously alluded (*The Province of Jurisprudence Determined*), qualifies the statement by the admission that the principle of utility itself requires that our conduct should be guided by *general rules,* formed according to the principle of utility, and not by an immediate appeal to utility itself in each particular instance. Thus qualified, the principle is precisely the same with that laid down by Kant, as the "groundland of the pure practical reason:"—"Act so that the maxims of thy will, in each particular instance, may hold equally as the principle of a universal legislation." And this philosopher, in common with the English utilitarians, regards this principle as a postulate which lies at the foundation of morality. Thus explained, it will be seen that there is no theoretical inconsistency between the utilitarian and sentimental moralists. Sir James Mackintosh expressly admits that the only criterion of morality in action,—that is, the only criterion by which right and wrong in human conduct can be determined,—is the consequences of such conduct on the happiness of mankind. It has been with reason objected, that the second department of the two into which he divides the science of ethics, "the nature of those feelings with which right and wrong are contemplated by human beings," does not in itself belong to morality at all. It is in truth a part of psychology, and nothing more, and that by his own admission, that the purpose of moral science is "to answer the question '*what ought to be.*'" The *obligation* of the rule of action is the same, whatever are the feelings with

which we may happen to regard right and wrong; and whatever may be their origin, and the process of their formation. That the nature of these feelings ought to be made an important item in every calculation of the consequences of our actions, would be admitted by any consistent utilitarian who is capable of such considerations, and that in obedience to his own principle. The science of psychology is admitted by such persons to be a valuable auxiliary to that of ethics, and as such has been elaborately treated by Mr. Mill, in his *Analysis of the Human Mind*. This we conceive to be all that Sir James Mackintosh, in the principles of his general philosophy, had a right to claim for that branch of science, to the elucidation of which he has devoted by far the greater part of his dissertation. The relation between utilitarianism and sentimentalism may consequently be expressed thus: It is our duty so to frame our conduct, that it may contribute as much as possible to the happiness of mankind. The happiness of a man consists, as experience proves, not in the gratification of one or two desires, but of as many as possible. But the more faculties a man can exercise the more numerous are his desires, and the greater the happiness of which he is capable; consequently, it is our duty to contribute as much as we can to the development of the faculties of all with whom we have to do: the means to this end are supplied by the science of experimental psychology, including the doctrine of the formation, among other faculties, of the moral sentiments.

The question now arrives, is this a complete theory of morals? We think not; and we will proceed to state our reasons for this opinion. It will be admitted, that in order to conceive of the existence of a particular class of pleasures, and by consequence of a particular class of faculties or desires of which these pleasures are the exercise or the gratification, we must be conscious of the existence of the same class in our own constitution. What is true of one class is true of all. Before, therefore, we can take upon us to determine wherein the *greatest* happiness of man consists, we must take care that our idea of human nature be a complete one; we must see to it that we leave out of consideration no element in the constitution of man. Nor is this enough. It will be admitted, as a fact of experience, that the gratification of certain of our desires does, if carried beyond certain bounds, impair and interfere with the free action of certain other equally important sources of enjoyment. Consequently, what is true of the constitution of a state is true, likewise, of the constitution of man: the action of its constituent parts requires to be determined by some measure or law which shall appoint to each the sphere and limits of its exercise. The Greek philosophers, who, whatever may be their deficiencies in subordinate inquiries, saw more distinctly than any before or since the true problems which philosophy ought to solve, have pointed to this law under different names—whether of the *chief good*, the *rule of right*, the *harmony of the soul*, or the like—as the great difficulty of ethics to the clearing up of which all other inquiries ought to be regarded as subordinate and tributary. Of all the moralists of antiquity Plato perceived this with the greatest clearness. His *Republic* is meant as an approximation to the determination of this law, alike in the individual and in the state. That we may not be accused of blind veneration for antiquity, we will adduce the most celebrated ethical writer of the last century in our justification. Those of our readers who have formed their conception of the objects of Bishop Butler's moral writings from the strangely partial view of them taken in Sir James Mackintosh's dissertation, will probably be surprised to hear that his is the name to which we allude. The preface which he has prefixed to his *Sermons* is intended as a brief preliminary statement of what he calls "the occasion, scope, or drift" of the detached inquiries which follow. Of what this scope or drift was we are bound to accept his own account; and before we can rightly apprehend it, he tells us we must "begin by stating to ourselves exactly the idea of a system, economy, or constitution, of any particular nature, or particular anything. We shall, I suppose, find that it is a one, or a whole, made up of several parts; but yet that the several parts, even considered as a whole, do not complete the idea, unless in the notion of a whole you include the relations and respects which these parts have to each other. Every work, both of nature and art, is a system; and as every particular thing, both natural and artificial, is for some use or purpose out of and beyond itself, one may add, to what has been already brought into the idea of a system, its conduciveness to this one or more ends. Let us instance a watch: Suppose the several parts of it taken to pieces, and placed apart from each other; let a man have ever so exact a notion of these several parts, unless he considers the respects and relations which they have to each other, he will not have anything like the idea of a watch. Suppose these several parts brought together and united anyhow; neither will he yet, be the union ever so close, have an idea which will bear any resemblance to that of a watch. But let him view those several parts put together, or consider them as to be put together in the manner of a watch; let him form a notion of the relations which those several parts have to each other—all conducive in their respective ways to this purpose, showing the hour of the day; and then he has the *idea* of a watch. Thus it is with regard to the inward frame of man. Appetites, passions, affections, and the principle of reflection, considered merely as the se eral parts of our inward nature, *do not at all give us the idea of the system or constitution of this nature; because the constitution is formed by somewhat not yet taken into consideration, namely, by the relations which these several parts have to each other*." Bishop Butler goes on to remark, that "what in fact or event commonly happens is nothing to this question;" for, "one may determine what course of action the economy of man's nature requires, without so much as knowing in what degrees of *strength* the several principles prevail, or which of them have actually the greatest influence." But between a machine and a man, says Butler, in allusion to the illustration from the watch, "there is a difference too important ever to be omitted. A machine is inanimate and passive; but we are agents. Our constitution is put in our own power. We are charged with it; and therefore are accountable for any disorder or violation of it." The inference which an impartial reader of these quotations, after comparing them with the *Sermons on Human Nature*, will necessarily draw is this, that not only has Butler's object and purpose been misconceived by Mackintosh, but that it was an object which, consistently with the rest of his philosophy, Mackintosh must have held to be unattainable. For it implies two things: first, that in order to complete the rule of human action, we must have an idea of perfect humanity; secondly, that before such rule can be binding upon man, we must show, not only that he *feels himself* or may be made to feel himself, but that he really *is*, accountable for its violation. Whether these two questions can be adequately disposed of without the introduction of higher, that is, of theological or metaphysical considerations, is a matter which each man must decide according to the tenor of his general philosophy. The former of the two was so distinctly perceived by Aristotle, that his whole ethical system must be viewed in reference to it; the latter lies at the root of the moral philosophy of Kant. Until the first is disposed of, the rule of action is implicated in an inevitable circle; without the second, no rule can be shown to be obligatory, and ethics can no longer be distinguished on the one hand from the history of internal, on the other from that of external, phenomena.

E'THIOPS MINERAL. The black powder obtained by rubbing mercury with sulphur.

ETHMOI'D. (Gr. ἠθμος, *a sieve*, and ειδος, *form*.) The ethmoid or cribriform bone. A bone of the head enclosed in the *os frontis*, between the orbitary processes; it is very light and spongy, and consists of a network of convoluted plates.

ETHNO'GRAPHY. (Gr. ἔθνος, *nation*, and γράφω, *I describe*.) The science which treats of the particularities of nations, describing their customs, peculiarities, &c. Although a peculiar name has been given to it, it is in general considered as a branch of the sciences of geography and history. (See *Balbi's Ethnography*.)

ETHU'LE. (Gr. αιθηρ, and υλη, *principle*.) A term applied by Berzelius to the elementary carbon and hydrogen of ether; he regards ether as an oxide of a compound of 5 equivalents of hydrogen and 4 of carbon.

E'TIOLA'TION, or CHLOROSIS, is that condition of a plant in which all the green colour is absent. Such a state is produced by want of light, and is artificially obtained by keeping plants in the dark in order to ensure their being more tender and insipid than is natural to them. Etiolated parts become green by exposure to light.

ETIQUE'TTE. (Fr. a ticket.) Is the ceremonial code of polite life, more voluminous and minute in each portion of society according to its rank. The word is derived from the custom of arranging places at processions, &c. by tickets delivered beforehand to applicants. The Byzantine court appears to have carried the practice of ceremonial observances to the most inconvenient and ludicrous extent. But of modern courtly etiquette, Philip the Good, Duke of Burgundy, is regarded by some as the founder (see *Conversations Lexicon*). His desire to conceal his inferiority in rank (as a great feudatory only) to the great sovereigns of Europe, whom he equalled in power, induced him to surround his presence with a multitude of officers and numberless formalities. At no time, probably, was the spirit of etiquette so predominant and so tyrannical as in the court of Louis XIV.; and the *Memoirs of Saint Simon* are full of the most extraordinary proofs of the subjugation of the minds of men of sense, wit, and even independent character in other respects, to its engrossing influence,—their pride in attaining any little point of precedence, and their mortification in failing of it. The smaller courts of Germany caricatured the ceremonial of that of the Great Monarch, and carried its strictness to an absurd extent. At the present day the ancient

etiquette of courts is continually losing something of its strictness.

ETYMO'LOGY. (Gr. ἔτυμος, *true*, and λογος, *description*, &c.) The science which treats of the origin or root of individual words, and of the relation borne respectively by their several meanings to that origin. It is a branch of the general science of philology. *See* PHILOLOGY.

EU'CHARIST. (Gr. εὐχαριστια.) Signifying properly giving of thanks, but generally used in theological language to denote the sacrament of the Lord's Supper. The celebration of this rite is derived from the account given by the Evangelists of the action of our Lord in offering to the apostles bread and wine, saying at the same time, "Take and eat, this is my body;" and "Drink ye all of this, for this is my blood of the new testament, which is shed for many for the remission of sins;" and adding at the same time, "Do this as oft as ye shall do it in remembrance of me." This commemoration is spoken of in the N. T. and by the Fathers as a sacrament and a mystery; it must be supposed, therefore, that there is an interior signification conveyed under our Saviour's words—a further effect to be derived from the communion in the bread and wine besides that which is obvious and external. Under the head of TRANSUBSTANTIATION will be found the solution which the Roman Catholics discover for this mystery. Consubstantiation, or the simultaneous presence of the body and blood with the bread and wine, is the attempt made by Luther to explain the operation of a divine mystery according to the literal interpretation of Scripture. According to the doctrine of the Anglican church, there is an inward and spiritual grace conveyed in the Eucharist to those who partake of it; and it is in this that our church differs from many Protestant communities, who conceive the communion to be nothing more than an outward act of obedience enjoined upon us as a commemorative ceremony, and only instrumental to our salvation in the same way as any other act of obedience. *See* SACRAMENT.

It is common in the Fathers to meet with the term sacrifice applied to the Eucharist, and this has been considered by the Romanists as favouring their view of its nature. They appeal also to the prophecy of Malachi, which alludes to a pure offering or an unbloody sacrifice, which shall be offered up to the Lord from the rising to the setting of the sun; and maintain, therefore, that the consecrated elements are offerings made to God for the sins of the people, in the same sense as the expiatory sacrifices of the Jewish law, and not merely commemorative tokens. From hence follows the supposed necessity of the sacrifice of the Mass, and its efficacy for the absent, or even dead, and the mediatorial character attributed in the Romish church to the priest. The Protestants, however, while they do not deny the applicability of the word sacrifice to the Eucharist, restrict it to one of the senses which it bears in the Hebrew phraseology; and consider the pure offering prophesied by Malachi to be an offering of prayer and thanksgiving, such as is constantly referred to by the Psalmist; as, CXLI. 2., "Let my prayer be set forth before thee as incense, and the rising up of my hands as the evening sacrifice;" LI. 17., "The sacrifices of God are a broken spirit," &c. The seventh chapter of Hebrews is considered decisive against the mediatorial character of the Christian priest; and the Eucharist is held by the church of England to be not a propitiatory but a commemorative sacrifice—a federal act of professing our belief in the death of Christ, and of renewing our baptismal covenant with him; and endued with virtue to confer grace upon those who partake of it sincerely and devoutly.

EU'CHLORINE. (Gr. ευ, *very*, and χλωρος, *green*.) A name given by Sir H. Davy to the oxide of chlorine, in consequence of its deep yellow-green colour.

EUCHO'LOGY. (Gr. ευχη, *prayer*, and λεγω, *I collect*.) A book of prayers; synonymous, in the phraseology of the Roman Catholic church, with *missal* or *breviary*.

EUCLA'SE. (Gr. ευ, *well*, and κλαω, *I break*.) A very rare mineral, brought in small greenish crystals from Peru and Brazil. It is a silicate of glucina and alumina.

EU'CRASY. (Gr. ευ, and κρασις, *temperature*.) An agreeable well-proportioned mixture of qualities, by which a body is said to be in good order, and disposed for a good state of health.

EUDIO'METER. (Gr. ευδια, *calm air*, and μετρον, *measure*.) This term is generally applied to instruments for facilitating the analysis of atmospheric air, or rather for determining the quantity of oxygen contained in a given volume of air; under the idea that the salubrity of air depended upon its relative quantity of oxygen. We now know, however, that this is not the case, and that the relation of the oxygen to the nitrogen in the atmosphere is not subject to any discernible fluctuation.

EU'LABES. (Gr. ευλαβής, *timid*.) A genus of Passerine birds, belonging to the family of thrushes, and distinguished by having broad strips of naked skin on each side of the occiput, and a bald spot on the cheek. The bill nearly resembles that of a thrush; their nostrils are round and smooth. The species are termed *Mainates* by the French ornithologists; and the Javan *mainate* (*Eulabes javamens*) of all birds is said to imitate most completely the language of man.

EULI'MA. (Derivation unknown.) A genus of marine shell-clad Gastropods, whose characters are *shell* turreted, acuminate, with many whorls; aperture ovate, acuminated posteriorly; outer lip thickened, and bearing numerous obsolete *varices* or wart-like processes; operculum horny, thin, and with its nucleus anterior.

EU'LOGY. (Gr. ευ, *well*, and λεγω, *I speak*.) In a general sense, an encomium pronounced on any person for his meritorious or virtuous qualities; but, in a more restricted meaning, it was used in ecclesiastical history to denote any present bestowed on the church after having been *blessed* or *hallowed*.

EUNI'CE. (Gr. The name of a Nereid in *Apollodorus*.) A genus of Marine Dorsibranchiate Anellidans, having tufted branchia, and a mouth armed with three pairs of horny jaws. One species (*Eunice gigantea*) attains the enormous length of between four and five feet.

EU'NUCH. (Gr. ευνη, *a bed*, and εχειν, in the sense of *to have the care of*.) A term applied to those who have been subjected to the operation of castration. The fortunes of such individuals form an eventful chapter in the history of the human race; whether we consider the purposes for which the operation was performed, or the numbers of those who have undergone it. This practice seems to have originated in the jealousy which prevails in eastern countries. As far back as the time of Herodotus, it was carried to a great extent by the Persians, who not merely intrusted to eunuchs the care of their wives and daughters, but considered them in every respect as more trustworthy than other individuals. In the middle ages the "chief of the eunuchs" was one of the most important functionaries of eastern government; and the seraglios of these countries are superintended by eunuchs even in the present day. In modern times the loss of virility is in some countries believed to preserve and improve the voice; and hence, especially in Italy, this operation is practised upon children intended to supply the operas of Europe with singers. Zeal for religion has also caused many persons to undergo this operation, in the view of guarding themselves from sensual pleasures. As early as the third century there arose a class of enthusiasts, who, animated by the example of Origen, not only castrated those of their own persuasion, but even all persons on whom they could lay their hands. Several of the Christian Roman emperors instituted severe prohibitions against this revolting practice; and at a later period the Council of Nice excluded from the pale of the church all who, actuated by whatever motives, had allowed themselves to be thus mutilated.

EUPA'TRIDÆ. (Gr. ευπάτριδαι.) In Ancient History, the nobles of Attica, in whose hands in early times all the power of government was vested, in consequence of which the lower orders sunk into a low state of degradation, being particularly oppressed by their debts which the pressure of their circumstances compelled them to incur, and which, if not paid, gave the creditor power over the bodies and liberties of the debtor and his family. These evils were remedied by the legislation of Solon, who reduced the interest of debts, and deprived the creditor of his power over the body of the debtor, and at the same time threw the judicial and much of the legislative power into the hands of the people at large or Demus (Δῆμος). The alterations in the constitution of Athens subsequent to the time of Solon by degrees deprived the Eupatridæ of all their political privileges, and finally established an unmixed democracy.

EU'PHEMISM. (Gr. ευφημειν, *to speak well of a person or thing*.) A figure in rhetoric, by which one expression is substituted for another, conveying, through some association of ideas, an image offensive to the hearer or reader. In classical writers, euphemism often arises from a superstitious avoidance of certain words and phrases; and among ourselves similar fastidiousness prevails on some points, as in the constant use of the words "deceased" and "departed" for "dead."

EU'PHONY (Gr. ευ, *well*, and φωνη, *sound*), in contradistinction to *Cacophony* (quod vide). That agreeable quality in language which results from happy combinations of the enunciative elements; such especially as, though essentially different in their characteristic powers, melt easily into each other, so as to preserve an uninterrupted flow through the respective members of a sentence, without labour to the speaker or offence to the hearer. No rules can be laid down to ensure this agreeable quality in composition: his taste, ear, and discrimination must be the guide of every writer.

EUPHORBIA'CEÆ. (Euphorbia, one of the genera.) A natural order of Exogenous plants, inhabitants of almost all parts of the globe; nearly allied to *Malvaceæ* and *Rhamnaceæ*, especially agreeing with the former in the starry structure of the hairs, the monadelphous stamens, and the definite number of ovules in three united

carpels. Their sensible properties are, on the whole, poisonous and exciting, both being of a volatile nature and often dispelled by heat. Thus the stem of *Jatropha manihot*, or *Cassava*, which, when raw, is one of the most violent of poisons, becomes a wholesome nutritious food when roasted: in the seeds the albumen is harmless and eatable, but the embryo itself is acrid and dangerous. Independently of the volatile principle there are two others, — viz. 1. Caoutchouc, the most innocuous of all substances, produced by the most poisonous of all families. 2. Turnsol, the bark of several crotons, the wood of *Croton tiglium* and common box, — the leaves of the latter, of *Cicca disticha*, and of several euphorbias, are sudorific, — and many other species, amongst which *Ricinus* may be mentioned, are purgative: the latter produces from its seeds by pressure the well-known castor oil.

EUPHO'RBIUM. (From Euphorbus, physician to king Juba, in honour of whom the plant was named.) An acrid gum resin, the produce of the *Euphorbia officinalis;* it is virulently purgative and emetic, and the dust of it is dangerously stimulant to the nose.

EU'PION. (Gr. ευ, *very*, and πιων, *greasy*.) A very limpid liquid which stains paper like oil, and which exists in the tar produced during the destructive distillation of animal and vegetable substances. Its specific gravity is 0·74, and it boils and evaporates at 340°. It is insoluble in water, but dissolves in ether and alcohol. It is insipid and inodorous, but highly inflammable.

EURI'PUS. (Gr. ευριπος.) In Ancient Architecture, the space which separatedthe arena from the seats in the circus.

EURO'PA. In Fabulous History, the daughter of Agenor, king of Sidon. She is represented as having been of such surpassing beauty that Jupiter became enamoured of her. In order to gain her affection the god transformed himself into a bull of wonderful whiteness, and while Europa was gathering flowers in a meadow near the sea shore, mingled with her father's herds. The virgin, attracted by the beauty of the bull, began to caress him; and at length, in the playfulness of youth, ventured to get on his back. Upon which the bull, taking advantage of her situation, made a retreat towards the sea, through which he carried her in safety. Arrived in Crete, the god resumed his real form, and declared his passion, which was returned; and from their connection sprang Minos, Rhadamanthus, and Æacus, the celebrated Elysian judges. The simple statement of Herodotus, that Europa was carried off by some Cretan merchants, who, according to some authors, arrived at Sidon for mercantile purposes with a ship bearing a white bull on its prow, but, according to Diodorus, with a commander named Taurus (bull), offers one of many probable solutions of this fabulous story. From her, according to mythologists, the quarter of the globe which we inhabit received its name. The word is possibly derived from Gr. ευρυς, *large*, and ωψ, *the eye;* large eyes having been regarded by the Greeks as a mark of great beauty.

EURY'DICE. In Fabulous History. *See* Orpheus.

EURY'THMY. (Gr. ευρυθμια, *justness of proportion*.) In Architecture, the regular, just, and symmetrical measure resulting from harmony in the proportions of a building or order. It is one of the six essentials of Vitruvius.

EUSTA'CHIAN TUBE. Named after the celebrated Italian anatomist Bartholomew Eustachius, who is said to have discovered it, though it is accurately described by Aristotle, who quotes an earlier Greek anatomist, Alcmeon, as having known it. This communication between the ear and the mouth begins in the anterior part of the tympanum, and runs in a bony canal forwards and inwards, terminating with the petrous portion of the temporal bone. It then proceeds, partly cartilaginous and partly membranous. gradually enlarging to its termination behind the soft palate. It is through this tube of communication with the ear that persons who have a perforated tympanum blow tobacco smoke: when the Eustachian tube is stopped or obliterated it produces deafness.

EUSTA'CHIAN VALVE. A semilunar membranous valve, which separates the right auricle of the heart from the inferior *vena cava*, first described by Eustachius.

EUSTA'THIANS. A sect of heretics of the 4th century; so called from their founder Eustathius, a monk whose opinions were condemned at the council of Gangea.

EU'STYLE. (Gr. ευ, *well*, and στυλος, *column*.) In Architecture, that species of intercolumniation or space between columns, which, as the name imports, the ancients considered the most beautiful, and which Vitruvius says exceeded all others in strength, convenience, and beauty; it was two diameters and a quarter of the column in width.

EUTE'RPE. (Gr. ευ, and τερπω, *I delight*.) In Mythology, the muse which presided over wind instruments.

Si neque tibias
Euterpe cohibet, nec Polyhymnia
Lesboum refugit tendere barbiton. (*Hor.* Ode I. l. 54.)

To this muse is ascribed also the invention of tragedy.

EUTHANA'SIA. (Gr. ευ, and θανατος, *death*.) Literally, an easy death. By political writers it is employed in various senses to indicate such peculiar theories as have the best tendency to uphold the state or disentangle it from difficulties. Thus, for instance, it is maintained that the issue of inconvertible paper money is the true *euthanasia* of public debts in modern countries.

EUTY'CHIANS. A sect of the fifth century, who appear to have been seduced into an erroneous view of the nature of Christ by the vehemence of their opposition to the heresy of the Nestorians. These latter had asserted the distinctness of the two natures in Christ; the Eutychians confounded them together, and supposed the human to be merged in the divine. Their originator, Eutyches, was the abbot of a monastery at Constantinople, and was excommunicated in the year 448 by a synod which was convened there for that purpose. This decision was controverted by another council at Ephesus in the following year; but the new opinions were finally condemned by the council of Chalcedon in 451, which established the orthodox doctrine that Christ was perfect God and perfect man, consubstantial with the Father as to his divinity, and with man as to his humanity, the two natures being united in him without conversion, without confusion, and without division.

EVANGE'LICAL CHURCH. (Gr. ευαγγελιον, *gospel*, literally good tidings: from ευ, *well*, and αγγελος, *messenger*.) The different Protestant sects of Germany assume this general title, implying their reliance on the Bible alone as the rule of faith: it more especially designates the Lutheran church.

EVA'NGELIST. (Gr. ευαγγελιστης.) One who brings good tidings. Hence the authors of the Four Gospels are called Evangelists.

EVA'NTES. Priests of Bacchus; so called from their usual exclamation during their orgies, "ohe evan."

EVAPORA'TION. The conversion of substances into vapour is one of the most important and general effects of heat. During this process, a considerable quantity of sensible heat passes into the *latent* or insensible state. When a vessel of water is placed upon the fire, its temperature gradually rises till it attains 212°; then, although it remains upon the fire, and of course receives heat as before, it does not become hotter, but is gradually converted into steam or vapour: so that the effect of heat is not to elevate temperature, but to change state or form; that is, in the case of water, to convert it into steam. Hence we assume that steam, though not hotter than water, contains a much larger quantity of heat, and this heat again makes its appearance when the steam is condensed or re-converted into water. At whatever temperature vapour is produced, it is similarly constituted; and that which escapes from water at ordinary temperatures, by the process usually called *spontaneous evaporation*, resembles the former in all respects: hence it is that evaporation is to surrounding bodies a cooling process; and that in the converse change, or the return of the vapour to the liquid state, heat is evolved and rendered sensible. The same general phenomena are observed with all other liquids, and those which evaporate rapidly at common temperatures often give rise to the production of a great degree of cold; such as spirit of wine, or ether. If the latter fluid be suffered to dribble over the bulb of a thermometer, it will cause it to sink below the freezing point of water; and by accelerating similar cases of evaporation, we obtain most intense degrees of artificial cold.

The circumstances that principally influence the process of evaporation are, extent of surface, and the state of the air as to temperature, dryness, stillness, and density.

EVE'CTION. (Lat. eveho, *I raise up*.) An inequality of the moon's motion, depending on the position of the transverse axis of the lunar orbit in respect of the line of the syzygies, or line joining the sun and earth. When the transverse axis lies in the same direction with that line, the quantity by which the solar force diminishes the gravitation of the moon is greatest when the moon is in the apogee, and least in the perigee. In this situation of the orbit, therefore, the difference between the moon's gravitation at her apogee and perigee is increased by the solar action, and the orbit consequently appears to have its eccentricity augmented. When the line of the apsides is in the quadratures, the contrary happens; the difference between the amount of gravitation at the apogee and perigee is diminished, and the eccentricity of the orbit appears also to be diminished. The evection is proportional to the sine of twice the angular distance between the sun and moon, diminished by the moon's mean anomaly; and its greatest value amounts to 1° 20′ 29·9.″ This inequality (sometimes called the *second* inequality of the moon's motion, the equation of the centre being the *first*) was noticed by Hipparchus, and Ptolemy gave a construction which represents its general effects with great accuracy. The term *evection* was first applied to it by Bullialdus.

E'VEN KEEL. A ship is said to be on an even keel, properly speaking, when she draws the same water abaft as forward; the expression, however, often implies, though inaccurately, not inclined to either side, or upright.

E'VERGREEN. A name applied to those plants whose leaves remain perfect upon a stem beyond a single season; as the *Ilex aquifolium*.

E'VIDENCE. In Law, has been defined "any matter of fact, the effect, tendency, or design of which, when presented to the mind, is to produce a persuasion, affirmation, or disaffirmation of the existence of some other matter of fact."

A witness, in a court of common law, is compelled to give his attendance, in civil cases, by subpœna, or by habeas corpus if the witness be in custody. The reasonable expenses both of going and returning must be tendered to the witness when he is served with the subpœna. A witness, refusing to attend on subpœna, may be attached for contempt of court, and is liable to an action at the suit of the party damaged. In criminal cases, the attendance of a witness for the prosecution is enforced either by subpœna, or more usually by the magistrates who take the depositions in the first instance binding him over to appear. His expenses, in a case of felony, are ensured to him by statute. The defendant may compel attendance of his witnesses by subpœna.

When the witness appears in court, objections may be taken to his competency; and those arising from his ignorance or unbelief, or turpitude of character, ought, in the usual course, to be taken before he is sworn.

Incompetency. — 1. Incompetency from defect of religious principle is where the witness disbelieves or is ignorant of the existence of a God, and of a future state of rewards and punishments. Infidels, therefore, are excluded; but no others of whatsoever sect or opinion. 2. Incompetency from turpitude arises from a conviction for treason, felony, and several misdemeanors; but is removed by pardon, or by reversal of the judgment, or by endurance of the punishment awarded by the sentence. 3. The next source of incompetency is interest; and the general rule on this subject is, that a party is disqualified only by a direct and certain interest in the event of the suit. But it will be obvious that the distinctions arising out of so general a proposition are infinitely minute, and create constant difficulty in practice. The following are a few of the leading rules:—

All parties to the suit, although but nominal, are excluded from giving evidence. A prosecutor, in a criminal case, is not a party, nor directly interested in the verdict, and is consequently admitted. A person to whom a liability would immediately result from the verdict is incompetent to give evidence for the party in whose success he is interested; as, for instance, one who has guaranteed a party against the event of the suit; or a co-partner; or an agent liable to his principal, in the case where a principal is sued for any damage arising from the agent's neglect. A witness is also incompetent where he has an interest in the record; that is to say, where the judgment of the court, if his party succeeded, would be evidence of a matter of fact to entitle him to some legal advantage. In criminal proceedings, however, no verdict obtained wholly or partly on the testimony of any witness can be evidence for or against that witness in any other proceeding; and therefore he cannot be objected to on that ground. Some exceptions also to this rule of exclusion arise from the necessity of the case: upon this principle the testimony of the servants of tradesmen, to prove the delivery of goods and payment of money, is daily admitted.

The objection to competency is removable in some cases by a release of all liability to the witness. But it is now provided, by 3 & 4 W. 4. c. 42., that whenever a witness is objected to as incompetent on the ground that the verdict would be evidence for or against him, he shall nevertheless be heard; and his name being entered on the back of the record, the verdict so obtained shall never be used as such evidence.

All testimony must be given under a judicial oath, with an exception only in favour of Quakers, which is now extended to criminal as well as civil cases.

Evidence, immediate and mediate. — Besides the exclusion of *witnesses* on the score of competency, large classes of *evidence* are inadmissible. Admissible evidence must be, in general, immediate; that is, it must convey the actual knowledge or belief of the witness. This rule excludes, as a general proposition, all hearsay; that is, all narration of the declarations made by others to the witness. There are, however, several classes of mediate testimony which are admissible. Such are, general reputation in certain cases; and declarations, made by a party to the suit, which contain admissions contrary to his own interest. So, in various cases, letters or entries made in books are admissible, where they contain similar admissions. Upon the same principle, the confession of a prisoner is evidence (if unextorted by fear or hope) in a criminal case. Depositions of a witness now deceased, but who had formerly given evidence on the same dispute, are admissible. Evidence may also be considered as divided into original or best, and secondary evidence. For instance, the reading of a document is better evidence of its contents than statements, either written or oral, respecting them. It is a general rule, that all secondary evidence is excluded, if better evidence (that is, evidence of a class which the law recognizes as better) happen to be attainable. Other exclusive rules rest on grounds of public policy. Thus husband and wife are excluded from giving testimony for or against each other. Communications between an attorney and his client, and, for particular purposes, some other private communications between parties, are in their nature privileged, and cannot be given in evidence.

Examination of Witnesses. — A witness, on being admitted in court, is first subjected to the examination of the party in whose behalf he is called, which is termed the *examination in chief;* and the principal rule to be observed by the party examining is, that leading questions are not to be asked. What are leading questions, it is not always easy to ascertain; but questions to which the answer yes or no would be conclusive of the issue fall undoubtedly within this designation. All questions which suggest an answer may be considered, in one sense, as leading questions; but they are not all equally objectionable. The witness is then cross-examined by the opposite party. The object of cross-examination is twofold: to weaken the evidence given by the witness as to the fact in question, either by eliciting contradictions or new explanatory facts; or, secondly, to invalidate the general credit of the witness. In the latter case, it is a general rule, that a witness may refuse to answer any question, if his answer will expose him to criminal liability; and this, whether immediately or by collateral inference. Whether he can refuse to answer a question tending to disgrace him, without involving him in danger, is a point which has been frequently debated, but which the general practice of our courts seems to settle in the affirmative. The credit of a witness may likewise be impeached by the general evidence of others as to his character. But in this case no evidence can be given of particular facts which militate against his general credit; as this would be in contravention of another rule, that collateral issues — questions of fact unconnected with the subject of dispute — shall not be raised during the course of a trial. Re-examination of a witness by the party who first examined him, must be directed to such new points only as have been raised by the cross-examination. If it is wished to put a question not connected with these points, the proper course is for the counsel to apply to the court to put the question for him.

Evidence, Documentary. — Written instruments, considered as evidence in a court of justice, have been divided into public judicial documents; public non-judicial; private documents; and mixed, which are partly public and partly private. The contents of the record of a court of justice are properly proved by inspection of the record itself; otherwise by *exemplification*, or by *sworn copy*. A copy of a record, under the seal of the Court of Chancery, or of one of the King's other courts, is an exemplification; as are also the records of some inferior tribunals. Office copies are evidence, wherever the law has entrusted a particular officer with the making of them. Sworn copies are copies proved on oath to have been examined with the original. All public documents, whether judicial or non-judicial, which cannot be removed, can be and usually are proved in this manner. But before it can be read, it must be proved that the original came out of the hands of the officer of the court, or from the proper place of deposit. A copy of a copy is in no case admissible.

Mixed documents are of a nature partly public and partly private; such as court-rolls of manors, and corporation books. Examined copies of these are evidence. The books of public companies — as, for instance, the East India Company — are evidence in questions between parties interested in them. Private writings are of two sorts: first, writings to which the person against whom they are offered was party or privy; secondly, writings of third persons. All documents of the first class are, in general, evidence against the party. And an admission under seal (as a deed or bond) is, in general, conclusive evidence against the obligor, or party binding himself; that is, he is *estopped*, or prevented, from offering to rebut it.

A discussion of the rules which govern the admissibility of written instruments not under seal as evidence would occupy far too wide a field for the present purpose. Oral evidence can in no case be received as an equivalent or substitute for an instrument, where a writing is required by law; or to give effect to such an instrument, if defective in any particular required by law; or to vary its terms, if it have been appointed, either by act of law or by compact of the parties, as a memorial of the transaction between them. This rule proceeds on the general principle already adverted to, that where the best evi-

dence can be had secondary testimony shall not be substituted for it. But oral evidence is admissible in various cases, to explain, to restrict, and to defeat instruments, on the ground of fraud or mistake.

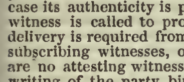
Entries in writing, as well as declarations by third persons, are in general excluded. The cases in which they may be admitted are, either where they serve to explain and accompany material facts; or, in some cases, on a principle of necessity, where the party who made them is supposed to have had peculiar grounds of knowledge as to the fact in dispute. In the first category, as a common instance, we may cite declarations of a trader at the time of his quitting his place of business, which are commonly received in evidence on bankruptcy questions. The second may be instanced by entries of bailiffs or stewards, which are received where the payment of rent is disputed.

Proof of Written Documents.—This is effected either by witnesses, by admission of the adversary, or by enrolment; the latter mode of proof being confined to a few classes of documents by virtue of acts of parliament.

In the first and common mode of proof, the instrument must either be produced, or its absence must be accounted for by loss or destruction (and if either of these negative assertions, as they may be called, cannot be directly proved, evidence of diligent search will be received, and its contents may be proved by counterpart or secondary evidence); or it must be proved to be in possession of the adversary, and that notice was given him to produce it. In the case where the instrument itself is produced, it is either attested or not attested. If the former, the attesting witness must be called; or his absence must be accounted for, and his handwriting proved; or it must appear that the instrument is thirty years old, and has come out of proper custody, in which case its authenticity is presumed. Where a subscribing witness is called to prove a deed, proof of sealing and delivery is required from him; where there are several subscribing witnesses, one is sufficient. Where there are no attesting witnesses to an instrument, the handwriting of the party binding himself is generally sufficient proof. On the proof of handwriting,—a very difficult matter of evidence,—we can only observe, that it is ordinarily proved by the testimony of a witness who has acquired a general knowledge of the party's hand, either by having seen him write (although but once), or by a correspondence with him, or other transactions. It is a general rule, that evidence by comparison of writings is not receivable; and this, although a skilled person (as a clerk from the post office) offer his opinion. (For the mode of taking evidence in courts of equity, *see* CHANCERY.) *Public* documents, when the originals are not procurable, are commonly proved by examined copies.

E'VIL, KING'S. *See* SCROFULA.

E'VOLUTE (Lat. evolvo, *I roll out*), in the theory of curve lines, is a curve from which any given curve may be supposed to be formed by the *evolution* or unlapping of a thread from a surface having the same curvature as the first curve. For example, let B H E be a model of a plane curve made of a solid material having some thickness; and let one end of a thread H E C be fastened to a point B on the edge of the model, and applied along its convexity, so as to coincide with it entirely between B and E, the remaining portion E C of the thread forming a straight line touching the curve at E. Suppose, now, the thread to be gradually unlapped from the curve B E, keeping it always tight: the extremity C will describe another curve, C P D. The curve E H B, by which the curve C P D is generated, is called the *evolute* of C P D; and the curve C P D is called the *involute* of E H B. All curves in which the curvature is neither infinitely great nor infinitely small, may be generated in this way by the evolution of a thread from another curve.



From this mode of generating curve lines it is obvious, first, that P H, the part of the thread disengaged from the arc E H, is a tangent to the evolute at H; second, that P H is a perpendicular to the tangent to the involute C P D at the point P; third, that it is the radius of curvature of C P D at P; fourth, that the point H is the centre of curvature of C P D at P, and that the evolute E H B is the *locus* of the centre of curvature of every point in the involute C P D. Hence the problem to find the evolute of any curve is the same as to find the locus of the points which successively form the loci of its centres of curvature.

Let A Q $= x$, and P Q $= y$; then x and y are the co-ordinates of the point P in the curve C P D, the origin being at A. Let also A K $= v$, and K H $= u$; then v and u are the co-ordinates of H, the centre of curvature of C P D at P; and their values are found from the formulæ,

$$v = x - \frac{dy}{dx} \cdot \frac{dx^2 + dy^2}{d^2 y}; \quad u = y + \frac{dx^2 + dy^2}{d^2 y};$$

in which x is regarded as the independent variable, and y as a function of x, the nature of which is determined by the equation of the curve C P D.

Since the radius of curvature H P is the sum of the arc H E and the straight line C E, it follows that H E is the difference of two straight lines; and since it is possible to form innumerable curves whose radii of curvature are expressible in algebraic terms, therefore corresponding to every such curve there is another curve, namely, its evolute, which can be exactly rectified. The theory of generating curve lines by evolution was proposed by Huygens, before the invention of the differential calculus, and published in his *Horologium Oscillatorium.* His object was to find the evolute of the common cycloid, with a view to the mechanical means of causing clock pendulums to vibrate in cycloidal arcs; for he had already discovered the beautiful property of this curve,—that all vibrations in its arc are synchronous, or performed in equal times, whether the arcs be great or small. *See* CYCLOID.

EVOLU'TION. (Lat. evolvo, *I unfold.*) In Physiology, the theory of generation, in which the germ is held to pre-exist in the parent, and its parts to be unfolded and expanded, but not actually formed, by the procreative acts. The principal and most consistent supporters of this theory maintain that the first created individuals contained the germs of all future possible successors, successively included one within the other; and that generation is merely the act of unfolding, or an evolution of the germ: Swammerdam, Bonnet, Spallanzani, Haller, and Cuvier maintain this theory.

The theory of evolution is opposed to that of epigenesis generation, in which the germ is held to be actually formed as well as expanded by virtue of the procreative powers of the parent. Its chief supporters are Harvey, Caspar Fred. Wolff, Blumenbach, and the professors of the modern German physiological school.

EVOLUTION, in Arithmetic and Algebra, denotes the extraction of roots. (*See* EXTRACTION.) In Geometry, evolution is the opening or unfolding of a curve.

E'VOVÆ. In Music, the vowels used with the ending notes of the ecclesiastical tones: it is a word, for brevity's sake, formed of the six vowels in the words *sæculorum amen*, which are subjoined to the notes in Antiphonaries, &c., to indicate that those are the ending notes.

EXACERBA'TION. (Lat. exacerbo, *I grow violent.*) An increase in the violence of symptoms of disease; as of pain, or especially of fever.

EXÆ'RESIS. (Gr. ἐξαιρέω, *I remove.*) One of the divisions of surgery adopted by old writers, and confined to operations concerned in the removal of parts of the body.

EXALTA'DOS. In Spanish History, the name of the party attached to what has been vulgarly termed the *liberal* system of politics, corresponding to the "extreme gauche" of the French, or Whig-radicals among ourselves.

EXANTHE'MA. (Gr. ἐξανθέω, *I effloresce.*) An eruptive disorder.

EXARCH. (Gr. ἔξαρχος.) The title of the viceroys of the Byzantine emperors in the provinces of Italy and Africa after they had been conquered by Justinian. The exarch of the former province fixed the seat of his government at Ravenna. They were also styled patricians.

EX CA'THEDRA. A Latin phrase; originally applied to decisions rendered by prelates, chiefly popes, from their cathedra or chair: *i. e.* in a solemn judicial manner. Hence applied to every decision pronounced by one in the exercise of his peculiar authority: a professor in his lecture room, a judge from the bench, &c.

E'XCELLENCY. A title of honour in various European states. It was borne, successively, by the Lombard kings; by some emperors of the West; by various minor Italian potentates; and it is now appropriated to persons in the actual execution of certain official services: ministers, some court dignitaries, and ambassadors, but not chargés d'affaires. Governors of English colonies are styled Excellency.

EXCE'NTRIC (Lat. ex, *out*, and centrum, *centre*), in the Ancient Astronomy, is the deferent circle in the circumference of which the centre of the epicycle of a planet is carried forward in its orbit round the earth. It was *excentric* in respect of the earth; that is, though the orbit of a planet was a circle described about the earth, the earth was not placed at the centre of that circle. In modern astronomy, the excentric is the circle which circumscribes the elliptic orbit of a planet. Hence, *Excentric Anomaly* is the arc of the excentric between the perihelion of the orbit and the straight line drawn through the centre of the planet perpendicular to the major axis. *See* ANOMALY.

EXCENTRI'CITY. In Astronomy, the distance of the foci from the centre of the elliptic orbit of a planet or satellite, the semi axis major being regarded as unity; or, it is the ratio of the distance between the focus and centre to the semi axis major. Thus, if a and b denote respectively the semi axes major and minor, and e the excentricity, we have $a e = \sqrt{a^2 - b^2}$. *Excentricity* is thus

to be carefully distinguished from ellipticity, which denotes the ratio of the difference of the two axes to the greater. For the excentricities of the different planets, see PLANET.

EXCEP'TION. In Law, a stop or stay to an action. In common law proceedings, a denial of a matter alleged in bar to an action. In chancery, what is alleged against the sufficiency of an answer.

EXCE'SS, SPHERICAL, in Trigonometry, is the quantity by which the sum of the three angles of a spherical triangle exceeds two right angles.

EXCHA'NGE, in Arithmetic, is the finding the value of one commodity or denomination of money in terms of another. When a unit of each denomination is determined in terms of a common standard, all the operations of this rule are applications of the rule of proportion.

EXCHANGE. In Commerce, a term used to designate that species of mercantile transactions by which the debts due to individuals at a distance from their creditors are paid without the transmission either of money or goods.

Among cities or countries having any considerable intercourse together, the debts mutually due by each other approach, for the most part, near to an equality. There are at all times, for example, a considerable number of persons in London indebted to Hamburgh; but, speaking generally, there are about an equal number of persons in London to whom Hamburgh is indebted; and hence, when A. of London has a payment to make to B. of Hamburgh, he does not remit an equivalent sum of money to the latter; but he goes into the market and buys a bill upon Hamburgh for an equal amount,—that is, he buys an order from C. of London, addressed to his debtor D. of Hamburgh, directing him to pay the amount to A. or his order. A. having indorsed this bill or order, sends it to B., who receives payment from his neighbour D. The convenience of all parties is consulted by a transaction of this sort. The debts due by A. to B., and by D. to C., are extinguished without the intervention of any money. A. of London pays C. of ditto, and D. of Hamburgh pays B. of ditto. The debtor in one place is substituted for the debtor in another; and a postage or two, and the stamp for the bill, form the whole expenses.

A bill of exchange may, therefore, be defined to be an order addressed to some person residing at a distance, directing him to pay a certain specified sum to the person in whose favour the bill is drawn, or his order. In mercantile phraseology, the person who draws a bill is termed the drawer; the person in whose favour it is drawn the remitter; the person on whom it is drawn the drawee, and after he has accepted the acceptor. Those persons into whose hands the bill may have passed previously to its being paid are, from their writing their names on the back, termed indorsers; and the person in whose possession the bill is at any given period is termed the holder or possessor.

The negotiation of inland bills of exchange, or of those drawn in one part of the United Kingdom on another, is almost wholly in the hands of bankers. Many of the banks established in different parts of the country have a direct intercourse with each other, and all of them have correspondents in London. Hence an individual residing in any part of the country who may wish to make a payment in any other part, however distant, may effect his object by applying to the nearest bank. Thus, suppose A. of Penzance has a payment to make to B. of Inverness. To send the money by post would be hazardous; and if there were fractional parts of a pound in the snm, it would hardly be practicable to make use of the post. How then will A. manage? He will pay the sum to a banker in Penzance, and his creditor in Inverness will receive it from a banker there. The transaction is very simple. The Penzance banker instructs his correspondent in London to pay to the London corrrespondent of a banker in Inverness the sum in question, on account of B.; and the Inverness banker being advised in course of post of what has been done, hands over the money to B. The whole charges are limited to a trifling commission and two-pence for postage; so that the affair is transacted in the cheapest as well as in the most commodious possible manner. Bills drawn by the merchant of one country upon another are termed foreign bills of exchange, and it is to their negotiation that the following remarks principally apply.

I. *Par of Exchange.* — The par of the currency of any two countries means, among merchants, the equivalency of a certain amount of the currency of the one in the currency of the other, supposing the currencies of both to be of the precise weight and purity fixed by their respective mints. Thus, according to the mint regulations of Great Britain and France, 1*l.* sterling is equal to 25 fr. 20 cents, which is consequently said to be the par between London and Paris. And the exchange between the two countries is said to be at a par when bills are negotiated on this footing; that is, for example, when a bill for 100*l.* drawn in London is worth 2520 fr. in Paris, and conversely. When 1*l.* in London buys a bill on Paris for more than 25 fr. 20 cents, the exchange is said to be in favour of London, and against Paris; and when, on the other hand, 1*l.* in London will not buy a bill on Paris for 25 fr. 20 cents, the exchange is against London, and in favour of Paris. (See table of the Par of Exchange, at the end of this article.)

II. *Circumstances which determine the Course of Exchange.* — The exchange is affected, or made to diverge from par, by two classes of circumstances. First, by any discrepancy between the actual weight or fineness of the coins, or of the bullion for which the substitutes used in their stead will exchange, and their weight or fineness as fixed by the mint regulations; and, secondly, by any sudden increase or diminution of the bills drawn in one country upon another.

a. It is but seldom that the coins of any country correspond exactly with their mint standard; amd when they diverge from it, an allowance corresponding to the difference between the actual value of the coins and their mint value must be made in determining the real par. Thus, if while the coins of Great Britain corresponded with the mint standard in weight and purity, those of France were either 10 per cent. worse or debased below the standard of her mint, the exchange, it is obvious, would be at real par when it was nominally 10 per cent. against Paris, or when a bill payable in London for 100*l.* was worth in Paris 2772 fr., instead of 2,520 fr. In estimating the *real* course of exchange between any two or more places, it is always necessary to attend carefully to this circumstance: that is, to examine whether their currencies be all of the standard weight and purity; and if not, how much they differ from it. When the coins circulating in a country are either so worn or rubbed as to have sunk considerably below their mint standard, or when paper money is depreciated from excess or want of credit, the exchange is at real par only when it is against such country to the extent to which its coins are worn or its paper depreciated. When this circumstance is taken into account, it will be found that the exchange during the latter years of the war, though apparently very much against this country, was really in our favour. The depression was nominal only; being occasioned by the great depreciation of the paper currency, in which bills were paid. (See art. "Exchange," new edition, *Ency. Britannica.*)

b. Variations in the actual course of exchange, or in the price of bills, arising from circumstances affecting the currency of either of two countries trading together, are *nominal* only; such as are *real* grow out of circumstances affecting their trade.

When two countries trade together, and each buys of the other commodities of precisely the same value, their debts and credits will be equal, and, of course, the real exchange will be at par. The bills drawn by the one will be exactly equivalent to those drawn by the other, and their respective claims will be adjusted without requiring the transfer of bullion or of any other valuable produce; but it very rarely happens that the debts reciprocally due by any two countries are equal. There is almost always a balance owing on the one side or the other; and this balance must affect the exchange. If the debts due by London to Paris exceeded those due by Paris to London, the competition in the London market for bills on Paris would, because of the comparatively great amount of payments our merchants had to make in Paris, be greater than the competition in Paris for bills on London; and consequently the real exchange would be in favour of Paris and against London.

It is plain, however, that all fluctuations of the real exchange must be confined within comparatively narrow limits; and that, though they may be under, they can never exceed, the expense of transmitting bullion from the debtor to the creditor country; for, if they exceeded this amount, it would plainly be more for the debtor's advantage to transmit bullion rather than bills, and the exchange would immediately sink to par.

It is usual to suppose, when the exchange is against a country, that it can only be adjusted by an exportation of bullion; but provided the fall of the exchange be *real*, and not *nominal*, — that is, provided the currency of the country which has the unfavourable exchange be in a sound state, and that it is neither depreciated from excess, nor from the coins being reduced below their mint standard, but that the depression originates in some circumstances affecting the trade of the country, as the occurrence of a bad harvest, the breaking out of a war, &c., — then, in such a case, it may, and most probably will not be necessary to export a single ounce of bullion. Suppose, to illustrate this, that an English merchant has 100*l.* to pay in Petersburgh, and that the real exchange is 3 per cent. against England, or that a bill that cost 103*l.* in London will only fetch 100*l.* in Petersburgh: now, suppose that the cost of transmitting bullion to Petersburgh is also 3 per cent.; the question is, what will the merchant do? If he had no other resource but to send a bill or bullion, it is plain it would be indifferent

to him which he sent. But he is not so restricted. He will compare together the prices of articles in London and Petersburgh; and if he find that there is any exportable article whatever costing in London 100*l.* that will sell in Petersburgh for 100*l.* after paying the expenses of carriage, he will obviously gain 3*l.* by exporting it, rather than transmitting bullion or a bill. The fact is, that a nation might cancel a foreign debt of 10 or 100 millions without sending abroad a single ounce of gold and silver: the latter are never exported, unless when it happens to be more profitable to export them than anything else. They always go abroad to find, and not to lose, their level.

III. A fall of the *nominal* exchange, that is, a fall of the exchange occasioned by the depreciation of the currency, has no influence whatever over trade. When the currency is depreciated, the premium which the exporter of commodities derives from the sale of the bill drawn on his correspondent abroad is countervailed by a precisely equal rise in the price of the commodity occasioned by the depreciation, so that the result is nothing. But it is otherwise when the *real* exchange is depressed, or when the sums payable to the foreigner exceed those receivable from him. In this case, there is no rise of prices, and the depression of the exchange operates as a stimulus to exportation. As soon as the real exchange diverges from par, the mere inspection of a price current is no longer sufficient to regulate the operations of the merchant. If it be unfavourable, the premium which the exporter will receive on the sale of his bill must be included in the estimate of the profit he is likely to derive from the transaction. The greater that premium the less will be the difference of prices necessary to induce him to export; and hence an unfavourable real exchange has an effect exactly the same with what would be produced by granting a bounty on exportation equal to the premium on foreign bills.

But, for the same reason that an unfavourable *real* exchange increases exportation, it proportionally diminishes importation. When the exchange is really unfavourable, the price of commodities imported from abroad must be so much lower than their price at home as not merely to afford, exclusive of expenses, the ordinary profit of stock on their sale, but also to compensate for the premium which the importer must pay for a foreign bill, if he remit one to his correspondent, or for the discount, added to the invoice price, if his correspondent draw upon him. A less quantity of foreign goods will therefore suit our market when the *real* exchange is unfavourable; and fewer payments having to be made abroad, the competition for foreign bills will be diminished, and the *real* exchange rendered proportionally favourable. In the same way, it is easy to see that a favourable *real* exchange must operate as a duty on exportation and as a bounty on importation.

It is thus that fluctuations in the real exchange have a necessary tendency to correct themselves. They can never, for any considerable period, exceed the expense of transmitting bullion from the debtor to the creditor country. But the exchange cannot continue either permanently favourable or unfavourable to this extent. When favourable, it corrects itself by restricting exportation and facilitating importation; and when unfavourable, it produces the same effect by giving an unusual stimulus to exportation, and by throwing obstacles in the way of importation. The *true par* forms the centre of these oscillations; and though the thousand circumstances which are daily and hourly affecting the state of debt and credit prevent the ordinary course of exchange from being almost ever precisely at par, its fluctuations, whether on the one side or the other, are confined within certain limits, and have a constant tendency to disappear.

This natural tendency, which the exchange has to correct itself, is powerfully assisted by the operations of the bill merchants.

England, for example, might owe a large excess of debt to Amsterdam; yet, as the aggregate amount of the debts due by a commercial country is generally balanced by the amount of those which it has to receive, the deficiency of bills on Amsterdam in London would most probably be compensated by a proportional redundancy of those on some other place. Now it is the business of the merchants who deal in bills, in the same way as of those who deal in bullion or any other commodity, to buy them where they are cheapest, and sell them where they are dearest. They would, therefore, buy up the bills drawn by other countries on Amsterdam, and dispose of them in London; and by so doing would prevent any great fall in the price of bills on Amsterdam in those countries in which the supply exceeded the demand, and any great rise in Great Britain and those countries in which the supply happened to be deficient. In the trade between Italy and this country, the bills drawn on Great Britain amount, almost invariably, to a greater sum than those drawn on Italy. The bill merchants, however, by buying up the excess of the Italian bills on London, and selling them in Holland and other countries indebted to England, prevent the real exchange from ever becoming much depressed. (For further information as to the principles involved in this curious and interesting department of commercial and international economy, see the able and excellent tract, entitled *Observations on the Course of Exchange*, by William Blake, Esq., and the art. "Exchange" in the new edition of the *Encyc. Britannica;* and for the practical details connected with the subject, see *Commercial Dictionary*.) We subjoin from the latter a table of the par of exchange between London and some of the principal foreign places for the negotiation of bills of exchange.

Par of Exchange between England and the following Places, — viz. Amsterdam, Hamburgh, Paris, Madrid, Lisbon, Leghorn, Genoa, Naples, and Venice; the same being computed from the intrinsic Value of their principal Coins, by comparing Gold with Gold, and Silver with Silver, according to their Mint Regulations, and to Assays made at the London and Paris Mints.

	Gold.		Silver.				Explanations.
			Old Coinage.		New Coinage.		
	Mint Regulations.	Assays.	Mint Regulations.	Assays.	Mint Regulations.	Assays.	Moneys of Exchange.
Amsterdam, banco	36 8	36 6·8	37 3	37 10·5	35 0	35 6·5	Schillings and pence Flemish per pound sterling. Agio 2 per cent.
Do. current - -	11 4·5	11 3·8	11 8·5	11 11·8	10 14·6	10 17·6	Florins and stivers per pound sterling.
Hamburgh - -	34 3·5	35 1·5	34 1	35 1·3	32 11	32 11·5	Schillings and pence Flemish banco per pound sterling.
Paris - - -	25 20	25 26	24 73	24 91	23 23	23 40	Francs and centimes per pound sterling.
Madrid - -	37·3	37·2	39·2	39·0	41·7	41·5	Pence sterling for the piastre or dollar of exchange.
Lisbon - -	67·4	67·5	60·41	58·33	64·30	62·69	Pence sterling per milree.
Leghorn - -	49·1	49·0	46·46	46·5	49·60	49·5	Pence sterling per pezza of exchange.
Genoa - -	45·5	45·5	46·46	48·9	49.4	52·0	Pence sterling per pezza fuori banco. *
Naples - -	41·22	- -	41·42	- -	43·9	- -	Pence sterling per ducat (new coinage of 1818).
Venice - -	46·3	46·0	47·5	49·9	44·6	46·1	Lire piccole per pound sterling.

* The currency of Genoa has consisted, since 1826, of *Lire Italiane* of exactly the same weight and fineness as francs; so that the par of exchange with Genoa is now the same as with Paris.

EXCHE'QUER CHAMBER, COURT OF, in Law, is constituted by 1 W. 4. c. 70. the proper tribunal for the trial of writs of error from the three superior courts, which before was only partially the case. In this court the writ is tried before the judges, or judges and barons, of the two courts which had not given the former judgment. Error from this court lies in the House of Lords, which is the last and highest appellate tribunal of the country.

EXCHEQUER, COURT OF, in Law, was originally established for the recovery of the king's debts and ordinary revenues of the crown. In its modern shape, it is in fact a combination of eight distinct ancient courts. It acquired concurrent jurisdiction with the other two superior courts in all personal actions (*see* COURTS, SUPERIOR) by the fiction of the complaining party being debtor to the king; a fiction which is now removed. It has exclusive jurisdiction in cases in which the king's revenue is concerned, whether personal actions, or informations filed under the various revenue acts. It has also an equitable jurisdiction; exclusive with respect to matters connected with the revenue, concurrent with the court of chancery in civil suits. It has also the original and proper equitable jurisdiction in cases of tithes. (*See* CHANCERY.) The chief and four puisné or younger judges of the Exchequer are termed Barons.

EXCHEQUER, COURT OF (in Scotland), established on its present footing by 6 Anne, c. 26., should consist of a chief baron and four junior barons (but three only have been commonly appointed). It has a privative jurisdiction as to duties of customs, excise, and other revenues of the crown.

EXCHEQUER BILLS, are bills of credit issued by authority of parliament. They are for various sums, and bear interest (generally from $1\frac{1}{2}d.$ to $2\frac{1}{2}d.$ per diem per 100*l.*) according to the usual rate at the time. The advances of the Bank to Government are made upon exchequer bills; and the daily transactions between the Bank and Govern-

ment are principally carried on through their intervention. Notice of the time at which outstanding exchequer bills are to be paid off is given by public advertisement. Bankers prefer vesting in exchequer bills to any other species of stock, even though the interest be for the most part comparatively low; because the capital may be received at the Treasury at the rate originally paid for it, the holders being exempted from any risk of fluctuation. Exchequer bills were first issued in 1696, and have been annually issued ever since.

Account of the Amount of the Exchequer Bills outstanding in each Year since 1815, and the Rate of Interest payable on such Bills.

Years ended 5 Jan.	Amount outstanding.	Rate of Interest on Exchequer Bills.			Years ended 5 Jan.	Amount outstanding.	Rate of Interest on Exchequer Bills.		
		Per cent. per diem.					Per cent. per diem.		
	L.	d.	d.	d.		L.	d.	d.	d.
1816	41,441,900		3½		1829	27,657,000		2	
1817	44,650,300		3½		1830	25,490,550	2	1¾	1½
1818	56,729,400	3	2½	2	1831	27,271,650		1½	
1819	43,655,400	2½		2	1832	27,133,350		1½	
1820	36,900,200	2½		2	1833	27,278,000		1½	
1821	30,965,900	2½		2	1834	27,906,900		1½	
1822	31,566,550		2		1835	28,521,550		1½	
1823	36,281,150		2		1836	28,976,600		1½	
1824	34,741,750		2		1837	26,976,000	1½	2	2½
1825	32,398,450	2		1½	1838	24,044,550	2½		2
1826	27,994,200	1½		2	1839	24,026,050		2	
1827	24,565,850		2		1840	19,965,050		1¾	
1828	27,546,850		2						

EXCISE DUTIES, in Revenue and Finance, are duties imposed on articles produced or manufactured at home, while in the possession of the producers or manufacturers. They were introduced into England by the Long Parliament in 1643, being then laid on the makers and venders of ale, beer, cider, and perry. The royalists soon after followed the example of the republicans; both sides declaring that the excise should be continued no longer than the termination of the war. But it was found too productive a source of revenue to be again relinquished; and when the nation had been accustomed to it for a few years, the parliament declared, in 1649, that the impost of excise was the most easy and indifferent levy that could be laid upon the people. It was placed on a new footing at the Restoration; and notwithstanding Mr. Justice Blackstone says, that "from its first original to the present time, its very name has been odious to the people of England" (*Com.*, book i. c. 8.), it has continued progressively to gain ground; and is at this moment imposed on several important articles, and furnishes nearly a third part of the entire public revenue of the kingdom.

For the more easy levy of the excise duties, England and Wales are divided into about fifty-six collections, some of which are called by the names of particular counties, others by the names of great towns. Where one county is divided into several collections, or where a collection comprises the contiguous parts of several counties, every such collection is subdivided into several districts, within which there is a supervisor; and each district is again subdivided into out-rides and foot-walks, within each of which there is a surveying officer or gauger. Some excise duties, that were justly objected to, have been repealed within these few years; and, with the exception of the duty on glass, which interferes injuriously with the manufacture, we are not sure that there is one of the existing duties that can be fairly objected to on principle, though the rate of duty might, in some instances, be advantageously reduced. It has been said, that the excise duties "greatly raise the cost of subsistence to the labouring classes." But this assertion has really no foundation. In fact, the only excise duty that can be said to fall on a necessary of life is that on soap, which produced in 1838 (in Great Britain) 809,031*l.*; but as the population of Great Britain amounts at present to about 18,000,000, the soap tax cannot, at an average, impose a burden of 11*d.* a year on each individual. If we estimate its annual pressure on a labouring family of five persons at from 2*s.* 6*d.* to 3*s.*, we shall not be within but beyond the mark.

The only taxes, in the various departments of the revenue, that can be truly said to fall on articles necessary to the labourer, are, besides soap, principally those on tea and sugar. We incline to think that the duties on these articles might be very materially reduced without affecting the revenue; but, however that may be, it cannot be truly affirmed that they entail any grievous burden on the labouring classes. The entire nett produce of the excise duties in Great Britain in 1838 amounted to 12,775,955*l.*, of which the duties on spirits and malt, that is, on spirits and beer, produced no less than 8,604,115*l.* In Ireland during the same year, the excise duties amounted to 1,974,566*l.*, of which the spirit and malt duties furnished above four-fifths, or 1,795,165*l.* The rate at which this revenue was collected was nearly 6¼ per cent. in Great Britain, and 9½ per cent. in Ireland. Now, we are bold to say, that no equal amount of revenue was ever raised with so little inconvenience or injury to the contributors. Even though they were not required by the public exigencies, the duties on spirits obstruct a pernicious habit, and should not be given up. They are the best of all possible duties; and the only thing to be attended to in their imposition, is not to carry them to such a height as to defeat their object by encouraging smuggling. We have yet to learn, supposing they are not carried beyond this limit, that a single good objection can be made to these duties.

The obscurity and complexity of the excise laws has been justly complained of. It is needless to say, that they ought to be brief, clear, and level to the apprehension of every one. But, so far from this being the case, they are in most instances lengthened, contradictory, and unintelligible. There were at no distant period some 40 or 50 acts in existence having reference to the glass duties, and at this moment from 25 to 30 have reference to the paper duties, and so for the others. It is, in fact, all but impossible for any one to tell what the law really is on many points; so that the trader is left at the mercy of the officers, and a wide door is opened to favouritism and fraud. This disgraceful state of things might, however, be easily remedied by getting the treasury or the excise to prepare a short abstract of the law as to each duty, drawn up in the clearest and least ambiguous manner possible, and without any of that verbosity, repetition, and technical jargon that infects acts of parliament, and renders them all but incomprehensible to ordinary persons. A manufacturer abiding by this abstract should be held to have abided by the law, and should not be further questioned on the subject. A measure of this sort might be easily carried into effect. It would be an immense improvement, and would go far to obviate the only good objection to the excise duties.

EXCITABI'LITY. A disposition to be affected by exciting causes. It is a term chiefly used in medicine, in reference to that state of system which is more or less susceptible of morbid excitement.

EXCOMMU'NICATION. An ecclesiastical censure, by which a man is cut off from communion with his church. The right possessed by any community of ejecting any person who contravenes the laws by which it is governed is founded on the original principles of society, and is exercised in some shape or other by every sect among Christians. If we suppose, however, one society to be the depositary of all God's covenants and mercies, and to afford the exclusive means of salvation, excommunication will in such case involve eternal perdition, and must be defended on some higher grounds than those of social expediency. An appeal is made to scripture in defence of this practice on the following grounds: — The power of binding and loosing is undoubtedly given to the apostles. St. Paul delivers over to Satan a heretic, or one who troubled the church; the sudden death of Ananias and Sapphira seems to have been inflicted upon them by the apostle himself as a punishment for their crimes; the faithful are charged to keep no company with heretics; Titus is directed by St. Paul to reject such after the first and second admonition. Upon the authority of these passages many Christian churches have assumed the power of excommunication. Protestants, however, do not generally venture to pronounce upon the future condition of a person thus excluded from covenanted benefits; whereas in the forms of excommunication of the Greek and Roman churches, the excommunicated person is solemnly devoted to the devil.

The English church retains a form of excommunication, in cases of adultery, incontinence, heresy, simony, and neglect of public worship, &c.; the practice, however, has long become obsolete. In English law, excommunication was the ordinary mode by which contempt of the ecclesiastical jurisdiction was punished and its process enforced. Forty days after sentence the writ *de excommunicatio capiendo* issued (called also a *significavit*, from the recital of the bishop's certificate with which it commenced), under which the party was apprehended by the sheriff. By stat. 53 G. 3. c. 127. the legal effect of excommunication is abolished, and the writ *de contumace capiendo* substituted for the former one.

EXCORIA'TION. (Lat. excorio, *I remove the skin.*) An abrasion of the cuticle.

EXCRE'TION. (Lat. excerno, *I separate from.*) A substance which is rejected from the body as useless.

EXCU'RRENT. In Botany, a term used in describing the ramification of any body whose axis always remains in the centre; the other parts being regularly disposed around it, as the stem of *Pinus abies.*

EXECU'TION. The carrying into effect of a judgment given in a court of law. Unless execution be taken out within a year and a day after the judgment has been given, the judgment must be revived by writ of scire facias. Execution may be against the person of defendant by imprisonment, which is under a writ of capias ad respondendum. There are also various writs of execution against the goods of a defendant and against his lands. Criminal execution is in the country directed

by the judge of assize who tries the prisoner, and in London by the recorder.

EXECUTION. In the Fine Arts, the mode of performing a work of art, and the dexterity with which it is accomplished.

EXE'CUTIVE. In the theory of Government, that part of the powers of the state which is employed in putting into execution the laws made by the legislative or the decrees of the judicial power. In England, all executive power is supposed to be vested in the king, and in inferior officers by his delegation.

EXE'CUTOR. In Law, an executor is a person appointed by a testator, and whose appointment is confirmed by the proper ecclesiastical court, to execute his will, and to represent him in his personal rights and liabilities. Thus the rights and liabilities of an executor in his representative capacity (the same as those of an administrator), are those of the testator or intestate, arising, — for or against him — either out of contract, or from injury done to his property, real or personal, or from injury done by him to the real or personal property of another; but the liabilities of an executor or administrator do not overreach the property or assets which he has received, or might but for his negligence or default have received, by virtue of his office.

The first and most important duty of executors and administrators is the payment of debts which attach to the property in their hands, in the following order; the reasonable expenses of the funeral, and the necessary expenses of proving the will, or of obtaining letters of administration, being first defrayed.

1st. Debts due to the crown by record or on specialty.

2dly. Debts due to the subject by virtue of the judgment of any court of record.

3dly. Debts acknowledged upon record, as by recognizance.

4thly. Debts due upon specialty, or on account of rent.

5thly. Debts of the crown not upon specialty or record.

6thly. Debts by simple contract.

Creditors of each class are entitled to be paid in full before any thing is allowed to debts of an inferior order; and as between themselves they are paid pro rata as far as the assets will extend. But an executor will be allowed, upon account, any debt that he may have paid without notice of another debt of a higher class; and as between creditors of equal degree, he may, before action brought at law, or decree to account in equity, give preference to any. He may also at any time as against creditors of an equal class retain a debt due to himself.

Next to debts stand, in the first place, specific legacies, *i.e.* gifts of specific parts of personal estate; and in the next place general legacies, that is, gifts of money payable out of the general residue of such estate: what remains after payment of legacies, where there are any, or where there are none after payment of debts, is divisible among the next of kin according to the Statute of Distributions. Specific legacies may be recovered at law; but the rights of general legatees, and of next of kin, are enforcible only in courts of equity, or in the ecclesiastical courts.

Most frequently also claims in the nature of debt or legacy to which the personal estate of testators or intestates is subject are prosecuted in courts of equity; which do not only, like courts of law, take cognizance of each individual right as brought forward, but will take upon themselves the whole administration of the estate, and retain it in their hands for the purpose of doing justice to all claimants.

In so doing courts of equity are bound to follow the legal order of priority above stated, so far at least as the assets are legal; *i.e.* either recoverable in courts of common law, or arising upon trust direct and proper and co-extensive with the legal interest (*vide* TRUST), to which the principle of *æquitas sequitur legem* applies. But where there are assets recoverable only in equity, and arising upon implied or resulting trusts, these are called equitable; and in the application of such assets the rule obtains of equality between all debts, the priority of debts to legacies, and among these of specific to general, being still observed. Where there are both legal and equitable assets, creditors availing themselves of their priority against the legal assets will not be admitted to any participation in the equitable assets till other creditors shall have received out of them the same proportion of their debts as the creditors of a higher degree shall have been already paid out of the legal assets.

By the recent act of the 3 & 4 W. 4. real estate not devised for or charged with the payment of debts is made assets for the payment of all debts, to be administered by courts of equity according to the legal order of priorities; but real estate so devised or charged still remains as before equitable assets. Executors and administrators as such have no concern in either case with the application of real assets.

Many questions arise in regard to legacies, — as to when they are vested, when specific or general, — which it is impossible to notice within the limits of this summary.

EXEGE'SIS. (Gr. ἐξ, and ἡγέομαι, *I lead.*) The term applied most usually to the exposition or interpretation of the Holy Scriptures; it is also used, however, in an unrestricted sense. This department of biblical learning has been most assiduously cultivated in modern times, especially by the Germans, as the writings of Michaelis, Schleussner, Rosenmüller, Gesenius, &c. amply testify.

EXE'RGUE. (Fr.) In Numismatics, the basis or lower limb of a coin or medal, when separated by a line from the rest of the face, which usually contains words giving the date, place, &c. of the coin, or other subsidiary matter. *See* NUMISMATICS.

EXFOLIA'TION. (Lat. exfolio, *I scale off.*) The separation of a piece of dead bone from the living.

EXHALATION. *See* VAPOUR, EVAPORATION.

EXHAU'STION. In Geometry, a method of demonstration employed by the ancient geometers to prove the equality of two magnitudes, by showing that their difference is less than any assignable magnitude. The ancients employed this method in their difficult researches, particularly in the theory of curve lines and surfaces, and in determining the areas and volumes which those surfaces contain. As they admitted no demonstrations but such as are perfectly rigorous, they did not consider curves as polygons of a great number of sides; but in attempting to discover the properties of any curve, they regarded it as the fixed term or limit to which the inscribed and circumscribed polygons continually approach, and approach the nearer as the number of their sides is increased. Thus they *exhausted*, as it were, the space between the polygons and the curve; and hence this method of procedure was called the *method of exhaustion.*

As polygons bounded by straight lines were known figures, their continual approach to the curve gave a more precise idea of its properties in proportion as the difference was diminished; and by following the law of continuity, an exact knowledge of these properties was at length obtained. But when the properties of the curve were thus divined, as it were, it remained to verify them by a *geometrical* demonstration; and this was done by proving that every contrary supposition necessarily leads to a contradiction. This method of demonstration is the *reductio ad absurdum.*

By the method of exhaustion the ancients demonstrated that the areas of circles of different diameters are to each other as the squares of their diameters; that the volumes of spheres are to each other as the cubes of their diameters; that pyramids of the same altitude are in proportion to their bases; that the cone is the third of a cylinder of the same base, &c. In the same manner Archimedes demonstrated that the convex surface of a right cone is equal to the area of the circle whose radius is a mean proportional between the side of the cone and the radius of the base; that the area of a sphere is four times that of one of its great circles; and that the area of any of its zones is equal to the circumference of a great circle multiplied by the height of the zone. The differential calculus of the moderns is only the method of exhaustion of the ancients reduced to a simple and commodious analysis. (See *Maclaurin's Fluxions;* and *Carnot, Métaphysique du Calcul Infinitésimal.*)

E'XHEDRA. (Gr. ἐξ, *out of*, and ἕδρα, *a chair.*) In Ancient Architecture, a small room in the baths and other buildings appropriated for conversation.

EXHIBI'TION. (Lat. exhibeo, *I show.*) A term applied in modern times to the public display of works of art. This word is also used to denote private benefactions instituted for the maintenance of scholars in the universities. *See* BURSARS.

EXHUMA'TION. (Lat. ex, *out of*, and humus, *the ground.*) The act of digging up a body interred in holy ground by the authority of the judge. In France the laws enforce exhumation on proof that any person has been killed in a duel.

E'XIGENT. In Law, a writ which lies when the defendant in an action personal, or in an indictment, cannot be found; and where, in the former case, nothing of his can be found within the county whereby he may be attached or distrained upon. The writ is directed to the sheriff, to proclaim the absent party on five county court days, one after another; and if he do not answer on the fifth, he is outlawed.

E'XILE. (Lat. exsilium, from exsul, *one banished ex solo from the soil of his country.*) In Roman law, the punishment of banishment, or, more strictly speaking, the consequence of the interdiction from the use of fire and water, pronounced in early times as a sentence against great offenders, which compelled them to expatriate themselves. It appears that the direct sentence of exile was not known to ancient Roman jurisprudence. (*Cicero ad Herenn.*) In modern France (before the Revolution), there was a distinction between banishment and exile. The former was a punishment assigned by the law, and producing infamy; the latter a measure of discipline, inflicted by the arbitrary act of the monarch (usually through lettres de cachet). Thus political offenders

were frequently exiled to their estates, to a certain distance from court, &c.

EXISTENCE. *See* PERCEPTION, MATERIALISM.

E'XIT. A word placed in the margin of plays to mark the time at which the player leaves the stage.

EXO'DIUM, in Greek Tragedy, signified the end or denouement of the play; or more properly that portion of it (generally the last act) in which the catastrophe is indicated, or the plot begins to be unravelled.

E'XODUS. *See* PENTATEUCH.

EX OFFI'CIO. (Lat. *by reason of office or duty.*) In general language, every act done by an officer either in prosecution of the general duty of his office, or in executing some special duty imposed by it, is said to be done *ex officio*. But, in more strict phraseology, a proceeding *ex officio* is one taken by an officer of his own will, in execution of what he takes to be the duty of his office; as, where a justice of the peace demands and takes surety of his own discretion, without the request of the injured party. An ex officio information is an information at the suit of the king, filed by the attorney-general, without applying to a court for leave. (*See* INFORMATION.) Ex officio criminal informations are employed in cases of libel, sedition, &c., when officially prosecuted.

EXO'GENOUS. (Gr. ἐξ, and γεινομαι, *I grow.*) A term applied to those plants a transverse slice of whose stem exhibits a central cellular substance or pith, an external cellular and fibrous ring or bark, and an intermediate woody mass, and certain fine lines radiating from the pith to the bark through the wood, and called medullary rays. They are called Exogens, because they add to their wood by successive external additions; and are the same as what are otherwise called Dicotyledons. They constitute one of the primary classes into which the vegetable world is divided, characterized by their leaves being reticulated; their stems having a distinct deposition of bark, wood, and pith; their embryo with two cotyledons; and by their flowers usually formed on a quinary type.

EXO'MPHALOS. (Gr. ἐξ, and ὀμφαλος, *the navel.*) A hernia or rupture at or near the navel.

E'XOPHTHA'LMIA. (Gr. ἐξ, and οφθαλμος, *the eye.*) The protrusion of the eyeball from the orbit. It is usually the consequence of concussions or blows; sometimes it is produced by a tumour in the orbit, which gradually pushes the eyeball out of its socket.

EXOPHY'LLOUS. (Gr. ἐξ, and φυλλον, *a leaf.*) A term invented by Dumortier to be applied to the young leaves of Exogens; since they are said to be always naked, while those of Endogens sheath each other.

EXO'PTILES. (Gr. ἐξ, and πτιλον, *a feather.*) A term invented by M. Lestiboudois for Dicotyledonous plants, because their plumula is naked.

EXORCI'SM. (Gr. ἐξορκίζω, *I bind or charge upon oath.*) The solemn adjuration by which those endowed with certain powers were believed to be able to subject evil spirits to their obedience: more particularly to compel them to leave the bodies of those supposed to be subject to demoniacal possession. The exorcists form one of the minor orders in the church of Rome.

EXO'RDIUM. (Lat. exordior, *I begin an oration.*) In Oratory and Literature, the opening part of an oration; which, according to ancient critics, should be drawn either from the subject itself or from the situation of the speaker; presenting either brief remarks on the general character of the topic on which he is about to deliver himself, or insinuations (according to the advice of Cicero), calculated generally to prejudice the audience in favour of the speaker, and against his adversary.

EXORRHI'ZÆ. (Gr. ἐξ, and ῥιζα, *a root.*) A term invented by Richard to be applied to the embryo of Dicotyledons; inasmuch as their radicle always elongates downwards, directly from the outside of the base of the embryo.

EXOSMO'SE. (Gr. ἐξ, and ωσμος, *impulsion.*) The passage of gases, vapours, or liquids through membranes or porous media from within outwards. Mr. Dutrochet having found that if two fluids of unequal density are separated by an animal or vegetable membrane, the denser will attract the less dense, through the membrane that divides them: this property he called Endosmose when the attraction is from the outside to the inside; and Exosmose when it operates from the inside to the outside of the body acted upon.

EXOSTO'ME. (Gr. ἐξ, and στομα, *a mouth.*) A term invented by Mirbel to denote the passage through the outer integument of an ovule, commonly called the foramen.

EXOSTO'SIS. (Gr. ἐξ, *from*, and οστεον, *a bone.*) In Anatomy, a swelling or tumour of a bone.

EXOSTOSIS. In Botany, a disease to which the roots and stems of trees are subject, when knots or large tumours are formed upon or among the wood. It is caused by a stoppage of growth on the one hand, and an attempt at excessive development on the other. It is from sections of the exostoses of trees that some of the most beautiful wood used by cabinetmakers is obtained.

EXO'STRA. (Gr. ἐξοστρα.) In Ancient Architecture, a machine for representing the interior part of a building as connected with the scene of a theatre.

EXOTERIC. *See* ESOTERIC.

EXOTHE'CIUM. (Gr. ἐξω, *without*, and θηκη, *receptacle.*) That portion of an anther from which the pollen is incorrectly supposed to separate; it is the coating of the anther.

EXO'TIC. (Gr. ἐξωτικος, *foreign.*) Any thing introduced to one country from some other country. In gardening it is sometimes applied to plants which require protection in winter, or to plants in general which are not European.

EXPA'NSION. One of the most common and obvious effects of heat, which expands or enlarges the bulk of all the forms of matter. The expansion of solids by increase of temperature is comparatively small; but it may be rendered sensible by carefully measuring the dimensions of any substance when cold, and again when heated: an iron bar, for example, fitted to a gauge, which shows its length and breadth, will no longer pass through the apertures when heated. Among solids the metals are most expansible and contractile by heat and cold; but they vary much in this respect, as shown in the following table, which exhibits the change of dimensions which several of them undergo when heated, from the freezing to the boiling point of water: —

	Temperature.	
	32°	212°
Platinum - - -	120000	120104
Steel - - -	—	120147
Iron - - -	—	120151
Copper - - -	—	120204
Brass - - -	—	120230
Tin - - -	—	120290
Lead - - -	—	120345
Zinc - - - -	—	120360

The average expansion of glass is very nearly the same as that of platinum. The expansibility of different *liquids* is also very variable; ether, for instance, and alcohol, are more expansile than water, and water more than mercury. The expansibility of mercury is applied to a very useful purpose in the construction of the common thermometer. In general all liquids expand and contract in proportion as they are heated and cooled; but to this law there is a remarkable and anomalous exception in regard to *water*. When a large thermometer tube is filled with water of the temperature of 60°, and placed in a cold situation, or in a freezing mixture of ice and salt, the water goes on shrinking in the tube, till it has attained the temperature of about 40°; and then, instead of continuing to contract till it freezes (as is the case with other liquids), it slowly *expands*, and actually rises in the tube until it congeals. In this case, the expansion above 40° and below 40° seems to be equal; so that water will be of the same bulk at 48° and at 32°. This anomalous expansion of water by cold is productive of some important consequences, considered as a natural operation; for if water, like other fluids, went on increasing in density till it froze, the consequence would be that large bodies of water, instead of being only superficially frozen in winter, would be converted throughout into solid masses of ice. Let us take a fresh water lake as an example. The earth being in winter warmer than the air, the heat is withdrawn from the surface of the water by the cold breezes that blow over it; and the whole body of water has its temperature lowered to 40°, *which is the point of its greatest density*, and a temperature perfectly congenial to fish and most other aquatic animals. The cold now continues to operate upon the surface of the water; but, instead of diminishing its bulk, and therefore rendering it *heavier* than the warmer water beneath, it expands it, and renders it *lighter;* so that under these circumstances a stratum of ice-cold water (at 32°) will be found lying upon the mass of warmer water beneath it (at 40°). The influence of the cold continuing, the surface of the lake will soon freeze, but the water immediately below the superficial covering of ice will be found comparatively warm; and as water is almost a non-conductor of heat, it will be a long time before the ice attains any thickness; and the whole body of water, if of any depth, can never freeze throughout. Indeed, it will be obvious that the retardation of freezing will be proportional to the depth of water which has to be cooled; and hence some very deep basins or lakes are scarcely ever even covered by ice.

As liquids are *enlarged* and consequently rendered specifically lighter by heat, very different effects are produced by applying heat to different parts of the vessels containing them. If the heat be applied to the bottom of the vessel, it is soon heated equally throughout, and made to boil; but if the surface only be heated, it may then be boiled and evaporated, while the lower parts remain quite cold.

Aëriform bodies and vapours are the most expansible

forms of matter, and they present an important peculiarity; for in other substances each individual has its own degree of expansion and contraction, whereas all pure aëriform bodies expand and contract alike; so that if we accurately determine the expansion and contraction of any one of them, that knowledge applies to all the rest. 100 measures of air when heated from the freezing to the boiling point of water, suffer an increase of bulk equal to 37·5 parts; so that 100 cubic feet of air at 32° become dilated to 137½ cubic feet at 212°.

EX PARTE. In Law, of the one part. A commission ex parte in chancery is that which is taken out and executed by one side or party alone, on the other party's neglecting or refusing to join.

EXPECTA'TION OF LIFE. By this term writers on annuities and reversions express the mean duration of human life, after a specified age, according to a given table of mortality. With regard to an individual of a given age, the *expectation of life* is the mean number of future years which individuals of that age, one with another, actually live; those who live longer than that period enjoying as much more life in proportion to their numbers as those who live a shorter time enjoy less. The *expectation of life*, according to this definition, differs altogether from what is called the *probable life*, or the number of years which an individual has an equal chance of surviving. The latter term denotes the period of time at the end of which the probability of being alive is equal to the probability of being dead, or is equal to ½; and this is manifestly the period in which the number of lives in the table, beginning with any given age, is reduced to one half. For example, if in a given table of mortality we find that 1000 individuals are living at the age of 40, and that of these 500 only are living at the age of 63, then the *probable life* of an individual aged 40, according to that table, would be 23 years; that is to say, it is an even wager whether he will be alive or dead at the end of 23 years. The *mean life*, or *expectation of life*, is, however, quite different in principle (though in most tables not very different in amount), and depends on the same mathematical probabilities of living over each future year of life, to the last in the table, as are employed in the calculation of life annuities. It is computed as follows: —

Let the probabilities that a life of a given age will live over

1, 2, 3, 4 .... x years,
be p_1 p_2 p_3 p_4 .... p_x respectively;

then the probability that the life will fail in any given year x, is $p_{x-1} - p_x$.

Now, in computing the portion of existence which an individual may expect to enjoy in respect of any future year x, there are two contingencies to be considered: — 1st, The individual may live over that year, in which case he will enjoy a whole year of life $= 1$. But the probability of this event is p_x; therefore $p_x \times 1 = p_x$ is the portion of time he may at present expect to live in respect of that year. 2d, The individual may die in the course of that year; and as the chances of dying at any particular part of the year are equal, we must suppose him to die at the middle of the year; in this case, therefore, he enjoys half a year of life $= \frac{1}{2}$. But the probability his death will happen in the xth year is $p_{x-1} - p^x$; consequently $\frac{1}{2}\left(p_{x-1} - p^x\right)$ is the portion of time he may hope to live, in respect of that year, on the second contingency.

Adding the two results together, we get $p_x + \frac{1}{2}\left(p_{x-1} - p_x\right) = \frac{1}{2}\left(p_{x-1} + p_x\right)$ for the whole of his expectation of life in respect of the xth year from the present. Substituting successively the numbers 1, 2, 3, &c. for x, in order to get the expectation for each succeeding year till the last age in the table, and denoting the sum of the expectations by E, we find (since $p_0 = 1$)

$$E = \tfrac{1}{2}(1 + p_1 + p_2 + p_3 + \&c.) + \tfrac{1}{2}(p_1 + p_2 + p_3 + \&c.);$$

consequently,

$$E = \tfrac{1}{2} + p_1 + p_2 + p_3 + \&c. \quad \ldots\ldots\ldots\ldots (1)$$

Thus it appears that the true value of the expectation of life is equal to the sum of the probabilities of the life enduring through 1, 2, 3, &c. years to the limiting age of the table of mortality, increased by ½. The labour that would be required to sum this series for every different age is avoided by deducing the expectation of one age from that of the next older, as is usually done in computing annuity tables. Thus, let E_1 denote the expectation of life for an individual one year older than the former, and let the probabilities of his living over 1, 2, 3, &c. years be respectively q_1, q_2, q_3, &c.; then we must have

$$E_1 = \tfrac{1}{2} + q_1 + q_2 + q_3 + \&c. \quad \ldots\ldots\ldots\ldots (2)$$

But from the nature of the probabilities in question,

$$p_2 = p_1 \, q_1$$
$$p_3 = p_1 \, q_2$$
$$p_4 = p_1 \, q_3, \&c.$$

Substituting, therefore, these values in (1), we find

$$E = \tfrac{1}{2} + p_1(1 + q_1 + q_2 + q_3 + \&c.) \quad \ldots\ldots\ldots (3)$$

Whence, on eliminating $q_1 + q_2 + q_3 + \&c.$, from the two equations (2) and (3), we get

$$E - \tfrac{1}{2} = p_1 (E_1 + \tfrac{1}{2}),$$

which is the most convenient form under which the formula can be put for computation.

For the explanation of the manner in which the probabilities p_1 p_2 p_3, &c., are determined from the ordinary tables of mortality, see ANNUITY.

The following table, from Mr. Milne's *Treatise on the Valuation of Annuities and Assurances* (vol. ii. p. 565.) shows the expectation of life at every age, according to the law of mortality at Carlisle: —

Age.	Expectat.	Age.	Expectat.	Age.	Expectat.	Age.	Expectat.
0	38·72	26	37·14	52	19·68	78	6·12
1	44·68	27	36 41	53	18·97	79	5·80
2	47·55	28	35·69	54	18·28	80	5·51
3	49·82	29	35·00	55	17·58	81	5·21
4	50·76	30	34·34	56	16·89	82	4·93
5	51·25	31	33·68	57	16·21	83	4·65
6	51·17	32	33·03	58	15·55	84	4·39
7	50·80	33	32·36	59	14·92	85	4·12
8	50·24	34	31·68	60	14·34	86	3·90
9	49·57	35	31·00	61	13·82	87	3·71
10	48·82	36	30·32	62	13·31	88	3·59
11	48·04	37	29·64	63	12·81	89	3·47
12	47·27	38	28·96	64	12·30	90	3·28
13	46·51	39	28·28	65	11·79	91	3·26
14	45·75	40	27·61	66	11·27	92	3·37
15	45·00	41	26·97	67	10·75	93	3·48
16	44·27	42	26·34	68	10·23	94	3·53
17	43·57	43	25·71	69	9·70	95	3·53
18	42·87	44	25·09	70	9·18	96	3·46
19	42·17	45	24·46	71	8·65	97	3·28
20	41·46	46	23·82	72	8·16	98	3·07
21	40·75	47	23·17	73	7·72	99	2·77
22	40·04	48	22·50	74	7·33	100	2·28
23	39·31	49	21·81	75	7·01	101	1·79
24	38·59	50	21·11	76	6·69	102	1·30
25	37·86	51	20·39	77	6·40	103	0·83

EXPE'CTORANTS. (Lat. expectorare, *to expectorate.*) Medicines which increase the secretion of the tracheal and bronchial mucus. The term *expectoration* is applied to any thing cast off from those vessels or from the cells of the lungs by spitting or coughing.

EXPIA'TION (Lat.) signifies, in its most extended meaning, the act by which a guilty person makes atonement to religion, morals, or society at large, for any crime or fault he may have committed, whatever be its nature or extent. The belief in the efficacy of expiation as a means of compensating for a breach of the moral law, formed an important feature in all the religious creeds with which we are acquainted. In this respect, there is a wonderful coincidence in the mythological system of the ancients, the creed of the Jews, and that of the Christian world. These ceremonies, of course, were very diversified, and varied with the character of every nation and the nature of the crime which it was intended to expiate. Among the Greeks and Romans, expiations were sometimes made for whole cities; and, in the more ancient times, to remove or prevent, or to avert an impending calamity, human victims were immolated. We need here hardly advert to the numerous kinds of expiations in use among the Jews, as the Old Testament is filled with accounts of them; and under the heads ATONEMENT and SACRIFICE, we have defined the great act of expiation by which the guilt of the human race has been atoned for, and God reconciled to man in the Christian dispensation.

EXPILA'TION. In the Roman Law, any injury done to the property of a minor was so designated.

E'XPLETIVE. (Lat. expleo, *I fill up.*) In Composition, chiefly poetical; a word not necessary to the sense, but used merely to fill up the measure of a verse, or give roundness to a period.

EXPLO'SION. (Lat. explosio.) In Natural Philosophy, a sudden and violent expansion of the parts of any object. Explosion differs from expansion in this, that whereas the former is always sudden, and only of momentary duration, the latter is the effect of some gradual and continued power, acting uniformly for some considerable time. See EXPANSION; MATTER, PROPERTIES OF.

EXPO'NENT, in Algebra, is used in various senses; thus we say the *exponent* of a power, the *exponent* of a rank, the *exponent* of a ratio. The exponent of a power is a number or algebraic character expressing the degree or elevation of the power to which the quantity is raised. For example, in the expression a^4, 4 is the exponent, denoting that a is raised to the fourth power. In the expression a^m the exponent m is indeterminate, as it may represent any number whatever. The exponent may also be fractional, in which case it denotes not the power, but the root of the quantity; thus $a^{\frac{1}{3}}$ denotes the

third or cube root of a. Or it may be negative, in which case it denotes the quotient that arises from the division of unit by the quantity raised to that power; for example, a^{-n} is the same thing as $\frac{1}{a^n}$. The earliest writers on algebra denoted the powers of numbers by an abbreviation of the name of the power. Harriot repeated the quantity, and for a^4 wrote $a\,a\,a\,a$; the present convenient system was introduced by Descartes.

The exponent of a rank is the number or place of any term in a series; thus, in the series of uneven numbers, 1, 3, 5, 7, 9, 11, 13, 15, &c., 7 is the exponent of the rank of the term 13, because 13 is the 7th term from the commencement.

The exponent of a geometrical ratio is the quotient that arises from dividing the consequent by the antecedent of the ratio. Thus, in the ratio of 2 to 8, the exponent is $\frac{8}{2}=4$; and in the ratio of 8 to 2, the exponent is $\frac{2}{8}=\frac{1}{4}$ Some mathematicians, however, consider logarithms as the exponents of ratios.

EXPONE'NTIAL. This term is variously applied. The *exponential calculus* is the method of performing algebraic operations on *exponential quantities*, by which is understood quantities raised to powers of which the exponents are indeterminate or variable. *Exponential curve* is a curve defined by an exponential equation, or an equation of the form $y=a^x$, or $y=x^x$. *Exponential equation* is an equation which contains an exponential quantity. Thus $y=x^x$ is an exponential equation. These equations are commonly resolved by means of logarithms. For example, if we had the equation $a^x=b$, in which x is the unknown quantity, by taking the logarithms of both sides we should get $x\log.a=\log.b$ and consequently $x=\frac{\log.b}{\log.a}$. But this method of solution is not always possible; for in the equation $ax+b^{2x}=c$ (and an infinity of others), the value of x can only be found by trial and error. *See* LOGARITHM.

EXPORTA'TION. The act of sending commodities out of one country into another. *See* COMMERCE.

EX POST FACTO. (Lat. literally, *by something done afterwards.*) A punishment inflicted in consequence of a law made with a view to a particular offence already committed is said to be inflicted ex post facto; and the phrase "an ex post facto law," is popularly applied to all laws enacted with a retrospective effect, and with intention to produce that effect, which are justly regarded as tyrannical. That species of laws which the Romans termed *privilegia*, i.e. laws passed in order to impose restrictions on individual citizens, were frequently ex post facto. The English practice of a *bill of pains and penalties* is a species of ex post facto legislation, and was much animadverted on in the debates which took place on the occasion of its adoption against Queen Caroline in 1820.

EXPOSURE OF CHILDREN. *See* FOUNDLINGS.

EXPRE'SSION. (Lat. expressio.) In the Fine Arts, the representation of the various passions of the mind. "Care," says Sir Joshua Reynolds in his Fourth Discourse, "must be taken not to run into particularities. Those expressions alone should be given to the figures which their respective situations generally produce. Nor is this enough; each person should also have that expression which men of his rank generally exhibit. The joy or the grief of a character of dignity is not to be expressed in the same manner as a similar passion in a vulgar face."

E'XTANT. (Lat.) In Literature, something that still exists or is in being. Thus it is said that but part of the writings of Livy, Cicero, Cæsar, &c. are *extant*, the rest being lost.

EXTE'MPORE. (Lat.) A term applied to any thing that is done without premeditation. *See* VOLUNTARY.

EXTE'NT, in Law, is a writ of execution (sometimes called an *extendi facias*), directed to the sheriff, against the body, lands, and goods, or the lands only, of a debtor. Writs of extent were of two kinds — extent *in chief*, and extent *in aid;* to both of which the king was entitled by ancient prerogative, for the purpose of obtaining satisfaction of debts originally due to him, or assigned to the crown. The writ of *extent in chief* is a proceeding by the king for the recovery of his own debt, and in which he is the real plaintiff. The writ of *extent in aid* is also sued out at the instance and for the benefit of the crown against the debtor of a crown debtor; but in this proceeding the king is the nominal plaintiff only. Under this writ the lands, tenements, and possessions, as well as the person of the defendant, may be taken in execution; and if within seven days he do not liquidate the debt, a writ of "venditioni exponas is issued to sell the same;" the crown claiming a priority of satisfaction over every other creditor.

E'XTRACT, or EXTRACTIVE MATTER. The term extract is applied in pharmacy to the brown substance which remains after the evaporation of certain decoctions or infusions of vegetables; thus we have *extract of bark*, *extract of rhubarb*, and so on. These extracts are usually mixtures of gum, starch, sugar, or other soluble matters, along with a certain portion of a peculiar vegetable principle of a brown colour, or which becomes so by exposure to air, and which is soluble in water and in alcohol, but scarcely soluble in ether. It combines with alumina, and is often the basis of brown dyes: it is this principle which chemists call *extractive*, and which is frequently closely allied to various forms of colouring matter.

EXTRACT OF LEAD. A term applied to the impure subacetate of lead obtained by boiling litharge in vinegar. It was first used by a surgeon of the name of Goulard, and hence called *Goulard's extract of lead.*

EXTRA'CTION OF ROOTS. An operation which consists in finding a certain *root* of a number or algebraic quantity; or in finding that number or quantity which, multiplied into itself a certain number of times, will produce the given number or quantity. If we take the series of numbers,

1, 2, 3, 4, 5, 6, 7, 8, 9, 10,

and multiply each into itself, we shall obtain the series of *2d powers* or *squares*,

1, 4, 9, 16, 25, 36, 49, 64, 81, 100;

and multiplying each of these again by its corresponding number in the first column, we get the series of *3d powers* or *cubes*,

1, 8, 27, 64, 125, 216, 343, 512, 729, 1000.

Taking any one of the first series of numbers, for example 7, we see that its 2d power (the 1st power is the number itself), or square, is 49, and its 3d power, or cube, 343. Reciprocally, 7 is said to be the 2d or square root of 49, and the 3d or cube root of 343. It is obvious, on inspecting the above series, that out of all the numbers, consisting of one or two digits, there are only nine which are the squares of other whole numbers; and that of all numbers composed of not more than three digits, that is to say, all numbers up to 999, there are only nine which are the cubes of whole numbers. The roots of all the other whole numbers are not only not integers, but, what is very remarkable, are not expressible by exact fractional numbers, and it is only approximations to their values that can be found.

The rules for extracting the square and cube roots of numbers are to be found in every elementary treatise of arithmetic; but require too many explanations and illustrations to be introduced here to any good purpose. The extraction of the cube root in particular is an intricate and laborious operation; and, since any root of a number can be found immediately from a table of logarithms, it is an operation of very little use. It is to be regretted that so much time as is frequently given to it in our schools should be so unprofitably employed.

The general solution of algebraic equations exceeding the fourth degree, has hitherto resisted the efforts of the greatest mathematicians; but in the case of equations with numerical coefficients (whatever the order of the equation) a value of the unknown quantity, that is, a root of the equation, can always be found by an arithmetical process. A general method of accomplishing this was first given by Vieta; another was proposed by Newton, which has been very commonly employed; but the important discovery by Mr. Horner of Bath of an easy means of performing the arithmetical computations required in Vieta's method has greatly simplified the operation, and in fact rendered the solution of an affected equation of any degree scarcely more laborious than the ordinary process of extracting the cube root. For an account of Horner's method, first published in the *Philosophical Transactions* for 1819, see *Young's Theory of Algebraic Equations;* or the *Companion to the British Almanac* for 1839, in which the reader will find an interesting historical account of the progress of the problem of evolution.

EXTRA'DOS. The exterior curve of an arch. Generally the term is used to denote the upper curve of the *voussoirs*, or stones which immediately form the arch.

EXTRAVAGA'NTES CONSTITUTIONES. In the Canon Law, certain papal constitutions not included in the Corpus Juris Canonici are so called, and comprised in a separate volume. They are those of John XXII. and a few of his successors in the papacy.

EXTRAVASA'TION. (Lat. extra, *external to*, and vas, *a vessel.*) A term applied to fluids when out of their proper receptacles or vessels. Thus when blood is thrown out upon the brain, or into any of the cavities of the body, it is said to be extravasated.

EXTRE'ME. (Lat. extremus.) In Logic, has the same meaning with *term*, when used in reference to a proposition. The subject and predicate are the two extremes of a proposition, the copula being, as it were, placed between them. In speaking of a syllogism, the extremes are understood to mean the extremes or terms of the conclusion.

EXTREME. In Music, a word employed in describing

those intervals in which the diatonic distances are increased or diminished by a chromatic semitone.

EXTREME AND MEAN RATIO. A straight line is said to be divided in extreme and mean ratio when the whole is to the greater part as the greater part to the less; or when the rectangle contained by the whole line and the smaller segment is equal to the square of the greater segment. Euclid shows how a line may be divided in this manner in the 11th prop. of his 2d book; and it is by means of this proposition that he constructs the decagon on a given straight line.

EXTRE′ME U′NCTION. One of the seven sacraments of the Romish church, founded upon the passage in the Epistle of St. James in which he says, "If any be sick among you, let him call upon the elders of the church, and let them pray over him, anointing him with oil in the name of the Lord." (v. 14.) The performance of this ceremony is supposed to purify the soul of the dying person from any sins that he may have committed, and which have not been previously expiated by participation in the other means of grace. The Protestants usually answer the text above cited by continuing the quotation to the next verse, where it is said, "And the prayer of faith shall save the sick, and the Lord shall raise him up;" from which they argue that reference is made to a miraculous gift which was exercised in the Apostles' time, and has no application to our days. With respect to the usage of antiquity, to which the Romanists lay claim, it is answered that the passages to which they refer allude to the ceremony not as a sacrament for the good of the soul, but only as a rite that carried with it health to the body. When the Apostle goes on to say, that the Lord will forgive the sins of the sick man, this evidently supposes him to have a lively faith; and that such faith is the condition of the miraculous cure.

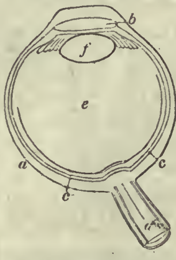
EXTRE′MITIES. (Lat. extremus.) In Painting and Sculpture, the head, the hands, and the feet. In Zoology, the arms and legs, and analogous members in the lower animals.

EXTRO′RSAL. A term used in describing the direction of bodies to denote their being turned from the axis to which they appertain; thus anthers, whose line of dehiscence is towards the petals, are said to be extrorsæ.

EXU′VIÆ. (Lat. *cast clothes.*) This term was applied by the Roman naturalists and poets to the shed skin of the snake: "Positis exuviis novus coluber," says Virgil. And it is extended in modern zoology to the external layer of the integument of every animal, when it is periodically shed entire or in large portions. The films of mucus thrown off from the external surface of most zoophytes and mollusks may be regarded as exuviæ; also those portions of the shell which are deserted and partitioned off by a new-formed plate, as in the *Spondylus varius*, and univalve chambered shells; but the exuvial layers are retained by adhesion to the last secreted portion of the shell. In insects the whole integument is shed generally several times in succession, the last *cadysis* taking place in the transition from the pupa to the imago state. In the *Crustacea* the exuvial shell is commonly cast annually; the cephalo-thorax or carapace cracks longitudinally down the back, and the limbs are withdrawn after successive painful efforts; the lining membrane of the stomach is at the same time shed.

Fishes seem to cast off exuvial layers of mucus only; but in most reptiles the epidermis is periodically moulted, either entire or in large coherent masses. In some species the moulting could only have been detected by careful watching, as the main evidence, the cast skin, is made away with the moment the operation is ended. Mr. Bell thus describes the *cadysis* of the common toad: — "On watching carefully I one day observed a large toad, the skin of which was particularly dry and dull in its colours, with a bright streak down the mesial line of the back; and on examining further, I discovered a corresponding line along the belly. This proved to arise from an entire slit in the old cuticle, which exposed to view the new and brighter skin underneath. Finding therefore what was about to happen, I watched the whole detail of this curious process. I soon observed that the two halves of the skin thus completely divided continued to recede further and further from the centre, and become folded and rugose; and after a short space, by means of the continued twitching of the animal's body, it was brought down in folds on the sides: the hinder leg, first on one side and then on the other, was brought forward under the arm, which was pressed down upon it; and on the hinder limb being withdrawn, its cuticle was left inverted under the arm, and that of the anterior extremity was now loosened, and at length drawn off by the assistance of the mouth. The whole cuticle was thus detached, and was now pushed by the two hands into the mouth in a little ball, and swallowed at a single gulp." The common snake (*Coluber natrix*) when in confinement moults as follows: — The formation of the new cuticle produces a detachment of the old from the subjacent living parts, and the latter then loses part of its transparency and smoothness. As the cuticle is continued over the cornea, the sight of the serpent is dimmed; its motions are also in some degree cramped, and it endeavours to free itself of its incumbrance by rubbing the sides of its mouth against any rough and hard resisting substance. The old cuticle is thereby detached from the circumference of the mouth, and is turned back over the head; and the impediment to vision being thus removed, the snake proceeds with more vigour and rapidity to detach and turn back the cuticle, by repeating the same actions as those with which it commenced the operation; and at length it literally creeps out of its skin, which is left inverted, and more or less entire, according to the degree of the animal's health and vigour at the time of the operation. The rattle-snake is described as actually inverting and drawing off its own skin. After having rubbed back the cuticle from the head, it throws the posterior part of the body in numerous coils around the anterior; one coil is placed in front of the detached part of the integument; and compressing the body strongly, it pushes forward the head and neck, gradually unfolding the coils behind, and stripping off the skin, as it advances forwards. In the warm-blooded classes the periodically moulted feathers of birds, and hairs of various species of Mammalia, may be regarded as exuvial deposits; as also the small scales of the scarf-skin which are incessantly cast off in man.

EYE. In describing the structure of the organ of vision anatomists generally refer to external and internal parts: the former include the eyebrows, or *supercilia*; the eyelashes, or *cilia*; and the eyelids, or *palpebræ*. The cartilaginous edge of the eyelids is called the *tarsus*, in which, and in the inner surface of the eyelids, are small glands which secrete a lubricating serous fluid, called, after their discoverer, the glands of Meibomius. Near the external corner or *canthus* of the eye, and in a depression of the frontal bone, are the lachrymal glands (*glandulæ lachrymales*), which secrete tears; their ducts open on the inner surface of the upper eyelid. The little projection at the inner angle of the eye is called the *lachrymal caruncle*. There are also two small orifices observable at the inner angle, one in the upper and one in the lower eyelid, which are called the *puncta lachrymalia;* they convey the tears by means of two small tubes to the *lachrymal sac*, from whence they pass by the *nasal duct*, which opens under the inferior spongy bone into the nose. The conjunctive membrane of the eye, called also *tunica albuginea*, or white of the eye, is a membrane which lines the inner eyelids and the fore part of the globe of the eye. The internal parts of the eye are, the *sclerotic membrane*, which is the hard outer case of the globe; the *choroid membrane*, which is the interior coat of the sclerotic, beginning around the optic nerve, and proceeding to the margin of the transparent cornea, where it deflects inwardly, forming the *iris*, the posterior surface of which is called the *uvea*, and its central opening the *pupil*, which is muscular, admitting of dilatations and contractions so as to modify the quantity of light admitted into the inner chambers of the eye. The *crystalline lens* is a pellucid body included in a delicate *capsule*, and lodged in a concave depression of the front of the *vitreous humour*, which is a transparent and pellucid pulpy texture, filling the ball of the eye behind the lens, and covered externally by the *hyaloid* or *arachnoid* membrane. The optic nerve enters the back of the eyeball by a perforation in the sclerotic and choroid coats, and is spread upon the posterior and inner surface of the latter, forming a pulpy film or nervous matter called the *retina*. The eye is moved by six appropriate muscles. In the annexed cut, representing a section of the ball of the eye, *a* is the sclerotic membrane or coat, *b* the iris, *c* the retina, *d* the optic nerve, *e* the vitreous humor, and *f* the crystalline lens. *See* VISION.



EYE OF A DOME. In Architecture, the circular aperture in its summit.

EYE OF A VOLUTE. In Architecture, the circle in its centre.

EYE′TEETH. The two upper *cuspidati* are so called in consequence of the length and direction of their fangs, which extend upwards nearly to the orbit of the eye.

EYRE, in Law, signifies the court of justices itinerant. The term is in all probability derived from the Lat. iter, *journey;* as Bracton styles the justices who presided in these courts *justiciarii itinerantes*.

F.

F. The sixth letter of the English and Latin alphabets; a labiodental aspirate, "bearing the same relation to the other labiodental aspirate, V, which the letters called *tenues*, *p*, *k*, *t*, bear to the *mediæ*, *b*, *g*, *d*." It corresponds with the Digamma (quod vide) of the Æolian dialect, to which it is closely related both in form and power; and is susceptible of a few interchanges, chiefly in the Spanish and Latin languages.

F, or FA. In Music, the note on the fourth line in the bass clef generally; but it stands on the third line when the part is Barytone. The ordinary character of the F or bass cleff is 𝄢, which Kepler has much laboured to deduce from F itself.

FA. In Music one of the syllables invented by Guido Aretino to mark the fourth sound of the modern scale of music; rising thus, *ut*, *re*, *mi*, *fa*.

FABACEÆ. (Faba, *a bean*.) An extensive natural order of plants. *See* LEGUMINOSÆ.

FA'BLE. (Lat. fabula.) In Literature, a term applied originally to every fictitious tale; but confined in modern usage to a class of tales, either in prose or verse, which inculcate a moral precept through the medium of a short fictitious story. In the very ancient Indian Fables of Pilpay, the Arabian of Lockman, and the Greek of Æsop, the fictitious personages introduced are chiefly animals, endued for the purpose of the story with human faculties and language; and hence modern fabulists have generally introduced similar agents in the greater number of their fables. In this sense, the fable is synonymous with apologue, and a species of the class allegory. Fables are either in prose or verse; but if the latter, they will not bear with propriety a highly poetical or ornamented character. Herder has divided fables, according to the character of their meaning, into three classes: — 1. Theoretic, intended to form or exercise the understanding; 2. Moral, which contain rules for the regulation of the will; 3. Fables of fate or destiny, in which the narrative contains no maxim of self-conduct, as it merely represents a series of contingencies brought on by necessary connection. But it may be doubtful whether every fable, in the sense in which the name is generally used, does not belong properly to the second class; the instances cited by Herder as appertaining to the first and third were certainly intended by the inventors to bear a moral meaning.

FA'BLIAUX. In French literature, the metrical tales of the Trouvères or early poets of the Langue d'Oil, or dialect of the north of France; composed, for the most part, in the 12th and 13th centuries.

FAÇA'DE. (Fr.) In Architecture, the face or front of any building towards a street, court, garden, or other place; a term, however, more commonly used to signify the principal front.

FACE, in Geometry, denotes in general one of the planes which form the surface of a polyhedron. In Fortification, *face* denotes a line of rampart, or the extent between the outermost points of two adjacent bastions.

FA'CIAL ANGLE, is that angle which is formed by the concurrence of two ideal lines, one of which passes by the hole in the skull termed the meatus auditorius externus to the anterior extremity of the alveolar margin of the upper jaw, while the other extends to the same point from the most prominent part of the forehead.

FA'CIES. (Lat.) In Zoology, a term applied to express the general aspect or external character of an animal, as it appears on a casual or first view; mostly with reference to another to which it bears a superficial resemblance.

In Anatomy, it signifies the anterior part of the skull forming cavities of the orbits, nose, and mouth.

FA'CIES HI'PPOCRA'TICA. The peculiar expression of countenance which indicates the approach of death; it has been accurately described by Hippocrâtes, whence the above common medical term.

FA'CING. In Architecture, that part of the work in a building seen by a spectator; but the term is usually employed to signify a better sort of material which masks an inferior one internally.

FAC SIMILE (Lat. facere, *to make*, and simile, *like*), expressed in French by the words *fais-semblable*, signifies an exact and faithful copy of any writing, engraving, or other work of art.

FA'CTION. (Lat.) In Ancient History, an appellation given to the different troops or companies of combatants in the games of the circus. Of these factions there were four,—the green, blue, red, and white; to which two others were said to have been added by the emperor Domitian, — the purple and the yellow. In the time of Justinian 40,000 persons were killed in a contest between two of these factions; so that they were at last suppressed by universal consent. The term faction is applied also, in a more general sense, to any party in a state which attempts without adequate motives to disturb the public repose, or to assail the measures of government with uncompromising opposition. In the ancient Greek republics, faction was carried to an extent unparalleled in modern times. "We may always observe," says Hume (*Essays*, vol.i. 423.), "where one party (faction) prevailed, whether the nobles or people (for I can see no difference in this respect), that they immediately butchered all of the opposite party that fell into their hands, and banished such as had been so fortunate as to escape their fury. No form of process, no law, no trial, no pardon." The middle ages were distinguished chiefly by two factions, the Guelfs and Guibelins, who long kept Italy in a state of alarm. In the present day, in England, the term *faction* is bandied about between the three great parties of the country, the Whigs, Tories, and Radicals, being applied indiscriminately by the adherents of one party to those of the other. *See* PARTY.

FA'CTOR. (Lat. facio.) In Mercantile Law, a mercantile agent, who is entrusted with the possession of the property which he is commissioned to dispose of. Under the law which obtained previously to the passing of the act 6 G. 4. c 94. it was held that a factor, as such, had authority to sell only, and not to pledge, the goods of his principal; and, consequently, that a party who had made a bonâ fide advance to the factor on the credit of the goods was liable to restore them to the principal without his being bound to repay the advance. By that statute it is enacted, that any person intrusted, for the purpose of consignment or sale, with goods, &c., and in whose name such shall have been shipped, shall be deemed the true owner, so far as to entitle the consignee to a lien thereon in respect of any money or negotiable security advanced by such consignee for the use of the person in whose name such goods, &c. shall have been shipped; provided the consignee has no notice, by bill of lading *or otherwise*, that such party is not the true owner. Various other provisions are added by the same act, to the effect that persons in possession of bills of lading shall be deemed owners, so far as to make valid contracts; that no person can acquire a security upon goods in the hands of an agent for an antecedent debt beyond the amount of the agent's interest in the goods; that persons may contract with known agents in the ordinary course of business, or out of that course, if within the agent's authority; that person may accept and take goods in pledge from known agents; and a right is preserved to the true owner to follow his goods, while in the hands of his agent or the agent's assignee, in case of the bankruptcy of such agent or assignee. A factor has a general lien on goods consigned to him, not only for incidental charges, but as an item of mutual account for the balance due to him, as long as he remains in possession.

In Scotland, the term *factor* is used synonymously with *steward* in England.

FACTOR, in Arithmetic and Algebra, is the name given to each of the quantities which we multiply into one another in order to form (*facere*) a product; that is to say, to the multiplicand and the multiplier. Factors are otherwise called *divisors*, especially in speaking of a number which is regarded as the product of several others.

FA'CTORY. Establishments supplied with machinery for the purpose of carrying on any branch of manufacture, are usually called *factories*. Hence we have woollen, cotton, flax, &c. factories, according to the different branches of industry carried on in each. Factories on an extensive scale are to be found only in countries far advanced in civilization, and where the arts are highly improved. In rude countries, and in the earlier stages of society, manufactures are necessarily carried on upon a small scale, with very imperfect instruments, and little or no division of labour. In factories, on the contrary, the most improved machinery is introduced; every individual has a peculiar task to perform, in the execution of which he cannot fail to acquire the greatest proficiency. We need not, therefore, be surprised to learn that, wherever factories are generally introduced; domestic manufactures are totally superseded, as all classes find it to be more for their advantage to buy the products furnished by the factories than to attempt to supply themselves with similar products by their own labour.

Many complaints have been made as to the injurious influence of factory labour on the health of the labourers, and especially of the young persons, employed in them. This, however, is a subject as to which there has been much misrepresentation. Children, that is, young persons between the ages of nine and fourteen years, as well as adults, are largely employed in factories; and, while the health and morals of the latter are said to suffer severely, the former have been described as being stunted in their growth, and rendered decrepit and miserable for life, by the prolonged confinement, drudgery, and ill treatment to which they are exposed. These representations of the injurious effects of what has been called *white slavery*, were at length embodied in a Report of a Committee of the House of Commons in 1832. We believe, however, that we run little risk in affirming that this report contains more false statements and

exaggerated representations than any other document of the kind ever laid before the legislature. It made a great sensation; and the discussions to which it, or rather the proposal that grew out of it, for limiting factory labour to ten hours a day, gave rise, induced government to appoint a commission to inquire, on the spot, into the actual condition of the labourers, and especially of the children, employed in factories. This commission collected a great deal of valuable and authentic information; and much light has since been thrown on the question of factory labour. It were absurd to pretend, as some have done, that the statements and representations as to its pernicious influence have been proved to be *wholly* destitute of foundation; but they have been shown to be very greatly exaggerated. That great inattention to cleanliness, and some very revolting abuses, have existed in some factories, particularly in those of the smaller class, is quite certain; but the instances of abuse bear but a small proportion to the total number; and, speaking generally, factory work-people, including non-adults, are as healthy and contented as any class of the community obliged to earn their bread in the sweat of their brow.

We do not, however, know that we should object to the total exclusion of children, from nine to thirteen years of age, from factories, provided we had any reasonable security that they would be moderately well attended to and instructed at home. But no such security is to be looked for. The parents of such children frequently want the ability, oftener the opportunity, and sometimes the wish, to keep them at home in any thing like a decent condition; to provide them with instruction, or to impress on them the importance of habits of cleanliness, sobriety, and industry. Were they turned out of the factories, few would either go to the country or to school. Four fifths of them would be thrown loose upon the streets, to acquire a taste for idleness, and to be early initiated in the vicious practices prevalent amongst the dregs of the populace in Manchester, Glasgow, Leeds, and other great towns. Whatever may be the state of society in these towns, we hesitate not to say that *it would have been ten times worse but for the factories.* They have been their best and most important academies. Besides taking the children out of harm's way, they have imbued them with regular, orderly, and industrious habits. Their earnings are considerable, and are a material assistance to their parents; at the same time that they make them perform their tasks with a zeal and alacrity that is rarely manifested by apprentices serving without pay, merely that they may learn some art, trade, or mystery. Many factories have also day schools, or Sunday schools, or both, attached to them, which the children attend. But, independently of this, the training they undergo in factories is of inestimable value, and is not more conducive to their own interests than to those of the public.

Besides supposing that the health of the population is injured by the extension of manufactures, it has been supposed that the extreme subdivision of labour in manufacturing establishments, and the undivided attention which every one employed in them must give to the single operation in which he is engaged, has a most pernicious influence over the mental faculties. The genius of the master is said to be cultivated, but that of the workmen to be condemned to perpetual neglect. "Many mechanical arts," says Dr. Ferguson (*Essay on Civil Society*, p. 303.), "require no capacity; they succeed best under a total suppression of sentiment and reason; as ignorance is the mother of industry as well as of superstition. Reflection and fancy are subject to err; but a habit of moving the hand or the foot is independent of either. Manufactures accordingly prosper most when the head is least consulted, and where the workshop may, without any great effort of imagination, be considered as an engine, the parts of which are men." Similar statements have been made by others. Even Dr. Smith, who has given so beautiful an exposition of the benefits derived from the division of employments, has in this instance concurred with the popular opinion, and has not hesitated to affirm that constant application to one particular occupation in a large manufactory "necessarily renders the workmen as *stupid and ignorant as it is possible to make a human being*." Nothing, however, can be more marvellously incorrect than these representations. Instead of its being true that the workmen employed in manufacturing establishments are less intelligent and acute than those employed in agriculture, the fact is distinctly and completely the reverse. The weavers and other mechanics of Glasgow, Manchester, and Birmingham, possess far more information than is possessed by the agricultural labourers of any county in the empire. And this is really what a less prejudiced inquiry into the subject would have led us to anticipate. The various occupations in which the husbandman has successively to engage, their constant liability to be affected by so variable a power as the weather, and the perpetual change in the appearance of the objects which daily meet his eyes, and with which he is conversant, occupy his attention, and render him a stranger to that ennui and desire for extrinsic and adventitious excitement which must ever be felt by those who are constantly engaged in burnishing the point of a pin, or in performing the same endless routine of precisely similar operations. This want of excitement cannot, however, be so cheaply or effectually gratified in any way as it may be by cultivating, that is, by *stimulating*, the mental powers. Workmen in general have no time for dissipation; and if they had, the wages of labour are too low, and the propensity to save and accumulate too powerful, to allow of any large proportion of them seeking to divert themselves by indulging in riot and excess. They are thus driven to seek for recreation in mental excitement; and their situation affords them every facility for amusing and diverting themselves in this manner. Agricultural labourers, spread over a wide extent of country, are without the means of assembling, except on some rare occasions, for the purpose either of amusement or instruction; but, by working together, those engaged in manufacturing establishments have constant opportunities of discussing all topics of interest and importance. They are thus gradually trained to habits of thinking and reflection; their intellects are sharpened by the collision of conflicting opinions; and a small contribution from each individual enables them to establish lectureships and libraries, and to obtain a large supply of newspapers and periodical publications. But whatever doubt may exist respecting the *cause*, whether it be ascribed to the better elementary instruction of the lower classes in towns and villages, or to the circumstances under which they are placed in after life, there can be none as to the fact that the intelligence of manufacturing workmen has increased according as their numbers have increased, and as their employments have been more and more subdivided. There is not, we apprehend, any real ground for supposing that they were ever less intelligent than the agriculturists; though, whatever may have been the case formerly, none will now venture to affirm that they are inferior to them in mental acquirements, or that they are mere machines without sentiment or reason.

No statutory restrictions respecting the employment of children in the mills and factories of the United Kingdom existed until the year 1802, when an act of parliament was passed (42 Geo. 3.) for the preservation of the health and morals of apprentices and others employed in cotton and other factories; and directing the magistrates to report whether the factories were conducted according to law; and to adopt such sanatory regulations as they might think fit. This act was followed, in 1816, by an act, generally called Sir Robert Peel's Act, imposing various regulations on the employment of children in cotton-mills.

Both of these acts were repealed in 1831 by an act, 1 & 2 Will. 4. c. 39., commonly called Sir John Hobhouse's Act, which provided that in cotton factories, to which alone it related, no child could legally be employed till it had attained the age of 9 years; and that no person under 18 years of age could be suffered to remain in the factories more than 12 hours in one day; and that on Saturdays they should only be employed in the factories for 9 hours.

Sir John Hobhouse's Act was repealed, in 1833, by the act 3 & 4 Will. 4. c. 103., which contains the following provisions, comprehending the whole statutory regulations at present applicable to cotton and other factories in the United Kingdom: —

1. That after the 1st of January, 1834, no person under 18 years of age shall be allowed to work in the night; that is, between half-past 8 P. M. and half-past 5 A. M., in any cotton or other factory in which steam, or water, or any other mechanical power, is or shall be used to propel the machinery, excepting in lace-factories.

2. That no person under 18 shall be employed more than 12 hours in one day, nor more than 69 hours in one week.

3. That there shall be allowed, in the course of every day, not less than $1\frac{1}{2}$ hour for meals to every person restricted to the performance of 12 hours' work.

4. That after the 1st of January, 1834, no child, except in silk mills, shall be employed who shall not be 9 years old.

5. That after the 1st of March, 1834, no child, except in silk-mills, shall be employed in any factory more than 48 hours in any one week, nor more than 9 hours in any day, who shall not be 11 years old; nor after the 1st of March, 1835, who shall not be 12 years old; nor after the 1st of March, 1836, who shall not be 13 years old; and that these hours of work shall not be exceeded, even if the child has worked during the day in more factories than one.

6. That children, and young persons whose hours of work are regulated, shall be entitled to 2 holidays and 8 half-holidays in every year.

7. That children, whose hours of work are restricted to 9 hours a day, are not to be employed without obtaining

a certificate from a physician or surgeon, certifying that they are of the ordinary strength and appearance of children of the age before mentioned, which certificate is to be countersigned by some inspector or justice.

8. That it shall be lawful for his majesty to appoint, during pleasure, 4 persons to be inspectors of factories, with extensive powers as magistrates, to examine the children employed in the factories, and to inquire respecting their condition, employment, and education; and that one of the secretaries of state shall have power, on the application of an inspector, to appoint superintendents to superintend the execution of the act.

9. That those inspectors are to make all rules necessary for the execution of the act, and to enforce the attendance at school, for at least 2 hours daily, out of 6 days in the week, of children employed in factories; from whose weekly wages a deduction, not exceeding 1 penny in every shilling, for schooling, shall be made.

10. That no child shall be employed who shall not, on Monday of every week, give to the factory master a certificate of his or her attendance at school for the previous week.

11. That the interior walls of every mill shall be whitewashed every year.

12. That a copy or abstract of the act shall be hung up in a conspicuous part of every mill.

13. That the inspectors shall regularly, once a year, report their proceedings to one of the secretaries of state.

The act also contains regulations extending the hours of work, where time shall be lost by the want of or an excess of water in mills situated upon a stream of water; respecting the steps to be taken in order to obtain regular certificates of age for the children requiring them; respecting the erection of schools where necessary; and respecting the proceedings to be had before inspectors and magistrates for enforcing the act, and the right to appeal from their decisions.

Account of all the Cotton, Woollen, Worsted, Flax, and Silk Mills or Factories in each County of England and Wales, and in the Kingdom, in the Year 1838; specifying the Amount and Description of the Moving Power, and the Number, Age, and Sex of the Persons employed in the same: compiled from Returns of the Factory Inspectors, printed by Order of the House of Commons in 1839.

Counties.	No. of Mills.		Moving Power.					Actual Power employed.	Persons employed.					
			Steam.		Water.		Total Horse Power.		Under 9 Yrs. of Age.	Ages between 9 and 13.	Ages between 13 and 18.	Ages above 18.	Totals.	
	Working.	Empty.	Engines.	Horse Power.	Wheels.	Horse Power.							Males.	Females.
ENGLAND.—*Cotton Mills.*														
Chester	154	12	210	6,921	60	1,726	8,647	7,104	- -	1,190	11,970	23,192	17,676	18,676
Cumberland	13	- -	11	293	5	66	359	359	- -	21	764	1,200	720	1,265
Derby	76	7	56	960	91	2,138	3,098	2,753	- -	727	3,721	6,014	4,231	6,251
Gloucester	1	- -	1	20	- -	- -	20	20	- -	- -	21	8	15	14
Lancaster	1,125	62	1,008	29,909	272	3,558	33,467	33,422	- -	7,579	58,562	85 982	69,889	82,234
Leicester	3	- -	4	36	- -	- -	36	36	- -	- -	102	142	54	190
Middlesex	11	- -	11	131	- -	- -	131	131	1	14	212	312	289	250
Norfolk	1	- -	1	12	- -	- -	12	12	- -	- -	54	76	6	124
Nottingham	13	- -	9	170	9	137	307	307	- -	34	564	862	454	1,006
Salop	1	- -	2	28	- -	- -	28	28	- -	6	17	16	15	24
Stafford	15	- -	4	139	14	357	496	496	- -	230	658	1,190	734	1,344
Surrey	3	- -	2	26	- -	- -	26	26	- -	- -	60	128	78	110
Warwick	4	- -	5	155	- -	- -	155	17½	- -	3	14	67	43	41
York, ex. of W. Riding	69	4	31	619	38	515	1,134	1,134	- -	394	1,655	2,177	2,171	2,055
York, W. Riding	100	- -	67	1,170	83	980½	2,150½	2,071½	- -	744	3,327	4,172	3,491	4,722
	1,589	85	1,422	40,589	572	9,477½	50,066½	47,917	1	10,942	81,671	125,538	99,866	118,286
WALES.														
Flint	5	- -	7	108	5	140	248	144	- -	78	395	537	376	634
Totals	1,594	85	1,429	40,697	577	9,617½	50,314½	48,061	1	11,020	82,066	126,075	100,242	118,920
ENGLAND.—*Woollen.*														
Chester	13	- -	2	15	12	81	96	96	- -	30	54	90	135	39
Cornwall	8	- -	- -	- -	10	45½	45½	42	- -	1	88	117	9	197
Cumberland	14	2	- -	- -	15	135	135	135	- -	53	105	116	176	98
Derby	3	- -	1	6	3	31	37	26	- -	7	2	26	31	4
Devon	39	2	- -	- -	48	521	521	469¾	- -	286	585	938	360	1,450
Dorset	2	- -	- -	- -	3	26	26	24	- -	9	23	26	29	29
Durham	3	- -	2	39	1	10	49	39	- -	21	37	31	35	54
Essex	1	- -	- -	- -	1	4	4	4	- -	- -	6	4	6	4
Gloucester	96	29	49	843½	219	1,628½	2,472	1,987½	- -	91	2,010	3,314	2,677	2,738
Hampshire	2	- -	- -	- -	2	11	11	11	- -	- -	8	6	5	9
Hereford	4	- -	- -	- -	4	19	19	17	- -	8	5	15	23	5
Kent	1	- -	1	4	1	8	12	12	- -	- -	7	9	4	12
Lancaster	101	4	61	1,024	70	607	1,631	1,631	- -	947	1,726	2,274	3,086	1,861
Lincoln	1	- -	1	6	- -	- -	6	6	- -	- -	9	3	9	3
Middlesex	4	- -	3	22	2	8	30	30	- -	1	10	2	11	2
Monmouth	9	- -	- -	- -	10	25	25	19	- -	25	25	21	34	37
Norfolk	3	- -	2	9½	- -	- -	9½	9½	- -	20	35	66	83	38
Northampton	1	- -	- -	- -	1	8	8	8	- -	9	8	8	11	14
Northumberland	3	- -	- -	- -	4	28	28	28	- -	9	6	38	30	23
Oxford	8	- -	1	8	11	106	114	113	- -	26	146	104	187	89
Salop	4	- -	- -	- -	4	38	38	34	- -	3	24	30	53	4
Somerset	30	1	13	260	41	372	632	545	- -	179	773	1,181	1,188	945
Surrey	4	- -	2	36	2	36	72	72	- -	3	38	29	63	7
Westmoreland	14	- -	5	107	14	123	230	230	- -	41	198	143	201	181
Wilts	53	2	39	718	56	412	1,130	807	- -	62	1,250	1,916	1,976	1,252
York, ex. of W. Riding	63	7	15	248	52	424	672	672	- -	165	583	620	917	451
York, W. Riding	543	- -	362½	7,492	191	2,067	9,559	9,302	4	3,617	9,568	12,991	17,818	8,362
	1,029	47	559¼	10,838	777	6,774	17,612	16,369¾	4	5,613	17,330	24,118	29,157	17,908
WALES.														
Brecon	10	1	- -	- -	10	31	31	29½	- -	17	19	46	48	34
Cardigan	9	1	- -	- -	9	13	13	10	- -	12	8	16	33	3
Carmarthen	19	2	- -	- -	21	26	26	25	- -	30	34	33	72	25
Denbigh	8	1	- -	- -	9	41	41	35	- -	27	66	103	146	50
Glennorgan	15	1	1	4	15	51½	55½	48½	- -	50	40	50	56	81
Merioneth	25	3	- -	- -	26	54	54	48	- -	18	50	66	75	59
Montgomery	61	1	3	22	66	262	284	253	- -	174	362	187	507	216
Radnor	3	1	- -	- -	3	9	9	9	- -	2	8	17	19	8
Totals	1,179	58	563¼	10,864	936	7,261½	18,125½	16,827¾	4	5,943	17,917	24,636	30,113	18,387
ENGLAND.—*Worsted.*														
Chester	1	1	1	20	- -	- -	20	2	- -	- -	2	1	2	1
Derby	1	- -	- -	- -	2	36	36	36	- -	11	26	54	32	39
Durham	4	- -	6	116	1	20	136	136	- -	36	209	187	130	302
Lancaster	12	1	10	181	5	80	261	261	- -	68	419	437	337	587
Leicester	26	- -	25	421	- -	- -	421	409	- -	72	679	983	662	1,072
Lincoln	1	- -	1	4	- -	- -	4	4	- -	4	1	4	3	6
Norfolk	3	- -	3	90	1	12	102	192	- -	38	223	124	86	299
Northampton	1	- -	1	12	1	12	24	24	- -	13	24	20	11	46
Northumberland	1	- -	- -	- -	1	3	3	3	- -	- -	1	3	4	
Nottingham	4	- -	4	75	1	25	100	100	- -	- -	154	209	150	213
Salop	1	- -	1	22	- -	- -	22	22	- -	25	32	44	22	79
Stafford	2	- -	1	3	2	33	36	36	- -	- -	40	76	51	65
Warwick	2	- -	2	21	- -	- -	21	20	- -	- -	32	104	56	80
Worcester	9	- -	3	106	9	93	199	192	- -	63	252	381	156	540
York, ex. W. Riding	6	- -	1	25	5	70	95	95	- -	57	11,170	142	102	267
York, W. Riding	342	- -	225¾	4,767	87	929	5,696	5,325	5	4,142	619	10,468	6,890	19,344
Totals	416	2	283¾	5,863	115	1,313	7,176	6,857	5	4,529	13,883	13,217	8,694	22,940

TABLE — *continued.*

Counties.	No. of Mills.		Moving Power.					Actual Power employed.	Persons employed.					
	Working.	Empty.	Steam.		Water.		Total Horse Power.		Under 9 Yrs. of Age.	Ages between 9 and 13.	Ages between 13 and 18.	Ages above 18.	Totals.	
			Engines.	Horse Power.	Wheels.	Horse Power.							Males.	Females.
ENGLAND.—*Flax.*														
Cumberland - -	9	- -	2	66	8	97	163	163	- -	16	144	206	57	309
Derby - - -	1	- -	1	16	3	15	31	31	- -	15	40	41	23	73
Devon - - -	3	1	- -	- -	4	51	51	45	- -	1	28	72	10	91
Dorset - - -	18	1	4	72	21	202	274	214	- -	19	250	387	113	543
Durham - - -	8	1	7	126	2	35	161	161	- -	- -	164	258	100	322
Gloucester - -	3	- -	4	63	- -	- -	63	39	- -	2	66	71	18	121
Hampshire - -	2	- -	- -	- -	2	28	28	28	- -	- -	52	54	3	83
Kent - - -	1	- -	1	20	- -	-	20	20	- -	- -	37	38	37	38
Lancaster - -	16	2	21	480	3	42	522	522	- -	78	1,392	1,411	1,083	1,798
Lincoln - - -	1	- -	2	24	- -	- -	24	24	- -	- -	33	29	19	43
Middlesex - -	3	- -	4	68	1	2	70	56	- -	2	4	57	10	53
Northumberland -	3	- -	4	74	1	12	86	86	- -	- -	120	132	42	210
Salop - - -	1	- -	2	116	- -	- -	116	116	- -	101	342	358	369	432
Somerset - -	13	1	5	67	16	124	191	138	- -	11	189	227	64	363
Surrey - - -	1	- -	1	10	- -	- -	10	10	- -	- -	20	21	4	37
Westmoreland - -	4	- -	2	70	4	24	94	94	- -	32	215	204	185	264
York, ex. of W. Riding	31	5	6	153	43	466	619	619	- -	312	770	999	751	1,330
York, W. Riding -	60	- -	59	1,709	3	32½	1,741½	1,525½	- -	831	3,396	3,346	2,489	5,084
Totals -	178	11	125	3,134	111	1,130½	4,264½	3,891½	- -	1,420	7,260	7,891	5,377	11,194
ENGLAND.—*Silk.*														
Berks - - -	3	1	- -	- -	3	30	30	30	1	48	57	73	28	151
Bucks - - -	2	- -	2	8	1	4	12	12	8	65	36	9	65	53
Chester - - -	92	12	81	794	28	240	1,034	786	454	2,709	4,154	4,515	4,870	6,962
Derby - - -	20	1	17	178	2	6½	184½	204	47	640	839	1,690	1,013	2,203
Devon - - -	3	1	- -	- -	4	72	72	48	4	79	119	203	62	343
Dorset - - -	5	- -	1	8	5	38	46	40	44	72	92	125	37	295
Essex - - -	7	- -	6	77	6	59	136	129	6	233	561	641	204	1,237
Gloucester - -	2	- -	- -	- -	2	5½	5½	5½	11	62	27	23	22	101
Hampshire - -	2	- -	- -	- -	2	18	18	18	13	56	79	74	21	201
Hertford - -	6	- -	5	41	4	52	93	93	56	272	247	209	367	417
Kent - - -	1	- -	1	8	1	6	14	14	- -	1	11	28	2	38
Lancaster - -	31	1	29	529	5	36	565	557	89	1,176	2,043	2,283	1,689	3,902
Middlesex - -	1	- -	1	18	- -	- -	18	18	2	44	64	44	33	121
Norfolk - -	4	- -	4	120	- -	- -	120	120	26	329	990	929	162	2,112
Nottingham - -	4	- -	3	27	1	12	39	29	18	110	129	192	177	272
Somerset - -	24	1	16	125	19	149	274	235	166	560	559	780	406	1,659
Stafford - - -	12	3	10	103	2	35	138	122	58	394	441	601	508	986
Suffolk - - -	3	- -	1	9	1	3	12	12	19	198	160	88	47	418
Surrey - - -	1	- -	- -	- -	1	8	8	8	8	22	13	22	21	44
Warwick - -	9	2	8	53	2	12	65	58	- -	99	133	303	218	317
Wilts - - -	5	- -	3	18	4	26	44	39	7	74	109	160	26	324
Worcester - -	10	- -	- -	- -	12	50	50	38½	46	97	75	116	68	266
York, W. Riding -	16	- -	11	193	5	66	259	270	2	102	366	613	603	480
Totals - -	263	22	199	2,309	110	928	3,237	2,886	1,085	7,442	11,304	13,721	10,649	22,903
Grand Totals -	3,630	178	2,600	62,867	1,849	20,250½	83,117½	78,523½	1,095	30,354	132,430	185,540	155,075	194,344

FA′CULÆ. In Astronomy, certain spots sometimes seen on the sun's disc, which appear brighter than the rest of his surface. These bright spots, and the variable appearances of the solar disc, have given rise to much speculation respecting the constitution of the sun. *See* SUN.

FA′CULTY. (In the Universities.) In the origin of the university of Paris (which is considered as the model of all European institutions in the middle ages) the seven liberal arts (grammar, logic, rhetoric, arithmetic, geometry, astronomy, and music) seem to have been the subjects of academic instruction. These constituted what was afterwards designated the Faculty of Arts. Three other faculties — those of divinity, law, and medicine — were subsequently added. In all these four lectures were given, and degrees conferred by the university. The four faculties were transplanted to Oxford and Cambridge, where they are still retained; although, in point of fact, the faculty of arts is the only one in which substantial instruction is communicated in the academical course. By an anomaly of ancient date, the English universities also give degrees in what is not properly a faculty, but only a branch of one of the faculties, viz. music. On the Continent, the faculty of arts is synonymous with that of philosophy. In England, that of divinity is not wholly distinct from, but superior to, that of arts; degrees in the latter being preliminary qualifications for those in the former.

FA′CULTY, DEAN OF. In Scotland, the elective president of the faculty of advocates, answering to barristers in England.

FAGOTTO. The same as *bassoon*, which see.

FAHLERZ. A mineralogical synonym of grey copper ore.

FA′HLUNITE. A mineral, from *Fahlun*, in Sweden. It is a hydrated silicate of alumina.

FAIE′NCE. (From Faenza, the original place of manufacture.) In the Fine Arts, pottery embellished with painted designs. Raffaelle in his early days is believed to have been much engaged on this department of the art; but the matter is very doubtful. It is certain, however, that many of his designs were transferred to porcelain, which hence obtained the name of Raffaelle's ware; but the date of their execution is posterior to that artist's death.

FAI′NTING. *See* SYNCOPE.

FAINTS. The impure and weak spirit constituting the first and last runnings of the still.

FAIR. (Either from the Latin feriæ or forum.) A meeting held at stated times of the year in particular places, for the purposes of traffic, to which merchants resort with their wares. Fairs, in Christian countries, were usually held on particular festivals; and are so still in England, unless where they have been fixed to particular days in the month by later grants of privileges. By the English law, the king's authority only is supposed to confer the privilege of holding a fair, with the court of pie-powder to determine disputes arising there, which is incident to it. Fairs are considered free, unless toll is due to the owners by special grant, or by custom, which supposes such grant.

FAI′RIES. Imaginary beings, who occupied a distinguished place in the traditional superstitions of the nations of Western Europe, and especially in these islands. Their English name is probably derived from "fair," or has the same etymology with that word; and, although some similarity has been traced between them and the Peris of the Persians (pronounced Feri by the Arabians), it is not probable that the resemblance of name is more than accidental. There is also a distinction between the fairy of our island and the Fata or prophetic sybil of the Italians, from which last the French Fée is derived; although the French, in their romantic mythology, have somewhat mingled the characteristics of the two. The British fairies, also, although they have something in common with the Dwergas or Gnomes of the Scandinavian mythology, are not identical with them; they are in fact peculiar to people of Celtic race, and the notions respecting them prevalent among the Celtic population in Scotland, Wales, and Ireland tally to a remarkable degree. The popular belief, however, was nowhere invested with so poetical a character as in the Lowlands of Scotland, where it forms a main ingredient in the beautiful ballad poetry of the district. The fairies of the Scottish and English mythology are diminutive beings, who render themselves occasionally visible to men, especially in exposed places, on the sides of hills, or in the glades of forests, which it is their custom to frequent. They have also dealings with men, but of an uncertain and unreal character. Their presents are sometimes valuable; but generally accompanied, in that case, with some condition or peculiarity which renders them mischievous: more often they are unsubstantial, and turn into dirt or ashes in the hands of those to whom they have been given. Mortals have been occasionally transported into Fairy-land, and have found that all its apparent splendour was equally delusive. One of the most ordinary employments of fairies, in vulgar superstition, is

that of stealing children at nurse, and substituting their own offspring in place of them, which after a short time perish or are carried away. The popular belief in fairies has been made the subject of poetical amplification in the hands of so many of our greatest writers, from Shakspeare to Scott, that it is not easy to disentangle the embellishments with which it has been invested from the original notions on which they are founded. The Fata of the Italians, who figures in their romantic epics, and from whom the French have made the Fée of their fairy tales, is quite a different personage: a female magician, sometimes benevolent, and sometimes malevolent, partaking herself of the supernatural character, and peculiarly gifted with the spirit of prophecy. Such is the Fata Morgana, to whom the celebrated optical delusion occasionally produced in the Straits of Messina was formerly attributed by popular belief.

FAITH. (Gr. πιστις, Lat. fides.) In Theology. It is observable that the writers of the New Testament employ one and the same word for faith and belief. In most modern languages, the use of two different terms has, perhaps, strengthened the feeling of a difference between the conviction of the heart and that of the understanding: the German, like the Greek, has one only. Faith, in the language of St. Paul, is "the substance of things hoped for, the evidence of things not seen." Perhaps these strong expressions might be more accurately rendered "confidence" in things hoped for (compare 2 Cor. ix. 4. xi. 17.), "conviction" of things not seen. (Heb. xi. 1.) Through this faith, the apostle proceeds to declare, men receive as true things delivered to them on divine authority, to which neither their senses nor their uninstructed reason bear testimony, and endure sufferings and do great actions for God's sake. And without it "it is impossible to please him." Such faith "was imputed" to Abraham "for righteousness" (Rom. iv. 21.); and thus, "being justified by faith, we have peace with God through Jesus Christ." (Rom. v. 1.) It is evident from these as well as many other passages in the Epistles of St. Paul, that this justification is attained only by that faith which obeys the command as well as relies on the promise of God; termed by theologians efficacious or saving faith. Nevertheless, it may be supposed that these passages were misinterpreted by many of those to whom they were addressed, as conveying the doctrine of salvation through the mere act of belief. Perhaps they were among those expressions of St. Paul which, according to St. Peter, those who were unstable "wrested to their own destruction;" since the Apostle James found it necessary to insist so strongly on the inefficacy of faith without works (ii. 17.), or a dead faith (*ib.* 20.), and to assert that "by works a man is justified, and not by faith only" (24.) It is needless to state how much theologians, in every age of the church, have been perplexed by the ethical problem thus presented. Their difficulties may be thought to arise, in great measure, from the inadequacy of our mental powers to separate the naked act of belief, to which, as far as is perceptible to our faculties, no quality of ethical right or wrong can attach, from the moral predispositions which have produced that belief, and the influence on the character which results from it; the whole, perhaps, entering into the Apostolic view of faith. In all ages and churches, there has been a tendency in some to insist exclusively on the doctrine of justification by faith, — a tendency which has sometimes proceeded so far, as in the case of Luther at one period of his life, as to induce them to undervalue or altogether reject the Epistle of St. James; in others, to postpone it to the other great truth of judgment according to works. But the former characteristic has more particularly marked the tenets which are commonly called Calvinistic, in which it is combined with the peculiar doctrine of election; the latter has been apt to prevail in Roman Catholic teaching, and to mingle with what is termed Arminianism in Protestant churches.

FAKI'R, an Arabic word signifying *poor;* applied in some Eastern countries to a sect of enthusiasts, who retire from the world and devote themselves to religious observances. They are chiefly remarkable for their assiduity in "mortifying the flesh," considering no infliction of the body as too severe, provided they can inspire the observer with reverence towards them. There are, however, some classes of Fakirs distinguished for good sense, learning, and piety.

FALCA'TE. (Lat. falx, *a sickle; sickle-shaped.*) In Zoology, when a part is curved with the apex acute.

FA'LCATED. (Lat. falx.) The moon is said to be *falcated* when her illuminated part appears in the form of a crescent or sickle, which happens when she is in the first and fourth quarters.

FA'LCIFORM PROCESS OF THE BRAIN. (Lat. falx.) A process of the *dura mater*, which arises from the *crysta galli* and terminates in the *tentorium*, separating the hemispheres of the brain.

FA'LCO. (Lat. falco, *a falcon.*) The name of a Linnæan genus of Accipitrine Diurnal birds, characterized by a beak crooked, and covered with a cere at the base; head closely invested with feathers. To the short Linnæan phrase descriptive of this group of birds of prey may be added, that the supraciliary arch projects above the eye, giving a bold and threatening physiognomy to these rapacious birds, the majority of which subsist on living prey. The first plumage differs from that of maturity, which is not acquired before the third or fourth year. The female is generally one third larger than the male. The Linnæan genus is now subdivided into the subgenera *Falco*, Bechstein; *Hierofalco*, Cuv.; *Aquila*, Brisson; *Haliætus*, Savigny; *Pandion*, Sav.; *Circætus*, Vieillot; *Harpyia*, Cuv.; *Morphnus*, Cuv.; *Astur*, Bechstein; *Nisus*, Cuv.; *Milvus*, Bechstein; *Pernis*, Cuv.; *Buteo*, Bechstein; *Circus*, Bech; *Gypogeranus*, Illig.

Of these subgenera the first two form what are termed the "noble" birds of prey, and they are the most courageous in proportion to their bulk. This quality is associated with a powerful form of the beak, of which the arch commences from the base, and which is armed with a strong tooth on each side near the apex. Their wings are strong, long, and pointed, the second quill-feather being the longest. It is from this division of falcons that the birds are selected for the sport of falconry.

In the "ignoble" division of the birds of prey, the longest quill-feather of the wing is almost always the fourth, and the first is very short, which gives the wing an appearance of having the extremity obliquely truncated. The bill is not armed with lateral tooth-like processes.

FA'LCONINES, *Falconinæ.* (Lat. falco, *a hawk.*) A subfamily of Accipitrine birds, having the genus *Falco* proper as the type; and characterized by a beak short, hooked from its base, and toothed near the apex; wings long, second quill shortest. It includes the genera *Ferax* and *Falco*. The term *Falconidæ* is used by some ornithologists in a sense as extended as *Diurnæ*, which see.

FA'LCONRY. The origin of this celebrated sport has given occasion to much controversy. It has been said that it was unknown to the Greeks; it is, however, described by Ctesias and Aristotle as practised in their time in India and Thrace. Martial and Apuleius present us with plain indications of the knowledge of this pastime among the Romans. In modern Europe, it appears to have been practised earliest, or at least with most ardour, in Germany: the title of the emperor, Henry the Fowler (A.D. 920), is said to be derived from an anecdote respecting his fondness for it. In the 12th century, it was the favourite sport of nobles and knights throughout Europe; and in that which followed its rules were reduced into a system by the Emperor Frederic II. (Barbarossa), and by Demetrius, physician to the Greek Emperor Palæologus. In that court the grand falconer was an officer of distinction; and the title was borrowed from it by the western sovereigns. According to the opinion of Strutt, the sport was not known so early in England as on the Continent; yet there are traces of it as early as the 8th century. From the commencement of the 17th, we may date its gradual decline. James I., devoted to hunting, was no admirer of falconry, which up to his time had been the favourite royal sport. But its final abandonment, except as the fancy of a few individuals, was owing to the gradual improvement in fire-arms presenting far easier methods of obtaining game. Among the many curious works which exist on this subject, once so universally interesting, may be mentioned the treatise *De la Fauconnesie* of Charles d' Esperon, Paris, 1605; the celebrated *Book of St. Alban's*, by the Prioress Juliani Berners, 1486; *Latham on Falconry*, 1658; *Ray's Idea of Falconry*, published with *Willoughby's Ornithology*. The Emperor Frederic II. (Barbarossa) did not disdain to give the world the results of his experience in the art, in a treatise published in 1596 from his MS., under the title *Reliqua librorum Frederici II. Imp. de arte venandi cum avibus*

FA'LCULA. (Lat. falx, *a sickle.*) In Zoology, a claw is so called when it is compressed, elongate, curved, and sharp-pointed.

FALL. The sea term for the rope of any pulley or system of pulleys. To *fall aboard* signifies to run foul of another vessel.

FA'LLACY (Lat. fallo, *I deceive*), in Logic and Rhetoric, has been defined "any argument, or apparent argument, which professes to be decisive of the matter at issue, while in reality it is not." Fallacies have been divided into those "in dictione," in the words; and "extra dictionem," in the matter. The latter of these it is not the province of logic to discover and refute; they being, strictly, instances in which the conclusion follows from the premises, and which therefore depend on the unsoundness of these premises themselves, which can only be detected by a knowledge of the subject-matter of the argument. Logical fallacies, or fallacies in dictione, are those in which the conclusion appears to follow, but in reality does not, from the premises; and which, consequently, can be detected by one unlearned in the subject-matter of the argument, but acquainted with the

rules of logic. These are subdivided, however, into fallacies purely logical, *i. e.* vicious syllogisms (*see* SYLLOGISM, PARALOGISM), and fallacies semi-logical; those, namely, which arise from the employment of a middle term in argument (*see* SYLLOGISM, PROPOSITION, MIDDLE TERM) ambiguous in sense. In rhetoric, a common set of artifices, by which the mind of the reader or hearer is diverted from the question at issue and fixed on some collateral topic, are termed fallacies; as, where the character of the proposer of a measure is discussed as a reason for or against the measure itself, &c. &c. &c.

FA'LLING HOME. The term applied to the timbers or upper parts of the sides of a ship when they curve inwards. The old ships fell home, or tumbled in (as it is also called), much more than the modern ones, which approach more nearly to being *wall-sided*.

FA'LLING STARS. *See* SHOOTING STARS.

FALL OF MAN. The disobedience of Adam and Eve as related in the book of Genesis, by which sin and death were introduced into the world.

The word *fall* is universally employed in the United States as synonymous with *autumn*.

FALLO'PIAN TUBE. The name given to a canal or tube, discovered by Fallopius, arising at each side of the fundus of the uterus, and terminating in the ovarium.

FA'LLOW. In Agriculture, lands are said to be under fallow when they are without a regular crop of corn or pulse. A naked fallow is one in which the soil remains a whole year without any crop whatever; and a turnip or green crop fallow is one in which the lands after being without a crop from harvest till the beginning of summer, and being properly laboured during that period, are sown with turnips or other similar crops in rows, and the ground cultivated in the intervals. Fallowing was practised by the Romans on all soils whatever, and has been continued through the dark ages, in all the cultivated parts of Europe, so as to have become, till lately, a general habit in the treatment of arable lands. The practice of taking two corn crops, and then allowing the land to rest or lie fallow, was, till the commencement of the present century, prevalent throughout Europe; and it is still a very common practice in most parts of the Continent. It appears to have been first broken through by the Flemings about the end of the 16th century; and subsequently in Britain, with the culture of turnips, above a century and a half later. Fallows, under the most improved systems of agriculture, are no longer had recourse to in the case of free or easily worked soils, where turnip fallows are made, or drill crops of legumes are substituted; but in very strong clays they are still found necessary, and this will probably continue to be the case till by the "frequent drain system," and long-continued culture, the strong clays become friable and fit for the drill husbandry, like the sandy loams and other free soils.

FALSE CADENCE. In Music, one wherein the bass rises a tone or semitone, instead of rising a fourth or falling a fifth.

FALSE KEEL. The timber added below the main keel, both to serve as a defence, and also, by deepening the plane surface, to enable the ship to hold a better wind.

FALSE'TTO. In Music, that part of a person's voice which lies above its natural compass, and is produced to various extents in different subjects, male as well as female. It rarely extends more than four or five notes above the natural voice, and is produced by diminishing the aperture of the throat.

FAMI'LIA. (Lat.) A house or family, being a subdivision of *gens* or clan (*see* GENS). Its members were distinguished by having the last of their three names or the cognomen the same.

FAMI'LIAR, or FAMILIAR SPIRIT; mentioned in the book of Samuel in a passage which has produced much observation from commentators. The genius or δαιμόνιον, which Socrates and some other celebrated ancients were said to have possessed as a companion, was a species of familiar. In modern Europe and Asia, the belief in familiar spirits forms an important feature in the widely spread superstition respecting the magical art. The subject is curiously examined in the article in the *Enc. Metropolitana*.

FA'MILY. In Zoology, the group next in value and comprehensiveness above the genus; existing in fact, though under the name of the genus, in the classification of Linnæus, who indicated the different groups of species therein comprehended by numbers, instead of collective appellations.

Such divisions of the Linnæan genus occur only in those instances in which an unusual number of species presented themselves to the consideration of the clear-sighted Swede. The progress of modern discovery has added so many new forms to the naturalist's catalogue, as to render necessary a corresponding subdivision of most of the Linnæan genera. To these subordinate groups of species distinct names are given, for the sake of convenience; and in order to designate the natural family which these groups compose, the name of the original or typical genus is generally retained, with the addition of the Greek patronymic *idæ* to the genitive case. Thus, *e. g.* the characters of the Linnæan genus *Mus* are applicable to a vast number of Rodents, which scientific precision requires to be arranged in numerous subordinate groups; these are distinguished by appropriate generic names in modern systems, and the term *Muridæ* is applied to the *family* which they collectively compose.

FAN, FANNERS, or FANNING MACHINE. A machine for separating the chaff, husks, dust, or other light matters from seeds which are to be preserved for sowing, or for some other purpose in general or domestic economy. The air is put in motion by a wheel, commonly driven by hand with leaves or fans instead of spokes, directed in a stream against the seeds to be fanned; which seeds are placed in a hopper, so regulated as to proportion their descent through the stream of air to the force of the current created by the fan wheel. Before fanners were invented the process was performed by hand in a manner the reverse of what it is now by machinery; that is, the seeds and refuse to be separated from them were taken up in shovelfulls, and thrown to as great a distance as possible through the calm air; when the full-bodied seeds, being the heaviest, were found at the greatest distance, and the chaff and other matters nearer, according to their degree of lightness. With the progress of the arts a system of screens and sieves was added to the fanning machine; in consequence of which, as it separated the seed from every kind of refuse, it is called a winnowing machine; and in that case, it not only separates the chaff and other light matters generally from the heavy matters, but it parts both according to their bulk and weight; so that the seed comes from the winnowing machine fit for being measured up for the market or store room, and the various kinds of inferior products in a state fit for immediate use.

FANA'TIC. (Lat. fanum, *a temple.*) An enthusiastic and visionary person, who, in matters chiefly relating to religion, disregards reason and scripture, and under the influence of his feelings alone adopts the wildest and most extravagant opinions. The term *fanaticus* was applied anciently to a set of prophetic priests (*Struv. Antiq. Rom.* p. vi. p. 312.), who performed the sacrifices in a wild and extravagant manner; and hence, by an easy transition, has been bestowed in modern times on those who make pretensions to inspiration, or who conduct their worship with extravagance or licentiousness.

FA'NCY. *See* IMAGINATION.

FANDA'NGO. (Spanish.) An air for dancing to, in triple time, and of a quick and lively character. It is the favourite dancing air of the Spaniards, among whom it is of great antiquity. The dancer is usually provided with castanets,—a practice borrowed from the Moors,—which serve to mark the time more distinctly than a stringed instrument alone would do. The Spaniards in dancing to this species of air often carry their gestures beyond the bounds of decency.

FANTA'SIA. (It.) In Music, a species of composition in which the author ties himself to no particular theme, ranging as his fancy leads amidst various airs and movements. Rousseau in his definition of this word confines its meaning to extempore composition, and makes this distinction between the *Capriccio* and the *Fantasia*; namely, that the former is a collection of singular and whimsical ideas strung together by an excited imagination and written down at one's leisure, whilst the latter is an off-hand display of whatever comes across the mind at the instant of execution.

FANTOCCINI. (It. fantoccio, *a puppet.*) Dramatic representations in which puppets are substituted in the scene for human performers.

FARCE. (From the French word, which again is derived from the Italian, and this from the Latin farcire, *to stuff.*) In English Dramatic Composition, a short piece of low comic character. The original term seems, like the Lanx Satura of the Romans, which gave its denomination to the satire, to signify a miscellaneous compound or mixture of different things. In modern languages it has borne various significations. Certain songs which were sung between the prayers on the occasion of religious worship are said to have been denominated Farces in Germany, during the middle ages; whence the word appears to have denoted simply an interlude of any kind. In England, the farce appears to have risen to the dignity of a regular theatrical entertainment about the beginning of the last century; since which time it has formed one of the most popular of our exhibitions, and usually performed by way of contrast, after a tragedy at the national theatres. The farce is restricted to three acts as its limit, but frequently consists only of two or one. Of all the pieces of this class which have successively amused English audiences, none have acquired a permanent literary reputation except those of Foote,—performances in which the licence of the theatre in satirizing living persons was carried to the utmost height. The *Fabulæ Atellanæ* of the Romans, which appears to have been short dramatic entertainments of a miscellaneous character, sometimes pastoral, sometimes tragi-comic, &c.

but not so coarse in plan or diction as the *Mimes* and their *Exodia*, which were satirical dialogues in verse between some set characters or stage-buffoons, appear to have filled in some respects the place of the modern farce. On the French stage the vaudeville answers to the English farce. *See* VAUDEVILLE.

FA'RCY, or FARCIN, is a disease of the horse which affects the lymphatics of the skin, either generally producing a distended appearance of the vessels like moles or buttons, when it is called the bud or button farcy; or locally, when it is chiefly confined to dropsical accumulations in the legs, and is called the water farcy. Both forms of the disease are contagious; and, like the glanders, an allied disease, both are difficult to cure. The button farcy is generally removed by burning off the buttons by caustics or a red-hot iron, and by the exhibition of mercury; and the water farcy by the exhibition of mercury alone. Both diseases are sometimes cured by feeding the animal entirely on green food. See Blaine in *Encyc. of Agr*. 2d edit. page 985.

FARI'NA. (Lat. far, *corn*, of which it is made.) Meal or flour, obtained by grinding and sifting wheat and other seeds; hence the term *farinaceous food*.

FA'RM. In Agriculture, a farm is a portion of land, with suitable buildings, fences, and other arrangements necessary for carrying on the business of farming, which is let to the farmer or occupier for rent. Farming is no doubt coeval with the invention of property in land; because we may suppose that when a proprietor had taken possession of a portion of territorial surface, and called it his own, he would require the assistance of various persons to cultivate it; and these persons he could only remunerate by giving them a share of the produce. Hence the origin of what on the Continent is called the Metayer system, — in which the landlord supplies the farmer or tenant with the soil, buildings, and the whole or a certain portion of the stock; while the latter supplies the labour of cultivation and management, and takes as a remuneration the half, or some other measure of the produce. In process of time, as the tenants or farmers began to acquire capital, they furnished the whole of the live and dead stock, as well as the labour of cultivation and management, and paid the proprietor or landlord a fixed rent in money or produce. To enable the tenant or farmer to do this with the greater security, leases were invented, by which the tenant holding the land for a certain number of years was enabled to lay out money for its improvement at the commencement of his lease, and to receive it back again in the form of increased produce before its termination.

At the commencement of this system of what may be called free farming, all farms were undoubtedly of very limited extent; but with the increase of capital and skill on the part of the farmer they have become greatly enlarged. Much has been written respecting the most profitable size of farms for the public; but this may safely be left to the interest of the parties immediately concerned. Whatever size of farm brings in the highest rent to the landlord will be the best size for the public; because the higher the rent the greater the amount of the produce that must be sent to market to pay it. That there is a natural limit to the size of farms there can be no doubt; but what this is is a different question, and has no connection with the other. It depends on the character of the surface, the kind of farming, and the climate. But though there is a natural limit to the size of farms, and which in any given case can be readily defined, there is no limit to the number of farms that an individual may hold but those of his capital and his skill.

FA'RMERY. The buildings and yards necessary for carrying on the business of a farm. Their situation should be central to the farm lands, in order that the distance from which the crops are brought from the fields to the farmery, and the manure carted from the farmery to the fields, may be reduced to the lowest degree; for when the farm buildings are on one side of the farm lands, it is evident that the cartage to or from the more distant fields must be attended with considerable loss of labour and time. The characteristic yard of the farmery is the rick yard, and the principal feature among the buildings is the barn.

FARMING. The business of farming, or the cultivation of lands held on lease, necessarily varies in different countries and climates; but one point is common to them all, — viz. that no article shall be cultivated which shall not fully remunerate the cultivator or farmer within the limits of his lease. Hence, as few leases in any part of the world exceed twenty years in duration, timber trees are never objects of cultivation by farmers; and it is only in particular cases that orchards and vineyards can be planted by them. As a business, farming may be described as that which under ordinary circumstances yields a lower degree of profit than any other mode in which capital and skill can be employed; but where abundance of capital and extraordinary skill are brought to bear on farming its profits, on an average of a long series of years, may perhaps not be much inferior to those of commerce and manufactures, on the average of a very long period. The great advantages of farming as a pursuit are — 1. That the articles produced, being of the first necessity, there is always a market for them at some price, without the necessity of any or of much exertion on the part of the farmer; 2. The certainty of always having a home and the means of existence on the farm; and 3. The comparative degree of independence which these circumstances are calculated to create in the mind. These advantages, however, depend much on the length of lease, and on the rent being equitable.

FA'RROW. A sow is said to farrow when she brings forth pigs; and the pigs brought forth are called a litter or farrow.

FA'RTHING. A small English copper coin, amounting to one fourth of a penny; it was anciently styled fourthing, as being the fourth of the integer or penny.

FA'RTHINGALE. A name given to the hoop of whalebone used formerly by the ladies of this and other European countries to spread out the petticoat to a wide circumference. It was introduced into England in the reign of Queen Elizabeth, and continued to be used on state occasions down to the commencement of the present century. (See *Strutt's Manners and Customs*.)

FA'SCES. (Lat.) In Ancient History, some of the insignia of authority of the chief magistrates of Rome. They consisted of bundles of wooden rods, each enclosing an iron axe so that its head appeared above; and were used as instruments of punishment, the rods being applied for minor offences, and the axe for capital crimes. They were carried before the magistrates on public occasions by officers called *lictors*, and the number appointed to each varied for the different magistracies. Thus the civic prætors had two, proconsuls and provincial prætors six, the consuls twelve, and dictators twenty-four. The municipal decemvirs also had the privilege of having two fasces carried before them in their own towns.

FA'SCIA. (Lat. *a band*.) In Architecture, a flat member in an entablature or elsewhere, like a flat band or broad fillet. The architrave, when subdivided for instance, has three bands, called fasciæ; of which the lower is called the first fascia, the middle one the second, and the upper one the third. *See* IONIC and the other Orders.

FA'SCIÆ. In Astronomy, bright stripes or belts observed on the discs of some of the planets, particularly Jupiter. The fasciæ or belts of this planet are sometimes broader and sometimes narrower, and alter their situation on the body of the planet, though they always appear parallel to his equator. *See* JUPITER.

FA'SCIÆ. In Anatomy, the tendinous expansions of muscles. The *fascia lata* is a strong tendinous sheath of the muscles of the thigh.

FA'SCICULA'RIA. (Lat. fasciculus, *a bundle*.) A genus of extinct Zoophites, whose calcareous cases are in the form of tubes aggregated together in conical bundles, like those of the organ-pipe coral (*Tubifora*). The *Fascicularia* are abundant in the English coralline crag formation.

FASCI'CULUS. In Botany, a form of inflorescence exactly similar to that called a corymbus, with the exception of the expansion being centrifugal in place of being centripetal.

FASCINA'TION. The fact of being charmed, operated upon, or influenced by the look of certain individuals, generally taken in an evil sense. The word is originally derived from the Greek βασκάινειν (*Theocr.* Idyl VI.), whence the Latin fascinare. *Fascination* is the power supposed to be possessed by certain persons of working mischief to others by means of a glance of the eye. We find it mentioned in Theocritus; and it was so prevalent among the Romans that it was personified as the god Fascinus, the patron of the evil eye. Virgil alludes to it thus: —

> Nescio quis teneros oculus mihi fascinat agnos.
> *Eclog.* 3.

It is to this day a common belief among the vulgar in almost all countries; but probably it is nowhere more generally retained than in Turkey and the kingdom of Naples and Sicily. In the former country, the Mussulmans deem it necessary to have recourse to a variety of amulets and charms, in order to preserve themselves from the evil eye of an enemy, or of an infidel. In Naples, the evil eye and its fascination (known to them by the name of gettatura) are subjects of dread and superstitious precaution among all classes of the people. There is a treatise on fascination by Vairus, prior of a convent at Benevento in that country (1589); another by Frommann (1675).

FA'SCINES (Lat. fascina, *fagot*), in Fortification, are bundles of fagots, twigs, or branches of trees, which, being mixed with earth, are made use of for filling up ditches, forming parapets, &c.

FASCIOLA'RIA. (Lat. fasciola, *a swathing band*.) A genus of Pectinibranchiate Mollusks, dismembered from the rock-shells (*Murices*) of Linnæus on account of the smooth band-like surface of their windings, which have

not any "varices;" and distinguished from the species of *Fusus* in having plaits on the columella, which are oblique, and consequently spiral.

FA'SHION. (Fr. façon; originally from the Lat. facere, *to make* or *form.*) A term used to signify the prevailing mode or taste in any country, the only recognized quality which it possesses being mutability. It may safely be averred that in proportion to the influence which fashion exercises in any country may its claim to civilization be vindicated, nothing being so characteristic of a rude and barbarous state of existence as a rigid adherence to the customs of antiquity. The term *fashion* has generally been considered as applicable chiefly to the adornment of the person, in conformity with the prevailing taste as introduced by some individual of consideration in society; but it has a much wider signification, being applied to the most trivial kind of conventional usages, a disregard or ignorance of which is sufficient in the eyes of the votaries of this tyrannical goddess to banish the offender beyond the pale of civilized society. The remark which Horace makes on the introduction, disuse, and revival of language is so applicable to the term in question, that we cannot forbear quoting it in this place:—

> Multa renascentur, quæ jam cecidere, cadentque
> Quæ nunc sunt in honore vocabula, si volet usus,
> Quem penes arbitrium est, et jus, et norma loquendi
> *Ars Poetica*, v. 70.

FA'SSITE. In Mineralogy, a variety of *augite* from Fassa in the Tyrol.

FA'STI. In Ancient History, the records of the Roman state, in which all public matters, military and civil, were registered by the high priest, according to the days on which they took place. The *Fasti* of Ovid is a poem giving an account of the Roman year, and the ceremonies attached to the different days, with their historical or mythological origin. The first six books, containing the first six months of the year, beginning with January, have come down to us; the rest are lost.

FASTI'GIUM. In Architecture, the same as PEDIMENT, which see.

FA'STING. In a theological sense, the abstaining from food as a religious observance. This practice is recommended in the New Testament by the example of the Apostles and early Christians, who are frequently represented as fasting, especially on solemn occasions, such as when Paul and Barnabas are sent forth by the Apostles to preach to the Gentiles. At the same time it must be observed, that during our Saviour's lifetime his disciples were notorious among the Jews for not fasting, as was the common religious practice of the day: from which we must not suppose that Christ did not appoint stated days or periods of fasting, such as among Christians in later times, as well as among the Jews then, have generally degenerated into heartless ceremonial observances, but left such exercises rather to the judgment and feelings of his disciples to be made by them part of their own private devotions. The observances, however, of stated fast days prevailed very early and universally in the church; and the Church of England has not hesitated, accordingly, to point out the practice of early antiquity as a guide to its children in this matter.

In the Romish church, Wednesday and Friday are observed as fasts throughout the year, those being the days on which our Lord was betrayed and crucified respectively. There are a considerable number of fast days that occur also in the course of the year; and the whole period of Lent is held as a term of abstinence, in which the stated fast days that occur are observed with especial rigour (in imitation of our Lord's forty days' fast in the wilderness). These were periods of real abstinence in the primitive church; but the little that was eaten does not appear to have been limited in early times, either in kind or quantity, by any positive precept. Fasting was practised differently by churches and individuals.

The objection then that is brought against the Romish church in this particular is, first, that it commands and enforces that which was originally left to the discretion of Christians; and secondly, that by so doing, and by multiplying the occasions on which such abstinence is enjoined, it causes the practice to be looked upon as a work meritorious in itself and efficient for the expiation of sins, which was never intended to serve any other use than that of a means towards attaining a godly frame of mind.

FA'TALISM. The belief in an overruling fate or destiny which annihilates free will and controls all human actions. For the philosophical doctrine of fatalism, see NECESSITY; for those religious opinions which have assumed a similar character, ELECTION, PREDESTINATION.

FATA MORGA'NA (called also *Castles of the Fairy Morgana*, the spectacle being supposed to be under the influence of the Queen of the Fairies, the *Morgan la Fay* of popular legends). A remarkable phenomenon of *mirage* or unusual refraction, mentioned by different authors and travellers as seen in the straits of Messina, especially in the vicinity of Reggio; and which consists in the appearance in the air, over the surface of the sea, of multiplied images of the objects on the surrounding coasts. It is thus described by Minasi:—"A spectator on an eminence in the city of Reggio, with his back to the sun and his face to the sea, and when the rising sun shines from that point whence the incident rays form an angle of about 45° on the sea of Reggio, sees upon the water numberless series of pilasters, arches, castles, well delineated, regular columns, lofty towers, superb palaces with balconies and windows, villages and trees, plains with herds and flocks, armies of men on foot and horseback, all passing rapidly in succession on the surface of the sea." There can be little doubt that this description, which has been frequently copied, and even admitted into treatises on optics, has received considerable embellishment from the aid of the imagination. Captain Smyth, in his excellent work on Sicily, observes, "I never met with a Sicilian who had *actually seen* any thing more than the loom or 'mirage' consequent on a peculiar state of the atmosphere; but which, I must say, I have here observed many times to be unusually strong." (*Memoir descriptive of the Resources, Inhabitants, and Hydrography of Sicily and its Islands*, p. 109.) See MIRAGE.

FATE. *See* DESTINY, NECESSITY.

FATES. (Lat. fatum, *that which is spoken.*) In Mythology, the three sister goddesses named Clotho (Spinster), Lachesis (Allotter), and Atropos (Unchangeable), whose office it was to spin the destinies of men, and break the threads when their appointed hours of death came. They were also called Parcæ by the Latins. Their Greek name was Μοῖραι, *i. e.* "the Dispensers."

FATHERS OF THE CHURCH. The early Christian writers whose works have thrown light upon the history, doctrines, and observances of the primitive church, and who are thereby entitled to be looked up to by us to a certain extent as guides and instructors. The period to which the list may be extended is, of course, arbitrary. St. Bernard in the 12th century is generally styled the last of the Fathers. The writers of the 1st century, or who were cotemporary with the first disciples, are distinguished by the term Apostolic Fathers. The general character of the writings of these celebrated men, their trustworthiness as witnesses, their authority as judges in matters of doctrine and discipline, and the utility of studying their works, have been, unfortunately, discussed by divines of different parties with far more of prejudice and the spirit of system than the love of truth. It has been sometimes the fashion to exalt and sometimes to depreciate them: seldom have they been used by learned men of any church for the simple and serious purposes of edification. A voluminous controversy was carried on upon this subject between some Protestants, chiefly of the Calvinist churches, who attacked the Fathers, and others, both Protestant and Catholic, who defended them, towards the end of the 17th century. On the former side, two works of some notoriety were produced,—*Daillé's Treatise on the Use of the Fathers*; and *Barbeyrac, Morale des Pères de l'Eglise*. Among many answers, may be cited that of Cellier to Barbeyrac, 1718. In England, Burnet, Hill, Peter Allix, Reeves (*Apologies of the Early Fathers, with Dissertations*, 1709), took part in it. The Benedictines of Paris, in the 17th century, published valuable editions of the principal Fathers, both Greek and Latin. Nourry, a learned member of that order, published an *Apparatus* to Despont's great collection, the *Bibliotheca Patrum*, in which much information is collected. Of late years Mr. Collinson, by his *Bampton Lectures* (1817), raised anew a spirit of controversy on the subject. At Oxford and at Paris, new editions of an extensive and valuable character of the Fathers are now in progress.

FA'THOM. An English measure of length, equal to two yards, or six feet.

FAT OF ANIMALS. A concrete oil contained in the cellular membrane of animals; it is generally white or yellowish, with little smell or taste, and varies in consistency according to the relative quantities of *stearine* and *elaine* which it contains. The ultimate elements of animal fat are the same as those of vegetable oils: according to the analysis of Chevreul, 100 parts of human fat are composed of 79·0 carbon, 11·4 hydrogen, and 9·6 oxygen. Hog's lard and mutton suet are very similarly constituted.

FA'TTENING DOMESTIC ANIMALS. The difference between feeding and fattening, as far as respects domestic animals, consists in this, that the object of the former is to maintain the animal in a state of health and vigour for the purpose of facilitating its growth to maturity, or if mature keeping it in good working condition; while the object of the latter is to accumulate on the animal more flesh and fat than is sufficient for either of these purposes, and in general as much as possible, so as to increase the bulk and weight of the flesh and fat in proportion to the size of the bone. Till within these few years, the means used by all fatteners of domestic animals, whether quadrupeds or poultry, were preventing the animals from taking exercise, and gorging them with food. The excessive fat produced by these means, more especially in sheep and swine, was found to be both disagreeable and unwholesome; and accordingly the most

approved system of fattening animals of every description, at the present day, consists in not merely supplying them with abundance of food, but also of the means of taking exercise. Hence the farmers in the most enlightened districts, such as Berwickshire, East Lothian, &c., instead of tying up their fattening cattle in stables like horses, and placing their food before them, put two or three together in small yards with sheds attached, in which they can run about, eat when they choose, and take shelter from the rain, the cold, or the sun at pleasure under the open shed. Swine are treated in the same manner, and also spring lambs that are fattened for the market. Poultry are no longer kept in coops and crammed, or rabbits in hutches; but the former are allowed to take exercise in fields sown with various herbs, and the latter are kept in a species of artificial warren, where they can take exercise by burrowing.

FAU'CES. (Plural of faux.) The posterior part of the mouth, terminated by the *pharynx* and *larynx*.

FAULT. In Mining and Geology, a dislocation of strata, whether from a break or slip, or the introduction of some extraneous mass.

FAUNA. The animals peculiar to a country constitute its *fauna*. The term is derived from the Fauni or *rural deities* of Roman mythology.

FAU'NUS. An Italian rural deity resembling the Grecian Pan, and, like him, endued with the gift of prophecy. Mention is sometimes made of several Fauni, who were represented, like the satyrs, with the horns and feet of goats. There was an annual festival instituted to their honour, called *Faunalia*.

FAUSSE-BRAYE. In Fortification, a low rampart going quite round the body of the place, the height being about 3 feet above the level ground.

FAUX. The orifice of the tube of the corolla, the tube being formed by the confluence of the petals.

FE'ALTY. In Feudal Law, the oath of fidelity (Fr. féauté) taken by every tenant on admission to be true to his superior lord. General fealty is that due from the subject to the prince; special fealty from tenant to mesne lord. Fealty is said to differ from homage in being due to every new lord. The oath, as administered in England, was fixed by stat. 17 E. 2. c. 2.; but it has long been obsolete, although, in copyhold tenements, the memory of it is still preserved by the customary entry of respite of fealty on the admission of a new tenant.

FEASTS, or FESTIVALS, are days set apart by the church, either for the grateful celebration of the most remarkable events connected with the scheme of redemption, or upon which to commemorate the actions and sufferings of such persons as have been most instrumental in carrying forward the designs of God for the salvation of mankind. This was a practice of the primitive church; but in process of time (as early as the 4th century) the great number of names which had been introduced into the calendar, and the many corruptions which the honour paid to their memory had engendered, rendered its observation both burdensome and superstitious. Accordingly at the Reformation the Protestants directed their attention to the retrenchment and purification of these ceremonies. The English church retains the festivals of the nativity, circumcision, manifestation, the death and resurrection and ascension of Christ, the purification of the Virgin and the annunciation (or Lady-day), Whit Sunday in honour of the Holy Spirit, and Trinity Sunday. Besides these the most remarkable of the Apostles and the Evangelists are commemorated on their respective days; and one day is set apart for the remembrance of all the saints. From this calendar, therefore, the names of the martyrs and saints of later ages are excluded (with which the Romish calendar is so crowded), partly from the uncertainty which hangs over the stories of many of them, and partly also in order to cut away what would otherwise have furnished a dangerous precedent. Festivals are either moveable or immoveable; the former depending upon Easter, the latter being fixed to certain days of their respective months.

FE'ATHER-EDGED. In Architecture, a term applied to a board whose section is triangular, or rather trapezoidal, one edge being very thin.

FEA'THERS. The term, in Zoology, is restricted to those productions of the dermal system which form the most exterior covering of birds, and which consist of the following parts, viz. a quill (*calamus*), a shaft (*rhachis*), and vanes (*pogonium externum et internum*).

The quill is that part of a feather by which it is attached to the skin; it is nearly cylindrical in form, hollow, and semitransparent, possessing in an eminent degree the opposite qualities of strength and lightness. The end which is implanted in the skin is more or less obtuse, and is pierced by an orifice called the lower umbilicus. At the opposite end, where it is continued into the shaft, and just at the meeting of the two lateral vanes, there is another orifice, called the upper umbilicus. The cavity of the quill contains an imbricated series of conical capsules, united together by a central pedicle, forming the membranous remains of the original formative pulp.

The shaft is quadrilateral, with a smooth convex surface, and an opposite concave surface traversed by a longitudinal impression continued from the upper umbilicus. It is covered by an outer layer of firm horny material like that of which the quill is formed, and this incloses a soft elastic substance called the *pith*.

The vane consists of *barbs* and *barbules*.

The barbs are attached to the sides of the shaft, and consist of narrow elongated plates, arranged with their flat sides towards each other, and their margins in the direction of the external and internal sides of the feather. By this disposition they offer much resistance to being bent out of their plane, though readily yielding to any force acting upon them in the line of the stem.

The barbules are minute and often microscopic processes, given off from either side of the barbs, and arranged in a single series, just as the barbs are placed with reference to the shaft. In true feathers, they are short, stiff, and curved in opposite directions on opposite sides of the barb; and the concavities of one series of barbules interlock with those of the adjoining barbs, whereby the whole vane presents a continuous and resisting surface, as in the quill-feathers of most birds. When the barbules are long and disjoined, the feather is termed a plume; in the long dorsal plumes of the peacock, the barbules themselves are ciliated.

In a few instances, as the apteryx and ostrich, the feathers are simple. In most birds each feather is complicated by a part termed the accessory plume. This is usually a small downy tuft; but it varies as to its size both in different species, and even in the feathers of different parts of the body of the same bird. In the body-feathers of the hawks, grouse, ducks, gulls, &c., the accessory plume is generally well developed, and acquires in some species a size equal to that of the feather from which it is produced. In the emeu this is the case with the whole plumage, and the quill of each feather supports two shafts. In the cassowary there are two accessory plumes, one of which is equal to the size of the original feather, the other is much smaller.

Feathers vary in form, size, and function, in different parts of the bird, and have accordingly received distinct names in ornithological science. Thus the feathers which surround the external opening of the ear, and which serve to augment the intensity of sound, are termed the *auriculars*. Those which lie above the scapula and humerus are called the *scapulars*. The small feathers which are arranged in imbricated rows upon the bones of the antibrachium are called the lesser coverts (*tectrices primæ*); those which line the under or inner side of the wings are the under coverts. The feathers which lie immediately over the quill-feathers are the greater coverts (*tectrices secundæ*). The largest quill-feathers of the wing, which arise from the bones corresponding with those of the hand, are termed primaries (*remiges primores*); those which rise from the ulna, towards its distal end, are the secondaries (*remiges secondariæ*); those which are attached to its proximal extremity are the tertiaries (*remiges tertiariæ*, seu *parapterum*). The quill-feathers which grow from the phalanx commonly called *thumb* form what is termed the bastard wing (*alula spuria*). The quill-feathers which are implanted upon the os coccygis are called *rectrices*.

The development of feathers is always preceded by that of down, which constitutes the first covering of young birds. Each down-fasicle consists of a small quill, supporting a bunch of equal-sized finely-ciliated filaments. The down-fascicles are succeeded by the feathers, which they guide, as it were, through the skin; and the feathers of each succeeding plumage serve, during the moult, as the *gubernacula* of those which follow.

The mechanism concerned in the formation of a feather is, as might be expected, of a very complicated character. It consists of vascular parts which secrete the material, and of moulds or capsules, in which the fluid material is thrown into the proper form; the whole is inclosed in an outer sheath, which is protruded with the new-formed feather from the skin, and which becoming dry and friable from contact with the atmosphere, crumbles away, and leaves the feather free to unfold its beautiful and complicated structure.

Every feather, the eloquent Paley justly observes, is a mechanical wonder: "their disposition all inclined backward, the down about the stem, the overlapping of their tips, their different configuration in different parts, not to mention the variety of their colours, constitute a vestment for the body so beautiful, and so appropriate to the life which the animal is to lead, as that I think we should have had no conception of any thing equally perfect if we had never seen it, or can now imagine any thing more so." For the laws which regulate the varieties and changes of plumage, see INDUMENTUM.

FE'BRUARY. (Lat. februo, *I purify*, because in that month funeral lustrations were performed at Rome.) The 2d month of the year, containing 28 days in common years, and 29 in leap years, the intercalary day being given to it as the shortest month.

FE'CIALS, or FETIALS. The Roman heralds, whose peculiar office it was to declare war and conclude peace. The former office they performed with the following ceremonies:—They were first sent to demand redress; and if it was not given within thirty-three days, they returned to the confines of the hostile state and threw a bloody spear into them, having proclaimed war according to a given formula before not less than three adult witnesses. The fecial, who took the oath in the name of the Roman people in concluding a treaty of peace, was called *Pater Patratus*. The college of Fecials was instituted by Numa, and is supposed to have been borrowed from the Greeks. They were probably twenty in number.

FE'CULA, or FÆCULA. (Lat. dim. of fæx, *a sediment.*) When certain vegetable products are bruised and mixed with water, the pulverulent matter which subsides is called the *fecula* or *fæces*; it is commonly of a starchy nature, hence starch is often called *fecula.*

FE'DERAL GOVERNMENT. (Lat. fœdus, *a league or treaty.*) A government formed by the union of several sovereign states, each surrendering a portion of its power to the central authority. But the amount of the power thus surrendered varies in different federations. Thus the government of the German empire as it existed before the French revolution, and that of the United Provinces of the Netherlands, were both termed federal; and the Swiss cantons, under the present Swiss constitution, have retained more of their individual sovereignty, both as to foreign relations and as to domestic arrangements, than those of the United States of America, each being at liberty, in some cases, to make treaties with foreign powers, and also having almost unlimited power to modify its own institutions; while the latter states have transferred the whole of their foreign affairs to the general government, and are moreover bound by their articles of union to remain democratic in constitution. The best work on the federative governments of antiquity is that of St. Croix, *Des Anciens Gouvernements Federatifs.*

FEE-FARM RENT, in Law, is defined a rent charge in fee, issuing out of an estate in fee of at least one quarter of the value of the land at the time of its reservation. Some authorities consider the amount as immaterial. No grant in fee farm can be made since the statute of Quia Emptores.

FEE'LERS. Organs fixed to the mouth of insects, generally less than the antennæ, and often jointed. *See* PALPS.

FEES. In Law, perquisites allowed to ministers of justice, fixed either by act of parliament or ancient usage. The word fee is derived either from an Ang. Sax. word signifying *money*, or the French foi, *faith.*

FEE SIMPLE, in Law, is an estate of freehold of inheritance in lands, tenements, or hereditaments. Tenant in fee simple absolute, or, as it is more briefly expressed, in *fee*, is one who has the fullest power of disposing of his tenement which the law allows; and not being disposed of by him either in his lifetime or by devise, it descends to his heirs general.

An estate to a man and his heirs qualified by a condition or limitation capable of abridging it, as an estate to A. and his heirs on condition of paying a sum of money on a stipulated day, and if he fail to do so then to another, is termed a fee conditional; or, with less propriety of language, a fee-simple conditional.

FEE TAIL, in Law, arose out of the statute *De Donis*, 13 Edw. I., which restrained the alienation of lands and tenements by one to whom they had been given, with a limitation to a particular class of heirs. A gift, for instance, to a man and the heirs of his body, constituted before the statute a fee-simple conditional, which could be alienated as soon as a child was born to the donee: after the statute it became inalienable, until more latitude was given by the invention of certain refined fictions of law.

A deed creating an estate tail is properly called a gift, and the giver and receiver the *donor* and *donee*. Estates tail are *general*, where only one person's body is specified from which the issue must be derived; *special*, where both the progenitors are marked out, as in a gift to A. and the heirs of his body to be begotten upon B. It may also be descendible to all the issue, or to male or female issue; in which case estates are said to be in tail male or in tail female. Half blood is no impediment in the descent of an estate tail general. Where lands and tenements are given to a man and his heirs in special tail (by a wife named in the grant), and the wife dies without issue, the husband is tenant in tail after possibility of issue extinct; and his estate is in most respects equivalent to one for life only.

Estates tail being contrary to the general policy of the law, legal ingenuity was taxed, in early times, to invent modes whereby they might be defeated; *i.e.* whereby the donee might destroy the special limitations of the gift, and acquire an estate in fee simple without incurring forfeiture. This was done by the fiction of *common recoveries* (of which the validity was established in the courts in the reign of Ed. 4.), and by that of fines, recognized by statute (4 H. 7. c. 24., 32 H. 8. c. 36.) A simpler process has been substituted for these ancient contrivances by the recent Real Property Act (3 & 4 W. 4. c. 74.)

FELIS. (Lat. *a cat.*) The name given by Linnæus to the genus of Ferine or carnivorous quadrupeds of which the common cat is an example. The essential characters of this genus repose on the strong, sharp, retractile talons with which all the four feet are armed, and the corresponding destructive nature of the dentary organs. These consist of six small incisors in each jaw, the exterior ones larger than the rest; two long and strong laniaries, bounding the series of incisors in the lower jaw; and two in the upper jaw of still greater length and strength, conical, sharp-pointed, slightly incurved, and separated from the incisors by an interval corresponding in size with the summits of the inferior laniaries, which always pass, when the mouth is closed, in front of those of the upper jaw.

The molar teeth are four in number on each side of the upper jaw, and generally three on each side of the lower; the two anterior in each series are smaller than the third, and furnished each with a single conical pointed middle process. The third molar is the largest in both jaws, and presents a very characteristic form in the lower one being compressed, and terminating in two sharp-pointed trenchant triangular lobes, which play upon the inner surface of three corresponding lobes of the tooth above: the appulse of the lower carnassial or sectorial tooth is checked, and the upper gum defended, by an internal tubercle in the upper sectorial. The fourth molar in the upper jaw is placed within the posterior margin of the third, and presents a simple transverse slightly convex plate, affording additional surface for the inferior sectorial to work against. The claws and teeth above described are better adapted for the seizure and destruction of living animals than are those of any other mammalia; and the power of wielding these weapons is enjoyed in a corresponding degree of perfection. There are no quadrupeds in which the muscles of the jaws and limbs are more fully developed. The teeth, as we have seen, are few, though formidable: those of the lower jaw occupy only its anterior half; the rest of the jaw consisting chiefly of a broad and high coronoid, and a strong angular process for the implantation of the immense muscles destined for its movements. The skeleton of the feline animals presents a light but well-built mechanism: the bones, though slender, are extremely compact; the trunk, having to contain the simple digestive apparatus requisite for the assimilation of highly organized animal food, is comparatively slender, and flattened at the sides. The muscular forces are thus enabled to carry the light body along by extensive bounds, and it is thus that the largest felines generally make their attack. When the impetus of the spring is added to the stroke of the paw, the lion or tiger has power to fell an ox, or smash the skull of a man at a single blow; and as the strength of the neck corresponds with that of the jaws and limbs, they are enabled to bear away with ease animals bigger and heavier than themselves. It fortunately happens that the feline animals have not the instinct of sociality, otherwise what terrestrial species could withstand a troop of lions or tigers hunting in concert like a pack of wolves? "Conscious of their own undisputed superiority," says the author of a favourite zoological work, "which secures them against the attacks of other animals, each with his female partner occupies a solitary den, which is usually concealed in the depths of the forest. Hence, when pressed by hunger, they issue forth in search of their prey, which they rarely attack with open force; but stealing on with noiseless tread, or stationing themselves in ambush in such situations as appear suitable to their purpose, watch with indefatigable patience the approach of their victim. Their motions are peculiarly characteristic of their habits and mode of life. Incapable of long-continued speed, their usual gait is slow, cautious, and stealthy, with their posterior limbs bent beneath them, and their ears distended to catch the most trifling noise. Guided by these organs, the internal structure of which is highly developed, they trace the sound of footsteps to an almost incredible distance, and direct themselves towards their prey with unerring certainty. In this quest the sense of smell, which they possess in a very low degree, affords them but little assistance; their sight, however, is good, and serves them equally well both by day and night, their extremely dilatable pupils adapting themselves with admirable precision to various intensities of light. To this object the frequently elongated form of their pupils, the light green or yellow colour of a large portion of the choroid coat of their eyes, and the extent of their nictitating membrane must also essentially contribute.

"No sooner is the object of their pursuit within reach of their attack than, suddenly bursting forth from their lurking place, or changing their slow and stealthy pace for a furious and overwhelming bound, they dart with the velocity of lightning upon their terrified victim. The great strength and extreme flexibility of their fore-paws enable them at once to dash him to the earth, and to seize him with an irresistible grasp. They then proceed

to rend him in pieces by the united efforts of their teeth and claws, and gorge themselves upon his lacerated flesh."

The feline animals or cats constitute a well-defined and circumscribed genus. The leopards, panthers, jaguars, and tigers are the most typical or truly feline species; in these the beauty of colouring, sleekness of skin, elegance of form, craft, suspicion, bloodthirstiness, agility under excitement, and sloth during repletion, are most strongly manifested. The lion combines more robustness of body with the feline attributes; and his pre-eminent stature receives an air of nobility and grandeur from the mane that decorates his head and neck. He has the credit, too, of a greater share of boldness and generosity than the other cats. His vocal organs also exhibit a modification of structure not present in the other felines, by which he has the power to utter his tremendous roar; —a roar which, when sent forth under the excitement of hunger, scares from their hiding places the timid ruminants which may be lurking within the compass of its fearful reverberations. Among the felines, one group is characterized by the shortness of the tail, and the tuft of hairs on the tip of the ears; this includes the lynxes.

The cheetah, or hunting leopard, deviates most in the half-retractile condition of the talons and the upright carriage of his body from the true feline characters; and with these physical modifications is combined so much of the canine disposition as enables this species to be used in packs for the purposes of the chase.

The middle-sized cats, which lurk in the branches of trees, as the leopards, ocelots, &c., have a fulvous ground colour, broken by irregular dark spots; a marking which admirably adapts them for concealment amidst foliage. A similar relation of adaptation to the peculiar theatre of their destructive habits may be traced in other species. The tiger, for example, which prowls on the ground, and creeps stealthily towards his victim between the stems of the trees and plants of the jungle, has his bright ground colour interrupted with black vertical stripes. The lion, which traverses the parched deserts of Africa, and lies in wait to intercept the antelopes which bound in troops from one oasis to another, would be rendered too conspicuous if his tawny hide were ornamented by the stripes or spots that characterize the feline livery; these, therefore, which are obvious enough in the earlier periods of his existence, become obliterated as he attains to maturity. A smaller feline species, the puma, or American lion, which plays the predatory character in a corresponding theatre of the New World, presents a similar uniformity of colour.

The feline animals bring forth from two to six young ones at a birth. The domestic cat is the most fertile; a circumstance which arises from the abundance of food, shelter, and protection consequent on her alliance with man. But, as has been frequently remarked, this, of all domesticated animals, is the least servile or restrained; and though instances of personal attachment are not wanting, the affection of the cat is rather to the house than to its owner. There are many singularities in the nature of the cat, which perhaps our comparatively limited acquaintance with the other felines leads us to regard as peculiar to this species. She is remarkably nervous, and readily startled; gives out the electric spark when her fur is rubbed contrary to its direction, as is very conspicuous when this is done in the dark. Under the excitement of fear, the same effect is produced on the long hairs of the tail as if a stream of electricity were transmitted through them, and they all stand out from the surface to which they are attached, giving the tail an appearance of treble its usual thickness; at the same time the back is raised, and the body drawn into its smallest compass. Cats are attracted by peculiar odours, and exhibit a violent fondness for catmint and valerian, rubbing their noses and rolling themselves in the latter with signs of great and uncontrollable excitement. Cats are very cleanly, are fond of warmth, and seek a soft place for their repose. They express their satisfaction by a peculiar soft vibrating noise. called "purring."

FE'LLING TIMBER. In Arboriculture, when a full-grown tree is cut down it is said to be felled; but this term is never applied to young trees or bushes, undergrowth, or hedges, which are said to be rooted out or cut over. Much has been written respecting the proper season for felling trees; some arguing in favour of midwinter, and others in favour of midsummer. The question principally turns upon the quantity and the value of the soft or outer wood in the trunk of the tree to be felled known by foresters and carpenters as the sap. As this sap or outer wood is the only portion of the trunk in which the sap or juices of the tree circulate, it is evident that if no value be set upon it the tree may be cut down at any season; because the truly valuable part of the trunk, the mature timber, is impermeable to the sap in its ascent through the soft wood, and is therefore in the same state at every season of the year. On the other hand, where much value is attached to the soft or outer wood, where this outer wood is wished to be made as valuable as possible, or where, as in the case of comparatively young trees, the greater part of the trunk consists of sap wood, felling ought to take place when there is least sap in the course of circulation. This season is without doubt midwinter, which, all other circumstances being equal, is unquestionably the best season for felling timber; the next best being midsummmer, when the sap is chiefly confined to the young shoots, the circumference of the soft wood, and the bark: as the worst is the spring, just before the development of the buds, when the tree is fullest of sap, and receiving constantly fresh supplies from the root; and in autumn, immediately before the fall of the leaf, when there is a superabundance of sap, from its being as it were thrown out of employment by the falling of the leaf. In general, all the soft woods, such as the elm, lime, poplar, willow, &c., should be felled during winter; hard woods, like the oak, beech, ash, &c., when the trunks are of large size, and valued chiefly for their heart wood, may be felled at any time.

FE'LLOW. In the colleges of the English Universities, and some other collegiate institutions, the superior members of the foundations are so termed in general. In some, however, all members of the foundation are fellows from their admission. The usages of different foundations in the two universities vary so materially, that no general account will apply equally to all. The fellows are, in general, graduates; elected either on free competition, or according to limitations fixed in the statutes of foundation. Most fellows are obliged to abandon their fellowships if they do not take orders at a certain period: there are, however, lay fellowships in both universities. Fellowships are also vacated in the universities (without exception) by marriage; and by the acceptance of preferment in the church from the college, or in some instances of other preferment of a certain value. From among the resident fellows are selected for the most part the governing officers and tutors of the colleges. The principal or head of the college is generally elected either by the whole or a select body of the fellows. There is a distinction in some colleges between senior and junior fellowships, in point of emolument, which does not exist in others. At Cambridge there is also a distinction between foundation fellowships and bye or appropriation fellowships; the former only, in most colleges, entitling the possessor to college offices. The value of fellowships is extremely various; nor do they always maintain the same amount, being generally dependent on corn-rents. The advantages obtained by the fellow are partly in income, partly, if resident, in free lodging and allowances towards board. There are fellowships of the value of 500*l.* or 600*l.* per annum, and others of 100*l.* or less; but a large proportion may be said to average from 150*l.* to 300*l.* a year. *Fellow* is also the general title of members of learned academies and societies in England.

FE'LLOWSHIP, or PARTNERSHIP. A rule in Arithmetic, of considerable use in balancing accounts among partners in trade. Considered as an arithmetical process, it is simply a method of dividing a number into parts which shall have given proportions to each other. Fellowship is either simple or compound. To simple fellowship belongs a question of this sort:—"A contribution of 20,000*l.* is levied on three towns, and each is required to pay in proportion to the number of its inhabitants. Now the 1st contains 2000 inhabitants, the 2d 3000, and the 3d 5000; what sum must each contribute?" This question is obviously the same as if it had been required to divide the number 20,000 into three parts, having the ratios of 2, 3, and 5, which is done by dividing 20,000 by the sum of 2, 3, and 5, that is by 10, and multiplying the quotient by each of those numbers separately; the several results are the sums required. Here $20{,}000 \div 10 = 2000$; and $2000 \times 2 = 4000$, for the share of the first; $2000 \times 3 = 6000$, for the share of the second; and $2000 \times 5 = 10{,}000$, for the share of the third. These results are in the given proportions, and their sum amounts to 20,000.

Compound fellowship is when the parts into which the given number is to be distributed are proportional to more than one set of numbers. This is usually called *fellowship with time*, because in distributing the profits of a mercantile transaction carried on by several partners the share of each must be proportional, both to the amount of the capital he contributed and to the time it was employed. It must therefore be proportional to the product of these two. Hence the rule for compound fellowship:—Multiply each stock by the time of its continuance, the products are the numbers to which the several parts of the sum to be distributed must be proportional; and with these numbers proceed, as in the case of single fellowship. Both cases, it may be remarked, belong to what is more correctly termed *Distributive Proportion*.

FE'LO DE SE. In Law, one who is found by the coroner's jury to have laid violent hands on himself, or occasioned his own death feloniously. This verdict occasions forfeiture of chattels, real and personal; but not of lands of inheritance. One found felo de se was formerly buried in the king's highway, with a stake driven

through the heart; but since 1823 (4 G. 4. c. 52.), privately buried in a burial ground, between the hours of nine and twelve at night.

FE'LONY. (A word of uncertain derivation. Sir H. Spelman derives it from the word fee or fief, and the Teutonic lohn, *reward* or *price;* that which costs or forfeits land. More probably from the same root with the verb *to fail.*) In Law, in the general sense, comprises every species of crime which occasioned at common law the forfeiture of lands and goods. Treasons, therefore, are, strictly speaking, felonies, though in common language distinguished from them. The term felony appears, in feudal law, to have been synonymous with forfeiture to the feudal lord. The general punishment attached to felony at common law was death; and if any statute, even now, makes a new offence felony without specifying the punishment, the law implies it to be capital. But some species of felony were not thus punishable at common law; and the gradual operation of altered opinion upon our code has removed this punishment from all but a few. The principal species of felony are, — 1. Offences against the person, such as murder, manslaughter, rape, &c.; assault with felonious intent, that is, with intent to injure the sufferer in a greater or less degree. The highest of these offences against the person are still punishable by death. The acts respecting these offences were consolidated by 7 & 8 Geo. 4. c. 31. Some of them, as common assaults, &c., are only misdemeanors. 2. Of offences against property, the great body is comprehended under the ancient appellation of *larceny.* 3. Embezzlement. 4. Burglary. 5. Malicious mischief to property, arson, riotous demolition of churches, chapels, houses, &c., are capital offences within this class. 6. Forgery. 7. Numerous offences of a public nature (many such, however, amount only to misdemeanor) — 1. Either against the king and government, as treason, sedition, embezzlement of the king's stores, &c.; 2. Against public justice; 3. Against the public peace; 4. Against public trade; 5. Against public police and economy. Under this head also are to be ranked some offences relative to game, while others come under the description of larceny.

FE'LSPAR. (Germ. feldspath.) An important mineral composed of silica, alumina, and potash, with traces of lime, and often of oxide of iron. Common felspar is of various shades of white and red; it forms an ingredient in granite, and is the base of some other rocks. It is often crystallized, and cleaves into rhomboidal fragments.

FE'LTING. (Germ. filzen.) The process by which different kinds of fur or wool are blended into a compact texture for the manufacture of hats. The anatomical peculiarities of the different hairs or furs are much concerned in the perfection of the felt; they must be such as to enable them to interlace and intertwine with each other. Hare and rabbit fur, wool, and beaver, are the chief materials used; they are mixed in proper proportions, and are tossed about by the strokes of a vibrating string or bow till they become duly matted together.

FELU'CCA. (Span. faluca; Fr. felouquer; Ital. feluca.) A small vessel, carrying two masts, and propelled by oars and sails, used chiefly in the Mediterranean and on the adjacent coasts for coasting voyages. Small war boats used in the same quarter are also so called.

FEMME COVERT. In Law, a term borrowed from the French to signify a married woman.

FEMUR. (Lat. *a thigh.*) In Vertebrate Anatomy, the first bone of the leg or pelvic extremity; in Entomology, the third joint of the leg, and is long, and usually compressed.

FEMUR. In Architecture, the interstitial space between the channels in the triglyph of the Doric order. These femora are sometimes called the legs of the triglyph.

FENCE. Any continuous line of obstacle interposed by art between one portion of the surface of land and another for the purpose of separation or exclusion. The kind of obstacle or material differs according to the animals which are to be separated, excluded, or confined, and the nature of the soil and situation. All fences are either live or dead, or a compound of these. Live fences are hedges; that is, rows of shrubs placed close together, and pruned on the sides, so as to form a sort of living wall. Dead fences are either stone walls, mounds of earth, or structures of wood or of other materials raised above the ground's surface, or upon ditches excavated in it. The latter are sometimes filled with water. Mixed fences are those in which some kind of dead fence is used with some kind of live fence; for example, a ditch with a bank of earth on one side, or a ditch with a wall or a hedge on one side; the latter the commonest of all fences. The introduction of fences into agriculture was about as great an improvement in the progress of that art, as that of the principle of the division of labour into the art of manufacture.

FE'ND OFF. The sea term for pushing off a boat or any heavy body to break the shock or avoid contact.

FENE'STRATE (Lat. fenestra, *a window*), in Entomology, signifies the naked hyaline transparent spots on the wings of butterflies.

FE'N LANDS. Lands, the subsoil of which is constantly in a state of saturation with water, and the surface is liable to be overflown by rivers or streams during spring or autumn. The soil of these lands is generally black, light, and rich, to the depth of two or three feet; and as the surface water readily filtrates through this soil to the subsoil, fen lands generally produce bulky crops of grass and corn. As they have very seldom any natural outlet for drainage, this is generally performed by machinery; and when this is the case few lands are more productive. Till lately windmills were employed for draining the English fens; but steam is now frequently had recourse to as the moving power, and the advantages to the cultivator are immense; because he can lay his lands dry at the season when it is most convenient that they should be so, whereas the operation of the windmill is always a matter of chance. For an account of the Fens in England, see *British Statistics;* and *M'Culloch's Geographical Dict.*, art. "Bedford Level."

FE'OFFMENT. In Law, a species of conveyance. It was in early times the public and solemn mode of alienating lands and tenements in possession, and was performed by a deed, accompanied by livery of seisin; which last was the delivery of the land itself, effected by certain symbolical acts and customary words. As secret conveyances to uses gradually prevailed, feoffments fell comparatively into disuse. The grantor is termed the feoffor, and the person receiving the feoffee.

FERÆ. (Lat. ferus, *wild.*) The name given by Linnæus to the order of Mammalia comprehending those which subsist more or less exclusively on the flesh of other animals. They are characterized by having three kinds of teeth, incisors, canines, and molars; unguiculate extremities, without an opposable thumb on the fore foot, but with the power of rotation in the forearm. This order corresponds with the *Insectivora*, and the Plantigrade, Digitigrade, and Pinnigrade *Carnivora* of Cuvier's *Carnassiers.*

FE'RGUSONITE. In Mineralogy, a crystallized compound of columbic acid and yttria with a small quantity of zirconia, and of oxides of tin, cerium, iron, and uranium. It has hitherto only been found in Greenland.

FE'RIÆ. In Roman Antiquities, solemn religious festivals. The most celebrated were the Feriæ Latinæ (Latin holidays), celebrated on the Alban mount by all the states of Latium in common. The deputies of the various cities, with those from Rome, met on the Alban mount, where, under the presidency of the latter, they sacrificed a bull to Jupiter Latialis, and under sanction of this ceremony took oaths to preserve their mutual friendship and alliance. This festival was originally instituted by the second Tarquin, in whose time and long subsequently it lasted for one day only; but in process of time it extended to four. It was observed by the consuls regularly before they set out for their provinces.

FERINES. (Lat. ferus, *wild.*) The English equivalent of the *Carnassiers* of the system of Cuvier; but generally employed to designate the group corresponding with the *Feræ* of Linnæus, and excluding the bats (*Cheiroptera*), which form the first family of Cuvier's *Carnassiers.*

FERMENT. (Lat. ferveo, *I boil.*) The substance which is essential to the process of fermentation. It is either naturally present in the fermentable juice, as in the grape; or it is added, as in the manufacture of beer, where *yeast* constitutes the ferment. Ferments are of an albuminous or glutinous character; the presence of nitrogen seems essential in their composition, hence they are classed by chemists among azotised compounds. Their modus operandi is still unexplained.

FE'RMENTA'TION. (Lat.) When certain vegetable substances are dissolved in water, and subjected to a due temperature (between 65° and 85°), they undergo a series of changes which terminate in the production of alcohol or spirit; these changes constitute the phenomena of *vinous fermentation.* Sugar and some ferment are essential to the process; and during the formation of the alcohol the sugar disappears, and carbonic acid is more or less abundantly evolved. The simplest case of fermentation is that of *must*, or of the expressed juice of the grape, which when exposed, either in close or open vessels, to a temperature of about 70°, soon begins to give off carbonic acid, and to become turbid and frothy; after a time a scum collects upon the surface, and a sediment is deposited; the liquor which had grown warm gradually cools and clears, loses its sweet taste, and is converted into *wine.* The chief component parts of must are water, sugar, mucilage, gluten, and tartar. During the fermentation carbonic acid escapes, the sugar disappears, and with it the greater part of the mucilage; the gluten chiefly forms the scum and a portion of the sediment; and the tartar, originally in solution, is thrown down in the form of a coloured deposit. It appears, therefore, that the new products, which are *alcohol* and *carbonic acid*, are principally formed at the expense of the sugar; and Gay Lussac's

experiments have shown that 45 pounds of sugar are resolved, in the process of fermentation, into 23 of alcohol and 22 of carbonic acid. Sugar and water alone will not ferment; the ingredient requisite to the commencement of the change is the gluten, which absorbs in the first instance a little oxygen from the air, becomes insoluble, and induces the subsequent changes. The reason why grapes never ferment till the juice is expressed, seems to depend upon the exclusion of air by the husk or membranes; and if grapes be bruised in a perfectly close vessel, carefully excluding oxygen, the juice undergoes no change; so that the mere breaking down of the texture of the fruit is insufficient. But a very short exposure of the pulp to air is sufficient to induce that change in the juice which leads on to fermentation, and which is afterwards independent of the further contact of air, the evolution of carbonic acid being exclusively referable to the decomposition of sugar. In *beer* the alcohol is derived from the sugar, original and produced, of the malt. When wine is exposed to air and a due temperature, a second fermentation ensues, which is called *acetous fermentation*, and which terminates in the production of *vinegar*. During this process oxygen is absorbed, and more or less carbonic acid in most cases evolved; but the apparent cause of the formation of vinegar is the abstraction of hydrogen from the alcohol, so as to leave the remaining elements in such proportions as to constitute *acetic acid*. Thus alcohol is theoretically constituted of charcoal, water, and hydrogen; and acetic acid of charcoal and water only: the oxygen of the air, therefore, converts the hydrogen of the alcohol into water, and so effects the change into vinegar.

FE'RMO. *See* CANTO FERMO.

FERN ROOT. The root of the *Aspidium filix mas*, or male fern. About two drachms of the dried root, in powder, followed up by a brisk purge, is occasionally given as a vermifuge. It was Madame Nouffer's celebrated specific.

FERNS. Cryptogamic plants of the highest grade of development, and more especially remarkable for the perfect manner in which their leaves are formed. *See* FILICES.

FE'RRO-CYA'NIC ACID. A compound of 3 atoms of cyanogen, 2 of hydrogen, and 1 of iron. It is the *ferro-chyazic acid* of Mr. Porrett, the term *chyazic* being composed of the initials of carbon, hydrogen, and azote, which are the ultimate elements of hydro-cyanogen.

FERRU'GO. In Botany, a disease of plants, commonly called rust. It is caused by the presence of myriads of minute fungi, chiefly of the genus *Uredo*, which are to plants what intestinal worms are to animals.

FE'RRY. (Germ. and Sax. fahren, *to pass over*.) In Law, a right arising from royal grant or prescription to have a boat to carry men and horses across a river, and to levy reasonable toll. The land on both sides ought to belong to the owner.

FE'RULA. A genus of Umbelliferous plants with thin flat fruit resembling that of the parsnip, and yellow flowers. The species are chiefly natives of Persia, where they yield the drug asafœtida. According to Kæmpfer this fetid gum-resin is an exudation from the root of *F. asafœtida*; but there is no doubt that it is also produced by several other species.

FE'SCENNINE VERSES (Verses Fescennini), so called from Fescennia, an Etrurian town, where they first had their origin, were rude extemporaneous pieces of poetry recited by the youth of Latium and Etruria at rustic festivals, especially at harvest home, with gestures adapted to the sense. They consisted principally of raillery and playful rustic abuse; a species of humour very much in vogue with the Grecian and Egyptian country people also. The Fescennine verses are chiefly remarkable from having given rise to satire, the only class of poetry of native Italian growth.

FE'SCUE GRASS. A valuable grass for meadows and pastures. (*Festuca pratensis*, Lin.) In deep rich soils somewhat moist it is considered as the most bulky and nutritive of all grasses; but in poorer soils it is equalled, if not surpassed, by the rye grass (*Lolium perenne*), and the meadow foxtail grass (*Aleopecurus pratensis*). The meadow fescue grows to the height of between two and three feet; but the sheep fescue (*F. ovœna*), and several other species, seldom grow above six inches or a foot in height, and are chiefly sown on sheep pastures, and used to lay down lawns and grassy surfaces to be mown in pleasure grounds. All the fescues are perennials; and they are all natives of Britain.

FESS. (Lat. fascia, *a wide belt.*) In Heraldry, one of the ordinaries. It is bounded by two horizontal lines across the escutcheon, equally distant from the *fess point* or centre of the escutcheon. A fess not reaching to the sides of the escutcheon is said to be *couped* (cut) or *humetty*. The diminutives of the fess are the *bar*, the *closet*, and the *barulet*. A fess with a barulet on each side of it is said to be *cotised*. A fess removed to the top of the escutcheon is termed a *chief*, and held to be an honourable augmentation.

FESTOO'N. (Fr. feston.) In Architecture, a carved representation of a wreath or garland of flowers, or leaves and fruit, or all of them, interwoven together; thick in the centre and small at each extremity, where it is fastened, and frequently turned over.

FE'TIALS. *See* FECIALS.

FE'TICH, *Fetichism*. The word Fetich is said to be derived from the Portuguese; and appears to have been brought into common usage from the writings of some travellers on the western coast of Africa. It is now comprehensively employed to signify any object of worship not representing a living (or rather perhaps a human) figure; thus excluding idols, properly so called. Fetichism is the worship of material substances. This perverted form of religion prevails very extensively among barbarous nations, and especially those of the Negro race. Among the latter, tribes, families, and individuals have their respective Fetiches; which are often objects casually selected, or chosen under the influence of some occasional superstition, as stones, weapons, vessels, plants, &c. &c.

FE'TLOCK. (Quasi *footlock*, whence the derivation.) In the *Manege*, a tuft of hair growing behind the postern joint of horses; hence the joint where it grows is called the fetlock joint.

FE'TTERED, in Zoology, is applied to the feet of animals when they are stretched backwards and appear unfit for the purpose of walking; or when they are concealed within the integuments of the abdomen.

FE'TTSTEIN. (Germ. *fat stone.*) *See* ELAOLITE.

FEU (Lat. feodum, *fief*), in Scottish Law, is used in contradistinction to *ward-holding* or military tenure, to signify that holding where the vassal makes a return in grain or money in lieu of military service. The *feu contract* is that which regulates the giving out of land, as between superior and vassal; the rent paid being termed the *feu duties*.

FEU'DAL SYSTEM. (From the modern Latin word *feodum* or *feud;* in English *fief* or *fee*.) A body of institutions of a peculiar character, introduced into Europe by the German and Gothic tribes which conquered the provinces of Rome, which prevailed for a long period, and has left important traces of its existence in most European countries. The words fief and feud are both, it is conjectured with much probability, corruptions of the Græco-Latin term *emphyteusis* (pronounced emphytefsis), signifying a contract whereby an individual acquired the enjoyment of a piece of land without the absolute property in it. Hence by contraction came *fef* or *fief*, and by the addition of a neuter termination *fevodum, feudum, feodum*. Another derivation, recently suggested, is from the Irish "fuidhur," "fuidh," signifying, in the Brehon Laws, a stranger who enjoys land within the domains of a clan, and the tenure by which he enjoyed it. It is singular that the word "vassal" is also probably of Celtic derivation. (*See* VASSAL.) The English word "feud" (quarrel or strife) is of an entirely distinct origin, being the same with the German *fehde*. The German equivalent for *fief* is another original word, *lehn*.

It is clear that feudal usages were absolutely unknown to the ancient Romans; but as among that people, and especially in the later times of the empire, there existed certain customs which were analogous in appearance, although not in origin, — such as the establishment of military colonies on the frontier, where the tenant of land was a soldier, and liable to be called into active duty; and the cultivation of great part of the empire by *coloni*, a distinct class of men, raised above the condition of the slave, and yet bound to render services to the proprietor, and in some instances annexed to the soil,—the barbarians in many instances adapted the conventional language and the laws of Rome to their own native customs; thus producing a confusion of idiom and practice, of which a better instance cannot be found than the fact already mentioned, that the word "feud" itself is derived from a legal term of the Greek empire (emphyteusis).

The immediate result of the conquest of Gaul, Italy, and Spain by the various barbarian tribes, was the division of the lands (except such portions as were left in the possession of the Roman cultivators and only rendered liable to tribute) between all the armed men of the nation. The shares were undoubtedly unequal even in the earliest of these divisions; but however differing in point of wealth, all the free proprietors were equal in rights: all were held liable to serve with the national force when called into the field; all had a voice, at least nominally, in the making of laws and in the choice of a sovereign. These free citizens are called by various names in the legislation of the different tribes; the Lombard title of *Arimannus* (ehren-mann, *man of honour*, or heer-man, *warrior*) seems to have been the most permanent. Such, however, was the general constitution of the kingdoms of the Lombards in Italy; the Franks in Gaul; the Visigoths, Ostrogoths, and Burgundians; and of the various states which grew up within the limits of Germany itself, after the confusion occasioned by the great migrations had passed away.

The decay of these aristocratic republics was brought about by nearly the same causes which operate in under-

mining all systems founded on equality of rights and classes. The constant wars and vicissitudes to which these governments were subject naturally raised up among the citizens some more powerful than the rest, and converted a great body of the freemen into dependents upon these. The dukes and counts, and other great men, became the actual controllers of the community: the free citizens, wherever unable to associate for mutual protection, were subject to innumerable vexations. From the earliest times, and before the fall of the Roman empire, it had been customary among the Germans for the princes and chief men to be attended by a select body of faithful companions, whose dependence on them, and services due to them, were recognized and fixed by general usage. This custom, under the new circumstances of the Germanic and Gothic kingdoms, acquired peculiar force. It became an object of ambition to the chieftains to have as many dependents as possible. With this view, every species of vexation was exercised by them towards the unprotected Arimannus, to induce him to abdicate his own independence, and enrol himself under their command. During the wars and confusions of the eighth and ninth centuries, the foundations of the feudal system were laid by this personal dependence assuming gradually the character of a territorial dependence also. The Arimannus was induced to surrender up his free or allodial lands to the king or count, and became his "liegeman" (fidelis), "antrustion" (our English word *trust* comes from the same origin), "vassal," or "man" (homo, whence *homagium*, homage), receiving back his lands to hold of the superior. This process can only now be traced by insulated documents and historical facts; but, arising out of the same circumstances in most countries of Western Europe, it took in all of them nearly the same course. It is ably developed by Hallam (in his first chapter on the *Feudal System*), and Meyer (*Institutions Judiciaires*, livre i.).

The success and energy of Charlemagne arrested for a time the decomposition of the old form of society; his empire extended over nearly all those portions of Europe which afterwards became feudal; and his various laws (in the end of the eighth and beginning of the ninth century) present us with a remarkable picture of what may be called the state of transition from the allodial to the feudal system. We find in them that the free proprietors, or Arimanni, still formed a very numerous body; and that the exigencies of military service fell most heavily upon them. They were obliged to serve at their own cost; while the counts, &c. brought their vassals to the field at their own expense. These laws are full of the vexations endured by the former class from the powerful military chieftains. On the other hand, the practice of attaching individuals to the person of the sovereign or superior by the grant of lands (*benefices*), and the obligations imposed on the inferior by the grant, are clearly developed. The distinction between *allodial* and *feudal* lands (though the latter term was not yet used) is as marked as at any subsequent period. But benefices were not yet hereditary: it is doubted by the most learned writers, whether or no they were, generally or frequently, precarious and revocable.

The decay of Charlemagne's empire, and the disasters of the two centuries which followed his reign, completed the formation of the feudal system. The great step by which that change was completed was when the benefices or fiefs became, like the former allodial properties, hereditary. There can be little doubt that this change was merely the result of those disastrous circumstances of civil and barbarian wars which during that period relaxed the slight bonds of the Carlovingian monarchy, and rendered every man as far as possible dependent on an immediate superior, and independent of a central authority. The earliest express creation of an hereditary fief is considered to be the donation of the duchy of Aquitaine to Eudes and his heirs by Charles-le-Chauve. The great vassals established their families permanently in the lands which they held of the fisc or royal domain: their liegemen, in turn, were gratified by acquiring the same right in their own subordinate fiefs. There can be no doubt that the nobility of modern Europe owes its origin, in general, to nearly the same period and the same causes: those families which succeeded in acquiring extensive fiefs, and preserving them for several generations, became noble by prescription. In the meantime, the Arimanni, or allodial proprietors, found their condition became worse from generation to generation; they were loaded with services and dues until, in the tenth century (as is shown by Meyer), the term "arimannia" became synonymous with exaction. But although the feudal system became so generally prevalent, that the maxim "Nulle terre sans seigneur" (importing that lands were presumed feudal until the contrary was shown) became generally received, yet in France and Germany they never became wholly extinct. In some districts of the former country the maxim was reversed, and lands were presumed allodial. (See *Hallam*.)

Character and Features of the Feudal System.—This institution is generally supposed to have been fully consolidated by the commencement of the eleventh century: the law of Conrad, the Salic, in Lombardy (1039), contains all its main features: the *Assises de Jerusalem*, and other compilations, show that in a century more it had been invested with all the refinements of a legal system.

By the principles of this system, the king was, in the last resort, proprietor of all the feudal lands of his kingdom. Those who were infeoffed of lands directly from the crown, and owed homage and service to the king, were termed tenants in chief (in capite), &c. These, again, infeoffed other inferior tenants, who held immediately of them; and this practice (called sub-infeudation) might be carried on through several gradations. Thus the same individual was a *vassal* or dependent of the crown, and *lord* or *suzerain* with reference to his own vassal who held of him, also termed *mesne* or mediate lord, a term which comprehended both these relations. But although all perfect fiefs resembled each other in their theoretical character, and particularly in their great attribute of military service; yet, in point of fact, tenants holding immediately of the crown stood in very different degrees of subordination. Thus, in France, the great vassals (the Dukes of Normandy, Britany, &c.) were immediate tenants of the crown, but in effect almost independent of it; while they exercised much stricter sovereignty over their own immediate tenants. But other lands, being the demesne of the crown itself, were held of it by lesser tenants in chief, who stood to the king in the same close relation as the vassals of the great feudatories did to them. Thus the government of France, at the period when the feudal system was in greatest vigour, was that of a collection of independent sovereigns, of whom one, the king, had a certain supremacy over the rest; but each, within his own domains, exercised an equal authority: and such was, in theory at least, the constitution of every feudal kingdom. The ceremonies used in conferring a fief were chiefly three:—1. *Homage*, by which the vassal owned the lord's supremacy; but *homage per paragium*, or simple homage, was unaccompanied by any feudal obligation; homagium ligeum, or liege homage, implied such obligations: the former only was rendered to the king by the great feudatories above mentioned. (See *Hallam's Middle Ages*, c. 2. part 1.) 2. The oath of *fealty*. 3. *Investiture*, or the conveyance of feudal lands, actual or symbolical. The chief *obligation* of a feudal tenant was military service; but the laws which regulated this essential part of the contract were so various, that it is not possible to give any comprehensive description of them. In some places every tenant was obliged to serve personally for his fief, whether large or small; in others (as England), the land was divided into a certain number of equal parcels, from each of which a soldier's service was due: the term of service was also variously regulated by custom. The conflicting rights of superior and inferior lords to the vassal's military service were also never satisfactorily adjusted. When feudality was in its most flourishing state, he commonly followed the banner of his immediate superior, even against the crown; but with the progress of the royal power, his obligations were gradually transferred to the king as lord paramount: military service was in most cases rendered commutable, in process of time, for an amercement in money. (*See* ESCUAGE.) There were other inferior obligations which attached to the military tenures, commonly called feudal incidents. These were chiefly, 1. *Reliefs;* i.e. sums of money paid to the lord by tenants of full age on taking fiefs by descent. 2. *Fines* upon alienation, which were sums paid on alienating a fief; a privilege which was only gradually acquired by feudal tenants, being contrary to the principles of the institution. 3. *Escheats;* i.e. the reversion of the fief to the lord, on failure of the tenant's heirs or forfeiture. 4. *Aids;* sums paid by tenant to the lord on certain specified occasions. And to these may be added the feudal rights of *wardship*, by which the lord, in some countries, had the custody of his tenant's person, and the enjoyment of his lands until he was of full age; and *marriage*, by which the lord had the right of disposing of such ward's land in marriage, or, if the marriage were rejected, to a sum of money equivalent to the marriage, *i.e.* as much as it was presumed the party seeking the marriage would have given the lord for the alliance. Forfeiture of the fief to the feudal lord was incurred by the tenant's violating any of the original conditions of fealty, homage, and military service. But the vassal was protected from the unjust aggression of the lord by that which seems to have been an inherent and necessary condition of the feudal system; the judgment, namely, of his peers, without which such forfeiture could not be incurred, supported, as it were, by the right of private warfare, which in the last resort was the resource both of the lord to enforce obedience from the vassal, and the vassal to protect himself against his equal or his superior: on failure of heirs, the fief fell or escheated to the lord. Fiefs holden by military tenure were, strictly, *proper* fiefs. There were also a great variety of tenures by rendering particular stipulated services, created, for the most part, in

comparatively late times, which were also deemed feudal in their character, and constituted *improper* fiefs; such were, especially, tenures by the performance of menial or other personal services, from which arose the English *grand serjeanty* (which see). All these tenures were of a higher or noble character; but in some countries large portions of the land were held either immediately of the king, or mediately of feudal lords, by base or inferior tenures. Such lands were styled *fiefs roturiers* in French jurisprudence: in English, this class of tenures was comprehended under the common term of *socage*, which comprised both tenures in *free* or common socage, and those in *villein* socage, from which are derived tenures in *ancient demesne*. (*See* SOCAGE.)

The division of ranks under the feudal system corresponded in theory, although not precisely in practice, to the territorial division of lands according to their tenures. Those who held their fiefs by knight-service were the original nobility of the soil; nor has the class of gentry, in most countries, any other origin. The bearing of arms, the distinctive character of sirnames, &c. &c., became afterwards, in course of time, the distinctive marks of the class of nobility, which no longer adhered so closely to the soil from which it sprang. Thus in France we find that a noble might, in later times, hold a fief roturier, while a roturier might hold a proper fief; although, in such a case, services such as were rendered by the gentry were of course commuted. But it may be in general observed, that almost the whole soil of France, north of the Loire, was under noble tenures; in the south only were free tenants, not noble, — a numerous class. In many parts of Germany the distinction between *adeliche güter* (noble fiefs) and *bauer güter* (peasant fiefs) has only been recently effaced, or still subsists: in Prussia it was abolished in 1807. In England the course of the feudal system was somewhat different; the class of free tenants in socage was far more numerous and influential: hence the yeomanry of England formed a body of men to which a parallel could hardly be found in any other country. The burgesses, or inhabitants of towns, constituted in feudal realms a class apart; and their communities were either really, or by fiction, emancipated by royal charters from the tenure by which they were supposed to hold their land either of the king or some mesne lord. Lastly, the lowest class of the population consisted of serfs or villeins, attached to the soil in many instances; but whose state varied so greatly under different circumstances, as to render it impossible to give any general description of their condition.

Such is a very brief and general outline of the complicated system of rights and duties which bears the historical name of feudal. It is necessary, however, to add, that this system assumed very different shapes in the different countries in which it prevailed. 1. France was the country in which feudalism had, if not its origin, at least its greatest extension, and was most nearly reduced in practice to its theoretical form. Up to the fall of the Carlovingian empire, that country must be regarded as an aggregate of provinces, inhabited by different nations, and governed by a variety of laws, but acknowledging the sovereignty of a monarch whose power was more or less obeyed, according to his own personal talents and other casual circumstances. After the separation of France and Germany by the treaty of Verdun in 843, a succession of feeble princes and the invasions of the Normans almost broke up the slender frame of the French monarchy. The governors or masters of extensive provinces, who had by this time secured to themselves the hereditary sovereignty of their respective benefices, became independent within their own limits: when feudal royalty was continued under the Capetian kings, these ranked as the great vassals of the crown. Their powers have been classed (by Mr. Hallam) under five heads: 1. the right of coining money; 2. that of waging private war; 3. the exemption from all public tributes except the feudal aids; 4. the freedom from legislative control; and 5. the exclusive exercise of original judicature in their dominions: of these, the fourth was the most characteristic of the French system. No general legislative power, vested in an assembly of the nation, seems ever to have existed in France as a whole. This circumstance, which in the first instance seemed to the great vassals their independence, proved in the end the cause of their decay; as, with the gradual increase of the royal powers, the legislative authority of the king himself, in the absence of any recognized national council to assist him, acquired continually increasing force. Meanwhile, the extraordinary power of the great vassals in France in some degree weighed down that of the inferior nobility; the ties of feudal subjection, weakened in the highest relation (that between the great vassals and the crown), were much stronger between the great lords and the lesser barons, chatelains, or vavassors, who depended on them. The king, according to the establishments of St. Louis, could not declare any new law in the territory of his baron without his consent, neither could the baron in that of his vavassor; but, in a partial point of view, the king and the baron, within their respective demesnes, exercised a much more real sovereignty than that which the former possessed over the latter. It was about the reign of Philippe-le-Bel, in the beginning of the 14th century, that the feudal system, which had lasted up to that time from its establishment in the 10th without material innovation, was in effect overthrown, and that the king of France began to be in reality master of his kingdom. This change was chiefly brought about by the extension of the king's juridical power by means of the parliaments; and lastly by the convocation of the states-general, as the representative body of the whole nation: the greater fiefs were re-annexed in the course of events to the crown, with the remaining power and privileges of their lords. — 2. There can be no question that feudal principles prevailed to a considerable degree in the polity of the Saxons in England; but when that kingdom was conquered by the Normans they imported with them the entire system, already invested (in the 11th century) with a legal and regular character. Hence, while feudalism grew up from the circumstances of society in France, it may be said to have been transplanted, as to most of its details, into England from a foreign soil. The land was parcelled out, as in France, between higher feudatories and inferior tenants holding of them by knight-service. But two circumstances chiefly produced the very different shape into which the system ultimately resolved itself: 1. The existence of the great body of freemen of Saxon descent, who were neither reduced into villenage, nor deprived of their lands, nor yet ennobled by being ranked along with the Norman military tenants. 2 The permanent national council, which seems to have been every where a peculiarity of the Norman system of government, and which, by taking cognizance of matters pertaining to the general interests of the realm, at once controlled the power of the king and that of the great barons as single and independent chiefs. Thus the country remained, even in the most troubled period of the Plantagenet dynasty, in constant union under some central authority; and the feudal principles were modified, both by the common law of the land, and also by various statutes, of which that commonly styled by its first words "Quia Emptores," passed in the reign of Edward II. which put an effectual stop to all farther *sub-infeudation*, was perhaps the most effectual. — 3. In Germany, as well as France, the feudal usages seem to have grown into a system under the sovereignty of the Carlovingian emperors. But in that country, owing, perhaps, partly to the constant danger from foreign invasion on the eastern side, which kept the people more together under the central authority, the sovereigns never lost, during the dark period of the 9th and 10th centuries, so much of their power as those of France. Hence the greater vassals did not acquire such complete independence; but when, after the 11th century, the elective character of the empire was more fully recognized, the imperial power decayed; and that of the vassals rose during the period in which the contrary progress was taking place in France. And as the inferior barons had not been depressed, as in the latter country, by the overgrown power of the superior, Germany presented the example of a country in which the feudal system was carried out more completely, and for a greater length of time, into actual existence than any other; nor is there any in which the frame of society, to the present day, shows so many relics of its long predominance. — 4. In Italy the feudal system, under the Carlovingian government, was widely prevalent. The chief cause, in that country, which weakened and brought it to decay, or rather prevented its complete establishment, was to be found in the power and independence of the large towns, which at first effectually resisted, and afterwards broke down, the strength of the nobility. — 5. In Spain feudal tenures were of late introduction, and very partially known, except in the kingdom of Arragon. — 6. In the northern and eastern kingdoms of Europe (Sweden, Denmark, Hungary, Bohemia) they were never introduced at all, except in some few instances wholly without general effect.

FE'VER. (Lat. febris.) A disease, one of the most general symptoms of which is increased heat of the body. The temperature is often actually higher than it should be; and often the sensations of heat, dryness, and even burning of the skin, are excessive, independent of any proportional increase of thermometric heat. The subject of fever has given rise to an infinity of medical discussion and theory; and the definitions of the disease, given by different writers, are not less varied than numerous. In fevers there is generally great constitutional derangement, unaccompanied by local or perceptible organic disease. Fevers generally begin with languor of body and mind; chilliness, amounting to shivering, though the skin often at the same time feels hot; the pulse is quicker than it should be; respiration hurried or laboured; pains are complained of in various parts, and especially about the head, back, and loins; the appetite falls off, or there is nausea and vomiting; the mouth is dry; the bowels generally constipated; and the urine small in quantity and deep in colour. These, which constitute

the first stage of ordinary febrile symptoms, are succeeded by alternate flushings, a quicker and fuller pulse, rapid alternations of shivering and burning heat, and by mental anxiety and wandering, which, under a great variety of aspects and modifications, constitute the second stage: they are succeeded by the third stage, in which the leading appearances are a cleaner tongue, a more natural pulse, a moist skin, calm mind, and the urine becomes more copious in quantity, and deposits a sediment as it cools. The symptoms of fever generally undergo an increase every evening, which is called an *exacerbation;* and this fluctuation often takes place more than once in the twenty four hours, the violence of the attacks increasing with their occurrence, and forming what is called a *continued fever*. After some days, a *crisis* takes place; that is, the symptoms either take a favourable or an unfavourable turn. If the exacerbation and remission of symptoms are well marked, and occur once or oftener in the day, the fever is called a *remittent;* if the fever leaves the patient after some hours' duration, and returns at stated intervals, it is called an *intermittent*. (*See* AGUE.) Fevers are also variously denominated, according to the prevalent symptoms, as *inflammatory*, *typhus or putrid*, *nervous fever*, &c.; or according to cutaneous appearances connected with them, such as *scarlet fever* and *yellow fever*.

FIARS. A word of Gothic origin, signifying, in Scotland, the prices of grain for the current year in the different counties, fixed by the sheriffs respectively in the month of February, with the assistance of juries. The form of striking the fiars, says Mr. Bell, in his Law Dictionary, is prescribed by the Acts of Sederunt, Dec. 21. 1723, and July 29. 1728. A jury must be called, and evidence laid before them of the prices of the different grains raised in the county; and the prices fixed by the opinion of the jury, and sanctioned by the judge, are termed the *fiars* of that year in which they are struck, and regulate the prices of all grain stipulated to be sold at the fiar prices. The fiar prices also regulate the price in contracts concerning grain (the product of the county) to be delivered, and where no price has been otherwise agreed upon between the parties. Having the prices of grain, &c. ascertained in each county has greatly facilitated the introduction into Scotland of the practice of letting land for corn rents convertible at the prices of the day. In England, where there is no such authentic local returns, there is great difficulty in converting corn rents into money rents, inasmuch as reference can only be made to the prices in some particular market, or in the kingdom at large; the one of which is too limited, and the other too extensive. See *Bell's Law Dictionary*, and the authorities there referred to.

FI'AT. (Lat.) In Law, a short order or warrant of some judge for making out certain processes, &c.

FIAT In Bankruptcy. *See* BANKRUPTCY.

FI'BRE. One of the two bases of all vegetable structures. It may be compared to a hair in inconceivable fineness, its diameter often not exceeding $\frac{1}{1200}$ of an inch; also the name of the finer divisions of roots.

FIBRI'LLÆ. In Botany, the minute subdivisions of the root, each being a small bundle of annular ducts, or sometimes of spiral vessels incased in woody tissue covered by a lax cellular integument, and in direct communication with the vascular system of the root. The apex is composed of lax cellular tissue and mucus.

FI'BRIN. A term applied by chemists to the muscular fibre when cleansed by washing from all adhering impurities; or to the coagulum of the blood when the whole of the colouring matter is washed out of it. It is white, insipid, and inodorous; its ultimate elements are, according to Gay Lussac and Thenard,

Carbon	53·36
Hydrogen	7·02
Nitrogen	19·93
Oxygen	19·69

It is merely a form of *albumen*.

FI'BROLITE. A rare mineral of a peculiar fibrous texure, accompanying *corundum* from the Carnatic and from China.

FI'BULA. A long slender bone of the leg, placed upon the outer side of the tibia, the lower end of which forms the external ancle.

FICOI'DEÆ. A natural order of shrubby or herbaceous Exogens, inhabiting hot sandy plains. They are related to *Crassulaceæ*, *Chenopodiaceæ*, and *Silenaceæ*, and especially to *Cactaceæ;* but are distinguished by their embryo being curved round mealy albumen, a superior calyx, and perigynous stamens. The succulent leaves of some are eaten, while others yield soda.

FICTION. In Literature. *See* NOVEL, ROMANCE.

FICTION OF LAW, has been defined, by writers on the civil jurisprudence, to be an assumption of the law upon an untruth in something possible to be done but not done. The utility of such fictions is merely, by substituting the imaginary for the true state of the case, to [...]ore rapidly over those parts of the subject which are not disputed, and arrive at the points really in issue. Among the more notorious fictions of the English law may be noticed the course of proceedings in the action of ejectment, in which an imaginary tenant brings his complaint of having been turned out of possession by a wrongdoer, in order to try the validity of the title of the landlord: that of a common recovery, by which estates tail were bound through a complicated proceeding (removed by recent statutes, *see* FEE-TAIL), consisting of an imaginary suit at law. The general rule is, that such fictions are not traversable; *i. e.* cannot be contradicted by him against whom they are used, so as to defeat the end for which they are invented. And for the same purpose the court will take notice that they are only fictions, if necessary, in order to prevent mere technical objections to them.

FID. A short bar of wood or iron put through the heel or lower part of a topmast, and resting by its ends on the trestle-trees, and on which the mast is therefore supported. When the topmast is to be got down, it is first lifted to take the pressure off the fid, which is then withdrawn.

FID, or SPLICING FID, is also a sharp cone of wood for opening the strands of rope.

FI'DEI COMMI'SSUM. (Lat. *committed or entrusted to faith.*) A species of testamentary disposition recognized by the Roman law, by which a testator, in indirect terms, charged his heir to deliver over to a specified person the whole or a part of the goods which he inherited. Fidei commissa were usually adopted as a means of bequeathing property to persons legally incapable of directly receiving the bequest. Fidei commissa were, as their name implies, at first dependent entirely on the faith of the heir for their execution; but that execution was rendered compulsory by Augustus in some cases; and this became afterwards the general law, the heir being, however, entitled, where he voluntarily accepted the testament and charged himself with its execution, to retain one fourth of the property entrusted to him for delivery.

FIDE JU'SSOR. In the Civil Law, one who engages himself for the debt of another, promising to pay in case the original debtor should make default: who is called in the law of England a *guaranter*.

FIEF. (Lat. feodum.) The French name for an estate in lands held of a feudal superior. In English law language, a *fee:* also termed a *feud* by writers on feudal jurisprudence. (*See* FEUDAL SYSTEM.) In the legal language of France, a *fief* was opposed to an *aleu*, or estate held allodially, without any lord paramount. Various derivations of the word have been given; but the most probable is that which traces it through the steps feodum, feudum, emphyteuticum, from the Gr. ἐμφυτευσις, a contract whereby the use of the land without the property in it was surrendered to a tenant.

FIELD. In Agriculture, a portion of land enclosed by a fence, or rendered distinct by some line of separation, so as to adapt it for culture. In former times, and until within the last two centuries, almost all the land cultivated with the plough throughout Europe was unenclosed; and the term field was then applied, in Britain at least, to the lands under culture by the plough. Subsequently, when farmers enclosed and subdivided a portion of the lands near the farm yard, these portions were called fields; and the more distant portion which remained open was called open field, or common field; while grass lands unenclosed were called commons. In the present improved state of agriculture, every farm is divided into fields, either simply by lines of demarcation, which are sufficient when no animals are to be grazed on the farm; or by lines of separation which will act as fences, such as walls, hedges, ditches, &c. where cattle are to be grazed. Without some regular fixed division of arable lands, it would be next to impossible to conduct a rotation or succession of crops. It is interesting to observe that as agriculture in a rude state had no fences, so this is also beginning to be the case in agriculture in its most refined form; because it is found much more advantageous, both for the production of butcher's meat and manure, to consume the grass and herbage grown on farm lands in farm yards, with the single exception of that portion which is eaten by sheep; and these are confined to successive portions of grass land by light netting hurdles, scarcely visible at a short distance. By thus getting rid of fences of every description, from a tenth to a fifth will be added to the contents of the greater number of corn farms; and a very considerable first cost and annual expense will be saved in planting hedges or building walls, and in keeping them in repair afterwards.

FIELD. In Heraldry, the tincture, or combination of tinctures, which forms the ground of the escutcheon on which the device or charge is delineated. *See* TINCTURE.

FIE'LDFARE. A bird of the thrush tribe (*Turdus pilaris*, Linn.), which is a seasonal visitant in this island. It makes its appearance about the beginning of October, migrating from the colder northern parts of the Continent in flocks, numerous according to the severity of the

season. They fly in a body; and if alarmed when dispersed over a field in quest of food, they collect together as they fly off, and often settle in a swarm on the same tree. They leave us about the latter end of February, or the beginning of March; and retire to breed in Sweden, Norway, Russia, and the northern parts of Asia as far as Kamtschatka.

FIELD LARK. *See* LARK.

FIELD MA'RSHAL. The highest military title in this and some other countries. It is conferred only on officers distinguished for brilliant military services or exalted station. The term is derived from the *maréchal de camp* in the old French service, and was long in use among the Germans in its present distinguished acceptation before it was adopted in this country. There are at present only five field marshals in the British army; the Duke of Wellington, the King of Hanover, the Duke of Cambridge, the King of Belgium, and Prince Albert.

FIELD OF VIEW, in a telescope or microscope, is the space within which objects are visible when the instrument is adjusted to focus.

FIE'LDVOLE. A name of the short-tailed field-mouse, or meadow-mouse (*Arvicola agrestis*, Cuv.). A species which subsists exclusively on vegetable productions; and being, like the rest of the rat tribe, extremely prolific, multiplies occasionally to such a degree, even in this country, as to become the most injurious of our wild quadrupeds. "After having followed the labours of the reaper, and taken their share of the harvest, the fieldvoles," says Mr. Bell, "attack the newly sown fields, burrowing beneath the surface, and robbing the husbandman of his next year's crop; and at length, retreating to the woods and plantations, commit such devastations on the young trees as would scarcely be credible, were not the evidence too certain to be doubted. In the years 1813 and 1814 these ravages were so great in the New Forest and the Forest of Dean, as to create considerable alarm lest the whole of the young trees in those extensive woods should be destroyed by them." A timely and assiduous attention to restraining the increase of this pernicious species by the aid of terriers, ferrets, and traps, is imperative on those who have the charge of young plantations; but when the numbers of the fieldvole have surpassed the usual bounds, then it is recommended to dig holes about a foot in depth, and the same in diameter, taking care to make them much wider at the bottom than at the top, so that the animal when once in cannot easily get out again. In holes of this kind Mr. Jesse states that at least thirty thousand fieldvoles were caught, in the course of three or four months, in Dean Forest plantations; that number having been counted out and paid for by the proper officers of the forest.

FI'ERI FACIAS. In Law, a judicial writ, that lies where judgment is had for debt or damages recovered in the king's courts; by which writ the sheriff is commanded to levy the debt and damages of the goods and chattels of the defendant. This writ is to be sued out within a year and a day after judgment; or the judgment must be revived by *scire facias*.

FIFE (Germ. pfeiffe.) A small wooden musical wind instrument of the flute species played by holes, exceedingly shrill in tone, and rarely used except in military bands.

FIFTEENTH. In Music, an interval of two octaves; also a name given to a stop on the *organ*, a double octave above the diapason, as its name imports.

FIFTH. In Music, one of the harmonical intervals or concords. It is the second in order of the concords, the ratio of the chords that afford it being as 3 : 2. It is called the fifth, as containing five terms or sounds between its extremes and four degrees; so that in the natural scale of music it comes in the fifth place or order from the fundamental. The ancients called it *Diapente*, and the Italians at present call it *Quinta*. The *imperfect*, *defective*, or *false fifth*, called by the ancients *semi-diapente*, is less than the fifth by a lesser semitone.

FIFTH-MO'NARCHY-MEN. A fanatical sect, who formed a principal support of Cromwell during the Protectorate. They considered his assumption of power as an earnest of the foundation of the fifth monarchy, which should succeed to the Assyrian, the Persian, the Grecian, and the Roman, and in which Jesus Christ should reign with the saints on earth for the space of a thousand years. Upon the restoration of the royal family, and the return of the kingdom to its former principles in church and state, a party of these enthusiasts, headed by a man of the name of Venner, made a desperate insurrection in the streets of London, which was put down with the slaughter of a great number of them.

FIGS (Lat. ficus, *a fig tree*), are the fruit of a small tree with broad-lobed leaves, inhabiting the south of Europe and similar latitudes in Asia. This fruit is not of the same nature as the apple, the orange, and other fleshy seed-vessels; but is a hollow receptacle, containing a great multitude of minute flowers, the ripe fruit of which is the seed, as it is wrongly called, that is imbedded in the pulp. It is remarkable that the fig tree, although it produces so agreeable a fruit, is in some measure poisonous, its milky juice being acrid to the taste, and of the same nature, although less intense, as that of certain Indian species called *F. toxicaria*, *Dæmonum*, &c., because of their venomous qualities. The genus *Ficus* itself is of considerable extent, and its species are among the most noble objects belonging to the vegetable kingdom in tropical countries, where they often yield caoutchouc of the finest quality. *Ficus elastica* is particularly valuable for this purpose, as are also various unknown species in the island of Java. The banyan tree, so celebrated for the large extent of ground covered by single individuals, which carry an enormous canopy of branches and leaves upon columnar trunks provided for the purpose as the tree advances in diameter, is a kind of fig tree, *Ficus religiosa*.

FIGURATE COUNTERPOINT. In Music, that which contains a mixture of discords together with the concords.

FI'GURATE NUMBERS. In Arithmetic, the name given to series deduced from any progression by differences of which the first term is unity and the ratio a whole number, by taking successively the sum of the two first, the three first, the four first, &c. terms of the progression; and then operating on the new series thus obtained in the same manner as on the original progression, in order to obtain a second series, and so on.

For example, let the progression be that of the natural numbers, the common difference of which is 1; then the progression and the different series of figurate numbers successively deduced from it are as follows:—

A. . .	1,	2,	3,	4,	5,	6,	7,
B. . .	1,	3,	6,	10,	15,	21,	28,
C. . .	1,	4,	10,	20,	35,	56,	84,
D. . .	1,	5,	15,	35,	70,	126,	210.

The first line, A, is the progression from which the series arises. The second line, B, is the series of *triangular numbers*, or *polygonal* numbers of the first order. Its formation is obvious, each term being the sum of the corresponding and all the preceding terms of the progression; whence, by the theory of series, its general term is,

$$\frac{n(n+1)}{1 \cdot 2}.$$

The third line, C, is the series of triangular pyramidal numbers, and is formed from B in the same manner as the latter was formed from A. Its general term is,

$$\frac{n(n+1)(n+2)}{1 \cdot 2 \cdot 3}.$$

The fourth line, D, is formed from C in the same manner as C from B, or B from A. Its general term is,

$$\frac{n(n+1)(n+2)(n+3)}{1 \cdot 2 \cdot 3 \cdot 4}.$$

If the original progression be,

1, 3, 5, 7, 9, 11,

the common difference of which is 2; then the series of figurate numbers successively derived from it are,

1, 4, 9, 16, 25, 36,
1, 5, 14, 30, 55, 91, &c.

The first of these is the series of square numbers, the second that of quadrangular pyramidal numbers. In like manner, if the common difference of the assumed progression be 3, then the successive sums will be the series of pentagonal numbers; if it be 4, the sums will give the hexagonal numbers, and so on. The formation of these different orders of figurate numbers will be readily understood from inspection of the following table:

Progressions.	First sums, or polygons of the first order.	Second sums, or polygons of the second order.
1, 2, 3, 4	Tri. 1, 3, 6, 10	1, 4, 10, 20
1, 3, 5, 7	Sq. 1, 4, 9, 16	1, 5, 14, 30
1, 4, 7, 10	Pent. 1, 5, 12, 22	1, 6, 18, 40
1, 5, 9, 13	Hex. 1, 6, 15, 28	1, 7, 22, 50

The names triangular numbers, squares, pentagons, hexagons, &c., have been applied on account of certain analogies which the numbers so denoted have with the geometrical figures bearing the same denominations. Thus, in the second column of the above table, which contains the polygons of the first order, the terms forming the first line or series express the different numbers of points which may be placed at equal distances, so as to form an equilateral triangle. The second line or series gives the different numbers of points which may be arranged in squares, the third those which form regular pentagons, the fourth those which form regular hexagons, and so on. In the third column of the table, the first series contains the several numbers of points which may be so disposed as to form a triangular pyramid, the second those which form a quadrangular pyramid, and so on.

The different series formed as above possess several curious properties, of which one of the most remarkable

is, that the general term, and the sum of any number of terms n, can always be expressed rationally in terms of n. In fact, the expression of the nth term of any series is the same as that of the sum of the n first terms of the series immediately preceding it, or from which it is immediately derived.

FI'GURE, in Rhetoric, has been defined, generally, as a mode of speech in which words are changed from their literal and primitive sense. It is almost impossible to give, within the limits of a definition, the precise and numerous meanings of which this term is susceptible; but under the separate heads, such as ANTITHESIS, METAPHOR, &c., will be found a notice of the different figures used in composition. In Logic, the word figure is applied to the form of a syllogism with regard to the disposition of the middle term. *See* TROPE.

FIGURE, in Geometry, is used in two different senses. In the first sense, it denotes, generally, a space bounded on all sides, whether by lines or by planes; in the second sense, it signifies the representation (on paper for example) of the object of a theorem or problem, in order to render the demonstration or solution more easy to be understood and followed. In this last sense, *figure* is synonymous with *diagram*.

All bodies are necessarily enclosed by one or more boundaries, and therefore possess figure: hence *figurability* is reckoned one of the essential properties of matter.

For *Figure of the Earth*, see EARTH and DEGREE; for *Figure of the Planets*, see PLANET.

Apparent Figure, in Optics, is the figure under which an object presents itself to our view. This depends on the situation of the points from which rays of light pass to the eye of the spectator, and may be very different from the real figure of the object; for a straight line, when placed in a particular direction, will be seen only as a point, a plane as a straight line, and a solid which presents only one of its faces will appear as a simple surface. (PERSPECTIVE.)

FIGURE HEAD. The figure, statue, or bust, on the projecting part of the head of a ship, called the cutwater.

FIGURES, in Arithmetic, are the numeral characters, or ten digits, by which numbers are expressed. They are supposed to be of Indian origin, and to have been introduced into Europe by the Moors of Spain in the 13th century; but the date of their introduction is much disputed. (ARITHMETIC.)

FI'LACER, or FI'LAZER. (Fr. fil, *thread.*) An officer of the court of Common Pleas, who files writs. The filacers (of whom there are fourteen) are mentioned as early as the stat. 10 H. 4. There are also filacers of the Queen's Bench.

FI'LBERT, or FILBERD, the well-known fruit of the cultivated hazel nut, or *Corylus avellana*, is a seed-vessel enclosed within an involucre or cupule, which is the part commonly called the husk. This organ is of the same nature as the cup of the oak, and the prickly case in which the nuts of the sweet chestnut and the mast of the beech are enclosed. In the filbert it is much larger than in the common nut; and it is this character, together with the lengthened figure of the nut, which distinguishes the two races of nuts and filberts, each of which abounds in varieties. The best known varieties of the filbert are the red, the frizzled, and the white, the latter being the kind most commonly grown in this country.

FILE. (Germ. feile.) This instrument is formed by cutting teeth upon a plate or tool of soft steel by the repeated blows of a straight-edged chisel. These teeth either form a single series of straight lines, or they are crossed by a second series; the former are called *single cut*, the latter *double cut* files. Files are required to be extremely hard; and unless they are carefully and skilfully hardened, they are apt to warp. The best files are made exclusively of cast steel, and are cut by hand, none of the file-cutting machines producing unexceptionable tools.

FI'LIFORM. (Lat. filum, *a thread.*) In Zoology, when a part is slender, thread-shaped, and of equal thickness.

FILL. The sea term for bracing a yard which had been laid aback, so that the wind may act on the after or proper side of the sail.

FI'LLET. (Fr. filet.) In Architecture, a small square member placed above or below other larger members in an order. The term as used by carpenters and joiners means a small piece to which boards, joists, or quarters are nailed.

FI'LLIGRANE, or FILLI'GREE. (Lat. filum, *thread.*) In Sculpture, an extremely fine ornamental work of flowers, fruits, &c., formed with gold or silver wire in serpentine layers, or plaited and worked otherwise together and soldered. It is an eastern invention.

FILO'SE. (Lat. filum.) In Zoology, when a part ends in a thread-like process.

FILTRA'TION. (Lat.) The process by which liquids are separated from substances mechanically suspended in them; it is also sometimes resorted to to separate colouring matters and other bodies which are in a state of solution, and which are removed by the substance or matter through which the liquids are filtered. Unsized paper is commonly used in the chemical laboratory for the former purpose, and is known under the name of filtering paper; it is properly folded, and placed for support in a glass funnel. In the arts, linen and calico bags of different forms are frequently employed, containing well-burned charcoal or other materials, through which the liquids requiring purification are suffered slowly to trickle. In *water filters*, the coarser particles are generally collected in a piece of sponge, and the further separation of the more finely divided matters or organic taints is effected by layers of sand of various degrees of fineness mixed with a proper quantity of charcoal. (See *Faraday's Chemical Manipulation;* and *Ure's Dict. of Arts, &c.*)

FIN. (Lat. finna.) A flattened expanded organ, projecting from the body, and serving as an instrument of locomotion in water.

Many species of the whale tribe possess an immoveable fin upon the back, composed merely of a reflection of integument over a mass of dense and ligamentous cellular membrane; the tail fin in the same order has a similar structure, but is moved by the action of the muscles upon the caudal vertebræ, which are continued through the middle part. The anterior fins, corresponding to the pectorals in fish, are susceptible of greater variety of motion, from being supported by a series of bones corresponding to those of the fore extremity of other mammalia. In fishes the fins are supported by elongated filamentary bones or rays, the nature and number of which afford the zoologists important characters for distinguishing the different groups; and in works of Ichthyology a system of notation is employed, which briefly but clearly expresses these characters. Thus the formula of the number of fin-rays in the perch is thus expressed:—

$$D.\ 15, 1 + 13;\ P.\ 14;\ V.\ 1 + 5;\ A.\ 2 + 8;\ C.\ 17.$$

Which signifies that D., the dorsal fin, has in the first fin 15 rays, all spinous or bony; in the second fin, 1 spinous plus 13 that are soft. P., pectoral fin, 14 rays, all soft. V., the ventral fin, with 1 spinous ray plus 5 that are soft. A., the aural fin, with 2 spinous rays plus 8 that are soft. C., the tail or caudal fin, 17 rays. In enumerating the rays, those only which extend from the longest ray in the upper portion to the longest ray in the lower portion, both inclusive, are counted.

FINA'LE. (It.) In Music, the last of a series of movements in a composition; also the closing scene of each act of an opera buffa.

FINA'NCE. The revenues of a king or state. The word is derived by some from the German *finanz;* by others from the barbarous Latin word *financiatio*, a loan.

FINCH. *See* FRINGILLIDÆ.

FINE, in Law, as a punishment, is a pecuniary mulct or amende imposed by a competent jurisdiction. The party thus mulcted for offences against a feudal superior was said, in the language of that jurisprudence, "finem facere de transgressione cum rege, domino," &c., to *make an end* of his offence: whence the word is derived. Fines are in no case determined as to amount by common law, and seldom by statute, except as to their maximum; but by the general cautions of Magna Charta and the Bill of Rights, excessive fines ought not to be imposed. Courts of record have in general the power of imposing fines in case of contempt, and also on conviction of offences punishable in this manner. The mode of returning, estreating (*i.e.* entering on the rolls of a court), and levying fines is now regulated by 3 & 4 W. 4. c. 99.

FINE OF LANDS. In Law, a species of conveyance or record for the settling and securing lands and tenements, now abolished by stat. 3 & 4 W. 4. c. 74.; although, as long as questions can still arise on the validity and effect of fines levied before that period, the legal doctrines respecting it cannot be said to be wholly obsolete. A fine was, in its original signification, an agreement or composition of a suit (whether real or fictitious) made between demandant and tenant in respect of lands and tenements, with the consent of the judges, and enrolled among the records of the court. Hence, by a common fiction, such an imaginary agreement was employed in certain cases as a mode of conveyance. Its chief properties were,—the extinguishment of dormant titles by barring strangers (unless they claimed within five years, under 1 Ric. 3. c. 7.); and, when levied of an estate in tail, the barring the issue in tail immediately, but not those in remainder or reversion, except when tenant in tail had such reversion in himself. A fine was effected with certain solemnities, as the termination of an imaginary action at law. The party conveying was termed the cognisor or conusor, the party to whom conveyance was made the cognisee of the fine. A fine, besides its peculiar properties in the settlement of lands held in tail, was the usual method whereby a feme covert joined in the sale, settlement, or incumbrance of an estate; for which, by the stat. 3 & 4 W. 4. above mentioned, a peculiar deed is substituted, to be executed and acknowledged by the married woman after examination by commissioners.

FINE'SSE (Fr.), may be defined simply as a peculiar aptitude of discovering, in any business, the best means of attaining the object in view ; or as the power of embracing in one comprehensive glance the various interests of any subject, together with ingenuity to devise and tact to carry out the plan best calculated to obtain success.

FINE STUFF. In Architecture, plaister used in common ceilings and walls for the reception of paper or colour. It is composed of lime, slaked and sifted through a fine sieve, then mixed with a due quantity of hair and fine sand. A mixture of lime and hair, used in the *first coat* and floating of plastering, is called *coarse stuff.*

FI'NGER BOARD. In Music, the black board attached to the neck of instruments of the viol class, on which the strings are pressed by the fingers for the purposes of adjusting their lengths so as to produce the different sounds.

FI'NGERING. In Music, the art of arranging the fingers on instruments of all classes, so that they may be in the best positions for performing the different passages written for such instruments.

FI'NIAL. (Lat. finis, *the end.*) In Gothic Architecture, the top or finishing of a pinnacle or gable, as it is now generally understood ; but in ancient documents an entire pinnacle is understood by this term.

FI'NISH. (Lat. finire, *to end.*) In the Fine Arts, the last working up of any object of art, whereby its completion is effected.

FI'NISHING COAT. In Architecture, the best coat of stucco work when three coats are used. When in the third coat fine stuff is used for paper, it is called setting.

FI'ORITE. A siliceous incrustation, from *Fiora* in Ischia.

FIRE. *See* FLAME and HEAT.

FIRE BALLS (called also *Bolides*, and *Fiery Meteors*), in Meteorology, are luminous bodies which suddenly appear in the sky, usually at a great height above the earth, and shoot through the heavens with immense velocity, and are sometimes accompanied with the fall of an aërolite. These meteors are of frequent occurrence, and numerous descriptions of their appearances at different times are to be found in the *Transactions of the Royal Society ;* but by far the most remarkable apparition of the kind on record, is that which was observed in America on the 13th of November, 1833, and is described in vols. xxv. and xxvi. of the *American Journal of Science*, and also the *American Almanac* for the year 1835. We will give a brief abstract of the relation, which is of extreme interest ; not only on account of the extraordinary nature of the appearances, but also as it seems to indicate that these phenomena, hitherto but little heeded, may serve to make us better acquainted with the constitution of the planetary system.

"The meteors began to attract notice by their frequency as early as nine o'clock on the preceding evening (Nov. 12.) ; the exhibition became strikingly brilliant about eleven, but most splendid of all about four o'clock ; and continued with but little diminution until merged in the light of day. A few large fire balls were seen even after the sun had risen. The entire extent of the exhibition is not ascertained, but it covered no inconsiderable portion of the earth's surface. It has been traced from the longitude of 61° in the Atlantic Ocean, to longitude 100° in central Mexico, and from the North American lakes to the southern side of the island of Jamaica. Every where within these limits the first appearance was that of fire-works of the most imposing grandeur, covering the entire vault of heaven with myriads of fire balls resembling sky-rockets. On more attentive inspection, it was seen that the meteors exhibited three distinct varieties ; the first consisting of *phosphoric lines*, apparently described by a point ; the second, of large fire balls, that at intervals darted along the sky, leaving luminous trains, which occasionally remained in view for a number of minutes, and in some cases for half an hour or more ; the third, of undefined luminous bodies, which remained nearly stationary for a long time.

"One of the most remarkable circumstances attending this display was, that the meteors all seemed to emanate from one and the same point. They set out at different distances from this point, and proceeded with immense velocity, describing in some instances an arc of 30° or 40° in less than four seconds. At Poland, on the Ohio, a meteor (of the third variety) was distinctly visible in the north-east for more than an hour. At Charleston, South Carolina, another of extraordinary size was seen to course the heavens for a great length of time, and then was heard to explode with the noise of a cannon. The point from which the meteors seemed to emanate, was observed by those who fixed its position among the stars to be in the constellation Leo ; and, what is very remarkable, this point was *stationary* among the stars during the whole period of observation ; that is to say, it did not move along with the earth in its diurnal rotation eastward, but accompanied the stars in their apparent progress westward. It is not certain whether the meteors were in general accompanied by any peculiar sound. A few observers reported that they heard a hissing noise like the rushing of a sky-rocket, or slight explosions like the bursting of the same bodies. Nor does it appear that any substance reached the ground which could be clearly established to be a residuum or deposit from the meteors. A remarkable change of weather from warm to cold accompanied the meteoric shower, or immediately followed it, in all parts of the United States."

The particulars which have been stated afford data for entering on the explanation of these mysterious phenomena. And, first, as the meteors appeared to emanate from a point which did not follow the earth's rotation, it is clear that they had not their origin in the atmosphere, but in the regions of space beyond it. The next question that occurs is, what was the distance from the earth of the region of space in which they had their origin ? It was ascertained that observations made in different latitudes indicated a corresponding parallax in declination ; and these observations being collected and carefully compared, gave an average distance from the surface of the earth of 2238 miles as the height of the meteoric cloud. This estimate must be regarded only as an approximation,—the best, however, that could be derived from data that are imperfect and often discordant. Assuming this result to be nearly correct, it is easy to compute the velocity with which the meteors would enter the atmosphere. A body falling from a height of 2238 miles by the attraction of gravity alone would acquire, at the distance of fifty miles from the earth (the supposed height of the atmosphere), a velocity of *four miles per second*, which is more than ten times the velocity of a cannon-ball. The meteors, therefore, on entering the atmosphere, would produce a sudden and powerful compression of the air before them. But when air is suddenly compressed, a great quantity of heat is extricated from it. In the present case, the heat would produce in the falling bodies an intense ignition ; and, if they were combustible, set them on fire. On submitting the subject to accurate calculation on established principles, it is ascertained that the quantity of heat extricated from the air by the falling meteors exceeded that of the hottest furnaces, and can only be compared to those immeasurable degrees of heat produced in the laboratory of the chemist. And this supposes the meteors to have entered the atmosphere with only the velocity due to the earth's attraction ; but if we suppose that they had also a relative velocity arising from the earth's motion towards them, they might then enter the atmosphere with a velocity of fourteen instead of four miles per second. In this case, the heat extricated from the air would be proportionally augmented. It is evident that the meteors must have been constituted of very light materials ; for, had their quantity of matter been considerable, with so prodigious a velocity they would have had sufficient momentum to reach the earth, and the most disastrous consequences might have followed. From the apparent magnitude of many of the meteors, and their probable distance, it was conjectured that they were bodies of very large size, though of course it is impossible to fix the limits of their magnitude with any certainty. Those masses were only stopped in the atmosphere, and prevented from reaching the earth, by transferring their motion to columns of air, large volumes of which would be suddenly and violently displaced. Now it is a remarkable fact, that the state of the weather, and the condition of the seasons following the meteoric shower, corresponded to those consequences of the disturbances of the atmospheric equilibrium. It is from the great and sudden changes of temperature caused by phenomena of this kind that the greatest danger is to be apprehended.

Theory of Fire Balls.—Various hypotheses have been proposed to account for these remarkable phenomena. In general, they have been regarded as meteors having their origin in the atmosphere ; and electricity, magnetism, hydrogen gas, have in turn been assigned as their immediate causes. Others again suppose them to be products of *nebulous* matter (perhaps of the same nature as the tails of comets), floating in the planetary regions, and which, when it happens to lie near the path of the earth in its revolution about the sun, will be attracted by terrestrial gravitation. The parallax of the meteors of 1833 indicates, as we have seen, that they proceeded from a point far beyond the limits of the atmosphere. The attentive examination of the circumstances of their appearances leads to other indications of a very remarkable nature. On projecting a diagram to represent the respective planes of the earth in its orbit, and the plane of the body from which the meteors proceeded, it appears that the earth was moving almost directly towards the meteoric body. Now the meteoric cloud remained apparently at rest, and of course nearly in the earth's path, for at least two hours. This could not have happened unless it had been moving nearly in the same direction as the earth, and with nearly the same angular velocity round the sun ; for had it been at rest, the earth, carried forward at the rate of 19 miles per second, would have

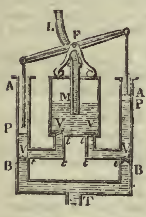
overtaken it in less than two minutes; and had the angular velocities of the two bodies not been nearly equal, they could not have remained so long apparently stationary with respect to each other. Hence it is inferred *that the body which afforded the meteors was pursuing its way with the earth round the sun.*

But supposing there is a body, or, which is more probable, a zone composed of myriads of little bodies, whose orbits intersect the plane of the ecliptic, is it not probable the earth must encounter some of them every time it passes through the point of intersection? A more attentive observation of these meteors than has yet been bestowed on them is perhaps necessary to solve this question. At present the following facts have been collected: — On the 12th of November, 1799, at Cumana, in South America, thousands of meteors or falling stars were seen to succeed each other during four hours. Of this exhibition an account is given by Humboldt and Bonpland. On the 13th of November, 1831, M. Berard, commander of the French brig Loiret, then off the coast of Carthagena in Spain, saw a great number of shooting stars and luminous meteors of large size. During more than three hours there occurred, on the average, at least two a minute. One of these meteors, which appeared near the zenith, in leaving an enormous train in the direction from east to west, presented a very large luminous band (equal to half the diameter of the moon), in which several of the colours of the rainbow were distinctly exhibited. Its trace remained visible during more than six minutes. (Arago, *Annuaire* for 1836.) On the 13th of November, 1832, remarkable exhibitions of meteors were seen at Mocha in Arabia; and on the 19th of the same month in various parts of England. On the 13th of November, 1835, a large and brilliant meteor fell near Belley, in the department of the Ain, in France, and set fire to a barn. On the same night a shooting star, larger and more brilliant than Jupiter, was observed at Lille by M. Delezenne; and, what is very remarkable, a number of extremely brilliant meteors were seen also on the same night, by Sir John Herschel and his assistant at the Cape of Good Hope, who, apprized of the phenomena that had been observed in America, were looking out for their appearance. The attention of observers being now generally called to the subject, the lapse of a few years will probably decide the question, whether the recurrence of the meteors on the same day of the year has been merely accidental; or a stream of nebulous matter has a temporary or permanent existence in that part of space through which the earth passes in its annual revolution, about the 13th of November. (*See* AEROLITE, SHOOTING STARS.)

FIRE BLAST. A term of very doubtful meaning, like the word blight. In Agriculture it is sometimes applied to plants which are suffering from the mildew fungi, or from minute insects; but its legitimate use would appear to be applicable only when the delicate parts of plants are too suddenly exposed to a brilliant sun, and the rapid transpiration which takes place in consequence dries up and shrivels their leaves.

FI'RE DAMP. The carburetted hydrogen gas of coal mines.

FIRE ENGINE. This most useful machine is constructed in a variety of forms, which all, however, agree in one principle. It generally consists of a double forcing pump communicating with the same air vessel; and instead of a force-pipe a flexible leathern hose is used, through which the water is driven by the pressure of the condensed air in the air vessel. The annexed diagram represents a section of the apparatus. The pipe T descends into a receiver or vessel containing a supply of water. This pipe communicates with two suction valves V, which open into the pump barrels of two forcing pumps A, B, in which solid pistons P are placed. The piston rods of these are connected with a working beam F, elongated so that a number of persons may work at both ends of it at once. Force-pipes *t*, *t*, proceed from the sides of the pump barrel above the valves V, and they communicate with an air vessel M, by means of forcing valves V, which also open upwards. The pipe descends into the air vessel near the bottom. This pipe is connected with the flexible leathern hose L, the length of which is adapted to the purposes to which the machine is to be applied. The extremity of the hose may be carried in any direction, and may be introduced through the doors and windows of buildings. By the alternate action of the pistons, water is drawn through the suction valve, and propelled through the forcing valves, until the air in the top of the vessel M is highly compressed. The pressure acts on the surface of the water in the vessel, and forces it through the leathern hose in a continued stream, so as to spout from its extremity with a force depending partly on the degree of condensation, and partly on the elevation of the extremity of the hose above the level of the engine. It is to be considered that the pressure of the condensed air has, in the first instance, to support a column of water, the height of which is equal to the level of the end of the tube above the level of the water in the air vessel; and until the pressure exceeds what is necessary for this purpose, no water can spout from the end of the hose; and, consequently, the force with which it will so spout will be proportional to the excess of the pressure of the condensed air above the weight of the column of water, whose height is equal to the elevation of the end of the hose above the level of the water in the air vessel. (*Cabinet Cyclopædia*, "Hydrostatics and Pneumatics," p. 326.)



The fire engine has received various improvements from Bramah, Dickenson, Simpkin, Raventree, Philips, and others. The above description applies to Newsham's engine. Braithwaite's *steam fire engine* is an application of the power of steam to the working of the fire engine. The mechanical arrangement consists of two cylinders of about six inches in diameter, one of them being the steam cylinder, and the other the water pump; and they are placed horizontally, so that a parallel motion is easily produced. This engine will deliver 9000 gallons of water an hour at the height of 90 feet. The time of getting the machine into action, from the time of igniting the fuel (the water being cold), is only 18 minutes. Some of the Fire Insurance Companies in London have floating engines on the Thames, which are extremely serviceable in cases of fire among the shipping or buildings near the river.

FIRE ESCA'PE. Any machine or apparatus for the purpose of enabling persons to escape from the upper stories of houses on fire. The contrivances which have been proposed for accomplishing this desirable object are very numerous, and are of two kinds; the first kind comprising those by means of which the escape is effected without external aid, and the second those requiring the assistance of persons without. Of the first kind the most obvious is a rope ladder, which may be kept in a sleeping apartment, and used upon occasion by fastening one end of it to a window-sill or bed-post. Mr. Maseres contrived an apparatus which consists of a long rope and an assemblage of cordage or belts, so disposed as to form a seat; the person about to descend binds himself into the seat, and then lowers himself to the ground by allowing the rope which is fastened to the window-sill to slide slowly through his hands; and in order that this may be done easily, the rope is made to pass through a series of holes in a block. But unfortunately contrivances of this kind can rarely be expected to be of any use; for supposing them at hand when the alarm of danger is given, few persons can command the coolness and attention which are requisite for fixing and adjusting the apparatus; and even then it is only the strong and active who could safely descend by such means from a considerable height.

With regard to escapes of the second kind, the object is to enable persons without to establish speedily a communication with an upper room, so as to afford the inmates the means of safe descent; or to remove them if necessary, as in the case of the feeble or children. A very portable sort of ladder, invented by Mr. Young, is described in the *Transactions of the Society of Arts* for 1813. It consists of a number of cross bars or rounds, connected with ropes, which form the sides of the ladder; the ends of the rounds are fitted into each other, so as to form a pole, which is readily elevated to a window; and at the extremity is an iron frame terminating in hooks which can be lodged in the window-sill. When the hooks are properly fixed, a sudden jerk suffices to separate the rounds, which immediately fall into their places when the ladder is formed and suspended from the frame. But this apparatus only answers the same purpose as a rope ladder, and is therefore liable to the same objections. Mr. Braby's fire escape, described in the 34th vol. of the same Transactions, consists of a car or cradle, which is made to slide on a slip of plank fixed to a pole, and is governed by a rope. Mr. Ford's escape consists of a spar of timber about 35 or 40 feet long, having two projecting arms at the top furnished with prongs, by which a firm bearing against the wall of a house is obtained. A grooved pulley is mortised into the spar near the top, and another near the bottom; over the pulleys runs an endless rope, to which is attached at one point a main rope, and at another the semicircular brace of a large grooved roller, which traverses up and down the space between the pulleys. This brace carries on the under side of the spar a hook, to which a cradle is attached, whereby persons can be easily lowered to the ground.

For a description of various other contrivances of a similar kind, we refer to the *Transactions of the Society of Arts* above quoted.

FI'RE FLY. A name commonly given to those insects which have the singular property of emitting a luminous secretion. This power is not confined to insects of one organization or order. Among the Coleoptera, the *Elater noctilucus* and the female glow-worm are conspicuous examples. The *Fulgoridæ*, or lantern and

candle flies, are also described, but some think apocryphally, as luminous insects.

FIRE, GREEK. This fire, which was employed in the wars of the Christians and Saracens in the middle ages, is said to have been invented during the reign of Constantine Pogonatus in the year 668 by Callinicus, an architect of Heliopolis. Naphtha was probably its principal ingredient, which, if skilfully projected and enflamed, creates great havoc and dismay, in consequence of its extreme combustibility and the difficulty of quenching its flame. (See a learned paper on this subject, by *Dr. M'Culloch*, in the *Quarterly Journal of Science*, vol. xiv.)

FI'RE-LOCK, or FUSIL. A musket or small gun, which is fired with a flint and steel; and thereby distinguished from the old musket, or *match-lock*, which was fired with a match. The date of the invention of firelocks is uncertain.

FIRE, ST. ANTHONY'S. *See* ERYSIPELAS.

FI'RE-WORKS. Artificial preparations made of gunpowder, sulphur, and other inflammable ingredients, displayed at public rejoicings and on other occasions. *See* PYROTECHNY.

FI'RKIN. A measure of capacity, being the fourth part of a barrel, or containing 9 ale gallons, or 7½ imperial gallons; that is, 2538 cubic inches.

FI'RLOT. A dry measure used in Scotland, but of different capacities, according to the article it is used for measuring. The Linlithgow *wheat firlot* is to the imperial bushel as ·998 to 1; and the *barley firlot* to the imperial bushel as 1·456 to 1.

FI'RMAMENT, in the language of the old astronomers, is the orb of the fixed stars, or the most remote of all the celestial spheres. In common language it signifies the same thing as *heaven*, or *sky*. *See* HEAVEN.

FI'RMAN (more properly *Fermân*), in the Persian language, signifies a command, and is the name given in Turkey, Persia, and India to mandates or certificates of the sovereign, issued for various purposes. Those best known to Europeans are given to travellers, and serve as passports. The Fermân has placed at its head in Turkey the cipher of the reigning sultan, written in a complicated manner, affixed by the chief secretary of the sign manual.

FIRST COAT. In Architecture, the *laying* the plaster on the laths, or the *rendering*, as it is called, on brick when only two coats are used. When three coats are used, it is called *pricking up* when upon laths, and *roughing in* when upon brick.

FIRST FRUITS. (Annates, or Primitiæ.) The profits of every spiritual living for the first year after its avoidance, which the new incumbent paid in Catholic times to the Pope, but since the Reformation to the king. The valuation is that which was made by Henry VIII. The stat. 2 Anne transfers the first fruits and tenths of all livings over 50*l*. at that time to a fund called Queen Anne's Bounty, for the increase of the smaller benefices, which are released from any payment of the kind.

FIRTH. *See* FRITH.

FISC. (Lat. fiscus.) The term used in the Roman law, and laws derived from it, to denote the property of the state. Under the emperors, however, it had acquired the signification of the peculiar domain or treasure of the prince, in contradistinction to *ærarium*, the public treasury. The word confiscation is derived from fisc; and every lord or body corporate to which things may be confiscated in course of law has, properly speaking, the right of fisc. Fiefs, being originally lands granted to individuals out of the king's domain, are sometimes termed *fisc* in writers of the middle ages. *See* FEUDAL SYSTEM.

FI'SCAL. Something relating to the pecuniary interest of the sovereign, or the community.

FISH. In Architecture, a piece of wood secured to another to strengthen it.

FISH. *See* PISCES.

FI'SHERY. The fisheries of the British Islands are partly coast and river, and partly carried on in the open sea at a greater or less distance from the shore. Of the former, salmon, herring, pilchard, and oyster are most important; of the latter, cod, turbot, and whale. 1. The salmon fishery has considerably diminished in importance of late years. That of Scotland is regulated by 9 G. 4. c. 39. and subsequent acts. 2. The herring fishery, at first almost engrossed by the Dutch, was fostered in 1749 by a tonnage bounty granted on vessels employed in it. Under this system the fishery does not appear to have thriven. The bounty was gradually withdrawn, and finally ceased in 1830. The most important seats of the herring fishery at the present day are the coasts of the north-east of Scotland. In 1834, 11,000 boats and 82,000 persons (fishermen and boys, coopers, curers, &c.) were employed in this fishery. 3. The pilchard fishery is a limited business, carried on almost entirely on the coasts of Devon and Cornwall. 4. Oysters are found on most parts of our coasts, but the principal seats of the trade of breeding them for the London market are Kent and Essex. 5. Turbot, cod, and mackerel are the principal articles of the fisheries off the British coasts. Turbot are chiefly caught by Dutch fishermen, and close to the shores of Holland. In 1833 a report was made by a committee on the British Channel Fisheries, in which the declining state of those fisheries is much commented upon, and attributed to three causes: the extensive interference and aggression of the French fishermen on the coasts of Kent and Sussex; the large quantities of foreign-caught fish illegally imported and sold; and the great decrease and comparative scarcity of fish in the channel; which last they attribute to the destruction of spawn. But by far the greatest fishery of cod, hake, ling, &c. is that carried on on the great bank of Newfoundland, and on the neighbouring coasts. The former is now chiefly engrossed by the French and Americans; but the British fishery, although principally confined to the coasts of Newfoundland and Labrador, is very extensive. Mr. M'Gregor, in his work on the North American Colonies, estimates the value of the produce, on an average of five years to 1832, at 857,000*l*. per annum. (ii. 596.) 6. The Greenland whale fishery was engaged in by the English in the 17th century, but not with vigour until encouraged by a bounty in 1740. During the late war it became extremely valuable; afterwards it declined in importance. In 1815, 146 vessels sailed; in 1834, 76 only. The southern whale fishery is a more modern branch of the traffic. (See *M'Culloch, Statist. of Great Britain*, ii. 21. &c.; article "Fisheries," in *Enc. Brit.*, new ed.; Report of the Committee on the Channel Fisheries, 1833: the former writer estimates the annual value of the fisheries at about 3,000,000*l*. per annum.) The coast and sea fisheries are protected by a variety of enactments. Fishing vessels are licensed by the commissioners of customs under 6 G. 4. c. 108. As to inland fishing, the law of offences in private fisheries is now consolidated by 7 & 8 G. 4. c. 27. Taking or destroying fish in water running through, or in land adjoining or belonging to the dwelling-house of the owner of the water, is a misdemeanour; in any water not within this description, but private property, or in which there is a private right of fishing, it is punishable with fine on summary conviction. Angling in the daytime is not within these enactments, but is punishable summarily with less penalty. The right of fishing in a river primâ facie belongs to the lord of the manor, who has the ownership of both banks. Fishery is said to be either several or free, or common of piscary. The first is in the owner of the soil, or one deriving title from him; the second is a royal franchise, conveying an exclusive right of fishing in a public river. Common of piscary is a liberty of fishery in common with others in a stream or river the soil whereof belongs to a third person, and resembles other commonable rights.

FISHPONDS, are ponds made by art, in which different kinds of fish are bred and fattened. In general this is only attempted with fresh-water fish; but in some places ponds have been formed on the sea shore, and so contrived as to have their waters renewed every tide, and in these sea fish have been kept for use for a considerable time. The fresh-water fish which is the most successfully managed in ponds is the carp.

FISSI'PARA. (Lat. findo, *I divide*, and pario, *I engender*.) Those animals are so called which propagate by spontaneous fission, or the detachment of a greater or less proportion of the body, having inherent power of self-support and growth. As the animals which manifest this mode of generation differ widely among themselves in their general organization, the term *fissipara* cannot be applied to designate any natural group; spontaneous fission is limited to the lowest classes of animals, as *Infusories*, *Polyps*; certain worms, as the *Naïs*, &c.

FISSIRO'STRALS, *Fissirostres*. (Lat. findo, and rostrum, *a beak*.) The name of a tribe of perching birds (*Insessores*), comprehending those which have a very wide gape, as the swallow.

FISSURE'LLA. (Lat. findo.) A genus of Gastropodous Mollusks, having a shell shaped like that of a limpet (*Patella*), but with a fissure at the apex of the cone, which opening is associated with a different form and arrangement of the breathing organs.

FI'STULA. (Lat. *a pipe*.) A long sinuous ulcer, often communicating with a larger cavity, and having a small external opening.

FI'STULA SPIRA'LIS. In Botany, a term used by Malpighi to denominate that kind of vegetable tissue now called the spiral vessel.

FISTULI'DANS, *Fistulides*. (Lat. fistula, *a pipe*.) A tribe of Echinodermatous animals, comprehending those which have an elongated cylindrical tube-like body.

FIVE POINTS. The principal points of controversy between the Calvinists and Arminians, which became the subjects of the decisions of the Synod of Dort. They relate to predestination, satisfaction, regeneration, grace, and final perseverance. See article ARMINIANS.

FIXED AIR. The old term for *carbonic acid*, from its existence in a fixed state in limestone, &c.

FIXED OILS. The common greasy oils are so termed in consequence of the high temperature which they sustain before giving out vapour.

FIXED STARS. Those which retain the same, or very nearly the same position, with respect to each other. It has been discovered, by the acccurate observations of modern times, that many of the stars have a proper motion. *See* STARS.

FI'XTURE, in Law, is a term generally applied to all articles of a personal nature affixed to land. This annexation must be by the article being let into or united with the land, or with some substance previously connected therewith. Thus a barn, built on a frame not let into the earth, is not a fixture; a brewer's stills, set in brickwork resting on a foundation, are fixtures; and the application of the same principle gives, in every case, the true rule to judge whether any thing be a fixture or not. Whatever is thus fixed becomes, by law, parcel of the freehold or realty. It is, therefore, on general principles, not removable; but there are exceptions to this rule established by custom; of which the principal arise out of the right of tenants to remove fixtures set up for purposes of trade, and in some instances for ornament and convenience (commonly called tenants' fixtures), and the right of executors to some fixtures, generally of the same description, as against the heir or devisee of the realty.

FLAG. In Naval affairs, the flags are,— the royal standard; the admiralty flag, an anchor on a red ground; the union, or jack, in which are blended together the crosses of St. George, St. Andrew, and St. Patrick: this is carried by the admiral of the fleet.

FLAGE'LLA. A term used by the older botanists to denote the twigs or youngest shoots of plants.

FLAGE'LLANTS. (Lat. flagellum, *a whip.*) A sect of enthusiasts who first appeared in the middle of the 13th century, and being then repressed, sprang up again with renewed violence in the 14th. Beginning first at Cremona in Italy, the contagion of the example spread in a few years throughout Europe; and every city was infested by multitudes who went naked from the loins upward, and inflicted upon themselves several daily flagellations, with the idea of obtaining thereby merit in the eyes of God. They formed themselves into a society, and at first were at least innocent in their behaviour; but as their numbers increased, they gave way to great excesses, and were eventually suppressed by a holy war proclaimed against them by Pope Clement VI.

FLAGE'LLUM. In Botany, a trailing shoot of the vine; sometimes used to denominate that form of stem called a runner.

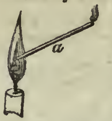
FLA'GEOLET. (Fr.) A wooden musical wind instrument, played with a mouth-piece, the holes and keys whereof are stopped with the fingers, in the same way as the flute.

FLAIL. A wooden implement for threshing corn by hand. It consists of the handle or hand-staff, which the labourer holds in his hand, and uses as a lever to raise up and bring down the swiple, or part which strikes the corn, and beats out the grain and chaff from the straw. The swiple is joined to the hand-staff by the caplins or couplings, which are thongs of untanned leather, and sometimes the skins of eels or of other fish. These thongs are passed through holes in the ends of the handle and swiple, and made fast by being sewed together. The flail was in use among the Romans, though the prevailing mode of separating corn from straw among the nations of antiquity was by treading it out with cattle in the open air. In the colder parts of Europe, this could never have been generally the case for obvious reasons; and hence the flail was the universal threshing implement till the introduction of the threshing machine, which is now taking the place of the flail in all countries where capitalists engage in farming. *See* THRESHING MACHINE.

FLAKE WHITE. A term often applied to the purest *white lead.*

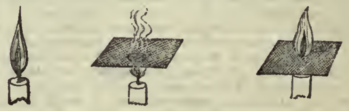
FLAME. (Germ. flamme.) When the temperature of inflammable gases or vapours is raised very high, and in the contact of air, they are said to *burst into flame;* if previously mixed with a due proportion of oxygen, or of atmospheric air, they *explode.* In the former case the combustion only goes on at the surface in contact with air, and is quiet and gradual; in the latter, every particle of the inflammable body being in contact with the supporter of combustion, the inflammation extends instantaneously through the whole mass. The nature of flame was first explained by Hooke in 1677 (in his *Lampas*); but the relation of the light to the heat of flames, and the whole philosophy of their constitution, was first developed by Sir H. Davy in his researches published in the *Philosophical Transactions* between 1815 and 1817.

All the leading phenomena of flame are well exhibited by a large gas-flame burning from a wide orifice. It presents a hollow cone, the heat and light of which are confined to its exterior surface. A transverse section of such a flame exhibits a ring of light surrounding a central uninflamed core: the inflammable gas or vapour may be drawn by a tube out of this central portion, as in the annexed figure, where *a* represents the tube inserted into the central non-luminous part of the flame, and where the abstracted inflammable vapour is again kindled at its extremity. (See illustrations of this subject in the papers of Mr. Sym and Mr. Davies, *Ann. of Phil.* vols. viii. and x.)



A flame may be extremely hot without being proportionately luminous, as is the case with the flame of hydrogen, which is scarcely visible in daylight, but the heat of which is shown by introducing into it a piece of fine platinum wire, which immediately becomes white hot, and emits abundance of light. The *light* of all flames is of a similar origin, and depends upon *solid matter* ignited and rendered incandescent by the heat of the flame: thus if magnesia or lime in fine powder be projected into the flame of hydrogen, the luminosity of the flame is immediately increased. Finely divided charcoal is the substance to which all common flames owe their luminosity. It is derived from the hydrocarbon produced by the decomposition of oil, wax, tallow, &c., as contained in coal gas; but as charcoal, unlike magnesia and lime, is itself combustible, it not only renders the flame luminous, but is burned in the act of so doing, and passes off in a well-regulated and perfect flame in the invisible form of carbonic acid gas.

When flames are cooled, they are at the same time extinguished; hence a flame cannot be made to traverse or recede through a metallic tube of small bore; and hence a flame may, as it were, be bisected by a piece of wire gauze held transversely across it: in which case the smoke, gas, or vapour and charcoal go through, but not hot enough to inflame, having been cooled down by their passage through the metallic meshes; but by applying a flame to this smoke, it may again be kindled. In this way the upper portion of the flame may be burned, while the inflammation of the lower half is prevented by the interposed cooling medium. These experiments are best illustrated by the flame of a gas-burner, and the two cases just cited are represented in the annexed figures.



FLA'MEN. The title applied by the Romans to the priests of any particular deity as distinguished from priests in general. Originally Numa instituted three orders of flamens; viz. those of Jupiter, Mars, and Quirinus (Romulus). But in after times this number was much increased by the introduction of new gods and superstitions, and by the worship paid to deceased emperors.

FLAMI'NGO. *See* PHŒNICOPTERUS.

FLANK. (Fr. flanc.) In Architecture, the side of any building.

FLANK, in Fortification, is that part of the bastion which reaches from the curtain to the face: the flank of one bastion serves to defend the ditch before the curtain and face of the opposite bastion. *See* FORTIFICATION.

FLANNEL. *See* WOOLLEN MANUFACTURE.

FLA'SHINGS. (Probably from flaque, *a splash.*) In Architecture, pieces of lead or other metal let into the joints of a wall so as to lap over the gutters or other conduit pieces, and prevent the splashing of rain injuring the interior works.

FLAT. In Architecture, that part in the covering of a house of lead or other metal which is laid horizontal.

FLAT. In Music, a character of this form ♭, which depresses the note before which it is placed a chromatic semitone. Flats and sharps were originally contrived to remedy the defects of musical instruments whereon temperament was required, the natural scale of music being limited to certain fixed sounds, and adjusted to an instrument in many points defective; for we can only proceed from one note to another by a particular order of degrees. Hence, from one note to another, upwards or downwards, we cannot find any interval at pleasure. To supply or remedy this defect, musicians have had recourse to a scale proceeding by twelve degrees, making therefore thirteen notes to an octave, including the extremes, which, though it does not make the instrument perfect, leaves little room for complaint. In instruments whose sounds are fixed, a sound or note dividing it into two unequal parts, called semitones, is placed between the extremes of every tone of the natural scale; so that we have twelve semitones between thirteen notes in the compass of an octave. In order then to keep the diatonic series distinct, the inverted notes answer for the name of the natural note next below, with this character ♯, called a sharp; or the name of the natural note next above it, with this character ♭, called a

flat. Thus D♭ signifies a semitone below D natural (♮). On keyed instruments the short keys are the representatives of these flats and sharps. The system, however, does not strictly produce what it represents: it is only an approximation. *See* TEMPERAMENT.

FLAT FIFTH. In Music, an interval of a fifth depressed by a flat, called by the ancients *semidiapente*.

FLAT FISH. *See* PLEURONECTES.

FLA'TTEN A SAIL. To extend it fore and aft, whereby its effect is lateral only.

FLATTING. In Architecture, a coat of paint, which, from its mixture with turpentine, leaves the work flat, or without gloss.

FLA'TULENCY. (Lat. flatus, *blast.*) A morbid collection of gas in the stomach and bowels, commonly symptomatic of indigestion or indulgence in certain kinds of vegetable food. Warm tonics and well-seasoned animal food, with weak brandy and water as a beverage at dinner, are the usual and effective remedies.

FLAX. (Germ. flachs.) The fibre of the *Linum usitatissimum*, which is spun into thread and woven into *linen* textures.

The flax is reaped a little before the seeds are ripe; it is stripped, and the stalks are then soaked in water, or *retted* (rotted), when fermentation running into putrefaction ensues, so as to destroy the foreign matters with which the fibres are blended in the plant; the flax is then dried, and broken or beaten and winnowed, so as to separate the fibrous from the other parts; these are afterwards heckled, and prepared for the spinner. (For an account of these operations, and of the machinery by which they are effected, see Ure's *Dictionary of Arts, &c.*, art. "Flax.")

FLECHE. In Fortification, a simple redan usually constructed at the foot of a glacis. *See* REDAN.

FLEECE, ORDER OF THE GOLDEN. One of the most distinguished among European orders of knighthood. It was founded by Philip III., duke of Burgundy, in 1430; and as by its foundation his successors were declared to be hereditary grand masters, that title passed, with the Burgundian inheritance, to the house of Austria; thence, after the death of Charles V., to the Spanish line of that house: but when the monarchy of Spain passed to the Bourbons and the Spanish Netherlands to Austria, the archdukes of Austria claimed the grand mastership; and claims are made on it at present both by the emperor of Austria and king of Spain; the order is consequently conferred both at Vienna and Madrid, and is, in both courts, the highest in point of rank. As its nominal object is the protection of religion, it is rarely conferred on any Protestants, with the exception, by courtesy, of Protestant sovereigns.

FLEET, in its most extended signification, is applied to a number of ships, pursuing in company either mercantile or warlike purposes, or both; but is more generally confined to the different detachments which form the *navy* of any country, stationed in various parts of the world for the purposes of defence, aggression, or intimidation. *See* NAVY, SQUADRON.

FLEET. The sea term for shortening any thing, by taking it up, that had been pulled out or stretched.

FLE'MISH SCHOOL. In Painting, the school formed in Flanders. The works of this school are distinguished by the most perfect knowledge of chiaro-scuro; high finishing without dryness; by an admirable union of colours well blended and contrasted, and by a flowing luxurious pencil. Its defects are somewhat similar to those of the Dutch school. The Flemish painters, like the Dutch, represented nature as they found her, and not as she should be. Rubens and Vandyke (the glory of this school), though men of the greatest genius, were not free from this defect, and the former especially. Teniers was another great master of the school in question; to it also belong Snyders, Steenwick, Neefs, Schwaneveldt, Van Eyck, &c.

FLE'TA. The title of an ancient treatise on English law, attributed to the reign of Ed. I., and named (according to tradition) from its composition by a judge in the Fleet prison.

FLEUR-DE-LIS. In Heraldry, a charge supposed to represent a lily: borne from a very early period in the royal arms of France. It is, however, more probably conjectured that the shape of this bearing was intended to represent the iron of a javelin.

FLE'XIBI'LITY. (Lat. flecto, *I bend.*) That property of bodies in virtue of which, when a sufficient force is applied to them, they change their form, and are bent. Flexibility is opposed to *stiffness* on the one hand, and to *brittleness* on the other; stiff bodies being such as resist bending, and brittle those which cannot be bent without a disruption of their parts. Of unorganized bodies the most flexible are the metals; and their flexibility is in general increased by heat, though brass is rendered brittle when subjected to a high temperature. Of organized bodies, young fresh plants and animal substances (excepting bone) are eminently flexible; and bodies of this class are rendered more flexible by heat and moisture. In many machines where great stability is required it is often a matter of much importance to be acquainted with the flexibility of the component materials, in order to determine the load they can support without yielding. (*See* COHESION.) Flexibility is only a relative term, for all bodies are more or less flexible; and in bars of wood or metal the stiffness or resistance to flexure is directly as the breadth and cube of the depth, and inversely as the cube of the length.

FLEXU'RA. (Lat. flecto, *I bend.*) In Mammalogy, the joint between the antibrachium and carpus, usually called the fore-knee in the horse; analogous to the wrist-joint in man.

FLE'XURE. The bending or incurvation of a line or surface. *Point of contrary flexure* is a term used in analytical geometry to denote that point of a curve at which the curvature passes from convex to concave, or *vice versâ*, with respect of the axis. At this point the radius of curvature is infinite. At the points of the curve immediately preceding and following, the centre of curvature lies on opposite sides of the curve.

FLINT. Common flints are nearly pure *silica*. They usually occur in irregular nodules in chalk. Their origin is an unsolved geological problem.

FLINT GLASS, or CRYSTAL. A species of glass which derives its name from flint, because that substance was formerly employed in its manufacture. It is very extensively used for domestic purposes; but is chiefly interesting to the philosopher on account of the property which it possesses of causing a greater dispersion of the rays of light which pass through a prism or lens formed of it than any other of the vitreous compounds. This property renders it invaluable in the manufacture of the object glasses of telescopes and microscopes; for by combining a concave lens of flint glass with one or two convex lenses of *crown glass*, which possesses a much less dispersive power, a compound lens is formed, in which the prismatic colours arising from a simple refraction are destroyed, and the lens rendered achromatic. This construction of object glasses was first discovered by a Mr. Hall, a country gentleman in Worcestershire, about 1729; but the discovery was forgotten, and no further notice taken of it for nearly 30 years, when it was again brought to light by John Dollond, after a long-continued course of experiments undertaken for the purpose of perfecting the telescope. It is, however, very difficult to prepare flint glass fit for the purposes of achromatic telescopes. This difficulty arises not from the want of sufficient dispersive power in the substance, but from the want of purity or homogeneity; the slightest impurity or inequality of composition in the glass giving rise to a streaked or imperfect image by reason of the unequal refraction of the rays. The composition of pure flint glass long remained a secret in the family of the Dollonds, and its manufacture formed a very profitable article of exportation; for till about the beginning of the present century, no flint glass of good quality was made on the Continent. Of late years, however, a great change has taken place in this respect; and glass of the best quality has been manufactured, both in France and Germany, in much larger masses than our English artists have yet succeeded in obtaining. This result has been mainly produced by the experimental researches of D'Artigues, Fraunhofer, Cauchoix, Guinand, and Korner. Formerly, an object-glass exceeding five inches in diameter could scarcely be produced. Fraunhofer succeeded in making them of nine, and even twelve inches. The object-glass of the large parallactic telescope belonging to Sir James South, at Campden Hill, was manufactured by Cauchoix; it exceeds twelve inches, and is throughout of the utmost purity. The exact proportion of the ingredients which enter into these choice specimens is not known, and probably their excellence depends in part on some accidental circumstances in the preparation. Korner produced some of his best specimens by employing the following ingredients: — 100 parts of quartz, first treated with muriatic acid; 80 parts of litharge, or red lead; and 30 parts of the bitartrate of potash. Flint glass for common purposes is usually made of 120 parts of fine white sand, 40 parts of well purified pearl ash, 35 parts litharge or minium, 13 parts nitre, and a small quantity of the black oxide of manganese; the latter ingredient being used to correct the green colour occasioned by the presence of oxide of iron in the sand. The principal difference between this and the glass used for optical purposes consists in the much greater quantity of lead in the latter, and which is introduced for the purpose of increasing its dispersive power. There is a valuable paper on the manufacture of glass for optical purposes, containing the results of an extensive series of experiments upon the subject, made in the laboratory of the Royal Institution, by Mr. Faraday, in the *Philosophical Transactions* for the year 1830, vol. cxx. *See* GLASS.

FLOAT BOARDS. The boards fixed to the rim or outer circumference of undershot wheels, which receive the impulse of the water and communicate the motion to the wheel.

FLOA'TED LATH AND PLAISTER. In Architecture, plaistering of three coats, whereof the first is pricking up (*see* First Coat); the second, floating or floated work; and the last of *fine stuff.*

FLOA'TED WORK. In Architecture, plaistering made of a perfectly plane surface, by means of a tool (which is a long rule with a straight edge) called a float.

FLOA'TING MEADOWS. Meadow lands, the surface of which is flat, adjoining a river or other source of water, with which they can be flooded or covered at pleasure. The water is turned on chiefly in the winter season, when it is more or less muddy, and leaves a deposit that serves as a kind of manure. It is also useful to vegetation, by preserving a higher temperature in the surface soil than it could maintain through the winter, if fully exposed to the action of the atmosphere; because, wherever water is in a fluid state, its mean temperature, and that of the bodies immediately in contact with it, must be above 32°, and at that temperature the grasses common in British meadows will grow. There are probably other benefits which grass lands receive from being covered with water during a portion of the winter season, but these have not yet been satisfactorily explained by science.

FLOA'TING SCREEDS. (Ital., probably from schierato, *ranged.*) In Architecture, strips of plaister arranged and nicely adjusted for guiding the *floating-rule.* *See* Floated Work.

FLOA'TSTONE. A porous variety of flint, which floats upon water.

FLO'CCI. (Lat.) In Botany, the woolly filaments that are found mixed with the sporules of many *Gastromyci:* the same name is also applied to the external filaments of *Byssaceæ.*

FLOCCILLA'TION. Picking the bed-clothes. This is a very alarming symptom in many acute diseases.

FLO'CCUS. In Mammalogy, the tuft of long flaccid hairs which terminate the tail.

FLOETZ ROCKS. A term applied by the German geologists to the secondary strata, because they generally occur in *flat* or horizontal beds.

FLOOR. (Sax. flope.) In Architecture, the pavement or boarded lower horizontal surface of an apartment. It is constructed of earth, brick, stone, wood, or other materials. Carpenters include in the term the framed timber work on which the boarding is laid, as well as the boards themselves.

Floor. The lower part of a ship's bottom.

FLOOR CLOTH. This useful and ornamental manufacture originated in this country about the year 1740, when a manufactory of it was established at Knightsbridge, near London, by Mr. Smith. It was originally made of narrow canvass sewn together like sail cloth, to which successive coats of paint were applied; but the seams proving inconvenient, a canvass was wove for the purpose, about four yards wide; it was then extended to seven yards in width, and afterwards to nine, which is the widest at present made. The manufactory at Knightsbridge, now carried on by Mr. Baber, is the largest establishment of the kind; the common dimensions of the oil cloths produced there being 20 yards by 8, and 30 yards by 7, giving therefore entire pieces of 160 and 210 square yards without seams. These canvasses are stretched upon frames, and accessible over their whole surface by stages erected for the purpose: these are the circumstances which render the large dimensions of the manufactory requisite. The canvass being duly strained is rubbed over with pumice stone, which renders its surface smooth and even, and then brushed over with a weak solution of size; when this is dry the first coat of oil colour is laid on, not with brushes, but with trowels, something in the manner of plastering; when this is dry a second coat follows it; and in this way seven coats of paint are usually applied in succession, three on the back and four on the front. When the cloth in this state, and of one colour, is sufficiently dry, it is removed from its frame upon a large roller, and carried to the upper part of the building to be *printed;* that is, to receive its pattern. This was originally effected by a process of stencilling; but in the year 1780 Mr. Smith introduced the great improvement of *block-printing,* by which the colours are more correctly laid on, and in greater body and variety. The printing table, which is about 30 feet long, 4 wide, and 2 feet 6 inches high, is very firmly constructed of deal timbers laid edgeways and clamped together, the surface being truely planed; the roll of painted cloth is placed underneath it, and as it is unrolled it gradually passes over the table, where it is printed, and is then drawn forward so as to hang perfectly free while drying, the height of the building being such as conveniently to admit of this, without rolling, doubling, or folding the material, which in these stages would of course injure it. The colours, which are the usual oil colours very carefully prepared, are put on in succession with wooden blocks, which are made of pear tree, box, or holly wood, and upon which the patterns are cut in relief; they are about eighteen inches square, and are applied in succession over the whole of the surface of the cloth lying upon the printing table. Every colour is put on by a separate block, and much dexterity is required in so placing them that the patterns may correctly interlace and join each other, without in any case overlapping or interfering: to effect this the workman is aided by guide pins, or *pitches,* as they are termed, which direct him in placing the block. The colours are first brushed or tiered upon hard cushions, from which they are transferred to the block, and thence to the cloth; and, though many are often required, it is astonishing how much effect is sometimes obtained by the judicious arrangement or mixture of two only, upon a third, which forms the ground. It will be obvious, from what has been stated, that the weight of the finished oil cloth, as compared with the naked canvass, is no unimportant criterion of its goodness; each square yard when finished weighing from three pounds and a half to four or four and a half: this distinguishes a good oil cloth from those which are vamped up and stiffened with size and other perishable materials.

Independent of the common application of oil cloth, it is not unfrequently advantageously employed as a roofing material, especially for covering verandas and other light structures. When used for this purpose, the canvass should be made of picked long flax, and thoroughly saturated with good oil paint; it will then stand our climate and last for 14 or 15 years.

FLOOR, FOLDING or FOLDED. In Architecture, one in which the floor boards are so laid that their joints do not appear continuous throughout the whole length of the floor, but in bays or folds of three, four, five, or more boards each.

FLOOR, STRAIGHT JOINT. In Architecture, one in which the floor boards are so laid that their joints or edges form a continued line throughout the direction of their length; in opposition to folding floor, where the joints end in folds.

FLORA'LIA. A festival celebrated with some magnificence in honour of Flora, the Roman goddess of flowers.

FLO'RETS. The flowers of a capitulum or anthodium; which are smaller in size, but not different in structure from ordinary flowers. Those which are placed in the middle of the capitulum are called *discoidal,* or *of the disk;* those in the circumference are named *radiant,* or *of the ray.*

FLORIN. *See* Money.

FLOS-FERRI. A coralloidal carbonate of lime, often found in veins of spathose *iron* ore.

FLOTA. A name given by the Spaniards to the ships that formerly sailed together, or under convoy, from Cadiz and the other ports of the Peninsula authorized to trade directly with the Transatlantic possessions of Spain.

FLOTI'LLA. (Span.) Literally a little fleet; in which sense, however, it is seldom used, being applied almost invariably to a fleet, how large soever, composed of small vessels. Thus the term flotilla was given to the immense naval force with which Napoleon meditated the invasion of Great Britain, and which consisted of 2365 vessels of every description, was manned by about 17,000 sailors, and carried 160,000 soldiers, and 10,000 horses. In Spain, the name flotilla is given to a number of vessels appointed to announce to the home government the departure and nature of the cargo of the flota or mercantile ships from foreign ports on their homeward voyage.

FLO'TSAM (floating), *Jetsam* (Fr. jeter, *to throw*), and *Lagan* (lying), as law terms, are usually joined together. The first, according to Blackstone, designates goods cast from a ship and swimming in the waves; jetsam, goods cast and sunk; lagan, sunk but tied to a buoy by the owners. Goods in either of these three predicaments belong to the king, if the owners be not known, and may by him be granted with other franchises.

FLOW'ERLESS PLANTS. Those plants that are destitute of flowers and sexes. They are the same as *cryptogamic,* or *acrogenous,* or cellular plants.

FLOWERS. The old chemists gave this name to several light flocculent substances obtained by sublimation; such as *flowers of sulphur, flowers of benzoes,* &c.

FLUE. In Architecture, the long open tube of a chimney from the fireplace to the top of the shaft for voidance of the smoke.

FLU'ENT or FLOWING QUANTITY, in Analysis, is the variable quantity, considered as increasing or diminishing. The term denotes the same thing as *integral,* which is now universally used in its stead, the differential and integral calculus having superseded the methods of fluxions and fluents. *See* Fluxion, Integral.

FLU'ID, or FLUID BODY, is that whose parts yield to the smallest pressure, and are moved among each other without any sensible resistance. Some writers distinguish between *fluid* and *liquid,* confining the latter term to those substances which *wet,* or whose particles adhere to other bodies plunged into them. Thus air, ether, mercury, water, alcohol, &c. are all fluids; but water and alcohol are also *liquids,* because they wet other

bodies, while air and mercury do not. The term liquid is, however, very frequently used in the same general sense as fluid. Fluids are of two kinds, elastic and non-elastic. The mechanical properties of elastic fluids, comprehending air and the different gases, constitute the science of *Pneumatics;* those of the non-elastic fluids, water, mercury, &c., *Hydrostatics* and *Hydraulics*. It is to be remarked, however, that the terms elastic and non-elastic are here used in a relative, not in an absolute sense; for water, alcohol, and probably all other fluids of the same class, are, to a certain extent, compressible and elastic, though they resist compression with a very great force.

FLUI′DITY (Lat. fluo, *I flow*), is that state of a substance in which its constituent particles are so slightly cohesive that they yield to the smallest impressions. The term is usually confined to express the condition of the non-elastic fluids; and hence it denotes one of the three states in which matter exists; namely, the solid, the fluid or liquid, and the gaseous. The state of fluidity is best defined as that in which bodies tend to form *drops*, as this disposition does not belong either to bodies in a gaseous form, or to solid bodies reduced to fine powder. The formation of drops arises from this—that the molecules of fluid bodies adhere to each other with a certain force, at the same time that they glide over one another without any sensible resistance. It is incorrect to say that the molecules of bodies in a state of fluidity offer no resistance to separation; for, on bringing a flat disc of glass or metal into contact with the surface of a liquid, a very sensible degree of force is required to separate them. That adhesion exists among the molecules of fluid bodies is also proved by various other phenomena. Water or mercury on a flat plate of metal collects in globules, and when slowly poured into a wine glass will remain heaped up as it were above the level of the edge.

Various hypotheses have been framed by philosophers to explain the different states in which matter is found to exist. Confining ourselves to the most general views, we may regard all bodies as assemblages of particles constantly maintained in equilibrium between two forces,—an attractive force which tends to unite the particles, and a repulsive force which tends to increase the distance between them. The solid state results from the preponderance of the attractive force. Conceive the repulsive force to receive an augmentation until it becomes equal to, or forms an equilibrium with, the attractive force. When the two forces are thus balanced, the particles exert on each other neither attraction nor repulsion, and the body is in the fluid state. Lastly, if the repulsive energy be still increased, the particles will be separated from each other to such distances that their mutual attractions will cease altogether to be sensible, and then the body passes into the gaseous state. Hence we may pronounce that there is no *natural* state of body; and that fluidity, solidity, the state of vapour, and the aëriform state are only accidental, and determined by the temperature of the medium in which the body is placed. *See* CRYSTALLIZATION, CAPILLARY ATTRACTION, GAS, &c.

FLUKE. A name commonly applied to a species of flat fish, or *Pleuronectes;* and also to an *Entozoon* of a similar form (*Distoma hepaticum*), which infests the ducts of the liver of different animals, especially of the sheep.

Fluke is also applied in navigation to the broad part of the anchor which takes hold of the ground.

FLUOBO′RIC ACID. A gas obtained by heating to redness a mixture of dry boracic acid and powdered fluor spar. Its specific gravity is 2·36. It is colourless, pungent, and produces a dense white cloud when it escapes into a moist atmosphere; it is resolved by the action of water into boracic and hydro-fluoric acids. It acts with great energy upon animal and vegetable substances, and chars them. It is probably a compound of 20 parts of boron and 108 of fluorine; or of one atom of boron and six atoms of fluorine.

FLUO′RIC ACID. *See* HYDROFLUORIC ACID.

FLU′ORINE. The hypothetical base of the hydrofluoric acid: it has not yet been obtained in a separate state.

FLU′OR SPAR. This is a common mineral product, found in great beauty in Derbyshire; hence known in this country under the name of the *Derbyshire spar*. It is generally crystallized in cubes, but its primitive form is an octahedron. It is of various colours, and often beautifully banded; especially when in nodules, which are much prized for the manufacture of vases, and occasionally used for beads, brooch stones, and other ornamental purposes. It is probably a compound of fluorine and calcium, hence a *fluoride of calcium*. The term *fluor* is derived from the fusibility of this substance; on which account it is sometimes used as a flux to promote the fusion of certain refractory minerals. It is manufactured at Matlock and Derby into a great variety of articles.

FLU′OSI′LICIC ACID. A gas obtained by applying a gentle heat to a mixture of one part of powdered fluor spar, one of silica, and two of sulphuric acid, in a retort. It is colourless, pungent, fumes when it escapes into a humid air, and is rapidly absorbed by water. Its specific gravity is about 3·6; 100 cubic inches weighing nearly 112 grains. It is decomposed by water, and forms silica and hydrofluoric acid. It consists of 8 parts by weight of silicium, and 18 of fluorine, its equivalent (upon the hydrogen scale) being 26.

FLUSH. (Lat. fluxus.) In Architecture, the continued surface in the same plane of two contiguous masses.

FLUTE. (Fr.) A wooden musical wind instrument played by holes and keys, stopped and opened with the fingers. The lips and tongue are both used in playing it. The octave flute is a smaller but similar instrument, whose pitch is an octave higher than the flute, as its name implies.

FLUTES, or FLUTINGS. (Fr.) In Architecture, upright channels on the shafts of columns, usually ending hemispherically at top and bottom. Their plan or horizontal section is sometimes circular or segmental, and sometimes, as in the Grecian examples, elliptical. The Doric column has twenty round its circumference; the Ionic, Corinthian, and Composite twenty-four. The Tuscan column is never fluted. They are occasionally *cabled*. (See that word.)

FLUVIA′LES. (Lat. fluvius, *a river*.) A natural order of Endogenous water plants common in all extra-tropical countries, and approaching somewhat to flowerless plants. Pollini, according to De Candolle, asserts that spiral vessels do exist in them, while Amici urges the contrary. Agardh refers to this order both *Ceratophyllum* and *Sparganium;* but those genera are nearer allied to *Juncaginaceæ*. Their sensible properties are unimportant. *Zostera* or sea wrack, one of the genera, is used to stuff cushions, and as a material for packing.

FLUX. (Lat. fluo, *I flow*.) Applied in technical chemistry to substances which are in themselves very fusible, or which promote the fusion of other bodies. When tartar is deflagrated with half its weight of nitre, a mixture of charcoal and carbonate of potash remains, which is often called *black flux:* when an equal weight of nitre is used, the whole of the charcoal is burned off, and carbonate of potassa remains, which, when thus procured, is called *white flux*. For flux and reflux of the sea, *see* TIDES.

FLUX. In Pathology, a disease attended by inordinate secretion from the bowels.

FLU′XION (Lat. fluxus, *flow*), in Analysis, signifies the same thing as differential, the term being suggested by a particular view of the manner in which variable quantities increase or diminish. Newton considered a curve as generated by the uniform motion of a point, and decomposed at every instant the constant velocity of this point into two others, one parallel to the axis of the abscissa, and the other parallel to the axis of the ordinates. These velocities are what he called the *fluxions* of the co-ordinates; while the arbitrary velocity of the point which describes the curve is the fluxion of the arc. Reciprocally, the arc described is called the *fluent* of the velocity with which it is described by the moving point; the corresponding absciss is the fluent of the velocity estimated in the direction of the absciss, and the ordinate the fluent of the velocity of the point estimated in the direction of the ordinate. The same considerations may be extended to the areas bounded by curve lines, to surfaces and the volumes which they determine, to forces which give rise to motion in bodies, and to the effects which they produce. In fact, the theory is applicable to every thing which forms the object of the mathematical or physico-mathematical sciences.

The method of fluxions is derived naturally from that of *prime* and *ultimate ratios;* for the variable velocity of a point is not the path described by it in a given time divided by this time; but it is the prime or ultimate ratio of that quotient, that is to say, the quantity to which that quotient approaches more and more in proportion as the time is supposed to be shorter. This observation has occasioned an objection to the method of fluxions,—namely, that of introducing into geometry, which is a branch of the pure mathematics, the idea of velocity, which belongs to the mixed mathematics; and of defining an idea which ought to be simple by one that is complex. The objection is frivolous; the only question of any consequence being whether the theory is more easily apprehended by this manner of exposition than by any other.

In applying the method of fluxions to mathematical investigation, the procedure is precisely the same as in the differential calculus; from which, indeed, it differs in no respect save that of notation. The method was invented by Newton; and the notation which he used was adopted by all English writers, and long obstinately adhered to, although the notation of Leibnitz, the inventor of the differential calculus, possesses over it many advantages, particularly in the more abstruse theories of analysis. At length, however, the great number of excellent works which appeared on the Continent, in all of which the differential notation was used, the manifest advantage of uniformity in the symbols employed in sci-

entific researches, and the intrinsic superiority of the foreign notation, caused that of fluxions to be gradually abandoned, and at the present time it has entirely disappeared in all mathematical works possessing any claim to merit. The first systematic treatise on fluxions in our language, in which the differential notation was employed throughout, was the article "Fluxions" in the *Edinburgh Encyclopedia*, which appeared in the year 1815.

FLY. In Mechanics, an appendage given to machines for the purpose of regulating and equalizing the motion, as in the windlass, jack, pile-engine, &c.; and sometimes for collecting force in order to produce a very great instantaneous impression, as in a coining press. Generally it is formed of a heavy disc or hoop at right angles to the axis; sometimes of heavy knobs at the extremities of a bar having the same position. The fly is of great use in all cases where the power, or the resistance, acts unequally in the different parts of a revolution.

FLY-CATCHER. *See* MUSCICAPA.

FLY'ING BUTTRESS. In Gothic Architecture, a buttress in the form of an arch, springing from a solid mass of masonry, and abutting against the springing of another arch which rises from the upper points of abutment of the first. It is seen in most of our cathedrals, and its office is to act as a counterpoise against the vaulting of the nave. If flying buttresses were built solid from the ground, it is obvious that they would interfere with the vista along the aisles of the church; hence the project of continuing a resistance by means of arches. Their stability depends on the resistance afforded by the weight of the vertical buttress from whence they spring. See the diagram, art. GOTHIC ARCHITECTURE AFTER THE 12TH CENTURY.

FLY'ING FISH. The species of two distinct genera of fish, in which the pectoral fins are so developed as to enable them to sustain themselves for a short time in the air, are so called. The more common species are the Exocœte (*Exocœtus volitans*), and the flying gurnard (*Dactylcptera volitans*).

FLY POWDER. An imperfect oxide of arsenic, formed by the exposure of native arsenic to the air; when mixed with sugar and water it is used to kill flies.

FO. The name given by the Chinese to Buddha, by one of those phenomena in literature whereby appellations are introduced from one language into others with which it has little or no affinity. Originally the name Buddha was expressed in the Chinese language with sufficient exactness by the term Fô-thau, pronounced Fôudah; but, as is usual in China with proper names, the last syllable was subsequently dropped. According to the Chinese historians, the religion of Buddha was introduced into China in the reign of Ming-ti, of the dynasty of the Hans, about the 64th year of the Christian era; but there is good reason to believe that the doctrines of the Indian reformer had been carried thither by some of his enthusiastic adherents long before that period, and that it is only to their official recognition by the government that this later date refers. This is not the place to give an exposition of the religious and philosophic principles of Fo (*see* BUDDHISM): suffice it to say that the same principles are adopted by all the Buddhists of the various countries where they are professed, with the exception of a few trifling deviations which the various translations of the Buddhist writings from their original Sanscrit have naturally generated. It is only when these writings, or at all events the chief of them, shall have been translated into the languages of Europe (which we have good grounds to suppose will soon be the case), that an accurate idea can be formed of the doctrines which they inculcate, and which have exercised so mighty an influence on the largest portion of the inhabitants of Asia. (See the *Penny Cyclopædia*.)

FO'CAL DISTANCE. (Lat. focus, *a hearth*.) In Optics, the distance between the centre of a lens or mirror, and the point into which the rays are collected.

FO'CUS, in Geometry, is applied to certain points belonging to the conic sections, which possess very remarkable properties. The focus of the parabola is a point in the axis having this property, that a radius drawn from it to any point in the curve makes the same angle with the tangent at that point that the tangent makes with the axis. Hence a ray of light proceeding from the focus, and reflected by the curve, proceeds in a direction parallel to the axis; or, if parallel rays fall on the concave side of a parabola, they are reflected into the focus. In the ellipse the two foci are situated in the greater axis, at equal distances from the centre; and if from both foci straight lines be drawn to the same point in the circumference, the two lines make equal angles with the tangent at that point. A ray of light, therefore, issuing from the one focus, is reflected by the curve into the other focus. In the hyperbola a similar property holds good; with this difference, that whereas in the ellipse the two straight lines fall both on the concave side of the arc, in the hyperbola one falls on the concave and the other on the convex; in other words, the two lines drawn from the foci to any point in the hyperbola make equal angles with the tangent on opposite sides of it. A ray of light, therefore, proceeding from one focus of a hyperbola, will be reflected by any point of the curve into the direction of a ray coming from the other focus and passing through that point. In the solar system, the sun occupies one of the foci of the orbits of all the planets and comets.

Focus, in Optics, is the space into which the rays of light are collected by a burning glass or mirror. On account of the apparent diameter of the sun's disc, the solar rays cannot be collected into a single point, even if we could suppose a lens or mirror to be formed into the perfect shape which geometry requires for that purpose. They cover a certain circular space, which space is called the focus; and its magnitude has the same relation to the apparent diameter of the sun, as the image of any other object formed in the focus of the lens or mirror has to the object itself. Let A C be a ray proceeding from the centre of the sun's disc, and B C another proceeding from its border; then the angle L C M is equal to the apparent semidiameter of the sun, that is $16'$; and if we make the focal distance L C $= f$, we have the semidiameter of the focus L M $= f$ tan. $16'$. But the tangent of $16'$ is very nearly $= \frac{1}{216}$; therefore the semidiameter of the focal circle is very nearly the 216th part of the focal distance. Hence we derive a rule for finding the intensity of the heat in the focus of a burning glass; since all the rays which fall on the glass are collected within the focal circle, the intensity of the heat in that circle is to the intensity of the heat falling on the glass in the ratio of the area of the glass to that of the focal circle. But circles are to each other as the squares of their diameters; whence, calling the diameter of the glass d, and supposing the light falling on it to be represented by unit, the intensity of the light or heat within the focal circle is d^2 divided by $(\frac{1}{108})^2 f^2$; or it is directly proportional to the square of the diameter of the glass, and inversely to the square of the focal distance. For a spherical lens, convex on both sides, the diameter of the focal circle is one-eighth of the thickness of the lens; but though it cannot be less than this quantity, in imperfect glasses it will considerably exceed it. *See* LENS, BURNING GLASS.

FO'DDER. (Germ. futter.) In Agriculture, the food given to quadrupeds, which consists of the stems and leaves of plants, such as the culmiferous stems of the grasses, the haulm of legumes, potatoes, &c.; or, in short, whatever is given as the ordinary food is designated fodder; whereas corn, beans, and other articles, which present nourishment in a more concentrated form, are not included under the term fodder, but rather known as solid food.

FODDER, is the name of a weight formerly used in the weighing of lead: it was of various magnitudes, but most commonly amounted to about 2400 lbs.

FOE'TUS. (Lat. feo, *I bring forth*.) From about the fifth month after pregnancy till the period of its birth, the child in the womb of its mother is termed a *fœtus*.

FOG. (Dan. fog.) In Meteorology, a dense vapour near the surface of the land or water. Fogs, in general, are the consequence of the nocturnal cooling of the atmosphere. The air, by its rapid cooling, becomes surcharged with moisture; a part of which, being precipitated in the form of a cloud, gives rise to the ordinary fog. During the day the heat of the sun generally disperses the fog, because the quantity of moisture which the air is capable of holding becomes more considerable in proportion as its temperature is increased.

In calm weather the surfaces of rivers, lakes, &c. are frequently in the morning covered with fog. The reason is this. During the night the air is colder than the water; the strata of air in contact with the water are consequently heated, and become saturated with moisture. The mixture of the vapour with the air, together with its elevation of temperature, renders the air specifically lighter. It rises in consequence, and mixing with the cold air in the superior strata, is cooled, and precipitates its moisture. The cloud or fog resulting from this precipitation can only rise to a small height, because the uniformity of temperature is soon restored. Hence it is easy to see how winds, or a great agitation of the air, prevent the formation of fogs over the surface of water. In the equinoxial regions, fogs sometimes continue during a considerable part of the year. Humboldt relates that Lima is often covered with a fog half the year, especially in the mornings and evenings; and that along the whole of that coast fogs supply the place of rain, which is extremely rare. In the polar seas thick fogs often prevail, even during the warmest months; and they are so dense that objects frequently cannot be distinguished at the distance of a few yards.

Sometimes, though rarely, fogs occur of which the cause is not very well understood. In 1783, the whole of

Europe was covered with a dense fog during nearly two months. On the 22d of May, 1822, about 5 o'clock in the afternoon, a fog covered Paris and the neighbourhood, which had the odour of nitrous gas: it continued about an hour. Dry fogs, or those in which no moisture is present, are supposed to be the vapours and ashes ejected by volcanos, and diffused in the atmosphere by the winds.

FOIL. (Fr. feuille, or Lat. folium, *a leaf*.) This term is generally applied to varnished metal. Common foil is manufactured as follows: — A copper plate, covered with a thin layer of silver, is rolled out into sheets under the flatting mill; the silver surface is then highly polished or covered with a colourless varnish. The *coloured foils* are similarly prepared with coloured varnishes.

FOLD. (Sax. ꝼealꝺe.) A temporary enclosure for keeping cattle or other agricultural animals together, either for the purpose of protection during night, or jointly for protection and feeding. Sometimes, also, sheep are folded for the purpose of manuring. The barrier of which folds are constructed is commonly wooden hurdles; but sometimes, when the fold is only to contain ewes and lambs, netting stretched between posts is made use of, there being a strong rope fixed to the lower parts of the posts close to the ground, to which the under edge of the netting is attached, while its upper edge is attached to a rope stretched along the tops of the same posts. The practice of folding sheep on naked fallows, with a view to manuring them, is still common in several parts of England; but the more improved sheep farmers consider that it deteriorates the wool, and impedes the fattening of the sheep, by keeping them for the greater part of every night wholly without food.

Fold. In Painting, the doubling or lapping of one piece of drapery over another.

FO'LIAGE. (Lat. foliatus, *leaved*.) In Architecture and Sculpture, a group of leaves of plants and flowers, so arranged as to form architectural or sculptural ornaments; as in friezes, panels, and also in the capital of the Corinthian order.

FO'LIATE, in the doctrine of curve lines, is the name given to a curve of the third order, defined by the equation $x^3 + y^3 = axy$. It is one of the species of defective hyperbolas, having one asymptote and two infinite branches; and its figure has some resemblance to a leaf, whence the name. (See *Newton's Enumeratio Linearum Tertii Ordinis*.)

FO'LIA'TION. The manner in which the nascent leaves are arranged within a leaf-bud.

FO'LIO (Ital. *a leaf*), in Account-books, signifies page. Thus folio 7, — written abridgedly fo. 7, — denotes the seventh page; Folio recto, or F° R°, signifies the first page; Folio verso, or F° V°, the second page of a leaf. A book in folio, or simply a folio, is that where the sheet is only folded in two, each leaf making half a sheet.

FOLI'OLUM. A leaflet borne upon the axis of a leaf.

FO'LKMOTE, among our Saxon ancestors, signified any popular or public meeting of all the folk or people of a place or district; for instance, of all the tenants at a court leet or court baron, or of all the freemen of the county, or of all the barons of the kingdom. Antiquaries are, however, by no means agreed as to the nature of the folkmote; some considering it an institution of great, others of minor importance. (See *Somner's Anglo-Saxon Dictionary; Brady's Introduction to Old English History; Fabian's Chronicles;* and *Wilk. Leg. Anglo-Sax.*)

FOLLI'CULUS. A one-celled, one or many-seeded, one-valved superior fruit, dehiscent by a suture along its face, and bearing its seeds at the base, or on each margin of the suture; differing from the legumen in having but one valve instead of two.

This term has also other significations; viz. 1. According to Linnæus, any kind of capsule. 2. The cases bearing the reproductive organs of *Equisetaceæ*. 3. According to Gærtner, a double, one-celled, one-valved, membranous, coriaceous capsule, dehiscing on the inside, and either bearing the seed on each margin of its suture, or on a receptacle common to both margins; as *Asclepias*, &c. 4. According to Willdenow, any oblong pericarpium bursting longitudinally on one side, and filled with seeds; as *Vinca*.

FO'MALHAUT. A star of the first magnitude in Piscis Australis.

FOMENTA'TION. Local bathing with hot water, or medicated decoctions.

FONT. (Lat. fons.) In Architecture and Sculpture, a vessel generally of stone or marble for containing the water of baptism in the Christian church. Some of the early fonts are extremely beautiful, and wrought with extraordinary richness of decoration. The singular inscription which is frequently found on the walls of baptisteries occurs also occasionally on ancient fonts — NIΨON ANOMHMATA MH MONAN OΨIN; which reads equally forwards or backwards, admonishing the reader to cleanse himself from evil deeds not less than use the outward ceremony of baptism.

FO'NTANEL. The interstice, or *mould*, as it is often called, which exists at birth between the frontal and parietal bones: it is closed by bony matter about the end of the third year.

FOOD. All substances susceptible of digestion and assimilation may come under the denomination of *food;* but the proximate principles of organic bodies on which their nutritive powers depend are comparatively few. Hence, although the articles employed in different countries for the support of animal life are almost infinitely various, their sustaining powers may be referred to certain substances capable of being separated and indentified by chemical analysis and tests. Amongst the proximate elements of vegetable food gluten and its modifications, starch, gum, sugar, and lignin or woody fibre, are by far the most important; and amongst those of animal food albumen, gelatin, and their modifications, together with fats and oils, which are common to both kingdoms of nature.

To illustrate the actual simplicity of our food as compared with its apparent multifariousness and complexity, it may suffice to state, that wheat and almost all the esculent grains consist principally of starch and gluten; that the same ingredients are found in many fruits and roots; that sugar, gum, or a relation of gum which is called vegetable jelly, together with minute traces of aromatic principles which give flavour, and more or less abundance of water, and of vegetable acids, are the chief component parts of apples, pears, peaches, currants, gooseberries, and all analogous tribes of fruits; a very few also contain oil. Then, as regards *animal* food, the muscular fibres of various animals closely resemble each other in composition and nutritive power; in some cases texture merely, and in others minute additions of foreign matters, confer upon them their relative digestibilities, and their different aspects and flavours: albumen or fibrine, and gelatin, small proportions of saline bodies, and a large quantity of water are found in them all.

It often happens that the truly nutritious part of food is so combined with or protected by indigestible matters, as to escape the solvent powers of the stomach, unless previously prepared and modified by various chemical and mechanical agents. Indurated woody fibre, for instance, or *lignin*, as chemists call it, will often resist the joint action of the stomach and bowels, and pass through the alimentary canal with scarcely any alteration. The husks of many seeds and fruits are composed almost exclusively of this material. This is the case with the kernels of the apple, pear, &c.; the seeds of the currant, gooseberry, melon, and so on; the skin or husk of peas, beans, &c., and of wheat, barley, and oats; so that unless this woody part is either broken down by the teeth, or previously removed, the food which it envelopes is protected from the solvent action of the secretions of the stomach. This is in some respects a wise and curious provision in nature; for birds in this way become the carriers of seeds, which pass through them not only undigested, but even retaining their vegetative powers; and in this way uninhabited and sterile portions of the globe may gradually become clothed with verdure, and shrubs and trees. Bones are highly nutritive; but unless broken into very small fragments by the masticatory powers of the animals which eat them, they too would elude digestion. In reference, however, to the food of man, much of its digestibility and nutritious power is referable to the important chemical operations preparatory to its use which are carried on in the kitchen: in other words, cookery is essentially a chemical art; and substances totally unfit, in their raw state, for reception into the stomach, are rendered palatable, digestible, and nutritious, by the skill of the cook. And here salt, and a variety of *condiments*, as they are called, and which are aromatic and stimulant substances chiefly of vegetable origin, play an important part; nor must the mere effect of heat be overlooked, for it is most important. Meat, by boiling and roasting, is not only softened in its fibre, but new substances are generated in it. Among these a peculiar extractive matter, and *osmazome*, or the principle which gives an agreeable flavour and odour to dressed meat, are especially recognized. Nor are the changes which vegetables suffer under the influence of heat less obvious.

There is another important point in the history of our food, namely, its *ultimate composition*. We have spoken of starch, sugar, gum, albumen, and other substances, as the *proximate* principles upon which we live; but what is the *ultimate* constitution of these secondary products, what are their true *elements?* It is curious that four *elements* only are principally concerned in the production of our food. These are carbon, hydrogen, oxygen, and nitrogen. Among vegetable substances gluten (including vegetable albumen) is the only one which abounds in nitrogen; gum, sugar, starch, and the rest are constituted of carbon, hydrogen, and oxygen only; and what is very remarkable is, that in all these important principles, and also in lignin, the oxygen and hydrogen bear to each other the same relative proportions as in water, so that they may be figuratively described as compounds of *charcoal* and *water*. Now there are two

very curious points in reference to that part of the chemical history of our food which has been adverted to: the one is, that no animal can subsist for any length of time upon food which is destitute of nitrogen; and the other, that a certain mixture of different kinds of food is absolutely essential. An animal fed *exclusively* on starch, or sugar, or albumen, or jelly, soon begins to suffer in health; peculiar diseases make their appearance, and his existence is painful and brief; but mix these together, and occasionally modify their proportions, and he then thrives and fattens. Magendie's experiments on this subject, together with those of Tiedemann and Gmelin, well illustrate this fact. Thus, geese fed upon gum died on the 16th day, those fed upon starch on the 24th, and those fed on boiled white of egg on the 46th: in all these cases they dwindled away and died as if of starvation.

Habit, as is well known, will do much in accustoming the stomach to particular descriptions of food; many persons live exclusively, or almost so, on vegetable, others on animal matters, and particular kinds of diet are forced on the inhabitants of many regions of the globe; but, as far as we are concerned, a due mixture of vegetable and animal matter is not only most palatable, but most conducive to health. Nothing is fit for food which has not already undergone organization; and *water*, though an essential part of the food of all animals, is obviously not in itself nutritious, though it performs the extremely important function of dissolving nutritive matter, so as to render it conveyable by the lacteals and other absorbents into the blood. No compound then of nitrogen, hydrogen, carbon, and oxygen, which can be formed artificially, can constitute food. Air, water, and charcoal, though involving the *elements* of our nutriment, are themselves unfit for our support; and it is only by passing through the hidden processes which are carried on in the vessels of living things, that they are so recombined and modified as to be rendered capable of supporting animal life. It is the vegetable world which commences this wonderful operation. Plants absorb their nutriment from the air and from the soil; they assimilate inorganic as well as organic matter; they become the food of the graminivorous tribes, and from these man derives the great bulk of his animal food.

In speaking of the composition of food, that of *milk*, the most important of all food, must not be forgotten; in it nature has wonderfully provided a mixture which, though secreted by an animal, partakes also of the nature of vegetable food, and it presents a perfect analogy to that combination of vegetable and animal matter which has been mentioned as most congenial to the palate and stomach. The albumen or *curd* of milk is a highly elaborated animal principle, abounding in nitrogen, yet, from its attenuated and soluble state, easy of digestion. A second principle of milk is what is termed *sugar of milk*; in composition and properties it resembles a vegetable product, and is intermediate between gum and sugar. The third component of milk is *butter*, partaking of the nature of vegetable oil and animal fat; there are certain saline and acid substances in small proportion; and all these matters are either dissolved or suspended in a large relative proportion of water.

I. Table showing the average quantity of nutritive matter in 1000 parts of several varieties of animal and vegetable food.

Blood	215	Wheat	950	Apples	170
Beef	260	Rice	880	Gooseberries	190
Veal	250	Barley	920	Cherries	250
Mutton	290	Rye	792	Plums	290
Pork	240	Oats	742	Apricots	260
Brain	200	Potatoes	260	Peaches	200
Chicken	270	Carrots	98	Grapes	270
Cod	210	Turnips	42	Melon	30
Haddock	180	Cabbage	73	Cucumber	25
Sole	210	Beet root	148	Tamarind	340
Bones	510	Strawberries	100	Almonds	650
Milk	72	Pears	160	Morels	896
White of egg	140				

The above table represents the relative proportion of solid digestible matter contained in 1000 parts of the different articles of food which are enumerated. When blood, for instance, is evaporated to dryness, at a temperature not exceeding 212°, the residue amounts to 215 parts in 1000, and may be regarded as almost entirely composed of digestible matters; it consists of albumen and colouring matter, with small proportions of saline substances. The different kinds of meat were dried in the same way. The loss of weight during their desiccation is almost wholly referable to water; and the dry residue composed of albumen or fibrine, with some gelatine, and perhaps traces of fat and of saline matters, represents the true nutritive value. Upon an average, therefore, the nutritive matter in a pound of meat is not more than four ounces. This, however, only applies to raw meat; for when dressed a considerable portion of its constituent water is often dissipated. The nutritive matter of wheat is chiefly starch and gluten, and in this species of grain the gluten is in much greater relative proportion to the starch than in barley, oats, or rye. In rice there is little else than starch. There can be little doubt that the great value of wheat as an article of food depends upon this excess of gluten, which is a nitrogenous substance, and has not inaptly been termed the vegeto-animal principle. In the esculent roots, such as carrots, &c., but especially turnips, sugar is the leading nutritive matter; and the common fruits contain sugar, gum, albuminous matter, and acids, together with a highly attenuated form of woody fibre, or lignin, which, in that state, is probably digestible.

The following table shows the ultimate composition of those proximate principles which have been above adverted to as constituting the nutritive part of food:—

II. Table showing the ultimate elementary composition of 1000 parts of the following proximate principles of animal and vegetable food.

	Carbon.	Hydrogen.	Oxygen.	Nitrogen.
Albumen	516	76	258	150
Gelatin	483	80	276	161
Fat	780	122	98	
Curd of milk	609	73	116	203
Sugar of milk	454	61	485	
Gluten	557	78	220	145
Starch	438	62	500	
Gum	419	68	513	
Sugar	444	62	494	
Lignin	500	56	444	

FOOLS, FEAST OF. A festival anciently celebrated in almost every church and monastery of France on New Year's Day, in which every absurdity and even indecency was practised. It was equivalent to the Saturnalia among the Romans, whence indeed it is said to be derived. This festival received some modifications in the different districts where it was celebrated, and acquired various designations according to the multifarious ceremonies of which it consisted. Thus it was termed "la fête des diacres souls, des cornards, des innocents," &c. Several bishops and councils attempted, though in vain, to abolish this festival; but at length about the 15th century it became less generally observed, and soon after fell into almost total disuse, though its characteristic absurdities are still maintained in the Carnival of the present times. For full details on the Feast of Fools see the *Encyclopedie des Gens du Monde*, under the head "Fous (Fête des)," and the authorities there referred to.

FOOL'S PARSLEY. An umbelliferous plant, common in waste ground, and so called from its resembling parsley enough in appearance to deceive ignorant persons. It is a poisonous plant, acting like hemlock upon the human system; and is easily known by the involucels having each three leaflets, which are always placed next the circumference of the umbel. It is the *Æthusa cynapium* of botanists.

FOOT. (Germ. fuss.) A measure of length. As this term is employed in almost all languages as a linear measure, it has doubtless been derived from the length of the human foot. Though the denomination is the same, the measure itself varies considerably in different European countries. In all of them, however, it is divided, like the English foot, into twelve equal parts or inches. *See* MEASURES.

FOOT. In Prosody, a measure consisting of two, three, or four syllables, long, short, or long and short. All the combinations of which these numbers are susceptible amount to twenty-eight; and such is accordingly the number of feet enumerated by Greek and Latin prosodists, according to the following table:—

⏑⏑	Pyrrhich	–⏑–⏑	Ditrochæus
– –	Spondee	⏑–⏑–	Diiambus
–⏑	Trochee	–⏑⏑–	Choriambus
⏑–	Iamb	⏑––⏑	Antispastus
⏑⏑⏑	Tribrachys	⏑⏑––	Ionicus a minore
–––	Molossus	––⏑⏑	Ionicus a majore
–⏑⏑	Dactylus	–⏑⏑⏑	Pæon primus
⏑⏑–	Anapæst	⏑–⏑⏑	Pæon secundus
⏑–⏑	Amphibrachys	⏑⏑–⏑	Pæon tertius
–⏑–	Amphimacer	⏑⏑⏑–	Pæon quartus
⏑––	Bacchæus	⏑–––	Epitritus 1
––⏑	Palimbacchæus	–⏑––	Epitritus 2
⏑⏑⏑⏑	Proceleusmaticus	––⏑–	Epitritus 3
––––	Dispondeus	–––⏑	Epitritus 4

But by rejecting those which are merely reduplications of disyllabic feet (Proceleusmaticus, Dispondeus, Ditrochæus, and Diiambus), the number is reduced to twenty-four; and by also striking off those which are compounds of disyllabic feet (Choriambus, Antispastus, two Ionics, four Pæons, and four Epitrites), the number of simple feet becomes twelve only. *See* RHYTHM.

FOO'TINGS. In Architecture, the spreading courses at the base or foundation of a wall.

FO'RAGE, in Military affairs, signifies the provisions brought by the troops into the camp for the sustenance of the army, &c. during a campaign.

FORA'MEN. (Lat. foro, *I pierce.*) In Anatomy, a

small opening. The *foramen ovale* is an opening between the two auricles of the heart of the fœtus, which closes at birth.

FORA'MEN. In Botany, the opening that exists in the integuments of every ovulum.

FORAMI'NIFERS, *Foraminifera*. (Lat. foramen, fero; *I bear*.) A name applied by D'Orbigny to a tribe of minute shells, which he believed to be formed by Cephalopods; they are now proved to belong to a lower-organized class of animals. *See* SYMPLECTOMERANS.

FORCE, in Mechanics, is that which produces motion, or a change of motion. Forces may be of different kinds; but they are all compared and measured by the quantities of motion which they respectively produce in a given time: in fact, we know nothing whatever of forces excepting through their effects.

In order to determine what will be the effect of a force upon any given mass of matter, three circumstances respecting the force are necessary to be known; namely, its intensity, the place where it acts or its point of application, and its direction. Its intensity is proportional to the space through which the unit of mass is moved in the unit of time; therefore, since the space described is proportional to the velocity (supposed uniform), if the mass remains constant a double force will produce a double velocity; and if the velocity is constant, a double mass must be urged by a double force. Hence the force of the body is proportional to the mass and to the velocity conjointly. Thus let m and m' be two masses, or the quantities of matter in two bodies, and v and v' be the velocities with which they respectively move in consequence of the two forces whose intensities are f and f; then f is proportional to $m\ v$, and f' to $m'\ v'$.

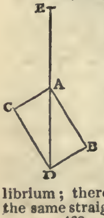
When a body is acted upon by more forces than one, it is obvious that it will not move in the direction or with the velocity due to one of the forces alone, but in a direction and with a velocity due to their collective influence. The effect produced by the joint action of the several forces is called their *resultant;* and it is determined both in magnitude and direction by the following theorem, celebrated under the name of the *Composition of Force:* — "If the lines which each of two forces acting singly would have caused a body to describe in a given time make any angle whatsoever with one another, the line which the body will describe in that time, when both the forces act upon it at the same instant, is the diagonal of the parallelogram under the two first-mentioned lines." Thus, let a body at A be acted upon by two forces at the same instant, one of which, if acting alone, would cause

it to move over the line A B in a given time, and the other acting alone would cause it to move over the line A C in the same time; then the direction of the motion resulting from the action of both forces will be that of the diagonal A D of the parallelogram A B D C, and at the end of the given time the body will be found at D. The theorem may be derived from the principle that the velocity of the body in one of the directions is not changed by the force impelling it in the other; but of this principle it is not easy to give a satisfactory demonstration, without introducing considerations drawn from the resources of the higher mathematics. (See *Poisson*, *Mecanique*, tome 1.)

It is obvious that by means of this theorem the resultant of any number of forces whatever may be found; for after finding the resultant of any two of the forces, we may conceive them to be removed, and their resultant substituted, when the resultant of this and the third force will be the resultant of three of the forces. This last resultant may then be combined with a fourth force, and so on till the whole of the forces have been included. This construction is called the polygon of forces.

As the forces represented by the straight lines A B and A C are *compounded* into a single force, represented in intensity and direction by A D; so any given force may be *resolved* into two others, such that the straight lines by which they are represented form the two sides of a parallelogram of which the line representing the given force is the diagonal. This composition and resolution of forces is of constant application in Mechanics.

If a body impelled at the same time by three forces re-



main at rest, these forces are proportional to the three sides of a triangle formed by drawing straight lines parallel to their directions. For, let the three forces acting on the point A be respectively represented in intensity and direction by the three straight lines A B, A C, A E; then by forming the parallelogram A B D C, and drawing the diagonal A D, we have the two forces represented by A B and A C equal to the single force represented by A D and acting in the direction A D. But the point A is by hypothesis in equilibrium; therefore A D must be equal to A E, and in the same straight line with it; whence, since B D is equal to A C, the three forces by which the point A is kept in equilibrium are respectively proportional to the three sides A B, B D, and A D of the triangle A B D.

Let the three forces be respectively denoted by P, Q, and R; then, the sides of a triangle being proportional to the sines of the opposite angles,

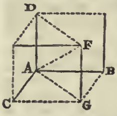
$$P : Q : R :: \sin. ADB : \sin. DAB : \sin. ABD.$$

But by reason of the parallel lines the angle A D B is equal to D A C, and A B D being the supplement of C A B their sines are equal; whence

$$P : Q : R :: \sin. DAC : \sin. DAB : \sin. CAB.$$

From this we infer that if a point A be kept in equilibrium by the action of three forces P, Q, and R, each of these forces is proportional to the sine of the angle formed by the direction of the two others. It is also a consequence of this proposition that if three forces be in equilibrium they must all act in the same plane, and any two of them must be greater than the third.

The resultant of three forces X, Y, Z, applied to the same point A in space, and severally represented in mag-



nitude and direction by the straight lines A B, A C, A D, is represented by A F, the diagonal of the parallelepipedon, of which the sides are A B, A C, and A D. For the two forces X and Y, which are represented by A B and A C, the two sides of the parallelogram A B G C will have for their resultant a force P, represented by A G, the diagonal of this parallelogram. And because A D is equal and parallel to G F, the figure A D F G is a parallelogram; and consequently the two forces P and Z, represented by A G and A D, will have for their resultant a force R, represented by A F, the diagonal of the parallelogram A D F G, which is also the diagonal of the parallelepipedon.

From this theorem it follows that any force whatever R can always be decomposed into three others, X, Y, Z, respectively parallel to three straight lines given in space, provided that no two of them be parallel; and if each of the three given lines be at right angles to the plane of the other two, and the angles which A F (the direction of the given force R) makes respectively with A B, A C, A D (the directions of the forces X, Y, Z) be denoted by a, b, c, we have then, evidently,

$$X = R \cos. a,\ Y = R \cos. b,\ Z = R \cos. c,$$

the three angles a, b, c, being connected by the relation

$$\cos.^2 a + \cos.^2 b + \cos.^2 c = 1.$$

In those investigations in mechanics where a number of forces are concerned, it is usual to resolve them all into three forces parallel to three rectangular co-ordinates; when the resultant of the three sets of rectangular forces will evidently be the common resultant of all the forces. If F, F′, F″, F‴, &c. be the forces; a, a', a'', a''', &c. the angles which they make with one of the three axes; b, b', b'', b''', &c. the angles which they make with another of the axes; and c, c', c'', c''', &c. the angles which they make with the third; and X, Y, Z be the three rectangular forces which are the sums of the components of all the original forces, F, F′, F″, F‴, &c.; then,

$$X = F \cos. a + F' \cos. a' + F'' \cos. a'' + F''' \cos. a''' + \&c.$$
$$Y = F \cos. b + F' \cos. b' + F'' \cos. b'' + F''' \cos. b''' + \&c.$$
$$Z = F \cos. c + F' \cos. c' + F'' \cos. c'' + F''' \cos. c''' + \&c.$$

As the three forces X, Y, Z are not situated in the same plane, and can therefore never be in equilibrium so long as any one of them has a real value, in order that the body may remain at rest under the action of all the given forces F, F′, F″, F‴, &c., it is necessary that the three conditions be fulfilled; namely, $X = 0$, $Y = 0$, $Z = 0$.

Forces have different denominations according to the manner in which they act; thus we have *Accelerating Forces*, *Central Forces*, *Parallel Forces*, *Uniform* and *Variable Forces*, &c. *See* ACCELERATION, CENTRAL FORCE, PRESSURE, &c.

Accelerating Force. — An accelerating force is that which continues to act upon a body after it has been put in motion; whence the body moves with a variable velocity, and, when the intensity of the force is constant, receives equal increments of velocity in equal intervals of time. We have a familiar example of an accelerating force of this kind in terrestrial gravity, under the action of which heavy bodies dropped from a height fall to the ground with a constantly accelerated velocity.

When a body is urged by an accelerating force, the relations between the force, the velocity, the space passed over, and the time, are expressed by three equations, which are called the equations of motion, and may be investigated as follows: —

Let t denote the time from the commencement of the motion, v the velocity acquired at the end of the time t, and a the space described by the moving body. During

an infinitely small time, $d\,t$, the velocity may be regarded as uniform, and the increment of the space in this time is $d\,x$; therefore, since the space described by a uniform velocity is proportional to the velocity and time conjointly, we have $d\,x = v\,d\,t$. (1.)

Let ϕ represent the force which accelerates the body at the end of the time t; since the motion may be regarded as uniform during an infinitely small time, if v be the velocity at the end of the time t, then $v + d\,v$ is the velocity at the end of the time $t + d\,t$, and therefore $d\,v$ is the increment of velocity due to the force ϕ during the time $d\,t$. Assume F = a constant force which produces a velocity = V in the portion of time which is assumed as unity (for instance, one second); then the velocity generated by F in the time $d\,t$ will be $V\,d\,t$. Now, since ϕ produces the velocity $d\,v$ in the instant of time $d\,t$, and F produces the velocity $V\,d\,t$ in the same instant, and since the forces are proportional to the impressed velocities, we have therefore $\phi : F :: d\,v : V\,d\,t$. Now, suppose F to be the unit of force, and V the unit of velocity, and the proportion becomes $\phi : 1 : d\,v : d\,t$; whence $d\,v = \phi\,d\,t$. (2.)

Differentiating the equation $d\,x = v\,d\,t$ on the supposition that $d\,t$ is constant, and substituting the resulting value of $d\,v$ in (2), we obtain $d^2\,x = \phi\,d\,t^2$. (3.)

The three differential equations now found, which define the motion of a body urged by an accelerating force, are usually exhibited as follows: —

$$v = \frac{d\,x}{d\,t},\ \phi = \frac{d\,v}{d\,t},\ \phi = \frac{d^2\,x}{d\,t^2}.$$

On eliminating $d\,t$ from the first and second, we obtain a fourth, $v\,d\,v = \phi\,d\,x$, which it is often convenient to employ. These equations, which may be considered as the foundation of the science of dynamics, are easily integrated when the accelerating force ϕ is supposed to be uniform. Their immediate integrals, taken on this supposition, give the equations of the motion, *in vacuo*, of bodies accelerated by gravity, the discovery of which sheds so much lustre on the names of Galileo and Newton. *See* GRAVITY.

Living Force, or *Vis Viva*, is a term frequently used by the mathematicians of the last century to denote the action of a force when it is estimated in such a manner as to be proportional to the square of the velocity. It has been stated above that when the masses moved are equal, the moving forces are respectively as the velocities. But the effect of a body in motion may be considered under different aspects. If we conceive the effect to be measured by the *time* which elapses before a resistance of uniform intensity reduces the body to rest, then the force is proportional to the velocity simply; but if, on the other hand, we conceive the effect to be measured by the distance passed over by the moving body while subjected to the uniform resistance, then the force will be proportional to the square of the velocity. These two measures may both be considered as correct; and they are not inconsistent when rightly understood. A warm controversy, however, arose on the subject, in which some of the most distinguished mathematicians of the time took a part; but when the ambiguity arising from the use of the word *force* in different senses was cleared away, both sides were found to be in the right. (See *Playfair's Dissertation, Ency. Brit.*)

FO'RCER. In Mechanics, a solid piston, applied to pumps for the purpose of producing a constant stream, or of raising water to a greater height than it can be raised by the pressure of the atmosphere. *See* PUMP.

FO'RCIBLE ENTRY AND DETAINER. In Law, a species of offence against the public peace, committed by violently taking or keeping possession of lands and tenements with menaces, arms, and force, and without authority of law, to the hinderance of him who has right of entry. The remedy is, under several statutes, by action; by the intervention of justices of the peace, who have power, on view of the force, to make a record of it, and commit the offender.

FO'RCING. In Horticulture, the art of accelerating the growth of plants, so as to obtain fruits or flowers at seasons when they are not produced naturally in the open air. The practice appears to be as old as the Romans; since Pliny informs us that Tiberius, who was fond of cucumbers, forced them to bear fruit in the winter time by growing the plants in boxes kept in houses with talc windows, which boxes were wheeled out during fine days, and always taken into the house again at night or in cold weather. From some epigrams of Martial it has been thought that the Romans had both vineries and peach-houses; talc (*lapis specularius*) being used instead of glass. In England forcing appears to have been practised from a very early period; radishes having been raised on dung beds covered during night by wheat straw from time immemorial, and cherries having been forced on wooden walls or boarded espalier rails, heated by linings of hot dung at the back, at least from the time of Charles II., and probably long before, since it is certain that melons and cucumbers were grown at Hampton Court for the royal table in the time of Henry VIII. At the present time forcing is carried on in Britain, and in analogous climates throughout Europe and North America, chiefly under glass roofs. Structures for forcing are known, as frames, pits, and houses, all of which have glass roofs; but there are also structures for forcing without glass roofs, such as cellars and sheds for growing mushrooms in the winter season; and also seakale, rhubarb, blanched succory, and such other stalks or leaves of plants as are eaten in a blanched state, and consequently do not require much light. The art of forcing plants must never be confounded with the art of growing them in artificial climates, though in both cases the principles by which the gardener proceeds are essentially the same; viz. the art of imitating nature. The chief difficulty of accomplishing this in forcing is the want of light; and hence the earlier in the season that any forced crop is produced, the greater is its deficiency in colour and flavour. Gentle forcing, so as, as it were, to anticipate spring, and bring fruits so far forward as to enable them to profit from the full influence of the sun during our short summers, may be considered as a real advantage, which will never cease to be sought for; and as a case in point we will mention the grape, the fruit of which is never brought to perfection in this country unless the plants have been partially forced. To force, in any country, the fruits which come to perfection in the open air in that country, such as the apple, pear, cherry, gooseberry, &c., in Britain, and analogous climates on the Continent, can only be considered as a luxurious waste of wealth, which would be more elegantly and usefully expended in forcing the fruits or in growing the flowers of warm climates, which can only be brought to perfection in this country under glass. Even this kind of forcing is open to criticism, on what may be called the greatest enjoyment principle. For example, there are certain fruits, such as the mango, the dourion, mangosteen, &c., which could only be grown in this country at an enormous expense, and probably when grown would not be worth eating; while there are certain other fruits, such as the pine apple and the banana, which can be grown in this country at a moderate expense to almost as great a degree of perfection as in their native climate. To attempt growing the former kind of fruit merely for the sake of overcoming the difficulty of doing so, we hold to be in bad taste; though we allow that some good might result from it to horticultural science, by calling forth the skill and ingenuity of gardeners: this, indeed, may be considered as the only permanent benefit which will be produced by forcing. With the progress of intercommunication by means of steam and railways, it seems highly probable that the fruits of warm climates will cease altogether to be cultivated in cold climates; with the exception of some, such as the cucumber, melon, banana, fig, &c., which require to be eaten when freshly gathered. Even at the present time, with the comparatively imperfect communication which exists between this country and the south of Spain and the West Indies, there is no reason why we should not be supplied with pines, grapes, and oranges throughout the year. The hot-houses of gardens will then be chiefly employed for the culture of exotic flowers and exotic plants of curiosity.

FORCING PUMP. *See* PUMP.

FORE. The sea term for the part of the ship near the head.

FORE AND AFT, implies lying in the direction of the head and stern; also, the whole of the vessel generally.

FO'RECASTLE. The upper deck near the head; this was formerly much raised, hence the name.

FO'REFOOT. A piece of timber at the fore extremity of the keel.

FO'RELAND. In Fortification, a piece of ground between the wall of a place and the moat. Foreland is also used synonymously with promontory, cape, headland, &c., as the North Foreland in Kent.

FORESHO'RTENING. In Painting, the representation of any object presented obliquely to the eye.

FO'REST. (In Germ. *forst*, from whence our word is probably derived, although the ultimate etymology is unknown. The Saxon word *hurst*, with which the names of so many places in the South of England terminate, has probably the same origin. In the primitive meaning of the word it probably signified an enclosed space, from which intruders were excluded: hence some have derived it from the Latin *foris*.) An extensive surface, covered naturally by trees and undergrowth; as opposed to a plantation, which has been made by art. In former times the greater part of every country in the temperate parts of Europe was undoubtedly covered with forest; and these by nourishing wild animals of every description, particularly wild swine, afforded a principal part of the food of man. With civilization, however, they gradually disappeared before the spread of extensive pastures or arable land. In every country a large portion of the forests belonged to the government, and formed a main source of its revenue. This is still the case in France and Germany, and till lately it was also the case to a

certain extent in Britain. Hence extensive tracts in England still bear the name of forest, though they are now in a state of cultivation, and in a great measure without trees. Many ancient laws and customs are recorded in books respecting the forests of the crown; but at present, as there are only three or four government forests in Great Britain, these laws and customs are of very little consequence, excepting to those living in their immediate neighbourhood.

Many of the spots which in England bear the name of forest have no appearance of having been covered with trees at any period since Britain became inhabited. The English forests (with the exception of the New Forest, of which the history is well known) are, however, so ancient that we possess no record of their origin. Their number has been reckoned at 68; another enumeration extends them to 76, but some of these are probably only parts of the same forest with different names. A forest is created by the king, by a commission issued out of the Court of Chancery; and, when its laws and ordinances have been framed and officers appointed, it becomes a forest by matter of record. Forests are grantable to subjects; but Savernake Forest in Wiltshire, held by the Marquis of Ailesbury, is, we believe, at present, the only instance. By the ancient forest laws, the Courts of the Forest were,— 1. The Justice Seat; a court of justice in eyre of the forest, held every third year to take cognizance of trespasses, pleas, and causes. (The last justice seat held in England for any other than mere formal business was for Windsor Forest in 1632.) 2. The Swain-Mote, or meeting of freeholders of the forest, held to receive and try presentments against offences in matters connected with the forest laws (in *vert* and *venison*); which presentments, 3. The Wood-Mote was held every forty days to receive and inquire into, but not to try. The principal officers of the forest were, its two justices in eyre, warden, regarders, foresters, rangers, &c.; some of which are still retained. The forest laws are of early date in England; those of King Canute are the earliest preserved. Under the first reigns after the Conquest their severity went on gradually increasing, and formed one of the chief oppressions under which the English suffered. But in 1224 the Carta de Foresta, granted by Henry III., fixed the limit of these aggressions. The capital punishments and mutilations of the former laws were rendered commutable for fines, and the king assented to a new perambulation of the forests: at which time, and subsequently, portions which had been illegally annexed to forests were disafforested. These portions are called Purlieus. In 1297, this charter was fully confirmed by Edward I. For an account of the existing forests of this country, see *Statistics of the British Empire*.

FO'RE-STAFF. A rude instrument, formerly used at sea for taking altitudes; and so called because in using it the observer turns his face to the object, instead of turning his back to the object, as is necessary in using the *back-staff*. Both these instruments have been superseded by the *sextant*.

FORESTA'LLING THE MARKET, in Law, is defined to be the buying up or bargaining for goods on their way to the market, in order to dispose of them at a higher price. But all mercantile practices having a tendency to enhance the common price have been, by a very sweeping intendment of the law, included within the same description. Forestallers are usually classed with ingrossers (those who bring up commodities to retail), and regraters (said to be derived from Fr. regratter, *to scrape over again*, from frauds practised in the dressing or scraping of second-hand cloth to sell again). Severe statutes have been passed at different times, from 5 & 6 Ed. 5. downwards, against this alleged offence. They were all repealed by 12 G. 3. c. 71. But it is said that the offence at common law still subsists: nor was it until 1827 (7 & 8 G. 4. c. 38.) that constables were expressly relieved from the (obsolete) duty of making presentments of forestallers at the quarter sessions. Although acts of this description have ceased to be subjects of criminal prosecution, it cannot be said that the public prejudice against them is yet worn out; although it is easily understood, and has been often proved, that in no way can the market for most commodities be rendered steady, the purchaser protected from the injurious consequences of excessive dearness, and the seller from those of glut and over-cheapness, as by the intervention of an intermediate body of wholesale dealers between the former and the latter.

FO'RFEITURE (Lat. forisfactura, *expulsion or outlawry*), has been defined to be a punishment annexed by law to some illegal act or negligence in the owner of real property, whereby he loses all his interest therein, and they go to the party injured as a recompence for the wrong which either he alone or the public with him hath sustained. Forfeiture is either civil or criminal. Civil forfeiture takes place when some alienation is made contrary to law, as in mortmain; or when a particular tenant alienes for a larger estate than he himself hath, as when tenant for life makes a conveyance in fee. Forfeiture for criminal causes takes place in treason or felony, and for one or two other offences. After judgment has been given, and the guilty party is said to be attainted, the forfeiture has a retrospective operation to the time when the offence was committed, so as to invalidate all sales and incumbrances that may have been effected since that time. Except in treason or murder, the forfeiture is only for the life of the offender; in treason and murder, however, the forfeiture extends to the disinherison of the heir.

FORFI'CULA. (Lat. forfex, *pincers*.) A Linnæan genus of insects, now forming a distinct order, *Dermaptera* (which see); and comprehending the subgenera *Labidura*, *Labia*, *Chelidura*, and *Forficula* proper, of which the labours of modern entomologists have made known numerous species; the common ear-wig (*Forficula auricularia*) is the type of this group of insects.

FORGE. (Fr.) The workshop in which iron is hammered and shaped by the aid of heat. The term is generally applied to the places in which these operations are carried on upon the comparatively small scale; the great workshops in which iron is made malleable for general purposes being called a *shingling mill*. A common forge consists of the hearth or fireplace, which is merely a cavity in masonry or brick-work well lined with fine clay or brick, upon which the ignited fuel is placed, and upon the back or side of which a powerful blast of air is driven in through the nozzle of a double-blasted bellows, which in a common forge is generally worked by a hand lever. Forges are sometimes constructed so as to be portable, when the bellows is most conveniently placed under the hearth; these are used in ships, and for various jobs on railways, &c.

FO'RGERY, in Law, is defined to be the fraudulent making or alteration of any record, deed, writing, instrument, register, stamp, &c., to the prejudice of another man's right. The statutes respecting this offence were consolidated by the act of 1830 (11 G. 4. and 1 W. 4. c. 66.), which also, after long and reiterated discussions, finally abolished the punishment of death in all cases, except for the forgery of wills and bills of exchange. This last remnant of the ancient code was finally removed in 1832 and 1837 by the statute 2 & 3 W. 4. c. 123., and 1 Vict. c. 84., by which the present punishments are fixed; varying from imprisonment for various terms to transportation for life, according to the classification of the offences comprehended under this general title.

According to a return contained in the report of the Constabulary Force Commission, 1839, the number of persons convicted of forging and uttering forged notes amounted to 104 in 1816, from whence it increased to 352 in 1820, fell to 134 in 1821, and since that time has diminished to a very small amount. The number of executions in 1812 was 23, in 1818 (the greatest) 24. The last execution for forgery took place in 1829.

FORLO'RN HOPE, in Military affairs, signifies certain men detached from several regiments or otherwise appointed to assume the initiative in an engagement; or, at a siege, to storm the counterscarp, mount the breach, &c. They are so called from the great danger to which they are inevitably exposed in such cases.

FORM. (Lat. forma.) In the Fine Arts, the bounding line of a material object. In Painting, the word is more generally applied to the human form. *See* BEAUTY.

FORMA'TION. A geological term, applied to a group of deposits or strata apparently referable to a common origin or period.

FO'RMEDON. In Law, a writ in the nature of a writ of right, which lies for him who has right to lands or tenements by virtue of an entail. (*See* FEE TAIL.) Formedon is in the *descender*, the *remainder*, or the *reverter*, according to the estate of the party who sues.

FORMI'CA. (Lat. *an ant*.) A Linnæan genus of insects, now the type of a very numerous and extensively distributed family (*Formicidæ*), belonging to the order *Hymenoptera*, and to that section which is negatively characterized by not being armed with a sting, and by not possessing any instrument for piercing the bodies of animals or the substance of plants for the purpose of oviposition.

The procreative economy of these well-known and most interesting insects is that to which all their wonderful habits and peculiarities are essentially related; and amongst those genera which the wisdom of Providence has ordained should form associations for the purpose of multiplying, preserving, and providing for their kind, the ants stand in a prominent and interesting rank, whether viewed as presenting some of the higher traits of animal instinct, or as a living evidence of an all-wise Intelligence, whose mute but incontrovertible orders are thus so implicitly and cheerfully obeyed.

In every species of insect the parents are relieved from the charge of providing for their offspring: they neither attend to their wants, nor defend them from harm in their immature and helpless state; and this, not from any deficiency of natural attachment, but from the brief period of their existence after having attained the state of maturity adapted for procreation; for at the close of this season the male generally dies before the eggs which

he has impregnated are excluded; and the female, whose last care has been to select a proper place for their development, soon dies after oviposition.

In the instincts and habits of which we are about to give a brief notice, the exception to the above rule is more apparent than real; for the individuals which manifest the feelings and discharge the duties of the mother are but foster-parents, and consist of females with undeveloped ovaria, and which are consequently unprolific, and are termed *neuters*. The males perish, and are destroyed by the neuters soon after having fulfilled their office; the prolific females, upon whom, on the contrary, the cares and affections of the neuters or workers are abundantly lavished, die soon after the ova are matured and excluded. This apparently threefold distinction of sex is peculiar to gregarious insects, as bees and ants.

Our intelligent countryman Gould describes five species of English ants; viz., 1. The hill ant (*Formica rufa*, Linn.); 2. The jet ant (*F. fuliginosa*, Latr.); 3. The red ant (*Myrmica rubra*, Latr.; *Formica*, Linn.); 4. The common yellow ant (*F. flava*, Latr.); and, 5. The small black ant (*Formica fusca*, Linn.).

In incipient societies of ants, as well as humble-bees (*Bombi*, Latr.) and wasps (*Vespæ*, Linn.), one female lays the foundation of the future colony, and the first brood which is hatched is very small. The larvæ, when first hatched, are hairy, and continue in the larva state twelve months or more.

The larvæ of the red ant do not, as other ants do, spin a cocoon when they assume the pupa state. The societies of ants, as also of other *Hymenoptera*, differ from those of the *Termites*, or white ants, in having inactive larvæ and pupæ, the neuters or workers combining in themselves the office of nurses, soldiers, and attendants. These undeveloped females never acquire wings. The female ants are furnished, at their first exclusion, with two pair of wings, which, after swarming in concourse with the males, they almost immediately cast. The office of the perfect or winged female is to provide a constant supply of eggs for the maintenance of the population. These are usually the least numerous part of the community. The office of the males (which are also winged during the time of swarming, and are extremely numerous) is merely the propagation of the species; after the season for this is past, they die. Sometimes the swarms of a whole district unite their infinite myriads, and, seen at a distance, produce a beautiful and curious effect, from the glancing of their silvery wings. The males and females quit the nests, their nursing places, about the end of July, or later, to the beginning or middle of September. The commotion which these winged individuals create in the nests, before they issue forth to fulfil their proper functions, is excessive. The whole swarm, when unhoused, alternately rises and falls with a slow movement to the height of about ten feet, the males flying obliquely, with a rapid zigzag motion, and the females, though they follow the general movement of the column, appearing suspended in the air, like balloons, seemingly with no individual motion, and having their heads turned towards the wind.

The noise emitted by countless myriads of these insects does not, however, exceed the hum of a single wasp; for their wings are weak, and bend to the wind, which carries the swarm irresistibly along. All the males, and the greater part of the females, are destroyed by becoming the prey of birds and fish, and other insectivorous creatures; for the loss of their wings, only lent them till the swarming season be past, renders them the most helpless and inactive beings, and they fall into the water in shoals, as well as bestrew the land. Dr. Bromley, while surgeon of the ship Clorinde, witnessed a scene which will give some idea of the multitudes of these insects which fall a prey to fishes alone.

"In September, 1814," he observes, "being on the deck of the hulk to the Clorinde, my attention was drawn to the water by the first lieutenant (since Captain) Haverfield, observing there was something black floating down with the tide. On looking with a glass, I discovered they were insects. The boat was sent, and brought a bucket full of them on board. They proved to be a large species of ant, and extended from the upper part of Salt Pan Reach out towards the Great Nore, a distance of five or six miles. The column appeared to be in breadth eight or ten feet, and in height about six inches, which I suppose must have been from their resting one upon another."

These ants were winged, so that they had probably been driven into the water by violent weather. When impregnation has taken place, the females alight, and then the neuters have been seen to seize and make prisoners of them, hanging upon their legs to detain them; leading them back to the formicary, and never quitting them till they are ready to lay their eggs, or become reconciled to state imprisonment, for such it really appears to be. They pay every attention to the royal prisoner's wants or comforts, leading her to the most genial spots in the nest, and regularly feeding her; but all this under a body guard, which, as her powers of locomotion become impeded by the enlargement of the ovaria, is gradually reduced to one sentinel, who is constantly relieved. The situation of this attendant is remarkable, being mounted on the queen-mother's body; and its office seems to be that of waiting till the eggs are produced, when it seizes and carries them off to the nurseries, or cells, prepared for this purpose. One of these queen ants will lay upwards of four or five thousand eggs in a year.

Gould gives an amusing account of the homage paid to the fertile mother of the future colony by the working ants. They will press round her, offer her food, conduct her by her mandibles through the difficult or steep passages of the formicary: they even carry her about their city. She is then suspended upon their jaws, the ends of which are crossed, and, being coiled up, she is packed so close as to incommode the bearers but little. When she is alighted, others surround and caress her, one after another tapping her on the head with their antennæ. They have a particular way of skipping, leaping, and standing upon their hind legs, and prancing with each other. These frolics they make use of in congratulation when they meet, and to show their regard for their queen. Some of them gently walk over her, others dance round her, and if separated from her will soon collect in a body and enclose her in the midst. When she dies, they have been known to pay her the same attentions for months, and to brush and lick her continually. Different species vary in their instincts, which produces some variation in their domestic proceedings, but the general line of conduct is the same throughout. In some nests several female ants have been known to live together on amicable terms, showing none of the spirit of exclusive rivalry so observable in the queen bee. Of all insects the ants seem to have the most perfect mode of communicating with each other. On this curious subject, the learned entomologists Kirby and Spence thus express themselves: — "The fact being certain that ants impart their ideas to each other, we are next led to inquire by what means this is accomplished. It does not appear that, like the bees, they emit any significative sounds; their language, therefore, must consist of signs or gestures, some of which I shall now detail. In communicating their fear or expressing their anger, they run from one to another in a semicircle, and strike with their head or jaws the trunk or abdomen of the ant to which they mean to give information of any subject of alarm. But those remarkable organs, their antennæ, are the principal instruments of their speech, if it may be so called, supplying the place both of voice and words. When the military ants before alluded to go upon their expeditions, and are out of the formicary, previously to setting off they touch each other on the trunk with their antennæ and forehead: this is the signal for marching; for, as soon as any one has received it, he is immediately in motion. If a hungry ant wants to be fed, it touches with its two antennæ, moving them very rapidly, those of the individual from which it expects its meal. The helpless larvæ, also, of the ants are informed by the same means when they may open their mouths to receive their food. Whether ants, with man and some of the larger animals, experience any thing like attachment to individuals, is not easily ascertained; but that they act as if they felt the full force of the sentiment which we term patriotism, or the love of the community to which they belong, is evident from the whole series of their proceedings. Distress or difficulty falling upon any member of their society generally excites their sympathy, and they do their utmost to relieve it."

The attachment of the neuters is continued to the offspring of the perfect female through the states of ova, larva, and pupa, and even increases at each progressive stage; their greatest cares are lavished on the cocoon, which they may be seen bringing out into the air in fine weather, and carrying back again into the nest when the heat is too great, or on the approach of rain, of which they have an instinctive knowledge. It is the cocoons, also, which are the first objects of their solicitude when the formicary is broken in upon; and although the cocoon is double the size of the neuter itself, yet it bears it away with an agility which shows that the weight is no incumbrance.

The combats between the ants of neighbouring communities are generally caused by the instinctive fondness which the workers have for the cocoons, and which they cannot see without attempting to appropriate it as an object of care and attention. In their battles they fight with fierceness and obstinacy, sometimes carrying off the head of the vanquished upon their antennæ, like an American Indian who bears his enemy's scalp about his neck as a trophy; not that the ant warrior voluntarily carries this troublesome proof of his valour, for he would willingly be rid of such an incumbrance, but this is seldom the case while he lives.

The males and females never fight; the neuters alone attacking or defending. Besides their other weapons, ants are furnished with the power of ejecting an acrid

juice from their abdomen, in sufficient quantity and force to repel any small antagonist.

Huber also gives a most terrific account of the civil wars between ants of the same species, but composing different communities. Nothing can exceed the ferocity or pertinacity of these battles. The infuriate creatures tear each other almost to pieces,—now struggling in single combat, till a third, coming up, puts an end to the affair, by helping to kill or take the enemy prisoner!—now fighting in bodies linked together, and refusing all quarter, till a reinforcement alters the tide of war, and gives victory to one side. But these battles are frequently renewed day by day, the combatants retiring as night approaches, till the rainy season brings the fierce little citizens to reason, and both parties retire to their citadel. It is a curious fact that, though the opposing armies are of one species, each party knows a fellow-lodger even in the wildest part of the action; for Huber states, that if by accident an ant had attacked a friend, caresses immediately succeeded to blows. M. P. Huber states as a fact the startling circumstance of certain species of ants (*F. rufescens*, and *F. sanguinea*, Latr.) procuring slaves which they carry off in predatory excursions while in an infant state. These slaves are of a small black species, and when reared perform the offices which generally devolve upon the neuters or workers in other societies; besides which they have to feed their masters and carry them about the nest. Indeed, so totally dependant are their masters upon these indefatigable little slaves, that the term should rather be reversed; for it appears that these lords of the community may not venture forth from the nest but with permission of the negroes; and M. P. Huber proved, by experiment, that they would die of starvation if not fed by these indispensable servants. There is likewise another species (the *F. cunicularia*, L.), which are forcibly carried off by the rufescent ants; but from their being more courageous than the negro species, the depredators are obliged to go with greater strength of numbers and more precaution. The account which M. Huber gives of these excursions after slaves is highly curious and interesting; the enemy, making use of manœuvres and tactics, and the assailed receiving them with such arrangements, as any but a close observer of insect economy and habits would declare to be impossible but to human intellect. The *F. sanguinea* is not, however, so helpless and utterly dependant on the black ants; but will rouse themselves upon occasion, and protect their slaves, and even transport them to another habitation when changing their residence, which is sometimes the case.

The negro and miner ants, when attacked by the marauding species in their dwelling, make every effort to place the young brood and the newly excluded females out of danger, carrying them to some distant place of security as soon as the alarm is given, and during the combat hundreds are so employed; but when tranquillity is once more restored, they bring back these precious charges, and place them within the walls of the fort, of which they barricade the entrances, and place a strong guard near in case of future attempts. To prove how dependant the rufescent ants are upon their little notable black servants, Huber tells of an experiment he made, by shutting up thirty of them in a glazed box, supplying them with honey in one corner of their prison, and placing with them larvæ and pupæ both of their own species and that of the negro. At first they made some little exertions in regard to the young, carrying them from one place to another, but soon seemed to find this too great an effort; and though food was in the box, most of them died in a few days, rather than help themselves to it. Huber, in commiseration of their wretched condition, then put in a single little negro ant, which actively set to work, making a cell in the earth, into which it collected the larvæ, and feeding the pupæ ready to emerge, as well as the still surviving neuters Huber also mentions other experiments tending to the same end, which perfectly succeeded in showing the vital importance of these slave ants to their masters under various circumstances, and proved that this curious habit depends on something more than the mere blind attachment of the imperfect females for *pupæ*.

Linnæus speaks of the strange fact of "ants milking their cows, the *Aphides*;" and Huber relates many highly interesting particulars in addition. He says, the ants not only suck the sweet juice which is constantly passing through the body of the *Aphides*, but make use of their antennæ during the operation, to produce a ready evacuation, patting the *Aphides* on the sides pretty briskly. They are very jealous of the possession of these their milch cows, sometimes fighting fiercely in their defence, and forming earthen boundaries for their detention. The British species of ant (*Formica flava*, Gould) is especially fond of collecting herds of the *Aphis radicum* in its hemispherical formicary, tending the eggs as it would those of its own brood. This yellow ant exceeds all the other species of Aphis-loving *Formica* in the great number of its herds.

It appears, from observations made both by Gould and Huber, that when a nest becomes overpopulated, or from some other reason, emigrations take place, which are conducted in a very interesting and singular manner. A few having apparently made up their minds on the subject, endeavour, by the usual signs, to induce others to accompany them to the spot chosen for the new encampment; and having so far succeeded, carry the newly-persuaded recruit upon their mandibles thither, who in his turn goes back with his conductor to the old nest, and engages a fellow-citizen to accompany him also, and thus by degrees the whole congregation emigrate. This emigration does not, in all instances, proceed by dint of persuasion; for the recruiting ant will, without warning, sometimes seize upon another, and carry it off suddenly to the new site: which rough proceeding does not, however, prevent the ant so removed in joining in the attempt to raise more recruits; for it returns, like the others, and fetches a companion. The turf ants (*F. cæspitum*, L.), upon these occasions, carry their fellow emigrants in an uncoiled form, with the head downwards. These observations chiefly apply to the great hill ant (*F. rufa*), though several other species migrate. They will, in case the new settlement is at a considerable distance, form temporary colonies by the way, all, however, uniting at last in one principal formicary.

Ants work during the night as well as by day.

Our native ants usually make their first appearance in March, and continue in activity till the middle or end of October. They are fond of basking and sporting in the sun; and their antics, at these times, are described by the best observers as exceedingly amusing, some appearing to wrestle, and others actually carrying each other on their back in the most playful manner. They are not torpid during the whole winter, but are, in genial and mild days, sometimes to be seen in full activity. Extreme cold causes them to cluster together in compact bodies, as if by this means to preserve a sufficient quantity of animal heat to allow of their occasional return to the labours of life. That ants will attack and kill, for food, insects and animals infinitely larger than themselves, is very well known: their strength is prodigious compared with their size. Mr. Kirby says, "I have seen an ant dragging a wild bee many times bigger than itself."

The bite of some foreign ants is very severe. Sir Joseph Banks observed a green species in New South Wales which inflicted a wound scarcely less painful than that of a bee. One, called the fire ant, is so called from its bite resembling the pain occasioned by a spark of fire. Some ants in Ceylon produce great anguish from their bite. Those species usually found in Great Britain may almost be called harmless in this respect.

There is a species in Cayenne (*Formica bispinosa*) which collects from the bombax and silk cotton tree a sort of lint which the natives value much as a styptic in cases of hæmorrhage; but though this species benefits man, there are several whose ravages have sometimes more than counterbalanced the good produced by these insects. Within the last century, what might truly be called a plague of ants appeared at one period in the island of Granada, in such hosts as to put a stop to the cultivation of the sugar cane. The destruction of this plant is not caused by the ants devouring it, but by their constructing their nest under its roots. At the time of this irruption, their numbers were only to be compared with sand strewed over every place and thing. They descended from the hills, and covered the plantations; and did not confine their attacks to plants, but rats, mice, and even birds, when alighting on the ground, fell a prey to them. Streams of water only opposed their frightful progress for a moment, masses of them rushing, or being impelled by the hosts behind, into the water, and only forming by their carcasses a raft or bank for the rest to pass upon. Fire was tried in vain as a barrier to their progress; such infinite swarms rushed into the blaze as to extinguish it. A reward of 20,000*l*. was offered to whoever should discover an effectual method of destroying them, but in vain. The standing crops of sugar cane were burnt down, and the earth dug up; but no human means was found effective. At length, in the year 1780, they were annihilated by the torrents of rain which accompanied an awful hurricane, which was most fatal in its effects to the other West India islands. But it is only fair to state, after such an account of devastation, that such an occurrence is exceedingly rare; and that these all-devouring creatures, besides being admirable in their household economy and laws, benefit us by removing and destroying multitudes of tormenting insects and reptiles, and in their turn serve as food to thousands of other animals.

Several species of Mammalia, in foreign countries, are expressly organized for restraining the undue increase of this genus of insect (see *Myrmacophaga*), having claws of prodigious strength for making a breach into the strong walls of the formicaries of the exotic ants, and a long glutinous tongue for sweeping off thousands of the disturbed community. In England, the habitations of

the various species of ants are less conspicuous, but not less curious, than the formicaries of tropical countries. They are thus described by Kirby and Spence:—

"The nest of the large red ants (*F. rufa*, L.), which are common in woods, at the first aspect seems a very confused mass. Exteriorly it is a conical mount, composed of pieces of straw, fragments of wood, little stones, leaves, grains; in short, of any portable materials within their reach; but, however rude its outward appearance, and the articles of which it consists, interiorly it presents an arrangement admirably calculated at once for a protection against the excessive heat of the sun, and yet to retain a due proportion of genial warmth. It is wholly composed of numerous small apartments of different sizes, communicating with each other by means of galleries, and arranged in separate stories, some very deep in the earth, others a considerable height above it; the former for the reception of the young in cold weather and at night, the latter adapted to their use in the daytime. In forming these, the ants mix the earth excavated from the bottom of the nest with the other materials of which the mount consists, and thus give solidity to the whole. Besides the avenues which join the apartments together, other galleries, varying in dimensions, communicate with the outside of the nest at the top of the mount. These open doors would seem ill calculated for precluding the admission of wet or nocturnal enemies; but the ants alter their dimensions continually, according to circumstances; and they wholly close them at night, when all gradually retire to the interior, and a few sentinels only are left to guard the gates. On rainy days, too, they keep them shut; and when the sky is cloudy open them partially.

"The habitations of these ants are much larger than those of any other species in this country, and sometimes as big as a small haycock; but they are mere molehills when compared with the enormous mounds which other species, apparently of the same family, but much larger, construct in warmer climates. Malouet states, that in the forests of Guiana he once saw ant-hills which, though his companion would not suffer him to approach nearer than forty paces for fear of his being devoured, seemed to him to be fifteen or twenty feet high, and thirty or forty feet in diameter at the base, assuming the form of a pyramid, truncated at one third of its height; and Stedman, when in Surinam, once passed ant-hills six feet high, and at least one hundred feet in circumference.

"The nest of *Formica brunnea*, Latr., is composed wholly of earth, and consists of a great number of stories, sometimes not fewer than forty,—twenty below the level of the soil, and as many above; which last, following the slope of the ant-hill, are concentric. Each story, separately examined, exhibits cavities in the shape of saloons, narrower apartments, and long galleries, which preserve the communication between both. The arched roofs of the most spacious rooms are supported by very thin walls, or occasionally by small pillars and true buttresses; some having only one entrance from above, others a second, communicating with the lower story. The main galleries, of which in some places several meet in one large saloon, communicate with other subterranean passages, which are often carried to the distance of several feet from the hill. These insects work chiefly after sunset. In building their nest, they employ soft clay only, scraped from its bottom when sufficiently moistened by a shower, which, far from injuring, consolidates and strengthens their architecture. Different labourers convey small masses of this ductile material between their mandibles; and with the same instruments they spread and mould it to their will, the antennæ accompanying every movement. They render all firm by pressing the surface lightly with their fore feet; and, however numerous the masses of clay composing these walls, and though connected by no glutinous material, they appear, when finished, one single layer, well united, consolidated, and smoothed. Having traced the plan of their structure, by placing here and there the foundations of the pillars and partition walls, they add successively new portions; and when the walls of a gallery or apartment, which are half a line thick, are elevated about half an inch in height, they join them by springing a flattish arch or roof from one side to the other. Nothing can be a more interesting spectacle than one of these cities while building. In one place, vertical walls form the outline, which communicate with different corridors by openings made in the masonry; in another, we see a true saloon, whose vaults are supported by numerous pillars; and further on are the cross ways or squares where several streets meet, and whose roofs, though often more than two inches across, the ants are under no difficulty in constructing, beginning the sides of the arch in the angle formed by two walls, and extending them by successive layers of clay till they meet; while crowds of masons arrive from all parts with their particle of mortar, and work with a regularity, harmony, and activity which can never enough be admired. So assiduous are they in their operations, that they will complete a story, with all its saloons, vaulted roofs, partitions, and galleries, in seven or eight hours. If they begin a story, and, for want of moisture, are unable to finish it, they pull down again all the crumbling apartments that are not covered in.

"Another species of ants (*F. fusca*, L.) are also masons. The societies of *F. fuliginosa*, Latr., make their habitations in the trunks of old oaks or willow trees, gnawing the wood into numberless stories, more or less horizontal. Two other tribes of carpenter ants (*F. æthiops*, and *F. flava*, Latr.) use saw-dust in forming their buildings. Some ants form their nests of the leaves of trees. One of these was observed by Sir Joseph Banks in New South Wales, which was formed by glueing together several leaves as large as a hand. To keep these leaves in a proper position, thousands of ants united their strength; and if driven away, the leaves spring back with great violence."

FO'RMIC ACID. A sour liquor which ants eject when irritated, and which was formerly obtained by bruising the insects and distilling them, mixed with water: a peculiar volatile acid passed over. It has been ascertained by Döbereiner, that an analogous acid may be artificially obtained by distilling, from a capacious retort, a mixture of 2 parts of tartaric acid, 3 of peroxide of manganese, and 3 of sulphuric acid diluted with 5 of water. The tartaric acid acquires oxygen from the oxide of manganese, and is resolved into water, carbonic acid, and formic acid. From the analysis by Berzelius of formiate of lead, it appears that formic acid is a compound of 2 atoms of carbon, 3 of oxygen, and 1 of hydrogen; or of 2 atoms of carbonic oxide and 1 of water.

FORMICA'TION. (Lat. formica, *an ant.*) The creeping sensation upon the skin, resembling the crawling of ants over different parts of the body.

FO'RMULA. In Algebra, the expression of a theorem or general rule for the solution of some problem. Thus the area of a triangle is expressed in terms of its three sides, a, b, c, and the semiperimeter, s, by the formula $\sqrt{s(s-a)(s-b)(s-c)}$.

FORMULA, or FORMULARY, in Medicine, &c., signifies a prescription.

FORNES. A term occasionally applied by medical writers to the infectious causes of diseases.

FORNIX. (Lat.) An arch. In Anatomy, this term is applied to a part of the *corpus callosum* of the brain, which, when viewed in a particular direction, somewhat resembles the shape of a Gothic arch. It is the medullary body, composed of two anterior and two posterior *crura*, situated at bottom and inside of the lateral ventricle, over the third ventricle and below the *septum lucidum*. *See* BRAIN.

FO'RSTERITE. A mineral named after Mr. Forster; it forms brilliant and small crystals, colourless and translucent, and is found at Vesuvius, accompanied by pyroxene. It contains silica and magnesia, but has not been carefully analyzed.

FORT. A castle or small fortress; a place of inconsiderable extent, fortified by nature or art. *Field-fort*, or fortlet, is a small fort, principally constructed for the defence of a camp, or for defending a *pass* or *post*.

FO'RTE. (Ital.) In Music, a direction to the performer to execute the part loudly to which the word is affixed. It is indicated by the single letter F. If two F F's, thus, are used, the part is to be played or performed *fortissimo*, very loud.

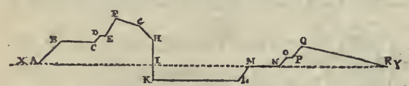
FO'RTIFICATION, also called *Military Architecture*, is the art of constructing such works of defence as may enable a comparatively small number of men to maintain possession of a city or place against the assaults of a superior force.

The nature of constructions necessary for defence will be determined by the means of aggression. In early ages, when the sling and the bow formed the principal weapons of offence, men considered themselves sufficiently defended by a single wall or a bank of earth, from behind which they could discharge their missiles against their assailants. In progress of time projecting towers were added, which served the double purpose of increasing the front of the besieged, and of enabling them to attack in flank the besiegers when approaching to scale the wall. The invention of the battering ram rendered no other change necessary than that of increasing the thickness and strength of the wall. To aid the means of defence, projecting galleries were constructed at the summit of the wall and round the towers, through the pierced floors of which stones and other missiles were showered down on the heads of the assailants. These galleries were called *machicoulis* or *massecoulis*, from the French *couler des masses;* because they served the purpose of enabling the besieged to let fall heavy masses, to which cords were attached, in order that they might be drawn up again and let fall anew when the enemy returned to sap. Apertures or loop-holes for the discharge of arrows and javelins were made in the battlements, or

pierced in the walls; and the defensive means were completed by surrounding the whole place with a deep moat or ditch. But the invention of gunpowder rendered it necessary to adopt an entirely different system of defence. Walls of masonry, however thick, can withstand for but a short time the assault of heavy artillery; hence those successive circumvallations and constructions of earth which constitute the defences of a modern fortress.

Happily for Great Britain, whose insular situation has exempted her from foreign invasion, her internal dissensions have neither been so frequent nor so protracted as to render the art of constructing permanent fortifications of much national importance. It has been on the continent of Europe, where war has flourished in greater vigour, that the art has been created and chiefly cultivated. A modern fortification consists of a great number of parts, to which, for the purposes of description, it is necessary to give distinct names; and it would naturally happen that those who first contrived the particular forms of the different parts would designate them by names drawn from their own language. These appellations, chiefly of French, but occasionally of Italian origin, have been transferred into our language by the ignorance of translators, and carefully retained through the pedantry of our military engineers; so that all our works, without exception, which treat of fortification, are obscured by a mass of barbarous jargon, through which it is difficult to catch a glimpse of the few simple principles which determine the forms of all defensive constructions.

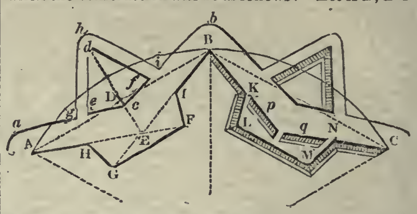
Modern fortifications, though differing in some subordinate details, which differences are dignified by the name of *systems*, closely resemble one another in all their essential parts. In order to explain their structure, it will be convenient to consider them first without reference to their form, or the position of the ground lines in respect of each other, but merely as defences against an army with artillery advancing directly in front. The annexed figure represents a vertical section of a regular



fortification on the ground line X Y, the place to be defended being supposed between X and A. The mass of earth A B C D E F G H forms the rampart with its parapet. A B is the interior slope of the rampart; B C is the *terre-plein* of the rampart, having a breadth of about 40 feet, on which the troops and cannon are placed; D E is called the *banquette*, or step, on which the soldiers mount to fire over the parapet; E F G is the *parapet*, of a height (about 7 feet) sufficient to protect the men and guns on the terre-plein, and sloped in the direction F G towards M, the opposite edge of the ditch, so that a man approaching there may be seen and fired at; G H is the exterior slope of the parapet; H I is the *revetment* or wall of masonry supporting the rampart, and strengthened by buttresses placed at small intervals behind it. This must be of sufficient height to prevent its being easily scaled; but yet must not rise higher than the edge of the exterior work at Q, in order that it may not be seen and breached by distant batteries. The exterior front of the rampart, covered with the revetment H K, is called the *escarp;* I K L M is the ditch, the dimensions of which will be determined by the nature of the ground, but must be such, in general, that its excavation or *deblai* must produce sufficient earth or *remblai* to form the rampart; the opposite side of the ditch L M is the *counterscarp*, also supported by a revetment of masonry; M N is the *covered way*, a space about 10 yards in breadth, having a *banquette* N O P, and protected by a parapet P Q, the superior slope of which, Q R, is called the *glacis*. The use of the covered way is to allow troops to be drawn up, unseen by the besiegers, for the purpose of making sorties; it also enables the garrison to keep up a closer fire on the approaches of the enemy, and its parapet forms a strong protection to the revetment of the rampart.

It is easy to see that the strength of a place will be increased by a succession of such works, so that when the besieged are driven from one they may retire to the next behind it. Sometimes there are three ditches with intermediate works, or rather works raised within the ditch itself, similar to the rampart, though of a less height, in order that the guns on the rampart may range above them. A work of this sort, between the inner and the main ditch, is called a *tenaille;* that between the main ditch and the outer ditch is called a *ravelin*. All works outside the ditch are called *outworks*.

Before proceeding to construct a fortification, it is necessary to lay down a *plan*. This will differ in some respects according to the system adopted; but the following description, which properly belongs to Vauban's First System, will explain the general method: — When the work is regular, the sides are all equal, and therefore the general form will be that of a polygon inscribed in a circle. The first thing to be done is to determine on the number of sides. We shall suppose them to be six, and the radius of the circumscribing circle to be 360 yards, when the construction will be as follows: — Let A B, B C



be two sides of a hexagon inscribed in a circle; each of these lines will be equal to the radius, or 360 yards. Bisect A B in D; draw the perpendicular D E, on which set off D E, equal to one-sixth of A B, or 60 yards; draw the lines A E F and B E G, in which take A H and B I, each equal to 100 yards, or five-ninths of A D; make H F and I G each equal to the distance H I; then the line A H G F I B is the principal outline of the front, and by making the same construction on each of the sides of the hexagon, we obtain the principal outline of the whole fortification, or that by which the first figure of the work is defined.

The part F I B K L is called the *bastion*, B I and B K are the *faces* of the bastion; I F and K L are its *flanks;* F L is the *gorge;* G F is the *curtain;* A F and B G are the *lines of defence;* B is the *flanked angle;* I and K are the *angles of the shoulder;* G, F, L, and M the *angles of the flank*. From the points A and B as centres, and a radius of 40 yards, describe circular arcs; if lines be drawn from the opposite angles of the shoulder H I to touch those arcs, the parts of those lines *a c*, *b c*, together with the arcs, will represent the *counterscarp* of the ditch. The curtain is defended by a *ravelin*, which is constructed thus: — From *c*, the re-entering angle of the counterscarp, set off, on the perpendicular D E, a line *c d*, equal to 110 yards, and from *d* draw *d e*, *d f*, in the directions of H and I, to meet the counterscarp; then *d e* and *d f* are the *faces* of the ravelin, and *c e* and *c f* its *semigorges*. The counterscarp *g h i* of the ditch of the ravelin is parallel to its faces, and rounded off at *h*. Stairs, called *pas-de-souris*, are constructed to facilitate the descent from the ravelin to the ditch. Besides the ravelin, there is usually another appendage to the bastion and curtain. This is the *tenaille*, represented in the figure by the parts *p q* made in the direction of the lines of defence; but it has sometimes other forms. The tenaille is made in the ditch before the curtain, with passages between the ends and the flanks of the bastion. It is a low work, having its parapet only about 3 feet higher than the level ground of the ravelin, and its use is to defend the bottom of the ditch by a grazing fire.

Such are the works which form the envelop of the place fortified; but various other constructions are in most cases added, according to the nature of the ground and other circumstances, for the purpose of protecting or strengthening such parts as are most exposed, or of interrupting the works of the besiegers. These additional constructions are either internal or external. Among the former are *retrenchments* of various kinds, either constructed at the same time with the principal works or thrown up during the siege. They are made behind the ramparts, or the bastions most exposed to attack, their use being to enable the garrison to continue the defence from behind a fresh obstacle when a rampart or bastion has been breached. When a hill or rising ground overlooks any of the works, a *cavalier* is raised, about ten or twelve feet higher than the rest of the works. This is commonly placed within the bastion when it has the same form, but sometimes on the middle of the curtain when its form is semicircular. Of the exterior works one of the most important is the *counterguard*, constructed to cover some of the principal parts, as the bastion or the cavalier, in such a manner that without obstructing their fire it prevents them from being breached till itself is taken. The counterguard is constructed parallel with the faces of the work it is destined to cover; and it must be lower than the principal work, though of a sufficient height to screen its revetment.

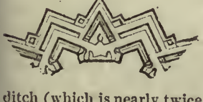
A *horn-work*, represented in the annexed figure, is composed of two branches, and a front composed of two half bastions and a curtain, resembling a front of the body of

the place. It is here represented as made before the curtain, but it may be also constructed before a bastion. A *crown-work* is of the same nature as a horn-work, but larger, and having two fronts, which give it somewhat the appearance of a crown. Horn-works and crown-works are constructed where a large spot of ground lies beyond the fortification which might be advantageous to an enemy, or to cover a gate or entrance into a town. *Lunettes, a a*, are placed on both sides of the ravelin, and are constructed on lines bisecting the faces of the ravelin at right angles. A *bonnet, b*, is a work covering the salient angle of the ravelin. *Tenaillons* are similar in construction to lunettes, but having one of their faces formed on lines which are the production of the faces of the ravelin, instead of bisecting those faces. The application of all these and other works of a similar description depends on the nature of the localities; and it must be left to the judgment of the engineer to determine in each particular case which is best adapted to the ground.

We have already alluded to the use and importance of the covered way. In order to increase its strength *traverses*, or portions of parapet, are thrown across it, which screen it from an enfilading fire, and enable the defenders to dispute its possession foot by foot. *Places of arms*, or places for assembling troops, and protected by traverses and *redoubts*, are also formed on it at the re-entering and salient angles of the counterscarp. The redoubts serve not only as a place of retreat, but facilitate the making of sorties upon the enemy's lodgments.

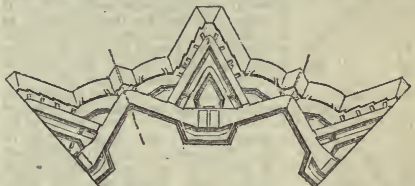
The descriptions given above belong more especially to that method of fortification which, in the military schools, is denominated Vauban's first system. Marshal Vauban served in the wars of Louis XIV., and in the course of his life directed the construction of thirty-three new fortresses, and the improvement of three hundred others. From the different constructions observed in these works have been compiled his *three* systems; which, however, in a general view of the subject, may be considered as only differing in points of detail, or in a greater or less degree of complication. In his second system, represented in the annexed figure, he separated the bastions from the body of the place by a ditch about 40 feet wide, in order that the besieger, after the breach and capture of the bastions, might be compelled to renew his operations against the *enceinte* or body of the place. The angles of the polygon are crowned by pentagonal towers of masonry, called *tower bastions*, to which, in fact, the regular bastions only form counterguards. It was from a desire to take advantage of these tower bastions, which he found already existing at Landau when called upon to fortify that place, that he was led to adopt the system in question. Vauban's third system does not differ in any material respect from the second. He increased the size of the ravelin, and gave it a redoubt. The tower bastions were likewise made larger, and the curtain which united them was broken inwards, so as to form two small flanks underneath; while casements for cannon were constructed, to co-operate with those of the tower bastions in the defence of the ditch.

Cochorn's System.—Contemporary with Vauban was the Baron de Coehorn, director-general of the fortifications of the United Provinces of Holland. This celebrated engineer is also the author of three different systems, though the third has never been constructed. His methods are only applicable in low swampy countries, like Holland; and the object which he kept principally in view was to throw such obstacles in the way of a besieging force that the place could only be approached with great difficulty and hazard. This he sought to accomplish by covering and flanking his works more effectually than had previously been done, and by depriving the assailant of the room necessary for erecting his batteries. An idea of his methods may be formed from the annexed figure, which represents his first system. It is constructed on a hexagon; the second was on a heptagon, and the third on an octagon. And it may be remarked of his systems in general, that they differ from Vauban's principally in the greater width of the ditch (which is nearly twice as wide as in Vauban's systems) and the narrow space between the flanks. Coehorn's principles have been adopted in the construction of the fortresses of Nimeguen, Breda, Manheim, Namur, and Bergen-op-zoom.



Cormontaigne's System.—The methods of Vauban were improved in many essential respects by Cormontaigne, a French officer of engineers, who died in 1750. In the system which he adopted, and which is here represented, the faces of the bastion are made longer than in Vauban's methods, and the flanks are placed at right angles with the faces of the opposite bastions. The enlargement of the bastion renders it capable of containing interior retrenchments; and the flanks, though shortened, are better covered. His ravelins are also constructed on a larger base, and contain a larger redoubt, from which the besiegers can keep up a reverse fire on breaches made in the collateral bastions; so that the assault upon the latter becomes impracticable until the ravelin and its redoubt are both captured. The communication round the extremities of the traverses of the covered way are arranged in a zig-zag line; so that the passage round the extremity of one traverse is defended by the fire of another in its rear, and the advance of the assailants along the covered way thereby checked. In general, Cormontaigne's system possesses greater defensive properties, and is more economical of materials.

Modern System.—The annexed figure represents what is called the modern system: it varies but little from that of Cormontaigne. The ravelin is made to cover the shoulder of the bastion more effectually by a greater projection, and its faces are retrenched by *coupures* or cuts through the rampart, perpendicular to the faces of the bastion, which prevent the enemy from taking the redoubt in the re-entering place of arms without first possessing himself of the redoubt in the ravelin.

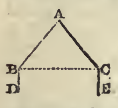


All the systems above enumerated, however they may differ in details, agree in their principal features, and present the same general outline. They may be all included under the name of the bastion system. Some engineers, however, among the most celebrated of whom are Montalembert and Carnot, have pointed out defects which appear to be inherent in the system, and proposed to give the polygon a different form. By suppressing the curtain and the tenaille, and producing the faces of the bastions inward, a line of rampart would be formed presenting simply a succession of salient and re-entering angles. According to this plan, the defence is made to depend on the number of reverse fires that can be maintained from casemated (*i.e.* bomb-proof) batteries; but as the plan has never been practically carried into effect, it is unnecessary to enter into particulars. In the present state of the military art, a fortress can be regarded as nothing more than a means of stemming for a time the torrent of an invading force. Such is the superiority of the means of attack over those of defence, that however strong the works may be, and however skilfully disposed, their reduction, when assailed by adequate means, is, generally speaking, a matter of absolute certainty. The besieging army, sheltered by its trenches from the missiles of the garrison, advances in zig-zag lines parallel to the faces of the ramparts, till it passes over or circumvents all the exterior defences of the place, and arrives at the main wall, where a breach has been made by batteries erected for the purpose. To this covered mode of attack, supported by the ricochet batteries, by which the defenders are driven from the ramparts and the guns dismounted, it is perhaps impossible to offer any effectual resistance. Indeed, such is the perfection to which the art of attack has been reduced, that even the length of time which any fortress will be able to hold out against an enemy provided with the proper train of sappers and miners, and the implements necessary for carrying on their operations, may be computed with the greatest precision.

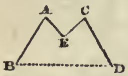
Field Fortification.—Field Fortification is the art of constructing all kinds of temporary works for assisting the operations of an army in the field, and enabling it to maintain a position against a superior force. In the disposition and construction of such works, the engineer must have regard to the nature of the locality, and endeavour to turn to the best account all its natural advantages, as well as the buildings, enclosures, &c., which may be found on it; and there is no part of his art in which talent and skill are so requisite, or in which he must rely so exclusively on the resources of his own judgment. On account of the endless varieties and accidents of the ground on which he has to act, the observance of fixed rules is indeed impracticable: nevertheless

there are certain general maxims which apply to the construction of fortifications of all kinds, whether temporary or permanent, and which must be observed in all his operations. For example, works constructed to flank others, must not be at so great a distance as to be beyond the effective range of musketry: the angles of defence should be nearly right angles, and the salient angles as obtuse as possible. The general nature of defensive works is also the same in all cases, namely, a ditch and a parapet; though, as the pick-axe and the spade are the only implements which an army in the field can carry about with it, the depth and width of the ditch and the height of the parapet are in field-works necessarily limited to what can be effected by these simple means.

Field-works are usually divided into three classes:—1. Works open at the gorge; 2. Works enclosed all round; and 3. Lines either continued or with intervals. To the first class belong *redans*, single and double, *tenailled heads*, and *bastioned heads;* to the second, *redoubts*, *star forts*, and *bastioned forts;* and to the third, lines of various kinds for defending a position. The *redan* is the simplest of all works, consisting merely of two lines, A B and A C, forming an angle with each other. It is only employed for such purposes as defending the avenues of a village, bridge, or defile. The length given it is usually about 50 yards. When the redan is thrown out in front of other works it is called a *fleche*, or arrow. Lunettes are also applied for similar purposes, and are formed by adding two parallel faces, B D and C E, to the redan, at the extremities of its open flanks.



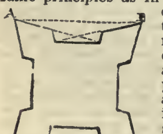
The *double redan*, or *bonnet de prêtre*, consists of two faces, A B and C D; and two flanks, A E and C E, usually shorter than the faces, and affording a reciprocal defence to each other. The re-entering angle at E should be a right angle; if it is less, the two flanks are in danger of being struck by each other's fire; and if it is much greater than a right angle, the defence will be weakened; for it is found by experience that soldiers placed behind a screen invariably fire straight before them, or at right angles to the screen. When a greater extent of front is to be fortified, the lines are disposed in the form of bastions or tenailles, and thence called *bastioned heads* and *tenailled heads*.



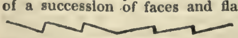
Redoubts are works closed on all sides, of a polygonal or quadrilateral figure, and usually square. An opening is left in one of the sides, for communication with the exterior, and a traverse is thrown up within for protection. As the work is without flanks, the ditches are left without defence. The angles are sometimes rounded, or cut off, in order that a fire may be maintained on an assailant advancing in the direction of the diagonal.

Star forts are enclosed works constructed upon an equilateral triangle or a square. In the former case they have six points, in the latter eight. When constructed on a square each of the sides (which may be about 90 yards long) is divided into three equal parts, and on the middle part an equilateral triangle is constructed, which gives the trace of the figure. The object of this work is to remedy the defects of the redoubt by flanking the angles of the square; but as a considerable space is consumed by the re-entering angles, it scarcely admits of sufficient troops and artillery being placed in it for its defence.

Bastioned forts are constructed in the field on the same principles as in permanent works; but are only constructed on the square or pentagon. The distance A B, or exterior side of the polygon, should not exceed the range of musketry, or about 200 yards. They are employed only in fortifying important positions, and require accordingly to be constructed in a more solid manner than other works of a temporary nature.



The last class of field-works comprehends *lines* of various descriptions. *Continued lines* are constructed to enclose a front, or connect principal works with one another by a continued parapet. They are constructed, according to circumstances, with redans, tenailles, or bastions, placed at certain intervals, seldom exceeding 180 yards. From the descriptions given above, the different forms of the *redan line*, *tenaille line*, and *bastion line* will be readily conceived. Sometimes they are formed of a succession of faces and flanks at right angles. In this case they are called *lines-en-cremaillères*. The flanks are about a fourth of the length of the faces, and afford a defence to the ditches. Lines with intervals consist of isolated works, as redans or redoubts, placed at distances which should not exceed 200 yards. and so as to afford one another a mutual defence.



Besides the works now enumerated, various expedients are resorted to in order to prevent, or at least to render more difficult, the appproaches of an enemy. Among these are *palisades*, *abatis*, *trous-de-coup*, *chevaux-de-frize*, *crows' feet*, &c.

The principal authors on Fortification are Errard, Stevinus, Antoine de Ville, Compte de Pagan, Coehorn, Vauban, Mallet, Belidor, Blondel, Montalembert, Bisset, Bousmard, Carnot, Mouzé, &c. For a practical treatise the reader may be referred to the article "Fortification" in the *Ency. Metropolitana.*

FORTRESS. Any fortified place. (See the preceding article.)

FORTIN, FORTRET. A sconce or small fort.

FORTU'NA. In Mythology, the goddess who presided over the destinies of mankind, and generally speaking over all the events of life. She was represented as blind, with winged feet, and resting on a wheel. This goddess was not known in the more ancient systems of the Greek theogony: all the guidance of human affairs, for instance, is intrusted by Homer to Destiny; but in Italy, and chiefly at Rome, Actium, and Præneste, her worship was most assiduously cultivated.

FO'RUM. (Lat.) In Ancient Architecture, a public market; also a place where the common courts were kept, and matters of judgment pleaded. The fora of the Romans were large open squares surrounded by porticoes; parts of which answered for market-places, other parts for public meetings of the inhabitants, and other parts for courts of justice. The forum was also occasionally used for shows of gladiators. There were in Rome seventeen; of these fourteen were for the sale of goods, provisions, and merchandize, and called Fora Venalia; the other three were for civil and judicial proceedings, and called Fora Civilia et Judicialia: of the latter sort was the forum of Trajan, of which the Trajan column formed the principal ornament. The forum of the Romans was identical with the ἀγορὰ of the Greeks.

FO'SSA (Lat. fossa, *a trench*), in Zoology, is applied to certain depressions on the external surface; generally the seat of cutaneous glands, as the lachrymal fossa in deer and antelopes, the *jugular fossa*, *inguinal fossa*, &c.

FO'SSA OVA'LIS. A depression in the right auricle of the heart, which in the fœtal state opened into the left auricle, forming the *foramen ovale.*

FOSSE (Fr.), in Fortification, is the moat or ditch surrounding the rampart. *See* FORTIFICATION.

FO'SSIL. (Lat. fodio, *I dig.*) Literally, any thing dug out of the earth. The term is now chiefly confined to organic remains.

FO'SSIL FARINA. A soft carbonate of lime.

FOSSO'RES. (Lat. fodio, *I dig.*) An extensive group of Aculeate Hymenopterous insects, most of the species of which are organized for excavating cells in earth or wood, in which they bury other insects in a wounded and feeble state, and at the same time deposit their eggs; so that the larvæ, when hatched, find a store of food prepared for their sustenance. The Fossorial Hymenoptera are solitary in their habits; and some species, which have not the requisite structure of the legs for burrowing, are parasitic, and, like the cuckoo among birds, lay their eggs in the nests of other species, at whose expense the young are reared.

FOSSO'RIAL. (Lat. fodio, *I dig.*) In Zoology, animals which dig their retreats and seek their food in the earth are so called. The locomotive extremities, which are organized for burrowing, as those of the mole, or mole-cricket, are called "pedes fossorii."

FO'SSULATE. (Lat. fossa, *a trench.*) When a surface presents one or more somewhat long and narrow depressions.

FO'THER, or FODDER, A SAIL. This is thrumming a sail; and covering it with loose stuff, and then passing it under the bottom of a ship that has sprung a leak or been aground, the pressure of the water forces the sail against the bottom, and partly stops the leak.

FOUGASS. In Fortification, a small mine, from 6 to 8 feet under ground. It is derived from the Lat. *focata.*

FOUL. The term applied to the wind when contrary; also to the bottom when uneven and rocky. *See* ANCHOR, FALL, HAWSE.

FOUNDA'TION. (Fr. fondation.) In Architecture, the lower part of a wall, on which the insistent wall is raised, and always of much greater thickness than such insistent wall. A practice has lately been introduced in this country of laying foundations (if not in water) on a bed of what is called *concrete*, which is a mixture of rough small stones or large gravel stones with sand and stone, lime and water, with just enough of the lime to act as a cementitious medium, with the best effect. *See* CONCRETE.

FOUNDA'TIONS. (Lat. fundo, *I institute.*) In Political Economy, the generic name given to institutions established and endowed by individuals, associations, or

the public, for the promotion of what is believed to be at the time when the foundation is made some useful or benevolent purpose. In most old-settled and rich countries there are foundations for a vast variety of objects. During the Middle Ages, it was very common to bequeath property for the foundation of monastic institutions and scholastic establishments. The two great universities of Oxford and Cambridge are noble examples of the last species of foundations; and by far the greater number of the grammar and free schools in most parts of England, and indeed of Europe, owe their origin to the same source. A great deal of property has also been bequeathed by benevolent individuals in this and other countries for the erection and endowment of hospitals, or foundations, of various descriptions, for the relief and assistance of the poor; and not unfrequently also property is appropriated, or a foundation instituted, for the amusement and recreation of the public.

But notwithstanding the large amount of property that has been appropriated in most countries to the establishment of foundations, and their extreme importance in a public point of view, it may appear rather singular that the principles and conditions on which they should be established are far from being well ascertained. No one can doubt that it is highly expedient to allow individuals or associations to institute foundations or to bequeath property for the promotion of beneficial public purposes. But, admitting this, the knotty question arises, how far should the legislature go in authorizing private parties to lay down the conditions under which the property so bequeathed, or the foundation, is to be administered. If, on the one hand, government interference be carried too far, the institution of foundations will be discouraged; and if, on the other hand, government do not interfere at all, the folly or the presumption of individuals will be allowed to legislate for all future ages; and a large amount of property may be appropriated for the support of institutions, which, though once believed to be beneficial, experience may prove to be disadvantageous. The regulation of foundations is therefore a matter of at least as much difficulty as importance, and involves a great variety of considerations. It is impossible, perhaps, to lay down any principles with respect to it that should apply in all cases; but some leading positions may notwithstanding be established, that should always be kept in view and referred to. We shall endeavour to state some of these in our articles on PROPERTY (RIGHT OF), WILLS AND TESTAMENTS, UNIVERSITIES, &c., to which we beg to refer.

FOU'NDING, or FOUNDRY. The building in which various metals are cast into moulds or shapes. Such of the details of the processes carried on in the respective metal foundries as are consistent with the plan of this work, will be found under the heads of the metals to which they refer. The furnaces used in fusing and founding metals are variously constructed, according to the nature of the metal and the quantity to be operated upon; and frequently two or more furnaces of different constructions are employed in the same foundry. The wind furnace, blast furnace, and reverberatory furnace, are the forms which are most generally employed. The wind furnace is either square or circular, and varies in dimensions, according to the size of the crucibles which it is intended to contain, and which are placed upon proper supports, resting generally upon the bars or grating of the furnace. It has three apertures; one above, for the purpose of introducing the crucible and fuel, and which is usually closed by a fire tile or brick; another below, for the purpose of admitting the air, so as to pass through the grate and fuel, and up the chimney; and the third communicating with the chimney, which should be lofty and supplied with a damper, for the purpose of regulating the draught of air through the fireplace, and consequently also the heat produced.

The blast furnace differs from the preceding in having no grating, and in the air being supplied by a bellows or blowing machine. The construction of these furnaces is much varied, according to circumstances; but the largest and most perfect are those employed in the iron works.

The reverberatory furnace is so constructed, that the flame and hot air from the fireplace are directed into a separate cavity intermediate between it and the chimney: in this cavity, commonly called the *hearth*, the materials to be fused are placed; and there is an aperture connected with it by which the fused metal is suffered to run out, or through which it may be removed in ladles for the purpose of supplying the moulds.

The materials of which the *moulds* are formed are very various. In some cases, as in stereotype founding, they consist of plaster of Paris; in bronze works for figures and statues, they are made of a mixture of plaster of Paris, sand, and brick-dust, and require the utmost skill and care in their preparation. Iron is usually cast in sand; brass and other metals in clay; and very frequently the moulds are made of cast iron.

FOU'NDLING HOSPITALS. In those ancient nations with the details of whose social life we are acquainted, the practice of exposing new-born infants seems to have been, as it is at this day in China, a species of legitimate infanticide. Neither Plato nor Aristotle, nor in general any political writers of antiquity, condemn it; they merely profess to lay down rules for the preservation of the healthier and stronger, at the expense of the more weakly. Among the Greeks, a more tender mother chose the market-place, or some temple, for the exposure of her child, in order to have the chance of some charitable hand succouring it: if its death was desired, it was abandoned in solitary places; and their dramas and romances are full of narratives in which this custom forms the foundation of the interest. Thebes, in republican Greece, is the only state in which the exposure of children is known to have been forbidden by law. The practice of exposure was common in republican Rome: the law is doubtful. The street called Velabrum (*Juvenal*, Sat. vi.), and the column called Lactaria (from this circumstance, according to some antiquaries) were places usually selected for the purpose. Abandoned children were declared by law to be the slaves or absolute property of those by whom they were brought up; and several were saved from death, not from humane motives, but that their foster-fathers might, by mutilating their persons and exhibiting them in the streets, derive an infamous livelihood from the alms given them by the passengers. At length the progress of Christianity put an end to these disgusting enormities. The exposure of children was made a punishable offence in A. D. 374; and their slavery was abolished by an edict of Justinian in 530.

Infanticide has most properly been prosecuted with the utmost rigour, and made a capital offence in almost all modern countries. But it was early supposed that were the exposure or abandonment of children wholly prohibited, there would, despite of all that could be done to prevent it, be a great deal of infanticide. In consequence of the prevalence of this feeling, it has been customary in the Christian world, from a very remote period, to connive at the abandonment of children, and to provide means for the support of those that might be abandoned; and hence the origin of Foundling Hospitals.

The first distinct trace of an express foundation for foundlings is at Milan in 787. In 1070 the order of Brothers of the Holy Ghost was established, with the express purpose of taking care of sick, orphans, and foundlings. After that time this species of foundations rapidly multiplied in every part of Europe. But while private beneficence was thus exerted in their behalf, the church, which in the earlier period had undertaken the general care of them, seems by degrees to have thrown on the commonalty, in most European countries, the charge of nourishing such as were not received into any of the foundations. Traces of legal contests between the religious and civil establishments on this subject are to be found in the history of France through the whole 16th century. The uncertain state of the law rendered their preservation in that country extremely precarious. St. Vincent de Paule, in the 17th century, undertook their cause; and the foundation of the great Foundling Hospital of Paris, in 1670, is due to his efforts. In the provinces, and in most Catholic countries, and in those under the Greek church, public charity took the same direction.

It has been customary in these establishments to receive all children brought to them, without inquiring whether they were the fruit of regular marriages or of illicit amours! It seems idle to deny that the multiplication of such establishments, by providing a ready method for disposing of children, must have hindered a few cases of infanticide; but the injury they have done to public morals, and the waste of human life that they have occasioned, are ten times greater evils than any they have obviated. It is long, indeed, since well informed persons in this and other countries were aware of the pernicious tendency of foundling hospitals; and it is probable that, at no very distant period, they will be every where suppressed. In France the multiplication of these hospitals, and of exposures, has called at last the attention of the public to the frightful immorality, mortality, and expense which attend it. In 1680, ten years after its foundation, the great hospital at Paris admitted 890; in 1750, 4000; in 1830, nearly 8000. In all France there were nourished at the public expense, in 1784, 40,000 children; in 1809, 69,000; 1826, 118,000. The number is now about 130,000. It varies greatly in the different departments; being greatest in the north, centre, and south; least in the eastern departments bordering on Germany, and in the western, or Britanny, La Vendée, &c. And the statistics of France plainly show, as Messrs. Terme and Montfalcon, the authors of the most comprehensive work on the subject, explicitly declare, that it is "not poverty, but luxury, which produces exposures." The two great measures for reducing the burden which have lately been partially put in execution, are the sup-

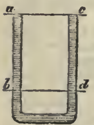
pression of the turning-boxes, or, in other words, rendering the abandonment *public;* and the removal of the new-born children into another department, which, it is said, always produces, when tried, a great reduction in the number of exposures. In Italy, Belgium, &c., similar institutions prevail, and a similar increase of burden has of late years been felt. It has, no doubt, been augmented by the improvement which has taken place in the management of these unfortunate creatures. Formerly death soon relieved the institutions of their maintenance. Towards the end of the last century, 80 per cent. of the children are said to have died at Paris in a single year; 90 at Marseilles; 91 at Dublin. The mortality is now much diminished; though it is thought that in France nearly 60 per cent. still die in their first year. The whole number of children annually exposed is said to be, at St. Petersburgh, about 45 per cent. of those born; Rome, 28; Lisbon, 26; Vienna, 23; Paris, 21. In England, Captain Thomas Coram is celebrated for his establishment of the Foundling Hospital in 1739. It was extremely popular at the time, and for many years was assisted by frequent votes of parliament. Similar institutions were projected in other parts of the country; but the enormous increase of abandonments, and the expense which they occasioned, produced such an alteration in public opinion, that the system of the Foundling Hospital was entirely altered; and, notwithstanding its name, it is now destined merely for the reception of orphans. Abandoned children in England become burdens to the parish in which they are found.

We may remark, by the way, that the statements now laid before the reader, as to the injurious influence of foundling hospitals, strikingly corroborate the principles laid down in the article FOUNDATIONS, as to the necessity of the legislature exercising a certain control over the property left to promote what is believed to be at the time a charitable or benevolent purpose. (See *Gouroff, Essai sur les Enfans Trouvés*, 1819; *Quart. Rev.* vol. xi.; *L'Abbé Gaillard, Recherches*, 1837; and the excellent work of Messrs. Terme and Montfalcon, already cited, *Histoire des Enf. Trouvés*, 1837.)

FOUNT. (Fr. fonds.) The quantity of types of any particular sort in a printing office, whether it be great or small. Thus a small fount may consist of fifty or one hundred pounds weight, comprising the usual proportion of the various letters of the alphabet; and a large fount of thirty thousand or forty thousand pounds weight, or more.

FOU'NTAIN. (Lat. fons.) By this term is designated any natural or artificial apparatus by means of which water springs up. In natural fountains the ascensional effort is produced by the hydrostatic pressure of the water itself; in artificial fountains it is produced either by the same pressure, or by that of compressed air, or sometimes by machinery.

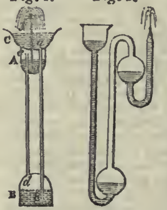
The theory of natural fountains is extremely simple, and depends on the well-known property of fluids — that, when enclosed in tubes or vessels communicating with one another, the fluid rises to the same level in all of them; and that its pressure on the sides of the tube at any point is proportional to the height of the vertical column above that point. Suppose *a b* and *c d* to be two pipes communicating with each other, and that water is poured into the first at *a;* it will ascend equally in both tubes, though they may be of very different sizes, and stand at the same level *a c*. Let us now suppose the tube *c d* to be cut away at *d*, and let the line *b d* be horizontal; then the pressure at *d* being the same as at *b*, the water will spring from *d* with a velocity $V = 2\sqrt{gh}$, where g is the accelerating force of gravity (equal to 32 feet in a second of time), and h is the altitude of the column *a b*. (*See* HYDRODYNAMICS.) The water, therefore, if it suffered no resistance from the air, or other impediment, would spring up from *d* to *c*.



Now it is precisely on this principle that all natural fountains are explained. The rain which falls from the atmosphere is absorbed in three different ways. One part of it collects in rills on the surface of the ground; these unite in streams or rivulets, which flowing into one another form rivers, and thus it is conveyed to the ocean. A second part is taken up in giving humidity to the soil, from which it is returned to the atmosphere by evaporation. A third portion descends into the earth, through soils of a spongy or porous nature, or through crevices and interstices in the strata, until it meets, frequently at a very considerable depth, with strata through which it cannot penetrate, and is then collected in subterraneous reservoirs. When confined in this manner it is subject to the pressure of the water which fills the channels through which it has descended; and when this pressure is sufficient to overcome the resistance of the superincumbent mass of earth, the water breaks through the superficial strata, and gushes forth in a spring. But if the strength of the superincumbent materials exceed the hydrostatic pressure, the water will remain stored up as it were in the subterraneous reservoir. Now if the ground above such a reservoir, or any channel communicating with it, be perforated, the water, having free access to the opening, will rise in it till it attains the level of the highest part of the channels from which it is supplied. If this level is above the surface of the ground, the water will have a tendency to rise; and when the ascensional force is considerable, it may by proper means be formed into a fountain. That subterraneous reservoirs formed in this manner exist in great abundance, and at great depths under the surface, we have sufficient evidence in the facility with which water may be obtained in almost all countries from *Artesian Wells*.

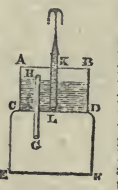
FOUNTAIN OF HERO. An ingenious hydraulic machine, of which the invention is ascribed to Hero of Alexandria, who lived about 150 years before our era. Its principle depends on the transmission of the pressure sustained by a body of water in one vessel to that in another by means of the elasticity of air. The essential parts of the apparatus consist of two close vessels, A and B, the first placed at some height above the other, and connected by a frame; and of three tubes or pipes, of which the first, *a b*, descends from a basin C to very near the bottom of the lower vessel B; the second, *c d*, rises from the summit of the vessel B to the top of A; the third, *e f*, rising from the lower part of A to some height above A, and forming the jet at *f*. Conceive the vessel A to be filled with water, and B with air. In this disposition of the apparatus, let water be poured into the basin C; this will descend through the pipe *a b*, and gradually fill the vessel B. But as it rises in B the air in that vessel escapes through the pipe *c d*, and is compressed at the top of A, and, by its spring or elasticity, forces the water through the tubes *e f*, and thus produces a jet at *f*, which will continue until the vessel A is nearly emptied, or B nearly filled. The force which produces the jet is equal to the pressure of a column of water, the height of which is equal to the difference of the levels of the water in C and B: according to theory, therefore, the water should spout to a height above its level in A equal to that distance.

Fig. 1. *Fig.* 2.



The second figure represents the fountain of Hero in another form. An apparatus constructed on this principle is employed for draining the water from the mines of Schemnitz in Hungary.

Artificial fountains are also produced by means of the elasticity of heated air, or of air condensed by any other means. Two different apparatus for this purpose are frequently met with in cabinets of natural philosophy. The first consists of two close vessels of tin, placed the one above the other, the lower one, C D E F, being of a considerable size; and the upper, A B C D, furnished with a tube or jet, K L, which reaches to near the bottom of the vessel. On applying the heat of a lamp to the lower vessel, the air within it expands, and making its way through the open tube G H is compressed at the top of the vessel A B C D, and thus by its pressure forces the water in that vessel through K L, forming a small jet at K. This apparatus being generally constructed in the form of a temple, produces a very pleasing effect.



The other apparatus to which we have alluded exhibits the appearance of a *fire-fountain*, and when neatly constructed forms an exceedingly elegant toy. On a pedestal of wood or metal, a glass globe with a pretty long neck, from the middle of which spring two branches, A and B, is placed in an inverted position, the globe being first filled with spirits of wine, and the neck well corked. The pressure of the atmosphere prevents the fluid from escaping at the orifices of the tubes A and B, while the temperature is undisturbed; but on applying the flame of a taper to the drops which form at these orifices, the globe is heated; steam is formed at the upper part, the elastic force of which causes the spirit to spring from the orifices, and this taking fire heats the globe to a still greater degree, and increases the action, so that two beautiful jets of burning spirit of wine are produced. As the pressure of steam is very apt to burst the globe, the exhibition of this experiment is attended with some danger.

FOURTH. In Music, one of the harmonical intervals; so called because it contains four sounds or terms between its extremes, and three intervals; or as being the fourth in order of the natural or diatonic scale from the fundamental.

FOVI'LLA. In Botany, the matter contained within the grains of pollen.

FOWLING. The art of catching birds with nets, birdlime, decoys, or other devices. It is also used for taking birds with hawks, falcons, and other birds of prey; more properly called falconry and hawking. In Latin this sport was called aucupium; from avis, *a bird*, and capio, *I take*.

FOX. *See* VULPES and CANIS.

Fox. A particular kind of strand made of rope-yarns.

FO'XGLOVE. The *Digitalis purpurea*; a common indigenous plant, the leaves of which, when carefully dried and powdered, or made into a tincture or infusion, are used in medicine. In small and repeated doses it lowers the pulse in an extraordinary manner, and produces debility and fainting: combined with other remedies, it forms an ingredient in some powerful *diuretics*.

FRA'CTION, in Arithmetic, is an aliquot part of unity. In order to form a precise idea of a fraction of any unit, we must consider the unit to be divided into a certain whole number of equal parts, of which parts we take one, two, three, &c.: the number of parts so taken is what constitutes the fraction. The expression of a fraction therefore necessarily involves two whole numbers; namely, one to denote the number of parts into which the unit is divided, and the other to express how many of these parts are to be taken to form the fraction. The first of these numbers is called the *denominator*, and the second the *numerator*. Thus, *seven eighths* of a foot, *five twelfths* of a pound, are fractions. In the first we suppose the foot or unit to be divided into eight equal parts, of which seven are taken; so that eight is the denominator and seven the numerator. In the second the unit or pound is supposed to be divided into twelve equal parts, of which five are taken; here twelve is the denominator and five the numerator. From these considerations it results that a fraction is a magnitude referred to a certain part of the principal unit, which part may itself be considered as a particular kind of unit. Thus the fraction *seven eighths* of a foot being the same as seven times the eighth part of a foot, this eighth part is a particular unit which the proposed fraction contains eight times. Hence two fractions are said to be of the same kind when their denominators are the same. For example, *five twelfths*, *six twelfths*, *eleven twelfths*, are fractions of the same kind; but *two thirds* and *three fourths* are fractions of different kinds, because their denominators are different.

In order to express fractions by the numerical digits, the numerator is placed over the denominator, with a line or bar between them. Thus the fraction three fourths is written $\frac{3}{4}$, five twelfths $\frac{5}{12}$, &c. Reciprocally, $\frac{13}{15}$, $\frac{17}{20}$, &c. designate the fractions thirteen fifteenths, seventeen twentieths, &c.

A fraction may also be regarded as the quotient that arises from the division of its numerator by its denominator. For example, the expression *seven eighths*, or seven times the eighth part of unity, is identical with the expression *the eighth part of seven*, or *seven divided by eight*.

From the definition which we have given of the numerator and denominator of a fraction, the following consequences result: — 1. If, without altering the denominator of a fraction, we multiply or divide its numerator by any number, the new fraction will be so many times greater or less than the original fraction. 2. If, without altering the numerator, we multiply or divide the denominator of a fraction by any number, the new fraction will be so many times smaller in the former case, and so many times greater in the latter, than the original fraction. 3. The value of a fraction is not altered by multiplying or dividing both numerator and denominator by the same number. It is on these three principles that the practical rules for the addition, subtraction, multiplication, and division of fractions are grounded.

Addition and Subtraction of Fractions. — In order that two fractions may be added together, or the one subtracted from the other, it is necessary that they be both of the same kind, or denomination; for it is only homogeneous things that admit of amalgamation. The fractions $\frac{2}{3}$ and $\frac{3}{4}$ cannot be added together in their present form, because they are of different denominations. But fractions can always be reduced to the same denomination, or to a common denominator, by means of the third principle above laid down; for numbers can always be chosen such that if we multiply the terms of each fraction by them severally, the resulting equivalent fractions will have the same denominator. Thus, multiplying the terms of the fraction $\frac{2}{3}$ by 4, we get the equivalent fraction $\frac{8}{12}$; and multiplying the terms of $\frac{3}{4}$ by 3, we get the equivalent $\frac{9}{12}$. The two proposed fractions are therefore reduced to the two others, $\frac{8}{12}$ and $\frac{9}{12}$, the sum of which is $\frac{17}{12}$, and the difference $\frac{1}{12}$. When any number of fractions are to be added together they are most conveniently reduced to a common denominator by this rule: — Find the least common multiple of all the denominators; divide this multiple by each of the denominators one after the other; and multiply the terms of the proposed fractions respectively by the corresponding quotients thus found; the results will be a series of equal fractions, all having the same denominator, and this expressed by the lowest possible number. When this operation has been performed, the sum or difference of the fractions is obtained by placing the sum or difference of their numerators over the common denominator.

Multiplication of Fractions. — Let it be proposed to multiply $\frac{3}{5}$ by $\frac{6}{7}$. As the multiplier $\frac{6}{7}$ is equal to six times the seventh part of unity, it is obvious that the product must be equal to six times the seventh part of three-fifths. Now by the second principle above laid down, the seventh part of $\frac{3}{5}$ is found by multiplying the denominator by 7; this gives $\frac{3}{35}$. And in order to obtain a fraction six times greater than $\frac{3}{35}$, we must multiply the numerator by 6, which gives $\frac{18}{35}$ for the product required. Hence for the multiplication of fractions we have this rule: — Multiply all the numerators together for the numerator of the product, and all the denominators for its denominator.

As a whole number can always be expressed in the form of a fraction by placing 1 under it for a denominator, this rule includes all the different cases.

Division of Fractions. — Let it be proposed to divide $\frac{3}{5}$ by $\frac{8}{11}$. Here the divisor $\frac{8}{11}$ being equal to 8 times the 11th part of unity, the dividend $\frac{3}{5}$ must (from the nature of division) be equal to 8 times the 11th part of the quotient. But, by the second principle, the 8th part of $\frac{3}{5}$ is $\frac{3}{40}$, therefore $\frac{3}{40}$ is the 11th part of the quotient required; consequently 11 times $\frac{3}{40}$, or $\frac{33}{40}$, is the quotient itself. Hence we deduce the general rule for the division of one fraction by another: — Multiply the numerator of the dividend by the denominator of the divisor, the product will be the numerator of the quotient; and multiply the denominator of the dividend by the numerator of the divisor, the product will give the denominator of the quotient required. It is obvious that this amounts to the same thing as to invert the terms of the divisor, and then proceed as in multiplication.

Fractional expressions are divided into several kinds: — proper and improper, simple and compound. A *proper fraction* is one whose numerator is less than its denominator, and its value consequently less than unity. An *improper fraction* is one whose numerator is equal to or greater than its denominator, and its value consequently equal to or greater than unity. A *simple fraction* is an expression consisting of one fraction only. A *compound fraction* is a fraction of a fraction, or a fractional part of some whole or mixt number. And a *mixt number* is an expression consisting of a whole number and a fraction.

The fractions of which we have now spoken are common or *vulgar* fractions; when the denominators are 10, 100, or in general any power of 10, they become *decimal* fractions, and are expressed by a different notation. *See* DECIMAL.

FRA'CTURE. (Lat. frango, *I break*.) In Mineralogy. When minerals are broken, they either exhibit a smooth regular surface, to which the term *cleavage* is generally applied; or they give an irregular or uneven surface, termed a *fracture*. Werner, who first employed this character in his description of minerals, divides their various fractures into compact, fibrous, radiated, and foliated. The terms *earthy*, *granular*, *uneven*, *hackly*, and *splintery*, the meanings of which will be sufficiently obvious, are employed by other mineralogists.

FRACTURE. In Surgery, this term is limited to broken bones. Such accidents are generally the result of external force; but it occasionally happens that the powerful action of certain muscles may cause a fracture, as is frequently the case in regard to the *patella* or knee-pan. Fractures are distinguished by surgeons into *transverse*, *oblique*, and *longitudinal*, depending upon the direction in which the bone is broken; and into *simple* and *compound*, dependent upon the circumstances with which the injury is accompanied. "By *simple fracture* surgeons mean a suddenly formed breach in the continuity of one or more bones, without any external wound communicating internally with the fracture; by a *compound fracture* they signify the same sort of injury of a bone or bones, attended with a laceration of the integuments, which laceration may be produced by the protrusion of one or both ends of the fracture through the skin, or by a ball or other body which enters or otherwise wounds

the soft parts at the same moment that it breaks the bone."

The history and treatment of fractures is an extensive and important department of surgery, upon which several treatises have been written by very eminent practitioners. An excellent article upon the subject will be found in *Cooper's Surgical Dictionary*, from which work we have borrowed the above definition.

FRAISE. In Fortification, a kind of defence which is formed by driving pointed stakes at a small angle with the horizon into the retrenchment of a camp, &c.

FRAMBŒ'SIA. (Framboise, *a raspberry*.) The yaws; a disease endemic in the Antilles and some parts of Africa, which is attended by cuticular excrescences something like mulberries, which discharge a watery fluid. It is contagious, but not dangerous.

FRAMING. (Sax. ꝼpamman, *to form*.) In Architecture, the rough timber-work of a house, including floors, roof, partitions, ceilings, and beams. Generally, any pieces of wood fitted together with mortices and tenons are said to be framed; as doors, sash frames, sashes, &c.

FRA'NCHISE. In Law, a species of incorporeal hereditament, synonymous with liberty, which is defined "A royal privilege, or branch of the king's prerogative, subsisting in the hands of a subject." For an account of the nature of the *elective franchise*, see PARLIAMENT.

FRANCI'SCANS. One of the four Mendicant Orders, founded by St. Francis of Assisi, in Umbria, in the year 1209. *See* art. ORDERS, MENDICANT.

FRANK. A coin in use in France, equivalent to 9·69*d*. *See* MONEY.

FRANK. A privilege enjoyed by the members of both houses of Parliament, some government offices, and certain public functionaries, of sending and receiving a certain number of letters *post free*; abolished Jan. 10. 1840. *See* POSTAGE.

FRANK ALEU. In Law, an absolute right to real estate in Lower Canada, and also in Guernsey and Jersey, acknowledging no feudal superior, and consequently not a *tenure*. *See* ALLODIUM.

FRANKALMOI'GN. (From two Norman-French words, signifying free alms.) In Law, a tenure by spiritual service, where an ecclesiastical corporation, sole or aggregate, hold land to them and their successors of some lord and his heirs in free and perpetual alms. Donations in Frankalmoign are now out of use, as none but the king can make them; but they were expressly excepted from the operation of stat. 12 C. 2. c. 24., which abolished military tenures.

FRANKINCENSE (said to be so called from its liberal distribution of odour). The gum-resin *olibanum*, which is the produce of the *Boswellia serrata*, and imported from the Levant, bears the commercial name of *frankincense*. When it is burned, or sprinkled upon hot coals, it exhales a very fragrant and diffusible odour.

FRA'NKPLEDGE, or FREEBORG. (German bürge, *pledge*.) A celebrated Anglo-Saxon usage, which appears to have been of two kinds. 1. That which may be termed *seignorial frankpledge*, by which every lord (hlaford) was rendered responsible for the appearance of his own *men* or dependants, when accused before justice, in the hundred court; when, if the party absconded, the lord became liable to the king in the amount of the "were" or amercement for the offence. 2. Collective or public frankpledge, which is the sense in which the word is most commonly used by modern writers, is of very obscure origin, but appears to have existed after the Conquest in the southern and eastern parts of England. The burghers and ceorls, or inferior class of freemen, were enrolled in small collective bodies termed tythings or decennaries (in many instances equivalent to the townships), under the superintendence of a chief pledge or tything-man. The tything thus organized was bound for the appearance of any one of its members under accusation. The "view of frankpledge" originated in the usage of calling together the individuals who were enrolled in each of these bodies at certain stated times; which were usually held at the court leet, but were not (as Blackstone states it) the main object of that institution, since courts leet were held from an early period in the northern parts of England, in which frankpledge never existed, as well as in the southern. On the view of frankpledge, the members of each tything also took the oath of allegiance under the Norman kings. (See *Turner's Anglo-Saxons; Sir F. Palgrave's Commonwealth of England*; and art. COURT LEET.)

FRANKS. A general appellation conferred by the Turks and other Asiatic nations on all the inhabitants of Europe.

FRATE'RCULA. The generic name for the puffins. *See* MORMON.

FRATERNITIES, were associations of laymen in the middle ages, formed for the purposes of general benevolence, and for the discharge of other Christian duties.

FRAUD, in Law, is the general name for any species of deceit in contracts, either by suppression of truth or assertion of falsehood. The most complete definition of it is that given by Forbes: — "Dolum malum esse omnem calliditatem, fallaciam, machinationem, ad circumveniendum, fallendum, decipiendum alterum adhibitum." (*Story's Commentaries on Equity Jurisprudence*.) With a view to the provisions of the English law, frauds may be divided into such as are cognizable by courts of common law, such as are cognizable in equity only, and such as are expressly provided against by statutes. It has been laid down as a general principle, that courts of common law can relieve against the consequences of fraud (by making contracts void, &c.) as well as courts of equity, wherever the fraud is clearly established; and that their inadequacy to provide a proper remedy arises only from their inability to attain the necessary evidence. But however this may be, it has long been a general principle, that courts of equity, in the language of Lord Coke, have jurisdiction over frauds, covin, and deceits, for which there is no remedy by the ordinary course of law. Hence arises one of the three great branches of equity jurisdiction — trust, fraud, account. (*See* CHANCELLOR.) The general principles of that jurisdiction appears to be, that the courts will relieve, by considering acts as performed of which the performance has been fraudulently prevented; by setting aside bargains made in ignorance of rights, or where there is material concealment of title, value, &c.; or, finally, misrepresentation in material particulars. Various acts have been made fraudulent, so as to produce the consequence of annulling contracts and avoiding conveyances by statutes: *e.g.* conveyances with intent to defraud creditors, by 13 Eliz. c. 5.; voluntary conveyances, 27 Eliz. c. 4.; various contracts, conveyances, &c. not executed with the formalities required by the Statute of Frauds, 29 C. 2. c. 3. Some frauds are of a criminal nature, and punishable by indictment; but they are chiefly such as affect the public, or such as are effected by means of false tokens.

FRE'CKLES. Small yellow specks and spots which appear upon the face, especially of fair persons much exposed to the weather. The best application is a dilute spirituous lotion (one part of brandy to eight of water), with a few drops of muriatic acid, so as to render it just perceptibly sour.

FREE'BOOTERS. (Germ. freibeuters, Fr. flibustiers.) A name given to some adventurers of all nations, but especially of France and England, who have obtained a place in history by the courage and intrepidity which they displayed in executing the most difficult enterprises. The origin of their history is merged in obscurity, and it is impossible to ascertain precisely whence their name is derived; but the *flibustiers* of the French naval historians are identical with the *buccaneers* of our own language. (*See* BUCCANEERS.) The South American islands formed the chief theatre of their depredations; and such was the relentless hostility with which they visited the Spaniards, that during the latter half of the 17th century, which embraced the most formidable period of the freebooters' career, their commercial operations in the Indian seas were nearly destroyed. At the commencement of the 18th century, the freebooters sustained in their expeditions a series of disasters, which sensibly diminished their numbers; and since that period the designation has been applied indiscriminately to any individual who regards "the universe as his property," and appropriates to himself either furtively or forcibly the possessions of another.

FREE'HOLD, in Law, is a term which is used in two different senses: 1. To express the quantity of estate which a man may have in lands or tenements; and, 2. To express a tenure by which lands and tenements are held. Thus, an estate of freehold, to satisfy the full acceptation of the term, must be both sufficient in quantity of interest and sufficient in tenure.

1. As to quantity of interest, all estates for a term uncertain in duration are estates of freehold; and they are divided into estates of inheritance, and not of inheritance. The first of these are either absolute (fee-simple) or limited (fee-tail, or fee-simple conditional). The second are estates for life, or for an uncertain period limited within the term of a life; as, an estate granted to a widow durante viduitate. Such estates as this are by the law regarded as estates for life, determinable on a given event. 2. With respect to tenure, freehold tenure is derived from the ancient free socage; and lands held by copy of court roll according to the custom of a manor, viz. copyholds, are not within this denomination. But lands held by custom of the manor, *not* by copy of court roll, are not copyholds, but customary freeholds.

In order, therefore, to give the privileges or impose the duties attached by the law to freeholders (such as serving on juries, voting at county elections, &c.), the estate in respect of which such right or duty attaches must be either for life or a greater interest, and must be held in freehold tenure.

FREEMA'SONRY. A well-known institution, the origin of which has given rise to much fabulous narrative and idle speculation. Some derive the mysteries of Freemasonry from those of the priests of Eleusis, and these

again from Egypt; others from the secret associations of the Templars. (*See* TEMPLARS, BAPHOMET.) The last opinion was illustrated at great length by M. Barruel (*Memoires du Jacobinisme*), who conceived both Freemasons and Jacobins to be the relics of a long-established conspiracy for the subversion of religions and empires. But our distinct historical information merely amounts to this, that the fraternity of architects or builders in the middle ages extended over all Catholic countries, and was especially patronized by the see of Rome. It is to this craft that we owe the magnificent Gothic edifices dedicated to religion, which contrast so strongly with the barbarous efforts of those ages in most other departments of art. It is said that this association was introduced into Scotland in the 13th century, and about the same time into England, it being ascertained that the Abbey of Kilwinning in the former country was raised by this fraternity; and it is believed to have continued to exist, although small in number, in these two countries after it had disappeared from the Continent. The Kilwinning and York lodges are respectively the most ancient in either country. But the mode and period in which the association became changed from a mere professional fraternity to a society of persons of all descriptions connected by secret symbols, is unknown. It certainly excited great attention, and numbered individuals of high rank as honorary members, as early as the 15th century. The Scottish masons appointed St. Clair of Roslin their hereditary grand-master in 1630; and the office was resigned by his descendant in 1736, when the grand lodge of Scotland was instituted. In 1725, the first French lodge was established; in 1730, the first American; in 1735, the first German. From that period until the present, while the society has existed among ourselves as a mere convivial and benevolent association, and has been patronized even by royalty and the nobility, it has been subjected on the Continent to a variety of suspicions; and it is most probable that political intriguers have availed themselves of the secrecy afforded by it to further their schemes. Indeed, in this country, the "Royal Arch" degree is said to have been devised by the Scottish Jacobites. Pope Clement XII. excommunicated the Freemasons in Spain and Portugal: until recent events, their name was synonymous with that of deists and revolutionists. But the most singular chapter in the history of the society relates to its fortunes in America; where it has given origin to two violent political parties. The story of the abduction and murder of a certain William Morgan, suspected of having revealed the secrets of the fraternity, made a great sensation in the Union, and is not cleared up at this day. The reader will find it detailed and commented on in Miss Martineau's recent work. (See *Lawrie's History of Freemasonry*, Edin. 1804; *Anderson's* ditto; *Preston's Illustrations of Masonry*; the *Freemason's Quarterly Magazine*; the German *Freimaurer Encyclopædie*, &c.)

FREE'THINKER. A term, usually of reproach, applied to those who reject the ordinary modes of thinking in matters of religion. It is almost synonymous with *Deist*, which see.

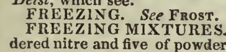
FREEZING. *See* FROST.

FREEZING MIXTURES. When five parts of powdered nitre and five of powdered sal ammoniac are mixed with sixteen parts of water, the thermometer falls in the mixture from 50° to about 10°; so that in this way a degree of cold much below the freezing point of water may be artificially and cheaply obtained, for the salts may be again procured by evaporation and used repeatedly. When ice or snow can be obtained, the most effective freezing mixture is produced by mixing it with about half its weight of salt; it carries the thermometer nearly to 0°. The utmost degree of cold produced by the skilful combination of the best freezing mixtures has not exceeded 140° below 0°.

FREIGHT. In Mercantile Law, the sum paid by the merchant or other person hiring a ship, or part of a ship, for the use of such ship or part for a specified voyage, or for a specified time. Freight must be mentioned, eo nomine, in a policy of insurance, and is not covered by a policy on goods.

FRE'SCO PAINTING. (It. fresco, *fresh*.) In Painting, a method of painting by incorporating the colours with plaister before it is dry, by which it becomes as permanent as the wall itself. This method of painting is extremely ancient. It was used by the Greeks, and can be traced even to Egypt. From difficulty of alteration when the colour is once absorbed, the greatest precision of design is necessary before commencing the work.

FRET, or FRETTE. (Etymology doubtful.) In Architecture, a species of ornament consisting of one or more small fillets meeting in vertical and horizontal directions. The section of the channels between the fillets is rectangular. The subjoined diagram shows two sorts of simple frets; but they are often much more complicated.



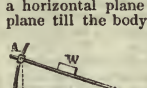
FRETS. The cross bars on the finger boards of stringed instruments of ivory or brass, by pressure whereon with the finger the string is stopped to produce a certain note in the scale. The use of frets is still continued on the Spanish guitar, and was formerly in constant use upon what was called the bass-viol for learners, and taken off when they had learnt by practice to measure the accurate distance of the stops. On lutes and viols they were always permitted to remain.

FRIAR. (Lat. frater, *brother*.) A brother or member of any religious order; but more exclusively applied to those of the Mendicant Orders, of which the four chief were the Dominicans, Franciscans, Carmelites, and Augustines. *See* ORDERS, MENDICANT.

FRI'CTION. (Lat. frico, *I rub*.) In Mechanics, the resistance produced by the rubbing of the surfaces of two solid bodies against each other. If the surfaces of bodies were perfectly smooth and polished, they would slide along one another without suffering any resistance from their contact, and all the simple relations between power and resistance determined by theory in respect of the different machines would hold good without any modification whatever. But this state of perfect polish never exists. The surfaces of all bodies with which we are acquainted, even when most carefully polished, retain a greater or less degree of asperity, which prevents them from sliding over one another without impediment; and in many cases the resistance thus created amounts to a large proportion of the whole resistance to be overcome. In order, therefore, to ascertain the real value of the effect of powers applied to machinery, it is necessary to determine the amount of the friction, and to add this new resistance to that which is given by the theory of mechanics.

The determination of the laws of friction, and its amount with respect to particular substances, have occupied the attention of many experimental philosophers and mathematicians, as Amontons, Euler, Desaguliers, Vince, &c.; but the first complete set of experiments on the subject was made by Coulomb about the year 1780. His results, though they have been partly modified by subsequent experiments, throw much light upon the subject, and are of great value to the practical engineer.

There are two modes by which the nature and operation of friction may be ascertained. The first is very simple, and consists in merely placing a heavy body W on a horizontal plane A B, and elevating the end of the plane till the body begins to slide. When this motion commences, it is evident that the force of gravity just begins to exceed the resistance occasioned by the friction, and as the gravity is known from the weight of the body and the inclination of the plane, we have thus the means of comparing the friction with a given force.



For let A E be drawn perpendicular to the horizontal line C B; then, since the weight, the friction, and the pressure make equilibrium, if we take A B to represent the weight W, the force down the plane (which is equal to the friction) will be represented by A E, and the pressure perpendicular to the plane by B E. Hence, putting $P =$ the pressure, $F =$ the friction, and $i =$ A B C, the inclination of the plane, we have $P = W \cos. i$, $F = W \sin. i$, and consequently $F = P \tan. i$. The angle i is called the *limiting angle of resistance*; and $\tan. i$, or the ratio of friction to pressure, is called the *co-efficient of friction*.

But this method is liable to some uncertainty. Most bodies, after having been in contact for some time, require a greater force to originate than to keep up progressive motion; but it is obvious that the inclination of the plane of descent marks only the initial obstruction. Coulomb accordingly adopted a different mode of proceeding. His general method was to draw a sort of loaded sledge along a horizontal bench, by means of weights placed in a dish attached to the sledge by a cord passing over a pulley. The sledge was mounted on sliders of the substance on which the experiments were to be made; and corresponding slips of the same or a different substance placed under the sliders on the bench. This apparatus has been called a *tribometer*. The following are some of the results which were obtained:—

Assuming the pressure as equal to 100 parts, the friction of oak against fir was 66 in the direction of the fibres, but amounted only to 16 when moved with the velocity of a foot each second; the friction of oak against oak in the direction of the fibres was 43, and across them only 27, the effect being still reduced by motion to 10; the friction of fir against fir in the direction of the fibres was 56, which sunk to 17 during motion; the friction of elm against elm in the direction of the fibres was 46, and reduced by motion to 10. On the other hand, the friction of copper upon oak, lengthwise, was 8 at the commencement of the motion, but increased to 18 when the velocity was a foot in a second; the friction of iron upon oak with the initial velocity was 11, and was increased by the motion to 18. But the mutual friction of metals appeared in general to be scarcely, if at all, affected by motion. In these experiments no unguents were used.

Where metals rub against wood, it is necessary that the two bodies continue longer in contact, in order that the friction may acquire its maximum. In the case of iron against wood at least 4 or 5 hours must elapse before the momentary increase of friction disappears; whereas in the case of wood against wood a single minute was sufficient. But the resistance appears to increase by contact, though less sensibly, even for several days. The application of grease to the surfaces of wood produces a similar effect, and the resistance does not attain its maximum till after a very considerable time. At the end of 5 or 6 days the resistance is perhaps 14 times greater than it was at the first instant, if the surface of contact is considerable in respect of the pressure; but when the surface is small, the friction reaches its maximum much more quickly.

An important part of the investigation was to ascertain whether the friction is increased by the velocity of the rubbing bodies. With respect to bodies of the same kind descending on inclined planes, Coulomb found that the time required for passing over the first half was a little more than double that required for passing over the second. But a body put in motion by a constant accelerating force employs for passing over one space, and over two equal consecutive spaces, times that are to each other in the ratio of $\sqrt{1} : \sqrt{2} = 100 : 142$; that is to say, if 100 units of time are consumed in passing over the first space, 142 will be consumed in passing over the first and second together, and consequently 42 in passing over the second. Now this agrees as nearly as possible with the result of the experiments; consequently we infer that a load drawn along a smooth plane by a constant accelerating force (that of a descending weight for example) is uniformly accelerated. But this requires that the friction, at every instant, destroys only a proportional quantity of the force added by the constant action of gravity. The conclusion, therefore, is, that, for moderate velocities at least, *the resistance due to friction is a constant quantity*, and very nearly the same for every degree of velocity.

Another point of great importance was to ascertain the relation the friction bears to the pressure; for example, in what ratio the friction is increased by doubling or trebling the load. Coulomb found that when wood has been allowed to rest on wood for some time, without the intervention of any unguent, the resistance occasioned by the friction is proportional to the pressure. This resistance for a short time increases rapidly by the contact, but attains its maximum in a few minutes. The friction of wood sliding on wood with any velocity is still proportional to the pressure; but the resistance is much less in amount than that which is required to detach the surfaces after some minutes of contact. In the case of oak, for instance, the force required to detach the surfaces after being some minutes in repose is to that which is necessary to overcome friction alone after motion has commenced in the ratio of 100 to 23. The friction of metals on metals is also proportional to the pressure; but the intensity is the same, whether the surfaces have been any length of time in contact, at rest, or are gliding along with an uniform velocity.

The friction of heterogeneous substances, as wood and the metals, is entirely different from the above. In the case of wood against wood dry, or of metal against metal, the friction of the rubbing bodies is very little influenced by the velocity; but in the present case the friction increases very sensibly with an augmented velocity. Coulomb inferred that the friction increased as the natural numbers, when the velocities are increased as the squares of those numbers. In all cases of a hard body rubbing against a very soft substance, the friction increases remarkably with the velocity.

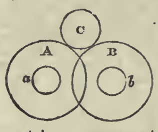
Since the friction is in general proportional to the pressure, it follows that it will not be altered by increasing or diminishing the extent of the rubbing surfaces. Nevertheless this consequence fails in the extreme cases. The friction is sensibly diminished when the surfaces in action are reduced to the smallest dimensions. Thus, while the friction of a ruler of brass against a similar one of iron is expressed by 26, it was found to be only 17 after the sledge had been mounted on 4 round-headed brass nails.

On the whole, the following conclusions may be stated as the general results of Coulomb's experiments respecting the friction of bodies *sliding* on each other.

1. Between similar substances, under similar circumstances, friction is a constant retarding force. 2. Friction is greatest between bodies whose surfaces are rough, and is lessened by polishing them. 3. It is greater between surfaces composed of the same material, than between the surfaces of heterogeneous bodies. 4. If the rubbing surfaces remain the same, the friction increases directly as the pressure. 5. If the pressure continue the same, the friction has no relation to the magnitude of the surface. 6. The application of grease in general diminishes the friction, though in very different degrees.

The obstruction which a cylinder meets with in rolling along a smooth plane is quite distinct in its character, and far inferior in its amount, to that which is produced by the friction of the same cylinder drawn lengthwise along a plane. For example, in the case of wood *rolling* on wood, the resistance is to the pressure, if the cylinder be small, as 16 or 18 to 1000; and if the cylinder be large, this may be reduced to 6 to 1000. The friction from sliding, in the same cases, would be to the pressure as 2 to 10, or 3 to 10, according to the nature of the wood. Hence, by causing one body to roll on another, the resistance is diminished from 12 to 20 times. It is therefore a principle in the composition of machines that attrition should be avoided as much as possible, and rolling motions substituted whenever circumstances admit.

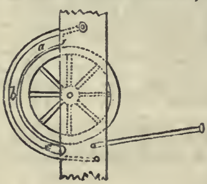
On this principle depends the advantage resulting from the application of *friction wheels* and *friction rollers*. The extremity of an axle C, instead of resting in a cylindrical socket, is made to rest on the circumferences of two wheels, A and B, to the axles of which, *a* and *b*, the friction is transferred, and consequently diminished in the ratio of the radius of the wheel A to the radius of the axle *a*. This ingenious contrivance appears to have first been applied by Henry Sully, in the year 1716. (*Descr. Abregée d'une Horloge, &c.*, Bordeaux, 1716.)



The following are deductions from Coulomb's experiments relative to the friction of rolling bodies: — 1. Like the friction of sliding bodies, it is a constant force. 2. It is affected by the nature of the surface so far as polish is concerned; but is not lessened by the interposition of unctuous substances. 3. It is less between heterogeneous than between homogeneous substances. 4. It is directly proportional to the pressure. 5. It has no relation to the magnitude of the surface. 6. It is much less than in the case of sliding surfaces, and varies in the inverse ratio of the diameter of the rolling body.

The friction of the axle of a wheel or pulley (whether the axle itself turns, or the wheel turns on the axle) is of a different kind from that of a cylinder rolling on a plane. It is less than that of sliding but greater than that of rolling bodies, and follows in all respects the laws of the friction of sliding bodies. A great advantage is here obtained by greasing the surfaces. By the application of fresh tallow the friction is reduced to one half.

Friction is one of the most effectual means of arresting motion. In some machines, especially wind-mills, cranes, &c., it is very important to have the power of suddenly stopping the machine, or at least of controlling its motion. This is effected by means of a strong bridle of wood or iron, *a*, *b*, *c*, fixed at one end, and at the other furnished with a lever, by pressing on which the bridle is brought into close contact with the broad rim of a wheel which participates in the general motion of the machine. The bridle may be made to bear on the whole circumference of the wheel; and a moderate pressure on the lever will produce a resistance sufficient to destroy the motion almost instantaneously.



Coulomb's experiments were also directed to ascertain the resistance arising from the rigidity of ropes when bent round rollers or cylinders. The results are as follow: — 1. The resistances of ropes are directly proportional to the tensions to which they are subjected. 2. The resistance increases with some determinate power of the diameter, and is greatest in ropes that have been strongly twisted, or are coated with tar. 3. The resistances are inversely as the diameters of the cylinders about which the ropes are bent.

When a rope is wound more than once round a cylinder, the resistance increases in a geometrical progression. This principle is frequently applied in practice: thus, in arresting the progress of a vessel, a rope is wound round a post, and a very few turns is sufficient to overcome any force which the rope is capable of withstanding.

A valuable series of experiments on friction was made some years ago by Mr. George Rennie, the details of which are given in the *Phil. Trans.* for 1829. The following are a few of the results: — Assuming as before the pressure equal to 100 parts, the friction of steel upon ice is 1·4; ice upon ice 2·8; hard wood upon hard wood 13; brass upon wrought iron 13·5; soft steel upon soft steel 14·6; leather upon iron 25; granite upon granite 30; yellow deal upon yellow deal 35; sandstone upon sandstone 36; woollen cloth upon woollen cloth 43. Some of the conclusions deduced by Mr. Rennie are as follow: — 1. In fibrous substances, such as cloth, friction is increased by surface and time, and diminished by pressure and velocity. 2. In harder substances, such as woods, metals, and stones, the friction is directly as the pressure,

without regard to surface, time, or velocity. 3. Friction is greatest with soft, and least with hard substances. 4. The effect of unguents is as the nature of the unguents, with reference to the substances to which they are applied.

In the *Memoires de l'Institut* for 1833, two very extensive sets of experiments are described, which were made by M. Morin, at Metz, under the auspices of the French government, for the purpose of verifying or correcting the results of Coulomb. In general, M. Morin's results differ widely in absolute amount from those of Coulomb, giving in some instances ratios three times as great; but they point to, and indeed fully establish, the same general conclusions. See Coulomb, *Théorie des Machines Simples* (Paris, 1821), and *Mem. des Savans Etrangers*, tom. ix. and x.; Ximenes, *Teoria e Pratica delle Resist. de Solidi ne' loro Attriti* (Pisa, 1782); Vince, *Phil. Trans.*, 1785; Rennie, *Phil. Trans.*, 1829; Morin, *Mem. de l'Institut*, 1833; *Ency. Brit.*, art. "Mechanics," &c.

FRICTION-WHEELS. See the preceding article.

FRI'DAY. (Germ. Freitag.) The sixth day of the week. The name is derived from *Freya* or *Friga*, a Saxon goddess. It is a fast day in the Romish church.

FRIE'NDLY SOCIETIES, or BENEFIT SOCIETIES. Voluntary associations of subscribers, for the purpose of forming a fund for the assistance of members in sickness, or other occasions of distress. It is supposed by Mr. Turner (in his *History of the Anglo-Saxons*), that the ancient guilds originated in associations of this description. "Of the various means that have been suggested in this view, and for enabling the poor to provide a resource against sickness and old age, none seem so likely to accomplish their object as the institution of friendly societies and savings' banks. The former are founded on a principle of mutual insurance. Each member contributes a certain sum, by weekly, monthly, or annual subscriptions, while he is in health; and receives from the society a certain pension or allowance when he is incapacitated for work by accident, sickness, or old age. Nothing, it is obvious, can be more unexceptionable than the principle of these associations. Owing to the general exemption from sickness until a comparatively late period of life, if a number of individuals under 30 or 35 years of age form themselves into a society, and subscribe each a small sum from their surplus earnings, they are able to secure a comfortable provision for themselves in the event of their becoming unfit for labour. Any single individual who should trust to his own isolated efforts would plainly be placed in an infinitely more hazardous position. Whenever an unfavourable contingency exists, the best and cheapest way of obviating its effects is by uniting with others, each subjecting himself to a small privation, so that none may be overwhelmed by any great calamity. However industrious and frugal, an individual, not a member of a friendly society, might not be able to insure his independence; inasmuch as the occurrence of any accident, or an obstinate fit of sickness, might, by throwing him out of employment, and forcing him to consume the savings he had accumulated against old age, reduce him to a state of indigence, and oblige him to become dependent on the bounty of others. Hence the paramount utility of the societies in question.

"For these and other reasons," says Mr. M'Culloch, "we are glad to find that friendly societies have been very widely introduced. There were enrolled from the 1st of January, 1793, to the commencement of 1832, no fewer than 19,783 such societies; of which 16,596 were in England, 769 in Wales, 2144 in Scotland, and 274 in Ireland. The societies existing in 1815 are said to have comprised 925,429 individuals. We have, however, some doubts as to the authenticity of this statement; but, if it may be depended on, the societies now in existence must comprise above 1,200,000 members! It should also be recollected that the progress of these societies, though great, and most honourable to the labouring population of Great Britain, has been not a little counteracted by the ignorance and mismanagement of their officers, and by the real difficulty of establishing them on a secure foundation. The great error has consisted in their fixing too high a scale of allowances. At their first institution they are necessarily composed of members in the prime of life; there is, therefore, comparatively little sickness and mortality amongst them. In consequence their funds rapidly accumulate; and they are naturally tempted to give too large an allowance to those members who are occasionally incapacitated. But the circumstances under which the society is placed at an advanced period are materially different. Sickness and mortality are then comparatively prevalent. The contributions to the fund decline at the time that the outgoings increase; and it has not unfrequently happened that the society has become altogether bankrupt; and that the oldest members have been left, at the close of a long life, destitute of all support from a fund on which they had relied, and to which they had largely contributed.

"But the errors in the constitution of friendly societies have been, in a great degree, amended. Various efforts, several of which have been productive of beneficial effects, have been made by private individuals and associations, and by the legislature, to obviate the chances of their failure, and to encourage their formation on sound principles. Two reports, by committees of the House of Commons, on the laws respecting friendly societies, printed in 1825 and 1827, supply a great deal of important and useful information; and the reports and tables published by the Highland Society are also valuable. There are, doubtless, several important points that still remain to be satisfactorily cleared up; but, in the mean time, enough has been done to enable government to interfere with effect in assisting the formation of friendly societies on a solid foundation. In this view several statutes have, at different times, been passed; but the act 10 Geo. 4. c. 56. repealed all previous statutes, and, with the act 4 & 5 Will. 4. c. 40., embodies the existing law upon the subject. All friendly societies, claiming the benefit of these acts, are obliged to submit a statement of their rules and regulations for the approval of the officer appointed by government for that purpose; and it is only in the event of their being approved by him, and the tables of payments and allowances appearing suitable to the justices, that the society is to be confirmed by the latter, and becomes entitled to the privileges conferred by the act in question. These consist in being allowed to invest the funds of the society in government securities at a minimum rate of interest (2½*d.* per cent. per diem), and in the funds of savings' banks. But it is, of course, open to any individuals, not seeking any connection with government, to establish friendly societies on any terms they may think proper." (*Statistics of the British Empire.*)

FRIEZE. (Ital. fregio, *adorned.*) In Architecture, the member in the entablature of an order between the architrave and the cornice. It is always plain in the Tuscan; ornamented with triglyphs and sculpture in the Doric; in the Ionic it is occasionally, in modern or Italian architecture, swelled, in which case it is called a *pulvinated* or *cushioned* frieze; and in the Corinthian and Composite it is variously decorated, according to the taste of the architect.

FRI'GA, or FREYA, in Northern Mythology. *See* Odin.

FRI'GATE, is applied to a ship with one covered gun deck, and carrying more than twenty-eight guns.

FRIGIDA'RIUM. (Lat. frigidus, *cold.*) In ancient Architecture, the apartment in which the cold bath was placed. It is sometimes used to denote the bath itself.

FRI'GID ZONE. The space about either pole of the earth terminated by the parallel of 76½ degrees of latitude. At this parallel the sun at noon, in the middle of winter, is 90 degrees from the zenith; and consequently, were it not for the refraction, would only be visible for an instant in the horizon. Within this parallel the sun continues invisible in winter, and constantly visible in summer, for a shorter or longer space of time, depending on the distance of the place from the pole, where the sun remains for one half of the year above the horizon, and the other half below it. *See* Zone.

FRINGI'LLA. (Lat. fringilla, *a chaffinch.*) A Linnæan genus of Passerine birds, characterised by a broad-based, sharp-pointed, strong, conical bill: now raised to the rank of a family, *Fringillidæ;* including the buntings (*Emberiza*); the cross-bills (*Loxia*); the grosbeaks (*Coccothraustes*); the linnets (*Linaria*); canary-birds (*Canaria*); finches (*Carduelis*); and many exotic subgenera of seed and grain-eating Conirostral birds.

FRITH, or FIRTH (Lat. fretum, *a narrow sea*), is a term chiefly applied to a narrow and deep inlet of the sea upon a river, as the Frith of Forth in Scotland. This term corresponds to the fiord of the Danes and Norwegians, who, in all probability, borrowed it from the English. Both Latin and Teutonic are derived not improbably from the same root, *fahren*, to pass over; whence ferry, ford, furt (Germ.), as in Frankfurt, Erfurt, &c.

FRITT. The materials of glass are first mixed together, and heated, so as to expel water, and induce fusion: the mass thus obtained is called *Fritt.*

FROG. *See* Batrachia and Rana.

FROND. A combination of stem and leaf in one organ, as in *Lemna*, *Marchantia*, and such plants. It is often also misapplied to the leaves of palm-trees and ferns, which differ in no respect from common leaves.

FRONDE, WAR OF THE. That maintained by the malcontent partizans of the parliament in France, under the regency of Louis XIV., against the government of Cardinal Mazarin. The name of Fronde (*sling*) was given to this war in consequence of some incidents of a street quarrel, which have been differently represented. The party opposed to government was called that of the Fronde; and the word Frondeurs has hence acquired in the French language the signification of discontented politicians. Among the best authorities to consult on this period of French history are, Mailly, *Esprit de la Fronde*, 2 vols. Paris, 1772; the well-known *Memoirs of*

Cardinal de Retz; and those of *Guy Joly*, 2 vols. Amst. 1718. See also other Memoirs in *Petitot's General Collection.*

FRONS. In Mammalogy, the region of the cranium between the orbits and the vertex. In Ornithology, the space between the base of the bill and the vertex.

FRO'NTAL BONE. The front bone of the head, which forms the forehead.

FRO'NTIER (Ital. frontiera, Lat. frons), means the boundary of a state, or the territories adjacent to the boundary. The best frontier is the sea; next best, great rivers or mountains, as the Rhine, Rhone, Alps, and Pyrenees. Prussia has the worst frontier of any European state, and will run a great chance of being annihilated on the occurrence of a Continental war.

FRO'NTISPIECE. (Lat. frons, *front*, and inspicio, *I look upon.*) In Architecture, the face or fore front of a house; but more usually applied to the decorated entrance of a building. This term is also used for the ornamental first page of a book, being, as the derivation imports, that part which first meets the eye.

FRONTLET. In Ornithology, the margin of the head behind the bill of birds, generally clothed with rigid bristles.

FROST, in Meteorology, is the freezing or congelation of water or the vapours of the atmosphere by cold. Water begins to freeze when the temperature of the air is such that the mercury in Fahrenheit's thermometer stands at 32°. At this temperature ice begins to appear, unless some circumstance, for example the agitation of the water, prevents its formation. As the cold increases the frost becomes more intense, and liquids which resist the degree of cold required to congeal water at length pass into the solid state. Frost is peculiarly destructive to vegetation. During severe frosts almost all vegetables fall into a state of decay, and even a moderate degree of frost is sufficient to destroy many of the more tender kinds. The injury which vegetables sustain from frost is greatest when it is preceded by a thaw or copious rains; for the plants are then saturated with moisture, which, expanding in bulk as it passes into the solid state, produces the rupture of the vegetable fibres. Fruits are in like manner destroyed by frost. Their watery portion is changed into crystals of ice, which, occupying a greater space than the fluid from which they were produced, burst the small vessels in which they are formed; hence the fruit is deprived of its flavour, and, when thaw takes place, falls into putrefaction.

The *hoar frost* or *white frost*, which appears in the mornings, chiefly in autumn and spring, is merely frozen dew. It is generally the consequence of a sudden clearing up of the weather after rain, when a considerable degree of cold is produced by the rapid evaporation. In our European climates, it usually happens that after a fall of rain the wind shifts into a northern quarter, and the atmosphere suddenly clears up. When this takes place during the night, or early in the morning, a strong radiation of heat from the earth commences, the cooling effect of which is increased by the copious evaporation from the wet surfaces of the plants and the grass. The influence of evaporation on the phenomenon is obvious from this, that the moisture which appears in the form of dew before sunrise is often changed into *rime* or hoar frost on the appearance of that luminary. The reason is, that as the atmosphere begins to be warmed by the sun's rays, the evaporation is accelerated, and consequently the cold at the wet surface of the ground augmented. Hence we see the reason why frosty nights are so much more prejudicial to the tender shoots of plants when they are succeeded by very bright mornings. Hence also hoar frost is formed on grass or plants when the thermometer, placed a few feet above the ground, indicates a temperature three or four degrees above the freezing point.

Various projects have been proposed at different times to avert the disastrous effects of the morning frosts on vegetation in spring; but unfortunately it is only on a very limited scale that any means can be adopted for the purpose. Whatever prevents the formation of dew will protect plants; hence a covering of net or thin gauze will often preserve the blossoms of wall-fruit. But the most effectual means is to check the radiation by screening the plant from the chilling aspect of the clear sky. *See* Dew.

FRUIT, in Botanical language, is the ovarium or the pistillum arrived at maturity; but the term is commonly extended to whatever is combined with the ovarium when it is ripe. It comprehends many kinds of what are commonly called seeds; as those of corn, buckwheat, caraway, parsley, &c.; as well as the succulent inflorescence of the pine-apple, which is a mass of ovaria and envelopes in a consolidated condition.

FRUST, or FRUSTUM. (Lat. frustum, *cut off.*) In Architecture, a piece cut off from a regular figure, as the shaft of a column is a frustum of a paraboloid.

FRU'STUM. In Geometry, the part of a solid next the base, formed by cutting off the top; or it is the part of any solid, as a cone, a pyramid, &c., between two planes, which may be either parallel or inclined to each other. The frustum of a pyramid, when the cutting plane is parallel to the base, is equal to the sum of three pyramids whose bases are,—1st, the lower base or end of the frustum; 2d, the upper base; and 3d, a surface which is a geometrical mean between these two. Hence the solid content of such a frustum, whatever be the figure of the base, is found by this rule:—Add into one sum the area of the two ends and the mean proportional between them, then one third of that sum will be the area of the base of an equal prism having the same altitude as the frustum; and consequently this area multiplied into the altitude gives the solid content of the frustum.

FRU'TEX (Lat. *a shrub*), is a plant whose branches are perennial, and proceed directly from the surface of the earth without any supporting trunk.

FUE'L. (Norm. Fr. fuayl.) Any combustible substance which is used for the production of heat constitutes a species of fuel; and in this extended sense of the term, alcohol, wax, tallow, coal gas, oil, and other inflammable bodies which are occasionally used, especially in the chemical laboratory, as sources of heat as well as light, might be included under it. But the term *fuel* is more properly limited to coal, coke, charcoal, wood, and a few other substances, which are our common *sources of heat*, and as such are burned in grates, stoves, fireplaces, and furnaces of different descriptions.

In this country coal, from its abundance and cheapness, is the commonly employed fuel; but where wood is abundant, or where its value is little more than that of felling it, it is used either in its original state or in the form of charcoal. But whatever substance is used, the ultimate elements of fuel are carbon and hydrogen; and the heat which is evolved by their combustion is derived from their combination at high temperatures with the oxygen of the air: the results or products of this combustion are carbonic acid and water, these escaping into the atmosphere by the flue or chimney generally attached to furnaces and fireplaces.

It is essential to good and profitable fuel that it should be free from moisture; for unless it be dry, much of the heat which it generates is consumed in converting its moisture into vapour: hence the superior value of old, dense, and dry wood, to that which is porous and damp; hence also the greater quantity of heat evolved during the combustion of charcoal as compared with that of wood, for even the driest wood always retains a certain quantity of water; hence also coke gives out more heat than pit coal, partly because it is absolutely dry, and partly because during the combustion or heating of coal, tar, oil, water, and gas are evolved, all of which carry off a certain proportion of the heat in a latent form. A pound of dry wood will, for instance, heat 35 pounds of water from 32° to 212°, and a pound of the same wood in a moist or fresh state will not heat more than 25 pounds from the same to the same temperature; the value, therefore, of different woods for fuel is nearly inversely as their moisture, and this may be roughly ascertained by finding how much a given weight of their shavings loses by drying them at 212°.

Charcoal is itself very hygrometric, and when exposed to air increases in weight to the amount of 10 or 12 per cent. in consequence of the absorption of humidity: a pound of dry charcoal is capable of raising, when properly burned, 73 pounds of water from the freezing to the boiling point.

The different kinds of pit coal give out variable quantities of heat during their combustion; upon an average, one pound of coal should raise 60 pounds of water from the freezing to its boiling point. The heating power of coke as compared with coal is nearly in the ratio of 75 to 69: a pound of good coke will heat from 64 to 66 pounds of water from 32° to 212°; its power, therefore, is about nine tenths that of wood charcoal.

The value of turf and peat as fuel is liable to much variation, and depends partly upon their density, and partly upon their freedom from earthy impurities. A pound of turf will heat about 26 pounds of water from 32° to 212°, and a pound of dense peat about 30 pounds: by compressing and drying peat its value as a fuel is greatly increased.

The following table, by Dr. Ure, shows the quantity of water raised from 32° to 212° by one pound weight of the

Combustible.	Pounds of Water which a Pound can raise from 32° to 212°.	Pounds of Boiling Water evaporated by One Pound.	Weight of Atmospheric Air at 32° required to burn One Pound.
Dry wood	35·00	6·36	5·96
Common wood	26·00	4.72	4·47
Charcoal	73·00	13·27	11·46
Pit coal	60·00	10·90	9·26
Coke	65·00	11·81	11·46
Turf	30·00	5·45	4·60
Coal gas	76·00	13·81	14·58
Oil, wax, or tallow	78·00	14·18	15·00
Alcohol	52·00	9·56	11·60

different combustibles enumerated in the first column; it also shows the number of pounds of boiling water which the same weight of fuel will evaporate, and the quantity of atmospheric air absolutely consumed during combustion. The quantity of air, however, as given in the last column, is much less than would be necessary in practice, where much of the air passes the fuel without coming into contact with it so as to have its oxygen consumed. The heating power also, as represented by this table, can seldom be *practically* attained.

FUE'ROS, is the term by which in Spain the peculiar rights and privileges of certain provinces are distinguished. It corresponds to the old French word *for* or *fors;* and is said to be derived either from the Latin word *forum*, or (what is more probable) from the Spanish *fuera*, which signifies *outside* or *without*, thereby indicating the difference which exists between the administration of the provinces in which the fueros prevail from that of the other constituent parts of the Spanish monarchy. The history of the fueros is lost in their profound antiquity; but there can be little doubt that their origin may be fairly associated with the political existence of the brave Cantabrians, who were never wholly subjugated to the Roman yoke, and who even when partially vanquished still maintained their ancient laws and customs inviolate. Be this as it may, it is well known that from their earliest origin the Basque Provinces enjoyed certain privileges unknown to the rest of the Spanish kingdom, and which, though originally not reduced to writing, and existing like our own common laws of old in the traditions of the country, were mutually and religiously observed both by the monarch and the people. In this state they remained till the year 1235, when, on the accession of Thibault, a French prince, to the crown of Navarre, some misunderstanding having arisen respecting the nature and extent of the fueros, it became necessary to embody them in a written code, which, with some considerable enlargement sanctioned by Charles V., was, down to the period of the last revolution, faithfully recognized by all the monarchs of Spain as the magna charta of the Basque Provinces. Though the immunities of the provinces, Guipozcoa, Alava, Biscay, and Navarre, exhibit considerable difference in detail, their main features are marked by a striking uniformity, the form of government which prevails in each province being essentially republican in all its branches. In the province of Biscay, for instance, which, with a few modifications more or less important, may serve as an example for the other provinces, the royal authority is purely nominal. The only privilege of the crown consists in nominating the corregidor, the highest officer in the state; but even this appointment is subject to the approval of certain members (called *deputation*) of the *junta* or states, in whose assemblies he has a seat and vote. In the junta is vested the chief management of affairs. This assembly forms, with the exception of the American congress, by far the most popularly constituted representative body in modern times, the right of voting being conferred on every man who possesses a domicile within the lordship; and its chief duties consist in administering the affairs of the commonwealth, in collecting the taxes, in providing for the protection and defence of the country, in nominating the official servants of the government, and in forming of itself a court of appeal from the decisions of the corregidor. Of the privileges and immunities of the province itself the following are the principal: — Freedom from paying any imposts but those due from the inhabitants to their own lordship, and which are fixed by themselves, and additionally whatever gratuitous contributions may be deemed necessary to meet the extraordinary emergencies of the state; the enjoyment of the privileges of nobility in the Castilian dominions on merely proving a descent from pure Biscayan blood; exemption from appearing before any tribunal beyond the limits of the lordship; to tolerate no royal intendant or comptroller within the province; to permit no *estanco* or royal monopoly, as in the rest of Spain; exemption from duty on imported merchandise; to have no royal administration, except that of the post-office; to admit no Spanish troops within the territory; to furnish no recruits for the royal army; to defend their territory with their own means and blood; and to visit with summary punishment all who may be convicted of extortion, or of any attempt to injure or even to interfere with the constitution of the province. These details, borrowed chiefly from an able article on this subject in the *Monthly Chronicle* for Nov. 1839, will convey to the reader some idea of the nature and extent of the *fueros*, the maintenance of which formed the sole ground for the sanguinary hostilities which for the last few years devastated the northern provinces of the Spanish territory; — hostilities which have at length happily been put an end to by the formal recognition of all the rights, privileges, and ancient customs of the Basque Provinces, on the part not only of the Spanish government, but also of the Cortes. (For further information on this subject, the reader is referred to a masterly resumé of a work entitled *El Fuero — Privilegios, Franquezas, &c., confirmados por el Rey Don Carlos, nuestros senor, &c.* 1762; commenced in *The Times* of Oct. 14., continued in the same journal 16th Nov. 1839, and ended March 1840.)

FUGA, or FUGUE. (Lat. fuga, *flight.*) In Music, a composition wherein the different parts follow each other, each repeating the subject at a certain interval above or below the preceding part.

FU'GLEMAN, or FLUGELMAN. A non-commissioned officer, appointed to take his place in front of a regiment as a guide to the soldiers in the movements of the drill. The word is derived from Germ. flügel, *a wing.*

FU'LCRA. (Lat. fulcrum, *a prop.*) A term invented by Linnæus to denote a tendril, a prickle, a spine, a hook, or any other process by which plants are enabled to support themselves upon other plants.

FU'LCRUM (Lat.), in Mechanics, is the fixed point about which a lever moves. *See* LEVER.

FU'LGORA. (Lat. fulgor, *an effulgence.*) The generic name of certain singular insects of the order *Homoptera*, and family *Cicadariæ*, which have the fore-part of the head produced in the form of a snout or large hollow receptacle; and the antennæ inserted beneath the eyes, only three-jointed, and terminated by a slender bristle. It is asserted by one naturalist (Mad. Merian), that the frontal projection emits a bright light; but others who have had opportunities of making observations on the "living lantern-fly," as the larger species is called, have not witnessed the exercise of its illuminating powers, if it really possess them.

The *Fulgora lanternaria* is a native of South America; the *Fulgora candelaria* of China. There are many other species included in the Linnæan generic character, but which now form the subgenera *Otiocerus, Lystra, Cixius, Pœciloptera, Issus, Anotia, Delphax, Fulgora proper, &c.*, in the family *Fulgoridæ.*

FULGURA'TION. A term applied by the assayer to the sudden brightening of the fused globule of gold or silver when the last film of oxide of lead or copper leaves its surface.

FU'LICA. (Lat. fuliga; from fuligo, *soot.*) The name of a genus of Wading birds of the family *Macrodactylæ*, now restricted to those which have a strong, moderate-sized, straight, conical, and compressed bill, with a dilated naked plate at the base of the upper mandible: the toes are furnished at the sides with a scalloped membrane; the wings middle-sized. The British species, or common coot (*Fulica atra*), is well known: all its congeners approach more or less to its sooty or blue-black colour.

FU'LLERS' EARTH. A mineral essentially composed of silica and alumina, with about 24 per cent. of water, used in fulling cloth. Like other soft aluminous minerals, it has the property of absorbing grease. It occurs in Hampshire, near Woburn in Bedfordshire, and at Nutfield in Surrey: its exportation was formerly forbidden under severe penalties. In most cases soap is now substituted.

FU'LLING. The art of cleansing, scouring, and pressing stuffs, cloths, stockings, &c., to render them stronger, firmer, and closer; it is also called *milling*, because these cloths, &c. are in fact scoured by a water mill. (See *Ure's Dictionary of Arts, &c.*)

F'ULMINATES. (Lat. fulmen, *a thunderbolt.*) Compounds of the fulminic acid with various bases, all more or less possessed of the property of exploding or detonating by heat or friction. The fulminates of silver and mercury (or fulminating silver and mercury) are objects of manufacturing interest; the former being used in detonating *bonbons*, and the latter more largely and importantly as a priming for the percussion caps of gun locks.

FU'LMINATING POWDER. A compound of three parts of nitre, two of purified pearlash, and one of flowers of sulphur, carefully mixed and dried before the fire: about 20 grains of this powder heated upon an iron plate over a slow fire become brown and pasty; a blue flame then appears upon it, and immediately after the whole explodes with a stunning report.

FULMINA'TION, used synonymously in a general sense with *denunciation;* but applied more peculiarly to the excommunications or anathemas pronounced by the papal see.

FULMI'NIC ACID. An acid composed of 2 equivalents of cyanogen = 52, and 2 of oxygen = 16. corresponding therefore in ultimate composition with the *cyanic acid.* In combination with the oxide of silver and oxide of mercury, this acid constitutes fulminating silver and fulminating mercury.

FUMARIA'CEÆ. (Fumaria, one of the genera.) A natural order of herbaceous Exogens, inhabiting all temperate climates, and related to *Papaveraceæ* so nearly as to be incorporated with them by some writers. Their sensible properties are not of any value; a few are objects of cultivation for their beauty.

FUMIGA'TION. (Lat. fumigo.) The diffusion of certain vapours through the air, for the purpose of destroying contagion and infection: goods are also fumi-

gated for the same purpose. Acid vapours have frequently been used for this purpose; there are, however, very few which are at all effectual, and some of them, such as vinegar, only serve to cover bad smells without destroying noxious effluvia. There is no substance so certain in its effects as *chlorine;* and it is cheap, and easily obtained either from muriatic acid and black oxide of manganese, or from a mixture of salt, sulphuric acid, and black oxide. In inhabited rooms it requires to be cautiously used, in consequence of its bad effects upon the respiratory organs; but even here it may be so extensively diffused as to be effective in destroying noxious matters, without serious injury to persons who breathe the atmosphere. When a room can be shut up it may be freely used, and it should be generated in saucers placed in different parts of the apartment (if a large one); and not upon the ground, but upon shelves high up in the room, for chlorine being heavier than air is thus more quickly and rapidly diffused. Infected clothes and furniture may at the same time be subjected to its action. Of all common diseases, the scarlet fever is that which appears to require the most scrupulous attention to careful fumigation.

FU′NCTION, in Analysis, signifies any mathematical expression considered with reference to its form, and not to the value which it receives by giving particular values to the symbols contained in it. Thus $a + x$ and $a^2 + x^2$ are both functions of x, though of different forms. In whatever manner an expression may be compounded of constant and variable quantities, it is always called a function of the variable quantities only, because it is only with reference to the manner in which the variables enter into the expression that it is necessary to consider the function. Thus the above expressions, as well as the following, $a + \log. x$, $b + \sin. p\,x$, c^x, are all functions of x, the quantities a, b, p, c, being constant, and independent of x. The *calculus* of functions may be regarded as standing in the same relation to algebra that algebra occupies with regard to common arithmetic. The definite abstract numbers about which arithmetic is concerned are in algebra laid aside for symbols of general number, thus enabling us to express a definite operation performed on an indefinite number. In the calculus of functions the generalization is carried a step farther; the definite character of the operation is dropped, and indefinite symbols of operation are used, which may be unknown, but determinable by certain conditions; or arbitrary, or conventionally definite, to denote particular operations. (See "Calculus of Functions," in the *Ency. Metrop.*, by Mr. De Morgan; also *Babbage's Elementary Treatise on the Calculus of Functions;* Lagrange, *Théorie des Fonctions Analytiques;* Cauchy, *Cours d'Analyse* and *Elémens du Calcul Infin.; Peacock's Algebra*, &c.)

FUNDAMENTAL BASS. In Music, the lowest note or root of a chord, which is found by inverting its notes so as to set them in thirds above such root.

FUNDS, PUBLIC. The name given to the public funded debt due by government.

The practice of borrowing money in order to defray a part of the war expenditure began, in this country, in the reign of William III. In the infancy of the practice it was customary to borrow upon the security of some tax, or portion of a tax, set apart as a fund for discharging the principal and interest of the sum borrowed. This discharge was, however, very rarely effected. The public exigencies still continuing, the loans were, in most cases, either continued, or the taxes were again mortgaged for fresh ones. At length the practice of borrowing for a fixed period, or, as it is commonly termed, upon *terminable* annuities, was almost entirely abandoned; and most loans were made upon *interminable* annuities, or until such time as it might be convenient for government to pay off the principal.

In the beginning of the funding system, the term fund meant the taxes or funds appropriated to the discharge of the principal and interest of loans; those who held government securities and sold them to others selling, of course, a corresponding claim upon some fund. But after the debt began to grow large, and the practice of borrowing upon interminable annuities had been introduced, the meaning attached to the term fund was gradually changed; and instead of signifying the security upon which loans were advanced, it has, for a long time, signified the principal of the loans themselves.

Owing partly, perhaps, to the scarcity of disposable capital at the time, but far more to the supposed insecurity of the revolutionary establishment, the rate of interest paid by government in the early part of the funding system was, comparatively, high. But as the country became richer, and the confidence of the public in the stability of government was increased, ministers were enabled to take measures for reducing the interest, first in 1716, and again in 1749.

During the reigns of William III. and Anne, the interest stipulated for loans was very various. But in the reign of George II. a different practice was adopted. Instead of varying the interest upon the loan according to the state of the money market at the time, the rate of interest was generally fixed at *three* or *three and a half* per cent.; the necessary variation being made in the principal funded. Thus, suppose government were anxious to borrow, that they preferred borrowing in a 3 per cent. stock, and they could not negotiate a loan for less than 4½ per cent., they effected their object by giving the lender, in return for every 100*l.* advanced, 150*l.* 3 per cent. stock; that is, they bound the country to pay him or his assignees 4*l.* 10*s.* a year in all time to come, or otherwise to extinguish the debt by a payment of 150*l.* In consequence of the prevalence of this practice, the principal of the debt now existing amounts to nearly *two fifths* more than the sum actually advanced by the lenders.

Some advantages are, however, derivable, or supposed to be derivable, from this system. It renders the management of the debt, and its transfer, more simple and commodious than it would have been had it consisted of a great number of funds bearing different rates of interest: and it is contended that the greater field for speculation afforded to the dealers in stocks bearing a low rate of interest has enabled government to borrow, by funding additional capitals, for a considerably less payment on account of interest than would have been necessary had no such increase of capital been made. *See* NATIONAL DEBT.

FU′NERAL (Lat. funus), may be defined generally as the last rites performed to a deceased person, of whatever nature they may be, whether of interment, burning, embalming, &c. Among the ancients ceremonies of this nature were accompanied by processions, and gladiatorial combats, called *funeral games;* and were usually followed, particularly where the deceased was of high rank or otherwise distinguished, by a discourse, or funeral oration, pronounced in his praise. (See SEPULTURE, RITES OF.)

FU′NGI. A large natural order of plants of a very low organization, consisting chiefly of cellular tissue, sometimes intermixed with flocculent matter, and very rarely with spiral vessels. They inhabit dead and decaying organic bodies, and are also a common pest to living plants, upon which they prey in the same manner as vermin and intestinal worms upon animals. A vast number of species are described by writers upon fungi, called mycologists; and they are often of great importance to man either for their use or their mischievous qualities. The common mushroom, the truffle, and morel, are delicacies well known at table: ergot is valuable in obstetric practice as a uterine stimulant; very many are dangerous poisons. Blight, mildew, rust, brand, &c., are diseases caused by the ravages of microscopic fungi; and finally the destructive effects of dry rot are owing to the attacks of *Merulius lachrymans* and many other species, some of which are microscopic. The best general work on Fungi is *Fries's Systema Mycologicum.* Numerous species are figured in the works of Greville, Bulliard, Sowerby, Corda, and Nees von Esenbeck.

FUNGI′COLA. (Lat. fungus, *a mushroom*, and colo, *to inhabit.*) The name of a family of Coleopterans, comprehending those which are found on mushrooms.

FUNGI′LLIFO′RMIS, a Latin term signifying *mushroom-headed*, is applied to any bodies having a short thick figure, one end of which is much more dilated than another.

FU′NGIN. The fleshy part of mushrooms purified by digestion in hot water.

FU′NGUS, in Surgery, is a term applied to the too luxuriant formation of flesh about an ulcer, or what is commonly called *proud flesh.*

FUNI′CULAR MACHINE. (Lat. funis, *a rope.*) In Mechanics, if a body fixed to two or more ropes is sustained by powers which act by means of those ropes, the assemblage is called the *funicular machine*, or *rope machine.* If a rope is stretched horizontally between two points, its own weight alone will prevent it from becoming perfectly straight, whatever force be employed in stretching it; and a very small force applied at its middle point, at right angles to its direction, will be sufficient to overcome a very great resistance at the points to which its extremities are attached. In this manner a very small force may be made to raise a very great weight to a minute height. This method of applying force is familiar to seamen, who frequently have recourse to it in bracing their sails.

FUNI′CULUS. A prolongation of the placenta in the shape of a cord, to which the ovules are attached.

FU′NNEL. (Lat. infundibulum.) In Architecture, the upper part of a chimney. In common life, it is a trumpet-mouthed utensil, with a pipe fixed to the apex for the purpose of conveying liquors into a vessel without spilling them.

FU′NNEL-SHAPED. In Botany: used in describing the general form of a calyx, corolla, or other organ, the tube of which is like a funnel or inverted cone; that is, narrowest at the base and widest at the orifice.

FUR. (Fr. fourrure.) The coated skins of wild animals, especially of those of high northern latitudes; such as the wolf, bear, beaver, &c. The hair or fur is cleansed, and the skin is generally slightly tanned or tawed. The most valuable furs, such as ermine and sable, come chiefly

from Russia. When unprepared, or merely dried, the fur skins go under the name of *peltry*.

FURFURA'CEOUS. (Lat. furfur, *bran*.) A term applied to certain eruptions in which the cuticle peels off in scales: also to a branlike sediment which is sometimes observed in the urine.

FU'RIES (Furiæ), in Mythology, called by the Greeks Erinnyes ('Ερίννυες) and Eumenides (Εὐμενίδες), were the avenging deities, who punished gods and men for their transgressions against those whom they were bound to esteem and reverence. Their number was not fixed, though sometimes they were considered to be three sisters. The Athenians, who, according to Plutarch (Soton), were particularly addicted to this sort of *euphemism*, called them also Σεμναι Θεαι, the *venerable goddesses*, their true names being considered ominous. By this name they were mentioned in the oaths taken at the Areopagus.

FURL. In Navigation, to roll the sail up and confine it closely to the yard; the sail being gathered up by the men on the yard, the leech or edge is passed along the yard to the middle or *bunt*, where the body of the sail, the foot and clews, are collected. In this way the sails of a man of war are removed nearly out of view in an almost incredibly short space of time.

FU'RLONG. An English measure of length, containing the eighth part of a mile.

FU'RLOUGH, in Military language, signifies the permission granted to an officer or soldier to absent himself for a given time from military duty.

FU'RNACE. (Lat. fornax.) An apparatus wherein is placed a cavity to contain combustible matter, which in various ways is supplied with air to facilitate its combustion. The two classes into which furnaces are divided are air or wind furnaces, and blast furnaces. In the former the air is conducted through the fire by the draught of a funnel or chimney which communicates with it; in the latter, the action of bellows or some other pneumatic apparatus supplies the air. The word furnace has generally, however, a more circumscribed application; being applied usually to an apparatus for the fusion of metals, or to that used in a chemical laboratory.

FU'RNITURE. In Printing, the materials used to extend pages of type to their proper length; also to separate them, when imposed, to a just distance from each other, so that when the sheet is printed and folded the margin shall be regular and uniform. (*See* IMPOSING.) It consists of pieces of oak wood planed up to specific thicknesses, and to about half an inch high; sidesticks and footsticks, which are placed at the outside of the pages, and made thinner at one end than the other, to allow the quoin to secure them more effectually; and quoins or wedges, usually made of beech wood, with which the pages are wedged up in a chase. *See* CHASE.

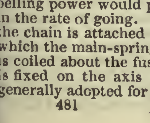
FU'RNITURE. (Fr. fournir, *to furnish*.) In Architecture, the visible brasswork of locks, knobs to doors, window shutters, and the like.

FU'RRING. (Fr. fourrer, *to thrust in*.) In Architecture, the small slips nailed on joists or rafters, where some parts of them are lower than others, or where the surface is not regular, so as to bring the boarding they are to receive into the same planes.

FURU'NCULUS. (Lat. furo, *I rage*.) A boil; an inflammatory tumour, which generally has a central core, and appears in full and healthy habits. Where boils prevail in delicate constitutions, they generally indicate a cachectic state, which is often corrected by a course of sarsaparilla.

FURZE. A prickly bush, found abundantly in exposed heaths in England and the more southern countries of Europe, from which it is by some supposed to have been introduced; a conjecture rendered probable by its not being able to bear the more rigorous of our winters. Its preference for sterile soil has caused it to be extensively used for fences in such land, as a cover for game and a shelter for young plantations. Its young and tenderer shoots are browsed upon by sheep and cattle. Botanists call it *Ulex Europæus*, and class it with the Leguminous order.

FUSE'E. In Watch-work, that part of the machinery about which the chain is wound, and which is immediately acted upon by the main-spring. The use of the fusee is to equalize the action of the spring. In proportion as the spring becomes unwound, its effort continually relaxes; so that if the first wheel were attached to the barrel, as is often the case in common watches, the inequality of the impelling power would produce a corresponding inequality in the rate of going. In order to correct this, one end of the chain is attached to and wound round the barrel in which the main-spring is contained; while the other end is coiled about the fusee, which has a conical shape, and is fixed on the axis of the first wheel. The principle generally adopted for determining the figure of the fusee



is, that its radius, at any point to which the chain is a tangent, should be inversely as the tension of the chain in that position. Within certain limits this is nearly true; and if we assume with Hooke that the force of a spring is proportional to the distance to which it is drawn from the position of rest, and also lay aside all consideration of the length of the chain wrapt about the fusee, it would be easy to show that the fusee should be the solid generated by the revolution of the equilateral hyperbola about its asymptote. This conclusion is, however, by no means correct; but though the subject has been treated by several eminent mathematicians, very little practical advantage has been derived from the theoretical investigations. In fact, a moderate approximation to the true figure (whatever that may be) is all that can be attained in practice, and all that is necessary.

FU'SIBLE METAL. An alloy of eight parts of bismuth, five of lead, and three of tin. It liquefies at a temperature below 212°.

FU'SIBLE SALT OF URINE. A name by which the old chemists designated the *ammonio-phosphate of soda*, obtained by the evaporation of urine.

FUSIL (Fr. fusee), in Heraldry, is a bearing of a rhomboidal figure more slender than the lozenge; its upper and lower angles being more acute than the two middle ones.

FU'SIL. A light musket nearly similar to a carabine, but in general more neatly finished. The fusil was originally used by officers attached to light companies; and in the British army it has given its name to several regiments called the *fusiliers*. The bore is usually calculated for balls of eighteen to the pound; and the length of the barrel is from thirty-four to thirty-eight inches.

FUST. The same as *Frust*, which see.

FU'STIAN. (Fr. fustaine.) A thick twilled cotton, of which velveteen, corduroy, and thickset are varieties. (*See* VELVET.) Fustian is generally dyed of a deep olive or lead colour.

FUSTIAN, in Criticism, is applied to writings remarkable for a forced elevation of style, or for an exaggerated or unnatural use of metaphors or other rhetorical figures.

FU'STIC. A yellow dye stuff. There are two kinds of fustic occasionally used by dyers. *Old fustic* is the wood of a large tree, the *Morus tinctoria*, which grows abundantly in many parts of the West Indies and America; it gives a dingy yellow dye, and is chiefly useful in the production of compound colours. *Young fustic* is the *Rhus cotinus*, or Venice sumach, a shrub growing in Italy and the south of France; it gives a greenish-yellow dye, and is also used as an accessory material.

FU'TTOCK PLATES. Flat iron bars or plates, receiving at one end the lower dead-eye of the topmast rigging, and at the other the futtock shroud.

FU'TTOCKS. In Nautical language, the timbers between the floor timbers and the top timbers.

G.

G. The seventh letter of the English alphabet, but the third in those of all the Oriental languages, and also of the Greek. The form of our G is borrowed from the Roman alphabet. G, in English, has two sounds: before *a*, *o*, and *u*, and occasionally before *i* and *e*, it is the medial letter of the guttural order; the other sound, which it possesses only before *e* and *i*, is one of the medials of the sibilant series. The guttural G is liable to a variety of changes in different dialects and languages. (See *Penny Cyclo.*) G, as a Roman abbreviature, is used for gratis, gens, gaudium, &c. G. V. signifies genio urbis, G. L. genio loci, and G. P. R. gloria populi Romani. As a numeral it denoted 400,—

G quadringentos demonstrativa tenebit.

On the French coins G indicates the city of Poictiers; and in chronology it is the seventh Dominical letter. G, in music, is the fifth note or degree of the diatonic scale, corresponding to the sol of the French and Italians. It is used also to designate the treble clef.

GABE'LLE. (Probably derived, through some unknown inflexion, from the Teutonic word geben, *to give*.) Any impost laid on commodities was originally thus termed in France; as, gabelle de vin, de draps, &c.: but the word acquired in the course of time the peculiar signification of a duty on salt, which is meant when the word "gabelle" is used simply. The Gabelle was first established in the early part of the 14th century, during the reign of Philip de Valois, and with a brief interruption of five years, from 1340 to 1345, continued to be levied down to the reign of Louis XVI., at which time the revenue it produced was estimated at 38 millions of francs. The distribution of this tax was most capricious and arbitrary, some provinces having been altogether exempt from, some more and others less subject to, its operation: and it may safely be affirmed that the gabelle was one of the greatest curses imposed on France previously to the

Revolution. (See *Com. Dict.*, art. "Salt;" art. "Taxation," *Supp. Encyc. Brit.*)

GA'BIONS, in Fortification, are baskets made of twigs, which, being filled with earth, are used as a screen from the enemy's fire.

GA'BLE. (Brit. from gavel.) In Architecture, the vertical triangular piece of wall at the end of a roof, from the level of the eaves to the summit.

GA'DFLY. *See* Œstrum.

GA'DOIDS, *Gadoidæ.* (Gr. γαδος, *a fish.*) A family of soft-finned fishes, which belong to the section *Subbrachians*, or those which have the ventral fins below or in advance of the pectorals, and of which the cod-fish (*Gadus morrhua*, Linn.) may be regarded as the type.

The general character of the Gadoid family is as follows:—Body moderately elongated, sub-compressed, and covered with soft and very numerous scales; head smooth; jaws and front of the vomer armed with pointed, unequal, moderate, or small teeth, disposed in several rows, like a rasp; gill-openings large, and with seven rays; most of the species with two or three dorsal and one or two anal fins; stomach strong and capacious; cœcal appendages very numerous; air-bladder large, with strong parietes, often dentated laterally. The greater number of the cod tribe inhabit the seas of cold or temperate latitudes; their flesh is white and well-flavoured; they are most prolific, and constitute the most important subject of fisheries. The great sand-bank of Newfoundland is the most famous of the cod-fisheries: here 100,000,000 pounds weight have been taken by the British alone in one year.

GA'DOLINI'TE. A mineral found almost exclusively in Sweden, containing yttria and oxide of cerium; named in honour of Dr. Gadolin, who discovered yttria.

GAFF. The boom or yard extending the upper edge of what are called *fore* and *aft* sails. The gaff turns round the mast, against which it rests in a circular opening (called the *jaws*) as an axis. It is supported by two independent ropes; the *throat halliards* at the mast, and the *peak halliards* at the outer end. It is steadied, when the sail is not set, by ropes at the extremity called *vangs*.

GAGE, or GAUGE. (Ang. S. gæggian, *to bind or confine.*) In Architecture, the length of a slate or tile below the lap; also the measure to which any substance is confined. Plasterers use the word to signify the greater or less quantity of plaster of Paris used with the common plaster to accelerate its setting.

Gage. In Physics, an instrument or apparatus for measuring the state of a phenomenon. *Gage of the air pump* is merely a barometer communicating with the inside of the receiver, which marks, in the usual manner, the pressure of the air within the receiver by the height of the equiponderant column of mercury, and consequently shows the degree to which the air is rarefied. A short barometer may be employed for this purpose; but in this case it will not be affected till the rarefaction of the air has been carried so far as to correspond with the length of the tube. An instrument for the same purpose, but on a different principle, was invented by Smeaton, and from its form called the *pear-gage*. It is a vessel suspended in the receiver, and exhausted to the same degree; but when the rarefaction is carried as far as intended, the open orifice of the gage is let down into a vessel containing mercury, which, on the readmission of the air, is forced up into the pear, and the degree of rarefaction is judged of by the quantity of mercury introduced. The idea is ingenious; but the indications given by this instrument are not correct. For *wind-gage*, see Anemometer; *water-gage*, see Hydrometer.

GAILLARDE. (Ital.) The name of a lively dance peculiar to Italy, and supposed to have been practised by the ancient Romans, whence it is sometimes designated Romanesque.

GALA'CTOPOIE'TIC. (Gr. γαλα, *milk*, and ποιεω, *I make.*) A term applied by some medical writers to diet and medicine supposed to promote the secretion of milk.

GALA'GO. *See* Otolicnus.

GALA'NGAL. A dried root brought from China; it has an aromatic smell, and a pungent bitter flavour, and was formerly used in medicine. The greater galangal is the produce of the *Kampferia galanga*, and the lesser of the *Maranta galanga*.

GALATHÆ'A. A genus of long-tailed (*macrourous*) Crustacea, including some very beautiful species (*Gal. rugosa, strigosa, et squamifera*), occasionally found on the British coasts. The true *Galathæa* have the thorax oblong or ovoid, the median antennæ produced, and the pincers elongated. This term is derived from the celebrated nymph of that name.

GA'LAXY, or MILKY WAY. (Gr. γαλα, *milk.*) In Astronomy, "that great luminous band which stretches every evening all across the sky, from horizon to horizon, and which forms a zone completely encircling the whole sphere, almost in a great circle. At one part it sends off a kind of branch, which unites again with the main body, after remaining distinct for about 150 degrees. This remarkable belt has maintained from the earliest ages the same relative situation among the stars; and when examined through powerful telescopes is found to consist entirely of stars, scattered by millions, like glittering dust, on the black ground of the general heavens." (*Herschel's Astronomy; Cabinet Cyclopedia.*) The phenomena of the milky way, says the same illustrious authority, "agree with the supposition that the stars of our firmament, instead of being scattered in all directions indifferently through space, form a stratum, of which the thickness is small in comparison with its length and breadth, and in which the earth occupies a place somewhere about the middle of its thickness, and near the point where it subdivides into two principal laminæ, inclined at a small angle to each other. For it is certain that to an eye thus situated, the apparent density of the stars, supposing them pretty equally scattered through the space they occupy, would be least in a direction of the visual ray perpendicular to the lamina, and greatest in that of its breadth; increasing rapidly in passing from the one direction to the other, just as we see a slight haze in the atmosphere thickening into a decided fog bank near the horizon by the rapid increase of the mere length of the visual ray. Accordingly such is the view of the construction of the starry firmament taken by Sir William Herschel, whose powerful telescopes have effected a complete analysis of this wonderful zone, and demonstrated the fact of its consisting entirely of stars." (P. 376.) *See* Star.

GA'LBANUM. A slightly fetid gum-resin, produced by the *Galbanum officinale*. It is imported from Turkey and the East Indies for medical use, but is a drug of little importance.

GA'LBULA. (Lat. the name of a bird in Martius.) A genus of Scansorial birds closely allied to the kingfishers by their elongated sharp-pointed beak, the upper ridge of which is angular; and by their short feet, the anterior toes of which are almost wholly united: these toes, however, are not precisely the same as those of the kingfishers. The plumage of the species of *Galbula*, which are called by the French "jacamars," is not so smooth as that of the kingfishers, and always has a metallic lustre. They are solitary birds, that live in wet forests, feed on insects, and build on low bushes.

GA'LBULUS. In Botany, a term invented by Gærtner, to denote a form of fruit similar to a cone, excepting that the galbulus is round, and has the heads of the carpels much enlarged. Example — the fruit of the juniper.

GA'LEA, in Antiquity, was the headpiece or helmet used in battle by the Roman soldiers.

Jam galeam Pallas et ægida
Currusque et rabiem parat.

The *galea* was used for the same defensive purposes as the *cassis;* but differed from it in this, that while the cassis was of *metal*, the galea was originally of *hides*. It was too heavy for general use; hence each army was attended by *galearii*, a species of military domestics, whose duty it was to carry the galeæ of the soldiers.

GALE'NA. (Gr. γαλεω, *I shine.*) Native sulphuret of lead.

GA'LENISTS. In Ecclesiastical History, a subdivision of the sect called Waterlandians in the 17th century. (*Mosheim*, Transl., vol. v. 496.) In Medical History the followers of Galen were so termed, in opposition to the practitioners of the chemical school.

GALE OF WIND. The sea term for a continued storm of wind: the lowest degree is the fresh gale, the next a strong gale, and the next a heavy or hard gale.

GA'LEOPITHE'CUS. (Gr. γαλεος, *a weasle*, πιθηκος, *an ape.*) A genus of Insectivorous Mammalia, having the bones of the arm and leg, but not those of the digits, excessively elongated, and supporting extensive lateral folds of skin serviceable as a parachute, but not as organs of flight. The species are restricted to the great islands of the Indian archipelago; their inferior incisors are remarkable for their complex form, like the teeth of a comb.

GALERU'CA. (Lat. galerus, *a cap or tuft.*) A genus of Tetramerous Coleoptera, now the type of an extensive family (*Galerucidæ*), including amongst other subgenera the noxious turnip flies (*Haltica*). All the *Galerucidæ* are vegetable-feeders, both in their larva and perfect state. There are about a dozen known British species of *Galeruca* proper, which are small, and generally dark or dull-coloured beetles.

GALIA'CEÆ. (Galium, one of the genera.) A natural order of herbaceous Exogens, inhabiting the cooler parts of the world. They are distinguished from *Cinchonaceæ* by their square stems and verticillate leaves without stipules. The *Rubia tinctoria* yields madder, and some of the other species produce a similar colouring substance. The torrefied grains of *Galium* are said to be a good substitute for coffee, and the flowers of *Galium verum* are used to curdle milk.

GALL. *See* Bile.

GALL BLA'DDER. An oblong membranous recep-

tacle attached to the under part of the liver. It retains the bile which regurgitates from the hepatic duct, and sends it through the cistic duct, which proceeds from its neck into the *ductus communis choledochus*, and thence into the duodenum.

GA'LLEON. Certain Spanish treasure ships with three or four decks, formerly employed in communicating with Peru.

GA'LLERY. In the Fine Arts, a term applied to a collection of works in painting or sculpture. The earliest gallery of which there is any record was that of Verres. It is described by Cicero, and was rich in pictures as well as sculpture. In Europe, at the present day, the gallery of the Louvre, though much reduced in 1815 by the restoration of many works of art which conquest had enabled the French to acquire, is the finest in Europe, if taken as a whole. That founded at Florence by Cosmo II. long enjoyed the first rank, but must be now considered secondary to the French collection. The other principal galleries of Europe are those at Munich, Dresden, Berlin, and, though last not least both in size and importance, that of the Vatican at Rome; which, however, is more generally called the Museum of the Vatican. The building for the reception of the National Gallery in London is wholly unworthy of the nation and of the fine situation which it occupies. The collection of pictures in this gallery is small, but some of them are of rare and unrivalled excellence. The gallery of antiques at the British Museum is, in many respects, matchless. The galleries of the Duke of Sutherland, Lord F. Egerton, Mr. Hope, and other private individuals, contain many very fine pictures.

GA'LLERY. In Fortification, a covered passage across the ditch of a fortified town. In Mining, *gallery* is a narrow passage from one part of the mine to another.

G'ALLEY. (Fr. galère.) A low-built vessel propelled by sails and oars, either on a single tier, or on tiers of benches one above the other. The war vessels of antiquity were all galleys. Among the Greeks those chiefly mentioned are the pentecontori, which appear to have had fifty oars disposed in a single tier; and the trieres (Lat. triremes), vessels with three banks of oars, concerning the disposition of which much controversy has taken place. It is commonly supposed that a trireme had three banks of oars one above the other; but this is rendered improbable by the circumstance of Pliny making mention of galleys having thirty, forty, and even fifty banks of oars, for it seems hardly credible that so many could have been arranged directly above each other. Some have suggested that the rows of oars in the trireme were disposed, not horizontally, but obliquely; in which case an increase in the number of banks of oars would augment the length, and probably the height would be increased in proportion. (See *Meibomius*, *De Fabrica veterum Triremium*.)

Galleys were likewise chiefly employed by the maritime nations of the middle ages in the Mediterranean. Their use in naval war hardly ceased until the end of the 17th century: and the Venetian republic, down to the period of its extinction, always maintained a number of war galleys. The Venetian galleys had a single tier only, and all modern galleys followed the same construction. These were formidable vessels in a calm, but unfit for a sea, and accordingly found chiefly in the Mediterranean. The Venetians had also a large high-pooped sort of galley called galeazza, whence the word galleass and galliott in old English writers.

The *Deal galley* is a long narrow boat used by the Deal boatmen, and managed on the most hazardous occasions in saving the crew of stranded vessels with consummate skill; it is also used by smugglers on account of its velocity. The *galley* is also the kitchen of a ship.

The punishment of the *galleys*, *i. e.* the employment of condemned criminals in the toilsome employment of rowing them, is said to have originated under the Greek empire; as well as the name Γαλεαροι, or galley slaves—in French galériens. It was used by all the nations bordering on the Mediterranean. In France, under the old jurisprudence, the punishment of the galleys was the severest after that of death. About the end of the reign of Louis XIV., when galleys themselves began to be disused, the galley slaves were employed in hospitals, public works, &c.; and the name of the punishment was changed by the constituent assembly (1798) to *travaux forcés*, compulsory labour, whence the word *forçat* for a criminal so condemned. Under the code of the empire the punishment was accompanied with forfeiture of property, infamy, and branding. By an alteration of the law effected in 1832, the brand was abolished; and the criminals, who had hitherto been intermingled in the three penal fortresses (Toulon, Rochefort, and Brest), were classified. Toulon is now appropriated to those condemned for 10 years and under; Brest, to those from 10 to 20; Rochefort, to the condemned for life. The name *Bagne*, which is applied in France to prisons in which those condemned to compulsory labour are confined, is derived from the famous Bagnio prison at Constantinople, so called on account of some baths situated there. The principal crimes now punished in this manner by the French law are — some acts of violence against the government or public law; coining and forgery; assaults followed by death on legal officers; murder, unless under such aggravated circumstances as are punished by death; cutting and maiming; rape, abduction, burglary, highway robbery, burning of insulated buildings, threatening letters, perjury, &c.

GA'LLI. The priests of Cybele were so named at Rome from the country (Galatia or Gallo-Græcia) in which Pessinus, the head quarters of her worship, was situated: also termed Curetes, Corybantes, and Idæi Dactyli. Cybele, the mother of the gods, was introduced to Rome from Asia on the occasion of a pestilence by the advice of the Sybilline oracles (*Liv.* 29. c. 14.), and her worship became in time one of the most popular in the city. Her priests were eunuchs, of which Lucretius (lib. ii.) gives the alleged reason. They are described as the vilest of mankind by the Roman satirists, yet they had extraordinary power over the vulgar. Juvenal describes them among the low companions of his debauched consul Damasippus: —

Et resupinati cessantia tympana Galli.

GA'LLIC ACID. An acid obtained from galls and several other vegetable astringents. Its ultimate components are 7 *car.* + 3 *h.* + 5 *o.*; its equivalent number is 85.

GA'LLICAN CHURCH. The distinctive title of the Roman Catholic church in France, which maintains a certain degree of independence in respect of the Romish see. The liberties of the Gallican church, first asserted in the Pragmatic Sanction (1438), were defined and confirmed in the Quatuor Propositiones Cleri Gallicani, promulgated in 1682. The occasion of this declaration was a dispute between Louis XIV. and Pope Innocent XI. concerning the right long practised by the French kings of occupying in their own persons the inferior preferments of a diocese which lapsed during the vacancy of the see. It was then determined by an assembly of the French clergy, that the pope has no temporal, but only spiritual rights, as the vicegerent of Christ; that even these are limited by canons and councils; and that the decrees of the holy see are subject to reversal upon the decision of the clergy in general. (See the *Declaration of the French Clergy concerning Ecclesiastical Power*, drawn up by the famous Bossuet, bishop of Meaux, in the assembly convoked by Louis XIV. in 1682.) While, however, it asserts this liberty in speculative points, the Gallican church does not differ from the Romish in any points of faith or ceremonial observances. It was upon the basis of these liberties that the concordat was founded by which the Catholic religion was re-established in France in 1801; and they continue to be maintained upon their original footing, now that the church is no longer connected with the state. It has always been the object of the Jesuits to bring the French church into more deferential submission to the Romish see; and at the present day the party among the clergy who desire this consummation is said to be on the increase. The controversy on this subject was carried on in the last century between the two classes called Cismontane and Tramontane divines. The new Gallican church of the Abbé Chatel, founded at Paris in 1831, seems not to have met with much success. The abbé styles himself primate of it. It denies the infallibility of the pope and of councils, rejects the celibacy of priests, leaves confession voluntary, and performs service in the mother tongue. In all these respects its doctrines approach those of the church of England. (See the *Profession de Foi de l'Eglise Catholique Française*, Par. 1831.)

GA'LLICISM. Literally, a phrase or construction peculiar to the French language, but used generally to denote such phrases or modes of speech in English as are formed after the French idiom.

GALLI'COLA. (Lat. galla, *a gall*, colo, *I inhabit.*) The name of a family of Pupiparous Hymenopterans, including those of which the larvæ inhabit the galls or vegetable excrescences caused by the perforation and oviposition of the parent insect.

GA'LLINA'CEANS, *Gallinacea.* (Lat. gallus, *a cock.*) *See* RASORES.

GALL-INSECTS, *Gall-insecta.* The name of a family of Hemipterans, comprehending those the females of which, towards the period of oviposition, assume a globular form, analogous to the galls caused by the *gallicoles.*

GA'LLINULE, or WATER-HEN. The type of the subgenus *Gallinula*, now dismembered from the *Fulica* of Linnæus, which term is restricted in modern systems of ornithology to the Coots proper.

GA'LLIOTT. A strong and cumbrous vessel used by the Dutch, having a main and mizen mast, which is often close aft.

GALL NUTS. Excrescences produced by the *cynips*, a small insect which deposits its eggs in the tender shoots of the *Quercus infectoria*, a species of oak abundant in Asia Minor. When the maggot is hatched it produces

a morbid excrescence of the surrounding parts, and ultimately eats its way out of the nidus thus formed. The best galls are imported from Aleppo and Smyrna; their principal ingredients are tan and gallic acid. The infusion of galls affords a dense white precipitate in solution of jelly, and a black precipitate with the persalts of iron. The latter property leads to the use of galls in the manufacture of ink and of black dye; they are also used as an astringent in medicine.

GALL OF GLASS. The salts and other impurities which float upon the fused materials for the manufacture of glass, and which is skimmed off. It is also called *sandiver*.

GA'LLON. An English measure of capacity. By act of parliament the imperial gallon is to contain 10 lbs. avoirdupois of distilled water, weighed at the temperature of 62° of Fahrenheit, and the barometer standing at 30 inches. This is equivalent to 277·274 cubic inches. The old English gallon, wine measure, contained 231 cubic inches; beer measure, 282 cubic inches. *See* MEASURES.

GA'LLOPER. In Artillery, the carriage on which the very small guns are conveyed.

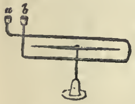
GALLS. Local affections or diseases of plants, caused by the puncture of insects. They are produced by an excessive deposition of cellular tissue, and are of no consequence to the general health of the individual subject to them.

GA'LL-STONES. Concretions occasionally found in the gall bladder and biliary ducts. They consist either of a peculiar fatty matter called *cholesterine*, or of inspissated bile, or of mixtures of the two. The gall-stones of the ox generally contain a peculiar yellow colouring matter, which is much valued by painters.

GA'LLY-WORM. *See* JULIDANS.

GA'LVANISM. (From Galvani, professor of anatomy at Bologna, the discoverer of some of the phenomena connected with this form of electricity in the year 1790.) Under this term are frequently included the phenomena of *Voltaic electricity* (which see). We shall here limit it to the apparent evolution of electricity by the contact of different metals: this is best observed by the muscular contractions which are produced in the leg of a frog recently killed, when two different metals, such as zinc and silver, tin and gold, &c., one of which touches the crural nerve, and the other the muscles, are brought into contact. Every time the metals touch each other the limb becomes powerfully convulsed; and if the experiment be made with a dead rabbit, so that one of the metals be in contact with the brain, and the other with the muscles of the extremities, the whole body of the animal is strangely agitated. Similar experiments have been made upon the bodies of criminals shortly after execution. These results, which have till lately been considered to depend upon the effects of electricity excited by the contact of the metals upon the nervous and muscular systems, led Volta to his celebrated researches, which terminated in the discovery of the *Voltaic battery*. Nearly all the cases, however, of the apparent production of electricity by contact have been satisfactorily traced by Faraday to chemical action. *See* VOLTAIC BATTERY.

GA'LVANO'METER. An instrument for ascertaining the presence of a current of electricity, especially Galvanic or Voltaic electricity, by the deviation which it occasions in the magnetic needle. The simplest form of galvanometer is a magnetic needle poised upon a point, and surrounded by one or more coils of copper wire covered with silk, the ends *a* and *b* being either left free, or terminating in two small copper cups containing mercury, for the convenience of communication with the source of electricity. When this needle is placed parallel to the coil, and in the magnetic meridian (as represented in the margin), it immediately deviates when the electric current passes through the coil; and the deviation is either to the east or the west, according to the direction of the current. *See* ELECTRO-MAGNETISM.



GA'MBA. A technical term in Mammalogy, applied by Illiger to the elongated metacarpus or metatarsus of the Ruminants and Solipeds.

GAMBO'GE. A yellow gum resin much used as a pigment, and in medicine as a drastic and nauseating purge. It is chiefly imported from Ceylon in cakes rolled up in flag leaves, and is the produce of the *Garcinia cambogia* and of the *Stalagmites cambogioides*.

GAME LAWS. The principal statutes relating to game, now in force, are the 7 & 8 Geo. 4. c. 29., the 9 Geo. 4. c. 69., and 1 & 2 W. 4. c. 32., by which last statute important changes have been made. By the common law, which followed the old forest law, as introduced into this country by the Normans, all game was the property of the king; no person whatsoever could enjoy the diversion of sporting, unless authorized by royal grant of a chase or free warren; and to kill a deer was deemed almost as heinous an act as to kill a man. But although at common law no persons could with impunity encroach upon the kingly prerogative of pursuing game, yet those were exposed to the additional pains and penalties of the statute law who committed this offence not being possessed of a certain rank or dignity, or of a certain amount of landed property. Strictly speaking, then, the superior condition in life of a party constituted the ground of his exemption from additional punishment, and not, as commonly supposed, a qualification to do that which was altogether interdicted, whether to the peer or the peasant. But the aggravated offence under the statutes, namely, that of sporting without rank or fortune, being in later times severely visited, while the original offence at common law was passed over, rank and fortune were, in the end, looked upon as a qualification; and a freehold estate of 100*l.* a year, or leasehold for 99 years of 150*l.* a year, or being the son and heir apparent of an esquire or person of superior degree, were accounted as so many qualifications. The statute law prohibited any persons whatsoever, whether qualified to kill game or not, from making it the subject of sale or merchandise.

By section 2. of the new act above mentioned, the word "game" shall include hares, pheasants, partridges, grouse, heath or moor game, black game, and bustards. The principal alterations in the law made by this act are, 1st, that all qualifications are now done away with, and that any person taking out a proper certificate may kill game on his own land, or that of another person with his leave; and 2dly, that every person having such a certificate may sell game to any person licensed to deal in it according to the act, who again is at liberty to retail it without restriction.

Most trespasses and offences relating to game are punishable upon summary conviction, before magistrates. The most serious of these offences is what is called night poaching. After two convictions before a magistrate for this offence it becomes a misdemeanor, to be proceeded against by indictment, and punishable by transportation for seven years, or imprisonment and hard labour. Night poaching committed by three or more persons in company together is a misdemeanor in the first instance, and punishable by transportation for fourteen years, or imprisonment and hard labour.

GAMES, have been resorted to in all ages, and among all nations, for the purposes of mental or physical exercise or amusement, according to their nature and peculiarities. The games of the ancient Greeks were, in their original institution, religious solemnities, founded, according to tradition, by gods and heroes, and continuing to be celebrated in their honour. They were the most important national assemblies, which brought the citizens of all the independent states of Greece in contact; and these festal communions (πανηγυρεις) served as the most popular bonds of social union among all who bore the Hellenic name. The four principal were, the Olympian, Pythian, Nemean, and Isthmian. (See those several articles. See *Wachsmuth's Historical Ant. of the Greeks*, chap. 1. part ii. s. 22.; *Hermann's Antiquities*, Oxf. trans., sec. 10. See also the treatise of Barbeyrac on the *Morality of Games*.)

GA'MING. In Law. All common gaming houses are nuisances in the consideration of English law. The first statute against public gaming is the 33 H. 8. c. 9. By 9 Ann. c. 54. securities given for the repayment of money lent for purposes of gaming are void; and any person losing and paying 10*l.* at one sitting may, within three months, recover the same, with costs, in any court of record. By 5 & 6 W. 4. c. 41. if any person make, draw, or execute any note, bill, or mortgage for a gaming debt, and actually pay to any indorsee, holder, or assignee of such note, bill, or mortgage, the sum thereby secured or any part thereof, such money shall be deemed to be paid on account of the person to whom such note, bill, or mortgage was originally given (upon the illegal consideration), and shall be deemed to be a debt due from such last-mentioned person to the person who shall so have paid such money, and shall be recoverable by action at law in any court of record. But though the English law has always been hostile to the practice of gaming, it has never been found sufficiently strong, or perhaps sufficiently willing, to suppress it. In London and in other large towns the existence of "Hells," as the places of resort for gaming are appropriately called, is notorious to all the world. In many of the Continental states gaming houses are licensed, and large revenues are in many instances derived from this source. It is only within the last two years that the French government abolished the practice of granting licences

Previously to that period the privilege of keeping gaming houses was farmed by a company, for which they paid the government 6,000,000 francs annually.

GA'MMARINES, *Gammarina*. (Gr. καμμαρον, *a lobster*.) The name of a family of Amphipodous Crustaceans, having the genus *Gammarus*, or the sand-hopper, as the type.

GA'MMONING. The rope by which the bowsprit is

bound firmly down to the cutwater, in which is a hole for the purpose of reefing several turns of it.

GA'MUT, or GAMMA UT. In Music, a scale whereon the musical notes are disposed in their several orders. Its invention is attributed to Guido Aretino, a monk of Tuscany; it is also called the harmonical hand, from Guido having made use of the figure of the hand to demonstrate the progression of his sounds.

GA'NGLION. (Gr. γαγγλιον, *a knot.*) An enlargement in the course of a nerve. A tumour in the sheath of a tendon.

GA'NGLIONEURA. (Gr. γαγγλιον, and νευρον, *a nerve.*) A name applied by Rudolphi to the Molluscous and Articulate divisions of the animal kingdom, which are characterized by a ganglionic type of the nervous system. In the articulated gangliated animals the ganglia are always disposed symmetrically along the middle line of the body, and brought into communication by a double chord: these have therefore been termed *Homogangliata.* In the Mollusca, on the contrary, the ganglions are dispersed, and placed at a distance from each other, and from the mesial plane, and are frequently unsymmetrical in their arrangement: these have therefore been termed *Heterogangliata.*

GA'NGRE'NE. (Gr. γρασειν, *to feed upon.*) The loss of vitality of a part of the body.

GA'NGWAY. The sea term for a narrow passage way; particularly that part of the upper deck which is next the ship's side, between the fore and main masts.

GA'NNET. *See* PELECANUS and SULA.

GAOL. (Fr. geole, Lat. caveola, *a cage.*) A prison. The present law as to building, repairing, and maintaining gaols and houses of correction, is regulated by the statutes 4 G. 4. c. 64., 5 G. 4. c. 12. and c. 85., and 2 & 3 Vict. c. 56. (1839), the latest act on the subject. No gaol can be erected under any less authority than that of an act of parliament. There must now be at least one common gaol and one house of correction in every county. Gaolers are appointed by the high sheriff; by 4 G. 4. they are allowed to exercise no other trade or office, and must reside within the prison. As to the discipline and management of gaols, see PRISON.

GAPE. In Ornithology, the opening between the mandibles of birds.

GA'RDANT, or GUARDANT. In Heraldry, a term applied to a beast when represented full-faced, as looking at the spectator. *Re-guardant,* when looking backwards.

GA'RDEN. (Fr. jardin.) A piece of ground, generally of limited extent, and attached to a house, and enclosed, in which are cultivated various vegetables, fruits, and flowers, for the use of man. In the infancy of civilized society, all these objects were cultivated in one enclosure; but as mankind advanced in civilization and refinement, and the number of objects to be cultivated increased, it became necessary to adopt separate departments; and culinary vegetables came to be cultivated in the kitchen garden, fruits in the orchard, flowers in the flower garden, ornamental trees and shrubs in the shrubbery or pleasure grounds, and timber trees in plantations, woods, and forests. Hence the word garden, in the extensive sense in which it is at present used, is no longer confined to a limited enclosure, but extends to an extensive area, in which are contained various scenes of utility, comfort, convenience, and luxury.

GA'RDENING. The art of cultivating a garden, which, as we have seen in the preceding article, comprehends a great variety of objects and scenes. All these at the present time are generally included under the following heads: — Horticulture, which comprehends the culture of culinary vegetables and fruits; floriculture, which includes the culture of ornamental and curious flowers, shrubs, and trees; arboriculture, which implies the culture of trees or shrubs used for various purposes in the arts and in general economy; and landscape gardening, or the general disposition of the scenery or landscape about a country residence. Horticulture includes the culture of the kitchen garden and orchard; floriculture, the culture of flower gardens, botanic gardens, shrubberies, and pleasure grounds; arboriculture, the culture of nurseries for fruit and forest trees and shrubs; and landscape gardening, the formation and management of lawns, roads, walks, lakes, ponds, and artificial rivers, of rock work, and of every description of objects in artificial scenery which come under the denomination of ornamental or picturesque. *See* HORTICULTURE, BOTANIC GARDEN, ARBORICULTURE, and LANDSCAPE-GARDENING.

GA'RGARISM. (Gr. γαργαριζειν, *to gargle.*) A wash for the throat.

GA'RNET. A mineral of which there are several varieties. The *precious garnet* is transparent, red, and in crystals or rounded grains; it is a silicate of alumina and iron, and is used for ornamental jewellery. *Common garnet* is often found in large crystals and masses, translucent, and of various colours.

GA'RNISHMENT. In Law, a warning or notice given to a party to appear in court or give information; a technical term, used only in one or two instances. Thus *garnishment* or warning is given to a third person, in whose hands money is attached within the liberties of the city of London by process out of the Sheriff's Court, who is termed a *garnishee.*

GA'RRISON. (Modern Lat. garnitio, *military stores, &c.*) A body of forces disposed in a fortress to defend it against the enemy, or to keep the inhabitants of the town where it is situated in subjection. The term *garrison* is sometimes used synonymously with *winter quarters,* viz. a place where a number of troops are laid up in the winter season without keeping the regular guard.

GARRO'TE, THE. A mode of capital punishment employed in Spain. The criminal is seated on a stool with his back to a stake. A tight collar is passed round his throat, of which the ends nearly meet; the executioner, standing behind him, twists them closer by means of a screw: the death is instantaneous.

GA'RTER, ORDER OF THE. The various accounts respecting the original foundation of this noble order are for the most part well known. The commonly received story, which attributes it to the dropping of the Countess of Salisbury's garter, is contradicted by many recent writers, who attribute its institution to Richard I., who tied thongs of leather as marks of distinction round the legs of several of his officers at the siege of Acre. In the opinion of Dr. Meyrick (*On Armour*, vol. ii. p. 54.), the garter is nothing more than a symbol of unity. The order was, however, either founded or restored by Edward III., and, according to general opinion, either in the year 1344 or 1350. The first of these dates was that of a festival in which the king formed himself and his associates into a company, under the patronage of St. George; but nothing is said respecting the garter until the latter year. The statutes of the Garter have been revived and augmented by King Henry V., Henry VIII., and George III. in 1805. It was generally called the order of St. George until the reign of Edward VI.; St. George of Cappadocia, the tutelar saint of England, being likewise patron of this order. It originally consisted of twenty-six knights, the king being the chief; and the same number is still retained, with the addition of princes of the blood royal as supernumeraries. In the beginning of the present century, it was estimated that eight emperors and twenty-eight foreign kings had been members of it. The number has been since much augmented. It is the most ancient of all the lay orders of chivalry, and may rightly be accounted the noblest in the world. The college of the order is held at the chapel of St. George, in the castle of Windsor. The vestments and ensigns of the order are, the mantle of blue velvet, changed to purple by Queen Elizabeth, but restored to the original colour by Charles I.; the surcoat, now of crimson velvet; the hood, which is now fixed to the mantle, a cap of black velvet with an aigrette of heron's feathers being worn on the head instead of it; the collar of gold, composed of twenty-six pieces made to resemble garters, with the badge of the order (the figure of St. George and the Dragon) pendent from it; and the garter, of blue velvet. The lesser George, as it is called, is attached to a blue ribbon, passing from the left shoulder to the right hip. The officers of the order are, the prelate (the bishop of Winchester for the time being); the chancellor (the bishop of Salisbury); the register (the dean of Windsor); garter king at arms (this officer combines two functions, being herald to the order of the garter, and also principal king at arms, the highest officer of the Herald's College under the earl marshal); and the usher or black rod. It has also a dean and twelve canons, &c., with twenty-six pensioners, or poor knights. The most authentic work on the order of the Garter is that of the learned antiquary Elias Ashmole, printed at London in 1715.

GAS. (Probably from the German *geist,* or spirit.) This term is applied to all permanently elastic fluids, or airs differing from atmospheric air.

GAS ILLUMINATION. Under the head CARBURETTED HYDROGEN, we have adverted to two gaseous compounds of carbon and hydrogen, which perform an important part in the economy of gas illumination. There are several other analogous compounds, which are produced in various relative proportions during the destructive distillation of pit coal, and which, therefore, are more or less concerned in the history of *coal-gas,* which, as far as gas illumination is concerned, may be defined as a mixture of two or more hydro-carburetted gases or vapours with small portions of other gaseous bodies, among which free hydrogen and carbonic oxide are the most common.

The application of the gases produced during the destructive distillation of pit coal to the purposes of illumination is a very modern invention. But the germ of it may be traced back exactly 100 years; for the first mention of the production of a permanently elastic and inflammable gas from coal occurs in the *Philosophical Transactions* for 1739, in which there is a paper by the Rev. Dr. Clayton describing a method of

filling bladders with what he calls the *spirit of coal*, obtained by distilling coal in a retort in the open fire. He says, "I filled a good many bladders therewith, and might have filled an inconceivable number more; for the spirit continued to rise for several hours, and filled the bladders almost as fast as a man could have blown them with his mouth, and yet the quantity of coals distilled was inconsiderable. I kept this spirit in the bladders a considerable time, and endeavoured several ways to condense it, but in vain; and when I had a mind to divert strangers or friends, I have frequently taken one of these bladders and pricked a hole therein with a pin, and compressing gently the bladder near the flame of a candle till it once took fire, it would then continue flaming till all the spirit was compressed out of the bladder; which was the more surprising, because no one could discern any difference in the appearance between these bladders and those which are filled with common air." Dr. Clayton seems also to have observed those curious phenomena which have lately excited so much attention under the terms *exosmose* and *endosmose;* for he goes on to say that he found "that this spirit must be kept in good thick bladders, as in those of an ox or the like; for if I filled calves' bladders therewith, it would lose its inflammability in twenty-four hours, though the bladders became not relaxed at all."

Dr. Hales (in his *Vegetable Statics*) and Dr. Watson (in his *Chemical Essays*) have each alluded to the properties of the gas from coal; but it was not until the end of the last century that the practicability of substituting coal gas for other inflammables, as a means of lighting streets and buildings, became an object of attention.

The idea of applying coal gas to economical purposes seems first to have occurred in 1792 to Mr. William Murdoch, then residing at Redruth, in Cornwall. His apparatus consisted of an iron retort, with tinned copper and iron tubes, through which the gas was conducted to a considerable distance; and there, as well as at intermediate points, was burned through apertures of varied forms and dimensions: he also washed the gas with water, and used other means for its purification. In 1798 Mr. Murdoch constructed a larger and improved apparatus for the purpose of lighting Boulton and Watt's celebrated manufactory at Soho, near Birmingham, which, on the occasion of the peace in 1802, was publicly illuminated by the same means. (See *An Account of the Application of Gas from Coal to Economical Purposes*, by Mr. W. Murdoch, *Phil. Trans.* 1808, p. 124.)

But the attention of the public in London was first called to this important subject by the experiments of Mr. Winsor, who, in 1803 and 1804, lighted the Lyceum theatre, and shortly afterwards one side of Pall Mall, with gas from coal. From that period, the manufacture of gas suggested itself as a lucrative speculation; several private gas works were erected, and companies were formed for the purpose of carrying it on upon an extended scale. Oil lamps were soon after banished from all the great thoroughfares of the metropolis; and in the course of from ten to fifteen years not only was every street and alley illuminated from the same source, but it was generally introduced into shops and houses; was adopted in the theatres and other public buildings; was carried into the suburbs; and has now become general in every town and city of the empire.

When coal is subjected to what chemists term *destructive distillation*, that is, when it is heated red-hot in close vessels, it yields a great variety of complicated products, which, as far as our present subject is concerned, may be classed under three heads: namely, first, permanent gases; secondly, vapours, which are condensable into the liquid or solid state by cooling; and, thirdly, the fixed or residuary matter, which remains in the retort. The object of gas manufacture is to separate these from each other, and so to purify the gaseous products as to render them fit for combustion.

The apparatus employed for this purpose consists, first, of the *retorts*, as they are called, or cast-iron cylinders, in which the coal is subjected to heat; secondly, the apparatus for condensing the solid and liquid products; thirdly, the purifiers, by which the gas is cleansed from various matters which would be prejudicial if retained; and, fourthly, the gasometers, in which the purified gas is ultimately received, and which are connected with the service pipes for its distribution. The following is a brief description of these several parts: —

The retorts are usually about 7 feet 6 inches long and 1 foot in diameter, and in the shape of an arched cylinder; from five to eight of them are set in brickwork, so as to be heated red-hot by one fire. Each retort has what is called a mouth-piece, which projects from the front of the brickwork, and from which there rises an upright pipe, about 12 feet high and 3 or 4 inches in diameter, and which carries the products of distillation into the hydraulic main. Each retort has a cover, which is kept in its place by holdfast screws, and rendered air-tight by lime luting. The hydraulic main is a long horizontal pipe, 12 or 14 inches in diameter, and into which the dip pipe of each retort dips, so as to be sealed by the fluid which fills the lower half of the main, and which is allowed to run off at that level. This fluid is of a very complicated nature; but tar and ammoniacal liquor are the terms applied to its chief component parts; and these, being condensed in the hydraulic main, serve to seal the ends of the dip pipes, and are constantly running off into what is termed the tar vessel. Those products of the distillation of the coal which are not thus in the first instance condensed are conveyed, by a pipe continued from the hydraulic main, through a series of tubes or other contrivances, so as to expose a large and cold surface. This part of the apparatus is called the *condenser;* in it the more volatile vapours are brought to the liquid state, and are collected in an appropriate receiver. The uncondensed gases then pass on to the *purifiers*, which are vessels so constructed as to expose them to the action of a very large surface of lime and water, or of slaked lime, by which carbonic acid and sulphuretted hydrogen are abstracted; and thence the gas, now purified, passes into the *gasometers*, where it is stored up for use.

It would be impossible within the limits of this article, and indeed irrelevant to the object of this Dictionary, to enter into minute details respecting the structure, uses, and arrangement of each of the above parts of the apparatus for the production of coal gas; but the reader may be enabled to form some idea of the importance and extent of the whole manufacture from the following outline of results.

There are, in the largest gas manufactories of London, from 500 to 600 retorts, each of which is charged four times a day with 2 bushels of coal. They are ranged in rows on either side of the retort house, and the flues from their respective furnaces are generally so arranged as to meet in one central chimney; but as coke is the usual fuel used for heating the retorts, there is commonly little or no smoke. Each chaldron of coals submitted to distillation yields on an average 24 gallons of tar, ammoniacal liquor, and other condensable products, and 12,000 cubic feet of purified gas; while there remains in the retorts a chaldron and a quarter of coke. To purify those 12,000 cubic feet of gas there is required about one bushel of lime, which, after its removal from the purifying vessels, is used for making mortar, luting the retorts, and other similar purposes; while the fetid liquor which runs from it is transferred to the ashpits of the furnaces, where it is consumed by evaporation, its vapour passing through the fire, and tending materially to preserve the bars of the furnaces by keeping them cool.

In a well-conducted gas establishment two men are required for the management of sixteen retorts, which are charged four times in the 24 hours; the retorts are kept in constant work throughout the 24 hours, so that relays of men are required for the night-work. In small gas works the agitators of the purifiers are worked by hand; but in the larger establishments there are usually one or more steam engines on the premises for this purpose, and for pumping water, lifting coals, and other heavy work.

The number and dimensions of the gasometers will of course vary with the circumstances, space, and extent of the manufacture: in the works of the Chartered Gas Company, at their station at Westminster, there are twenty-one gasometers, each containing on the average 30,000 cubic feet.

There are, besides those parts of the apparatus above adverted to, and which are essential to the manufacture, several other ingenious and beautiful contrivances in our larger gas works, which may be considered as auxiliaries. One of these is the station meter; a large instrument through which the whole of the gas passes in its way to the gasometers, and by which its volume is registered, so that the quantity made during any given time can be immediately ascertained, and the weekly, monthly, or annual production accurately determined. The gas meter was invented by Mr. Clegg, formerly engineer to the Chartered Gas Company. It consists of a hollow cylinder, which is made to revolve upon its axis by the ingress and egress of gas into and from the three compartments into which it is divided, the cylinder being partly immersed in water; and by a train of wheel work connected with it the number of its revolutions in a given time is registered, and the number of cubic feet of gas which traverse it in a minute, hour, day, or year, shown upon separate dials. The invention of this instrument forms an important epoch in the history of gas manufacture; for it is now constructed upon any scale, and is applicable to any case of the consumption of gas; so that by having a meter in each house of a size appropriate to the number of burners employed, the companies are enabled to sell their gas by measure, and have an unerring check upon the quantity which each instrument consumes.

Another beautiful contrivance, adopted in most of our gas works, is that by which the pressure upon the gas in the main and service pipes is adjusted; so that when a

number of burners are suddenly extinguished, or suddenly lighted, in any part of the district which is supplied, there shall be an intimation of the change at the works, so as to prevent either excess or deficiency of supply; or, in other words, to prevent the lights which remain from flaring up on the one hand, or being nearly or quite extinguished on the other. This is effected by a small and nicely adjusted gasometer connected with the service main, and which, by its rising and falling with diminished or increased pressure of the gas within the main, points out the necessity of opening or shutting the valve by which the gas is admitted from the gasometers to a greater or less extent. This small regulating gasometer has a vertical rod connected with it, which carries a pencil made to bear upon a paper cylinder properly ruled and divided, and which is made to rotate upon its axis by communication with a timepiece; so that every change of pressure which takes place during the night, for instance, is shown by the aberration of the line. Mr. Crossley, to whom the improvement of the gas-meter, by which it is rendered universally applicable, is due, is also the inventor of these pressure registers.

The following particulars may serve to give an idea of the quantity of gas annually consumed in London, of the quantity of coal required for its production, and of the general economy of this mode of illumination. It must also be borne in mind that gas is an article of increasing consumption; and that in proportion as attention is paid to its manufacture, and more especially to the *fittings* as they are called — that is, to the pipes, cocks, burners, and other arrangements required for its use and distribution in houses — it will become more generally adopted in private dwellings, so as, in all probability, to supersede ere long all other sources of artificial light. Nor are the attempts which have been made to employ it as a source of *heat* unimportant. Gas stoves, although hitherto made upon very erroneous principles, are not without their advantages; and it has been promisingly applied to some of the operations of cooking.

The oldest of the London gas works is the establishment belonging to the Original Chartered Company. They have three stations: the largest situated in Peter Street, Westminster; the second in Brick Lane, St. Luke's; and the third in the Curtain Road, Shoreditch. This company consumes 50,000 chaldron of coals annually, the produce of which, in gas, may be estimated at about six hundred million cubic feet, or about eighteen million seven hundred and fifty thousand pounds *weight* of gas. It may be assumed that each chaldron of coals weighs 2880 lbs., and yields an average produce of 12,000 cubic feet of purified gas. The prime cost of gas is about four or five shillings per 1000 cubic feet; the usual retail price is from seven to ten shillings per 1000 cubic feet.

The Chartered Company probably supply about a fifth part of the whole of the gas consumed in London and the suburbs; so that the total annual consumption of coal employed for this important manufacture in the London district only probably exceeds two hundred and fifty thousand chaldrons, and the quantity of gas produced for the supply of this district amounts annually to three thousand million cubic feet. The *weight* of this quantity of gas exceeds 75 millions of pounds; and the *light* produced by its combustion may be considered as equivalent to that which would be obtained by the combustion of 160 millions of pounds of mould candles of six to the pound.

The operations of the London Gas Light Company, which was established in the year 1833, are also on a scale of great magnitude. This company was called into existence by the dissatisfaction which existed among gas consumers at the defective supply, both in quantity and quality, previously afforded. Their works, situated at Vauxhall, are not only the most powerful, but the most complete in arrangement of any in the world. From this point their mains ramify to a prodigious extent in Middlesex as well as Surry; and by the admirable mode in which they are laid, aided by the power of their works, they are enabled to supply gas at Highgate Hill (seven miles off), with the same precision and in the same abundance as at Vauxhall. The extent of their pipes exceeds one hundred and fifty miles.

The cost of light equivalent to that of seven mould candles (six to the pound) is, in coal gas, $\frac{3}{4}$*d.* per hour; in an Argand oil lamp, 3*d.* per hour; in mould candles, $3\frac{1}{2}$*d.* per hour; in wax candles, 1*s.* 2*d.* per hour.

GA'SKET. A platted cord, by which the sails, when furled, are kept bound up close to the yards or gaffs. The same term is applied to the platted hemp used for packing the piston of the steam engine and its pumps.

GA'STEROPODS, *Gasteropoda.* (Gr. γαστηρ, *the belly*, and πους, *a foot.*) The name of a class of Molluscous animals, comprehending those which have a ventral muscular disc of greater or less extent, adapted for creeping. The class is divided, according to the modifications of the breathing organs, into the orders *Pulmonata, Nudibranchia, Inferobranchia, Tectibranchia, Pectinibranchia, Tubulibranchia, Scutibranchia,* and *Cyclobranchia.* The carinaria, in which the ventral foot is reduced to a rudimental compressed plate, forms the type of an aberrant group or order, called *Heteropoda.* The pulmonated snail or slug may be regarded as types of the Gasteropodous Mollusks.

GASTRÆ'UM. (Gr. γαστηρ.) A term in Zoology, applied to the whole of the prone or under surface of an animal's body.

GA'STRIC JUICE. The peculiar fluid secreted by the stomach, and essential to the process of *digestion.* When collected from the stomach of an animal killed while fasting, it is transparent and saline, but during digestion it is distinctly acid; and Dr. Prout found that the free acid which it contains is the *muriatic.* One of the most characteristic properties of the gastric juice is its solvent power over the varieties of animal fibre, or albumen, and the facility with which it coagulates milk, and then dissolves the coagulum. *See* DIGESTION.

GASTRI'LOQUUS. *See* VENTRILOQUIST.

GASTRI'TIS. Inflammation of the stomach. It is attended by great irritability of the stomach, indicated by hiccup, vomiting, and much pain and general uneasiness: the pulse is small and hard, and there is fever, attended by prostration of strength. It is a very dangerous disease, and requires prompt treatment; especially bleeding, general and local; blisters; hot bath, or fomentation. The constant sickness generally prevents the exhibition of any of the ordinary remedies. When it arises from poison, the stomach pump and other distinct treatment is often requisite.

GASTROCHÆ'NA. (Gr. γαστηρ, and χαινω, *I gape.*) A genus of Bivalve Mollusks, in which a large hiatus or gape intervenes between the closed valves on the ventral aspect of the animal. The mantle is perforated, opposite to this gape, by a small aperture for the passage of the foot; and is prolonged posteriorly into two muscular tubes or siphons. The Gastrochenes inhabit burrows, which they perforate in the substance of madrepores or calcareous rocks, and they line their perforations with a calcareous tube.

GA'STROCNE'MIUS. (Gr. γαστηρ, and κνημη, *the leg.*) The muscle which forms the protuberant part of the leg: the calf.

GA'STRODYNIA. (Gr. γαστηρ, and οδυνη, *pain.*) A painful affection of the stomach, often attendant upon dyspepsia.

GA'STROMANCY. (Gr. γαστηρ, and μαντεια, *prophecy.*) A kind of divination practised among the ancients by means of words issuing or seeming to issue from the belly. This term is applied also to a species of divination performed by means of glasses or other round transparent vessels, in the centre of which certain figures appear by magic art.

GAUGE, or GAGE. *See* GAGE.

GAUGE-POINT, is a term used in Gauging to denote the diameter of a cylinder whose altitude is one inch, and its content equal to that of a unit of a given measure. For example, the old wine gallon contained 231 cubic inches. The diameter of a cylinder of the same capacity, and whose altitude is one inch, is 17·15 inches; which, therefore, is the gauge-point for this measure.

GA'UGING, in Mensuration, is the measuring of the capacities of vessels, chiefly casks, barrels, vats, &c., and determining the contents of the substances contained in them. The principles of gauging are those which geometry furnishes for the measurement of solids in general; but as the contents of vessels of the kind now mentioned are so frequently required to be known, at least approximately, for the purposes of commerce and the collection of the revenue, a set of technical rules and appropriate instruments have been contrived, by the help of which the art can be, and generally is, practised mechanically by those who are utterly ignorant of the principles on which it depends. The instrument generally used for the purpose is the *gauging-rod*, or *diagonal-rod*, by which the contents of a cask are inferred from its diagonal length, measured from the bung to the extremity of the opposite stave at the head. On one face of a square rule, generally about four feet long, is a scale of inches for taking the measure of the diagonal; and on the opposite face is a scale expressing the corresponding contents of the cask in gallons. It is obvious that this method of proceeding can only give approximate results, on the supposition that all casks are similar solids. (See *Symon's Practical Gauger; Leadbetter's Treatise on Gauging; Hutton's Mensuration*, &c.)

GAUGING RULE. *See* SLIDING RULE.

GAULT. A provincial name in the east of England for a series of beds of clay and marl, the geological position of which is between the lower and upper greensand.

GAU'NTLET, RUNNING THE. A barbarous punishment of former times, by which the criminal was obliged to pass between the seamen arranged in two rows, and provided with knotted cords, with which they flogged him.

GAUZE. A textile fabric generally made of silk, and said to have been invented in Gaza, a city of Palestine.

GA'VELKIND. An old English custom or tenure annexed to all lands in the county of Kent not especially exempted, by which the land of the father is equally divided at his death among all his sons, or the land of the brother among all his brethren if he have no issue of his own. Tenure in gavelkind is considered by Blackstone to have been in the nature of free socage. In most places the gavelkind tenant had the power of devising by will before the Statute of Wills. The same custom seems to have been prevalent in Wales, where all gavelkind lands were made descendible to the heir at common law by stat. 34 & 35 H. 8. c. 36. In Kent the lands have been for the most part disgavelled, or deprived of their customary descendible quality, by particular statutes; but lands in Kent are presumed to be gavelkind, unless the contrary be shown.

GA'VIAL. *See* CROCODILE.

GA'VOT. (Fr. gavotte.) In Music, an air for a dance, which has two strains; the first having usually four or eight bars, and the second eight or twelve more, each of which are played twice over. It is of a brisk nature.

GAZE'LLE. The name of a small, swift, and elegantly formed species of antelope, the *Antelope dorcas* of Linnæus; long famed for the peculiar lustre and soft expression of its large dark eyes.

GAZE'TTE. A periodical paper, published at short intervals, containing articles of general intelligence. Both on the Continent and in England such sheets were generally termed *Mercuries* in the first times of their invention, and appeared only occasionally; the earliest among ourselves were published during the general apprehension from the presence of the Spanish armada; but some doubt has been lately thrown on the authenticity of the specimens preserved in the British Museum. The first gazette produced in France (under that title) was in 1631: the first in England in 1665, when the court resided at Oxford on account of the plague of London. From that period the Gazette has regularly appeared twice a week, containing such notifications as are either published by the court or the government, or such as are authoritatively required by law in private transactions. The name Gazette is said to be derived from Gazzeta, a small Venetian coin, being the price that was paid for one of the flying sheets of commercial and military information (notizie scritte), which were first published by that republic in 1563. *See* NEWSPAPER.

GAZETTEE'R, is applied in England to a work containing a brief account of all or any of the countries of the world, arranged in alphabetical order. To this class belong *Brookes's General Gazetteer*, and similar works.

GA'ZONS, in Fortification, are the turfs, or pieces of earth covered with grass, with which the faces of works raised of earth are lined in order to keep them up and preserve their form.

GECKO'TII. A family of lizards, having for its type the genus *Gecko*; in which most of the species present a curious organization of the foot, by which the sole is converted into a sucker, enabling the animal to creep up vertical walls and along ceilings against gravity, like the flies upon which they feed.

GEHE'NNA. A term in Scripture, adopted from the usage of the Jews to signify hell or the place of eternal punishment. The word is a slight corruption of Gehinnou, or the Valley of Hinnom, in the neighbourhood of Jerusalem, wherein, at a place named Tophet, it was recorded that certain idolatrous Jews had sacrificed to Moloch. The sewers of the city were emptied into this hollow, and perpetual fires were kept up to consume the noxious matter, and prevent pestilential effluvia. Hence, it is said, the name of the place came to be used metaphorically in the sense above described. From this word seems to be derived the old French gehenne, *torture*; and from thence the common word gêne, *constraint*.

GE'HLENITE. A mineral in small grey or yellow crystals, found in the valley of Fassa in the Tyrol, named in honour of Gehlen the chemist. It is a ferrosilicate of alumina and lime.

GE'LATIN. (Lat. gelu, *ice*.) An abundant proximate principle in animals. It is confined to the solid parts of the body, such as tendons, ligaments, cartilages, and bones, and exists nearly pure in the skin; but it is not contained in any healthy animal fluid. Its leading character is the formation of a tremulous jelly, when its solution in boiling water cools; and it may be repeatedly liquified, and again gelatinized, by the alternate application of heat and cold. Isinglass, glue, and size are various forms of gelatine, the first being this substance in a very pure state. Its most distinctive chemical character is the formation of a dense white precipitate when its solution in warm water is poured into an infusion of galls or other form of vegetable tannin. A solution of one part of gelatin in 5000 of water is rendered slightly turbid by the addition of a strong tincture of galls. Gelatin is a nutritious article of food. The ultimate components of gelatin are 47·8 carbon, 7·9 hydrogen, 16·9 nitrogen, 27·4 oxygen.

GE'LATINES. Mr. Kirby thus renders the term *Radiaires molasses* of Lamarck, by which are designated the same radiated animals as those called *Acalephes* by Cuvier: the bodies of these Radiaries are generally of a gelatinous consistency.

GELD (Ger. *money*), in the Laws of the Saxon and other Teutonic communities, is used in the sense of any fine, rent, or payment: for instance, the fine paid as compensation for an injury, as in the compound *weregild*; the compensation for murder, *dannegild*, &c.

GEM. (Lat. gemma.) In Sculpture, a precious stone, used for the purpose of sculpture. The practice of carving gems is of remote antiquity, though it is doubtful whether they were able to cut the diamond or use the emerald and topaz for sculptural purposes. The stones usually selected are rock crystal of different colours, jasper, chalcedony, onyx, cornelian, and blood stone. Among the Greeks the art was carried to great perfection; but having fallen with the other arts into disuse, its revival was effected in Italy in the 15th century, and modern masters have more than rivalled some of the ancient productions.

GE'MINI. (Lat. *the Twins*.) The third constellation of the zodiac, into which the sun enters about the 21st of May in each year. The Twins are named from Castor and Pollux; sometimes, also, from Apollo and Hercules. The constellation is easily distinguished by means of two conspicuous stars of the second magnitude near together; Castor being that which is furthest to the west, and Pollux that which is furthest to the east.

GEMMI'PARES, *Gemmipara*. (Lat. gemma, *a bud*, and pario, *I produce*.) The animals which propagate by buds, as the *hydra*, or fresh-water polype, &c.

GEMS, ARTIFICIAL. These are made of a very fusible, transparent, and dense glass, or *paste*, as it is called, containing a large proportion of oxide of lead, and generally some borax: the colours are given by metallic oxides. Much of their perfection depends upon the skill with which the exact tint of the real stone is imitated, and upon the care with which they are cut and polished.

GE'NA. (Lat. gena, *the cheek*.) A term applied in Zoology to the region between the eye and the mouth, generally extended over the zygomatic arch.

GENDA'RMES, or GENS D'ARMES. In the 15th and 16th centuries, the heavy French cavalry, which constituted the only national force, were termed Gendarmes, or men-at-arms. Each lancer had four, five, or six followers on horseback, attached to him in various capacities; so that a *lance*, in the language of historians of that epoch, comprehends six or seven men. After the cuirass and lance had become obsolete, the name of gendarmes ceased to be thus applied. It was afterwards transferred to a corps of police. In consequence of the unpopularity of this corps in Paris, the gens d'armes were abolished after the revolution of 1830, and a new police force organized under the title of Municipal Guard. (See the *Ency. des Gens du Monde*.) In all the German states, there is a body of mounted military police, with this appellation, of which the Germ. equivalent, is "Landdragoner."

GE'NDER. (Lat. genus.) In Grammar, the designation of sex by the form of a word. (See an elaborate article in the *Penny Cyclopædia*.)

GENEA'LOGY. (Gr. γενεα, *family*, and λόγος, *description*.) The pedigree of each family. A series of several persons, descended from a common progenitor, is called a line. A direct line is either ascending (father, grandfather, &c.: in the civil law particular names were given to seven degrees in this line), or descending (son, grandson, &c.). The collateral lines comprehend the several lines which unite in a common progenitor; and are either equal or unequal, according as the number of degrees in the lines is the same or different. The collateral relations on the father's side are termed in the civil law cognati, on the mother's agnati.

GE'NERAL, in the Army, is, next to field marshal, the highest military title adopted by the European states. Like most military designations, it owes its origin to the French, who, about the middle of the 15th century, conferred the title of lieutenant-general on the individual to whom the monarch (by virtue of his birth the commander or general of the national forces) entrusted the superintendence of the army. The title of general is conferred either on the commander-in-chief of the forces of a nation, or on the commander of an army or grand division; it is also given to the officers next in rank to the general, who, besides performing functions peculiar to their own offices, frequently act as the substitutes of their superior, with the designation of lieutenant-general and major-general.

GE'NERAL ASSE'MBLY OF THE CHURCH OF SCOTLAND. *See* ASSEMBLY, PRESBYTERIANS.

GENERALI'SSIMO. A title conferred, especially by the French, on the commander-in-chief of an army consisting of two or more grand divisions, each under the superintendence of a general. According to Balzac, this dignity was first assumed by Cardinal Richelieu on the occasion of his leading the French army into Italy; but

the term does not appear to have found favour among the other European states.

GENERA'LITY. A French territorial division under the government prior to the Revolution. The generalities amounted in all to 34. This division was principally with reference to the collection of taxes.

GENERALIZA'TION, in Logic, has been defined as the act of comprehending under a common name several objects agreeing in some point which we abstract from each of them, and which that common term serves to indicate. (*Whateley's Logic*, p. 388.)

GENERA'TION, or GE'NESIS, in Geometry, denotes the formation or production of a geometrical figure or quantity. A line is said to be *generated* by the motion of a point, a surface by the motion of a line, and a solid by that of a surface. A sphere or spheroid is generated by the revolution of a semicircle, or semi-ellipse, about its diameter; and a circle by the revolution of its radius about one of its extremities. The figure thus produced, or generated, is called the *generant;* and it is a general property of every such figure that its area or content is equal to the product which arises from multiplying the generating quantity into the length of the path described by its centre of gravity. All quantities may be considered as generated by motion; and hence arose the terms *fluxion* and *fluent* in the infinitesimal analysis.

GE'NESIS, BOOK OF. *See* PENTATEUCH.

GENE'THLIAC. (Gr. γενεθλιάζειν; from γένεθλον, *a birth.*) An ode or other short poem composed in honour of the birth of an individual.

GENE'VA. *See* GIN.

GE'NIA. (Gr. γενειον, *the chin.*) Terms in Anatomy compounded of this word, and applied to muscles attached to the chin.

GENI'CULATE. (Lat. genu, *the knee.*) Bending abruptly in an obtuse angle, like the knee when a little bent.

GE'NII, called by the Eastern nations Genn or Gien, are a race of beings created from fire, occupying an intermediate place between man and angels, and endowed with a corporeal form, which they are capable of metamorphosing at pleasure. They are said to have inhabited this earth many ages before the creation of man, and to have been at last driven thence for rebellious conduct against Allah. Their present place of abode is *Ginnistan*, the Persian Elysium; but they are represented as still interesting themselves deeply in the affairs of this earth, over which they exercise considerable influence. Every one is aware of the important part which the genii perform in the interesting stories of the East; and indeed a more correct idea may be formed of their origin, characteristics, and history, from a perusal of the *Arabian Nights' Entertainments*, than can be conveyed by the most elaborate dissertation. For an account of the superstitions of the modern Arabs in regard to genii, see *Lane's Modern Egyptians.*

GE'NITIVE CASE. (Lat. genitivus, *generative.*) That inflexion of the noun which denotes the relation of property. *See* GRAMMAR.

GE'NIUS. (Lat. gigno, *I produce.*) According to the belief of the old Italian races, especially the Etruscans, the genius was a spiritual agency of very indeterminate character, which seems to have been appropriated not only to every human family and individual as a companion, but to every god, and even to places and things. This conception was altogether foreign to Grecian mythology, although in later times it became mingled in that of Rome with the Grecian notions respecting demons. (*See* DÆMON.) As, for instance, in the idea of a double genius, good and bad. Censorinus (*De Die Natali*) says, " The genius is that god under whose protection every mortal is born and lives." Hence the worship of the genius was closely connected with all domestic ceremonies and feelings: the marriage bed was *lectus genialis;* the day of the genius, *genialis dies*, sacred to mirth and relaxation; the genius accompanied human fortunes in their vicissitudes (Vultu mutabilis, albus et ater — *Hor.*); and death was typified by the figure of a genius with a lamp reversed. The genii of places were usually represented and worshipped under the figure of snakes. Whether there is any connection between the Italic genius and the djinn of oriental nations (*see* GENII) is a doubtful point.

GENS. In Ancient History, a clan or sect, forming a subdivision of the Roman people next in order to the curia or tribe. The members and houses (*familiæ*) composing one of these clans were not necessarily united by ties of blood, but were originally brought together by a political distribution of the citizens, and bound by religious rites, and a common name, derived probably from some ancient hero. This common name, which distinguished the *gentiles* or members of the same clan, was the second of the three borne by a Roman citizen, and was specially termed the *nomen*. It is supposed that each of the *curies* originally contained ten *gentes*, and that each of these was represented in the senate by one of its members. (See *Vico, Scienza Nuova; Niebuhr's History of Rome*, 2d ed. p. 387.)

GE'NTIAN. In Pharmacy, the root of the *Gentiana lutea*, a plant abundant in the Swiss and Austrian Alps, and in the mountainous parts of Germany. An infusion or tincture of gentian root is an excellent stomachic bitter.

GE'NTIANA'CEÆ. (Gentiana, one of the genera.) A natural order of herbaceous Exogens, inhabiting most parts of the world. They are very near to *Apocynaceæ*, from which they differ in their herbaceous habit, permanent corolla, want of milk, and in many other characters. From *Scrophulariaceæ* they are distinguished by their regular flowers, the stamens of which are equal in number to the lobes of the corolla; but they are with difficulty distinguished if the flowers are absent. Lastly, they have a natural relation to *Cinchonaceæ*, inasmuch as the genera *Mitreola* and *Houstonia* have both been mistaken by good botanists for Cinchonaceous plants. Their chief characteristic sensible property is an intense bitterness, which resides both in the stems and roots, rendering them tonic, stomachic, and febrifugal; on which account the roots of *Gentiana lutea* and others are admitted into all pharmacopœias. Many of the species are beautiful in the hands of the cultivator. The prevailing colours are red and blue.

GE'NTILE. (Lat. gens, *nation.*) The original meaning of the Latin word *gentilis* is, one of the *same* kith or nation with the speaker. In a later age of Latinity, individuals of foreign or barbarous races were called Gentiles. (*Auson;* and *Cod. Theodos.*) The Jews designated all not professing their religion indiscriminately as " the nations," τα ἔθνη (N.T.); and hence the Greek word ἐθνικος (whence our heathen and the corresponding Latin word gentile) became used to signify Pagans, in opposition to Christians and Jews. The word *gentilis* is used in this sense by St. Jerome, Prudentius, and Christian writers of that age in general. The jealousy with which the Jews regarded all foreign nations, and the bigotted obstinacy with which they clung to their notions of their own peculiar sanctity and favour in the sight of God, are well known. The earlier half of the history of the Acts contains the account of the struggle which Christianity maintained against these prejudices before it finally subdued them, even in the breasts of the Apostles and first teachers themselves. The design of Christ that all nations should be admitted to the benefits of his mission, is clearly shown in many of his own words and actions; but, upon his crucifixion, his followers appear in the first instance to have shrunk from carrying out this great principle. Their preaching is confined for some time to Jerusalem; and there, it is to be remarked, they are treated with no severity, and obtain considerable success. But upon the appointment of the deacons, who appear to be Hellenists — much more lax in their Judaical notions and prejudices than the Jews of Palestine, — and upon the preaching of Stephen, which was probably the first bold declaration of the equality of the Gentile with the Jew, the anger of the people is immediately roused; the flame of persecution breaks suddenly forth; the disciples are driven from Jerusalem, and scattered abroad in places where they are brought more in contact with foreigners; and the vision which is vouchsafed to Peter recognizes distinctly the claim of the Gentiles to the benefits of the Gospel. The observance of certain Jewish ceremonies continued, however, for a long time to be a stumbling-block to the most devout and sincere Christians. St. Paul combats the notion of the necessity of submitting to some of these, — especially circumcision; yet even he feels obliged to make some indulgence to the prejudices of the Judaizing party. In after times this party occupied one distinct division of the Christian world, split itself into various sects, such as the Ebionites and Nicolaitans, and for a long time exercised considerable influence even within the pale of the church.

GE'NTLEMAN. (The English word *gentle*, in its original sense, signifies one belonging to a *race* or *family;* Lat. gens.) In Heraldry, a rank expressed in Latin by the term generosus. All entitled to coat-armour are gentlemen; but the name is more commonly applied to the lowest rank of those who have no other distinguishing title. Gentlemen by blood were those who could show four generations of gentlemen, both in the paternal and maternal line. Those who could not prove this, but against whom the contrary was not known within memory of man, were gentlemen by prescription. Gentlemen were also created by letters patent of the king. Officers (not menial) of the king's household, persons holding a royal commission, civil or military, persons who had taken a degree in the liberal arts, and persons adopted by gentlemen, were considered entitled to this rank, which has now been long obsolete as a distinction.

GENTLEMEN PENSIONERS. In England, a band of forty gentlemen, entitled esquires, whose office is to attend the king's person to and from the Chapel-Royal, and on other occasions of solemnity. They were instituted by Henry VIII.

GE'NTLES. The maggots or apodal larvæ of the flesh fly (*Musca carnaria*), and other Diptera, are sometimes so called.

GE′NUS. (Lat.) In Zoology, that distinct but subordinate group of animals which gives its name as a prefix to that of all the species of which it is composed.

GENUS. In Logic, one of the predicables, which is considered as the material part of the *species* of which it is affirmed. *See* LOGIC, PREDICABLE.

GENUS. In Music, the general name for any scale of music. If a scale proceed by tones, it is called the *diatonic* genus; if between the tones semitones are introduced, it is called the *chromatic* genus. When the subdivisions are smaller, as quarter tones, it is called the *enharmonic* genus.

GE′OCE′NTRIC. (Gr. γη, *earth*, and κεντρον, *centre.*) A term frequently used in Astronomy, signifying literally *having the earth for its centre.* The apparent motion of any planet, as seen from the earth, is called its *geocentric motion.* The *geocentric latitude* of a planet is the angle formed by a straight line, supposed to be drawn from the planet to the earth, with the plane of the earth's orbit or the plane of the ecliptic. *Geocentric longitude* of a planet is the angle at the earth formed by two straight lines, one of which is drawn to the first point of Aries, and the other to that point of the ecliptic which is intersected by a perpendicular circle, the plane of which passes through the earth and planet. *Geocentric* is opposed to *heliocentric*, which refers to the centre of the sun. These terms are only used in speaking of bodies belonging to the solar system. The fixed stars are at such prodigious distances, that they are referred to the same points in space, whether we consider them as seen from the earth or the sun.

GE′ODES. (Gr. γεωδης, *earthy.*) Nodules of ironstone, hollow in the centre. Rounded pebbles having an internal cavity lined with crystals are also so called.

GEO′DESY (Gr. γη, and δαιω, *I divide*), literally signifies the *division of the earth*, in which sense it is synonymous with land surveying; but it is usually employed in a more general sense to denote that part of practical geometry which has for its object the determination of the magnitude and figure either of the whole earth, or of any given portion of its surface. In this sense it comprehends all the geometrical or trigonometrical operations that are necessary for constructing a map of a country, measuring the lengths of degrees, &c. In order to construct an accurate map, or determine the form and dimensions of a country, it is necessary, in the first place, to determine the absolute distances between the several stations or points; secondly, to determine the azimuths of the lines thus measured, that is, their situation with respect to the meridian; and thirdly, the differences of latitude and longitude of the stations. The operations necessary for determining the absolute distances, comprehending the measurement of a base, the observation of angles, the computation of the sides of the triangles, and their reduction to the same level, are called the *geodesical* or *geodetical* operations; while those which are required for determining azimuths and latitudes are called the *astronomical* operations. The determination of the figure and dimensions of the earth is a problem of very great importance to astronomy and geography, and has accordingly at all times been a subject of much interest to mathematicians; but it is only since towards the middle of the last century that operations on an adequate scale for its solution have been undertaken in different parts of the world. For the results of the more important of these operations, see DEGREE.

GEO′GNOSY. *See* GEOLOGY.

GEO′GRAPHY. (Gr. γη, and γραφω, *I describe.*) The description of the earth. The etymology of the term indicates the nature and extent of this department of knowledge, which, in fact, embraces every thing relating to the circumstances and condition, natural or artificial, of the globe which we inhabit. The immense variety of subjects comprehended in the science of Geography are usually arranged under three great divisions, — *Mathematical, Physical*, and *Political Geography.*

Mathematical Geography. — This division of geography has for its object the determination of the form and dimensions of the earth, its relations with the celestial bodies, the relative positions and distances of places on its surface, and the representation of the whole or portions of its surface on globes or maps.

In order to describe the earth the first element that must be ascertained is its general form. That the surface of the earth is convex, is apparent even to the senses. Let a spectator stand on the sea shore, and attend to the successive appearances of a ship proceeding to sea. First, the lower part becomes invisible; then the whole hull; and, lastly, the masts and rigging, the lower parts disappearing first. Now this phenomenon can only be explained by the convexity of the portion of the water between the ship and the spectator; and when the curvature of the sea is recognized, the conclusion can scarcely be avoided that the land, abstracting from its local inequalities, participates in the same curvature, and that the earth is a round body. The same conclusion is drawn from the gradual coming on of day and night, and the deplacement of the stars in proceeding towards the north or south; for if the earth were flat, the sun, in appearing above the horizon, would illumine the whole of its surface at the same instant; and on the supposition of its being either flat or cylindrical, the pole star would maintain the same elevation, whereas to the traveller who advances northward it gradually appears more elevated, and to him who advances southward more depressed. All these appearances are observed in the same manner on whatever part of the earth we are placed; and from them alone the globular form of the earth might be inferred, even if the fact had not been placed beyond doubt by the voyages of circumnavigators. Astronomers in modern times have indeed discovered that it is not a perfect sphere, being flattened in a slight degree at two opposite points (which are the poles of rotation); but the deviation from perfect sphericity is so small, that for all the purposes with which geography is concerned it may be neglected without sensible error. *See* FIGURE OF THE EARTH.

In order to determine the relative positions of points on a sphere in the most commodious manner, mathematicians refer them to two *great circles*; that is to say, circles formed by the intersection of the surface of the sphere by a plane passing through its centre. The earth is a body which revolves about an axis of rotation; the position of this axis, therefore, with respect to the celestial constellations, determines one great circle, namely, the *equator*, or the circle which is equally distant from the two poles of rotation, and divides the globe into two opposite hemispheres. The equator, therefore, being marked out by nature, or by the apparent revolutions of the celestial bodies arising from the real diurnal rotation of the earth, is a circle to which all places are most conveniently referred: and it has this property, that it never undergoes any change of place on the sphere; for astronomers have proved that since the date of the earliest observations, the poles of rotation, and consequently the equator, have always maintained the same invariable position on the earth's surface.

The distance of a place from the equator cannot be directly measured; but by means of astronomical observations we can determine that distance in aliquot parts of the earth's circumference, that is, in degrees of a great circle. It is not, however, sufficient to know how many degrees a place is distant from the equator. It is necessary, also, in order to distinguish it from all other places, to know how it is situated with respect to a certain *meridian*, or great circle perpendicular to the equator, and consequently passing through the poles. In reference to the diurnal rotation of the earth, all meridians are in precisely the same circumstances; the choice is consequently entirely arbitrary, and geographers, as well as astronomers, generally select that which passes through the capital of their own country as the circle to which they refer all other places. The equator and the assumed meridian thus form the co-ordinates of the sphere. The distance of any place from the equator, measured on the arc of the meridian, is the *latitude* of the place; and its distance from the assumed meridian, measured on a circle parallel to the equator, is its *longitude*; and when the latitude and longitude of any place are both known, the position of the place itself is entirely determined. The latitude of a place is ascertained by observing the height of the pole above its horizon; and the longitude of one place in respect of another, by the interval of time which elapses between the passage of any celestial body over their respective meridians. *See* LATITUDE and LONGITUDE.

Besides the rotatory motion about its axis, the earth has also a motion of revolution about the sun, which is completed in the course of one year. The first of these motions causes the succession of day and night; the second the vicissitudes of the seasons, and the inequality of the length of the natural days. These two last phenomena depend on two circumstances: — 1st, that the axis of the earth is not perpendicular to the plane of the ecliptic, or the plane in which the annual revolution is performed; and 2d, that the extremities of this axis, or the two poles of rotation, continue to be directed to the same points of the celestial sphere during the whole time of the revolution. Hence it follows that the plane of the equator, though invariable in respect of absolute space, is continually changing its position in respect of the sun; and the apparent effect is the same as if the sun had a vibratory motion in the heavens, rising above the plane of the equator E E one half of the year, and falling below it during the other half. When the sun is in the equator at S, the two poles of the earth n and s are in the great circle which divides the illuminated from the dark hemisphere. When the sun reaches his greatest northern declination at S′, the il-

luminated hemisphere is *a* E *a'*, and the north pole *n* comes considerably within it. On the other hand, when the sun's declination is south, as at S'', the south pole *s* comes into the illuminated hemisphere, while *n* is left in darkness. When the sun is at S his apparent diurnal motion is performed in the equator, and the days and nights are of equal length all over the world. The angle which the planes of the equator and ecliptic make with each other is about $23\frac{1}{2}^{\circ}$; consequently, since the greatest declination of the sun from the equator is the same quantity, it must happen that at midsummer the sun is $23\frac{1}{2}^{\circ}$ to the north of the equator, and at midwinter $23\frac{1}{2}^{\circ}$ to the south of it. The inequality of the natural days is an immediate consequence of the sun's declination; for as the solar rays come to the earth parallel, one half of the globe must always be illuminated at once, and the other half in darkness; consequently when the sun declines $23\frac{1}{2}^{\circ}$ to the north of the equator, all that part of the earth which is within $23\frac{1}{2}^{\circ}$ of the north pole will remain, while the earth performs its diurnal revolution, within the illuminated hemisphere. A small circle of the sphere parallel to the equator, and at the distance of $23\frac{1}{2}^{\circ}$ from the pole, is called the *polar circle;* and at this latitude the sun, when at his greatest declination, comes exactly to the horizon at midnight, without setting; consequently the length of the longest day is twenty-four hours. At the equator the length of the day is always twelve hours; and from the equator to the polar circle the length of the longest day is greater and greater as the latitude increases. At the pole the sun is one half of the year above the horizon, and the other half below it; and from the polar circle to the pole the length of time the sun continues above the horizon without setting increases with the latitude from twenty-four hours to six months. The two small circles of the sphere parallel to the equator, which limit the sun's greatest declination, are called the *tropics;* and the whole surface of the globe is divided by the two tropics, and the two polar circles, into five *zones* or spaces; namely, the *torrid zone*, which is included between the two tropics, or extends $23\frac{1}{2}^{\circ}$ on either side of the equator; the two *temperate zones*, or the spaces included between the tropic and polar circle in each hemisphere; and the two *frigid zones*, or the spaces between the poles and their respective polar circles. These may be called the astronomical divisions of the globe, as they depend on the position of the earth's axis of rotation with respect to the plane of its orbit, and are determined by astronomical observations.

Physical Geography has for its object the description of the principal features of the earth's surface, as consisting of land and water; the extent and configuration of the continents and islands; the elevation and direction of the mountain chains; the conformation of the plains and valleys; their altitude above the level of the sea; and the soil, climate, and animal and vegetable productions of different countries. It embraces also the various phenomena of the ocean, which may be classed under the term *Hydrology;* the depth of the sea, and the inequalities of its depth, its saltness and temperature; the direction and velocity of currents, the tides, the polar ice, &c. In like manner it comprehends also many of the questions which are usually treated under the terms *Meteorology* and *Climate;* the mean temperature of different countries; the height of the snow line; the prevailing winds; the barometric pressure; the quantity of annual rain, of evaporation, &c.; and the effect of all these circumstances on the condition of the human race.

On casting our eye on a globe or map, we immediately perceive the very unequal distribution of land and water on the surface of the earth. The land occupies a very little more than one third of the whole surface, and the water all the remaining portion. Nor is the inequality of the distribution in respect of the two hemispheres less remarkable. Of the whole land about four fifths is situated in the northern hemisphere, and the remaining one fifth in the southern. In a general view, the land consists of three great masses: the *old continent*, which comprehends Europe, Asia, and Africa; the *new continent*, or America; and *New Holland*,—which are separated from each other by the great oceans. The general features of the two continents differ remarkably. In the old continent the general direction of the land, and of the great mountain chains, is from west to east, almost parallel to the equator; while in America the general direction is from north to south, along the meridian. Thus the four great systems of mountain ranges in Asia,—namely, the Altai, the Thian-chan, the Kuen-lun, and the Himalaya,—all stretch from west to east; and the Andes, which extends from one extremity of America to the other, ranges in the perpendicular direction from north to south. Another striking feature of the land is, that all the great peninsulas are pointed to the south pole. This is the case with South America, Africa, Arabia, Hindostan, Malaya, Cambodia, the Corea, Kamtschatka, California, Alaska, Greenland, Florida, Italy, &c.; in short, the only two exceptions are Yucatan in the Gulf of Mexico, and Jutland in the German Sea, which are both formed of alluvial land, and may therefore be supposed to owe their formation to partial influences which have not operated on the great continental masses. This similarity of disposition can only be attributed to the agency of some mechanical cause; and the phenomena strongly suggest the idea of the terraqueous masses having been shaped into their existing forms by the action of a great wave or current flowing from the southern to the northern pole. (See ATMOSPHERE, CLIMATE, GEOLOGY, TIDES, WIND, &c. See also an excellent article on this subject by Dr. Traill in the *Encyclopedia Britannica.*)

Political Geography considers the earth as the abode of mankind; and has for its object the description of all that relates to the moral or social condition of the different nations; their language, religion, government, degrees of civilization; and the population, resources, and local relations of different countries. This part of geography is consequently related to history and statistics, and does not fall within the scope of this work. (See *M'Culloch's Geographical Dictionary; Murray's Encyclopedia of Geography;* the large work of Malte Brun, of which there is an English translation; the *Dictionnaire Géographique Universel;* the *Systems of Malte Brun and Balbi abridged*, published by Black; and, for recent discoveries, the *Journal of the Royal Geographical Society of London.*)

GEOLOGY. (Gr. γη, *the earth;* λογος, *a discourse.*) Till within the last five-and-twenty years geology consisted of a very limited collection of facts, strung upon amusing but insufficient theories and hypotheses; but it may now be said to have taken its place amongst the rigid and exact sciences. It requires for its successful exposition not only an intimate acquaintance with the mineralogical history of the crust of the globe, but it also involves a series of extensive and distinct inquiries respecting the physical and chemical causes that are and have been active in producing present and past changes; and it branches out into several distinct investigations connected with the discovery of organic remains, in the successful pursuit of which no small share of zoological and botanical information are requisite, and which also demand the aid of comparative anatomy.

There is this therefore to recommend geology, that it excites a distinct interest in the external characters of a country or district, independent of the beauties or ruggedness or sublimity of its aspect, or of its geographical peculiarities, and endeavours to trace a connection between its *exterior* features and *interior* structure; and in these its simplest details it bears upon agriculture, and ultimately upon all those numerous arts in which mineral substances are concerned. The farmer should be a geologist, and so should the architect: the miner and the mineralogist *must* be so. But this is, as it were, the mere title of the volume; for when we come more narrowly to peruse its contents, we do indeed find it "as a book wherein men may read strange matters." It is full of relics, so extraordinary as to arrest the attention of the most superficial inquirer, and to awaken the deepest interest in the philosophic observer: it is thronged with records of strange and mighty changes and convulsions; of revolutions in climate, and in the genera and species of the organic creation; it carries the mind back to a period indefinitely remote, when our present continents were at the bottom of an ocean, from which they seem to have been elevated sometimes by the slowest degrees, and at others by a more rapid and violent cause, and when both sea and land were tenanted by distinct tribes and races of extraordinary animals and vegetables; it shows that every thing as we *now* find it has been gradually and successively developed as it were, and that man himself has appeared but late upon this singular stage.

In this article our principal object will be to give an outline of the present state of geology, and an explanation of the terms of the science. To attain this object, the works which we have principally consulted, and from which, with the kind permission of their authors, we have made copious extracts, are those of Lyell and De la Beche: the explanatory diagrams are chiefly from the same sources. To them, and to the works of Phillips, Bakewell, Mantell, and Buckland, and to the *Transactions of the Geological Society*, we must refer our readers for details which would have been inconsistent with the objects of this Dictionary.

In tracing out the present appearance of the earth's surface, and in examining minutely the effects of causes now in action, there is nothing, as Hutton has said, in which *we* can distinctly perceive either the evidence of a beginning or the prospect of an end. Geometers have taught us that in the midst of all the fluctuations which can possibly take place in the elements of the orbits of the planets by reason of their mutual attraction, the general balance of the parts of the system will always be preserved, and every departure from a mean state periodically compensated. But, in saying that *we* can discover nothing that points to a beginning or threatens an end, we only mean that mere human powers are as yet inadequate to such a discovery.

There are, it is true, some circumstances in the physical constitution of our own planet which do *obscurely* point to an origin and a formation, but from them nothing distinct can be concluded. On the other hand, neither the researches of astronomy nor of geology give us the slightest grounds for regarding either our system, or the globe we inhabit, as of *eternal* duration ; in short, if we would speculate to any purpose, either upon the former state of our globe, or upon the succession of events which from time to time may have changed the condition and the form of its surface, we must confine our views within limits far more restricted, and to subjects much more within the reach of our capacity, than either the beginning or the end of the world. These, indeed, were almost the sole inquiries of the older geological school, the favourite speculations of a race of geologists now nearly extinct. Within the limits of the present century even geology has undergone an entire change of character, and is, as we have already remarked, brought within the list of the inductive sciences. Geologists now no longer ransack their imaginations for theories of the formation of the globe from chaos, or bewilder themselves with its hypothetical transformations ; but they aim at a careful and accurate examination of the records of its former state, and of the indisputable evidences of former life and habitation which the organic remains of its strata afford.

These wonderful wrecks of a former state of nature, preserved, like ancient medals and marbles in the ruins of an extinct empire, afford a kind of rude chronology, by the aid of which the successive depositions of the strata in which they are found may be marked out in epochs more or less definitely terminated, and each recognized by some peculiarity which enables the diligent observer to recognize the deposits of any period, in whatever part of the globe they may occur. And, so far at least as investigation has hitherto gone, these deposits are in the same *order of succession* in every part of the world.

But, in using these terms, we must not forget how very little we do actually know of the earth's surface. We talk of certain strata extending over the *whole* globe, forgetting that nearly three fourths of it are covered by the waters of the ocean, and that consequently of that portion we can know but little,and that little imperfectly; and that of the fourth which remains in the shape of dry land not one thousandth part has been at all examined, or at least not investigated. Again, we speak of the *crust* of our globe, and of the *bowels* of the earth, and the *depth* of the sea, and the *loftiness* of mountains, forgetting how insignificant all these things really are, compared with the entire bulk of our planet ; that our deepest mines hardly penetrate to a depth surpassing the ten thousandth part of the distance from the surface to the centre ; that the profoundest recesses are mere scratches upon the surface ; that the loftiest hills and most inaccessible mountains are only as grains of dust and of sand sprinkled on the surface of one of our moderate-sized artificial globes.

Such being the real state of our information, and such the limitations to which all further pursuit is subjected, we may well be animated by the magnitude and extent of the inquiries which this limited range displays. " And finding, even in these restricted bounds, the amplest proofs of order and design, the mind is naturally led to the sublimest inferences respecting what is unseen, and even to the conception of a power and intelligence to which we may well apply the term *infinite;* since we not only see no limit to the instances in which they are manifested,but find, on the contrary, that they continually open upon us in increasing abundance, in proportion as we are enabled to extend our sphere of observation and inquiry ; and that as the study of one prepares us to understand and appreciate another, wonder follows on wonder, till our faculties become bewildered in admiration, and our intellect falls back on itself in utter hopelessness of arriving at an end."

We may now state of what the external film or cuticle of the globe appears to consist, and examine how far we are justified in surmising respecting the nature of its deeper-seated parts, and of such portions as are out of the reach of actual inspection.

We say that the crust of the earth is *stratified*, because it consists chiefly of distinct strata or layers of different materials. These differ in depth and extent ; but, what is most essential to our present purpose, they follow each other, on the large scale and as masses, in an apparently regular and uniform succession in all places, districts, and countries where they admit of examination and have been attentively studied. They appear, in most instances, to rest upon, and are blended with, invaded, and in some few instances overflowed as it were by, substances which are *not* distinctly stratified, and which most geologists have agreed in calling *unstratified rocks*. The former, or the stratified rocks, from their texture and contents have apparently been formed under water ; and some of them, especially the uppermost series, abound in fossil remains of the organized kingdom. The *unstratified* rocks, on the other hand, are in many instances of indisputable volcanic origin ; and others, from their position, texture, and effects upon their neighbours, are also presumed to be of igneous formation. *Water*, therefore, on the one hand, and *fire* on the other, seem to have been the great agents to which the present aspects of the earth's surface are referable. In proceeding to enumerate the principal *divisions* of the stratified rocks in their order from above downwards, we must remind the reader that the series is frequently rendered irregular by the deficiency of one or more of its members ; and that sometimes whole series of strata seem to have been removed from certain districts by causes which we shall afterwards endeavour to trace, constituting what have been called *denudations*.

In this diagram A represents the crystallized or *unstratified* rocks, presumed to be of igneous origin, upon which lie the *stratified* rocks, B, C, and D. The rocks A were formerly called *primitive*, and were supposed to be the original crystalline crust of the globe, upon which the strata B C D had been subsequently deposited ; but it is now supposed that the rocks B, C, and D have been upheaved by the subsequent intrusion of A by volcanic agencies from beneath.

The substances which usually constitute the ground we tread upon are produced chiefly by causes in daily operation—soils and detritus of various kinds washed down from the neighbouring hills by the influence of rain and torrents, and forming what have been generally called *alluvial* deposits : these are more or less associated with matters probably of a similar but a more ancient origin, and which, suspected by some to be relics of the deluge, have been termed *diluvial* deposits ; such as *gravel* and *boulder stones*.

We then find in many parts of England and elsewhere occasional patches of what have been termed *tertiary* rocks, which often are of singular interest, and frequently consist of detached and insulated deposits surrounded by other rocks, and, in reference to their neighbours, occupying a position very like that of the water of lakes, inland seas, and gulfs, in relation to a continent ; and, like such waters, being often very deep, but of limited extent : hence they are often designated as *basins*. They consist of clays and calcareous and arenaceous matters, in which are embedded remains of marine animals, blended with fresh-water species, quadrupeds, and even birds. These lie upon chalk, which is the newest rock of the secondary series. They constitute the *supracretaceous* rocks of which the basins of Paris, London, and the Isle of Wight, and parts of Suffolk, furnish instances. Chalk constitutes the uppermost of the secondary series of the European area ; and it is immediately succeeded by certain varieties of sand and sandstone, included by Mr. De la Beche in his *Cretaceous* group. We then (in the same area) come to the *Oolitic* group, composed of calcareous freestone and of lias, resting upon the varieties of red sandstone, and succeeded by coal, mountain limestone, and *old* red sandstone ; and these are followed by the *Greywacke* group, forming the *transition* series of Werner, a part of which has been ably described under the name of *Silurian system* by Mr. Murchison, resting upon a lower portion termed *Cambrian system* by Professor Sedgwick. The Greywacke may be conveniently divided into three portions : — 1. *Upper*, equivalent to the old red sandstone of England ; 2. *Intermediate*, equal to the Silurian system ; and 3. *Inferior*, equivalent to the Cambrian series. These are often made up of fragments of the older series, or contain a few ancient organic relics. They rest upon the *inferior* order of stratified nonfossiliferous rocks, and upon the *unstratified* or primary series.

In endeavouring to trace out the history of the respective strata to which we have adverted, it would, perhaps, be most philosophical to commence our inquiries with the causes that are now active in producing alterations upon the surface of the globe ; to consider the action of changes of temperature, and of water and other agents, that tend to degrade and disintegrate the surface, to wear down its asperities, and to modify the present order of things,—among which earthquakes and volcanos form a prominent feature. But the narrative will be more clear if we first sketch out the history of the *formations*, considering them in reference to their position, their composition, their organic relics, and the purposes to which they are applied in the arts ; and then, having adverted to their relative durabilities and aspects as mountain masses, we may consider the action of rivers, and of the ocean, both as destructive and as renovating agents, tracing out their connection with meteoric phenomena, and with the effects of volcanic fires. We shall thus be

enabled to compare present with past changes, and to form an opinion upon the great controversial question which now seems chiefly to engage theoretical geologists; namely, whether things have always gone on pretty much as we now see them, or whether our globe has been subject to great and destructive changes and convulsions out of the ordinary course of nature.

§ I.

First, then, as respects those superficial and insulated formations constituting the *tertiary* or *supracretaceous* group of rocks. Our knowledge of their distinct existence is chiefly due to the labours of Cuvier and Brongniart, whose *Memoir on the Environs of Paris* was published in 1811. In this part of Europe they form patches or basins; but there is much reason to believe that they have once been more continuous and extensive, and that their present insulated character is, partly at least, due to the elevation of the strata below them, by which they have been broken up, and in part also removed by denudation.

Amongst these formations we may also class many extensive series of rocks in different parts of Europe, which, although they bear records of having been deposited at different and probably remote periods, are still, compared with the strata beneath them, of comparatively modern origin, and belong to the general epoch of the supracretaceous series.

It will easily be understood that one characteristic test of the date or age of a rock formation is to be found in the fossils which are entombed in it. If these are of *genera and species now existing*, it is an inference in favour of modern formation; if the *genera* are extant, but the *species* extinct, we are carried back to a more remote date; and if the *genera* are also extinct, we presume upon a yet more remote period of deposition. It is obvious, also, that other conclusions of great importance may be deduced from the same source, and that the remains of certain quadrupeds, amphibious animals, and fresh-water and marine fish and shells, will announce the existence of dry land, lakes, or seas, at the periods of the respective depositions; — and again, from *alternations* of these deposits, we are often enabled to infer the successive or alternate states of dry land, lakes, and the ocean, upon one and the same spot. All these inferences require to be drawn with the utmost circumspection, and many concomitant circumstances to be taken into the account; but the data, when judiciously used, are of the greatest interest and importance, and give the most unexpected and extraordinary yet philosophical clues to the discovery of a former and very remote state of things upon the surface of the globe.

The tertiary rocks, when tried by the test just hinted at, may be subdivided into three or four periods, founded upon the comparison of their respective fossils; all these periods are distinct from and anterior to that which has elapsed since the earth has been tenanted by man, and which may therefore be called the historical, *recent*, or contemporaneous period.

In the most modern of the above periods, the formations are such as contain fossil testaceous remains, of which the *greater part* are referable to recent species. In some of these there is an immense preponderance of recent species, and the formations pass by insensible gradation into those of the historical period; as in part of Sicily and the district about Naples. In others, the recent species vary from one third to one half of the entire number; as in the subappenine hills and in the English crag. The formations of the next period contain a minority only of imbedded fossil shells of recent species (Touraine and the beds of the Loire); and in the last, they are of such very sparing occurrence, as to indicate what may be considered as the first commencement of the existing state of the animal creation (Paris and London basins).

These three periods or formations Mr. Lyell designates by the terms *Pliocene*, *Miocene*, and *Eocene*. (Pliocene, from πλειων, *major*, and καινος, *recent*, because the major part of the fossil testaceæ of this epoch are referable to recent species; Miocene, from μειων, *minor*, a minority only of fossil shells embedded in the formations of this period being of recent species; Eocene, from ηως, *aurora*, because the very small proportion of living species contained in these strata indicates the dawn, as it were, of the present state of the animal creation.) To give some idea of the contents and arrangement of these strata, we may briefly refer to the Paris, Hampshire, and London districts.

A descending section of the strata near Paris presents the following orders of succession: — The uppermost rock consists of various marls and siliceous compounds, containing organic remains, which characterize it as of fresh-water formation; to this succeed marls, sand, and limestone, with marine shells; then fresh-water marls, siliceous limestone, and gypsum, with the bones of animals; then a coarse limestone abounding in marine remains, often hard, and applicable to architectural purposes; and lastly, lying upon the uneven surface of the chalk, plastic clay, with beds of sand containing lignite, amber, and shells both of marine and fresh-water animals.

In this extraordinary assemblage some of the organic relics are of great interest. The gypseous strata contain the bones of extinct mammalia and other animals, which have been almost recalled, as it were, into existence by the scientific skill of Cuvier, who has given sketches of their probable forms and habitudes. There are the remains of about fifty species of quadrupeds, all extinct, and nearly 4-5ths of them belonging to a division of the order *Pachydermata*, now only represented by four living species; namely, three tapirs and the daman of the Cape. There are a few carnivorous animals, among which are a a species of fox and gennet; — there are the dormouse, squirrel, bat, and an opossum (a marsupial animal, now confined to America and Australia). There are about ten species of birds; and, among the reptiles, crocodiles and tortoises.

Though we shall again advert to the probable and apparent causes of this extraordinary assemblage of relics, it may be worth while to refer to some general points connected with the geology of the Paris district, which seem to explain certain states of the earth's surface then existing.

In the first place, as respects their general arrangement, we find that they do not repose horizontally upon each other, but that there are irregularities, announcing hills and valleys upon the original surface of the chalk on which all these deposits rest. So that the plastic clay and its associates were deposited in these hollows, filling them more or less up: upon this the lowest marine stratum (*calcaire grossier*) was formed, also following the uneven surface beneath. Then came the gypseous deposit, containing land and river shells, with fragments of wood, and the assemblage of skeletons: respecting which it deserves particular notice, that they are often entire, the most delicate extremities being preserved, as if the carcasses clothed with their flesh and skin had been floated down soon after death; so that Prevost has suggested that a river may have swept away the bodies of the animals and plants which lived on its borders, or in the akes which it traversed, and may have carried them down to a gulf into which flowed waters impregnated with sulphate of lime, and by which they were gradually consolidated. But whatever was the cause of this singular state of things, it is clear that the deposit of sulphate of lime afterwards ceased; that the relative level of the sea and land apparently became altered; and that marls with sea shells were formed, and pebbles were produced, to which oysters became attached, some of the pebbles being pierced by boring shells. To these deposits succeeds sand with *broken* organic remains, filling up inequalities of surface, and apparently announcing a long-continued action of water. Then those causes which prevented the envelopment of organic remains ceased, and marine exuvlæ became entombed in great abundance; and lastly, to close this eventful history, a varied deposit follows, containing the remains of such animals and vegetables as are known only to exist on dry land, or in marshes or fresh water. This variety of mineral structure has been supposed to result from springs holding various substances in solution entering various parts of a shallow lake. That it was shallow is probable, from the remains of the small seed vessels of fresh-water plants belonging to the genus *Chara*. These curious remains were once supposed to be microscopic shells: they have been called *Gyrogonites* (from γυρος, *curved*, and γονος, *seed*). They occur frequently in fossil formations of different eras.

In the Isle of Wight there is a succession of fresh-water and marine strata, which, as far as fossil contents go, agree in many respects with the Paris district; but in mineral character they are very different. They appear almost exclusively mechanical; and the chemical solutions of silica, and of sulphate and carbonate of lime, which seem to have prevailed about Paris, are not to be traced here. But the bones of mammalia corresponding to the celebrated gypsum deposits of Paris have been disinterred at Binstead, near Ryde.

Here as elsewhere we find signs of an upheaving of the strata, as announced in the different succession of formations, and in the verticality of certain neighbouring beds. In the Isle of Wight, and also on the opposite coast of Hampshire, the fresh-water beds rest upon sand; and there seems, as in the Paris beds, to have been alternations of currents with more quiescent deposits.

A peculiar clay underlies London and the adjoining district, commonly known as *London clay*. It is of various colours, and contains argillaceous and calcareous matters; but the latter rarely so far predominate as to form limestone, or even marl. It contains layers of argillo-calcareous nodules, called *septaria*, and occasional beds of sandstone. Its thickness varies, sometimes exceeding 500 feet. As many of the marine shells found in it have been identified with those of the Paris basin, it is probable that the formations belong to the same epoch. No remains of terrestrial mammals have as yet been found in it, so that we want that evidence of the vicinity of dry

land at the time of its formation; but, that such was the case appears probable from the immense number of seeds and fruits, some of them resembling the cocoa nut and spices of tropical regions. The lower beds of the London clay, called *plastic clay*, are contemporaneous with the equivalent plastic clay of Paris; they contain beds of sand, shingle, clay, and loam, irregularly alternating, and rest upon the irregularities of the chalk beneath.

Although sulphate of lime is not found in the distinct manner noticed in the Paris basin, the clay of London is in many places abundant in it, and it is sometimes found in fine crystals. Its presence is also announced in the hardness of the spring waters that issue from it, as contrasted with the softness of the springs from the plastic clay sands.

In Norfolk and Suffolk there is a rock already mentioned, known under the provincial name of *crag*. It appears from its position and fossil contents to appertain to the newest formations, being yet more modern than London clay, and containing a considerable number of testaceous remains identical with species inhabiting the neighbouring seas. Its mineral character is difficult to define. It generally consists of sand, gravel, and marl; and sometimes presents itself in the form of a soft stratified rock, composed almost entirely of corals and echini, or of loam and clay, containing bones of terrestrial quadrupeds and drift wood, with fragments of older rocks, and gradually passing into alluvium.

Having thus enumerated some of the peculiarities of these tertiary strata, there are two or three questions connected with the formation generally, which, before we leave it, it will be right briefly to advert to. In the first place, the great elevation at which some of these strata occur above the level of the sea would seem to indicate to the superficial observer a retreat or falling of the waters of the ocean. But more accurate inquiry forbids such a conclusion, and leads to another, at first more extraordinary inference; namely, that the land has often been elevated, the proofs and illustrations of which we shall again recur to. Secondly, that the organic remains, animal as well as vegetable, and also the mineral structure of many of these rocks, show that the temperature of these parts of the globe has undergone a considerable declension from its former state; for there are among them evidences of something more than a tropical climate, and of thermal or even boiling springs. The cause of this change of the globe's temperature forms an important subject of discussion with geologists. Some, however, have contended that this evidence of change of temperature, as far as it rests upon organic relics, is insufficient; for, say they, we do not absolutely know that such animals and vegetables, though they *now* require a high temperature, may not at some former period have been adapted to a lower one; and they adduce the Siberian elephant, and a few analogous cases, as proofs. But as we now find every animal and vegetable adapted to their proper situations, we have a right to infer the existence of the same fitness and design at all antecedent periods, and under every possible state of the globe, and therefore to conclude that similarly constituted animals and vegetables have in general had similar habitats.

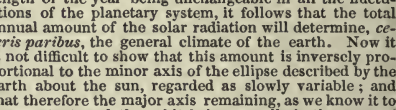
We therefore are obliged to conclude that the earth's surface has suffered a notable decrease of temperature, or at least that there has been a great change of climate over large tracts of the globe. In relation to this question, some have argued the possibility of a decrease of temperature from internal causes,—have considered the whole globe as having cooled from absolute fusion,—and that this process has now only gone to a certain extent, so as that its interior is still glowing. They adduce volcanos and thermal springs as proof of this, and maintain that the warmth which we experience in deep mines is attributable to this central source of heat.

In so far as this hypothesis of a central heat is resorted to to explain a change in *climate*, it seems inadequate; for it is unphilosophical to assume that the same effects would result from such a cause as those which are produced by the influence of the sun's rays and by peculiarities of surface.

Another, and perhaps upon the whole a more plausible explanation of this subject, refers the change to the varying influence of the disposition of land and sea over the surface of the globe. A change of such distribution in the lapse of ages, by the wearing down of old continents and the elevation of new, is a fact which we shall be able to demonstrate; and the influence of such a change on the climates of particular regions, if not of the whole globe, may be fairly concluded from what we know by actual observation of insular, oceanic, and continental climates. Here then, "in language of very high authority," we have a cause on which a philosopher may consent to reason; though whether the changes actually going on are such as to warrant the whole extent of the conclusion, or are even taking place in the right direction, must be considered as undecided till the matter has been more thoroughly examined. It will be observed that this *theory*, for so it may fairly be called, supposes a combination of external and internal causes; the latter raising or depressing the land in proper situations, the former supplying the necessary heat. It also infers the possible return of a warm climate; so that the same situations might be alternately placed under the influence of a raised and depressed temperature, or as it were of an equatorial and polar clime.

Lastly, and the suggestion is sanctioned by the authority of Sir John Herschel, we may look to the astronomical fact of the actual slow diminution of the excentricity of the earth's orbit round the sun. This, as a general cause, affecting the mean temperature of the whole globe, and as one of which the effect is both inevitable and susceptible to a certain degree of exact estimation, certainly deserves to be considered. It is evident that the mean temperature of the whole surface of the globe, in so far as it is maintained by the action of the sun at a higher temperature than it would have were the sun extinguished, must depend on the mean quantity of the sun's rays which it receives; or, which comes to the same thing, on the total quantity received in a given invariable time; and the length of the year being unchangeable in all the fluctuations of the planetary system, it follows that the total annual amount of the solar radiation will determine, *ceteris paribus*, the general climate of the earth. Now it is not difficult to show that this amount is inversely proportional to the minor axis of the ellipse described by the earth about the sun, regarded as slowly variable; and that therefore the major axis remaining, as we know it to be, constant, and the orbit being actually in the state of approach to a circle, and consequently the minor axis being on the increase, the mean annual amount of solar radiation received by the whole earth must be actually on the decrease. We have here, therefore, an evident real cause of sufficient universality, and acting in the right direction, to account for the phenomenon: its adequacy is another consideration. *Herschel's Preliminary Discourse.*) We may suggest the possibility of the three causes adverted to acting in unison, to account for the complicated and curious effects of which we seek an explanation.

Such, then, are the leading considerations arising out of the inspection of the most superficial, and apparently the most recent, of the earth's strata. They suggest a general change in the disposition of sea and land; an alteration in their relative levels, sometimes often repeated; the existence of animals and vegetables now extinct; and a remarkable alteration in the general temperature of the globe. How far the supposed causes of these changes are borne out by observations upon the more ancient formations, will be seen as we proceed in our examination of the descending series.



In the above diagram A A represents the chalk upon which the tertiary strata B C D have been deposited; the latter may be supposed to be of different ages, as indicated by their included fossils, and all of a more recent date than the chalk upon which they lie.

The tertiary rocks rest either upon chalk or upon the geological equivalents of chalk; and the formations of this series constitute a prominent feature of the district which surrounds the London basin, for as soon as we leave the tertiary deposits which characterize the vicinity of the metropolis we enter upon the cretaceous strata. The ranges of chalk in this part of the kingdom are very extensive; and in consequence of their smooth and rounded outline, and the singular cup-shaped concavities and deep hollows in which their sides abound, they confer a monotonous peculiarity on the scenery. They are, however, of much interest in their geological relations. Salisbury Plain and Marlborough Downs form as it were a centre from which the chalk emanates in a north-east direction, through Buckingham, Bedford, and Cambridge shires, and terminates in one direction upon the coast of Norfolk. Another branch, intersected by the valley of the Humber, traverses Lincolnshire, and terminates at Flamborough Head in Yorkshire. The extreme western point of the chalk is not far from Honiton in Devonshire, whence it branches towards the south-east to the Isle of Purbeck, and again appears forming a ridge that crosses the Isle of Wight. Another range of chalk commences near Hungerford in Berkshire, and passes by Alton and Rochester to the coast of Kent, forming the cliffs between Deal and Folkstone. From near Alton another branch passes off, terminating at the lofty promontory of Beechy Head on the coast of Sussex. In these districts some of the chalk hills are of no inconsiderable elevation. Near Dunstable and Shaftesbury, for instance, it forms hills nearly 1000 feet above the level of the sea. Between Lewes in Sussex and Alton in Hampshire there are several similar ele-

vations. Between Alton and Dover the highest point is about 800 feet; and Dover Castle Hill about 470 feet.

The geological history of the chalk offers many matters of interest. Where it is denuded of alluvial and tertiary deposits, and also under these, its surface appears water-worn; and the fissures which it exhibits are often filled with rolled masses, debris and flints. One of its most remarkable characters, in England at least, is the presence of numerous beds of flint in the upper part of the chalk strata; while the lower beds are generally deficient in flints, and argillaceous or sandy. These flints are commonly in distinct nodules, horizontally arranged; but they sometimes are vertical or variously inclined, and occasionally form seams, cutting the chalk at different angles.

The great abundance of organic remains in the chalk has been observed from a very early period; they have recently been carefully examined, and proved to be almost entirely marine. No remains of mammalia have been detected in them; but in Yorkshire and Sussex *reptiles*, one of them of a considerable size, have been observed. The *Mososaurus Hoffmanni*, and a crocodile, fish, and shark's teeth, have been found; as also zoophites, shells, mollusks, and a few crustaceous animals.

The origin of chalk it is difficult to explain. There appears no evidence of its having been deposited from chemical solution; but, on the other hand, it bears marks of a mechanical deposit, as if from water loaded with it in fine division. And upon this principle some gleam of light may perhaps be thrown upon the enigmatical appearance of the flints; for it is found that if finely powdered silica be mixed with other earthy bodies, and the whole diffused through water, the grains of silica have, under certain circumstances, a tendency to aggregate into small nodules; and in some chalk small grains of quartz are discoverable.

Many of our chalk strata afford decided evidence of great disturbances having taken place among them, probably at the period of their elevation from the sea. Illustrative instances of such disturbances are given by Mr. Lyell in the case of the chalk of Newbury in Berkshire, and of the ravine called the Coomb, near Lewes, in Sussex; the latter shows how narrow openings of this kind may have been accompanied by shifts and dislocations, as well as fracture of the strata. The steep declivities on each side and the bottom of the ravine are covered with green turf, and no outward signs of disturbance are visible; but when we examine the section in the neighbouring chalk-pits, we find that there has been much internal derangement.

The evidence of this derangement is shown in the annexed diagram, where A and B represent the chalk with and the chalk without flints on each side of the gap.

These dislocations, or shifts or faults, are common in all strata, though most observed in coal districts, from the importance of the material affected by them.

It must be confessed that such appearances are favourable to the idea of those local convulsions alluded to in referring to certain tertiary strata. For if portions of the secondary rocks emerged from the sea during that period, it is probable that the chalk underwent many oscillations of level; that certain tracts became land and then sea, and then land again; so that parts of the surface first excavated by currents or rivers were occasionally submerged, and after having been covered by tertiary deposits upraised again; and assuming the elevation of the chalk to have been slow, every part of it must have been exposed for some time to the action of the waves: hence the valleys upon its surface, and the broken and rolled flints which overspread it.

In describing the general characters of the chalk, we have limited ourselves to England; but in other countries the mineralogical characters of this formation are such as would lead us to arrange it with other groups, were it not that the included organic remains mark them as of the same epoch: such are the hard limestone and sandstone of the Alps, Pyrenees, and some other primitive countries.

The lower beds of chalk graduate into a variety of sands and sandstones of different aspects and degrees of induration, and often abounding in green particles composed of silicate of iron; whence the term *green-sand*. These beds are associated as one formation, in consequence of the general character of their fossil remains: there is also an argillaceous deposit, provincially known under the name of *gault*, which belongs to the same class.

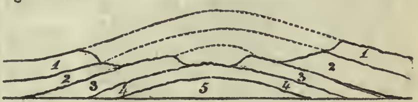
But we now descend by gradual transition to the clays, sands, and limestones of a distinct formation, known in this country as the *Weald rocks*, *Hastings sands*, and *Purbeck beds*. These had generally been confounded with the preceding green-sands of the chalk formation; but a closer examination of their organic remains shows them of distinct origin; for, strange to say, after what we know of the chalk, they abound in terrestrial and fresh-water remains: showing the existence of dry land, and lakes and rivers, before the chalk rocks were formed; and showing also, by the way in which they blend with the sands above, that the change of circumstances which permitted the residence of marine animals over a surface previously inhabited by fresh-water animals was not sudden, but gradual. The examination of these strata has been ably and diligently pursued by Mr. Mantell, whose splendid illustrative collection is now in the British Museum.

The clays and sandstones of this formation contain concretions and veins of argillaceous iron; and these were formerly worked in the Weald of Sussex, as shown by the relics of ancient iron works, and by the abundance of remaining slags, which are at this day still used for mending the roads about Rotherfield, Mayfield, &c. The extensive triangle of which Folkstone, Beechy Head, and Alston are the points, is characterized by this formation, forming greater part of the region intervening between the North and South Downs, known as the *Valley of the Weald*.

This district is very instructive, both as to theoretical and practical geology. It seems highly probable that the chalk has once been continuous, but that it has been washed away by breakers and currents, and fractured by the power which has elevated the strata. In illustration of this important point of theory, the section of the country between the London and Isle of Wight *basins* may be referred to.

If we set out from London, travelling southwards, on leaving the immediate vicinity of the metropolis we ascend an inclined plane of flinty chalk, and then find ourselves on the summit of a declivity consisting chiefly of the different members of the chalk formation. This is called the *escarpment* of the chalk; it overhangs a valley excavated chiefly out of the lower beds of the chalk formation, such as sandstones and gault, and is continuous along the southern termination of the North Downs; so that it may be traced from the sea at Folkstone westward to Guilford and the neighbourhood of Petersfield, and thence to the termination of the South Downs at Beechy Head, where the strata are cut off abruptly by the inroads of the ocean, but where it is evident that they must have at one time been continued.

This denudation is frequently referred to by geological theorists, as rendering it extremely probable that the secondary districts were gradually elevated and denuded when the basins of London and Hampshire were still submarine, and while they were progressively filling up with tertiary sand and clay. It would also appear that subsequently to the emergence of the secondary rocks an immense mass of their upper portions has been removed by the force of water, and that the materials thus carried away were probably conveyed into the depths of the contiguous sea.



The above diagram will serve to explain a valley of denudation, the strata 1, 2, and 3 being to a greater or less extent removed or washed away, and different surfaces of these, and of 4, being now exposed.

We now again advert to the organic contents of the Weald rocks, which, as already stated, are such as indicate the existence of fresh water and dry land before the present chalk deposits were formed; and although some of the inferences of geologists upon this subject appear at first startling and even romantic, they are perfectly fair deductions from the phenomena observed.

The Hastings sands consist of sand and sandstone, with occasional beds of clay and shale, containing silicified wood and fragments of carbonized vegetables, lignite, ironstone, and argillaceous limestone; and the Purbeck beds include varieties of sand and limestone much used for pavement. From the organic remains of these rocks it would appear that they were formed chiefly in fresh water; in lakes, rivers, or estuaries. There is a formation in the Isle of Portland belonging to this series which has been called the *dirt bed*, and which has also been found near Weymouth and elsewhere. It appears from its contents to announce the first appearance of dry land, succeeded by submersion of the same land under fresh water in which the Weald rocks were formed; not suddenly, for there are no marks of violence, but gradually, the shells being tranquilly entombed in the sandy and calcareous deposits.

We shall find, in examining the oolitic rocks upon

which these rest, that they abound in marine remains; so that we must suppose a rise of the land or a depression of the sea to such an extent as to permit the sea-formed rocks to become dry land, upon which tropical plants flourished. Then this land again became in its turn depressed; but so quietly that the trees were apparently left in their natural positions, and even the pebbles and soil not washed away. There is, in short, a great resemblance between these very ancient relics and those of submarine forests of later date upon the coast; except that the former are tropical plants, the latter oak, hazel, &c.

In the sands we find entombed tortoises, crocodiles, plesiosauri and megalosauri, and huge iguanodons. (Mantell, *Phil. Trans.* 1825.)

It is probable that these monstrous reptiles sported in the waters and basked upon the banks of the lake or estuary into which trees and different vegetables were drifted. Now it will be remembered that the sea again resumed its dominion after this state of things, because these strata are covered by the chalk rocks already recognized as marine deposits; and as there are no marks of violence where the Wealden rocks and the green-sands of the cretaceous series come together, but, on the contrary, as they gradually pass into each other, these extraordinary transitions seem to have been gradual, and not attended by any violent or sudden catastrophe.

Such, then, are the remarkable records of the Wealden rocks, and there are analogous cases in other parts of Europe.

The *oolitic rocks* form a very important and curious, but rather complicated series of strata, in this country; in which, however, there are certain analogies which enable us to group them into one general assemblage. Mr. Lonsdale's paper on the Bath district may be referred to as giving a lucid account of the varieties and peculiarities of these rocks. The oolitic limestones are well known from their common use as building materials under the names of Bathstone, freestone, &c. They are intermingled with limestones which do not possess the oolitic structure, and with arenaceous and argillaceous beds. *Lias*, the lowest member of the series, is an argillo-calcareous deposit, commonly containing numerous organic remains.

In England, this formation extends from the sea coast of Dorset, near Bridport, to the northern extremity of the Cleaveland Hills, in Yorkshire, in one range of hills, broken by the vale of the Humber. The lias is often bituminous, and is impregnated with sulphate of soda, sulphate of magnesia, and common salt: it abounds in ammonites, belemnites, and other chambered shells; and in bivalves, and some univalves; gryphites (a deeply incurved bivalve), encrinites, and pentacrinites, and other zoophites; and the remarkable saurian animals already noticed.

To the rocks enumerated under the general term of the *oolitic group* there succeed a series of sandstones, which from their prevailing colour are generally known as the *red* sandstone and marl formation, and which are incumbent upon the coal deposits of this country. Their organic relics are numerous; and they derive interest from being the seat of our great beds of salt, which occur in the counties of Cheshire and Worcester.

In the salt itself there is nothing very remarkable, except, perhaps, its occasional purity. It is sometimes colourless, and contains not more than 2 per cent. of foreign matter; in other parts it is tinged red, and more or less mixed with earthy impurities. The *brine springs*, which often yield 20 per cent. of salt, are doubtlessly derived from the accession of water to similar solid masses.

How the salt came where we now find it, is a question of no easy solution. It has been supposed that it was produced at the bottom of salt-water lakes, and the existence of beds of salt in certain lakes of Africa and South America is quoted in favour of such an hypothesis.

Another substance abundant in this formation, and apparently more or less connected with the salt deposits, is gypsum, or sulphate of lime; known, also, under the name of alabaster. It has been already mentioned as occurring in the tertiary strata, forming the cement which entombs the organic remains of the Paris basin, and where it was probably formed by sulphuric exhalations and springs acting upon the detritus of the secondary chalk, which there appears to have suffered such extensive degradation.

In our red-sand districts the salt and gypsum are distinct, but they are not unfrequently mixed; and in Egypt a highly saline gypsum is sometimes used as a substitute for salt. This rock, when exposed to air and water, would of course lose its more soluble common salt; and hence, probably, the scriptural and oriental allusion to the inefficiency of *salt* which has lost its *saltness*.

In the north of England, magnesian limestone is associated with these strata. It is usually of a yellowish or fawn colour, not abundant in organic remains, and is often a valuable and durable building stone.

The next substances which occur in descending order are the *coal strata* or *measures*, or *coal basins*, as they are sometimes called; and if, upon our journey downwards, we have been struck with the extraordinary aspect of the *animal* kingdom at certain periods or epochs of the earth, we shall now meet with matters quite as wonderful in the remains of *extinct vegetable tribes*, while at the same time we have brought before us a substance of such importance to our commercial welfare and national resources, that every trifle connected with its history assumes an air of peculiar and distinct interest.

There are two or three points, and those of much theoretical importance, respecting the origin of coal, in which geological authorities seem nearly unanimous. The one is, that our present coal is exclusively of vegetable origin, formed apparently from the destruction of vast forests; and from the prodigious quantities of timber drifted by some of the great rivers of the world into the present ocean, it is by no means improbable that a similar formation is now going on in the depths of certain parts of the sea: and, secondly, from the nature of the preserved vegetables, it would seem that the climate of these parts of Europe *was* of a tropical character. It may also be inferred that these strata were deposited in the neighbourhood, and often probably upon the verge, of extensive tracts of dry land; for the trees that are found in coal strata are often like those of our submarine forests, or of the Portland dirt-bed, as far as position goes; and, finally, that they were afterwards elevated, and often singularly dislocated and contorted by forces, the nature of which we shall afterwards consider.

In some coal fields there are appearances which justify the term *coal basin;* they are of limited extent, frequently dip as it were to a common centre, and consist of various beds of sandstone, shale, and coal, irregularly stratified, sometimes mixed with conglomerates,—the whole showing a mechanical origin.

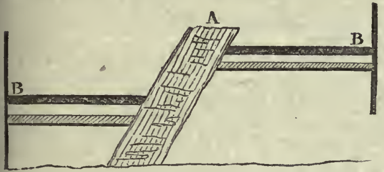
That these depositions have taken place, and that the change of the wood into coal has often been effected under great pressure, and often under pressure and heat, seems evident from the appearances of some of the vegetable masses, and also from the manner in which the carburetted hydrogen escapes in the form of *blowers* from the strata; as if it were pent up in their cavities under vast condensation, and sometimes perhaps even in a liquid form.

An opinion respecting the origin of coal, first advocated by De Luc, and more recently by Adolphe Brongniart (the celebrated fossil botanist), is, that coal beds have been extensive sheets of vegetable matter, resembling in that particular *peat bogs*, which have, one after the other, been submerged and covered by sand and silt. There are numerous facts in favour of this view, which has also been sanctioned by Mr. De la Beche, as, upon the whole, more consistent with the phenomena presented by coal formations.

It has been well observed by one of the most instructive geological writers, that in the present condition of the coal measures we have opportunities of observing design, even where things are so disposed as at first sight apparently to preclude any such inference. The accumulation of vegetable matter at a remote epoch in the history of the world, for the convenience and consumption of creatures which were long afterwards to exist upon its surface, must strike the least inquiring; but when the twisted, dislocated, upturned, and broken strata so common in the coal districts are before us, the design appears to the superficial observer to be frustrated, especially when the miner complains of them as interrupting or even preventing his progress; so that this apparent confusion has sometimes been regarded as a bar to the ingenuity and industry of man in extracting the combustible so valuable and requisite. When, however, we contemplate the subject more closely, we find that these very irregularities and inconveniences are in reality highly advantageous, for they often heave up seams of coal that would otherwise be beyond reach; and they perform the yet more important service of excluding the passage of subterraneous waters from one part of the workings to another: so that the miners in collieries situated in one particular mass have only to contend with the waters in it; whereas if the strata were always unbroken and continuous, such would be the abundance of water flowing into the workings that the utmost difficulty and expense would be incurred in proceeding, and it would often be necessary altogether to abandon the further extraction of the coal. The section of strata in Jarrow colliery, near Newcastle, shows how curiously they are sometimes fractured and dislocated; and in the coal measures at Little Haven, St. Bride's Bay (Pembrokeshire), we have a good instance of their occasional contortions.

The annexed diagrams represent a section of a coal basin, and the disturbance and dislocation of the strata by dykes or cross-courses. A A, in the first figure, are the dykes by which the shales and coal, B B B, are disturbed; and, in the second, the seam of coal B B,

which, as in the other case, was once continuous, has been dislocated by the intrusion of the dyke A.



Though there may be many beds and seams of coal in one field, it is seldom that many of them are worked; they are generally of uniform thickness through a great extent, but are sometimes subject to irregularities. When less than two feet thick, they are seldom worked to any great extent.

The nature of the upper stratum of stony matter, or *roof*, is very important. If compact, it is secure from falling, and keeps out water; if loose, the expense incurred in supporting it absorbs the profits of the coal. The deepest coal mines of England are those of Northumberland and Durham, which are worked nearly 1000 feet below the surface. The thickest bed of coal is said to be at Wood Mill Hill colliery in Staffordshire, and to exceed 40 feet. From 6 to 9 feet is the average thickness of the most productive seams.

Coal strata are often accompanied by *clay ironstone;* an ore of iron not so rich in metal nor so pure as many others, but which has acquired infinite importance from its association with coal and limestone, the substances which are requisite to reduce and purify it. The richest varieties of this ore are said to yield about 25 to 30 per cent. of metal, and it is the chief source of the enormous quantities of iron manufactured in this country.

§ II.

Mountain Limestone, which is the next rock in descending order, may be considered as forming the foundations as it were, or basins, in which the coal is commonly deposited, and in this respect bears some correspondence to the chalk and its tertiary formations.

This kind of limestone is of various colours, and often so full of organic remains as to appear almost entirely made up of them, especially of encrinal columns; but sometimes scarcely an organic relic is to be detected, and it is veined and variegated with streaks of calcareous spar. Both these varieties form useful and often handsome marble.

This rock is of further interest, as being that which in the centre and north of England is the seat of our most productive lead mines; hence it is called *metalliferous limestone*. The great patch of limestone extending from the Tweed to the Tees, bounded by the coal measures on the east, and on the west by the Cheviot Hills, is especially known as the *lead measures*. The characters of the rocks are very variable. The veins hitherto worked occupy a space of about 15 miles north and south, and 20 west and east, and run, with little exception, nearly west and east.

The Yorkshire limestone district, exclusive of its metallic veins, is traversed by others, which, as they are only filled with lapideous substances, are of little interest to the miner, but of deep importance to the geologist. They often intersect the metallic veins, disturbing the parallelism of the strata, and often occasion much irregularity and confusion. There is here an instance of the elevation of the strata to more than two fathoms upon the side of one of these cross veins. The contents of these cross courses are very miscellaneous; and where the material they are filled with is much harder and more durable than the assailed strata, their course is often perceptible upon the weather-worn surface of the country which they traverse. Such is the cross vein of the lead measures called the Devil's Backbone, forming a ridge that may be traced a considerable distance along the country through which it passes.

The Derbyshire limestone district is well known, and frequently visited on account of the romantic scenery and wonders in which it abounds. Castleton is its northern point, and it extends southward about 25 miles to Weaver Hill. Its breadth is very irregular, but nowhere exceeds about twenty miles. Its eastern end contributes to the delightful and varied scenery of Matlock, and its north-western extremity is celebrated for the wonders of the Peak.

In regard to the varied aspect of this district, it may be observed that the different strata of limestone differ considerably from each other; that beds and dikes of another species of rock intervene, provincially called *toadstone;* and that the respective edges of these strata come to the surface; and, lastly, that the country is traversed by a great fault or dislocation.

The singular turreted and broken appearance of these limestone rocks, and the fantastic shapes which their various masses occasionally assume, are well seen in Dovedale; and some of their other peculiarities, especially their curvatures, and some of the dislocations which they have suffered, are evident in Matlock and its neighbourhood. In the High Tor the stratification appears horizontal and regular when viewed in front; but a more accurate examination shows that it is curved and irregular: a section made by the river Derwent, near the toll bar, well illustrates this peculiarity. Another instance of *curved* strata may be seen in Crich Cliff, about 4 miles east of Matlock; it is an isolated hill about 900 feet above the level of the river. According to Mr. Bakewell the mass of the hill consists of arched strata of limestone. The different beds of limestone are of very different qualities and composition; the upper cherty, and often bituminous, abounding in corallites and encrini, &c., often curiously seen in relief upon its weather-worn surface. Beneath the rock contains beds of magnesian limestone and silicious limestone or dunstone, and towards its lower parts beds of black marble. The lowest limestone stratum is that which forms the Peak Forest, the downs of Buxton, and the Weaver Hills; and in it are several remarkable caverns. Here also we find at Castleton those curious nodules of fluor spar celebrated for the manufacture of vases, &c.; also that very singular mineral, the elastic bitumen, or fossil caoutchouc. The subterranean streams which traverse many of these caverns, the *stalactites* and *stalagmites* in which they abound, and the thermal waters which characterize the district, are all important points to be noticed. The toadstone of Derbyshire is sometimes represented as regularly stratified between the limestone beds, but this requires further investigation; and at all events the beds, if such they are, are liable to many extraordinary irregularities. The toadstone never contains shells or organic remains; calcedony, zeolite, and globules of calcareous spar are not uncommon in it; and whatever theory may be entertained in respect to it, it evidently bears the character of a formation distinct from its associates. In the cave at Castleton it forms a large irregular column, having the appearance of the rock called basalt.

The veins in the limestone in Derbyshire contain the ores of lead, manganese, copper, zinc, and iron: the proper repository of the lead appears to be the limestone, though it also occurs in some other strata, and rarely in the toadstone, in which it is always in small quantities, and merely in strings or very imperfect veins. Near Bristol the limestone hills rise from below the red sandstone, and form the edges of the coal basin. In some places it is very bituminous, as on the Avon at Chepstow, and even exudes petroleum. On the Welsh coast of the Bristol Channel we have another ridge of limestone, forming the basin, as it were, in which the great coalfield of South Wales is situated. The hills on the west of Swansea and the cliffs on the south of Pembroke are of this formation; and again on the banks of the Wye it constitutes scenery of a soft but most romantic character. There is something singularly fascinating in the landscape of the limestone districts, resulting not only from the varied forms and groupings of the mountain masses, but depending also upon the nature of the substance, and of the soil derived from its decay. Upon the perpendicular and projecting precipices lichens of various and singular hues alternate with the grey surface of the uncovered rock; a variety of shrubs are scattered by nature's hand upon its picturesque and waving sides; ivy and other creeping plants issue in gay luxuriance from its crevices, and the glens and valleys are adorned by every variety of verdure.

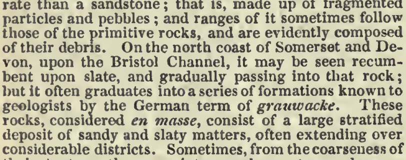
We may now cast a glance upon the probable state of the globe at the period at which the coal and the subordinate limestone rocks were formed. In regard to the latter it would appear that they extend over a great part of central and northern Europe; and that rocks containing the same organic remains are found in the lake district of North America, and are even abundant upon the borders of the Arctic Sea. The great quantity of corals found in this formation, as well as its vast extent, seem to prove that it was formed in a deep and extensive sea, in the midst of which there were many isles. These isles were apparently composed of primary and of volcanic rocks, which being exposed to the erosive action of torrents, to the artillery of the waves, and to superficial

decomposition, supplied materials for the pebbles, sand, and shale, which, together with substances introduced by mineral springs and volcanic eruptions, contributed the inorganic parts of the carboniferous strata. In regard to the fossil remains of these strata, the vegetation of the coal districts is stated by botanists to possess the characters of an insular and not of a continental flora; and we may suppose the carbonaceous matter to have been derived from trees swept into the sea by torrents, and from peaty matter, which even in our climate often blackens the rills of marshy grounds. It has been acutely observed by Mr. Lyell, that if we seek for present points of analogy to this state of things, we must either turn to the North Pacific, and its numerous submarine or insular volcanos between Kamschatka and New Guinea; or, in order to obtain a more perfect counterpart to the coralline and shelly limestones, we may explore the archipelagos of the South Pacific between Australia and South America, where coral reefs, consisting in great part of compact limestone, are spread over an area not inferior perhaps to that of our ancient calcareous rocks, though we even suppose these to be prolonged from the North American lakes to central Europe.

In these remarks we anticipate a subject requiring more full discussion, and they are merely introduced here to direct attention to the coincidences and analogies between the present order of things produced by causes now active and by the ordinary proceedings of nature, and those great but remote changes of the earth's surface often unnecessarily referred to extraordinary catastrophes and convulsions.

Beneath this great limestone formation strata of sandstone occur, which from their position, as opposed to those *above* the coal, are known under the name of the *old red sandstone.* It often appears more as a conglomerate than a sandstone; that is, made up of fragmented particles and pebbles; and ranges of it sometimes follow those of the primitive rocks, and are evidently composed of their debris. On the north coast of Somerset and Devon, upon the Bristol Channel, it may be seen recumbent upon slate, and gradually passing into that rock; but it often graduates into a series of formations known to geologists by the German term of *grauwacke.* These rocks, considered *en masse*, consist of a large stratified deposit of sandy and slaty matters, often extending over considerable districts. Sometimes, from the coarseness of their texture, they pass into *conglomerates;* and sometimes, from its fineness, graduate into *roofing slate*, apparently formed of highly comminuted detritus. In this formation the sandstones are comparatively deficient in organic relics, but they abound in the limestone. Upon the whole they exhibit marks of *slow* deposition. This series of rocks, namely, the formation intervening between the mountain limestone and the inferior granitic or hypogene rocks, has been ably investigated by Mr. Murchison, who has assigned to them the name of *Silurian*, from their being best developed in that part of England and Wales formerly included in the ancient British kingdom of the *Silures.* The lower part of the Grauwacke series constitutes the Cambrian rocks of Professor Sedgwick.

There are some curious facts respecting the stratification of the slaty portions of these rocks, which, as they apply to slate generally, it may be proper here to mention; and as an illustrative instance, that noticed by Mr. De la Beche as occurring at Bovey Sand Bay, on the east side of Plymouth Sound, may be referred to: *a a*, *curved* beds



of slate, the laminæ of which meet the apparent lines of stratification at various angles, being even perpendicular to them. The beds are cut off by the fault *f* from the slates *c*, the laminæ of which are confusedly horizontal. The whole is covered by detritus of fragmented slate *b*.

We are now gradually descending into the *non-fossiliferous* rocks; for the lower grauwackes graduate into slates destitute of organic remains, and into rocks of chemical rather than of mechanical origin. Thus we arrive at that very remote condition of our planet, when neither animal nor vegetable life seems to have existed on its surface; and instead of wandering in imagination amid forests, lands, and seas, surrounded by strange vegetables, and by animals yet more strange, our attention must be directed to the laws which govern inorganic matter.

Of these *inferior*, *stratified*, and *non-fossiliferous* rocks, one of the most abundant and important is *argillaceous* or *clay slate.* It differs in texture and composition; and except from its geological position, is often scarcely distinguishable from the slates of the grauwacke series. When chlorite prevails, it is called *chlorite slate;* and it passes into *hornblende slate*, and into *mica slate*, and is associated with *quartz rock.*

The origin of these rocks is extremely ambiguous. In regard to clay slate, it is apparently a mechanical deposit of very finely comminuted matter. It often contains regular crystals of pyrites: it is of various colours, generally grey, black, or reddish, and like most other rocks derives its colours from the oxides of iron. Beds of this slate, when finely lamellar, are valuable, as furnishing materials for roofing. Those which are least absorbent of water, and which split into the thinnest and smoothest plates, are selected; but they should not be *too thin*, as they then fail in durability, and do not resist the force of storms. Slate is also largely employed for other architectural purposes, and for the construction of tanks and cisterns. In this country there are extensive quarries in Westmoreland, Yorkshire, Leicestershire, North Wales, Cornwall, and Devonshire.

The forms, tints, and general associations and outlines of some of the mountains of Cumberland especially, and the English lake scenery in general, are illustrative of the mountains of the grauwacke and slate formations. The former exhibit united softness and grandeur; the latter a more elevated and rugged aspect. We have varied and grand instances of slate in the mountainous district of North Wales, and in Cumberland and Westmoreland. The cluster of hills, of which Skiddaw forms the highest elevation, may perhaps be referred to as genuine clay slate; and in Devonshire and Cornwall the granitic range, which traverses the promontory like a backbone, beginning at Dartmoor and terminating at the Land's End, has slate overlying it on both sides. The scenery of Fowey, Looe, Tintagel, and other places on the north and south sides of Cornwall, derives its grandeur and charms from the various assemblages of slaty headlands, promontories, creeks, and islands. Sometimes its strata jut out in bold fantastic forms upon the ocean, and sometimes gradually shelve away into gentle slopes. Their verdure is usually scanty and uncertain; but here and there a clayey soil finds a resting place, and cherishes patches of shrubs interspersed with trees of loftier growth, and attracting attention by the sterile and fragmented surface which often surrounds these insulated spots. The beauties of the coast of Cornwall are singularly contrasted by the barren exterior of its central road and great mining district; where scarcely a blade of grass relieves the black and sombre hues of the ground, but where heaps of rubbish, once rich in embowelled treasures, give a gloomy irregularity to the surface; and where the ponderous heaving of machinery raises subterranean rivers to a new level and into new channels, and enables the miner to arrive at treasures which but for the inventive genius of Watt would have remained inaccessible.

The mountainous aspect of slate is seen to great perfection on the western side of Wales; where Snowdon, Plynlimmon, and Cader Idris, with many of their respectable associates, present the peaked summits, the dark and narrow valleys, the steep precipices, and the fragmented slopes that peculiarly belong to this formation.

Associated with the rocks of the inferior stratified group (slate, mica-slate, gneiss), there are those beautiful varieties of white and crystalline limestone known as the statuary marbles of Greece and Italy. They vary in their texture. That of the lake of Como, which is the building stone of Milan cathedral, is a good instance of coarse-grained marble; and sometimes it acquires a slaty fracture from the admixture of mica or talc, and passes into *dolomite* from the presence of magnesia.

Before we quit these rocks, there is one remarkable feature which belongs to them and others, and which may now be adverted to, though its *cause* will perhaps be more evident hereafter; namely, the singular contortions to which they are subject. The strata of slate, for instance, are often waved to a greater or less extent; and sometimes an entire bed affects a serpentine irregularity, which gradually merges into a straight line above and below. These contortions are sometimes, to all appearance, independent of any other kind of rock. Sometimes they are apparently caused by veins of a granitic, porphyritic, or basaltic character, invading the slate as it were from below, and bending it into various irregularities, or sometimes merely dislocating and breaking its strata: as if, in the one instance, it had acted upon soft, yielding, and unconsolidated matter; and in the other, as if it had been violently protruded into the surrounding strata of an already hardened mass. These contortions are not peculiar to the slaty rocks; they may also be seen in the newest and in the oldest formations, varying infinitely in their forms and dimensions. They have sometimes misled geologists as to the relative positions or conformity and nonconformity of alternating rocks; so that it requires great care, though at first sight it may appear extremely easy, to determine whether one rock rests on the upturned edges of another or not.

In taking leave of the stratified rocks, we lose sight of

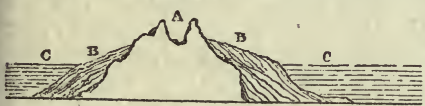
that regularity of superposition which is of so much use in assigning to them the periods of their formation, and which, in conjunction with their organic remains, affords such important evidence respecting their relative ages, and the circumstances of climate under which they have been deposited.

Their minute examination shows the caution with which certain theories connected with them require to be received. The gradual transitions of one kind of rock into others on the one hand, and their sudden and abrupt lines of demarcation on the other; their verticality in one place, and their horizontality in others; their occasional resemblances and frequent dissimilarities, are circumstances which will lead the unprejudiced observer to receive all geological hypotheses with the utmost circumspection. Another important point relates to the dissimilar texture and contents of rocks appertaining to the same series, but occurring in different situations and countries: thus the *equivalent* of our chalk is a granular limestone in part of the Alps; and here, as in other cases, it is the identity of the organic remains that determines the geological era.

We have now then arrived at the crystalline, massive, and unstratified rocks, which seem to form the bases or foundations upon which the others have been deposited. They have therefore been called *primary* or *primitive rocks;* and as they are destitute of organic remains, they were regarded at one time as of more ancient origin than the superincumbent strata. But the progress of inquiry has led to a very different view of the origin and antiquity of these rocks; and modern geology, in assigning to them an igneous origin, assumes that though they have been formed at different epochs, they are often of more recent production than the older stratified rocks, and even sometimes of a date subsequent to those depositions which form the tertiary series.

Upon this subject the theories of M. de Beaumont have excited much attention. He assumes that the different mountain chains of the world have been thrown up at different geological periods; that each great chain runs in a certain uniform direction; and that their relative dates of protrusion may be ascertained by their effects upon the sedimentary strata. If, for instance, we find the great mass of crystalline rock on all sides surrounded by tranquil and horizontal sedimentary deposits, we infer the deposition of the latter *subsequent* to the former. But if we find the sedimentary deposits *upheaved* by the crystalline rocks, we then infer the posterior date of the latter; and if other horizontal sedimentary deposits lie upon the upraised series, another geological date is obtained as respects them.

The following diagrams will perhaps assist the illustration of De Beaumont's theory. A may represent a chain of granitic rocks; and B, C, and D the incumbent rocks or strata. From the dislocated and inclined position of B, and the horizontal and undisturbed state of C, it may be presumed that the chain A was elevated subsequently to the existence of B B, but before the deposition of C C. On the other hand, in the lower figure, C C have also been elevated, whilst D D are undisturbed; whence the inference that in this diagram the chain A is of a later date: here D D represent the undisturbed or horizontal deposits.



Reasoning upon such grounds, it has been attempted to prove that the great mountain chains of the earth are of various dates, some formed prior to and others subsequent to their secondary or sedimentary neighbours. Thus also, if we assume that these great crystalline masses have been thrust up from below, may we account for the elevation of rocks abounding in organic remains. Whether these mountains have been *suddenly* or *gradually* upheaved, is a very important point in controversial geology. The one opinion has been advocated by De Beaumont, the other by Mr. Lyell. According to De Beaumont, there have been long periods of repose in the history of the earth, during which the deposition of sedimentary matter has gone regularly on; and there have been short periods of violence, during which that continuity was broken by the sudden formation of great mountain chains. It is supposed that all the chains thrown up by a particular revolution, or at one time, are nearly parallel; but that those thrown up at different periods have different directions, so that they sometimes cross each other: that, therefore, there has been a recurrence of these paroxysmal movements from the remotest geological periods; and, of course, that they may still be reproduced, and break the present repose of our globe. It is presumed that the latest of these revolutions (even within the historical period) was that which upraised the Andes, for that chain is the best defined and least obliterated feature in the present exterior configuration of the globe; and as the instantaneous appearing of such enormous mountain masses must have caused a prodigious agitation in the waters of the ocean, it is probable that a deluge was one of its effects; and, lastly, as common volcanic powers are apparently inadequate to these successive revolutions, they are assumed to depend upon the secular refrigeration of the interior nucleus of our planet causing a fracture of the outer crust, and the consequent spirting out, as it were, of some of its interior contents.

There is much that is imposing, and to all appearance satisfactory, in parts of this bold theory; but the question is, how far is it strictly consistent with facts? Have we any evidence of such frightful convulsions? are they consistent with what we actually know of the earth's structure? are they in accordance with present phenomena? or can we frame any other theory equally applicable, and less at variance with the changes now in progress, and with the known causes of those changes? These are questions which Mr. Lyell has directed himself to, and which involve the effects of existing volcanos, and of various causes of decay and reproduction that now affect the surface of the earth, and to which we shall allude afterwards: they are discussed at length in his valuable work which we have already so abundantly quoted — his *Principles of Geology*.

Proceeding in the retrospective survey of geological monuments, from those of recent to those of more ancient date, we have traversed a series of strata, each characterized by their relative positions in respect to the others, but more unequivocally distinguishable into regular epochs of formation by their organic relics. These we have found gradually to diminish, and ultimately to disappear; the rocks slowly losing their sedimentary character, and appearing as crystalline aggregates, and consequently as products of chemical rather than of mechanical action.

The formations at which we have now arrived include granite, and its associates greenstone and basalt; and from these more ancient substances we pass by regular analogies to a variety of evidently volcanic products, — some of remote antiquity, others formed within the historical period. How this interesting series of rocks are thus connected into one group, and what the evidences are of their igneous origin, will appear presently.

As they form the basis upon which the sedimentary rocks appear to lie, rising to the surface in the central and highest parts of the great mountain chains, and at the same time passing down and forming the inferior parts of the crust of the earth, they were once, as already stated, called *primitive rocks*, and regarded as having been formed anteriorly to the others; but the more close examination of their relations to the sedimentary deposits just adverted to, and of the changes which they have effected upon them, have induced modern geologists to reject such an hypothesis, and to consider them as of a later date; varying, however, in this respect among themselves, and hence divided into *ancient* and *recent* groups, or *plutonic* and *volcanic* formations.

To represent the great mountains of the world, — the Alps, the Andes, and the Himalayan chains,—as upheaved in a liquid or semifluid state from below by processes analogous to those exhibited by the volcanos and earthquakes of present times, has been by some regarded as a bold but improbable conjecture, and as outreaching in improbability many of those theories which have been unanimously condemned as absurd and insufficient. But when we carefully compare the nature of the rocks which compose them, and their influence upon those which they invade and elevate, and examine the vast powers of existing volcanos, the enormous quantities of matter which they have ejected, the force with which they act, the upraising power of earthquakes as manifested within the historical period, and their evident connection with volcanic phenomena, and more especially when these forces are considered as operating under the great pressure of a superincumbent ocean, we find a connected series of facts and analogies which justify the conclusion. We may here examine the rocks in question, and the evidences which they bear of a distinct formation; reserving the history of contemporaneous volcanic phenomena, and of the effects of earthquakes, for a subsequent section.

The first circumstance which strikes us in these formations is the height to which they tower above the sedimentary rocks. In Britain, Ben Nevis and Cairngorm, in Inverness-shire, are between 4000 and 5000 feet above the level of the ocean; Mont Blanc is between 15,000 and 16,000 feet above the same level, and is the highest

mountain in Europe; Soxate, the highest summit of the Andes, from 24,000 to 25,000; and the highest peak of the Thibet chain, 26,000 to 27,000 feet.

Under the term *granitic formation*, we may include not merely granite (which is a crystalline aggregate of quartz, felspar, and mica), properly so called, but other rocks into which it merges, either from the predominance of one or other of its ingredients, from the loss of one or other of them, or from the occasional addition of some new mineral. We may also include in this division of rocks those substances which are their occasional accompaniments.

When mica abounds, granite passes into *gneiss;* and when the felspar is nearly or altogether wanting, it forms *mica slate;* and this again often passes into *quartz rock* from the scantiness or absence of mica. These would seem to be sedimentary rocks gradually passing into granite. They may be traced upon the one side into clay slate, and into granite on the other. *Hornblende*, which is an alumino-silicious mineral containing magnesia, and abundant in black oxide of iron, forming prismatic crystals, is often intermixed with granite, and sometimes with felspar only, forming *sienite* and *sienitic rocks;* and when crystals of felspar are as it were embedded in massive felspar, the rock is called *porphyritic* or *porphyry*.

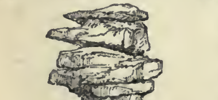
The presence of granular or crystalline marble amidst these rocks has already been mentioned. Respecting its source, there is room for difference of opinion; but it possibly may have been fossiliferous limestone, the organic relics of which have been destroyed by the heat which conferred upon it its semicrystalline form: and it has been proposed to account, upon the same principle, for the absence of organic relics in the slaty rocks of this series.

Serpentine is a rock which it is somewhat difficult to define. Hornblende, schiller spar or diallage, and felspar, and perhaps also talc, appear to be essential to its constitution, and sometimes they are distinctly visible; while at others the rock is so fine-grained as to be nearly homogeneous. Its variety of colours (whence its name) recommends it for ornamental purposes, but it is too soft to admit of a permanent polish. *Talc* forms inelastic laminæ, soapy to the feel, and differs little from *steatite*, which often pervades serpentine in veins.

Such are the varieties of the granitic group; the *hypogene rocks* of Lyell (from *ὑπο*, *under*, and *γινομαι*, *I am formed*), that is, nether-formed rocks: he calls the stratified rocks of this class *metamorphic*.

The largest granite tract of England is that of Devon and Cornwall, where its sides are covered by slate, but where it rises in several places to the surface; it also forms the rocky promontory of the Land's End. There is here nothing either picturesque or sublime belonging to the granite formation. Dartmoor appears the head quarters of dreariness and desolation, forming a large mountain tract of nearly 80,000 acres in extent, strewed with boulders and fragments, and appearing to set cultivation at defiance. This granitic district is nowhere of any considerable elevation; its highest point, near Okehampton, is 2070 feet.

The peculiarities of the West of England granite are best seen at the Land's End, where a large patch of it protrudes in a wedge-shaped promontory. It appears formed of fragments and masses placed upon each other in the rudest disorder, and sometimes in fantastic piles and insulated blocks, which, though arising from the peculiar manner in which the rock is decomposed and dislodged by the weather, have been mistaken for Druidical remains. These *tors*, as they have been called, have been described by Dr. M'Culloch (*Geol. Trans.*), and some of them are depicted in the engravings annexed to his paper. One, called the *Cheesewring*, near Liskeard, consists of five blocks, of which the upper are larger than the lower, the whole pile being about 15 feet high. The stones composing this and other similar piles suffer by the action of the weather most rapidly upon their edges and angles, which gradually become rounded, and the blocks then begin to totter and ultimately fall. This tendency of square blocks to become spheroidal, and which has sometimes been mistaken for the effect of friction, shows that attrition and transportation by streams are not always essential to their rounded appearance. The celebrated *Logging-stone* well exhibits the tendency of this kind of granite to cuboidal separation. Some of the Shetland Isles present magnificent specimens of the wear and tear of granite. On the west of Meikle Roe the softer veins have mouldered away, while the firmer rock which included them has remained unaltered; and in this way long narrow ravines are laid open which give access to the waves. The singular cluster of rocks at Hillswickness,



Cheesewring.

Hillswickness.

which has been compared, when seen at a distance, to a small fleet of vessels with spread sails, also affords a good instance of granitic disintegration on the one hand, and of its permanence on the other; weathering storms and an ocean which would long ago have consigned softer materials to utter destruction.

There are, however, some varieties, which decay with comparative rapidity. De Luc talks of the *friable granite* of the Hartz, and Saussure describes the mouldering down of that of the Alps. The waters of the Arve are rendered turbid by the pulverulent felspar that comes from the *Aiguilles de Chamouny* and other points that border the *Mer de Glace*. The road across Dartmoor from Ashburton to Chagford traverses, in one place, such loosely compacted granite as to resemble a bed of gravel. The granite of the Carglaise mine, near St. Austle, is so soft and pulverulent, that the excavation might almost be taken for a chalk pit; and in the same vicinity the immense quantities of white porcelain earth, as it is called, is of similar origin, and apparently derived from the perishable nature of the felspar, which, giving way, suffers the grains of quartz and mica to fall out. Chemical analysis points to the loss of the alkali of the felspar as the cause of this extreme proneness of some kinds of granite to decay. Independent, however, of chemical composition, mere mechanical texture and the general aggregation of mountain masses have much to do with their relative durabilities. When the arrangement of granite resembles that prevalent in the greater part of Cornwall, water gradually penetrating between the blocks and masses freezes there, and thus slowly removes or transfers them to unstable ground; while the more solid texture of other varieties of granite, denying the access of water to its fissures, is slower in suffering the decay referable to that powerful cause.

Gneiss and mica-slate often form mountain masses in association with each other and with the varieties of granite. The former is seen singularly contorted upon the coast of Lewes; and mica-slate rock is associated with the serpentine of Cornwall, and is seen in great perfection among the Scotch granitic scenery, more especially in the vicinity of Dunkeld, and in extraordinary magnificence in the lofty mountain of Benmore. Ben Lawers, on the north of Loch Tay, and many of the neighbouring mountains, furnish highly instructive specimens of granite passing into gneiss, mica-slate, and chlorite-slate. About three miles south of Dunkeld, a stratum of grauwacke is seen incumbent upon chlorite-slate, gradually passing into a fine gray roofing slate, and this recumbent upon mica-slate. The peculiar and differing dip of the respective strata, the singular manner in which they are pierced and traversed by veins of felspar and quartz, and their association with micaceous iron, are circumstances highly interesting in respect to the origin of hypogene rocks; and the beauty and magnificence of the district in regard to scenery is not less than its diversified geological peculiarities.

Mica-slate, abounding in garnets, and often sprinkled with red patches originating in their decomposition, and becoming sienitic from the interspersion of hornblende, is prevalent upon the banks of the Tay and about Dunkeld; but it is in Glentilt that the geologist, both practical and theoretical, will find the most ample materials for the study of the association and junctions of this series of rocks.

In the immediate neighbourhood of Blair, the Tilt exhibits upon its banks a section of the rocks forming its bed; and the micaceous strata here and at the falls of the Bruar incline nearly at the same angle to several points of the compass, giving a curious confusion and interweavement to their assemblage. Ascending a few miles up the glen we observe granular limestone in the midst of the granite, which sends forth so many veins as to *reticulate* the slate; and often there appear to be detached fragments of granite in the limestone and shistose rocks.

There are other places in which analogous peculiarities of granite and its associates may be observed; for instance in St. Michael's Mount, upon the south coast of Cornwall, where the granite not only graduates into mica-

slate, but the latter is traversed by granite veins, which appear to break and indurate it. Exclusive of Cornwall and Devonshire, the hypogene or plutonic rocks are comparatively rare upon the surface of England. The Malvern Hills, Mount Sorrel in Leicestershire, and a few of the ridges of Cumberland and Westmoreland, afford specimens of these rocks. In the Isle of Man and in Anglesey granite is associated with clay-slate; and near Gwindy in Anglesey the points of granite curiously protrude from beneath the slate.

In reference to the origin of granitic rocks, it appears almost impossible to reject that theory which regards them as having been formed by the igneous fusion of sedimentary rocks; while it cannot be denied that peculiar circumstances must have conspired in conferring upon these formations their distinct and peculiar characters. Their analogy to basalt, greenstone, and trap will presently be noticed, and the close resemblance of the latter to existent and contemporaneous volcanic products traced out. But then why is not granite formed by our present volcanos? or why are more modern lavas so distinct from these ancient rocks? The probable cause of the difference lies in the circumstances under which the subterranean fusions have been effected; in the case of granite, probably under *great pressure*, and out of the contact of air and water. What is now going on at great depths, and under the pressure of fused masses and a fathomless ocean, it is impossible actually to ascertain, and analogy only can guide us; but the circumstances just mentioned appear essential to the formation of highly crystalline rocks, and the extremely slow cooling of these fused masses would also favour many of their peculiarities. In demanding this liquefaction and gradual refrigeration the plutonic geologist has often been sneered at for the exorbitancy of his postulates; but the great length of time which lava streams require to cool, even in the open air, justifies the conclusion. The melted matter poured out of Jorullo in Mexico, in 1759, which accumulated in some places to the height of 550 feet, retained a high temperature for fifty years after the eruption. For what immense periods then may not great masses of subterranean lava remain red hot, and how gradual must be the process of their refrigeration! This process, indeed, may be retarded for an indefinite time; for the lava in the crater of Stromboli has been in a state of constant ebullition for the last 2000 years, and this mass of fused matter must of course communicate with some great reservoir below. In the Isle of Bourbon also, where there has been an eruption every two years for a very long period, the lava below must be in a state of permanent liquefaction. In adverting to the effects of long-continued fusion upon earthy and alkaline compounds, and to the various textures and characters of rocks which may thus result from the liquefaction of similar materials, sometimes producing distinct crystalline aggregates, at others more homogeneous products, we are sanctioned by the result of actual experiments; and although our artificial products are necessarily formed upon a scale of trifling insignificance as compared with the natural ones, we sometimes obtain extraordinary and unexpected results — to such an extent, that it is impossible by any *à priori* reasoning to determine what new mineral products may not be obtained by the varied effects of heat upon components little dissimilar.

When, therefore, melted matter is injected into the fissures of a contiguous rock, it may either cool *rapidly* if that rock had not previously acquired a high temperature; or if it had, it may continue for centuries at a high temperature, and consequently attain various textures, and present a variety of distinct minerals.

We have already stated what our means are of judging of the relative ages of these rocks. Some of the granitic chains appear to be of great antiquity, antecedent to the secondary and tertiary rocks; though perhaps there may be a few cases in which they are apparently contemporaneous. It is also probable that they are constantly in a state of *production*, perhaps to be upheaved at some future period by operations which we shall afterwards endeavour to unravel.

From granite and its associates we pass to a class of rocks often designated as the *trap formation*, including whinstone, basalt, greenstone, &c. They are apparently of igneous origin, and approach in many instances very closely in their effect and character to the lavas of contemporaneous volcanos.

The term *trap rock* has been especially applied to those *step-like* or scalar declivities which mountain masses of this substance sometimes present. In employing this term, we shall rather use it as a generic name of the rocks in question, than as specifically implying the materials of which they are composed; and since the varieties known under the names of greenstone, basalt, toadstone, whin, pitchstone, and amygdaloid belong to this same class, and often graduate into each other, these terms may be occasionally employed as characterizing individual specimens of trap rock,—designating the fine-grained homogeneous rock *basalt*; the greenish varieties which especially occur among the older rocks, and sometimes approximate to the nature of sienite, *greenstone*; those containing nodules of calc-spar, quartz, agate, zeolite, &c., *amygdaloid* or *toadstone*.

The general character of these rocks is, that they appear amongst stratified deposits of all dates, and among the oldest and newest rocks: sometimes graduating through greenstone and hornblende rocks into varieties closely connected with granite; at others degenerating, as it were, into substances closely resembling the lavas of existing volcanos. When they assume a stratified character, it arises from their apparent injection in a state of fluidity amongst other rocks, or from having been subjected to peculiar laws of action whilst cooling; and where they come into contact with other rocks, they often fill their rents and fissures with dikes and veins, and harden or alter them in such a way as to leave indisputable records of their igneous origin, — converting chalk into marble, coal into cinder or coke, sandstone into chert and jasper; and the veins themselves present different textures, dependent on their bulk or breadth, and upon the greater or less rapidity with which they appear to have cooled. The following may be selected as illustrative instances of the aspects, characters, and situations of trap rocks:— Under the name of greenstone it is seen in characteristic masses, associated with the granite, mica-slate, and serpentine of the Lizard Point in Cornwall. Near Kington and Radnor in Wales, it accompanies clay-slate and old red sandstone; and upon the northern side of Snowdon, Plynlimmon, and Cader Idris, coarse-grained, and with regular crystals of hornblende in one place, and in another fine-grained, homogeneous, and even basaltic or columnar. In Derbyshire, under the name of toadstone, this rock is associated with mountain limestone, and with new red sandstone or red marl in the coalfields of the north of England and elsewhere. In Antrim we find it variously blended with the sandstone and chalk, and even sometimes superior to the newest secondary formations. These instances will serve to show the varied *position* of these rocks. In regard to their *aspects*, we observe them in Cornwall forming blocks and masses, not unlike the granite of the county. Sometimes, as in the coalfields, it forms immense walls or dikes, and even axes of elevation; sometimes, as in Derbyshire, it has the *appearance* of stratification. In the Isle of Mull and elsewhere it is massive and amorphous, and in many places it is columnar; of which the coast of Antrim, the island of Staffa, and some parts of Mull furnish such magnificent instances. The Isle of Mull, Ulva, and the Tresharnish Isles exhibit trap rocks and veins in the greatest variety; and the veins of the Isle of Sky are not only remarkable for their singular extent and arrangement, but for the changes they produce upon the rocks they penetrate, and which are of such a nature as to throw some few rays of light upon the most recondite chemical phenomena connected with geology. Two of these veins penetrate the white marble of Strath. At their junction the trap passes into a substance resembling serpentine, and is penetrated by fissures containing steatite; while the marble acquires all sorts of colours and changes in composition, from argillaceous to magnesian, and from magnesian to silicious. In other parts the trap veins exhibit the several varieties of greenstone, basalt, and amygdaloid.

The island of Staffa is one of the most celebrated basaltic monuments of the world: it is about a mile and a half in circumference; and its greatest elevation, which is upon its north-west side, is about 144 feet. Its lowermost bed upon that side is a basaltic conglomerate. The columns are compact and uniform in texture, dark greyish-black interiorly, and rusty brown where exposed to the weather. Amorphous and columnar basalt and a stratum of pebbles foreign to the island form its upper portion. Fingal's Cave is justly considered as the most beautiful of ocean caverns, and owes its existence to the circumstance of the columns being jointed in that place, while their general character is to be without divisions; hence the successful invasion of the waves in this particular quarter. The entrance is 70 feet high, and resembles a Gothic arch; the width 40 to 50 feet, the length 227 feet. Its interior preserves a considerable degree of regularity throughout, its sides being columnar, and in many places broken and irregularly grouped, so as to catch a variety of direct and reflected tints, mixed with unexpected shadows, and producing a picturesque effect which no regularity could have conferred. The sea never entirely ebbs out of this cave, but the broken range of columns which forms the exterior causeway is continued on each side within it. "This cave," says Dr. M'Culloch, "has been frequently described, but no description is adequate to the representation of its varied beauties and singular associations.

Fingal's Cave.

If it were even destitute of that order and symmetry, that richness arising from multiplicity of parts combined with greatness of dimensions and simplicity of style which it possesses — still the prolonged length, the twilight gloom half concealing the playful and varying effect of reflected light, the echo of the measured surge as it rises and falls, the pellucid green of the water, and the profound and fairy solitude of the whole scene, could never fail strongly to impress any mind alive to the wonders and beauties of nature." Mackinnon's Cave and the Boat Cave in the sland are also worthy the traveller's attention.

The Giant's Causeway, and the various promontories of the coast of Antrim, form another basaltic district of great grandeur and interest.

The Causeway itself consists of three piers of columns, which extend into the sea, and are walled round as it were by precipitous rocks from 200 to 400 feet high, in which are several striking columnar assemblages, vertical, inclined, curved, and horizontal, and in some places appearing as if wedged or driven into the surface of the precipice: Bengore, which bounds the Causeway on the east, consists of alternate ranges of tabular and massive with columnar basalt: Pleskin presents several colonnades of great height and regularity, separated from each other by tabular basalt; and at Fairhead there is a range of columns from 200 to nearly 300 feet in height, supported by a steep declivity, which forms a terrace nearly 600 feet above the level of the sea beneath.

Sometimes basalt rises in massive and abrupt rocks, assuming the appearance of an uniform homogeneous substance, and scarcely exhibiting any of that singular tendency to columnar regularity which we have just had occasion to admire in Staffa and the Causeway. The castles of Dumbarton, Edinburgh, and Stirling are built upon such masses. At other times it forms low, rugged, and unpicturesque strata, sometimes remarkably bent, but without forming decided columns.

We have already noticed the effects of these rocks upon their neighbours, and upon the strata which they penetrate and invade. As these involve a variety of important theoretical considerations, it will be proper to consider them a little more in detail.

In describing the effects of the intrusion of granite into the superincumbent slates and stratified rocks, we noticed the fragments that occasionally occur in the granitic veins, their induration, and other symptoms of fusion and violence; and in the veins and dykes of basalt we meet with precisely similar effects. Near Edinburgh the sandstone is hardened and rendered like jasper by the whin dykes, and loose pieces are occasionally seen to have been floating as it were in the fused basalt. In Antrim the limestone is sometimes overtopped by basalt, and the dykes as they traverse it harden it into a species of marble, and the neighbouring flints are reddened. In coal mines those accumulations of carburetted hydrogen gas which form what are called the blowers, appear to have resulted from the action of veins of basalt.

In addition to this evidence, we have some of a chemical nature, which is not less decisive; and it is to be regretted that such experiments have not been extended.

The first great experiment of this kind was made by Mr. Gregory Watt; he fused 7 cwt. of fine-grained basalt, and suffered the fused mass to cool gradually, so that the whole process lasted eight days. The mass after fusion was three feet and a half long, two feet and a half wide, eighteen inches thick at one end, and only four at the other. The structure was singularly altered, and in many places there were aggregations of spheroids of a radiated texture, not unlike the globular structure exhibited by some kinds of decomposing basalt, and occasionally forming by their mutual pressure a tendency to prismatic or columnar arrangement.

In glass which has been slowly cooled we occasionally observe somewhat similar and highly interesting effects; its texture is variously modified, and globules of a radiated and crystalline texture are formed in it from a new arrangement of its molecules. And, lastly, certain sandstones and clays may assume in some instances a columnar texture by the action of long-continued heat short of fusion. Dr. M'Culloch observed in a hearthstone of an old furnace which had been in constant work for 18 years, that a prismatic structure extended through its whole mass, and he thus explains the occasional columnar structure of sandstone when in contact of basalt; and in regard to some kinds of basalt itself, he observes that its frequent amygdaloidal structure proves that it was originally cellular and porous like lava, the cells having been subsequently filled up by the infiltration of the various substances found in them. It is a mere dispute about terms, therefore, to refuse to these ancient eruptions the name of *submarine volcanos;* for such they are in every essential point, though they no longer eject fire and smoke.

The examination of the igneous rocks of Sicily has proved that all the ordinary varieties of trap have been produced under the waters of the sea, since the Mediterranean has been inhabited by a great proportion of the existing testaceous species. "We are therefore entitled to feel the utmost confidence that if we could obtain access to the existing bed of the ocean, and explore the igneous rocks poured out within the last 5000 years beneath the pressure of a sea of considerable depth, we should behold formations of modern date scarcely distinguishable from the most ancient trap rocks of our island. We cannot, however, expect the identity to be perfect, for *time* is ever working some alteration in the composition of these mineral masses; as, for example, by converting porous lava into amygdaloids."

§ III.

We have now examined the structure of the crust of our globe, and found it to consist of a succession of sedimentary deposits of different dates, characterized by peculiarities of mineral structure and composition, and by distinct organic relics, upheaved and displaced by a series of crystalline rocks apparently of igneous origin, and in many instances similar in composition and effects to the products of existent volcanos.

These must be now more particularly examined, for the purpose of ascertaining how far we are justified in attributing to analogous agents those stupendous powers of elevation and dislocation which the theory of the crystalline or hypogene rocks has obliged us to call to our aid. The extent of volcanic fires, their connection with earthquakes, the nature of their products, their usual effects, and their modified action under the influence of pressure, are the principal points now requiring attention.

The geographical extent of volcanic districts is very considerable, and demonstrates the universality of subterranean fire in all quarters of the globe. It is true that the points of eruption and the movements of great earthquakes are confined to certain regions in which the volcanic vents are distributed at intervals, and most commonly in a linear direction; but there is abundant evidence that the igneous powers are at work continuously throughout the intermediate spaces, for the ground is from time to time convulsed, gases and vapours are disengaged, and hot springs issue, the waters of which are very commonly impregnated with the same mineral matters which are discharged by the eruption of the volcano.

There are also abundant proofs of the existence of volcanic fires under various parts of the bed of the ocean, where their effects, though at present unseen and unknown, are probably destined to become evident at some future but very remote period.

The substances thrown out by volcanos are chiefly earthy and alkaline bodies in a state of fusion: masses of red-hot and melted rock, stones, cinders, ashes, steam, and various gases are their accompaniments; and although they differ very materially in the quantity of ejected matter, their products so generally agree in quality that they are doubtless all referable to the operations of one cause. What that cause is, is a question which has long been agitated, but is as yet not very satisfactorily determined; although considerable advances have been made towards an explanation of the phenomena by those great discoveries in chemistry which bear the stamp of Davy's name, and which have taught us the existence of a class of bodies possessed of previously unknown and unsuspected properties, and which are in some respects applicable to the solution of the problem before us.

These bodies are the metallic bases of the alkalies and earths; many of which, the moment that they touch water, explode, burn, melt, and become converted into red-hot matter, not unlike some sorts of lava.

It has been said that if we adopt the existence of great masses of these highly inflammable and active metals deep within the earth as one of the causes of volcanic force, that they would remain inactive without water; consequently that the access of water is a necessary condition. We find, in fact, that many of the great volcanos of the world are not far from the sea or from lakes; but it must also be admitted that there are great volcanic districts to which water has no apparent access. In central Asia there is a volcanic district, with an area of nearly 3000 geographical miles, between 300 and 400 leagues distant from the sea. The central chain of the Andes too is at a great distance from the sea, and yet has several active volcanic vents. But we know too little of the interior of our globe, of what hidden waters it may contain, or what may be the subterranean communications of the ocean, to justify us in excluding this theory upon such grounds, were it otherwise satisfactory and accordant.

When these highly inflammable metals act upon water, they combine with its oxygen, and the hydrogen is evolved; and as hydrogen is very rarely traced as a product of volcanic eruptions, its absence has been urged as fatal to this theory. But upon this point we are also not well informed; the hydrogen may be evolved, and yet its presence not determinable; or, if evolved at a high temperature and in the contact of air, it would burn probably with explosion, and reproduce water. Now aqueous va-

pour is often ejected with explosive force from volcanos; and this sudden generation of steam, in part perhaps resulting from the explosive union of hydrogen and oxygen, may be one great source of their power and violence, and of the concussions attendant on earthquakes.

But there are properties of these singular metals which are less evident, and may yet play an active part where their mutual affinities are concerned. In certain proportions, sodium and potassium form an alloy liquid as water, highly inflammable; and when touched by certain other metals, mercury for instance, becoming red-hot and explosive. Now these properties, curious as they are, may possibly belong, in a yet more eminent degree, to certain alloys and other compounds of the metallic bases of the earths, for we know as yet little of the chemical properties of these bodies; and it may be presumed, upon strict analogy, that there may be other agents of a similar kind, and gifted, perhaps, with yet more energetic powers: for who could even have ventured to imagine the existence of such remarkable bodies as potassium and sodium before their discovery? So that upon the whole, if we cannot frame a perfect theory of volcanos upon these chemical principles, they at all events go some way towards an explanation of some of their concomitant phænomena, as will appear from the details we are about to enter upon. One difficulty, however, we are certainly not prepared to meet; namely, the perpetuity, as it may almost be called, of some active volcanos, — volcanos which have continued to burn and throw out lava and cinders, not only for years, but for successive ages. The lava in the crater of Stromboli has been in a state of ignition for 2000 years; so that there must here be a constant accession of heat, if not renovation of fuel.

We have ample evidence of the connection of earthquakes with volcanos; and all great eruptions have commonly been preceded by violent convulsions which have ceased upon the bursting forth of the volcanic fires, as if the pent-up matters had found a vent. All this shows the *cause* of the eruption to be deep below the surface, and perhaps sanctions the notion of the existence of great masses of ignited matter below the rocks that form our mountains; or even the idea of some of the ancient as well as modern geologists, that the interior and nucleus of the globe is in a state of most intense incandescence, — an idea already alluded to when noticing the evidences of change of climate deduced from the examination of fossil plants. Another fact in reference to this view deserves notice; namely, that there is a very manifest connection between volcanic vents situated at great distances from each other. Such a connection has been suspected between Vesuvius and Etna; and some of the volcanos of the Andes appear to alternate in their eruptions, though at great distances from each other.

When lava is examined as near as possible to the vent whence it issues, it is usually a semifluid mass about the consistence of honey. It soon cools externally, and its surface becomes rough and irregular; but, being a very bad conductor of heat, the interior remains red-hot long after the surface has cooled. It is probable that large masses of lava ejected into the sea retain their high temperatures in the central parts of the mass for a great and even indefinite length of time.

The *quantity of matter* which has been thrown to the surface by volcanic agencies during the historical period is very enormous, and may serve to give an idea of their influence in modifying the surface of the globe, when such powers are considered in reference to great periods of time. In illustration of this point we may select the volcanos of Iceland, because our details respecting them are well authenticated; though it must be recollected that they probably fall into insignificance when compared with what has happened in some of those districts of Asia and South America which are ravaged by subterranean fires. In the following sketch of these volcanic districts we shall avail ourselves as hitherto of Mr. Lyell's excellent abstract of volcanic history, as given in his *Principles of Geology*.

Iceland itself is little else than a mass of lava; and so intense is the energy of volcanic action in that region, that some eruptions of Hecla have lasted six years without ceasing. Earthquakes have often shaken the whole island, causing a complete revolution in its geographical physiognomy; such as the rending of mountains, the elevation of some and the sinking down of others, the desertion by rivers of their channels, and the appearance of new lakes. Upon the coast too, and in great depths of water, new islands have been thrown up, some of which have remained and others disappeared. In this island too, the volcanic vents are often in alternate action, one serving, as it were, for a time as a safety valve to the rest; and when, as is often the case, new cones are thrown up, they generally take a linear direction. In 1783, a new island was thrown up off the coast, consisting of high cliffs; and with such an ejection of pumice, that the ocean was covered to the distance of 150 miles, and ships impeded in their course by the shoals of floating stones. Ere a year had elapsed, however, the sea resumed her ancient domain, the volcanic cliffs had disappeared, and nothing was left but a rocky reef from 5 to 30 fathoms under water. In June, Skaptar-Jokul, 200 miles distant from the new isles, threw out a torrent of lava, which in the first place flowed down into the river Skapta, and completely dried it up; its channel was between high rocks, and was in some places 400 to 600 feet deep and 200 broad. Not only did the lava fill these great defiles up to the brink, but overflowed the adjacent country and filled up a deep lake. There was then a short intermission in the eruption; but in a few days it was resumed, and the newly ejected lava flowed rapidly over the surface of the first, and damming up numerous streams, deluged the neighbouring country with water, and destroyed several villages; — when, after flowing for several days, it was precipitated down a tremendous cataract, and filled the profound cavity which the waterfall had been hollowing out for ages. Afterwards the lava took a new direction, and discharging itself into the bed of another river (the Hyversfliot), occasioned a scene of destruction rivalling the former: the lava accumulated to a great depth, and coming to the plains spread out into broad lakes of fire, some of which were from 12 to 15 miles wide, and 100 feet deep. When the fiery lake which filled the valley of the Skapta had been augmented by new supplies, the lava flowed up the course of the river to the foot of the hills where it rises. This eruption continued two years; and when Mr. Paulson visited it eleven years after (in 1794), the lava was still smoking, and its vents filled with hot water. Although the population of Iceland did not exceed 50,000, twenty villages were destroyed, exclusive of those inundated by water; and all the cattle of the district, and more than 9000 human beings, perished.

We have quoted the narrative of this eruption as giving, upon good authority, some notion of the *extraordinary volume* of melted matter produced. Of the two branches of lava, and they flowed nearly in opposite directions, one was 50 and the other 40 miles in length; the extreme breadth of one branch was from 12 to 15, and of the other about 7 miles. The ordinary height of the currents was about 100 feet; but in deep ravines and defiles they sometimes attained 600 feet. How striking a feature, Mr. Lyell remarks, would these streams form in the geology of England, had they been poured out on the bottom of the sea after the deposition, but before the elevation of our secondary and tertiary rocks! and how easily may we now refer the trap and basaltic rocks to similar causes!

But there are some phenomena connected with volcanic action which seem to be caused by yet more extraordinary agents than those we have adverted to; namely, their *great projectile and explosive force*, — the effects of which are, in some instances, upon so stupendous a scale as to appear utterly incredible, had we not the clearest and most unobjectionable evidence. Let us select one or two illustrative relations, and then see how far we are acquainted with any powers or agents in nature adequate to explain the results.

From the era of the discovery of the New World to the middle of the last century, the great volcanic district of Mexico had remained undisturbed. It is an elevated plateau, between 2000 and 3000 feet above the level of the sea, and bounded by hills of ancient igneous origin. It was occupied by fields of sugar-cane and indigo, and watered by two brooks. In June, 1759, alarming sounds and earthquakes preceded the bursting forth of flame from the ground, and fragments of red-hot rocks were thrown to prodigious heights. A great chasm was formed, from which six volcanic cones were thrown up, the least of which was 300 feet high; and Jorullo, the central volcano, was elevated 1000 feet above the level of the plain. It sent forth streams of basaltic lava, including fragments of granitic rocks, and its eruptions did not cease till 1760. Humboldt visited the country forty years afterwards: there then appeared round the base of the cones, and spreading from them over an extent of four square miles, a convex mass of matter, between 500 and 600 feet high, gradually sloping in all directions towards the plains, and which was still so hot that he lighted a cigar in one of its fissures. It was covered with thousands of little mounds, which emitted *steam and sulphuric acid*. The two small rivers lost themselves below the east extremity of the plain, and reappeared as hot springs at its western limit. Humboldt attributed the convexity of the plain to inflation from below, supposing the ground for the extent of four square miles to have puffed up like a bladder to the elevation of 550 feet in the highest part; but of this there seems no good evidence, except the hollow sound made by the steps of a horse upon the plain, and this might result from any porous material. A subsequent eruption of Jorullo happened in 1819, and it is much to be regretted that no European travellers have since visited the spot. It is known, however, that ashes fell in Guanaxato, 140 miles from Jorullo, in such quantity as to lie 6 inches deep in the street; and the tower of the cathedral was thrown down. Of these forces, thus elevating matter from below, and throwing up extensive plains and lofty mountains, we have numerous other instances; and in

further illustration of their great power may cite the elevation of islands in deep water by submarine volcanos. Those off Iceland have been already noticed. In 1811 a volcano forced its way from beneath the sea off the island of St.Michael, one of the Azores, forming a crater above the water a mile in circumference, and about 300 feet high. In the middle of the 17th century an island was thrown up among the Hebrides, which in a month again disappeared. In July, 1731, a volcano rose in the sea between the island of Pantellaria and the coast of Sicily, forming a crater 240 feet diameter and 20 feet above water. Many shoals are no doubt of volcanic origin.

The Pacific ocean, in equatorial latitudes, seems to be one vast theatre of igneous action; and its innumerable archipelagos, such as the New Hebrides, Friendly Islands, and Georgian Isles, are all volcanic, with active vents here and there interspersed. Of such a formation Owhyhee is a magnificent example. The whole mass, estimated as exposing a surface of 4000 square miles, is composed of lava, the highest peaks of which are between 15,000 and 16,000 feet above the level of the sea. The crater of Kiraue is described by Mr.Ellis as situated in a lofty elevated plain, bounded by a precipice 15 or 16 miles in circumference, apparently sunk from 200 to 400 feet below its original level. The surface of this plain, he says, was uneven, and strewed over with loose stones and rocks; and in the centre of it was the great crater. At the edge of it a sublime and appalling spectacle presented itself,—an immense gulf in the form of a crescent, about 2 miles long and 1 wide, and apparently 800 feet deep, yawned beneath; the bottom was covered with one vast flood of burning matter in a state of terrific ebullition, rolling to and fro its fiery surge and flaming billows: fifty-one conical islands, as it were, forming as many distinct craters, rose round the edge of this burning lake, emitting columns of smoke or pyramids of flame; and several of them vomited from their ignited mouths streams of lava, which rolled in blazing torrents down their black indented sides into the lake below.

We may conclude this part of our subject with a brief notice of one other volcano; namely, that of Tomboroo in the island of Sumbawa, the account of which we owe to the late Sir S. Raffles. It began on the 5th of April, 1815. It appears that a Malay prow, while at sea, on the 11th, was enveloped in utter darkness; and that afterwards passing the Tomboroo mountain, at the distance of 5 miles, the commander observed that the lower part appeared in flames, while the upper portion was concealed in clouds. Upon landing to procure water, he found the ground 3 feet deep in ashes, and several large vessels thrown on shore by the concussions of the sea.

At the commencement of the explosion the commander of the E. I C. cruiser Benares, which was at Macassar, supposed that there was an engagement of pirates somewhere in the neighbourhood, so closely did the reports resemble those of cannon. On the 11th the ship was again shaken, as it was thought, by the discharge of cannon. At 8 a.m. on the 12th, the face of the heavens to the south and west had assumed a dingy aspect, and it became darker than it had been at sunrise. A dusky red appearance gradually spread over the heavens; and by 10 it was so dark that a ship could hardly be seen a mile off. By 11 the whole heaven was obscured, except a small space in the east horizon, whence the wind came. The ashes now fell in showers, and the appearances were most awful and alarming. By noon the light which had lingered in the horizon disappeared, and complete darkness ensued. At half-past 7 the next morning there was a glimmering of light, and objects could just be perceived on deck. When day returned the appearance of the ship was most singular; every part being covered with grey dust, which lay in heaps of a foot deep on many parts of the deck. On the 13th the vessel left Macassar, and made Sumbawa on the 18th. Approaching the coast, she encountered an immense quantity of pumice, with numerous burnt trees and logs; and the anchorage was greatly altered, for the vessel grounded on a bank where there had previously been 6 fathoms water. The shores were entirely covered with ashes and cinders ejected from Tomboroo, although 40 miles distant. The explosions were terrific; and there is evidence of their having been heard in Sumatra, upwards of 900 nautical miles from Sumbawa. Lieut. Phillips, who was despatched to afford relief to the perishing inhabitants, learned from the Rajah of Saugar that on the 10th of April the fire and flame raged with exhaustless fury, till all became dark from the quantity of falling matter. At this time stones fell very thick, from the size of a walnut up to that of two fists. Then a whirlwind arose, which destroyed every house in the village of Saugar, tore up the trees, and carried them into the air, together with men and cattle. The sea rose 12 feet above its usual levels, and swept away all within its reach, including some thousands of the inhabitants.

Extraordinary and appalling as these narrations are, they might be greatly extended. In 1772 the inhabitants of a district of Java were alarmed by flashes of light issuing from one of their volcanos. They took flight; but before they could all escape the mountain fell in, with thundering reports like cannon. The extent of ground swallowed up was 15 miles by 6. Forty villages were ingulfed, and 3000 persons destroyed. We have not space to advert to the historical details of Vesuvius and Etna. In the Bay of Naples, Monte Nuovo was thrown up in one day,—nearly 500 feet high, and a mile and a half in circumference. Of the eruptions of Vesuvius there are numerous and excellent narratives. It deserves especial notice in relation to this mountain, that before the Christian era, and from the remotest periods of which we have any tradition, this volcano was in a state of inactivity; affording no other indications of its volcanic character than such as were deducible from the resemblance in its structure to other volcanos, like the *extinct volcanos*, as they are called, of the present day. Pliny does not include it in his list of active vents, but Strabo adverts to its volcanic aspect. Its form was then very different from that which it now exhibits, and the sides were covered with fertile fields; and at its base were the populous cities of Herculaneum and Pompeii. The first symptom of renovated activity was 63 years after Christ, when an earthquake shook the neighbourhood; and in August, 79, it erupted lava. The elder Pliny, who commanded the Roman fleet, then stationed at Misenum, in his anxiety to get a near view of the phenomena was suffocated by the exhalations. His nephew has given a lively description of the scene, but has inexplicably passed over the destruction of Herculaneum and Pompeii. Indeed, so vague are the narratives long subsequent to that event, that had those buried cities never been discovered, the accounts of their tragical end would probably have been regarded as fabulous. Tacitus, the friend and contemporary of Pliny, merely says that cities were destroyed; Suetonius is silent respecting them; Martial adverts to their immersion in cinders; but the first writer who alludes to them by name is Dion Cassius, who flourished about a century and a half after Pliny. We have some interesting historical facts, showing that Pompeii and Herculaneum were destroyed by ashes and mud, and not by red-hot lava. When the amphitheatre at Herculaneum was first cleared out, ashes were arranged on the steps just as snow would lie had it fallen there: the whole superincumbent mass was from 70 to 112 feet deep. The foundation of both cities is ancient lava. It is curious that, notwithstanding the much greater depth of Herculaneum than Pompeii, it was first discovered by the accidental circumstance of a well being sunk in 1713, which came directly down upon the theatre, where the statues of Cleopatra and of Hercules were soon discovered.

In both cities records have been found commemorating their having been rebuilt after they had been thrown down by an earthquake which happened in the reign of Nero, 16 years before the inhumation of the cities. Very few skeletons have been discovered in either city; so that it is probable the greater number of the inhabitants escaped, carrying with them no doubt the principal part of their valuable effects. In the barracks at Pompeii were the skeletons of two soldiers chained to the stocks; and in the vaults of a villa in the suburbs were the skeletons of seventeen persons, who probably fled there for safety: they were found enclosed in indurated tufa, in which was preserved a perfect cast of a woman with an infant in her arms. Although her form was imprinted in the rock, nothing but her bones remained: to these was suspended a chain of gold, and rings with jewels were on the fingers of the skeleton. Earthen amphoræ were ranged along the side of the vault. The writings scribbled by the soldiers in their barracks, and the names of the owners of each house written over the doors, are still legible. The colours of many of the paintings on the stuccoed walls are almost as vivid as if recently painted; and a collection of shells was found in the house of a painter, who probably amused himself with natural history, in as good a state of preservation as if they had remained the same number of years in a museum. The beams of the houses are black exteriorly, but little altered within; and the state of preservation of several animal and vegetable products is truly astonishing. Fishing nets are very abundant; linen with the texture; and almonds, chesnuts, and walnuts in a fruiterer's shop. In a baker's a loaf retaining its form, with a name stamped upon it; and a box of pills upon the counter of an apothecary, with a small cylindrical roll by the side of it, evidently prepared to be cut into pills. In 1827, olives in a square jar, and caviar, were found in a state of wonderful preservation. At Herculaneum the animal and vegetable substances are preserved by having been apparently enveloped in a paste which consolidated, and then allowed them to become slowly carbonized. At Pompeii they are penetrated by a grey pulverulent tufa. The history of the Papyri is well known. It is supposed that only a small part of Herculaneum has as yet been explored, and that the quarters hitherto cleared out at great expense are those where there was the least probability of discovering manuscripts.

It would, however, be irrelevant here to enlarge upon these and other details of buried cities; but the few facts mentioned, and which are abridged from Mr. Lyell's summary, are not without geological importance, as giving some idea of the little change which the lapse of seventeen centuries has effected.

There are many instances of rocks of decided volcanic origin, that is, *extinct* volcanic vents, in districts where all other trace of activity has been lost since the earliest historical times, except hot and mineral springs; such are the Vivarais and Auvergne in central France, and the district of Eifel, near Coblentz, on the Rhine. The attempts to determine the ages of these rocks, or to ascertain the periods of their activity by their association with primitive, secondary, or tertiary strata, are not in general satisfactory: those who are curious upon this point may be referred to the details given by Mr. Lyell.

Important as are the geological results of volcanic action, those of earthquakes, which extend over greater areas, and produce extensive changes in the configuration of the earth's crust, demand perhaps even greater attention.

There can be little doubt as to the unity of cause in volcanos and earthquakes; they frequently precede violent volcanic eruptions, and often seem to arise from explosive matters accumulating their force from want of vent. They are often felt over great extents of territory. The earthquake which destroyed Lisbon, in 1755, was felt over the whole of Europe, and extended even to the West Indies. What enormous powers or forces, therefore, must be called into action in order to produce such extensive results!

It would be useless here to quote long details respecting the effects of earthquakes; but it will be necessary to select two or three illustrative cases, and especially to direct our attention to those phenomena connected with them which immediately bear upon geological changes.

The great earthquake at Lisbon occurred on the 1st of November, 1755. A sound like loud thunder was heard under ground, and instantly afterwards the greater part of the city was shaken down; so that, in six minutes, at least 60,000 persons are said to have perished. The sea first retired, but was violently agitated, and presently rolled in in a huge wave sixty feet high. Many of the largest mountains in Portugal were shaken from their foundations, and most of them were wonderfully split and rent. It was supposed that they emitted fire and smoke; but lightning and dust, perhaps, gave rise to the appearance. The New Quay, a massive marble structure, sunk down with an enormous concourse of persons upon it who had taken refuge there for safety; and it was so ingulfed, that not one of the dead bodies ever floated to the surface; and many vessels anchored near it, and full of people, were swallowed up as in a whirlpool. No fragments of the wrecks ever rose again, and the water upon the spot was deepened by 100 fathoms. Many ships at sea experienced violent concussions. Off St. Lucar, the captain of the Nancy frigate thought he had struck on the ground; but, on heaving the lead, found he was in great depth of water. Another ship, 40 leagues west off St. Vincent, experienced so violent a concussion that the men were thrown up a foot and a half perpendicularly from the deck.

The agitation of the sea during earthquakes has almost always been remarked, and probably such effects are more common than is supposed; for in almost all parts irregularities in its motion are at times observable, which cannot be referred to temporary currents or winds in the offing. The movement is generally a quick flow and reflow of the water, and often so trifling as to escape the attention of all ordinary observers; though detected by seamen and fishermen, who are surprised to find the boats suddenly floated, or as suddenly left dry.

In the Lisbon earthquake, many of the rivers and lakes of Great Britain were singularly disturbed. Loch Lomond suddenly rose between two and three feet, and as suddenly subsided.

In the great Calabrian earthquake, in 1783, an interesting narrative of which is given by Mr. Lyell, the aspect of the country was singularly changed. The earth appears to have had an undulating, vibratory, and horizontal motion; there were the usual tremors in the neighbouring ocean; numerous deep and extensive gaps and fissures were formed, and faults and dislocations in the strata; large landslips took place, and extraordinary lacerations; large buildings and farms were ingulfed; and in some places the chasms closed upon their prey with such violence that on excavating afterwards to recover articles of value, the workmen found detached parts of buildings jammed together in one compact mass. Some of the resulting gaps and ravines were upwards of a mile long, and from 200 to 300 feet deep and broad. Large lakes were formed, sometimes filled with thermal waters from below, and sometimes the consequence of the obstruction of streams; land and houses were in some places uplifted, in others depressed, in others transferred with all their plantations to a distance varying from a few feet to upwards of a mile.

In these narratives it is a matter of much geological importance to establish clearly the fact of elevations and depressions of districts and strata; and, if possible, to ascertain the amount of such change in perpendicular position. Upon these points the Chilian earthquake of 1822 affords some satisfactory evidence. According to Mrs. Graham's (now Lady Calcott's) account, the shock extended for more than a *thousand miles* along the coast, and a great part of the country was bodily elevated for a length of more than a hundred miles; the beach and the bottom near the shore being raised from three to four feet. The uplifting of the former was rendered evident by the adhesion of the shell-fish to the rocks; and it was observed that there were other lines of beach *above that newly elevated, attaining in parallel lines a height of about fifty feet above the sea*, seeming to show that previous elevations had been effected by the same causes. An old wreck of a ship, which before could not be approached, became accessible from the land; cones of earth were thrown up in several districts by the forcing up of water, mud, and sand, through funnel-shaped hollows. The elevation inland appeared, by the effect upon water-courses, to have been two or three times greater than upon the beach.

There are some other points connected with earthquakes and volcanos which, though generally considered of subordinate importance, seem to refer very immediately to their causes; such, for instance, as intermittent and boiling springs, and the escape of carbonic acid gas.

The geysers of Iceland are fine specimens of the former; their waters hold so large a quantity of silica in solution as to incrust every thing they run over. They rise in a tract covered by lava. The Great Geyser springs from a spacious basin at the summit of a mound formed of silicious incrustations deposited by the spray of its waters. In the centre of this basin is a pipe 78 feet deep, through which the water rises, flows over, and is thrown up in jets, attended by loud explosions and subterranean rumblings, and slight tremors of the ground. When these jets are most violent, they shoot to 200 feet high; and after playing for some time, a snorting noise is heard, which gradually becomes as loud as thunder, and steam rushes forth with prodigious violence. This deafening roar lasts for a variable time, and the eruption terminates, coming on again after a variable interval of rest.

Of this phenomenon we have a plausible explanation, and one which bears most importantly upon the theory of volcanos and earthquakes.

Suppose the surface water of the country to penetrate into the chasm A by the fissures B B, while at the same time steam of great force and temperature emanates from the fissures D D. A portion of this steam is first condensed by the water in A, which it gradually raises to its boiling point; then it forms high-pressure steam, and drives the boiling water through the pipe into the basin C, and after the whole has been ejected the steam itself rushes out. Now, if we suppose a number of large subterranean cavities at the depth of several miles below the surface, in which melted lava accumulates, and that water penetrating to these is converted into steam; this, together with other gases pent up, and perhaps liquefied by pressure in similar cavities, or generated by the decomposition of melted rocks, may press upon the lava and force it up the duct of a volcano, in the same manner as the column of water is driven up the pipe of the geyser. But the weight of lava being immense, the pressure exerted on the sides and roofs of such large cavities and fissures may well be supposed to occasion not merely slight tremors, but even violent earthquakes. Sometimes the lateral pressure of the lower extremity of the high column of lava may cause the more yielding strata to give way, and so for a time give relief to the fused matter. Sometimes, on the contrary, a weight equal to that of the vertical column of lava, pressing on every part of the roof, may heave up the superincumbent strata, and force lava into every fissure; which, on consolidation, may support the arch, and cause the land above to be permanently elevated: on the other hand, subsidences may follow the condensation of vapour when cold water descends through fissures, or when heat is lost by the cooling down of the lava.

Besides aqueous vapour, several gases are emitted by volcanos, and among them *carbonic acid*, which is also frequently given out by fissures in the earth, and by mineral springs not associated with direct volcanic action. Its occurrence in the Grotto del Cane is well known. It is given out in enormous quantities near the lake of Laach, and in Brohlthal on the Rhine, where it is used in a chemical manufactory: 600 pounds of the gas are calculated to be discharged from only one of the jets in twenty-four hours. Near Fort Diadine, on the Euphrates, it issues through the cracks of the limestone rocks with a loud hissing noise, and in such quantities as to kill animals that unwarily approach it. The Upas valley, in Java, appears to be a cavity filled to a certain height with carbonic acid: it is about half a mile in circumference, and about 35 feet deep, without vegetation, and covered

with skeletons of men and various animals, such as tigers, hogs, deer, &c., which have perished by their entrance into the gas.

We might enumerate many similar cases of the accumulation of carbonic acid; but those quoted are sufficient to show that it often issues from the strata of the earth in enormous volume, and therefore doubtless from reservoirs where it is pent up under great pressure; and in all probability there are large accumulations of it in a liquid form, in which state it exerts a pressure, at common temperatures, of from 50 to 60 atmospheres upon the walls that confine it, and at higher temperatures of much greater force. We are also perhaps warranted in inferring that there are subterranean cavities, not only filled with this, but probably with other gases, perhaps also in their liquid forms, and of still greater tensive force; and if so, what may not be the mechanical and chemical energies of some of these, acting upon the highly inflammable metals at very elevated temperatures? Upon the whole, it does not appear that powers are wanting adequate to the greatest observed effects; that these are constantly in activity; and that stupendous as the results appear in their collective effects, the great mountains of the globe *may* have been elevated by causes now in action; that, at all events, we *need* not call to our aid unknown powers, since existing causes (especially if it be admitted that they were once more energetic than at present, and that the agents have, as it were, spent a part of their force) appear adequate to the explication of this class of geological phenomena; and if we now have powers in activity, and we have seen that such there are, which are capable of elevating 100 miles of rocky coast 3 or 4 feet, why may not a succession of such elevations, even admitting them not to have been greater than at present, carried on through an indefinite period of time, have occasioned those liftings up of the mountains which we have had such abundant occasion to advert to? It is well known that slight forces continuously repeated produce gigantic effects. It has, says Mr. Lyell, been argued by the opponents of this view, "that it is useless to appeal to time, for time can effect no more than its powers are capable of performing. If, say they, a mouse be harnessed to a large piece of ordnance, it will never move it, even if centuries upon centuries were allowed. This is true enough. But let us suppose a lever applied capable of propelling it forward at the rate of an inch in a century; it is clear that in a sufficient succession of centuries we should have advanced a mile: any force that could move it at all must, if it continue in action, continue to propel it."

The full bearing of this question, however, will be more evident when we have considered the causes which are now effective in producing sedimentary formations, in wearing down the present surface of the globe, and in conjunction with those more violent powers which we have just noticed in giving rise to various superficial inequalities.

§ IV.

We have now surveyed the structure of the earth's surface, and have traced the apparent causes of many of the changes which it has undergone, and which have contributed to its present state and aspect; but there are a variety of processes now active, and of changes now going on, which are slowly tending to modify the existing order of things, and which, if considered in reference to their continuity through past ages, and to their accumulated effects through ages to come, will perhaps assume an air of unexpected importance.

Among the powers of matter which change the earth's surface, heat and cold are obviously at all times concerned in exciting dilatations and contractions, and thus keeping up a perpetual and varying motion among the particles upon which they act. Of such changes the sun is the grand source; to whose varying influence the earth in its diurnal revolutions upon its axis, and in its annual circumvolutions through space, is always exposed.* It may perhaps *seem* that the mere influence of change of temperature, derived from the solar rays, must be of little efficacy in disintegrating hard and solid substances; but when we reflect upon the very extensive range of natural temperatures, and on the great receptive and emissive powers in respect to radiant heat which the surfaces of some rocks present, very considerable transitions from heat to cold, and the reverse, may ensue, and, acting upon certain *textures*, may alone lend powerful aid to that general work of decay which is commonly called the *weathering* of rocks.

But when the influence of change of temperature is conjoined with the varied agencies of water, the powers of destruction will not only be materially increased, but rendered, in many instances, rapid and irresistible. About three fourths of our globe are covered by the waters of the ocean, the mean depth of which is probably about 3 miles. The mean height of the dry land above the ocean's level does not exceed 2 miles; so that the present dry land might be so distributed over the bottom of the ocean that the surface of the globe would present a mass of waters. This is an important possibility, when geologically considered; because, with it at command, every variety of superficial land and water may be imagined, and consequently every variety of organic life, each suited to the various situations and climates under which it would be placed. In consequence of the general uniformity of level preserved by the ocean, it enters the numerous irregularities of the land, and sometimes forms inland seas as it were, in which geological changes, differing from those which occur in the open ocean, may occasionally take place, as in the Mediterranean and the Baltic. There are also inland seas, or *lakes*, as they are usually called, not in direct communication with the open sea; some of salt and others of fresh water. The latter cover very large tracts; and it is obvious that in *them* depositions may take place exclusively characterized by terrestrial and fresh-water remains.

It is also obvious that earthquakes and volcanos will materially contribute towards existing changes, and, cooperating with aqueous forces, may often produce a joint effect to which neither could separately give rise; as when frequent earthquakes aid the excavating power of water in carving out a valley, or widening one which already exists. Of these powers the statements in the preceding section furnish abundant proofs; so that we may now more exclusively attend to aqueous causes, some of which are of a destructive, others of a renovating or reproductive character.

When lands are much elevated above the sea they condense the vapours of the atmosphere, in consequence of their low temperature, and thus become reservoirs of water which irrigate the valleys and plains below, and descending, often by steep declivities, acquire an impetuosity calculated to surmount powerful obstacles. The summits, therefore, of mountains are particularly subject to atmospherical influences, and to great alternations of temperature and moisture. We have already alluded to the gigantic force of water freezing in the chasms and crevices of rocks; and it is in this way that great havoc is effected where comparatively little wet falls, and that the decay of rocks in high latitudes goes on as rapidly, or more so, than where they are deluged by the tropical torrents of rain. This mechanical power of water is often aided by its solvent energies; and although these are usually very slow in their operation, the time for which they are continued and the extent of surface upon which they operate produce a great aggregate effect. Some granitic rocks thus disintegrate apparently by the washing out of their alkaline constituents; in other cases carbonic acid aids the solvent power; and in others the air in water converts black oxide of iron into red, and the decay of the rocks is rapid in proportion to the extent of this conversion. The *granite tors* of Dartmoor and of the Land's End furnish curious instances of the effect of *slow* decay from several causes, among which the tendency in the rock to cubical and prismatic fracture must not be overlooked. By degrees the surfaces become separated; and the wearing continuing to proceed more rapidly near the parts which are most external, and therefore most exposed, the masses which once were angular and prismatic acquire an irregular curvilinear boundary, and the stones assume that appearance which has sometimes been regarded as artificial, and has induced persons to consider them as Druidical remains. Enormous stones are thus thrown from their original positions, and becoming rounder and rounder by the progress of decomposition assume a spheroidal figure, often referred to the continuous action of running water: under favourable circumstances *logging stones* are, as we have previously observed, thus produced. The weathering of some of these tors is so gradual that the life of man scarcely allows an individual to observe a change, whence we may infer the long periods that have been requisite to bring about their present appearances. It is possible that chemical changes may sometimes be aided by the electrical powers called into action, and as a more imme-

* "The sun's rays," says Sir J. Herschel (*Astronomy*, p. 211.), "are the ultimate source of almost every motion which takes place on the surface of the earth. By its heat are produced all winds, and those disturbances in the electric equilibrium of the atmosphere which give rise to the phenomena of terrestrial magnetism. By their vivifying action vegetables are elaborated from inorganic matter, and become in their turn the support of animals and of man, and the sources of those great deposits of dynamical efficiency which are laid up for human use in our coal strata. By them the waters of the sea are made to circulate in vapours through the air, and irrigate the land, producing springs and rivers. By them are produced all disturbances of the chemical equilibrium of the elements of nature, which, by a series of compositions and decompositions, give rise to new products, and originate a transfer of materials. Even the slow degradation of the solid constituents of the surface, in which its chief geological changes consist, and their diffusion among the waters of the ocean, are entirely due to the abrasion of the wind and rain, and the alternate action of the seasons; and when we consider the immense transfer of matter so produced, the increase of pressure over large spaces in the bed of the ocean, and diminution over corresponding portions of the land, we are not at a loss to conceive how the elastic power of subterranean fires, thus repressed on the one hand and relieved on the other, may break forth in points where the resistance is barely adequate to their retention, and thus bring the phenomena of volcanic activity even under the general law of solar influence."

diate agent electricity is not without its influence: The thunder storm shivers rocks and hurls them down in mighty fragments, often fusing their surfaces, and sometimes consolidating soft materials. Near Drig in Cumberland, the sandy soil contains hollow tubes produced by lightning striking and penetrating the ground; some of these have been traced to a depth of 40 feet, and furnish curious illustrations of the passage of the electricity. When running water is mixed with sand and pebbles it acquires a new mechanical power, and these carried along by streams grind down and excavate the adjacent strata, so that the superincumbent portions are ultimately precipitated into the stream. The obstruction causes a temporary accumulation of water behind, which afterwards bursts the barrier; and in this way small ravines are slowly widened into narrow valleys, in which sinuosities are caused by the deflection of the stream first to one side and then to the other. The unequal hardness of the materials through which the channel is eroded tends also to modify the lateral power of excavation, and thus the little stream acquires a serpentine direction. When the flexures are great, a direct line is often restored by the river cutting through the isthmus which separates two or more of its curves. These windings occur from similar causes in some of the largest rivers of the world; and not only in those which flow through flat alluvial plains, but large valleys are excavated to a great depth through solid rocks in this serpentine form. These tortuous flexures of rivers show that the valleys in which they flow were not produced or excavated by any flood of uncommon power and magnitude, or by any diluvial operation; for such causes would probably have produced straight channels.

In referring to the transporting powers of water, it has been justly observed by Mr. Lyell, that we are often surprised at the facility with which small streams bear along sand and gravel; for we usually estimate the weight of rocks in air, and do not sufficiently reflect on their comparative buoyancy when submerged in a denser fluid. The specific gravity of most rocks is only from twice to thrice that of water; so that the fragments lose from a third to half of what we usually call their *weight*.

The power of rivers in transporting mud, sand, and gravel, is shown by the accumulation of those substances at their mouths, where they terminate either in lakes or in the sea; and the history of storms and floods affords many memorable instances of the force with which they transport heavy materials. In August, 1829, Aberdeenshire and the adjacent counties of Scotland were visited by a storm and hurricane which extended over a space of 5000 square miles,—flooding the rivers, carrying away bridges, and removing masses of rock of some tons weight, and transporting from 1000 to 3000 tons of gravel to great distances in one day.

In alpine countries the moving of massive stones is facilitated by the ice which adheres to them, and forms with the rocks a mass of less specific gravity. The glaciers also, formed of consolidated snow, carry down prodigious loads of rock and sand, which are generally ranged in long ridges running parallel to the glacier, and from 20 to 40 feet high. They are slowly protruded into the valleys, where the ice melts, and the whole accumulation is swept away by torrents.

If the materials which streams have to work upon are but loosely consolidated, the rapidity with which they sometimes excavate deep channels is truly astonishing. After the heavy rains which followed the eruption of Vesuvius in 1822, the water flowing from the Atrio del Cavallo cut, in *three days*, a new chasm 25 feet deep.

We may also adduce striking examples of the erosion of deep chasms in comparatively hard and durable materials. Some of the clearest illustrations of this excavating power are presented in the valleys of central France, where the ancient channels of rivers have been filled up by lava, through which the present streams have re-excavated a passage from 20 to 70 feet deep, and often of great width.

This subject has been well illustrated by another case quoted by Mr. Lyell, upon the base of Etna, where a great current of lava descending in 1603 from near the summit of the volcano flowed into the alluvial plain of the Simeto, one of the largest of the Sicilian rivers, which skirts the base of Etna, and falls into the sea a few miles south of Catania. It entirely filled up and obliterated the bed of the river with indurated lava; yet now (that is in the course of two centuries) it has re-excavated for itself a new passage, which is from 40 to 50 feet deep, and more than 100 wide.

But of the numerous examples which might be cited of the powers of rivers to carve out their courses and excavate valleys in their rocky boundaries, the falls of Niagara are perhaps the most magnificent. That river flows from Lake Erie to Lake Ontario, the distance between them being 32 miles; and the level of the former lake is 330 feet above that of the latter. As it leaves Lake Erie, the Niagara is almost level with its banks, and three quarters of a mile wide; so that should it rise 8 or 10 feet, Canada and the state of New York would be inundated. Proceeding towards the falls, it has a descent of 50 feet in half a mile, and rushes with great force. At the verge of the cataract, an island divides it into two falls: one 1800 feet wide, and 158 feet perpendicular; the other 600 feet wide, and 164 feet high. This enormous body of water is precipitated over a ledge of hard limestone in horizontal layers, which rests upon a soft shale. This crumbles away so rapidly, that the harder limestone forms a projecting mass, which overhangs the space below, and being left without support, falls from time to time in large masses into the abyss beneath; occasionally producing shocks which are felt at some distance, and attended by a noise like thunder. As soon as the river has passed the falls, its character is completely changed; it runs furiously in a deep trench cut in the horizontal strata, so that the ravine is only perceived on approaching the edge of the precipice. Through this deep chasm the river flows for 7 miles; and then the table-land, which is nearly level with lake Erie, suddenly sinks down at a town called Queenstown, and the river traverses a plain which continues to the shore of Lake Ontario.

Now it appears probable that the great cataract of the river was once at Queenstown, and has gradually retrograded from that place to its present position, about 7 miles up. Within the last 40 years the falls have receded 50 yards; so that, supposing the ratio of recession never to have exceeded this slow progress, it must have required nearly 10,000 years for the excavation of the whole ravine; and should it not be accelerated in future, it will require nearly 30,000 years for the falls to eat their way backwards to Lake Erie, to which they most undoubtedly seem destined to arrive. Of course this calculation is only provisional, and may be interfered with by many causes; but supposing Lake Erie to remain nearly in its present state, the sudden escape of such an immense body of water would cause a tremendous deluge. But Lake Erie is constantly diminishing in depth by the enormous quantities of matter brought down by the rivers which feed it. Long Point, near the influx of Big Creek River, has advanced three miles within the last three years: another important effect of rivers. There are other causes which in this case would probably prevent a sudden debacle; for the waters of a lake with a rocky barrier can only be suddenly let out so as to produce a deluge when the hard barrier separating it from the land at a lower level presents a perpendicular face to the whole depth of the lake, and accordingly inundations from such causes are comparatively rare. (See *Lyell's Principles*.)

We come now then to consider the further progress of the *detritus* carried down by rivers. It is clear that their tendency will be to fill up valleys and hollows: lakes will gradually diminish in depth, or even be choked up and again cut through; and low lands flooded, and deposits left upon them. In some situations, rivers raise their beds when restrained by artificial embankment. Of this the Po furnishes a remarkable example, traversing the plains upon a high mound like an aqueduct, even more elevated than the roofs of the houses in the city of Ferrara.

In other cases, where two or more streams unite into one river, so that the water does not expose a surface equal to the two previous surfaces, the action of the united waters is to deepen the channel.

Of the matters carried down by rivers large quantities are transported to their mouths, and there deposited either in lakes or in the ocean bed. The Lake of Geneva is thus receiving enormous supplies of detritus from the Rhone; so that from calculations which have been made of its increase, and of the diminution of the depth of the lake, it appears probable that if we could obtain a section of the accumulation formed during the last eight centuries, we should see a great series of strata from 600 to 900 feet thick, and nearly two miles in length, inclined at a slight angle. We should also find a number of smaller deltas at the mouths of the smaller rivers, each composed of such materials as the respective rivers happen to have brought down.

When the Rhone again issues from this lake, it is as pellucid as crystal; but its pure waters are presently again mixed with the turbid sediments of the impetuous Arve, bringing down the granitic detritus of the glaciers of Mont Blanc. It afterwards receives vast contributions from the Alps of Dauphiny, and from the primary and volcanic mountains of central France; and when at length it enters the Mediterranean, it discolours its blue waters with a whitish sediment for the distance of between six and seven miles from its mouth, throughout which space the current of fresh water is perceptible. Mr. Lyell has collected a body of very curious information respecting this and other deltas, of which we can only here hint at the general results.

It appears that by the confluence of the Rhone, and the currents of the Mediterranean driven by winds from the south, sand bars are often formed across the mouths of the river, by which means considerable spaces become divided off from the sea, and subsequently from the river

also when it shifts its channels of efflux. As some of these are subject to the occasional ingress of the river when flooded, and of the sea during storms, they are alternately salt and fresh; so that both fluviatile and marine shells are found in them. Of the new deposits in this delta great part consists of calcareous and arenaceous rock cemented by carbonate of lime. A cannon taken up near the mouth of the river was entirely entombed in solid calcareous rock.

The delta of the Po in the Adriatic presents another instance of the vast accumulations of matter that are thus deposited by rivers; and it appears that within the historical period, that is, within 2000 years, the accessions of land have increased from 2 to 20 miles in breadth. Adria, a sea-port in the time of Augustus, is now about 20 miles inland; and Ravenna, which was also a sea-port, is 4 miles from the main sea.

The delta of the Nile also affords some interesting geological considerations; but we must look to the great rivers of Asia and America for the most instructive examples of these formations.

Of the delta of the Ganges and Barrampooter we have some curious information from Major Rennel. These rivers descend from the highest mountains in the world into a gulf which runs 225 miles into the continent. The part of the delta bordering on the sea is composed of a labyrinth of rivers and creeks, infested by tigers and alligators, and equal in extent to the whole principality of Wales. The mud and sand poured into the gulf in the flood season is so great, that the sea only recovers its transparency at the distance of 60 miles from the coast. And in further proof of the immense transportation of earthy matter, we have the great magnitude of the islands formed in the channels of the river during a period even far short of a man's life. Some of these, many miles in extent, have originated in large sand banks thrown up at points, and afterwards insulated by the stream; others are caused by various accidental obstructions, such as sunk trees or boats. In the great gulf below Luckipoor, some of the islands rival the Isle of Wight in size. These newly-formed lands are soon overrun with reeds, grass, and shrubs, which form impenetrable thickets, where tigers, buffalos, deer, and other wild animals take shelter; so that both animal and vegetable remains must continually be precipitated into the flood, and sometimes become embedded in the sediment of the delta. Crocodiles also swarm upon the shoals; and the habits of these animals are such as to render them particularly liable to become imbedded in the horizontal strata of mud which are annually deposited in the Bay of Bengal over many hundred square miles. Mr Lyell has also gone into the history of the Mississippi, the course of which is very instructive, in consequence of the undisturbed and natural state of its banks, and the varieties of climate through which it flows. Its delta is divided into innumerable lakes, marshes, and streams, inhabited by multitudes of alligators; and millions of logs and trunks of trees are brought down at particular seasons, and either carried out to sea, or bound together by adventitious vegetation, so as to retard the river and become embedded in mud.

We thus find that matters washed down from the decay and disintegration of the land into lakes and seas are there accumulated, and are *now* forming *stratified deposits*, varying in their nature and texture, and often abounding in organic relics; but, to form a just notion of the magnitude of these processes, they must be compared with objects with which we are more familiar. Now it is probable that the waters of the Ganges hold in suspension from 2 to 3 per cent. of solid matter; but if we only assume *one* per cent., which is perhaps the average of most rivers, we are, says Mr. Lyell, brought to the extraordinary conclusion that there passes down, every two days, into the Bay of Bengal, a mass equal in weight and bulk to the great Egyptian pyramid.

We have already adverted to the enormous quantity of matter occasionally ejected by volcanos. The most voluminous current of lava which has flowed from Etna within historical times was that of 1669, calculated at 140 million cubic yards. Now this would only equal in bulk one-seventh of the sedimentary matter carried down in a single year by the Ganges (assuming 1 per cent. of sand); so that allowing seven such eruptions in a century, it would require 100 Etnas to transfer a mass of lava from the subterranean regions to the surface equal to the mud carried down in the same time from the Himalaya mountains into the Bay of Bengal. (*Lyell's Principles of Geology.*)

That enormous quantities of matter, therefore, are thus by slow and silent operations carrying down into the deep, and there forming strata which may one day be upheaved and assume the character of dry land, will now be obvious; and shows how some of the mightiest operations in nature are effected insensibly, without noise or disorder, and without the aid of extraordinary convulsions, mighty deluges, or other temporary and sudden causes. We might form some curious speculations respecting the *nature* of the strata thus forming. Some will be argillaceous, some calcareous, hard and soft, coarse and fine, depending upon a variety of obvious interfering causes: some abounding in organic remains, others without them; and among these, from the number of shipwrecks and other casualties, human remains and works of art must often be abundantly interred.

From the wearing down of rocks and strata, and the excavation of valleys by rivers, streams, and alternations of temperature, we may now take a cursory view of the action of the sea on coasts.

The waves of the ocean operate, in many instances, like mighty artillery, battering and breaking down the solid barriers opposed to their inroads. If the rocks are soft, the wear is proportionately rapid, as we see upon the east coast of our island, where many spots now standing in the sea, or even covered by its waters, are marked in old maps as sites of towns and villages, the inhabitants having gradually retreated inland. Where the rocks are hard, or where they are so stratified as to oppose resistance, the declension of coast is much more gradual. The substances thus delivered into the sea are acted on according to their respective weights, forms, and textures: some transported by tides and currents; others rolled about, and ground down upon the shore; and where indurated masses are contained in softer materials, flints for instance in chalk, they remain at the base of the cliff, and tend to protect it from the breakers and check its further excavation.

Veins and dikes sometimes are curiously exposed and insulated by this wear and tear. Arches are cut out and caverns excavated, and even the hardest rocks often drilled as it were in various directions.

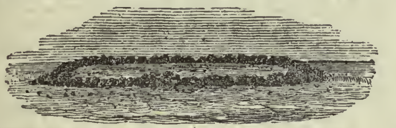
The protecting influence of the waves is seen in those long lines of shingles and sand which often defend low and marshy land, especially at the mouths of valleys, from the access of the sea; and the higher the tide and the heavier the gale, the higher the rampart that is raised. These beaches travel in the direction of the prevalent winds; and of this engineers are practically aware, as we see by the works which they erect to arrest their progress.

An instructive example of the nature and effects of accumulations of this sort is furnished by the Chesil Bank, which connects the Isle of Portland with the mainland; it is about 16 miles long, and the size of the pebbles increases from west to east. Its formation is probably due to a meeting of tides between the peninsula and the land. The storm of 1824 burst over it, and overwhelmed the village of Chesilton. Another example of land thus protected is on the south coast of Devon. What is called Slapton Sands is in fact a ridge of pebbles, which protects and blocks up the mouths of several valleys. Sand is also often accumulated and thrown up in the same way as shingles; and when it is left by the tide and dried by the sun winds often transport it to great distances, so as even to overwhelm large districts, — houses, cultivated lands, and even forests, disappearing beneath them. On the eastern shore of the Bay of Biscay, these moving heaps force lakes of fresh water before them, derived from the rains which are pent up; and several villages in the department of the Landes have been thus buried, and others are now threatened with destruction. They have been calculated to advance at the rate of 60 to 70 feet in a year. Sometimes these sands become consolidated by the percolation of calcareous or ferruginous waters. Of this we have an example on the north coast of Cornwall, where the sand is formed of comminuted shells; and the drift having taken place at different times, the recent sandstone thus formed is stratified with occasionally interposed vegetable remains. Where church-yards have existed, human remains have been entombed; and an old pot of coins has been found in this formation. This rock is so hard that holes are bored in it for the purpose of securing vessels. The parish church of Crantock is built of it. The fossil skeletons of Guadaloupe appear to have been preserved by this species of rock formation.

Among reproductive causes now in action, none are of more curiosity or interest than the operations of the small zoophytic animals which produce coral, and which, labouring on through long periods of time, gradually accumulate such enormous masses of carbonate of lime as to form, together with shells which they entangle and envelope, islands of no inconsiderable dimensions.

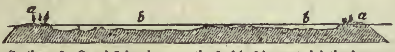
Coral reefs are usually of a form approaching to the circular, and the water is shallow in the centre, but surrounded by a very deep, and even unfathomable sea. When the reef is so high as to remain nearly dry at low water, the animals leave off building; and then the rim or edge of the great basin becomes covered by calcareous sand, which offers a foundation for the growth of marine vegetables, and afterwards a resting place for the seeds of trees and plants cast upon it by the waves. Trunks of trees, also carried by rivers from continents and islands, after their long wanderings are often pitched ashore; and sometimes carry with them small animals, such as lizards and insects, which become the first inhabitants. The Pacific ocean, throughout a space comprehended between

the thirteenth parallel of latitude on each side of the equator, is a great nursery of coral islands; also the Arabian and Persian gulfs. Between the coast of Malabar and that of Madagascar there is a great sea of coral. Flinders describes an unbroken reef 350 miles long upon the coast of New Holland; and between that country and New Guinea coral formations extend throughout a distance of 700 miles, interrupted by no intervals exceeding 30 miles in length. The growth of coral is, when compared with human epochs, extremely slow; but the facts just cited show that they have produced results of no mean importance, as influencing the general aspect of the earth's crust. Their circular form, the steep angle at which they plunge into the sea, and the countries in which they occur, render it extremely probable that they are the crests, as it were, of submarine craters; and occasionally lava and volcanic rocks have been found in their central lagoons: these have generally a deep narrow passage, which is kept open by the efflux of the ocean at low tides. These openings are almost always on the

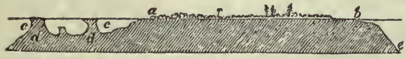


Whitsunday Island in the Pacific, with its enclosed Lagoon.

leeward side, and the windward side of the islands is more complete and perfect than the other; so that, from this fortunate circumstance, ships can enter and sail out with ease; indeed the safety of many of these harbours is entirely dependent upon this cause. It would seem most probably to arise from the large masses of coral rock that are thrown up by the waves on the windward side. These rocks are probably subject to elevations and depressions connected with volcanic agencies. Mr. Lyell thinks that the carbonate of lime, which is the building material employed by the busy little architects of these islands, is in all probability derived from calcareous springs issuing into the sea from fissures in the volcanic bottom.



Section of a Coral Island. — *a a* the habitable part, *b b* the lagoon.



Section of a Coral Island upon a large Scale. — *a b* the habitable part; *b e* slope of the side; *c c* parts of the lagoon; *d d* knolls of coral.

We may now conclude this subject by a brief reference to those erratic blocks and pebbles which are so widely scattered over different districts, and which, with the deposits of bones and stalactite in certain caverns, are often regarded as especial proofs of diluvial action.

Where pebbles occur immediately upon the beach, and are evidently derived from the fragments of neighbouring rocks rolled into form by the action of waves, or where larger masses, forming what are called *boulder stones*, are found in similar situations, or lying upon the strata of which they constitute the fragments and relics, there is no great difficulty in accounting for one or the other; but where immense deposits of gravel are found, not only inland, but out of the reach of all running waters, and where boulder stones are found in similar situations, and very distant from the rocks of which they are the apparent remains, our curiosity and ingenuity are then excited to ascertain how they came into their present places, and whence they are derived. We must of course always carefully distinguish between these importations, as they may be called, of foreign matters, and those kinds of detritus which merely result from the weathering of the rocks.

We have elsewhere pointed out the numerous evidences which we have of fractures, elevations, and depressions of the strata; of the consequent existence of *faults*; and of the formation of valleys, frequently in the line of such faults and fractures. Now it seems clear that all these effects must have been attended in many instances by proportionate changes in the levels of waters, and that there must have been great inundations and torrents passing over such districts at the times of their disturbance; and further, that where land once covered by water has been elevated, rounded masses of rock or boulders, as well as gravel of all degrees of fineness and all manner of composition, may have been elevated along with them. Here, then, are two apparent causes of gravel and boulders.

But independent of these sources of such appearances, there are other geological phenomena, which seem to indicate the passage of great masses of water over the British isles in a direction from north to south: upon the neighbouring continent of Europe, too, evidences of currents setting in the same direction, and transporting gravel and boulders, are not wanting. Of course these currents have in many places been greatly modified as to direction by the valleys, hills, and mountains which they encountered; so that their detritus is in many instances scattered in other directions. In some cases ice, in the form of glaciers, appears to have been a cause of the transportation of masses and fragments of rock to places far remote from their original source. The glaciers which descend from alpine regions are charged with blocks and fragments, and any current of water rushing through the valleys into which they descend would float them and their burthens. It is probable that those immense masses of ice called icebergs are portions of polar glaciers; and these, with their contents, are often floated into warmer climates, so that the debris which they carried with them may thus have been dispersed at the bottom of parts of the ocean far distant from the source of such materials. These circumstances show (when taken in conjunction with the facts already enumerated respecting the causes which influence the decay of rocks) how careful we must be in reasoning respecting the age and sources of blocks, gravel, and those remains generally called *diluvial;* and how difficult it is to form any inference respecting their sources and transport, excepting in cases where these are at hand and obvious. Whatever may have been the cause of such passages of torrents over the land, and the evidences of them are quite sufficient, it is obvious that they must have destroyed nearly all such living beings as came in their way, or as frequented those parts of the earth over which they swept. Accordingly the remains of various animals are found in such deposits; and their examination and comparison with living genera and species, and with those more ancient animals before alluded to in the tertiary and secondary strata, is a very curious and interesting subject of inquiry. Dr. Buckland's researches connected with these relics have given them additional interest, especially as connected with certain theoretical points of diluvial geology, and with their assemblage in caverns. In these caverns the bones are usually mixed with mud, stones, and fragments; and circumstances sometimes seem to show that the animals resided in them for a great length of time: they are covered by *stalagmite*, which forms the pavement as it were of the cave, and effectually conceals and preserves the organic remains. The celebrated Kirkdale cavern in Yorkshire, discovered in 1821, contains the remains of the hyæna, tiger, bear, wolf, fox, weasel, elephant, rhinoceros, hippopotamus, horse, ox, deer, hare, rabbit, rat, mouse, raven, pigeon, lark, thrush, and a species of duck. From the mode in which these remains were strewed over the bottom of the cavern when the mud was removed, the great proportion of hyæna's teeth over those of other animals, and the manner in which many of the bones were gnawed and fractured, Dr. Buckland inferred that this cavern was the den of hyænas during a long succession of years; that they brought in, as prey, the animals whose remains are now mixed with their own; and that this state of things was suddenly terminated by an irruption of turbid water into the cave, which buried the whole in mud. In other caves other animals have been found, indicating the same general facts of the existence of animals now no longer known in these latitudes. Where the bones of man or works of art have been found in these caves, there is generally good evidence of their being of a much later date than the remains of quadrupeds; but occasionally the bones of extinct quadrupeds are so mixed with those of existent testacea as to show that they at least were co-existent.

GE'OMANCY. (Gr. *γη, earth*, and *μάντεια, prophecy.*) Divination by points or circles made on the earth. It was termed by old writers "a part of natural magic, the daughter and abbreviation of astrology." Geomancy was among the acts of divination most sedulously cultivated by professors of that science in the 15th and 16th centuries. Nativities were cast, fortunes predicted, and oracular answers obtained to questions, by the inspection of certain combinations of lines and figures representing the conjunctions of the planets, &c. *See* ASTROLOGY.

GEOME'TRICAL. Something relating to geometry. Thus *geometrical construction* is the representation of a proposition, or of an algebraic equation, by means of a diagram formed by geometrical lines; as straight lines, circles, &c.

Geometrical curves, or *geometrical lines*, are those in which the relation between the abscissa and ordinates is expressed by a finite algebraic equation. *See* CURVE.

Geometrical locus is the line traced by a point which varies its position according to some determinate law. For example, if from any number of given points straight lines are to be drawn to meet in another point, under this condition that the sum of their squares shall be equal to a given space, then innumerable points may be found by which the condition will be satisfied, and the *locus* of all those points is the circumference of a given circle. (See *Simson's Loci Plani*, or *Leslie's Geometrical Analysis.*)

Geometrical progression is a progression in which all

the successive terms have the same ratio. Thus the progressions

$$1, 2, 4, 8, 16, 32, 64, \&c.$$
$$a, a^2, a^3, a^4, a^5, a^6, a^7, \&c.$$

are geometrical; the common ratio of the first being 2, and of the second a. The general property of a geometrical progression is, that the product of any two terms, or the square of any one single term, is equal to the product of every other two terms taken at an equal distance before and after the former. *See* PROGRESSION.

Geometrical Proportion. — Four quantities are said to be in geometrical proportion, or simply proportionals, when the ratio of the first to the second is equal to the ratio of the third to the fourth. Thus, if $a : b$ is equal to $c : d$; then the four quantities, a, b, c, d, are in geometrical proportion. A general property of this proportion is, that the product of the two extreme terms is equal to the product of the two means. *See* PROPORTION.

GEO'METRY. (Gr. γη, *earth*, and μετρον, *measure*.) The science which treats of the properties of figured space. The etymology of the term suggests the object to which geometry was first applied, viz. the measurement of land. It is pretended that the science was invented in Egypt, where the annual overflowing of the waters of the Nile obliterated the land marks, and rendered it necessary to have recourse to measurement in order to ascertain the proper allotment of each individual; but whatever may have been the origin of the *term*, the occasions on which it is necessary to compare things with one another in respect of their forms and magnitudes are so numerous in every stage of society, that a geometry more or less perfect must have existed since the first dawn of civilization.

Objects of Geometry. — In geometry bodies are considered only in reference to the properties of extension or magnitude, figure, and divisibility. Every body occupies in indefinite space a certain determinate place, or finite portion of space, which is called its *volume*. The limits or boundaries which distinguish the place of the body, and separate it from the surrounding space, are called *surfaces*; a surface is therefore common to the two portions of space which it separates. As the limitation of space gives rise to the idea of surface, so the limitation of surface produces *lines*, a line being the boundary of a surface, or the place in which two surfaces intersect each other, and therefore common to both. In like manner the limitation of a line, or the intersection of two lines, produces a *point*. But a point marks only position, and has no properties. A line has length; a surface length and breadth; and a volume length, breadth, and thickness. Hence the properties of lines, the properties of surfaces, and the properties of volumes or solids, comprehend the objects of geometry.

Although the notion of a point is acquired from the consideration of lines, that of a line from the consideration of surfaces, and that of a surface from the consideration of bodies or material objects, it does not follow from this that points, lines, and surfaces are themselves really material. Geometry regards all bodies in a state of abstraction very different from that in which they actually exist; and the truths which it discovers and demonstrates are pure abstractions, — hypothetical truths, which are not, however, on that account, the less useful. For example, it is impossible by any mechanical means to draw a line absolutely straight, or to describe a perfect circle; but the nearer the line approaches to perfect straightness, and the more accurately the circle is described, the nearer will their properties approach to those of the ideal straight lines and circles which are the objects of geometrical consideration. The theorems of geometry are therefore not strictly true in their application to material bodies, but they approximate sufficiently to truth for all practical purposes. They enable us to ascertain, with all the precision of which our senses are capable, the distances of inaccessible objects, the dimensions of a given surface, the contents of a given solid; to compute the distances and motions of the planets; to predict the celestial phenomena; and to navigate a ship from any given point of the globe to any other.

Divisions of Geometry. — Geometry is divided into elementary and transcendental. *Elementary geometry* treats only of the straight line and circle; of figures bounded by straight lines and circles; and of solids bounded by these figures. The circle is the only curve line introduced into the elements of geometry; the simplicity of its description, the ease with which many of its most useful properties are deduced, and the necessity of making use of it in the simplest constructions,— such as raising a perpendicular, measuring an angle, and even making one straight line equal to another, — being reasons for this preference. The construction of algebraic equations of the second degree, and in general all problems that can be solved by means of straight lines and circles, are also referred to elementary geometry. *Transcendental geometry*, properly speaking, is that which has for its object all curves different from the circle; as the conic sections, and curves of the third and higher orders. It comprehends, also, the construction of equations of the third and fourth as well as of the higher degrees. But some writers understand by *transcendental geometry* the applications of the differential and integral calculus to the investigation of the properties of curve lines and surfaces. Geometry is also divided into *ancient* and *modern*; ancient geometry being that form of demonstration and investigation which was employed by the Greeks, and of which *Euclid's Elements* form a well-known example; modern geometry that in which algebra, or the differential or integral calculus, is made use of. We also speak of *pure geometry*, *practical geometry*, and *applied geometry*. *Descriptive geometry* has already been considered under that term.

Methods of Demonstration.—Of the different methods of demonstration adopted in elementary geometry, one of the simplest, and at the same time one of the most fertile, is the method of *superposition*. This consists in showing that two figures being applied to each other, or being laid the one upon the other, entirely coincide, or fill the same space; from which coincidence we infer the equality of all their parts, each to each. Thus Euclid, in order to prove that two triangles which have two sides of the one equal to two sides of the other each to each, and also the angles contained by those sides equal, are equal in all respects, supposes the one triangle to be placed upon the other, and shows that from the hypothesis an entire coincidence must necessarily take place; whence it follows that the remaining angles of the one triangle are equal to those of the other each to each, and the remaining side of the one to the remaining side of the other. On this principle is founded the whole doctrine of the comparison of triangles, and, consequently, of all rectilineal figures; for it is demonstrable that any two equal rectilineal figures may, by resolving them into parts, be applied by superposition one upon the other, so as entirely to coincide.

Another frequently convenient method of demonstration is that which is called by logicians the *reductio ad absurdum*. It consists in assuming the proposition which is announced to be not true, and in reasoning from this assumption till consequences are deduced which are either contradictory of the hypothesis, or of some proposition previously demonstrated. Many examples of this method occur in the *Elements* of Euclid; but it is to be remarked, that though the proof which it gives is perfectly rigorous and satisfactory, the procedure is in some respects indirect, and therefore should not be adopted unless when it affords a shorter and simpler demonstration than can be obtained by a direct mode of reasoning. It is especially applicable to those propositions which are the reciprocals of others already demonstrated, and to incommensurable quantities.

In their more difficult researches, and particularly in those relative to curve lines and surfaces, the ancient geometers had recourse to the *method of exhaustions*. Admitting no demonstrations but such as are perfectly rigorous, they did not consider it consistent with the strictness of geometrical reasoning to regard curve lines as polygons of a very great number of sides; but when they proposed to investigate the properties of any curve, they regarded it as the fixed term to which the inscribed and circumscribed polygons continually approach in increasing the number of their sides. The continual approximation of these polygons to the curve afforded an idea of the properties of the latter, the more accurate as the number of sides was greater. But it still remained to prove, by some recognized principle of demonstration, the truth of the properties that had thus in a manner been divined; and this was done by showing that every supposition contrary to them necessarily led to a contradiction. In this manner they demonstrated that the areas of different circles are to each other as the squares of their respective diameters; the volumes of spheres as the cubes of their diameters; that pyramids of the same height are as their bases, &c. (Carnot, *Réflexions sur la Métaphysique du Calcul Infinitésimal.*)

Analysis and Synthesis.—The Greek geometers employed two distinct modes of investigation, *analysis* and *synthesis*; the one, as the names imply, being the inverse of the other. In the *Mathematical Collections* of Pappus, book vii., analysis and synthesis are thus described: — Analysis is the method which, setting out from the thing demanded, arrives by means of certain established consequences to something known before, or placed among the number of principles acknowledged as true. It passes from a proposition through all its antecedents; and is therefore called *analysis*, or *resolution*, or an *inverted solution*. In *synthesis*, on the contrary, we begin from the proposition with which the analysis concluded, ordering properly the above antecedents, which now present themselves in the form of consequents, and pass from one to another till we arrive at the conclusion sought, or that from which we started in the case of analysis. These two methods have each their peculair use. The first is the method of invention, and is employed in

order to discover a construction which will satisfy the proposed conditions; the second is the method of demonstration, and employed to prove the sufficiency of the construction to which the analysis has led. In general, both methods are employed simultaneously when the object is to discover new relations, or the solution of new problems; but when the object of the geometer is to prove to others the propositions which he has discovered, the synthetical method is usually preferred.

Application of Algebra to Geometry.— A different kind of analysis from that of which we have now been speaking consists in the application of algebra to the solution of geometrical problems. This has opened up a new and rich field, entirely unknown to the ancients, and been the direct cause of the great extension of the modern mathematics. In general, when a problem is of a certain degree of difficulty, the use of the algebraic notation, which substitutes the simple arithmetical operations of multiplication and division for the complex geometrical methods of the composition and resolution of ratios, is attended with great advantage. By the aid of algebra, the properties of curve lines, their tangents, points of inflexion, asymptotes, branches, rectification and quadrature — subjects which the ancient geometry could reach only in some limited cases, and with great difficulty — are demonstrated with the utmost facility. Some mathematicians of eminent rank, delighted with the beautiful specimens of investigation afforded by the ancient geometry, have regretted the extensive application of algebra which characterizes the scientific works of the present day; but in a science which presents so many real difficulties, and in which so many discoveries remain to be made, the path which leads most directly to the object aimed at, and which, moreover, is the easiest to follow, is that which ought to be preferred. Without the aid of algebra and the new calculus, geometry could not have been applied to dynamics, and only in a few limited cases to any other branch of natural philosophy.

History of Geometry.— It has already been mentioned that geometry is supposed to have had its origin in Egypt. From that country it is said to have been transported into Greece by Thales. The celebrated proposition of the square of the hypothenuse was the discovery of Pythagoras. Anaxagoras of Clazomene composed a treatise on the quadrature of the circle; and Plato had certainly made considerable advances in the science, as is proved by the simple and elegant solution which he gave of the duplication of the cube. About fifty years after the time of Plato, Euclid collected the propositions which had been discovered by his predecessors, and formed of them his famous *Elements;* a work which continues to the present day to be regarded as one of the best (if not the very best) introductions to the mathematical sciences. It consists of fifteen Books, of which thirteen are known to have been written by Euclid; but the 14th and 15th are supposed to have been added by Hypsicles of Alexandria. Apollonius of Perga, about 250 years B.C., composed a treatise on the *conic sections*, in eight books; and he is said to have been the first who applied to those curves the appellations by which they have ever since been distinguished,— namely, the parabola, the ellipse, and the hyperbola. (*See* CONIC SECTIONS.) About the same time flourished Archimedes, the most illustrious of the ancient philosophers, who distinguished himself in geometry by the discovery of the beautiful relations between the sphere and cylinder, by his work on *conoids* and *spheroids*, by his discovery of the exact quadrature of the parabola and his very ingenious approximation to that of the circle. In the list of names which have come down to our times in connection with geometry, we may mention Eudoxus, Archytas, Eratosthenes, Aristarchus, Dinostratus, and Nicomedes; but for an account of the discoveries or inventions by which they are individually celebrated, we must refer to Montucla's *Histoire des Mathématiques.* The school of Alexandria produced Pappus and Diophantus; but the Greek geometry, though it was afterwards enriched by many new theorems, may be said to have reached its limits in the hands of Archimedes and Apollonius; and a long interval of 17 centuries elapsed before this limit was passed. In 1637, Descartes published his *Geometry;* a work which will ever be remarkable, as containing the first systematic application of algebra to the solution of geometrical propositions. Soon after this followed the discovery of the *infinitesimal calculus;* and from that time to the present geometry has shared in the general progress of all the mathematical sciences.

Works on the Ancient Geometry:— Euclid, *Elements of Geometry*, and *Book of Data;* Apollonius, *Conics;* Archimedes, *Opera;* Pappus, *Mathematicæ Collectiones;* Vieta, *Opera Mathematica;* Huygens, *Opera;* R. Simson, *Opera Reliqua*, and *Loci Plani;* Stewart, *Propositiones Geometricæ;* T. Simpson, *Elements of Geometry;* Legendre, *Elements of Geometry;* Leslie, *Elements of Geometry*, &c. For an account of the numerous editions of *Euclid's Elements* (which have been translated into every European language), see Murhard, *Bibiliotheca Mathematica;* but to the list contained in that work should be added the more recent edition of Peyrard, in Greek, Latin, and French (Paris, 1814). An edition of the first six books, in Greek and Latin, by Camerer and Hauber (Berlin, 1824), also deserves to be noticed, on account of the valuable notes with which it is accompanied.

GEOPO'NICA. (Gr. γη, and πονη, *labour.*) The name of a Greek compilation of precepts on rural economy, extracted from ancient writers. The name of the compiler is unknown; but the authorities which he quotes are numerous, and deservedly celebrated. (See Niclas's edition, 4 vols. 8vo. Leipsic, 1781.)

GEO'RGICS. (Gr. τα γεωργικά, *things pertaining to husbandry.*) The title of a poem of Virgil's, in four books, on agriculture, and the care of cattle, bees, &c. It is considered the most perfect of his works.

GEORGIUM SIDUS. *See* URANUS.

GERA'NIA'CEÆ. (Geranium, one of the genera.) A natural order of herbaceous or shrubby Exogens, growing in most parts of the world, nearly related to *Oxalidaceæ*, *Balsaminaceæ*, and *Tropaolaceæ*, with which they are by some botanists associated. They are distinguished by the peculiar dehiscence of their fruit, the tumid joints of their stem, and their stipulate leaves. Their sensible properties consist in an astringent principle, and an aromatic or resinous flavour. Many of them, especially those of the genus *Pelargonium*, are beautiful objects, and much cultivated in gardens.

GERMAN SCHOOL. In Painting. In this school we find an attention to individual nature, as usually seen, without attempt at selection, or notion of ideal beauty. The German painters seem to have set a particular value on high finishing, rather than on a good arrangement and disposition of the subject. Their colouring is far better than their drawing, but their draperies are generally in bad taste. Though among the painters of this school some are free from the application of these observations, they are not sufficient in number to change the general judgment that must be passed upon it. Wohlgemuth, Holbein, and Albert Durer are the heads of it. These observations do not apply to a school which seems now rising in Germany, and which, with such leaders as Retsch and others, seems likely to put the school of painting there on a level with its highly splendid intellectual powers in all other branches of the arts and sciences.

GE'RMEN. (Lat. *a bud.*) In Botany, the organ commonly called the *ovarium.*

GERMINA'TION. (Lat. germen.) The process by which a plant is produced from a seed. The phænomena of germination are best observed in dicotyledonous seeds; such, for instance, as the bean, pea, lupin, &c. These seeds consist of two lobes or cotyledons, enveloped in a common membrane; when this is removed a small projecting body is seen, which is that part of the *germ* which afterwards becomes the root, and is termed the *radicle:* the other portion of the germ is seen on carefully separating the cotyledons, and is termed the *plumula;* it afterwards forms the stem and leaves. When the ripe seed is removed from the parent plant it gradually dries, and may be kept often for an indefinite period without undergoing any change; but if placed under circumstances favourable to its germination, it soon begins to grow: these requisite circumstances are a due temperature, moisture, and the presence of air. The most favourable temperature is between 60° and 80°; at the freezing point none of the more perfect seeds vegetate; and at temperatures above 100°, the young germ is usually injured. No seed will grow without moisture: water is at first absorbed by the pores of the external covering, and decomposed; the seed gradually swells, its membranes burst, and the germ expands. The root is at first most rapidly developed, the materials for its growth being derived from the cotyledons; and when it shoots out its fibres or rootlets, these absorb nourishment from the soil, and the plumula is developed, rising upwards in a contrary direction to the root, and expanding into stem and leaves. For this growth the presence of air is requisite; if it be carefully excluded, though there be heat and moisture, yet the seed will not vegetate. Hence it is that seeds buried very deep in the earth, or in a stiff clay, remain inert; but, on admission of air by turning up the soil, begin to shoot forth. From experiments which have been made upon the germination of seeds in confined atmospheres, it appears that the oxygen set free by the decomposition of water combines with a portion of the carbon of the seed, and carries it off in the form of carbonic acid, and that the consequence of this is the conversion of part of the albumen and starch of the cotyledons into gum and sugar; so that most seeds, as we see in the conversion of barley into malt, become sweet during germination. Light is injurious to the growth of a seed. It is, therefore, obvious that the different requisites for germination are attained by placing a seed under the surface of the soil warmed by the sun's rays, when it is moistened by its humidity and by occasional showers;

excluded from light, but within reach of the access of air.

When the young plant is perfected, the cotyledons, if not converted into leaves, rot away, and the process of nutrition is carried on by the root and leaves: the principal nourishment is taken up from the soil by the root, and chiefly by its small and extreme fibres; so that when these are injured or torn, as by careless transplantation, the plant or tree generally dies. The matters absorbed, consisting of water holding small portions of saline substances, and of organic matter in solution, become the *sap* of the plant; and this is propelled upwards in the vessels of the stem, or of the outer layer of wood, into the leaves; here it is exposed to the agency of air, or of light: it transpires moisture, and occasionally carbonic acid. But the leaves also at times absorb moisture, and during the influence of light they decompose the carbonic acid, and, retaining the carbon, evolve oxygen; the sap thus becomes modified in its composition, and the characteristic proximate principles of the vegetable are formed. These return in appropriate vessels from the leaves, chiefly to the inner bark, where we accordingly find the accumulation of the peculiar products of the plant: they also enable it annually to form a new layer of wood. Hence it is that the transverse section of the wood exhibits as many distinct zones as the tree is years old. We are ignorant of the causes of this circulation of the sap; but that it does follow the cause which has been stated is proved by the operation which gardeners call *ringing*, and which they sometimes resort to, to make a barren branch bear flowers and fruit: it consists in cutting out and removing a circular ring of bark, so as to prevent the return of the sap by the descending vessels, which at first ooze copiously, but afterwards the wound heals, and the juices are accumulated in all parts above the extirpated ring, producing tumefaction in the limb, and often inducing a crop of flowers and fruit, or causing those to appear earlier than on the uncut branches. If a tree be wounded so as to cut into the central portions of the wood, or the outer layer of new wood, the flow of ascending sap is then seen to take place upon the lower section, where the vessels are that carry it up to the leaves; and the flow of descending is principally confined to the upper section of the inner bark, from which, after a time, new bark is produced, and the parts again united.

GE'ROCO'MIA. (Gr. γερων, *an aged person*, and κομειν, *to be concerned about*.) That part of medicine which relates to the diet and treatment of old age.

GERU'SIA. (Gr. γερουσία, *an assembly of elders*.) In Ancient History, the senate of Sparta. The number of this council was thirty, including the two kings; and the qualifications of its members were, pure Spartan blood, and an age not below sixty years. The election was performed in a primitive manner by acclamation, the candidates being brought forth one by one before the people. He who was greeted with the loudest applause was held to receive the highest honour next the throne. The functions of the gerusia were partly deliberative, partly judicial, and partly executive. It prepared measures which were to be laid before the popular assembly; it exercised a criminal jurisdiction, with power of capital punishment; and also wielded a kind of censorial authority for the correction of abuses. (See *Mem. de l'Acad. des Inscrip.* vol. xv.; *Müller's Dorians*.)

GE'SNERA'CEÆ. (Gesnera, one of the genera.) A natural order of herbaceous Exogens, inhabiting the tropics, allied to *Bignoniaceæ;* from which it differs in the partly inferior one-celled ovary, apterous seeds, and habit; from *Cyrtandraceæ* in the one-celled ovary, simple placenta, and albuminous seeds; from *Scrophulariaceæ* by the same characters, with the exception of the seeds. The fruit, when succulent, is sometimes eatable, mucilaginous, and sweetish. Many beautiful species of *Gloxinia, Gesnera*, and *Sinningia* are known in our gardens.

GEY'SERS. (From an Icelandic word signifying *raging* or *roaring*.) The celebrated spouting fountains of boiling water in Iceland. The Geysers are situated about 30 miles from the volcano Hecla, in plains full of hot springs and steaming fissures. Their jets are intermittent, and the height to which they rise appears to vary much at different times. Olafsen and Povelsen estimate that of the Great Geyser, when they saw it, at 550 feet. Few English travellers have seen it spout higher than 90 or 100; but Mr. Henderson saw it reach 150 feet in 1815, and one of the smaller Geysers, when a stone was thrown into it, 200. The latest account of the Geysers is in the work of the Hon. A. Dillon (*A Visit to Iceland*, 1840).

GHAUTS. A term applied originally to the narrow and difficult passes in the mountains of Central Hindostan, but which has been gradually extended to the mountains themselves. They consist of two great chains extending along the east and west coasts of the Deccan, parallel to each other, or rather diverging, and leaving between them and the sea only a plain of 40 or 50 miles in breadth. The precise altitude of these mountains has not been ascertained, but their general elevation is from 3000 to 4000 feet; and while the extent of the Eastern Ghauts has been limited to a line of 300 miles, the chain of Western Ghauts is said to extend without interruption nearly 1000 miles. See *Murray's Encyc. of Geography*.

GHEBRES. *See* GUEBRES.

GHI'BELLINES. In Italian History, the name of a political party, which maintained the supremacy of the German emperors over the Italian states, and their claims to investiture, &c., disputed by the Popes. *See* GUELFS.

GHOST. *See* DÆMON, DÆMONOLOGY, APPARITION.

GHOST, HOLY, ORDER OF. The principal military order of France under the old regime; instituted in 1574 by Henry III., for nobles only; abolished at the Revolution; reconstituted by the Bourbons.

GIANT. (Gr. γιγας; said to be the same with γηγενης, *earth-born*.) The giants of Grecian antiquity are not the same with the Titans, although frequently confounded with them in poetry: the latter were produced by Earth to combat Saturn; the former afterwards, against Jupiter. (*Servius ad Æn.* ii. 40.) They were destroyed by the gods of Olympus, in the famous giganto-machia, or giant-fight, of which the scene was laid in the Campi Phlegræi of Campania. The appellation "giant" in the Old Testament, given to various races of men, is thought rather to refer to violence, power, &c., than to actual stature; but individual giants, such as Og and Goliath, are undoubtedly recorded. In Northern Mythology, the giants were the aboriginal inhabitants of the earth (*Olaus Magnus*, book v.), called Josnar. There is a learned as well as amusing article on this subject in the *Enc. Metr.* (See for remarks on natural deviations from ordinary stature in individuals and races of men, *Pritchard's History of Mankind*, vol. ii.; Lawrence, *Lectures on Man*.)

GIAOUR. (Turk. *a dog*.) An epithet conferred on all, but more especially on Christian unbelievers, as those who do not profess an adherence to Mohammedanism are styled by the Turks.

GI'BBET, or JIB. The projecting beam of a crane on which the pulley is fixed.

GIBBO'SE. (Lat. gibba, *a hunch*.) Humped. When a surface presents one or more large elevations.

GI'BBOUS. (Lat. gibbus, *convex, protuberant*.) This term is applied in Astronomy to the appearance of the moon when more than half full or enlightened. In the telescope, the planet Venus exhibits a similar appearance.

GIE'SECKITE. A mineral discovered in Iceland by Giesecke. It is a hydrated silicate of alumina and potash: it occurs in brownish hexagonal prisms.

GIFT, in Law, is, in its general sense, a conveyance which passes either lands or goods. But when restricted to immoveable property, it signifies in its proper sense the creation of an estate tail. (*See* FEE-TAIL.) It is so termed from the operative words of the conveyance, which are always "I give," or "have given." A gift of personal property differs from a grant in being wholly gratuitous and without consideration.

GIGA, or JIG. (Ital.) In Music, an air for dancing in triple time, usually $\frac{6}{8}$ or $\frac{12}{8}$.

GIGA'NTOMA'CHIA. (Gr. γιγας, *a giant*, and μαχη, *a battle*.) In Painting, representations of combats with or between giants. The term is more particularly applied to the conflicts waged between Jupiter and the giants. *See* GIANT.

GIG. A well-known kind of light carriage drawn by one horse. *Gigs, or gig machines*, are rotatory cylinders covered with wire-teeth, for teazling woollen cloth.

GI'LDING. The application of a superficial coat of gold on wood, metal, and other materials. The beauty and durability of gold render it the most valuable of all ornamental substances; but, on account of its weight and high price, its use in these respects would be exceedingly limited, were it not the most extensible and divisible form of matter, so that it may be made to cover a larger surface than an equal quantity of any other body. Metals are usually covered with gold by the process of *water gilding*. It consists in perfectly cleaning their surface, and then, in the case of silver, for instance, rubbing it over with a solution of gold in mercury, called *amalgam of gold:* the vessel is then heated over a clear charcoal fire, by which the mercury is driven off, and the gold left adhering to the silver surface, upon which it is afterwards burnished. The surface of copper or brass is usually prepared by cleaning and rubbing it over with a solution of nitrate of mercury, which amalgamates the surface, and enables the gold amalgam, when subsequently applied, to adhere; heating and burnishing are then resorted to as before. Brass and copper buttons are gilt in this way; and the requisite quantity of gold is so small that twelve dozen buttons of one inch diameter may be completely gilt upon both surfaces by five grains of gold. Other kinds of gilding are performed by gold leaf, which, if intended for out-door work, is laid on by the help of *gold size*, which is drying oil mixed with calcined red ochre; or, if for picture and looking-glass frames, they are pre-

pared by a size made by boiling parchment clippings to a stiff jelly, and mixed with fine Paris-plaster or yellow ochre. The leaves of books are gilt upon the edges by brushing them over, while in the binder's press, with a composition of four parts of Arminian bole and one of powdered sugar candy mixed up with white of egg; this coating, when nearly dry, is smoothed by the burnisher, then slightly moistened, and the gold leaf applied and burnished. To impress gilt figures on book covers, the leather is dusted over with finely powdered mastic; the iron tool by which the figure is made is then moderately heated and pressed upon a piece of leaf-gold, which slightly adheres to it; being then immediately applied to the leather with a certain force, the tool makes an impression, and, softening the mastic, transfers and fixes the gold. In gilding glass and porcelain, powdered gold is blended with gum-water and a little borax, and applied by a camel-hair pencil; the article is then put into an oven or furnace; the gum burns off, and the borax, by vitrifying, cements the gold to the surface, upon which it may afterwards be polished by the burnisher. Within the last few years nearly all the gilt articles manufactured at Birmingham, such as buttons, neck-chains, ear-rings, and so forth, have been gilt by a process patented by Mr. Elkington, in which, after the articles have been properly cleansed by a weak acid, they are immersed in a hot solution of nitromuriate of gold, to which a considerable excess of bicarbonate of potash has been added; in the course of a few seconds they thus receive a beautiful and permanent coat of gold.

GI'LLIESIA'CEÆ. (Gilliesia, one of the genera.) A small natural order of Exogens, allied very nearly to *Liliaceæ*, of which they may in fact be considered an anomalous form. Their principal peculiarity consists in having irregular flowers, surrounded externally by calyx-like bracts. They inhabit Chili, are little known, and of no known use.

GILLS. Parts of the body are so called in which the blood-vessels are in greater number than is necessary for mere preservation or growth, and are minutely subdivided for the purpose of submitting the blood to the influence of air contained in water.

GI'MBALS, or GIMBOLS. (Lat. gemellus, *a pair*.) A piece of mechanism consisting of two brass hoops or rings which move within one another, each perpendicularly to its plane, about two axes placed at right angles to each other. A body suspended in this manner, having a free motion in two directions at right angles, will assume the vertical position: hence the apparatus is employed for suspending portable or mountain barometers, sea-compasses, &c.

GI'MLETING THE ANCHOR. Turning it by the stock round its shank as an axis, like a gimlet.

GIMP. Silk twist, interlaced with brass or other wire

GIN. (Fr. genievre, *juniper*.) Ardent spirit flavoured by the essential oil of juniper. It was originally made by the Dutch, and is hence distinguished in this country by the name of Hollands. The liquor bearing the above name in this country is of British manufacture, and is frequently flavoured by oil of turpentine, and rendered biting upon the palate by caustic potash. In Holland, the finest gin bears the name of Schiedam, the principal place of its manufacture, and where there are many distilleries. Owing to the excessive duty, 22*s*. 6*d*. per gallon, gin is one of the principal articles of clandestine importation. *See* Spirits.

Gin, in Mechanics, is a machine used for raising great weights, driving piles, &c. It usually consists of three long legs or spars, which support a pulley at the top, round which a rope is passed for elevating the weight.

GI'NGER. The dried rhizoma of *Zingiber officinalis*, a native of the East Indies, and abundantly cultivated in America and the West India islands, whence Europe is chiefly supplied. It is a good stimulant and carminative; and the fresh root preserved makes an agreeable, warm, and not very unwholesome sweetmeat. The acrimony of ginger appears to reside in a peculiar extractive matter which is soluble in alcohol; hence a spirituous tincture of ginger contains the virtues of the root.

GI'NSENG. A Chinese word applied to the root of the *Panax quinquefolium*: it has a bitter-sweet flavour, and is considered as a powerful restorative in China, where its consumption is very great. It is found chiefly in the northern parts of Asia, and in America; but it is almost wholly from the latter source that the Chinese draw their supplies. In 1832, there were sent from the United States to China 407,067 lbs. of ginseng, valued at 99,303 dollars. (See *Commercial Dict.*)

GIPSY. *See* Gypsy.

GIRA'FFE. (Arab. xariffa.) The tallest quadruped on the face of the earth, and the largest and most singular of the Ruminant order. Pliny informs us that it was called *Nabun* by the Æthiopians of his time, and *Camelopardalis* by the commonalty at Rome. "*Nabun* Æthiopes vocant, collo similem equo, pedibus et cruribus bovi, camelo capite, albis maculis rutilem colorem distinguentibus, unde appellata *camelopardalis*. Dictatoris Cæsaris circensibus ludis primum visa Romæ." (*Hist. Nat.* lib. viii.) The natural philosophers of Rome had again, subsequent to the gorgeous spectacles of Cæsar, the means of studying the living giraffe. Not fewer than ten of these rare and beautiful animals were publicly exhibited at one time by the third *Gordian*, which afterwards were brutally slaughtered in the arena of the amphitheatre, at the millenarian games, in the reign of the emperor Philip. Notwithstanding these opportunities, all the zoological information regarding the giraffe which we derive from the naturalists of Rome is comprised in the brief notice above quoted from the writings of Pliny; a notice which is too vague to have served to enable us again to recognize the strange compound of horse, ox, camel, and pard exhibited to the wondering Romans, had it not been more intelligibly recorded in medals, mosaic pavements, and the ornaments of public buildings. The resemblance of the giraffe to the horse in regard to its neck is restricted to the presence of a mane, composed of short stiff black hairs, which resembles rather that of the gnu or ass. In the length, slenderness, and flexibility of the neck, the giraffe surpasses all other quadrupeds; the comparison of the legs and feet of the giraffe to those of the ox is still less fortunate, because the two posterior or spurious hoofs common to the ox with most other Ruminants are wanting in the giraffe, as in the camel; but the toes are not joined to a common broad elastic sole, as in the camel; they are completely separated, and provided each with a well-formed sharp-pointed hoof. The head of the giraffe resembles that of the camel in the absence of a naked muzzle, and in the shape and organization of the nostrils, which are oblique and narrow apertures, defended by the hair which grows from their margins, and surrounded by cutaneous muscular fibres by which the animal can close them at will. This is a beautiful provision for the defence of the air passages and the irritable membrane lining the olfactory cavities, against the fine particles of sand which the storms of the desert raise in almost suffocating clouds. The large, dark, and lustrous eyes of the giraffe, which beam with a peculiarly mild but fearless expression, are so placed as to take in a wider range of the horizon than is subject to the vision of any other quadruped. While browsing on his favourite acacia the giraffe, by means of his laterally projecting orbits, can direct his sight so as to anticipate a threatened attack in the rear from the stealthy lion, or any other foe of the desert. To an open attack he sometimes makes a successful defence by striking out his powerful and well-armed feet; and the king of beasts is said to be frequently repelled and disabled by the wounds which the giraffe has thus inflicted with his hoofs. The horns of the giraffe, small as they are, and muffled with skin and hair, are by no means the insignificant weapons that they have been supposed to be. We have seen them wielded by the males against each other with fearful and reckless force; and we know that they are the natural arms of the giraffe most dreaded by the keeper of the present living giraffes in the Zoological Gardens, because they are most commonly and suddenly put in use. The giraffe does not butt by depressing and suddenly elevating the head, like the deer, ox, or sheep; but strikes the callous obtuse extremity of the horns against the object of his attack with a sidelong sweep of the neck. One blow thus delivered at full swing against the head of an unlucky attendant would be fatal; — the female once drove her horns in sport through an inch deal board. Notwithstanding those natural arms of hoofs and horns, the giraffe does not turn to do battle except at the last extremity; where escape is possible, it seeks it in flight. This is extremely rapid, especially along rising ground; but cannot be maintained for a sufficient period of time to enable it to escape the Arab mounted on his long-winded steed. The paces of the giraffe, owing to the disproportion between his long legs and short body, are very peculiar; when walking at a brisk rate, it seems to move forward simultaneously the two legs of the same side, as noticed of old by the learned bishop of Sicca, in his account of the presents brought to Hydaspes by the ambassadors of the Axeomitæ (Abyssinians). "It differed," says Heliodorus, "in gait from every other land or water animal, and waddled in a remarkable manner: each leg did not move alternately, but those on the right side moved together independently of the other, and those on the left in the same manner, so that each side was alternately elevated." Both legs of the same side are undoubtedly off the ground at the same time through the greater part of the step; but upon a close inspection the hind-leg is always seen to be first lifted from the ground, and after a very brief interval the fore-leg of the same side is moved. In the sanded paddock appropriated to the giraffes in the Zoological Gardens, they exhibit in the warm days of summer all their various and singular paces. In the simple walk the neck, which is then stretched out in a line with the back, gives them a stiff and awkward appearance; but this is entirely lost when they commence their graceful undulating canter. To judge by the movement of the legs, this pace appears to be less rapid than it

actually proves, when the extent of ground is observed over which it has carried them in a given time. The motions of the legs are now very peculiar and uncommon; the hind pair are lifted alternately with the fore, and are carried, or rather swung forward, outside of and beyond them at each bound. When excited to a swifter pace they often kick out their hind-legs during their course, and their nostrils are then actively and unwontedly dilated. The general figure of the giraffe, its raised anterior parts, elongated neck, light and tapering head, and long, slender, and flexible tongue, are all conditions which beautifully harmonize with its geographical position and the nature of its food. No Ruminant of its magnitude could exist in the arid tropical regions to which the giraffe is peculiar, if it were not modified so as to be able to obtain vegetable sustenance independently of ordinary pasturage. But in those localities shrubs and trees continue to put forth buds and leaves when all the herbage on the surface of the earth is scorched up; and it is for the purpose of browsing on the green food supplied by lofty branches that the Ruminant type is modified in so extraordinary a manner as we witness it in the giraffe. A zoologist, ignorant of the giraffe, could never have anticipated or conceived so beautiful and perfect a solution of this difficult problem in the scheme of animal enjoyment. The tongue is an organ exquisitely formed for prehension; it is used to hook down the branches which grow beyond the reach of the muzzle of the giraffe, and the animal in captivity instinctively puts it to use in a variety of ways. We have seen the giraffe, in the Jardin des Plantes at Paris, stretching upwards its neck and head, and protruding its tongue to the full extent to hook out single straws, which were platted into the partition separating it from the contiguous inclosure. In our own menagerie at Regent's Park many a fair lady has been robbed of the artificial flowers which adorned her bonnet by the nimble filching tongue of the rare object of her admiration. The giraffe seems, indeed, to be guided more by the eye than the nose in the selection of objects of food; and if we may judge of the apparent satisfaction with which the mock leaves and flowers so obtained are masticated, the tongue would seem by no means to enjoy the sensitive in the same degree as the motive powers. The difference in the size of the nerves of sensation and motion which we observed in the dissection of the tongue accords with these habits of the living animal. From the same dissection it was proved that the movements of the tongue, both those of extension, prehension, and retraction, were due to muscular, and not, as Sir Everard Home supposed, to vascular action. Observations of the living animal, and dissection of the dead, have at length dispelled most of the errors and doubts which obscured the exact knowledge of the nature and zoological affinities of the giraffe. Up to a very recent period we find it described as having callosities on the knees and over the sternum, like the camel, and as a kind of lusus with three horns; of which one, being articulated over a suture in the middle line of the forehead, seemed to take away from the chimerical nature of the unicorn by indicating a transition to that heraldic monster. The truth is, however, that the giraffe possesses neither those callosities nor this median articulated horn. It is essentially a true Ruminant, having a stomach divided into four compartments, the paunch being simply papillose, without water bags; and the reticulum with extremely shallow hexagonal cells, as in the reindeer. It is also a horned Ruminant, the horns being two in number, small, straight, and simple, like those of the pricket deer. But in the giraffe the bony base of each horn is articulated by a broad rough epiphysial basis to the cranium; it is covered by a vascular periosteum and a hairy integument, which is not deciduous. These horns, or rather antlers, terminate in a truncate extremity capped with a callous plate, and fringed with long and strong black hairs: these horns are present in both sexes, as in the reindeer; and are larger in the male. The median protuberance is a simple thickening of the contiguous parts of the frontal and nasal bones. In the form of the mouth the giraffe differs from every other Ruminant. The upper lip is not bifid, as in the camel; and though it is prolonged and covered with hair, as in the elk, it differs in its elegant and tapering form.

The giraffe has a long neck, and has not spurious hoofs, and this far it resembles the camel; but the cervical vertebræ in the camel tribe present a peculiarity of structure, combined with their length, in which the giraffe does not participate. The camels have many other peculiarities of internal organization, to some of which we find resemblances in certain ordinary Ruminants, but not in the giraffe. Its place in the Ruminant series is between the deer and antelope. These extensive families are respectively distinguished, not only by the nature of their horns, but by a well-marked anatomical character: the gall-bladder is present in the antelopes, and not in the deer. In three giraffes lately dissected in this country a gall-bladder was present in one, and not in the other two. In that in which it was discovered it presented an abnormal structure, being bifid at the fundus, and divided into two compartments. We may infer, therefore, that in this part of their organization, as in the structure of their horns, the giraffes are more nearly akin to the deer tribe than to the antelopes. Yet it must not be forgotten that while we search in vain among the *Cervidæ* for an equine mane and tufted tail, such as ornament the giraffe, we find both these peculiarities combined in the gnu among the antelopes. A giraffe more than two thirds grown will eat daily in confinement eighteen pounds of clover-hay, and eighteen pounds of a mixed vegetable diet, consisting of carrots, mangel-wurzel, barley, split beans, and onions; and will drink four gallons of water. They copulate in March. The female has four inguinal udders: she brings forth one young one at a birth; and the period of gestation is fifteen months. The new-born giraffe measures six feet from the fore-hoofs to the top of the head. In a few hours it is able to follow the dam. It resembles the mature animal in the markings of the hide. The first giraffe known to have been produced in captivity was brought forth in June, 1839, at the gardens of the Zoological Society of London.

GI'RASOL. A milk-white or bluish opal, which, when turned to the sun or any bright light, reflects a reddish colour; hence its name, from gyro, *I turn*, and sol, *the sun*.

GI'RDER. (Sax. ᵹẏꞃꝺan, *to inclose.*) In Architecture, a principal beam in a floor for supporting the binding or other joists, whereby their bearing or length is lessened. Perhaps so called because the ends of the joists are inclosed by it.

GI'RDLE. (Anglo-Sax. girdan, *to encircle.*) A belt or band of leather or some other substance used in girding up the loins. The girdle (Gr. ζωνη, Lat. cingulum) was in use among the Hebrews, Greeks, and Romans, for various purposes more or less important. By the Hebrews it was worn chiefly upon a journey, and sometimes as a mark of humiliation and sorrow; and by the Greeks and Romans it was used as a military ornament. Hence in the Latin phraseology *cingulum deponere* denoted "to quit the service." To deprive a soldier of his girdle was the deepest mark of ignominy with which he could be branded; and even among the civilians, who always wore a girdle over the tunic to render their motions unembarrassed, the want of this appendage was considered strongly presumptive of idle and dissolute propensities. In conformity with this opinion, or perhaps in allusion to the occasional substitution of the girdle for the purse among the Romans, Horace has affirmed that "you may do what you please with him who has lost his girdle,"—

Ibit eo quo vis qui zonam perdidit.

Zonam solvere virgineam was a well-known phrase appropriated to the marriage ceremony. To Venus was attributed by the poets the possession of a particular kind of girdle, called *cestus*, which was said to have the power of inspiring love.

It was formerly the custom in England for bankrupts or other insolvent persons to put off and surrender their girdles in open courts.

GIRO'NDE, THE. In French History, a celebrated political party during the Revolution; its members were termed Girondists or Girondins. The name was derived from that of the department La Gironde (in which Bordeaux is situated), which sent to the legislative assembly of 1791, among its representatives, three men of eloquence and talent (Guadet, Gensonné, Vergniaud), who were among the chief leaders of the party. Its principles were republican. During the continuance of that assembly the Girondists formed a powerful, but not always consistent party. Out of these Louis XVI. chose his republican ministers in the beginning of 1792. But after the massacres of September in that year the party in general withdrew from all connection with the Jacobins, and approximated towards the Constitutionalists. In the Convention the Girondists at first commanded a majority, but on the king's trial they were much divided; and, being pressed by the violence of the sections of Paris, they were at length expelled the assembly: thirty-four of them were outlawed, and finally twenty-two of their leaders guillotined (7th and 31st October, 1793), while a few escaped, and others put an end to themselves. Perhaps the most celebrated member of the Gironde party was a lady, Madame Roland, the wife of the minister of that name, who was executed when the party fell, and whose writing — the *Appel au Peuple* — bears all the stamp of that high republican enthusiasm which characterized them. (The remaining part of her memoirs is of suspicious authenticity.) Various apologies and eulogies of the party have appeared. Its members were not without high qualities; but its counterpart will be found in all revolutions, in that body of men of high theoretical views of social reform and little practical knowledge, who are commonly lifted into power by supporters more energetic but less high-principled than themselves at one turn of affairs, and sure to be thrust down in a short time by their own former adherents. (See particularly the

histories of Mignet and Thiers, for general views on the subject; for details, the *Histoire Parlementaire* of Messrs. Buchez and Roux, who are perhaps too unfavourable to the party.

GIRT LINE. A rope to lift the rigging up to the mast head on first rigging the ship.

GIVEN, in Geometry, signifies something that is known. Thus, a straight line is given in *position* when we know the situation of two points through which it must pass; and it is given in *magnitude* when we know its length. A triangle is given in *species* when we know the magnitude of each of its three angles, and a circle is given when we know its centre and radius.

GLA'BROUS. (Lat. glaber, *smooth.*) A term applied in Mammalogy to those parts of the surface of a quadruped which are naturally devoid of hair; and in Entomology, when a surface is smooth and devoid of hair or pubescence.

GLA'CIERS. (Fr.) The name given to the immense masses of ice which accumulate on the peaks and slopes, and in the upper valleys, of lofty mountains. The phenomena of glaciers form one of the most interesting subjects of scientific investigation, whether we regard their formation, structure, or appearance. In all parts of the globe they have the same general characteristics; but though the glaciers of other countries have often been described by geographers and naturalists, it is chiefly in respect to those of Switzerland that we possess detailed information. In that country, as indeed in every other, those parts of the mountains that rise above the line of congelation are covered with perpetual snow, which being partially thawed during the summer months, is on the approach of cold converted into ice, thus constituting what is called a *glacier*. The ice so formed descends along the slopes of the mountains into the valleys, by which their ridges are furrowed, where it accumulates into vast beds or fields; presenting, where the descent is gradual, a very level surface, and with few crevices, but where there is a rapid or rugged declivity, being rent with numerous chasms *, and covered with elevations rising from 100 to 200 feet. Though the snow line on the Alps is found at an elevation of about 8000 feet above the level of the sea, some of the glaciers descend so far downward that their lower extremity is not more than 3500 feet above it. This is particularly the case in the valley of Chamouni, where the singular spectacle is presented of huge pyramids of ice of a thousand fantastic shapes in juxtaposition with the most luxuriant pastures, or towering in majestic grandeur in the midst of verdant forests. The principle of the descent of the glaciers is twofold: viz. one of a slow and gradual character, like the dunes of France, by which a progressive movement of about twenty-five feet annually is effected; the other of a rapid and impetuous kind, in which a portion of the ice having been disrupted from the main body glides down the mountain's side, accumulating as it goes, and precipitating into the valleys beneath immense stones, fragments of rock, and other substances to which it had adhered. Philosophers and naturalists have attributed this downward movement of a glacier to various causes; but by far the most prevalent opinion respecting it is that of Saussure, who maintained it was nothing more than a slipping upon itself, occasioned by its own weight. On the other hand, M. Agassiz ascribes this motion to the expansion of the ice, resulting from the congelation of the water which has filtered into it and penetrated its cavities; while Mr. R. Mallet is inclined to attribute it to the hydrostatic pressure of the water which flows at the bottom and makes rents in the mass. When the debris which the glaciers accumulate in their descent has been deposited in the valleys, it constitutes what in Savoy is termed their *moraine* or border, an essential feature in the Alpine glaciers. These borders present every variety of aspect; but their most usual appearance is that of unfathomable bogs or morasses wholly destitute of vegetation, and in many instances fraught with infinite peril to the traveller. They are generally arranged in long ridges or mounds from 30 to 40 feet high; and being often two, three, or even four in number, resemble so many lines of entrenchment.

The Alpine glaciers occupy a superficial extent of 1484 square miles. From Mont Blanc to the borders of the Tyrol there are reckoned about 400, of which the greater number varies from 10 to 15 miles long, and from 1 to 2½ broad; their mean vertical thickness ranges from 100 to 600 feet. Besides the grand and picturesque appearance they present externally, their lower extremities are sometimes excavated by the melting of the ice into the form of immense grottoes, adorned with the finest stalactic crystallizations, whose brilliant azure tints are reflected on the foaming streams and torrents which generally issue from these caverns, forming altogether so beautiful and imposing a picture as to defy the most faithful pencil to portray it adequately. The glacier ice does not resemble that found in ponds and rivers: not being formed in layers, but consisting of small grains or crystals of congealed snow, it has neither the compactness, the solidity, nor the transparency of river ice; and though "every single crystal seems perfectly white, the whole mass is of a blue colour, passing through every variety of shade, from the most feeble sky-blue to that of the lapis lazuli." From the large accessions of snow and ice which the glaciers receive, especially in winter, it might reasonably be conjectured that they must be gradually increasing in size, and would consequently in the course of time break through their usual limits and overwhelm the cultivated lands of the surrounding country. This, however, is by no means the case. It no doubt often happens that on some occasions the glaciers are observed to descend lower than usual; but, when this takes place, the warm atmosphere of the lower valleys into which they have advanced (whose temperature rises in proportion to their depression) operates with such powerful effect in reducing their bulk, that they are invariably found to recede proportionably. Thus nature has established a compensating process, by which an effectual though simple check is administered to the encroachment of the glaciers upon the cultivated lands of the Alpine valleys. There are various other phenomena connected with the glaciers, for a full account of which the reader is referred to *Saussure's Voyage dans les Alpes*. See also *M'Culloch's Geographical Dict*., art. "Alps;" *Penny Cyclo*., art. "Glacier;" and arts. ICEBERG and MORAINE in this work.

* "These chasms are frequently many feet wide and more than 100 deep. Their formation, which never takes place in winter, but is frequent during summer, is accompanied with a loud noise resembling thunder, and a shock which makes the adjacent mountains tremble. They are subject to change every day, and almost every hour; and it is this circumstance that renders the ascent of the glaciers so dangerous to travellers."— *Geog. Dict*., art. "Alps."

GLA'CIS. In Fortification, a sloping bank of earth, extending from the parapet of the counterscarp to the level country.

GLADIA'TORS. (Lat. gladiatores; from gladius, *a sword.*) Sword players, who were originally employed to fight at the funerals of illustrious Romans, in order to appease their manes by the effusion of blood. They were subsequently introduced into the public amphitheatres, and became one of the most favourite spectacles of the Roman people. The gladiators were either captives or condemned criminals, or else people of the lowest rank, who served for hire, the profession being considered one of the greatest infamy. In spite of this, however, under some of the emperors, persons of the first families, who had enjoyed the highest honours of the state, entered the arena, either at the command of the despot, or in order to gratify him; and even females of patrician blood, in some instances, followed their example. Gladiators did not merely use the sword, as their name strictly implies, but were armed in various ways. (*See* MIRMILLO and RETIARIAN.) The gladiators were, in general, desperate and ruffian characters; and considerable bodies of them were sometimes kept in the pay of wealthy and turbulent citizens, or hired as bullies. Perhaps the best exposition of the opinion of the more philosophical Romans on the subject is thus given by Cicero:—"Crudele gladiatorum spectaculum et inhumanum nonnullis videri solet: et haud scio an non ita sit, ut nunc fit: cum vero sontes depugnabant, auribus fortasse multa, oculis quidem nulla poterat esse fortior contra dolorem et mortem disciplina." (*Tusc. Quæst.* 2.) It is commonly, but inexactly said, that the shows of gladiators were put a stop to by the Christian emperors. They certainly had not ceased in A. D. 404, and probably not before the conquest of Italy by the Goths. (Beugnot, *Destruction du Paganisme en Occident*, book ix. ch. 2.)

GLA'DIUS. (Lat.) The name of the internal horny plate of the calamaries, which was called by the Greeks ξιφος, or the sword.

GLANCE COAL. *See* ANTHRACITE.

GLAND. In Anatomy. This term is applied to those organs of the body in which *secretion* is carried on, and which appear to consist of a congeries of blood-vessels, nerves, and absorbents: they are frequently distinguished according to their secretion, into mucous, sebaceous, lymphatic, and lachrymal; or, according to their form and texture, into simple, compound, conglobate, and conglomerate.

GLANDS, LENTICULAR. In Botany, a term invented by Guettard to denote brown oval spots found upon the bark of many plants, especially willows, indicating the points from which roots will appear if the branch be placed in circumstances favourable to their production. They are, in fact, nothing but protuberances formed by the pressure upon the epidermis of subjacent roots attempting to pierce through it.

GLASS. (Germ.) A transparent, impermeable, and brittle substance. There are several varieties of glass, applicable to different purposes, and differing in their composition. Its essential ingredients are silica and potash or soda, to which a variety of other substances are occasionally added; one of the most common and important of which is oxide of lead, by which the fusibility and density of the glass is increased, so that it is more easily worked, and more brilliant, especially when ornamented

by cutting: of this latter description is the glass called *flint glass*, used for decanters, drinking glasses, chandeliers, &c. It consists of about 52 parts of silica, 34 of oxide of lead, and 14 of potash. Chemically speaking, therefore, it is a double silicate of potash and lead, containing 12 atoms of silica, 1 of potash, and 1 of oxide of lead. *Crown glass*, used for windows, is a compound of silica and soda, with a portion of lime. *Green bottle glass* is made of a mixture of sand with impure wood ash, kelp, and a portion of brick clay. These kinds of glass are manufactured by the operation called *blowing*. *Plate glass*, invented by Abraham Thwart, was first manufactured in Paris in 1688. It may be composed of 300 lbs. of fine sand, 200 of soda, 30 of lime, 32 oz. of black oxide of manganese, 3 of cobalt azure, and 300 lbs. of fragments of good glass. These materials, when in perfect fusion, are poured upon a hot copper plate; the mass is then rolled out, annealed, and afterwards polished by grinding with sand, emery, and colcothar. The difficulty of producing a perfect plate, without specks, bubbles, or waves, together with the risk of breakage, render large plates very expensive: on account of their necessary thickness they are also very heavy.

The manufacture of glass is one of the highest beauty; and considering the worthlessness of the materials of which it is made, and the various purposes of a useful, ornamental, and scientific nature which it subserves, may be regarded as perhaps the most important in the history of inventions. The period of its invention is involved in great obscurity; but if we believe Pliny, we are indebted for this necessary of life, as we are for the gift of letters, to the Phœnicians. The popular opinion upon this subject refers the discovery to accident*; but, as Dr. Ure has observed, there were circumstances in the ancient arts likely to lead to it, such as the fusing and vitrifying heats required for the formation of pottery and for the extraction of metals from their ores. But, be this as it may, the Egyptians were certainly acquainted with the art of glass-making; for in some nomes glass beads have been found coloured with a metallic oxide, and pieces of glass have been discovered in the ruins of Thebes. (See M. Boudet, *Desc. de l'Egypt*, vol. ix.; *Aul. Mémoires*.) In Strabo and Pliny's time, the inhabitants of Sidon and Alex were famed for the production of beautiful glass, which they cut, engraved, gilt, and stained of the richest colours, in imitation of precious stones, and exported to all parts of the then civilized world. At Rome, too, glass was manufactured into various articles of convenience and ornament; and so great was the luxury of this article, or so exquisite its manufacture in those days, that Nero is reported to have given 6000 sesterces for two glass cups. For a long time Venice is said to have excelled all the countries of Europe in this manufacture; of which, indeed, it may be said to have enjoyed a monopoly till about the middle of the 17th century, when the invention of blown mirror glass by Colbert gave France a decided superiority over its rival. At what period the manufacture of glass was introduced into England is not precisely known; but there can be no doubt that till near the close of the 17th century, this country was obliged to have recourse to foreigners for the supply of the common article of drinking glasses. In 1673, the Duke of Buckingham materially improved the fabrication of British plate-glass by bringing over several Venetian artisans to the works at Lambeth, which were under his patronage; and the manufacture was still further improved by the arrival of the French refugees subsequently to the revocation of the edict of Nantes. The above works, however, were soon abandoned; and it was exactly one century (1773) later that the first establishment of magnitude for the production of plate-glass was formed, under the title of "The Governor and Company of British Cast Plate-Glass Manufacturers." This company was incorporated by act of parliament, and soon after erected works on an extensive scale at Ravenhead, near Prescot, in Lancashire, which have continued in constant operation down to the present time. Since that period immense improvements have been made in the manufacture of every species of glass throughout all the countries of Europe, though the art may be said to have reached perfection only in England and Bohemia.

The application of glass to the glazing of windows is of comparatively recent introduction into dwelling-houses, though it was general in churches and other public buildings as early as the third or fourth century. In London, this manufacture was first begun in 1557; but that the use of window-glass was by no means universal even twenty years later, is evident from the fact that at Alnwick Castle, the residence of the Duke of Northumberland, the glass casements used at that period to be taken down in the absence of the family, to preserve them from accident.

* Pliny ascribes the origin of glass to the following accident: — A merchant-ship laden with natron being driven upon the coast of the mouth of the river Belus in tempestuous weather, the crew were compelled to cook their victuals ashore; and having placed lumps of the natron upon the sand as supports to the kettles, found, to their surprise, masses of transparent stone among the cinders.

In Scotland, even in the early part of the last century, glass was seldom seen in the windows of country houses; and a few years previously, even in the royal palaces and the town houses of the nobility, the windows of the upper stories alone were furnished with it. Since that period, however, a mighty change has been effected; for now even the windows of the meanest cottage in Great Britain are, almost without exception, supplied with glass, which, as Mr. M'Culloch has well observed, ought rather to be considered as a necessary of life, than as the most elegant and useful of conveniences.

In 1833, the number of establishments for the manufacture of every description of glass in the United Kingdom was 126, of which 106 were in England, and the remainder equally divided between Scotland and Ireland. The principal seats of the manufacture are beyond all comparison Newcastle and South Shields; but it is also carried on with great success at Stourbridge, Dudley, Liverpool, Bristol, and Warrington, and to a considerable extent in Leeds, Manchester, and London. The value of the glass annually produced in the United Kingdom is estimated at 2,000,000*l.*; and the workmen employed in the different departments at upwards of 50,000. In 1837, the total gross revenue derived from the glass duties amounted to 903,856*l.* 12*s.* 10*d.*; of which England produced 837,277*l.* 14*s.* 9*d.*, Scotland 56,220*l.* 4*s.* 11*d.*, and Ireland 10,378*l.* 13*s.* 2*d.* In no branch of manufacturing industry is the prejudicial effect of high duties upon the consumption of articles of convenience more strikingly illustrated than in the history of the duty upon glass in this country. It would be out of place here, however, to enter upon this subject; and we can only refer the reader for full information to the *Commercial Dictionary*, and the *Statistics of the British Empire*, vol. i. p. 715. 2d edit.

GLASS PAINTING. In Painting. The method of staining glass in such a manner as to produce the effect of representing all the subjects whereof the art is susceptible. A French painter of Marseilles is said to have been the first who instructed the Italians in this art, during the pontificate of Julius II. It was however, practised to a considerable extent by Lucas of Leyden, and Albert Durer. The different colours are prepared as follows: — *Black* is composed of two thirds of iron scales or flakes, and the other third of small glass beads, or a substance called *roccaglia* by the Italians. *White* is prepared from sand, or small white pebbles, calcined, pounded, and then ground finely; one fourth part of saltpetre is added, and the mixture is then again calcined and pulverized: when dyed a little gypsum or plaster of Paris is added. *Yellow* is formed from leaf silver ground and mixed in a crucible with saltpetre or sulphur; then ground on a porphyry stone; and lastly ground over again with nine times the quantity of red ochre. *Red*, one of the most difficult of the colours to make, is prepared of litharge of silver and iron scales, gum Arabic, ferretta, glass beads, and bloodstone, in nearly equal quantities. Experience alone will command success in making this colour. *Green* is formed from æs ustum one ounce, the same quantity of black lead, and four ounces of white lead, incorporated by the action of fire. When calcined a fourth part of saltpetre is added, and after a second calcination a sixth part more; after which a third coction is made before using it. *Azure*, *purple*, and *violet* are prepared in a similar manner to green, omitting the æs ustum, and in its stead using sulphur for azure, perigneux for purple, and both these drugs for violet. *Carnations* are compounded colours, are calcined, and mostly mixed with water; and must be finished part by part, and each with great despatch, before the plaster dries, and there is little opportunity for blending. The lights cannot be heightened; but the shadows may, when they begin to dry, be a little strengthened. Promptitude and facility in execution are the great requisites for this method of painting. *See* Cartoon.

GLAU'BER'S SALT. Sulphate of soda, originally made by Glauber, in his process for obtaining muriatic acid, by distilling a mixture of common salt and sulphuric acid.

GLAU'COLITE. (Gr. *γλαυκος*, *blue.*) A mineral of a bluish green colour, found near the lake Baikal, in Siberia; it is a silicate of alumina and lime.

GLAUCO'MA. (Gr. *γλαυκος*.) A disease of the eye, supposed to arise from dimness of the vitreous humour, and giving it a blueish green colour.

GLAUCO'PIS. (Gr. *γλαυκος*, and *ωψ*, *an eye.*) A genus of Passerine birds established by Forster, and including certain species remarkable for the presence of fleshy wattles attached to the base of the beak; whence they are commonly termed "wattle-birds." Temminck characterizes the genus as follows: — Bill moderate, strong, and thick, with the base enlarged towards the commissure; upper mandible convex, vaulted, curved towards the end, and without any notch; lower mandible following the curvature of the upper, straight below, hidden in part by the sides of the upper mandible. Nostrils basal, lateral, round, partially closed by a large

membrane, and entirely hidden by curled feathers advancing from the forehead. Feet robust, the tarsi longer than the mid-toe; toes nearly of the same length; the base of the inner toe, and nearly the whole of the outer toe, attached to the middle toe. Wings short; the first quill short, the three following graduated, and the fifth the longest. Tail long and graduated.

GLAU'COUS. Sea green; a term used in describing the colour of bodies, to denote a dull green passing into blue. Also used in describing the polish of bodies, to denote their being covered with a fine bloom of the colour of a cabbage leaf. Glaucescent is the diminutive of this.

GLAU'CUS. (Gr. *γλαυκος, blue.*) In Grecian Mythology, the name of a marine deity, the son, according to some of the genealogists, of Neptune, and one of the Näiads; according to others, of Polybius and Alcyone. He enjoyed the power of prophecy.

In Zoology, *Glaucus* is the name of a genus of Nudibranchiate Mollusks, remarkable for their beautiful azure tint. The species of *Glaucus* are found in the warmer latitudes floating in the open sea.

GLEA'NING. (Fr. glaner.) The practice of collecting corn left in a harvest field after the harvest has been carried, which (Levit. c. 19., Deut. c. 24.) appears by the Mosaic law to have been allowed to the poor. The right of the poor to glean is, however, not admitted in the English common law.

GLEBE. (Lat. gleba, *arable soil.*) In Law, church land; usually taken for that which is annexed to a parish church of common right, and belongs to the parson or vicar.

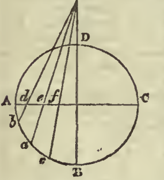
GLEE. In Music, a composition for voices in three or more parts. The subjects of the words are various, being gay, grave, amatory, pathetic, or bacchanalian. It may consist of only one movement, but usually has more.

GLEE-MAN. (From the Anglo-Saxon gleo, glig, &c. signifying *music.*) Itinerant minstrels were so called by the Saxons: their appellation is translated joculatores by the Latin writers of the middle ages. The name appears to have been supplanted by the Norman minstrel, shortly after the Conquest.

GLIRES. (Lat. glis, *a dormouse.*) The Linnæan name of the order of Mammalia distinguished by two long chisel-shaped incisors in each jaw. *See* RODENTIA.

GLOBE. A round body, or sphere; a term commonly applied to the earth. The term *artificial globe* is more particularly used to denote a globe of metal, plaster, paper, &c., on the surface of which a map of the earth or of the celestial constellations is delineated, with the principal circles of the sphere. In the former case it is called the *terrestrial*, in the latter the *celestial globe*. Artificial globes are used for the purpose of conveying to children the first ideas of the figure and rotation of the earth, of latitude and longitude, and the situation of places with respect to each other, and to the sun at the different seasons of the year. It is usual to employ them also for the purpose of solving mechanically a few elementary problems of astronomy, relative to the difference of the hour of the day at different places, the times of the rising and setting of the sun, the limits of the visibility of eclipses, &c. The answers, however, which can be found to questions of this nature, by means of ordinary globes at least, can only be regarded as rude approximations; and hence the use of globes should be limited to general explanation.

GLO'BULAR CHART. A delineation of the terrestrial surface, or any part of it, on a plane, according to the principles of the *globular projection*. Let A B C be the hemisphere to be projected, and A C the plane of projection; in order to make a globular projection, the eye is placed at the point E in the straight line B D, which passes through the pole B and the centre of the sphere, and at a distance D E above D equal to the sine of 45°. The peculiar advantage of this projection is that equal arcs, *a b*, *a c*, of great circles, are represented by straight lines *d e*, *e f*, which are nearly equal. If the plane of projection is the equator, the different meridians will be represented by straight lines, and the parallels of latitude by concentric circles. But in general the projection is made on a meridian, in which case the projections of the other meridians are ellipses. The globular projection was first proposed by Lahire. *See* MAP, PROJECTION.



GLO'BULA'RIA'CEÆ. (Globularia, one of the genera.) A small natural order of shrubby or herbaceous Exogens, inhabiting the hot and temperate parts of Europe. Placed by Jussieu and De Candolle near to *Primulaceæ;* but in greater affinity with *Dipsaceæ*, with which they agree in most respects, differing from them only in having a superior ovary. Their sensible properties are bitter tonic and purgative.

GLOBULAR SAILING. *See* NAVIGATION.

GLO'BULINE. A term given by Kieser to the green globules lying amongst the cells of cellular tissue. This word has been applied by Turpin, a French phytotomist, to all minute vesicular granules of a vegetable nature, which he considers the organic elements of vegetation. It is either cellular or vesicular tissue in a young state and disintegrated, or granules of starch or particles of colouring matter collected into microscopical balls.

GLO'RY. (Lat. gloria.) In Painting and Sculpture, a circle, either plain or radiated, surrounding the heads of saints, &c., and especially of our Saviour. The term glory is used in the sacred writings in various senses, all of which, however, may be easily deduced from the original meaning of its Hebrew equivalent, which signifies *weight*. Thus *the glory of God* means all those attributes and qualities which give him *weight* in our eyes, or inspire us with reverence. (See *Taylor's Concordance*.)

GLOSS. (Gr. *γλῶσσα, tongue.*) In the Rhetoric of Aristotle, this word is used in the sense of a foreign, obsolete, or otherwise strange idiom; which, judiciously employed, he reckons among the ornaments of style. From the sense of "something requiring interpretation" the word came to mean the interpretation itself; strictly, of a single word or phrase. In the twelfth century, the comments or annotations of learned jurists on passages in the text of the Roman law were denominated glosses; when these extended to a running commentary, they were termed an apparatus. The glosses were collected by Accursius in the 13th century, and from that period they formed for a long time a body of authority reckoned equal or even superior to the text itself.

GLO'SSARY. (Lat. glossarium.) A dictionary of difficult words and phrases in any language or writer; sometimes used for a dictionary of words in general. Of all the works published under the title of glossary, the most celebrated by far is the *Glossarium Mediæ et Infimæ Latinitatis* of Du Cange. The best edition of this learned and admirable work is that edited by Carpentier, in 6 vols. folio, 1733—1736. Carpentier's *Supplement*, in 4 vols. folio, 1766, is an indispensable addition.

GLO'TTIS. (Gr. *γλωττα, the tongue.*) The superior opening of the larynx or windpipe.

GLOVES. (Anglo.Sax. glof.) Well-known articles of dress used for covering the hands. The practice of covering the hands with gloves has prevailed among almost all the nations of the earth from time immemorial, and is common at once to the rude Tartar, who seeks by their means to protect himself from cold, and to the refined European, with whom their use is an emblem of luxury. (*Gough. Sep. Mon.* i. p. 185.) In the middle ages, gloves constituted a costly article of dress, being often highly decorated with embroidery and richly adorned with precious stones. In the age of chivalry it was usual for the soldiers who had gained the favour of a lady to wear her glove in his helmet; and, as is well known, the throwing of a glove was the most usual mode of challenging to duel. This latter practice prevailed so early as the year 1245. *Matthew Paris's History*. (See the *Penny Cyc.*, and the authorities there referred to.)

GLOW-WORM. *See* LAMPYRIS.

GLUCI'NIUM. The metallic base of the earth glucina, discovered by Vauquelin in 1798, and hitherto only found in three rare minerals,—the emerald, beryl, and euclase. The name is derived from *γλυκυς, sweet*, in consequence of the sweet taste of its salts. The metal, which is of a dark grey colour, was first obtained in 1828 by Wöhler; he procured it by acting upon the chloride of glucinium by potassium. The equivalent of glucinium is 18, and glucina consists of 18 glucinium + 8 oxygen.

GLUE (Lat. gluten), is prepared from the clippings of hides, hoofs, &c. These are first washed in lime water, and afterwards boiled and skimmed; the solution is then strained through baskets, and gently evaporated to a due consistency; then cooled in wooden moulds, cut into slices, and dried upon nets. Good glue is semitransparent, deep brown, and free from spots and clouds. When used it should be broken in pieces, and steeped for twenty-four hours in cold water, by which it softens and swells; the soaked pieces are then melted over a gentle fire, or, what is better, in a water bath, and in that state applied to the wood by a stiff brush. Glue will not harden in a freezing temperature, the stiffening depending upon the evaporation of its superfluous water. The chemical properties of glue are those of an impure *gelatine*.

GLU'TEN. (Lat.) The viscid elastic substance which remains when wheat flour is wrapped in a coarse cloth, and washed under a stream of water, so as to carry off the starch and soluble matters. Gluten exists in many grains, and occasionally in other parts of vegetables; but it is a characteristic ingredient in wheat, giving wheat flour its peculiar toughness and tenacity, which particularly fits it for the manufacture of bread, and for viscid pastes, such as macaroni and vermicelli. There is generally more gluten in the wheat of warm climates than of cold; hence the excellence of that grown in the

south of Europe for the manufactures just mentioned. Gluten contains nitrogen, and has consequently been called the vegeto-animal principle on this account: it yields ammonia when subjected to destructive distillation, and the vegetables which contain it give out a peculiarly disagreeable odour during their putrefaction.

GLU'TEUS. (Gr. γλουτος, *the buttocks.*) The large and thick muscle upon which we sit, and which serves to extend the thigh by pulling it directly backwards. It also assists in its rotatory motion.

GLU'TTON. The name of a carnivorous plantigrade quadruped (*Gulo arcticus*); also applied by some micrographers to a diaphanous species of *nais*.

GLY'CERINE. (Gr. γλυκυς, *sweet.*) A sweet substance formed in the process of saponification. It was originally observed in the formation of common plaster by boiling oil with oxide of lead and water.

GLYCY'RRHIZIN. The peculiar saccharine matter of the root of *Glycyrrhiza glabra*, or common liquorice.

GLYPH. (Gr. γλυφω, *I carve.*) In Architecture, a vertically sunken channel. From their number those in the Doric order are called *triglyphs*.

GLY'PTIC. (Gr. γλυφω.) In Sculpture, a term denoting the art of carving on stone or any other hard substance.

GLY'PTODON. (Gr. γλυφω, and οδους, *a tooth.*) The name of an extinct gigantic quadruped belonging to the family of Armadillos (*Dasypodidæ*), and covered, like them, with a tesselated osseous armour. It is distinguished from the existing armadilloes not only by its size, which equals that of the rhinoceros, but by its teeth, which are longitudinally fluted, whence its generic name.

GLY'PTOTHE'CA. (Gr. γλυφω, and θηκη, *deposit.*) A building or room for the preservation of works of sculpture; a word adopted by the Germans, as in the instance of the celebrated Glyptothek at Munich.

GNAT. *See* Culex.

GNATHI'DIA. (Gr. γναθος, *a jaw.*) A technical term in Ornithology for the lateral parts or rami of the mandible or lower jaw, which are joined to the cranium behind, and meet in front at a greater or less angle.

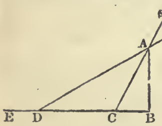
GNA'THOTHE'CA. (Gr. γναθος, and θηκη, *a sheath.*) In Ornithology, the horny or cutaneous integument of the beak.

GNEISS. A species of granite, which from excess of mica is generally of a lamellar or slaty texture. It is a German miner's term.

GNOME. A name given by the fanciful writers of the Cabalistic school to that class of their supposed elemental spirits which inhabit the earth. Their name is more properly *Gnomons;* derived from the Greek γνώμων, *knowing, cunning.* (See *Darwin's Botanic Garden.*)

GNO'MIC POETS. (Gr. γνωμη, *a sentence or opinion.*) Greek poets, whose remains chiefly consist of short sententious precepts and reflections, are so termed in classical bibliography. The principal writers of this description, of whom a few fragments are extant, are Theognis and Solon, who lived in the 6th century before the Christian era. With them Tyrtæus and Simonides are joined by Brunck in his edition (*Gnomici Poetæ Græci*, Argent, 1784), although these writers have little of a gnomic character. The metre of these poets is elegiac.

GNO'MON. (Gr. γνωμων.) In Astronomy, an instrument for measuring the lengths of shadows, and thereby determining the altitudes of the sun. Let A be the top of a vertical style, column, or pillar, or a small hole in a wall A B, the height of which above the horizontal line B E is accurately known; a ray of solar light coming in the direction S A reaches the ground at C, and the length of the shadow projected by the gnomon is B C. Now, as the length of B C can be accurately measured, and as A B is known, and the angle at B is a right angle, it is easy to find by the rules of plane trigonometry the angle A C B, or the sun's altitude. Suppose S C B thus found to be the sun's meridian altitude on the day of the summer solstice, and S′ D B his meridian altitude on the day of the winter solstice; then half the difference between these two altitudes is the obliquity of the ecliptic, or the sun's greatest declination. And when the sun's declination and meridian altitude are both known, the latitude of the place of observation is likewise determined. In this way Pytheas, in the time of Alexander the Great, found at Marseilles the ratio of the height of the gnomon to the meridional shadow on the day of the solstice to be 120 to $41\frac{4}{5}$ (*Montucla*, vol. i. p. 191.), whence the obliquity of the ecliptic is concluded to have been at that time about 23° 49′.



Gnomons were probably the first astronomical instruments; and they appear to have been much in use among the Egyptians, the Chinese, and even the Peruvians. (*Goguet, Origine des Loix.*) The Egyptian obelisks are supposed to have been intended as gnomons. It is evident that observations of this kind cannot give the sun's altitude with much exactness. The shadow is never so well defined that its limits can be ascertained with astronomical precision; besides, the observation requires to be corrected for parallax, refraction, and the sun's semi-diameter, — elements which can only be determined by means of instruments of a very superior description to the gnomon, and which, consequently, render the latter useless. The astronomer Ulug-Beg, about the year 1437, erected a gnomon at Samarcand, the height of which was 165 Paris feet

Gnomon, in Dialling, is the style of the dial, the shadow of which marks the hour. It is placed so that its straight edge is parallel to the axis of the earth's rotation.

Gnomon. In Geometry, the part of a parallelogram which remains when one of the parallelograms about its diagonal is removed; or the portion of the parallelogram composed of the two complements and one of the parallelograms about the diagonal. The term is seldom used, excepting in *Euclid's Elements.*

GNOMO'NIC PROJECTION. The representation of a hemisphere on a plane touching it at the vertex, the eye being placed at the centre of the sphere. In this projection all great circles of the sphere are projected into indefinite straight lines, small circles parallel to the plane are projected into circles, and those which are oblique to it into ellipses or hyperbolas. *See* Projection.

GNOMONICS. The art of constructing dials. *See* Dialling.

GNO'STICISM. (Gr. γνωσις, *knowledge.*) A philosophical system of religion which prevailed in the East during the four first centuries of our era, and exercised great influence upon Christian theology, giving birth to numerous and widely diffused heresies, and insinuating itself under a modified form even into the writings of the most orthodox fathers. The origin of the system is involved in considerable obscurity: in its leading principles it seems to point to the oriental philosophy as its genuine parent; but it is objected to this solution that the fathers refer it, together with the errors similarly introduced by Platonism, to a Greek origin, and appeal to the cosmogonies of Hesiod and others as the real exemplars from which it is imitated. It is to be remarked, however, that the fathers were universally ignorant of the oriental philosophy; from which we may conclude that their opinion upon such a point is not necessarily decisive. A modern solution conceives Alexandria to have been the central point to which the speculations of the Greeks and the orientals converged, and from whence they frequently re-issued, after having undergone the process of fusion into a common mass. It is certain that Alexandria was, during the time we have spoken of, a celebrated resort of Gnostic opinions, both within and without the church.

The grand principle of this philosophy seems to have been an attempt to reconcile the difficulties attending upon the existence of evil in the world. Evil, it was supposed, being the contrary of good, must be contrary to, and therefore the opponent of, God: if the opponent of God, then independent of him and coeternal. From the many imperfections which are involved in all outward and sensible objects, it was held that matter must contain in itself the principle of all evil. The human soul, on the contrary, which aspires after and tends to a higher and more perfect development, was held to be the gift of the Supreme Deity, imparted to man for the sake of combating against the material principle, and with the prospect of finally subduing it. From the Supreme God on the one hand, and matter on the other, succeeding philosophers produced various fanciful genealogies of superior intelligences, under the name of Æons, — a Greek word, signifying properly periods; thus representing these divinities themselves by a name expressive of the time and order of their generation, much as in our current language the terms reign, or government, are frequently put for the king or ministers governing. The Demiurgus, who formed the world out of matter, appears to have been an Æon derived from the evil principle. He was also the God of the Old Testament, who was considered by the Gnostics to be an object of aversion to the One Supreme God, to counteract whose machinations the Æon Christ was sent into the world. This is the earlier and simpler system, which is attributed to Simon Magus: the number of the Æons was fancifully multiplied in later times, and an extravagant theory of morals founded upon the system The object of these principally was, as may be supposed, to depreciate the honour due to the body, as being a part of matter, and to elevate the thinking faculty, or at least to remove it from all consideration of worldly things. The Gnostics imagined that by assiduous practice of certain mental and bodily austerities they could obtain an intuition of the divine nature, and dwell in communion with it; and this part of their system is adopted to a considerable extent by Clemens Alexandrinus, whose opinions, as expressed in his *Pædagogus*, are very similar to those of a Pietist of more modern times.

The Gnostics split in process of time into various sects,

distinguished rather by the different cosmogonies they invented, than by any variation in principle. Of these the principal were founded by Carpocrates, Basilides, Tatian, and Valentinus. The system did not survive the 4th century. The Christians seem sometimes to have adopted the general designation of Gnostics. (See *Burton's Bampton Lectures; Neander; Mosheim*, vol. i. (Transl.) p. 133, &c.; Gieseler, *Text-Book of Eccl. Hist.* i.; *Riddle's Christian Antiquities*, p. 133.)

GOAT, the English name for the well-known ruminant of the genus Capra. The goat is characterised by its long horns, which are rounded posteriorly, angular on the anterior edge; transversely rugose, and rise at first perpendicularly, afterwards bending outwards and a little backwards. It is clothed by long hair, which, in the Cashmere breed, is soft and fine, and forms the staple of the celebrated shawls of that name. Beneath the long hair is a soft wool. The female produces two kids at a birth, which derive their nourishment from two teats supported on a large pendant udder. The period of gestation is five months. The milk of the goat is less apt to curdle on the stomach than that of the cow, and is thus better adapted for the weak and consumptive. The flesh of both the goat and kid is much esteemed in many countries, though of a peculiar flavour, arising probably from the aromatic shrubs and heaths on which the goat delights to browse. In Portugal and other countries the goat is used as a beast of draught. A notion of the wholesome influence imparted by the goat to the stable in which it may sleep, is very prevalent among the grooms of this country.

GO'BBING. In mining, the refuse thrown back into the excavations remaining after the removal of the coal.

GODROO'N. (Fr. godron.) In Architecture, an inverted fluting, beading, or cabling, used in various ornaments and members.

GO'DWIT. *See* LIMOSA.

GOG and MAGOG. The names of two warriors noticed in different portions of the sacred writings (Gen. x.; Ezekiel, xxxviii, &c.), and which since the Christian era have been regarded as nearly synonymous with Antichrist. The author of the Apocalypse (xx. 8.) uses the terms to express the nations hostile to Christianity; and Mohammed, in the Coran (21. 96.), employs them in a somewhat analogous sense. As is well known, the names Gog and Magog are given to the two huge warlike figures that adorn the Guildhall of London; but it is impossible to account for this singular application of the words.

GOITRE. *See* BRONCHOCELE.

GOLA, or GULA. (Lat.) In Architecture, the same as *Cyma*, which see.

GOLD. (Germ.) The most valuable and longest known of the metals. It sometimes occurs in regular veins in primary mountain districts; but the largest quantity is found in alluvial soils, and frequently in the beds and sands of rivers, as in Africa, South America, Mexico, Hungary, and Siberia. It is generally separated by washing away the lighter materials with which it is mixed, and subsequently by the process of *amalgamation*. Gold has been from the earliest period used as a measure of value and universal equivalent. For details on this subject, *see* MONEY.

Gold is characterised by its yellow colour; its extreme permanence in air and fire; its density, which is about 19·3; its malleability, which is such that it may be beaten into leaves not more than one two hundred and eighty thousandth of an inch in thickness; and its ductility, a grain of gold being drawn out into 500 feet of wire. Gold is not acted upon by the common acids; but chlorine and nitro-muriatic acid corrode and dissolve it, forming a chloride of gold, which is soluble in water.

The *alloys* of gold have been examined in detail by Mr. Hatchett. (*Phil. Trans.* 1803.) Of these the most important is that used for the gold coin of the realm, commonly called *standard gold*, which consists of eleven parts of pure gold and one of copper; it is extremely ductile and malleable, but harder than pure gold, and therefore better calculated to resist the wear and tear of circulation. The specific gravity of this alloy is 17·157: 20 lbs. troy of it are coined into 934 sovereigns and one half sovereign; 1 lb. troy, therefore, produces $46\frac{29}{40}$ sovereigns; the same weight was formerly coined into $44\frac{1}{2}$ guineas. The colour of this alloy is deeper yellow than that of pure gold, and verges upon orange: it frequently happens that a part of the alloy of gold coin is silver, hence the pale colour of some sovereigns as compared with others. Among the metals which destroy the colour and malleability of gold, none is so remarkable as lead. It appears from Mr. Hatchett's experiments that when lead forms about one two-thousandth part of the alloy, it is too brittle for rolling, and that the fumes of lead destroy the good qualities of gold. The chemical equivalent of gold is probably about 200, and that of the protoxide 208, and of the protochloride 236. The peroxide is a compound of one proportional of gold and three of oxygen, and the perchloride contains three proportionals of chlorine. When ether is agitated with solution of chloride of gold it takes up the metal, and forms a yellow ethereal solution of gold; when polished steel instruments are dipped into this solution, and immediately washed in water and wiped with a piece of soft leather, they become beautifully gilt with a very thin film of gold. *See* GILDING.

GOLDEN FLEECE. *See* ARGONAUTS. FLEECE, &c.

GO'LDEN NUMBER. *See* CYCLE.

GO'LDEN RULE. *See* RULE.

GO'LDFINCH. The common name of our well-known and brightest-plumaged songster; the *Carduelis elegans* of most modern ornithologists, *Fringilla carduelis* of Linnæus. This species feeds chiefly on the seed of the thistle and plantain; but builds its nest, which is of the neatest construction, in the fork of a branch of some densely-leafed tree, and lays four or five eggs, of a bluish white, spotted with brown at the greater end. The female is less brightly clad than the male, and the young have a comparatively simple plumage, in which brown predominates. In captivity the goldfinch is remarkable for its docility, and is prized for its beauty as well as its song. Hybrids are bred between the goldfinch and canary, and are much admired.

GOLF. A game with a ball and clubs, almost peculiar to Scotland, where it enjoys a degree of popularity equal to cricket in England.

GOLT. *See* GAULT.

GO'MARITES. In Ecclesiastical History, the Calvinist divines of the church of Holland in the 17th century were so called, from Francis Gomar, a colleague and opponent of Arminius at Leyden. *See* ARMINIANS. *Mosheim* (Trans.), ed. 1826, v. 325.)

GOMPHI'ASIS. (Gr. γομφος, *a nail.*) A disease of the teeth, when they loosen and fall out of the sockets. The grinding teeth are also called *gomphioi*.

GOMPHO'SIS. (Gr. γομφος.) A species of junction of bones where they are let into each other, something like pegs in a board.

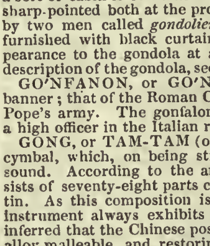
GO'NDOLA. (Ital.) The name given to the pleasure boats used at Venice, where the numerous canals with which it is intersected generally render it necessary to substitute boats for carriages. The gondola is from 25 to 30 feet long, and 5 feet wide in the centre, in which a sort of cabin is constructed for passengers. They are sharp-pointed both at the prow and stern, and are rowed by two men called *gondolieri*. The cabins are always furnished with black curtains, which give a sombre appearance to the gondola at a distance. For an accurate description of the gondola, see Lord Byron's *Beppo*, 19, 20.

GO'NFANON, or GO'NFALON. In Heraldry, a banner; that of the Roman Catholic church carried in the Pope's army. The gonfalonier or standard-bearer was a high officer in the Italian republics of the middle ages.

GONG, or TAM-TAM (of the Chinese). A species of cymbal, which, on being struck, produces a very loud sound. According to the analysis of Klaproth, it consists of seventy-eight parts copper and twenty-two parts tin. As this composition is extremely brittle, and the instrument always exhibits marks of the hammer, it is inferred that the Chinese possess the art of rendering the alloy malleable, and restoring it to its natural state of elasticity and brittleness when the instrument is formed. It is struck with a wooden mallet covered with leather.

GO'NIATITES. (Gr. γωνια, *an angle.*) A genus of extinct Cephalopods with chambered spiral shells; nearly allied to the *Ammonites*, but differing in having the lobes of the septa free from lateral crenatures or denticulations, so that the outline of these is continuous and uninterrupted. Goniatites are found in the mountain limestone of Yorkshire.

GONIO'METER. Gr. γωνια, *angle*, and μετρον, *measure*.) An instrument for measuring angles, and more particularly the angles formed by the faces of crystals. The instrument, chiefly used by mineralogists, was invented by Dr. Wollaston. It consists of a brass circle graduated on the edge, and furnished with a vernier, by which the divisions may be read correct to a minute. The circle moves in a vertical plane, and is supported on a stand. The axis of the circle is a hollow tube, within which is a smaller axis, fitting so tightly that when turned round it carries the other axis and consequently the wheel along with it, unless the latter is purposely prevented from moving. The interior axis is furnished with a milled head *a*, and the exterior with a milled head *b*;



so that when the head *a* is held and *b* turned the circle may be moved independently of the smaller axis, and when *b* is held and *a* turned the smaller axis may be

turned independently of the circle. Attached to the end of the smaller axis is a sort of universal joint, capable of being fixed in different positions by means of screws. The crystal to be examined is attached to the joint at *c* by a little soft wax, and placed so that its edge shall be parallel to the axis of motion; which adjustment is obtained by placing it so that the image of some horizontal object, as the bar of a window, successively reflected from the two faces of the crystal, coincides with another horizontal line seen by direct vision. When this adjustment has been made, the instrument is turned till the horizontal object is seen reflected from one of the faces. The smaller axis is then held fast, and the other turned till the index of the vernier points to the zero of the graduated limb. The circle is then turned round, along with the smaller axis, till the same object is seen in the same position by reflection from the other face of the crystal; when the arc passed through by the circle is obviously the supplement of the angle formed by the two faces of the crystal. In order, however, to avoid calculation, the supplements of the angles are marked on the limb, so that the angle to be measured is read off immediately.

Other forms of the goniometer have been proposed by Charles, Malus, and Brewster. (See Biot, *Traité de Physique*, tom. iii.; and *Brewster's Treatise on Philosophical Instruments*.)

GO'NOPLAX. (Gr. γωνια, *a knee*, and πλαξ, *a plate*.) A genus of crabs or short-tailed Crustaceans (*Brachyuri*), characterized by the angular square or rhomboidal form of their upper crustaceous plate or carapace, and by the length of the eye-stalks. One species (*Gonoplax rhomboides*) inhabits the Mediterranean, and is a good swimmer; but most of the rest of the genus are tropical.

GO'NYS. (Gr. γονυ.) In Ornithology, the inferior margin of the symphysis of the lower jaw, or the united anterior extremities of the guathidia.

GOOD FRIDAY. The name given in England to the anniversary of our Saviour's crucifixion. The French and most other European nations substitute the epithet *holy* for *good:* the Germans designate this day "Stiller-freitag," or "Char-freitag:" the latter appellation being derived from an old word, "charen," signifying *to do penance*, or *to suffer*. From the first dawn of Christianity Good Friday has been regarded as a solemn festival by the great body of the Christian world.

GOOD WILL. In Law, the custom of any trade or business. A contract to transfer it is, in general, good at law; though not usually enforced in equity. In what cases the good will of a partnership can be claimed as property by the representatives of a deceased partner appears doubtful.

GOOSE. *See* ANAS.

GOO'SEWINGS OF A SAIL. Half the sail loosed; the other half being kept furled, from the violence of the wind.

GO'RDIAN KNOT, in History, was a knot made by Gordius, king of Phrygia, in the harness of his chariot, so intricate as to baffle every effort to untie it. The oracle having declared that he who untied this knot should be the conqueror of the world, Alexander the Great, as is well known, made the attempt; but fearing lest in the event of his failure it should be considered as a bad omen, and interpose an obstacle to his future conquests, he cut it asunder with his sword; and thus, says Quintus Curtius, either fulfilled the oracle or eluded it. Aristobulus, however, gives a different version of the story. (See *Arrian*, book iii. c. 20.; and *Plutarch*, *in vit. Alex.*)

GORGE. (Fr.) In Fortification, the entrance into a bastion or other outwork. The *gorge* of a bastion is what remains of the sides of the polygon of a place after cutting off the curtains. The *gorge* of a ravelin, or demilune, is the space between the two ends of the faces next the place. The *demi-gorge* is that part of the polygon between the flank and the centre of the bastion. *See* FORTIFICATION.

GORGE. In Architecture, the same as *cavetto*, which see.

GO'RGET. (Fr. gorge, *a throat*.) In Plate-armour, the piece covering the neck attached to the helmet. The old covering for the neck was called *camail*, made of leather or cloth, and attached to the hood; on this plates of steel were riveted; and thus the gorget was formed, about the time of Edward II. The name is supposed to have originated in Lombardy.

GORGET. A surgical instrument used in the operation of lithotomy.

GORGONEI'A. (Gr.) In Architecture, carvings of masks imitating the Gorgon or Medusa's head.

GO'RGONS. In Mythology, three sister deities, fabled by the Greeks to dwell near the Western Ocean. Their heads, which were twined with serpents instead of hair, had the power of turning all who beheld them to stone; of which property Perseus made use after he had, by the help of Minerva, cut off the head of Medusa.

GO'SPEL, is used to signify the whole system of the Christian religion, and more particularly, as the term literally implies, the good news of the coming of the Messiah. The word was also originally applied to the books which contained an account of the life of Christ, many of which were in circulation in the first century of the Christian era; though only four, those of Matthew, Mark, Luke, and John, were considered canonical by the fathers.

GO'THIC ARCHITECTURE. *See* ARCHITECTURE, and ENGLISH ARCHITECTURE.

GOULA'RD'S EXTRACT OF LEAD. A subacetate of lead, obtained by boiling powdered litharge in vinegar.

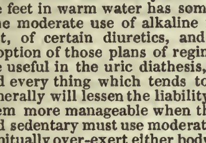
GOUT. The origin of this term, from the French *goute*, is obscure: it is a common disease among the higher classes of society, especially among those who indulge in the luxuries of the table, or inherit a disposition to its attack. Females are much less subject to it than males. Medical writers have distinguished several species of gout, and have called the disease in its ordinary form the *regular gout*. The first symptoms of its attack are those of dyspepsia and irregularity of bowels, low spirits, and some fever and restlessness; but these often pass unobserved till, the patient is roused in the night by violent pain in some part of the leg, generally in the vicinity of the great toe, and of one foot only: there is much throbbing and uneasiness, with more or less swelling and inflammation, and the least motion commonly produces great increase of suffering. After some hours the pain and fever abate, perspiration comes on; he falls asleep, and awakes comparatively easy. These fits or paroxysms are apt to return at intervals, and often every evening; but they decrease in violence, and at length go off, frequently with some decided increase of perspiration or other evacuation: the affected part itches, and the cuticle peels off, more or less lameness or uneasiness remaining. But the fit only thus leaves the patient for a time, and returns at intervals of longer or shorter duration, according to his habit of body and the care which he takes of himself; and the attacks not only become more frequent and severe, but last longer, and extend to other limbs; and when they have been frequently repeated, they leave a permanent stiffness of the joints, upon which *gouty concretions* are often deposited: and if much attention is not paid to the state of the urine, fits of sand and gravel not uncommonly precede or accompany those of gout. Where the disease is of long standing, and the form of it severe, the body becomes maimed and decrepit, and the mind often worn and irritable; the joints of the feet and hands, and even the larger joints of the extremities, are stiff and nearly immovable; and the formation of the chalky matter, as it is called, about the joints increases. If we consider the nature of this secretion in the joints, which is *urate of soda*, and the tendency of gouty persons to those morbid states of the kidneys and urine which depend upon excess of uric acid, and even upon the frequent alternation of fits of gravel with those of gout, the question will naturally suggest itself whether gout is not a symptom of what is often termed the *uric diathesis*, and whether the remedies applicable to it may not be beneficial in gout; and that in many cases they are so, seems to have been amply proved by experience. (*See* CALCULI.) It was once a favourite maxim that the gout was an effort of the system to relieve itself of some peccant matter; that, therefore, it was to be left almost to itself, and that patience and flannel were the chief remedies: this method still has its advocates, chiefly in consequence of the dangerous results that have sometimes attended more active plans of treatment in causing the revulsion of the gout from the limb to the stomach or head. But though there may be a difference of opinion in regard to certain energetic modes of relieving the disease, no one can object to the adoption of gentle means of quieting the urgency of the symptoms, and to the adoption of such diet and plan of living as appears to diminish the frequency of their recurrence. Warm laxatives, moderate diaphoretics and diuretics, and occasionally opiates, are among the former; and plain food or vegetable diet, with moderate exercise and tonics, are good preventives. Those, however, who have witnessed the sufferings of a regular paroxysm, and the evils of its duration and repetition, will see the necessity of doing something more; that is, of speedily quelling the pain and carrying off the attack, if it can be done with any chance of safety and success; and this experience shows to be often the case, though much care and judgment are undoubtedly requisite in conducting such treatment. In strong and healthy habits, the affusion of cold water is one of the most effective palliatives of the pain and inflammation; and by its timely application, *in proper cases*, the most beneficial results have ensued. Another celebrated remedy in this disease, and which by some has improperly been called a *specific*, is *colchicum*, or *meadow saffron*; — a due dose of which, taken at bed-time, has carried off the paroxysm; and this it often does without any remarkable evacuation, though it sometimes handles the patient severely as a purgative, and nauseates and

depresses to an alarming extent. This method of cure must not be unadvisedly and generally adopted; but in some cases, where gout had been long established, and where the frequency and duration of the fits and their inroads upon the constitution were increasing to an alarming extent, and that at an advanced period of life, colchicum, carefully administered, seems to have carried off the severity, if not the frequency of the attacks, and to have prolonged existence in consequence. But there are forms of gout, and consequences of gout, the management of which requires the utmost skill and experience: it is sometimes transferred or translated from the limbs to some internal part, in which case it is called *retrocedent gout;* or it produces sickness, dejection of spirits, fainting, palpitation, and giddiness, as in what is termed *atonic gout;* or it falls at once upon some internal part, especially the stomach, and is then called *misplaced gout.* In gout of the head and of the stomach the symptoms are often frightfully severe, and the pain excessive; and as these forms of gout are of most common occurrence in debilitated habits and broken constitutions, they become, on that account, the more difficult to treat: the expulsion of the disease to the extremities is in such cases sometimes effected by ether, brandy, or what are termed *gout cordials,* which generally consist of warm aperient tinctures; but before these are administered, it must be ascertained that the symptoms are really those of gout, and not idiopathic or common inflammatory actions. In such cases, putting the feet in warm water has sometimes been serviceable. The moderate use of alkaline remedies, of a vegetable diet, of certain diuretics, and generally speaking the adoption of those plans of regimen and medicine which are useful in the uric diathesis, are also useful in gout; and every thing which tends to repair the constitution generally will lessen the liability to its attacks, and render them more manageable when they occur. The indolent and sedentary must use moderate exercise, and those who habitually over-exert either body or mind must endeavour to tranquillize both: without such precautionary measures are most peremptorily enforced, no gouty person can expect much benefit from physic.

GOU'TY CONCRETIONS. These form in the joints of gouty persons, especially of the toes and fingers, and are sometimes, from their appearance, called *chalk stones;* they are composed of uric acid and soda.

GO'VERNMENT. In Politics, a word used in different senses: — 1. As the collective body of the fundamental laws of a state: as when the government of a country is said to be monarchical, aristocratical, &c. 2. The body of persons charged with the conduct of the executive in any country: thus, the king or presiding magistrate, the cabinet ministers, chiefs of departments, &c. in every country, form what is commonly styled its government.

GO'VERNOR. – A contrivance for regulating the speed of machinery, which has long been in use in mill-work, but has of late years attracted more attention by its adaptation to the steam engine. It consists of two heavy balls B B, attached to the extremities of two rods B F, B F, which play upon a joint at E, passing through a mortise in the vertical shaft D D. These



are united by joints at F to the short rods F H, which again are connected by joints at H to a ring which slides on the shaft D D. A horizontal wheel, W, is attached to D D, having a groove to receive a rope or strap on its rim, by means of which the motion is communicated to D D from a corresponding wheel on some shaft of the machinery to be regulated. It is evident, from the disposition of the rods, that if the balls B B are by any means raised or drawn asunder, the extremities F F of the rods turning on the pivot E will also be separated, and their distance from the axis increased. This will draw the rods F H in the same direction, and cause the ring or collar H to descend. This ring is connected with the end I of a lever, whose fulcrum is at G, and whose other extremity K is connected by some means with the part of the machine which supplies the power. Suppose now the velocity from any cause to undergo a sudden increase; by reason of the increased centrifugal force arising from the whirling motion, the balls B B will recede from the shaft D D, and raise the extremity K of the lever. On the other hand, if the velocity is diminished, the centrifugal force of the balls will be diminished, and they will fall by their own weight nearer the axis, and cause the end K of the lever to descend. When the governor is applied to a steam-engine, the rod K I communicates with a flat circular valve V, placed in the principal steam-pipe, and so arranged that when K is elevated as far as the divergence of the balls will allow, the opening of the pipe will be closed by the valve V, and the passage of steam entirely stopped. On the other hand, when the balls subside to their lowest position, the valve will be entirely open. Thus, when the velocity is increased, the supply of steam is checked; and when it is diminished, the supply of steam is immediately increased; by which means a uniform proper velocity of the machinery is maintained.

When the governor is applied to a water-wheel, the lever is made to act on the shuttle through which the water flows, and thereby controls its quantity. When applied to a wind-mill, it regulates the sail-cloth so as to diminish the efficacy of the power upon the arms as the force of the wind increases, or *vice versâ.* (*Lardner's Cyclopedia*, art. "Mechanics;" *Gregory's Mechanics*, vol. ii.) See also REGULATOR.

GO'VERNOR-GENERAL, THE, OF INDIA, is also the head of the local government of the presidency of Bengal. He exercises some of the most important rights of sovereignty; as, declaring war and making peace, framing treaties, and, to a certain extent, enacting laws. He has a council, consisting of five members; of whom three are servants of the Company; one appointed by the directors, but not a servant of the Company; and the fifth is the commander-in-chief. But the governor-general is independent of his council, except in a judicial capacity. If the council dissent, its members can record their reasons; such dissent, however, only operates as a suspensive veto on the decision of the governor-general for 48 hours. He has the commission of captain-general, and may head military operations in any part of India. He has also the power of suspending the governors of the other presidencies. But in his disputes with his own council or other governor, he is under the supervision of the Court of Directors and Board of Control at home. Regulations passed by the governor-general in council become immediately effective, but are subject to reversal by the home authorities.

GRACE (Lat. gratia), in the language of the New Testament, is primarily the favour and love of God towards any person: from thence it comes to be used in various derivative senses, being put generally for all the extraordinary means and assistances with which men are endowed to bring them to salvation, in all of which regard is had to the sacrifice of Christ as the ground upon which God vouchsafes them. The term is used, farther, for the good actions and dispositions of men, which may be supposed to be derived from the operation of the grace of God in the first instance.

The explanation of the term "grace" has given rise to some of the most remarkable controversies in ecclesiastical history. It is evident that it borders close upon the question of free will and necessity, and the discussion of the one is inextricably entangled in the difficulties that beset the other. The Pelagians, holding extreme opinions on the side of the freedom of the will, conceived the idea of grace operating from without, and controlling or in any way directing men's actions, to be subversive of their fundamental principle: they contrived, therefore, to understand the words of Scripture throughout of the *natural* good dispositions of men, whom they supposed to find favour in the sight of God by their own merit, and by their own voluntary acceptance of his promises to inherit eternal life. St. Augustin, on the contrary, maintained against them that the mere desire for grace is itself a special gift of God,—a free grace independent of and antecedent to any human actions, to the exclusion of any counteracting principle; a doctrine which, if rigidly interpreted, seems certainly irreconcilable with that degree of liberty which is a necessary element in the moral government of the world.

GRACE. In the Fine Arts, a quality arising from elegance of form and attitude combined. A figure may be just in its proportions, its parts and members may be all perfectly regulated, yet it may be deficient in grace. It is scarcely possible in words to express this quality, yet it is constantly seen in nature; and it is scarcely possible to contemplate a picture by Raffaelle without feeling its power.

GRACE AT MEALS, THE SAYING OF, is a Jewish custom, and appears to have been sanctioned by the practice of our Saviour. (Mark, viii. 6.; Matth. xiv. 19.) It is mentioned by Jerome and Tertullian as usual among the early Christians. A custom of beginning meals by prayers was common in classical antiquity. (*Livy*, xxxix. 43.; *Quintil. Declam.* 301.)

GRACE, DAYS OF, in Commercial Law, are certain days allowed by the custom of merchants to be added to the time requisite for presentment of a bill. Thus, if an instrument drawn in this country be payable "a certain time after date," three days of grace are added: a bill drawn on the 27th of August, payable "two months after date," is therefore due on the 30th of October. So if a foreign bill be drawn at one, two, or more "usances," the days of grace are added to the usance. The usance between London and Paris is one calendar month: a bill drawn in London on Paris, "at one usance," on the 2d January, is consequently due on the 5th February. The number of days of grace varies in different countries. In France none are allowed.

GRA'CES. (Gr. χαριτες; Lat. gratiæ.) In Mythology, the three sister goddesses, Euphrosyne, Aglala, and Thalia; attendants on Venus. The Graces, in Sculpture, were originally represented clothed; but in later times entirely naked. (*Hor. Od.* lib. iii.; *Pausan.* lib. ix.) In one of the groups of statues described by Pausanias they held respectively a rose, a die, and a leaf of myrtle. In the *Iliad* they appear as attendants of Juno; in the *Odyssey*, of Venus. Their temples were often dedicated also to Venus, to Cupid, the Muses, Mercury, or Apollo. (There is a dissertation on these goddesses by Massieu, *Acad. des Inscr.* vol. iii.)

GRACES. In Music, ornamental notes attached to principal ones, such as the appoggiatura, shake, &c.; which see.

GRACIO'SO. The buffoon; a favourite character on the Spanish stage. (See *Quart. Rev.* vols. lix. lxxviii.)

GRA'CULA. (Lat. graculus, *a jay*.) A genus of Dentirostral Passerine birds, characterized by a moderately long, slightly arched, and notched beak; nostrils situated anterior to the base of the beak, oblong, open, and notched; tongue with a short apex, often bifid. One species of this genus (*Gracula tristis*, Cuv.) is a native of India, and has been imported into the islands of Bourbon and the Mauritius, where it is held in the highest estimation for the services it performs in restraining the undue increase of locusts. The bird commonly called the mino grackle (*Gracula religiosa* of Linnæus) is the type of the genus *Eulabes* of Cuvier.

GRADA'TION. (Lat. gradus, *a step*.) In Painting, the gradual blending of one tint into another.

GRADA'TION. In Music, a diatonic ascending or descending succession of chords.

GRA'DATORY. (Lat. gradus.) A term applied in Mammalogy to the extremities of a quadruped which are equal, or nearly so, and adapted for ordinary progression on dry land. In Ornithology, the "pedes gradarii" are those in which the whole tibia is covered with feathers.

GRA'DIENTS. *See* RAILWAYS.

GRA'DUATE. (Lat. gradus.) One who has taken a degree in a college or university. *See* DEGREE, COLLEGE, UNIVERSITY.

GRADUATED. In Ornithology, when the quill-feathers of the tail increase in length by regular gradations.

GRADUA'TION. In Practical Astronomy, the division of circular arcs into degrees, minutes, &c. This is an art which, though depending on the geometrical properties of the circle, requires, to be successfully executed, the application of very great practical skill. For the principles, see Mascheroni, *Géométrie du Compas;* and for the practical part, *Troughton's Account of a Method of Dividing Astronomical and other Instruments, &c.*, in the *Phil. Trans.* 1809; also the article "Graduation" in *Brewster's Encyc.*, by the same eminent artist.

GRADUA'TOR. Contrivances for accelerating spontaneous evaporation by the exposure of large surfaces of liquids to a current of air have been termed graduators; and in some salt works, where the brine is strengthened by allowing a shower of it to trickle over faggots, the process is called *graduation*. Vinegar is sometimes manufactured by suffering a mixture of alcohol and water previously mixed with a little vinegar or some ferment to filter through a tub filled with beech shavings, through which a current of air is at the same time passing.

GRA'FTING. In Horticulture, the operation of affixing one portion of a plant to another in such a manner as that a vital union may take place between them. Grafting may be performed both with herbaceous and ligneous plants; but in practice it is chiefly confined to the latter, and more especially to the propagation of esteemed varieties of fruit trees. A grafted plant consists of two parts: the stock or stem, which is a rooted plant fixed in the ground; and the scion, sometimes, but erroneously, termed the graft, which is a detached portion of another plant to be affixed to it. The operation of grafting can only be performed within certain physiological limits; but what these are science has not yet absolutely determined.

In general, all the species of one genus may be grafted on one another reciprocally; but this is not universally the case, because the apple cannot be grafted on the pear, at least not for any useful purpose. In general, it may be presumed that all the species of a natural order, or at least of a tribe, may be grafted on one another; but this does not hold good universally. The reverse of this doctrine, however, viz. that the species belonging to different natural orders cannot be grafted on one another, holds almost universally true; and therefore a safe practical conclusion is, that in choosing a stock the nearer in affinity the species to which that stock belongs is to the scion the more certain will be the success.

Grafting is one of the most important operations in horticulture, as affording the most eligible means of multiplying and perpetuating all our best varieties of fruit trees, and many kinds of trees and shrubs not so conveniently propagated by other means. Varieties of fruits are originally procured by selection from plants raised from seed, but they can only be perpetuated by some mode which continues the individual; and though this may be done by cuttings and layers, yet by far the most eligible mode is by grafting, as it produces stronger plants in a shorter time than any other methods.

Grafting is performed in a great many different ways, but the most eligible for ordinary purposes is what is commonly called splice grafting, or whip grafting. In executing this mode both the scion and the stock are pared down in a slanting direction; afterwards applied together, and made fast with strands of bast matting, in the same manner as two pieces of rod are spliced together to form a whip handle. To insure success, it is essentially necessary that the alburnum or inner bark of the scion should coincide accurately with the inner bark of the stock; because the vital union is effected by the sap of the stock rising up through the soft wood of the scion. After the scion is tied to the stock, the graft is said to be made; and it only remains to cover the part tied with a mass of tempered clay, or any convenient composition that will exclude the air. The season for performing the operation is, for all deciduous trees and shrubs, the spring, immediately before the movement of the sap. The spring is also the most favourable season for evergreens; but the sap in this class of plants being more in motion during winter than that of deciduous plants, grafting, if thought necessary, might be performed at that season.

Grafting by approach, or inarching, is a mode of grafting, in which, to make sure of success, the scion is not separated from the parent plant till it has become united with the stock. For this purpose the stock and the plant containing the scion must be growing close together; and the scion being drawn to one side, and made to approach the stock, is spliced to it by cutting off a portion of its bark and wood, and a similar portion of the bark and wood of the stock, applying the one to the other so that their alburnums may join, and then making both fast by matting, and excluding the air by clay, grafting wax, or moss. When the scion has effected a vital union with the stock, its lower extremity is cut through, so as to separate it from the parent plant, and it now becomes an independent graft. In this way trees of difficult propagation may be propagated with certainty; while if any of the other modes of propagation, whether by cuttings or grafting, were adopted, a proportion of the cuttings or scions would, in all probability, be lost.

Grafting herbaceous plants differs in nothing from grafting such as are of a woody nature, excepting that the operation is performed when both stock and scion are in a state of vigorous growth. Grafting herbaceous plants is but little practised in England, and on the Continent chiefly as a matter of amusement. The only useful purpose to which it has hitherto been applied is that of grafting the finer kinds of dahlias on tubers of the more common and vigorous growing sorts. In the Paris gardens the tomato is sometimes grafted on the potato, the cauliflower on the borecole, and one gourd on another, as matter of curiosity.

Grafting the herbaceous shoots of woody plants—the greffe herbace of the French—is scarcely known among English gardeners; but it has been extensively employed by French nurserymen, and even in some of the royal forests of France. The scions are formed of the points of growing shoots; and the stocks are also the points of growing shoots cut or broken over an inch or two below the point, where the shoot is as brittle as asparagus. The operation is performed in the cleft manner; that is, by cutting the lower end of the scion in the form of a wedge, and inserting it in a cleft or slit made down the middle of the stock. The finer kinds of azalias, pines, and firs are propagated in this way in the French nurseries; and thousands of *Pinus laricio* have been so grafted on *Pinus sylvestres* in the forest of Fontainebleau. At Hopetoun House, near Edinburgh, this mode of grafting has been successfully practised with *Abies Smithiana*, the stock being the common spruce fir.

GRA'LLÆ. (Lat. grallæ, *stilts*.) The Linnæan name of the order of long-legged wading birds.

GRA'MINA'CEÆ. An order of Endogenous plants, commonly called grasses, in which the parts of fructification are essentially perfect, although they are in a very unusual state in what may be called their accessory organs. They have neither calyx nor corolla; but, in lieu of them, imbricated scales, called paleæ and glumes: the latter of which give rise to the name *glumaceous*, often applied to these plants. They are nearly allied to sedges, from which they differ in having the sheaths of their leaves slit and their stems hollow. Corn of all kinds, the bamboo, the sugar-cane, many kinds of pasture plants, and reeds, belong to different species of *Graminaceæ*. Ergot is the ovary of rye attacked by a fungus called *Ergotatia abortans*. The flinty surface of the stems or straw renders many valuable for domestic use, as for forming the *plat* from which straw bonnets, &c. are

manufactured. The systematical arrangement of grasses is a difficult and unsatisfactory task, and has occupied the attention of many botanists. The most recent work upon the subject is *Kunth's Agrostographia*, published at Berlin in 1836. *Sinclair's Hortus Gramineus Woburnensis* is a useful account of the relative qualities of pasture grasses.

GRAMMAR. (Gr. *γραμματικη τεχνη*, *the grammatical art;* from *γραφω*, *I write.*) The science which has for its object the laws which regulate human language. Language, in its widest acceptation, may be defined to be the expression, by means of outward signs, of what passes in the mind. If, therefore, it is to admit of rules, or general laws, it is plain that we must seek those laws either in the constitution of the mind where it originates, or of the outward materials of which it is composed. These are either sounds, visible images, or gestures. The first two of these, as admitting of the greatest variety, and capable of being most easily distinguished from each other, form by far the most considerable part of language, and that part alone which grammar takes account of. The material of language, when it is *sound*, is capable of analysis into a definite number of simple elements. It is not our object at present to enter on the consideration of this part of language, whether consisting of sound, or marks to designate sound. We pass on to its more important class of laws, which result from the internal conditions of the mind; and which, viewed in that reference, constitute the subject matter of philosophical grammar, properly so called. An analysis of our mental faculties must therefore precede any attempt to define the province and settle the principles of grammar. Of the various divisions of the human faculties proposed by philosophers, we shall adopt, as best suited to our purposes, that which distinguishes them into two grand classes, — the province of affection, and that of perception or intellection. The discriminating mark of the former class, under which we include alike the outward senses and the inner sense or emotion, is this, that the faculties which it includes imply a state of mind or consciousness, and that only. By perception or intellection, on the other hand, are meant those states of mind which refer to a real or supposed *object*, out of the mind itself. "To know" and "to know nothing" are contradictory conceptions; every act of knowledge implies at once an object and a mind to which that object is present. Each of these portions of the mind has its appropriate expression, its peculiar language. The language of emotion is common to men and animals. It consists, for the most part, of certain simple sounds or exclamations, which, if capable of being reduced to rules at all, must rest for those rules on physiological considerations, which form the province of philosophical grammar. We must seek that province, consequently, in the language of intelligence or reason. Rational discourse, or human language, may be figuratively expressed as the outward *type* or *form* which thoughts, and the laws which regulate them, impress on the *material* of sound. In the words of Plato, "reason and discourse are one; only the former, as the conversation of the soul with herself, which goes on without the intervention of sound, has obtained among us the name of discourse of reason." We do not deny that language, in this limited sense, may become the expression of emotion in ourselves, and excite emotion in others. Both these objects, however, it can effect only *mediately:* the first, by converting, through reflection, an emotion into an object of consciousness; by rendering it *intelligible* to ourselves, then *intelligible* to others: the second, only *through* the understanding of those whom we address. The laws of language must therefore correspond with the laws of the intellect: if there is any thing universal and necessary in the one, its representative or image must be found repeated in the other. But the necessary laws of thought are the object matter of logic. It might, therefore, seem that logic and universal grammar are convertible terms. Both sciences consider alike the forms of the intellect, and the right mode of expressing these forms in language. But they differ in this, that logic considers the intellectual process primarily, and its expression in language only incidentally; whereas grammar considers the former only in so far as it conduces to the right understanding and due regulation of the latter. Having previously distinguished philosophical from merely practical or empirical grammar, we may now distinguish philosophical grammar itself into universal and particular. The first, as we have seen, corresponds to logic: — as the one is the science of those conditions which must be presupposed in order to render *thought* and *intelligence* possible; so the other contemplates the conditions which are to render possible the *outward expression* of thought and intelligence. The same relation which universal grammar bears to logic, particular grammar, philosophically treated, may be said to hold to the kindred science of psychology. It considers the experimental laws of the mind with the same view with which universal grammar contemplates those that are necessary. It takes into the account the effects of accidental association, in order to explain the idioms or peculiarities of the particular language before it. It calculates, so to speak, the disturbing forces which act on the general law.

In developing the principles of universal grammar, we shall consider, in order, the various kinds of words or "parts of speech" into which language is ordinarily distinguished.

The first class of words corresponds to the faculty called by logicians apprehension, or simple apprehension. They are commonly named *nouns*, or *substantives*, or *nouns substantive;* and express either individuals, as "John, Charles;" or classes, as "man, animal." They are called substantives, because they express a real or supposed substance (Lat. *sub*, *stare*), a something which is conceived to stand under, or, in scholastic language, to be the support of, certain qualities. These qualities may in their turn be considered as substances, and expressed by substantives, as *whiteness*, *greenness*. When considered in relation to the substance of which they are properties, they constitute the second class of words, — *adjectives*, or *nouns adjective*. Thus we say "a *white* horse, a dazzling *whiteness;*" where the same conception which in the former case is regarded as a quality, and expressed by an adjective, is in the second converted into a substance, itself the *support* of other properties.

Thus far the only intellectual power implied in language is that of forming general conceptions. A conception, when formed, is capable of being resolved back into its constituent parts. In the conception "stag" we find the property of swiftness contained. This *attribution* of a quality to a substance is what logicians call a *judgment;* its expression in language is an *affirmation*, or *proposition*. The *sign* of this attribution is called the *copula:* "The stag *is* swift." Every judgment which has regard to matter of fact considers an event either as past, present, or future: "The hair *was* light, *is* dark, *will be* grey." When the attribute property or quality is combined with the copula or word signifying the affirmation or attribution, a third class of words is produced, to which we give the name of *verbs*. Thus instead of saying, "the sun *is* bright," we may say, "the sun shines;" where the latter form of expression is equivalent to, or capable of being analyzed into, the former. A *verb* is therefore a compound part of speech, consisting of an adjective and a *copula* or *affirmation*, and signifying not only the conception of a *property*, but our perception or judgment that such property does inhere or belong to some substance, or else that it *has* belonged or *will* belong to it. The relation between property and substance, expressed in every proposition, may be differently stated as the relation of part to whole, of species to genus, of individual to species; distinctions which do not concern us at present, inasmuch as grammar, no less than logic, has regard only to our mode of conceiving things, not to things as they are in themselves.

The three parts of speech which we have thus analyzed — the substantive, the adjective, and the verb — are called the *primary* or *essential* parts of speech. They are those without which no discourse could take place, no act of judgment be communicated; in other words, without which no sounds could have *meaning*. The parts of speech which remain to be considered are the *pronoun*, the *article*, the *adverb*, the *preposition*, the *conjunction*, the *interjection*.

The *pronoun* is so called from its being a substitute for a noun; a compendious contrivance to avoid repetition, or needless and inconvenient specification: as, "John is tall and *he* is handsome," which is equivalent to saying "John is tall and *John* is handsome." They are commonly subdivided into personal or substantive, adjective, demonstrative, relative, indefinite, and interrogative pronouns.

Articles are words joined to substantives, for the purpose of defining whether the substance or conception is to be understood in a general sense, or in particular relation to an individual. When the first is our intention, we use in English no article whatever: as, "*Man* is corrupt;" by which we mean that corruption is an attribute of the genus "man," and not of any particular individual to the exclusion of others. In Greek, however, the use of the article is frequently equivalent to the omission of it in English, as *ἡ ευσεβεια*, *piety*. If we used the article *a* or *an*, we should, in most instances, mean that some individual or other of the species was contemplated: "I saw *a* horse." When we use the definite article *the*, we mean to specify which individual of the species we have in view.

The *adverb* derives its existence from the difficulty of defining by one word the precise quality of a particular object. When we say a thing is "green," we may call up in the minds of our hearers the image of a very different shade of greenness from that which we are describing. If we say it is "*very* green," our language is more definite. An adverb may consequently be described as a *modifying* part

of speech, joined with adjectives or verbs to define more accurately the degree of the quality or circumstances of the action predicated. That it is not an essential part of language is evident from the circumstance that its place may be supplied either by a termination. as "green*ish*," for "rather green;" or by a periphrasis, as "he walks with speed," instead of "he walks rapidly."

Prepositions are those parts of speech which express relations between substances. and are consequently joined only with substantives; as, "*from* the city *to* the country." We shall consider them more at length when we come to treat of the inflections of words.

As prepositions express objective relations, so *conjunctions* may be said to represent those of a subjective nature; or those relations which we perceive to exist between the judgments of our own intellect, whether of mere succession, of inference, or the like. They are consequently used to connect propositions together; as, "John is wise, *therefore* he is good;" "John is wise *because* he is good," &c. They are to the syllogistic faculty, or the faculty which perceives the connection and dependence of simple judgments, what the *copula* is to the faculty which forms these judgments. As the one forms words into propositions, so the other are necessary to combine propositions into sentences.

The *interjection* is the expression of emotions, and emotions only. It is not, therefore, confined to *human* discourse; and as it has nothing to do with the operations of the intellect, is incapable of logical combination with other words. It might therefore be doubted whether it can with propriety be called a part of speech or not.

We have said that the last-mentioned "parts of speech" were not *necessary* constituents of language. We so far qualify that assertion, in regard to prepositions in particular, as to admit that they are the expressions and modes of conception which the human understanding unavoidably forms. Whether, in technical language, the necessity be a *formal* or a *material* necessity, we forbear to discuss at large; since it is a subject on which logicians are not agreed. We ourselves are inclined, with Kant, to think it *formal*. We conceive the relations of cause and effect, of time and place, of action and passion, to be as much pure educt of the understanding, and as independent for their *form* on experience, as those of *part* and *whole*, *substance* and *attribute*, which we have seen to constitute the necessity for the primary parts of speech. They differ, however, in this, that the latter *must* enter into every proposition to render it a proposition at all; while those we are now considering may or may not, according to the matter in hand. In all languages they are expressed more or less perfectly. In our own, and in the other branches of the Teutonic stock, this expression is effected in two ways. Either the relation intended to be implied is expressed by an affix or prefix to the radical or abstract portion of the word itself; or the relation is regarded as abstracted from all particular objects between which it might be conceived to subsist, and, so abstracted, is embodied in a distinct word or particle. Thus what the Latins expressed by the termination *o* or *i*, as "domin*o*," "nub*i*," is represented in English by the prepositions "to" or "for." Generally speaking, the earlier a language the richer it is found to be in terminations; which, as the faculty of abstraction becomes habitual, are commonly abridged in number, and replaced by particles. A word which admits a variety of such modifications is said to be *declinable*. The only *declinable* or *inflected* parts of speech are the substantive and the verb, and in some languages the adjective and participle, with the representative parts of speech, the pronoun and article. The reason of this is sufficiently obvious. It is between supposed *substances* that the relations of cause and effect and those of place are conceived to exist; while the relations of *time* pertain to action and passion, or those changes in the state of substances which are expressed in language by verbs. The declension of adjectives is an anomaly in language. It probably results from the facility with which we convert in our thoughts a quality or attribute into a substance: unless it is to be accounted for by what grammarians call "attraction;" a supposed influence which the inflexion of a word exerts over those immediately in contact with it, and which is owing partly perhaps to the desire of euphony, and partly to a confusion of thought, the effect of association. The sum total of the modifications which the words of a language admit constitute what is called the *accidence* of that language. The circumstances under which such modifications or inflexions take place are the subject-matter of that part of grammar which is named *syntax*. These inflexions are, in *nouns*, case, number, and gender; in *verbs*, tense, mood, person, and, in most languages, number.

The *cases* of nouns are the expression of the relations of substances. In Latin there are, besides the nominative, or absolute form of a conception, and the vocative, used in addressing or calling to another person (a compound of a noun and an interjection), four cases properly so called; the genitive, the dative, the accusative, and the ablative. Of these the English language retains in its nouns one only, the genitive; in its pronouns two, the genitive and accusative. All other cases it replaces by prepositions.

The genitive case expresses the relation of *property*. A single conception is capable of being analyzed into a number of constituent parts, which are either necessary to the whole conception, or bound up with it by association more or less habitual. We represent this process in language by some change either in the word which signifies the *property*, or in that which denotes the containing substance. The last is the case in most European languages. Thus, we speak of a "horse'*s* colour," of "Socrates' philosophy."

The dative case implies *participation* in the effect of an action, expressed in English by the preposition "to" or "for." "Dedi ei,"—"I gave it *to him*;" where the effect of my act of giving is *shared only* by another.

The accusative is used where the effect of an action is conceived as passing over *entire* to another substance: "Laceravi librum,"—"*I tore the book*;" where the whole of the immediate effect is conceived as confined to the book which I tear. It is also called the objective case.

The ablative case, if we regard its etymology only, we should define to be that which expresses loss or privation. In this sense it ought to be considered as a modification of the dative, or the case which expresses the incidental or participated effects of an action; and we accordingly find that in Latin the English preposition "from" is frequently expressed by the dative. There is, however, a kind of relation which no other case serves precisely to convey, that of outward proximity. which is expressed in English by such prepositions as *at*, *near*, *by*, *upon*, and in Latin by the ablative case, which consequently is not so useless or superfluous a form as some grammarians have considered it to be.

Besides the inflexion of case, nouns admit, in most languages, those of number and gender. The latter is a mere generalization from experience; and though it may be convenient to have a termination to designate it, it is not necessary, as is apparent from our own language, which expresses this distinction only in its pronouns, and in some few of its substantives. Our conceptions of number are doubtless conditions of our mental constitution. They may be generalized under the forms of unity simple, unity comprehensive, and plurality. Unity, whether regarded simply or as an aggregate, is expressed by the singular number. Many languages, besides singular and plural, have a form to denote duality, or *two things together*; a fact which, probably, is owing to the duality of the parts of the human body, as the hands, feet, &c.

We proceed to consider the different kinds of *verbs*, and their modifications. Verbs are divided into transitive, intransitive, and passive. They admit necessarily of time and mood; accidentally and by usage of *person* and *number*.

A property, taking the word in the most general sense of which it is capable, may be conceived either as a state, a process, or as a power in action. To the first two correspond the verbs commonly called intransitive, or neuter, as "I rest," "I grow," "I fall." When a power is in action, we measure it by its effects on some substance; we conceive the action as *passing on* to another object, as "the clouds bring rain." The verb which expresses this transition is called the verb active or transitive. But not only are we able to conceive an object exerting power; we may also consider it as susceptible of influence or change from the action of another object. This is expressed by the verb passive, as "the dog *was beaten*." Many other modifications of action and change have their appropriate forms in different languages. Such are the verb middle or reflex in Greek, the verbs frequentative and desiderative in Greek and Latin. These, however, are matters of idiom, not of universal necessity.

Equally extensive with the conceptions of cause and effect is that of time, as the universal condition of all change in nature. The words which signify the one must therefore be capable of expressing the other. Hence the necessity for *tenses* in verbs, or the inflexions which determine the time of the action, as present, past, or future. We may further abstract an action from its relation to time altogether; and this abstraction is in some languages, as in the Greek, represented by a form appropriate to the purpose, called the aorist.

The modifications of verbs which we have been considering concern change or action objectively, or in relation to the substances which they are supposed to affect. Our judgments themselves are also liable to certain modifications, which, as regarding only the way in which we conceive of events, may be said to constitute the subjunctive conditions of verbs. Our knowlege of an occurrence may be either certain or uncertain; and uncertain either absolutely, or only under particular suppositions. When we simply express our judgment that a thing is, has been, or will be, in such and such a state,

we are said to speak indicatively, or in the *indicative mood*. When we consider a thing as possible merely, we use the *potential mood*, denoted in English by the auxiliary verbs "may" or "might." When we speak of it as dependent for its occurrence on certain conditions, or in case of its occurrence as connected with certain probable or inevitable consequences, we use the *conjunctive mood:* "I *would* go, if he *would* let me." Different languages express these modifications of judgment more or less perfectly; none, perhaps, with absolute accuracy.

Two other modal forms still remain to be considered. They have been called by grammarians the *imperative* and *optative moods*, as conveying the expression of a command or a wish. They may be included under the general term of desiderative, and imply at once the conception of an event and our desire that that event should take place. They may therefore be regarded as forming the connecting link between verbs and interjections; between the words which belong to the perceptive and those which pertain to the emotive part of our nature.

What is commonly named the *infinitive mood* may be considered as the point of transition from a verb to a substantive. It is, so to speak, a *substantized attribute*, and is used as the subject of a proposition as correctly as substantives themselves: *e.g.* "*To die* is gain."

The *participle* is usually ranked as a separate part of speech. It may be said to hold the same intermediate place between a verb and an adjective, as the infinitive holds between a verb and a substantive. It possesses all the properties of the verb, save affirmation; that is to say, to the properties of the adjective it adds the power of denoting time.

The attribution to verbs of number and person is logically as anomalous as it is to assign gender and number to adjectives. Most languages fall into this error, which is, however, susceptible of a very easy historical solution. It arose, doubtless, from the original custom of annexing the pronoun to the termination of the verb, and continuing the use of the inflection after its import had been forgotten, and when the pronoun had been formed into an independent part of speech.

Those who wish to investigate the principles of grammar more closely, would do well to consult Mr. Harris's *Hermes*, perhaps the most complete philosophical treatise on grammar that has appeared in England. See also the article "Grammar," in the *Encyclopædia Metropolitana*, where the paradoxical opinions of Mr. Horne Tooke on this subject are ably confuted. Professor Thiersch, in his *Greek Grammar*, some time since translated into English, has interspersed some ingenious and valuable inquiries into the general principles of language, from which the student may derive many important hints.

GRAMMA'RIAN. Literally one versed in grammar; but the term was used by the classic ancients as a title of honourable distinction for all who were considered learned in any art or faculty whatever. (See Vossius's work on Grammar.)

GRANA'DE. *See* GRENADE.

GRA'NARY. (Lat. granum, *corn.*) A building in which to lay or store corn, especially that designed to be kept a considerable time. Various scientific principles have been laid down for the erection of buildings of this nature, of which the reader will find a full account in *Rees's Cyclopædia;* but the most curious, as well as most efficient contrivances for housing and keeping grain in good order, are to be met with in some parts of Sicily. They consist either of excavations into calcareous rocks, or holes in the ground shaped like a bottle, walled up, and rendered waterproof by the neck of the bottle being hermetically closed with a stone fastened with gypsum. They contain about 200 salme, or about 1600 English bushels of corn, which may be thus preserved for an indefinite period; at least it has been found in perfectly good condition after the lapse of a century. (*Simond*, p. 25.; *Swinburne*, vol. ii. p. 405.)

GRAND. (Fr.) In the Fine Arts, a quality by which the highest degree of majesty and dignity is imparted to a work of art. Its source is in form freed from ordinary and common bounds, and to be duly felt requires an investigation of the different qualities by which great and extraordinary objects produce impression on the mind.

GRANDE'E. (Span. grande; from *grande de España.*) The highest title of Spanish nobility. The collective body of the higher nobility in Spain is termed *la grandeza*. They were originally the same with the *ricos hombres*. Grandees bear different titles — duke, marquis, &c.; but there is no essential difference of rank between these titles: all are equal among themselves. Grandeeships descend through females, and thus become accumulated in families. (*Quart. Rev.*, 1838.)

GRAND JURY. *See* JURY.

GRANGE. A farm-yard or farmery, which consists of a farm-house, and a court of offices for the different animals and implements used in farming, and also of barns, feeding houses, poultry houses, &c. *See* FARM-YARD, or FARMERY.

GRA'NITE. A crystalline aggregate of quartz, felspar, and mica, with the occasional addition of other minerals. It is regarded by modern geologists as of igneous origin, and as having been protruded from below, so as to elevate and dislocate the adjacent strata, and occasionally to penetrate them in the form of veins. Granite is a hard and generally durable rock, and of vast importance as a building material, and in its applications to pavements. The crystals of felspar are sometimes very large and distinct, and constitute the whitish imbedded masses which are seen in such perfection in some of the granite pavements of London, especially of London and Waterloo Bridges. When the mica prevails in granite, its texture becomes lamellar, and it passes into the rock which has been called *gneiss;* which again, by the gradual secession of the felspar, degenerates into *mica-slate*. There are some kinds of granite which are undergoing rapid disintegration and decay, in consequence of the joint action of air and water upon the felspar; the potash of which appears to be removed, and the residue falls into a white powder, composed chiefly of silica and alumina in a state of very fine division: it is thus that the celebrated *Cornish clay* is produced, which is in such request for the purposes of pottery. The curious district in which the Carglaise tin mine, near St. Austle, is situate, is a good and characteristic specimen of decomposing granite. *See* GEOLOGY.

GRANI'VORÆ. (Lat. granum, *a grain;* voro, *I eat.*) The name given by Temminck to an order of birds, including the Insessorial species, which feed on grains: other animals with a similar diet are termed "granivorous."

GRANT. In Law, a mode of conveyance by deed, appropriate to estates in lands and tenements not in possession, and also to incorporeal hereditaments.

GRA'NULATE. (Lat. grana, *a grain.*) When a surface is beset with many very small elevations like shagreen.

GRA'NULATION. The method of dividing metallic substances into grains or drops. It is usually effected by pouring the melted metal into water; and if fine division is required, it must pass through a perforated ladle or sieve; and in order to obtain spherical particles, it must fall from such a height as to have become solid before it meets with the water: hence the height of the towers in which *shot* is made.

GRA'NULATIONS. This term is applied to the little granular formations which arise in sores that are healing, and by which the destroyed parts are filled up and the edges brought together. When healthy they are of a red colour, not exuberant; when unhealthy they are pallid, and become soft, spungy, and irregular.

GRAPE-SHOT. In Artillery, a quantity of small shot put into a canvas bag, and corded together in the form of a cylinder, the diameter of which is adapted to the piece of ordnance from which it is intended to be discharged. It is now superseded by *canister-shot*.

GRAPHO'METER. (Gr. γραφω, *I write*, and μετρον, *measure.*) A mathematical instrument used in land surveying; otherwise called a *semicircle*.

GRA'PHITE. (Gr. γραφω.) The substance improperly called *black lead*, of which pencils are made. It is a peculiar form of mineral carbon with a trace of iron. The finest is found only at Borrodale in Cumberland. Coarser varieties are not uncommon.

GRA'PNEL. A small anchor for a boat.

GRA'PPLING IRONS. Small grapnels with four flukes for securing ships together in action.

GRA'PTOLITES. (Gr. γραφω, *I write;* λιθος, *a stone.*) A genus of fossil Zoophites, nearly allied to the existing sea-pens (*Pennatulæ*) found in the bituminous shales of the silurian sandstone deposits.

GRASSHOPPER. *See* LOCUST.

GRASS LAND. In Agriculture, land kept perpetually under grass, as contrasted with land which is alternately under grass and tillage. Perpetual grass lands are generally such as from the soil and situation are too moist to be ploughed with advantage, or too hilly and irregular on the surface to be ploughed at all. Hence we have hill pastures, and low moist meadows. The former admit of very little improvement, excepting that of drainage, and occasionally, in low hills, of irrigation; while the latter may not only be drained, but may be manured, and in some cases irrigated. *See* PASTURE, MEADOW, and IRRIGATION.

GRATE, may be described as the iron frame and bars for holding the fuel burnt in our fireplaces. It is, however, confined to the use of coal; wood fires being better kept up on what are called "dogs."

GRAU'WACKE. A German miner's term, implying *grey rock;* adopted in Geology to designate some of the lowest secondary strata, which form the chief part of the *transition rocks* of some geologists. *See* GEOLOGY.

GRAVE. In Music. *See* ALLEGRO.

GRA'VEL. A term applied to a well-known material of small stones, which vary in size from a small pea to a walnut, or something larger. It is often intermixed with other substances, such as sand, clay, loam, flints, pebbles, iron ores, &c., from each of which it derives a distinctive appellation. *See* GEOLOGY.

GRA'VEL. In Gardening, gravel is an important article, being that of which walks are formed whenever it can be procured. In selecting gravel two qualities are chiefly to be sought for; viz. a fine colour, and the property of binding. The most common colour of pit gravel is a rusty brown; and that of river or sea gravel a gray, with different shades of white, red, or brown. The best colour is considered to be a deep rich yellow, which is that of the gravel of Kensington, the stony parts of which are flints, — supposed to be the finest in the world, and which used formerly to be shipped, not only to different sea-ports of Great Britain and Ireland, but to various places on the Continent, to Petersburgh, to India. and even to South America. The binding properties of gravel are two: the presence of ferruginous clay of the same rich colour as the gravel, and which causes the gravel to set or become hard as soon as it is exposed to the action of the atmosphere; and the irregular and angular shapes and sizes of the stones. Where the stones are round or oval, with regular smooth surfaces, they never form a good binding gravel, even if they should be mixed with ferruginous clay. The reason is, that those stones which are on the surface, having no mechanical hold on those which are beneath or beside them, but being merely slightly cemented by means of ferruginous clay, are easily loosened and thrown out of their places by the action of frost, or even by the alternate action of drought and moisture. Hence, where no other gravel but that found in rivers or on the sea shore can be found for making garden walks, one half of the stones ought to be broken and mixed with the other half before laying them on the walks. The Kensington gravel, applying that term to all those of a similar colour and quality in England, binds better than any other, not only on account of the ferruginous clayey matter with which it is mixed becoming hardened by the atmosphere, but also because the stones are exceedingly irregular in size and shape.

GRAVEL, URINARY. *See* CALCULUS and ELRINE.

GRA'VER, called also BURIN. The sharp tool, whose extremity is of a triangular form, for cutting the lines of an engraving on the copper. *See* ENGRAVING.

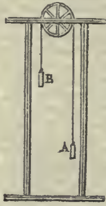
GRAVI'METER. (Lat. gravis, *heavy*, and Gr. μετρον, *measure*.) An instrument for ascertaining the specific gravities of bodies, whether liquid or solid. The particular instrument to which the term is usually appropriated was invented by M. Guyton; who adopted this name in preference to *areometer* or *hydrometer*, because these latter terms imply that the liquid is the thing weighed; whereas, when solids are weighed, the liquid is only the term of comparison to which the unknown weight is referred. *See* HYDROMETER.

GRAVITA'TION, GRAVITY. (Lat. gravis, *heavy*.) These terms are often used synonymously to denote that mutual tendency which all the bodies of nature have to approach each other, with forces which are directly as their masses and inversely proportional to the squares of their distances.

That every particle of matter in the universe has a disposition to press towards, and if not opposed to approach to every other, is a fact of which we derive the knowledge partly from our constant experience of what takes place at the earth's surface, and partly by reasoning from the observed motions of the celestial bodies. This mutual tendency of all the particles of matter to each other is called the *attraction of gravitation*. In reference to any particular body, or mass of matter, the aggregate attraction of all its particles is usually called simply its *gravity*.

Of Terrestrial Gravity.—Universal experience demonstrates that all heavy bodies, when unsupported, fall towards the surface of the earth. The direction of their motion may be ascertained by a plumb-line; and it is found to be always perpendicular to the level surface of the earth, that is, to the surface of stagnant water. But the earth is very nearly spherical, and a line perpendicular to the surface of a sphere must pass through its centre; hence the direction of a body moving in consequence of the force of terrestrial gravity is towards the centre of the earth. And this is the direction in which it must move if the force of gravity is the resultant of the attraction of all the particles of terrestrial matter on the falling body; for it has been demonstrated (by Newton) that a sphere attracts an exterior body in the same manner as if all its matter were condensed into a single point at its centre.

As bodies when left without support fall from all heights to which they may be carried, it may be inferred that gravity acts on them during the whole time of their descent, and is therefore a uniformly accelerating force. This might also be inferred from the fact, which is easily rendered sensible, that bodies which fall from a greater height arrive at the earth with a greater velocity. But Galileo was the first who proved by experiment that the acceleration of falling bodies is uniform, and that the spaces descended through are consequently as the squares of the times of descent. Experiments of this kind are attended with some difficulty on account of the resistance of the air. In order to render this resistance insensible, Galileo caused bodies to descend on planes having a small inclination to the horizon, in which case (neglecting the effects of friction) the velocity is diminished in the ratio of the sine of the plane's inclination. By mounting the descending body on wheels, and forming the inclined plane of a hard substance capable of receiving a perfect polish, the friction may also be so much diminished as not to change the nature of the motion. But the best method of showing experimentally that gravity is a uniformly accelerating force is by means of an apparatus called (from its inventor) Attwood's machine.



This consists of a pulley, the axle of which turns on friction rollers, and having a groove on its edge to receive a string. Over the wheel a fine silken cord is stretched, to the ends of which are attached two equal weights, A and B. In this state the weights counterbalance each other, and no motion ensues; but if to one of the weights a small load m be added, so as to give it a preponderance, the loaded weight will immediately begin to descend. The motion which now takes place is exactly of the same kind with that of a body descending freely; but the velocity is diminished in the proportion of the additional load m to the sum of the three, m, A, and B; for the force, which is impressed by the additional weight, is expended in giving velocity not only to it, but also to the two weights A and B attached to the string. By this machine the properties of uniformly accelerated motion are experimentally shown to hold true in the descent of falling bodies; for if the additional load be such as will carry the weight to which it is added through 1 foot in the first second of time, it carries it through 4 feet in 2 seconds, through 9 in 3 seconds, and so on. A proof is therefore afforded by this means that terrestrial gravity is a uniformly accelerating force.

Terrestrial gravity acts equally on all bodies; that is to say, impresses on all of them an equal quantity of motion, whatever their nature may be. This property of gravity was also demonstrated by Galileo. In different hollow spheres, of equal weight and diameter, he enclosed equal weights of different substances: the spheres were suspended by strings of equal length, and made to vibrate in very small arcs, and it was found that the time of an oscillation was the same in all of them. Common experience would seem to be at variance with this result. Light bodies, as feathers, paper, &c., fall slowly and irregularly; and some substances, as smoke, vapours, &c., even ascend. But this, as is well known, arises from the buoyancy of the atmosphere. In the exhausted receiver of an air-pump a piece of gold and a feather fall with the same speed, and strike the bottom at the same time.

Measure of Terrestrial Gravity. — Having ascertained the law according to which gravity acts on bodies at the surface of the earth, the next question is to determine its absolute intensity, or the velocity which it communicates to a body falling freely in a given time. On account of the rapidity of the descent of heavy bodies, this cannot be done by direct experiment; nor could Attwood's machine be employed for the purpose with sufficient certainty. The only mode by which an accurate result can be obtained is by measuring the length of a pendulum which makes a given number of oscillations in a given time. Let l be the length of the seconds' pendulum, π the ratio of the circumference to the diameter, and g the accelerating force of gravity, that is, twice the space through which a body falls by the action of gravity in the first second of time; then (PENDULUM) we have the equation $g = l\pi^2$. Now the length of the pendulum vibrating seconds of mean solar time in London, in vacuo, and reduced to the level of the sea, has been determined to be 39·1393 British standard inches; and $\pi = 3{\cdot}14159$; therefore g is found $= 386{\cdot}3$ inches, or $32\frac{1}{5}$ feet. The height, therefore, through which a body would fall in vacuo in a second of time at London is half of this quantity, or $16\frac{1}{10}$ feet. It will be observed, however, that this value of g does not express the whole of the earth's attraction, a small part of which (about the 1-464th) is counteracted by the centrifugal force corresponding to the latitude: it is the force of gravity diminished by the centrifugal force, or what is properly called *gravitation*.

From experiments made with the greatest care, it appears that the extreme amount of the variation of the gravitating force between the equator and the poles is one part in 194 of the whole quantity; that is to say, any body which at the equator weighs 194 pounds, if transported to the pole would weigh 195 pounds. The difference of gravitation, therefore, at the equator and the poles, is expressed by the fraction $\frac{1}{194}$. Now it has been demonstrated by Newton that the ratio of the centrifugal force at the equator to gravitation there is $\frac{1}{289}$. This is

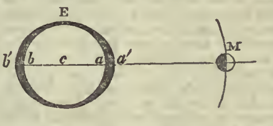
considerably smaller than the fraction $\frac{1}{194}$; but the difference, which is $\frac{1}{590}$, arises from the oblate figure of the earth, in consequence of which a body placed at the pole is at a less distance from the centre than one at the equator, and is therefore attracted more than it would be at the equator, even if the earth stood still, and there was consequently no centrifugal force. From this it may be readily understood that the figure of the earth is determinable by measuring the intensity of gravitation under different latitudes. *See* DEGREE, EARTH.

Universal Gravitation.—Galileo, who had so fully succeeded in exploring the nature of terrestrial gravity, did not suppose that its action extended to bodies beyond the immediate vicinity of the earth. The more speculative genius of Kepler led him to speak of gravity as a force acting mutually from planet to planet, and particularly from the earth to the moon; and he even supposed the tides to be produced by the gravitation of the waters of the sea towards the moon. He did not, however, suppose it to have any concern in the regulation of the celestial motions. Hooke also supposed the heavenly bodies to have a gravitation to each other; but his notions respecting its nature were inaccurate, and he did not attempt to define the law of its variation. This great discovery was reserved for Newton. While meditating on the nature of this force, the thought occurred to him that since gravity is a tendency not confined to bodies on the very surface of the earth, but reaches even to the summits of the loftiest mountains without its intensity or direction suffering any sensible change, may it not reach to a much greater distance, and even to the moon? Before this question, however, could be answered, it was necessary to suppose a law according to which its intensity diminishes. Newton soon perceived that this law would require the force of gravity to diminish exactly as the square of the distance increases; or that the attractive force of the earth at the distance of the moon must be as much less than it is at the surface of the earth, as the square of the radius of the earth is less than the square of the moon's distance from the earth. In a general way, the hypothesis is easily verified. The moon's orbit differs not much from a circle whose radius is equal to 60 times the semidiameter of the earth, and the circumference of her orbit is therefore about 60 times the circumference of a great circle of the earth. Now the diameter of the earth being nearly 8000 miles, and the period of the moon's revolution being 27 d. 7 h. 43 m., it is easy to compute that the versed sine of the arc described by the moon in a minute (which is the same as her deflexion from the tangent or straight line she would describe if there were no force attracting her to the earth) is $16\frac{1}{10}$ feet. But the mean distance of the moon from the earth being 60 times the distance of heavy bodies at its surface from its centre, and her gravity increasing in proportion to the square of the distance, her gravity would be 60×60 times greater at the surface of the earth than at her present mean distance, and therefore would carry her through $60 \times 60 \times 16{\cdot}1$ feet in a minute near the surface. But by what was proved by Galileo respecting the descent of heavy bodies, the same force would carry her through 60×60 times less space in a second than in a minute; and therefore the same force which compels the moon to move in her orbit about the earth, supposed to vary according to the inverse square of the distance, would cause her to fall, near the surface of the earth, through 16·1 feet in a second. Now this is exactly the space through which heavy bodies descend in a second; therefore the moon *may* be retained in her orbit by the power of terrestrial gravity.

Newton, however, did not allow the argument for universal gravitation to rest on loose considerations of the lunar orbit as a circle described with an average velocity about the earth. He demonstrated that bodies moving under the influence of an attractive force which diminishes according to the inverse square of the distance must describe conic sections having a focus at the centre of force, and observe the laws of motion which Kepler had discovered to belong to the planetary orbits. He succeeded also in proving that some of the principal inequalities of the lunar and planetary orbits are necessary consequences of the mutual gravitation of the different bodies of the system to each other; and that the same mysterious power not only regulates the motions of all the planets and satellites in space, but also determines the figure of the earth, causes the precession of the equinoxes, and produces the tides of the ocean.

Assuming the different bodies which compose the solar system to be acted upon by their mutual gravitation, according to the law proposed by Newton, namely, that each body attracts every other with a force proportional to its mass directly and to the square of the distance inversely, the determination of the motions of the several planets and satellites becomes a question of pure geometry when the requisite data are determined by observation. If, however, the problem were required to be solved in its most general terms, and it were necessary to consider simultaneously the effects of all the bodies in the system, the difficulties of calculation would be enormous, and in fact no methods of analysis hitherto discovered would be sufficient to grapple with them. Fortunately the actual condition of the system is such as to afford great simplifications. The principal planets are isolated in space, at great distances from each other, and their masses are very small in comparison of that of the central body; so that the effects of their mutual attractions are not such as to alter the general elliptic form of their orbits, but merely produce small *perturbations* of their orbits and motions, which admit of being separately computed. By availing themselves of these favourable conditions, mathematicians have succeeded in expressing the whole of the complicated movements of the planets and satellites by analytical equations; and such is the perfection to which this branch of physical science has attained, that there is now no irregularity in the motions of the bodies of the solar system, no deviation from their mean state appreciable to the most delicate astronomical observations, which has not been explained, and its period and amount accurately calculated on the principle of universal gravitation, according to the law discovered by Newton. *See* PLANET.

The effects of gravitation, as manifested in the influences of the celestial bodies on each other, enable us to form several conclusions respecting its nature and mode of action. That gravity belongs not only to matter in the aggregate, but to every particle of which bodies are composed, is rendered evident by the manner in which the moon disturbs the waters of the ocean. Let E be the earth, and M the moon. If the moon's gravity acted only on the aggregate mass and not on each particle, it would have no effect on the figure of the earth, and consequently no tide would be produced. But the action of the moon on the different parts is unequal.



Those at a, which are nearest the moon, are more attracted than those at the centre c; which again are more attracted than the parts at b, which are farthest from the moon. The consequence is, that a fluid particle at a is drawn away as it were from the general mass, and an accumulation takes place at a'. For the same reason, the attraction at c being stronger than at b, the mass of the earth is drawn away from the parts at b, and the fluid is in a manner left behind, and accumulates at b'. Hence we perceive the reason why it is high water on opposite sides of the earth at the same instant of time. In fact, in consequence of the moon's attraction, the fluids on the surface of the earth have a tendency at every instant to arrange themselves in the form of an elongated spheroid, the greater axis of which points towards the moon.

It is also proved by astronomical phenomena that gravity is a force which is transmitted from body to body, not successively, but instantaneously. Were gravity transmitted with a measurable velocity, the *rate* of velocity would sensibly affect the secular variation of the mean motion of the moon. By a comparison of the results of theory with observation, Laplace found that the velocity of the attracting force, if not infinite, must be at least *fifty millions* of times greater than the velocity of light. (*Méc. Célste*, liv. xvi.)

Another question which may be put with regard to the nature of gravity is, whether its action is in any degree modified by the interposition of the substances through which it penetrates? For example, whether the attractive force of the earth, which must penetrate the whole substance of the moon before its influence reaches the particles on the opposite side of that body, acts with the same intensity on those particles as on those nearest the earth, regard being had to the law of the distance? Now, if the attractive force suffered any diminution in passing through the lunar substance, the parallax would thereby be affected; and, from the amount of the parallax, it is certain that the intensity of terrestrial gravitation on the different molecules of the moon suffers no variation, excepting what arises from the different distances of the molecules. It may therefore be considered, says Laplace, as sufficiently established that the force of gravity is of so subtle a nature that the densest bodies of the universe offer no obstacle to its free passage.

A third conclusion is, that the law of gravity is not modified in any respect by the different natures of the celestial bodies. If the action of the sun on the molecules of the earth differed only by a millionth part from its action on the molecules of the moon, the difference would occasion a variation of the sun's parallax amounting to several seconds. But the supposition of any such variation is impossible. It follows, therefore, that the gravitating force of the sun, in equal times and at equal distances, impresses equal velocities on the earth and moon. It is also demonstrated from the theory of Jupiter

and Saturn, that Jupiter acts on Saturn according to the same law as on his own satellites. Gravity is therefore a force altogether independent of the nature of the substances on which it acts.

GRAVITY, SPECIFIC. The specific gravity of a body is the ratio of its weight to the weight of an equal volume of some other body assumed as a conventional standard. The standard usually adopted for this purpose is pure distilled water at a given temperature. In England, the temperature is generally taken at 62° of Fahrenheit's scale; the French take it at 32°, or that of melting ice; sometimes at the temperature at which its density is the greatest (about 39·4° of Fahrenheit). The latter is by far the more convenient, inasmuch as it can be easily maintained without variations; whereas it is hardly possible to perform experiments at the exact temperature of 62°, in consequence of the continual variations of the temperature of the air. It is only, however, when very great precision is required, that it is necessary to make the experiment with water at any particular temperature; in general, it is sufficient to note the temperature, and apply a correction depending on the known density of water at the different degrees of the thermometric scale.

The most obvious method of ascertaining the *relative weights* or specific gravities of two different bodies is to immerse them successively in a cylindrical or prismatic vessel of a known area, containing a liquid of less density than either. When a solid is immersed in a liquid, the liquid occupies as much more space than it did before as is exactly equal to the bulk or volume of the body; and therefore by immersing equal or known weights of different bodies in a vessel of the form specified, the relation between the heights at which the liquid stands will give the relation between their densities. This was the method proposed by Archimedes for solving the famous problem of the crown of Hero.

The method now employed is susceptible of far greater accuracy. It depends on this principle, that a body when immersed in a fluid loses just as much of its weight as is equal to the weight of an equal volume of the fluid. By weighing a body, therefore, first in air (or rather in vacuo), and then in a liquid, the ratio of its specific gravity to that of the liquid will be found as follows:— Let $s=$ the specific gravity of the body, $v=$ its volume, $w=$ its weight in air, and $W=$ its weight in the liquid; also let $s'=$ the specific gravity of the liquid, and v' and w' be respectively the volume and weight of a given portion of it. Now it is evident, in the first place, that if the volume of a body be supposed constant, its specific gravity will be directly proportional to its weight; and, in the second place, if the weight remains constant, the specific gravity will vary inversely as the volume; that is to say, the smaller the volume the greater is the specific gravity. The specific gravity of a body is therefore directly as its weight, and inversely as its volume. Hence we have

$$s : s' :: \frac{w}{v} : \frac{w'}{v'}.$$

But if we suppose $v=v'$, the weight of the portion of liquid whose volume is v' will be equal, by the principle laid down, to the difference between the weight of the body in air and in the liquid, that is, equal to $w-W$; whence $w'=w-W$, and the proportion becomes

$$s : s' :: w : w - W;$$

from which we deduce $s=s'\dfrac{w}{w-W}$. Now let the liquid be pure water at the standard temperature, then $s'=1$, and we have simply $s=\dfrac{w}{w-W}$; so that in order to obtain the specific gravity of a solid body, its weight in air must be divided by the loss of weight it sustains when weighed in pure water.

The process of finding the specific gravity of any solid body denser than water is rendered very simple by means of the *hydrostatic balance*. When the solid is less dense than water, its weight in that liquid cannot be ascertained directly; but it may be found by attaching the body to another sufficiently dense to cause both to sink. Let $l=$ the weight of the light body in air, and $x=$ its weight in water; $h=$ the weight of the heavy body in air, and $h'=$ its weight in water; $c\ (=l+h)=$ the weight of the compound or united mass in air, and $c'=$ its weight in water. All these quantities are found by experiment, excepting x. Now we have obviously $l-x+h-h'=c-c'$; therefore $l-x=(c-c')-(h-h')$. But if s denote the specific gravity of the light body, we have, by what has already been shown, $s=\dfrac{l}{l-x}$; therefore, $s=\dfrac{l}{(c-c')-(h-h')}$.

In this manner, the specific gravity of a solid in the state of powder may be found by placing it in a vessel whose weight in air and in water has been previously determined.

The specific gravity of a liquid may be found in several ways by means of the hydrostatic balance. Let a solid body of any convenient form, for example a sphere of glass, be taken, and let $w=$ its weight in air, $w'=$ its weight in water, and $w''=$ its weight in the fluid whose specific gravity is to be ascertained; then, taking s to denote the specific gravity of the solid body, s' the specific gravity of water, and s'' the specific gravity of the liquid, we have by the first formula $s=s'\dfrac{w}{w-w'}$, and also $s=s''\dfrac{w}{w-w''}$; therefore $s'\dfrac{w}{w-w'}=s''\dfrac{w}{w-w''}$; and making $s'=1$, we deduce $s''=\dfrac{w-w''}{w-w'}$. It is evident that this process is equivalent to finding the ratio of the density of the solid body first to water, and then to the liquid to be experimented on.

Another method is to take a phial of known weight and weigh it when filled with water; the increase of weight is of course the weight of the water. It is then filled with the liquid, and again weighed, and the weight of the contained liquid thus ascertained. We have then the weights of equal bulks of the water and the liquid, whence the ratio of their specific gravities is known.

For many practical purposes, and especially for determining the specific gravities or *strengths* of spirituous liquors, it is necessary to have recourse to more expeditious methods than that of the hydrostatic balance. In such cases, the instrument called an hydrometer is employed. (*See* HYDROMETER.)

The specific gravities of the gaseous fluids are usually determined in terms of that of atmospheric air. The difference between the weights of a flask when exhausted of air by means of the air-pump and when filled with the gas gives the weight of the gas which it contains. But experiments of this kind require to be made with great care, as they are much affected by small variations of the temperature, pressure, and hygrometric state of the atmosphere. For a detailed account of the method of proceeding, and the manner of applying the requisite corrections, see *Biot's Traité de Physique*, tome i.

The subjoined tables give the specific gravities of the substances which most frequently occur: for a more extended list, we refer to Brisson's Table (*Pesanteur spécifique des Corps*); or to the *Ency. Britannica*, art. "Hydrostatics."

I. Table of the Specific Gravities of Solids and Liquids at the Temperature of 32° of Fahrenheit, the Density of Water being 1.

Acid, Acetic	-	1·062
Arsenic	-	3·391
Arsenious	-	3·728
Benzoic	-	0·667
Boracic, crystallized	-	1·479
fused	-	1·803
Citric	-	1·034
Formic	-	1·116
Fluoric	-	1·060
Molybdic	-	3·460
Muriatic	-	1·200
Nitric	-	1·271
Do. highly concentrated	-	1·583
Phosphoric, liquid	-	1·558
solid	-	2·800
Sulphuric	-	1·850
Agate	-	2·590
Alcohol, absolute	-	0·797
of commerce	-	0·836
Alum	-	1·714
Amber	from 1·064 to	1·100
Ambergris	from 0·780 to	0·926
Amethyst, common	-	2·750
oriental	-	3·391
Amianthus	from 1·000 to	·313
Ammonia, aqueous	-	0·875
Arragonite	-	2·900
Azure-stone	-	2·850
Barytes, Sulphate of,	from 4·000 to	4·558
Carbonate of,	from 4·100 to	4·600
Basalt	from 2·421 to	3·000
Beryl, oriental	-	3·549
occidental	-	2·723
Blood, human	-	1·053
crassamentum of	-	1·245
Borax	-	1·714
Butter	-	0·942
Camphor	-	0·988
Caoutchouc, or India rubber	-	0·933
Carnelian, speckled	-	2·613
Chalcedony, common,	from 2·600 to	2·65
Chalk	from 2·252 to	2·657
Chrysolite	-	3·400
Cinnabar, from Almaden	-	6·902
Coals	from 1·020 to	1·300
Copal	-	1·015
Coral, red	from 2·630 to	2·857
white	from 2·540 to	2·570
Corundum	-	3·710
Cyder	-	1·018
Diamond, oriental, colourless	-	3·521
Ditto, coloured varieties,	from 3·523 to	3·550
Diamond, Brazilian	-	3·444
coloured varieties,	from 3·518 to	3·550
Dolomite	from 2·540 to	2·830
Dragon's Blood (a resin)	-	1·204
Ether, Acetic	-	0·866
Muriatic	-	0·729
Nitric	-	0·908
Sulphuric	from 0·632 to	0·775
Emerald	from 2·600 to	2·770
Fat of beef	-	0·923
Felspar	from 2·438 to	2·700
Flint, black	-	2·582
Gamboge	-	1·222
Garnet, precious,	from 4·000 to	4·230
common,	from 3·576 to	3·700
Glass, crown	-	2·520
green	-	2·642
flint	from 2·760 to	3·000
common plate	-	2·760
Granite	from 2·613 to	2·956
Gum arabic	-	1·452
Gunpowder, loose	-	0·836
solid	-	1·745
Gypsum, compact,	from 1·872 to	2·288
crystallized,	from 2·311 to	3·000
Heliotrope, or Bloodstone,	from 2·629 to	2·700

Table I. (*continued*).

Honey		1·450
Honeystone, or Mellite,	from 1·560 to	1·666
Hornblende	from 3·250 to	3·830
Hornstone	from 2·533 to	2·810
Hyacinth	from 4·000 to	4·780
Jasper	from 2·358 to	2·816
Jet		1·300
Indigo		1·009
Ironstone from Carron		3·281
Lancashire		3·573
Isinglass		1·111
Ivory		1·825
Lard		0·947
Lead — Glance, or Galena, from Derbyshire	from 6·565 to	7·786
Limestone, compact,	from 2·386 to	3·000
Magnesia, native, Hydrate of		2·330
Carbonate of,	from 2·220 to	2·612
Malachite, compact,	from 3·572 to	3·994
Marble, Carrara		2·716
Parian		2·560
Mastic (a resin)		1·074
Melanite, or black Garnet,	from 3·691 to	3·800
Metals — Antimony		6·702
Arsenic		5·763
Bismuth		9·880
Brass	from 7·824 to	8·396
Cadmium		8·600
Chromium		5·900
Cobalt		8·600
Columbium		5·600
Copper		8·900
Gold, cast		19·258
hammered		19·361
Iridium, hammered		23·00
Iron, cast at Carron		7·248
forged into bars		7·788
Lead		11·352
Manganese		8·000
Mercury		13·598
Molybdenum		8·600
Nickel, cast		8·279
forged		8·666
Osmium and Iridium, alloy of		19·500
Palladium		11·800
Platina, forged		20·336
drawn into wire		21·042
in plates		22·069
Potassium at 59° Fah.		0·865
Rhodium		11·000
Selenium		4·3000
Silver		10·474
hammered		10·510
Sodium at 59° Fahr.		0·972
Steel, soft		7·833
tempered		7·816
hardened		7·840
Tellurium,	from 5·700 to	6·115
Tin, Cornish		7·291
hardened		7·299
Tungsten		17·40
Uranium		9·000
Zinc	from 6·200 to	7·191

Mica	from 2·650 to	2·934
Milk		1·032
Mineral Pitch, or Asphaltum,	from 0·905 to	1·233
Mineral tallow		0·770
Myrrh (a resin)		1·360
Naphtha	from 0·700 to	0·847
Nitre		1·900
Obsidian	from 9·348 to	2·370
Oils, Essential — Amber		0·868
Aniseseed		0·986
Carrawayseed		0·904
Cinnamon		1·043
Cloves		1·036
Lavender		0·894
Turpentine		0·870
Wormwood		0·907
Expressed — Sweet Almonds		0·932
Hempseed		0·926
Linseed		0·940
Olives		0·915
Poppyseed		0·939
Rapeseed		0·913
Whale		0·923
Opal, precious		2·114
common	from 1·958 to	2·114
Opium		1·336
Orpiment	from 3·048 to	3·500
Pearl, Oriental	from 2·510 to	2.750
Pearlstone		2·340
Peruvian Bark		0·784
Phosphorus		1·770
Pitchstone	from 1·970 to	2·720
Plumbago or Graphite,	from 1·987 to	2·400
Porcelain, from China		2·384
Sèvres		2·145
Porphyry	from 2·458 to	2·972
Seltzer		1·003
Proof-spirit		0·923
Pumice-stone	from 0·752 to	0·914
Quartz	from 2·624 to	3·750
Realgar	from 3·225 to	3·338
Rock-crystal	from 2·581 to	2·888
Ruby, Oriental		4·283
Sapphire, Oriental,	from 4·000 to	4·200
Sardonyx	from 2·602 to	2·628
Scammony of Smyrna		1·274
Schorl	from 2·922 to	3·452
Serpentine	from 2·264 to	2·999
Silver Glance	from 5·300 to	7·208
Slate (drawing)		2·110
Spar, Fluor	from 3·094 to	3·791
calcareous	from 2·620 to	2·837
Spermaceti		0·943
Stalactite	from 2·323 to	2·546
Stone, Bristol	from 2·510 to	2·640
grinding		2·142
Portland		2·496
rotten		1·981
Sugar		1·606
Sulphur, native		2·033
fused		1·990
Talc	from 2·080 to	3·000
Tallow		0·941
Topaz	from 4·010 to	4·061

Tourmaline	from 3·086 to	3·361
Turquoise	from 2·500 to	3·001
Ultramarine		2·362
Vinegar	from 1·013 to	1·080
Water, distilled		1·000
sea		1·029
of Dead Sea		1·248
Wax, Bees'		0·964
Shoemakers'		0·897
Whey, cows'		1·019
Wine, Bourdeaux		0·993
Burgundy		0·991
Constance		1·081
Malaga		1·022
Port		0·997
White Champagne		0·997
Wood, Alder		0·800
Apple-tree		0·793
Ash		0·845
Bay-tree		0·822
Beech		0·852
Box, French		0·912
Dutch		1·328
Brazilian, Red		1·031
Campeachy		0·913
Cedar, Wild		0·596
Palestine		0·613
Cherry-tree		0·715
Citron		0·726
Cocoa		1·040
Crab-tree		0·765
Cork		0·240
Cypress, Spanish		0·644
Ebony, American		1·331
Indian		1·209
Elder-tree		0·695
Elm-tree		0·671
Filbert-tree		0·600
Fir, Male		0·550
Female		0·498
Hazel		0·600
Juniper-tree		0·556
Lemon-tree		0·703
Lignum Vitæ		1·333
Mahogany		1·063
Maple-tree		0·750
Mulberry, Spanish		0·897
Oak-heart, 60 yrs. old		1·170
Olive-tree		0·927
Orange-tree		0·705
Pear-tree		0·166
Plum-tree		0·785
Pomegranate-tree		1·351
Poplar		0·383
White Spanish		0·529
Vine		1·327
Walnut		0·681
Willow		0·585
Yew, Dutch		0·788
Spanish		0·807
Woodstone	from 2·045 to	2·675
Zeolite	from 2·073 to	2·718
Zircon	from 4·385 to	4·700

II. Table of the Specific Gravities of the Gases and Vapours, that of Atmospheric Air being 1.

Gases — Atmospheric Air	1·000
Ammoniacal	0·590
Carbonic Acid	1·527
Carbonic Oxide	0·972
Carburetted Hydrogen	0·972
Chlorine	2·500
Chlorocarbonous Acid	3·472
Chloroprussic Acid	2·152
Cyanogen	1·805
Gases — Euchlorine	2·440
Fluoboric Acid	2·371
Fluosilicic Acid	3·632
Hydriodic Acid	4·340
Hydrogen	0·069
Muriatic Acid	1·284
Nitric Oxide	1·041
Nitrogen	0·972
Nitrous Acid	2·638
Gases — Nitrous Oxide	1·527
Oxygen	1·111
Phosphuretted Hydrogen	0·902
Prussic Acid	0·937
Sub-carburetted Hydrogen	0·555
Sub-phosphuretted ditto	0·972
Sulphuretted ditto	1·180
Sulphurous Acid	2·222

GRAYLING. *See* SALMO.

GRAZIO'SO. (It.) In Music, an instruction to the performer that the music to which this word is affixed is to be executed elegantly and gracefully.

GREAVE. (Fr. grève.) A piece of armour defending the shin (in the patois of Burgundy, grève still signifies shin). The greave was a piece of steel hollowed to fit the front of the leg, and fastened with straps behind. The Greeks termed them *κνημιδες*, whence the common epithet of *ἐυκνημιδες Ἀχαιοι*, or "well-greaved Greeks," in the *Iliad*. It appears that the greave common among the Greeks was used in some instances by the Roman soldiery, but only on one leg, the other being covered with the buckler. It is said to have been discontinued in the armies of the Greek empire, under the emperor Maurice (about the end of the 6th century), and again brought into use in those armies of the middle ages about 1320. They were also called *jambs*, *bein-bergs*, &c. They were originally of leather, quilted linen, &c. The *clavons* were a species of greaves made of cloth.

GREAVES, or GRAVES. The sediment of melted tallow, composed of the membranous, vascular, nervous, and muscular matters blended with the fat, and which not being fusible, are easily separated from it by straining; they are made up into cakes, and sold by the tallow-chandlers, being chiefly used as a coarse food for large house-dogs.

GREBE. *See* PODICEPS.

GRECIAN ARCHITECTURE. *See* ARCHITECTURE.

GREEK CHURCH, THE, comprises the great bulk of the Christian population of Russia and Greece, Moldavia and Wallachia, besides various congregations scattered throughout the provinces of the Turkish and Austrian empires, who acknowledge the patriarch of Constantinople as their head. This prelate, although possessing a certain spiritual supremacy over this extensive community, has never ventured to assert any claim to the temporal power so long wielded by his rival at Rome. His ambition was curbed in the first instance by the jealousy of the emperors, with whom he was brought into closer contact; and since the Mohammedan conquest the state of weakness and poverty into which the Christian church in Turkey has been thrown has annihilated all views of aggrandizement. In earlier times, however, the Constantinopolitan pontiffs clearly showed that they did not lack the will to raise themselves to an equal station in the East with the growing authority of the popes in the West. The origin of the separation which has now prevailed for many hundred years between two such important sections of Christendom as the Latin and Greek churches, approaching so near as they do in many of their fundamental principles, is to be attributed to the rival pretensions set up by the bishops of the two imperial cities, and dates almost from the foundation of the younger capital.

As early as the year 451 the council of Chalcedon assigned Asia Minor, Pontus, Thrace, and the frontiers of Illyricum for the extent of the spiritual jurisdiction of the church of Byzantium, and conferred upon its bishop the same honours and privileges as had been already conceded to the pope of Rome. The patriarchs of Antioch and Alexandria maintained at this period an independent authority; but were gradually reduced under the predominant influence of the patriarch of the East. The aggressions, however, of the rival pontiffs did not proceed pari passu: the Roman, being further removed from the imperial authority, which was seated at Ravenna, assumed by degrees a direct temporal authority over the neigh-

bouring districts, which led the way to the prodigious indirect supremacy which he usurped after the lapse of several ages. The Constantinopolitan, on the contrary, was always strictly watched, and fettered by the proximity of the Eastern emperors; and the extension or declension of his authority depended in most cases more upon the particular character of the wearer of the crown than of the mitre. The first doctrinal ground of dispute was the assertion of the Latin church, about the beginning of the 9th century, of the double procession of the Holy Ghost from the Father and the Son. The word *filioque*, first surreptitiously inserted into the Constantinopolitan creed many years after its promulgation, became the badge of the Western church; and whatever apparent advantage the shameful forgery above mentioned might give to the opposite party, it is very certain that the other dogma, the procession from the Father alone, had never been declared by a council of the church. And the silence of the symbols upon it was no argument against either the truth of the doctrine, or the fact of its having been held, as much as any doctrine may be said to be so, before it has been brought forward into discussion and settled in men's minds by the great mass of the learned world.

The discussions produced by this controversy were brought to a head by the sudden elevation of Photius, a layman, to the patriarchate, by the command of the emperor. In six successive days he passed through the six preliminary orders: he became successively monk, reader, subdeacon, deacon, priest, bishop, and finally, on the seventh day, was consecrated patriarch; and all this to the violent exclusion of the existing pontiff, Ignatius. The appointment of Photius, who was a man of extraordinary talents, alarmed the Romish see. The cause of Ignatius was supported in the West; and the intruder excommunicated by Nicholas I. The thunder of Rome was retorted by a charge made on the part of Photius against the Latin church of five distinct heresies; which it may be as well to enumerate, in order to show the frivolity of the greater part of the grounds of dispute at this period. 1. It was objected that the Romanists fasted on the Sabbath, or seventh day of the week; 2. That they permitted the use of milk and cheese in the first week of Lent; 3. That they forbade their priests to marry; 4. That they authorized bishops to baptize with the chrism, and forbade the priests; 5. That they had interpolated the creed of Constantinople with the word *filioque*, and held the doctrine therein implied.

These proceedings widened the breach which had already in fact taken place by the formal transference which the emperor had effected of several provinces east of the Adriatic, from the jurisdiction of Rome to that of Constantinople. The Roman party continued, however, still powerful in the East, and the intrigues of the papal see were frequently successful; until in 1054 the mutual excommunications pronounced upon each other by Leo IX. and Cerularius caused the final separation, which has continued to the present day.

The opinions of the Greek church bear considerable affinity to those of the Latin. The fundamental distinction is the rejection of the spiritual supremacy of St. Peter, and the denial of any visible representative of Christ upon earth. In the view which it takes of the procession of the Holy Ghost it is at variance not only with the Roman Catholic church, but with Protestants also. It recognizes, however, the seven sacraments; authorizes the offering of prayer to the saints and Virgin; and encourages the use of pictures, though forbidding that of images. It holds in reverence also the relics and tombs of holy men; enjoins strict fasting and the giving of alms, looking upon them as works of intrinsic merit; and numbers among its adherents numerous orders of monks and nuns. It allows, however, the marriage of its secular priests, and rejects auricular confession. It holds that modified form of the Roman doctrine of the eucharist which is denominated consubstantiation; and apparently entertains some confused notions of a purgatory, in consideration of which it offers prayers for the dead. It administers baptism by immersion.

The services of this church mostly consist of ceremonial observances; preaching and the reading of the scriptures form but a small part of them: the former, indeed, was at one period altogether forbidden in Russia. The mass of the people are in a state of the grossest ignorance upon religious subjects; and the worship of the lower orders, under the influence of a poor and unlettered ministry, is hardly distinguishable from the grossest heathenism.

GREEN CLOTH, BOARD OF. A court of justice belonging to the king's household, daily sitting in the king's palace, under the lord high steward. It is attended by various officers of the household, and by the steward of the Marshalsea, who is always a barrister. They meet for the purpose of taking daily accounts of expenses, making provision and payments for the household, and paying the wages of the king's servants under the lord high steward. It has jurisdiction in all offences committed in the king's palaces, and within the verge of his court.

GREEN-HOUSE. In Gardening, a house with a roof and one or more sides of glass, for the purpose of containing plants in pots which are too tender to endure the open air the greater part of the year. The green-house, being a structure of luxury, ought to be for the most part situated near the house, in order to be enjoyed by the family in inclement weather; and, if possible, it should be connected with the flower-garden, as being of the same character with reference to use. Its length and breadth may be varied at pleasure, but its height should never be less than that of the loftiest apartments of the house to which it belongs. The best aspect is to the south or south-east; but any aspect may be chosen, provided the roof is entirely of glass, and abundant heat is supplied by art. In green-houses facing the north, however, the more tender plants will not thrive so well in winter: more artificial heat will be required at that season; and the plants should be chiefly evergreens, and other plants that come into flower in the summer season, and grow or flower but little during winter. In most green-houses the plants are kept in pots or boxes, and set on stages or shelves, in order that they may be near the roof, so as to receive the direct influence of the rays of light immediately on their passing through the glass. An orangery differs from a green-house in having an opaque roof, and in being chiefly devoted to plants which produce their shoots and flowers in the summer season and in the open air; and they are set in the orangery merely to preserve them through the winter. Such a structure might with more propriety be termed a conservatory; but custom in the present day has applied this term to structures having glass-roofs in which the plants are not kept in pots, but planted in the free soil, and in which a part of them are encouraged to grow and flower in the winter months. *See* ORANGERY and CONSERVATORY.

GREEN ROOM, in the Theatre, the name given to the actors' retiring room; so called, in all probability, from its being originally painted or otherwise ornamented with green.

GRE'ENSAND. Beds belonging to the chalk formation: they often contain *chlorite* or *green earth* scattered through the sandstone and limestone of which they consist. *See* GEOLOGY.

GREEN, SCHEELE'S. An arsenite of copper. *Mineral green* is a subcarbonate of copper, and *Brunswick green* an oxychloride of copper.

GREEN SICKNESS. *See* CHLOROSIS.

GREENSTONE. A variety of traprock composed of felspar and hornblende. *See* GEOLOGY.

GREEN VITRIOL. The metallic salts of sulphuric acid were formerly designated *vitriols:* sulphate of iron was termed *green vitriol*. It is a compound of 1 atom of oxide of iron and 1 atom of sulphuric acid: the crystals contain 7 atoms of water; hence the crystallized salt consists of 36 protoxide of iron, 40 sulphuric acid, and 63 water, and its equivalent is =139. Sulphate of copper is called *blue vitriol*, and sulphate of zinc *white vitriol*.

GREGO'RIAN CALENDAR. The reformed calendar of the church of Rome, introduced by Pope Gregory XIII. in 1582, in which the error of the civil year of the Julian calendar was corrected by the omission of three intercalary days in four centuries, and the moon's age, with the time of Easter, with the other moveable feasts depending on it, indicated by the table of epacts. *See* CALENDAR.

GREGO'RIAN EPOCH. The epoch or time at which the computation by the Gregorian calendar commenced. This was in March, 1582.

GREGO'RIAN TELESCOPE. The first and most common form of the reflecting telescope, invented by James Gregory, professor of mathematics in the university of St. Andrew's, and afterwards of Edinburgh, and described by him in his *Optica Promota*, published in 1663. *See* TELESCOPE.

GREGO'RIAN YEAR. The civil year of the Gregorian calendar. In the Gregorian calendar the common year consists of 365 days, and every fourth year is a leap year, or contains 366 days, excepting the last years of every century of which the number is not divisible by 4. Thus, the years 1700, 1800, 1900, are not leap years; but 1600 and 2000 are leap years, the numbers 16 and 20 being divisible by 4. The period is consequently 400 years, in the course of which there occur 97 intercalations; so that 400 years contain $365 \times 400 + 97 = 146097$ days, and therefore one Gregorian year consists of 365·2425 mean solar days, or 365 d. 5 h. 49 m. 12 sec. But the true solar year consists of 365 d. 5 h. 48 m. 49·62 sec. The Gregorian year, therefore, errs in excess by 22·38 seconds; but the error is not worth taking into account, as it only amounts to one whole day in 3866 years.

GRENA'DE. A hollow ball of iron about two inches and a half in diameter, charged with gunpowder and furnished with a proper fuse; it is often called a hand grenade, being thrown from the parapets of besieged places upon the invaders beneath.

GRENADI'ERS, was the name given at first to the soldiers who threw the grenade; but it was afterwards

conferred on certain troops of the line, distinguished from the latter chiefly by some peculiarities of dress, accoutrements, &c. This appellation originated with the French in 1667, but was speedily adopted into all the armies of Europe; and wherever the name has been introduced, the finest-looking and tallest men of the regiment have always been selected to form what is called the grenadier companies.

GRE'S. (Fr.) Sandstone or grit.

GRESSO'RIAL, in Ornithology, is applied to the feet of birds which have three toes forward, two of which are connected, and one behind.

GRETNA GREEN MARRIAGES. A species of marriage, so called from its being usually celebrated at that place. The following statement, which we have borrowed from the *Geographical Dictionary*, conveys so full and accurate particulars of these far-famed marriages, that we have taken the liberty of transferring it to our columns.

"The marriage ceremony merely amounts to an admission before witnesses that certain persons are man and wife; such acknowledgment being sufficient, *provided it be followed or preceded by cohabitation*, according to the law of Scotland, to constitute a valid marriage. A certificate to this effect being signed by the officiating priest (who has never been above the rank of a tradesman), and by two witnesses, the union, under the above condition, becomes indissoluble. The marriage service of the church of England is sometimes read, in order to please the parties. The marriages of this sort celebrated at Gretna Green are estimated at between 300 and 400 a year; but as similar marriages are celebrated at Springfield, Annan, Coldstream, and other places along the border, their total number is said to amount to 500 a year! The parties are generally from England, and of the lowest ranks; though there are not a few instances of persons of the higher ranks, and even of lord chancellors, having had recourse to the services of the *soi-disant* parsons of Gretna Green. A trip to Gretna, or the presence of a self-dubbed parson, is not, however, at all necessary. Parties crossing the Scottish border, and declaring before witnesses that they are man and wife, are, under the previously mentioned conditions, married according to the law of Scotland. This law has been much objected to, but we are inclined to think with no good reason. It would, indeed, be no difficult matter to show that it is, on the whole, productive of numerous advantages. No where, perhaps, are there so few rash or improvident marriages as in Scotland; and the retrospective effect of the existing law, or its influence in legitimising the children born before marriage, is perhaps its most valuable feature. But it is necessary to observe, that though legitimated in Scotland, children born previously to a Scotch marriage are not legitimated in England, and do not succeed, except by special bequest, to heritable property in that part of the U. Kingdom. In all respects, however, Scotch marriages convey the same rights and privileges in England as English marriages. The practice began at Gretna Green about 90 years ago by a person named Paisley, a tobacconist, who died so lately as 1814. It is now carried on by various individuals: indeed each inn has its rival priest, in addition to others who carry on the business on their own account; and so far has competition reduced the fees, that though large sums (40*l.* or 50*l.*) have been received, the solatium, in some instances, is now so low as half-a-crown. One of these functionaries, who breaks stones daily on the verge of England, has the best chance of succeeding; for he accosts every party as they pass, and tries to strike the best bargain."

GREYWACKE. *See* GRAUWACKE, GEOLOGY.

GRI'FFIN. (Gr γρυψ.) A fabulous animal of antiquity represented with the body and feet of a lion, the head of an eagle or vulture, and as being furnished with wings and claws. The griffin is one of those imaginary creations to which the ancients were so confessedly partial, but it belongs more to the romantic than the classical mythology. It plays a prominent part in the fairy tales and romances of the middle ages; and, like the dragon which was fabled to guard the golden apples of the Hesperides, its chief duties consisted in watching over hidden treasures, and in guarding captive princesses, or the castles in which they were confined. The griffin is at once the symbol of strength and swiftness, courage, prudence, and vigilance—qualities which its form is well calculated to represent; and hence it has been adopted into the language of heraldry, where it constitutes a prominent feature in the armorial bearings of many princely and noble families.

GRIMA'CE. (Fr.) In Painting and Sculpture, an unnatural distortion of the countenance, from habit, affectation, or insolence.

GRIPE. The fore part of a ship. — *To gripe*, the tendency af a ship to bring her head up to the wind when carrying sail on the wind.

GRIT. Hard sandstone, employed for millstones and grindstones, pavement, &c.

GROAT. An old English silver coin equal to 4*d.* of our present money. It was introduced by Edward III. about the year 1351, and has lately been again adopted and issued from the mint: the first coinage of these modern silver groats or four-penny pieces took place in 1835.

GROATS, in Agriculture, are the small grains formed from oats by being cut in the mill, after having the husks or shells taken off from the grain.

GROIN. (Sax. ʒnopꞇn, *to grow.*) In Architecture, the line formed at the intersection of two arches which cross each other at any angle.

GRONI'NGENISTS. In Eccl. History, a subdivision of the sect of Anabaptists. (See *Mosheim*, Transl., vol. v. p. 492.)

GROOM. A name now usually applied to servants who are employed about horses. From the Flemish grom, *a boy*. The *groom-porter* was an officer of the royal household in the lord steward's department, whose place is said to have succeeded that of the master of the revels. Groom is still the denomination of several officers of the royal household, chiefly in the lord chamberlain's department; such as grooms in waiting, groom of the stole or robes, &c. &c.

GROOVE. (Sax. ʒpaꝼan, *to dig.*) In Architecture, a sunken rectangular channel. It is usually employed to connect two pieces of wood together, the piece not grooved having on its edge a projection or *tongue*, whose section corresponds to and fits the groove.

GROSS. In Commerce, the number of 12 dozen.

GROSSULA'CEÆ. (Grossularia, one of the genera.) A natural order of shrubby Exogens, natives of most parts of the world, excepting Africa and the tropics; formerly confounded with *Cactaceæ*. Placed by Von Martius between *Saxifragaceæ* and *Onagraceæ;* but nevertheless, on account of their albuminous seeds, appearing to have affinities of another nature, especially with *Berberaceæ* and the vine. The gooseberry and currant are fruits of this order, to which many beautiful hardy shrubs common in our gardens also belong.

GROSSULA'RIA. (Lat. grossula, *a gooseberry.*) A green garnet found in Siberia.

GROTE'SQUE. (Fr.) In the Fine Arts, a term applied to capricious ornaments, which as a whole have no type in nature; consisting of figures, animals, leaves, flowers, fruits, and the like, all connected together.

GROTESQUE. In Architecture, artificial grotto-work decorated with rockwork, shells, &c.

GROTTO. (It.) The name given to subterraneous natural excavations formed in the heart of mountains or other places. Many of these cavities are famed for the mephitic exhalations that issue from them, and to this class belongs more especially the Grotto del Cane, near Naples; but there others not less celebrated for their beauty and grandeur, of which the grottoes of Antiparos and Fingal are well-known examples. In picturesque gardening, the term is applied to an artificial or ornamental cave or low building intended to represent a natural grotto. The best specimen of this kind is the grotto attached to the Colosseum, which may be considered a model for all similar designs.

GROUND. (Sax. ʒpunꝺ.) In the Fine Arts, a word of various application. In Painting, it is the first layer of colour on which the figures or other objects are painted; in Sculpture, it is the surface from which, in *relievi*, the figures rise; and in Architecture, it is used to denote the face of the scenery or country round a building.

GROUND BAIT. Balls made of greaves, bran, boiled grain, gentles, &c., mixed up with clay and thrown into the water, by which the fish are brought together upon those spots which the angler selects for his sport.

GROUND PLATE, or SILL. In Architecture, the lower part of a timber building, which receives the principal and other posts.

GROUNDS. In Architecture, pieces of wood flush with the plastering, for which they serve as a guide, &c., to which mouldings and other finishings are attached.

GROUP. (Fr. groupe.) In Painting, an assemblage of objects, whose lighted parts form a mass of light, and their shaded parts a mass of shadow: the word is also used to denote any adjoining assemblage of figures, animals, fruits, flowers, &c. In speaking also of objects of different sorts, it is usual to say that one object *groups* with another. Lights in groups should, as well as shadows, be connected together, or the necessary repose will be wanting. In Sculpture, the word *group* is applied to a design in which there are two or more figures. In Music, *group* signifies a number of notes linked together at the stems.

GROUSE. *See* TETRAO.

GROUT. (Sax. ʒpuꞇ.) In Architecture, mortar reduced to a state of fluidity by the addition of water: a mixture of plaster and fine stuff, putty, or coarse stuff, used in finishing the best ceilings; also for mouldings, and sometimes for setting walls.

GRU'IDÆ. The name of the family of wading birds represented by the stork (*Grus*).

GRUS. (Lat. the *Crane.*) One of the modern constellations in the southern hemisphere. *See* CONSTELLATION.

GRY'LLIDÆ. (Lat. gryllus, *a locust.*) The name of the family of locusts, having the genus *Gryllus* for the type.

GRYPA'NIUM. (Gr. γρυπος, *incurved.*) In Ornithology, the *rostrum grypanium* is that form of beak in which the culmen is more or less carinated, and is so continued to the apex of the incurved maxilla.

GRYPHÆ'A. (Gr. γρυπος.) A genus of Ostracean Bivalves, remarkable for the curvature of the apex or beak of the shell; it is chiefly represented by fossil species, one of which, *Gryphœa virgula*, characterizes the Kimmeridge clay, near Oxford, and the upper oolite of parts of France.

GRYPHO'SIS. (Gr. γρυποειν, *to incurvate.*) A growing inwards of the nails.

GUA'IACUM, is a peculiar resinous substance obtained from the *Guaiacum officinale*, a tree of the West Indies. It has some chemical peculiarities which distinguish it from the common resins, especially its property of becoming blue and green by the action of certain oxidizing substances. Decoction of the wood of the tree, and the tincture of the resin, have been employed in the cure of rheumatism, and as an alterative; but it is an unimportant medicine.

GUA'NO. A substance found upon certain small islands, especially in the South Sea, which are the resort of large flocks of birds, and chiefly composed of their excrement: it is said to form beds fifty to sixty feet in thickness. It is an excellent manure.

GUARANTE'E, in Law, is an undertaking to answer for the failure of another. By the Statute of Frauds, a person is not liable on a special promise in the nature of a guarantee unless a written agreement, or memorandum of such promise, shall be signed by the party making the promise, or some person lawfully authorized by him.

GUA'RDIAN, in Law, he who has the custody of such persons as are incapable of directing themselves, and especially of infants. Guardians at common law were—1. In chivalry (under the feudal principle of wardship, abolished with the other incidents of military tenure by 12 Ch. 2.). 2. By nature; the father in all cases; the mother to daughters, where no guardian is assigned by the father's deed or will. 3. For nurture; appointed by the ordinary in default of father or mother. 4. In socage, being the nearest of kin to an infant entitled to real estate who cannot inherit that estate.

GUA'RDIAN OF SPIRITUALTIES. In Ecclesiastical Law, the person to whom the spiritual administration of a diocese is entrusted during the vacancy of the see.—Of *Temporalties*, one appointed by the king during such vacancy to take care of the goods and profits, and deliver an account to the Exchequer.

GUARD, NATIONAL, OF FRANCE. This famous institution was first devised by the Municipal Committee of Safety of 1789, which sate at the Hôtel de Ville, in Paris, before the taking of the Bastille. The corps which was then raised at first carried green colours, afterwards replaced by the tricolor. It was more fully organized by a decree of September, 1791, to be raised by voluntary enlistment, both in Paris and the departments, in the proportion of one man out of every twenty citizens. The staff of the national guard was dissolved by the Convention after the 13 Vendémiaire (1795), and it was placed under control of the military authorities. Napoleon made of the national guard a species of military nursery, and large portions of it volunteered in 1813 to act beyond the frontiers. Under the Restoration the national guards were deprived of the privilege of choosing their own officers; and in 1827, in consequence of their public demands for the dismission of the ministry (Villele's), they were dissolved. By their constitution, as remodelled in 1830, they elect their own officers up to the rank of sublieutenant inclusive: the rest are appointed by the king.

GUARD, THE IMPERIAL, in the armies of the Emperor Napoleon, was formed from a small corps of lifeguards (as they might be termed) which had served to defend the Convention, the Corps Legislatif of 1795, the Directory, and afterwards the Consulate. In 1805, when Napoleon became emperor, the consular guard had already been increased to 3300 infantry and 2100 cavalry, besides artillery and marines. Its augmentation and equipment became afterwards one of Napoleon's favourite pursuits; and as soldiers could not be enrolled except after serving four campaigns in the line with distinction or from the preparatory corps called the young guards, it was an institution of the highest military policy. In the end of 1812, the Imperial Guard, old and young, consisted of 56,000 men; and its farther increase was only prevented by the calamities of the following years. At the Restoration, the soldiers of the young guard returned to the line; those of the old guard were formed into royal regiments.

GUARD, YEOMEN OF THE, were first raised by Henry VII. in 1485, and appear to have been the first standing military corps ever set on foot in this country. They were at first fifty men, half armed with bows and arrows, and half with arquebusses; afterwards some carried halberds. The arquebusses were exchanged for partizans (which they now carry) in the reign of William III.

GUARDS. Troops attached to the person of the sovereign. In modern times, the designation is applied in most countries to a body of men distinguished from the line by difference of pay, dress, &c., and possessing a certain military rank. Body-guards have been an inseparable accompaniment of monarchy from the earliest ages: the Assyrian and Persian monarchs employed them. The corps of Argyraspides, or silver-shields, were selected by Alexander out of the bravest men of his army. The Roman emperors had their Prætorian guard. Napoleon first created a small troop of body-guards, with the title of Guides, while yet only general, in his first Italian campaign. From this arose by degrees the great institution of the Imperial Guard, itself an army, with its two great divisions of old and young, and 120 pieces of cannon; the whole of which corps was broken up at the Restoration. On the revolution of 1830, the royal guards of France were disbanded, and none have been since embodied in that country. In England, the guards (otherwise called household troops) consist of the life-guards, the royal regiment of horse-guards, and three regiments of foot-guards. Many of the European sovereigns, before the French Revolution, had small corps of foreign troops which served in this capacity. Thus the French kings had, in early times, a body of Scotch guards, termed archers; at a later period, a body of Swiss guards, called the Cent-Swisses; and after the Restoration of 1815 several battalions of Swiss guards were organized for the same service. This system has almost disappeared, since the troubles of the Revolution have introduced a spirit at once more military and more national into the councils and populations of Europe. The Pope still retains his Swiss guards.

GUA'VA. The fruit of the *Psidium pomiferum*, from which a jelly is made in the West Indies.

GU'DGEON. The common name of a small species of the Cyprinoid family of soft-finned fishes; having, like the barbel, cirri or feelers at the mouth, and both the dorsal and anal fins short, but without a strong bony ray at the commencement of either. The species consequently forms the type of a distinct subgenus called *Gobio*.

GU'DGEONS. In Machinery, the pins inserted in the extremities of a shaft, or the axle of a wheel, on which it turns, and which support the whole weight. In order to diminish friction, gudgeons are made as small as possible in diameter; leaving, however, sufficient strength to support the weight. They are frequently formed of cast iron, on account of its cheapness; but wrought iron of the same dimensions is considerably stronger, and will support a greater load.

GUE'BERS, or GUEBRES (*i. e.* Giaours, *infidels*). The sectaries of the ancient Persian religion, of which the chief peculiarity consisted in the worship of fire, are so termed by the Mohammedans. They still exist in some of the southern and eastern districts of Persia; but a colony of them has been long established at Bombay, and other parts of the western coast of India, and has attained to wealth and distinction. These are termed in India *Parsees*, from the nation from which they originally sprang. The Guebres explain the worship of fire by professing to regard it as a symbol only of the Divinity. Their sacred books are termed the Zend-Avesta. *See* PARSEES.

GUELF, ORDER OF, or ROYAL GUELPHIC ORDER. An Hanoverian order of knighthood, founded in 1815 by George IV., then Prince Regent. It consists of grand crosses, commanders, and knights, both civil and military.

GUELFS. In Italian History, during the middle ages, a political party, the feuds between which and the opposite party of the Ghibellines long distracted that country. The former name is derived from that of the great German house of the Welfs or Guelfs. These, in the 12th century, were dukes of Bavaria; and carried on war in Germany with the house of Hohenstauffen, from one of whose castles (Weiblingen) the name Ghibelline is supposed to have been derived. The latter house having become the ruling power in Germany under Frederic I., that prince invaded Italy in order to reassert the rights of the empire; and thus these party names, first used in a German feud, were transplanted into that country. The chief adversaries of the house of Hohenstauffen in Italy were the Popes, who thus became the heads of the Guelf party; and the struggle between the two became, in the 13th century, when Frederic II. was involved in contests with several successive pontiffs, a contest between the temporal and spiritual power. In that instance the latter prevailed; but the Ghibellines remained, notwithstanding, powerful, especially in the north of Italy; and, in the beginning of the following century,

the invasion of the emperor Henry of Luxemburg added considerably to their power. In the early part of that century the leading Ghibelline powers generally were, Milan under the house of Visconti, Verona under that of La Scala, and the Aragonese kings of Sicily; the chief Guelf states the republic of Florence, the Angevin kings of Naples, &c. Other states were alternately under the control of the two parties as they in turn predominated. At this time the poet Dante, who had embraced Ghibelline principles, not merely on party grounds, but from exalted political speculation, threw the lustre of his genius over the civil feuds of his age. In the course of the 14th century, especially after the removal of the papal seat to Avignon, the original principles of the two parties were entirely lost; while the names continued, and factions bearing those appellations constantly agitated the interior of Italian cities and monarchies down to the middle of the 15th century, or even to a still later period. The most complete works which can now be consulted on the subject are those of Raumer (*Geschichte der Hohenstauffen*), and Sismondi (*Républiques Italiennes*).

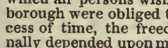
GUERRI'LLA. (Span. *little war.*) The plan of harassing the French armies by the constant attacks of independent bands, acting in a mountainous country, was adopted in the north of Spain during the Peninsular war. It was first reduced into a kind of system in 1810. (See *Napier's Peninsular War*, book ix. chap. 1.) The bands which conducted this desultory warfare were called Partidas: the name of Guerrilla is, by a misapplication of the term, frequently applied to them.

GUIDE. (Fr.) In Music, the leading part in a canon or fugue.

GUILD, or GILD. (Sax. gildan, *to pay*: said to be derived from payments made by a member of a guild on admission.) A fraternity or association, generally of merchants. The Collegia Opificum of the later Roman empire appear to have been societies of this description, in which a body of artizans or traders exercising the same craft were united together for purposes of mutual assistance, and possessed what we should term corporate rights. The Anglo-Saxon guilds were voluntary associations for various purposes, religious and social as well as commercial; and the oldest English guild of which the history is at all ascertained is said to have been the Cnighten guild of London, which has been thought by its name to have been a military company; but this is doubtful, and its history is altogether extremely obscure. But the more important guilds of later times have been all mercantile. The guild-merchant, in many boroughs of England, seems to have been a trading society, into which all persons wishing to exercise trade within the borough were obliged to be admitted; and hence, in process of time, the freedom of the borough, which originally depended upon mere inhabitancy, became connected with admission to the guild, and the guild and corporate body of the borough became co-extensive. A more remarkable change took place in the constitution of London, where the several trading companies by degrees so completely engrossed the government that admission into one or the other of them (the liveried companies) became a necessary qualification for the exercise of municipal rights; while some relics still remain (such as the division of the city into wards) of the more ancient state of things. The name guild is still preserved in the ancient boroughs of Scotland, and the dean of guild is the second municipal magistrate of a Scottish borough. The zünfte of German cities, and the trading companies of those of France and Italy, have acted an equally important part in the history of those countries.

GUILLEMOT. *See* Uria.

GUILLOCHE. (Fr.) In Architecture, an ornament composed of curved fillets, which by repetition form a continued series.



GUILLOTI'NE. (Fr.) The name given to the instrument of capital punishment used in France; so called from Joseph Ignace Guillotin, by whom it was introduced into that country. This person was born at Saintes, and, established as a physician at Paris, obtained a certain celebrity in the early period of the Revolution by the strong part which he took in favour of the rights of the Tiers-Etat. He was elected in consequence a deputy to the National Assembly. When that body was occupied in its long discussions relative to the reform of the penal code (in 1790) Guillotin proposed the adoption of decapitation, — up to that time used only for nobles, — as the only method of capital punishment. From sentiments of humanity he recommended the employment of a machine which had been long known in Italy under the name of "mannaja," and in other countries also; for something much resembling it had been used in Scotland (*see* Maiden), and in England within the jurisdiction of the borough of Halifax. The Assembly applauded the idea, and the machine was adopted, to which the Parisians have given the name of "Guillotine," and of which Guillotin is most erroneously supposed to have been the inventor. It consists of two upright pieces of wood fixed in a horizontal frame; a sharp blade of steel moves up and down by means of a pulley in grooves in the two uprights; the edge is oblique instead of horizontal in shape, which gives it the mechanical power of the wedge. The criminal is laid on his face, his neck immediately under the blade, which severs it at a blow from his body. It is equally a vulgar error that Guillotin perished by the instrument which bears his name. He was imprisoned during the Reign of Terror, but released at the revolution of July 1794; and died in 1814, after founding the association termed the Academy of Medicine.

GUI'NEA. An English denomination of money; formerly a coin, but now disused. Its value is 21*s*. The coin weighed 129½ grains, and contained 118·7 grains of pure gold. Guineas were first coined in the reign of Charles II. (1662) of gold brought from Guinea; whence the name.

GUI'NEA PEPPER. A species of *capsicum*.

GUI'NEA WORM. The *Filaria medinensis*. A worm which affects the skin, especially of the legs, in warm climates. Whilst it remains under the skin this worm produces little uneasiness, till a part suppurates, and it puts out its head; much pain being experienced on attempting to draw it out, especially if it be broken.

GUITA'R. (It. chitarra.) A musical stringed instrument, whose invention is attributed to the Spaniards. The strings are stretched over a body much larger than the violin, but of somewhat similar shape; except that the sharp corners are rounded off, and the strings, which are more in number than the violin, and are not carried over a bridge, are struck or pulled with the fingers.

GU'LA, in Zoology, is the region of the throat nearest the lower jaw.

Gu'la. In Architecture. *See* Gola.

GULES. (Fr. gueule, *a throat.*) In Heraldry, red; one of the colours, or tinctures, employed in blazonry. It is equivalent to ruby among precious stones, Mars among planets. In engraving it is represented by a vertical line.

GULL. *See* Larus.

GULPH. In Geography, an arm of the sea extending more or less into the land, and distinguished from a *bay* only in being of greater size and extent than the latter. It is derived from the Gr. κολπος, signifying *bosom*, and has been adopted with a slight variation into all the languages of modern Europe.

GUM. A vegetable product, distinguished by solubility in water, and insolubility in alcohol; it is tasteless and inodorous. Gum-arabic, which is the produce of the *Acacia vera*, may be taken as a sample of the purest form of gum. It is imported from Barbary and Morocco. Its specific gravity is 1·45. Its solution is viscid, and is termed *mucilage*. Gum is used as a demulcent in medicine, and for giving gloss and stiffness to linens, silks, &c. It consists of carbon 41·4, oxygen 52·09, hydrogen 5·51; or, in other terms, of 41·4 charcoal and 58·6 water.

GUM-RESIN. An exudation from many trees, composed of a mixture of gum and resin, or of a substance intermediate between the two.

GUN. Under this general term most of the species of firearms are included, the pistol and mortar being almost the only exceptions. Great guns, or cannon (*see* Cannon), began to be used as military engines about the middle of the 14th century; but small guns, or muskets, appear to have been introduced nearly two centuries later, namely, 1521. They were first used by the Spanish infantry at the siege of Rhege Muskets were at first of a very clumsy construction, being so heavy that they could not be levelled and fired from the shoulder; accordingly the soldier was provided with a rest, which it was necessary to carry along with him and plant in the ground in order to support the weapon before it could be used. The gun was generally fired with a match; sometimes by means of sparks generated by the revolution of a notched wheel of steel, placed directly above the pan containing the priming. Muskets with rests were employed so late as the civil wars in the time of Charles I.; afterwards a lighter matchlock musket came into use; and about the beginning of the last century the troops throughout Europe were armed with firelocks.

The barrel forms the essential part of the gun; and the first requisite to a good barrel is toughness in the material of which it is made, for safety in using it depends mainly on this quality. The best iron for the formation of musket barrels is that which has been much worn, and toughened by the loss of its fiery particles; and, accordingly, old horse stub-nails are much in request for this purpose, and sold at a high price to the barrel-forgers. Formerly the best gun barrels were made in Spain; and their superiority was attributed to the excellency of the iron made use of, which consisted almost exclusively of stub nails, and the old shoes of the horses and mules: but the barrels now made in this country are not inferior to those of any country in the world. The method of making the barrel is this: — the iron is first formed into a thin flexible bar, something like a cooper's

hoop, and when heated is plied or twisted round a mandril, much in the same manner as a ribbon of leather is turned round the handle of a whip. For the best barrels the breadth of the bar does not exceed half an inch; and it is turned round the mandril in such a manner that the edges are brought close together, but do not overlap. In this position it is welded by horizontal strokes with the hammer. But in common guns a broader bar is employed; and its edges, which are placed so as to overlap considerably, are welded down on each other. The Damascus barrels, prized for their beauty, though inferior in strength, are composed of iron and steel in certain proportions laid crossways, and hammered together the whole length of the barrel. After the barrel has been forged, the inside is rendered smooth and perfectly cylindrical by boring it with a bit, or rather bits of different sizes used in succession. In rifles a certain number of parallel grooves, either straight or slightly twisted, are cut in the inside of the barrel, of equal depth and fineness, and through its whole length. The exterior is smoothed by turning it on a lathe.

By act of parliament every gun barrel offered for sale must be tried by a certain quantity of powder and weight of shot according to its size; but the best gun-makers do not trust to this legal test, and subject them to a severer trial by water-proof. For fowling pieces and other guns of the best description the flint lock is now laid aside, and the percussion or detonating lock almost universally substituted. This ingenious invention belongs to a Scottish clergyman, the Reverend Mr. Forsyth, minister of Belhelvie in Aberdeenshire; but it has since received some great improvements, especially in the application of the copper cap,— to which indeed may be attributed all its superiority. The following are the dimensions of the new pattern musket carried by the British troops: —

Length of the barrel, in inches - - -	42
Diameter of the bore - - - - -	·75
Diameter of the ball for service - -	·676
Weight of the ball for service, in ounces avoirdupois - - - - - - -	1·06
Weight of the firelock with bayonet, in pounds avoirdupois - - - - -	12·25
Length of barrel and bayonet, in inches -	59

The carbine carried by regiments of light cavalry is 16 inches in length, and weighs 6 pounds. (*Encyc. Brit.*, art. "Gun-making.")

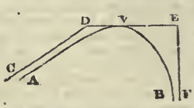
Great guns, or cannon, used formerly to be very long in the bore, and constructed with a view to support large charges of powder; but the experiments of Robins and Hutton proved that neither great length of the bore nor large charges are ever necessary. In consequence of these experiments, a great improvement took place in the artillery services of Europe about the beginning of the French revolutionary wars. The best length has been found to be about 17 calibres. No field-piece has now a bore of more than 18 calibres in length. In the English service the regulation length is 14 calibres; in America, during the late war, it was reduced to 12; but has since been increased, on what principle it does not appear, to 18. The length of the gun must, however, be regulated in many cases by the service for which it is destined. In battering guns a certain length in front of the trunnions is absolutely necessary; for, generally speaking, they are fired from embrasures of earth, which would be injured by the firing if the mouth of the gun did not reach beyond it. Navy guns should also project to a certain distance beyond the side of the vessel, and the same reasons apply to garrison as to battering guns.

With regard to the shape of guns, it is easy to see that it ought to be such as to give them the greatest strength at the part which suffers the greatest strain in firing. This is probably at the part where the ball is lodged. Count Rumford therefore proposed to make the thickness of the metal greatest at this point, and planned a gun swelling in a curve from the breech to the lodgement of the ball, and again contracting in a curve from that point to the projection of the muzzle. In some guns, as the American navy 32-pounder, the form is cylindrical from the base ring to the trunnions, and thence conical to the swell of the muzzle. In respect of British guns, the proportion of the weight of metal of an iron gun is to that of the shot, in heavy guns, as about 224 to 1 or 2 cwt. to 1 lb.; in medium guns as 168 to 1, and in light guns 112 to 1. The length of a 32-pounder, used in the lower deck of line-of-battle ships, is 9 ft. 6 in., and its weight 55 cwt., being about 192 times that of the ball. The medium 12-pounder brass gun is 6 ft. 6 in. in length, weighs 18 cwt., and has a calibre of 4·6 in. in diameter. The length of brass 18, 12, 9, 6, and 3 pounders is 17 calibres. (See *Ency. Brit.*, "Gunnery.") The greater quantity of metal at the breech of a gun than at the muzzle not only gives greater strength to the gun at the part where the danger of bursting is the greatest, but also tends to diminish the force of recoil.

GU'NNER. The first of the three warrant officers of a king's ship. He has the charge of the ordnance, ammunition, and other duties.

GU'NNERY. A branch of the military art, which has for its object the management of guns and mortars, and of charging and directing them so as to hit a proposed mark at any distance within the range of the shot. To accomplish this purpose, it is necessary to know the nature of the path which a projectile describes in the air with a given initial velocity, the quantity of gunpowder necessary to produce that velocity, and the elevation that must be given to the gun in order to counteract the effect of gravity and the resistance of the air on the ball in its flight. Various other considerations require also to be attended to; as the proportion between the length of the gun and the diameter of its bore, the proper *windage* or excess of the diameter of the bore above that of the ball, and the size or weight of the ball proper to produce a certain effect, — to batter down a wall, for example, or to penetrate a ship's side. The method of mounting and working guns, so as to render them most serviceable in military operations, belongs to the head ARTILLERY.

If we abstract from the effect of the resistance of the air, the path described by a projectile is easily determined. The only force which acts on the ball to deflect it from the straight line in which it is projected is gravity, and it consequently describes an arc of a parabola. (PROJECTILE.) But any deductions from the parabolic theory of projectiles are of little or no use in the actual practice of gunnery; for in consequence of the great resistance which the air opposes to a body moving through it with the velocity of a cannon ball, the circumstances of the motion are completely changed. In the parabolic theory, the motion of the ball in the horizontal direction is assumed to be constant and uniform. But the resistance of the air brings another force into action, the intensity of which depends on the velocity of the ball, and which is exerted in a direction exactly opposite to that of the ball's motion; hence the velocity of the ball is continually diminished through its whole course, and in consequence the ascending and descending branches of the trajectory, AV and VB, are unequal and dissimilar. Instead of being branches of the same parabola, they become different arcs of the hyperbolic kind, having asymptotes, CD and EF, dissimilarly situated; the former being inclined to the horizontal line DE, and the latter perpendicular to it.



The motion of the ball in its ascent, being opposed by the resistance of the air as well as by gravity, will neither ascend so high nor range to so great a distance as in the parabolic theory; and in descending through the branch VB its motion downwards is constantly accelerated by gravity, while its horizontal motion is constantly retarded; so that its direction continually approaches to the perpendicular, or a parallel with EF. This resistance of the air is so great as to amount in some cases to twenty or thirty times the weight of the ball itself, insomuch that a ball which in the air ranges only to the distance of one mile, if projected with the same velocity in vacuo would range ten or twenty times that distance.

The determination by theory of the trajectory described by a projectile in the air is, as Dr. Hutton remarks, one of the most difficult problems in dynamics. "Even the solutions of Newton, Bernoulli, Euler, Borda, &c. &c., after the most elaborate investigations, assisted by all the resources of the modern analysis, amount to no more than distant approximations; and are rendered nearly useless, even to the speculative philosopher, from the assumption of a very erroneous law of resistance in the air, and much more so to the practical artillerist, both on that account, and from the very intricate process of calculation which is quite inapplicable to actual service." (*Tracts*, vol. iii.) It may easily be inferred from these remarks that no practical rules can be founded on deductions from pure theory; and that it is necessary to have recourse to trial and experiment in order to obtain even an approximate knowledge of the path of a body projected with so great a velocity as that of a cannon ball.

The first extensive series of accurate experiments on this subject was made by Benjamin Robins, and is described by him in his *New Principles of Gunnery*, published in 1742. In this work, which is one of very great merit and elegance, Mr. Robins has treated very fully of the resistance of the atmosphere, the force of gunpowder, the advantages and defects of different guns, and indeed of almost every thing relating to the flight of military projectiles. Another set of experiments was undertaken by Dr. Hutton at Woolwich, in 1775, of which an account was published in the *Phil. Trans.* for 1778. A second course of experiments was performed by Dr. Hutton in 1783, 1784, and 1785; the principal objects of which were to determine the effect of the length of the gun on the velocity of the ball, the velocities with different charges of powder, the effect of varying the weight of the piece, the penetration of balls into blocks of wood, the ranges

and times of flight, &c. The details of these experiments, which were conducted with great skill and ability, are given in the 2d and 3d volumes of his *Tracts*. Previous to this time a number of experiments similar to those of Robins were made in France by D'Arcy, an account of which is given in the *Memoirs of the Academy* for 1751, and in his *Essai d'une Théorie d'Artillerie*, published in 1760. There is also an extensive series of experiments on the effects of musket balls of different weights, and fired with different charges of gunpowder, by Count Rumford, recorded in the *Phil. Trans.* for 1781, and re-published with additions in 1802. Since the days of Dr. Hutton further experiments with heavy guns appear to have been made from time to time at Woolwich, under the direction of the ordnance department, as there is an account of a very heavy ballistic pendulum, weighing 7408 lbs. avoirdupois, constructed under the care of Dr. Olinthus Gregory in 1815 and 1818, together with some results from experiments on it with a 24-pounder, given in the *Annales de Chimie*, tom. v. and ix., and also in Dupin's *Voyages dans la Grande Bretagne;* but as we are not aware that these results have ever been published in any official form, we know not what credit is to be attached to them. The experiments of Dr. Hutton continue to the present time to afford the best data for the theory of practical gunnery.

There are various methods by which the initial velocity (the principal element in the theory) of military projectiles may be determined. The first is by the *ballistic pendulum*, which consists merely of a heavy block of wood suspended in such a manner that it can swing freely about an axis; into this the ball is fired; and as it is too thick for the ball to pass through it, the whole momentum of the ball is transferred to the block, and the extent of the arc through which it vibrates shows what this momentum has been; whence, as the weights of the block and the ball are known, the velocity with which the latter entered the block may be computed. (BALLISTIC PENDULUM.) Another method of determining the initial velocity of the ball is by means of the recoil of the gun. The principle is, that the explosive force of the powder must communicate equal quantities of motion to the gun and to the ball in opposite directions: consequently, by suspending the gun, loaded with additional weights, in the manner of a pendulum, the extent of its arc of vibration will give the means of estimating the quantity of motion impressed on it; whence the initial velocity of the ball can be computed. Both the above methods were employed by Dr. Hutton: Robins employed the first only. A third method consists in transferring the momentum of the ball to a rotatory machine instead of a pendulum. An ingenious apparatus for this purpose was contrived by Dr. Gregory, but the method has been little used.

The following are the practical conclusions deduced by Dr. Hutton from his experiments: —

1. The velocity is directly as the square root of the weight of the powder, as far as to the charge of about eight ounces; and so it would continue for all charges were the guns of an indefinite length. But as the length of the charge is increased, and bears a more considerable proportion to the length of the bore, the velocit falls the more short after that proportion.

2. That the velocity of the ball increases with the charge to a certain point, which is peculiar to each gun, where it is greatest; and that by farther increasing the charge the velocity gradually diminishes till the bore is quite full of powder.

3. It appears that the velocity continually increases as the gun is longer, though the increase of velocity is very small in respect of the increase in length, the velocities being in a ratio somewhat less than that of the square roots of the length of the bore, but somewhat greater than that of the cube roots of the length, and is indeed nearly in the middle of the ratio between the two.

4. The range increases in a much less ratio than the velocity, and indeed is nearly as the square root of the velocity, the gun and elevation being the same. Very little is gained in the range by a great increase in the length of the gun, the charge being the same; and indeed the range is nearly as the 5th root of the length of the bore, an increase so small as to amount only to about one-seventh part more range for a double length of gun.

5. It appears that the time of the ball's flight is nearly as the range, the gun and elevation being the same.

6. It appears also that there is no sensible difference caused in the velocity or range by varying the weight of the gun, nor by the use of wads, nor by different degrees of ramming, nor by firing the charge of powder in different parts of it.

7. But a great difference in the velocity arises from a small degree of windage. Indeed with the usual established windage only, namely, about 1-20th of the calibre, no less than between 1-3d and 1-4th of the powder escapes and is lost; and as the balls are often smaller than that size, it frequently happens that half the powder is lost by unnecessary windage.

8. It appears that the resisting force of wood to balls fired into it is not constant; and that the depths penetrated by different velocities or charges are nearly as the logarithms of the charges, instead of being as the charges themselves, or, which is the same thing, as the square of the velocity.

9. These, and most other experiments, show that the balls are greatly deflected from the directions they are projected in; so much, indeed, as 300 or 400 yards in a range of a mile, or almost 1-4th of the range, which is nearly a deflection of an angle of 15 degrees. (*Dictionary*, art. "Gunnery.")

Dr. Hutton gives the following table as the results of his experiments with a medium one-pounder gun, the iron ball being nearly two inches in diameter; showing the velocity of the ball, the range, and time of flight, corresponding to different charges, the elevation of the gun being 15 degrees: —

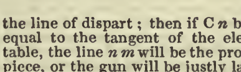
Powder.	Initial Velocity per Second.	Range.	Time of Flight.
Ounces.	Feet.	Feet.	Seconds.
2	860	4100	9
4	1230	5100	12
8	1640	6000	14½
12	1680	6700	15½

In the application of the rules derived from experimental inquiry, it is necessary to take into consideration the effect that is intended to be produced. The power of penetration which a ball possesses is proportional to the square of its velocity; hence, when the object is merely to penetrate, the greatest velocity should be given. Thus in breaching walls the guns are first directed so as to cut grooves in the wall, in order to detach as it were a portion from the rest of the mass. This is done by the penetration of the balls; but the detached portion must then be battered so as to cause it to fall. For this purpose a heavy ball with small velocity is most effectual. In close naval engagements great velocities are less destructive than small ones. The ball, for example, which has just force sufficient to go through a ship's side, generally breaks and splinters the interior surface, and thereby causes far more damage than when it retains a considerable velocity after having passed through; for in the latter case it will only cut a hole without splintering the wood. On this principle the *carronade* (a short species of ordnance fired with a small charge of powder in proportion to the ball) has been introduced into the naval service.

Pointing and elevating Guns. — The art of pointing cannon so as to strike distant objects depends on two things; 1st, on placing the gun in such a position that its axis is in the vertical plane passing through the object aimed at; and 2d, on giving it such an elevation as will counteract the effect of the incurvation of the flight of the ball. When a gun is both pointed and elevated, it is said to be *laid*.

A line drawn from the highest point of the base ring to the highest point of the swell of the muzzle is called the *line of metal*. Now if the line of metal be directed to the object, that line will necessarily be in the same vertical plane with the object; but by reason of the conical shape of the gun, the line of metal has an inclination to the axis, which is called the *dispart*, and in consequence of which the axis will only be in the same vertical plane with the line of metal when the trunnions are perfectly horizontal. If they are not so (and the condition cannot be easily attained or preserved), the shot will be thrown to that side of the object on which the lower trunnion is. This inconvenience is obviated by placing a dispart sight on the muzzle, at a height perpendicularly above its highest point equal to half the difference of the diameters of the muzzle and base ring; for then a line which passes from the highest point in the base ring to the extremity of the dispart thus placed on the muzzle ring will be parallel to the axis, and consequently the shot will not be thrown to the right or left of the object, however much the one trunnion may be lower than the other.

In order to determine the proper elevation to be given to the gun, it is necessary to know the distance of the object fired at. Tables have been constructed from actual practice, showing the angles of elevation which in different guns correspond to different distances; and the angle being found from the table, the proper elevation is given by means of a brass tangent-scale which slides up and down in the breech. Thus suppose C D E F to be the piece, A B its axis, F m half the difference of the diameters of the muzzle ring and base ring set upon the muzzle, so that C m may be the line of dispart; then if C n be set upon the base ring equal to the tangent of the elevation found from the table, the line $n\,m$ will be the proper line for pointing the piece, or the gun will be justly laid when $n\,m$ is directed to the object. In practice the length of C n is found with sufficient accuracy by multiplying the length of the gun in feet by ·21; the product giving C n in inches. This rule is founded on the supposition that the tangent of one



degree of a circle, whose radius is one foot, is equal to the 21-100ths of an inch, which is very near the truth.

The following table (from the *Ency. Brit.*, art. "Gunnery"), constructed from actual practice at Woolwich, shows the elevations corresponding to different ranges with iron ordnance of the kinds therein specified:—

Nature.	Weight of Gun.	Charge.	Elevation.	Range.	Elevation.	Range.	Elevation.	Range.
	Cwt.	*Lbs. Oz.*		*Yds.*		*Yds.*		*Yds.*
42-pr.	58¼	14 0	0·00°	400	1·33°	1100	3·50°	1500
32	55½	10 11	0·25	500	2·00	1200	3·75	1550
24	50	8	0·50	600	2·25	1250	4	1600
18	42	6	0·75	700	2.50	1300	5	1800
12	34	4	1·00	800	2·75	1350	6	1980
9	31	3	1·25	900	3·00	1400	7	2148
			1·50	1000	3.25	1450	8	4000

(*Robins's Math. Tracts; Hutton's Tracts; Sir Howard Douglas's Naval Gunnery;* Paixhans, *Force et Faiblesse de la France;* and the *United Service Journal* for 1834.—For a very complete theoretical discussion of the experiments hitherto made, the reader may consult a *Mémoire sur la Vitesse initiale des Projectiles*, in the *Journal de l'Ecole Polytechnique*, tom. xv. 1835.)

GU'NNEY. (Bengal.) A coarse sackcloth made in Bengal of the fibres of two species of *corchoron.* Rice, saltpetre, pepper, and other articles exported from Calcutta are packed in bags or sacks made of this material; they also form a considerable article of exportation.

GU'NPOWDER. A compound of about 78 parts of saltpetre, 12 of charcoal, and 10 of sulphur. The ingredients should all be perfectly pure, separately reduced to powder, thoroughly mixed, moistened, and beaten or pressed into a cake; which is afterwards broken up, granulated or corned, dried, and polished by attrition. Coarse powder is less carefully and nicely manufactured. The force of the explosion of gunpowder is the consequence of the sudden and abundant production of gaseous matter expanded by the intense heat resulting from the action of the combustibles upon the nitre. The gases evolved are chiefly carbonic oxide, carbonic acid, nitrogen, and sulphurous acid, and their volume probably exceeds two thousand times the bulk of the powder. Count Rumford's experiments show the immense energy of this astonishing agent as a source of mechanical power (*Phil. Trans.* vol. 87.): 28 grains of gunpowder, confined in a cylindrical space which it just filled, tore asunder a piece of iron which would have resisted a strain of 400,000 lbs. applied at no greater mechanical advantage. With regard to the introduction of gunpowder into warlike operations, Dr. Thomson has the following remarks:—The discoverer of this compound, and the person who first thought of applying it to the purposes of war, are unknown. It is certain, however, that it was used in the fourteenth century. From certain archives quoted by Wiegleb, it appears that cannons were employed in Germany before the year 1372. No traces of it can be found in any European author previously to the thirteenth century; but it seems to have been known to the Chinese long before that period. There is reason to believe that cannons were used in the battle of Cressy, which was fought in 1346. They seem even to have been used three years earlier, at the siege of Algesiras; but before this time they must have been known in Germany, as there is a piece of ordnance at Amberg on which is inscribed the year 1303. Roger Bacon, who died in 1292, knew the properties of gunpowder; but it does not follow that he was acquainted with its application to fire-arms.

GUNPOWDER PLOT. In English History, the celebrated conspiracy of certain disappointed Roman Catholics to destroy the king, James I., and the two Houses of Parliament, by gunpowder, which was detected on the 4th of November, 1605. Its details are among the most popular portions of English history, and too well known to need repetition. But the miraculous exercise of sagacity by which King James is commonly said to have detected the nature of the plot, from the mysterious letter sent to Lord Monteagle, is now perhaps negatived beyond a doubt. It had long been remarked that Salisbury and Carlisle (probably before the scheme between themselves and their royal master was concerted) had claimed for *themselves* the credit of the discovery; and it now appears that Lord Monteagle had been previously rewarded by government for mysterious services, apparently rendered in the capacity of spy: so that it is highly probable that he was acquainted with the design of the malecontents, and that the celebrated letter was an invention, destined to conceal the real mode of discovery. Those who are anxious to study the Roman Catholic version of the story will find it ably detailed in the pages of *Lingard* (vol. vii. ch. 1. 4to ed.). That writer seeks to throw the whole onus of the conspiracy on Catesby, its chief promoter, and to exculpate Father Garnet; but Mr. Jardine (in his *State Trials*), who has fully investigated the subject, is of a different opinion.

GU'NTER'S CHAIN, so called from its reputed inventor, is the chain commonly used for measuring land. It is 66 feet or 4 poles in length, and is divided into 100 links, each of which is joined to the adjacent one by three rings; and the length of each link, including the connecting rings, is 7·92 inches. The advantage of this measure consists in the facility which it affords to numerical calculation. The English acre contains 4840 square yards; and Gunter's chain being 22 yards in length, the square of which is 484, it follows that a *square chain* is exactly the tenth part of an acre. A square chain again contains 10,000 square links, so that 100,000 square links are equal to an acre; consequently, the contents of a field being cast up in square links, it is only necessary to divide by 100,000, or to cut off the last five figures, to obtain the contents expressed in acres.

GUNTER'S LINE. A logarithmic line engraved on scales, sectors, &c., serving to perform the multiplication and division of numbers instrumentally, as a table of logarithms does arithmetically. The numbers are usually drawn on two separate rulers sliding against each other. In rough calculations this line affords considerable facilities.

GUNTER'S QUADRANT. A quadrant of a peculiar kind adapted to the problems of finding the hour of the day, the sun's azimuth, and other common problems of the sphere.

GUNTER'S SCALE, casually called by seamen *the Gunter*, is a large plain scale having various lines of numbers engraved on it, by means of which questions in navigation are resolved with the aid of a pair of compasses. On one side of the scale the natural lines (as the line of chords, the line of sines, tangents, rhombs, &c.) are placed, on the other the corresponding logarithmic ones.

GU'NWALE means, generally, the upper part of the solid workmanship of the vessel's side: the part above this is called the bulwark.

GU'TTA SERENA. *See* AMAUROSIS.

GUTTÆ. In Architecture. *See* DROPS.

GUTTI'FERÆ, or CLUSIACEÆ. A natural order of arborescent, shrubby, and occasionally parasitical Exogens, inhabiting the tropics.

GU'TTUR (Lat. guttur, *a throat*), in Mammalogy, is applied to the whole under surface of the neck.

GU'TTURALS. Letters pronounced by a peculiar effort of the throat. There are no gutturals properly so called in the English language, although the guttural sound may often be heard in some provincial pronunciations of the letter *r*. Nor are there in the pure French or Italian, although they are freqent in the dialects: *e.g.* the letter *c* hard (as in *casa*) has the Tuscan a strong guttural sound. In the Spanish language alone, of those derived from the Latin, gutturals are common. In German, the guttural *ch* is largely used. In the Celtic languages, *gh* and *ch* are also sounded with much variety of guttural intonation.

GUY. A rope used to swing any weight, or to keep steady any heavy body and prevent it from swinging while being hoisted or lowered.

GYMNA'SIARCH. (Gr. γυμνάσιαρχος.) An Athenian officer who had the charge of providing the oil and other necessaries for the gymnasia. This was one of the offices called λειτούργιαι at Athens, the expenses of which were defrayed from the private pocket of the individual on whom they devolved, and who received no salary from the state.

GYMNA'SIUM. (Gr. γυμνάσιον, from γύμνος, *naked.*) Originally a space measured out and covered with sand for the exercise of athletic games. Afterwards, among the classical Greeks, the gymnasia became spacious buildings or institutions for the mental as well as corporeal instruction of youth. They were first built at Lacedæmon, whence they spread through the rest of Greece, &c. into Italy. They did not consist of single edifices, but comprised several buildings and porticoes, used for study and discourse, for baths, anointing rooms, palæstras in which the exercises took place, and for other purposes. Two of the Athenian gymnasia, viz. the Lyceum and Academy, were rendered famous by being the scenes of the lectures of Aristotle and Plato respectively.

The term Gymnasium has descended to modern times. In Germany the higher schools, intended to give immediate preparation for the universities, are termed gymnasia. In Prussia the scholars undergo examination on leaving them: their compositions at this examination are sent to the minister of instruction and ecclesiastical affairs; and they receive testimonials of fitness, No. 1, 2, or 3, according to their degree of proficiency. Persons who have fitted themselves for the universities without passing through the gymnasia are examined by a committee appointed by government, which sits half-yearly for the purpose.

GYMNA'STICS. Under this name were comprised by the ancients all those games and exercises which were performed with the body partly naked (γυμνός); such as wrestling, boxing, running, throwing the quoit, playing

at ball, &c. They were first instituted at Lacedæmon, where they were not confined to men, but were also considered a necessary part of the education of females. In the rest of Greece, where they subsequently spread, they were also held of the highest importance, and as such were conducted under the superintendence of the government. and entered conspicuously into the political schemes of the philosophers. In this respect the Greeks offered a remarkable contrast to their Asiatic neighbours, among whom it was considered a great disgrace even for a man to be seen naked. At Rome gymnastics were principally exercised by the mercenary athletes.

GY'MNODONTS, *Gymnodontes.* (Gr. γυμνος, *naked ;* οδους, *a tooth.*) The name of the family of Plectognathic fishes comprehending those which have the jaws protruding, and covered with a more or less complex layer of dense ivory substance serving the office of teeth.

GYMNO'SOPHISTS. (Gr. γυμνοσοφισται, *naked philosophers.*) A sect of Indian philosophers who lived naked in the woods, whence they derived their name, and submitted to other strange austerities. They believed in the immortality of the soul and its migration into several bodies. They enjoyed great reputation for astronomical and physical science.

There was likewise an African sect of philosophers bearing the same name, who are said to have lived in Æthiopia, near the sources of the Nile, whose habits differed from those of the Indian sect, inasmuch as they lived as anchorites, while the latter congregated in societies.

GYMNO'TUS, or rather *Gymnonotus.* (Gr. γυμνος, *naked*, and νοτος, *the back.*) The name of the genus of electric eels which are found in the fresh waters of South America: they have a median fin extended along the belly, but none on the back. Although to all outward appearance the gymnotus is nearly allied to the eel, yet, were that part of the body cut off which contains the nutrient, respiratory, and generative organs, — all the parts, in fact, which are essential to the existence of the gymnotus as a mere fish, — it would present a short and thick-bodied form, very different from that of the eel. The long electric organs are tacked on, as it were, behind the true fish, and thus give the gymnotus its anguilliform body. The back-bone and muscles are of course coextended with the electric organs for their support and motion; and the air-bladder is continued along the produced electrophorous trunk, to give it convenient specific levity. Two long dorsal nerves are continued from the fifth and eighth cerebral nerves for ordinary sensation and motion. The spinal chord is continued along the vertebral column, for the exclusive supply of the electrical organs. These organs are four in number; two very large above, and two small ones below. The electricity discharged from them decomposes chemical compounds, produces the spark, and magnetizes iron, as does that of the torpedo. But the magnetizing power seems to be relatively weaker, while the benumbing shock communicated to other animals is stronger than in any other electric fish.

GYNÆCE'UM. (Gr. γυναικειον.) In Ancient Architecture, the portion of a Grecian house set apart for the occupation of the female part of the family.

GYNÆCE'UM. In Botany, a term invented by Rœper to denote that organ commonly called the pistillum: it may be understood to signify the female apparatus in plants.

GYNA'NDRIA. (Gr. γυνη, and ανηρ, *a male.*) The name of one of the classes in the sexual system of plants invented by Linnæus. Its character is to have the stamens, style, and stigma consolidated into a body, called a column. The class chiefly consists of the plants now named *Orchidaceous.*

GYNŒCO'CRACY. (Gr. γυνη, and κρατεω, *I govern.*) A term sometimes used to indicate that state in which women are legally permitted to assume the reins of government. It is used by way of contradistinction to the *Salique law*, which precludes the fair sex from the privilege of sovereignty. There are only four states in Europe to which the operation of the Salique law does not extend — England, Russia, Spain, and Portugal.

GY'NOPHORE. (Gr. γυνη, and φερω, *I bear.*) The stalk upon which some ovaria are seated, as in the Passion-flower.

GYNOSTE'MIUM. (Gr. γυνη, and στημων, *a stamen.*) A term invented by Richard to denote the column of an Orchidaceous plant. It is a combination of a filament and a style.

GYPOGE'RANUS. (Gr. γυψ, *a vulture*, and γερανος, *a crane.*) This name was invented by Illiger for a most singular genus of Accipitrine birds, in which the structure of the bird of prey is modified by a lengthening of the legs and neck to adapt the species to combat with and destroy the most poisonous of the serpent tribe. The instincts of the gypogeranus, or secretary bird, as it is termed, correspond with its structure, and it preys principally on serpents; not refusing, however, lizards, or even insects. The bill is shorter than the head, curved nearly from its base, not toothed; the wings are armed with a short, strong, and obtuse spur; the feathers are continued down the long tibia to the tarsal joint, covering the front but not the back part of it; the toes are short, but strong; the anterior ones united by a membrane at the base. Species of the secretary vulture inhabit the Cape, the Gambia coast, and the Philippine Islands. The Cape secretary (*Gypogeranus serpentarius*) lives in pairs, builds on high trees, and runs with considerable swiftness.

GY'PSIES. The history of this strange nation of vagrants has been recently illustrated by the labours of several German writers, particularly Grellman (*Historical Inquiry respecting the Gypsies*, translated into English by Raper, 1787) and Bischoff (*German and Gypsy Dictionary*). Their English name is a corruption of the word "Egyptian:" the French call them Bohemians; but the names by which they are most widely known throughout Europe are, the German *Zigeuner*, Russian *Tzigan*, Italian *Zingaro*, Spanish *Gitano*, Turkish *Chinganeh*, — all apparently varieties of the same distinctive appellation. Their origin has long been a subject of curious but unsuccessful antiquarian research. In western Europe, they made their first appearance early in the fifteenth century, under a leader who styled himself the Duke of Lower Egypt: fortune-telling and thieving were then, as now, their predominant occupations. They were at that time treated as heathens and sorcerers, and the most severe laws were repeatedly enacted against them, but without effect. At present they are found not in Europe only, but in Asia Minor, Egypt, Turkey, &c., forming everywhere a distinct race. In Germany, as well as England, they profess various trades, as itinerant horsedealers, smiths, farriers, &c.; but have never been reclaimed in any number to settled occupations. In England their most ordinary haunts are in the midland and southern counties chiefly, whither they are invited by the abundance of green lanes, downs, forests, or chases. They possess a language of their own; and are apparently destitute of religion, although in most countries professing that of the people among whom they dwell. (See *Marsden on the Language of the Gypsies; Hoyland's Hist. Survey*, 1816; *Quart. Rev.* vol. lv. Mr. George Borrow's *Account of the Gypsies of Spain*, 2 vols. 12mo. 1841, may also be consulted with great advantage.)

GY'PSUM. (Probably derived from γη, *earth*, and εψω, *I concoct.*) Crystals of native sulphate of lime.

GY'RI (Gr. γυρος, *a circle*), in Mammalogy, the annular series of scales in the tails of certain quadrupeds.

GY'RODUS. A fossil fish of the family of *Pycnodonts.* It occurs in the oolite of Baden.

GYRO'GONITES. (Gr. γυρος, and γονος, *seed.*) Bodies found in fresh-water deposits; originally mistaken for small shells, but afterwards ascertained to be the seed-vessels of plants of the genus *Chara.*

GY'ROMANCY. (Gr. γυρος, and μαντεια, *prophecy.*) A species of divination performed by drawing a ring or circle and walking round it.

H.

H. An aspirate of the guttural kind, used in all modern and in most ancient languages. The claims of *h* to be regarded as a letter have been denied by many grammarians; and certainly, when it is remembered that the sound of this letter is produced by a mere emission of the breath, without any conformation of the organs of speech, this opinion would seem well founded. There are others, however, who insist that there is no feature in the sound or qualities of this letter which it does not possess in common with some other consonants, and consequently any attempt to invalidate its claim to the distinction militates equally against them. The figure H was used by the Greeks to signify the aspirate, until about the 5th century before Christ. After that time it was gradually abandoned in Greek writing, while its use was still preserved by the Latins. In the former language it was superseded by the small mark called the *spiritus asper* (ʽ), which was placed above the letter to which the aspirated sound was to be given. The various interchanges of which this letter is susceptible will be found in the *Penny Cyclo.* The chief of these is the substitution, in Latin, of the letter *s* for the aspirate of the Greeks; as *sub* for ὑπο, *sal* for ἁλς, *sex* for ἑξ, *septem* for ἑπτα, *serpo* for ἑρπω, &c. In English, this letter is frequently dropped altogether in pronunciation: in German, it is sounded only at the beginning of words; and wherever it otherwise occurs, it has the effect of lengthening the vowel after which it is placed, as in *sēhnen*, *wāhrheit.* In Latin, many words are written indifferently with or without this letter; as aruspex, haruspex, onustus, honustus, &c. As an abbreviation, *h* was used by the Latins for homo, hæres, and hora; and as a numeral it expressed 200.

HAA'RKIES. (German.) Capillary pyrites in very delicate acicular crystals. The term is also applied by the German mineralogists to a native sulphuret of nickel.

HA'BEAS CO'RPUS. (Lat.) In Law, the title of a writ, of which there are several kinds. *Habeas corpus ad respondendum*, is to remove a prisoner, confined by the process of an inferior court, in order to charge him with a new action in a court above. *Habeas corpus ad subjiciendum* is a high prerogative writ, directed to a person detaining another, and commanding him to produce the body of the prisoner. This is the writ which, by stat. 31 C. 2. c. 2., must be granted on application of any party committed and charged with any crime except treason or felony; or, if charged with those crimes, having been acquitted or not tried on the second term or session after his commitment.

HABE'RE FA'CIAS POSSE'SSIO'NEM. (Lat.) In Law, a judicial writ, which lies where one hath recovered a term of years in action of ejectment to put him into possession. *Habere facias seisinam*, a similar writ to give seisin of a freehold estate recovered by ejectment or other action.

HA'CKLE. A board set with sharp iron spikes for combing or pulling out hemp.

HA'DES. (Gr. ᾅδης; also ἀΐδης, which is said to be derived from ἀ and εἴδω, *I see; invisible.*) In Classical Mythology, the abode of the dead. According to Hesiod the mortals of the brazen age were the first who descended to Hades. (See especially the 11th book of the *Odyssey;* Hesiod, Εργα και Ἡμεραι; *Æneid*, book vi.; Warburton's Dissertation on the latter; Heyne, *Excursus* 8. ad loc.; *Spence's Polymetis*, Dial. 16.) Hades was also an appellation of the god Pluto; in which sense alone, it is said, Hesiod uses it.

HA'DING. In Mining, the direction of a slip or *fault*. The deviation from the vertical of a mineral vein is called its *hade*.

HADJ. (Arab.) The Mohammedan pilgrimage to Mecca and Medina: whence Hadji, a pilgrim, or one who has performed this pilgrimage; Hedjaz, the Holy Land, where these cities are situated. By far the most authentic description of it is that of Burkhardt, who performed it, in the guise of a Mohammedan, in 1814. It is fixed to a particular lunar month, and consequently takes place in every season of the year. It was a custom long anterior to the establishment of Islamism, when the famous "black stone" of the Caaba at Mecca was an object of idolatrous veneration. Every year a black silk stuff is now sent by the sultan to cover the Caaba. There are usually five or six caravans; from Syria, Egypt, Barbary, the East, and the North. In 1814, the number of pilgrims was about 70,000, and this was considered small. The pilgrims go through several ceremonies at Mecca, of which the principal are the *towaf*, or procession round the Caaba, and drinking of the well Zemzem; they then proceed to the summit of Mount Ararat; and lastly to Medina, the place of the prophet's burial. (*Burkhardt's Travels in Arabia*, 1829; *Quart. Rev.* vol. xlii.)

HÆMATE'MESIS. (Gr. αἱμα, *blood*, and εμειν, *to vomit.*) Vomiting of blood from the stomach, generally preceded by weight and uneasiness about the region of the stomach, and unaccompanied by cough and the other symptoms of *hæmoptysis*.

HÆ'MATITE. (Gr. αἱμα.) Native oxide of iron: its streak and powder are blood-red.

HÆMATOCE'LE. (Gr. αἱμα, and κηλη, *a tumour.*) A tumour arising from extravasated blood.

HÆMATOSI'NE. (Gr. αἱμα.) The red colouring matter of the blood.

HÆMATO'XYLINE. The colouring principle of the wood of the *Hæmatoxylon campechianum*, or logwood.

HÆMATU'RIA. (Gr. αἱμα, and ουρον, *urine.*) A discharge of bloody urine.

HÆMODORA'CEÆ. (Hæmodorum, one of the genera.) A natural order of Endogens principally inhabiting New Holland. They differ from *Amaryllidaceæ* in their flowers and equitant leaves; from *Iridaceæ* in their stamens, and in the anthers bursting inwards. They are curious, but not useful or beautiful plants; except in the case of *Anigoranthus*, a genus containing some striking herbaceous species.

HÆMO'PTYSIS. (Gr. αἱμα, *blood*, and πτυω, *I spit.*) The coughing up of blood, sometimes produced by fulness of the blood-vessels of the lungs, or by the rupture of blood-vessels as a consequence of ulceration. It is distinguished from blood coming from the stomach by the comparative smallness of its quantity, and by its usual florid colour: the latter is usually blackened by the acid, and often mixed with the contents of the stomach. The age at which this disease commonly shows itself is from fifteen to five-and-twenty, and it is sometimes brought on by violent exercise or a fit of coughing. It is not very uncommon as a symptom of suppression of some natural evacuation; and when unattended by symptoms of consumption and constitutional cough, and occurring in persons otherwise strong and healthy, it is often not dangerous: when it occurs in some fevers, and in inflammation, it may even be a favourable symptom. Bleeding, aperients, acids, diaphoretics, nauseants, and occasionally the exhibition of small doses of sugar of lead and of styptic astringents, are the remedies usually resorted to.

HÆ'MORRHAGE. (Gr. αἱμα, and ῥαγη, *rent.*) A bleeding or flow of blood. This may arise from two causes: either a full state of the vessels, or *plethora*, when it has been called *active hæmorrhage;* or from a debilitated state of the vessels, or of the system generally, when it is called *passive hæmorrhage*. When hæmorrhage occurs from either of these causes, it usually requires methods of treatment adapted to the particular case. Where hæmorrhage is the consequence of wounds, the bleeding vessels must be secured by ligature; or where this cannot be done, styptic applications are applied.

HÆ'MORRHOIDS. (Gr. αἱμα, and ῥεω, *I flow.*) Tumours of the veins of the rectum, constituting the disease commonly called piles.

HÆRE'SIARCH. (Gr. αἱρεσις, *heresy;* αρχω, *I begin.*) In Ecclesiastical History, the founder of an heretical sect. *See* HERESY.

HÆRESI'MACHÆ. (Gr. αἱρεσις, and μαχομαι, *I fight.*) In Ecclesiastical History, those who have written controversial works against heresies. Of the earliest Christian writers of this description, who wrote chiefly against Basilides, Marcion, and the Montanists, we have only fragments remaining. The first complete treatise of this description extant is that of Irenæus against the Gnostics (A. D. 180).

HAG, or HAG-FISH. A vernacular name for a species of Cyclostomous fish called *Myxine glutinosa* and *Gastrobranchus cæcus* by ichthyologists.

HAGIO'GRAPHA. (Gr. ἁγιος, *holy*, and γραφη, *writing or Scripture.*) The Holy Scriptures. The term is also applied to histories or legends respecting the lives and actions of the saints. See *Riddle's Christian Antiquities*, 1839, p. 394., as to that particular class of the Hebrew Scriptures which were termed by the Jews *Hagiographa*.

HAIL. (Germ. hagel.) A well-known meteor, which occurs chiefly in spring and summer, not unfrequently accompanied with thunder. It is formed of rain or atmospheric vapours congealed by cold in the upper regions of the atmosphere, and falling to the ground in small roundish masses, or *hailstones*. On examining attentively the interior structure of hailstones they are usually found to contain an opaque nucleus of a spongy or porous texture, resembling hardened snow, surrounded by a layer of ice of greater or less transparency. Sometimes several transparent layers are distinguishable, and sometimes the layers are alternately transparent and opaque. Hailstones have also been observed having a radiating structure. Their form is exceedingly various; in general it is roundish, but sometimes pyramidal, angular, or even thin and flat, with irregular surfaces. The usual size of hailstones is about a quarter of an inch in diameter; but they are frequently of much greater magnitude, and instances are on record in which the dimensions would appear incredible if they were not attested by observers of known character. Halley relates that on the 9th of April, 1697, there fell in Flintshire hailstones which weighed 5 ounces. On the 4th of May, 1697, Robert Taylor, in Hertfordshire, observed hailstones which measured 14 inches in circumference; that is, about 4 inches in diameter. Parent, on the 15th of May, 1703, found them at Iliers as large as his fist. On the 11th of July, 1753, at Toul, some were collected by Montignot measuring 3 inches in diameter. Volta affirms that on the night of the 19th of August, 1787, in a hail storm which ravaged the city of Como and its environs, some of the stones were found to weigh 9 ounces. In the terrible hail storm which traversed the whole of France and the Netherlands on the 13th of July, 1788, M. Tessier relates that hailstones were picked up which weighed 8 ounces. And Dr. Noggerath informs us that on the 7th of May, 1822, hailstones fell at Bonn, weighing from 12 to 13 ounces. From these relations we may form some idea of the destruction occasioned by a severe hail storm in a cultivated country.

Of the different circumstances accompanying a fall of hail, the following are the most remarkable: — Hail usually precedes storms of rain, sometimes accompanies them; but never, or very rarely, follows them, especially if the rain is of any duration. The time of its continuance is always very short, generally only a few minutes, and very seldom so long as a quarter of an hour. The quantity of ice which falls from the clouds in so short a time is prodigious, the ground being sometimes covered with it to the depth of several inches. The clouds from which hail is precipitated appear to be of very considerable extent and depth, inasmuch as they produce a great obscurity. It has been remarked that they have a peculiar grey or reddish colour, and that their lower surfaces present enormous protuberances, while their edges exhibit deep and numerous indentations. Hail is always accompanied with electric phenomena.

Various hypotheses have been proposed to explain the physical cause of hail, and the phenomena by which it

is accompanied. The theory requires the solution of two questions: first, how the cold which causes the congelation of the aqueous particles is produced? and, secondly, how a hailstone, after attaining a sufficient size to fall through the air by its own weight, remains suspended a sufficient length of time to acquire a volume of twelve or fifteen inches in circumference? But both these questions are attended with very considerable difficulty; and after all that has been written on the subject, the theory of hail is still involved in great obscurity.

The first hypothesis we shall mention is that of the celebrated Volta. In order to solve the first question, Volta supposed that the solar rays which impinge on the upper surface of a dense cloud are almost entirely absorbed, whence a very rapid evaporation results, and that this evaporation produces a sufficient degree of cold to freeze water. To this part of the theory it has, however, been objected that the evaporation of a liquid through the effect of heat can only become more rapid in consequence of the liquid acquiring a higher temperature; in other words, that a liquid cannot, at the same time, receive an additional quantity of caloric and have its temperature diminished without the intervention of some other cause. For instance, let two sheets of paper be moistened to the same degree, and one of them be exposed to the sun's rays, and the other placed in the shade; it will soon be seen that the one on which the sun's rays fall dries more quickly: its evaporation is greater; but, at the same time, it becomes warmer than the other, whereas, according to Volta's argument, it ought to become colder.

Volta's solution of the second question is ingenious, but not satisfactory. Admitting the nuclei of the hailstones to be formed, and that there exists a sufficient degree of cold to produce their enlargement by freezing the aqueous vapours, he supposes two large strata of clouds, charged with opposite electricities, to be disposed the one over the other; in which case the hailstones, still very small, falling on the lower stratum would experience the two following effects:—In the first place, they would penetrate the stratum on which they fall to some extent, and be covered with a new coating of ice. In the second place, they would acquire the same electricity as the cloud, and consequently be repelled by it; while at the same time they would be attracted by the upper stratum, on account of its preserving the opposite electricity. And the electric attraction of the cloud being supposed greater than the force of gravity, the hailstones would thus pass from the lower to the upper stratum, where analogous effects would take place, and whence, consequently, they would be repelled to the lower stratum. Thus they would be kept passing alternately from the one stratum to the other, until at length, either becoming too heavy, or the clouds losing their electricity, or being carried by the wind to too great a distance from each other, the cause which kept the hailstones suspended in the atmosphere becomes inadequate to support them, and they are precipitated to the ground.

It is obvious that the accuracy of this theory cannot be proved by any direct experiment; and doubts have even been raised whether the existence of electric forces sufficient to move masses of ice of the size which hailstones are frequently found to have, in the manner the theory supposes, be really possible. The following, which is much simpler, seems adequate to the effects. We may suppose the cold necessary for the formation of hail to be produced by the wind; and that when the hailstones are formed they are also carried along through the atmosphere by currents of wind in a direction very oblique to the horizon, by which means they may be kept suspended a sufficient length of time to acquire the dimensions they possess by congealing the particles of humid vapour with which they successively come in contact. Thus the same cause, namely, the wind, determines the production and the enlargement of hailstones; and the electricity with which the phenomenon is always accompanied is only the effect of the passage of the particles of water from the liquid to the solid state.

For further information on this subject the reader is referred to an interesting article by Arago in the *Annuaire Presentée au Roi* for 1829; also Pouillet's *Elémens de Physique*, tome ii.

HAIR. (Germ. haar.) The characteristic covering of the Mammiferous class of animals. It consists of slender more or less elongated horny filaments, secreted by a matrix, consisting of a conical gland or bulb, and a capsule, which is situated in the mesh-work of the corium, or true skin. The hairs pass out through canals in the corium, which are lined by a thin layer of cuticle adherent to the base of the hair: the straightness or curl of the hair depends on the form of the canal through which it passes. Spines, bristles, fur, and wool are all modifications of hair, having the same chemical composition, mode of formation, and general structure.

In the spines of the porcupine the bulb secretes a fluted pith, and the capsule invests it with a horny sheath, the transparency of which allows the ridges of the central part to be seen. In the spines of the hedgehog, the spine-like whiskers of the walrus, and the bristles of the hog, the twofold structure of the hair is very conspicuous; but in the finer kind of hair, as of the human head and beard, the central pith can only be demonstrated in fine transverse sections viewed with a microscope. Some kinds of hair, as of the human head, the mane and tail of the horse, are perennial, and grow continuously by a persistent activity of the formative capsule and pulp; other kinds, as the ordinary hair of the horse, cow, and deer, are annual, and the coat is shed at particular seasons. In the deer the horns are shed contemporaneously with the deciduous hair.

Many quadrupeds, especially those of cold climates, have two kinds of hair: a long and coarse kind, forming their visible external covering; and a shorter, finer, and more abundant kind, which lies close to the skin, and called "fur." It is one of the processes in the arts to remove the coarse hair, and leave the fur attached to the dried skin, as in the preparation of seal-skin, &c. The peculiar characteristic of wool, and that on which its valuable qualities chiefly depend, is the serrated character of its surface, arising from its structure, which consists of a series or succession of inverted cones, the base of each being directed from the root of the woolly fibre, and receiving the apex of the succeeding cone. It results from this structure that the pressure to which the workman subjects the wool in moving it backwards and forwards, brings the fibres together and multiplies their points of contact. The agitation gives to each hair a progressive motion towards the root, and the serrations of one hair fix themselves on those of another hair which happens to have its root turned in the opposite direction, and the mass at length assumes that compact form which is termed "felted" wool. The microscope has likewise demonstrated various other remarkable modifications in the form of the hair in different quadrupeds. In the mole, *e. g.*, each hair is alternately constricted and expanded from its root to its apex, whereby it readily assumes any position, and lies flat and smooth, either towards the head when the little burrower is retrograding in his subterraneous galleries, or in the contrary direction when moving forwards. The organization of the hair is such as to allow of its undergoing certain changes when once formed, according to the state of health and general condition of the rest of the frame, and even to be affected by loss of colour in consequence of violent mental emotions in the human subject. Some of the lower animals, as the Alpine hare, are subject to periodical change of colour of their fur, by which it is made to harmonize with the prevailing hue of the ground which they habitually traverse.

The chemical properties of hair were first pointed out by Mr. Hatchett, in his paper in the *Phil. Trans.* for 1800. It chiefly consists of an indurated albumen, and when boiled with water it yields a portion of gelatine. Soft flexible hair, which easily loses its curl, is that which is most gelatinous. Vauquelin discovered two kinds of oil in hair: the one colourless, and in all hair; the other coloured, and imparting the peculiar tint to hair. Black hair also contains iron and sulphur.

HAIRS. In Botany, minute, transparent, filiform processes, composed of cellular tissue more or less elongated and arranged in a single row. They spring from the surface of plants, appear always to have a circulating system, and probably act both as absorbents of moisture and protectors of the surface in which they grow. Many sorts are distinguished by phytotomists, the principal of which are the secreting or glandular, which are composed of cellules that are visibly distended either at the apex or base into receptacles of fluid; and the lymphatic, which consist of tissue tapering gradually from the base to the apex.

HA'LBERT. A word of uncertain derivation, applied to an *offensive* weapon, which consists of a shaft five feet long, with a steel head, partly in the form of a crescent. This weapon was formerly in considerable use in the army, and indeed gave its name to a body of men called halberdiers; but it is now rarely to be met with except in some boroughs in Scotland, where it is used by the civic officers who attend the magistrates in processions, and on other public occasions.

HA'LCYON. *See* ALCEDO.

HALCYON DAYS. A name given by the ancients to the seven days that precede and follow the winter solstice, from the circumstance of the halcyon or alcedo selecting that period for incubation. While this process was going on, the weather was generally remarkable for its calmness; and hence the expression has passed into a proverb, signifying days of peace and tranquillity. This circumstance is beautifully alluded to by Ovid in the following lines:—

> Perque dies placidos hiberno tempore septem
> Incubat Halcyone pendentibus æquore nidis.
> Tum via tuta maris: ventos custodit et arcet
> Æolus egressu: præstatque nepotibus æquor.

HALCYONI'DÆ. (Gr. *ἀλκυων, a king-fisher.*) The family of Fissirostral birds, having the kingfisher as the

type. (*Halcyon*, from ἁλκυων, itself is derived from Gr. ἁλς, and κυω, *I procreate*, because the halcyons build their nest on the sea-shore.)

HALIO'TIDÆ. (Gr. ἁλς, *the sea*, and ους, *the ear*.) A family of Gastropods, having as its type the genus *Haliotis*, or the sea-ear

HALL. (Sax. heal.) In Architecture, properly a large room for the transaction of public business; also a manor house where courts are held for the admission of tenants and other manorial business. It is perhaps a term improperly applied, as now, to the entrance of a dwelling-house, though not so to a servants' hall. At Oxford an unendowed college is styled a *hall;* but at Cambridge the term is used indiscriminately for *college*, whether endowed or not.

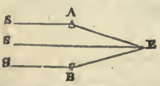
HALLELU'JAH. (Heb. *praise ye the Lord.*) A well-known doxology, derived from the Old Testament. It was used, among the early Christians, at Easter, and during the interval from thence to Whitsuntide. (*Greg. Epist.* ix. Ep. 12.) See *Riddle's Christian Antiquities*, p. 334.

HA'LLIARDS, *Haulyards*. Ropes by which yards, sails, and signals are hoisted.

HA'LO. (Lat. halo.) In Meteorology, a luminous circle or ring, usually coloured, surrounding the sun or moon under certain conditions of the atmosphere. Of such rings there are two kinds, which appear to depend on essentially different physical causes. The first are of small dimensions, their diameters being between 5° and 12°; and generally three or more concentric rings appear together, differently coloured, and presenting appearances similar to the optical phenomena of the rings of thin plates. These are usually called *coronæ;* and they appear either when a small quantity of aqueous vapour is diffused through the atmosphere, or when light fleecy clouds pass over the sun or moon. The second kind consists usually of a single luminous ring, but of much larger dimensions, the diameter being about 45°. It is to the meteors of this second kind that the term *halo* is usually appropriated.

The apparent diameters of halos of the second kind have frequently been measured, and are always found to subtend at the eye of the observer an angle of between 44° and 46°. The lunar halo is simply a white luminous circle, without colour, excepting a pale red, which sometimes fringes the interior edge of the circle. But the colours of the halos about the sun, though not so bright as those of the rainbow, are, however, marked with sufficient distinctness. The red occupies the interior part of the luminous circle; the indigo and violet the outer part, and shade away by insensible degrees till they are blended with the general colour of the sky. In some circumstances a second halo is observed concentric with the former, but of much larger extent, its apparent diameter being about 90°. The colours of this secondary halo are faint and pale, and its luminousness much inferior to that of the inner halo. The halos are very frequently attended by a horizontal white circle, with brighter spots, or *parhelia*, near their intersections with this circle, and with portions of inverted arches of various curvatures. *See* PARHELIA.

Various causes have been assigned for the origin of halos; but the most probable is that of Mariotte, who supposes the phenomenon to arise from the refraction of light in passing through small transparent and prismatic crystals of ice floating in the higher regions of the atmosphere. Water assumes, in congealing, a great variety of crystalline forms, among which are frequently found crystals whose faces are inclined to each other in an angle of 60°; thus forming prisms of ice of which the refracting angle is 60°. These prisms are turned in all possible directions, and consequently the sun's rays fall on their faces at all different inclinations. But in certain positions of the prism with respect to the incident light, the rays which traverse it suffer a minimum deviation, which happens when the refracted ray makes an isosceles triangle with the two sides of the prism. The path of the ray in the interior of the crystal in this case makes an angle of 60° with the face of the crystal, or an angle of 30° with the perpendicular to that face. This last angle is the angle of refraction; and it is known by experiment that in the case of ice, the angle of refraction being 30°, the angle of incidence is 41°; hence the ray falls on the crystal at an angle of $90° - 41° = 49°$; consequently the deviation of the ray from its original direction is $60° - 49° = 11°$. On escaping from the crystal, the ray suffers a second flexure of the same amount; and the total deviation from its first direction is now $2 \times 11° = 22°$, which is the semidiameter of the halo. It follows, therefore, that the parallel rays



S A, S B, from the sun falling on such prisms at A and B at angles of incidence equal to 41°, will be refracted into the directions A E and B E, which make angles A E S and B E S equal to 22°; and an eye situated at the intersection E will see a luminous circle of which the apparent diameter, or angle A E B, is about 44°. With respect to the secondary or external halo, whose diameter is about 90°, it may be attributed, says Dr. Young (*Lectures*, vol. i. p. 444.), either to two successive refractions through different prisms, or with greater probability, as Mr. Cavendish suggested, to the refraction of the rectangular terminations of the prisms.

This theory explains the order in which the colours are disposed. The ratio of the refraction of the violet ray being greater than that of the red ray, the former will suffer a greater deviation, and consequently the violet band of the halo will have a greater diameter than the red. Supposing this theory to be correct, the condition necessary for the appearance of halos is the existence of particles of ice in the upper regions of the atmosphere. The appearance of a halo, therefore, furnishes information respecting the temperature of the air at great altitudes above the earth.

The formation of *coronæ*, or the small halos so frequently seen round the sun and moon in fine weather, is ascribed by Fraunhofer and Sir John Leslie, not to the *refraction* but to the *deflection* of light in passing by the small watery globules súspended in the atmosphere. If a piece of tinfoil punctured with the point of a needle be held close to the eye, the sun will appear through it surrounded with a halo very near his disk, but spreading more in proportion as the hole is contracted. Supposing that an aqueous globule of equal dimensions would produce an equal deflection, the magnitude of the globules might thus be inferred from the diameter of the halo. When the halo approaches nearest to the luminous body, the largest globules are floating, and therefore the atmosphere is surcharged with humidity; whence the justness of the remark that a dense halo close to the moon portends rain. For a full exposition of the theory of halos and other similar meteors, the reader is referred to a Memoir by Fraunhofer in *Schumacher's Astronomische Abhandlungen*, 3 tes. heft; or to the article "Hof," in *Gehler's Physicalisches Worterbuch*. See also *Newton's Optics; Smith's Optics;* Pouillet, *Elémens de Physique; Cabinet Cycl.*, art. "Optics;" *Ency. Brit.*, art. "Meteorology."

HA'LOGENS. (Gr. ἁλς, *salt.*) Substances which by combination with metals produce saline compounds; such as chlorine, iodine, bromine, fluorine, which are simple halogens; and cyanogen, which is a compound halogen.

HA'LOID (Gr. ἁλς.) This term is applied to a class of chemical combinations composed of two bi-elementary compounds, one or both of which are analogous in composition to sea salt. The principal groups consist of double chlorides, iodides, fluorides, and cyanurets.

HALTI'CA. A genus embracing numerous species of small and often minute Coleopterous insects, of the family *Galerucidæ*, and section *Tetramera*. These insects have the femoral joints of the hind legs thick and strong, and are consequently good leapers. The native species are smaller than the foreign ones, but are more noxious than might be expected from their diminutive size. The notorious turnip-fly, or rather turnip-flea (*Chrysomela nemorum* of Linnæus), is a species of the present genus.

HAMADRY'ADS. (Gr. ἁμα, *together*, and δρυς, *an oak.*) Certain nymphs or inferior deities supposed by the Greek and Roman poets to preside over woods and forests, and, as their name implied, to live and die with the particular trees to which they were attached.

HA'MITES. (Lat. hamus, *a hook.*) A genus of extinct Cephalopods, which inhabited chambered shells, losing their spiral form soon after their commencement and then continued for a considerable extent with a single bend upon themselves like a hook. The *Hamites* are found in the greensand formation in England.

HA'MLET. (Diminutive of the Saxon ham, *home or house.*) A small village. In Law, a hamlet is a portion of a village or parish, and synonymous with *vill.*

HA'MMER BEAM. (Sax. hamer.) In Architecture, an horizontal piece of timber from or near, but above, the foot of a rafter, the object of which is to act as a tie.

HA'MMOCK. The sailors' bed. An oblong piece of hempen cloth: at each end are fastened several small lines, meeting in a grummet or iron ring; these form the *clues*. The whole, having a mattrass and pillow, &c. placed in it, is hoisted up into its place by small ropes called *laniards*, between two battens or screws in the beams of the deck over head, about nine feet distant asunder. The hammock is a very agreeable bed, especially in cold weather; but some little practice is requisite at first in getting in and out successfully. During the day the hammocks, lashed up tight in the form of caterpillars, are stowed in the nettings along the upper edge of the bulwark.

HA'MSTER. A Rodent quadruped, somewhat larger than a rat, common in all the sandy regions that extend from the north of Germany to Siberia; extremely noxious from its fertility and great destruction of grain, but an object of interest on account of the economic instincts which conduce to its preservation and support. The hamster excavates a complicated burrow, consisting of different apartments for rearing the young, hibernating, and storing up winter food. An old hamster will often

amass a hundred pounds' worth of grain, and fill up a subterraneous magazine which is sometimes seven feet deep. To effect this hoard nature has provided the hamster with a means of transport in two large cheek-pouches, which, during its incursion among cultivated grounds, it crams full of grain, beans, or peas, and empties on its return to its hole by pressing the two fore-paws against the cheeks. The hamster, however, is not wholly dependent on its winter store for existence. During the inclement months, when the frost becomes severe, animation is in great measure suspended, and the need of nourishment abrogated: respiration ceases, the animal heat falls, sensation is benumbed, and a kind of vegetative life is maintained by a slow circulation of dark or venous blood through both sides of the heart. When the returning warmth of spring stimulates the organic machinery to its wonted activity, the awakened hamster finds in the nourishment which it has providently stored up the means of supplying the consequent waste, and of maintaining its vital energies. They are thus enabled to commence the business of procreation in April, and the female rears a litter of six or eight twice or thrice every year. In about three weeks the young are able to provide for themselves, and are driven from the holes of the parents. The hamster (*Mus cricetus* of Linnæus) is the type of the genus *Cricetus* of Cuvier, characterized by the short tail and cheek-pouches. The teeth nearly resemble those of the rat.

HAMULA'RIA. (Lat. hamus, *a hook.*) A species of worm said to have been found in the bronchial glands of a person who died of typhus.

HA'NAPER OFFICE. A common law office in the court of Chancery, in which writs were anciently kept in small separate wicker baskets (hampers, *hanaperia*), of which specimens may still be seen among the records at the Chapter House. Writs relating to the subject were deposited there; those concerning the crown in the Petty or Little Bag, whence another office of the same court is denominated.

HA'NDLING. (From *hand.*) In Painting, management of the pencil by touch. Handling should be bold, with freedom, firmness, and spirit.

HA'NDSPIKE. A wooden lever employed on board a ship in working the windlass and capstan, one end of which is squared to fit the holes in the capstan head and in the barrel of the windlass.

HANK. In Spinning, the name given to two or more skeins of yarn, silk or cotton, when tied together. When single, they are called skeins.

HANKS. Rings of ash or iron, by which sails are confined to their stays, upon which they traverse while setting or hauling down.

HANNO'S PERIPLUS. *See* PERIPLUS.

HANSA, HANSE, or HANSEATIC LEAGUE. In European History, a celebrated confederacy of cities on the coasts of the Baltic, and in the adjoining countries. The first league was formed in 1239, between Hamburg, Minden, and many other towns, to which Lübeck soon afterwards acceded: it was for the purpose of mutual defence against foreign potentates, especially the Danish king Waldemar, as well as the neighbouring nobles of Germany. The league rapidly spread, and comprehended, at one period, eighty-five cities, divided into four provinces. It had four chief foreign depôts: at London, Bruges, Novgorod, and Bergen. In the 14th and 15th centuries the league became of high political importance, and made war and peace as an independent sovereign power, but it was never recognized by the German empire. Its decay was gradual, and, owing to the increased protection given to commerce by the princes of the several states in which these cities were situated, rendering the alliance for mutual defence unnecessary. The name is derived from Hansa, an old Teutonic word signifying *league*.

HA'QUEBUT. A word of French origin, or more probably a corruption of the term *arquebuse* or *harquebuse*, with which it is identified in meaning. *See* ARQUEBUSE.

HA'RBOUR, has been defined to be a piece of water communicating with the sea, or with a navigable river or lake, having depth sufficient to float ships of considerable burden, where there is convenient anchorage, and where ships may lie, load, and unload, screened from the winds and beyond the reach of the tide. For a view of the utility of harbours in general, and the qualities essential in good harbours, with a notice of the principal harbours in this and other countries, see *The Commercial Dictionary*.

HARD BODIES, in Natural Philosophy, are such as resist any pressure or percussion whatever: in opposition to soft bodies, the parts of which readily yield to pressure, and do not recover themselves; and to elastic bodies, the parts of which also yield to pressure or impact, but presently recover themselves when the disturbing force ceases to act.

HA'RDNESS. In Physics, that quality of bodies in virtue of which their particles resist the action of any external force tending to alter their relative positions, or to impart to them any motion in respect of each other. Newton supposes the primary particles of all bodies to be perfectly hard, and not capable of being broken or divided by any power in nature; but we are still too little acquainted with the constitution of matter to determine with any certainty the conditions of the elementary particles which render bodies hard, brittle, elastic, &c.

HARDNESS. In Mineralogy. Minerals may occasionally be distinguished and identified by their relative degrees of hardness; to specify which various scales have been suggested, among which that of Mohs is perhaps the most simple. According to it the relative degrees of hardness are expressed in numbers, referring to the following standard substances, which are easily obtained in a state of purity, or crystallized; namely,

1. Talc.	6. Adularia (Felspar).
2. Rock-salt.	7. Rock-crystal.
3. Calc-spar.	8. Topaz.
4. Fluor-spar.	9. Corundum.
5. Apatite.	10. Diamond.

Any mineral which neither scratches nor is scratched by any one of the above substances is said to possess the hardness expressed by the attached number. Thus if a mineral neither scratches nor is scratched by calcareous spar, its hardness is represented by 3; if it scratches felspar and not rock-crystal, its hardness is stated to be between 6 and 7.

HA'RDWARE, is used to signify every kind of goods manufactured from metals, comprising iron, brass, steel, and copper articles of all descriptions. The hardware manufacture is one of the most important carried on in Great Britain. Its principal seats are Birmingham and Sheffield, which furnish immense quantities of knives, razors, scissors, gilt and plated ware, fire-arms, &c., both for home consumption and exportation. The total aggregate value of the joint hardware manufactures of England and Scotland may be estimated (*Statistics of British Empire*, i.) at not less than 17,500,000*l.* a-year, affording direct employment in the various departments of the trade to 360,000 persons.

HARE. *See* LAGOMYS and LEPUS.

HARELIP. A fissure or perpendicular division of the lip, so named from its supposed resemblance to the upper lip of a hare. Children are frequently born with this malformation, and sometimes it is the consequence of accidents or wounds. It most usually affects the upper lip; and is not only a serious deformity, but may prevent the infant from sucking and cause impediment of speech. The cleft is sometimes double. This malformation admits of partial or entire relief by a surgical operation, which should generally not be performed upon very young infants, in consequence of the risk of convulsions.

HA'REM. (Turk.) The name given to those apartments in the houses of the East which are appropriated to the exclusive use of the females of the family. *See* SERAGLIO.

HA'RLEQUIN, in the Italian Comedy, is the name given to the person who performs a part something similar to that of the clown or merry-andrew of the mountebank stages in our own country. Harlequin forms also one of the standing characters in the grotesque entertainment of the pantomime. The word is of doubtful etymology. *See* PANTOMIME.

HARMONICA. *See* MUSICAL GLASSES.

HARMO'NICAL I'NTERVAL. In Music, the same as *Concord*, which see.

HARMO'NICAL PROGRESSION. A series of numbers, such that any three consecutive terms are in harmonical proportion. The principal property of this progression is, that the reciprocals of the terms form an arithmetical progression; and, conversely, the reciprocals of an arithmetical form an harmonical progression.

HARMO'NICAL PROPORTION, called also *Musical Proportion*. Three numbers are said to be in harmonical proportion when the first is to the third as the difference of the first and second is to the difference of the second and third: thus, 2, 3, and 6, are in harmonical proportion, because 2 : 6 : : 1 : 3. And four numbers are said to be in harmonical proportion when the first is to the fourth as the difference of the first and second is to the difference of the third and fourth: thus 9, 12, 16, and 24, form an harmonical proportion; for 9 : 24 : : 3 : 8.

HARMO'NICS. In Music, the doctrine of the differences and proportions of sounds with respect to acute and grave. This doctrine was by the ancients divided into seven parts; viz. of sounds, of intervals, of system, of the genera, of the tones or modes, of mutation, and of melopæia.

HARMO'NIC TRIAD. In Music, the chord of a note consisting of a third and perfect fifth, or, in other words, the common chord.

HA'RMONITES. A sect of enthusiasts, founded by one Rapp, in Wurtemberg, about 1780; who, finding no toleration there, emigrated with his followers to America. He first settled in Pennsylvania, and afterwards removed to Indiana; but about 1822 again returned to the former state, and established himself near Pittsburg. Many details will be found on the subject of his sect in books of

travels in America, but few written with any knowledge of the subject beyond mere external observation. It is a mistake to suppose that his followers lived in celibacy; but they regarded marriage as no part of the discipline of their church, and treated it as a civil act only.

HA'RMONY. (Gr. ἁρμονία.) In Music, an agreeable combination of sounds heard at the same instant. As a continued succession of single musical sounds produces melody, so does a continued combination of several together in succession produce harmony.

HA'RMONY OF THE SCRIPTURES, GOSPELS, &c. The correspondence of the several writers of different parts of the Scriptures in their respective narratives, or statements of doctrine. The earliest Harmony of the Gospels was composed by Tatian, in the second century, with the title *Diatessaron*. Among many other valuable works of this description may be mentioned Osiander, *Harm. Evangelica*; Cartwright, *Harm. Ev. Commentario illustrata*, 1647; Le Clerc, *Harmonie Ev.*, Amst. fol. 1699; *Macknight's Harmony of the Four Gospels*, 1756.

HA'RMONY, PRE-ESTA'BLISHED. A hypothesis invented by Leibnitz, to explain the correspondence between the course of our sensations and the series of changes actually going on in the universe, of which, according to that philosopher and many others, we have no direct knowledge. (*See* PERCEPTION.) This hypothesis is connected, in the Leibnitzian system, with the doctrine of monads, — certain spiritual powers or substances, one of which constitutes the principle of vitality and consciousness in every living being. Each of these is, in its degree, a mirror, in which the changes going on in the universe are reflected with greater or less fidelity. But between simple substances, such as spirit and matter, soul and body, no real reciprocal action can take place. The Author of the universe has consequently so ordained that the series of changes going on in any particular conscious monad, corresponds precisely to those of the monads in contiguity to which it is placed. Hence arises our belief that mind is acted on by matter, and vice versa; a belief which leads to no practical errors in virtue solely of this pre-established harmony. (See *Tennemann. Grundr.* p. 339.; *Brown's Lectures*, 31.)

HARMO'STES. (Gr. ἁρμοστής; from ἁρμόζω, *I fit.*) In Ancient History, a Spartan magistrate, called also sometimes *sophronistes* (σωφρονιστής, *moderator*), who was appointed to superintend a conquered state. It is conjectured from *Thucyd.* iv. 53. that the office was annual. Other Greek states which made conquests afterwards borrowed the name. Xenophon speaks of Theban *harmostæ* in Achæa. (*Hist.* l. vii.)

HA'RMOTOME. (Gr. ἁρμος, *a joint*, and τεμνω, *I divide.*) A mineral chiefly from Andreasberg, in the Hartz, the crystals of which often intersect each other, and are easily separable. It is also called cross-stone, or staurolite. *See* CROSS-STONE.

HA'RMUS. (Gr. ἁρμος.) In Ancient Architecture, a tile used for covering the joint between two common tiles.

HARP. (Germ. harfe.) A musical stringed instrument of great antiquity, in which the strings are stretched on a triangularly-formed frame, and pinched, or rather pulled, by the fingers, to set them in vibration and produce the different sounds. The harp is represented on many Egyptian monuments; and though it is usually admitted to be of Eastern origin, it seems doubtful whether it was known to the Greeks and Romans in any shape analogous to its present form. Of late years this instrument has been much improved by pedals and other devices; but it is still imperfect, and more suited to the chamber than the orchestra.

HA'RPA. (Ger. harfe.) A genus of Pectinibranchiate Mollusks, dismembered from the Linnæan *Buccinum*, and remarkable for the elegance of form and beauty of the markings of the shell: this is traversed by longitudinal compressed sinuous parallel ribs, which may be compared to the strings of a harp.

HA'RPALUS. (Gr. ἁρπαλεος, *rapid.*) A genus of predaceous Coleopterans, and the type of a family (*Harpalidæ*), which is one of the principal divisions of the Linnæan genus *Carabus*.

The *Harpalidæ* are divided into three principal sections, characterized by modifications of the anterior *tarsi* of the male.

1. *Harpalinæ*, having the four anterior tarsi of the males dilated.
2. *Feroninæ*, having the two anterior tarsi dilated, and the joints heart-shaped.
3. *Patellimana*, having the two anterior tarsi of the males dilated; the joints being square or rounded.

Each of these sections contains numerous subgenera, of which *Harpalus proper* contains many British species. *Harpalus ruficornis* is perhaps the most common; it exceeds half an inch in length, with opaque black elytra and body, and red legs and antennæ.

HA'RPAX. A genus of fossil shells, oblong and somewhat triangular, the hinge being formed by two projecting teeth. (*Parkinson.*)

HA'RPIES. (Gr. Ἅρπυιαι; from ἁρπάω, *I seize.*) In Greek Mythology, the daughters of Pontus and Terra, according to some mythologists. Hesiod makes them three in number, with the names Iris, Aello, Ocypete. They were a species of furies or monsters, winged and clawed like birds. They are best known from the celebrated description in *Virgil* (*Æn.* iii. 211. &c.). See a memoir in vol. xii. of the *Mem. de l'Ac. des Inscr.* for the varying mythological accounts respecting them.

HARPOO'N. A well-known spear for striking the whale.

HA'RPSICHORD. (Fr.) A keyed musical instrument, in which the sounds are produced by means of small vertical sticks, called jacks, upon which the keys act as levers. In the jacks are inserted short pieces of quill; these, upon passing the strings, set them in vibration. This instrument is now little used; indeed, we believe, in the present day none are manufactured.

HARPY'IA. (Gr. Ἅρπυια, *Harpy.*) This term has been applied both to a genus of Raptorial birds and to a genus of Lepidopterous insects.

HA'RROW. In Agriculture, a rectangular frame with a number of spikes inserted in it on one side. This frame, when dragged over ploughed land, breaks the furrow slices into small pieces, for the purpose of preparing the land for seed in some cases, and for covering the seed in others. The most common form of the frame of the harrow is rectangular, and the usual material employed is wood, with the spikes of iron; but in some cases both the frame and the spikes are of wood, and in others both are of iron. Occasionally the frame is a circle of iron; and the spikes are inserted in it, at such distances that when the frame is drawn along in a straight line the spikes, or tines as they are technically termed, pass through every part of the soil traversed by the frame or harrow. In the common kinds of harrows the spikes are inserted at right angles to the frame; but in the improved forms they are inserted at an oblique angle, or pointing forwards, by which means the harrow is drawn much more easily through the soil. The best implement of this description at present in use is Finlayson's harrow. This implement, by means of a long lever, can be regulated to such a nicety as to stir the soil to the depth of only one or two inches, for the purpose of covering grass or clover seeds; or it can be pressed into it of such a depth as to serve, in the case of stubble lands, instead of ploughing. Wilkie's harrow and Kirkwood's harrow can be used for similar purposes. They differ nothing from Finlayson's in principle; but being on a smaller scale can be worked with fewer horses than Finlayson's, which commonly requires four or six.

HA'RROWING. The process of drawing a harrow through the soil for the purpose of reducing it to a level, of covering seed, or of turning up weeds in ploughed ground, or moss in grass lands. In agriculture the harrow is drawn by horses or oxen; and in market-gardening, where a light harrow is sometimes employed, by men. In either case the more rapid the motion of the harrow, up to a certain point, the more efficient will be its operation. For meadow lands, the object of harrowing is to disperse the little heaps of earth raised during winter and early spring by moles and worms; and for this purpose the harrows in some parts of the country are turned upside down; while in others, as in Middlesex, thorn branches are tucked into a frame resembling a harrow, and dragged over the surface for the purpose of effecting the same object. This is called a bush harrow.

HA'RTSHORN, SPIRIT OF. An impure solution of carbonate of ammonia, obtained by the destructive distillation of harts' horn or any kind of bone. An impure solid carbonate of ammonia, called *salt of hartshorn*, is formed at the same time.

HA'RVEST. (Germ. herbst.) In Agriculture, the period at which any crop is reaped. The term is more commonly applied to the crops of corn or hay, though it might, with propriety, be applied to the potatoe crops, or to hops and other field products.

HA'RVESTING. The operation of pulling, cutting, rooting up, or gathering field crops, and drying or otherwise preparing them for being stored up for winter use. The first harvest which occurs in Britain and similar climates is that of the forage grasses, or other plants made into hay; the next is the harvest of cereal grasses, or of corn crops; and the third the potatoe harvest, or harvest of root crops, such as potatoes, carrots, turnips, mangel wurzel, &c. There is also the harvest of occasional crops; such as that of rape-seed, turnip-seed, dyers' wood, hemp, flax, and various other articles.

HASTA'TI. (Lat. hasta, *a spear.*) One of the three grand divisions of the Roman infantry, so called because they were armed with spears. It consisted of young men in the flower of life, who were always drawn up in the first line of battle. The other two divisions were called Principes and Triarii; to which, in the first Punic war, was added another, called Velites, or *light* troops, from volare, *to fly*.

HATCH, is the covering of a hatchway. In very bad weather the hatches are battened down, to keep the water which comes in upon the decks from getting below.

HA'TCHETINE. A fusible wax-like substance, found occasionally in nodules of ironstone: named after Mr. Hatchett. It is usually placed by mineralogists amongst bitumens.

HATCHMENT. In Heraldry, a species of *achievement* or funereal escutcheon, suspended in front of a house to mark the decease of one of its inmates. These escutcheons are always drawn up with heraldic precision; so that those acquainted with the science of heraldry can discover at a glance, from the form and accompaniments of the field and the colour of the ground of the hatchment, the sex, position, and rank of the deceased. *See* HERALDRY, ESCUTCHEON.

HA'TCHWAY. A large opening in a ship's deck for communicating with the decks below, the hold, &c.: there are the fore, main, and after hatchways.

HAT. (Germ. hut.) What is usually called a *beaver* hat is made of a variety of furs, chiefly those of the hare and rabbit, mingled with wool, and in the best hats a proportion of beaver's fur; but the latter is altogether omitted in common *stuff* hats. The furs are mixed; the long hair is picked out; and they are then placed on a hurdle, which is shaken and made to vibrate by being struck with a bow-string; in this way the dust is shaken out, and the fibres are to a certain extent interwoven. (*See* FELT.) A quantity of this mass of fur sufficient for one hat is called a *bat* or *capade* (see *Ure's Dictionary*, art. "Hatmaking"): it is pressed, kneaded, and at length moulded so as to form a kind of conical cap, the irregularities or small fibres of the different furs entangling with each other so as to keep the whole adherent. The cap is then dipped into warm water acidulated by sulphuric acid, and wrought by the hands for several hours, by which it is thickened or fulled; the knots are picked out of it, fresh felt here and there added, and the beaver ultimately applied; the hat is then shaped, water-proofed by a lac varnish, tied upon a block, dyed, stiffened by the application of a solution of glue, steamed, brushed, and ironed; the brim is then trimmed, and it is ready for lining and binding.

Silk hats have a foundation of woollen felt, similar to those which are covered by beaver, upon which a silk plush is afterwards applied.

Various processes have lately been suggested, and some of them carried into effect, for the purpose of improving this manufacture. Several of these are described and figured in *Ure's Dictionary*, but their extension and introduction have hitherto been successfully opposed by the journeymen hatters, "among whom," says Dr. Ure, "there exists an organized combination, by which the masters throughout the kingdom are held in a state of complete servitude." "The public of a free country," he adds, "ought to counteract this disgraceful state of things by renouncing the wear of stuff hats, a branch of the business entirely under the control of this despotic union, and betake themselves to the use of silk hats, which from recent improvements in their fabric and dyeing are not a whit inferior to the beaver hats in comfort, appearance, or durability, while they may be had of the best quality for one fourth part of their price."

HA'TTEMISTS. An ecclesiastical sect in Holland, so called from Pontian von Hattem, a minister in Zealand: nearly allied to the Verschorists. They arose in the latter part of the 17th century. They appear to have denied the *expiatory* sacrifice of Christ. It is added, that they denied the corruption of human nature, and the difference between moral good and evil. (*Mosheim*, Transl., ed. 1826, v. 386.)

HAU'BERK. (Ital. usbergo.) A piece of armour, supposed to be of German origin, common in the chain-mail, or rather ringed mail, of the twelfth century; being a jacket or tunic, with wide sleeves reaching a little below the elbow, the hood being of one piece with it. The hauberk of ringed mail ceased to be worn about the reign of Henry III., when the oriental chain-mail, properly so called, came into fashion for a short period.

In France only persons possessed of a certain estate, called *un fief de hauber*, were permitted to wear a hauberk, which was the armour of a knight; esquires might only wear a simple coat of mail, without the hood and hose.

HAUGH. A Scotch term, applied to lands which in England would be called meadow or pasture.

HAUL. The sea term for pulling upon a rope directly.—*To haul the wind*, to bring the ship to sail close by the wind after running in some other direction.

HAUPT TON. (Ger. *head note.*) In Music, that note on which the mark *tr.* is placed, when a shake is indicated; the secondary or superior note being called the *hülfston.*

HA'USTELLATES, *Haustellata.* (Lat. haustellum, *a sucker.*) A name of a grand section of insects, including all those which in the perfect state have the oral apparatus adapted for suction.

HAUTBOIS. *See* OBOE.

HAÜYNE. A blue mineral in small granular or spherical masses, generally found in basalt or lava. Named after Haüy, the celebrated French mineralogist.

HA'VEN. (Germ. hafen.) The same as *harbour*, which see.

HAWK. *See* FALCO.

HAW'KERS, PEDLARS, and PETTY CHAPMEN. In Law, persons travelling from town to town with goods and merchandize for the purpose of sale. They are required to take out licences under 50 G. 3. c. 41. Wholesale traders are exempt from the provisions of this act, as are also licensed auctioneers going from town to town.

HAWKING. *See* FALCONRY.

HAWK-MOTH. *See* SPHINX.

HAWSE. The part of the bows close to the cables. The cables pass through the *hawse holes*, which are made in the timbers and in the *hawse piece* outside. When the ship has two anchors down, and the cables diverge from each other, the hawse is said to be *clear*, when crossed by the ship turning half round, there is a *cross* in the hawse. Another cross makes an *elbow;* then a *round turn:* in the last two cases the hawse is said to be *foul.* The process of disengaging the cables is called *clearing hawse.* The danger of a foul hawse is, that if it comes on to blow the cables cannot be veered from their friction against each other.

Freshening hawse is veering out a little cable to expose a new surface to the friction in the hawse hole, or across the cutwater.

Athwart hawse implies across the bows of a vessel at anchor.

HAWSER. A large rope or small cable.

HA'YMAKING. The operation of cutting down, drying, and preparing forage grasses and other forage plants for being stacked for winter use. The plants are mown down at the time when they are supposed to contain diffused throughout the whole plant a maximum of nutritious juices, viz. when they are in full flower. Dry weather, and if possible that in which sunshine prevails, is chosen for this operation; and the mown material is spread out, and turned over two or three times in the course of the same day in which it is cut. In the evening it is put into small heaps. In the morning of the second day these heaps are spread out, and turned over two or three times; and in the evening they are formed into heaps somewhat larger than they were the day before. If the weather has been remarkably warm and dry, these heaps, in the course of the third day, are carted away and made into a stack; but if the weather has been indifferent, the process of opening out the heaps and exposing them to the sun is repeated on the third day, and stack-making is not commenced till the fourth. A great deal might be said on the subject of haymaking; but it would be altogether unsuitable in a work of this nature. Suffice it to state, that the grand object in making hay is to preserve the colour and natural juices of the herbage, which is best done by continually turning it so as never to expose the same surface for any length of time to the direct influence of the sun. In stacking the hay the object is to preserve this green colour, and at the same time induce a slight degree of fermentation, which has the effect of rendering the fibres of the plants which compose the hay more tender, and changing a part of the parenchymous matter into sugar, on the same principle as is effected by malting barley. This sweet taste renders the hay more palatable to horses. The best directions for haymaking will be found in *Middleton's Agricultural Survey of Middlesex.*

HA'Y-WARD. (Fr. haie, *hedge.*) An officer anciently appointed in the lord's court to take care of the cattle of a manor, and prevent them from injuring the hedges or fences.

HEAD. The fore extremity of a ship. It generally means the cutwater, which is adorned with a figure. *By the head*, implies that the ship's head is depressed in the water. *Head sails, head yards*, are the sails and yards in the fore part of the ship.

HE'ADACH. This is a common symptom in various diseases; it frequently occurs both in full and in debilitated habits, and also in persons who are otherwise healthy. One form of headach consists in a degree of torpor and of confusion, with a dull pain over the whole head, dimness of sight, and inability to attend to anything requiring thought or fixed attention. Sometimes it is referable to disordered stomach or bowels, but it also comes on without any such assignable cause. These headachs are relieved by nervous stimulants, such especially as camphor, ether, and ammonia. A cup of strong coffee or of green tea often acts like a charm; and if the pain prevents rest, a small dose of opium is sometimes necessary, with perfect rest and quiet. Some very troublesome cases are relieved by cold applications to the temples and head, others by snuff and nasal stimulants. There is a peculiar form of headach which consists of throbbing and pain of one particular part, or sometimes over one side of the head; it lasts an hour or two and then goes off, and returns again at stated intervals. This is called *hemicranium*, or *intermitting headach*, and for

its permanent cure often requires bark or sulphate of quinia: blisters behind the ears are also of service. In bilious or sick headach, emetics and purges are required. Obstinate headachs are not unfrequently got rid of by change of air, scene, and occupation; especially where they are the result of too intense intellectual application.

HEA'DBOROUGH. (Sax. borg, *pledge*.) The chief of the ten *pledges* in frankpledge (*see* FRANKPLEDGE); also styled borsholder, tythingman, &c.

HEA'DERS. In Architecture, bricks or stones with their heads or short faces in front.

HEADING COURSES. In Architecture, those courses which consist entirely of headers.

HEA'DLAND. In Geography, a term nearly synonymous with cape, mull, or promontory; which see.

HEADLAND, or HEAD RIDGE, in Agriculture, is a ridge or border, commonly ten or twelve feet broad, which is continued round a field in some cases, and which in others is only formed at the two opposite sides, for the purpose of affording space for the horses to turn on while ploughing.

HEALDS. The harness for guiding the warp threads in a loom.

HEA'RING TRU'MPET. An instrument for concentrating sound, and conveying it to the ear. It is generally a short bent tube, wide at the one end where the sound enters, and narrow at the other where the ear is applied. The principle on which it acts is the reflection of sound at an angle equal to that at which it strikes a smooth surface; and accordingly the form of the instrument ought to be so regulated that the whole of the vibrations are collected into a focus at the smaller end. But it is not necessary that the form which theory points out should be very accurately observed; the principal advantage is gained by confining the advancing sound by a continual reflection, and preventing it from spreading laterally and being dissipated.

HEART. (Germ. herz.) The human heart is a hollow muscular organ of a somewhat conical shape, the broad part of which is called its base, and the smaller end its apex. Its base is placed upon the right of the bodies of the vertebræ, and its apex obliquely to the sixth rib on the left. Internally it is divided into a *right and left ventricle;* the former anterior, and the latter almost posterior, in consequence of the oblique manner in which it is placed. Its inferior surface rests upon the diaphragm. Attached to the base of the heart are two *auricles*, so called from their resemblance in shape to the ear of an animal: they are muscular sacs. In the right auricle are four apertures; two of the venæ cavæ, one of the coronary vein, and one an opening into the right ventricle. In the left auricle there are five apertures; namely, one into the left ventricle, and those of the four pulmonary veins. Each ventricle has two orifices; one from the auricle by which the blood enters, and another into the artery by which it passes out. They are supplied with valves; those at the arterial openings being called, from their form, *semilunar valves;* those at the orifice of the right auricle *tricuspid*, and those at the orifice of the left auricle *mitral*. The valve at the termination of the vena cava inferior, just within the auricle, is called the *valve of Eustachius*. The cavities are lined with a strong smooth membrane. The *pulmonary artery* arises from the right ventricle, and conveys venous blood to the lungs, where having been changed into arterial blood by the action of the air, it returns by the *pulmonary veins*, which terminate in the left auricle; the venæ cavæ, which bring back the mass of venous blood from all parts of the body, terminating in the right auricle. The circle, therefore, which the blood takes is this: — It is returned from the various parts of the body by the venæ cavæ into the right auricle, whence it is forced into the right ventricle, and then through the lungs; whence it returns into the left auricle, and from it into the left ventricle; and thence, by the aorta, through the general arterial circulation. The substance of the heart is supplied by nerves and vessels of its own, which are called *coronary vessels;* the coronary arteries branch off from the aorta, and the coronary veins return their blood into the right auricle. The nerves are branches of the eighth and great intercostal pairs.

HEART WHEEL. The name given to a well-known mechanical contrivance for converting a circular motion into an alternating rectilinear one, common in cotton mills. It is an ellipse turned either on an axle, or by means of a winch and handle on one of its foci, or its centre, on whose edge a moveable point or circle presses; the latter receives an alternating motion from the circumference of the ellipse, which in its revolution presses it to different distances from the centre of motion. The practical disadvantages of this contrivance are the inequality of pressure and of moving force which will be required at different parts of the rotation of the ellipse, and the consequent wearing of some parts of it faster than others. (*Gregory's Mechanics*, vol. ii.)

HEART WOOD. In Botany, the English term for duramen. It is the central part of the trunk of a tree hardened by the deposition in its tissue of various secretions, which clog up the passages and forbid the passage of any thing through them.

HEAT. This term has been applied both to the sensation experienced on touching a hot body, and to the cause of that sensation: in the latter sense it is synonymous with the term caloric. The cause of the phenomena of heat is unknown; but they are supposed to depend upon the presence of a highly attenuated, imponderable, and subtile form of matter, the particles of which repel each other, but are attracted by other bodies. The escape of heat through space is called the *radiation* of heat, and its communication by contact *conduction*. The term *specific heat* is applied to the quantity of thermometric heat required to raise different substances to the same temperature. Thus experiments prove that the quantity of heat which will raise olive oil two degrees will only raise water one degree; hence a pound of water at 212° may be said to contain twice as much heat, or to have twice the capacity for heat that belongs to oil: or the specific heat of water being = 1, that of oil is 0·5. When heat changes the state or form of bodies a large quantity disappears, and remains in them so long as they retain one form. To heat in this state of combination, and inappreciable by the thermometer, the term *latent heat* or *caloric of fluidity* has been applied. *See* EXPANSION, EVAPORATION, &c.

HEATH, or HEATHER. In a general sense the term *heath* is applied to waste land in which the prevailing plants consist of one or more of the common species of heath — *Calluna* and *Erica*. (*Calluna vulgaris*, Sal. The *Erica communis* of Linnæus.) This plant covers many hundreds of acres in the Highlands of Scotland, in Ireland, and in similar climates on the Continent. It attains, in many places, the height of three or four feet; and is used for thatching houses, making besoms, and for a variety of other purposes. The tender tops form a substitute for mattresses in Highland cottages; and they are also eaten green and in a dried state by horses, cattle, and sheep, in countries where the grasses and clovers do not begin to grow till late in the spring.

HEAVE, in nautical phrase, to employ force to move great weights by the lever, &c.; as *to heave up* the anchor by the capstan or windlass; *to heave down* the ship, or pull her over on one side to get at a leak; also *to heave taught* (tight), or turn the capstan till the rope or chain applied to it becomes tight.

HEAVEN, the Celestial Sphere, or Firmament, or Sky, in Astronomy, denotes the spaces in which the celestial bodies are placed, or through which they apparently perform their diurnal revolutions. Aristotle and his disciples believed the heavens to be composed of incorruptible elements, incapable of destruction or of any change whatever; and this opinion long continued to exercise a baneful influence on the progress of astronomy, as it led to the consequence that the celestial bodies are altogether of a different nature from the earth, and have nothing in common with our planet. It was finally overthrown by the discoveries and reasoning of Galileo. The term *heaven* is also frequently used to denote the orb or sphere in which a celestial body appears to move; and hence the ancient astronomers assumed the existence of as many heavens as they observed different and apparently independent motions. They supposed the various heavens to be solid, because they could not otherwise sustain the bodies placed in them; and spherical, because perfect motion must be performed in a circle which is formed by the section of a sphere; and crystalline, because the different bodies are visible, though their orbs include one another. The first heaven was that of the Moon, the second of Venus, the third of Mercury, the fourth of the Sun, the fifth of Mars, the sixth of Jupiter, and the seventh of Saturn. The eighth, which is that of the fixed stars, was called particularly the firmament. Ptolemy added a ninth, which was the *Primum Mobile*. All these reveries have been exploded by the discovery of the true system of the world, and the laws of the planetary motions.

HEA'VY SPAR. Native sulphate of baryta. This is a common mineral in many mining districts. It occurs in several crystalline forms, of which the cleavage is a right rhomboidal prism; it also occurs fibrous, radiated, and stalactitic. Some beautiful specimens of the latter variety have been found in Derbyshire of a brown colour. The crystals are usually white, or nearly colourless. The specific gravity of sulphate of baryta is 4·1 to 4·6. It consists of 77 baryta, 40 sulphuric acid, its equivalent being 117. It enters into the composition of some kinds of pottery, but its chief consumption is in the adulteration of white lead.

HE'BE (Gr. Ἥβη), in Grecian Mythology, was the goddess of youth, whose office it was to hand round the nectar at the banquets of the gods. She was the daughter of Jupiter and Juno.

HE'CATE. (Gr. Ἑκάτη). In Mythology, a Grecian goddess, daughter of the Titan Perses and Asteria. She presided over popular assemblies, war, the administra-

tion of justice, and the rearing of children. There is a good deal of obscurity attached to this goddess, who is often confounded with Artemis or Diana, and Proserpine; whence she is sometimes considered the patroness of magic and the infernal regions. She was called the triple goddess, and was supposed to wander along the earth at night. Statues were set up to her in market places, and especially at cross roads.

HE'CATOMB. (Gr. ἑκατόμβη.) Properly a sacrifice of a hundred oxen; but the word is often used to signify a large sacrifice of any kind of victims.

HECATO'NPEDON. (Gr. ἑκατον, *a hundred*, and πους, *a foot*.) In Ancient Architecture, any temple of the length of one hundred feet.

HECATO'NSTYLON. (Gr. ἑκατον, and στυλος, *a column*.) In Ancient Architecture, a building having a hundred columns.

HECKLE. (Germ. heckel.) An instrument used in separating the fibres of flax and placing them in parallel tresses.

HE'CTIC FEVER. (Gr. ἕξις, *habit*.) A constitutional fever, attended by debility, a small quick pulse, paleness, loss of appetite, excessive perspiration, and emaciation. It generally affects more or less of an intermittent character; but the exacerbations and remissions are irregular, and the sweating stage is not followed by that relief which it usually announces in other febrile attacks. It is often symptomatic of some particular disease, and requires to be treated accordingly. Where this is not the case, or where it merely seems an attendant on general debility, a course of sarsaparilla and a milk diet are often very beneficial; but where this remedy induces perspiration and nauseates, a great deal of management is required in carrying it on for a sufficient length of time to prove of service.

HEDGE. A living wall formed of woody plants, sown or planted in a line, and cut or clipped in such a manner as to form a compact mass of any degree of width and height that may be required for the purpose of shelter, separation, or defence. The fences most generally used in agriculture are made of the white thorn (*Cratægus oxyacantha*, Lin.), because it has spiny branches, and forms a strong defence against cattle. Fences for the purposes of shelter and separation are chiefly used in gardening, and for the most part are formed of evergreen shrubs, such as the holly, yew, box, &c.; or sub-evergreens, such as the privet; of flowering shrubs, such as the *Cydonia japonica*; or of deciduous shrubs or trees with persistent leaves, such as the hornbeam and beech. In the management of hedges of every description an important point is to keep them thick, and impervious to wind or animals near the ground; for which purpose the section of the hedge requires to be made broader at the base than at the top, in order that the exterior leaves in every part of the hedge may enjoy in an equal degree the influence of light, air, and perpendicular rains.

HE'DGEHOG. *See* Erinaceus.

HEEL. The after extremity of the ship's keel: also the foot of a mast. — *To heel over*, to incline to one side.

HE'GIRA. In Chronology, the era used by the Mohammedans in the computation of time. The epoch or first day of this celebrated era, so extensively employed in the East, corresponds to Friday the 16th day of July in the year 622 of the Christian era. It is a problem of some importance to convert dates expressed by the Mohammedan computation into the corresponding dates of our calendar; for effecting this it is necessary to be acquainted with the form of the Mohammedan year.

This year is strictly lunar; and the civil months are adjusted to the lunar months by means of a cycle of 30 years, containing 19 common years of 354 days, and 11 intercalary years of 355 days; the cycle thus containing 10,631 days, or 29 Julian years and 39 days. Each year is divided into 12 months, containing alternately 30 and 29 days, excepting that the last month of the intercalary year contains also 30 days. The intercalary years are the 2d, 5th, 7th, 10th, 13th, 16th, 18th, 21st, 24th, 26th, and 29th of the cycle. The names of the Mohammedan months, with the number of days in each, are as follow: —

	Days.		Days.
Moharem	30	Shaban	29
Saphar	29	Ramadan	30
Rabiu I.	30	Shawall	29
Rabiu II.	29	Dhu'l Kadah	30
Jomadhi I	30	Dhu'l Hajah	29
Jomadhi II.	29	——— in intercalary years	30
Regeb	30		

Such are the chronological elements by means of which Mohammedan dates are reduced to the Christian era. The rule by which the reduction may be accomplished is as follows: —

1. Divide the number of years (of the Hegira) elapsed by 30; the quotient will be the number of cycles, and the remainder the number of years elapsed since the beginning of the current cycle. Call the quotient A, and the remainder B, and let x be the number of intercalary years in B; then the number of days that have elapsed from the commencement of the Hegira to the beginning of the year in which the date occurs is given by this formula,

$$10631\ A + 354\ B + x;$$

for 10,631 is the number of days in the cycle, and 354 the number of days in the common lunar year. To the sum obtained by this formula add the days since the beginning of the current year, and the result is the number of days from the commencement of the Hegira to the given date.

2. To the number of days from the commencement of the Hegira to the given date add the number of days between the commencement of our era and the Hegira, and the sum is the number of days from the first of our era to the given date. The number of days from the beginning of our era to the Hegira, or to the 16th of July, 622, is 227,016.

3. Having now found the number of days from the Incarnation to the given date, it only remains to convert the sum into Julian years. For this purpose divide by 1461 (the number of days in the Julian intercalary period), and call the quotient C. Divide the remainder by 365, and call the quotient D, and the remainder of this last division y. Then 4 C + D is the number of Julian years elapsed since the beginning of the Christian era, and y is the number of days that have elapsed of the current year. This gives the date in Old Style. To reduce it to the Gregorian Style, it is only necessary to add 11 days. (See art. "Chronology," in the *Encyclopedia Britannica*.)

HEIGHT. In Geometry, the same as *altitude*, which see.

HEI'GHTEN. (From *height*.) In Painting, a verb signifying to make prominent by means of touches of light or brilliant colours, as contrasted with the shadows.

HEIGHTS, MEASUREMENT OF. The determination of the relative altitudes of points on the earth's surface is of equal importance in physical geography as the determination of their latitudes and longitudes. There are three different methods by which the operation is usually effected. When it is required to determine not only the height of one point or station relatively to another, but the relative heights of a number of points above a common horizontal plane (as for tracing the line of a canal), recourse is had to the operation of levelling. The second method is to observe the angle of elevation or depression of one station as seen from another, and to compute, from the observation and from the distance of the two stations, the difference of altitude by the rules of trigonometry. The third method, and the most important, as being, generally speaking, the most applicable, is to deduce, by means of the known physical properties of the atmosphere, the differences of vertical height from the observed differences of atmospheric pressure as indicated by the barometer. To this method we shall here confine our attention.

Pascal, who first explained the true cause of the suspension of the mercurial column by referring it to the pressure of the atmosphere, and established the fact of the pressure by his celebrated experiment on the Puy de Dôme, was also the first to suggest the application of the barometer to the measurement of mountains; but as the constitution of the atmosphere and the laws of gaseous bodies were in that age entirely unknown, the numerous attempts which were made to estimate heights in this manner, soon after the introduction of the instrument, had very little success. The first step towards the introduction of a correct theory was the discovery by Mariotte that the elastic force of air (which is the same as the pressure) is exactly proportional to its density; — an important relation, which is true of all the gases and vapours, and goes by the name of Mariotte's law. Dr. Halley next discovered the remarkable relation which connects the density of the atmosphere with the altitude, and proved that the densities decrease in a geometrical progression when the altitudes increase in an arithmetical one. Dr. Halley likewise supposed that the observations might be affected by differences of temperature; and he roughly estimated the variation to amount to a fifteenth part between winter and summer.

De Luc was the first who gave precision to barometrical measurements by taking into account the influence of heat in expanding the air; and by substituting the mercurial for the spirit thermometer, he rendered the determination of temperatures, on which the method so mainly depends, a matter of much greater certainty than it had formerly been. He also investigated the dilatation of air at different temperatures, and gave a formula for the computation of barometrical measurements, which was adapted to the English system of measures by Dr. Maskelyne, and used (with some alterations in the values of the coefficients) by Sir George Shuckburgh and by General Roy in the determination of the altitudes of many of the principal mountains in Britain.

Laplace, in the *Mécanique Céleste*, has given a formula which embraces all the different circumstances on which the solution of the problem depends, and enables us to compute their influence numerically, when the constants

to be found from observation have been accurately determined. Among these are the ellipticity of the earth, the relative densities of air and mercury at a given temperature, their expansion by heat, and the variation of the elastic force of atmospheric air (composed of a mixture of dry gases and watery vapour) corresponding to a given thermometric change. In the present state of our knowledge, some doubt still remains on several of these points; but they are all known with sufficient approximation to render the barometer a most valuable instrument for geodetical purposes. It not only gives the relative altitudes, above the general level, of places however distant at which simultaneous observations are made, but even enables us to assign the height of any station on the earth at which the *mean* height of the barometer is ascertained. We now proceed to give the formula by which the height is computed from the observations.

The temperatures being expressed in degrees of the centigrade scale, let us assume

ϖ = the atmospheric pressure at temperature zero,
D = density of atmospheric air at temperature zero,
θ = the temperature in degrees,
α = ·00375, the dilatation of air for 1° of increased temperature,
$k = \dfrac{\varpi}{D}$, the ratio of the pressure to the density.

If the pressure remains constant, and we suppose that while the temperature changes from 0 to θ any volume V of air becomes V′, and its density D becomes D′, then $V' = V(1 + \alpha\theta)$; and therefore, the densities being inversely as the volumes, $D' = \dfrac{D}{1 + \alpha\theta}$.

Let us next suppose the pressure to vary while the temperature θ remains constant, and that D′ becomes ϱ when ϖ becomes p; then, by the law of Mariotte, $\varpi : p :: D' : \varrho$. Substituting for D′ its above value, and observing that $\varpi = k\,D$, this proportion gives

$$p = k\,\varrho\,(1 + \alpha\theta) \ldots\ldots (1.)$$

This formula holds good for all the gases and vapours, and for their mixtures, as well as for air.

To form the differential equation of the equilibrium of the atmospheric column at any altitude z above the surface, suppose a column of air whose base is 1 to be divided into thin horizontal slices; then the difference of the pressures on the under and on the upper surface of any slice will be equal to the weight of the slice. Let, therefore, p be the pressure, and g' the force of gravity at the height z; then ϱ being the density, and $d\,z$ the thickness of the slice, we have

$$d\,p = -\,g'\,\varrho\,d\,z \ldots . (2.)$$

Let g be the force of gravity at the foot of the column, or at the surface of the earth, and r the mean radius of the earth = 20,887,030 feet (*see* EARTH); then, neglecting the small variation of centrifugal force due to the height z, $g' = g\,r^2 \div (r + z)^2$. Substituting in equation (2.) this value of g', and eliminating ϱ by means of equation (1.), there results

$$\frac{d\,p}{p} = \frac{-\,g\,r^2\,d\,z}{k\,(1 + \alpha\theta)\,(r + z)^2}.$$

Integrating this equation on the supposition of θ being constant, and determining the constants so that $p = \varpi$ when $z = 0$, we find

$$\log.\frac{\varpi}{p} = \frac{+\,g\,r\,z}{k\,(1 + \alpha\theta)(r + z)} \ldots . (3.)$$

To apply this formula to the determination of the difference of altitudes of two stations, let

h, h' = heights of the mercury in the barometer at the lower and upper stations respectively in inches,
m, m' = the densities of the mercury at the two stations,
T, T′ = the temperatures of the mercury (in centigrade degrees),
t, t' = the temperatures of the air,
g, g' = force of gravity at the lower and upper station,
ϖ, p = the pressures; then

$$\varpi = m\,g\,h,\; p = m'\,g'\,h'.$$

Now it has been determined by experiment that the density of mercury increases by the 1-5550th part for each centigrade degree by which the temperature diminishes; therefore,

$$m' = m\left(1 + \frac{T - T'}{5550}\right);\ \text{and}\ g' = g\,\frac{r^2}{(r + z)^2};$$

whence, assuming $c = 1 + \dfrac{T - T'}{5550}$, $\dfrac{\varpi}{p} = \dfrac{h\,(r + z)^2}{c\,h'\,r^2}$,

and therefore

$$\log.\frac{\varpi}{p} = \log. h - \log. c\,h' + 2\log.\left(1 + \frac{z}{r}\right).$$

Substituting this in equation (3.), and transposing,

$$z = \frac{k}{g}\,(1 + \alpha\theta)\left[\log. h - \log. c\,h' + 2\log.\left(1 + \frac{z}{r}\right)\right]\left(1 + \frac{z}{r}\right) \ldots . (4.)$$

It now remains to convert the quantities in this formula (all of which are known excepting z) into numbers.

1. The logarithms which enter the equation being hyperbolic, in order that the tabular logarithms may be used it is necessary to divide the second member by the modulus M = ·43429.

2. The quantity k, which expresses the ratio of the pressure or elastic force of atmospheric air to its density, depends upon the force of gravity as well as on the temperature, and must therefore be determined with respect to some particular place. Let G denote the accelerating force of gravity at Greenwich, H the standard height of the barometer, m the density of mercury, and D that of air, both at the freezing temperature; then $\varpi = m$ G H, and $k = \dfrac{\varpi}{D} = \dfrac{m\,H}{D}\cdot G$. For the height, H = ·76 metres, or 2·449348 feet, the ratio of m to D, in respect of dry air, was found by Biot and Arago to be 10462. According to this determination, we have k = 26086·8 × G. For air saturated with moisture, they found k = 26152·3 × G. Hence if we adopt the mean of the two coefficients as representing the ordinary state of the atmosphere, we have

$$k = 26120 \times G,\ \text{in feet.}$$

3. The gravity, g, in equation (4.) is that which corresponds to the lower station, and to the latitude of the place of observation. Denoting the latitude of the station by l, and that of Greenwich (to which G corresponds) by L, we have from the theory of the earth

$$\frac{g}{G} = \frac{1 + n\sin. 2\,l}{1 + n\sin. 2\,L} = \frac{1 - \frac{1}{2}n\cos. 2\,l}{1 - \frac{1}{2}n\cos. 2\,L}$$

(very nearly). Here the coefficient n is $\frac{5}{2}$ times the ratio of the centrifugal force to gravity at the equator, diminished by the ellipticity, or $\frac{5}{2} \times \frac{1}{289} \times \frac{1}{302}$ = ·005145 (*see* EARTH); and $\frac{1}{2}n$ = ·00257. But L = 51° 28′ 39″, and cos. 2 L = — ·2242; whence we find

$$g = \frac{(1 - \cdot 00257)\cos. 2\,l}{1\cdot 00058}\,G,$$

and we have therefore in feet

$$\frac{k}{M\,g} = \frac{26120 \times 1\cdot 00058}{\cdot 43429\,(1 - 00257\cos. 2\,l)} = \frac{60168}{1 - \cdot 00257\cos. 2\,l}$$

4. For θ we may take $\frac{1}{2}(t + t')$, the mean temperature of the lower and higher station. In the case of perfectly dry air, α = ·00375; but as the density of air mixed with vapour increases as the temperature is diminished in a faster ratio than dry air, we may assume as the nearest probable value, α = ·004. This gives $\alpha\,\theta = \dfrac{2\,(t + t')}{1000}$.

For the sake of abridging, put

$$K = \frac{60168}{1 - \cdot 00257\cos. 2\,l}\left(1 + \frac{2\,(t + t')}{1000}\right),$$

then the equation (4.) becomes

$$z = K\left[\log. h - \log. c\,h' + 2\log.\left(1 + \frac{z}{r}\right)\right]\left(1 + \frac{z}{r}\right).$$

In computing from this formula, an approximate value of z is obtained by making

$$z = K\,(\log. h - \log. c\,h');$$

by the substitution of which in the second member of the above equation a more exact value is found, and the result is the height of the second station above the first in feet.

Instead of the numerical factor 60168 feet in the coefficient K, Poisson (*Mécanique*, tom. ii.) has 18337·46 mètres, which is equal to 60163 feet. The difference arises from our having assumed a slightly different value for the eccentricity of the earth, and having referred the gravity G to the latitude of Greenwich instead of Paris.

The temperatures have been assumed to be expressed on the centigrade scale, as the most convenient for computation. If T and t are for Fahrenheit's thermometer, it is only necessary to substitute $1 + \dfrac{T - T'}{9990}$ for $1 + \dfrac{T - T'}{5550}$, and $1 + \dfrac{t + t' - 64}{900}$ for $1 + \dfrac{2\,(t + t')}{1000}$, respectively, in the factors c and K.

When the altitude is not very considerable, the fraction $z \div r$ is very small, and may be considered as constant; in which case it may be incorporated with the factor 60168. Substituting for 60168 the number 60345 (deduced from a number of measurements by Ramond), and supposing the substitution to change K into K′, the formula for the altitude will become

$$z = K'\,(\log. h - \log. c\,h'),$$

which is the formula most frequently used.

The most recent and complete investigation of the

subject of barometric measurements is that of Bessel, in *Schumacher's Astronomische Nachrichten*, vol. xv. See also Biot, *Astronomie Physique*, tom. iii.

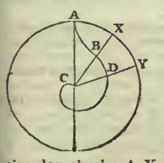
HEIR. (Lat. hæres.) In Law, one who succeeds by descent to lands, tenements, and hereditaments. Strictly speaking, a person is not properly called heir in the lifetime of his ancestor; according to the ancient maxim, *nemo est hæres viventis*. (For the rules which govern this succession in England by common law and statute, see Descent.) *Heir-apparent* is he who (by law or custom) must succeed, by descent, to the hereditaments, if he survive the present tenant; as, at common law, the eldest son. *Heir-presumptive*, he who stands nearest in succession in the default of an heir-apparent; as an eldest brother where there is no issue. *Heir-at-law*, or *heir-general*, is he who succeeds by descent to lands in fee-simple. *Heir-special*, issue in tail claiming by the form of the gift. (*See* Fee-Tail.) *Heir by custom*, he who succeeds to lands or tenements by custom; as all the sons by gavelkind. *Heir-male*, i. e. the nearest male in the succession, is not strictly a term of English law, since lands cannot descend in this way; but some dignities are thus limited. A devisee is sometimes called *heir by devise*, or *hæres factus*. Bastards, aliens, persons attaint of treason and felony, cannot be heirs; but idiots and lunatics may. Things that pass with the land, as conditions and covenants real, goods and chattels annexed to the freehold (*see* Fixtures), and terms of years to attend the inheritance, are in ordinary legal language said to go to the heir: as also *heir-looms*, being such goods and chattels as go by special custom along with the inheritance. In Scottish law, the word *heir* is taken in a larger acceptation, as to personal as well as real property. Heirs-at-law are termed in it *heirs whatsomever*. It recognizes several species of heirs: as the heir-active, who has the right of action; heir of line, or lineal heir; heir by conquest, who succeeds to estates to which the deceased donor did not himself succeed by descent; heirs portioners, in English law coparceners; heir of tailzie (or in tail), and so forth. By the civil law, heirs are of two kinds — legitimate, or by act of law; and instituted, or by the will of the possessor: the former only answering to those who are properly designated as heirs in our own law, the latter to our *purchasers*. Legitimate are either *heirs of blood* — heirs under the title "unde vir et uxor" (by which, in default of heirs of blood, a husband or wife succeeded to the goods of the deceased spouse; a provision not generally preserved in modern Continental law); and heirs *irregular*, — such as the lord to whom an escheat falls, &c. Heirs instituted are of many kinds.

HEIR-LOOMS. In Law, such goods and personal chattels as go to the heir along with the realty. The quality of heir-looms is fixed by custom; deeds, charters, deer in a park, &c., are usually such. "Loom" is from an old Saxon word "limb," or member.

HELI'ACAL. (Gr. ἥλιος, *the sun*.) Something relating to the sun. In the ancient astronomy, a star is said to rise *heliacally* when, after being in conjunction with the sun, and consequently invisible, it rises so soon before the sun as to be visible in the eastern horizon in the morning twilight; and it is said to set *heliacally* when the sun approaches so near to it that it is lost in his light, or ceases to be visible in the western horizon when he has disappeared. At the opposite season of the year the same star rises as the sun sets, and sets as the sun rises; it is then said to rise and set *acronically*. When a star or planet rises and sets at the same instant with the sun, it is said to rise and set *cosmically*. These technical terms occur frequently in the works of Hesiod, and in Ovid's *Fasti*. The ancients fixed the commencement of the seasons by the positions of the stars relatively to the sun at his rising and setting.

HELIÆ'A. (Gr. Ἡλιαία.) In Ancient History, the chief of the ten courts among which the 6000 Athenian jurymen were distributed, and which on important occasions sometimes contained them all. It probably derived its name from being open to the sun (ἥλιος). Before this tribunal causes of consequence to the state and individuals which did not involve bloodshed were brought. (See *Mem. de l'Acad. des Inscrip.* vol. xviii.; *Boeckh's Public Economy of Athens*.)

HE'LICOID, or PARABOLIC SPIRAL (Gr. ἕλιξ, *a spiral*), in Geometry, is a curve line which is generated as follows: — Suppose the axis of the common or Apollonian parabola to be bent into the circumference of a circle, the ordinates X B, Y D, still retaining their places and perpendicular positions with respect to the axis; then the spiral curve, A B D, which passes through the extremities of the ordinates, is the helicoid. It is obvious from this definition that all the ordinates, being perpendicular to the circumference of the circle, meet in its centre C; and if x represent any circular absciss A X, and y the corresponding ordinate

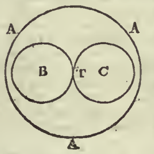


X B, the equation of the curve will be the same as that of the parabola; namely, $y^2 = a\,x$, a being the parameter.

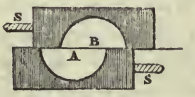
HE'LIOCAMI'NUS. (Gr. ἥλιος, *the sun*, and καμινος, *a furnace*.) In Ancient Architecture, an arched apartment heated by the rays of the sun.

HE'LIOCE'NTRIC. (Gr. ἥλιος, and κεντρον, *centre*.) The *heliocentric longitude* of a planet is the angle at the sun's centre, formed by the projection of its radius vector on the ecliptic and the straight line drawn from the centre of the sun to the first point of Aries; and the *heliocentric latitude* of a planet is the inclination of the straight line which joins its centre with that of the sun to the plane of the ecliptic. The greatest heliocentric latitude is consequently equal to the inclination of the planet's orbit.

HELIO'METER. (Gr. ἥλιος, and μετρον, *measure*.) A kind of micrometer for measuring the diameters of the sun, moon, and planets, or any small apparent distance between celestial objects. The instrument best known by this name appears to have been proposed or suggested by a Mr. Savery (*Phil. Trans.* vol. xlviii.), about the year 1743; but it was first applied by Bouguer in 1747, and has since been improved by Dollond and Fraunhofer. The principle on which the instrument is constructed is as follows: — Two object-glasses of the same focal distance, or rather the two halves of a divided object-glass, are placed side by side in the same tube with an apparatus so contrived that the distance between the centres can be increased or diminished at pleasure. In this manner two images of the sun are formed at the focus of the common eye-glass. Thus the circle A A A representing the field of view of the telescope, or the visible circle at the common focus of the two object-glasses and the eye-glass, and the two small circles representing the two images of the sun formed by the two object-glasses, when the observer proposes to measure the diameter of the sun, the two object-glasses are brought by means of a tangent screw to such a distance from each other that the two images touch in a point T, and the distance between the centres of the two object-glasses, estimated in seconds, gives the distance between B and C, the centres of the images; that is, the diameter of the sun.

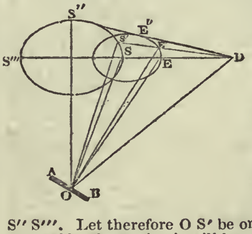


Formerly the heliometer was formed by two complete lenses; but as it was found very difficult to give them precisely the same focal length, and as the size of the tube was required to be inconveniently large, they are now made of the same lens by dividing it across its centre. The centres of the two semi-lenses are separated by means of the screws S S, which act on the plates in which they are mounted; and the distance of the centres A and B is measured by a scale and vernier. This apparatus is otherwise called the *divided object-glass* micrometer. The principle has also been applied to the microscope. *See* Micrometer.



HE'LIOSCOPE. (Gr. ἥλιος, and σκοπεω, *I view*.) The name given by Scheiner to an instrument of his own invention for observing the sun without hurting the eye. The ordinary method is to place a disc of coloured glass before the eye-piece of the telescope.

HE'LIOSTAT. (Gr. ἥλιος, *the sun*, and στάω, *I stand*.) An instrument invented by Gravesande for the purpose of obviating in optical experiments the inconvenience arising from the continual change of direction of the solar rays, by reflecting them in the same straight line. The principle on which the heliostat is constructed may be explained as follows: — Let S S′ S″ S‴ be the diurnal circle described by the sun, O a point on the surface of the earth which may be regarded as the centre of the circle S S′ S″ S‴, A B the mirror, and O D the direction in which it is required that the ray shall be reflected. The solar rays will successively coincide with the straight lines which form the sides of the conical surface O S S′ S″ S‴. Let therefore O S′ be one of these rays, and let us consider the motion it will be necessary to give to the mirror in order that all the rays O S, O S′, &c. may be reflected by the mirror in the direction OD. Produce OD till it meet the plane of the earth's diurnal circle in D, and let D S S‴ pass through the centre of the circle. Join D S′, and draw O E′ at right angles to A B, meeting D S′



in E′. The angles of incidence and reflexion being equal, the angle S′ O E′ is equal to E′ O D: therefore S′ E′ is to E′ D in the ratio of S′ O to O D. But S′ O and O D are constant, therefore the ratio of S′ E′ to E′ D is constant. But D is a given point; therefore by a simple theorem in elementary geometry (*Leslie's Geom. Analysis*, b. iii. prop. 2.) the locus of E′ is a given circle. It follows, therefore, that the axis of the mirror must describe in 24 hours the surface of a cone, the base of which, parallel to the plane of the equator, is a circle determined in magnitude and position by the given direction O D, and the parallel which the sun is describing on a given day of the year.

It is easy to conceive a mechanism by which this object may be accomplished. Suppose a clock to be placed with its dial parallel to the equator, or the axis of the index hands parallel to the axis of the earth; and suppose a rod connected with the extremity of the hour hand to meet the axis produced and make with it the proper angle; then a mirror fixed perpendicularly to the rod will have the motion required.

For a description of the original instrument see *Gravesandes' Phys. Elementa;* but it has been greatly improved by Charles, Malus, &c. See *Journal de l'Ecole Polytechnique*, cahier 16.; *Biot, Physique Experimentale*, tom. ii.

HE′LIOTROPE. A deep-green siliceous mineral, somewhat translucent, and often variegated with blood-red spots: from Gr. ἡλιος, *the sun*, and τϱεπω, *I turn*. Its vulgar name is *bloodstone*. There is also a common sweet-scented *plant* of this name.

HE′LIX. (Gr. ἑλιξ, *a whorl.*) The name of a Linnæan genus of the *Vermes Testacea*, characterized by the entire and crescent-shaped opening of the shell, and forming in the system of Cuvier the type of a family of terrestrial and air-breathing Gastropods, including the genera *Vitrina*, Draparnaud; *Bulinus*, Adanson; *Pupa*, Lam.; *Chondrus*, Cuv.; *Succinea*, Drap.; and *Helix* proper, of which our common garden snail, *Helix hortensis*, is an example.

The great vine snail (*Helix pomatia*, Linn.) formed one of the luxuries of the tables of the ancient Romans, and by peculiar feeding and other treatment was brought to attain an immense size. It is still an article of food in certain cantons in Switzerland and France. The snails do much damage to the vegetables in cultivated grounds, biting off pieces of the leaves by means of a semicircular dentated horny plate, which is affixed to the upper lip.

Helix, in Anatomy, is applied to the reflected margin of the external ear.

Helix, Helices. In Architecture, the curling stalks or volutes under the flowers in each face of the abacus of the Corinthian capital.

HE′LLEBORE. (Gr.) In Pharmacy, this term is applied to the roots of the black and white hellebore. The root of black hellebore (*Helleborus niger*), called also *Melampodium*, has a bitterish acrid taste, and is a drastic purge and emetic: the root of the white hellebore is similar, but more active in its operation. (*See* Veratria.) It was formerly used in the cure of gout, and in some maniacal cases where no effect is produced except by very powerful means; but these remedies have now fallen into disuse. The leaves of the *Helleborus fœtidus*, or stinking hellebore, have also been used to evacuate worms from the intestines; but they are dangerously active.

HELLE′NIC. The name given to the common dialect which prevailed very generally among the Greek writers after the time of Alexander. It was formed, with very slight variations, from the pure Attic of the age preceding its introduction.

HELLENI′STIC. The name given to that dialect of the Grecian language that was used by the Jewish writers. Its peculiarities consisted in the introduction of foreign words very little disguised, but more especially of oriental metaphors and idioms; but not at all in the inflexions of words, which were the same as in the Hellenic.

HE′LLENISTS (Gr. ἑλληνισται, from Ἑλλην, *a Greek*), the name by which the Jews who from their foreign birth or travel used the Greek (Hellenic) language are distinguished in the Acts of Apostles. The word is derived, according to a common method of formation in the Greek language, from the verb ἑλληνιζειν, *to Hellenize*, or adopt the manners of a Greek. There were great numbers of Jews scattered throughout the Roman empire at this period, more especially in the Asiatic and East African provinces, where the Greek was the current language; and as they were in the habit of making frequent journeys to and from Jerusalem, they heard the preaching of the Apostles, and became efficacious instruments in conveying the knowledge of the word throughout all lands. From their long sojourn in foreign countries they were distinguished from the Hebraists, or native Jews, by the greater liberality of their views with respect to the nature of the promises of the Old Testament. It appears from Acts, vi. 1., that these Jews retained the distinctive name of Hellenists after their conversion to Christianity, and that there continued to subsist some jealousy between them and the native Christians.

HELM, implies the mechanism of the steerage, especially the tiller: as, to put the helm *a-starboard*, is to put the tiller over to the right side; *a-port*, to the left side; *up*, to the weather side; *down*, to the lee side.

HELM, or HE′LMET. Defensive armour for the head: a word of Scandinavian derivation. The armour of the ancients, which particularly guarded the head, was known by the general denominations of head-piece, casque, and helmet. Helmets were anciently formed of various materials, but chiefly of skins of beasts, brass, and iron. An open helmet covers only the head, ears, and neck, leaving the face unguarded. Some open helmets have a bar or bars from the forehead to the chin, to guard against the transverse cut of a broad-sword; but it affords little defence against the point of a lance or sword. A close helmet entirely covers the head, face, and neck; having on the front perforations for the admission of air, and slits through which the wearer may see the objects around him; this part, which is styled the visor (from the French word *viser*, to take aim), lifts up by means of a pivot over each ear. Some helmets have a bever (from *buveur*, drinker, or from the Italian *bevere*, to drink), which, when closed, covers the mouth and chin, and either lifts up by revolving on the same pivots as the visor, or lets down by means of two or more pivots on each side near the jaws. The use of the bever was to enable the wearer to eat and drink more commodiously than could be done in a helmet with a visor only. The helmets of the Greeks and Romans were mostly open, not unlike scull-caps, as formerly worn by our dragoons. Montfaucon says he never saw an ancient helmet with a visor to raise or let down, although he is of opinion that they had those contrivances. It seems as if the Romans, at least those of which Pompey's army was composed at Pharsalia, had open helmets, as Cæsar directed his soldiers to strike them in the face, which order, had their faces been covered, he would not have given. The two Grecian helmets in the British Museum have a kind of contrivance to cover the nose. Over the top of the helmet rose an elevated ridge called the crest, representing lions or dragons, &c., to make the warrior appear taller and more terrible. (*Mirror*, 1839.)

HELMET, or HELMET-SHELLS. *See* Cassis.

HELMINTHO′LOGY. (Gr. ἑλμινς, *a worm*, and λογος *a discourse*.) The natural history of worms. *See* Intestinalia.

HE′LMSMAN. The man who steers. A good helmsman opposes in time the tendency of the ship to deviate from her course by a small motion, which he relaxes as soon as the effect is felt, and thus disturbs her sailing as little as possible. A bad helmsman gives her too much helm, and keeps her perpetually yawing from one side to the other. The steerage, therefore, is of the utmost consequence in chase.

HELO′PIDÆ. (Gr. Ἑλοψ, the name of an obnoxious reptile.) A family of Heteromerous Coleopterans, belonging to the section *Stenelytra*, and including numerous subgenera and species. The typical genus *Helops* is remarkable for having the anterior tarsi of the males dilated. Of this genus there are four British species known, of which the *Helops caraboides* may be found at the roots and under the bark of trees: it presents a lengthened ovate form, a brown colour, a punctured surface, and dusky red antennæ and tarsi.

HE′LOTS. (Gr. εἱλῶται.) In Ancient History, the slaves of the Spartans, who consisted originally of the Achæan inhabitants of Laconia, who were subdued by force of arms by the Dorian invaders. The name was derived from Helos, a town of Laconia, of which the inhabitants were thus reduced to servitude; but to this class were afterwards added the Messenians, who still clung to their native soil after its subjugation by the Spartans. They were employed either as domestic slaves, cultivators of the land, or in the public works; and though they do not appear to have been treated ordinarily with much severity, yet the recollection of their former state urged them frequently to revolt, while their numbers rendered them so formidable to their masters as to drive the latter to schemes of the most abominable treachery for their repression. (See particularly *Müller's Hist. of the Dorians;* Wachsmuth, *Hist. Ant. of the Greeks* (transl.) i. 323.)

HE′LVER. A miner's term; the handle of a tool.

HE′MACRYMES, *Hemacryma*. (Gr. αἷμα, *blood*, and κϱυμος, *cold*.) A name by which Latreille designates the animals with cold blood.

HE′MATHERMS, *Hematherma*. (Gr. αἷμα, θεϱμη, *heat*.) The name given by Latreille to the animals with warm blood.

HE′MATIN. (Gr. αιμα.) The red colouring principle of logwood.

HE′MATITE. One of the varieties of native oxide of iron. It occurs in nodules, and in radiated masses of a crystalline fracture. Its name is derived from the red colour which it presents superficially or when rubbed to powder.

HEMATOSIN. *See* HÆMATOSINE.

HEME'LYTRA. (Gr. ἡμισυς, *half;* ἐλυτρον, *a sheath.*) The name given to the superior wings or wing-covers of Tetrapterous insects, when they are coriaceous at the base and membranous at the extremity; as in the order *Hemiptera.*

HE'MERALOPIA. (Gr. ἡμερα, *day,* and ωψ, *the eye.*) A disease of the eye which renders vision very imperfect except in broad daylight; it has been relieved by tonics and gentle stimulants, with the occasional application of blisters behind the ears.

HE'MEROBAPTISTS. (Gr. ἡμερα, *day;* βαπτιζω, *I baptize.*) An ancient sect among the Jews, so called from washing themselves as a religious solemnity every day. It is thought by some that the Christians of Saint John, or Sabians, descend from them. (*Mosheim,* Transl., ed. 1826, iv. 226.)

HEMERO'BIANS, *Hemerobiidæ.* (Gr. ἡμερα, and βιος, *life.*) A family of Neuropterous insects, of the section called *Planipennes* by Latreille; characterized by having a slender body, which is greatly exceeded in length by the finely reticulated wings. The ova are deposited in clusters, attached each by a long glutinous pedicle to the leaves of various plants; and by some mycologists have been described as fungi. The larvæ of these insects are remarkable for their ravenous habits; and as they feed chiefly on the plant-lice (*Aphides*), are highly beneficial. They subsist on their juices, suck them to death, and with a singular instinct they clothe themselves with the skins of their victims. Of the typical genus *Hemerobius* there are fourteen known British species, of which the *Hem. perla,* Linn., is the most beautiful. It is sometimes called the "golden-eye;" is of a green colour; the wings transparent, and veined with green.

HEMICRA'NIA. (Gr. ἡμισυς, *half,* and κρανιον, *the head.*) A pain of one side of the head: it is often intermittent.

HEMI'GAMOUS. (Gr. ἡμισυς, and γαμος, *marriage.*) In Botany, a term employed in speaking of grasses, when of two florets in the same spikelet one is neuter and the other unisexual, whether male or female, as in *Ischæmum.*

HE'MIOLO'GAMOUS. (Gr. ἡμισυς, ὁλος, *entire,* and γαμος, *marriage.*) A term employed in speaking of grasses, when in the same spikelet one of two florets is neuter and the other hermaphrodite, as in several species of *Panicum.*

HEMIO'PIA, or HEMIO'PSIA. (Gr. ἡμισυς, and ωψ, *the eye.*) A disordered vision, in which objects appear divided.

HEMI'PTERA. (Gr. ἡμισυς, and πτερον, *a wing.*) An order of Haustellate insects, having the wing-covers of a consistence intermediate between the elytra of beetles and the ordinary membranous wings. By Latreille the term is restricted to those insects the wing-covers of which are coriaceous at the base and membranous at the top; the term *Homoptera* being applied to those Fabrician *Hemiptera* of which the elytra are deflected and of uniform consistence throughout.

When the *Hemiptera* quit the egg they present the form of small hexapod larvæ, differing but little from the perfect insect save in the absence of wings: before these are acquired the skin is shed several times, during which the larva acquires an increase of general bulk. The pupa is active, and is distinguished by having the wings and elytra concealed in small dorsal cases: the next moulting exhibits the perfect insect with the hemelytra and wings fully developed. The bed-bug (*Cimex lectularius*), and water-boatman (*Notonecta*), are examples of the present order of insects.

HE'MISPHERE. (Gr. ἡμισυς, and σφαιρα, *a sphere.*) In Geometry, the half of a sphere, bisected by a plane passing through its centre. In Astronomy, it is used to designate the half of the terrestrial sphere divided by the equator. Hemisphere also denotes a map or projection of half the terrestrial or celestial sphere on a plane.

HE'MISTICH. (Gr. ἡμιστιχιον; from ἡμι, *half,* and στιχος, *verse.*) In Poetry, half a verse. The unfinished verses in Virgil's *Æneid,* concerning which it is not known whether they were purposely left in that state, or are owing to the incompleteness of the poem, are usually called hemistichs. The alexandrine, or French hemi-verse, requires a regular pause at the end of the first hemistich.

HE'MLOCK. A common umbelliferous plant of a peculiar odour, and possessed of narcotic powers. For medical use the leaves should be collected just before the plant flowers; if intended for powder, they should be carefully dried at a temperature not exceeding 212°; if for extract, the juice should be squeezed out by moderate pressure, and evaporated in a water or steam bath to a proper consistency. The *extract of hemlock* is perhaps the best preparation; but as its activity is liable to vary, it should be given with caution. An average dose is five grains; an over dose produces giddiness, wandering of the mind, dilated pupil, convulsive motions of the muscles of the face, and the other symptoms of this class of poisons. Hemlock is a powerful sedative, and often serviceable as a substitute for or accompaniment to opium. In allaying morbid irritability of the system attended by any local or general excess of vascular action, as in certain stages of phthysis, in the coughs that are apt to hang about patients who have suffered from pulmonic inflammation, in glandular tumours and unhealthy sores, hemlock is often preferable to opium. It has also been found very useful in chronic rheumatism, and occasionally in the treatment of whooping cough. A poultice composed of a mixture of finely powdered fresh hemlock with bread and water, or of the extract of hemlock, is applied to allay the pain of irritable ulcers and cancerous sores: it is sometimes singularly effectual, at others it seems inert, and sometimes appears to increase irritation. The virtues of hemlock reside in a peculiar alkaline principle, which has been termed *conia,* combined in the herb with a distinct acid, the *coneic acid.*

HEMP. (Germ. hanf.) The fibres of the bark of the *Cannabis sativa.* It is prepared for spinning in the same way as flax, and is made into strands or yarn for ropes, sailcloth, &c. This plant is supposed to be a native of India, but it has long been naturalized and extensively cultivated in Italy, and many other countries of Europe, particularly Russia and Poland, where it forms an article of primary commercial importance. It is also cultivated to a considerable extent in many parts of America; but in the United Kingdom it is but little grown, except in a few districts of Suffolk and Lancashire.

HE'NBANE. This is a common plant, flowering in July; the *Hyoscyamus niger.* The expressed juice of the leaves evaporated to the consistency of extract has long been used as a sedative or narcotic. It has a peculiar strong and disagreeable odour, and a nauseous bitterish taste. From two to five grains of the extract of henbane are often found equivalent to about one grain of *opium,* and where the latter disagrees it often produces quiet: in many cases henbane and various forms of opium may be combined. Henbane is apt to produce giddiness; but it does not constipate the bowels, and has rather a diuretic tendency.

HE'NDECASYLLA'BIC. (Gr. ἑνδεκα.) A verse of eleven syllables. The Latin hendecasyllabic, of which the principal specimens left to us are from the pen of Catullus, consist of a spondee, dactyl, and three trochees —

Vivamus, mea Lesbia, atque amemus.

The Italian heroic verse, and those of England and Germany, when increased by the addition of a final short syllable, are iambic hendecasyllabics.

The licence of adding an eleventh syllable (and sometimes also a twelfth) is more frequently admissible in English dramatic than epic versification.

HENRI'CIANS. The followers of an Italian monk of the name of Henry, who in the twelfth century preached with fanatic zeal, principally against the corruptions and impostures of the Romish church. He traversed the south of France from Lausanne to Toulouse, and met with great success at all the towns at which he halted. He rejected the baptism of infants, declaimed vehemently against the vices of the clergy, and exposed the vanity and absurdity of many of the ceremonies of the church. At length his followers were turned against him by the eloquence of St. Bernard, and he died in prison, into which he had been thrown by Eugenius III., in the year 1148. (*Waddington's History of the Church,* c. 10.)

HE'PAR. (Gr. ἡπαρ.) This term, signifying *liver,* was applied by the old chemists to various compounds of sulphur with the metals, having a brown-red or liver colour.

HEPATA'LGIA. (Gr. ἡπαρ, *the liver,* and αλγος, *pain.*) A painful affection of the liver.

HEPA'TICÆ. (Hepar, *liver,* in allusion to the form of some of the species.) A natural order of flowerless plants, growing in damp shady places in all temperate climates; in some respects allied to mosses, and in others to lichens. They are of no known importance; but are interesting to systematic botanists, because they offer strong traces of sexual apparatus in plants of a very low kind of organization.

HEPATI'TIS. (Gr. ἡπαρ.) Inflammation of the liver. The acute or active form of this disease is ushered in with pain in the region of the liver, sickness, costiveness, and a strong, hard, and frequent pulse; there is also generally great pain about the clavicle and shoulder. Bleeding, and purging with salts, senna, and calomel, and a blister, are usually effectual in Europe in subduing an attack of this disease: in warm climates, calomel and mercurials must often be continued till they affect the mouth. In *chronic* hepatitis the same general plan of treatment must be followed up, especially as regards the use of mercurials: with these, and gentle aperients and mild bitters, the yellowness of the complexion, lowness of spirits, and other concomitants of what in warm climates is called *the liver,* are usually subdued, at least in Europe. The chronic hepatitis of India always requires for its permanent cure a change of climate.

HE'PTAGON. (Gr. ἑπτα, *seven*, and γωνια, *angle*.) In Geometry, a plane figure of seven sides. The area of a regular heptagon is equal to the square of one of its sides multiplied into the constant number 3·6339124, or seven fourths of the tangent of the angle at the base to radius 1.

HEPTA'GONAL NU'MBERS, are a kind of polygonal numbers, of which the difference of the terms of the corresponding arithmetical progression is 5. Thus,

Arithmeticals . . . . 1, 6, 11, 16, 21, &c.;
Heptagonals . . . . 1, 7, 18, 34, 55, &c.;

the latter being formed by the continual addition of the terms of the first. Among other properties of heptagonal numbers there is one very remarkable; namely, that if any heptagonal number is multiplied by 40, and 9 added to the product, the sum is a square number.

HEPTANDROUS. (Gr. ἑπτα, and ανηρ, *a man*.) Any flower having seven stamens.

HE'PTARCHY. (Gr. ἑπτα, and ἀρχω, *I govern*.) In English History, the division of England into seven Saxon kingdoms, which are represented in most of our histories to have existed at the same time with and independently of each other. The seven kingdoms in question, according to the common divisions, were Kent, Sussex, Wessex, Essex, East Anglia, Mercia, Northumberland. But in point of fact there was no period of history when these seven kingdoms existed together; and, in the constant fluctuations of conquest, fresh subdivisions and unions of territory were continually made by the fortune of war. The sovereign who succeeded in obtaining a temporary supremacy over his neighbour kings generally assumed the title of Bretwalda, or ruler of the Britons, of whom Ella, king of Wessex, was the first; but it was afterwards borne by kings both of Kent, East Anglia, and Northumbria. In 617, Edwin, king of the atter district, appears to have acquired a temporary sovereignty over the whole of England, which was also gained by his nephew Oswald in 634; but after the brother of the latter king, Oswio, no Saxon monarch assumed the title of Bretwalda. After the death of the latter Mercia rose in the scale; and its king, Offa, ruled nearly the whole of the Saxon territories in the last half of the eighth century. After his death Egbert, king of the West Saxons, raised his power on the ruins of that of Mercia; and having subdued and rendered tributary the other kingdoms then subsisting, he became, about 830, master of the whole Saxon realm, and is reckoned as the eighth Bretwalda or ruler of Britain. With his reign the heptarchy is usually considered to have ended. (See *Palgrave's History of England*; *Turner's Anglo-Saxons*.)

HERA'CLEONITES. An early sect of heretics belonging to the Gnostics, so called from Heracleon, whose tenets they embraced. They rejected all the ancient prophecies, regarded themselves as superior to the Apostles, and, under the pretext of a sublime or elevated exposition of the Scriptures, propounded the wildest and most extravagant paradoxes.

HERACLI'DÆ. A general designation for the descendants of Hercules, who, after the death of that hero, were expelled from the Peloponnesus by Eurystheus, king of Mycenæ. The return of the Heraclidæ, which took place about 140 years after their expulsion, or 80 years after the siege of Troy, forms a celebrated epoch in ancient chronology, as it has been generally considered to mark the transition from the heroic or fabulous ages to the period of authentic history.

HERÆ'A. The name of a celebrated festival instituted at Argos in honour of Juno, whom the Greeks called Hera. Another festival of this name, in honour of the same goddess, was held at Elis every five years.

HE'RALD. (Gr. κηρυξ.) An officer of arms, possessed of important functions. The ancient heralds (κήρυκες among the Greeks, feciales among the Romans) were privileged persons, sacred by superstition as well as by the law of nations. Modern heralds, besides their employment on messages between states and in matters of public negotiation (in which capacity their services are grown into disuse, or become merely subordinate), acquired a new character from the prevalence of hereditary devices on coats of arms early in the middle ages. The multiplicity of these inventions rendered it necessary that there should be certain persons about a court skilled in interpreting or in "blazoning" them; according to the rules of the imaginary science to which these fanciful creations were subjected. (*See* HERALDRY.) It became also necessary that they should have a perfect knowledge of the hereditary arms, ensigns armorial, badges of honour, &c. belonging to each family, in order that they might constitute an authority to which appeal might be had in the disputes which frequently arose respecting the rights of individuals to these honourable distinctions. Hence the heralds became, in modern European countries, the depositaries of much of the genealogical science which is conversant in the pedigrees of noble or gentle families. They have also important parts to fulfil on occasions of public solemnity, pageants, installations, nuptials, funerals, &c. Edward III. was the first English sovereign who created two heraldic kings-at-arms (Surroy and Norroy), whose office was exercised south and north of Trent respectively. Richard II. gave the earl-marshal power to preside in a court of chivalry, assisted by the heralds. But the first heraldic collegiate chapter was held at the siege of Rouen, in 1420. The kings-at-arms were fixed at three, their present number, by Henry VIII. Edward VI. fixed the establishment of heralds on the site of the building which they at present occupy in the city of London. The present Heralds' College (by which name the kings-at-arms, heralds, and pursuivants are incorporated) consists of— 1. Three kings-at-arms — Garter, Clarencieux, and Norroy; of whom the first holds the highest rank. His duties are chiefly to grant supporters, arrange funerals, and present the order of the Garter to foreign princes. 2. The heralds are six in number; styled Windsor, Chester, Lancaster, Somerset, York, and Richmond: they, with the kings-at-arms, form the collegiate chapter. 3. The four pursuivants (Portcullis, Rouge Dragon, Blue Mantle, and Porte Croix) are junior officers, or probationers, who afterwards succeed to the higher offices. The duties of the officers of the Heralds' College are various, and their powers have been considerable, although curtailed by modern indifference to the purity of their ancient science. They keep the records of the arms, crests, and cognizances of every gentleman, *i.e.* person entitled to bear them; and they have considerable authority for the purpose of preventing parties from bearing arms to which they have no right. Their title to confer arms, or rather to assign coats of arms to persons applying for permission to bear them, is still generally recognized. Heraldic visitations of counties, with a view to collect information on the subject of genealogies and coat-armour, was held as early as the reign of Henry IV. In 1528, a regular commission was granted for the whole kingdom; and visitations were held at intervals of twenty or thirty years from that time to the beginning of the last century. (See *Noble's History of the College of Arms*, 1805.)

HE'RALDRY. The science of conventional distinctions impressed on shields, banners, and other military accoutrements. Heraldry has been divided into personal and national. The first of these treats of bearings belonging to individuals, either in their own or in hereditary right. Devices adopted by champions in the field, and borne on their shields or on their banners, are of very high anquity. The sculptures on the shields of Achilles and Hercules, in *Homer* and *Hesiod*, are rather ornamental than heraldic. But in the Seven Chiefs against Thebes of Æschylus, we find the cognizances of these renowned leaders distinctly blazoned, as worn by them on their shields, in the same fashion with those of the knights in the middle ages. The Romans do not seem to have had any customary devices for individuals resembling our armorial insignia; except their distinctive crowns for particular services. The jus imaginum, or right of possessing small

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EXPLANATION OF THE PLATE.

I. *Lines.*

1. Horizontal or straight. 2. Angled. 3. Bevilled. 4. Escartelé 5. Nowy, or Franché. 6. Arched, or enarched. 7. Double arched. 8. Wavy, or undée. 9. Invected. 10. Engrailed. 11. Battled-embattled, or crenellée. 12. Battled-embattled. 13. Nebuly. 14 Potent. 15. Indented. 16. Dancettée. 17. Dove-tailed. 18. Urdée. 19. Rayonnée, or radiant.

II. *Points of the Escutcheon, Colours, and Furs.*

20. Escutcheon, points of. 21. Or. 22. Argent. 23. Gules. 24. Azure. 25. Sable. 26. Vert. 27. Purpure. 28. Tenne. 29. Sanguine. 30. Ermine. 31. Ermines. 32. Erminois. 33. Pean. 34. Vair. 35. Varry cuppy.

III. *Differences, or Filiations.*

36. (First son) Label of three points. 37. (Second) Crescent. 38. (Third) Mullet. 39. (Fourth) Martlet. 40. (Fifth) Annulet. 41. (Sixth) Fleur-de-lys.

IV. *Ordinaries, &c.*

42. Chief. 43. Pale (between two annulets). 44. Pallet. 45. Party per pale. 46. Border. 47. Bars. 48. Fess. 49. Bend. 50. Bend sinister. 51. Border. 52. Chevron. 53. Cross. 54. Cross of St. John of Jerusalem, or Malta. 55. Cross patonce. 56. Cross moline. 57. Cross of St. Andrew. 58. Crosses humettée. 59. Cross moline in saltier. 60. Cross bottonée, or trefoil. 61. Cross crosslet, fitchée. 62. Cross flory. 63. Cross mascle. 64. Cross fitchée. 65. Lozenge, fleury.

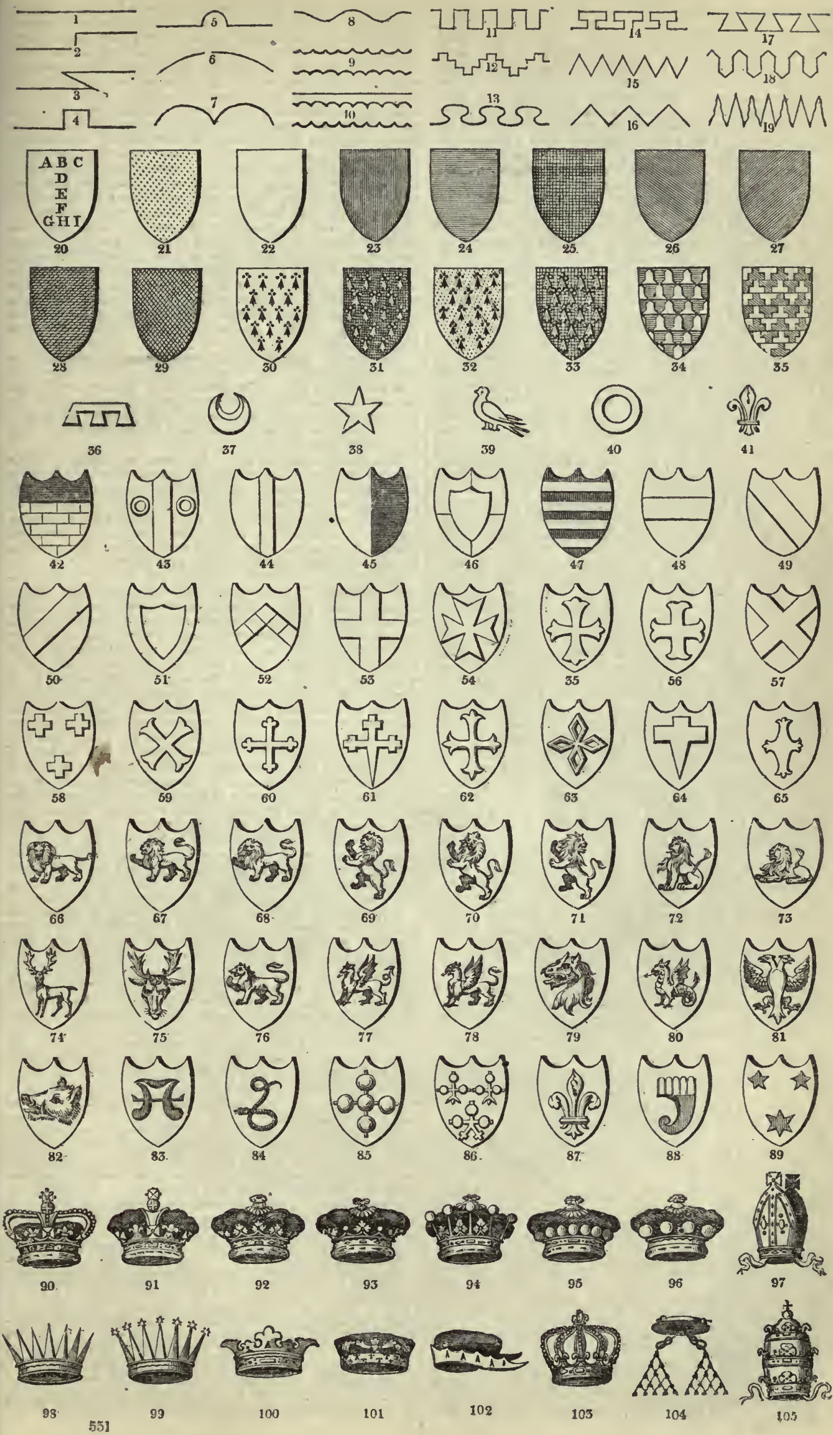
V. *Miscellaneons Bearings.*

66. Lion, statant guardant. 67. Passant. 68. Passant guardant. 69. Rampant. 70. Rampant guardant. 71. Rampant reguardant. 72. Sejant. 73. Couchant. 74. Stag at gaze. 75. Stag's head caboshed. 76. Tiger, heraldic. 77. Dragon. 78. Griffin. 79. Dragon's head erased. 80. Wivern. 81. Eagle displayed, with two heads. 82. Boar's head erased. 83. Water-budgets. 84. Snake, bowed-debruised. 85. Quatrefoil. 86. Trefoils. 87. Fleur-de-lys. 88. Clarion, or rest. 89. Mullets.

VI. *Crowns, Coronets, &c.*

90. Crown of England. 91. Coronet of the Prince of Wales. 92. Coronet of a duke. 93. Marquis. 94. Earl. 95. Viscount. 96. Baron. 97. Mitre of a bishop. 98. Eastern, or antique coronet. 99. Celestial crown. 100. Crown of Edward I. 101. Mortier, or cap of state. 102. Chapeau, or cap of maintenance. 103. Crown of France. 104. Cardinal's hat. 105. Crown triple, or tiara of the pope.

The principal of these heraldic terms will be found explained under their several articles in the Dictionary.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statues of distinguished individuals of the family, seems to have been their only external hereditary distinction. Early in the middle ages, however, we find abundant notice of cognizances borne by individuals. These were more especially in use in tournaments, where the knights, being clad in complete armour, were unknown to the spectators, except by their banner or shield (*see* BLAZONRY); and probably it was in the lists of the tournament that the fanciful science of heraldry first found its subject matter. This science appears to be a compound of inventions collected from very different quarters. The East, the land of allegory and symbol, seems to have contributed many of its most singular devices. Its ordinaries, colours, metals, and gens, are said to be derived from Germany; and German heraldry appears to be a national science, from the circumstance that its terms of art are nearly all of native origin. But the Normans and French undoubtedly cultivated it with the greatest success, and reduced it to its present systematic form. Our English terms of heraldry are, as is well known, derived entirely from the French language, although not wholly from France; as some additions were made to the science by the Norman-English. Hereditary coat-armour, it is said, cannot be traced with certainty to an earlier period than the 13th century; but it seems that, in the reign of Henry III., the vocabulary of heraldry was nearly as full and definite as at the present day. National heraldry, or the adoption of distinctive emblems by civil communities, is far more ancient than personal. Badges, we know, were borne on the national standards of antiquity: an eagle was the device of Persia and of Rome, an owl of Athens, &c.; and Turkey and Persia, where personal heraldry is unknown, possess at this day national ensigns of correct heraldic character.

Arms are said, in the heraldic science, to be of dominion or pretension (national); arms of community, belonging to episcopal sees, cities, corporations; arms of patronage, to governors of provinces, &c.; arms of concession, or augmentations of honour, granted by sovereigns to individuals, which in the next generation become hereditary; arms of family, or hereditary arms; arms of alliance, showing the union of families and relations of individuals (marked by various devices termed differences, &c.; *see* DIFFERENCE); arms of succession, which accompany the possession of certain estates or lordships; and, finally, arms of assumption, taken up by individuals from caprice or vanity, which, although common enough in the present day, are borne in violation of all heraldic laws; or, arms taken up with the permission of the sovereign, through his principal herald (in England, king at-arms). Armorial bearings were chiefly displayed, in the times of chivalry, on the shield or escutcheon. They were also borne on the pennon, or banner; on sword-hilts, as early as A.D. 1250; on the mantle or surcoat (hence the phrase coat-of-arms); and, in modern times, on carriages or articles of furniture. The science of heraldry, united as it is with that of family genealogy, was for centuries one of the most favourite literary pursuits (if it can be termed such) among the higher ranks of the community. It has been enriched with much legendary knowledge, and diversified with many fanciful antiquarian theories. It is entitled to respect, not merely on account of its intimate connection with historical knowledge, but also on account of the refinement and curious variety of the learning itself; which, grounded on merely imaginary principles, has been wrought into a system of the minutest accuracy. The best known English work on heraldry is that of *Gwillim*. The *Encyclopedia Heraldica* of Berry contains many modern additions. See also *Edmonson's complete Body of Heraldry*, 1780; *Dallaway's Inquiries*, 1783; and the article "Heraldry" in the *Enc. Metr.*, with the various authorities, English and foreign, there referred to.

HERBA'CEOUS (Lat. herba), in describing the texture of bodies, denotes their being green and cellular, as the tissue of membranous leaves. It is also applied to such perennial plants as lose their stems annually, while their roots remain permanent in the ground.

HERBA'RIA. (Lat. herba.) Collections of dried plants, such as the old botanists called *horti sicci* or dry gardens. They are formed by gluing to sheets of paper branches and other parts of plants pressed flat, and dried in the sun or otherwise. If well prepared, they are as useful to the botanist as plants alive; but it is necessary to have some practical skill to be able to employ them advantageously. The largest public herbaria are those of the Museum at Paris; the Imperial collection of Vienna; the Royal of Berlin; and that of the British Museum, formerly Sir Joseph Banks's. Nothing certain is known of the extent of these collections, but they probably contain in some cases as many as 60,000 species. The herbarium is an unattractive part of public museums; but a very important one for numerous purposes of science, both practical and speculative.

HE'RCULES. In Mythology, one of the most celebrated personages of antiquity, believed to be the son of Jupiter and Alcmæna. the daughter of Electryon, king of Mycenæ. The history and wonderful exploits of this hero are so well known, that it would be superfluous to dwell upon them here. There is, perhaps, no subject connected with antiquity to the right comprehension of which such formidable difficulties are presented; and hence the numerous attempts that have been made to separate truth from fiction in the history of Hercules, by divesting it of the mythological traditions with which it had been encumbered by all the writers of antiquity. In some shape or another, all the profane nations of antiquity seem to have possessed a divinity to whom they attributed an extraordinary degree of bodily strength, combined with indomitable perseverance and moral energy in prosecuting and overcoming difficult achievements. The reader will at once recognise, as belonging to this class, the Baal of the Syrians, the Melkarth of Phœnicia, and the Rama of Hindostan; who, like the Grecian Hercules, outstripping in bodily and intellectual endowments the great mass of the people of the rude era in which they lived, achieved a multiplicity of deeds which were looked upon as altogether miraculous, and which procured for their authors empire and dominion during their lives, and after death a place among the gods. (See *Müller's Dorians*, and the authorities there referred to.)

HE'RCULES. One of the old constellations in the northern hemisphere.

HE'RDERITE. (So called from Herder, who discovered it.) A mineral found in crystals embedded in fluor at Ehrenfriedensdorf, in Saxony; its primary form is a bright rhombic prism; its lustre is vitreo-resinous; and its specific gravity 2·985.

HEREDI'TAMENTS. In Law, all things which pass to the heir, being either corporeal (land, with those adjuncts which legally are comprised within that designation), or incorporeal, which are things collateral to land, or issuing out of it, and are enumerated in *Blackstone's Commentaries*, under the heads "Advowsons, Tithes, Commons, Ways, Offices, Dignities, Franchises, Crodies or Pensions, Annuities, and Rents."

HE'RESY. A word signifying the taking up of certain opinions in theological matters: from the Greek αἱρεσις, *choice*, which classical writers apply to the sects of philosophers. It is now confined to a theological sense, and is defined by Roman Catholic authorities to be the *voluntary* assumption and *obstinate* maintaining of error in matters of faith. They hold all error to be voluntary where the party knowingly deviates from the judgment of the church. The Protestants do not for the most part profess to have any certain standard by which men may judge whether their fellow men be heretical. We may infer from the directions of St. Paul to Titus that the nature of heresy was understood by the first preachers of Christianity; but it does not necessarily follow that any infallible tests should exist at the present day. It seems most consonant to a sense of human infirmity, and is the judgment of most divines of the Reformed persuasion, that those only should be considered as heretics by any community who maintain what are accounted by it erroneous opinions, either against their real convictions, or without condescending to listen to fair and reasonable argument, and in defiance of persons whose station, learning, and piety should entitle them at all events to attention.

HE'RIOT. In Law, originally a tribute given to the lord of the manor on occasion of his engaging in a war (here or heer-geld). In English law a heriot is a customary service, due for the most part on copyhold tenures, and termed heriot custom, being usually the best beast, whether horse, ox, or cow, that the tenant dies possessed of, which is due and payable to the lord of the manor. Some heriots, however, are due on reservation in a grant or lease of land; such are termed heriot service. In heriot custom the lord may seize the specific article which he seeks to recover; for heriot service he may either seize or distrain generally on the goods of the tenant on the land.

HERI'SSON. (Fr. *a hedgehog*.) In Fortification, a beam armed with iron spikes, and used as a barrier to block up a passage.

HE'RITABLE RIGHTS, in Scottish Law, comprehend in general rights to land and things connected with land which pass to the heir; the distinction being in most practical respects merely identical with that of English law between realty and personalty. Heritable jurisdictions were grants of criminal jurisdiction bestowed on great families by the crown. They were abolished after the rebellion of 1745 by the act 20 G. 2. c. 40.

HE'RMES. *See* MERCURY. TRISMEGISTUS.

HERMA'PHRODITE. (Gr.; from the well-known mythological fable of the union or confluence of the bodies of the nymph Salmacis and Hermaphroditos, the son of Ἑρμης, Mercury, and Αφροδιτη, Venus.) An organized body, in which there is either a real or apparent combination of the characteristics of the two sexes. The first is the "true," the second the "spurious" hermaphrodite. Hermaphrodites are also "natural" or "preternatural."

The animals in which the organs of the two sexes are naturally combined in the same individual are confined to the invertebrate division, and are most common in the

Molluscous and Radiate classes. If the term hermaphrodite may be applied to those species which propagate without the concourse of the sexes, but in which no male organ can be detected, as well as to those in which both male and female organs are present in the same body, then there may be distinguished three kinds of hermaphroditism.

First, The *Cryptandrous*, or in which the female or productive organs are alone developed. — Ex: The cystic Entozoa, the hydrostatic Acalephes, some Polypes, and Sponges.

Second, The *Heautanarous*, or in which the male organs are developed, but so disposed as to fecundate the ova of the same individual. — Ex.: The Cirripeds, the Rotifers, the trematode and cestoid Entozoa, and some Acephala, as the *Cyclas*.

Third, The *Allotriandrous*, or in which the male organs are so disposed as not to fecundate the ova of the same body, but where the concourse of two individuals is required, notwithstanding the co-existence in each of the organs of the two sexes. — Ex.: The gastropodous Mollusks, with the exception of the Pectinibranchiate order, and class *Annellida*.

All the other invertebrates, as the Cephalopods and pectinibranchiate Gastropods, most of the acephalous Mollusks, the insects, Arachnidans and Crustaceans, the Epizoa and the nematoid Entozoa, the Echinoderms and Medusæ, are, like the vertebrate classes, diœcious, or composed of male and female individuals.

The unnatural hermaphrodites may be divided into those in which the parts peculiar to the two sexes are blended together in different proportions, and the whole body participates of a neutral character, tending towards the male and female as the respective organs predominate; and into those in which the male and female organs occupy respectively separate halves of the body, and impress on each lateral moiety the characteristics of the sex.

This latter and very singular kind of hermaphroditism has hitherto been found only in insects and Crustaceans. In the extracts from the Minute Book of the Linnæan Society, printed in the 14th volume of their *Transactions*, it is stated that Alexander Macleay, Esq., Sec.L.S., exhibited a curious specimen, showing that two Papiliones referred to distinct families by Fabricius are in reality the male and female of the same species. This specimen presented the forms and colours of both sexes, divided by a longitudinal line on the body; the right wings and side of the body being as in the male (*Papilio polycaon*, Fabr.), and the left as in the female (*Papilio laodocus*, Fabr.).

In *Loudon's Magazine of Natural History* (vol. iv. p. 434.), an experienced entomologist, Mr. J. O. Westwood, has given descriptions and figures, not only of dimidiate hermaphrodites (the example is the *Bombyx penii*), but also of quartered hermaphrodites. The latter singular condition is exemplified in a specimen of the *Bombyx castrensis*, in which the right wing, left antenna, and left side of the abdomen are male; the left wing, right antenna, and right side of the abdomen are female: and again in a specimen of stag-beetle (*Lucanus cervus*), in which the left jaw and right elytrum are masculine, and the right jaw and left elytrum feminine.

In most dimidiate hermaphrodites the left side is masculine; but an example of the contrary has been observed in *Sphinx populi*. It is to be regretted that the condition of the internal organs of generation cannot be ascertained in the above singular examples; but this deficiency is in some degree supplied by the results of Dr. Nicholl's dissection of an hermaphrodite lobster (*Philos. Trans.* xxxvi. p. 290.), in which a testis was found on that side of the body which exhibited externally the male characteristics, and an ovarium on the opposite side.

In Botany, hermaphroditism is the rule, and a separation of sexes the exception, in the structure of flowers or reproductive organs.

HERME'TIC ART. The imaginary art or science of alchemy; so termed from Hermes Trismegistus, a personage of questionable reality, looked up to by the alchemists as the founder of their art. Some spurious works bearing his name are still extant. *See* ALCHEMY.

HERME'TIC SEAL. When a vessel or tube is perfectly closed by fusing its mouth or extremity, it is said to be *hermetically sealed*.

HE'RMITS, or E'REMITES. (Gr. ἐϱημος, *desert.*) Persons who, in the early ages of Christianity, secluded themselves from the world for devotional purposes, betaking themselves to solitary and desert places (ἐϱημός), whence their name. In the first five centuries of our era this class of persons was extremely numerous; nor have individuals been wanting in later ages who have undergone the same privations with the same mistaken views, and have acquired great reputation for sanctity in consequence. (See *Gieseler's Text Book*, vol. i.; *Riddle's Christian Antiquities*, 1839, p. 743.; *Heribertus, Vitæ Patrum et Eremitarum*, 1628; *Cavacius, Illustrium Anachoretarum Elogia*, 1625; *Enc. Metropolitana.*)

HERMODA'CTYLS. (Gr. Hermes, a river in Asia, and dactylus, *a date:* or from Εϱμης, *Mercury*, and δακτυλος, *finger;* i. e. *the fingers of Mercury.*) This term has long been applied to a species of colchicum tuber, probably that of the *Colchicum Illyricum:* it is irregularly heart-shaped, and has a furrow upon one side, not unlike the tuber of the *Colchicum autumnale*, now so much used in the cure of gout: it is imported from Turkey, and was formerly esteemed as a cathartic. Some of the old writers who are fond of the doctrine of signatures, compare the shape of the hermodactyl to that of a gouty finger, and have recommended its efficacy in that disease.

HERNANDIA'CEÆ. (Hernandia, one of the genera.) A small natural order of arborescent Exogens, inhabiting the Indian Archipelago and Guinea. They are very near *Thymelaceæ*, differing only in their fibrous drupaceous fruit, lobed cotyledons and involucre; and are very different from *Lauraceæ* and *Myristicaceæ*, to which orders they have been referred. The leaves, stem, &c. are slightly purgative: the roots of *Hernandia* are antidotes to the Macassar poison, its juice is a depilatory, and its leaves make a good sort of tinder.

HE'RNIA. (Gr. ἑϱνος, *a branch.*) A rupture. The term is generally applied to a tumour arising from a protrusion of part of the intestines or omentum into a sac composed of peritoneum: the groin, or upper and fore part of the thigh, below Poupart's ligament, are common situations. Other viscera may also occasionally form hernial tumours. When the condition of the accident is such that the parts cannot be reduced or returned into the abdominal cavity, the hernia is said to be *strangulated*, and in that case the passage through the intestines is interrupted; there is sickness and constipation; and inflammation, and even mortification of the part ensue, unless by an operation the cause of the stricture is removed and the gut returned. What is termed *congenital hernia* is the protrusion of a portion of intestine along with the testicle in its descent through the abdominal ring into the scrotum. Where a rupture exists in early infancy, it is commonly referable to this cause. The surgical history of ruptures is a very complicated and extensive, but highly important subject: it has been ably illustrated by several eminent practitioners, who have published treatises upon their causes and treatment.

HE'RO. (Gr. ἡϱως.) Lennep derives it from the verb αϱω, *I lift.* But the root of it is probably to be found in the same original word which appears in the Latin herus, *master;* Germ. ari-mann; perhaps the Sanscrit sura. The heroes of the Greeks were deceased mortals to whom divine honours were paid. It is probable, indeed, that such was the origin of their gods themselves (*see* POLYTHEISM); but if so, hero worship was a secondary or added system, which grew up in a later age. The word "hero," in Homer, is simply synonymous with warrior; nor is there any trace (at least in the *Iliad*) of hero-worship. It seems to have commenced not long after the composition of that poem. The last to whom any honours approaching to divine seem to have been paid were the Athenians slain at Marathon. The heroic age, commonly so called in Grecian poetry, seems to have ended with the descendants of those who returned from Troy. (*Wachsmuth, Hist. Antiq. of the Greeks; Thirlwall's History of Greece*, chap. 5. *Carlyle's Hero Worship*)

HERO'DIANS. A sect existing among the Jews at the period of our Saviour's preaching. (See Matthew, c. xvi.; Mark, c. viii. v. 15.) Much doubt exists as to their history and tenets: some commentators, both ancient and modern, imagine that they were fanatics, who regarded Herod the Great as the Messiah; others, that they were a mere political party, attached to the family of Herod; while a third opinion (Bergier, *Dictionnaire de Théologie*) is, that they supported some innovations attempted by Herod in the religious observances of the country by the partial introduction of Pagan usages. (See *Milman's History of Christianity*, i. 311.)

HERO'IC VERSE, that appropriated to epic or heroic poetry: in Greek and Latin, the hexameter. In English, Italian, and German, the iambic of ten syllables, either with or without the additional short syllable. In French, the iambic of twelve syllables. *See* EPIC, HEXAMETER.

HE'RPES. (Gr. ἑϱπειν, *to creep.*) A cutaneous disease, consisting of clusters of minute vesicles generally containing a brownish or milky lymph: in about eight or ten days they scab off, and other crops appear. It is not limited to any part of the body, but is generally preceded by more or less fever and pain or irritation of the part. It is often called the *tetters*. Another form of it constitutes the *shingles*. These eruptions are sometimes confounded with erysipelas, from which they are distinguished by the want of tumefaction and considerable constitutional symptoms, and by the natural state of the skin between the crops of eruption: they are distinguished from some similar eruptions by the vesicular form of the cuticular elevations at their first appearance, by their regular progress, and limited duration.

HE'RPETO'LOGY. (Gr. ἑϱπετος, *a reptile;* λογος, *a*

discourse.) That branch of science which treats of the history of reptiles.

HE'RPETON. (Gr. ἑρπετος, *a reptile.*) A genus of serpents, allied to *Eryx;* and characterized by two soft prominences covered with scales which are appended to the muzzle. Botanists have a herpeton which is a section of *Viola*.

HE'RRING. (Germ. heer, *an army;* in reference to the great numbers in which the fishes so called appear, at stated seasons, along our coasts.) The name is commonly applied to two distinct but closely allied species of the genus *Clupea*, Linnæus: to the one Mr. Yarrell restricts the name of *Clupea harengus;* the other is denominated *Clupea Leachii*, in commemoration of the excellent naturalist who first appears to have beena ware that our coast produced a second species of herring.

The genus *Clupea* is so nearly allied to the genus *Salmo* that they are both included in the same natural family, under the name of *Halecoids*, by M. Agassiz; the principal external difference consists in the absence of the small adipose dorsal fin in the *Clupea.* But in the clupeoids, as in the salmon tribe, the upper maxillary as well as the intermaxillary bones enter into the formation of the mouth, and are both armed with teeth; the body is always covered with numerous scales; and, in the greater number of the herring tribe, there is an airbladder, and the duodenum is complicated with many *cœca*, or pyloric appendages.

The annual migration of the herring is not, as has been described, from one latitude to another, but simply from a deeper to a shallower part of the ocean. The common species, impelled by the stimulus of the increasing burthen of milt or row, quits the deeper recesses of the ocean, where it has passed the winter and spring months, and approaches the shallower water near the coasts, where the ova may be deposited, and impregnated with the requisite amount of heat, light, and oxygen for their development.

The common herring visits different parts of our coast in autumn, generally earlier on the southern than on the northern localities, and deposits its ova and spawn towards the end of October. In this state the fish are termed "shotten herring," and they retire from the shore into deep water.

Leach's herring has a different season of sexual migration. "It is found," says Mr. Yarrell, "heavy with roe at the end of January, which it does not deposit till the middle of February Its length is not more than seven inches and a half, and its depth near two inches."

During the long period in which the herring stays in deep water, the shoals occasionally travel so far as to appear at the next season of oviposition at a different part of the coast from that where they were previously abundant. Hence the herring has been described as a most capricious fish; and it is truly said, "that there is scarcely a fishing station round the British islands that has not experienced in the visits of this fish the greatest variations, both as to time and quantity, without any accountable reason.

Herrings are taken in drift nets, and during the night. The stretching of the nets in the daytime is forbidden, as it is supposed that the practice would alarm and drive away the shoal. The darkest nights, and a breeze that ruffles the surface of the water, are the circumstances which most favour the capture of the herring.

HERRING FISHERY. *See* FISHERIES.

HE'RRNHUT. (Ger. herr, *the Lord;* hut, *protection.*) An establishment in Upper Lusatia, comprising, it is said, at present 120 houses, and 1500 inhabitants, which was founded by a few Moravians about the year 1722, under the patronage of Count Zinzendorf. The principles of the society thus formed are seclusion from the world, the enjoyment of a contemplative life, and the possession of all goods in common. Its members are bound together, under the title of Moravian Brethren, by strict laws and observances. Accusations have been thrown out against them of their indulging, in their retirement, in many licentious practices; but it is certain that their industry supplies many of the markets of Germany with various useful and ornamental articles of handiwork; that their zeal has prompted them to establish affiliated societies in many parts of Europe and America; and that in religious matters they are neither extravagant themselves, nor intolerant of others. (See *Mosheim*, vol. vi.)

HERSE, HERSI'LLON. In Fortification, a lattice or portcullis armed with spikes, to block up a gateway, or impede the march of an enemy.

HER'THA (sometimes written Aertha, Aortha, and Eorthe). In German Mythology, the name generally assigned in modern times to the chief divinity of the ancient German and Scandinavian nations. She was worshipped under a variety of names, of which the chief were exactly analogous to those of Terra, Rhea, Cybele, and Ops, among the Greeks and Romans. Long before the Christian era the knowledge of Hertha appeared to have been extended over a great portion of northern Europe; for in his work, *De Moribus Germanorum*, c. 40., in which the reader will find a graphic description of the peculiarities of her worship, Tacitus speaks of the wonderful unanimity which tribes that had no other feature in common displayed in worshipping this goddess, whom he designates Herthus, or *Mother Earth.* Her chief sanctuary was situated, according to the same authority, in a sacred grove in an island of the ocean, *in insula oceani*, which, by some writers, has been supposed to be Riga, and by others Zetland or Heligoland; but no modern researches have been able accurately to fix its locality. A great deal of curious information upon this subject is to be found in *Grimm's Deutsche Mythologie*, chap. x.

HESPE'RIA. (Gr. Ἑσπερια, *Evening;* the name of the daughter of Atlas.) A genus of butterflies, now the type of a family, including several subgenera, to some of which belong the British species, eight or ten in number.

HESPE'RIDES. In Greek Mythology the daughters of Night, or the granddaughters of Hesperus the brother of Atlas, three or seven in number, possessors of the fabulous garden of golden fruit watched over by an enchanted dragon at the western extremities of the earth. Such at least is the most ordinary form of the fable, but it is very variously represented; and these varieties are collected by M. Massieu, in a very complete dissertation on the subject, in vol. iii. of the *Mémoires de l'Ac. des Inscrip. et Belles Lettres*. There are also some observations on the subject in vol. xviii. p. 54. There is a difference among the mythologists whether the treasures of the Hesperides were in reality *fruit* or *sheep*, the word μῆλα signifying either (*Diod. Sic.* lib. v.); but the former is the received form of the story among the poets. (*Ovid, Metam.* 4.; *Virg. Ecl.* 6.; *Apollon. Rhod.;* and in the well-known lines of Milton,

> Hesperus and his daughters three,
> Singing around the golden tree

and, the oldest of all, Hesiod,

> —— αἱς μηλα περην κλυτου Ωκεανοιο,
> χρυσεα καλα μελουσι, φεροντα τε δενδρεα καρπον.

Some have explained this pleasing fable by the groves of orange and lemon trees, known to the Greeks only in the western parts of Africa.

HESPERI'DIUM. In Botany, a many-celled, few-seeded, superior, indehiscent fruit, covered by a spongy separable rind; the cells easily separable from each other, and containing a mass of pulp, in which the seeds are embedded — example, the orange.

HE'SYCHASTS. (Gr. ἡσυχασται, from ἡσυχια, *quiet; Quietists.*) In Eccl. History, a singular class of fanatics, who were established in the 15th century in some of the Greek monasteries of Mount Athos. They pretended to have attained a perfect interior life of devotional repose by intense contemplation. One of their maxims, apparently derived from some of the strange practices of the Indian ascetics, directs the disciple to "raise his spirit above all vain and transient things, repose his head on his breast, and turn his eyes with his whole power of meditation upon his navel." Hence these visionaries derived the nickname of Ὀμφαλοψυχοι, or Umbilicarii: they were also termed Thaborites, from their notion respecting a divine light inhabiting the heart of the devotee. (*Waddington's Hist. of the Church*, chap. xxvi.)

HETÆ'RIA. (From the Greek ἑταιρεια, derived from ἑταιρος, *a companion.*) This word is frequently used by classical writers to signify an association of any description; thus the fraternities of the early Christians are called Hetæriæ. In modern times two celebrated associations among the modern Greeks have assumed the name. The first was the Hetæria of the Philomusoi, or Friends of the Muses; a society formed for the purposes of education, founded (it is said) by Capodistrias, about 1814: it established schools at Athens and Miliæ in Thessaly, and numbered at one time 80,000 associates. It was dissolved in 1821; but renewed in 1824, when Athens was in the hands of the Greeks. The more celebrated political Hetæria owes its foundation to the celebrated Rigas, who died in 1798. It was renewed about 1816, extended its ramifications through all Greece, and produced the Greek revolution, begun by Ypsilanti in 1821.

HETEROCE'PHALOUS. (Gr. ἑτερος, *various*, and κεφαλη, *a head.*) In Composite plants, when some flower heads are male and others female in the same individual.

HE'TEROCHRO'MOUS. (Gr. ἑτερος, and χρωμα, *colour.*) When in a flower-head the florets of the centre or disk are different in colour from those of the circumference or ray.

HE'TERODOX (Gr. ἑτερος, and δοξα, *opinion*), signifying a person who holds opinions different from some standard with which they are compared, is opposed in theological language to *orthodox*, one who holds the right opinion. The standard of orthodoxy, by which all heterodox opinions must be tried, resides, humanly speaking, in the judgment of each particular sect of believers. It is, however, generally allowed to represent the highest and strictest interpretation of the creeds which were received in the ancient church, and in England is conceded by

general consent to what is called the High Church party. The use of these terms is said to have come into fashion in England in the beginning of the last century, when there arose a party within the church who, from the laxity with which they interpreted its formulas, and the assumed liberality of the views they took of its nature and authority, were styled Latitudinarians. The High Church or Orthodox party, on the other hand, were those who pushed their opposition to these innovators to an extreme length, but contented themselves with branding the others with the title of Heterodox, as a milder term than that of heretical, to which they would probably have been subjected in earlier and more violent times.

HETERO'GAMOUS. (Gr. ἑτερος, and γαμος, *marriage.*) In Grasses, when the arrangement of the sexes is different in different spikelets from the same root, as in *Andropogon:* in Composite plants, where the florets are of different sexes in the same flower-head.

HE'TEROGE'NEOUS ATTRACTION. *See* AFFINITY, CHEMICAL.

HETEROGENEOUS QUANTITIES, in Mathematics, are such as are incapable of being compared together in respect of magnitude, as lines and surfaces, surfaces and solids, &c.

HETERO'GYNA. (Gr. ἑτερος, and γυνη *a female.*) A tribe of Aculeate Hymenoptera, in which the females are of different kinds; one fertile, the other infertile, called neuters, as the ants, *Formicidæ* and *Mutillidæ*. See those words.

HETEROME'RANS, *Heteromera.* (Gr. ἑτερος, and μηρος, *a leg.*) Signifying that the legs have a different structure from one another. The Coleopterous insects are so called which have five joints in the tarsus of the first and second pairs of legs, and only four joints in the tarsus of the third pair. Latreille divides this somewhat artificial section into four groups.

1. *Melasomes*, having the wing-covers hard, wings generally wanting, claws simple, and maxillæ with a hook. — Ex.: *Pimeliidæ, Blapsidæ, Tenebrionidæ.*

2. *Taxicornes*, having the wing-covers hard, wings present, antennæ perfoliate or clavate, claws simple, maxillæ without a hook. — Ex.: *Diaperidæ, Cossyphidæ.*

3. *Stenelytres*, having the wing-covers hard and contracted posteriorly, wings present, antennæ simple, claws simple or toothed. — Ex.: *Helopidæ, Cistelidæ,* &c.

4. *Trachelides*, having the wing-covers flexible, wings present, head inserted upon a neck, claws bifid. — Ex.: *Meloe, Mordella, Horia, Lagria,* &c.

HE'TEROPODS, *Heteropoda.* (Gr. ἑτερος, and πους, *foot.*) The name of an order of Gastropods, comprehending those which have the foot compressed, and in the form of a thin vertical fin; as in the *Carinaria.*

HETERO'PTERANS, *Heteroptera.* (Gr. ἑτερος, and πτερον, *a wing.*) The name of a section of Hemipterans, comprehending those in which the hemelytra terminate abruptly by a membranous appendage.

HETERO'SCII, or HETERO'SCIANS. (Gr. ἑτερος, *another*, and σκια, *shadow.*) An epithet applied by the ancient geographers to the inhabitants of the two temperate zones, because their shadows at mid-day are always projected in the same direction in respect of themselves, but in opposite directions in respect of each other; in one case to the north, and in the other to the south.

HETERO'TROPAL. (Gr. ἑτερος, and τρεπω, *I turn.*) A term applied to the embryo of a seed when the former lies across the latter; that is to say, neither pointing to its base nor apex.

HE'XACHORD. (Gr. ἑξ, and χορδη.) In Music, a progression of six notes, to which Guido attached the syllables *ut, re, mi, fa, sol, la.* The hexachord is also called a sixth; and is twofold, greater and less. The former is composed of two greater, two less tones, and one greater semitone, making five intervals; the latter of two greater tones, one lesser and two greater semitones.

HEXAE'DRON, or CUBE. (Gr. ἑξ, *six*, and ἑδρα, *seat.*) One of the five regular or Platonic solids, so called from its having *six* faces. The whole surface of a hexaedron is equal to 24 times the square of the radius of the inscribed sphere, and to 8 times the square of the radius of the circumscribed sphere. Its solid content is 8 times the cube of the inscribed sphere. The other four regular solids are the tetraedron or pyramid, the octaedron, the dodecaedron, and the icosaedron.

HE'XAGON. (Gr. ἑξ, and γωνια, *angle.*) In Geometry, a plane figure bounded by six straight lines. When these are equal, the hexagon is regular. The side of a regular hexagon is equal to the radius of its circumscribing circle, a property which has numerous useful applications. The area is equal to the square of the side multiplied into the constant number 2·598076; that is, into three times half the tangent of 60°.

HEXA'METER. (Gr. ἑξ, and μετρον, *measure.*) The most important species of verse used by the Greeks and Romans. It consisted of six feet, either dactyls or spondees, which might be used indifferently in any part of the verse; with two important exceptions, that the last foot must invariably be a spondee, and the last but one a dactyl. In some instances a spondee is introduced into the fifth foot, or last but one; a licence which, if judiciously used, gives an agreeable variety to the otherwise unbroken fall of the verse, which is thence termed *spondaic.* (*See* FOOT, CÆSURA.) Hexameter verse was employed on almost every topic to which poetry can be applied. In modern times several poets of France, England, and Germany have attempted to introduce this measure into the language of their respective countries. The few specimens we have seen of it in French appeared to us wholly unsuccessful. The little countenance given to the attempts made by Dr. Southey and others, to introduce it among ourselves is conclusive, we think, against its ever being generally adopted in England; but, on the other hand, it has been cultivated in Germany with great success, as the *Hermann and Dorothea* of Goethe, and many other examples that might be cited, abundantly prove. How admirably the spirit of this measure had been caught by the learned Voss, and transfused into his translation of the great Virgilian and Homeric poems, is known to every scholar; and a similar instance may be seen in a beautiful little poem in the same language, called *Hannchen und die Küchlein*, by Eberhard. The qualities and effect of the hexameter have been well described by Schiller in the following distich, of which we subjoin an excellent translation by Coleridge; who, by the way, we may state, was long supposed to be the original author: —

> Schwindelnd trägt er dich fort auf rastlos strömenden Wogen;
> Hinter dir siehst du, du siehst vor dir nur Himmel und Meer.

> Strongly it bears us along, in swelling and limitless billows;
> Nothing before and nothing behind but the sky and the ocean.

(See *Quart. Rev.* vol. xlii.; and *Edin. Rev.* vol. xxxv.)

HEXA'NDROUS. (Gr. ἑξ, and ανηρ, *a male.*) Any flower having six stamens.

HE'XAPLE. (Gr. ἑξ, and ἁπλοω, *I explain.*) The combination of six versions of the Old Testament by Origen is so called: viz., the Septuagint, Aquila, Theodotian, Symmachus, one found at Jericho, and another at Nicopolis. See BIBLICAL HISTORY, &c.

HE'XAPODS, *Hexapoda.* (Gr. ἑξ, and πους, *a foot.*) A name applied by Mr. Kirby to a sub-order of Apterous insects, including those which have not more than six legs.

HE'XASTYLE. (Gr. ἑξ, and στυλος, *a column.*) In Architecture, that species of temple or other building having six columns in front.

HIA'TUS. (Lat. *yawning, gaping.*) A word which has passed into several modern languages. In Diplomatics and Bibliography, it signifies a deficiency in the text of an author, as from a passage erased, worn out, &c. In Grammar and Prosody, it properly signifies the occurrence of a final vowel, followed immediately by the initial vowel of another word, without the suppression of either by an apostrophe. This, in Greek and Latin poetry, was only admissible in certain excepted cases; as where, in Greek, a final long vowel is succeeded by an initial short vowel, and becomes sometimes short by position; or in Latin, where the *cæsura* (*see* CÆSURA) gave an additional force to the first vowel, as in the celebrated line,

"Ter sunt conatī imponere Peliō Ossam,"

which affords an instance of both, the first hiatus being occasioned by the cæsura; the second, an imitation of the Greek prosody. In French the hiatus is carefully avoided: in English less so, although by the more accurate poets still regarded as a blemish, except in some instances where a long vowel is followed by a short one. The worst species of hiatus is where the same vowel sound is repeated.

HIBI'SCUS (for Hybriscus; Gr. ὑβρις, *haughtiness*). A genus of very handsome plants, belonging to the Malvaceous order, with unusually large and showy flowers. They are numerous in the tropics, where they generally form fine trees; but some of the species are only annual. Of the latter *H. trionum* is a commonly cultivated plant, known in the seed-shops under the name of *bladder katmia.* Very few of the species are of any interest. *H. Syriacus* is the *Althæa frutex* of shrubberies; *H. abelmoschus* yields the musk-seed of pharmacy; and *H. esculentus*, the *Gobbo* or *Ochro* of the tropics, bears seed-vessels abounding so much in mucilage as to be a common ingredient in the soups of the hotter climates of the world. *H. Rosa sinensis*, a Chinese plant, is remarkable for the property possessed by its flowers of dyeing black.

HIDA'LGO. A Spanish nobleman of the lower class; literally "hijo d'algo," son of somebody: in Portuguese, "fidalgo." It is absurdly derived by B. St. Vincent from "hijo de goto." The title is now obsolete.

HIDE. (Germ. haut.) This term is limited in commerce to the strong and thick skin of the horse, ox, and other large animals.

HIDE-BOUND. In Farriery, applied to a certain disease of cows and horses in which the skin adheres to their sides.

HIDE OF LAND. *See* HYDE.

HI'ERA PICRA. (Gr. ἱερος, *sacred*, and πικρος, *bitter.*) A compound of aloes and canella bark made into a powder with honey.

HI'ERARCHY (Gr. ἱερος, and αρχω, *I rule*), is a general term, comprehending the various ranks and orders of the sacred ministry, whether of angels, according to an ancient opinion, or of the pastors of the church of God upon earth.

HIEROGLY'PHICS. (Gr. ἱερος, *sacred*, and γλυφω, *I engrave*.) Sculpture-writing or picture-writing; *i.e.* the expression of a series of ideas by representations of visible objects. The name is more peculiarly applied to a species of writing in use among the ancient Egyptians. According to the system of Champollion, the hieroglyphical writing of the Egyptians consists of three different species of characters:—1. The hieroglyphic, properly so called, in which the representation of the object conveys the idea of the object itself; either entire, or in an abridged form. Many words were thus expressed, chiefly those denoting common visible objects. These are termed by Champollion figurative, and divided into *figurative proper*, *figurative conventional*, and *figurative abridged*. 2. The second class of hieroglyphical characters consists of those which represent ideas by images of visible objects, used as symbols; and these are generally employed in the expression of abstract ideas or complex modes: as, a *tumult*, represented by a man throwing arrows; *adoration*, by a censer containing incense, &c. In some of these the connection between the type and antitype is obvious; in others, it depends on associations which are not understood by us, and consequently cannot be traced. These characters are what the Greeks more peculiarly termed hieroglyphics: they are called by Champollion *symbolical*. 3. The third class consists of *phonetic characters*, in which the sign represents not an object but a sound. This, according to Champollion, was effected by the following device. The figure representing a letter was the likeness of some animal or other object of which the name began with that letter. Thus Champollion has constructed an alphabet of initials, in which the letter A is represented by an eagle, the initial letter of the Egyptian word "eagle" (Ahorn) being A; and so forth. Twenty-nine elementary sounds were thus represented. But the writer was not confined to the use of one representative of a letter only. At first sight it would appear that all objects, the initial of whose name was a particular letter, might be used to express that letter; but custom seems to have applied only a certain number of objects to this use: some letters have eighteen or nineteen known representatives, others six or seven. In selecting out of these, the writer seems to have been guided by notions of what was suitable in reference to the word which he was writing; as, for example, the S in the word Si, *son*, is commonly represented by the figure of a goose, on account, according to Horus Apollo, of the supposed attachment of that bird for its young. The honour of the recent progress made in the explanation of hieroglyphical writing is divided between the English orientalist Dr. Young, and the Frenchman Champollion; but the latter appears to have had no small share in the original discoveries, as well as to have carried the science to a high degree of cultivation. Besides the hieroglyphic character, the Egyptians used the *hieratic* and *demotic*, which were, both of them, conversions of the hieroglyphic into a kind of current hand: the latter nearly alphabetical. The most civilized people of America, the Mexicans, at the time of the Spanish conquest, had advanced as far as the discovery of hieroglyphical or picture writing, although they did not possess a written alphabet. The Chinese writing was, originally, wholly ideographic; *i.e.* expressing ideas by symbols (answering to the second class of Egyptian hieroglyphics, with some admixture of the first). But in process of time the greater part of the characters have become simply phonetic. (See Dr. Young's "Egypt" in the *Enc. Brit.*, and his "Account of Recent Discoveries," 1823; the works of Champollion; Jablonski, *Pantheon Ægyptiacum; Quart. Review*, vols. xliii. liii.; *Edinb. Rev.*, vol. xlv.; *Salt's Essays;* Seyffarth, *Rudimenta Hieroglyphices*, 1825.)

HIEROGRA'MMATISTS. (Literally *sacred writers*.) The name given to certain Egyptian priests whose duty it was to decipher hieroglyphics and preside over the religious services.

HIEROMNE'MON. (Gr. ἱερομνήμων, *an observer of sacrifices*.) In Ancient History, the title of one of the two deputies sent to each meeting of the Amphictyonic Council by each tribe composing that confederacy. His office was, as the name imports, to superintend the religious rites on the occasion.

HIERO'NYMITES, or JERONYMITES. An order so named from its patron St. Jerome. It originated in Spain, and comprehended religious of both sexes. The Hieronymite convents are usually in mountainous and solitary places, in imitation of the retreat of St. Jerome to his hermitage at Bethlehem.

HI'EROPHA'NTES. (Gr. ἱερος, and φαινω, *I show*.) The title of the priest who initiated candidates at the Eleusinian Mysteries. He was necessarily a citizen of Athens, and held the office for life; which was regarded as one of high religious importance. (*Meursius on the Eleus. Mysteries; Potter's Grecian Antiquities*, vol. i. *Mem. de l'Acad. des Inscr.* vol. xxi.)

HIGH CHURCH. In English History, an epithet usually applied to those opinions which tend to exalt the ecclesiastical power, and to the parties which embrace them. According to Burnet (*Times*, vol. ii. p. 249.), the term "high church party" began to be used about the year 1700. Those who belonged to it were at that time considered to be unfriendly to the settlement of the nation at the Revolution, and disposed to Jacobite principles. Under Queen Anne, high church principles were for a short time in the ascendency; but after the accession of George I., in 1715, it is difficult to point out any political party which has seriously embraced them. But in matters relating to the discipline of the church itself, a "high church" and a "low church" party, the former attaching more and the latter less value to ecclesiastical dignities and ordinances, have always existed in the establishment of England.

HIGH COMMISSION, COURT OF, in English History, was erected by 1 Eliz. c. 1. as an ecclesiastical tribunal, without power to fine or imprison. The commissioners seem, however, to have committed various arbitrary acts towards the end of that queen's reign. One of their warrants was declared of no authority in 42 Eliz. Under Charles I. it assumed enormous and illegal powers, becoming a court for the trial of all manner of offences which might be construed as ecclesiastical; and was one of the grievances complained of and abolished by the Long Parliament, 16 Car. 1.

HIGHGATE RESIN. A fossil resin discovered on cutting the road through Highgate Hill: it is embedded in the clay in detached nodules.

HI'GHNESS. A title first attributed to bishops; afterwards to European kings in general (succeeded by Majesty in the sixteenth century), afterwards to sovereign princes and their descendants. The title of "Royal Highness" was first assumed by the Duke of Orleans, brother of Louis XIII., in 1631; and it is now conferred on all royal princes and princesses, whether in the direct line of succession or not. The elector of Hesse Cassel and the grand dukes of Germany have also the title of *royal highness*. The children of the emperors of Russia and Austria, and their descendants, are styled *imperial highness;* and all other princes not included in the above category bear the title *serene highness*, which is a literal translation of the term *Durchlaucht*, by which they are addressed in Germany.

HIGHWAY. A highway is a way over which the public at large have a right of passage, and includes a horse road, or a mere footpath, as well as a carriage road. It was considered formerly that no way which did not lead to a market town was a highway; but it is now settled that any way common to all people, without distinction, is a highway. A public navigable river is also called a highway. The right of the public in a highway is, however, a right of passage over it, and nothing more. The soil itself, and all the profits upon it, as trees, or underneath it, as mines, minerals, &c., and also any strips of waste land lying between the highway and the lands adjoining it on either side, belong, in moieties, to the owners of such adjoining lands. But if such strips of waste land be contiguous to or communicate with an open common, they are then taken to be part of the common. A highway may originate from a continual user of land by the public in traversing it without interruption from the owner, or from an express dedication of it by him to their use. A much shorter period of user will establish a right in the public than a right in any private person to a way; the user in the former case being so open and notorious that the owner of the land may fairly be presumed to have had early notice of it, and to have assented to it by not opposing it. Accordingly, a public way may be acquired by an enjoyment for five or six years, although twenty years' enjoyment is necessary in the case of a private way. A highway may also take its origin from statute, or from necessity. A highway originates from necessity when the accustomed line of highway is out of repair so as to be impassable; in which case the public have a right to traverse the adjoining ground, even if it be sown with grain.

The duty of keeping highways in repair is cast by the common law upon the occupiers of lands in the parish generally; but particular persons may be liable to repair by prescription or tenure. They may also be liable in respect of inclosure; that is, if a highway be free from fences on either side, and the owner of the adjoining land chooses to fence it off from the highway, he will then be liable in respect of his enclosure, because he has thereby deprived the public of using his land as a way of necessity, in the event of the original highway becoming impassable for want of repair. The omission to repair on the part of the parish or party liable is an indictable offence, and may be punished accordingly. Various statutes regulate the mode in which the occupiers in a parish are to contribute labour, carts, and cattle, for the purpose of repairing highways, and to perform upon them what is therefore called statute duty. Surveyors, also, are annually appointed in furtherance of the same objects. Highways

are frequently placed by the legislature under the jurisdiction of trustees; such highways are popularly called "turnpike roads." If sufficient materials for the repair of roads cannot be found on the waste lands of a parish, the surveyors have authority to take them from the lands of any private person ("such lands not being a garden, yard, avenue to a house, lawn, park, paddock, or inclosed plantation, or inclosed wood, not exceeding one hundred acres in extent"), on making him satisfaction for the materials taken away and the damage done, to be ascertained by the justices at special sessions. Any expenses incurred by the above proceedings may be reimbursed to the surveyors by an assessment made upon the occupiers in the parish, under the authority of two justices.

The laws for the regulation of highways have recently been consolidated and amended by the 5 & 6 Will. 4. c. 50. By previous acts of parliament, and by the common law, the county at large were bound to repair a public bridge, and also the highways at the end of such bridge to the extent of 300 feet. The recent act provides that in future when any bridge shall be built which the county shall be liable to repair, "all highways leading to, passing over, and next adjoining to such bridge, shall be from time to time repaired by the parish, person, or body politic or corporate, or trustees of a turnpike road, who were by law before the erection of the bridge bound to repair the highway." A most important alteration has been effected by the same act with respect to the creation of highways by dedication. Formerly, as appears above, if land had been traversed as a way by the public for a few years without interruption, a highway was at once established, and the liability to repair it was cast upon the parish; but by this act no road is to be deemed a highway which the inhabitants of a parish shall be compellable to repair, unless the person proposing to dedicate it to the use of the public shall give three months' notice to the surveyor of the parish of his intention to dedicate such highway, and the inhabitants of the parish, in vestry assembled, shall deem it of sufficient utility to them to justify its being kept in repair at the expense of the parish. If the vestry shall not deem it of such utility, a magistrate, on the surveyor's application, is to summon the party proposing to dedicate the new highway to appear before the justices at special sessions, and the question as to its utility is to be determined at their discretion.

HIMA'NTOPUS. (Gr. ἱμας, *a thong*, and πους, *a foot:* the term Himantopodes is given by Pliny to certain birds remarkable for the slenderness of their legs.) The name is now restricted to a genus of *Grallæ*, or wading-birds, in which the legs are proportionally longer and more attenuated than in any other species: the bill is long and slender, depressed at the base, and compressed toward the tip, with the nasal groove extending half the length of the bill. This genus includes the British species called the common stilt, or longshanks (*Himantopus melanopterus*). It is an occasional visitor, and a rare bird.

HI'PPIDES. The name under which Latreille and Eichwald designate a family of the tribe of Macrourous Decapod Crustaceans, typified by the genus *Hippa*.

HI'PPOBO'SCA. (Gr. ἱππος, *a horse*, and βοσκω, *I feed.*) A genus of Dipterous insects belonging to the Viviparous section of the order, in which the young are not only excluded from the ovum, but undergo their first metamorphosis in the womb of the parent, and are brought forth in the pupa state. (*Pupipara*, Latr.; *Homaloptera*, Leach.) The genus is now the type of a numerous family (*Hippoboscidæ*), generally known by the name of "forest flies," and divided by recent entomologists into numerous subgenera. The horse-fly (*Hippobosca equina*) is the type of the family.

HIPPOCRATEACEÆ. (Hippocratea, one of the genera.) This is a small natural order of plants, distinguished from *Celustraceæ* by little except the flowers being triandrous, and the filaments broad at the base. There are no species of any general interest included in the order.

HIPPOCRE'NE. (Gr. ἱππος, and κρηνη, *a fountain.*) A celebrated fountain at the foot of Mount Helicon, supposed to have been produced by the horse Pegasus having struck his foot against the mountain. It was regarded in antiquity with peculiar veneration, as it was believed to be a favourite haunt of the Muses, and was consequently looked upon as one of the chief sources whence the poets drew their inspiration. *See* Muses, Pegasus.

HI'PPODROME. (Gr. ἱππος, and δρομος, *a course.*) In Ancient Architecture, a place appropriated by the Greeks to equestrian exercises, and in which the prizes were contended for. The most celebrated in antiquity of these was at Olympia, which was four leagues long and one in breadth. The term is still in use.

HIPPOPO'TAMUS. (Gr. ἱππος, and ποταμος, *a river.*) A genus of aquatic Pachyderms, represented at the present time by a single species (*Hippopotamus amphibius*, L.) which inhabits the rivers of Africa. The generic characters are four toes on all the feet, inclosed in small hoofs; six molar teeth on each side of both jaws; very large and strong canines, of which the upper ones are nearly straight, the lower ones curved, and working upon each other so as to produce a chisel-edge; four incisors in each jaw, the upper ones short and conical, and bent inwards towards the mouth; the under ones long, cylindrical, and pointing forwards. The hippopotamus lives during the daytime immerged in the waters of its native rivers, rising to the surface and protruding its nostrils for the purpose of breathing: it comes to the land to feed during the night. Remains of species of hippopotamus are found in the tertiary formations of Europe, one of which hardly exceeded the size of a hog. In the tertiary beds at the base of the Himalaya range, an extinct species of hippopotamus has been discovered which had six incisor teeth in each jaw.

HI'PPOPUS. (Gr. ἱππος, *a horse;* πους, *a foot.*) The name of a genus of Acephalous Mollusks, significative of the resemblance which their shell bears to the foot of a horse. The valves of this shell are equal, regular, but inequilateral and transverse; the hinge has two compressed unequal teeth; the ligament is marginal and external. The *Hippopi* belong to the family *Tridacnidæ* of the Lamarchian system; but are distinguished from the genus *Tridacna*, by having the posterior slope and lunule closed, or nearly so, and the inner margin dentated at that part. The spines which arm the ribs are tubular, and are never arched orva ulted. The type of the genus is the *Hippopus maculatus*, or spotted hippopus; the *Æstrea hippopus* of Linnæus.

HIPPU'RIC ACID. (Gr. ἱππος, and ουρον, *urine.*) A peculiar compound deposited from the urine of the horse when it is mixed with muriatic acid. It closely resembles and is sometimes substituted for *benzoic acid;* but it contains nitrogen, and its salts are distinct from the benzoates.

HI'PPURITES. A genus of extinct Mollusks, supposed to be bivalves, and referred to the extensive group called *Rudistes* by Lamarck. The principal valve of the present genus is of a sub-cylindrical or elongated conical form, traversed by one or more internal longitudinal ridges, and closed by a small sub-circular discoid valve like an operculum.

The *Hippurites* are characteristic of the rocks of the cretaceous era in the south of France, Spain, Greece, and other countries bordering the Mediterranean.

HIPS. (Sax. hype.) In Architecture, the inclined diagonal edges of a roof where the sides intersect; hence a hipped roof is one in which two sides at least must intersect.

HI'RCINE. (Lat. hircus, *a he-goat.*) A term applied by Chevreul to a liquid fatty matter which may be separated from mutton suet, and gives it a peculiar rank smell, resembling that emitted by the male goat at the period of the rut. When saponified, it produces *hircic acid.*

HI'RING AND SERVICE, in Law, constitute the relation between master and servant. The general rule with respect to hiring and service is, that if there be no special agreement, but a general one without mention of time, the hiring is for a year certain; if the servant continue in his employment beyond that year, a second year is implied, &c. Consequently, if a master dismiss a servant hired generally, the servant is entitled to wages for the current year, unless the dismissal be for such a cause as will legally absolve the master from his contract: *ex.g.* moral misconduct, or refusal to obey orders. But in the case of domestic servants the contract is, by general custom, dissoluble by a month's warning on either part, or payment of a month's wages

HI'RSUTE. (Lat. hirsutus, *bristly.*) In Zoology, when an animal or part is covered with long stiffish hairs thickly set.

HIRUDINEÆ. *See* Leech.

HIRU'NDO. (Lat. hirundo, *a swallow.*) A genus which forms the type of the Fissirostral or wide-gaping Passerine birds of the Cuvierian system. It is now divided into the subgenera *Cypselus*, including the swift and *Hirundo* proper, embracing the chimney swallow (*Hirundo rustica*), sand martin (*Hirundo viparia*), &c. Our British species are occasional visitors, and the heralds, generally speaking, of the summer season, though we see now and then a premature straggler, which has given rise to the proverb "one swallow does not make a summer." Africa appears to be the chief resort of the British species during the winter season. Their disappearance at this season has, it is true, been accounted for on the hypothesis that the swallows passed the winter in a torpid state, submerged in river-heads or other fresh waters. No warm-blooded and quick-breathing animal does or can hybernate under water; and with respect to a bird, it is sufficient to observe that its extra-vascular plumage would be destroyed and decomposed by a six months' immersion. Swallows, like the cuckoo, immigrate to us for the purpose of breeding.

HI'SPID. (Lat. hispidus, *rough.*) In Botany, a term used in describing the superficial appendages of bodies, to denote their being covered with long rigid hairs, as the stem of *Echium vulgare.*

Hi'spid. In Zoology, when a surface is rough from minute spines or very rigid bristles.

HI'STER. A Linnæan genus of Coleopterous insects, now raised to a family (*Histeridæ*), belonging to the section *Pentamera*, and the subsection *Clavicornes* of Latreille. Many of the species of this family are remarkable for the instinctive promptitude and perfection with which they alter their ordinary appearance when alarmed, by drawing in their antennæ and folding up their legs, so as to feign death, and in many cases to take on the resemblance of a small black pebble or seed; whence one of the species is called *Seminulum*. It is this habit which probably suggested the generic name, from *histrio*, an actor. There are about fifty known British species referable to the Linnæan genus, and now divided into the subgenera *Abræus*, *Orithophilus*, *Dendrophilus*, *Platysoma*, and *Hister* proper.

HISTO'RICAL PAINTING. In Painting, that department of the art which comprehends all representations whereof history furnishes the subject. But under this head are generally included subjects from fabulous history, and those founded on allegory.

HISTORIO'GRAPHER. (Gr.) A professed historian, or writer of histories. It has been a common, although not uniform practice in European courts, to confer the place of public historiographer on some learned man as a mark of royal favour. Voltaire had at one period the title of Royal Historiographer of France.

HI'STORY. (Gr. ἱστορία, from the verb ἱστορέω, *I inquire*.) This word is first used in the commencement of the work of Herodotus, which he there calls by the title Historia. It is probable that this ancient writer thus fixed the sense in which the word has ever since been used,—as applicable, strictly and properly, to the civil history of man, although it has been analogically used to express other branches of investigation, as in the term Natural History, still in use; an application also sanctioned by classical usage, in the instances of *Theophrastus's History of Plants*, *Aristotle's History of Animals*, &c.

Civil history, properly so called, has also been subdivided into several branches: first, according to the class of events or actions which is made the subject of narration; as ecclesiastical, political, and literary: secondly, according to the extent of the subject; as universal history, in contradistinction to the history of particular nations or districts, or of individual men, more properly tern ed biography.

Our most ancient civil history is to be found in the Old Testament. But its objects are confined, after the brief and introductory narration of the first ages of the world, to the annals of a separate and peculiar people, the Jews, and such incidental notices of the affairs of other nations (Assyrians, Phœnicians, Egyptians, &c.) as the inspired writers found necessary for the illustration of their main topic. But the great empires and kingdoms which surrounded the little commonwealth of the Hebrews were also connected, by various circumstances of religion and descent, with the first of the two nations (Greek and Roman) whose annals constitute what is termed classical history, with which again our own history, or that of modern Europe, is in intimate association. Hence, in a general view of civil history, the whole subject may perhaps not be unappropriately classed under five heads; indicating, as it were, five different bodies of history, which in the main are distinct from each other in the subject, and partly in the sources from whence our knowledge is derived, although mutually throwing much light on each other.

I. The Jewish history, as contained in the Old Testament.

II. The history of the empires and states of antiquity in that portion of the world known to the classical and Jewish historians, and illustrated by classical and Jewish history; viz. Assyria, Persia, Egypt, Phœnicia, and its colony Carthage.

III. Classical history, properly so called; the history of the national affairs and conquests of the Greeks and Romans.

IV. The history of those nations and states (chiefly oriental) which possess annals of their own, independent of classical, Jewish, and modern European literature; China, India, modern Persia, Arabia, and the Mohammedan conquests.

V. Modern European history, including that of the colonies and conquests of Europeans.

1. The Jewish history, as we have said, is to be found in the Old Testament, some Apocryphal books, and in the writings of uninspired Jewish authors (Josephus and Philo-Judæus) who have investigated the antiquities of their country.

2. Of Assyria, Egypt, Phœnicia, ancient Persia, Carthage, &c., we possess no historical notice except such as is derived, 1. From Jewish or classical authors; 2. From monuments, especially in Egypt. Phœnician historical authors of repute (Sanchoniatho, Berosus, &c.) are alluded to by classical writers, and perhaps in part abridged by them; but we have no actual remains of their compositions on the authenticity of which reliance can be placed. With respect to Persia, much industry has been expended in endeavouring to extract from the histories of modern native writers coincidences with the narrations of Greek and Roman authors, but hitherto with little success.

3. The poems of Homer are generally regarded as containing the oldest fragments of Grecian history. Herodotus is the oldest Greek prose writer. His invaluable history comprises a description of several countries bordering on Greece and the Mediterranean; concise narratives of Egyptian, Persian, and Assyrian history; and a connected account, more or less detailed, according to circumstances, of the history of Greece, both civil and domestic, for about fifty years previous to the invasion of Xerxes, with which his annals close. (B. C. about 480.) The history of the Grecian commonwealth is pursued in detail by Thucydides and Xenophon for about a century afterwards. After that period our knowledge of Greek domestic history is confined to the incidental notices derived from various cotemporary writers, and the general compilations of later historians. Among these may be mentioned, as authors from whom a large portion of our actual knowledge is derived, Diodorus Siculus, the author of a very miscellaneous general history, of which great part is lost, who lived about the age of Augustus; Polybius, whose history is more especially devoted to Roman affairs; Arrian and Quintus Curtius, the historians of the conquests of Alexander; Livy, as to the transactions between Greece and Rome; Justin, the compiler of a brief but useful abridgment of general history; Plutarch, in his Lives of Illustrious Men, &c. These writers bring the student down to the period of the subjugation of Greece by Rome; after which all history of Greek affairs, properly so called, terminates, until the establishment of the Eastern empire, and we have little knowledge of the state of Greece and the Græco-Asiatic kingdoms in their provincial state.

Ancient Roman history, down to the first Punic War, is chiefly known from the compilations of Livy and Dionysius of Halicarnassus, writers whose credit is rendered extremely doubtful by modern investigation; and, where these fail, from incidental sources. In the History of the Punic Wars, the narrative of Livy is aided by the admirable work of Polybius. From the end of the second Punic War to the dictatorship of Sylla (nearly 150 years), our materials for Roman history are very deficient; the want of cotemporary writers being supplied only by later compilations, and by the incidental knowledge derived from writers on various subjects, the course of whose composition led them to touch on past events—of whom by far the most valuable is Cicero. From the period of Sylla's dictatorship to the accession of Vespasian (nearly 150 years), we have the advantage of a succession of cotemporary writers, some of them actors in the events which they describe, and comprising some of the greatest names in literature—Sallust, Cicero, Cæsar, Velleius Paterculus, Tacitus. Yet even here there is one considerable *lacuna*, comprising the last thirty years of the reign of Augustus, as to which our knowledge is scanty. From the accession of Vespasian to the reign of Constantine, a long period elapses during which our historical acquaintance with the events of an empire then comprising the greater part of the civilized world is vague and defective. Dio Cassius and Herodian are the two best writers on history who can be named in this long interval; the latter, during the short epoch which he illustrates as a cotemporary, is full and valuable. After the accession of Constantine, we have abundant materials for history, both ecclesiastical and civil, from the hand of cotemporary authors, down to the reign of Justinian in the East, and of Theodoric in the West, although the quality of the writers is sensibly degenerated. Perhaps the comparative obscurity and uncertainty into which history is plunged after the last of these two epochs, and the absence of all standard writers after Procopius, render it the best period to fix upon for the arbitrary limit between ancient and modern history. It will be seen from this brief summary that the only periods of any extent as to which we have the assistance of cotemporary historians (or original authority, properly so called), in the whole extent of classical history, are,—1. As to Greece, from B. C. 500 to B. C. 380.; 2. As to Rome, from the dictatorship of Sylla to the accession of Vespasian (B. C. 76 to A. D. 70); and, finally, the reigns of Constantine and his successors.

4. After the downfal of the Roman empire, a long series of revolutions in dynasties and nations followed before Western Europe was parcelled out into the several great countries which, notwithstanding all subsequent changes in political limits, have since subsisted as geographical divisions—Britain, France, Spain, Germany, Italy, the Scandinavian regions. Another period elapsed before the three great countries of Eastern Europe—Russia, Poland, Hungary—were added as distinct members to the family of European states; and the Greek empire in Europe remained apart, distinct in language,

manners, and political history, from both the other divisions.

From the fall of the Roman empire to the revival of literature (a period comprising in round numbers about eleven centuries) our knowledge of the affairs of Western Europe is derived from a series of writers, in each country, who are usually comprehended under the title of chroniclers. A chronicle, or book of annals, is properly a history of which the continuous narrative is so interrupted that each year forms a separate section, and events are thus related nearly in strict chronological order. This is a form very commonly adopted by the historians of the dark ages, of whom the greater proportion were monks, who appear to have noted down the acts which occurred within their own sphere of knowledge or memory, derived from the accounts of older men, merely to satisfy the vague desire of communicating knowledge to posterity, within the limited circle of the monastery or society to which they belonged. But a great many of the histories of the middle ages are not even in the form of chronicles; they have all the requisites which the most fastidious criticism can require of a regular history. Unity of purpose, and a sustained and energetic style, are qualities in which some of the early national annalists of modern Europe have been unsurpassed by their more instructed successors.

The Venerable Bede, who wrote in the 9th century, presents us with the first name of true credit and authority among the annalists of England. Of our monkish Latin chroniclers in later times, Matthew Paris is perhaps best entitled to the character of an historian. After the period of the invaluable Saxon chronicle, we have no English histories in the native language of the country worthy of note, with the exception of a few meagre rhyming chronicles, until the revival of letters and discovery of printing. In France, the long collection of native Latin chroniclers presents us with few names of interest after the time of the celebrated Gregory of Tours; but the Crusades called forth, for a short space, an unusual spirit of historical description. When we arrive, however, at the 14th and 15th centuries, we find among the native French historians two authors, Froissart and Philip de Comines, whose narratives are no less delightful from the talent and energy of the writers, than from the romantic character of the times which they pourtray. The annals of Italy are to be sought in the pages of a long series of chroniclers, from the 8th century downwards, of whom the most valuable are published together in Muratori's great collection. Their works are uniformly in Latin until the 13th century. But towards the end of that age the Tuscan dialect was elevated, as it were at a single step, to the rank of a literary language; and the little Tuscan republics produced a succession of historians, many of them remarkable for the purity of their style, and some (as the three Villani at Florence) for their extensive information and historical talent. Germany and Spain, in the middle ages, produced few historical works above the rank of dry chronicles. But the annals of the Scandinavian nations form the most important part of their early and peculiar literature. The Greek empire produced, also, a series of chroniclers, whose works have been collected in the *Corpus Historiæ Byzantinæ*.

The period of the revival of letters, and the following century, were distinguished by the appearance of several writers of first-rate merit in the department of history. In Italy, Guicciardini; in France, De Thou; in Spain, Herrera; and our own Camden may be added, not without justice, to the number. To follow the progress of history in modern times would be an impossible task. Suffice it to say, that with the advance of literary knowledge and the increase of education, historical writers seem to become more strongly divided into two very different classes: those who furnish contributions towards the history of their own times, especially the writers of memoirs, — a delightful and useful branch of literature, of which France gave the first examples, and still produces the most numerous; and the historians, more properly so called, who collect, discuss, and criticize, endeavouring to extricate the truth from the mass of former materials. The latter, in our times, has become more peculiarly the province of literary men. Philosophical history, in which the mere narrative of facts is regarded as subordinate to the elucidation of general truths, and too frequently to the establishment of favourite theories, is a modern improvement in the art; and Voltaire is commonly regarded, not without some truth, as the founder of the school of philosophical historians, among whom the highest rank in popularity has been attained and deserved by Gibbon.

5. The history of the more remote oriental nations, and also of those which derive their religion and civilization from Arabia, may be conveniently classed apart; because the knowledge of it is derived from wholly different sources, and requires, as it were, a peculiar education. Chinese and Indian history form two entirely distinct bodies of knowledge. With regard to that of the Mohammedan nations, it may be observed that it is brought into contact with that of modern Europe in several distinct countries and periods; of which the most remarkable instances are the Crusades, the annals of the Moors in Spain, and the history of the Turkish empire in its transactions first with the Greeks, and afterwards with the other nations of Christendom. It is a curious subject for the philosophical historian, and one which has not hitherto received the attention it merits, to compare the different accounts of the same events which have been transmitted to posterity by writers of distinct nations, religions, and languages, whose minds, from difference of education, habitually viewed almost every object in a totally different light.

HISTRIO'NIC ART. The art of acting in dramatic representations is not unfrequently so called, from the Lat. histrio, or hister, *an actor*. (*See* THEATRE.) The word histrio is of Etruscan derivation, as was the Roman dramatic art also. See *Mem. de l'Ac. des Inscr*. vol. xxvii.

HITCH. In Naval affairs, a particular kind of knot, of which there are several.

HITHE. An old Saxon word, signifying a port, wharf, or minor harbour, at which goods are shipped or landed: Queenhithe on the Thames is an example.

HOA'RY, in describing the superficial appendages of bodies, denotes their being covered with very short dense hairs, placed so closely as to give an appearance of whiteness to the surface from which they grow.

HO'BILERS (Lat. hobellarii), in England, were feudal tenants bound to serve as light horsemen, or bowmen; for the word seems to have been of somewhat uncertain employment. The smaller feudal gentry were long styled in France "Hobereaux."

HOE. In Agriculture and Gardening, an instrument for stirring the surface of the soil, cutting annual weeds up by the roots, and earthing up plants. The hand hoe is a thin plate of iron six or eight inches broad, and sharpened on the edge, fixed at right angles on the extremity of a pole or rod, which serves as a handle. This is called a draw hoe; because in the operation of hoeing the instrument is drawn or pulled towards the operator. Another description of garden hoe has the blade or iron plate fixed on the extremity of the handle, and in continuation of it: and this is called a thrust hoe; because in hoeing the operator always pushes the hoe forward. This kind is also called a Dutch hoe, most probably from having been first introduced from Holland. In agriculture there are hoes of the thrust kind drawn by beasts of labour, and commonly called horse hoes. In general form they resemble a plough; but instead of the share they have one or more iron blades, or plates with sharp edges, fixed to perpendicular iron rods at their lower extremities. These sharpened plates being drawn through the soil, cut through the roots of weeds an inch or two beneath the surface. Agricultural or field hoes are only used in the case of those field crops which are sown or planted in rows. There are a great many kinds of field or horse hoes; but it is worthy of remark that they differ very little in mechanical merit. The implement, indeed, does not seem susceptible of the same degree of improvement as the plough and the harrow.

HOEING. The operation of stirring the surface, cutting off weeds, or earthing up plants with a hoe. In the case of any of these operations dry weather must be chosen, otherwise the result will either be useless or injurious. Plants rooted up by the hoe in wet weather will produce fresh roots and grow again, while plants earthed up under similar circumstances will have the leaves which are covered by the soil decayed by it. In either case also, the ground will be hardened by the treading of the feet of men or horses, so as to obstruct the progress of the roots, and to exclude air and water from penetrating through it to them. Hoeing is sometimes performed on surfaces which are without weeds, for the purpose of stirring the soil; but in such cases pronged hoes, or hoes having three or more long spikes or teeth, are more effective than hoes with broad plates or blades.

HO'GSHEAD. An ancient measure of capacity, containing 63 old wine gallons.

HOLD. (Sax. healdan.) The inside of the bottom of the ship. It is divided into compartments by bulkheads across; and contains the ballast, water, coals and wood, provisions, and cargo.

HOLD. In Music, the same as PAUSE, which see.

HOLIDAYS, are considered to be those days, exclusive of Sundays, on which no regular public business is transacted at public offices. They are either fixed or variable, and vary in different public offices. The variable holidays are Ash Wednesday, Good Friday, Easter Monday and Tuesday, Holy Thursday, Whit Monday and Tuesday. *See* FERIÆ.

HO'LINESS. The title by which the Pope is addressed; equivalent to the Latin "Sanctissime."

HO'LING. (From hole.) In Architecture, piercing the plates to receive the nails.

HO'LING. Undermining beds of coal.

HOLM. (Sax. and Danish.) An island, or fenny place surrounded by water. Two well-known islands in the

Bristol Channel are called the Steep Holm, and Flat Holm.

HOLM OAK, or HOLLY OAK. *See* QUERCUS.

HO'LOCAUST. (Gr. ὅλος, *the whole*, and καίω, *I burn.*) A solemn sacrifice among the ancients, in which the whole of the victim was consumed upon the altar, in contradistinction to the usual custom which enjoined that only a portion thereof should be consumed. A similar custom prevailed among the Jews; it is called in Scripture a *burnt offering*.

HO'LOGRAPH. (Gr. ὁλόγραφον; from ὅλος, *whole*, and γράφω, *I write.*) In the Civil Law, a will written entirely by the hand of the testator.

HOLOTHU'RIANS. (Gr. ὁλοθούριον.) The name of the family of Echinoderms, having the genus *Holothuria* for its type. The body presents a subcylindrical elongated form; is defended by a coriaceous not spiny integument, open at both ends, and perforated by numerous small canals, in linear series, through which prehensile and adhesive suckers are protruded. At the anterior extremity is the mouth, surrounded with complicated retractile tentacula. At the opposite end is the aperture of the cloaca, in which the rectum and a respiratory branched tube terminate. The intestine is very long, and convoluted; and it frequently happens that when the animal is disturbed, it is protruded from the body or ruptured by the violenee of the contraction of the muscular parietes of the abdomen. The "trepang" of Eastern commerce is a dried species of *Holothuria*.

HOLT. (Sax. *a wood;* Germ. holz.) The termination of many names of places in England, derived from their ancient situation in a wood.

HO'LY ALLIANCE, THE. A league formed between certain of the principal sovereigns of Europe, after the defeat of Napoleon at Waterloo: on the proposal, it is said, of the Emperor Alexander. It arose from the religious enthusiasm which was prevalent at that period of deliverance from French domination, and with which the Russian emperor was just then considerably imbued. The act of this alliance is said to have been sent in his handwriting to the Emperor of Austria and King of Prussia, and signed by them. It is not supposed that the original terms of the league were other than indefinite: for the maintenance of justice, religion, &c. in the name of the Gospel. But it was subsequently connected with the determination of those monarchs to support, in conjunction with England and France, existing governments throughout Europe, by the Declaration of November, 1819: afterwards, the congresses of Troppau, Laybach, and Verona established the character of the alliance; to which the war of France against Spain, in 1823, gave additional illustration. Since the secession of England and France, the alliance can scarcely be said to have any active existence. (See *Ed. Rev.* vol. xxxii. xxxix.)

HO'LY ROOD, or HOLY CROSS. A festival kept on the 14th of September, to commemorate the exaltation of the Holy Cross. It is from this circumstance that the royal palace in Edinburgh has derived its appellation.

HO'LY STONE. A stone used by hand, with sand, to scour the ship's decks. The large stone worked by ropes is called the *bear*. The sand is used with water; but it has long been a very general practice in the navy to use dry sand below: this is called *dry holy-stoning;* it is considered more healthy than using water frequently.

HO'LY THURSDAY, or ASCENSION DAY. In the Romish Calendar, the 39th day after Easter Sunday. A festival in commemoration of Christ's ascension.

HO'MÆOMERI'A. (Gr. ὁμοιομέρεια, *similarity of parts.*) The name given to the physical theory of Anaxagoras, a Grecian philosopher of Clazomenæ, who flourished in the fifth century B.C. According to this hypothesis every material substance is made up of infinitely small parts similar to itself. Hence the growth and nourishment of animals and vegetables was accounted for, by supposing the alimentary substance to be analysed into its various component parts corresponding to the parts of the substance nourished. For instance, corn was supposed to contain particles of blood, bone, flesh, skin, &c., which by the process of digestion were separated from each other, and added to the corresponding parts of the animal body. This theory bears some resemblance to that of the *monads* of Leibnitz in modern times. *See* MONAD.

HO'MÆOPATHY. (Gr. ὅμοιος *similar;* and πάθος, *feeling or affection.*) The homæopathic method of healing diseases was first proposed by Samuel Hahnemann, a German physician, in 1796. It consists in the administration of medicines which are presumed to excite in healthy persons symptoms similar to those of the disease which is to be treated, upon the principle that *similia similibus curantur*. Thus they maintain that sulphur produces a pustular eruption upon the skin, and therefore cures pustular eruptions; and that quinia produces febrile symptoms, and therefore cures agues, and so forth. Not the least absurd part of this practice is the smallness of the doses in which the homæopathic remedies are administered, it being presumed that by infinite subdivisions the virtues of remedies are proportionately refined and exalted. A grain, for instance, of any active remedy, such as aloes, is triturated with 1000 grains of sugar of milk; when this mixture is complete, a grain of it is again diluted with 1000 of the vehicle; and so of medicines which the ordinary practitioner administers in doses of one or two grains or more, the homæopathist prescribes in the quantity of a millionth or the decillionth of a grain, or even less. Hahnemann was also a believer in animal magnetism. It is not surprising that enthusiasts of this cast should occasionally start up; but it is remarkable that they should find converts among persons in their right senses.

HO'MAGE. (Lat. homagium, or hominium, from homo, *man*, the usual term by which the vassal or dependant of a prince is designated in the older writers of the middle ages.) The symbolical acknowledgment of dependence due from a vassal to a feudal lord or superior when invested with a fief, or obtaining it by succession. In the earliest periods of he feudal system fealty and homage appear to be confounded (see *Sir F. Palgrave on the English Commonwealth*, vol. ii. p. cccxc.); but in later times the distinction was clearly established, and fealty might sometimes be due where homage was not. Homage was either homagium ligeum, *liege homage*, by which full and unreserved allegiance was rendered; or homagium non ligeum, *simple homage*, a mere acknowledgment of feudal superiority, with a saving or exception of the rights of other feudal lords. The one was personal, and could not be renounced (hence the doctrine of *allegiance*); the other bound the vassal only so long as he held the fief in respect of which it was due.

HO'MALIA'CEÆ. (Homalium, one of the genera.) A natural order of arborescent or shrubby Exogens, inhabiting the tropics. According to Brown related to *Passifloraceæ*, but distinguished by their inferior ovary. De Candolle places them between *Samydaceæ* and *Chailletiaceæ*. They are plants of some beauty, but of no known use.

HOME, in Naval language, is said of any thing that is close in its place; it is applied to the sheets of the sails, the shot and cartridge in a gun, and any article of stowage.

HO'MICIDE. (Lat. homo, *a human being*, and cædo, *I kill.*) In Law, the killing of any human creature; which is either justifiable — viz. 1. In case of necessity, public or private; 2. By permission of law for the advancement of justice; 3. For the prevention of forcible and atrocious crime. Or excusable — 1. By misadventure; 2. In self-defence on a sudden affray, or chance-medley. Or felonious: of which the species are — 1. Self-murder; 2. Manslaughter, which is defined "the unlawful killing of another without malice, express or implied;" 3. Murder, or the wilful killing of another by malice aforethought; 4. Petit treason, which by the Statute of Treasons was confined to the cases of a servant wilfully killing his master, a wife her husband, or an ecclesiastical person his superior; but the distinction in judgment between this offence and murder is now abolished.

HO'MILY (Gr. ὁμιλία, *an assemblage*), was used by the early fathers in the same sense as our word sermon; both of which, according to their original meaning, signify the familiar discourse with which the primitive teachers enforced their doctrines, in opposition to the more remote and declamatory orations which were more fashionable at the time. Up to the fifth century the practice of preaching was confined to the bishops, and the only homilies extant are of their composition. The term, which has now become obsolete, was in constant use as late as the Reformation; and the English Book of Homilies is a collection of plain sermons, setting forth the principal doctrines of Christianity, and pointing out the principles of Protestantism; of which the first part was published by Cranmer in the reign of Edward VI., and the second by order of convocation in that of Elizabeth.

HOMOCHRO'MOUS. (Gr. ὁμοῦ, *together*, and χρῶμα, *colour.*) When all the florets in the same flower-head are of the same colour.

HOMO'GAMOUS. (Gr. ὁμοῦ, and γάμος, *marriage.*) In Grasses, when all the florets of the spikelets of the same individual are hermaphrodite; in Composite plants, when all the florets of a flower-head are hermaphrodite.

HOMOGE'NEOUS. (Gr. ὁμοῦ, and γένος, *kind.*) Homogeneous bodies are those of which the constituent elements are all similar. Homogeneous quantities are such as can be added to or subtracted from each other.

HOMO'LOGOUS. (Gr. ὁμοῦ, and λόγος, *ratio.*) Having the same ratio or proportion. In Geometry, those sides of similar figures which are opposite to equal and corresponding angles are proportional to each other, and therefore said to be *homologous*. The areas and solid contents of such figures are likewise homologous for the same reason.

HOMO'NYMS. (Gr. ὁμοῦ, and ὄνομα, *a name.*) Words which agree in sound but differ in signification, as the substantive "bear" and the verb "bear."

HOMOOU'SIANS and HOMOIOU'SIANS. Names by which the Orthodox and Arian parties were distin-

guished in the great controversy upon the nature of Christ in the 4th century; the former word signifying that the nature of the Father and Son is the *same*, the latter that they are *similar*. (*Gibbon*, vol. iii. *See* ARIANS.) Homoousian (Gr. ὁμοουσιος) is derived from ὁμος, *the same*, and ουσια, *being*; Homoiousian (ὁμοιουσιος) from ὁμοιος, *similar*, and ουσια. (See also *Milman's Hist. of Christianity*, ii. 443.)

HOMOPHO'NOUS. (Gr. ὁμος, *the same*, and φωνη, *voice or tone*.) In Music, of the same pitch, or unisonal. Two or more sounds are said to be homophonous when they are of exactly the same pitch.

HOMO'PHONY. (Gr. ὁμος, and φωνεω, *I speak*.) Homophonous words or syllables, in language, are words or syllables having the same sound, although expressed in writing by various combinations of letters. Languages which abound in homophonies are, 1. Some Oriental monosyllabic tongues, namely, the Chinese and its kindred dialects, in which very few sounds comprise the whole vocabulary, and the same sound is expressed by a variety of ideographic characters (in Chinese there are only 400 such sounds, multiplied by the distinctions of tone and accent to 1600 or 2000); and, 2. Some European tongues in which, according to the genius of the dialect, the syllables of the original languages from which the words are chiefly derived have been contracted in speaking, and part of their sounds dropped, while the greater part of the letters is retained. Thus in English, and still more in French, which is peculiarly a dialect of Latin abounding in contractions, homophonies are numerous (in the latter tongue the number of syllables differently spelt, all having nearly the sound of our broad A, amounts to more than a hundred); while in Italian, in which the original proportions of the Roman language are preserved, they are scarcely to be found at all.

HOMO'PTERANS, *Homoptera*. (Gr. ὁμος, and πτερον, *a wing*.) The name of an order of insects, dismembered from the *Hemiptera* of Linnæus, including those in which the wing-covers are of an uniform semi-membranous consistency. Latreille divides this order into the three following divisions: viz.

1. The *Cicadariæ*, having the tarsi three-jointed, and the antennæ very short, terminated by a fine bristle.
2. The *Aphidiens*, having the tarsi two-jointed, and the antennæ longer, without a terminal bristle; containing the families *Aphidæ* and *Psyllidæ*.
3. The *Gallinsecta*, having the tarsi one-jointed, terminated by a single claw. The males have two wings, and are destitute of a mouth; the females are wingless, and furnished with a sucker.

HOMO'TROPAL. (Gr. ὁμος, and τρεπω, *I turn*.) In Botany, a term used in describing the direction of bodies, to denote any one having the same direction as the body to which it belongs, but not being straight.

HO'NEY. (Germ. honig.) A sweet viscid substance elaborated by the bee from the juices of the nectaries of flowers, and deposited in the waxen cells of the *honeycombs*. That which spontaneously runs out of the comb is called virgin honey. Pure honey consists of a syrup or uncrystallizable sugar, and of a solid or granular sugar which resembles that obtained from the grape.

HONEY STONE. A yellow mineral found in octoedral crystals at Artern in Thuringia. It is extremely rare. It consists of a peculiar acid (the mellitic acid) combined with alumina and water.

HONG. The Chinese name for the foreign factories situated at Canton. The hong merchants are those persons who are alone legally permitted to trade with foreigners. They are ten in number; and are always held responsible by the government for paying all duties, whether on imports or exports in foreign vessels. No foreign ship that enters the Chinese ports can commence unloading until she has obtained a hong merchant as security for the duties.

HONORA'RIUM. (Lat honos, *honour*.) A term used almost synonymously with *fee*, and applied at present chiefly to the fees tendered to professors in universities, and to medical or other professional gentlemen for their services. It was originally applied solely to the salaries of the great officers of state, whose services it was considered, by a perhaps pardonable euphemism, were remunerated only, as it were, *honoris causa*; a shade of meaning which is still perceptible in the present use of the term.

HO'NOUR (Lat.), in Law, signifies the more noble sort of seigniories, on which other lordships or manors depend by the performance of customary services.

The term *honour*, in its common sense, is susceptible of various significations; all of which, however, may easily be traced to its original meaning, *esteem or regard built on opinion*. Among the Romans honour was deified; and in modern times the term plays a no less important part, being used, in various terms of phraseology, to indicate certain rules by which society in general, and especially that portion of it called *fashionable*, has tacitly consented to regulate its proceedings, any deviation from which is attended by expulsion from its pale. To this class may be referred, with slight modifications of meaning, the phrases *debt of honour*, *law of honour*, *court of honour*, *affair of honour*, &c., which are all self-explanatory. The term was formerly the style of a man of rank generally; but it is now distinctively conferred on the Vice-chancellor, and the Master of the Rolls.

HO'NOURABLE. A title prefixed to the Christian names of the younger sons of earls, and to those of all the children, both sons and daughters, of viscounts and barons. It is also conferred on persons filling certain offices of trust and dignity, such as the maids of honour of the queen and queen dowager; and collectively on certain public bodies or institutions, as the House of Commons, the Congress of the United States, the East India Company, &c. &c. The title of *right honourable* is given to all peers and peeresses of the United Kingdom; to the eldest sons and all the daughters of peers above the rank of viscount; to all privy councillors; and to some civic functionaries, as the lord mayors of London and Dublin, the lord provosts of Edinburgh and Glasgow, &c.

HONOUR, LEGION OF. *See* LEGION, &c.

HOOPING COUGH. *See* WHOOPING COUGH.

HOP. The *Humulus lupulus* of Linnæus, the female flowers of which are used for imparting a bitter flavour to malt liquors for the purpose of preserving them from fermentation. The hop plant is a perennial indigenous to Britain and different parts of Europe; but to produce abundance of hops it requires to be very carefully cultivated in good soil, and even then is one of the most precarious of crops. The fields in which hops are grown are commonly called hop gardens: a loamy soil on a dry subsoil is chosen, and the plants are placed in hills, stools, or groups of three or four in a group, the hills being in rows five or six feet apart, and at about the same distance in the row. A full crop is not produced till the fourth or fifth year after planting. Every year the ground is dug in winter, and kept clear of weeds during summer; and the hills have poles, generally three or four to a hill, for the plants to twine on: the purchase of these poles, the fixing them in the soil every spring, the taking them down and stacking them every autumn, and their removal every five, six, eight, or ten years, according to the kind of wood used, constitute a considerable part of the expense of hop culture. The hops when mature are picked by hand, and as they are picked they are carried to a drying kiln, dried, and packed into bags or pockets; and this is also an expensive process. The hop plant is particularly liable to be injured by insects, by cold and continued rains, and by thunder storms; in consequence of which it is estimated that a full crop is not obtained oftener than above once in five years. Hence it is easy to conceive that the price of hops must vary greatly in different years, and that the grower who has a command of capital may profit largely by keeping them back from market when the prices are low, and only exposing them when they are high. In order to keep hops for two or three years, they require to be powerfully compressed, and put into much closer canvass bags than when they are to be sent immediately to market; they also require to be kept in dry airy lofts, neither too warm nor too cold. The culture of hops was introduced into England from Flanders in the reign of Henry VIII. The most extensive plantations are in Kent, Sussex, and Herefordshire; but they are cultivated to a considerable extent in many other counties. The hop growers are placed under the surveillance of the excise, a duty of 18*s*. 8*d*. per cwt. being charged upon all hops grown in this country. In 1837, the number of acres of land under cultivation of hops was 56,323; and in the same year the duty amounted to 310,794*l*. 4*s*., of which Kent contributed nearly one half.

HO'PLITES. (Gr. ὁπλιται, from ὁπλα, *arms*.) The heavy-armed infantry of Grecian antiquity. According to the Athenian regulations (similar probably to those of other states) the higher classes of citizens only, as estimated by the census, were liable to this expensive form of military service; in process of time, however, it seems that the Thetes or inferior classes also served as Hoplites. The Hoplites were armed in early times with the spear, heavy defensive armour, and large shield; the latter were exchanged after the time of Iphicrates for the light cuirass and target.

HOP OAST. A particular description of kiln used for drying hops. The floor of the kiln is generally of wire cloth, and the heat is generated in a stove with flues below. The hops after being put on the kiln are frequently turned, and in general they are rendered sufficiently dry in the course of a few hours; when dried they are taken to a loft and left to cool for a day or two, and then put into bags, having been previously subjected to the slight action of the fumes of burning sulphur (sulphurous acid), by which they are to a certain extent bleached.

HO'PPLE. A mode of fettering the legs of horses or other animals turned out to graze on a common or other unenclosed place.

HOP POLES, are poles or stakes annually inserted at the roots of hop plants for their stems to twine round. When a hop plantation is first made, as the plants are

weak the poles are not required to be more than five or six feet in length; but in the third or fourth year they require to be ten or twelve feet in length. Any kind of young trees or saplings may be used as hop poles; but the most durable are those of the oak, the ash, the sweet chestnut, and the larch. The locust or *Robinia* was strongly recommended as a durable hop pole by Cobbett; but though this wood is very durable when of not more than a certain age, it does not appear to be so when of the size most proper for hop poles. Much of the durability of the hop pole no doubt depends on the soil in which it is grown; but, all circumstances being alike, poles of larch wood, which are much employed in the neighbourhood of Farnham, have been found to last longer than any other.

HO'RARY CIRCLES, on Globes, are hour lines, or circles marking the hours, and drawn at the distance of 15° on the equator from each other. They are the same as *meridians*.

HO'RARY MOTION, is the motion of a celestial body, or the space which it moves through, in an hour. The apparent horary motion of the heavenly bodies in their diurnal revolution is 15°; for as the whole circle is completed in 24 hours, the 24th part of it, or 15°, must be passed over in one hour.

HORDE. A collective name given to those migratory nations who, like the Tartars, are not addicted to a pastoral life, but exist by plunder and rapine.

HO'RDEIN. A modification of starch, which, according to Proust, constitutes about 55 per cent. of barley-meal.

HO'RDEOLUM. (Lat. dim. of hordeum, *barley*.) A small tumour on the eyelid, somewhat resembling a barley-corn; it is a little boil projecting from the edge of the eyelid, and is commonly called a *stye*.

HO'REHOUND. This indigenous plant has a bitter and somewhat aromatic flavour, and is considered as an expectorant, and as giving relief in asthma; hence the celebrity of *horehound tea* among the common people.

HORI'ZON (Gr. ὁρίζω, *I bound* or *terminate*), in Astronomy and Geography, is the plane of a great circle of the sphere, dividing the visible from the invisible hemisphere. The horizon is either *sensible* or *rational*. The sensible horizon is a plane which is a tangent to the earth's surface at the place of the spectator, extended on all sides till it is bounded by the sky; the rational horizon is a plane parallel to the former, but passing through the centre of the earth. Both the sensible and rational horizon are relative terms, and change with every change of the spectator's position on the surface of the earth; in all cases they are perpendicular to the direction of gravity.

If the eye of the spectator were in the plane of the sensible horizon, stars would not appear to rise till they are above that plane; but if he is elevated above the horizon, a greater extent of the earth's surface will be visible, and the stars will appear to rise before they reach the plane which is a tangent of the earth. Hence the sensible horizon is sometimes defined to be the conical surface which has its apex in the eye of the spectator, and embraces that portion of the earth over which the eye can reach. The visual rays which are tangents to the earth are situated in this surface, and consequently point below the true sensible horizon, or the rational horizon which is parallel to it; and the angle which a visual ray makes with the plane of the horizon is technically called *the depression of the horizon*, or *the dip*. The dip can be easily computed from the known dimensions of the earth, and the height of the eye above its surface; but the real depression of a visible object below the horizon cannot be determined in this manner, on account of the refraction of the atmosphere, which prevents the rays of light from coming to the eye in a straight line.

HORIZO'NTAL RANGE, in Gunnery, is the distance to which a piece of ordnance will carry a ball on a horizontal plane. Supposing no resistance from the atmosphere, the greatest range would be when the piece is elevated at an angle of 45°; and in all other positions the horizontal range would be as the double of the sine of the angle of elevation. In a resisting medium the maximum horizontal range requires the elevation to be less than 45°. It is found by experience that with the ordinary velocity a cannon shot ranges the farthest when the elevation of the piece is about 30°. *See* GUNNERY.

HORN, partakes of the chemical nature of the cartilaginous part of bone; it consists chiefly of albumen, with some gelatine and a trace of phosphate of lime. *See* CORNUA.

HORN (commonly called French Horn). A brass musical wind instrument of a complex spiral form, increasing in diameter to its end or mouth, which the French call its *pavillon*. The inflexion of it is much regulated by the insertion of the hand in the pavillon.

HO'RNBLENDE. A mineral of a dark green or black colour, abounding in oxide of iron, and entering into the composition of several of the trap rocks. It is the *amphibole* of Hauy.

HORNBLENDE-SCHIST. A slaty variety of hornblende, generally including felspar and grains of quartz; it is of a dark green or black colour. Where clay slate is in contact with granite, it sometimes passes into hornblende slate.

HOR'NET. *See* VESPIDÆ.

HO'RNING, LETTERS OF In Scottish Law, a species of diligence (*i. e.* process) against a debtor. They are writs in the king's name, proceeding on the warrant of a decree of the Court of Session, or of the magistrates of boroughs, and of various other inferior authorities; but in these cases a warrant of the Court of Session must also be obtained. They direct the debt to be paid within a limited number of days (according to the nature of the debt). In default of such payment the debtor incurs the charge of rebellion, and is thereupon liable to *caption* or arrest.

HO'RNPIPE. The name of a well-known dance, for the skilful performance of which the British sailors have long been celebrated. The origin of the name is uncertain; but it is believed to be derived from a kind of musical instrument called *pib-corn* (Ang. *hornpipe*), consisting of a wooden tube with holes and a reed, and a horn at each end, which was formerly used in Wales. (See *Barrington's Archæologia*, vol. iii. 177.)

HORN SILVER. A name given by the older chemists to chloride of silver, which when fused puts on a horny appearance. For the same reason chloride of mercury or calomel is occasionally called *horn quicksilver;* and chloride of lead *horn lead.*

HO'RNSTONE. A variety of flint of a semitransparency somewhat resembling that of horn. One of the varieties of porphyry goes under the name of hornstone porphyry.

HORN WORK. In Fortification, a kind of outwork carrying on the head or fore part two demi-bastions resembling horns, whence the name.

HORO'GRAPHY. (Gr. ὥρα, *hour*, and γράφω, *I write.*) The art of drawing hour-lines, or of constructing dials.

HOROLO'GIUM, or HOROLOGE. (Gr. ὥρα, and λογος, *discourse.*) A term frequently used by ancient writers to denote a clock, watch, or other machine for measuring time.

HORO'LOGY (Gr. ὥρα, and λογος, *discourse*), signifies literally an explanation of the methods of measuring and marking the hours of the day. Anciently the term *horologium* was applied to any sort of contrivance for measuring the hours, as the clepsydra and sundial (see the terms); but as these instruments have been superseded by clocks and watches, horology is now usually understood to signify a description of the principles on which machines for the measurement of time, moved by weights or springs, are constructed.

Machines for measuring time are designated by the general appellation of *clocks* and *watches;* but they are also distinguished by peculiar names arising from certain modifications in their construction, or from certain particular purposes they are intended to serve. By the term *clock* is understood an instrument which not only shows, but also strikes, the hours. A *time-piece* is one which shows the hours without striking them; a *quarter-clock* is one which strikes the quarters as well as the hours; an *astronomical clock* is one which shows sidereal time; a *watch* is a portable or *pocket time-piece;* a *repeater* is one having a contrivance by means of which it can be made at any time to repeat the hours; a *chronometer* is a watch of the best kind, or one fit to be employed for astronomical purposes.

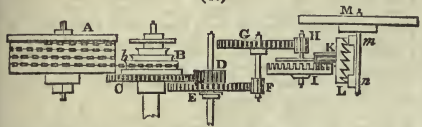
In a general view, horological machines may be regarded as consisting of three essential parts: — 1st, a moving power, which produces a rotatory motion about an axle; 2d, a train of wheel-work, by means of which a velocity is obtained having any required ratio to that of the primary axle; and 3d, a regulator, by which the rapidity of the revolution is determined, and uniformity of motion produced. The moving power is either a heavy weight which descends by the force of gravity, or a spring which is coiled up within a barrel and unwinds itself by the force of its elasticity; the first being preferred on account of the perfect regularity of its action when the instrument is to remain fixed in a place, and the second being necessary for pocket time-pieces and those which cannot be kept in a fixed position, as on ship-board. The train of wheel-work is chiefly remarkable on account of the delicacy and accuracy of its construction. The regulator is either a pendulum, of which, by the theory of falling bodies, the oscillations are isochronal or performed in equal times; or a heavy balance, the reciprocal vibrations of which are also isochronal. *See* BALANCE, PENDULUM.

Of the various mechanical contrivances introduced into horological machines for accomplishing particular purposes, it would be useless to attempt a description in this place, as our limits will not permit them to be given with that minuteness of detail which is indispensable in order to convey a clear idea of their action. The most important is the *escapement* (or scapement), or that part of the mechanism by which the original rotatory motion

is converted into a reciprocating motion, and gives impetus to the pendulum or balance. Some other parts are also of primary importance; as the *maintaining power*, a contrivance by means of which the motion is maintained, or the machine kept going, while the weight or spring is being wound up; the *fusee*, by which in watches and spring-clocks the force acting on the wheel-work is rendered equal in all states of the tension of the spring. *See* FUSEE.

The general arrangement of the wheel-work of a clock or watch may be understood from the following description. Fig. 1. represents the movement of a common

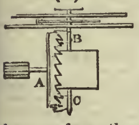
(1.)



vertical watch, the frame plates being omitted, and the dial being supposed to be turned downwards. A is the *barrel*, containing the spring which produces the motion. B is the *fusee*, connected with the barrel by the chain *b*. C is the *fusee-wheel*, called also the *first* or *great wheel*, which turns with the fusee, and works into the pinion D, called the *centre-wheel pinion:* this pinion, with the *centre wheel* or *second wheel* E, turns once in an hour. The centre wheel E works into the *third-wheel pinion* F; and on the same arbor is G, the *third wheel*, which drives the fourth or *centrate-wheel pinion* H, and along with it the *centrate wheel* I. The teeth of this wheel are placed at right angles to its plane, and act in the pinion K, called the *balance-wheel pinion;* L being the *balance-wheel*, or *scape-wheel*, or *crown-wheel*, attached to the same arbor. The balance-wheel acts on the two pallets *m* and *n* attached to the *verge* or arbor of the balance M; and these being placed at a distance from each other equal to the diameter of the balance-wheel, and in different planes, receive alternately from the scape-wheel an impetus in opposite directions which keeps up the vibratory motion of the balance.

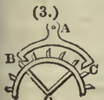
This last part of the mechanism, which it requires some attention to understand, is represented more distinctly in fig. 2., where A is the scape-wheel, and B and C the two pallets. The pallets, it is to be observed, are not placed on the verge in the same plane, but their planes form an angle equal to the excursion of the balance; so that, supposing one of them to be about 40 or 50 degrees from the mean point towards the right, the other is just as many degrees from the same point towards the left. The teeth of the scape-wheel are bent forward in the direction of the motion, like the teeth of a saw, and their number is odd. Suppose, now, a tooth of the scape-wheel to have caught the pallet B; it will continue to bear on that pallet, and to accelerate the balance, until, by the revolution of the verge, the extreme edge of the pallet comes into the plane of the extremities of the teeth, when the pallet escapes. But as the balance continues for a short time longer to move in the same direction, the pallet C now comes in between two teeth at the point diametrically opposite to the front of the tooth which B has just quitted; and as the vibration of the balance now commences in the opposite direction, this pallet is in its turn pressed upon and accelerated by the wheel.

(2.)



The *crown-wheel escapement*, now described, is the oldest and the original form, and is still used in common watches, where it answers sufficiently well; but when applied to clocks regulated by pendulums, it is exceedingly defective; for as it requires the vibration to be made in an arc of considerable extent, the pendulum must of necessity be short and light, and hence it becomes a very imperfect regulator. In order to obviate these defects, Clement, a London watchmaker, in 1680, invented the *crutch* or *anchor* escapement, which was greatly improved upon by Graham about the year 1700. Graham's escapement is represented in fig. 3. O is the centre of the scape-wheel. B A C, the crutch or anchor, consists of a heavy piece of metal attached to the rod of the pendulum with which it moves. A is its centre of motion; and in the original construction of Graham, the distance of A from O was equal to the diameter of the scape-wheel. The extremities of the crutch form the pallets, the acting faces of which are inclined planes; while the parts on which the teeth successively fall are cylindrical surfaces, the radii of which are equal to OA. The tooth being received on this surface, slides along it without tending to accelerate or retard the pendulum, until the pendulum arrives near the middle of its vibration, when the inclined plane comes to the extremity of the tooth, and the tooth then begins to act upon the plane, and to turn the pallets, and consequently accelerate the pendulum. By this arrangement the motion of the wheel only continues during the short time the tooth is sliding along the plane of the pallet, while during the rest of the vibration the tooth rests on the cylindrical surface, and the wheel stands still, or is *dead;* whence this escapement is called the *dead beat*, or the *escapement of repose*. In Hooke's form, where the cylindrical surfaces are wanting, the impulse given to one pallet carries the opposite with some force against the approaching tooth, and drives the wheel backward, or produces a recoil; and this force being applied at the extremities of the vibrations, tends greatly to disturb their isochronism. By Graham's method there is no recoil: the impetus is given while the pendulum is near the middle of the vibration, and the velocity the greatest; and during the rest of the vibration the pendulum is nearly altogether free of the action of the wheels.

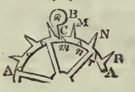
(3.)



Numerous other modifications of the crutch escapement have been proposed, and some of them carried successfully into effect; but for their description we must refer to the works in which the subject is technically treated. There are two, however, which, by reason of the greater ingenuity displayed in their contrivance, and their almost universal application to the best kinds of pocket watches, require particular notice. These are the *duplex* and the *detached* escapement, the latter being that which is used in modern chronometers.

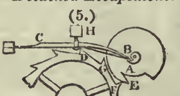
Duplex Escapement.—This is represented in fig. 4. A A is part of the scape-wheel, which is furnished with two sets of teeth, whence probably the name is derived. M N R are the teeth of repose, lying in the plane of the wheel; *m n r* are the teeth of impulse, and stand perpendicular to the plane of the wheel. B C is the impulse pallet, fixed upon the arbor of the balance just above the plane of the wheel, so that its extremity C may be caught by the teeth *m n r*, and receive the impulse from them, as they successively pass. A small ruby roller is also placed upon the arbor, behind the pallet, having a notch in one side of it for receiving the teeth M N R. When the tooth *m* has passed the claw of the pallet, the tooth M falls upon the ruby roller, where it rests until by the returning vibration of the balance the notch is brought to the point of the tooth. The tooth then falls into the notch, and thus passes the roller; and the next impulse tooth *n* comes up to the pallet, on the point of which it acts with great advantage in consequence of the long lever. As the successive impulses are all given in the same direction, the balance necessarily makes two vibrations for each impulse given by the upright tooth. The chief advantage of this construction consists in there being only one pallet, and in the action being independent of great accuracy in the execution of the teeth of the scape-wheel, which is indispensable in the case of the escapements already described, and also for the lever escapement, which in fact is only a modification of the crutch.

(4.)



Detached Escapement.— The annexed diagram, fig. 5., represents Earnshaw's construction. A is the main pallet projecting from the verge or arbor of the balance, concentric with which is another small pallet, called the *lifting pallet*, which, when the balance is vibrating from A towards B, lifts a very slender spring B, and with it the detent spring C, so as to set at liberty or unlock the tooth D, the point of which rests on a ruby pin projecting from the detent spring C, and forming the detent. The point E of the principal pallet having passed the tooth F, the wheel moves forward by the action of the main-spring, until the next tooth G falls upon the ruby pin and is locked. The screw H serves to adjust the position of the detent and the strength of the locking. In the return of the balance, the pallet A passes easily by the detent spring by forcing back the slender spring B. As in the case of the duplex, the balance here makes two vibrations for each impulse.

(5.)



Maintaining Power. — In order that a clock or watch, when perfectly regulated, may continue to indicate true mean time, it is necessary that it have some contrivance for continuing the action while it is wound up. Various methods of accomplishing this have been devised. One of the simplest consists in the interposition of a spring between the fusee and the wheel impelled by it, a little inferior in force to the main-spring (or weight), so as to remain always bent until the pressure of the main-spring is removed by the action of winding, when it begins to act upon a fixed point on one side and the wheel of the fusee on the other, so as to propel the work for a short time with a force nearly equal to that of the main-spring.

Some of the other parts of the mechanism, as the wheels for moving the minute and seconds hands, the

striking part of a clock, and the repeating part of a watch, though they form a considerable part of the bulk of the machine, require no great refinement of invention or dexterity of construction, and will be better understood from the inspection of a common clock and repeating watch than from any description which could be given.

The history of the invention of clocks is very imperfectly known. By some it has been ascribed to Pacificus, archdeacon of Verona, in the 9th century, and by others to Boethius in the early part of the 6th. The Saracens are supposed to have had clocks which were moved by weights as early as the 11th century; and as the term is applied by Dante to a machine which struck the hours, clocks must have been known in Italy about the end of the 13th or beginning of the 14th century. It is said that the first clock made in England was furnished out of the proceeds of a fine imposed upon the chief justice of the King's Bench in 1288, and that it remained in its original situation, in old Palace Yard, as late as the reign of Elizabeth. In the reign of Richard II. a large astronomical clock was made by Richard of Wallingford, abbot of St. Albans, which was regulated by a fly. But the most ancient clock of which we possess any certain account was erected in a tower of the palace of Charles V., king of France, about the year 1364, by Henry de Wyck or de Vick, a German artist. A clock was erected at Strasburg about 1370, at Courtray about the same period, and at Spire in 1395. In the following century public clocks appear to have existed in all the principal towns of Europe, and private ones to have come into very general use.

The earliest clocks were doubtless very rude and imperfect instruments, and their present state of excellence must have been attained by slow and successive improvements. Wheel work, set in motion by springs and weights, was known in the time of Archimedes; and in order to have a timepiece it was only necessary to apply some contrivance to regulate the motion. For this purpose recourse was first had to a fly wheel; but it would soon be found that the fly, the action of which depends on the resistance of the air, would form a very imperfect regulator. The clock of Henry de Wyck, above mentioned, was regulated by an alternating balance, which was formed by suspending two heavy weights from a horizontal bar fixed at right angles to an upright arbor, and the movement was accelerated or retarded by diminishing or increasing the distance of the weights from the arbor. It had no regulating spring, and the action may consequently be supposed to have been very irregular; nevertheless clocks regulated in this way were used for astronomical purposes by Walther, Tycho Brahe, Mœstlin, the landgrave of Hesse, and others. The capital improvement of the pendulum dates from about the middle of the 17th century; but it is very uncertain by whom the application was first made or proposed. Galileo was the first who remarked, or at least the first who formally announced, in his work on mechanics and motion, which was published in 1639, the isochronal property of oscillating bodies suspended by strings of the same length; and it has been pretended that he actually applied a pendulum to a clock for the purpose of observing eclipses and determining longitudes. There is, however, no proof of this fact, which has been strongly disputed. Sanctorius, in his *Commentary on Avicenna*, describes an instrument to which he had applied a pendulum in 1612. Richard Harris is said to have constructed, in 1641, a pendulum clock in London for the church of St. Paul's, Covent Garden. Vincenzo Galilei, a son of Galileo, is stated, on the authority of the *Academy del Cimento*, to have applied the pendulum in 1649. It was applied by Huygens in 1656; and by Hooke, for whom the invention has been claimed, about 1670. But to whomsoever the merit may belong of having first made the application, Huygens is unquestionably the first who accurately explained the theory of the pendulum; and hence, perhaps, the invention of the pendulum clock has been usually ascribed to him. Huygens demonstrated that the vibrations in circular arcs are not independent of the length of the arc, and that in order to obtain perfect isochronism, the ball of the pendulum must move in the arc of a cycloid; and, ingeniously applying a property of the cycloid, of which he was the discoverer, namely, that its involute is a curve similar to itself, he procured the requisite motion by causing the pendulum to vibrate between cycloidal cheeks about which the upper and flexible part of the suspending rod wrapped itself in its motion. But it was found that no practical advantage could be obtained from this beautiful contrivance; and in fact it was soon rendered unnecessary by the invention of the anchor escapement, which gives the means of rendering the arcs of vibration very small, in which case the error depending on the length of the arc becomes insensible. The application of the spiral spring to the balance is the undoubted invention of Hooke.

Another invention, which marks an epoch in the history of horology, is that of a method of counteracting the effect of changes of temperature on the pendulum rod and balance. The mercurial compensation pendulum was invented by Graham about the year 1715. Graham likewise suggested the method of effecting the compensation, by means of the unequal expansions of different metals; an idea which was subsequently realized by Harrison in the construction of the gridiron pendulum, which is now very generally used. The compensating apparatus in the watch balance depends upon the same principle, but the mechanical arrangement is necessarily very different. See BALANCE.

For full information on this subject the reader is referred to the following works:—Berthoud, *Essai sur l'Horlogerie;* Id., *Histoire de la Mésure du Tems; Cumming's Elements of Clock and Watch-Work; Derham's Artificial Clockmaker; Harrison's Principles of his Timekeeper; Earnshaw's Explanations of Timekeepers; Reid's Treatise on Clock and Watch-making;* the article "Horology" in the *Penny Cyclopedia*, &c.

HORO'METRY. (Gr. ὥρα, and μετρον, *measure.*) The art of measuring hours.

HO'ROSCOPE. (Gr. ὥρα, and σκοπεω, *I observe.*) A representation of the aspect of the heavens and positions of the celestial bodies at a particular moment, drawn according to the rules of the imaginary science of astrology. Thus the aspect of the heavens at the moment of the birth of an individual is his horoscope, and supposed to indicate his future destinies. See ASTROLOGY.

HO'RPOE. See UPUPA.

HORRIPILA'TION. (Lat. horror, and pilus, *a hair.*) The common expression of the "hair standing on end," implies the shuddering sensation to which medical writers often apply this term.

HORSE. See EQUUS.

HORSE. In Nautical affairs, a foot rope to support the feet of the seamen while leaning over a yard or boom to furl the sail. Also, a rod or rope along which the edge or the corner of a sail traverses by means of hanks.

HORSE POWER. This term, as applied to steam engines, refers to the weight which they are capable of raising to a given height in a given time. Watt estimated a single horse power at 32,000 pounds avoirdupois lifted to the height of one foot per minute; this is, however, nearly double the work of a single horse as usually applied to raising weights.

HORSE RA'DISH, the root of the *Cochlearia armoracia*, which when scraped is often eaten as a condiment and an ingredient in sauces, has a place in the *Materia Medica* as a stimulant, and a compound spirit and compound infusion are directed in the *Pharmacopœia:* the latter very soon becomes putrid, and neither are useful.

HORSE SHOE. In Fortification, a work of a round or oval form.

HO'RTICULTURE. (Lat. hortus, *a garden*, and colo, *I cultivate.*) The culture of the kitchen garden and orchard. In the kitchen garden are cultivated every description of root, herb, flower, and fruit, used in cookery; and in the orchard the more hardy fruits used in cookery, and in the dessert. The finer fruits are grown against espaliers, walls, hot walls, or under glass. The chief difference between horticulture and agriculture is, that in the former art the culture is performed by manual labour in a comparatively limited space called a garden; while in the latter it is performed jointly by human and animal labour in fields, or in an extensive tract of ground called a farm. See GARDENING, AGRICULTURE, and FARMING.

HO'RTUS SICCUS. A collection of dried plants preserved in books or papers.

HOSA'NNA. (Heb.) An exclamation, signifying literally *save now*. This Hebrew word occurs only once in the Old Test., viz. Psalm cxviii. 25. This psalm is the last of those which compose the "great Hallel.;" and hence, perhaps, this invocation was used by those who conducted our Saviour into Jerusalem. (Matt. xxi., Mark xi., John xii.) It was afterwards commonly adopted in the church. (*Riddle's Christian Antiquities*, p. 335.)

HOSIERY. See WOOLLEN MANUFACTURE.

HO'SPITAL. (Fr. hôpital.) In Architecture, a building raised and endowed for the reception of persons incapable of supporting themselves and procuring medical assistance, or as a refuge for the unfortunate or needy. Many of the charitable institutions in Great Britain are called hospitals; and are incorporated bodies, possessed of great wealth, which is expended in the support of schools, &c. (See *M'Culloch's Statistics; De Gerando, de la Bienfaisance publique*, vol. iv. book 3.)

HOSPITAL GANGRENE. A species of ulcerating gangrene, peculiarly characterized by its infectious nature, and its tendency to attack wounds or ulcers in crowded hospitals.

HO'SPITALLER, in its original acceptation, was applied to certain religious bodies, who held it their duty to provide lodging and entertainment for those persons engaged in pilgrimages. One of the most celebrated institutions of this kind was that at Jerusalem, which gave its name and origin to the Knights Hospitallers,—a well-

known religious body, instituted about the end of the 11th or the beginning of the 12th century. They soon afterwards settled permanently in England, and gradually attached a degree of wealth and importance unequalled in the history of similar bodies. They followed the rule of St. Austin, and wore a black habit with a white cross upon it. At their original institution they were styled Knights of St. John of Jerusalem; afterwards Knights of Rhodes, and again Knights of Malta; these two islands having been successively conferred on them by different monarchs. *See* St. John of Jerusalem, Knights of.

HOSPI'TIUM (Lat.), signifies in general a place or inn for the reception of strangers, in which sense it is used by old writers; but it is in modern times almost wholly restricted to the celebrated inns on St. Bernard and St. Gothard, in Switzerland, to which travellers to and from Italy resort.

HO'SPODAR, or WOIWODE. The lieutenants appointed by the Porte to govern the two Christian provinces of Moldavia and Wallachia are so called. By the treaty of Adrianople between Prussia and Turkey (1829), these officers are to hold their appointments for life, and to pay a fixed annual tribute.

HOST (from the Latin hostia, *a victim*), is applied in Theological language to the bread and wine under the appearance of which the Roman Catholics conceive the body and blood of Christ to be present upon the altar. The elevation of the Host is a ceremony prevalent in all Catholic countries, in which the consecrated elements are raised aloft and carried in procession through a church, or even through the streets of a city. On these occasions the people fall on their knees and worship the Host. The origin of the custom is dated from the 12th century, when, it is said, it was thought necessary to make this public and conspicuous declaration of the Eucharist on the occasion of the promulgation of the opinions of Berengarius against transubstantiation.

HO'STAGE. (Lat. hospes, *guest.*) A person left as surety for the performance of the articles of a treaty. The practice of taking hostages is now almost unknown in the mutual relations of civilized communities; but was formerly so common as to have given rise to many questions in the law of nations. Hostages were divided into principal and accessary; the latter being where it is expressly stipulated by treaty that the hostage shall be answerable for the event. One of the points debated among civilians on this subject was, whether such a hostage could lawfully stake his life, and whether in the event of his doing so it was lawful to take it. The affirmative was argued from the most ancient example of hostageship on record, — Reuben's words to Jacob, "slay my two sons if I bring not Benjamin back." According to Philip de Comines, the Liegois having given hostages to Charles Duke of Burgundy, with express power to put them to death in the event of an infraction of the treaty, and that event having taken place, it was much debated in the council whether the power should not be carried into execution; and after much discussion their lives were spared. It has also been questioned whether an hostage can be delivered up against his will: Grotius decides in the affirmative. The extent of the rights of conquerors over hostages, the events which may dissolve their obligation, the effect of their escape upon the convention between the principals, and other points of the subject, are treated at length by writers on national law.

HOTCHPOT, in Law, is a blending or mixing together of lands given in marriage with lands in fee falling by descent. As if A. had two daughters, and gives a third part of his lands in marriage with one of them to her husband, and dies seised of the other two thirds: in order to acquire any farther share of these lands, the married daughter must bring the lands first given into hotchpot; that is, she must renounce the gift, and allow the land to be confounded with the rest, in order that she may inherit her whole share; otherwise her sister will have the remaining two thirds of the lands. There is also a rule of hotchpot with respect to the distribution of personal property within the stat. 22 & 23 C. 2. c. 10.; as, where a certain sum is to be raised and paid to a daughter for her portion by a marriage settlement, if the daughter would have any further share of her father's personal estate she must bring this money into hotchpot, and allow it to form part of the distributable residue.

HOTE'L (Fr.), signifies, in a general sense, a large inn for the reception of strangers; but in a particular sense, especially in France, it is applied to the residences of the king, nobility, or other persons of rank: or it is used synonymously with hospital, as the *Hotel Dieu*, *Hotel des Invalides*, &c.

HO'THOUSE. A general term for the glass structures used in gardening, and including stoves, greenhouses, orangeries, and conservatories. Pits and frames are garden structures with glass roofs, with the sides and ends of masonry or wood; but they are generally so low as not to admit of being entered and walked in, and this seems to prevent them from being included under the term hothouse. *See* Stove, Greenhouse, Pits and Frames.

HOTWALL. In Gardening, walls for the growth of fruit trees, which are built with flues or other contrivances for being heated in severe weather, so as to facilitate the ripening of the wood or the maturity of the fruit. The most common form of hotwalls is that in which flues or tunnels are conducted through them, into which the smoke and heated air from fires are made to ascend from a furnace at the bottom of the wall to a chimney on the top; but in some cases hotwalls are formed by constructing the entire wall hollow, tying the two sides together by cross-stones or bricks, and introducing heat by means of pipes of metal containing steam or hot water along the bottom of the vacuity, the heat of which rises to the top of the wall, and heats every part in its progress. In all climates north of the meridian of London, hotwalls are of great use for ripening fruits and young shoots, and preserving tender plants. *See* Wall.

HOUNDS. In Naval Architecture, the projecting parts of the sides of the mast, near its head, which, like shoulders, support the rigging, &c.

HOUR, in its general acceptation, denotes the twenty-fourth part of a mean solar day, or of the time in which the earth makes a complete revolution in respect of the sun. The division of the artificial day, or time from sunrise to sunset, into twelve equal parts, belongs to the remotest ages of antiquity (see *Goguet, Origine des Loix, &c.*); the division of the *night* into the same number of parts was introduced at Rome in the time of the Punic wars. The Italians make the day commence at sunset, and reckon on to twenty-four hours, or to the succeeding sunset. Astronomers also reckon twenty-four hours from mid-day to mid-day; but in the civil reckoning only twelve hours are counted, namely, from midnight to midday, and from mid-day to midnight. The hours which result from the division of the artificial day into twelve parts are called *temporary hours*, from being of unequal lengths at the different seasons of the year.

HOUR CIRCLES, or HORARY CIRCLES. The same as meridians; being great circles of the sphere perpendicular to the equator, and their planes making with each other angles of fifteen degrees.

HOUR-GLASS. A species of chronometer or clepsydra, measuring intervals of time by the running of water or sand from one glass into another.

HOU'RIS. The name given by the Europeans to the imaginary beings whose company in the Mohammedan paradise is to form the principal felicity of the *believers.* The name is derived from hûr al oyûn, signifying *black-eyed.* They are represented in the Koran as most beautiful virgins, with complexions like rubies and pearls, and possessed of every intellectual and corporeal charm. They are not created of clay, as mortal women, but of pure musk; and are endowed with immortal youth, and immunity from the diseases and defects of ordinary beings. (See *Koran*, chap. 55, 56., Sale's translation; and the Prel. Discourse, s. 4.)

HOURS. (Gr. Ὧραι.) In Mythology, divinities regarded in two points of view—as the goddesses of the seasons, and hours of the day; and their number is stated in different ways accordingly. Their duty was to hold the gates of heaven, which they opened to send forth the chariot of the sun in the morning, and receive it again in the evening. No classical poet has described them with greater beauty than Shelley, in a celebrated passage of his *Prometheus Unbound.* These goddesses are often depicted as forming the train of Venus. (See Homer, *Hymn. ad Ven.* 145.; Hes., *Erg.* ver. 75., and *Hymn. ad Apoll.* ver. 194.; see also *Gray's Ode on the Spring.*)

HOURS, CANONICAL. The seven hours of prayer, observed, it is said, by the Catholic church since the 5th century; chiefly in monasteries. The number seems before that time to have varied, although some peculiar seasons of the day and night were always set apart for this observance. They became finally fixed at seven by the rule of St. Benedict; a number, perhaps, recommended by the literal acceptation of the words of David (Psalm cxix.), "Seven times a day will I praise thee." These hours are termed, in the language of the Latin church, matins, prima, tertia, nona, vespers, completa or completorium, which last takes place at midnight. At the time of the Reformation the canonical hours were reduced in the Lutheran church to two, morning and evening; the "reformed" church never observed them. (See *Bingham's Ant. Eccl.* 5.; *Riddle's Christian Ant.*; *Ersch and Gruber's Encycl.*, "Horæ.")

HOUSE. (Germ. haus.) A human habitation, or place of abode of a family. Among the eastern nations, and those to the south, houses are flat on the top, with the ascent to the upper story by steps on the outside. As we proceed northward, a declivity of the roof becomes requisite to throw off the rain and snow, which are of greater continuance in higher latitudes. Among the ancient Greeks, Romans, and Jews, the houses usually enclosed a quadrangular area or court, open to the sky. This part of the house was by the Romans called the *impluvium*, or *cavædium*, and was provided with channels to carry off the waters into the sewers. Both the Roman and Greek

house is described by Vitruvius, to whose works we must refer the reader for further information on these heads. The word *house* is a term used in various ways; as in the phrase "a religious house," either the buildings of a monastery, or the community of persons inhabiting them, may be designated. In the middle ages, when a family retired to the lodge connected with the mansion, or to their country-seat, it was called "keeping their secret house." (See *Northumberland Household Book*.) Every graaation of building for habitation, from the cottage to the palace, is embraced by the word house; so that to give a full account of the requisites of each would occupy more space than could be devoted to the subject in this work: indeed to say more would be to write a treatise on domestic architecture.

HOU'SEHOLDER. In Law, the occupier of a house. Where the right of voting for members of parliament is in inhabitant householders, it has been settled by a current of decisions that no one is to be considered as such who does not possess the exclusive right to the use of the outward door of the building. He retains the character, however, although by taking inmates he may for a time have relinquished the exercise of that exclusive right. The "outward door," to satisfy this description, need not be a door opening on the public way; a room or set of rooms having a separate and exclusive outward door (as chambers in one of the Inns of Court) may in the eye of law constitute a house. The same principle is followed in criminal law, where, to constitute the offence of burglary, it is necessary that a "house" shall have been broken and entered.

HOUSEHOLD, THE KING'S. The chief officers of the king's household are,—1. The lord chamberlain; under whom are the vice-chamberlain, groom of the stole, lords of the bedchamber, gentlemen of the privy chamber, &c. 2. The lord steward; in whose office are the treasurer and comptroller of the household, yeomen of the guard, gentlemen pensioners, master of the horse, &c.

HOUSEHOLD TROOPS. *See* GUARDS.

HOUSE OF CORRECTION. A prison for the punishment of idle and disorderly persons, vagrants, trespassers, &c. They are regulated by 4 G. 4. c. 64. and other statutes. *See* BRIDEWELL, PRISON.

HOU'SING. (From house.) In Architecture, the space taken out of one solid to admit of the insertion of another.

HO'VEL. An open shed for sheltering cattle, for protecting produce or materials of different kinds from the weather, or for performing various country operations during heavy rains, falls of snow, or severe frosts.

HOW'ITZER. (Germ. häufen, *to fill up*.) A species of mortar, or piece of ordnance, of iron or brass. The iron howitzers used in the British service are four or five feet long, and eight or ten inches diameter.

HOY. A small vessel having generally one mast.

HUBERT, ORDER OF SAINT. The highest Bavarian order of knighthood, founded in 1444.

HUE AND CRY. In Law, the common process of pursuing a felon. This custom is of ancient origin, and evidently arose from the practice of pursuing the offender with a loud outcry, that all might try to bring him to justice.

HU'GUENOTS. In French History, a name given in the sixteenth century to the Protestants or Calvinists of France. The writers of that time were not acquainted with the true derivation of this popular nickname, to which they assigned various absurd etymologies; it is, undoubtedly, a corruption of the German "Eidgenossen," signifying the Swiss confederates. Geneva was the literary and ecclesiastical metropolis of the French reformed; and consequently they were naturally confounded, in the eye of the Catholic populace, with the Swiss, who supported that republic by their alliance. After a long period, during which they increased in numbers under occasional persecution (under Francis I. and Henry II.) a large party of the Huguenots took part in the conspiracy of Amboise in 1560; and although the free exercise of their religion was secured to them by the edict of January (1562), yet they were driven by the violations of that edict to take up arms against the government of Francis II. in the same year. At that period their leaders were of the houses of Bourbon (King of Navarre and Prince of Condé) and Chatillon (the Admiral Coligny). They were powerful in numbers, and still more in wealth and consequence. A very large proportion of the higher nobility; of the middle nobility and gentry, especially in the central and south-western parts of France; the whole or greater part of the population in some towns, as Rouen, La Rochelle, Dieppe, Nismes; finally, a large body among the peasantry in some districts, especially of the south, where the doctrines of the Albigeois were never fully extinguished; — these belonged to their party. But during the religious wars of the 16th century they gradually lost ground under the increasing zeal and fanaticism of the great Catholic body; and after the conversion of Henry IV. most of their chiefs among the nobility successively abandoned the faith. They sustained two civil wars in the following century against Louis XIII., which cost them the loss of the strong places which they had held, and of many of their privileges. The history of the Protestant church in France then ceased to be the history of a political party; and the name of Huguenots, about the same time, began to pass out of ordinary use. De Thou, Davila, D'Aubigny, Lanoue, are perhaps the most valuable of the numerous cotemporary historians of the 16th century. Of modern compilations, *Smedley's History of the Religious Wars of France;* Wraxall; Sismondi, vols. xvi. to xx.; *Browning's History of the Hugonots from the Edict of Nantes*, an useful compendium, with references to the best authorities, published in 1839.

HUI'SSIER. (Fr. from the old word huis, *a door;* whence our *usher*.) Executive officers in the French courts of justice, whose original function was to keep the door of the tribunal. Such officers were styled by the Romans apparitores, cohortales, executores, and by a variety of other names. In France the huissiers were originally a subdivision of the general class of *servientes, sergens;* but afterwards these latter came to be called indiscriminately huissiers. Their functions are now numerous and important. They give notice on behalf of and execute the processes of the courts to which they are attached, both civil and criminal. Those of the Court of Cassation are appointed by itself; those of the Cours Royales on the recommendation of those courts; those of courts of commerce by the government. The officers termed huissiers-priseurs, or commissaires-priseurs, are employed as appraisers at public sales.

HU'LFSTON. (Germ.) In Music, the secondary or superior note in a shake. *See* HAUPT TON.

HULK. The name given to an old ship laid by as unfit for further service. The hulks near Woolwich consist of old ships to which convicts are sent previously to their departure from the country.

HULL. The body of a ship, exclusive of the masts, rigging, &c.

Hull down, expresses that the hull of the ship is concealed by the convexity of the sea.

HUMANITA'RIAN. A term sometimes applied to those who deny the divinity of Christ, and assert him to have been *mere man*. This, however, is more than the word exactly signifies, and the term Psilanthropist, or mere Humanitarian, has been suggested as conveying the idea more precisely. *See* SOCINIAN, UNITARIAN.

HUMA'NITIES. A word employed in modern European schools and colleges of various nations, to signify grammar, rhetoric, and poetry, including the study of the ancient classics. It has the same sense with polite literature. A student in humanities (literæ humaniores) is termed a *humanist*.

HU'MBLE BEE, *See* MELLIFERA.

HU'MBOLDTINE. A native oxalate of the protoxide of iron. It occurs crystalline and massive, and of a yellow colour; the massive variety is earthy and greenish yellow.

HU'MBOLDTITE. A name given to a variety of *Datholite*, or borosilicate of lime. It occurs crystallized. These minerals are named in honour of Humboldt, the celebrated traveller.

HU'MERUS. (Lat.) The bone of the arm. The first of the radiated system of bones of the anterior extremity, articulated with the scapula in the vertebrated animals. In Entomology, Mr. Kirby so calls the third joint of the anterior pair of legs in Hexapod insects.

HU'MIFU'SUS (Lat. humus, *the ground*, and fundo, *I pour or spread out*), in Botany, denotes the spreading of plants over the surface of the ground: procumbent.

HUMIRIA'CEÆ. (Humirium, one of the genera.) A natural order of arborescent or shrubby Exogens, inhabiting Brazil, but not very well understood. They differ from *Meliaceæ* in their albuminous seeds and their slender embryo; agreeing in the latter respect, and in their balsamic wood, with *Styraceæ*. *Humirium floribundum* yields, on being wounded, a liquid yellow balsam, called Balsam of Umiri, resembling the properties of Copaiva and Balsam of Tolu.

HU'MITE. A mineral named in honour of Sir Abraham Hume, in whose celebrated collection it was found. It occurs in yellow-brown or colourless crystals on Monte Somma. It has not been analyzed.

HU'MMING BIRD. *See* TROCHILUS.

HUMOUR. *See* WIT.

HU'MOURS OF THE EYE. *See* EYE.

HU'NDRED. A hundred is a territorial division, having for its object the more convenient and efficient administration of justice; anciently subsisting in other countries, particularly France and Lombardy, as well as in England, and adopted in this country as the subdivision of a county. The institution of the hundred, as well as that of the county and tything, is, upon no precise authority, usually referred to the reign of Alfred; but it is probable that the division was of an older date, and that it was not introduced into all parts of England at the

same time. It is certain, at any rate, that the term had not in all parts the same application; for the meaning usually given to it, namely, that of a district containing a hundred free families, even if it be reconcilable with what appears to have been in early times the state of the population in the southern counties, is totally inconsistent with any reasonable conjecture as to the population of the north, where the hundred generally includes a much larger district. It is probable, therefore, that the term having originated in the south with the meaning stated, was subsequently applied to the divisions previously established in the northern counties under the name of Wapentakes. To each hundred belonged a court baron, similar in the nature and extent of its jurisdiction to the county court, and also a court leet (*see* tit. LEET); both of which were usually, and by the common law, held either by the sheriff, or by a deputy or steward having authority under him. But in some cases the jurisdiction of the court baron and court leet, or of one of them, within the hundred, was by special grant of the crown vested in private persons, and exercised by them or their deputies. The essential use of the hundred was in the liability of the hundreders, when offences were committed within their district, either to produce the offender, or make good the damage. This liability, much restricted by statute, still subsists in certain cases of riotous and wilful mischief. The division into hundreds is frequently used in acts of parliament as a convenient mode of reference.

HU'NDRED WEIGHT. A denomination of weight containing 112 pounds. It is subdivided into 4 quarters, each containing 28 pounds. *See* WEIGHTS.

HU'NTERS, *Venantes*. A tribe of spiders are so called which are incessantly running or leaping about in the vicinity of their abode, to chase and seize their prey.

HU'RDLE. A frame usually made of wood, but sometimes of iron, for the purpose of forming temporary fences. The frame consists of two perpendicular stakes, into which are fixed five or six horizontal bars, and the whole is braced together by one or two diagonal pieces. When a fence is to be formed the hurdles are put down end to end; and they are made fast to the ground by the insertion of the lower end of the stakes into it, and to one another by a tie fastened round their upper ends, or by a moveable wooden pin passed through them.

HURO'NIA. A name given by Mr. Charles Stokes to certain radiated articulated bodies formerly referred to the *Polyparia*, found in the transition limestone of Lake Huron. (*Geol. Trans.* vol. i., New Series.)

HU'RRICANE. (Span. huracan.) A violent storm, generally accompanied by thunder and lightning, and distinguished from every other kind of tempest by the vehemence of the wind, and the sudden changes to which it is subject. Hurricanes prevail chiefly in the East and West Indies, the Isle of France, and in some parts of China. The following graphic description of the usual phenomena attending the West Indian hurricanes, from the pen of Edmund Burke, may be interesting to the reader: — "It is in the rainy season, principally in the month of August, more rarely in July and September, that they are assaulted by hurricanes, the most terrible calamity to which they are subject from the climate. This destroys at one stroke the labour of many years, and frustrates the most exalted hopes of the planter, and often just at the moment when he thinks himself out of the reach of fortune. It is a sudden and violent storm of wind, rain, thunder, and lightning, attended with a furious swelling of the sea, and sometimes with an earthquake; in short, with every circumstance which the elements can assemble that is terrible and destructive. First they see, as a prelude to the ensuing havoc, whole fields of sugar-canes whirled into the air, and scattered over the face of the country. The strongest trees of the forest are torn up by the roots and driven about like stubble. Their windmills are swept away in a moment. Their works, their fixtures, the ponderous copper-boilers and stills of several hundred weight, are wrenched from the ground and battered to pieces. Their houses are no protection; the roofs are torn off at one blast, whilst the rain, which in an hour rises five feet, rushes in upon them with an irresistible violence. There are signs which the Indians of these islands taught our planters, by which they can prognosticate the approach of a hurricane. It comes on either in the quarters or at the full or change of the moon. If it will come on at the full moon, you being at the change, observe these signs. That day you will see the sky very turbulent. You will observe the sun more red than at other times. You will perceive a dead calm, and the hills clear of all those clouds and mists which usually hover about them. In the clefts of the earth, and in the wells, you will hear a hollow rumbling sound like the rushing of a great wind. At night the stars seem much larger than usual, and surrounded with a sort of burs. The north-west sky has a black and menacing look, and the sea emits a strong smell and rises into vast waves, often without any wind. The wind itself now forsakes its usual steady easterly stream, and shifts about to the west, from whence it sometimes blows with intermissions violently and irregularly for about two hours at a time. You have the same signs at the full of the moon. The moon itself is surrounded with a great bur, and sometimes the sun has the same appearance." *See* STORMS, TORNADO.

HURST. (Sax.) A wood; hence the termination of the names of several places in England, particularly in Kent and Sussex.

HU'SBANDRY. A comparatively primitive term, including both agriculture and gardening, or all those country occupations which the father of a family is expected to perform in the country. The term is very commonly used as synonymous with agriculture. The Berwickshire husbandry, the convertible husbandry, are terms used in agriculture for certain systems of cropping in which the land is alternately kept under grass and tillage.

HUSSA'RS. A name given to some well-known equestrian troops, used in all the armies of Europe. The term is of Hungarian origin (being derived from husz, *twenty*, and ar, *pay*, every *twenty* houses furnishing *one* man), and was first applied to the body of troops raised by the nobles of Hungary on occasion of the appeal made to the latter in 1458 by Mathias Corvin. The equipments of such troops are extremely light and elegant, and their arms consist of a sabre, a carbine, and a pair of pistols. In the British cavalry there are five regiments of Hussars.

HU'SSITES. The followers of John Huss, a Bohemian reformer and divine, who was convicted of heresy by the council of Constance, and burnt by order of the Emperor of Germany, in 1415. The circumstances attending the origin of this sect are interesting; inasmuch as while, on the one hand, there is no doubt but that the writings of Huss and Jerome of Prague were the source from which Luther drew a great part of his opinions and views, it is ascertained at the same time that it was from the books of Wiclif that Huss was himself induced to institute his bold inquiries into the faith and morals of the church. The errors which were charged against him contain many of the opinions now held by all Protestants; but several of these he himself denied, and those for the assertion of which he ultimately suffered have neither been universally held by reformers, nor seem of very great importance. They were these: — 1. That Pope Sylvester and the Emperor Constantine did evil to the church when they enriched it. 2. That if any ecclesiastic be in a state of mortal sin, he is disqualified for the administration of the sacraments. 3. That tithes are not dues, but merely eleemosynary. On the other hand, he held the Romish idea of transubstantiation; and the opinion of the necessity of communion in both kinds, which became afterwards the most remarkable feature in the doctrines of the Hussites, is not in reality to be ascribed to their founder. The condemnation of Huss is also remarkable, as it is from the circumstances attendant on it that the imputation of not keeping faith with heretics is originally charged upon the Roman church. The Emperor Sigismund gave Huss a safe conduct, to secure him from any ill consequences that he might apprehend from delivering himself up voluntarily to be examined by the council. Nor did the council assert any right to condemn him. They handed him over to the secular arm, to the emperor himself. But it is confidently asserted that when the emperor scrupled to violate a promise which was undoubtedly binding upon him, it was at the pressing instance of the pope or cardinals that he allowed the execution to take place. The apologists of the Roman Catholics in this matter affirm that this safe conduct imported only that Huss might *go to Constance* without being harmed; the words of the original instrument, however, are reported to be, "Transire, stare, morari, redire liberé permittatis."

After the execution of Huss, and of his disciple Jerome in the following year, there arose a violent insurrection among their partizans in Bohemia, who maintained themselves for many years by force of arms, and split into two sects, under the denominations of the Calixtines and the Thaborites. The former, so called from demanding the cup in the sacrament, were finally reconciled to the church by the concession which they required. The latter were so called from the name they gave to the hill on which they pitched their camp in the neighbourhood of Prague, and carried their notions upon the authority of the church and its ministers, ceremonies, and all the exterior of religion, to the length of an extravagant simplicity. The Bohemian Brothers and the Beghards, who gave so great an impulse to the Reformation, were the descendants of this branch of the Hussites. (Cochlæus, *Historia Hussitarum*; *Gieseler's Text-book*, iii. 355., translation.)

HU'STINGS. (Either from the French hausser, *to lift*, or Sax. hus, *house*, and ting, *court* or *judgment*.) The principal court of the city of London, held before the lord mayor and aldermen: also, in common language, the booth or elevated place on which candidates at a parliamentary election are proposed, and address their constituents.

HUTCHINSO'NIANS. The name given to those who embraced the opinions of John Hutchinson, a well-known philosopher and naturalist of the 18th century. Though the followers of Hutchinson have never constituted a sect, they have reckoned among their number several distinguished divines both of the established churches of the United Kingdom and of dissenting communities. The number of professed Hutchinsonians is rapidly decreasing, though the principles and views of their founder are still entertained by many. The chief characteristics of Hutchinson's philosophy consist in his rejection of Newton's doctrine of gravitation; and in his maintaining the existence of a plenum on the authority of the Old Testament, which according to him embraces a complete system of natural philosophy as well as of religion. See his works, 12 vols. 8vo. 1748.

HY'ACINTH. (Gr.) In Mineralogy, one of the names given to the yellow or brown crystals of zircon. It occurs in beds of streams and rivers, especially in Ceylon, along with rubies, sapphires, &c. Its most usual form, when in crystals, is a four-sided prism terminated by four rhombic planes.

HYACI'NTHUS. In Grecian Mythology, the son of Amyclas king of Laconia, and of the muse Clio, accidentally killed by Apollo while they were playing at quoits. The story is thus related:—Zephyr, enraged at the preference displayed by Hyacinthus for Apollo, caused the wind of which he was the god to turn from its course a quoit thrown by Apollo, which hitting him on the forehead instantaneously caused his death. The latter immortalized his favourite by causing the flower which still bears his name to spring from his blood, and inscribing the word AI (Gr. αι, *alas*) on its leaves, to indicate the deep grief of the god for his loss. An annual festival named Hyacinthia, was celebrated at Amyclæ in honour of Hyacinthus. (*Athen. Deipn.* iv. p. 139.)

HYACY'NTHINE. A brown or greenish mineral in eight-sided prisms, transparent and doubly refractive.

HY'ADES. (Gr. ὕειν, *to rain.*) In Mythology, the name given to the daughters of Atlas and Pleione, who, overwhelmed with grief at the fate of their brother Hyas, who was torn in pieces by a bull, are said to have wept so violently that the gods, in compassion, took them into heaven and placed them in the Bull's forehead, where they still continue to weep, and are thence supposed to presage rain. They form a cluster of five stars in the face of Taurus.

HYADES. *See* TAURUS.

HYÆ'NA. (Gr. Ὑαίνα.) A genus of digitigrade Carnivorous Mammals, separated by Storr from the *Canis* of Linnæus, from which it not only differs in dentition and other important particulars, but, in general, manifests a closer affinity with the *Viverridæ;* between which and *Felis*, the genus *Hyæna* is placed by Cuvier. The characters of this genus are, five molars above and four below, on each side, the three anterior molars being conical, smooth, and remarkably large, adapted for breaking the bones of their prey; the tongue has a broad patch of cuticular spines on the anterior part of its dorsum; the legs are each terminated by four claws; there is a peculiarly large perineal glandular pouch; and the neck and jaws are remarkable for the strength of their muscles. The species of hyæna are nocturnal; they prey on dead carcasses. An extinct species (*Hyæna spelæa*) was abundant in England and France anterior to the glacier epoch, and has left its remains in many caverns in both countries.

HYALÆ'A. (Gr. ὕαλος, *glass.*) A genus of beautiful Pteropodous Mollusks, remarkable for the delicacy and transparency of the shell. This bears a close resemblance to a bivalve, with the two valves unequal and soldered together at the hinge. That portion of the shell which corresponds to the ventral aspect of the animal is convex; the dorsal plate is nearly flat, and is longer than the other; the hinder or closed margin of the shell is produced into three sharp points. The inhabitant is provided with two large wing-like processes of the mantle, which it protrudes, when swimming, from the anterior open fissure of the shell. The species are found floating in the Mediterranean and tropical seas.

HY'ALITE. (Gr. ὕαλος, λιθος, *a stone.*) A yellow or grey variety of uncleavable quartz or opal; it is commonly concretionary or chalcedonic, of a vitreous fracture and lustre. It occurs in trap rocks in grains, filaments, and rhomboidal masses: it is silica combined with about 6 per cent. of water.

HY'ALOID. (Gr. ὕαλος, and εἶδος, *form.*) A term applied to transparent membranes, and more particularly to that which invests the vitreous humour of the eye.

HYBERBO'REANS. (Gr. ὑπερ, *beyond*, and βορειας, *the north wind.*) The name given by the ancients to the unknown inhabitants of the most northern regions of the globe, who, as their name implied, were supposed to be placed beyond the influence of the north wind, and consequently to enjoy a mild and delightful climate. The question of the existence and exact situation of the Hyberboreans long formed one of the most intricate in the whole compass of ancient history; but the general opinion now inclines to regard them as synonymous with the Laplanders, Norwegians, and some other nations of northern Europe. (See the *Encyc. des Gens du Monde.*)

HYBERNA'CULUM. A term invented by Linnæus to denote a leaf-bud; which he rightly considered the winter-quarters of the point of growth in a plant.

HY'BERNATION. (Lat. hybernus, *wintry.*) The act by, or the state in, which certain animals exist during that season of the year when excess of cold or of heat, or lack of food, prevents their going abroad and performing their customary functions. As the state is generally superinduced by the rigours of winter, it has received its denomination from that circumstance; but in the tropics the effects of the hottest and driest weather, in reducing the numbers of the insect world, are such as to render it necessary for many reptiles and some insectivorous mammals, as the *Tenrecs*, to pass into a state of inactivity or torpidity, in order to maintain life until the recommencement of the rainy season. The condition of hybernation is, in fact, less the alteration of temperature, than the abstraction of the means of subsistence dependent thereon; as, *e.g.*, the disappearance of insects in the winter season of our own climate.

Animals so highly organized as the warm-blooded and quick-breathing mammalia cannot maintain their complicated organic machinery in action without frequent supplies of food: an interruption in this respect of a few days, or at most a few weeks, is fatal. If, therefore, the phenomenon of hybernation had been known only in the cold-blooded classes, an insectivorous mammal in a climate where insects could not subsist for several months in the year would be inconceivable. The modification of the vital powers by which a warm-blooded animal is made even temporarily to assume the state and properties of a reptile, is perhaps one of the most striking instances of special adaptations to meet an exceptional case that the history of animals presents. When the atmosphere becomes vacant of insect life, and the bat, in its nocturnal flittings, would vainly traverse it in search of food; and when the few insects that survive the winter have burrowed too deeply in the earth, or concealed themselves in hiding-places too secure for the reach of the hedgehog,—these species, with starvation staring them in the face, are preserved by the suspension of those functions, the maintaining of which in a state of activity is essentially dependent on an uninterrupted supply of nutriment. The bat suspends itself in the innermost recesses of its cave, the hedgehog creeps to its concealed nest, and both resign themselves to deep repose; but the breathing becomes gradually slower than in ordinary sleep, the pulsations of the heart diminish in force and frequency, the supply of stimulating arterial blood to the muscles and the brain is progressively reduced, relaxation of the muscular fibres is converted into stiff inaction, and sleep sinks into stupor: at length respiration entirely ceases, and with it those chemical changes in the capillary circulation on which animal heat mainly depends. The preservation of life, in its passive or latent state, is now due to the irritable property of the heart's fibre, which is excited to contract by the blood in its present dark or carbonized state, and continues to propel it slowly over the torpid frame during the whole period of hybernation. This slow circulation of venous blood through both the pulmonic and systemic vessels is the only recognizable vital act during that period, and the material conveyed by the absorbents into the circulating fluid is sufficient to counterbalance the slight waste thus occasioned. So long, therefore, as the state of torpidity continues, the hedgehog and bat are independent of supplies from without, but they purchase that independence by a temporary abrogation of their vital faculties: cold, senseless, motionless, and asphyxiated, their entry into death's chamber is prevented only by their being brought to his very door.

The hybernation of lizards, snakes, frogs, toads, and other cold-blooded reptiles, is accompanied by analogous changes, differing only in degree; for as the heart in these animals is, at all times, destined to propel blood imperfectly oxygenated,—as the respiratory or oxygenating apparatus is imperfect,—and as the heat of the body in them rises and falls with the external temperature, a slight deterioration of these lower conditions of the circulating and respiratory functions induces torpidity, with the consequent loss of appetite and independence of food. Some quadrupeds, as the dormouse and squirrel, which subsist on articles of diet better adapted to be laid up in store than insects, carry a winter provision to their hybernating nests; and their torpidity is more nearly allied to a profound but ordinary sleep; respiration is never wholly suspended; the waste of the organism is proportionate to the degree of activity in the working of the machine, and they occasionally rouse themselves and take in the requisite supply from their provident store. Insectivorous birds, being independent, through their power of traversing space, of the vicissitudes of climate

and their consequences, transport themselves, when their food fails in one country, to latitudes favourable to its abundance: hence the immigration of the cuckoo and swallow at the commencement of the genial season, and their subsequent disappearance.

HY'BRID. (Gr. ὕβρις, *a mule.*) The produce of a female plant or animal which has been impregnated by a male of a different variety, species, or genus.

The most common hybrids are those which result from the connection of different varieties of the same species, as the produce of the wild boar and domestic sow; the endless modifications which result from analogous interbreeding from varieties of the rose and other ornamental or useful plants are familiar examples of the principle among vegetables.

Specifical hybrids have been produced from the artificial fertilization by Kœlreuter of the *Nicotiana rustica* with the pollen of the *Nicotiana parriculata;* and Schiek has demonstrated, by numerous observations, that a multitude of plants produce specifical hybrids in a state of nature.

Hybrids from different species of insects, under similar circumstances, have been obtained; as from the connection of *Papilio jurtina* with *P. janira*, of *Chrysomela œnea* with *Chr. alni*, of *Phalangium cornutum* with *Ph. opilio*. Specifical hybrids have been obtained in the class of fishes by artificial impregnation between the *Cyprinus carpio* and *Cypr. carassias*, and between the *Cypr. carpio* and *Cypr. gibelio*. In birds, hybrids have been bred between the goldfinch and canary, between the reeves and the common pheasant—the pheasant and the common fowl—the swan (*Anas olor*, L.) and the goose (*Anas anser*, L.*)—between the *Tetrao tetrix* and *Tetrao urogallus*—between the *Corvus corone* and *Corvus cornix*, &c. Among Mammals, hybrids have been produced between the lion and tiger, the dog and wolf, the dog and jackal, the dog and fox, the goat and ibex, the horse and zebra, the zebra and ass, and the horse and ass; the produce of the two last species, as it is the most common and useful of hybrids, being termed *par excellence* "the mule."

But a fruitful connection is not only possible between individuals of different varieties or of distinct species, but also occasionally between animals of different genera. Generical hybrids have thus resulted from the union of the goat (*Capra hircus*) with the antelope (*Antilope rupricapra*), of the stag with the cow, and of the bull with the sheep, notwithstanding their disparity of size. Among reptiles, between the toad (*Bufo*) and the frog (*Rana*); among insects, between *Cantharis melanura* and *Elater niger*, and between *Melolontha agricola* and *Cetonia hirta*. Experiment alone can determine the amount of affinity beyond which fertilization is impracticable, but at present it seems to be restricted to individuals belonging to genera of the same natural group.

The tendency of all the natural phenomena relating to hybridity is to prevent its taking place, and when it has occurred to arrest the propagation of varieties so produced, and to limit their generative powers so as to admit only of reversion to the original specific forms.

It would seem that in most cases the fertilizing particles had a specific power over the ova derived from the same species, or were attracted by them in a peculiar manner; for the milt and roe of different species of fishes are not unfrequently excluded in the same locality, yet hybrids are not met with in consequence. Spallanzani was not able to impregnate the ova of the frog with the semen of the newt, nor to produce a fertile combination of those of the toad and newt; nor did the injection of the semen of the dog into the vagina of the cat impregnate any of her ova.

The individuals of different species which produce a hybrid offspring do not voluntarily copulate. The salacious mare must be blindfolded, or she will not receive the ass. The stallion refuses to mount the she-ass, if a mare be in sight. Hunter states that, being desirous "to have a she-wolf lined by some dog, she would not allow any dog to come near her, but was held while a greyhound dog lined her; while in conjunction she remained pretty quiet, but when at liberty endeavoured to fly at the dog." Buffon reared puppies of the wolf, fox, and dog together, to familiarize them with each other; but when they were in heat, the females of each species exhibited an insurmountable repugnance to the male of the others, and mortal combats ensued instead of fertile union between the different sexes of the different species. (*Annales du Muséum*, t. xii. p. 119.)

In a few exceptional cases, serving only to establish the rule of their infertility, specifical hybrids have been known to propagate together, and produce a degenerate intermediate race, which soon becomes extinct: it more commonly happens that a hybrid is sterile, or propagates only with an individual of pure breed.

On the assumption that a hybrid produced by two individuals of undoubtedly distinct species is sterile, experiments have been made on the breeding powers of hybrids, to determine the nature of doubtful species. Thus Hunter believed that he had obtained absolute proof of the jackal being a dog, and to have equally made out the wolf to be of the same species; and he then proceeds to speculate whether the wolf is from the jackal, or the jackal from the wolf; for he had obtained pups from the connection of a female hybrid jackal-dog and a male terrier, and between a female hybrid dog-wolf and a male greyhound; and he adds, in respect of the latter fact, that "it would have equally proved the same fact if she had been lined either by a wolf, a dog, or one of the males of her own litter." (*Hunter's Animal Œconomy*, by Owen, 8vo. p. 323.) But this assertion, that the fertility of a hybrid with an individual of a pure breed proves the fact of the identity of two supposed distinct species equally with the production of offspring from the connection of hybrid with hybrid, cannot be admitted. To prove the identity of two supposed distinct species, on the assumption that the fertility of the hybrids from the two gives the proof required, it should be shown that such hybrids are fertile among themselves, and capable of propagating indefinitely an intermediate variety. Hunter's celebrated experiments, however, only proved that two nearly allied species will produce a hybrid offspring, and that such hybrid may be impregnated by an individual of the pure breed; but this fact illustrates the general law by which the reversion of the hybrid to the pure breed is provided for; while, on the other hand, the intermixture of distinct species is guarded against by the aversion of two specifically different individuals to sexual union.

HYDA'RTHRUS. (Gr. ὕδωρ, and ἄρθρον, *a joint.*) The white swelling: the joints most subject to it are the knee, elbow, wrist, and ankle. It is distinguished from rheumatic swelling of the joints by a fixed and wearing pain preceding the tumefaction, and often existing for a long time before any enlargement of the part is perceptible; also by the general state of the habit.

HYDA'TIDS, *Hydatis.* (Gr. ὑδατίς, *a bladder.*) A term somewhat vaguely applied both to morbid cysts and true Entozoons of the order *Cystica*. Of the latter some are globular, with a tunic composed of a double albuminous membrane between which the sporules or ova are developed. In the species developed in the human liver, the ova are detached from the internal surface, and it is hence termed *Acephalo-cystis endogena*. In a species infesting similar organs in the lower animals the ova are detached from the external surface, and it is called *Acephalo-cystis exogena*. In a higher organized genus of Hydatids, a slender more or less elongate process is continued from the cyst, and terminates in an extremity provided with suckers and a coronet of recurved hooklets, like the head of a tape-worm: this genus is termed *Cysticercus*. Another genus has numerous similarly organized appendages attached to the cyst, and is accordingly termed *Cœnurus*. It is an hydatid of the last genus which is developed in the brain of sheep, and produces the "giddy sickness" or "staggers."

HYDE, or HIDE. A measure of land, common in Domesday Book and old English charters. Its derivation is obscure. It is somewhat fancifully drawn from the ancient fable (common to many nations) of the deceit practised by a colonist in acquiring from the owners so much land as he could cover with the hide of an ox, and then dividing it into strips so as to make it extend over a large space. Its contents are also uncertain, but are stated by some authorities to amount to 100 Norman or 120 English acres. (*Warner's Hist. of Hampshire; Ellis's Introduction to Domesday.*)

HY'DRA. In Mythology, a fabulous many-headed monster, which was said to infest the lake Lerna in Peloponnesus. According to the fable, on one of its heads being cut off it was immediately succeeded by another, unless the wound was cauterized. It was one of the labours of Hercules to destroy this monster, which he is said to have accomplished by the constant application of firebrands to the wounds as the heads were cut off. The term *hydra* is sometimes used in a metaphorical sense for any manifold evil.

HY'DRA. This once dreaded name is restricted in modern Zoology to a genus of minute fresh-water Polyps. The term *Hydrus* was applied by Linnæus to a genus of water-snakes.

HY'DRA. One of the ancient constellations in the southern hemisphere.

HYDRA'CIDS. Acids containing hydrogen as one of their essential elements; such as the hydrochloric or muriatic acid, the hydriodic acid, &c.

HY'DRAGOGUE. (Gr. ὕδωρ, *water*, and ἄγω, *I expel.*) The term is generally applied to violent cathartics, which bring away a large quantity of watery secretion from the intestines.

HYDRA'RGO-CHLORIDES. Compounds of the bichloride of mercury with other chlorides, forming a class of haloid salts.

HYDRARGY'LLITE. (Gr. ὕδωρ, Lat. argilla, *clay.*) A name given to the native phosphate of alumina, under

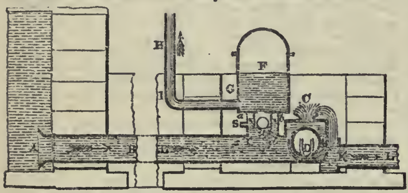
the erroneous idea that it consisted of alumina and water.

HYDRARGY'RIA. (Gr. ὑδωρ, and αργυρος, *silver.*) An eruptive disorder occasioned by the use of mercury.

HYDRA'RGYRUM. Quicksilver, or mercury.

HY'DRATES. Compounds containing water as one of their proximate elements, and in definite proportion. Caustic potash is a *hydrate of potassa*, composed of 1 equivalent of potassa = 48, and 1 of water = 9. Slaked lime, which is an apparently dry white powder, is a *hydrate of lime.*

HYDRA'ULIC RAM, or WATER RAM. An ingenious hydraulic machine for raising water by means of its own impulse. The principle of its action and the mechanism of its construction may be described as follows:—



The water arriving at A from the reservoir with the velocity due to the height of the fall passes along the pipe A B, which should have an inclination of at least an inch for every two yards, escapes through an orifice C, which may be shut at pleasure by means of a valve. A reservoir, F, filled with air is attached by means of a cylinder, *a b c d*, to the pipe A B D; in the middle of the bottom of the reservoir F is a circular orifice, to which there is adapted a short cylindrical tube, of which the extremity E is also furnished with a valve. Another valve S serves to supply the air to the space comprised between the cylinder *a b c d* and the tube E. G I H is an ascensional tube rising from the reservoir F. The water which escapes at C is carried off by the waste pipe K L.

The form of this apparatus (or perhaps its mode of action) suggested the name it has received. The pipe A B C is called the *body of the ram;* and the extremity, where the valves and the reservoir F are placed, is called its *head.* Both valves D and E are formed of hollow balls supported on muzzles, and of such a thickness of metal that they weigh about twice as much as the quantity of water they displace.

We may now consider the effects of the engine when in action. The water flowing through the orifice C acquires the velocity due to the height of the fall, and raises the ball D from its support till it comes to the orifice C; the extremity of this orifice is covered with leather, or with cloth filled with pitch, so that when the ball is applied to it the passage of the water is effectually prevented. As soon as this orifice is closed, the water raises the ball E which had shut the orifice of the reservoir F; and a portion of it introduces itself into this reservoir, and into the pipe G I H. It thus loses the velocity which it had when the orifice C was shut, and the balls D and E fall down in consequence, the one on its support, and the other on the orifice at E. When this takes place, every thing is in the same state in which it was at first. The water begins again to flow through the orifice C; the valve D is again shut; and the same effects are repeated in an interval of time, which, for the same ram, undergoes little variation.

Every time the impulse is renewed a quantity of water is forced up into the reservoir F and the tube H; and as it is prevented from returning by the action of the valve, it must necessarily be delivered at the extremity of H. The use of the air-vessel F is to keep up a continuous motion of the ascending column of water. The communication with the external atmosphere being cut off, the air within F is compressed by a force proportional to the height of the surface of the water in H above its surface in F; and this compressed air acting by its elasticity on the water, maintains a continuous flow through H. The air-vessel, however, though it assists the action of the ram is not an essential part of it; the continuity of the discharge of water may be effected by means of two or more rams, of which the ascensional pipes G I H all terminate in a single branch. On this principle works have been erected at Marly, in France, which raise water in a continuous jet to the height of 57 *mètres*, or 187 English feet.

As the ascending column of water communicates with the air in the reservoir F, this would soon be exhausted if a fresh portion of air were not introduced at each stroke of the ram. The little tube S, which is stopt by a valve opening inwards, serves for this purpose. At the instant when the orifice C is closed a recoil takes place, by which the water is thrown back from the head of the ram towards the cistern; and a partial vacuum being thus produced within the cylinder *a b c d*, the pressure of the external atmosphere forces open the valve in the canal S, and a portion of air enters the cylinder, whence it is driven into the reservoir, excepting the small part of it which lodges in the space between the cylinder *a b c d* and the tube E. (Hachette, *Traité des Machines.*)

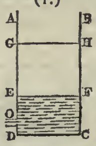
The invention of the hydraulic ram, at least in the improved form here described, belongs to Montgolfier of Montpelier. A machine, however, on the same principle had previously been suggested, and even erected at Chester, by our countryman Mr. Whitehurst, but much less perfect in its mode of action; for the orifice C, instead of being opened and shut by the action of the water itself, required to be opened and shut by the hand by means of a stop cock. Owing to this circumstance, Whitehurst's machine was of little utility, and appears to have soon been entirely forgotten.

HYDRAU'LICS (Gr. ὑδωρ, and αυλος, *a pipe*), is that branch of natural philosophy which treats of the motions of liquids, the laws by which they are regulated, and the effects which they produce. By some authors the term *Hydrodynamics* is usually applied to the general science of the motions of fluids; while *Hydraulics* is more particularly applied to the art of conducting, raising, and confining water, and to the construction and performance of water-works.

There is no part of mechanical science which offers greater difficulties to the mathematician, or where the results of theoretical investigation present so little agreement with experience. This arises from the excessively complicated nature of the movements which take place among the particles of a liquid mass when its equilibrium has been disturbed, and partly from the great number of disturbing causes by which those movements are affected.

The first and principal problem of hydraulics is to determine the velocity with which a liquid flows through an aperture in the bottom or sides of the containing vessel.

(1.)



In order to discover the law of this velocity, let A B C D (fig. 1.) be a vessel filled with water to the height E F, and let O be a very small opening in the side of the vessel; while the water stands at E F it will issue from O with a certain velocity depending on the height E F above O. Let it therefore be proposed to determine to what height, G H, the vessel must be filled in order that the velocity of the efflux through O may be doubled. From the principles of hydrostatics it is shown that the force urging a particle of the liquid at O through the orifice is the pressure due to the height of the vertical column above O. Now we may consider, in the first place, that when the velocity of a particle in motion is doubled, the momentum, or moving force, must also be doubled; and, in the second place, that if the velocity of the efflux is doubled, twice the number of particles will be put in motion in the same interval of time; and consequently the momentum or moving force must be doubled on this account also. Hence when the velocity of the discharge through O is doubled, the moving force, which in the present case is the pressure, must be quadrupled. But the pressure is proportional to the height of the fluid above O, hence the height must be quadrupled. By the same process of reasoning we conclude that to obtain a threefold velocity a ninefold depth would be necessary, and so on; and, generally, that the depths must be increased as rapidly as the squares of the velocities; or, in other words, the velocities are proportional to the square roots of the depths of the orifice below the surface.

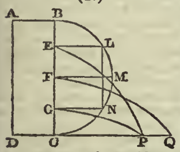
By means of this law the absolute velocity with which water issues from an orifice at any depth under the surface may be ascertained, provided we can determine the velocity for any particular depth. Now if we suppose the orifice O to be on a level with the surface of the liquid, or if we suppose O to be in the bottom of the vessel covered with an infinitely thin film, there would be no pressure on a particle at O, which, therefore, would drop out merely by the effect of its own weight, and consequently with the velocity of a heavy body beginning to fall. But the velocity of a falling body is proportional to the square root of the height from which it has fallen; therefore, since it has been shown that the velocity of the discharge through an orifice is also proportional to the square root of the height of the liquid above the orifice, and that the two velocities are the same in one particular case, it follows that they must be the same in all cases; and hence we have this important theorem:—"The velocity with which a liquid issues from an infinitely small orifice in the bottom or side of a vessel that is kept full, is equal to that which a heavy body would acquire by falling from the level of the surface to the level of the orifice."

Several consequences follow immediately from this fundamental theorem. In the first place, if the aperture is enlarged, each particle of the liquid presenting itself there will escape with the same celerity; and hence the quantity of water that issues through an orifice is as the area or section of the orifice multiplied into the square root of the depth. Again, if the water is thrown up in a perpen-

dicular jet, it ought to ascend to the height of the reservoir; or if several orifices are made in the same vessel, each presented upwards, the jets escaping from each of them would all rise to the same height. But by reason of the resistance of the air, the friction on the sides of the orifice, the mutual cohesion of the liquid particles which impedes their separation and escape, and the action of opposing currents formed in the interior of the liquid, these conclusions must be received with considerable modifications. The effects of the disturbing causes can only be determined by a comparison with experiment.

Water issuing through a hole or pipe in the side of a vessel kept full, like all other projectiles when the resistance of the air is supposed to be withdrawn, describes a parabola in a vertical plane. Let A B C D (fig.2.) be a cylindrical vessel filled with water, and E an orifice in its side; the water will be projected from E with a velocity which would carry it horizontally through double the space B E in the same time that a body falls from B to E. But from the instant it escapes at E it begins to descend with an accelerated motion to the level of D C, while it continues its uniform horizontal flight, and thus describes a parabola meeting the ground in P. Now, by the theory of projectiles, the velocity of a body moving in a parabola is equal to that which is acquired by a body falling through half the parameter of the diameter, and it was shown that the velocity at E is equal to 2 B E; therefore the directrix passes through B, and consequently $4\,BE \times EC = CP^2$. On B C, as a diameter, let there be described a semicircle B L C; then $BE \times EC = EL^2$, and consequently $CP^2 = 4\,EL^2$; whence $CP = 2\,EL$, or the horizontal range is double the ordinate E L. The horizontal range is therefore greatest when the aperture is at F, the middle of B C, and is then C Q, which is equal to 2 F M, or to the altitude B C. In all other cases there are two apertures, E and G, equidistant from F, which give the same range; for by the nature of the circle there are two equal ordinates, E L and G N.

(2.)



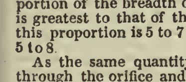
There is a circumstance connected with the efflux of a liquid through an orifice which requires particular attention. While a liquid is flowing out in this manner, the particles continue to descend in vertical lines till they reach within a short distance of the orifice, as at C D (fig.3.), when those not immediately above it change the direction of their motion, and approach the orifice with different degrees of obliquity, converging as it were to a centre, the position of which is somewhat without the orifice. In consequence of this the vein of water as it issues out is contracted, its breadth at *m n* being less than the width of the orifice. This contraction of the jet was first noticed by Sir Isaac Newton, who gave it the name of the *vena contracta*, or the *contracted vein* of the liquid. The distance from the orifice at which the contraction is greatest depends in some degree on the magnitude of the orifice, and is equal to about half its diameter when the orifice is circular and small. The consequence of this contraction is that the discharge of water is not so great as the theory gives it, but is reduced in the proportion of the breadth of the vein where the contraction is greatest to that of the orifice. According to Newton this proportion is 5 to 7 nearly; and according to Bossut 5 to 8.

(3.)

As the same quantity of liquid must evidently pass through the orifice and the contracted vein in the same interval of time, it follows that the velocity at the latter point must be greater; and therefore in applying the theorem respecting the velocity of discharge, it is the velocity at the contracted vein which must be regarded.

It is found by experience that if a short tube, about one or two inches long, is inserted in the vessel, and the water be allowed to flow through the tube, the contraction of the vein is very considerably diminished, and the quantity of water discharged through the tube is considerably greater in the same time than through an orifice of equal diameter. Venturi found that the discharge through a smooth hole in the bottom of a reservoir of tin amounted to 64 quarts in 100 seconds; a short pipe of the same diameter being applied to the bottom of the reservoir, so as to be flat and even with it, the discharge was augmented to 82 quarts in the same time; and on giving the bottom of the vessel the form here represented, leaving the area of the orifice at A (fig.4.) the same as before, the discharge was increased to 98 quarts. By enlarging the lower end of the pipe, and giving it a curvature as B, the quantity of water delivered in the same time received a still farther augmentation. Such additional pipes are called *adjutages*.

(4.)



The velocity and other circumstances relative to the motion of water in conduit pipes, and in open canals and rivers, cannot be accurately determined from any theoretical principles; but very numerous experiments have been made on the subject, from which results have been deduced of great value in directing the practice of the engineer. When water flows from a reservoir in long horizontal pipes of the same diameter, the discharges made in equal times are nearly in the inverse ratio of the square roots of the lengths. But this rule applies only within limits which are not very extended, and is not admissible with respect to long pipes. It was found by Bossut that water has its celerity diminished eight times by passing through a tube of one inch in diameter and 204 feet long. In order to obtain the greatest discharge from a pipe, it is necessary that the inside be smooth, the width uniform, and sudden bendings avoided. The want of evenness of surface impedes the motion of the fluid, which is further obstructed by any violent change of celerity or direction. Whether the channel be contracted or enlarged, the change is unavoidably attended with a proportional loss of impulsion. Any sharp flexure of the pipe or conduit will occasion a still greater waste of the inciting force. It is also found that a curvilineal pipe discharges less water than a rectilineal one of the same length, and that when the flexures are vertical the quantity discharged is less than when they are horizontal. When a large pipe has a number of contrary flexures, the air sometimes mixes with the water, and occupies the highest parts of each flexure, by which means the velocity of the fluid is greatly retarded, and the quantity discharged much diminished.

When liquids flow through very small orifices, or capillary tubes, the resistance is greatly augmented, and the rules which apply to orifices or pipes of considerable diameter no longer hold good. In this case the celerity depends very considerably on the temperature of the liquid. Thus pure water, at a temperature near the boiling point, is found to flow through a capillary tube five times faster than when the temperature is near the freezing point. Alcohol is found to flow six times faster when the temperature is raised 124 degrees. Quicksilver is less affected, but it endures heat through a wider range.

With respect to water running in open channels, or in rivers, the resisting forces are so numerous, and of so irregular a nature, that it is of little use to attempt to deduce their effect from any general principles. In all cases the velocity is increased by the depth of the stream and of the declivity on which it runs to a certain limit; that is, till the resistance, which increases with the velocity, becomes equal to the acceleration, when the motion of the stream becomes uniform. The resistance of course depends much on the evenness of the bottom and sides of the channel. The greatest velocity of a river is at the surface and in the middle of the stream, from which it diminishes towards the bottom and sides, where it is least. It has been found by experiment that if from the square root of the velocity in the middle of the stream, expressed in inches per second, unity be subtracted, the square of the remainder will be the velocity at the bottom. Thus, let v = the velocity at the surface in the middle of the stream, then the velocity at the bottom will be expressed by $(\sqrt{v} - 1)^2 = v - 2\sqrt{v} + 1$. It has also been found by experiment that the mean velocity (or that with which, were the whole stream to move, the discharge would be the same with the real discharge) is equal to half the sum of the greatest and least velocities, as computed by the above formula. The mean velocity is therefore $v - \sqrt{v} + \frac{1}{2}$. These formulæ are deduced from the experiments of Du Buat. (See *Playfair's Elements of Natural Philosophy*.)

When the sections of a river vary, the quantity of water remaining the same, the mean velocities are inversely as the areas of the sections; but when the river receives a permanent addition, the velocity is immediately increased. The effect of this is to augment the action on the sides and bottom, in consequence of which the width is augmented, and sometimes, though more rarely, the depth. This increase of width, by multiplying the points of resistance, again reduces the velocity, till an equilibrium is established between the velocity and resistance; after which the bed of the river changes only by insensible degrees. *See* River.

The determination of the force with which a liquid in motion strikes a solid at rest, and the force necessary to propel a solid immersed in a liquid, is another important part of hydraulics; though, of the general principles hitherto deduced from theory, there are only a very small number which afford a tolerable approximation to the results of experiment. The force of a stream must be regarded as compounded of the force of each particle and of the number of particles that strike in a given time. Now the force of each particle is proportional to the velocity with which it impinges; and the number of particles that strike in a given time is also proportional to the velocity of the stream, supposing its section to remain the same; hence the whole force of the stream is as the

square of the velocity. It follows that if the plane struck by a stream be itself in motion, the impulse will be as the square of the difference of their velocities; and if a stream strike obliquely on a plane, its force is less than if it struck directly on the same plane in the ratio of the cube of the sine of the obliquity to the cube of the radius. But it would appear from experiment that this last consequence only holds true when the angle of inclination is greater than 60 degrees. It might seem (and it is agreeable to theory to suppose) that a plane moving against a liquid at rest with a given velocity, would receive the same impulse as if the liquid were to move with that velocity and the plane to remain at rest. This, however, is not confirmed by experience, which proves that the resistance of a liquid to a body in motion is considerably less than the percussion of the liquid moving with the same velocity against the body at rest. The difference arises from the action of the liquid on the hinder part of the moving body, by which the resistance is in some degree counteracted. But the resistance depends very materially on the figure of the body, and the relation of its length to its breadth. A conical-shaped body, when its length is considerable, is more easily drawn through the water with its broad than with its narrow end foremost. In general, it is found that whatever tends to diminish the adhesion of the body to the liquid tends also to diminish the resistance. A wedge which has its sides rubbed with grease is found to move more freely through the water; hence the great benefit derived from sheathing a ship's bottom with copper. *See* RESISTANCE.

The following are some of the best works on this subject:—Bossut, *Traité Elémentaire d'Hydrodynamique;* Belidor, *Architecture Hydraulique;* Du Buat, *Principes d'Hydraulique:* Prony, *Nouvelle Architecture Hydraulique*, and *Récherches Physico-Mathématiques sur la Théorie des Eaux courante; Experimental Inquiry concerning the Motion of Fluids*, by J. B. Venturi, translated by W. Nicholson; *Ency. Brit.*, articles "Hydrodynamics," "River," &c.

HYDRIO'DIC ACID. A gaseous compound of hydrogen and iodine, obtained by the mutual decomposition of iodide of phosphorus and water. It is composed of 126 iodine + 1 hydrogen; and its equivalent, therefore, is 127. The specific gravity of this gas is 4·4. One hundred cubic inches weigh 136 grains. It is rapidly absorbed by water, furnishing a sour, colourless, and dense liquid, which soon becomes brown by exposure to air, in consequence of the evolution of a little free iodine. It is instantly decomposed by chlorine, which abstracts the hydrogen to form hydrochloric (muriatic) acid, and sets the iodine free.

HYDROBRO'MIC ACID. A gaseous acid composed of 78 bromine + 1 hydrogen. It is obtained by the mutual decomposition of bromide of phosphorus and water.

HYDROCA'RBON. A term applied by chemists to compounds of hydrogen and carbon. These elements unite in several proportions, and form a variety of curious definite combinations, which are commonly termed *hydrocarburets.*

HYDROCA'RBURETS. Compounds of hydrogen and carbon. There appear to be several definite combinations of these elements; among them the following deserve especial notice:—1. *Light carburetted hydrogen gas*, which is the *firedamp* of coal mines and of marshes: 100 cubic inches weigh about 17·4 grains. It consists of 2 atoms of hydrogen = 2, and 1 of carbon = 6; its equivalent is 8. It burns with a pale blue flame. 2. *Olefiant gas*, which is formed during the distillation of equal measures of alcohol and sulphuric acid: 100 cubic inches weigh 30·5 grains. It is composed of 2 atoms of hydrogen = 2, and 2 of carbon = 12; and its equivalent, therefore, is 14. It burns with a bright white flame. Coal gas consists of a mixture of these two hydrocarbons. The term *olefiant gas* is derived from the action of chlorine upon it, which, when mixed with the gas over water, gradually condenses it into a liquid looking like oil, which is a *hydrochloride of carbon.* 3. *Quadricarburetted hydrogen*, which is produced during the destructive distillation of oil (Faraday, *Annals of Philosophy*, xxvii. 44.), and which is a vapour condensable at 0°, of which 100 cubic inches weigh 61·2 grains. It consists of 4 atoms of hydrogen = 4, and 4 of carbon = 24; and its equivalent is 28. It burns with a dense and very smoky flame. This compound has also been called *etherine*, 1 volume of the vapour of *ether* being constituted of 1 volume of quadrihydrocarbon and 1 of water vapour. 4. *Bicarburet of hydrogen*, obtained, like the last, from the volatile products formed during the destructive distillation of whale oil. When the quadrihydrocarbon has been distilled off from the more volatile portion, that which remains yields a product which congeals at 0°. It is a brittle white solid at that temperature: 100 cubic inches of its vapour weigh 85·3 grains, and it consists of 3 atoms of hydrogen = 3, and 6 of carbon = 36; its equivalent, therefore, is 39. These are the principal forms of hydrocarbon which have been satisfactorily identified: they all afford carbonic acid and water when burned in a sufficiency of oxygen; and the proportions in which these are formed, together with the specific gravities of their respective vapours, furnish the data upon which their composition is estimated. *See* NAPHTHA and NAPHTHALMI.

HYDROCA'RDIA. Dropsy of the pericardium.

HY'DROCE'LE. (Gr. ὑδωρ, and κηλη, *a tumour.*) A collection of watery or serous fluid in the tunica vaginalis testis.

HYDROCE'PHALUS. (Gr. ὑδωρ, and κεφαλη, *the head.*) Dropsy of the brain, or water in the head. The acute form of this disease is almost limited to childhood; it is marked by febrile symptoms, pain of the head, and in very young children enlargement of it. The eyes are irregularly directed and the pupil dilated. The eyes are not perfectly closed in sleep, and there appears a degree of delirium, as far as can be judged of in children: coma, convulsions, and paralysis are frequent consequences. The ventricles of the brain are the chief seat of the watery accumulation. Bleeding from the temporal artery or jugular vein, cold applications to the head, and brisk purgatives with calomel, are the leading remedies.

HY'DROCHARA'CEÆ. (Hydrocharis, one of the genera.) A natural order of floating Endogens, inhabiting Europe and some other places, known by their tripetaloideous flowers with an inferior ovary. They agree with *Alismaceæ* in habit and in want of albumen, but differ in their carpels being definite in number. They are not of any known use, but many of the species are handsome when in flower.

HYDROCHLO'RIC ACID. A gaseous compound of 1 atom of chlorine = 36, and 1 atom of hydrogen = 1; the equivalent, therefore, of the hydrochloric acid is = 37. *See* MURIATIC ACID.

HY'DROCO'RISÆ. (Gr. ὑδωρ, and κορις, *a bug.*) The name of a tribe of Hemipterans, including the water-bugs; these differ from the *Geocorisæ*, or land-bugs, in having minute antennæ inserted beneath the eyes. This tribe includes the water-scorpions (*Nepidæ*), and the boat-men (*Notonectidæ*).

HYDROCYA'NIC ACID. (Gr. ὑδωρ, and κυανος, *blue.*) This highly noxious compound was first discovered in Prussian blue, and hence called *Prussic acid.* It is best obtained by gently heating in a small retort a mixture of three parts of cyanuret of mercury and two of hydrochloric acid: the evolved vapours should be passed through a tube containing fragments of marble, in order to absorb any hydrochloric acid that may chance to distil over, and ultimately condensed in a receiver immersed in a freezing mixture. The hydrocyanic acid is a colourless liquid, having a very strong odour, resembling that of bitter almonds; its specific gravity at 45° is 0·7. It boils at 80°, and freezes at 0°. Dissolved in a large quantity of water, it imparts to it the smell and taste of laurel or bitter almond water: it is intensely poisonous. It consists of 26 cyanogen + 1 hydrogen, or of 14 nitrogen + 12 carbon + 1 hydrogen; and its equivalent is 27.

HYDRODYNA'MICS (Gr. ὑδωρ, and δυναμις, *power*), is the science which applies the principles of dynamics to determine the conditions of motion or rest in fluid bodies. It is usually divided into two branches; namely, *hydrostatics*, which explains the laws of the equilibrium, pressure, and cohesion of fluids; and *hydraulics*, which explains the laws of their motion, together with the machines in which they are chiefly concerned. Though the term *hydrodynamics* is sometimes applied generally to fluids of all kinds, it is more usually restricted to the non-elastic or incompressible fluids, as water, mercury, &c.; in which case the science which treats of the equilibrium of the compressible and elastic fluids, like air, is called *aerostatics*, and that which treats of their motion *pneumatics*

Hydrodynamics, though a science of immense importance in its applications to the various purposes of life, was not cultivated to any extent by the ancients, all their knowledge of the doctrine of fluids being limited to a few propositions regarding the pressure and equilibrium of water. Archimedes, indeed, established the general principles which serve as the foundation of hydrostatics, in his treatise *De Insidentibus Humido;* and Ctesibius and Hero, who flourished at Alexandria about 120 years after Christ, invented the fountain of compression, the syphon, and the forcing pump. Julius Frontinus, who was inspector of the public fountains at Rome in the reigns of Nerva and Trajan, wrote a work on the Roman aqueducts, and the modes of distributing water then in use; but he appears to have been unacquainted with the law of the velocities of running water depending on the depth. The first modern treatise on hydrodynamics was published in 1639 by Castelli, a disciple of Galileo, entitled *Della Misura dell' Acque Correnti*, and contains a satisfactory explanation of various phenomena in the motion of fluids. Torricelli discovered the important property that the velocities of fluids issuing through an orifice are as the square roots of the pressures; Mariotte, in his *Traité du Mouvement des Eaux*, employed the principle of Torricelli, and explained the

discrepancy between theory and observation by ascribing it to the retardation of the water's velocity arising from friction. Guglielmini was the first who treated of the motion of water in rivers and open canals. The subject of the oscillation of waves, one of the most difficult in the whole science, was first investigated by Sir Isaac Newton, who determined the duration of the oscillations, and thence concluded that the velocities of waves formed on the surface of water are in the subduplicate ratio of their size. He was also the first who observed the contraction in the vein of a fluid issuing through an orifice, and regarded the contracted section as the true orifice, by which the theory was rendered more conformable to experience. The *Hydrodynamica* of Daniel Bernoulli was published in 1738. His theory of the motion of fluids consists in supposing, 1st, that the surface of a fluid in a vessel, while emptying itself by an orifice, remains always horizontal; and 2d, that if the fluid mass is conceived to be divided into an infinite number of horizontal strata, all the strata remain parallel, and descend vertically with velocities inversely proportional to their breadth, or to the horizontal sections of the reservoir. From these suppositions, and by means of the application of the principle of the conservation of living forces, he obtained solutions of the principal problems of hydrodynamics. The mathematical theory of the motion of fluids was farther investigated by John Bernoulli, Maclaurin, and the celebrated D'Alembert; the latter of whom placed it in an entirely new light by the application of Euler's calculus of partial differences. One of the best treatises on hydrodynamics which we possess is that of the Abbé Bossut, in which are given the results of a very extensive set of experiments performed with great judgment and accuracy. Similar experiments, and more extensively varied, were afterwards undertaken by Du Buat, whose *Principes d'Hydraulique*, in three volumes, contains a theory founded solely on the results of experiments. Du Buat was the first who determined experimentally the influence of heat in promoting fluidity. Among other experiments more recently undertaken for the purpose of throwing light on this interesting and difficult subject, we may mention those of Coulomb, of Eytelwein of Berlin, of Bidone of Turin, of General Sabatier of Metz, of Mr. George Rennie, and of Mr. Jardine of Edinburgh, from which some valuable results have been obtained relative to the discharge of water from long pipes.

The analytical theory of hydrodynamics resolves itself into the integration of equations of partial differences, a branch of the calculus which we owe to the illustrious Euler. Euler himself gave the general formulæ for the motion of fluids, founded on the laws of their equilibrium, and thus reduced the whole mechanics of fluid bodies to a single question of analysis. If these formulæ could be integrated, we should be able to determine completely, in every case, all the circumstances of the motion and action of a fluid subjected to the influences of any forces whatever; but such is the difficulty of the subject that the integration, except in a few limited cases, has hitherto resisted the efforts of the greatest mathematicians. Lagrange, in his *Mécanique Analytique*, has deduced the analytical formulæ of the motion of fluids from the principle of virtual velocities, and thus shown that dynamics and hydrodynamics are only branches of one great principle, and results as it were of a single general formula. Laplace, in the *Mécanique Céleste*, has also given the general equations of hydrodynamics, and applied them to the questions of the figure of the earth and the tides. Since the days of those illustrious mathematicians, the theory has been illustrated with reference to applications to particular cases by Poisson, Cauchy, Navier, Challis, and others; but it cannot be said to have received any material extension.

Treatises on hydrodynamics are very numerous. Besides the works of Lagrange and Laplace, and the others above mentioned, we would refer the student to *Bossut's Hydrodynamique; Poisson's Mécanique; Moseley's Elementary Treatise on Hydrostatics and Hydrodynamics.* (*See* HYDROSTATICS and HYDRAULICS.)

HYDROFLU'ORIC ACID. A highly corrosive and very volatile liquid, obtained by distilling in leaden or silver vessels a mixture of 1 part of *pure* fluor spar in fine powder with 2 of sulphuric acid. This compound acts vehemently upon glass and all silicious combinations; it is probably a compound of 18 fluorine + 1 hydrogen.

HY'DROGEN. (Gr. ὑδωρ, and γεννααιν, *to generate.*) This important element is only known to us in the gaseous or permanently elastic form. It was formerly called *inflammable air*, and was sometimes considered as identical with *phlogiston*, or the matter of heat. It is usually procured by the action of sulphuric acid and zinc or iron upon water, or by passing the vapour of water over red-hot iron. Pure hydrogen is a colourless, tasteless, and inodorous gas. 100 cubic inches at mean temperature and pressure weigh 2·13 grains; so that its specific gravity compared with air is as 69 to 1000, and it is exactly 16 times lighter than oxygen. It burns in contact with air with a pale blue flame; and when mixed with three or four times its volume of air, or with half its volume of pure oxygen, and inflamed, it burns rapidly, and in the latter case with violent explosion. The only product of this combustion is *water*, which is thus shown to consist of 1 part by weight of hydrogen with 8 of oxygen; so that upon this datum the number 8 becomes the equivalent of oxygen, and 9 that of water. Hydrogen is not absorbed by water, and animals soon die when confined in it.

HYDRO'GRAPHY. (Gr. ὑδωρ, and γραφω, *I write.*) The description of the waters which exist at the surface of the earth, particularly with reference to the bearings of the coasts, the depths, currents, and other circumstances required to be known for the purposes of navigation. This term implies the same thing with regard to the sea that geography implies with regard to the land. *Hydrographical charts* or *maps* are projections of some part of the ocean, in which the rhumbs, meridians, parallels, &c., with the coasts, capes, rocks, shallows, &c., are laid down for the uses of navigation.

HYDRO'GURETS, or HY'DURETS. Compounds of hydrogen with metals, &c.

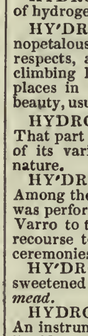
HY'DROLEACEÆ, are a small natural order of Monopetalous Exogens, resembling *Boraginaceæ* in some respects, and *Convolvulaceæ* in others; not, however, climbing like the latter. They chiefly inhabit watery places in tropical climates, and have flowers of some beauty, usually belonging to the Cyanic series.

HYDRO'LOGY. (Gr. ὑδωρ, and λογος, *discourse.*) That part of natural history which treats of water, and of its various properties and modes of existence in nature.

HY'DROMANCY. (Gr. ὑδωρ, and μαντεια, *prophecy.*) Among the ancients, a method of divination by water. It was performed in various ways. Its origin is ascribed by Varro to the Persians; and Numa is said to have had recourse to it for instruction how he should settle the ceremonies of religion.

HY'DROMEL. (Gr. ὑδωρ, and μελι, *honey.*) Water sweetened with honey, which, when fermented, forms *mead.*

HYDRO'METER. (Gr. ὑδωρ, and μετρον, *measure.*) An instrument for determining the specific gravities of liquids, and thence the strengths of spirituous liquors; these being inversely as their specific gravities. Various instruments of different forms have been proposed for ascertaining readily the specific gravities of fluids; but as Sikes's hydrometer is directed by act of parliament to be used in collecting the revenue of the United Kingdom, it may be considered as more deserving of description than any of the others. This instrument is represented in the annexed figure.



A B is a flat stem, divided on both sides into eleven equal parts, each of which is again subdivided into two. The stem carries a hollow brass ball B C, in which is fixed a conical stalk C D, terminating in a pear-shaped bulb D. Eight different weights of a circular form, and marked with the numbers 10, 20, 30, 40, 50, 60, 70, and 80, are cut in the manner represented at W, so that they can be placed on the stalk C D. When the strength of spirits is to be measured, one of the circular weights is placed on C D, which is found by trial to be capable of sinking the ball so far that the surface of the liquid cuts the stem at one of the divisions between A and B. The number of this division is then observed, and also the temperature of the liquid; and the corresponding strength per cent. of the spirit is then found in a table which accompanies the instrument.

Another easy method of determining the densities of different liquids, frequently practised, is by means of a set of glass beads previously adjusted and numbered. Thrown into any liquid, the heavier balls sink and the lighter float at the surface; but one of them approaching the density of the liquid will be in a state of indifference as to buoyancy, or will float under the surface. The number on this ball indicates, in thousandth parts, the specific density of the liquid.

HY'DROME'TRA. (Gr. ὑδωρ, and μητρα, *the womb.*) Dropsy of the uterus.

HY'DROME'TRIDÆ. (Gr. ὑδωρ, and μητρα, *a birth-place.*) A family of *Geocorisæ*, or land-bugs, but of aquatic habits; not, however, living in water, but frequenting the surface.

HY'DROPE'RICA'RDIUM. (Gr. ὑδωρ, and περικαρδιον.) Dropsy of, or an unnatural accumulation of watery fluid in, the sac of the heart.

HY'DROPERSULPHU'RIC ACID, or BISULPHURET OF HYDROGEN. A compound of 2 equivalents of sulphur and 1 of hydrogen: its equivalent is 33.

HY'DROPHANE. (Gr. ὑδωρ, and φαινω, *I shine.*) A

variety of opal, which is white and opaque when dry, but becomes transparent in water.

HYDRO'PHIDES. (Gr. ὑδωρ, and οφις, *a serpent.*) A name applied to the section of *Ophidians*, including the water-snakes. These are principally distinguished by having the tail compressed or flattened sideways, for the purpose of swimming. They are armed with poison fangs; but these are of small size, and are associated with a row of non-venomous maxillary teeth.

HYDRO'PHILIDÆ. (Gr. ὑδωρ, and φιλεω, *I love.*) A family of Pentamerous Coleopterans, including those species which have short clavate antennæ, long and slender palpi, mandibles bidentate at the tips; body oval and convex; and the hind-legs often ciliated. The *Hydrophilidæ*, like the *Dyticidæ*, are aquatic beetles, and have wings by which they can transport themselves from one piece of water to another; but they are vegetable-feeders, and are less active in their movements than the predatory water-beetles. The family includes many genera. The typical species, *Hydrophilus caraboides*, is common in the stagnant ponds and ditches of this country.

HY'DROPHO'BIA. (Gr. ὑδωρ, and φοβεομαι, *I fear.*) A disease remarkably characterized by alarm at the approach of water, and caused by the bite of a mad dog or other rabid animal; but it does not appear capable of being communicated by the human subject. At some indefinite period after the bite, and often long after all local injury has healed, itching and pain in the bitten part, heaviness, great restlessness and uneasiness, and mental alarm ensue, followed by pains about the neck, sense of choking, and great irritability and horror at any attempt to drink, although solid food can generally be swallowed. Fever, vomiting, excessive thirst, spitting of viscid saliva, and difficult respiration then come on, with irregular pulse and convulsions, under which the sufferer sinks more or less rapidly according to the strength of his constitution. Delirium sometimes precedes death, but not always; in many instances the judgment appears unaffected. It unfortunately happens that nothing in the way of cure, and little even as palliation, has been successfully effected in this disease; but there appears little doubt that the timely application of preventive measures has been successful, and of these the amputation or excision of the bitten part, and the application of caustics to it, or both united, are most to be relied on; and the sooner they are resorted to the better the chance of success, but it appears that they may be effective any time before the appearance of symptoms. Among caustics, the nitric acid is perhaps the most effective. It energetically acts upon and decomposes all animal matter, and fluids more especially; and if applied very soon after the bite, can scarcely fail to be effective: it also penetrates the wound, and forms a sloughing sore. The appearance of madness in dogs, in its early stages at least, is unfortunately not very well defined, nor always easily distinguishable from their other maladies: whether the bite is less dangerous before they become evidently rabid than afterwards, seems to be doubtful. In general the animal is observed to be unusually dull and unsociable, refuses food, hangs his head, and appears drowsy: he flies at strangers, but usually recognizes his master, though with great comparative indifference. Afterwards his breathing is quick and heavy; frothy matter runs from his mouth; he walks slowly, but occasionally runs and starts forward; at length he forgets his master, often falls down, flies at every body in his way, grows furious, and in four-and-twenty or thirty hours dies.

HYDROPHYLLA'CEÆ. (Hydrophyllum, one of the genera.) A natural order of herbaceous Exogens, inhabiting America; very near to *Boraginaceæ*, from which they are known by their one-celled, many-seeded fruit, and many other characters. Some *Polemoniaceæ* have the habit of this order. Some of the species of *Eutoca* and *Phacelia* are cultivated on account of their pretty flowers.

HY'DROPHYTES. (Gr. ὑδωρ, and φυτον, *a plant.*) Plants which thrive in water; a name confined by botanists to Algaceous plants found in fresh water. It has been remarked by Mr. Lyell (*Principles of Geology*) that the number of hydrophytes is very considerable, and their stations more varied than could have been anticipated; for while some plants are daily covered and uncovered by the tide, others live in abysses of the ocean at the extraordinary depth of 1000 feet; and although in such situations there must reign darkness more profound than night, at least to our organs, many of these vegetables are highly coloured.

HY'DROPS. (Gr. ὑδωρ.) Dropsy. An unnatural accumulation of fluid in the cellular membrane or cavities of the body.

HY'DROPTHA'LMIA. (Gr. ὑδωρ, and οφθαλμος, *the eye.*) Dropsy of the eye.

HYDRORACHI'TIS. (Gr. ὑδωρ, and ῥαχις, *the spine.*) A tumour upon the spine of infants; at first of a blue colour, but afterwards becoming translucent; it is attended with paralysis of the lower limbs, and usually fatal in its consequences.

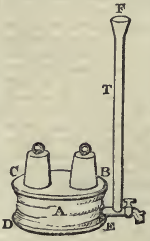
HY'DRO-SALTS. Salts of the hydracids.

HY'DROSCOPE. (Gr. ὑδροσκοπιον, from ὑδωρ and σκοπεω, *I view.*) An instrument anciently used for measuring time by means of the flowing of water through a small orifice. It consisted of a cylindrical tube, conical at the bottom. The cylinder was graduated; and as the water trickled out at the apex of the cone, its surface became successively contiguous to the divisions marked on the cone, and thereby pointed out the hour.

HYDROSTA'TICA. (Gr. ὑδωρ, and στaω, *I stand.*) The name of an order of *Acalephes*, including those which have one or more air-vessels appended to their body.

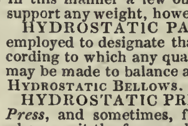
HYDROSTA'TIC BALANCE. A balance for weighing substances in water, for the purpose of ascertaining their specific gravities. *See* BALANCE.

HYDROSTATIC BELLOWS. An apparatus for illustrating the *hydrostatic paradox*, or that peculiar property of liquids in virtue of which they transmit pressure equally in every direction. In the annexed figure B C and D E are two flat boards united by leather or flexible cloth A, water-tight. A short tube fitted with a stop-cock communicates with the interior of the bellows, by which the liquid may be discharged. From the short tube a long tube T rises perpendicularly, and terminates in a funnel F. The upper board B C is loaded with weights, which press it against the lower board D E. On pouring water into the funnel F it will descend through the tube T, and enter between the boards; and by continuing the supply a column will be formed in the tube, the weight of which, transmitted through the water in the bellows, will raise and support the weights on the board. The load which may be thus raised is easily determined. Every portion of the surface of the board B C, equal in area to the section of the tube, is pressed upwards by a force equal to the weight of the water in the tube above the level of B C. Hence, if the section of the tube T is one square inch, and the surface of the board B C is 1000 square inches, then a column of water in T weighing one pound will sustain a weight on the board of 1000 pounds. In this manner a few ounces of water may be made to support any weight, however great. *See* HYDROSTATICS.



HYDROSTATIC PARADOX. A term frequently employed to designate that principle in hydrostatics according to which any quantity of water, however small, may be made to balance any weight, however great. *See* HYDROSTATIC BELLOWS.

HYDROSTATIC PRESS, also called the *Hydraulic Press*, and sometimes, from the name of the engineer who gave it the form under which it is now constructed, and brought it into general use, *Bramah's Press*, is a machine by means of which an enormous force of pressure is obtained through the medium of water. The principle is the same as that of the *hydrostatic bellows;* from which, indeed, it only differs by the substitution of a strong forcing pump for the long tube, and a barrel and piston for the leather and boards. It consists of a short and very strong pump-barrel A B, with a solid piston C of proportionate strength, which is pushed upwards against the thing to be compressed by water driven into the barrel beneath it at F from the small forcing pump E. If the small pump have only one thousandth of the area of the large barrel, and if a man by means of its lever handle D press its piston down with a force of five hundred pounds, the piston of the great barrel, in virtue of the hydrostatic principle of equal pressure in all directions, will rise with a force of a thousand times five hundred pounds, or more than 200 tons. The hydrostatic press is applied to a great variety of useful purposes; for compressing bales of goods, as paper, cotton, wool, tobacco, &c.; for expressing oils from seeds, raising weights, uprooting trees, &c.



HYDROSTATICS (Gr. ὑδωρ, and στaω, *I stand*), is the science which explains the properties of the equilibrium and pressure of liquids. It is the application of statics to the peculiar constitution of water or other bodies existing in the perfectly liquid form.

The whole doctrine of the equilibrium and pressure of liquids is deduced from the following fundamental law:— "When a liquid mass is in equilibrium under the action of forces of any kind, every molecule of the mass sustains an equal pressure in all directions." This law is derived from the very nature of a liquid body, which is such that

all its particles are independent of each other, and perfectly moveabel in every direction; whence if any particle sustained a greater pressure in one direction than another, it would necessarily, by reason of the absolute facility of motion with which it is endowed, give way and move towards that part where the resistance is least, and consequently there would not be equilibrium.

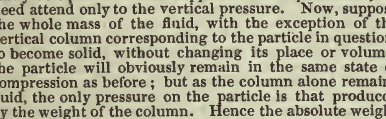
One of the most obvious consequences of the above law is, that the surface of a liquid when at rest in an open vessel, and acted upon by no other force than gravity, is horizontal, or perpendicular to the direction of gravity. If the directions of gravity are parallel, the surface will consequently be a plane; if they converge to a point, the surface of the liquid will be a portion of a sphere. Stagnant water at the surface of the earth, therefore, assumes the spherical figure; but by reason of the magnitude of the sphere the curvature of any small portion of it is insensible, and the surface may be regarded as a plane. A ring surrounding the earth would bend away from a perfectly straight line only eight inches in a mile.

If a free communication is made between two or more vessels containing a liquid by pipes or tubes or otherwise, the surface of the liquid when in equilibrium will always stand at the same level. Let A B, A′ B′ be two tubes, united by a third B B′ placed in the horizontal position, and suppose water to be poured into one of the tubes at A; it will pass along the tube B B′, and rise in B′ A′ and B A simultaneously, its surfaces at A and A′ always remaining level, or at equal vertical heights above B B′. This property is familiarly illustrated in the case of a tea-pot, or any vessel having a spout.

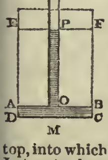
The liquid contained in a vessel being at rest, and subjected to the action of gravity only, any particle of it is pressed in all directions (vertically, horizontally, or obliquely) by a force which is equal to the weight of the vertical column of the liquid incumbent on it. This important proposition may be demonstrated in the following manner: — As the pressure in all directions must necessarily be equal from the supposition of equilibrium, we need attend only to the vertical pressure. Now, suppose the whole mass of the fluid, with the exception of the vertical column corresponding to the particle in question, to become solid, without changing its place or volume, the particle will obviously remain in the same state of compression as before; but as the column alone remains fluid, the only pressure on the particle is that produced by the weight of the column. Hence the absolute weight of the column forms the measure of the pressure sustained by the particle in all directions when surrounded by the liquid.

Instead of a particle of the liquid itself we may consider the column to rest on an indefinitely small portion of the bottom or the sides of the vessel in which it is contained, and it will follow that the pressure on an indefinitely small portion of the area at any point of the bottom or sides is perpendicular to the plane of that area, and equal to the weight of a vertical column of the liquid standing on it as a base and reaching to the surface. Hence the whole pressure sustained by any finite portion of the bottom or sides of the vessel is equal to the weight of a column of the liquid having for its base the surface pressed on (extended into a plane if necessary), and for its altitude the distance of the centre of gravity of that surface from the surface of the liquid.

From this proposition it obviously follows that the pressure on the bottom of the vessel depends only on the magnitude of the bottom and the depth of the liquid, and is entirely independent of the form of the sides and



of the quantity of liquid in the vessel. Suppose the three vessels A, B, and C, to have the areas of their bottoms equal, and that the fluid stands in each to the same depth; then the pressure on the bottom of each vessel is the same, and equal to the weight of the liquid which would be contained in a vessel having an equal bottom and its sides perpendicular.



This proposition gives rise to consequences which at first view appear absurd, and has hence been called the hydrostatic paradox. Let A B C D be a close vessel with a small hole O in the top, into which a narrow tube O P is screwed water-tight. Let water be poured into the tube till the vessel A B C D is filled, and the water stands in the tube at the level P. According to the principle just established, the pressure on the bottom C D is proportional to the depth P M, or in fact equal to the weight of water which would fill a vessel of the magnitude E D C F. Now this is the case, however shallow the vessel A B C D, and however narrow the tube P O may be; and hence a very small quantity of water may be made to exercise a pressure of any amount, however great, on the bottom or sides of the vessel containing it.

The whole pressure on the top A B of the vessel, and tending to raise it, is equal to the weight of the water in the tube P O, increased in the ratio of the area of A B to the area of a section of the tube. Suppose a section of the tube to be one square inch, and the area of A B to be 100 square inches; then a column of water O P, whose weight is one pound, will exert a pressure on A B equal to 100 pounds. It is obvious that the pressure in the narrow tube P O may be produced not merely by the addition of water, but by the application of any kind of force, such as the working of a piston, &c.; and if the bottom or lid of the vessel A B C D be made moveable, the pressure on either may be brought to bear on one point of an external body, and produce an enormous compression. It is on this principle that the very useful engine, the *hydrostatic press*, is constructed. *See* HYDROSTATIC PRESS and HYDROSTATIC BELLOWS.

Many striking phenomena of the natural world are referable to this principle, and it has extensive application in engineering. If the smallest quantity of water should lodge to a considerable height in the gravel, sand, or loose earth behind a wall or embankment, it would exert a lateral pressure sufficient to push the solid materials from their base. Hence a sudden shower often occasions great devastation. The same principle also regulates the construction of pipes for the supply of water to cities. The pressure acting on the inner surface of the pipe, and tending to burst it, being proportional to the depth below the level of the reservoir, the parts of the pipe much below that level must have a greater strength than is necessary at a higher situation. A pipe, the diameter of whose bore is 4 inches, has an internal circumference of about 1 foot; and the internal surface of 1 foot of such a pipe will be 1 square foot, or 144 square inches. If such a pipe were 140 feet below the level of the reservoir, it would sustain a bursting pressure amounting to about 60 pounds on every square inch of its surface; for a column of water, the area of whose section is one square inch, and of which the height is 27·727, or nearly 28 inches, weighs one pound; and 28 inches are contained 60 times in 140 feet. Hence a piece of the pipe 1 foot long will sustain 144 times this pressure, that is, a bursting pressure of 8640 pounds. This exceeds considerably that which is produced in any high-pressure steam engine.

Weight of Bodies immersed in Liquids. — A body immersed in a liquid is pressed upwards by a force equal to the weight of the liquid it displaces; and the difference between the absolute weight of a body and its weight when entirely immersed, is the same with the weight of a quantity of the liquid equal in bulk to the body. This proposition, which is capable of strict demonstration from the fundamental property of fluids, may be illustrated as follows: — Suppose any interior portion of a liquid to become solid; it would evidently remain in the same state of indifference or equilibrium as before. It must, therefore, be borne up by the vertical pressure of the liquid with a force just equal to its weight, or, which is the same thing, to the weight of the liquid whose place it occupies. And if we conceive this congealed mass to have its weight augmented or diminished, it will be pulled downwards or upwards by the difference between its new weight and the weight of an equal bulk of the liquid. Substitute any solid body instead of this block of ice, and the loss of weight it sustains by the immersion will be equal to that of the volume of liquid it displaces.

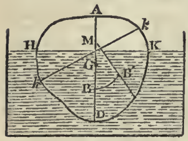
On this principle is founded the method of ascertaining the relative densities or *specific gravities* of different bodies. The specific gravity of a body is the ratio of its weight to the weight of an equal bulk of water. Let, therefore, W be the weight of a body in air, and W′ its weight in water; then $W - W'$ is the weight of a quantity of water equal in bulk to the body, and $\frac{W}{W - W'}$ is its specific gravity. The specific gravities of bodies are therefore found by weighing them first in air and then in water. *See* GRAVITY, SPECIFIC.

Solid Bodies floating on Liquids. — The equilibrium of solid bodies floating on liquids, a subject discussed by Archimedes in his treatise *De Humido Insidentibus*, is an important part of hydrostatics, in consequence of its relation to the construction and stowage of ships. A body placed on a fluid specifically heavier than itself, will sink so far that the weight of the fluid displaced is equal to the whole weight of the body; and when it assumes the position of equilibrium, the line which joins the centre of gravity of the body and the centre of buoyancy (which

is the same as the centre of gravity of the immersed part supposed to be homogeneous) is perpendicular to the surface of the water, or the horizon.

The centre of gravity of a body is a fixed point relatively to the body itself; but the centre of buoyancy, which depends on the figure of the immersed part, will change its place when the figure or relative situation of the immersed part undergoes any alteration. It is on the relative situations of the centres of gravity and of buoyancy that the character of the equilibrium of a floating body depends; namely, whether it is stable or unstable, or indifferent. If the figure and position of the body be such that on pulling it a little aside from the situation of rest its centre of gravity takes a higher position, the body has a tendency to redress itself, and the equilibrium is stable. On the contrary, if by a slight change of position the centre of gravity comes to occupy a lower place, the body will not return to the position of equilibrium, but will be overturned or upset. In this case the equilibrium was unstable. But a body may be so constituted (for example, a homogeneous sphere, or a cylinder floating with its axis horizontal) that in every position the centres of gravity and of buoyancy are in the same vertical line. In this case the equilibrium cannot be disturbed, and is called the equilibrium of indifference, the body having no tendency to maintain one position more than another.

To illustrate this, and to show at the same time the circumstances on which the stability of the equilibruim depends, let A H D K be a body floating on water, and let H K be the line of floatation; also let G be its centre of gravity, and B its centre of buoyancy, which will be in the same vertical with G when the body is at rest, and will obviously be below G. The body is now pressed down by its own weight collected at G,



and pushed up in the opposite direction by an equal force at B. Suppose it to be drawn aside from the position of rest till the water line comes into the position *h k;* the centre of buoyancy B will now be transferred to B′, and the line of support will be a line passing through B′ perpendicular to the surface of the water. Let this line meet the principal axis A D in M; then the equilibrium will be stable or unstable according as M is above or below G, the centre of gravity. If M is above G, the vertical thrust tends to redress the body and restore the equilibrium; but if the vertical B′ M meets the principal axis below G, the body will be pushed more aside till it is overset. The point M possesses several remarkable properties. Its position in the axis A D remains unaltered when the body is drawn aside from the position of equilibrium; and it limits the greatest elevation which the centre of gravity can have in order that the equilibrium may be stable. It was denominated by Bouguer the *metacentre*, and its position may be determined in all cases where the figure and specific gravity of the floating body are given.

As the stability of a floating body depends on the height of the metacentre above the centre of gravity, the construction of a ship should be so regulated, and its cargo so arranged, that the centre of gravity of the whole mass should be at the lowest possible point. Hence the heaviest part of the cargo is stowed away nearest the ship's bottom; and vessels having discharged their cargo must be *ballasted*, in order to give them requisite stability. When a vessel is without a cargo and empty, the weight of the masts and rigging raises the centre of gravity to such a height as to render the equilibrium unstable, or at least renders its stability so small that it cannot be safely subjected to the ordinary pressure on the sails necessary to give motion, and consequently would be altogether incapable of encountering a gale or a heavy sea.

Another important application of the theory of hydrostatics is to the form that ought to be given to the several parts of embankments, dams, the flood-gates of canals, and other works constructed for the purpose of confining or opposing the course of water. This inquiry, which is purely mathematical, is grounded on the principle that the pressure in any lateral point is directly proportional to its vertical depth under the surface of the water. *See* Hydraulics and Hydrodynamics.

HY′DROSULPHATES, or HY′DROSU′LPHURETS. Compounds of hydrosulphuric acid or sulphuretted hydrogen.

HY′DROSULPHU′RIC ACID. Sulphuretted hydrogen. This compound was also called *hydrothionic acid* (from hydrogen, and Gr. θειον, *sulphur*).

HY′DROTHO′RAX. (Gr.) Dropsy of the chest. The symptoms are, difficult breathing when in a recumbent posture, paleness, cough, thirst, swelling of the legs and feet, quick and often irregular or intermitting pulse.

HY′DRUS. (Gr. ὑδωρ, *water*.) A genus of water snakes, characterized by a compressed or laterally flattened tail adapted for swimming; and by having max maxillary teeth, like non-venomous serpents, but wit the first larger than the rest, and grooved for the trans mission of a poison-duct.

The species are confined to the seas of the warmer latitudes.

Hy′drus. The Water Snake; a constellation in the southern hemisphere formed by Lacaille. *See* Constellation.

HYGEI′A. (Gr. ὑγιεια, *health*.) The Goddess of Health, in the Greek Mythology: daughter or wife of Æsculapius, according to the different recitals of genealogists. Her statues (of which the most celebrated was at Sicyon) sometimes represented her attended by a large serpent coiled round her body, and elevating its head above her arm to drink of a cup which she held in her hand. Isis, in Egyptian monuments, appears sometimes in a similar attitude. The employment of the serpent as a mythological symbol of life and health has been by some derived from the history contained in the first chapter of Genesis.

HY′GEINE. That branch of medicine which relates to the means of preserving public health.

HYGRO′LOGY. (Gr. ὑγρος, *moist*, and λογος, *a discourse*.) A medical term, implying the doctrine of the humours or fluids of the body.

HYGRO′METER. (Gr. ὑγρος, and μετρον, *measure*.) An instrument for measuring the degrees of moisture or dryness of the atmosphere.

Variations in the state of the atmosphere with respect to moisture and dryness are manifested by a great variety of phenomena; and accordingly numerous contrivances have been proposed for ascertaining the amounts of those variations by referring them to some conventional scale. All such contrivances are called *hygrometers;* but though the variety of form that may be given to them, or of substances that may be employed, is endless, they may all be referred to two classes; namely, 1st, those which act on the principle of *absorption;* and, 2d, those which act on the principle of *condensation*.

1. *Hygrometers on the Principle of Absorption.* — Many substances in each of the three kingdoms of nature absorb moisture from the atmosphere with greater or less avidity, and thereby suffer some change in their dimensions, or weight, or some of their physical properties. Animal fibre is softened and relaxed, and consequently elongated, by the absorption of moisture. Cords composed of twisted vegetable substances are swollen, and thereby shortened, when penetrated by humidity; and the alternate expansion and shrinking of most kinds of wood, especially when used in cabinet work, and after the natural sap has been evaporated, is a phenomenon with which every one is familiar. Many mineral substances absorb moisture readily, and thereby obtain an increase of weight. Now it is evident that any of these changes, either of dimension or of weight, may be regarded as the measure of the quantity of moisture absorbed, from which the quantity of water existing in the atmosphere in the state of vapour is inferred; but many, indeed the far greater part of them, are so small in amount, or take place so slowly, that they afford no certain indication of the actual state of the atmosphere at any particular moment.

Of the different kinds of hygrometers whose construction depends on change of dimension arising from the absorption of moisture, there are two deserving of notice on account of their historical celebrity, though they are now seldom if at all used where accurate meteorological observations are attempted. One is the *hair* hygrometer of Saussure; the other the *whalebone* hygrometer of De Luc.

Saussure's hygrometer consists of a human hair prepared by boiling it in a caustic ley. One extremity of the hair is fastened to a hook, or held by pincers; the other has a small weight attached to it, by which it is kept stretched. The hair is passed over a grooved wheel or pulley, the axis of which carries an index which moves over a graduated arch. Such is the essential part of the instrument, and it is easy to conceive how it acts. When the surrounding air becomes more humid the hair absorbs an additional quantity of moisture, and is elongated; the counterpoise consequently descends, and turns the pulley, whereby the index is moved towards the one hand or the other. On the contrary, when the air becomes drier the hair loses a part of its humidity, and is shortened. The counterpoise is consequently drawn up, and the index moves in the opposite direction. The accuracy of the indications of this instrument depends on the assumed principle that the expansion and contraction of the hair are due to moisture alone, and are not affected by temperature or other changes in the condition of the atmosphere. Experiment shows that the influence of temperature is not very great; but after all precautions have been taken in preparing the instrument, it is found to be exceedingly irregular in its movements, and subject to great uncertainties. Besides, the substance is soon deteriorated, and will scarcely maintain its properties unimpaired during a single year.

The hygrometer of De Luc consists of a very thin slip of whalebone cut transversely, or across the fibres, and stretched by means of a spring between two points. One end is fixed to a bar, while the other acts on the shorter arm of the index of a graduated scale. When the whalebone absorbs moisture it swells, and its length is increased; as it becomes dry it contracts; and the space over which the index moves by the one or the other of these effects gives the measure of the expansion or contraction, and the corresponding change in the hygrometric state of the atmosphere. The action of this hygrometer appears to be more uncertain than that of Saussure.

The hygrometers which have been proposed on the principle of a change of weight arising from the absorption of moisture, are liable to still greater objections. Changes of weight may indeed be measured with great accuracy by the common or torsion balance; but in the present case they are so small, that the particles of dust which are at all times floating in the atmosphere may produce a great alteration in the results. A great variety of substances which attract moisture have been employed, such as sponge, cotton, bibulous paper, caustic potash, the deliquescent salts, sulphuric acid, &c.; but the indications which they give are deserving of very little credit. Changes of property indicated by the torsion of cords formed of gut, hemp, cotton, &c., and the torsion of certain vegetable fibres, are still more fallacious.

2. *Hygrometers on the Principle of Condensation.*—The instruments of this class are of a far more refined nature than those which we have been describing. In order to give an idea of the general principle on which they depend, let us conceive a glass jar, having its sides perfectly clean and transparent, to be filled with water, and placed on a table in a room where the temperature is, for example, 60°, the temperature of the water being the same as that of the room. Let us next suppose pieces of ice, or a freezing mixture, to be thrown into the water, whereby the water is gradually cooled down to 55, 50, 45, &c. degrees. As the process of cooling goes on, there is a certain instant at which the jar loses its transparency, or becomes dim; and on attentively examining the phenomenon, it is found to be caused by a very fine dew or deposition of aqueous vapour on the external surface of the vessel. The precise temperature of the water, and consequently of the vessel, at the instant when this deposition begins to be formed, is called the *dew point*, and is capable of being noted with great precision. Now this temperature is evidently that to which, if the air were cooled down, under the same pressure, it would be completely saturated with moisture, and ready to deposit dew on any body in the least degree colder than itself. The difference, therefore, between the temperature of the air, and the temperature of the water in the vessel when the dew begins to be formed, will afford an indication of the dryness of the air, or of its remoteness from the state of complete saturation.

But the observation which has now been described is capable of affording far more interesting and precise results than a mere indication of the comparative dryness or moisture of the atmosphere. With the help of tables of the elastic force of aqueous vapour at different temperatures, it gives the means of determining the absolute weight of the aqueous vapour diffused through any given volume of air, the proportion of vapour existing in that volume to the quantity that would be required to saturate it, and of measuring the force and amount of evaporation.

The elastic force of aqueous vapour at the boiling point of water is evidently equal to the pressure of the atmosphere. This may be assumed as corresponding to a column of mercury 30 inches in height. Mr. Dalton, in the fifth volume of the *Manchester Memoirs*, has given the details of a most valuable and beautiful set of experiments, by which he ascertained the elastic force of vapour from water at every degree between its freezing and boiling points in terms of the column of mercury which it is capable of supporting. As the same experiments have since been frequently repeated, and the different results present all the accordance which can be expected in so delicate an investigation, the tension of vapour at the different temperatures may be regarded as sufficiently well determined. Supposing, then, we have a table exhibiting the elasticity or tension corresponding to every degree of the thermometer, the weight of a given volume of vapour, for example a cubic foot, may be determined as follows:—

Steam at 212°, and under a pressure of 30 inches of mercury, is 1700 times lighter than an equal bulk of water at its greatest density, or a temperature of about 40°, and a cubic foot of water at that temperature weighs 437272 grains; the weight, therefore, of a cubic foot of steam at that temperature and pressure is $437272 \div 1700 = 257{\cdot}218$ grains. Hence we may find the weight of an equal bulk of vapour of the same temperature under any other given pressure, suppose 0·56 of an inch; for the density being directly as the pressure, we have 30 in. : 0·56 in. : : 257·218 grs. : 4·801 grs., which is the weight required.

Having found the weight of a cubic foot of vapour under a pressure of 0·56 of an inch, and at the temperature 212°, we may find its weight under the same pressure at any other temperature, suppose 60°. It is ascertained by experiment that all aëriform bodies, whether vapours or gases, expand the 1-480th part of their volume for every accession of temperature equivalent to one degree of Fahrenheit's scale; therefore, reckoning a volume of gas at 32° as unity, its volume at 60° is to its volume at 212° as $1 + \frac{28}{480}$ is to $1 + \frac{180}{480}$; or as 1·058 : 1·375; and the density and weight being inversely as the volume, we have

1·058 : 1·375 : : 4·801 grs. : 6·222 grs.

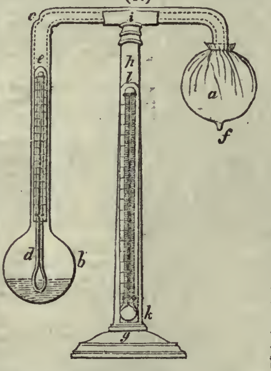
for the weight of a cubic foot of vapour at temperature 60°, and under a pressure of 0·56 of an inch of the mercurial column.

The following table, abridged from *Daniell's Meteorological Essays*, shows the force or tension, weight, and expansion of aqueous vapour, at different temperatures on Fahrenheit's scale:—

Temp.	Force.	Weight of a Cubic Foot.	Expansion.
0	·068	·856	·9334
5	·083	1·034	·9438
10	·098	1·208	·9542
15	·119	1·451	·9646
20	·140	1·688	·9750
25	·170	2·028	·9855
30	·200	2·361	·9959
35	·240	2·805	1·0062
40	·280	3·239	1·0166
45	·340	3·893	1·0270
50	·400	4·535	1·0375
55	·476	5·312	1·0479
60	·560	6·222	1·0583
65	·657	7·230	1·0687
70	·770	8·392	1·0791
75	·906	9·780	1·0895
80	1·060	11·333	1·1000
85	1·235	13·081	1·1104
90	1·430	15·005	1·1208
95	1·636	17·009	1·1312
212	30·000	257·218	1·3749

Having thus explained the principle of the condensation hygrometer, we will now describe one or two of the forms under which it has been most frequently constructed. Daniell's hygrometer is represented in the annexed figure. *a* and *b* are two thin glass balls of 1½ inch diameter,

(1.)



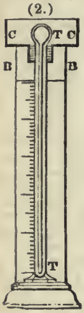
connected together by a tube having a bore about 1-8th of an inch. The tube is bent at right angles over the two balls, and the arm *b c* contains a small thermometer *d e*, whose bulb, which should be of a lengthened form, descends into the ball *b*. This ball having been about two thirds filled with ether, is heated over a lamp till the fluid boils, and the vapour issues from the capillary tube *f* which terminates the ball *a*. The vapour having expelled the air from both balls, the capillary tube is hermetically closed by the flame of a lamp. The other ball *a* is now to be covered with a piece of muslin. The stand *g h* is of brass, and the transverse socket *i* is made to hold the glass tube in the manner of a spring, allowing it to turn and be taken out with little difficulty. A small thermometer *k l* is inserted into the pillar of the stand. The manner of using the instrument is this:—After having driven out all the ether into the ball *b* by the heat of the hand, it is to be placed at an open window, or out of doors, with the ball *b* so situated that the surface of the liquid may be on a level with the eye of the observer. A little ether is then to be dropped on the covered ball. Evaporation immediately takes place, which, producing cold upon the ball *a*, causes a rapid and continuous condensation of the ethereal vapour in the interior of the instrument. The consequent evaporation from the included ether produces a depression of temperature in the ball *b*, the degree of which is measured by the thermometer *d e*. This action is almost instantaneous, and the thermometer begins to fall in two seconds after the ether has been dropped. A depression of 30 or 40 degrees is easily produced, and the ether is sometimes observed to boil and the thermometer to be

driven below zero of Fahrenheit's scale. The artificial cold thus produced causes a condensation of the atmospheric vapour upon the ball *b*, which first makes its appearance in a thin ring of dew coincident with the surface of the ether. The degree at which this takes place must be carefully noted. In very damp or windy weather the ether should be very slowly dropped upon the ball, otherwise the descent of the thermometer will be so rapid as to render it extremely difficult to be certain of the degree. In dry weather, on the contrary, the ball requires to be well wetted more than once, to produce the requisite degree of cold. (*Daniell's Meteorological Essays.*)

The instrument which has now been described is extremely beautiful in principle; but it may be doubted whether, even when the greatest caution is observed, the temperature which it indicates is precisely that at which the deposition of dew takes place. The deposition first occurs in a narrow ring on a level with the surface of the ether in the ball *b*, thereby indicating that the ether is colder at the surface than a little under it. But if the temperature is not uniform throughout the ball, it is evident that only a small part of the bulb of the thermometer can be placed in the point where the greatest cold exists; consequently the temperature indicated by the thermometer will be greater than is necessary for producing the deposition of moisture: in other words, the dew point will be given too high.

Various attempts have been made to obviate the defects of Daniell's hygrometer, but hitherto without much success. The apparatus proposed by Pouillet may be described as follows:—A small cup C C, formed of gold, and extremely thin, is fixed to a little collar of ivory B B′ supported on a stand. The stem of an inverted thermometer T T descends through a perforation in the bottom of the cup, and is fitted closely into it and sealed, the ball of the thermometer being placed at the centre of the cup. In order to prevent the mercury from separating, a small portion of air is left in the stem. When an observation is to be made sulphuric ether is poured into the cup; and in consequence of the rapid evaporation which takes place a considerable degree of cold is produced, and a deposition takes place on the outside of the cup. The degree of the thermometer at the instant the brightness of the metal begins to be dimmed gives the dew point. The correctness of the indication depends on the identity of temperature of the ether, the metal of the cup, and the thermometer. Bright gold is found to answer the purpose better than any other metal. (Pouillet, *Élémens de Physique.*)

(2.)



As the hygrometer is one of the principal instruments in meteorological researches, its theory and the best form of its construction have been the subject of frequent discussion in the various scientific journals.

HY′GROME′TRIC. This term is commonly applied to substances which readily become moist and dry with corresponding changes in the state of the atmosphere, or which readily absorb and retain moisture. Sea weed, several saline substances, porous clays, potash and its carbonate, chloride of calcium, sulphuric acid, are in this sense of the term said to be hygrometric.

HY′GROSCOPE. (Gr. ὑγρος, and σκοπεω, *I view.*) An instrument by means of which changes in the condition of the atmosphere with respect to moisture are observed. *See* HYGROMETER, by which the same changes are measured.

HY′LÆOSAU′RUS. (Gr. ὕλη, *a wood*, and σαυρος, *a lizard.*) A name given by Dr. Mantell to an extinct gigantic genus of reptiles, the fossil remains of which he has discovered in the wealden strata of Sussex.

HYLO′BIUS. (Gr. ὕλη, and βιος, *life.*) A genus of Tetramerous Coleoptera, belonging to the *Curculionidæ*, or family of weevils, and noted for the ravages committed by one species, *Hylobius abietis* (*Curculio abietis* and *Curculio pini* of Linnæus) upon firs and larches, especially in young plantations. This insect varies from five to nine lines in length, is of a pitchy black colour, with numerous yellow spots on the elytra. It has been found in the pine woods of Shropshire, the north of England, and Scotland.

HYLOZO′ISM. (Gr. ὕλη, *wood*, used by ancient philosophers to signify the abstract idea of matter, and ζωη, *life.*) In Philosophy, strictly the doctrine that matter lives. Some writers have confined this name to the tenet of the *anima mundi*, or soul of the world; others to the theory of a peculiar life residing in the whole of nature, approaching, therefore, in its sense to pantheism. This life is either merely organic or actually sentient: the latter notion has been also called *hylopathism*. (See the remarks on Cudworth's Intellectual System in *Hallam's Literature of Europe*, iv. 188.; and *Ersch and Gruber's Encyclopædia.*)

HY′MEN. Among the ancients, the God of Marriage. The origin of the worship of this divinity is attributed to the following story:—A young Athenian, named Hymenæus, in humble circumstances, having become enamoured of a rich and noble lady, from whose presence he was debarred, attired himself in female habiliments, and joined a religious procession to Eleusis, in which his mistress took part. On their way thither the parties who composed it were attacked by pirates, who carried them into captivity; but Hymenæus seized the opportunity when they were asleep of putting them to death, and departing immediately for Athens, engaged to restore all the ladies to their families on condition of his obtaining permission to marry the object of his affection. The Athenians consented; the nuptials of Hymenæus were crowned with happiness; and from that period the Greeks instituted festivals in his honour, and invoked him at the celebration of their marriages. The formula employed on these occasions was, "O Hymenæe Hymen, Hymen O Hymenæe." (*Cat. Carm.* 61, 62.) *Hymeneal* is used to signify a song or ode composed in celebration of a marriage.

HYME′NIUM, in describing fungi, denotes that part in which the sporules immediately lie. It is commonly called the gills in the genus *Agaricus*; but in *Boletus* is a corky or spongy substance pierced full of holes, and in other genera presents a variety of peculiar appearances.

HYMENO′PTERANS, *Hymenoptera*. (Gr. ὑμην, *a membrane*, and πτερον, *a wing.*) An order of mandibulate insects, comprehending those which have four membranous wings with few nervures. Latreille divides this order into the following sections and tribes:—

1. *Terebrantia:* Abdomen of the females furnished with a saw or borer.
   - *a. Securifera:* Abdomen sessile, furnished with a saw; larvæ with feet.
   - *b. Pupivora:* Abdomen pedunculated, furnished with a borer; larvæ footless.
2. *Aculeata:* Abdomen of the females armed with a sting.
   - *a. Heterogyna:* Females wingless.
   - *b. Fossores:* Females winged, wings not folded; basal joint of posterior tarsi simple.
   - *c. Diploptera:* Females winged, wings folded.
   - *d. Mellifera:* Females winged, wings not folded; posterior tarsi enlarged, and converted into a polliniferous organ.

(See the above terms; and APIS and FORMICA.)

HYMN. (Gr. ὑμνος.) An ode in praise of the Deity, or some divine personage. The earliest Greek hymns are those attributed, probably without foundation, to Homer: imitated by Callimachus. They are in heroic verse, except one of Callimachus in hexameters and pentameters; and their contents, for the most part, are narrations of the events in the mythological history of the respective gods and goddesses to whom they are dedicated, related in an encomiastic strain. The choric strains of some of the tragedians in honour of deities, introduced into their dramas, appear also to have the character of hymns; especially as dramatic performances, among the Greeks, had something of a religious solemnity attached to them. The Theurgic Hymns were strains of a higher character, and intended only for those who were initiated into certain mysteries, supposed to have for their object the diffusion of more exalted notions of the divinity. Those which are falsely attributed to Orpheus, and pass by his name, are said to be of this class; but, except from their obscurity, it is difficult to say from what reason. Philosophical hymns, intended for the use of the followers of a still higher species of worship, are mentioned in the division of ancient hymns; but we have no genuine examples of such compositions. In modern literature, hymns are pieces of sacred poetry intended to be sung in churches; of which the Psalms of David, the most ancient pieces of poetry, properly so called, on record (except the book of Job), furnish the chief example and model. St. Hilary, bishop of Poitiers, is said to have been the first who composed hymns to be sung in churches. The Latin hymns of the Roman Catholic church are well known, from the exquisite music to which they have been united. (See *Riddle's Christian Antiquities*, p. 313. As to the classical hymns and hymnographers, see the *Mem. de l'Acad. des Inscr.* vols. xii. and xvi.)

HY′OSCYA′MIA. The active principle or alkaloid of the common henbane (*Hyoscyamus niger*).

HYPÆ′THRAL. (Gr. ὑπο, *under*, and αιθηρ, *the air.*) In Architecture, a building or temple uncovered by a roof. The temples of this class are arranged by Vitruvius under the seventh order, having six columns in front and rear, and surrounded by a *dipteral* or double portico. The famous temple of Neptune at Paestum, still remaining, is an example of this species of building.

HYPA′LLAGE. (Gr. ὑπαλλασσω, *I change slightly.*) In Grammar and Rhetoric, a species of inversion, in which not only the natural or customary succession of words is changed, but the sense presents a species of transposition, in which predicates are transferred from their proper

subject to another. Such examples as "gladium vagina vacuum," *the sword empty of the scabbard*, "in nova fert animus mutatas dicere formas corpora," where the adjective "new" is transferred from "form" to "body," present striking instances of this figure; but although such deviations from the natural sense could not be admitted in modern language, similar locutions are not wholly wanting among ourselves.

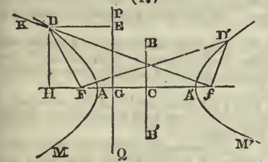
HYPANTHO'DIUM. A term given by Link to that form of inflorescence where the receptacle is fleshy and covered with minute flowers, but not enclosed within an involucrum; as in *Dorstenia* and *Ficus*.

HYPE'RBOLA. (Gr. ὑπερβολη; from ὑπερ, *above*, and βαλλω, *I throw*.) In Geometry, one of the conic sections, formed by cutting a cone by a plane which is so inclined to the axis that when produced it cuts also the opposite cone, or the cone which is the continuation of the former on the opposite side of the vertex. The term *hyperbola* was given to this curve by Apollonius on account of its property, that the square of any ordinate is greater than the rectangle under the corresponding absciss and the parameter, or differs from that rectangle in *excess*.

Like the ellipse and parabola, the hyperbola may be defined in various ways, and all its properties investigated without any reference to the cone, but considered entirely as a plane curve. The definitions most usually adopted are the following: —

If two points F and f be given in a plane, and a point D be conceived to move around them in such a manner that the difference between the two distances D F and D f is always constant the point D will describe on the plane an hyperbola D A M. By assuming first one of the given points F, and then the other f, as that to which the moving point is nearest, the difference of the lines D F and D f in both cases being the same, two hyperbolas D A M and D′ A′ M′ will be described opposite to each other; so that the curve consists of two branches.

(1.)



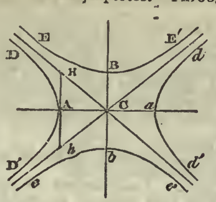
The points F and f are the *foci* of the hyperbola; and C, which bisects the distance between the foci, is its *centre*. The line A A′ is the *major* or *transverse axis*: and a straight line B B′, passing through the centre, perpendicular to A A′, and of such a length that the square of its half C B or C B′ is equal to the difference between the squares of C F and C A, is the *minor* or *conjugate* axis. The curve may be described mechanically as follows: — Let one end of a string be fastened to F, and the other to K, the extremity of a ruler f D K; and let the difference between the length of the ruler and of the string be equal to A a. Let the other end of the ruler be fixed to the point f, and let the ruler be made to revolve about f as a centre in the plane in which the axes are situated, while the string is stretched by means of a pin D, so that the part of it between K and D is applied close to the edge of the ruler: the point of the pin will by its motion trace a curve line D A M upon the plane, which is one of the hyperbolas required; and if the ruler be made to revolve about the other focus F, while the end of the string is fastened to f, the opposite hyperbola will be described by the pin D′.

2. The hyperbola may also be defined as follows: — Let F be a given point, and P Q a straight line given in position; if another point D move in the same plane, so that its distance D F from F shall have always to the perpendicular D E, or its distance from the given line P Q, the constant ratio of two given lines X and Y, of which X is greater than Y, the locus of the point D will be a hyperbola. The line P Q is called the *directrix*, and its distance C G from the centre C is such that C G is a third proportional to C F and C A. It is obvious that F A is to A G in the given ratio of X to Y.

3. Another distinguishing property of the hyperbola is that the rectangle under A H and H A′ is to the square of the ordinate H D in the ratio of the square of C A to the square of C B. Let C A $= a$, C B $= b$, C H $= x$, and H D $= y$; then A H · H A′ : H D^2 : : $a^2 : b^2$, that is, $(x - a)(x + a) : y^2 : : a^2 : b^2$, or $x^2 - a^2 : y^2 : : a^2 : b^2$; whence $y^2 = \frac{b^2}{a^2}(x^2 - a^2)$, an equation which may be put under this form, $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$.

4. Like the ellipse, the hyperbola may also be defined by a polar equation. Let F D $= r$, C A $= a$, C F the eccentricity $= e$, and the angle A F D $= \phi$; then $r = \frac{e^2 - a^2}{a + e \cos. \phi}$.

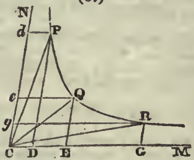
The hyperbola has two infinite branches, and it has also two asymptotes. Through A, one of the vertices of the transverse axis, let a straight line H A h be drawn equal and parallel to B b, the conjugate axis, and bisected at A; the straight lines C H, C h, drawn through the centre, and the extremities of that parallel, are asymptotes, and if produced indefinitely do not meet the curve, though their distance from it becomes less than any assignable line.



The asymptotes of two opposite hyperbolas are common to both; and they are likewise the asymptotes of two other hyperbolas, E B E′, $e\ b\ e'$, whose transverse axis B b is the conjugate axis of D A D′, and whose conjugate axis is the transverse axis of D A D′. These two hyperbolas, E B E′ and $e\ b\ e'$, are called *conjugate* to the former pair; and, in general, whatever property belongs to the opposite hyperbolas D A D′, $d\ a\ d'$, the same belongs also to the conjugate hyperbolas E B E′ and $e\ b\ e'$.

One of the most remarkable properties of the asymptotes is the following: — If one of the asymptotes C M be divided in continued proportion in the points D, E, G, &c., and straight lines be drawn from the points of section parallel to the other asymptote, meeting the curve in the points P, Q, R, &c.; the spaces D P Q E, E Q R G, &c., without the curve, are equal. The hyperbolic sections C P Q, C Q R, &c., are also equal to each other, and to the spaces D P E Q, E Q R G, &c.

(3.)



Hence, from the nature of logarithms, the sectors C P Q, C P R, &c., or the equal spaces D P Q E, D P R G, &c., represent the logarithms of the ratios of C D to C E, to C G, &c.; and if C D represent the unit of the arithmetical scale, the sector C P Q, or the space D P Q E, will express the logarithm of C E on any logarithmic system depending on the angle of the asymptotes. From the points P, Q, R, &c. let P d, Q e, R g, be drawn parallel to C M; the ordinates C d, C e, C g, &c. are also in geometrical progression decreasing; and wherever the points D, E, G, &c. are situated, all the parallelograms C d P D, C e Q E, C g R G, &c. are equal. Hence if C M be taken as the line of the abscissa, and the ordinates be taken parallel to C N, and if we make at the same time C E $= a$, C e $= b$, the nature of the curve will be expressed by this equation, $x\,y = a\,b$. *See* CONIC SECTIONS.

HYPE'RBOLE. In Rhetoric, a figure by which expressions are used signifying more than it is intended to represent to the hearer or reader; as when thoughts and sentiments are clothed in tumid language, or ideas are brought forward which in themselves are incredible, in order to induce a belief of something less than that which is offered. Exaggeration is hyperbole applied to narrative, when false assertions are added to true in order to increase the impression made by them.

HYPERBO'LIC LOGARITHMS. A system of logarithms; so called because the numbers express the areas between the asymptote and curve of the hyperbola, those areas being limited by ordinates parallel to the other asymptote, and the ordinates decreasing in geometrical progression. But as such areas may be made to denote any system of logarithms whatever, the denomination is not correct. The term Napierean logarithm (from the inventor of the logarithms, Baron Napier) is more frequently used, at least by the Continental writers, to denote the same thing. The hyperbolic logarithm of any number is to the common logarithm of the same number in the ratio of 2·30258509 to 1, or as 1 to ·43429448. *See* LOGARITHM.

HYPE'RBOLOID, or HYPERBOLIC CONOID. (Gr. ὑπερβολη, and ειδος, *form*.) A solid formed by the revolution of an hyperbola about its axis. *Hyperboloids* also denote hyperbolas of the higher kind, defined, generally, by the equation $x^m\,y^n = a^{m+n}$. The asymptotic area of any hyperbola of which this is the equation is $\frac{n}{n-m}\,x\,y$; and it is very remarkable that this space is always quadrible, except in the case of the common hyperbola, in which m and n being each 1 the denominator $n - m$ becomes zero.

HY'PERCATALE'CTIC. (Gr. ὑπερ, *above*, and καταληκτικος, *deficient*.) In Greek and Latin poetry, a verse exceeding its proper length by one syllable.

HY'PERCRI'TICISM, consists in viewing the works of an author in an ungenerous spirit, exaggerating minor defects, and overlooking or undervaluing such merits or

beauties as might fairly be considered to outweigh the former.

HY'PERICA'CEÆ. (Hypericum, one of the genera.) A natural order of Exogenous plants, usually having yellow flowers, with the petals wider on one side than the other, and marked with black dots, while the leaves are in many cases marked with transparent dots. They are usually strong-scented and astringent. Some of them have coppery red flowers, and yield a resinous substance resembling gamboge.

HYPE'RION. *See* TITAN.

HYPE'ROCHE. (Gr. *pre-eminence.*) In Music, an interval nearly equal to one comma and a half.

HYPEROXYMU'RIATES. Combinations of the chloric and perchloric acids were formerly so called: thus, chlorate of potash was called hyperoxymuriate of potash.

HY'PERSTHENE. Labrador hornblende. It is a ferrosilicate of magnesia, with traces of alumina and of lime. It occurs crystalline and massive; it is resplendent, and of a grey green or reddish hue.

HY'PERTHYRUM. (Gr. *ὑπερ*, *upon*, and *θυρα*, *a door.*) In Architecture, the lintel of a doorway.

HYPE'RTROPHY. (Gr. *ὑπερ*, and *τροφη*, *excess of nutrition.*) A term frequently applied to the morbid enlargement of any part of the body "This term ought to be restricted to cases in which a part, though increased in bulk, retains its natural organization and structure." (*Cooper's Dictionary.*)

HY'PHA, in describing *Algæ*, denotes the filamentous, fleshy, watery thallus of *Byssaceæ.*

HY'PHEN. (Gr. *ὑφεν*, *together with.*) In Writing, a mark or character thus (-), implying that two words or syllables are to be connected.

HYPNO'TICS. (Gr. *ὑπνος*, *sleep.*) Medicines which induce sleep.

HYPOCAU'STUM. (Gr. *ὑπο*, *under*, and *καιω*, *I burn.*) In Ancient Architecture, a vaulted apartment from which the fire's heat is distributed to the rooms above by means of earthen tubes. This method, first used in baths, was afterwards adopted in private houses, and diffused an agreeable and equable temperature throughout the different rooms.

HY'POCHONDRI'ASIS. (Gr. *ὑπο*, *under*, and *χονδρος*, *cartilage.*) Uneasiness about the region of the stomach and liver, or of the hypochondriac region, is one of the symptoms of this disease. Particular circumstances may induce this disorder in any individual; but it is most commonly met with in persons of sallow or pale complexions, spare habit of body, and dark hair and eyes. Its mental symptoms are low spirits, a groundless apprehension of evil, imaginary local sensations, and erroneous impressions respecting the opinions and sentiments of others, with a tendency to misconstrue their actions; aversion to society; want of mental and bodily energy; seeing persons and things and hearing conversations and noises which are purely imaginary. The bodily symptoms are flatulency and all the other concomitants of indigestion,— costiveness, dimness of sight, noises in the ears, want of appetite and sleep in most cases, in a few voracity and drowsiness. As this disease is usually connected with imperfect action of the liver and debility of the stomach and bowels, mild aperients, small doses of calomel or blue pill, and tonics are to be prescribed; occasionally doses of more powerful purges, such as calomel and jalap, or scammony with salts and senna, must be resorted to where the bowels are foul and overloaded; and where there is much headach a blister to the neck, or the loss of a *little* blood by cupping, or from the arm, may be of service. The regularity of the circulation is often much disturbed, and it is generally necessary to keep the feet warm.

Change of scene and of occupation, cheerful society, moderate exercise of all kinds, and great kindness and attention on the part of the medical adviser, are generally among the essentials in the treatment of this diseased state. But every amusement and relaxation must be carefully proposed and pursued; and though it is generally necessary firmly but gently to remonstrate against the whims and caprices of hypochondriacs, yet sometimes they must be conceded to. When persons are full of evil forebodings and false alarms, it is sometimes well to induce them to keep a diary of their feelings, the perusal of which as they recover, or in their happier moments, is often comforting proof to them of the utter want of foundation of some of their most inveterate notions. Persons who are very irritable and over-anxious, or who, after having been actively engaged in business, retire to a life of ease and idleness, who take no interest in study, amusement, or exercise; and those, again, who have kept bad hours, or who have led debauched lives, or who have studied intensely,— are those in whom some of the worst forms of hypochondriasis occur. It is seldom, in the most aggravated cases of this disorder, that well-grounded hopes of recovery may not be held out, and that its recurrence may not be prevented by timely and firm treatment; but if it be allowed to run its course, it often ends in melancholy.

HY'POCRATE'RIFORM. (Gr. *ὑπο*, *κρατηρ*, *a cup*, and *φορμη*, *shape.*) That form of a corolla which consists in a cylindrical tube which is longer than the flat spreading limb, as in the flowers of the genus *Phlox*. It is called in English salver-shaped.

HYPOGÆ'OUS. (Gr. *ὑπο*, and *γη*, *the earth.*) Literally subterranean. In Botany it denotes all parts in plants which grow beneath the surface of the earth.

HY'POGENE. (Gr. *ὑπο*, and *γινομαι*, *I am formed.*) A class of rocks which have not assumed their present form and structure at the surface of the earth, but are apparently of igneous origin, and thrust up from below. *See* GEOLOGY.

HYPO'GYNOUS (Gr. *ὑπο*, and *γυνη*, *a female*), in Botany, in describing the situation of plants denotes any thing growing from below the base of the ovarium.

HY'POMO'CHLION (Gr. *ὑπο*, and *μοχλος*, *lever*), in Mechanics, is the fulcrum or support of a lever, or the point against which the pressure is exerted. This term is only met with in the old treatises on mechanics; the equivalent term fulcrum being now generally used.

HY'PONI'TROUS ACID. An acid intermediate between nitric oxide and nitrous acid, composed of 1 equivalent of nitrogen = 14, and 3 of oxygen = 24, the equivalent of the hyponitrous acid, upon the hydrogen scale, being = 38.

HY'POPHO'SPHOROUS ACID. An acid composed of 2 atoms of phosphorus and 1 of oxygen, or 32 phosphorus + 8 oxygen.

HYPOPHY'LLIUM. (Gr. *ὑπο*, and *φυλλον*, *a leaf.*) A term invented to denote a petiole that has the form of a small sheath, is destitute of lamina, and surrounds the base of certain small branches, having the appearance of leaves; as in asparagus. It is nothing but a rudimentary leaf.

HYPO'PIUM. (Gr. *ὑπο*, and *πυον*, *pus.*) A disease of the eye, in which there is an apparent collection of pus under the transparent cornea; that is, in the chamber of the aqueous humour.

HYPOSCE'NIUM. (Gr. *ὑπο*, and *σκηνη*, *a scene.*) In ancient Architecture, the front wall of a theatre facing the orchestra from the stage.

HYPO'STASIS. (Gr. *ὑποστασις*, from *ὑπο* and *ἱστημι*, *I stand.*) A term invented by the Greek fathers to express the distinct *personality* of the Father, Son, and Holy Ghost. *Προσωπον*, in Latin persona, whence our *person*, signifies properly a face or mask. This term, however, is retained by the Latin fathers, who, like ourselves, had no word which could exactly represent hypostasis, which differs from *οὐσία*, *substance*, inasmuch as the latter is used for the divine substance, essence, or being,— that which is common to each of the hypostases, persons, or individual substances which compose the one Godhead.

HY'POSULPHU'RIC ACID. An acid intermediate between the sulphurous and sulphuric acids. It may be regarded as containing 2 atoms of sulphur ($16 \times 2 = 32$), and 5 of oxygen ($8 \times 5 = 40$); or as constituted of 1 atom of sulphurous acid = 32, and 1 of sulphuric acid = 40. In either case its equivalent is 72.

HYPOSULPHU'ROUS ACID. An acid constituted of 2 atoms of sulphur ($16 \times 2 = 32$), and 2 of oxygen ($8 \times 2 = 16$). It is necessary to take this view of composition, its equivalent number being 48.

HYPO'THECA'TION. (Gr. *ὑποθηκη*, *that which is subject to a pledge.*) In the Civil Law, an engagement by which the debtor assigns his goods in pledge to a creditor as a security for his debt, without parting with the immediate possession; differing, in this last particular, from the simple pledge. The term hypothecation is usually applied to things immoveable only (*i. e.* according to the division of the English law, to things real, things personal savouring of the realty, and choses in action), and not to things moveable (*i. e.* things personal in possession). It answers in general to the English mortgage. *See* MORTGAGE.

HYPO'THENUSE (Gr. *ὑπο*, and *τεινω*, *I stretch*), in Geometry, denotes the longest side of a right-angled triangle, or the side which subtends the right angle. The famous 47th proposition of the First Book of *Euclid*, namely, that in any right-angled rectilinear triangle the square described on the hypothenuse is equal to the sum of the squares described on the two sides, is said to have been discovered by Pythagoras, who was so much pleased with it that he sacrificed a hecatomb to the Muses in gratitude. Camerer, in the Notes to his edition of the first Six Books of *Euclid*, in Greek and Latin, has collected no fewer than seventeen different demonstrations of this celebrated theorem from the principles of elementary geometry.

HYPO'THESIS (Gr. *ὑποθεσις*, from *ὑπο*, and *τιθημι*, *I place*), in Mathematical Science, is a supposition made with a view to draw from it some consequence which establishes the truth or falsehood of a proposition, or gives the solution of a problem. In a mathematical proposition there are two things to be considered,— the *hypothesis* and the *conclusion;* the hypothesis being that which is granted or supposed, and the conclusion that which follows from

reasoning from the data. In the following proposition, "If two triangles be equiangular, their homologous sides are proportional;" the first part, *if two triangles be equiangular*, is the hypothesis or *data* from which we are to reason; and the second part, the *homologous sides are proportional*, is the conclusion or consequence at which we arrive by reasoning from that hypothesis.

In Physics, the term hypothesis denotes a gratuitous supposition to account for some phenomenon or appearance of the natural world. If the hypothesis serves to explain a great number of the circumstances accompanying a phenomenon, it acquires a certain degree of probability; and if all the known circumstances can be deduced from it, the probability becomes very great, and in the lapse of time may amount to certainty. Thus the hypothesis of the diurnal rotation of the earth and its translation in the ecliptic, imagined by Copernicus to explain the planetary phenomena, has acquired all the characters of certainty from continual astronomical observation. In like manner, Kepler's hypothesis that the planets move in elliptic orbits, has been so fully confirmed by subsequent discoveries and computations, that, however doubtful it might be at first, no one who is capable of understanding the evidence can hesitate to receive it as an established law of nature. "A well-imagined hypothesis," says Sir John Herschel, "if it have been suggested by a fair inductive consideration of general laws, can hardly fail at least of enabling us to generalize a step further, and group together several such laws under a more universal expression. But this is taking a very limited view of the value and importance of hypotheses. It may happen (and it has happened in the case of the undulatory theory of light) that such a weight of analogy and probability may be accumulated on the side of an hypothesis, that we are compelled to admit one of two things — either that it is an actual statement of what really passes in nature; or that the reality, whatever it be, must run so close a parallel with it as to admit some mode of expression common to both, at least in so far as the phenomena actually known are concerned. Now, this is a very great step, not only for its own sake, as leading us to a high point in mathematical speculation, but for its applications because whatever conclusions we deduce from an hypothesis so supported must have at least a strong presumption in their favour; and we may be thus led to the trial of many curious experiments, and to the imagining of many useful and important contrivances, which we would never otherwise have thought of, and which, at all events, if verified in practice, are real additions to our stock of knowledge and to the arts of life." (*Discourse on the Study of Nat. Philosophy*.)

HY'POTRACHE'LIUM. (Greek ὑπο, *under*, and τραχηλος, *the neck*.) In Architecture, the slenderest part of the shaft of a column, being that immediately below the neck of the capital.

HY'POTYPO'SIS (Gr. ὑποτυπωσις, from τυπος, *a type*), in Rhetoric, signifies an animated representation of a scene or event in descriptive language highly enriched with rhetorical figures.

HY'RAX. (Gr. ὑραξ, *a shrew-mouse*.) This term is now applied to a genus of small Mammalia which rank next the rhinoceros in the order of their affinities, and are the most diminutive representatives of the Pachydermatous order. The two known species are found in hilly districts at the Cape (*Hyrax capensis*), and in Syria (*Hyrax Syriacus*): the latter species is the "coney" of Scripture.

HYSTERA'NTHUS, in describing the duration of leaves. denotes their appearance after the flowers; as in the almond.

HYSTE'RIA. (Gr. ὑστερα, *the womb*, with which it is supposed that the disease is generally connected.) It generally attacks unmarried females between the ages of 15 and 35, coming on with low spirits and anxiety, sickness, short breath, and palpitations; sobbing; and a sense of distension of the bowels, which afterwards seems to concentre itself in the stomach, and then rise like a ball into the throat, where it produces gasping, stupor, convulsive motions, crying, laughing, hiccough, flow of saliva from the mouth, and delirium: at length the spasms abate, and the person gradually recovers, generally with the expulsion of wind from the stomach. Some of these symptoms are often much more prevalent than others, so that the disorder assumes many forms: it is also very variable in its duration, lasting from an hour or two to one or two days. The treatment varies extremely with the apparent causes of the disorder; sometimes bleeding and depletives, at others stimulants and tonics are required; in mild cases sprinkling with water and applying nasal stimulants give relief. Great attention to the exciting cause, exercise, moderate and judicious amusements and occupations, regular hours, and change of air and scene, are among the best preventives of its recurrence.

HYSTERI'TIS. Inflammation of the womb. This dangerous disease generally occurs the second or third day after delivery; it is attended by fever and pain of the part, and requires active antiphlogistic treatment.

HYSTERO'LOGY, or HYSTERON PROTERON. (Gr. ὑστερος, *the latter of two*, and λογος, *speech*.) In Rhetoric, a figure by which the ordinary course of thought is inverted in expression, and the last put first; as, where objects subsequent in order of time are presented before their antecedents, cause before effect, &c. Some comprehend the figure usually called anticlimax (*see* CLIMAX) under the name Hysterology.

HY'STRICI'DÆ. (Gr. ὑστριξ, *a porcupine*.) The name of the family of Rodent Quadrupeds, of which the porcupine (*Hystrix cristata*) is the type.

I AND J.

I, the ninth letter of the English and most European alphabets, represents two very different sounds in different languages. In England it is equivalent to the French or German sounds of the two letters *a i*, pronounced rapidly; and in the German and all other languages with which we are acquainted, it is identical with the sound of the long English *e*. In the Greek language the letter *i* is the simplest of the alphabetical characters, being represented by a single stroke, thus, ι. It is also susceptible of various interchanges, more particularly in the Latin, Greek, and French languages. When two *i*'s followed in succession, the Romans used to contract them into a single long *i*, as *Di* for *Dii*, *tibicen* for *tibiicen*; or made the letter larger than usual, as *ChIus*. Shakspeare sometimes substitutes *I* for ay or yes.

> Did your letters pierce the queen?
> *I*, sir; she took 'em and read 'em in my presence.

According to Gebelin, the letter *i* in hieroglyphic writing represents the human hand, the instrument of which man avails himself in all his necessities, the seat of his power and might. As a Roman numeral it denotes 1; and if placed before V or X, it diminishes by a unit the number expressed by these two letters. The form of J was originally identical with that of I; and it is only within the last century that any distinction was made between them. In the English and French languages J has a sibilant sound, but the Germans pronounce it exactly as the English *y* before a vowel. The Latin sound of this letter is very ambiguous, the question being usually decided by the parties who discuss it according to its pronunciation in the vernacular. In the Spanish language J represents a guttural, and is frequently substituted for X, which has the same sound.

IA'CCHUS. *See* BACCHUS.

IA'MBICS. A species of verse used by the Greek and Latin poets, and especially by the Greek tragic poets. The derivation of the word has never been ascertained, but it can boast of an origin nearly coeval with the Greek language. The iambics of the Greek tragic poets consisted of three entire metres or six feet, and were thence styled the tragic *trimeter acatalectic*. They were composed originally, as their name implies, of a succession of iambi (◡ –); but at a later period, various other feet were admitted, of which the subjoined table will convey an idea.

1.	2.	3.	4.	5.	6.
◡ –	◡ –	◡ –	◡ –	◡ –	◡ –
◡ ◡ ◡	◡ ◡ ◡	◡ ◡ ◡	◡ ◡ ◡	◡ ◡ ◡	
– –		– –		– –	
– ◡ ◡		– ◡ ◡			
◡ ◡ –					

Hence it will be seen that a tribrachys may be introduced into all the places except the last; a spondee in the first, third, and fifth places: a dactyl in the first and third places; and an anapest in the first. It was, however, long a question of great doubt among grammarians into what places the anapest might be legitimately introduced. The discussion at one period ran high, particularly between English and German critics; but it now seems to be universally admitted that this foot may be used in every odd place of the verse except the last: with the general restriction, that in the 3d and 5th places it should be contained in a proper name, as Antĭgŏnē, or in a preposition and the word which it governs. The comic writers used much greater licence in the iambic trimeter, admitting an anapest, even in common words, into every place but the last. For a full exposition of this and the other iambic metres employed by the Greek and Latin poets, the reader may consult *Hermann's Elementa Doctrinæ Metricæ; Porson's* editions of the *Tragedies of Euripides;* and the article "Iambic Verse" in *Rees's Cyclopædia*. In most modern European languages, the verse of five iambic feet is a favourite metre. In French it is used almost entirely in lighter poetry, as by La Fontaine and similar writers, the heroic verse being the sixth foot, or alexandrine; but in English, German, and Italian, the former is the verse of ordinary use in serious composition. The Italians divide it into — 1. The *verso cadente*, in which the line is decasyllabic, consisting of five iambi: *e.g.*

> "E come albero in nave si levo." DANTE.

This variety is very rarely admitted in serious composition, and is ill suited to the character of the language. Poets have, however, sometimes sportively attempted whole series of versi cadenti; as in the set of sonnets of Casti, called *I tre Giuli*. 2. The verso eroico, or hendecasyllabic, which is the ordinary one, ending in a short syllable:

"Canto l'armi pietose, e 'l capĭtānŏ."

3. The verso sdrucciolo, which ends with two short syllables after the fifth iamb:

"Passi oziosa, e di tua gloria immēmŏrĕ."

This also is rarely used in serious writing; but its occasional employment adds a peculiar grace to lighter poetry. In English, according to the genius of the language, the decasyllabic line is most common; the hendecasyllabic occasional, and more frequent in blank verse than in rhymes, in consequence of the comparative rarity of trochaic rhymes; the sdrucciolo, also occasionally used by dramatic poets: *e. g.*

"What's Hecuba to him, or he to Hēcŭbă?"

The licence is sometimes carried so far as to add three short syllables to the last iamb: *e. g.*

"The senator shall bear contempt herēdĭtărȳ."

The German language is rich both in iambic and trochaic terminations: consequently the decasyllabic and hendecasyllabic are more indiscriminately employed than in either English or Italian; and it is not uncommon to use the elegant variety of alternate iambic and trochaic rhymes, like the French masculine and feminine.

I'BEX. (Lat. *a wild goat.*) The name is restricted to a species of goat; the *Capra ibex* of Linnæus, *Bouquetin* of Buffon and the French naturalists. It is characterized by having large horns, with a flattened anterior surface, and marked with prominent transverse ridges or knots. It inhabits the summits of the highest mountain chains in the continents of Europe, Africa, and Asia, but does not exist in the New World.

I'CEBERG. (Germ. eis, *ice*, and berg, *mountain.*) The name given to the masses of ice resembling mountains often found floating in the polar seas. They are sometimes formed in the sea itself by the accumulation of ice and snow; at other times they seem to be glaciers which have been piling up on shore till quite overgrown, and ultimately broken and launched into the ocean by their own weight. Masses of this sort abound in Baffin's Bay, where they are sometimes two miles long, and half or one third as broad. Scoresby counted 500 of these bergs drifting along in latitudes 69° and 70° N., which rose above the surface from the height of 100 to 200 feet, and measured from a few yards to a mile in circumference. (*Voyage in* 1822, p. 233.) Many of them were loaded with beds of earth and rocks, of such thickness that the weight was conjectured to be from 50,000 to 100,000 tons; and on closer examination the mass was found to be composed, among other substances, of granite, gneiss, micaschist, clayslate, granular felspar, and greenstone. Some idea may be formed of the immense depth to which icebergs descend, from the fact that the mass of ice below the level of the water is about eight times greater than that above. Icebergs have been known to drift from Baffin's Bay to the Azores, and from the South Pole to the immediate neighbourhood of the Cape of Good Hope. (See *Lyell's Geology*, book ii. c. 3.; *Murray's Encyc. of Geography.*)

ICELAND MOSS, *Lichen Islandicus*, *Cetraria Islandica*. This is a common lichen in the mountainous districts of Europe. It contains a bitter principle, and a considerable quantity of starchy matter; it is tonic and nutritive, and is often prescribed in disorders of debility, and in pulmonary consumption.

ICELAND SPAR. A transparent rhomboidal variety of calcspar, or carbonate of lime. This form of crystallized carbonate of lime is particularly valuable for experiments on the double refraction and polarization of light.

ICE SPAR. A variety of felspar, from Somma near Naples.

ICH DIEN. (Germ.) Literally *I serve;* the motto of the Prince of Wales, which was originally adopted by Edward the Black Prince in proof of his subjection to his father Edward III., and has been continued without interruption down to the present time.

ICHNEU'MON. (Gr. ἰχνεύμων, Pharaoh's rat, the destroyer of crocodiles; perhaps from ιχνεύω, because it tracked the foot-prints of the crocodile.) A name applied in zoology, in a double sense, to a Viverrine genus of quadrupeds, and to a family of Pupivorous Hymenoptera. As regards the Mammalia the name is changed for *Herpestes* by Illiger, and the latter has been generally adopted by English zoologists. (*See* Herpestes for the generic characters.) The ichneumon of the Nile (*Herpestes Pharaonis*) was one of the sacred animals of the ancient Egyptians; and although many fabulous feats were narrated of it as the enemy of the crocodile, there is no doubt but that its industrious instinctive searching out of the eggs of the crocodile as an article of food tends materially to diminish the number of that destructive reptile. The ichneumon preys, however, on the eggs and young of various species of animals. Mr. Bennett relates that on one occasion a grey ichneumon (*Herpestes griseus*) killed no fewer than a dozen full-grown rats, which were loosed to it in a room sixteen feet square, in less than a minute and a half. For an account of the insect ichneumons, see Pupivora.

ICHNO'GRAPHY. (Gr. ιχνος, *a model*, and γραφω, *I draw.*) In Architecture, the representation of the ground plot of a building. In perspective it is its representation intersected by a horizontal plane at its base or ground floor.

I'CHOR. (Gr.) A thin watery discharge. By the Greeks it was applied to the divine fluid that issued from the wounds of the gods.

I'CHTHIOCO'LLA. (Gr. ιχθυς, *a fish*, and κολλα, *glue.*) *See* Isinglass.

ICHTHYO'LOGY. (Gr. ιχθυς, and λογος, *a discourse.*) The science which treats of the nature, uses, and classification of fishes.

Fishes are those oviparous vertebrate animals which have a heart consisting of one auricle and one ventricle, which breathe water, and have the nasal cavity communicating with the external surface only. In a few species an air-bladder is present, and so organized as to act the part of a lung; but the principal if not exclusive organ of respiration consists, throughout the whole class, of branchiæ or gills. The gills are composed of rows of slender flattened processes suspended by arches, attached in general to the hyoid bone, and covered with a membrane or tissue of innumerable minute and close-set blood-vessels. The water which the fish takes in by the mouth, instead of being swallowed, passes through the interspaces of the gills, and escapes by the fissures on each side of the head, called gill-apertures. The air contained in the water acts upon the blood, which is minutely subdivided in the branchial vessels; and the bilocular heart serves exclusively to propel the whole of the venous blood to the branchial arteries, and is thus analogous in function to the pulmonary auricle and ventricle of the warm-blooded classes. The blood having been decarbonized in the gills is collected into the dorsal arterial trunk or aorta, and is propelled, without the influence of a systemic heart, to all parts of the body; whence it is again returned by the veins to the branchial auricle and ventricle.

The whole structure of a fish is as evidently adapted for swimming as that of a bird for flight. Being suspended in a fluid of nearly the same specific gravity as itself, it needs not widely-expanded wings for its support. Many species, moreover, have the air-bladder so organized and developed as, by its contractions and dilatations, to vary the specific gravity of the fish, and aid in its ascent to the surface, or descent into the depths of the water. Ordinary progression is effected by the motions of the tail, which, by the action of powerful muscles, displaces the water alternately to the right and left; the gills, also, in expelling the water backwards, may contribute, by the reaction of the current, to propel the fish forward. The ordinary extremities, therefore, being of little use, are reduced to a low or rudimental condition; they are chiefly remarkable for the number of parts corresponding to the digital phalanges of the higher classes, and which, from their disposition, are called "rays." The pieces analogous to the bones of the arms and legs are extremely shortened, and often quite concealed; the membrane supported by the diverging rays rudely represents the hands and feet. The members thus constructed are called "fins;" those which answer to the anterior extremities are called the "pectoral fins;" those which answer to the posterior extremities are the "ventral fins." Other rays attached to peculiar bones above or between the extremities of the spinous processes support the vertical fins, which are mesial and single, either above the back, beneath the tail, or at the extremity of the tail. The upper vertical fin or fins are called the *dorsal*, the lower ones the *anal*, and the terminal one the *caudal* fin. The fin-rays are of two kinds. Some consist of a single bony piece, usually hard and pointed, sometimes flexible and elastic, and divided longitudinally; they are called "bony or spinous rays:" the others are composed of a vast number of little joints, generally branched at the extremity; they are called "soft, jointed, or branched rays." In general the fins, which are placed in pairs, and correspond to the ordinary extremities, are four in number; but sometimes there are but two, and sometimes they are entirely wanting. When both pectoral and ventral fins are present, they may have the ordinary relative position; *i. e.* the pectoral fins may be considerably in advance of the ventrals—such fishes are said to be "abdominal;" or the ventrals may be placed below, or on the same or nearly the same transverse line as the pectorals — such fishes are termed "thoracic;" or the ventrals may be situated in advance of the pectorals, under the throat of the fish — when the species are called "jugu-

lar" fishes. The vertebræ of fishes, when completely ossified, are united, with very few exceptions, by opposite concave surfaces. Most fishes have the body covered with scales. They are destitute of organs of prehension, except the teeth. The imperfection of the organ of touch is remedied in some by the development of soft tentacles or feelers.

The teeth are very various as to their number, form, and relative size. They are either anchylosed to the jaw-bones, attached to ligaments, or implanted in sockets; when the latter, the tooth has always a single and simple fang. The teeth may be placed on the maxillary, intermaxillary, or lower jaw-bones; upon the vomer or sphenoid bones; upon the palatine or pterygoid bones, the tongue, the branchial arches, or the pharyngeal plates; or they may be entirely wanting.

Besides the branchial arches, the hyoid bone supports on each side a number of rays, which support the branchial or opercular membrane. This membrane is also generally further strengthened by three osseous plates called the "opercular," "subopercular," and "interopercular" bones: the kind of door thus formed is joined to the tympanic bone, and plays upon a piece called the "preopercular" bone.

With respect to the subdivision of the class of fishes into orders, Cuvier admits the great difficulty which exists in defining them by fixed and easily appreciable characters, and after many attempts adopted the following classification.

He first divided the class into two sub-classes.

Sub-class I. *Pisces ossei*, or fishes properly so called.
II. *Pisces cartilaginei*, or *Chondropterygians*, cartilaginous fishes.

The first sub-class are arranged according to the modifications of their organs of locomotion. All the osseous fishes which have the anterior part of the dorsal fin, or the first dorsal where there are two, supported by bony rays, with some bony rays in the anal fin, and at least one bony ray in each of the ventrals, are collected into an order, called *Acanthopterygians*.

All those osseous fishes in which, with the exception of the anterior dorsal and pectoral rays, all the others are soft, constitute the order *Malacopterygians*.

The *Malacopterygii* are subdivided, according to the relative position or absence of the ventral fins, into "abdominal," "jugular," or "sub-brachial," and "apodal" fishes.

Those fishes which have the branchiæ in the form of tufts constitute the order of *Lophobranchii*.

Those fishes in which the maxillary and palatine arches are firmly united, or, as it were, soldered to the cranium, are called the *Plectognathi*.

The *Chondropterygian* fishes are divided into the three orders of—
Sturionians,
Selacians, and
Cyclostomes. (See those words.)

The chief modification in the arrangement of the class of fishes has been the consequence of a study of the nature and affinities of the numerous extinct forms, and a comparison of these with existing species.

M. Agassiz has proved that certain species, which stand out as exceptions to the ordinary form and structure of the class among recent fishes, are the types of extensive orders which peopled the seas of the ancient world, and now characterize particular strata. This naturalist has likewise observed more closely than his predecessors the relations which subsist between the external scales and the internal structure; and he accordingly proposes to arrange the class of fishes according to the modifications of the scaly covering, and divides them into four orders, each of which contains fishes having a cartilaginous skeleton: and in each there are both Acanthopterygian and Malacopterygian, Abdominal and Apodal genera. These orders are named *Placoides*, *Ganoides*, *Ctenoides*, and *Cycloides*. (See those terms.)

I'CHTHYOPHTHA'LMITE. (Gr. *ιχθυς*, and *οφθαλμος*, *the eye*.) A species of zeolite of a peculiar pearly lustre, resembling the eye of a fish (whence its name).

I'CHTHYOSAU'RUS. (Gr. *ιχθυς*, *a fish*, and *σαυρος*, *a lizard*.) A genus of extinct marine animals, which combined the characters of saurian reptiles and of fishes with some of the peculiarities of the Cetaceous Mammalia. The vertebræ of the back-bone of the *Ichthyosauri* resemble those of fishes in having their bodies joined by opposite concave surfaces; but the superior arches remain permanently detached, as in reptiles. The cranium resembles in structure that of the crocodiles, but is characterized by a peculiarly large orbit, in which a circular series of osseous sclerotic plates, analogous to those of the crocodile and birds, but relatively much larger, has been so frequently found as to prove it to be a generic structure. The nostrils are situated, not as in the crocodile, near the point of the snout, but close to the anterior part of the orbit.

The teeth resemble in structure those of the crocodiles; but are lodged, as in some of the Lacertine Sauria, in a groove, and not in distinct sockets. The locomotive extremities are similar in construction to the paddles of the whale; but they are four instead of two in number, and the anterior paddles are connected by a broad coracoid, a complete clavicle, and a supplementary coracoid bone to a strong sternum; the flattened phalangeal bones supporting the fin are polygonal, and are relatively shorter and more numerous than in the whale tribe. The hind paddles are smaller than the fore, and are attached to a pelvis similar to that of the crocodile. Small supplemental bones are wedged into the lower part of the joint of the atlas and occiput, and a few of the succeeding vertebral joints; and the tail often presents a fracture at a particular point, whence the existence of a caudal fin has been inferred. From the form and position of masses of crushed and apparently half-digested fish bones and scales in the abdominal cavity of the ichthyosaurus, it is concluded that they preyed chiefly on fish; that they had a simple and capacious stomach, and an intestine provided with a spiral valve. The geological range of the ichthyosaurus seems, says Dr. Buckland, to have begun with the muschelchalk, and to have extended through the whole of the oolitic period into the cretaceous formation. The most recent stratum in which any remains of this genus have yet been found is the chalk marl at Dover. The chief depository of the bones of the *Ichthyosauri* occurs in the lias at Lyme Regis in Dorsetshire.

ICHTHYO'SIS. (Gr. *ιχθυς*.) A roughness and thickening of the skin, portions of which become hard and scaly, and occasionally corneous, with a tendency to excrescences. Friction, warm bath, and occasionally stimulating ointments, have been of service in mitigating the progress of this disease; but it seldom yields permanently to any plan of treatment.

I'CHTHYS. (Gr. *a fish*.) A word found on many seals, rings, urns, tombstones, &c., belonging to the early times of Christianity, and supposed to have a mystical meaning, from each character forming an initial letter of the words *Ιησους Χριστος, Θεου Υιος, Σωτηρ*; *i. e.* Jesus Christ, the Son of God, the Saviour. This interpretation is not unlikely, when we consider at once the universal reverence with which the fish was symbolically regarded among most ancient nations, and the many signs and ceremonies adopted by the Christians with some change of meaning from the religious rites of the surrounding nations.

ICO'NOCLASTS. (Gr. *εικων*, *an image*, and *κλαω*, *I break*.) Literally, breakers of images; a title applied to two of the Byzantine emperors, Leo the Isaurian and his son Constantine Capronymus, who during their reigns, which extended from 726 to 795, persevered in overthrowing the images in the Christian churches, and in extirpating their worship. The 338 bishops, also, who attended a council at Constantinople in the reign of the latter prince, and declared themselves in favour of his views, were stigmatized by the orthodox party under the same name. In the year 787, however, a general council was assembled at Nicæa by the empress Irene, who inclined towards the old superstition, and the images were on this occasion restored to their former honours. This council, the second of Nice, is the last respecting which the Greek and Latin churches coincide; the practice, however, of the Greek church makes a distinction between the use of pictures, which it allows, and graven images, which it studiously rejects. (*Mosheim, Eccl. Hist.* vol. i. p. 262., transl.; *Schlosser's History of the Iconoclast Emperors*, Frankfort, 1812; *Neander*, parts 3 and 4.)

I'COSAE'DRON. (Gr. *εικοσι*, *twenty*, and *ἕδρα*, *base*.) One of the five regular or Platonic bodies, bounded by twenty equilateral and equal triangles. It may be regarded as formed of twenty equal and similar triangular pyramids, whose vertices all meet in the same point; and hence the content of one of these pyramids multiplied by twenty gives the whole content of the icosaedron. Let the linear edge of one of its faces be denoted by a; then the surface of the icosaedron is $= 5\,a^2\sqrt{3} = 8{\cdot}660254\,a^2$; and the solidity $= \frac{5}{6}\,a^3\sqrt{\frac{7+3\sqrt{5}}{2}} = 2{\cdot}181695\,a^3$. (See *Hutton's Mensuration*, or *Sharpe's Geometry Improved*.)

I'COSA'NDROUS. (Gr. *εικοσι*, and *ανηρ*, *a male*.) Literally, any flower having twenty stamens or thereabouts; but it is usually confined to those flowers in which these stamens are inserted into the calyx.

I'CTERUS. (Gr. *ικτερος*.) The jaundice: so called from its resemblance to the golden thrush, which the Latin form of the word signifies.

I'CTIDES. (Gr. *ικτις*, *a weasel*, and *ειδος*, *form*.) A genus of nocturnal carnivorous Mammals, intermediate between the Plantigrade and Viverrine Digitigrade tribes, having the plantigrade walk of the raccoons and coatis, and the slender conical snout of the civets and other *Viverridæ*. The dental formula of the genus is

$$\text{Incis. } \frac{6}{6};\ \text{can. } \frac{1.\,1.}{1.\,1.};\ \text{præmol. } \frac{3.\,3.}{2.\,2.};\ \text{mol. } \frac{3.\,3.}{3.\,3.} = 38.$$

The teeth resemble those of the *Paradoxurus*, but are thicker and more tuberculous; and thus contribute,

with the plantigrade structure of the feet, to indicate the affinity of the *Ictides* to the Plantigrade *Feræ*. Three species of the present genus are recorded; they are all natives of Southern Asia, and are called *Benturongs*. The common Indian species (*Ictides albifrons*) is of the size of a domestic cat; but its body is longer and heavier, its legs shorter, and its gait lower and more crouching. The tail is extremely thick at its commencement, and gradually tapers to its extremity, where it curls upwards. The pupil of the eye contracts during daylight into a vertical fissure. A benturong, which was kept in captivity many years, was fed on a mixed diet of animal and vegetable substances; and they most probably subsist on similar food in a state of nature.

IDE'A. (Gr. ιδεα, from ιδειν, *to see.*) Literally, the image or resemblance of any object conceived by the mind. There is no word in any language the definition of which, from the obscurity of metaphysical writers, is attended with such difficulty as the term *idea;* and the difficulty is enhanced when we consider the vagueness with which its equivalents are expressed in different languages, and the many metaphysical systems that have been constructed on their several significations. Like many other terms of mental philosophy, the word *idea* is derived from the most eminent of the senses, that of sight, and in its most extended acceptation is employed to indicate "every representation of outward objects through the senses, and whatever is the object of thought." To give even a cursory glance at the various theories of the origin and nature of ideas would be to write the history of mental philosophy from Plato to Kant, and would far exceed our limits, even if the difficulty of the subject did not deter us from the attempt. The reader will find the best exposition of some of the theories alluded to in *Dugald Stewart's Phil. Essays*, Appendix II.; *Kant's Critik der reinen Vernunft; Ritter's Geschichte der Philosophie; Reid on the Human Mind;* and the *Edin. Review, Green's Hunterian Oration*, 1840.

IDEAL (BEAU), or IDEAL BEAUTY. An expression in the Fine Arts, used to denote a selection for a particular object of the finest parts from different subjects, united in that one so as to form a more perfect whole than nature usually exhibits in a single specimen of the species; or, in other words, the divesting nature of accident in the representation of an individual. From the nature of the expression and its definition, it is clear that it more immediately attaches to the arts of painting and sculpture: in architecture it is susceptible of refinements dependent on the selection of examples, upon which, however, a less universal agreement exists.

IDE'ALISM. (Gr. ιδεα, *form.*) A term applied to several metaphysical systems, varying in its signification according to the meaning attached in each particular scheme to the word *idea;* from which it is derived. In England the best known system of idealism is that of Berkeley. In reference to this philosopher's doctrines, the word is used in its empirical sense for the object of consciousness in sensation. (*See* PERCEPTION.) In its Platonic or transcendental sense, the term *idealism* has been applied to the doctrines of Kant and Schelling; neither of whom is an idealist in the way in which Berkeley may be so called. The system of Berkeley may be thus expressed:—The qualities of supposed objects cannot be perceived distinct from the mind that perceives them; and these qualities, it will be allowed, are all that we can know of such objects. If, therefore, there were external bodies, it is impossible we should ever know it; and if there were not, we should have exactly the same reason for believing there were as we have now. All, therefore, which really exists is spirit, or the thinking principle,—ourselves, our fellow men, and God. What we call ideas are presented to us by God in a certain order of succession, which order of successive presentation is what we mean by the laws of nature.

IDE'NTITY, PERSONAL, denotes the sameness of the conscious subject, *I*, throughout all the various states of which it is the subject. The question, Wherein consists our identity, and what is its evidence? has been a source of manifold controversy to modern metaphysicians. By philosophers of the materialist school the doctrine has been ejected, as incompatible with daily and obvious experience. But independently of any hypothesis respecting the nature of the soul in itself, it has been argued, and with some plausibility, that as all our knowledge of a substance is derived from the qualities or phenomena which it presents to our senses, so that all we can mean by a substance being the same with itself is that it possesses the same qualities which it previously did (for if not, the substance is changed); so all we can know of the substance *mind* in particular is derived from observation of the changes which it undergoes. But we find that what we conceive to be the same individual does, at different periods, assume under the same circumstances widely varying appearances. A man shall laugh at what when he was a child would have excited his anger or jealousy. This reasoning contains an evident fallacy. It does, in fact, like all other reasoning of the same kind, imply that very doctrine which it means to refute. Consciousness, it is asserted, is the joint effect of two substances acting one on the other. How, then, can we affirm that one of these substances is changed, unless by assuming that the other remains the same? How can we show that the phenomenon laughter in the man is different from the phenomenon jealousy or anger in the boy, unless we admit that we who *observe* these phenomena,—*i. e.* by the premises, on whom these phenomena produce a given effect—remain the same as we were when we were affected previously in a different manner. A lump of sugar, as we take it to be, no longer melts in what we take to be water. Assuming that the water remains water, we may fairly infer that the lump in question is not sugar, or vice versâ; not so if we profess ourselves equally ignorant of the identity of both substances. This argument, it will be seen, applies equally to the materialist and non-materialist. Such may be said to be the *negative* evidence of our identity. Its positive evidence rests on the necessity and universality of its belief, as implied in every act of memory. *To remember* is to refer a past state of consciousness to the same subject which now at the present moment recals it. (See *Bishop Butler's Treatise on Personal Identity; Brown's Phil. of Human Mind.* Lect. 12, 13, 14. &c. &c.)

IDE'NTITY, SYSTEM OF. In Philosophy (otherwise called Identism), a name which has been given to the metaphysical theory of the German writer Schelling. It rests on the principle that the two elements of thought, the objects respectively of understanding and reason, called by the various terms of matter and spirit, objective and subjective, real and ideal, &c., are only relatively opposed to one another as different forms of the one *absolute* or *infinite;* hence sometimes called the two *poles* of the absolute. *See* SCHELLING, PHILOSOPHY OF.

IDEOGRA'PHIC CHARACTERS. (Gr. ιδεα, *an idea*, and γραφω, *I write.*) In Philology, characters used in writing which express figures or notions, instead of the arbitrary signs of the alphabet. The Chinese characters are ideographic, although the symbols, at first intended to represent distinct objects, have become by use merely conventional. The hieroglyphical characters of the ancient Egyptians were of the same description. Ideographical writing is opposed to phonetic. *See* PHONETIC.

IDEO'LOGY (Gr. ιδεα, and λογος, *a discourse*), literally the science of mind, is the term applied by the later disciples of Condillac to the history and evolutions of human ideas, considered as so many successive modes of certain original or transformed sensations. The writings of this school are characterized by an unrivalled simplicity, boldness, and subtlety; and the different phases of its doctrines are admirably exhibited in the physiological researches of Cabanis, the moral dissertations of Garat and Volney, and the metaphysical disquisitions of Destutt de Tracy. (*Damiron, Hist. de Phil. en France, &c. &c.*)

IDES. (Supposed to be derived from the obsolete verb iduare, *to divide.*) One of the three epochs or divisions of the ancient Roman month. The *calends* were the first days of the different months; the *ides*, days near the middle of the months; and the *nones*, the ninth day before the ides. In the months of March, May, July, and October, the ides fell on the 15th; in the other months on the 13th. The Romans used a very peculiar method of reckoning the days of the month. Instead of employing the ordinal numbers first, second, third, &c., they distinguished them by the number of days intervening between any given day and the next following of the three fixed divisions. For example, as there were always eight days between the nones and the ides, the day after the nones was called the eighth *before* the ides, the next the seventh *before* the ides, the next the sixth before the ides, and so on. In leap years, when February had twenty-nine days, the extra day was accounted for by calling both the twenty-fourth and twenty-fifth days of that month the sixth day before the calends of March; whence the leap year got the name of bissextile (from bis, *twice*, and sextus, *sixth*). *See* BISSEXTILE.

I'DIOM. (Gr. ἴδιος, *peculiar.*) In Philology, a mode of speaking or writing foreign from the usages of universal grammar or the general laws of language, and restricted to the genius of some individual tongue. Thus, a sentence or phrase consisting of words arranged in a particular manner may be a Latin idiom; the same, arranged in a different manner, an English idiom, &c. The use of a particular inflexion of a word may also be an idiom. We also use the term idiom in a more general sense, to express the general genius or character of a language. We have a number of subordinate words to express the idioms of particular tongues: thus, a Latin idiom is a Latinism, a French idiom a Gallicism, &c. The word idiom is also not uncommonly, but incorrectly, used in the same sense with the French *idiome;* a dialect or variety of language. *Idiotisme* is the French term expressing the correct signification of the English "idiom."

I'DIOPA'THIC. (Gr. ιδιος, and παθος, *an affection.*)

A disease which does not depend upon any other disease and which is thus opposed to those diseases which are *symptomatic.*

I'DIOSY'NCRASY. (Gr. ἰδιος, συν, *with*, and κρασις, *a temperament.*) A state of constitution peculiarly susceptible of certain agents which in general produce no effect, or one perfectly different. Thus honey and coffee act with some few persons as violently aperient; very minute doses of antimony are occasionally followed by powerful emetic effects, and of mercury by salivation, &c.

I'DIOT. (Gr. ἰδιωτης, originally *a private individual.*) In contemplation of Law, one who has been born totally deficient in understanding, or has lost it by sickness, so as to have no lucid intervals: lunatic, properly speaking, one who has lucid intervals. The care of idiots and lunatics is a branch of the prerogative of the crown, and exercised ordinarily by the chancellor. By the common law persons were found idiots or lunatics by verdict of a jury on a writ de idiotâ or de lunatico inquirendo; but in later times by commissions issued, on petition from near relations, under the great seal. Commissions are also frequently issued to determine not specifically whether the party be an idiot, &c., but whether he be under such imbecility as to require protection in the management of his affairs; and such is now the more ordinary course. The custody of an idiot's estate is then entrusted to the committee of the estate.

IDIO'TICON. (Gr.) A word of frequent use in Germany, signifying a dictionary confined to a particular dialect, or containing words and phrases peculiar to one part of a country.

I'DOCRASE. (Gr. ἰδεα, *form*, and κρασις, *mixture; indicating that its forms are a mixture of the forms of certain other minerals.*) The volcanic garnet. It is of various colours, and is sometimes called volcanic crysolite or hyacinth. It occurs in the ejected masses of Vesuvius, and elsewhere. It is an alumino-silicate of lime, with about 5 per cent. of oxide of iron.

I'DOL, IDO'LATRY. (Gr. εἰδωλον, *a similitude, representation, or image;* λατρεια, *worship.*) The figures of metal, stone, or wood, by which Pagans for the most part represent their divinities, are termed *idols*, and the worship paid to them *idolatry*. This practice is expressly forbidden by the second commandment of the Decalogue, which says, "Thou shalt not make unto thyself any graven image: Thou shalt not bow down to them nor worship them,"— which must be interpreted to forbid the making of an image for the purpose of worshipping it. The absurdity and criminality of idolatry are also clearly pointed out by the light of nature. Roman Catholics, however, are accused of idolatry, upon the supposition of their performing acts of adoration to the images of Christ, the Virgin, and Saints: the adoration of the Host, or consecrated elements, is also made a charge against them. The reply which they make, that "they kneel not to the image, but to the spiritual being represented by it," is the answer of every enlightened heathen in his own case, but does not express the feelings of the multitude; nor was room allowed to the Jews for any such subterfuge.

In a wider sense, the adoration of any visible objects, such as the sun and the host of heaven (Sabianism), is idolatry; and the adoration of animals by the Egyptians. But in the more restricted signification of the word, it denotes the adoration by men of the works of their own hands; properly as images (ειδωλα), supposed to represent divine beings. Although Grecian idolatry was dignified by all the charms which art could throw around it, it appears that the most popular idols were rude and almost formless images; traditionary representations of the divinities, to many of which the vulgar notion attributed a divine origin, believing them to have fallen from heaven. Such were the Hermæ of Athens; the image of Diana (Διοπετης) at Ephesus, mentioned in the Acts; the sacred "Ancilia," or shields, of the Romans: which seem to have commanded more of the veneration of the common people than the Pallas of the Parthenon, or the Jupiter Olympius of Elis. (See *Vossius, De Origine Idololatriæ; Graves on the Pentateuch; Creuzer, Symbolik der alten Voelker; Spence's Polymetis; Mem. de l'Acad. des Inscr.* vol. xxxviii.)

I'DRIALINE. A fusible inflammable substance, found by Dumas in a mineral from the quicksilver mines of Idria in Carniola.

I'DYL. (Gr εἰδυλλιον, the diminutive of εἶδος, *form.*) A short pastoral poem. The Greek word is derived from ειδος, *form*, or *visible object;* and hence the object, or at least the necessary accompaniment of this species of poem, has been said to be a vivid and simple representation of ordinary objects in pastoral nature. But in common usage the signification of this word is hardly different from that of eclogue. The poems of Theocritus are termed Idyls, those of Virgil Eclogues; but it would be difficult to assign a distinction between the two, except what arises from the greater simplicity of language and thought which characterizes the former. Many critics, however, aver that the eclogue requires something of epic or dramatic action; the idyl only picturesque representation, sentiment, or narrative. (*See* ECLOGUE, BUCOLIC.) In English poetry, among this class may be ranked *The Seasons* of Thomson, *Shenstone's Schoolmistress, Burns' Cottager's Saturday Night, Goldsmith's Deserted Village,* &c. &c.

IGASU'RIC ACID. A name given by Pelletier and Caventou to an acid which is found combined with strychnia in the *Nux vomica* and St. Ignatius's bean.

IGNA'TIUS'S BEAN. The seed of the *Ignatia amara*, used in the Philippine Islands as a cathartic and emetic. *See* STRYCHNIA.

I'GNIS FA'TUUS. (Lat. *vain or foolish fire;* a translation of the Fr. feu follet.) A kind of luminous meteor, which flits about in the air a little above the surface of the earth, and appears chiefly in marshy places, or near stagnant waters, or in churchyards, during the nights of summer. There are many instances of travellers having been decoyed by these lights into marshy places, where they perished; and hence the names *Jack-with-a-lantern, Will-with-a-wisp:* the people ascribing the appearance to the agency of evil spirits, who take this mode of alluring men to their destruction. The cause of the phenomenon does not seem to be perfectly understood; it is generally supposed to be produced by the decomposition of animal or vegetable matters, or by the evolution of gases which spontaneously inflame in the atmosphere.

IGNI'TION. (Lat. ignis, *fire.*) The act of setting fire to, or of taking fire; as opposed to combustion or burning, which is a consequence of ignition. The term *spontaneous ignition* is applied to cases in which substances take fire without previous application of heat: thus spongy platinum is said to become spontaneously ignited when introduced into a mixture of oxygen and hydrogen gases, and to cause their combustion. The particles of steel struck off by collision with flint become ignited on passing through the air, and falling upon gunpowder ignite it, and combustion ensues. Iron wire, when red hot, is also often said to be *ignited*, or in a state of ignition; and when in that state it is plunged into oxygen gas, or into chlorine, it undergoes combustion, and burns in those gases with the further extrication of heat and light.

IGNORA'MUS. (Lat. *we are ignorant.*) In Law, the endorsement of a grand jury on a bill of indictment, equivalent to "not found." The jury are said to *ignore* a bill when they do not find the evidence such as to make good the presentment.

IGUA'NA. (Cuvier states, with reference to the derivation of this term, that it was originally a St. Domingo word, where it was pronounced by the natives *hiuana* or *igoana*, and quotes Hernandes and Scaliger as his authorities. He then proceeds to say, that Bontius regards it as derived from the Javanese word *leguan*. In this case the Portuguese or Spaniards must have transported it to America, where they transformed it into *iguana*. They apply this term to the monitor as well as to the *iguana*. The *leguan* of Bontius is a monitor. The best authorities in erpetology have adopted the Latinized *iguana* as the generic name of the reptiles under consideration.) A genus including certain large and beautiful lizards common in the tropical parts of America, some of which feed on vegetable substances, and are esteemed delicious food. The common iguana (*Iguana tuberculata*, Laur.) has accordingly received the specific names *delicatissima* and *sapidissima*. The generic name *iguana* is now restricted to those species which present the following characters:— A large thin fold of skin or dewlap under the chin; cephalic cuticular plates, polygonal, unequal in diameter, flat or carinated; a double row of small palatal teeth; maxillary teeth, with their edges finely dentilated; a crest on the back and tail; toes long and unequal; a single row of femoral pores; tail very long, slender, compressed, covered with small, equal, imbricated carinated scales.

IGUA'NIDÆ. (From *Iguana.*) The family of lizards, of which the genus *Iguana* is the type, and which is divided, according to minor modifications of the leading characters of the Iguanas, into the subgenera *Iguana* proper, *Corythophones, Basiliscus, Aloponotus, Amblyrhynchus, Metopoceros, Cyclura, Brachylophus, Enyalus,* and *Ophryœssa.*

IGUA'NINÆ. (From *Iguana.*) The *Lézards iguaniens* of French erpetologists. This extensive tribe of Lacertine Sauria is divided by MM. Duméril and Bibron into two groups, *Pleurodontes* and *Acrodontes*.

The *Pleurodontes* include the families *Iguanidæ, Polychridæ, Anoliidæ, Tropidolepididæ,* and *Opluridæ*.

The *Acrodontes* embrace the families *Galeotidæ, Agamidæ, Phrynocephalidæ,* and *Stellionidæ*.

A short and thick tongue, with base not retractable in a sheath, and with the extremity free, mobile, and very slightly cleft, is the general character of this extensive tribe.

IGUA'NODON. (From *Iguana;* and Gr. οδους, *a tooth.*) An extinct genus of gigantic herbivorous reptiles, dis-

covered by Dr. Mantell in the wealden fresh-water formation of the South of England, in the localities of Tilgate Forest, Isle of Wight, and Purbeck. The chief distinctive character of this genus is the form of the teeth, which are dentilated along the margin of the crown, as in the *iguana;* but thicker, so as to present, when worn down, a broader grinding surface. The structure by which these teeth were adapted to the cropping of coarse and tough vegetable food, such as the *Clathrasiæ* and similar fossil plants of the wealden strata may be supposed to have afforded the *iguanodon*, is thus described by Dr. Buckland:—"The teeth exhibit two kinds of provisions to maintain sharp edges along the cutting surface, from their first protrusion until they were worn down to the very stump. The first of these is a sharp and serrated edge, extending on each side downwards from the point to the broadest portion of the body of the tooth. The second provision is one of compensation for the gradual destruction of this serrated edge, by substituting a plate of thin enamel to maintain a cutting power in the anterior portion of the tooth until its entire substance was consumed in the service. Whilst the crown of the tooth was thus gradually diminishing above, a simultaneous absorption of the root went on below, caused by the pressure of a new tooth rising to replace the old one, until by this continual consumption at both extremities the middle portion of the older tooth was reduced to a hollow stump, which fell from the jaw to make room for a more efficient successor." The anterior surface of the crown of the tooth also, instead of being flat and even, was traversed by alternate longitudinal ridges and furrows, the latter serving "as ribs or buttresses to strengthen and prevent the enamel from scaling off, and forming, together with the furrows, an edge slightly wavy, and disposed in a series of minute gouges or fluted chisels; hence the tooth became an instrument of greater power to cut tough vegetables under the action of the jaw, than if the enamel had been a continuous straight line. By these contrivances also it continued effective during every stage through which it passed, from the serrated lancet point of the new tooth to its final consumption."

From the proportions which the bones of the *iguanodon* bear to those of the *iguana*, this extinct monster of a former world is calculated to have been 70 feet in length from the snout to the end of the tail; the length of the tail alone is calculated to have been 52½ feet, the circumference of the body 14½. The thigh bone of the full-sized *iguanodon* is twenty times the size of that of the *iguana*. The snout of the *iguanodon* was armed with a short but strong horn; but the long and powerful tail formed probably its most formidable instrument of attack and defence.

IL'EUM. (Gr. ειλεω, *I turn about*.) The last portion of the small intestines, terminating at the valve of the cœcum.

I'LIA. (Lat.) The flanks, or the part of the abdomen which includes the small intestines. The *os ilium* is the haunch bone, the upper part of the *os innominatum*, which supports the intestines.

I'LIAC PA'SSION. (Lat. ilia, *the bowels*.) A vomiting of bilious and fecal matter in consequence of obstruction in the intestinal canal.

I'LIAD. (Gr. Ιλιας.) The oldest epic poem in existence; commonly attributed to Homer, but according to some modern hypotheses the work of several hands. The theme of the poem is the siege of Ilium (whence its name), or Troy; or, more properly speaking, the quarrel of Achilles with Agamemnon, general of the Grecian army before that city. It consists of twenty-four books. The first book relates the origin of the quarrel; and the residue of the poem contains an account of the efforts made by Agamemnon and the chiefs who adhered to his party to conquer the Trojans without the aid of Achilles, their defeat, the pacification of Achilles, his resumption of arms in the common cause, and the death of Hector by his hand. Neither the landing of the chieftains, nor the conclusion of the war and capture of Troy, come within its range. *See* EPIC.

ILLA'TIVE CONVERSION, in Logic, is that in which the truth of the converse follows from the truth of the exposita, or proposition given. Thus the proposition "no virtuous man is a rebel," becomes by illative conversion "no rebel is a virtuous man." "Some boasters are cowards;" therefore, à converso, "some cowards are boasters."

ILLUMINA'TI, or THE ENLIGHTENED. A secret society, formed in 1776, chiefly under the direction of Adam Weishaupt, professor of law at Ingolstadt in Bavaria. Its professed object was the attainment of a higher degree of virtue and morality than that reached in the ordinary course of society. It numbered at one time 2000 members. It was suppressed by the Bavarian government in 1784. It has been supposed that this and some other secret societies were actively engaged in preparing the way for the French revolution; but of this no satisfactory proof has been adduced. (See the *Ency. von Ersch and Gruber*.)

ILLUSTRA'TION, in Rhetoric, appears to differ from Comparison or Simile in this only, that the latter is used merely to give force to the expression; the former to throw light upon an argument. The term illustration is, however, sometimes used in a wider sense, in which it seems to comprehend example, which is the recital of a particular fact or instance evincing the truth of a general proposition laid down in the argument; and parable, which is a species of symbolical narrative, in which the actors and events are intended to represent certain other actors and events in a typical manner. *See* PARABLE.

I'MAGE. (Lat. imago.) In Rhetoric, a term somewhat loosely used; but which appears generally to denote a metaphor dilated, and rendered a more complete picture by the assemblage of various ideas through which the same metaphor continues to run, yet not sufficiently expanded to form an allegory.

I'MAGE. A representation of the Deity in stone, wood, or metal. (*See* art. IDOL.) The custom of representing Christ, the Virgin, and the Saints by images in the churches, which forms a principal feature of Roman Catholic worship, is an ancient but not a primitive practice. For the principal events in the history of Christian image worship, see art. ICONOCLASTS.

I'MAGE, in Optics, is the spectrum or appearance of an object, made by reflection or refraction; or the *image* of an object may be more correctly defined as the locus of all the pencils of converging or diverging rays emanating from every point of the object, and received on a surface. It is by means of optical images that vision is effected. The eye is an assemblage of lenses which concentrate the rays emanating from each point of the object on a tissue of very delicate nerves called the *retina*, where an exact image or representation of the object is formed; and it is this image which is perceived or *felt* by the retina.

The brightness of an image depends evidently on the quantity of light concentrated in each point. Setting aside the effects of aberration, the brightness must therefore be proportional to the apparent magnitude (as seen from the object) of the mirror or lens by which the rays are reflected or refracted, multiplied by the area of the object and divided by the area of the image. But the apparent magnitude of the lens, as seen from the object, is proportional to the square of the diameter of the lens divided by the square of the distance of the object; and the area of the object divided by the area of the image is equal to the square of the distance of the object divided by the square of the distance of the image from the lens: therefore the brightness of the image is proportional to the square of the diameter of the lens divided by the square of the distance of the image from the lens; that is to say, the brightness or degree of illumination of the image depends only on the apparent magnitude of the lens, as seen from the image, and not in any way on the distance of the object. When the object and its image are only physical points, and have no apparent magnitude, as stars for example, the brightness of the image is simply proportional to the magnitude of the lens, or to the square of the diameter of the aperture of the telescope; and for this reason certain stars are rendered visible by large telescopes, while their light is too feeble to be perceived by smaller ones.

The images of external objects are painted on the retina in a reversed position, and from the retina the impressions are ransmitted to the sensorium by the optical nerves. *See* EYE, OPTICS.

I'MAGERY may be defined as the generic term for *similes*, *allegories*, and *metaphors*, or such rhetorical figures as denote similitude or comparison.

IMA'GINARY QUANTITIES, or IMPOSSIBLE QUANTITIES, in Algebra, are the even roots of negative quantities, or the imaginary results of some impossible operation. The square root of any positive number may be affected indifferently with the positive or negative sign; thus $\sqrt{9a^2} = \pm 3a$; because $+3a$ or $-3a$, raised to the square, equally produce $9a^2$. But if the number or quantity is negative, the extraction of its square root is impossible, because the square of any quantity, whether positive or negative, is essentially positive; that is to say, a negative quantity cannot be the square of any real quantity whatever. The symbolical expressions $\sqrt{-9}$, $\sqrt{-4a^2}$, $\sqrt{-5}$, indicate operations which are impossible; and hence they are designated *imaginary* expressions. But though the quantities denoted by these symbols have no real values, the symbols themselves may have all the algebraic operations performed on them which can be performed on real quantities. Thus, $\sqrt{-9} = \sqrt{9}\cdot\sqrt{-1} = 3\sqrt{-1}$; and $\sqrt{-4a^2} = \sqrt{4a^2}\cdot\sqrt{-1} = 2a\sqrt{-1}$. Such expressions are of very frequent occurrence in the higher analysis, and sometimes lead to results of the greatest importance, which it would be difficult, if indeed possible, to obtain in another way. (See *Peacock's Algebra*.)

IMAGINARY ROOTS OF EQUATIONS, are roots

which can only be indicated by imaginary expressions. D'Alembert first demonstrated that every imaginary root of an equation can be reduced to the form $a + b\sqrt{-1}$, where a and b are real quantities; and from this it is proved that if an equation have a root of the form $a + b\sqrt{-1}$, it has also another of the form $a - b\sqrt{-1}$; so that imaginary roots always enter an equation by pairs, or their number is always even.

IMAGINATION, in Metaphysics, may be said, in its widest sense, to be synonymous with invention, denoting that faculty of the mind by which it either "bodies forth the forms of things unknown," or produces original thoughts or new combinations of ideas from materials stored up in the memory. It would be vain to enumerate the various definitions of this term, or to attempt to give even an abstract of the diversity of views entertained by philosophers respecting the nature and extent of its operations. While some (and among these Reid and Addison) limit the domain of this faculty so far as to teach that it is nothing more than a *lively conception* of the objects of sight, differing from conception only as a part from the whole; others, like Dugald Stewart, place it in the foremost rank of the mental faculties, attributing to its operation the origination and development of the sublimest and boldest thoughts in all the departments of human knowledge. Dr. Reid's chapter *on the Train of Thought in the Mind* gives a vivid though simple picture of the power of the imagination; while, at the same time, it exhibits a tolerably faithful specimen of the difficulty of treating this subject, owing to a want of precision in the definition of the term. In many philosophical disquisitions imagination is used as nearly synonymous with *fancy*. But it should seem that this is an erroneous application of the term; for, as Dugald Stewart observes, the latter should rather be considered as that peculiar habit of association which presents to our choice all the different materials that are subservient to the efforts of the former, and which may therefore be considered as forming its groundwork. *See* Association. Poetry.

IMA'N. An inferior order of ministers of religion in the Turkish empire. The chief imân of each mosque (Imam'ul-Haikh) performs the ordinary civil functions which in Europe have been in most countries assigned to parish priests, assisting at the circumcision, marriages, burials, &c. of his parishioners. He presides over the assembly of the faithful at the ordinary prayers; but the solemn noon prayer on Friday is under the superintendence of the Khatib, a higher minister (who is also called from that circumstance the *Imam'ul Djumâ*, or Friday Imân). The legitimate successor of Mahomet, in whom, in theory, the temporal and ecclesiastical government of Islam should reside, is termed *Imam* by way of pre-eminence; but the Mussulmans are not agreed among themselves as to the character of this dignity, or as to those who have rightfully borne it. The Persians reckon twelve legitimate Imams, of whom they believe the last (Mahadi) to be still living. (See *Taylor's Hist. of Mohammedanism*, ch. viii.)

IM'BRICATED. In Botany, a term used in speaking of the arrangement of bodies, to denote that their parts lie over each other in regular order like the tiles upon the roof of a house; as the scales upon the cup of some acorns: also applied in speaking of the æstivation of petals or leaves, to denote that they overlap each other at the margin without any involution.

IMBRO'GLIO. (A word borrowed from the Italian brogliare, *to confound or mix together*; whence the French brouiller and English embroil.) In literary language, the plot of a romance or a drama, when much perplexed and complicated, is said to be an "imbroglio." The small burlesque theatrical pieces so termed by the Italians derive their ludicrous character from a similar species of absurdity.

IMITA'TION. (Lat.) In Music, a species of composition in which each part is made to imitate the other. Sometimes the motion or figure of the notes is only imitated, and frequently by a contrary motion, making what is called a *retrograde imitation*, or *imitazione cancherizante*. Imitation, according to M. Brossard, differs from a *fugue* in that the repetition must be a second, third, sixth, seventh, or ninth; whereas in a fugue the repetition must be in the unison fourth, fifth, or octave, and the intervals exactly the same in the *comes* and *guide*.

IMME'RSION (Lat. immergo, *I plunge under*), in Astronomy, denotes the disappearance of any celestial object behind another or in its shadow. Thus in an eclipse of one of Jupiter's satellites, the immersion takes place when the satellite disappears behind the body of the planet, or enters into the planet's shadow; and in an occultation of a planet or fixed star by the moon, the immersion is the disappearance of the star or planet behind the body of the moon. In like manner, the reappearance of the body is called its emersion. The immersions and emersions of fixed stars occulted by the moon, are phenomena of great importance for correcting the lunar tables.

IMMERSION, BAPTISM BY, seems to have been the most ancient mode adopted in the Christian church. The *trine* immersion, in honour of the three persons of the Divinity, is mentioned by Tertullian, and prescribed in the Sacramentary of Gregory the Great; but *single* immersion was held valid by that pope, and his decision was confirmed by the fourth council of Toledo, A.D. 633. (*Riddle's Christian Antiquities*, 462.)

IMMOLA'TION. (Lat.) A ceremony used in the Roman sacrifices, which consisted of throwing upon the head of the victim some sort of corn or frankincense, together with the *moal*, or salt cake, and a little wine.

IMMU'NITY. In Jurisprudence, legal freedom from any legal obligation. Thus the phrase "ecclesiastical immunities" comprehends all that portion of the rights of the Church, in different countries, which consists in tho freedom of its members, or of its property, from burdens thrown by law on other classes.

I'MPACT. (Lat. impingo, *I impinge on any thing.*) In Mechanics, the instantaneous action of one body on another to put it in motion. If the body moves in the direction of the stroke, the impact was direct; if in a different direction, the impact was oblique.

IMPA'GES. (Lat.) In Architecture, a word usually taken to mean the rails of a door.

IMPA'LEMENT. In Heraldry, the division of a shield palewise, when the shield is said to be *party per pale*. *Impalement per baron et feme* is the division which takes place on marriage; when the husband's coat is borne on the dexter side of the pale, and the wife s on the sinister. Formerly, the husband's and wife's arms were impaled *by dimidiation*; that is, the dexter half of the husband's coat impaled with the sinister half of the wife's: and this inconvenient mode of marshalling was pursued in French heraldry down to the period of the Revolution.

Impalement. A species of punishment formerly in use among the Turks and some barbarous nations, which consisted in thrusting a stake through the body, and thus leaving the victim to a lingering death. Instances are on record of persons enduring this horrid torture for several days before death released them from agony. (See *Shaw's Travels in Barbary*.)

IMPANA'TION, in Theology, otherwise termed *Assumption*, signifies the substantial union of the body and blood of Christ with the elements of the eucharist without a *change* in their nature. The word appears to be first used in the controversy about the real presence in the 11th century, and to be applied, by the supporters of transubstantiation, to the less material doctrine of Berengarius and his followers. It has since been objected, by Roman Catholics, to the Lutheran theory, that it revived the old error of impanation. The supporters of the opinion of Berengarius were sometimes termed *Adessenarii*; from the word adesse, *to be present*.

IMPA'RLANCE. (Fr. parler, *to speak*.) A mode of delaying proceedings in a civil action by petition to the court for further time. General imparlance was to the next term; special imparlance to a specified day, which might be in the same term. The practice of imparlance appears to be abolished by 2 W. 4. c. 39., except as to actions not commenced under the process given by that act.

IMPASTA'TION. In Sculpture, the mixture of different matters bound together by means of cements capable of resisting the action of fire or air.

IMPEA'CHMENT. (From the Latin impetere, *to prosecute*.) A species of process against persons accused of treason, or high public crimes and misdemeanours of an inferior description. The first regular instances of this proceeding appear, according to Mr. Hatsell, on the rolls of parliament in the latter end of the reign of Edward III. Before that time the Lords seem to have exercised a high but irregular jurisdiction over state offences, at the prayer of the crown or of private persons. But in the case of Richard Lyon, 1376, we first find the Commons appearing in their public capacity as prosecutors: and several similar instances occur in the course of the following century. But from the reign of Henry VI. to that of James I. impeachments seem to have fallen into disuse; bills of attainder, and prosecutions in the Star Chamber, having been prosecuted in their stead. In the seventeenth year of James I. this form of proceeding was revived against Sir Giles Mempesson for having procured illegal patents, and from that time to the present has been the regular constitutional form of accusation for state offences. The form of the accusation exhibited by the Commons is styled *the articles of impeachment*. It is an undoubted right of the Commons to exhibit such articles against a peer for treason, or any other high crimes and misdemeanours; but it has been doubted whether the Lords have jurisdiction in capital cases over a commoner in this proceeding. In one instance (in 1681) they refused to do so, but have in several other instances admitted their competency. Managers are appointed by the Commons to conduct the prosecution before the Lords. In case of an impeachment of a peer for

treason, it is usual to address the crown to appoint a lord high steward; but the appointment of such an officer does not seem essential to the conduct of an impeachment. By 12 & 13 W. 3. c. 2. it is enacted that a pardon under the great seal shall not be pleadable to an impeachment. This, however, does not deprive the king of his prerogative of pardoning after conviction. It was determined, on the impeachment of Warren Hastings, that this proceeding in the Lords is not put an end to by the prorogation or dissolution of parliament; and an act was passed to prevent prorogation or dissolution from having the effect of putting a stop to the previous proceedings in the House of Commons. Judgment on impeachment must proceed on the same evidence which would be required in the ordinary courts of justice; in which respect this proceeding differs from that by bill of attainder.

IMPE'NETRABI'LITY. In Physics, one of the essential properties of matter or body. It is a property inferred from invariable experience, and resting on this incontrovertible fact, that no two bodies can occupy the same portion of space in the same instant of time. Impenetrability, as respects solid bodies, requires no proof; it is obvious to the touch. With regard to liquids, the property may be proved by very simple experiments. Let a vessel be filled to the brim with water, and a solid incapable of solution in water be plunged into it; a portion of the water will overflow exactly equal in bulk to the body immersed. If a cork be rammed hard into the neck of a phial full of water, the phial will burst, while its neck remains entire. The disposition of air to resist penetration may be illustrated in the following way: — Let a tall glass vessel be nearly filled with water, on the surface of which a lighted taper is set to float. If over this glass a smaller cylindrical vessel, likewise of glass, be inverted and pressed downwards, the contained air maintaining its place; the internal body of the water will descend, while the rest will rise up at the sides, and the taper will continue to burn for some seconds, encompassed by the whole mass of liquid. (*Leslie's Elements of Natural Philosophy*.)

IMPE'NNATES, *Impennes*. (Lat. in, and penna, *a wing*.) The name of a tribe of swimming birds, having short wings covered with feathers resembling scales. The penguin (*Aptenodytes*) is a good example of this group.

IMPE'RATIVE MOOD. (Lat. impero, *I command*.) That form of the verb which denotes command, entreaty, or, in general, desire. *See* GRAMMAR.

IMPE'RFECT CADENCE. In Music. *See* CADENCE.

IMPE'RFECT CONCORDS. In Music, such as are liable to change from major to minor, or the contrary, as are thirds and sixths; still, however, not losing their consonancy.

IMPE'RFECT NUMBER. A perfect number is one whose aliquot parts, added together, make a sum equal to the number itself. An imperfect number, consequently, is one such that the sum of its aliquot parts, or divisors, is not equal to the number itself. Thus 12 is an imperfect number; for the sum of its divisors, 1, 2, 3, 4, 6, is 16, which is greater than 12.

IMPE'RFECT TENSE. In Grammar, that modification of a verb which expressses that the action or event of which we speak was at a certain time to which we refer in an unfinished state. This is in English designated by the auxiliary "was," joined with the present participle.

IMPE'RIAL. (Fr.) In Architecture, a species of dome whose profile is pointed towards the top and widens towards the base, thus forming a curve of contrary flexure.

IMPE'RSONAL VERBS, in Grammar, are those used only in the third person; as ἔξεστι, licet, *it is lawful*. It is quite clear that every verb, whether active or passive, must have a necessary reference to some noun, either expressed or understood, for its nominative; and hence the doctrine of impersonal verbs has been justly rejected by the best grammarians, both ancient and modern. *See* GRAMMAR.

IMPETI'GO. (Lat. impetire, *to infest*.) An eruption of small pustules, sometimes called the moist tetter: the vesicles discharge an acrid ichor. Something of this kind is often produced by particular trades, where irritating substances are applied to the skin. Cleanliness, cooling ointments, and occasionally the nitrated mercurial ointment much diluted, are useful. Harrowgate water and baths have been recommended, and mild aperients. The eruption is not contagious.

I'MPETUS. (Lat. *force*.) In Mechanics, the same with momentum or force. *Impetus*, in Gunnery, is the altitude through which a heavy body must fall to acquire a velocity equal to that with which the ball is discharged from the piece.

I'MPLEMENTS, AGRICULTURAL. Almost all the operations of agriculture may be performed by the plough, the harrow, the scythe, and the flail; and these are the sole implements in the primitive agriculture of all countries With the progress of improvement, however, many other implements have been introduced; the more remarkable of which are the drill-plough, the horse-hoe, the winnowing machine, the threshing machine, the hay-making machine, and the reaping machine. The object of all these implements and machines is to abridge human labour, and to perform the different operations to which they are applied with a greater degree of rapidity and in a more perfect manner than before.

I'MPLEMENTS, HORTICU'LTURAL. The essential implements of horticulture are the spade and the pruning knife. The rake might be added, but it can be done without; because if seed be sown on a rough surface, it may be covered by beating that surface smooth with the spade; and if on a smooth surface, it may be covered by scattering with the spade a very thin sprinkling of earth over it. Even the pruning knife might be dispensed with; because culinary vegetables might be pulled up by the roots, or cut off at the surface of the ground with the spade; and fruit trees will produce crops without pruning, as by disbudding and thinning with the finger and thumb as large fruit may be grown as ever will be produced by the use of the knife. It must be confessed, however, that the knife and the rake are very nearly essential instruments of horticulture. With the progress of horticulture a great number of implements, instruments, utensils, and machines have been brought into use. Of these may be mentioned the hoe for stirring the soil and cutting up weeds; and this implement on a larger scale in warm countries is used as a substitute for the spade. The watering pot in modern gardening is an important utensil, and the syringe a machine that can scarcely be dispensed with. In the forcing department, we have the thermometer, the hygrometer, and various contrivances for supplying and regulating heat, admitting or excluding air, and producing artificial vapour or rain.

IMPLICA'TION. (Lat. implico, *I evolve*.) In Law, an inference necessarily arising from something declared. Thus contracts are said to be either express or implied. *See* CONTRACT.

IMPLU'VIUM. (Lat.) In Ancient Architecture, the outer part of the court of a house which was exposed to the weather. In the summer time it was the practice to stretch an awning over it.

IMPO'NDERABLE SUBSTANCES. Heat, light, electricity, and magnetism are so called, being supposed to depend upon very subtile forms of matter of inappreciable weight.

IMPORTS AND EXPORTS. The articles imported into and exported from a country. *See* COMMERCE.

IMPO'SING (Fr. imposer), in Printing, is the arrangement of the pages of a sheet upon the imposing stone in their proper order, so that when printed and the sheet folded they will follow each other consecutively; putting the furniture about them, with the chase; and wedging them up, so as to be ready to print..

IMPOSI'TION OF HANDS (Lat. impono, *I place upon*), is maintained in the English and other churches, as conformable to the apostolic practice and that of the earliest ages, in which confirmation and the ordination of priests and deacons are supposed to have been accompanied with the performance of this ceremony. In Acts vi., the apostles lay their hands on those appointed to be deacons; in Acts viii. and xix., the converts who had been already baptized by Philip and John are in the same manner confirmed by Paul and the other apostles.

IMPOSSIBLE QUANTITY. *See* IMAGINARY QUANTITY.

I'MPOST. (Lat. impono, *I lay on*.) In Architecture, the capital of a pier or pilaster which receives an arch. The impost varies with the order whereto it is applied. Sometimes the whole of the entablature serves as an impost to an arch. The term is applicable to any supporting piece. *Impost* is also frequently used as synonymous with tax or public burden.

IMPRE'SSION. (Lat. imprimo, *I press upon*.) In the Fine Arts, the sensation on the mind which is excited by a work of art. The word is also used to denote a copy of an engraving drawn off from the plate or block on which the subject is engraved.

IMPRE'SSMENT. The forcible levying of mariners for the king's service at sea. The power of impressment is a branch of the king's prerogative. It is mentioned in the statute 2 Richard 2. c. 4. as a recognized usage. Various classes of mariners are exempted from it by particular statutes. The officer impressing acts under an impress warrant for that especial purpose; but the regularity of this instrument is carefully watched by the courts, and criminal informations have been also granted against officers guilty of unnecessary severity or acts of private malice in carrying it into execution. (See, for arguments in favour of maintaining this practice, *Quart. Rev.* vol. xlix. p. 496, &c.; against, *Wealth of Nations*, M'Culloch's ed., note xii.)

IMPRIMA'TUR. (Lat. *let it* (*the book*) *be printed*.) The term applied to the privilege which, in countries subjected to the censorship of the press, must be granted by a public functionary appointed for the purpose before

any book can be printed. This formula was much used in English books printed in the 16th and 17th centuries; and this permission is even still vested in some of our own universities, especially in Scotland, where it is nothing unusual to find on the title-page of some works recommended to public favour by the senatus academicus the "imprimatur" of the principal.

IMPRI'NT. (Fr. imprimer.) The designation of the place where, by whom, and when a book is published, always placed at the bottom of the title. Among the early printers it was inserted at the end of the book, and is styled the colophon. By the act 39 Geo. 3. c. 79., every printer is obliged to affix his name and residence to each article he shall print, and if it consists of more than one leaf, then upon the first and last leaves, under a heavy penalty; but there are some exceptions.

IMPRO'MPTU. (Lat. *in readiness.*) In Literature, any short and pointed production supposed to be brought forth on the spur of the moment; generally of an epigrammatic character.

IMPRO'PER FRACTION, in Arithmetic and Algebra, is a fraction whose numerator is equal to, or greater than, its denominator.

IMPROPRIA'TION, in Law, is where the tithes, glebe, or other ecclesiastical dues of a parish are in the hands of a layman. The religious societies having, at the time of the Reformation, the property of many benefices in their hands, clauses were inserted in the acts by which they were dissolved to give that property absolutely to the king, by whom it was granted out to lay proprietors. In common language, such benefices are said to be *impropriated* as are in the hands of laymen; such as are held by spiritual corporations, sole or aggregate, are termed *appropriated.*

I'MPROVISATO'RE. (Lat. improviso, *unforeseenly, unpremeditatedly.*) An Italian word, signifying a person who has the talent of composing and reciting a suite of verses on a given subject immediately and without premeditation. This peculiar talent, thus restricted, appears to belong, almost exclusively, to the Italian language and people. Much, no doubt, of the facility of these improvisatori, which appears almost preternatural to one unaccustomed to hear them, arises from the peculiar ease and flexibility of their language, and its richness in rhymes. But this circumstance will not wholly account for so singular a national faculty; for, about the time of the revival of letters, Italy possessed improvisatori in Latin as well as Italian. Many poets have enjoyed considerable celebrity in their day from their success in this mode of composition; but we are not aware that any of their poems have acquired a permanent celebrity, although often taken down from their recitation. Tuscany and the Venetian States have been most famous for the production of improvisatori, especially Sienna and Verona; in which latter city the talent seems to have been perpetuated by succession. The chevalier Bernardino Perfetti, the most famous of all these reciters, was of Sienna: he flourished in the first half of the 17th century. He is said to have possessed unbounded erudition, and to have been able to pour forth extempore poetical essays on the most abstruse questions of science. There have been many distinguished females possessed of this talent (improvisatrici). Corilla, the most celebrated of them, was of Pistoia in Tuscany. She was the original of Madame de Staël's *Corinne.* She received in 1776 the laureate crown at Rome, an honour which had also been accorded to Perfetti. Germany is said to have produced one noted improvisatrice, Anna Louisa Karsch. There appears no reason why the term improvisation should not also be applied to the delivery of unpremeditated discourses in prose. It is the exertion of a very similar faculty, perfected in the same manner by habit to a degree almost inconceivable by those not accustomed to witness its exercise. It is, however, much more general. The North American Indians are represented to possess it in a high degree. In Europe, it is most generally to be found in the pulpit. Public secular oratory of this unpremeditated description is far more common in England, and the power much more sedulously cultivated, than in any Continental country. (See *Forsyth's Italy; Ed. Rev.* vol. xxii.; *Encyc. Metr.*)

INAU'GURA'TION (Lat. inaugurare, *to take omens*), was originally applied to the Roman ceremony of admission to the college of augurs, or soothsayers, or to the selection of a proper site for the erection of temples or other national edifices; but it afterwards received a more extended signification, and is now used in a sense nearly synonymous with the *consecration* of a prelate, or the *coronation* of a king or emperor. It means also an introduction to any office with certain ceremonies.

INCA, or YNCA. A name given by the Indians of ancient Peru to their kings and princes of the blood. The empire of the Incas, founded, according to tradition, by the celebrated Manco Capac, extended over the tableland of the Andes, from Pasto to the neighbourhood of Chili, as well as the low lands on the coast. It was destroyed by the Spaniards under Pizarro and Almagro. The blood royal of the Incas is preserved, or believed to be so, among the Indians of the present day; and Tupac Amaru, who carried on a long and nearly successful insurrection against Spain in the latter part of the last century, professed to be descended from them.

IN CÆNA DOMINI. (Lat. *at the Lord's Supper.*) The name of a celebrated papal bull, containing a collection of extracts from different constitutions of the popes, comprising those rights which, since the time of Gregory VII., have been uninterruptedly claimed by the Roman see, and a proclamation of anathema against all who violate them. It was annually read on Holy Thursday, whence it receives its name; but lately on Easter Monday. The sects of heretics are cursed in it by their several designations. A copy of the bull is hung up at the door of the churches of St. Peter and St. John Lateran; and all patriarchs, primates, bishops, &c., are required to have it read once or more annually in their churches.

INCANDE'SCENCE. (Lat. in, and candere, *to be warm.*) The luminosity exhibited by a substance when heated up to a certain point.

INCANTA'TION. (Lat. in, and canto, *I sing.*) A form of words combined with certain ceremonies and mixtures of heterogeneous substances used by the ancients for many superstitious purposes. They were most commonly resorted to by unsuccessful lovers; in which case they were termed *love potions*, or *philtres*, which see.

INCARCERA'TION. (Lat.) Literally, imprisonment. In Surgery, this term is generally applied to ruptures or herniæ, with the same meaning as *strangulation;* but, according to Scarpa, an *incarcerated* hernia is that in which the course of the intestinal matter is interrupted without any considerable injury of the bowel itself; whereas in *strangulated* hernia the vitality of the bowel is affected, or there is organic injury of its coats. The functions of the merely incarcerated intestine are healthily resumed upon its return into the abdomen, which is not the case where true strangulation has taken place.

INCARNA'TION. (Lat. caro, *flesh.*) A word in common use among theologians to express the union of the Godhead with the Manhood in Jesus Christ. St. John says, "The Word was made flesh, and dwelt among us;" a text sufficiently explicit, when coupled with other expressions respecting the divine nature of the Word, to maintain the doctrine of the incarnation among the vast majority of the Christian world. But the subtle inquiries which men have instituted into the manner and nature of this union have given rise to many varieties of opinion, and to many sects which have incurred the reproach of heresy. Not the Socinians only, but the Arians and Sabellians also, are led necessarily by their premises into heterodoxy upon this point; the Nestorians, however, and Eutychians, may be considered the principal sects which have joined an orthodox belief, as to the relations of the three persons of the Trinity one to the other, with peculiar conceptions of the manner of the union of the two natures in Jesus Christ. (See the respective articles.)

The real manner of this union, or indwelling of the God in the Man, is allowed to be a mystery such as cannot be fully apprehended by the human intellect. It is easier to point out the errors which beset its investigation than to express in words the true doctrine. The phrase, "The Word was made flesh," cannot imply that the divinity was lost and annihilated in becoming flesh; nor that it changed its own nature and was turned into humanity. In either of these cases, Christ would cease to be a divine being while on earth. Nor did the Godhead inspire the Manhood after the manner in which the Prophets had been inspired in earlier times; for the terms applied to Christ are of a very different kind. Nor, on the other hand, could the humanity be lost and absorbed in the divinity, which would seem to destroy the sympathy with which the man Christ regarded mankind, upon which so much of the superstructure of his religion is raised.

INCE'NDIARY. (Lat. incendo, *I burn.*) Literally, one who sets fire wilfully to a building or stores; but it is used also in a metaphorical sense for any political agitator who seeks to inflame the minds of the people. *See* ARSON.

INCENSE. *See* FRANKINCENSE.

INCE'PTIVE. (Lat. incipio, *I begin.*) A word used by Dr. Wallis to express such *moments* or first principles as, though possessed of no magnitude themselves, have yet the power of producing it by being extended or enlarged. Thus a point or a line, though the former has no proper magnitude and the latter no breadth, are both said to be *inceptive* of enlargement. In the Latin language *inceptive* or *inchoative* verbs (the latter term being derived from the Lat. inchoare, *to begin*) are those which, according to grammarians, are characterized by the termination *sco* or *scor* added to their primitives, and are expressive of a commencement of increase or augmentation of the qualities indicated by the words from which they are derived: as *augere*, to increase; *augescere*, to begin to increase: *pallere*, to be pale; *pallescere*, to grow pale.

INCE'RTUM O'PUS. (Lat.) In Ancient Architecture, a species of walling whose face exhibits an irregularly formed masonry, not laid in horizontal courses.

INCH. A measure of length; the twelfth part of a foot.

INCH. A word used as a prefix to certain small Scottish islands, as Inch-Keith, Inch-Garvie. It is derived from the old Irish or Gaelic word inis, signifying an island.

I'NCIDENCE. (Lat. incido, *I fall upon*.) The meeting of one body with another. The term *angle of incidence* is used by writers on mechanics and optics in different senses. Thus, in the case of a body striking against a plane, the angle of incidence is by some understood to signify the angle formed by the line in which the body moved with a straight line perpendicular to the plane; while others use the term to denote the angle which the line of incidence makes with the plane itself. When light or any elastic body is reflected from a surface, the angle of incidence is equal to the angle of reflection; and in the case of refraction, the sine of the angle of incidence has to the sine of the angle of refraction a constant ratio.

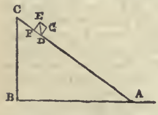
I'NCIDENT. In Law, something necessarily appertaining to and depending on another, which is termed the principal.

INCINERA'TION. (Lat. incinero, *I reduce to ashes*.) The combustion of organic substances for the purpose of obtaining their ashes or incombustible residue.

INCI'SORS, *Incisores*. (Lat. incido, *I cut*.) The teeth implanted in the intermaxillary bones of the upper jaw, and in the corresponding place in the lower jaw, and which are generally shaped for the purpose of cutting or coarsely dividing the food.

INCLINA'TION. (Lat.) A term of frequent occurrence in geometry, mechanics, physics, and astronomy. It is in all cases measured by an angle. Thus, the *inclination of the orbit of a planet* is the angle between the plane of its orbit and the plane of the ecliptic. In the history of geometry, the *problem of inclinations* is a subject that was treated of by Apollonius in two books, which are lost, but of which a description has been given by Pappus. The problem proposed was this: "To insert a straight line of a given magnitude, and tending to a given point, between two lines which are given by position." The problem was restored by Marinus Ghetaldus; and various other investigations have since been given by the method of the ancient analysis.

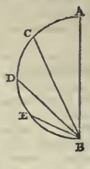
INCLI'NED PLANE. One of the five simple mechanical powers. The theory of the inclined plane is easily deduced from the decomposition of forces. Let



A C be the position of the plane, B C its altitude, and A B the horizontal distance of the foot of the plane from the perpendicular B C. Suppose a load to be placed on the plane at D, and let it be required to determine the relation between its whole weight and its tendency to descend along the plane. Let D E denote the vertical pressure of the weight, and decompose this into D F parallel to the plane, and F E perpendicular to it; and complete the parallelogram F G. Now the part F E is supported by the resistance of the plane; there remains, therefore, only the force represented by F D to urge the descent of the weight along the plane. But the triangle D F E is obviously similar to C B A, and therefore D F is to D E as C B to C A; that is, the force of descent along the plane is to the whole weight of the body as the height of the plane to its length, or as the sine of its elevation is to radius. The force, therefore, which is required to raise a body along the plane, is less than that which is required to raise it perpendicularly in the same proportion.

This fundamental proposition was first demonstrated by Stevinus of Bruges, but by a very different process of reasoning. He supposed a chain or chaplet composed of equal links to be thrown over the triangle A B C, and the two ends to be united a little below the base A B. It is evident that this chain would remain at rest, for on altering its position each link would be succeeded by a similar one in the same situation; and if it began to move of itself it would move for ever, a supposition which is absurd. But the part below the base, being suspended equally at both extremities, is evidently in a state of equilibrium; therefore the part which hangs along the perpendicular B C must balance the part lying along the inclined plane; and the weights of these two parts being as their lengths, it follows that a weight placed on the plane is to the force required to sustain it as the length of the plane to its height.

There are two properties connected with the motion of bodies on inclined planes which deserve to be noticed. The first is, that the velocity acquired by a body in descending from any altitude to a horizontal plane is the same when it reaches the horizontal plane, whether it has been allowed to fall freely in the vertical, or been constrained to move along an inclined plane at any angle of elevation. The second is, that the times of descent through all chords of the same circle to the lowest point are equal, and equal to the time the body would take to fall through a height equal to the diameter of the circle.



Thus, let A B be the diameter, and C B, D B, and E B chords of a circle; the time a heavy body would consume in falling vertically through the diameter is the same as that in which it would roll down the inclined plane C B, or D B, or E B. In other words, bodies placed at A, C, D, and E, and abandoned at the same instant to the action of gravity, would arrive at B at the same time. In these propositions it is supposed, of course, that there is no resistance from friction.

INCLO'SURE. (Lat. includo, *I shut up*.) This term, in a general sense, is one of the first acts of appropriation, since in a new country when any portion of land is purchased, or taken possession of, it is inclosed; that is, surrounded by a boundary line, indicated by certain objects, natural or artificial, or of both kinds. In a particular sense, to inclose land is to divide it into fields, and surround these by fences, in order that each field may be devoted to a particular description of culture. If nothing farther than the cultivation of plants of different kinds were carried on in the fields of a farm, their subdivision by fences would be altogether unnecessary; but as in most cases fields are kept alternately under tillage and pasture, it is desirable to have fences to confine the pasturing animals to the field appropriated for their use.

INCLU'SA. (Lat. includo, *I inclose*.) The name of a tribe of shell-bearing Acephalous Mollusks in the system of Cuvier, characterized by the closed state of the mantle, which every where surrounds and envelopes the body, leaving only a narrow aperture for the passage of the foot, and being prolonged posteriorly into two siphons projecting beyond the shell, which is always open at its two extremities. The bivalves of this family are remarkable for their powers of burrowing and excavating clay, sand, wood, or even stony rocks; and many of the genera secrete, in addition to the ordinary valves, a calcareous lining to their burrows, which forms a tube surrounding the valves themselves. The relative proportions of the tube and valves well illustrate the so-called law of the "balance of organs," the valves becoming diminished in size as the external sheath is more developed. In the ship-borer (*Teredo navalis*), which has the longest tube, the valves are of the smallest size, being reduced to the office of mere boring instruments, instead of serving to protect the soft parts of the animal. In the watering-pot shell (*Aspergillum*, Lam.) they cease to be moveable organs, and are blended or confluent with the external tube; this is dilated at the anterior extremity, which is surrounded with a projecting radiated ridge, and closed by a convex plate, perforated like the mouth of a watering pot.

INCLU'SI, or RECLU'SI. (Lat. *shut up*.) In Ecclesiastical History, a class of religious persons who lived as hermits in single cells, generally attached to monasteries, sometimes in the neighbourhood of villages and towns,—under the law of not leaving them unless in case of extreme necessity, and with the approbation of the bishop; whose seal, or that of the abbot, was impressed on its door. The cells are said to have been commonly twelve feet in length and breadth. Nuns became sometimes, but more rarely, recluses.

INCO'GNITO (Ital. *unknown*), abbreviated into *incog.*, denotes the disguise resorted to by the great when they are unwilling to be recognized. It consists either in assuming a different name or title for the nonce, or in travelling from one place to another without a retinue or other marks of distinction.

INCOMBU'STIBLE CLOTH. This term was originally applied to cloth with which asbestus was interwoven; on burning away the fibre, the incombustible mineral texture remained.

More recently, cloth and other materials have been rendered to a great extent incombustible by impregnating them with certain saline substances, which, upon the application of fire, form a species of glaze upon the goods, and prevent them burning with flame by protecting them from the necessary access of air. (*See* COMBUSTION.) Borax, alum, and phosphate of soda, or ammonia, are the most effectual salts for this purpose; and by properly applying them, with starch, if to muslin dresses, curtains, or bed furniture, or with size to paper hangings and scenery, these several articles may be rendered incapable of burning with flame, and thus serious accidents by fire prevented. Wood may also be rendered comparatively incombustible by soaking it in solutions of the above salts. *See* ASBESTUS.

INCOMME'NSURABLE. Two numbers or homogeneous quantities of any kind are said to be incommensurable when they have no common measure, or when no number or quantity of the same kind can be found which will divide them both without a remainder. Thus the numbers 21 and 22 are incommensurable. The

side of a square and its diagonal are incommensurable lines, as is proved by Euclid in his tenth book. Numbers are said to be *incommensurable in power* when their squares or second powers are incommensurable; as 2 and 3, the squares of which, 4 and 9, have no common measure. It is owing to the incommensurability of quantities, that it is found so difficult to explain the doctrine of proportion in the elements of geometry.

INCOMPA'TIBLES. In Chemistry, salts and other substances are said to be *incompatible* which cannot exist together in solution without mutual decomposition. Thus the soluble salts of lead and of baryta are incompatible with sulphuric acid and the sulphates, because the sulphates of lead and of baryta are insoluble, and consequently thrown down in the form of precipitates.

INCOMPRE'SSIBILITY. That quality of bodies in virtue of which their volumes cannot be diminished. There are no substances, perhaps, absolutely incompressible. Liquids, however, resist compression with great force; but the experiments of Canton have proved that water has its bulk sensibly enlarged by withdrawing the pressure of the atmosphere. Nevertheless the extent to which the compression can be carried is very small. On enclosing water within an iron cannon, the sides of which were three inches in thickness, and applying a very great force of pressure, the cannon burst before the volume of water had been reduced to 19-20ths of its original dimensions. A pressure equal to that of the atmosphere reduces the bulk of water only about 48 parts in one million.

I'NCREMENT (Lat. *increase*), in the higher Mathematics, denotes a small but finite increase of a variable quantity. It is the difference between two successive values of the function of a quantity increasing according to a determinate law. *The method of increments* was the name given by Dr. Brook Taylor to a method of analysis invented by him, and which has since been extensively cultivated under the appellation of the *calculus of finite differences*. It is of great use for the summation of series, and furnishes an easy and rapid solution of a great variety of difficult problems to which other means of investigation would hardly apply. *Taylor's Methodus Incrementorum* was published in 1715, and contained the celebrated theorem which has since been made the basis of the differential calculus. (See *Euler's Calculus Differentialis;* Bossut, *Calcul Différentiel et Intégral;* Lacroix's large work; and Sir J. Herschel's Essay in the Appendix to the Cambridge translation of *Lacroix's Differential and Integral Calculus*.)

Increment, in Rhetoric, is a species of climax rising gradually from the lowest to the highest. *See* Climax.

INCRUSTA'TION. (Fr.) In Architecture and Sculpture, a work fixed with cement or cramp irons into notches made to receive it; such as inlaid work and mosaics, &c.

INCUBA'TION. (Lat. incumbo, *I brood over.*) Hatching, or the lying down of an animal upon her own or another's eggs, communicating to them, and maintaining them at, her own temperature: a condition essential to their development. In many animals the development of the fœtus takes place after the exclusion of the egg, and whilst it is maintained in contact with the external surface of the parent's body, as in the crab and lobster tribes, beneath the caudal plates; or agglutinated to the surface of the abdomen, as in certain species of pipe-fish (*Syngnathus*); or concealed in cutaneous marsupial cavities, as in other species of *Syngnathus*, and the *Hippocampus;* but in these and other instances from the cold-blooded animals, the protection of the ova seems to be the object of their attachment to the parent, and not the communication of warmth or any other influence essential to their development. It is only in the Oviparous class with warm blood, or birds, that true incubation takes place, and in this class without any exception. Another characteristic of true incubation is that the place of the eggs determines that of the incubator, which can only perform its office by *lying down upon the eggs;* while in most of the examples of false incubation in the cold-blooded animals, the eggs are retained by special contrivances in contact with the parent, without occasioning any restraint upon her postures or movements.

That a due degree of warmth is the essential object of incubation in birds, is proved by the ancient and well-known practice of substituting artificial heat, by which fertile eggs are hatched in the same period, and the excluded chick is as fully and strongly developed, as when produced by natural incubation. (See *infra*.)

The mean temperature of incubation is 100° Fah.; it may vary from 95° to 105°, and towards the close of the process, may be suspended for one or two hours, or for a longer period, according to the degree of extraneous heat which the eggs may derive from their situation, without fatal consequences to the embryo.

The power of communicating the requisite degree of warmth to their eggs arises out of the unusual development of, and determination of blood to, a peculiar plexus of vessels distributed over the skin of the abdomen, and which, in most birds, is connected with a derivation of blood from the internal organs of generation, after the subsidence of the functional activity of the ovarium and oviduct, to the external integuments. The vascular, hot, and sensitive condition of the skin of the abdomen is the exciting cause of that uncontrollable propensity to incubate which the Greeks denominated "storge," and which, with its associated phenomena of patience, abstinence, and self-denial, forms so remarkable a feature in the economy of birds. The egg of the bird presents several peculiarities in relation to the circumstances under which it is to be developed: its oval form permits a greater proportion of its surface to be in contact with the heat-communicating skin of the parent than if it had been a spherical body; while the shell, by virtue of its hard calcareous texture, and its arched disposition about the soft contents, sufficiently defends them from the superincumbent pressure. As warmth is the only essential influence which the egg derives from the parent, the shell is porous, and permeable to air, and the germ is surrounded by an adequate store of nutritious matter. This matter is of two kinds: the external, called the white of the egg, or albumen, which wholly disappears during the process of incubation; and the internal part, or yolk, inclosed in a peculiar membrane, and rendered lighter and of an orange colour by the admixture of a peculiar oil. The germ is situated at the superficies of the yolk, beneath the vitelline membrane, in the circular opaque white spot called the "cicatricula," or "tread;" and a peculiar mechanism is superadded to the yolk by means of which the germ-bearing surface of the yolk is always kept uppermost and next the warmest surface of the egg, and at the same time is relieved from the pressure against the hard shell, to which it must have been subject if the light yolk had not been restrained from rising to absolute contact with that surface. Both these purposes are effected by the attachment of two cords of condensed albumen, continued at one end from near the poles of the yolk, but a little more distant from the germ-bearing side than the line of the transverse axis, and expanding at the opposite end, which is lost in the layers of albumen near the poles of the egg. Thus by their presence and place of attachment these cords, called the "chalazæ," restrain and regulate the rising of the yolk; so that whichever way an egg be turned, the larger proportion of the light yolk always rises above the attachment of the restraining cords, with the cicatricula upon its summit. The period of incubation is generally directly as the size of the bird, but the degree of development which the chick attains prior to exclusion varies. As a general rule, it is inferior in birds of flight, as the Accipitrine and Passerine orders, than in the terrestrial, wading, and swimming birds; and the warmth and complexity of the nest bears relation to this difference of development. If the thrush had been forewarned that her young would be excluded from the egg naked and helpless, she could not have prepared beforehand a warmer and more comfortable abode than her instinct had led her to construct for their accommodation; and if with such a nest we contrast the rude recess of straw in which the hen deposits and incubates her eggs, it might be imagined that she knew beforehand that her chickens would come into the world well clothed, and strong enough at once to run about and pick up their own food. In this case, therefore, the nest relates only to incubation; in the other to incubation and subsequent rearing of the young: and according to the degree of development attained during incubation, and the associated condition of the nest and habits of the parent, birds have been divided into two great groups, the *Aves altrices*, and *Aves præcoces*. *See* Avis.

Artificial incubation has been practised from a remote period by the Egyptians and Chinese; the former, indeed, have carried this process to such a high degree of perfection, as in many instances to have entirely superseded the use of the hen in hatching. It is effected either by means of an oven, stove, or steam, the principles of which will be found detailed in *Ure's Dictionary of Arts, &c.* This process has received considerable attention from the French philosophers; but perhaps the best exemplification of its results that has been witnessed in Europe is given by the *Eccaleobion*, which was lately exhibited in Pall Mall. This term, recently invented to express the process of artificial incubation, is derived from the Gr. ἐκκαλέω, *I call out* or *produce*, and βίος, *life*.

I'NCUBUS. (Lat. incubo, *I lie upon;* because the sufferer feels as if something pressed upon his chest.) The nightmare. The name incubus is derived from imaginary fiends or spectres, to whom strange powers are attributed by the writers on dæmoniacal agency. Many noble families were supposed to have their origin from the connection of incubi with females, as in the well-known instance of Robert of Normandy, called *le Diable*. (See *Encyc. Metr.*)

INCU'MBENT. (Lat. incumbo, *I lie upon, or occupy.*) A term applied to the holder of an ecclesiastical benefice.

INCUNA'BULA. (Lat. *a cradle.*) In Bibliography, a term applied to books printed during the early period

of the art: in general confined to those which appeared before the year 1500.

INCU'RVED. (Lat. incurvo, *I curve inwards.*) In Zoology, when a part is curved inwards.

INDECLI'NABLE. In Grammar, a word admitting of no declension or inflexion. Adverbs, prepositions, particles, conjunctions, are all indeclinable. In classical languages, indeclinable nouns are those few (chiefly borrowed by the Greeks and Latins from foreign languages) of which the termination is not altered in the several cases.

INDE'FINITE. In Botany, when stamens are above twenty in number: the word is applied to all other parts when their number is greater than can be readily counted. This term always refers in botany to number, and never to form

INDEFINITE PROPOSITION, in Logic, is one which has for its subject a common term, without any sign to indicate whether it is distributed or undistributed. *See* PROPOSITION.

INDEHI'SCENT (Lat. in, and dehisco, *I gape*), is said of a fruit the pericarpium of which continues perfectly closed, without opening in any degree when ripe.

INDE'MNITY. (Lat. in, *without*, and damnum, *loss.*) In Politics and Jurisprudence, a word of various significations, but applied usually to laws passed to relieve individuals from penalties to which they are liable in consequence of acting in an illegal manner. The Act of Indemnity, annually passed by the British parliament for many years prior to the repeal of the Test and Corporation Acts in 1828, was a measure for the relief of persons who had assumed any office without qualifying themselves for it by taking the oaths prescribed by those enactments. In Feudal Jurisprudence, the right of the lord to a certain duty payable by religious establishments to compensate him for the loss of those fines on alienation which would probably have accrued from time to time had their property remained in lay hands, was termed indemnity. In the language of modern politics, compensations paid by a state to other states, corporations, or individuals, for losses sustained through its acts, bear the same name. Acts of indemnity are also sometimes passed to relieve ministers from the responsibility of measures exceeding their strict constitutional powers, taken by them when parliament was sitting to meet some unforeseen public emergency, or in ignorance, it may be, that they had exceeded the powers vested in them by the constitution. In 1825 a law of indemnity was passed in France to compensate the losses sustained by the emigrants, their families, and those of persons who had been condemned to death for political offences in the course of the Revolution. The sum allotted to this purpose was an annual amount of 30,000,000 francs (about 1,200,000*l.*). A special commission was appointed to carry it into execution; but it appears that its labours were broken off before their completion by the political changes of 1830.

INDE'NTURE. In Law, a writing or deed comprising some contract between two or more parties. The name is derived from the ancient practice, according to which the original and counterpart original (to be retained by each party respectively) were written on the same skin of parchment, and then the two parts were separated by a notched or indented cut, so that when applied to each other they would appear to match. (*See* DEED.)

INDEPE'NDENCE, DECLARATION OF, in the History of the United States of America. The "Declaration of Rights" was adopted by the first general congress of the then revolted colonies, which met at Philadelphia in September, 1775. In this declaration that assembly asserted the right of internal legislation and taxation to be in the provincial legislatures, and declared various acts of the mother country to be infringements and violations of the rights of the colonists. The second congress, which met in May, 1776, adopted on July 4. of that year a declaration of independence; by which, after again recapitulating the grievances complained of in the former declaration, it declared the colonies to be free and independent states, absolved from all allegiance to Great Britain. The first draught of this famous declaration was prepared by a committee of five; consisting of Jefferson and Adams (both afterwards presidents), Franklin, and Sherman and Livingston. Jefferson and Adams were afterwards deputed as a sub-committee to prepare the declaration itself; but, in the shape in which it finally appeared, it was in fact the work of the former.

INDEPE'NDENTS. A Protestant sect; so called because they maintain that every single congregation of Christians which meet in any one place for public worship forms a church or independent religious society in itself, unconnected with, and not amenable to, any other church or congregation. They consequently condemn every thing like a national establishment of religion, whether episcopal or presbyterian; and insist that each congregation of Christians has inherent and indefeasible power in itself to exercise ecclesiastical government, to fix their own tenets and form of religious worship, and to adopt their own standard of church discipline, without being responsible to bishops, presbyteries, or synods, or even to the state itself. The Independents were not at any time, and are not at this day, remarkable for any peculiarity of religious creed. They have always maintained, speaking generally, Calvinistic doctrines; their only peculiarity consisting in their maintenance of independent ecclesiastical government.

Of the history of this sect it may be proper to give a brief account. On the reformation of religion in England, the great body of Protestants adopted, under the auspices of the government, the episcopal form of church polity, which was in consequence established as the national religion. But there were not a few who conscientiously thought that this polity too nearly resembled that which had been supplanted; and objected, besides, to the vestments adopted by the clergy in the celebration of divine worship, to the liturgy, and above all to the sign of the cross used in baptism, as unscriptural and erroneous. These non-conformists, or dissentients from the established faith, are known in history under the name of *Puritans*, as the followers of Novatian had been denominated in the third century. They were evidently so called in derision, in consequence of the superior purity and sanctity they assumed, and of the greater deference they showed to scripture authority, both as to doctrine and the form of religious worship. But while they forsook the national church, and condemned many of her tenets, they did not agree among themselves. They were, in truth, unanimous in nothing but in resisting the constitution of the predominant hierarchy. Some of them were in favour of presbytery, or ecclesiastical government vested in a gradation of church courts, such as Calvin had established in Geneva, and as Knox had introduced into Scotland. Others were against every form of state religion, or union of churches under the same ecclesiastical government; but regarded each congregation of Christians as being *jure divino* a complete and independent church, competent to judge, decide, and act for itself, without any external interference or responsibility whatever. Of this latter opinion, which constitutes the pure principle of English Independency, the author and great advocate was Robert Brown, who was originally a clergyman of the Protestant episcopal church, from which he seceded, and avowed his new doctrines about the year 1580. (*Neal's Hist. of the Puritans*, vol. i. ch. vi. London, 1822.) Brown is represented by Neal as a vehement and popular declaimer, and insinuating in his manners; and hence he succeeded in detaching many from the episcopal faith, and in establishing several separate churches. He not only advocated the leading principles of Independency as we have stated them above, but taught that the priesthood was neither a distinct order in the Christian church, nor conferred an indelible character; that every person regarded by the majority of a congregation as qualified to teach might be set apart for that office by the election of his brethren, and by imposition of their hands; in like manner, by their authority, he might be discharged from that function, and reduced to the rank of a private Christian. He also maintained that the right of the pastors to preach was not peculiar to them; on the contrary, that any member who thought proper to exhort or instruct the brethren enjoyed the inherent right of doing so, or of "prophesying" before the whole assembly. Hence it happened that after the stated pastor had finished his services, the ordinary members were allowed to communicate in public their sentiments on any religious subject. (*Ibid.*; and *Mosheim's Ch. Hist.* vol. v. 355-6. London, 1822.) But while Brown enforced these views, and claimed liberty of conscience to himself, he was not willing to allow similar privileges to other sects, particularly the Church of England. "The Brownists," for so the Puritans were now called, "did not differ from the Church of England in any articles of faith; but were very rigid and narrow in points of discipline. They denied the Church of England to be a true church, and her ministers to be rightly ordained. They maintained the discipline of the Church of England to be popish and anti-Christian, and all her ordinances and sacraments invalid. Hence they forbade their people to join with them in prayer, in hearing, or in any part of public worship; nay, they not only renounced communion with the Church of England, but with all other reformed churches, except such as should be of their own model." (*Neal*, i. 303.)

Brown and his followers, as they had imbibed such extreme views, cannot be expected to have been allowed to live undisturbed in the dark times to which we refer. He, in truth, suffered severely for his principles, both for some works he published, and for the ecclesiastical doctrines which he travelled throughout England in propagating. He was committed, as he afterwards boasted, to no fewer than thirty-two prisons in succession, in some of which he could not see his hand at noonday. Nor were his adherents more mercifully treated: many of them were fined and imprisoned, and some put to death. (*Neal*, i. 313.) Under these circumstances, a body of the party, with Brown at their head, fled to Holland,

and founded churches at Middleburg, Amsterdam, and Leyden. But these establishments were neither solid nor lasting. When the Brownists were delivered from the hands of the bishops their oppressors, they quarrelled among themselves; and their leader, weary of his office, returned to England in 1589, and not merely renounced the opinions which he had suffered so much in promulgating, but returned into the bosom of the church which he had abandoned, and which he had so long and so severely calumniated.

The Brownists that still remained in Holland, now left to their own discretion, and learning moderation from experience, were not unprepared to modify or reform the severity of the discipline of their founder. This judicious change was brought about by John Robinson of Norfolk, member of the congregation at Leyden; "a man who had much of the solemn piety of the times, and who, perceiving the defects that reigned in the discipline of Brown, and in the spirit and temper of his followers, employed his zeal and diligence in correcting them, and in modelling the society in such a manner as to render it less odious to his adversaries, and less liable to the just censure of those true Christians who looked on charity as the end of the commandments." (*Mosheim*, v. 359-60.) Hitherto the sect had been called Brownists: they now renounced that name, and have since been known under the title of Independents; and Robinson, who wrote an "Apology" (*Apologia justa et necessaria pro Exulibus Anglis, qui Brownistæ vulgo appellantur.* Lugd. Batav. 1619. 8vo.) for them, in which he gave a minute and systematic exposition of their principles, was considered as their founder. The Independents were much more commendable than the Brownists, particularly in the moderation of their sentiments and the order of their discipline. They laid aside that hostility to other sects which Brown had inculcated. They agreed with the reformed churches generally in articles of faith. They wished to maintain communion with them. They differed with them only on the subject of church government. They were also much more attentive than the Brownists had been to the establishment of a regular ministry in their communities; for, while the latter promiscuously allowed all ranks and orders of men to teach in public, and to perform the other pastoral functions, the Independents had, and still have, a certain number of ministers chosen respectively by the congregations where they are fixed. Nor is any person among them permitted to speak in public till he has received the sanction of the congregation. (*Ib.*; and *Mosheim*, ut supra.)

Independency, thus put on a more rational and Christian footing in Holland, was introduced into England by Mr. Henry Jacobs in 1616; an individual who established the first Independent or (as it is not inappropriately called) Congregational Church in this country. For some time, however, the sect made but slow progress in England. Its members concealed their principles from public view, to avoid the penal laws that were in existence against non-conformists. But during the latter part of the reign of Charles I., when, amidst the shock of civil and religious discord, the authority of the Episcopal Church began to decline, the Independents assumed greater courage, and publicly avowed their principles with a degree of confidence not previously exhibited by them. From this period their progress was rapid: a circumstance that may be imputed to a variety of causes, particularly the learning of their teachers, the unpopularity and declining state of episcopacy, and the support of Oliver Cromwell, who espoused their cause and enrolled himself among the list of their members. They probably were, during Cromwell's time, the most powerful and important religious body in England; though for a few years previously to the death of Charles I. the Presbyterians may be said to have had the ascendency. Indeed, presbytery had been established by act of parliament as the national church; and it was chiefly owing to the growing influence of the Independents that this act was rendered inoperative. (*Murray's Life of Samuel Rutherford*, chap. viii. Edinburgh, 1628.) Notwithstanding the "Apology" written by Robinson, which was regarded as containing the best summary of the principles of the sect, the Independents as a body had not agreed on any standard of faith and discipline; but, in the year 1658, their leading members held a meeting in London, under the sanction of the Protector, and passed "the Savoy Confession, or a Declaration of the Faith and Order owned and practised by the Congregational Churches in England, agreed upon and consented unto by the Elders and Messengers in their Meeting at the Savoy, Oct. 12. 1658." This Confession, and Robinson's "Apology," on which it is mainly founded, contain a synopsis of their various tenets; and from these it appears, as Mosheim remarks, "that they differed from the Presbyterians or Calvinists in no single point of any consequence, except that of ecclesiastical government." (*Adam's Religious World Displayed*, ii. 312-13.)

Thus matters stood at the date which we have just specified. What might have been the issue of the struggle between the Independents and Presbyterians if Cromwell had lived, or if the dynasty which he established had lasted, cannot be told. But the restoration of Charles II., and with him the episcopal church, put an end to the influence of both sects. The Act of Uniformity was passed in 1662; the object of which was to crush non-conformists, particularly the Independents and Presbyterians. The Act required from clergymen a direct recognition of the principle of episcopacy. The effect of this was the retirement of about 2000 clergymen from their respective churches—Independents, Presbyterians, and Baptists; whom Dissenters still characterize in history as "the illustrious two thousand," the ejected members," or "the Bartholomew worthies." The Independents, however, though proscribed, still subsisted; but in a state of persecution, dejection, and weakness. But the Revolution of 1688, and the Act of Toleration, which was passed in the subsequent year, brought them peace and the free exercise of their religion. They were now a small body as compared with the Presbyterians; but the two sects, having much in common, and differing only as to church government, entered into an association with each other, under certain heads of agreement, which tended to the maintenance of their respective institutions. (*Whiston's Memoirs of his Life and Writings*, vol. ii.; *Mosheim*, v. 361-63.)

Since the period of the Revolution, the Independents have greatly increased both in numbers and importance. The extraordinary revival of religious zeal which took place about the middle of last century, under the influence of the two Wesleys and Whitfield, was of essential service to the sect of which we are treating. Many other persons, awakened to a deeper sense of religion, refusing to unite with any of the three bodies of Methodists, the Wesleyan, the Whitfieldian, or the Countess of Huntingdon's, joined the Independents, and formed numerous churches in connection with that sect. The Independents have long ago withdrawn from their association with the Presbyterians, or indeed with any body of Dissenters, and act by themselves. They are distinguished from all other Protestant communities chiefly by the two following circumstances:—*First*, They reject the use of all creeds and confessions (including the Savoy Confession and Declaration) drawn up by fallible men; requiring of their teachers no other test of orthodoxy than a declaration of their belief in the gospel of Jesus, and their adherence to the Scriptures as the sole standard of faith and practice. *Second*, They attribute no virtue whatever to the rite of ordination; for they declare that the qualifications which constitute a regular minister of the gospel are a firm belief in the Bible, fervent piety, a desire for the glory of God and the salvation of mankind, a competent stock of knowledge, and an initiation to the pastoral charge from some Christian congregation. These two circumstances constitute the distinguishing characteristics of the Independent denomination. They do not believe, as may also be mentioned, that an imposition of the hands of bishops or presbyters at ordination confers any new power or prerogative; though it is their custom to impose hands in inducting a pastor to a particular charge as a token of recognition in a new relation. In point of religious doctrine they vary from the high Calvinism of the Savoy Confession; though moderate Calvinism is maintained, speaking generally, by both pastors and people. The Independents teach that every point both of doctrine and church discipline is vested exclusively in the congregation, and that whatever is supported by a majority must necessarily be law. They do not think it imperative to assemble synods; yet if any such be held, which they are periodically, they look on their resolutions as prudential counsels; but not as decisions to which they are obliged to conform. (*Adam's Rel. World Displayed*, ii. 314.)

Of the extent and influence of the Independents in England a pretty correct idea may be formed from the number of their colleges or academies, and of their chapels. These colleges or academies are exclusively confined to the education of ministers belonging to their own denomination. Some of these institutions are wealthy endowments: others of them are supported by annual subscriptions. Their number is ten; the oldest of which is at Homerton, Middlesex, which was founded in 1730. The last established college is at Manchester, which was instituted in 1837. The others were founded at different intermediate dates. The number of Independent chapels in England in 1829, according to the *Congregational Magazine* for the year 1829, was 1683; but that number is now understood to have been increased to upwards of 1700. In Scotland the Independents have 95 chapels, and in Ireland about 30; but it is reckoned that they have no fewer than 1000 congregations in the United States.

INDETE'RMINATE. In Mathematics, quantities which change their values are said to be *indeterminate*, in opposition to those whose values remain fixed and invariable. For example, in the equation of the ellipse

$b^2 x^2 + a^2 y^2 = a^2 b^2$, the co-ordinates x and y are indeterminate, while the axes a and b are constant, quantities.

INDETERMINATE. In Botany, when a stem is never terminated by a flower, nor has its growth stopped by any other organic cause: example, *Veronica arvensis*.

INDETE'RMINATE ANA'LYSIS, is a branch of Algebra which has for its object the investigation of problems which admit of an infinite number of different solutions. When the enunciation of a problem furnishes a less number of equations than there are unknown quantities, the problem is indeterminate in this sense,—that the equations may be satisfied by assigning to the unknown quantities an infinity of different values. It happens, however, in the greater number of cases, that the nature of the question requires the values of the unknown quantities to be expressed in whole and positive numbers; a condition which greatly restricts the number of solutions.

As in the ordinary algebraic analysis, problems belonging to the indeterminate analysis are of the first or second degree, according as the simple powers or squares of the unknown quantities enter into the equations expressing their conditions. Every equation of the first degree, containing two unknown quantities, may be reduced to the form $ax + by = c$; and it is plain that if only one equation of this sort is given, the values of x and y are wholly indeterminate, for any value whatever may be given to one of these quantities, and it will be easy to find a value of the second which will satisfy the equation. In the indeterminate analysis, the object is to find all the values which x and y can have in whole numbers; the constants a, b, and c denoting whole numbers, either positive or negative.

For example, let it be proposed to divide the number 159 into two parts, one of which is divisible by 8, and the other by 13. If we denote by x and y the quotients of the required parts, divided respectively by 8 and 13, these parts themselves must be $8x$ and $13y$; consequently the problem is expressed by this equation,

$$8x + 13y = 159 \ldots. (1.),$$

and it will be solved when x and y are expressed by whole positive numbers.

In the first place, this equation gives $x = \frac{159 - 13y}{8}$, or $x = 19 - y + \frac{7 - 5y}{8}$; but as x and y must be whole numbers, it is obviously necessary that $\frac{7 - 5y}{8}$ be also a whole number. Suppose this to be n; we have then $\frac{7 - 5y}{8} = n$; whence $5y + 8n = 7 \ldots. (2.)$, an equation of the same form with (1). The value of y deduced from this is $y = \frac{7 - 8n}{5}$ or $y = 1 - n + \frac{2 - 3n}{5}$. Now, precisely in the same manner as before, since y and n are whole numbers, $\frac{2 - 3n}{5}$ must necessarily be a whole number. Suppose this to be n', and we have $\frac{2 - 3n}{5} = n'$; whence

$$3n + 5n' = 2 \ldots. (3.)$$

From this last equation we get $n = \frac{2 - 5n'}{3}$, or $n = -n' + \frac{2 - 2n'}{3}$. Continuing the same process, we now make $\frac{2 - 2n'}{3} = n''$ (where n'' must be a whole number), whence $2n' + 3n'' = 2 \ldots. (4.)$;

from which we obtain $n' = \frac{2 - 3n''}{2}$, or $n' = 1 - n'' - \frac{n''}{2}$. Suppose, next, $\frac{n''}{2} = n'''$, and there results

$$n'' = 2n''' \ldots. (5.)$$

Thus at last an equation has been found which is satisfied by making n''' equal to any whole number whatever; and, on attending to the different steps of the process, it will readily be observed that x and y, and the indeterminate quantities n, n' n'', n''', are connected by the following system of equations:—

$$\begin{aligned} x &= 19 - y + n \\ y &= 1 - n + n' \\ n &= 0 - n' + n'' \\ n' &= 1 - n'' - n''' \\ n'' &= 2n'''. \end{aligned}$$

On deducing from these equations the values of x and y in terms of n''', we find $x = 15 + 13n'''$, and $y = 3 - 8n'''$. Now, on making n''' successively equal to 0, 1, 2, 3, &c., or equal to −1, −2, −3, &c., these two equations will give all the values of x and y in whole numbers, whether positive or negative, by which the equation $8x + 13y = 159$ can be satisfied. But if, as the conditions of the problem require, we take account only of the positive solutions, the values of n''' must be so assumed that the expressions $15 + 13n'''$ and $3 - 8n'''$ are both positive; and it is manifest that this can only be done by assuming $n''' = 0$, or else $n''' = -1$, for all other numbers substituted for n''' render the one or the other of these two expressions negative. If we make $n''' = 0$, we obtain $x = 15,\ y = 3$;
and if we make $n''' = -1$,

$$x = 2,\ y = 11;$$

and either of these two systems of values verifies the proposed equation.

The preceding example will show, more distinctly than perhaps any rule would do, the general methods employed to solve indeterminate algebraic problems of the first degree. With regard to equations of the second degree, the difficulties of solution are infinitely greater, and in fact involve some of the most abstruse theories of algebraic analysis. The subject is discussed at length in *Legendre's Théorie des Nombres*.

The oldest treatise on the subject of the indeterminate analysis is the *Arithmetic* of Diophantus of Alexandria, the best edition of which is that of Toulouse, 1670; with a *Commentary* by Bachet, and notes by the celebrated Fermat. On the revival of the mathematical sciences, the subject was extensively cultivated by Fermat, Descartes, Wallis, Lord Brounker, and others. One of the most luminous elementary treatises on the subject is contained in the second volume of *Euler's Algebra*.

INDETERMINATE COEFFICIENTS. A method of analysis invented by Descartes, and of very extensive application in the higher mathematics. The principle of the method of indeterminate coefficients consists in this, that if we have an equation of this form,

$$A + Bx + Cx^2 + Dx^3 + \&c. = 0,$$

in which the coefficients A, B, C are constant quantities, and x a variable which may be supposed as small as ever we please, each of these coefficients, taken separately, is necessarily equal to zero: that is to say, we must always have $A = 0$, $B = 0$, $C = 0$, &c., whatever may be the number of terms of the given equation.

In fact, since x may be supposed as small as we please, it is always possible to render the sum of all the terms of the given equation which have x for a factor as small as we please; that is, the sum of all the terms following the first may be rendered as small as we please. Hence the first term differs from zero only by a quantity which may be less than any assignable quantity; but the first term A being constant, its difference from zero cannot be any finite quantity assumed at pleasure, for this would suppose it to be variable. It follows, therefore, that A can be nothing else than zero; that is, we must have $A = 0$, whence there remains

$$Bx + Cx^2 + Dx^3 + \&c. = 0.$$

Divide this last equation by x, and there results

$$B + Cx + Dx^2 + \&c. = 0;$$

and, for the same reasons as before, it is manifest that we must have $B = 0$. Proceeding in the same manner, we find successively $C = 0$, $D = 0$, &c.

The principle here explained is extremely fertile in applications, and in fact gives the means of resolving by ordinary algebra all the questions which are considered as belonging to the infinitesimal analysis. The respective procedures of both methods, when properly simplified, are absolutely the same; all the difference consists in the manner of viewing the subject.

I'NDEX. In Bibliography, an alphabetical table, containing the principal subjects of a work, or words employed in it, with references to the part of the work in which they are to be found. Many independent works, containing catalogues of various kinds, have been also entitled index.

I'NDEX. (Lat. indico, *I point out*.) A term often applied to the fore finger.

I'NDEX. In Music, the same as *Direct*, which see.

I'NDEX EXPURGATO'RIUS. A catalogue of works, which the church of Rome prohibits the faithful from reading, or condemns as heretical. It is annually published at Rome.

I'NDEX OF A QUANTITY, in Arithmetic and Algebra, is used in the same sense with *exponent*. Thus, in the expression $(a + b)^3$, 3 is the index, and denotes that the quantity $a + b$ is to be raised to the third power, or cube. The index of a logarithm, or its *characteristic*, is the figure prefixed to the logarithm for the purpose of indicating the unit's place in the corresponding number. *See* LOGARITHM.

I'NDEX OF REFRACTION, in Optics, expresses the constant ratio which exists between the sines of the angles of incidence and refraction. Thus, with respect to a ray of light falling obliquely on the surface of water, the sine of the angle of incidence is found by experiment to be to the sine of the angle of refraction in the constant ratio of 1·336 to 1. Hence 1·336 is the index of refraction in water. *See* REFRACTION.

INDIAN ARCHITECTURE. *See* ARCHITECTURE.

INDIAN INK. A species of ink used in Europe for the lines and shadows of drawings. It is principally manufactured in China, and there used for writing. From the experiments of Dr. Lewis, it appears to be a compound of fine lampblack and animal glue. *See* INK.

I'NDIANITE. A mineral which occurs in granular masses, associated with garnet, felspar, and hornblende. It is hard enough to scratch glass, and of a white or gray colour.

INDI'CATIVE MOOD. (Lat. indico, *I point out.*) That form of a verb which expresses a simple or unconditional judgment. *See* GRAMMAR.

I'NDICATOR. (Lat. indico.) A genus of birds belonging to the cuckoo tribe (*Cuculidæ*), characterized by a straight finch-like bill, with compressed sides and a triangular base, the culmen and gonys being equally inclined towards the tip, and the gonys angulated; wings lengthened, pointed; tail moderate, rounded; feet short; middle toe much longer than the tarsus.

The species of *Indicator* are remarkable for their habit of indicating the nests of bees, and of guiding men to them by their motions and cries; whence both their scientific name and common appellation of honey guides.

INDICA'TOR. A muscle of the lower part of the fore-arm which extends the fore finger.

INDICA'VIT. (Lat. *he has shown.*) In Law, a species of the writ of prohibition. It lies for a patron of a church, whose incumbent is sued in the spiritual court by another clergyman for tithes amounting to a fourth part of the profits of the advowson; and depends on stats. West. 2. c. 5., 13 Ed. I. st. 4.

INDI'CTION. (Lat. indictio, *establishment*, *order*, or *denunciation.*) In Chronology, a cycle or period of fifteen years, the origin of which is involved in obscurity. Unlike other cycles, the indiction has no reference to any astronomical phenomena; but is supposed to relate to certain judicial acts, probably the publication of tariffs of the taxes, which took place at stated intervals under the Greek emperors. The Cæsarean indiction fell on the 8th of the calends of October (24th of September); the indiction of Constantinople (beginning A. D. 312) on the the 1st of September); the pontifical indiction on the calends of January. It is a date commonly employed in very ancient charters. The commencement of this computation is generally referred to the 1st of January of the year 313 of the common era; hence, by counting backwards, it will be found that the first year of our era corresponded to the fourth of one of the cycles of indiction. The year of indiction, corresponding to any other year of our era is found therefore by this rule:— Add 3 to the date, divide the sum by 15, and the remainder is the year of the indiction. The remainder 0 indicates the 15th of the cycle. Thus the year 1800 was the third of the indiction. See as to the historical commencement of the era of indictions, *Gibbon's Decline and Fall*, ii. 223. last ed. *Mem. de l'Acad. des Inscr.* vol. xli.

INDI'CTMENT, PROCESS BY. (Lat. indico, *I proclaim against.*) In Law, all persons, without exception, are liable to be arrested on a warrant of a justice of peace, if charged on suspicion with a crime; and some officers, as the sheriff or constable, have the power of apprehending without a warrant on some occasions. When the party is arrested and brought before a justice of peace, he is examined, and the information of those who came with him is taken; and the depositions of the witnesses, if taken down in the presence of the prisoner, are evidence against him on the trial. If the offence be bailable, the justice must then take sufficient bail on the part of the prisoner. If otherwise, he commits him to prison; and the witnesses are bound over to attend and give evidence, the king being in all cases the nominal prosecutor. The grand jury being summoned by the sheriff (at every session of the peace, commission of oyer and terminer and gaol delivery), consisting of not fewer than twelve nor more than twenty-three of the principal men of the county, receives the *indictment* or *presentment* (as it is also termed) preferred against the prisoner, and either *finds* or *ignores* it; returning it into court, in the first case, indorsed a *true bill;* in the latter, *not found.*

An indictment may be found in the absence of the prisoner; but cannot be tried unless he personally appears. The summons, when he is absent, in order to bring him into court, is by *capias;* and if he still abscond, he may be further pursued to outlawry. When the prisoner appears on this process, or voluntarily, or is brought up in custody, he is *arraigned;* that is, called before the bar to answer the indictment. If the prisoner refuse to answer (in which event he was subjected, in former days, to the famous *peine forte et dure*, by which it was intended to torture him into pleading, in order that the forfeiture of his goods might attach), a plea of not guilty is now recorded, and the trial proceeds; if he plead guilty, judgment is awarded. Otherwise he may plead — 1. To the jurisdiction; *i. e.* that the court before which he is arraigned is not competent to try the offence. 2. In abatement for misnomer; but the advantage of this plea is now taken away by 7 G. 4. 3. He may demur to the sufficiency in law of parts of the indictment. 4. He may plead one of the four special pleas in bar (former acquittal, former conviction, former attainder, and pardon). 5. He may plead not guilty of the crime alleged. If the prisoner plead not guilty, the fact of his guilt is forthwith tried on examination of witnesses by the petty jury. The nobility, it must be observed, are tried by their peers for treason or felony, and misprision of these crimes; but in other cases by a jury. The jurors are taken by the panel or list returned by the sheriff; and *criminal offences* are tried by the same common jurymen who try the issue of facts in civil cases in which a *special* jury has not been demanded. (*See* JURY.) The rules of evidence observed on the trial are mostly the same with those which prevail in civil actions. (*See* EVIDENCE.) One testimony, however, peculiar to this branch of law, is that of an accomplice; but it is considered essential that his testimony should be confirmed by other evidence. The verdict of the jury must in all cases be unanimous. After trial and conviction follows judgment, unless arrested by motion for that purpose, which it still may be on some exceptions to the indictment in point of law. Benefit of clergy, as it was termed, was usually prayed after conviction; and was held, in cases where not abolished by statute, to discharge the claimant from the capital part of the punishment. But this ancient privilege, which had long been founded on a mere fiction of law, was abolished by 7. G. 4. c. 36. Forfeiture of real property, absolutely, is a consequence of judgment in cases of high treason. The forfeiture of goods and chattels relates to, that is, takes effect upon, conviction; but fraudulent conveyances without consideration, in order to escape the forfeiture by the transfer of the property after or in contemplation of indictment, are void as against the king. The sentence of punishment pronounced or recorded on judgment is in some cases fixed and stated, so that the judges cannot modify the statutory penalty; in others (as in all offences at common law unregulated by statute), it is wholly or partly discretionary.

A criminal judgment may be reversed by writ of error for notorious mistakes and irregularities. A reprieve suspends the execution of a judgment: a pardon avoids the judgment altogether; and a pardon may be conditional on the prisoner's submitting to a substituted punishment, which is the ordinary mode of mitigating the severity of the law in capital felonies.

INDIGE'STION. *See* DYSPEPSIA.

INDI'GETES. The title of a class of Latin divinities, concerning the exact import of which there is some dispute; but it is probably most correctly referred to deified heroes, who became tutelary deities after death, according to the ancient mythology — as Romulus. The word is of very doubtful etymology.

I'NDIGO. A blue substance much used as a dye-stuff. The best indigo is obtained from an Asiatic and American plant, the *Indigofera*. The plant is bruised and fermented in vats of water, during which it deposits indigo in the form of a blue powder, which is collected and dried, so as to form the cubic cakes in which it usually occurs in commerce. Indigo is quite insoluble in water; when heated it yields a purple vapour, which condenses in the form of deep blue or purple acicular crystals. When indigo is exposed to the action of certain deoxidizing agents, it becomes soluble in alkaline solutions, losing its blue colour and forming a green solution, from which it is precipitated by the acids *white;* but it instantly becomes blue by exposure to air. This *white indigo* has been termed *indigogene*, and indigo appears to be its oxide. It is best obtained by mixing 3 parts of finely powdered and pure indigo with 4 of green vitriol, 5 of slaked quicklime, and 100 of water, repeatedly shaking the mixture. In about twenty-four hours the supernatant liquor, which is transparent, and of a green colour, is to be decanted off, and poured into dilute muriatic acid, when the deoxidized indigo is thrown down; but in order to prevent its absorbing oxygen and becoming blue, it must be most carefully excluded from the contact of air, which may be effected by syphoning it off into the acid, collecting it in vessels filled with hydrogen, and washing it with water deprived of air and holding in solution a little sulphate of ammonia. In this white state indigogene absorbs between 11 and 12 per cent. of oxygen to become blue indigo. It would appear from Dumas' experiments that indigogene is a compound of

	Atoms.		Equivalents.
Carbon - - -	45	=	270
Hydrogen - -	15	=	15
Nitrogen - - -	3	=	42
Oxygen - -	4	=	32
	1		359

and that indigo consists of 1 atom of indigogene = 359,

and 2 of oxygen = 16. The chemical equivalent of indigo, therefore, is 375.

When indigo is dissolved in concentrated sulphuric acid, it forms a deep blue liquid, known to the dyers by the name of *Saxon blue*. The great mart for indigo is Bengal, and he other provinces subject to the presidency of that name, from the 20th to the 30th deg. of N. lat.; but it is also cultivated, though not nearly to the same extent, in the province of Tinnevelly, under the Madras government in Java; in Luconia, the chief of the Philippine Islands; and in Guatemala and the Caraccas in central America. The following remarks, from the *Commercial Dictionary*, will exhibit the history of this now indispensable commodity, and the difficulties with which it had to contend before it obtained a permanent footing in the commerce of Europe. "It appears pretty certain that the culture of the indigo plant, and the preparation of the drug, have been practised in India from a very remote epoch. It has been questioned, indeed, whether the *indicum* mentioned by Pliny (*Hist. Nat.* lib. xxxv. c. 6.) was indigo; but, as it would seem, without any good reason. Pliny states that it was brought from India; that when diluted it produced an admirable mixture of blue and purple colours (*in diluendo misturam purpuræ cæruleique mirabilem reddit*); and he gives tests by which the genuine drug might be discriminated with sufficient precision. It is true that Pliny is egregiously mistaken as to the mode in which the drug was produced; but there are many examples in modern as well as ancient times to prove that the possession of an article brought from a distance implies no accurate knowledge of its nature, or of the processes followed in its manufacture. Beckmann (*Hist. of Inventions*, vol. iv. art. "Indigo") and Dr. Bancroft (*Permanent Colours*, vol. i. pp. 241—252.) have each investigated this subject with great learning and sagacity; and agree in the conclusion that the *indicum* of Pliny was real indigo, and not, as has been supposed, a drug prepared from the *isatis* or woad. At all events, there can be no question that indigo was imported into modern Europe, by way of Alexandria, previously to the discovery of the route to India by the Cape of Good Hope. When first introduced, it was customary to mix a little of it with woad to heighten and improve the colour of the latter; but, by degrees, the quantity of indigo was increased; and woad was, at last, entirely superseded. It is worth while, however, to remark, that indigo did not make its way into general use without encountering much opposition. The *growers of woad* prevailed on several governments to prohibit the use of indigo! In Germany, an imperial edict was published in 1654, prohibiting the use of indigo, or '*devil's dye*,' and directing great care to be taken to prevent its clandestine importation; 'because,' says the edict, 'the trade in woad is lessened, dyed articles injured, and money carried out of the country!' The magistrates of Nuremburg went further, and compelled the dyers of that city to take an oath once a year not to use indigo; which practice was continued down to a late period. In 1598, upon an urgent representation of the states of Languedoc, at the solicitation of the woad growers, the use of indigo was prohibited in that province; and it was not till 1737, that the dyers of France were left at liberty to dye with such articles, and in such a way, as they pleased." (*Beckmann*, vol. iv. p. 142.)

INDI′GOLITE. Blue *tourmalin*.

INDIGO′TIC A′CID. An acid obtained by boiling indigo in nitric acid diluted with an equal weight of water. It forms white crystals, very soluble in hot water, but very sparingly soluble in cold water. It consists, in the 100 parts, of 48·23 carbon, 2·76 hydrogen, 7·73 nitrogen, and 41·28 oxygen; or, according to Dumas, of 1 atom of indigogene = 359, and 30 atoms of oxygen = 240.

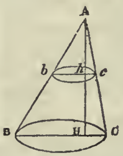
INDIVI′DUAL. (Lat. individuus.) In the Fine Arts, that which is proper or peculiar to a single object of a species.

INDIVI′SIBLES. Infinitely small quantities which admit of no further division.

In Algebra, the *method of indivisibles* is the name given to a peculiar species of calculus, invented by Cavalieri, a disciple of Galileo, and much used by mathematicians before the invention of the method of fluxions, or the differential and integral calculus; for which it prepared the way, and of which to a certain extent it supplied the place.

In the method of indivisibles lines are considered as composed of an infinite number of points, surfaces as composed of an infinite number of lines, and solids of an infinite number of surfaces. These hypotheses are no doubt inconsistent with the rigorous exactness of the ancient geometry, and, taken in the strict sense of the terms, absurd; for lines, however they may be multiplied, can never compose a surface, or any thing else than linear magnitude; nor can surfaces, however they may be added together, compose a solid, or any thing but an area. Nevertheless, inaccurate as these ideas are, the conclusions deduced from them are strictly correct; and they afford, in numerous cases, a means of obtaining readily and easily what could only be found by a very long and troublesome process in following the ancient and rigorous method of exhaustions. In fact, the objections apply rather to the manner in which the hypotheses are stated than to the method itself, which, in reality, is merely a formula of abbreviation, extremely useful as a means of avoiding the tediousness of the method of exhaustion without diminishing in any way the accuracy of the results. Its purpose is to give at once the result of an infinite series of successive approximations; and, as is remarked by Professor Playfair, nothing perhaps more ingenious, and certainly nothing more happy, ever was contrived, than to arrive at the conclusion of all these approximations without going through the approximations themselves.

As an example, — Let it be proposed to determine the volume of a cone. From A, the vertex of the cone, let a perpendicular A H be drawn to its base. Conceive this perpendicular to be divided into an infinite number of equal parts, and through each of the points of division a plane to pass parallel to the base of the cone; according to the principles of the method of indivisibles, each of these planes, as $b\,c$, limited by its intersection with the surface of the cone, will be one of the elements of the volume of the cone, and the whole volume will be the sum of all these elements.



Now, by the properties of the cone these elements are to each other as the squares of their distances from the vertex; therefore, taking A to represent the area of the base of the cone B C, a the area of the plane $b\,c$, H the height A H, and h the height A h, we have $A : a :: H^2 : h^2$; whence $a = \frac{A}{H^2} h^2$. Now, if we make V = the sum of these elements, or the volume of the cone, it is evident that we have V equal to the constant $\frac{A}{H^2}$ multiplied by the sum of the squares h^2. But the distances h increase as the series of natural numbers from nothing to H; consequently the quantities h^2 represent the squares of those numbers from 0 to H^2. Now it is known that the sum of the squares of the natural numbers, from 0 to H^2 inclusive, is

$$\frac{2\,H^3 + 3\,H^2 + H}{6};$$

but in the present case the number H being supposed infinite, all the terms in the numerator after the first will be infinitely small in comparison of the first, and ought therefore to be rejected; whence the sum of all these squares is reduced to $\frac{1}{3}H^3$. Multiply, therefore, this value by the constant $\frac{A}{H^2}$ found above, we have for the volume of the cone $V = \frac{1}{3}A\,H$; that is to say, the volume of the cone is equal to the product of its base by a third of its altitude.

In a smilar manner the areas of innumerable curves, and the cubature of many solids, are found without difficulty. It was in this way that Torricelli, or Roberval, found the quadrature of the cycloid, — a problem of great celebrity among the early mathematicians. The work of Cavalieri, *Geometria Indivisibilibus continuorum nova quadam ratione promota*, was published at Bologna in 1653; but he had treated of the subject in a previous work, *Exercitationes Geometricæ Sex*, published in 1647.

INDU′CEMENT. In Law, a term used specially in various cases to signify a statement of facts alleged by way of previous explanation or introduction to other material facts. Averments which are mere inducement need not be proved so precisely as others.

INDU′CTION (Lat. *in*, and duco, *I lead*), the counter-process in scientific method to deduction, implies the raising individuals into generals, and those into still higher generalities; deduction being the *bringing down* of universals to lower genera or to individuals. Every deduction, therefore, to be valid, must rest on a prior induction, which, in order that we may obtain logical certainty, must be a *complete* induction; that is to say, must include *all* the individuals which constitute the genus. This, it is evident, is impossible, so long as we assume the only power necessary to induction to be the observation of particulars; for these are infinite in number: we can never be sure that we have observed them all. We are therefore compelled, if we are to admit the possibility of science properly so called, to allow the necessity of some spontaneous action of the understanding in every inductive process; of a faculty, in short, which takes occasion from experience to arrive at the knowledge of truths not contained in that experience. Philosophers differ widely in the language under which they convey their belief of this truth. Had the thing itself, however, been more distinctly borne in mind, we should have been saved much useless obscurity; in particular, we should

have escaped that altogether futile distinction made by logicians between "perfect and imperfect induction." All the certainty that can be obtained in physics is a hypothetical certainty, founded on our belief that the course of nature is uniform; but as regards the form of our reasoning, which is all that the logician contemplates, that remains the same whether the certainty be real or assumed. (See for valuable accounts of the Baconian system of induction, *Playfair's Introductory Essay to the Enc. Brit.*; and *Hallam on the Literature of Europe*, vol. iii.)

INDU'CTION. In Electricity, when one electrified substance is opposed to another, the latter acquires, under certain circumstances, an opposite electric state upon the surface opposed to the inducing body, and is rendered electro-polar. *See* ELECTRICITY.

INDU'LGENCE. (Lat.) A power claimed by the Roman Catholic church of granting to its contrite members remission for a certain term, either on earth or in purgatory, of the penalty incurred by their transgressions. The practice was first instituted in the eleventh century by Popes Gregory VII., Victor, and Urban II., as a recompence to those who embarked in the perilous enterprise of the Crusades; but its benefits in process of time extended to all who, either by donations or other services, contributed to the wellbeing of the church. It was the profligate sale of indulgences that first excited Luther to commence his warfare against the see of Rome; and although the traffic in indulgences has been reprobated by many councils, and some minor corruptions have been partially reformed, still the Council of Trent decreed the usefulness and validity of such instruments, and left the whole control of their nature and manner of issuing them entirely in the discretion of the pope for the time being. (For an elaborate exposition of this subject, see the *Bibliothèque Sacrée*, article "Indulgence;" also *Mosheim*, iii. 83. translation.)

INDUME'NTUM. (Lat. induo, *I put on.*) In Zoology, the term is restricted in its signification to the plumage of birds. This consists of the peculiar epidermic organs called feathers and down, with sometimes a scanty admixture of hair. (The description of the component parts of plumage is given under the head of FEATHERS.) The plumage is generally more than once changed before it attains that state which is characteristic of the fully mature bird. The period during which these mutations are proceeding varies from one to five years, and many birds rear a progeny before they acquire the plumage of maturity. When the indumentum of the male bird differs in colour from that of the female, the young birds of both sexes resemble the latter in their first plumage; but when both the adult male and female are of the same colour, the young have then a plumage peculiar to themselves. In some species the adult birds have a plumage during the breeding season decidedly different in colour from that which they bear in winter: in these cases the young birds differ in colour from both parents, and have a plumage which is intermediate in its general tone to that of the two periodical states of the parent birds, and bearing indications of the colours to be afterwards attained at either period.

The changes in the colour of the plumage of birds are effected either by a total moult of the old and acquisition of new feathers; or by a partial moult, and the admixture of new feathers with a certain proportion of the previous plumage; or on the bird's obtaining a certain number of new feathers without shedding any of the old ones; or, lastly, by the fully formed feather itself becoming altered in colour: the last two changes take place in the adult birds at the approach of the breeding season. The change of colour of a fully developed feather is produced either mechanically by the wearing away of the lighter coloured tips, which exposes the brighter tints of the plumage beneath, or by some internal chemical or vital influence upon the colouring matter of the feather itself: the latter change begins at that part of the web nearest the body of the bird, and gradually extends outwards till it pervades the whole feather.

INDU'SIAL LIMESTONE. A fresh-water limestone found in Auvergne, abounding in the indusiæ or cases of the larvæ of *Phrygania*, great heaps of which have been encrusted by hard travertin and formed into rock.

INDU'SIUM. (Lat. induo.) A cup that surrounds the stigma of Goodeniaceous and some other plants; it is also the name of the membrane that covers the thecæ in Dorsiferous ferns.

INDU'VIÆ. (Lat.) The withered remains of leaves that not being articulated with the stem cannot fall off; the part covered by them is said to be *induviate*.

INEQUA'LITY, in Astronomy, is applied to any deviation in the motion of a planet or satellite from its uniform mean motion.

INE'RTES. (Lat. iners, *slothful.*) The name of an order of birds in the ornithological system of Temminck, including the *dodo* and *apteryx*.

INE'RTIA. (Lat. iners.) This term is used to denote the principle or law of the material world that all bodies are absolutely passive or indifferent to a state of rest or motion, and would continue for ever at rest, or persevere in the same uniform and rectilinear motion, unless disturbed by the action of some extrinsic force. The ancients attributed to matter a certain inaptitude, reluctance, or renitency to motion; but that a body in motion required the operation of an extrinsic cause to bring it to rest was first discovered by Galileo. Kepler, conceiving the disposition of a body to maintain its motion as indicating an exertion of power, prefixed the word *vis*; and the compound expression, *vis inertia*, though less accurate, has been generally retained. Inertia is one of the inherent properties of matter, and unceasingly recalled to our observation in every incident of life.

INESCU'TCHEON. In Heraldry, a species of ordinary, being an escutcheon placed upon the fess point (*see* FESS); and containing, it is said, the third part when charged, the fifth when otherwise. All escutcheons borne within escutcheons are by some heralds called by this name.

IN ESSE. (Lat.) A term applied to things actually existing. A difference is made by authors between *in esse* and *in posse*: the latter being applied to things that are not, but may be; the former being said of things actually apparent and visible.

I'NFANT. In Law, a person under twenty-one years of age. He is not considered in law as having sufficient ability to contract, and is protected from his own improvidence and the artifices of designing persons by his not being liable for any engagements into which he may have entered, except for necessaries suited to his condition in life. His contracts, however, are not absolutely void, but only voidable; and though they cannot be enforced against him, yet he may, if he do not choose to avoid them, enforce them against another, and may always confirm them on the termination of his minority. He is in general responsible in damages for torts committed by him, as for slander or assault. His responsibility for crimes varies according to his age and discretion: under seven years of age he cannot be guilty of felony; between seven and fourteen a presumption arises that he is doli incapax; but this presumption may be repelled by proof that he could plainly distinguish between good and evil, and he may then suffer death as a felon; and after fourteen he is in general as amenable to punishment as a person of full age.

His disabilities, many of which are in the nature of privileges, and established for his protection, are numerous: he cannot fill any office connected with the administration of justice, or sit in parliament; he cannot be an executor, nor appear in court by attorney. The consent of parents or guardians, or of the Court of Chancery, is requisite to his marriage.

I'NFANTE, INFANTA. The titles borne by the younger sons and the daughters of a king of Spain, the eldest son being styled Prince of Asturias. It is found in a document of the year 999, applied to the sons of King Veremond II. It appears, however, to have been anciently given to all hidalgos. (*Quart. Rev.* vol. lxii. p. 104., where the reader is referred to the Ley de Partidas, 1, 2.) The word "childe" was similarly used in England in the middle ages.

INFA'NTICIDE, or CHILD-MURDER, by the law of England is placed upon the same footing with other homicide. By 9 G. 4. c. 41. s. 14. a woman indicted for murder of her child may, if acquitted of the murder, be convicted of the misdemeanour of secreting the body of the child to conceal its birth. To administer poison, or use other means to procure the miscarriage of a woman great with child, is a capital felony by the same statute (c. 14.). The exposure of new-born infants, especially females, is a common practice among many savage nations at the present day, and especially prevalent among the Chinese. According to Lord Macartney, the number of infanticides committed in Pekin alone exceeds 20,000 a year; but it is to be hoped that this calculation is highly exaggerated.

I'NFANTRY. The general name for soldiers who serve on foot. The term is in all probability derived from the Italian word *fante*, signifying a child or young person; and was originally conferred on the young Italian peasantry, who served in the wars on foot, the nobles being usually mounted. There are, however, various other accounts of the origin of the term. Among the ancient Greeks and Romans, the infantry constituted the chief strength of an army; and, with the exception of that period in European history during which the institutions of chivalry prevailed, when the tournament with its gay appendages engaged the attention of all the powerful nobles and otherwise distinguished persons, who thus imparted to the *cavalry* a factitious importance, it has generally been regarded as the principal military arm. Since the institution of standing armies this has been peculiarly the case. From the period of the Conquest down to the reign of Henry VIII., the infantry of

this country consisted of the inferior vassals of the feudal tenants, and from the cause above referred to was neglected both in discipline and accoutrements; but the connection of that monarch with Charles V. of Germany and Francis I. of France, whose rivalry in arms had introduced great improvements into this arm, was the means of directing attention to the defects of the English infantry, and paved the way for the introduction of that system of discipline which after the lapse of three centuries has now brought it to perfection. The British army comprises, exclusively of the militia, artillery, engineers, and marines, 99 regiments of regular infantry, three regiments of foot guards; besides a rifle brigade, two West India regiments, and the Ceylon rifle regiment. *See* ARMY, and the authorities there referred to.

INFE'CTION. *See* CONTAGION.

INFE'RIÆ. (Lat.) Sacrifices offered by the Greeks and Romans to the Dii Manes, or the souls of deceased heroes, or any person whose memory was held in veneration. These sacrifices consisted of almost every kind of offering, and were instituted on the ninth and thirtieth days after interment. They are supposed by some writers to have been the origin of the exequies (quod vide) of the Roman Catholic church.

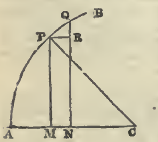
INFE'RIOR. A term given to a calyx that is distinct from the ovarium, as in *silene;* or to an ovary that adheres to the calyx, as in the myrtle. It is a bad expression, though commonly employed, for which the French school have substituted the words nonadherent and adherent.

I'NFERO-BRANCHIA'TA. (Lat. inferus, *lower;* Gr. *βραγχια, gills.*) An order of Gastropods, characterized by the position of the gills, which are situated beneath the produced margin of the mantle; they consist of two long series of leaf-shaped vascular organs. This order comprehends, in the system of Cuvier, two genera, *Phyllidia* and *Diphyllidia.*

I'NFIDEL. (Lat.) A term applied to such persons as are not baptized, or do not believe in the Christian religion. *See* DEIST.

I'NFINITE. (Lat. infinitus, *boundless.*) In Geometry, an infinite quantity is properly that which is greater than any assignable magnitude; and as no such quantities exist in nature, it follows that an infinite quantity is merely an abstraction of the mind, formed by excluding the idea of limit or boundary. An *infinitely small quantity* is a quantity considered as less than any assignable magnitude. There is, however, a peculiar signification attached to this expression in mathematical language, which has frequently been misunderstood. Infinitely small quantities are not absolute zeros, or even quantities actually less than certain determinate magnitudes; they are merely quantities which the conditions of the proposed question permit to be regarded as variable until the calculation is entirely completed, and as diminishing continually until they become as small as we please, without its being necessary to change the values of those quantities of which the relation is sought. It is in this circumstance only that the peculiar character of what are called infinitely small quantities consists, and not in the *littleness* which their denomination seems to imply, or in the absolute nullity which may be attributed to them.

INFINITE'SIMAL. In Geometry and Analysis, an infinitely small quantity; that is to say, a quantity which is less than any assignable magnitude. The *infinitesimal analysis* is the art of employing infinitesimal quantities as auxiliaries, in order to discover the relations which exist among the proposed quantities. It differs from the differential calculus, or the method of fluxions, only in respect of its metaphysical principles; the analytical processes are precisely the same in both. In the theory of infinitesimals, a curve is regarded as a polygon of an infinite number of sides, any one of which represents the arc. Thus, let P Q be one of those sides; then P Q is the hypothenuse of a right-angled triangle, of which the sides P R and R Q are the differentials of the co-ordinates A M and M P, or of x and y. Hence, making P Q $= dz$, we have $dz^2 = dx^2 + dy^2$. On the same principle, if s denote the infinitely small element of the area, or the space M P Q N, we shall have $ds = ydx + \frac{1}{2}\,dy\,dx$ (for M P Q N $=$ M P R N $+$ P Q R $=$ M P $\cdot$ M N $+ \frac{1}{2}$ Q R $\cdot$ P R). But the second part of this expression, namely, $\frac{1}{2}\,dy\,dx$, is an infinitesimal of the *second order*, being the product of two infinitely small quantities, and therefore infinitely smaller than $y\,dx$, which is an infinitesimal of the first order. The part $\frac{1}{2}\,dy\,dx$ must therefore be omitted, being of no value in comparison of the quantity to which it is added and we have consequently $ds = y\,dx$. The elemental triangle P Q R also shows at once the differential values of the trigonometrical lines. Thus, supposing the curve A B to be a circle whose centre is C, then the radius C P being unity, and the arc A P being denoted by z, we have 1 : cos. z : : P Q : Q R : : dz : d sin. z; whence d sin. $z =$ cos. $z\,dz$. Again, 1 : sin. z : : P Q : P R : : dz : $-\,d$ cos. z; therefore d cos. $z = -$ sin. $z\,dz$.



The theory of infinitesimals affords very great facilities in the application of the calculus to the higher geometry, and especially in the doctrines of physics. Whatever view may be taken of the principles, the results, if deduced by correct reasoning, are rigorously accurate; and the mathematician will scarcely be restrained by metaphysical considerations from attempting to reach his object in the shortest way, which, in very numerous applications of the calculus, is by the infinitesimal method.

INFI'NITIVE MOOD. In Grammar, that inflexion of the verb which expresses the conception merely, without affirming or denying it, of any subject. *See* GRAMMAR.

INFI'NITY. *See* INFINITE.

INFI'RMARY. (Lat. infirmus, *weak.*) An hospital for the reception of the sick poor, either supported by the public, or endowed by benevolent persons with funds to defray the necessary expense. Establishments bearing this name are not uncommon in all considerable towns of the British empire. *See* HOSPITAL.

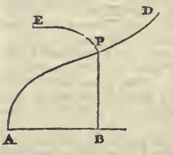
INFLAMMA'TION. In Pathology, this term is applied to redness and heat of some part of the body, attended by pain and swelling: the vascular action of the part is increased; and if it does not subside or terminate in *resolution*, it produces three different effects, which, where they take place healthily, follow each other in regular order. These are, 1. adhesion; 2. suppuration; 3. ulceration.

I'NFLEXED. (Lat. inflecto, *I bend.*) In Zoology, when a part is bent inwards.

INFLE'XION, in Grammar, in strictness of language, is any change which takes place in a word from a modification of its sense between the *root* and the *termination.* The inflexion must therefore not be confounded with the termination itself. Thus the syllable *am* is the root of all the words employed in the conjugation of the Latin verb amo, *I love;* in the imperfect tense, the inflexion is the syllable *ab*. The termination varies according to the person; amabam, amabas, amabat.

INFLE'XION. In Optics, the same as *diffraction;* or that property of light by reason of which, when it passes very near the borders of an opaque body, it is turned from its rectilinear course. *See* DIFFRACTION and LIGHT.

Point of inflexion, in Geometry, is that point of a curve line where the curvature in relation to the axis changes from concave to convex, or from convex to concave. The same point is also called the point of *contrary flexure;* and if the direction changes suddenly with relation to the ordinate as well as the absciss, the point becomes a *point of regression.* Thus, let A P be a curve which from A to P is concave towards the axis A B, and from P to D convex towards the axis; the point P, at which it passes from concave to convex, is the *point of inflexion;* and if the curve at P is turned backwards as P E, the P is the point of regression. The determination of these points is attended with no difficulty, and the method of determining them will be obvious from the following considerations. When a curve is concave to the axis, the differential of the ordinate (that of the absciss being supposed constant) decreases; consequently the second differential, or $d^2\,y$, is negative. On the contrary, when the curve is convex to the axis, dy increases, and d^2y is positive. At the point, therefore, at which the curvature changes from concave to convex, d^2y changes its sign; but as no variable quantity can change its sign without becoming nothing or infinite in relation to its former magnitude, it follows that at the point of inflexion, or regression, $d^2y = 0$ or infinity. Hence to find the point of inflexion in any given curve, it is only necessary to find from the equation of the curve the value of $\frac{d^2y}{dx^2}$; this value, made equal to 0 or infinity, will give an equation by which x is determined. This subject is treated at length in the work of Cramer, *Sur les Lignes Courbes;* also in Lacroix's *Calcul Differentiel et Integral;* and noticed in almost every work on the Differential Calculus.



INFLORE'SCENCE. (Lat. inflorescere, *to flourish.*) The general arrangement of the flowers upon a stem or branch. It consists of the following principal kinds: viz. the spike, the raceme, the panicle, the capitulum, the umbel, and the cyme; each of which is mentioned in its place.

INFLUE'NZA. (As if produced by the influence of the stars.) An epidemic *catarrh*, generally attended by languor, headach, quick pulse, and febrile symptoms, which often run very high, and assume a variety of aspects, dependent upon the season and other causes. The possibility of the existence of some highly poisonous and irritating vapour, though in very minute quantity, as the exciting cause of influenza, has been suggested by Dr. Prout. It may possibly be of volcanic origin; and such a

substance as selenluretted hydrogen, the effects of which, even in extremely minute quantity, are highly deleterious, might perhaps account for some of the phenomena of this extraordinary disease.

IN FO'RMA PAU'PERIS. In Law, a person is said to sue as a pauper, or *in forma pauperis*, when he takes advantage of the stat. 11 H. 7. c. 12., swearing himself not to be worth five pounds; in which case he is entitled to have original writs and subpœnas gratis, and attorney and counsel assigned him without fee, and is excused from paying costs when plaintiff. By misconduct, and under certain other circumstances. the party is dispaupered, and loses his privilege. He is capable of recovering costs, although not liable.

INFORMA'TION. In Law, an accusation exhibited against a defendant for some criminal offence; not on the oath of jurors, but on the special allegation of an officer empowered to exhibit it. Criminal informations are either partly at the suit of the king and partly at that of a subject, namely, such as are brought upon certain penal statutes at the suit of common informers; or wholly at the suit of the king. These are of two sorts: 1. those filed ex officio by the attorney-general, which is a proceeding resorted to in the case of some particular misdemeanours of a public nature, as libels and various other offences concerning the public government; and 2. informations filed at the suit of the master of the crown office, which lie for some gross and notorious misdemeanours, as riots, batteries, libels, &c., not immediately tending to disturb the government.

INFO'RMED STARS (Informes Stellæ), in Astronomy, are stars not included in any of the constellations. *See* CONSTELLATION.

I'NFRALAPSA'RIANS. In Ecclesiastical History, a sect of Presbyterians who maintain that God has created a certain number of human beings only to be damned, without allowing them the opportunity of salvation even if they chose to embrace it. They are thus designated because they hold that the decrees of God were formed *infra lapsum*, after his knowledge of the fall, and in consequence of it. *See* SUPRALAPSARIANS.

INFUSO'RIA. (Lat. infundo, *I pour in.*) A name applied by Otho Fr. Müller to an assemblage of microscopic animalcules which are for the most part developed in infusions of decayed animal and vegetable substances. Some of these minute organized beings were known to Linnæus, and were placed by him at the end of the class *Vermes*, in a genus which he denominated *Chaos*. Müller, who made the Infusoria a subject of special study, discovered numerous distinct genera and species, which he named and classified according to their outward form. Gmelin and Lamarck introduced Müller's discoveries and classification of the Infusoria into their systems without any particular modification. Cuvier, in 1829, observes, that "Naturalists usually close the catalogue of the animal kingdom with beings so extremely minute as to be invisible to the naked eye, and which have been discovered only since the invention of the microscope has unveiled to us, as it were, a new world. Most of them present a gelatinous body of the greatest simplicity, and for these this is undoubtedly the situation; but authors have placed among the Infusoria animals apparently much more complicated, and which only resemble them in their minuteness and the dwelling in which they are usually found." These higher-organized Infusoria were placed by Cuvier at the head of the class in a distinct order, under the name of *Rotiferes* or *Rotifera*, a name which has subsequently been retained. Cuvier attributes to these animalcules a mouth, a stomach, an intestine, and an anus; and notices the prominences on the anterior part of the body, which some observers had regarded as eyes. The anterior lobated organ and its vibratory denticulations, the successive action of which gives to the organ the appearance of a swiftly rotating wheel, forms the main external character of the order. Cuvier includes in the order *Rotatoria* the genera *Furcularia*, Lam.; *Vaginicola*, Lam.; *Tubicolaria*, Lam.; *Brachionus*, Müller.

The investigations of Ehrenberg, with the aid of a superior microscope to that of his predecessors, have brought to light many additional organs and complexities of structure in the *Rotifera*, besides several genera and species before unknown; and since these researches naturalists have generally regarded the *Rotifera* as a distinct class of Invertebrata, which Professor Grant has placed in the Articulate sub-kingdom, and Professor Owen in the *Nematoneura*, or higher division of Cuvier's Radiata. For the character, subdivision, and organization of the *Rotifera*, see that word.

The second order of Infusoria in Cuvier's system is denominated *Homogenea*; a term sufficiently expressive of the inadequate ideas current at that recent period respecting their organization. Cuvier says, "The body of the *Homogenea* presents neither viscera nor other complication, and is frequently destitute of even the appearance of a mouth." Ehrenberg has since shown that they have not only really a mouth, but that the greater part of the *Homogenea* of Cuvier possess a digestive cavity complicated with many cæcal pouches or stomachs; and accordingly proposes to name the order *Polygastrica*. Cuvier includes in his second order of Infusoria the genera *Urceolaria*, Lam.; *Trichoda*, *Leucophra*, *Kerona*, *Himantopus*, *Cercaria*, *Furcocerca*, *Vibrio*, *Proteus*, *Volvox*, and *Monas*. As the polygastric structure has not been detected in any species of *Cercaria*, but as, on the contrary, some species, as *Cercaria lemnæ*, possess a simple alimentary canal, this genus, together with the cercarial *Spermatozoa*, and the *Vibrionidæ*, which all possess a straight and simple alimentary canal, have been removed from the Infusoria, and classed by Mr. Owen with the Entozoa.

Thus the animals of infusions, although of comparatively simple organization, possessing neither a heart nor respiratory organs, yet manifest at least three distinct types of structure, and are referable to three different classes of animals.

Many genera of Infusoria are protected by an external siliceous case. The observations which Ehrenberg had made on the modifications of the form and surface of these cases of the existing Infusoria led to his capital discovery of their remains in a fossilized state. The mineral called *Polir-scheifer*, used for a long period in the arts for polishing metals and other substances, was first dicovered to be composed of myriads of the microscopic flinty cases of polygastric Infusoria belonging to the genera *Grilionclla*, *Bacillaria*, *Diatorna*, &c. Whole strata of considerable extent and thickness have since been found to consist almost exclusively of the fossil remains of Infusoria.

INGLU'VIES. (Lat. *a crop.*) The crop or dilatation of the œsophagus, in which the food is accumulated and macerated, but not digested. It is largest in the Gallinaceous birds and pigeons, but exists in certain birds of prey; also in the flamingo, and others.

I'NGOT. A word of doubtful origin, signifying chiefly the small masses or bars of gold and silver intended either for coining or exportation.

INGRO'SSING. *See* ENGROSSING, FORESTALLING.

INHA'BITANT. In Law, a word used in various technical senses. Thus a person having lands or tenements in his own possession is an inhabitant for the purpose of repair of bridges, wherever he may reside; but for purposes of personal services the "inhabitant" must necessarily be a resident. For the purpose of the poor rate, the word means a person residing permanently and sleeping in the parish. Where the right of voting is in "inhabitant" householders, a variety of divisions in committees of the House of Commons, in some instances conflicting, have taken place on the point. But it appears to be generally understood that an inhabitant is one who keeps a house in his own occupation, either personally residing in it, or having it occupied by servants and ready for his residence; having what is termed the "animus levertendi," or intention to return.

INHARMO'NICAL RELATION. In Music, that in which a dissonant sound is introduced.

INHE'RITANCE. In Law, an estate or real property which a man has to himself and his heirs, or the heirs of his body, &c., is termed a freehold of inheritance.

INHIBI'TION. (Lat. inhibeo, *I restrain.*) In Scottish Law, a species of diligence; *i. e.* process. It is a writ in the king's name, passing under the signet, whereby a debtor is prohibited from contracting any debt which may become a burden on his heritable property in competition with the creditor at whose instance the inhibition is taken out; and from granting any deed of alienation, &c., to the prejudice of the creditor. The heir of the debtor is not affected by the inhibition of his ancestor. Other species of inhibition are, that of a husband against his wife, intended to signify that her superintendence over domestic affairs has ceased, on which his liability for domestic expenditure contracted by her also ceases; and inhibition of tithes or teinds.

INHIBITION. In Ecclesiastical Law, a writ, commonly issuing out of a higher court Christian, to forbid an inferior judge from further proceeding in a cause before him; being analogous to a prohibition issuing out of one of the king's superior courts of justice.

INIS. An Irish word signifying island, used as a prefix to the names of some islands on the coast of Ireland, and of several towns situated on lakes or rivers in the same country; as Inisfallen, Iniskilling, &c.

INI'TIATIVE. (Lat. initium, *a beginning.*) In Politics. In legislative assemblies constituted so as to comprise more than one chamber, or more than one distinct and co-ordinate power, that branch of the legislature to which belongs of right the power to propose measures of a particular class is said to have the initiative with respect to those measures. Thus in England all propositions for taxing the subject, whether directly or indirectly, must begin in the Commons; a usage which has been adopted in most modern constitutions. On the other hand, there are some private bills which by custom originate in the Lords; and one bill, that, namely, for a

general pardon, is proposed in the first instance by the crown. In France, by the charter of 1830, the three branches of the constitution enjoy like privileges in proposing laws; but custom generally concedes the initiative to the Chamber of Peers, excepting in the case of money bills, which must, as in England, originate with the Chamber of Deputies.

INJU'NCTION, in Law, is a writ which issues under the seal of a court of equity. It is granted in various cases, where the court thinks fit to interfere on equitable grounds with the acts of parties, or with the course of other jurisdictions. Thus injunctions are granted under certain circumstances to stay proceedings at common law; to restrain the negotiation of notes and other securities; to restrain parties from the commission of waste; to preserve property which is in course of litigation, &c. Injunctions are also granted to direct parties to quit possession of lands, &c. after a decree. Disobedience to an injunction is punishable as a contempt of the court from which it issues.

INK. (Germ. dinte.) The colouring matter of common writing ink is the tannogallate of iron, which is suspended in water by gum arabic; a little logwood is generally added to deepen and improve the colour. A good writing ink is made as follows:—Take six ounces of finely bruised galls, four ounces of gum arabic, four ounces of green vitriol, and six pints of soft water. Boil the galls in the water; then add the other ingredients; and mixing the whole well together, keep it in a well-corked bottle, occasionally shaking it. In two months' time carefully pour off the ink from the residue into glass bottles, which should be well corked; a few cloves or a drop or two of creosote put into each bottle prevent moulding. The addition of a little sugar to ink gives it a gloss, and prevents its drying rapidly and perfectly; so that it is generally used in what is called *copying ink*, from the writing with which copies may be taken by pressure. *Indian ink* is a compound of very fine lampblack and size. It cannot, like common writing ink, be removed by acids; but as it does not bite or sink into the paper, it may generally be wiped off with a moist sponge. *Printing ink* is made with boiled linseed or nut oil and lampblack. *Red ink* is a solution of alum coloured with brazil wood. Boil two ounces of brazil wood, half an ounce of gum arabic, and a quarter of an ounce of alum in a pint of water for ten minutes; strain the decoction, and set it aside to clear. *Sympathetic inks* are compounds which when written with will remain invisible till heated: solutions of cobalt thus become blue or green, lemon juice turns brown, and a very dilute sulphuric acid blackens. *Marking ink* is made as follows: — Dissolve one drachm of lunar caustic (fused nitrate of silver) in half an ounce of water previously thickened with a little sap green: write with this upon the linen previously prepared for its reception by the application of a weak solution of carbonate of soda thickened with a little gum arabic, and suffered to dry upon the linen.

INLI'DANS, *Inlidæ*. The name of a family of Myriapods, having the inlus or gally-worm as the type.

I'NNOCENTS' DAY. In the Calendar, a festival celebrated on the 28th of December, in commemoration of the infants murdered by Herod.

INNO'MINATUM. (Lat. in, priv., and nomen, *a name; without a name.*) Each of the lower bones of the pelvis is called *os innominatum;* because the three bones of which it consists originally, namely, the *ischium*, the *ilium*, and the *pubis*, or the hip bone, the haunch bone, and the share bone, grow afterwards together so as to form what appears to be a single bone, which is thus left nameless.

INNS OF COURT. Four corporate societies established in London. Every candidate for the rank of barrister-at-law is obliged to be admitted a member of one of these societies, and submit to its regulations as a student. These are, — 1. the Inner Temple, to which three *Inns of Chancery* (Clifford's, Lyon's, and Clement's) belong; 2. the Middle Temple, with Strand Inn (no longer existing) and New Inn dependent on it; 3. Lincoln's Inn (with Furnival's and Thavie's Inns), Gray's Inn (with Staple's Inn and Bernard's Inn).

INNUE'NDO. (Lat. innuo, *I nod or beckon.*) In Law. In the old Latin forms of pleadings this term was used as a word of reference, when in relating the words of another party it was necessary to describe more particularly the person or thing meant by that party; as, for instance, in a declaration in action for slander, which is the most ordinary modern case of the employment of the innuendo, the plaintiff avers that the defendant said that "he," innuendo (meaning the plaintiff), was a thief, &c. Hence the use of the word "an innuendo" in ordinary language to signify a covert allusion.

INO'CULATION. The insertion of poisonous or infectious matter into any part of the body; but in this country the phrase is commonly used to signify the insertion of the virus of the common smallpox, the insertion of the virus of the cowpox being called *Vaccination*. Inoculation was introduced into general notice by Lady Mary Wortley Montague, whose son was inoculated at Constantinople about the year 1721, and whose daughter was the first who underwent the operation in this country. A milder disease is thus propagated than when it is received in the natural way. Inoculation is performed by inserting the point of a lancet armed with proper matter just under the cuticle, and afterwards gently rubbing the armed part over the pricked cuticle. *See* VACCINATION.

INO'CULATION OF GRASS LANDS. The ordinary method of turning a ploughed field into a meadow or pasture is by sowing it with grass seeds; but as this part of agriculture has hitherto been very ill understood, and the result of sowing grass seeds has frequently not answered the expectations of the sower, the practice of what is called *inoculation* has of late years been invented, though practised but in very few instances. This consists in preparing the soil as if it were to be sown down with grass seeds; but instead of sowing these on the surface, there are distributed over it small fragments of turf taken from the best old pasture land which the neighbourhood affords. These fragments may be about two or three inches square, and they are laid down on the surface at the rate of about one in every square foot. After they are deposited grass seeds mixed with clover are scattered over the surface, and the field is rolled to press down the the turf and press in the seeds. In consequence of the fragments of turf being placed on fresh soil, the grasses and other vegetables which they contain, if of the creeping kind, grow luxuriantly, and their stems cover the intervals between the fragments; but if the grasses which the fragments contain should not be of the creeping or stoloniferous kinds, it is evident that the intervals between them must chiefly depend for their grassy surface on the seeds which have been sown. On the whole, the inoculation of grass land may be considered as a needlessly expensive process, altogether unscientific, and unsuitable to the present advanced state of agriculture.

INO'RDINATE PROPORTION, in Geometry, is a proportion in which the terms are placed out of the regular order.

INOSCULA'TION. (Lat. inosculatio.) The union of vessels by conjunction of their extremities. This term is sometimes limited to the communication of trunks or large vessels with each other; and where the ramifications which unite are small or capillary, the vessels are said to *anastomose*.

I'NQUEST. In Law, an inquisition of jurors in causes, civil or criminal, when the facts are referred to their trial, being impanelled by the sheriff for that purpose. Also the persons to whom the trial of fact in any question, civil or criminal, is committed. An inquest of office, or inquisition, is an inquiry made by the king's officer, sheriff, coroner, &c., by virtue of their office, or by writ sent them for that purpose, or by persons acting under a special commission, to inquire concerning any matter which entitles the king to the possession of lands and tenements, or goods and chattels; as forfeiture for offences, wreck, treasure-trove, &c. The king's title in general commences on office found.

INQUISI'TION. The title given to a court armed with extensive criminal authority in various European countries; especially instituted to inquire into offences against the established religion. The first of these tribunals of faith was that established in the south of France after the conquest of the Albigeois in the 13th century. They were established in Spain in the middle of the same century, not without much opposition on the part of the bishops and secular clergy, who, in Castile, long maintained their exclusive spiritual jurisdiction. In 1840, the supreme general inquisition was founded at Seville by Queen Isabella, with the aid of the Cardinal Pedro Gonzalez de Mendoza. This great court, commonly known by the name of the Holy Office, had far more extensive authority than those local tribunals of the same name which had previously been established. Thomas de Torquemada, prior of a Dominican convent, was its first president, with the title of inquisitor-general. The process of the inquisition was widely different from that of all other courts of justice. The kings named the grand inquisitor, who appointed his assessors, some of whom were secular, but the greater part regular ecclesiastics: the counsellors were six or seven in number, of whom one, by the ordinance of Philip III., must be a Dominican. A party who was brought under cognizance of the court by secret accusation was immediately seized by its officers (termed officials or familiars), and his property put under sequestration. If the accused was fortunate enough to absent himself, and did not appear at the third summons, he was excommunicated, and in some cases burnt in effigy. The subsequent process of the court by imprisonment, secret examination, and torture, is well known. Penitent offenders were subjected to imprisonment, scourging, confiscation, and legal infamy. Those convicted, who were sentenced to death, were burnt at the Autos da Fe, which usually take place on some Sunday between Trinity and Advent. During the eighteenth century, the chief officers of the inquisition were for the most part men of intelligence and moderation, and its proceedings chiefly directed against parties guilty of such offences against

decency or religion as would have been punishable in most European countries, although not by an equally arbitrary process. But there were exceptions to this general character; and by the provincial courts of inquisition, of which Spain contained sixteen, some acts of barbarous injustice were committed. According to a common calculation, 340,000 persons had been punished by the inquisition from 1481 to 1808, of whom nearly 32,000 were burnt. In that year it was abolished by Napoleon. It was afterwards re-established by Ferdinand III. in 1814; but having been again abrogated by the Cortes in 1820, it has not been since reconstituted. In Portugal, the supreme court of inquisition was established in 1557. Its history in many respects resembles that of the Spanish court; but in the eighteenth century its power was greatly curtailed by ordinances which required a certain degree of publicity in its procedure. It was abolished by the Cortes of 1821. There were courts of inquisition in various southern provinces of France, the principal that of Languedoc, established at Toulouse, which was first founded after the war against the Albigeois; but their power was limited not long after their creation, and fell into desuetude long before their final abolition. In several Italian states courts of inquisition have been established; but the institution has never taken much hold on the sentiments or habits of the people of that country. It was restored at Rome by Pius VII. after the expulsion of the French, but had jurisdiction only over the faith and conduct of the clergy. Several well-known histories of the inquisition have been published, particularly that of Limbosch. The reader may also consult *Mosheim*, vol. iii.; *Prescott's Ferdinand and Isabella*; *Quart. Rev.* vol. lv.; *Llorente's Hist. of the Inquisition.*

INSANITY. *See* LUNACY, MADNESS.

INSCRI'BED FI'GURE. In Geometry, a circle is said to be inscribed in a triangle when it touches each of the three sides of the triangle. In like manner, it is inscribed in a polygon when it touches all the sides of the polygon. A triangle or polygon is inscribed in a circle when each of the angles of the figure stands on the periphery of the circle. It is a very obvious but remarkable property, that the area of a triangle is equal to the product of the radius of the inscribed circle into half the perimeter of the triangle.

INSCRI'PTION. In Numismatics, words placed in the middle of the reverse side of some coins and medals. *See* NUMISMATICS.

INSECTA. *See* ENTOMOLOGY.

INSECTI'VORA. (Lat. insecta, *insects*, and voro, *I devour.*) The name of a tribe of Zoophagous Mammals, comprehending those which live wholly or chiefly on insects; also of an order of birds in the ornithological system of Temminck.

INSE'RTED COLUMN. In Architecture, one standing, or appearing to stand, partly in a wall.

INSE'RTION, is a term employed in Botany to denote the manner in which one part grows out of another. It was invented at a time when the laws of vegetable structure were unknown, and it was supposed that bodies that really grow from each other were inserted into each other. Thus stamens said to be inserted into a calyx are in reality stamens that adhere to the sides of a calyx.

INSESSO'RES. (Lat. insideo, *I sit.*) A name by which Mr. Vigors has designated his second order of birds, including the *Passeres* and *Scansores* of Cuvier; and which C. Bonaparte applies to a primary division of birds in his *Systema Vertebratorum*, including the *Passeres*, *Scansores*, and *Accipitres* of Cuvier. As the term signifies those birds which perch, it is applicable to numerous species belonging to Linnæan and Cuvierian orders not yet included by later innovations under the term of Perchers or *Insessores.*

INSOLA'TION, or SCORCHING. A local disease of plants, attributable to exposure to too bright a light, which causes an excessively rapid evaporation, the effect of which is to kill the part in which the evaporation takes place.

INSO'LVENCY. In Law, the inability of an individual not engaged in trade to pay his debts. The insolvency of a trader is called Bankruptcy, which see. Several statutes have been enacted successively for the relief of insolvent debtors, by releasing them from imprisonment on surrender of the whole of their effects to their creditors. Their provisions were consolidated in the last general insolvent act (7 G. 4. c. 57.), and are now materially modified by the Act for abolishing Arrest on Mesne Process (1 & 2 Vict. c. 110.). The Insolvent Court consists of four commissioners and other officers; and is a court of record, with power to examine witnesses, compel attendance, &c. The courthouse is in London (Portugal-street); but single commissioners make circuits three times a year through England and Wales. The court proceeds upon petition from prisoners in actual custody; or, if the prisoner do not pray, on petition from a creditor. An order is then made vesting the prisoner's estate and effects in the provisional assignee of the court; which, however, is void if the petition be dismissed. The duty of the provisional assignee is to receive and dispose of the property, and account for the produce to the court. Other assignees are afterwards appointed by the court, in whom the property vests, who must formerly have been creditors; but this appears to be no longer necessary. The insolvent delivers into court a schedule, which must contain a full account of his property. The petition is then heard; and at the hearing creditors may oppose the discharge, and compel a full investigation of the prisoner's accounts. The court may order the discharge either forthwith, or may remand him for a discretionary period, but not exceeding three years, if any frauds or malpractices on his part with reference to the state of his affairs should be detected. The insolvent then executes a warrant of attorney for the amount of his debts which the distribution of his property is inadequate to cover, and other modes are provided by which his future property may be made available for his creditors. It has long been proposed, and is now under contemplation (1840), to unite the bankrupt and insolvent courts.

INSPIRA'TION. (Lat. in, and spiro, *I breathe.*) The act of drawing air into the lungs. *See* RESPIRATION.

INSPIRA'TION. *See* REVELATION.

INSTALLA'TION. (Modern Lat. in, and stallum, *a seat.*) A name applied to the ceremony of instating persons in honours or dignities; as a knight of the Garter in the chapel of St. George at Windsor; a chancellor in a university; or a dean, prebendary, or other ecclesiastical dignitary, in the stall of the cathedral to which he belongs.

I'NSTANT. (Lat.) A part of time or duration in which no succession is perceived. There are three kinds of instants distinguished by the schoolmen; a *temporary*, a *natural*, and a *rational* instant. The first is a part of time immediately preceding another; the second is what is otherwise termed a *priority of nature*, which obtains in things subordinated in acting, as first and second causes, or causes and their effects; and the third is not any real instant, but a point which the understanding conceives to have existed before some other instant, founded on the nature of the things which cause it to be conceived.

INSTA'NTIÆ CRUCIS. In Philosophy, *crucial* instances or examples; a phrase invented by the fancy of Bacon. The use of crucial examples or experiments is to facilitate the process of induction. For example, A and B, two different causes, may produce a certain number of similar effects; find some effect which the one produces and the other does not, and this will point out, as the direction-post at a point where two highways meet (crux), which of these causes may have been in operation in any particular instance. Thus, for example, many of the symptoms of the oriental plague are common to other diseases; but when the observer discovers the peculiar *bubo* or boil of the complaint, he has an *instantia crucis*, which directs him immediately to its discovery. (See, amongst other commentaries on Bacon, *Playfair's Introduction*, and *Ed. Rev.* vol. xxxvi.)

INSTINCT. *See* REASON.

I'NSTITUTE. The principal philosophical and literary society of France, formed in 1795 by the union of four academies. (*See* ACADEMY.) *Institute* is applied also to several works embodying the principles of Roman law; of these the chief are those of Justinian and Gaius.

INSTITU'TIONS. (Lat. instituo, *I instruct.*) In Literature, a term denoting originally a system of the elements or rules of any art or science, but signifying in a more comprehensive sense all associations formed for the improvement of society at large, or the parties immediately concerned, by whatever name they are designated, or to whatever object the labours of the members are directed. Institutions formed for the promotion of learning or science have been distinguished by the name of academies or societies, and associations constituted for commercial purposes are usually styled companies; while those formed for other purposes have various designations, or have some epithet prefixed descriptive of their character.

I'NSTRUMENT, MUSICAL. A musical instrument is one for the production of musical sounds, either by percussion, wind, the drawing a bow across strings, or the production of sound from the vibration of the strings by pulling or pinching them transversely, as in the harp or guitar.

I'NSULATED. (Lat. insula, *an island.*) In Architecture, a term implying that the building to which it is applied is detached from any other. Thus a church is said to be insulated when it adjoins no other building; so also a column is said to be insulated when standing out free from a wall; hence the columns of peripteral temples are insulated.

INSULA'TION. A body is said to be insulated which, containing a quantity of free caloric, or the electric fluid, is surrounded by non-conductors, and the communication with other bodies thereby cut off. *See* ELECTRICITY.

INSU'RANCE. A contract of indemnity, whereby the insurer, in consideration of a certain premium, undertakes

to indemnify the insured against loss arising by the occurring of a contingent event; such as the destruction of houses by fire, the loss of ships at sea, the failure of crops through the inclemency of the seasons.

Insurance is sometimes synonymously used with *assurance;* but the latter term is now more frequently applied to one particular class of contracts, namely, those which depend on the continuance or failure of human life, while *insurance* is applied to risks of all other kinds. For the explanation of the principles on which life assurances are calculated, see ASSURANCE.

In all cases of insurance, the first thing to be determined is the degree of probability that the event under consideration will take place; but it seldom if ever happens that this is known with any moderate degree of precision. Even in the commonest cases, it is perhaps altogether impossible to procure the data necessary for the accurate determination of this element. Suppose, for example, an insurance is to be effected on a ship bound on a voyage to China: in what manner is the probability of its reaching its destination in safety to be determined? Even if an accurate account had been kept of all the voyages made during a century, and the number of successful as well as the number of unsuccessful ones were precisely known, the data would still be very insufficient for determining the risk of the loss of any individual vessel. The loss of a ship is not a simple event like the turning up of a number on the face of a die. The greater or less prevalence of hurricanes at the season of the year when the voyage is to be made; the strength of the ship and sufficiency of its equipment; the skill of the commander, and the character and discipline of the crew,—are all elements materially affecting the risk, but which it is impossible to reduce to numerical values and precise calculation. All, therefore, that can be done is to adopt certain mean or average values, deduced from observations of the fate of vessels in circumstances not indeed precisely the same, but having some degree of similarity. To the insurer, if he sufficiently multiplies his adventures, the result will be the same in the long run as if he had a more accurate appreciation of the separate influences of which the probability of the safe arrival of a vessel at a given port is composed; but the evil which results from this deficient knowledge of facts is, that the owner of a good ship, by paying the same premium for insurance as the owner of a bad one, is charged for indemnification against a risk which he really does not run; and hence the motives for improving the construction of vessels are not only destroyed, but it even becomes an object of pecuniary interest to expend in their equipment nothing beyond what is necessary to give them that moderate degree of goodness or sea-worthiness which suffices to render them insurable on the ordinary terms. This system, however much it is to be deprecated, is rather advantageous than otherwise to the underwriters or insurers; because their premiums are charged in proportion, and it renders insurance more necessary: the pecuniary loss falls ultimately on the million who consume the merchandise; and as to the loss of human life, *that* consideration will probably operate as a check to cupidity only in so far as it may tend to raise the wages of seamen.

With respect to insurances against fire, the exact appreciation of the risk is not less difficult than in the case of marine insurances; but mathematical nicety on this subject is of little importance, for the amount of experience afforded by the general prevalence of the practice, and the competition which exists among the numerous rival companies, have probably had the effect of adjusting the premium to the average risk with all the accuracy which is practically attainable. The premium charged by the London offices for insuring property of the value of 100*l.* for a year is one shilling and sixpence, which corresponds to an average annual loss of nearly one in 1300; but it is to be observed that the sum which is charged as premium is presumed to be sufficient not only to cover the losses, but also to defray the expenses of the establishment, and to afford an adequate interest on the amount of the capital laid out or risked by the insurance company. Notwithstanding the extent to which the practice of insuring is now carried, it is probable that it would be still more general were it not for the circumstance that the government imposes a tax on the transaction of three shillings per annum for each 100*l.* insured, which is double the amount of the premium charged by the insurer. In 1837, the government duty on insurances amounted to 863,196*l.* 12*s.* 3*d.*, which supposes the value of the property insured in that year to have been upwards of 575 millions.

The characteristic property of insurances, of whatever nature, is their tendency to reduce to a certain average value the profits or advantages arising from all speculations of the same kind, however great the number may be. The gain which the insurer makes on his successful speculations indemnifies him for the loss he sustains by those which are unsuccessful; and to the insured the result is the same as if they had paid their premiums into a common fund, and agreed to make good to each other their individual losses. The insurers are only the intermediate agents of this supposed association, and their profits may be regarded simply as the salary of their functions. If other means exist of dividing the risks, insurance becomes unnecessary. A mercantile company employing a very great number of ships, or taking part in a very great number of enterprises, would derive no benefit from insurance. The loss on those which are unsuccessful is compensated by the premiums saved on the whole; in fact the company acts as insurer to itself. On this principle the government neither insures vessels belonging to the royal navy nor public buildings.

INTA'GLIO. (It. intagliare, *to cut in.*) In Sculpture and Gem Sculpture, a stone or gem in which the subject is hollowed out so that an impression from it would present the appearance of a bas relief.

I'NTEGER. (Lat. *entire.*) In Arithmetic, a whole number; as opposed to a fractional number, or a mixed number.

I'NTEGRAL CALCULUS. The branch of mathematical analysis which treats of the processes by which a function may be found such that its differential shall be a given quantity. By English writers this function used to be denominated the *fluent*, or *flowing quantity;* and the method of finding it was called the *inverse method of fluxions.* Foreign mathematicians, who adopted the views and notation of Leibnitz, have called it the *integral* or *sum* of the proposed differential; and this phraseology is now universally adopted by the mathematicians of our own country.

The method by which the integral of a proposed differential quantity is to be found is, generally speaking, neither obvious nor capable of being reduced to fixed and general rules. When an integral is proposed, its differential may always be found by general rules; but there is no direct method of returning from the differential to the integral: the analyst can only compare the differential expression which is to be integrated with the differentials of known quantities, and from such comparison infer the form of the corresponding integral. The principal art employed in the integral calculus consists in transforming the proposed functions into expressions which are known to be the differentials of given quantities.

In order to denote the integral of a quantity, the symbol $\int$ (originally S, the initial letter of the word *sum*) is employed. Thus $\int X\,dx$ denotes the integral of the differential $X\,dx$.

1. To begin with the simplest cases,—Let it be proposed to integrate the expression $x^m\,dx$, or to find the function denoted by $\int x^m\,dx$. It has been shown, under the term DIFFERENTIAL CALCULUS, that the differential of a quantity x^n is $n\,x^{n-1}dx$; that is to say, $d\,x^n = n\,x^{n-1}d\,x$. Let $n = m+1$, and this becomes $d\cdot x^{m+1} = (m+1)\,x^m\,dx$; whence we have $x^m\,dx = \frac{d\cdot x^{m+1}}{m+1}$; or, as the constant quantity $(m+1)$ does not affect the differentiation, $x^m\,dx = d\cdot\frac{x^{m+1}}{m+1}$. But as the integral of an expression $d\cdot P$ is evidently P, the equation gives, on integrating both members, $\int x^m\,dx = \frac{x^{m+1}}{m+1}$. From this we derive the following general rule for integrating a differential of one term: — Increase the exponent of the variable quantity by unity, and then divide by the new exponent and by dx.

It is necessary, however, to remark, that the integral thus formed may either be the expression from which the differential $x^m\,dx$ was derived, or it may be that expression increased or diminished by any constant quantity. For the differential of $a\,x^5$ being $5\,a\,x^4\,dx$, and of $a\,x^5+b$ being also $5\,a\,x^4\,dx$ (b being any constant quantity whatever); it follows that if we have to integrate the expression $5\,a\,x^4\,dx$, the integral will be incomplete, unless we add to it a quantity which though indeterminate does not change its value with the variation of x. We have, therefore, in general, $\int x^m\,dx = \frac{x^{m+1}}{m+1} + C$, where C is a quantity, positive or negative, the particular value of which remains to be determined by the nature of the problem under consideration. This quantity, C, which is necessary in order to complete the integral, was denominated by the older English writers *the correction of the fluent;* in the language of modern analysts, it is *the arbitrary constant.*

2. The differential of a polynomial being composed of the sum of the differentials of its terms taken separately, the integral of a polynomial is in like manner formed by adding into one sum the integrals of its component terms.

Thus,

$$\int (a\,dx + b\,x\,dx - c\,x^n\,dx) = a\,x + \tfrac{1}{2}\,b\,x^2 - \frac{c\,x^{n-1}}{n-1} + C;$$

and one constant is only necessary, for the sum of the constants which arise from the integration of the separate terms may evidently be represented by a single letter. In the same manner, the integral of a function having the form $(a + b\,x + c\,x^2)^n$ may be found when n is a whole positive number, it being only necessary to raise the root to the power denoted by n.

3. By the differential calculus, $d \cdot \log. x = \frac{d\,x}{x}$. When any differential expression, therefore, can be reduced to this form, its integral will be found by means of a logarithm. Thus, supposing it were required to find the integral of $\frac{a\,d\,x}{a + b\,x}$. Suppose $a + b\,x = z$, and we have $d\,x = \frac{d\,z}{b}$. Substitute this in the given expression, and we have $\frac{a\,d\,x}{a + b\,x} = \frac{a\,d\,z}{b\,z}$. But $\int \frac{a\,d\,z}{b\,z} = \frac{a}{b} \int \frac{d\,z}{z} = \frac{a}{b} \log. z + C$; which, on writing for z its value, becomes $\frac{a}{b} \log. (a + b\,x) + C$.

4. An extensive class of differential expressions, of very frequent occurrence in the solution of problems, is integrated by means of circular arcs. Let x be the sine of an arc z, we have then $x = \sin. z$; and by the differential calculus $d\,x = \cos. z\,d\,z$, whence $d\,z = \frac{d\,x}{\cos. z}$. But, by the properties of the trigonometrical lines, $\cos.^2 z + \sin.^2 z = 1$; whence $\cos. z = \sqrt{1 - \sin.^2 z}$, or $\cos. z = \sqrt{1 - x^2}$; consequently $d\,z = \frac{d\,x}{\sqrt{1 - x^2}}$. Transposing the terms of this equation and integrating, we find $\int \frac{d\,x}{\sqrt{1 - x^2}} = z + C$, z being an arc of which the sine is x. Whenever, therefore, an expression occurs of the form $\frac{d\,x}{\sqrt{1 - x^2}}$, we know that its integral, though it cannot be expressed generally in numbers when a numerical value is given to x, is represented by means of an arc of a circle. The expression $\frac{d\,x}{\sqrt{a^2 - x^2}}$ is reducible to the same form; for, on dividing the numerator and denominator by a, or $\sqrt{a^2}$, and making $\frac{x}{a} = u$, we get $\frac{d\,x}{\sqrt{a^2 - x^2}} = \frac{d\,u}{\sqrt{1 - u^2}}$; and $\int \frac{d\,u}{\sqrt{1 - u^2}}$ = arc of which the sine is u, or $\frac{x}{a}$. The constant C in the present case is zero, for the arc and its sine both vanish together.

Let us suppose, in the second place, $x = \cos. z$. By differentiating we find $d\,x = -\sin. z\,d\,z$; whence $d\,z = -\frac{d\,x}{\sin. z} = -\frac{d\,x}{\sqrt{1 - \cos.^2 z}} = -\frac{d\,x}{\sqrt{1 - x^2}}$. Transposing and integrating as before, $\int -\frac{d\,x}{\sqrt{1 - x^2}} = z + C$, z being the arc whose cosine is x. In this case, the constant C must be determined from this consideration that when the cosine of an arc is 0 the arc itself is equal to a quadrant. Supposing, then, $x = 0$, and consequently $\frac{d\,x}{\sqrt{1 - x^2}} = 0$, and denoting the semicircumference as usual by π, the integral becomes $0 = \frac{1}{2}\pi + C$; whence $C = -\frac{1}{2}\pi$. Substituting this value of π, we get $\int -\frac{d\,x}{\sqrt{1 - x^2}} = z - \frac{1}{2}\pi = -(\frac{1}{2}\pi - z)$.

Lastly, let us suppose $x = \text{tang.}\,z$. The differential of the tangent of an arc is equal to the differential of the arc divided by the square of the cosine. Hence $d\,x = \frac{d\,z}{\cos.^2 z}$; and therefore $d\,z = d\,x \cos.^2 z$. But $\cos. z = \frac{1}{\sec. z}$; whence $d\,z = \frac{d\,x}{\sec.^2 z} = \frac{d\,x}{1 + \tan.^2 z} = \frac{d\,x}{1 + x^2}$. Transposing and passing to the integral, we have $\int \frac{d\,x}{1 + x^2} = z + C$. In this case, as the arc and its tangent vanish together, $C = 0$; therefore $\int \frac{d\,x}{1 + x^2}$ = arc whose tangent is x.

To this form we may reduce the expression $\int \frac{d\,x}{a^2 + x^2}$. Divide the terms by a^2, and make $\frac{x}{a} = u$; it then becomes $\int \frac{1}{a} \cdot \frac{d\,u}{1 + u^2}$, or $\frac{1}{a} \int \frac{d\,u}{1 + u^2}$; whence $\int \frac{d\,x}{a^2 + x^2} = \frac{1}{a} \times$ arc whose tangent is $\frac{x}{a}$.

5. In transforming differential expressions into others of which the integrals are known, it is frequently very convenient to employ an artifice which is usually termed *integration by parts*. This consists in making an integral of the form $\int v\,d\,u$ depend on another of the form $\int u\,d\,v$. Thus, by the differential calculus, $d\,(u\,v) = u\,d\,v + v\,d\,u$; transposing and integrating, we get $\int u\,d\,v = u\,v - \int v\,d\,u$, which is the formula by which the artifice in question is accomplished. As an example, let it be proposed to find in this manner the integral $\int x^m\,d\,x$. Make $x^m = u$, and $d\,x = d\,v$; we have then $v = x$, $u\,v = x^m\,x = x^{m+1}$, $d\,u = m\,x^{m-1}\,d\,x$, and $v\,d\,u = m\,x^m\,d\,x$. Substituting these expressions in the formula $\int u\,d\,v = u\,v - \int v\,d\,u$, it becomes $\int x^m\,d\,x = x^{m+1} - \int m\,x^m\,d\,x$; whence (since $\int m\,x^m\,d\,x = m \int x^m\,d\,x$) we have by transposing $(1 + m) \int x^m\,d\,x = x^{m+1}$, and therefore $\int x^m\,d\,x = \frac{x^{m+1}}{1 + m}$, which is the same expression as was given above. It may be remarked, that by the use of this artifice the integral of the expression $x^m\,d\,x$ has been found by differentiating x^m, and making the substitutions ordinarily employed in common algebra.

Another method of integration consists in transforming the given expression into a series, and taking the integrals of the several terms separately. Let it be proposed, for example, to integrate by the method of series the expression $\frac{d\,x}{a + x}$, which is the differential of the logarithm of $(a + x)$. In the first place, $\frac{d\,x}{a + x} = \frac{1}{a + x} \times d\,x$; but on expanding $\frac{1}{a + x}$ into a series by division, we have

$$\frac{1}{a + x} = \frac{1}{a} - \frac{x}{a^2} + \frac{x^2}{a^3} - \frac{x^3}{a^4} + \&c.;$$

and multiplying both sides by $d\,x$, and integrating by the the rules already explained, we find

$$\int \frac{d\,x}{a + x} = \frac{x}{a} - \frac{x^2}{2\,a^2} + \frac{x^3}{3\,a^3} - \&c. + C:$$

that is to say,

$$\log. (a + x) = \frac{x}{a} - \frac{x^2}{2\,a^2} + \frac{x^3}{3\,a^3} - \&c. + C.$$

In order to determine the constant, suppose $x = 0$, and the expression becomes $\log. a = C$; whence, substituting this value of C,

$$\log. (a + x) = \log. a + \frac{x}{a} - \frac{x^2}{2\,a^2} + \frac{x^3}{3\,a^3} - \&c.;$$

a series by which the logarithm of one number may be found from another, when the difference between them is small in comparison of the latter number; or, which is the same thing, when the series converges with sufficient rapidity.

As a second example of this method, let the proposed differential be $\frac{d\,x}{1 + x^2}$, or $\frac{1}{1 + x^2} \times d\,x$. In this case we have

$$\frac{1}{1 + x^2} = 1 - x^2 + x^4 - x^6 + \&c.;$$

whence, multiplying by $d\,x$ and integrating the terms,

$$\int \frac{d\,x}{1 + x^2} = x - \frac{x^3}{3} + \frac{x^5}{5} - \frac{x^7}{7} + \&c. + C.$$

But $\frac{d\,x}{1 + x^2}$ is the differential of the arc whose tangent is x; therefore,

$$\text{arc (tan.} = x) = x - \frac{x^3}{3} + \frac{x^5}{5} - \frac{x^7}{7} + \&c. + C:$$

and as the arc and its tangent both vanish together, the constant C is in this case = 0.

The series which has now been found for the arc in terms of the tangent converges only when the tangent is less than radius, or when x is less than unit; but it may be put under a form which will be convergent when x is greater than unit, or the arc greater than 45°. Thus, the series

$$1 - x^2 + x^4 - x^6 + \&c.$$

was obtained by dividing 1 by $1 + x^2$; but if instead of dividing by $1 + x^2$, we divide by its equal $x^2 + 1$, we shall find

$$\frac{1}{x^2+1}=\frac{1}{x^2}-\frac{1}{x^4}+\frac{1}{x^6}-\frac{1}{x^8}+\&c.;$$

whence

$$\int\frac{dx}{x^2+1}=\int\left(\frac{1}{x^2}-\frac{1}{x^4}+\frac{1}{x^6}-\frac{1}{x^8}+\&c.\right)dx+C;$$

and on multiplying each term of the second member by dx and integrating,

$$\text{arc}\ (\tan.=x)=-\frac{1}{x}+\frac{1}{3x^3}-\frac{1}{5x^5}+\&c.+C.$$

In order to find the constant, we cannot in this case suppose $x=0$, for on this supposition the second member of the equation is infinite; but if we suppose $x=$ *infinity*, the arc becomes a quadrant, or $\frac{1}{2}\pi$, and the equation becomes

$$\tfrac{1}{2}\pi=0+C', \text{ or } 0=-\tfrac{1}{2}\pi+C;$$

and subtracting this equation from the former,

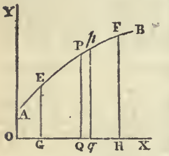
$$\text{arc}\ (\tan.=x)=\tfrac{1}{2}\pi-\frac{1}{x}+\frac{1}{3x^3}-\frac{1}{5x^5}+\&c.$$

which converges the more rapidly the greater we assume the value of x.

The preceding examples will give an idea of the method by which the primitive function is obtained from its differential; but the subject is of by far too extensive and abstruse a nature to be entered into at any length in this place. We shall therefore content ourselves with indicating some of the applications of the integral calculus to geometry.

One of the first objects to which the new calculus was applied by its inventors was the finding of the quadratures, or areas, of curve lines, and their rectification, or the determination of the lengths of their arcs.

Let A B be a curve referred to two rectangular co-ordinates O X and O Y; let E and F be given points in it; and let it be required to find the quadrature of the curvilinear space between E G and F H, the ordinates passing through E and F. Through P any point of the arc E F draw the ordinate P Q, and also $p\,q$ indefinitely near to P Q; then the space P Q $q\,p$ is the differential element of the area G E P Q, and the area itself is equal to the sum of all the differential elements taken between E G and F H. But by the principles of the differential calculus the space P Q $q\,p$ is ultimately (that is, when Q q is less than any assignable quantity) equal to the rectangle under P Q and Q q; therefore, making as usual O Q $=x$, P Q $=y$, and $s=$ the area, we have $ds=y\,dx$, and consequently the area $=s=\int y\,dx$. In order to apply this formula it is necessary, in the first place, to determine y in terms of x by means of the equation of the given curve.



Suppose the given curve to be the common Apollonian parabola, the equation of which is $y^2=a\,x$, a being a constant. From this equation $y=a^{\frac{1}{2}}x^{\frac{1}{2}}$, and consequently $y\,dx=a^{\frac{1}{2}}x^{\frac{1}{2}}dx$; whence, passing to the integral by means of the formula $\int x^m\,dx=\frac{x^{m+1}}{m+1}+C$, we obtain $\int a^{\frac{1}{2}}x^{\frac{1}{2}}dx=\frac{2}{3}a^{\frac{1}{2}}x^{\frac{3}{2}}+C$, which, on substituting for $a^{\frac{1}{2}}$ its value in terms of y, becomes $\frac{2}{3}y\,x+C$. This is the general expression for the area of the parabola; to determine it between the proposed limits we have only to substitute in it the values of x and y at those limits. At the point E it becomes $\frac{2}{3}$ O G · GE + C; and at the point F it becomes $\frac{2}{3}$ O H · H F + C. Subtracting, therefore, the first of these from the second we have the space G E F H $=\frac{2}{3}$ (O H · H F − O G · GE), the indeterminate C being eliminated by the subtraction.

From this example it is easy to see that the space represented by the integral $\int y\,dx$ is the increment which a certain area receives while the independent variable x passes from one state of magnitude to another; and that the absolute magnitude which represents the integral cannot be known before C is determined or eliminated as above. For the purpose of expressing the limits within which the integral is to be taken a particular notation is employed. Let O G $=k$, and O H $=l$; then it is usual to write

$$\text{area G E F H}=\int_l^k y\,dx,$$

to express that the integral includes all values of x, from $x=k$ to $x=l$. The one of these is the value of x at its commencement, the other at its completion; and the integral itself is an indeterminate quantity till the initial and final values of x are assigned.

The rectification of curve lines is another of the earliest applications of the integral calculus. To rectify a curve, signifies to find a straight line equal to its arc. According to the principles of the differential calculus, if z denote the arc of a curve, then $dz=\sqrt{d\,x^2+d\,y^2}$; consequently, if the value of $d\,y^2$ be found by means of the equation of any curve in terms of x (or that of $d\,x^2$ in terms of y) and substituted in this equation, the radical will contain only one variable, and when the expression is capable of being integrated the curve is rectifiable. It is, however, only in a comparatively small number of cases that the differential of the arc of a curve can be integrated in finite terms.

As an example, let us take the circle, the equation of which is $x^2+y^2=a^2$, reckoning the co-ordinates from the centre. From this equation $y=\sqrt{a^2-x^2}$, whence $dy=\frac{-x\,dx}{\sqrt{a^2-x^2}}$, $dx^2+dy^2=\frac{a^2\,dx^2}{a^2-x^2}$, and $dz=\frac{a\,dx}{\sqrt{a^2-x^2}}$. This expression cannot be integrated otherwise than by an infinite series. We have already seen that it is reducible to the form $\frac{dx}{\sqrt{1-x^2}}$. But the expression $\frac{1}{\sqrt{1-x^2}}$ expanded by the binomial theorem gives

$$1+\tfrac{1}{2}x^2+\frac{1\cdot3}{2\cdot4}x^4+\frac{1\cdot3\cdot5}{2\cdot4\cdot6}x^6+\&c.;$$

whence, multiplying by dx and integrating the terms separately,

$$\int\frac{dx}{\sqrt{1-x^2}}=x+\frac{x^3}{2\cdot3}+\frac{1\cdot3\,x^5}{2\cdot4\cdot5}+\frac{1\cdot3\cdot5\,x^7}{2\cdot4\cdot6\cdot7}+\&c.$$

Now, if in this series we write $\frac{x}{a}$ for x, and multiply the whole by a, we shall have

$$\int\frac{a\,dx}{\sqrt{a^2-x^2}}=x+\frac{x^3}{2\cdot3\,a^2}+\frac{1\cdot3\,x^5}{2\cdot4\cdot5\,a^4}+\frac{1\cdot3\cdot5\,x^7}{2\cdot4\cdot6\cdot7\,a^6}\&c.$$

for the length of the arc of the circle whose radius is a and absciss x. Suppose $x=a=1$; this series gives for the length of the quadrant

$$1+\frac{1}{2\cdot3}+\frac{1\cdot3}{2\cdot4\cdot5}+\frac{1\cdot3\cdot5}{2\cdot4\cdot6\cdot7}+\&c.$$

The quadrature and rectification of the circle are problems which have exercised the ingenuity of mathematicians ever since the invention of the science; but the solution neither of the one nor the other can be obtained in finite terms.

The application of the integral calculus to the determination of the volumes and surfaces of solids, is perfectly analogous to the determination of the areas and arcs of plane curves. Supposing the solid to be generated by the revolution of a plane curve about its axis, the expression for its volume is $\pi\int y^2\,dx$, where π is the semicircumference of the circle whose radius is unit. The expression for its surface is $2\,\pi\,y\sqrt{d\,x^2+d\,y^2}$. In these expressions the values of y^2, y, and $d\,y^2$ must be found in terms of x from the equation of the curve by the revolution of which the solid is formed; and when the values thus found are substituted, the formulæ will contain no other variable than x.

The integral calculus also affords the readiest, and, in general, the only means of determining the centres of gravity, of oscillation, gyration, &c.; and is, in fact, the instrument by which mathematicians have succeeded in solving the difficult and important questions of dynamics and physical astronomy, and in ascertaining the laws which regulate the motions of the material world.

As the integral calculus, with its various applications, embodies almost the whole of mathematical science, the treatises which have been composed to explain or illustrate its principles are by far too numerous to be mentioned in this place. Almost all the improvements of the calculus were first given in the form of Academical Memoirs. The great repositories in which it is contained are the writings of Newton, Cotes, Demoivre, the Bernoullis, Maclaurin, Simpson, Euler, D'Alembert, Lagrange, Laplace, Legendre, Monge, Poisson, Gauss, Ivory, &c. The best systematic treatises are Euler's *Calculus Integralis*, in 4 vols. 4to., now very scarce; and Lacroix's *Traité du Calcul Différentiél et du Calcul Intégral*, in 3 vols. 4to. Of the minor works we may mention Bossut's *Calcul Différentiél et Intégral;* Boucharlat; Lacroix's smaller treatise, translated by Babbage, Herschel, and Peacock; and the treatises which have recently been published at Cambridge, particularly those of Hymer, Peacock, Myers, Hind, &c.

INTEGRANT PARTS, in the Corpuscular Philosophy, are the small parts of a body, by the aggregation of which it may be conceived to be formed. *Integrant parts* result from the mechanical division of a body; *constituent parts* from its chemical decomposition.

I'NTELLECT. *See* UNDERSTANDING.

INTE'NDANT. (Lat. intendo, *I give my mind to any thing.*) A title in common use among the French,

applied to persons who have the conduct, inspection, and management of any office or function; as intendants of the marine, of the finances, of provinces, buildings, houses, &c., which are all self-explanatory terms.

INTE'NTIONS, FIRST AND SECOND. A distinction drawn by the schoolmen between those acts of thought which relate to an object out of the mind, and those which consist in the mind's reflex action on its own states of consciousness. Thus the generalizations *animal*, *production*, are *first intentions:* such terms as *abstraction*, *inference*, &c., are the expression of *second intentions*. It is to be regretted that this distinction is disused by modern inquirers, or misunderstood by them, as in particular by Whately. Great ambiguity might be avoided in philosophical language were it closely kept in view; as in such terms as *cause* and *effect*, which may either allude to a connection between natural phenomena in themselves, or to our mode of viewing them derived from the essential laws of the understanding. The distinction was first revived in the present century, in a learned and acute review of Whately's Logic contained in the 115th Number of the *Edinburgh Review*.

INTE'RCALARY DAY. (Lat. calo, *I call*. *See* CALENDAR.) In the Calendar, a day inserted out of the usual order to preserve the account of time. Thus every fourth year containing 366 days, while the other years contain only 365, one of the months in that year must have an additional day, which is called the intercalary day. The additional day was given to February, as being the shortest month, and in the ancient Roman calendar was inserted between the 24th and 25th days. In the ecclesiastical calendar it still retains that place; but in the civil calendar it is the 29th. *See* BISSEXTILE.

INTERCE'LLULAR PASSAGES, in Vegetable Anatomy, are the spaces that exist between the cells, tubes, or vessels of which the tissue of a plant consists. As the cells are usually, and the tubes or vessels are always round, it necessarily follows that when pressed together there will be spaces left between their sides.

I'NTERCOLU'MNIATION. (Lat. inter, *between*, and columna, *a column*.) In Architecture, the distance between two columns measured at the lower parts of their shafts. It is one of the most important elements in architecture, and on it depend the effect of the columns themselves, their proportion, and the harmony of an edifice. Intercolumniations are of five species, viz. Picnostylos, Systylos, Diastylos, Aræostylos, and Eustylos; under which several terms in this work they are defined, and to them the reader is referred.

I'NTERCO'STAL. (Lat. inter, and costa, *a rib*.) A term applied to muscles and vessels situated between the ribs.

I'NTERDICT. (Lat.) In Ecclesiastical History, a spiritual weapon by which the Popes used in former times to reduce individuals or whole states to the most abject submission to their power. In the middle ages it was the most terrible blow which could be inflicted on the people or the prince. When an interdict was laid upon a kingdom all spiritual services ceased; the churches were shut up; the sacraments were no longer administered; no corpses were buried with funeral rites; and all the ministry of the church which was then believed to be the only channel of salvation was forbidden to be exercised. The first memorable occasion on which this method of warfare was adopted was the marriage of King Robert of France with Bertha his cousin, when Gregory V. in 998 issued interdicts against the whole country, and compelled the sovereign to dissolve his union. It had, however, been often used before by bishops; an instance is quoted by Moreri as early as A.D. 870. (See *Gieseler's Text Book*, ii. 117., translation.) The ban under which England was laid in the reign of John by Innocent III. is well known in the history of this country. The latest pretensions to the exercise of this power were assumed by Pius VII., when he issued an inefficient decree against Napoleon in 1809.

INTERDICT. The technical term in Roman law for a decree of the prætor concerning the acquisition, retention, or recovery of property. For an elaborate article on this subject see the *Penny Cyclopædia*.

I'NTEREST. The premium or sum of money given for the loan or use of another sum of money, generally estimated at so much *per cent.*, or per 100*l.* The sum lent, and for which the interest is paid, is called the *principal*, and the sum charged as interest is called the *rate*. The rate will evidently be proportional to the time; for whatever interest is paid for the use of 100*l.* for one year, twice that interest will be required for the use of 100*l.* for two years. The principal added to the interest, or the whole sum paid back to the lender, is called the *amount*.

Interest is either *simple* or *compound*. *Simple interest* is that which is reckoned and allowed upon the principal only during the whole time of the loan; *compound interest* is reckoned not only on the principal sum lent, but also on the interest as it becomes due. It is convenient to treat of these separately.

1. *Simple Interest.* — Let us assume
a = the amount,
p = the principal sum lent,
n = the number of years for which it is lent,
r = the rate, or interest of 1*l.* for one year.

Now, the interest of 1*l.* for one year being r, the interest of p pounds for one year is $p\,r$, and for n years $p\,r\,n$. The amount, therefore, of p pounds for n years, at the rate r, is $p + p\,r\,n$; or, $a = p\,(1 + r\,n)$. From this equation we may determine any one of the four quantities in terms of the others. The four equations are as follow: —

$$a = p\,(1 + r\,n) = \text{the amount,}$$
$$p = \frac{a}{1 + r\,n} = \text{the principal,}$$
$$n = \frac{a - p}{p\,r} = \text{the time in years,}$$
$$r = \frac{a - p}{p\,n} = \text{the rate of interest.}$$

These formulæ suffice for the solution of all questions of simple interest. It is only necessary to observe, that when the time is less than a year, n is a fraction: for example, if the time is seven months, $n = \frac{7}{12}$; and if the time is 100 days, then $n = \frac{100}{365}$. If the rate of interest be 4 *per cent. per annum*, then $r = \cdot 04$; if the rate be 5 *per cent. per annum*, $r = \cdot 05$; and so on.

2. *Compound Interest.* — Though the law does not permit money to be lent at compound interest, yet in purchasing annuities, reversions, leases, &c., or effecting assurances on life, it is always allowed; the subject is therefore of considerable importance.

In order to show the manner in which any given sum increases at compound interest, let us suppose 100*l.* to be lent at the rate of 5 per cent. per annum. At the end of the first year this will amount to 105*l.* Now this 105*l.* may be regarded as a new principal lent out the second year at the same rate; its interest will therefore be 5*l.* 5*s.*; and consequently the amount at the end of the second year is 110*l.* 5*s.* This again may be regarded as a new principal; and in the same manner the amount at the end of the third year will be 115*l.* 15*s.* 3*d.*, and so on for any longer period. At simple interest the amount at the end of any given time will be greater, as the number of payments or times the interest is added to the principal is greater.

As before, let
a = the amount,
p = the principal,
n = the number of years,
r = the rate of interest.

Therefore, since 1*l.* amounts to $1 + r$ at the end of the first year, and as every other sum is increased in the same proportion, we have $1 : 1 + r :: 1 + r : (1 + r)^2$ = the amount of 1*l.* at the end of the second year. In like manner, we have $1 : 1 + r :: (1 + r)^2 : (1 + r)^3$ = the amount at the end of the third year, and so on. In general, the amount of 1*l.* at the end

of the 1st year $= 1 + r$
2d $= (1 + r)^2$
3d $= (1 + r)^3$
4th $= (1 + r)^4$
nth $= (1 + r)^n$.

The amount, therefore, of any principal p, at the end of n years, is $p\,(1 + r)^n$; and from this we derive the following formulæ for finding any one of the four quantities when the three others are given: —

$$a = p\,(1 + r)^n = \text{the amount,}$$
$$p = a\,(1 + r)^{-n} = \text{the principal,}$$
$$n = \frac{\log.\,a - \log.\,p}{\log.\,(1 + r)} = \text{the number of years,}$$
$$r = \left(\frac{a}{p}\right)^{\frac{1}{n}} - 1 = \text{the rate of interest.}$$

As an example, suppose it were required to find in how many years a sum of money lent at compound interest, at 5 per cent. per annum, would double itself. Here the quantity to be found is n, and we must apply the third formula. We have in the present case $a = 2\,p$, and $1 + r = 1{\cdot}05$; therefore, $n = \frac{\log.\,2\,p - \log.\,p}{\log.\,1{\cdot}05} = \frac{\log.\,2}{\log.\,1{\cdot}05} = \frac{3010300}{0211893} =$ 14·2067 nearly; therefore, at the rate of 5 per cent. per annum, any sum of money doubles itself in $14\frac{1}{5}$ years.

In the above formulæ the interest is supposed to be payable yearly, and r denotes the simple interest of 1*l.* for one year; but if the payments become due at different intervals from a year, then r will not be the *annual* rate of interest actually yielded by the principal, but the nominal rate which determines the amount of the first payment. For example, suppose the payments due half-yearly, and the nominal interest or simple interest for a year 5 per cent.; 100*l.* principal will produce 2*l.* 10*s.* of interest the first half year. But the interest the second half year being on 102*l.* 10*s.*, will be 2*l.* 11*s.* 3*d.*; so that

while the nominal interest is 5 per cent., the interest actually made in a year on 100*l.* is 5*l.* 1*s.* 3*d.*

The advantages arising from a sum of money put out to compound interest for shorter periods than a year may be determined as follows: — Suppose the payments to be made half-yearly; then each payment being half of the annual simple interest, the amount of 1*l.* at the end of the year will be expressed by $\left(1+\frac{r}{2}\right)^2$, which is equal to $1+r+\frac{r^2}{4}$. But the amount at a yearly payment is $1+r$; the advantage, therefore, of the half-yearly payment is $\frac{1}{4}$th of the square of r. If the payments of interest be supposed to be made quarterly, then the amount of 1*l.* at the end of the year will be expressed by $\left(1+\frac{r}{4}\right)^4=1+r+\frac{3r^2}{8}+\frac{r^3}{16}+\frac{r^4}{256}$, which exceeds the amount, when the payment is yearly, by $\frac{3r^2}{8}+\frac{r^3}{16}+\frac{r^4}{256}$, or by $\frac{3r^2}{8}$ nearly, the remaining terms being very small, and of scarcely any sensible value. Generally, if the interest is payable m times a year (each payment being the mth part of the annual simple interest), the amount of 1*l.* at the end of the year will be expressed by

$$\left(1+\frac{r}{m}\right)^m=1+r+\frac{m-1}{2m}r^2+\frac{(m-1)(m-2)}{2\cdot 3m^2}r^3+\frac{(m-1)(m-2)(m-3)}{2\cdot 3\cdot 4m^3}r^4+\&c.$$

As r is a small number, all the terms of this series multiplied by the cube and higher powers of r may be omitted, and the amount becomes $1+r+\frac{m-1}{2m}r^2$, which exceeds the amount when the payment is yearly by $\frac{m-1}{2m}r^2$. If we suppose m to be infinitely great, or the interest to become due and to be added to the principal *momently*, the series becomes

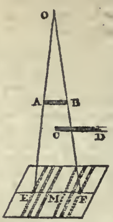
$$1+r+\frac{r^2}{1\cdot 2}+\frac{r^3}{1\cdot 2\cdot 3}+\frac{r^4}{1\cdot 2\cdot 3\cdot 4}+\&c.;$$

which is equal to the number whose Napierean logarithm is r, or the number whose logarithm is $r \times \cdot 4342945$ in the common tables. Suppose the rate to be 5 per cent., we have $\cdot 05 \times \cdot 4342945 = \cdot 0217147$, the natural number corresponding to which is 1·05127; consequently the amount of 100*l.* at 5 per cent., on the hypothesis of *momently* payments for a year, is 105·127*l.* = 105*l.* 2*s.* 6½*d.* nearly, exceeding the amount at simple interest only by 2*s.* 6½*d.*, which differs very little from $\frac{1}{2}r^2$.

INTERFE'RENCE. In Optics, a term first employed by Dr. Young to express certain phenomena which result from the mutual action of the rays of light on each other. The phenomena in question are considered of very great importance, and have accordingly been examined with great care, on account of the proof which they are supposed to give of the truth of the undulatory theory of light.

The phenomena may be thus explained: — Suppose two minute pencils of light, radiating from two different luminous points, to fall on the same spot of a screen or piece of paper, and making a small angle with each other. If the spot on which both pencils fall is at the same distance from both foci or luminous points, the intensity of the illumination is greater than would have been produced by either pencil alone. Now it has been found that there is a certain difference between the lengths of the paths at which the intensity of illumination produced by their concourse is the same as when the paths are equal. Call this difference d; then it is also found by experience that similar bright bands or fringes are produced when the difference between the lengths of the paths of the two pencils is $2d$, or $3d$, or $4d$, &c. But it is very remarkable that when the difference between the lengths of the two paths is $\frac{1}{2}d, \frac{3}{2}d, \frac{5}{2}d$, &c., the two pencils, instead of adding to each other's intensity, destroy one another, and produce a black spot or fringe. The two pencils thus act on each other, increasing the effect in one case and diminishing it in another; and it is this mutual action which is called *interference*.

In order to study the phenomena in detail, Dr. Young admitted a pencil of homogeneous light into a darkened chamber through a hole made with a fine needle in a sheet of paper, and observed at different distances the shadow of a thread or opake disc (the diameter of which did not exceed 1-30th of an inch) placed a little behind the opening. Having remarked that the shadow received on a screen was divided by parallel bands, of which that in the middle was always white, he proved that the bands were produced by the interference of the rays passing by the two sides of the thread or disc. This was demonstrated by intercepting the light which fell on one of the sides of the disc by means of a screen placed between the disc and shadow, and allowing it to pass freely by the other side, as represented in the annexed figure; in which O is the hole, A B the disc, E F its shadow, and C D the interposed screen, the border of which receives the shadow of the side B of the disc. The instant the screen is brought within the shadow of A B, all the fringes of the shadow immediately disappear, although the light inflected by the side of the disc A continues to follow the same route as before; which necessarily supposes that it receives some modification from the proximity of that which passes by the side B.



The field of inquiry which had thus been opened by the ingenuity of Dr. Young was explored to a much greater extent by Arago and Fresnel. Instead of the screen C D, Arago introduced the edge of a thin plate of glass into the shadow of the disc, and found that the luminous fringes received various modifications, according as the plate of glass was more or less thick. When the plate was of a certain thickness, the central fringe M was brought nearer to F, and the first dark fringe on the same side occupied the place which had before been occupied by the second; the second took the place of the third, and so on. On the other side of M the appearance was the reverse; the third fringe took the place of the second, the second of the first, and the first was brought into the middle of the spectrum at M. On using glass a little thicker, the displacement was doubled; the first fringe fell upon the place of the third, the second on that of the fourth, and so on. This experiment of Arago proves that the mutual action of the rays does not alone depend on a particular modification which the rays receive at the boundaries of a body which they graze in their course, but also on the different media which they traverse from their source to the point where they interfere.

Fresnel adopted a still more ingenious method of performing the experiment. Having placed two plane metallic mirrors in a vertical position, and so as to make a very obtuse angle with each other, he concentrated, by means of a lens of small focal length, a pencil of homogeneous light directed horizontally, at a point so situated before the mirrors that part of the diverging cone fell upon the one mirror and part of it upon the other. The rays of light reflected from the two surfaces being rendered convergent by the position of the mirrors, again met each other at a small angle; and at the point of intersection produced alternations of brilliant and dark fringes. These fringes are parallel to the line of intersection of the two mirrors, and on screening one of the mirrors they immediately disappear.

In the experiment of Dr. Young and Arago it might be supposed that the fringes were produced by some physical action of the interposed body on the light; but in Fresnel's experiment the light is reflected in the usual way, and no question can be raised about the influence of the body by the borders of which it passes. The fact is thus established beyond all doubt, that two rays of light, issuing from a common source, and after pursuing a different path meeting again under a small obliquity, exercise an influence on each other to the extent of doubling the intensity of the light on the one hand, or destroying it altogether on the other. The phenomenon of two rays of light neutralizing each other and producing their mutual extinction, is one of the most remarkable in the whole range of physical science. Though first explained by Dr. Young and established by the Arago and Fresnel, it had formerly been observed and described by Grimaldi.

The fact of the interference of the luminous rays having been established, it was interesting to determine the constant interval d, or difference between the lengths of the paths of the two pencils at which the greatest effect is produced. This interval has been very carefully determined both by Fresnel and by Fraunhofer, and is found to be different for the different colours. The following are values of d found by Fraunhofer for the different colours of the spectrum, expressed in decimals of an English inch: —

Red - - -	d = 0·00002582
Orange yellow - -	= 0·00002319
Green - - -	= 0·00002073
Blue - - -	= 0·00001912
Indigo - - -	= 0·00001692
Violet - - -	= 0·00001572

These values of d, being obtained by direct experiments, are independent of any hypothesis respecting the propagation of light: they are equally real, whether light be supposed to be emitted from a luminous body, or produced by the vibrations of an elastic medium; or rather they are numerical conditions which must be satisfied by any theory of light which may be adopted. But the phenomena of interference are scarcely susceptible of probable explanation by the theory of emission; whereas, if

we adopt the undulatory hypothesis, their explanation is remarkably simple. Indeed, they afford the most decisive reasons yet known for adopting that theory in preference to the other. According to the undulatory system, the phenomena are thus explained: —

If two luminous waves reach an ethereal molecule at the same instant of time, it will receive two simultaneous impulsions, and the resulting motion will be directed in the diagonal of the parallelogram of which the two sides represent the impulsions: consequently, if the component velocities are nearly in the same direction, the resultant will be nearly equal to their sum; and if they are in opposite directions, equal to their difference. Let us now suppose, 1st, that two vibratory movements produced by a series of equal and successive undulations indefinitely repeated in an elastic medium are simultaneously experienced at the same point, situated at any distance from their common centre; 2d, that after having followed different paths, their directions at this point are sensibly confounded; 3d, that in consequence of the unequal lengths of the two paths, or of their unequal velocities, the time which a wave takes to arrive at the point by the first path (A) is shorter than that which it takes to arrive by the second path (B). These suppositions being made, it is evident that an ethereal molecule situated at a point common to the two paths A and B will begin to vibrate in consequence of the undulations propagated along A before the undulation which comes by B reaches it; and when this second undulation does take effect, the motion of the ethereal particle will be increased or diminished according as the new impulse conspires with or opposes the former. Three cases may occur: —

1. The difference of the lengths of the paths, or the difference of velocities, may be such that the wave coming by the path B may reach the molecule at an interval of time after it has been affected by the wave coming by A precisely equal to that of a semi-vibration. In this case, the vibrating molecule having reached its limit of excursion on one side, and about to return to the point of repose, would at that instant receive an impulse constraining it to move in the opposite direction with the same velocity. The coexistence of the two systems of vibrations would therefore destroy the motion, and the molecule would remain at rest. The same thing will take place if the difference of the lengths of the paths or velocities is such that the vibrations propagated along B arrive at the intersection of the paths precisely $\frac{3}{2}$, $\frac{5}{2}$, $\frac{7}{2}$, &c. of a period of undulation after those which come by A.

2. The undulations propagated along B may arrive at the molecule after those coming by A at an interval of time exactly equal to that of a complete vibration, or of several vibrations; in which case the molecules would receive the impulse of two vibrations conspiring together, and consequently the velocity and amplitude of its excursions would be doubled instead of being destroyed.

3. The interval between the two impulses may be neither an odd nor an even multiple of the time of a semi-vibration. In this case, the molecule will vibrate with a velocity less than the double of that which it would have if each impulse took place independently of the other. (*Herschel's Treatise on Light*, in the *Ency. Metropolitana*.)

It is a strong presumption in favour of the undulatory theory of light, that it affords not only a complete and satisfactory explanation of the whole of the phenomena of diffraction, but also the means of submitting them to arithmetical calculation. *See* LIGHT.

I'NTERIM. (Lat. *in the mean time.*) In modern European History, the name given to a decree of the Emperor Charles V. after the overthrow of the Protestant League of Smalcalde, in which he attempted to reduce to harmony the conflicting opinions of the Protestants and Romanists. The use of the cap, however, and the marriage of the clergy, were the only points which he conceded to the Reformers; and it became a question among them, and gave rise to many serious disputes, whether they could conscientiously submit even to a temporary decree of such a nature. The enactments of the *interim* were intended only to remain in force till some definitive settlement could be made; whence it derives the name by which it is generally known. It received the force of law at the Diet of Augsburg, in 1548. Its provisions against the Protestants were, however, in most respects set aside by the treaty of Passau, 1552. (See *Mosheim*, vol. iv.)

INTERJE'CTION. In Grammar, a part of speech expressing simple emotion, without involving any act of conception. *See* GRAMMAR.

INTERLO'CUTOR. (Lat. inter, and loquor, *I speak.*) In Literary phraseology, a person who is introduced as taking part in a dialogue; in Dramatic literature, termed *dramatis persona*: the latter name, however, comprehends such as appear on the stage but take no part in speaking, termed by the Greeks mute personages.

INTERLO'CUTORY JUDGMENTS. In Law, such as are given in the course of a cause upon any proceeding arising out of it, and do not finally determine it: as, the judgment in an action of damages upon which a writ of inquiry issues to assess such damages. So a decree in chancery is either final or interlocutory. — In Scottish law, a judgment of the court of session, or lord in ordinary, which if allowed to become final will be conclusive, is termed interlocutor.

I'NTERLUDE. (Lat. inter, *between*, and ludo, *I play.*) A short dramatic piece, generally accompanied with music: properly, such as is represented or performed between the acts of longer performances.

I'NTERMEDE, or INTERMEZZO. In Dramatic Literature, nearly the same with interlude. A short musical piece, generally of a burlesque character; but many not intended merely for introduction between the acts of a more serious performance, are comprised under these names by the French and Italians.

INTERMI'TTENT. Any disease which ceases for a time and again returns, so that the patient is free from it in the intermediate intervals. *See* AGUE.

INTERMI'TTING SPRINGS, are springs which after having run for a certain time stop altogether, and after a time begin to run again, and then stop; and so on alternately, the flowings and intermissions generally succeeding each other at pretty regular intervals. These phenomena, which often excite wonder in the ignorant, and have sometimes even been ascribed to the influence of witchcraft, are explained on the principle of the siphon. Let A be cavern in a mountain, and *a b c* a channel communicating with A, and terminating in the side of the mountain or adjacent plain; and let us suppose the cavern to be fed by small streamlets of water, of which the united supply is less than can be discharged by the channel *a b c*. Let the cavern be supposed empty.

The water from the rills or fissures by which it is fed will collect at the bottom, and as it rises in the cavern will also rise in the channel *a b* till it reaches the highest level *b*, when it will begin to flow out through *b c*, and by the property of the siphon will continue to flow till the whole cavern is drained to the level of *a*. The cavern then begins to fill anew, and the same series of phenomena is repeated at intervals, of which the length depends on the relative capacity of the cavern and channel, and the abundance of the supply through the fissures. When the supply is constant, the intervals of intermission will be equal. Some springs of this kind do not cease altogether to flow, but only discharge a much smaller quantity for a certain time, and then a greater quantity. In this case they are called variable or reciprocating springs. They may be caused by the circumstance of a smaller fissure connecting the cavern with the lower part of the channel *c*, through which a portion of water continues to flow while the main discharge is stopt; or there may be several siphons all communicating with a common outlet. It is easy to imagine a combination of circumstances by which the discharge of water will be greatly increased by the elastic force of air compressed at the top of the cavern A. This will take place when the fissures which communicate with the external atmosphere are filled with water, and there is in consequence no opening by which the air in the cavern can escape. The water will then be propelled through the channel with considerable force, or even raised in a jet, by the very same principle as in the fountain of Hero. (See *Musschenbrock*, Introd. t. ii. § 2379.; *Desaguliers, Exper. Phil.* vol. ii. p. 173.; *Nicholson's Phil. Journ.* xxxv. p. 178.; *Ferguson's Lectures on Select Subjects*, by Brewster.)

INTERMODI'LLION. (Lat. inter, *between*, and modillion.) In Architecture, the space between two modillions, which is equal throughout the entablature.

I'NTERNODE. (Lat. inter, and nodus, *a knot.*) In Botany, the space that intervenes upon a branch between the leaves.

INTERNU'NTIUS, or INTERNUNCIO. An envoy of the Pope, sent to small states and republics; distinguished from the nuncio, who represents the Pope at the courts of emperors and kings. Also a species of diplomatic officers, who ranked, according to the old practice, between ambassadors and plenipotentiaries. Since the Congress of Vienna, as no mention of internuncios is made in its rules, they are considered on a level with plenipotentiaries. This is (or lately was) the title of the Austrian envoy at Constantinople.

INTERO'SSEOUS MUSCLES. Small muscles between the metacarpal bones of the hand and the metatarsal of the foot: the former are concerned in moving the fingers, and the latter the toes.

INTERPILA'STER. (Lat. inter and pilaster.) In Architecture, the space between two pilasters, which depends entirely on the same rules as intercolumniation, and that more especially if both are employed in the same building.

INTERPLE'ADER. In Law. A bill of interpleader, in equity, is filed by a person who is under an obligation of debt or rent to one of the parties to a suit in equity,

but cannot ascertain, until the determination of the suit, to which of the parties he is indebted; and by this bill he desires to interplead, in order that he may save himself harmless in the event of the success of either party. In the common law courts, by 1 & 2 W. 4. c. 58., relief can be given in some cases against adverse claims made on sheriffs and other officers, and persons having no interest is the subject of such claims, by a judge's order calling on the third party to appear and maintain or relinquish his claim.

INTERPOLATION. In Algebra and Astronomy, is a method employed for filling up the intermediate terms of a series of numbers or observations, by numbers which follow the same law. The general problem to be resolved is this: — Given two series of numbers, the corresponding terms of which have some determinate relation to each other, and of which the first is called the series of roots, and the second the series of functions; to find the function corresponding to any term in the series of roots from the numbers in the series of functions which precede or follow that which is required. Thus, supposing the series of roots to be the natural numbers 101, 102, 104, 105, and the series of functions to be the logarithms of those numbers; then the question may be to find the logarithm of 103 by means of the logarithms of 101, 102, 104, and 105. In the language of algebraists, the problem is to determine the value of Y_{x+n} in a function of the terms which precede or follow Y_x.

In Astronomy and Physics, interpolation signifies the method of finding a mathematical law which will connect together a number of observed facts. Thus, supposing 20 places of a comet have been determined by observation; these places are said to be interpolated when a curve defined by an analytical equation has been found which passes through them all, for by means of this curve the place of the comet at any intermediate time can be found. According to this view of the subject, the problem of interpolation is altogether indeterminate; for an infinity of analytic curves of different forms may be found which will pass through 20 given points: but in general the circumstances of the question impose such restrictions as render it determinate. In the instance now given we know that the curve must be an ellipse; and as an ellipse cannot be made to pass through 20 points taken any how, the question resolves itself into this: — To find the ellipse which will *most nearly* pass through the given points, or represent the given observations. Another question now arises, — what conditions must be fulfilled in order that the observations may be represented *most nearly?* These conditions must be determined from other considerations. Suppose the condition to be that the sum of the squares of the errors of observation (that is, of the differences between the observed places of the comet and the corresponding places in the orbit to be found) shall be a minimum; the problem is now quite determinate, though its solution may be sufficiently difficult and laborious.

The method of interpolation by differences was first employed by Briggs in the calculation of logarithms; but was afterwards treated in a more general way by Wallis, Newton, Cotes, Stirling, and others. In the fifth lemma of the third book of the *Principia*, Newton has given a solution of the problem of determining the curve which passes through the extremities of any number of ordinates. By modern writers the subject is treated as a branch of the calculus of finite differences. It is discussed at length by Laplace in the 2d vol. of the *Mécanique Céleste*, and also in the *Theorie Analytique des Probabilités;* by Lagrange, in the *Journal de l'Ecole Polytechnique*, &c. See also the Treatise on Differences and Series by Sir John Herschel in the Appendix to the English translation of Lacroix's *Differential and Integral Calculus*, or the 3d vol. of Lacroix's large Treatise.

INTERRE'GNUM. (Lat.) The period between the death of one king and the accession of another under the Roman monarchy; or under the republic, the space of time when there were by some accident no curule magistrates who could hold the public assemblies of the people (comitia), during which an interrex was appointed. *See* INTERREX.

I'NTERREX. A person appointed to discharge the royal functions during a vacancy of the throne. The Romans first elected an interrex after the death of Romulus, and the custom was continued while the monarchy lasted. The manner of their election was this, — the senate chose ten individuals out of its body, each of whom discharged the functions of royalty for five days in an order appointed by lot. It has been supposed that these ten senators were not elected, but they were the respective seniors of the ten decuries into which the original body of patricians was divided, and that this office devolved on them by virtue of their rank. An interrex was also appointed sometimes under the republic to preside over elections of magistrates, &c. when the consuls were absent, or their election declared void and no dictator had been created.

INTERSCE'NDENT. (Lat. inter, and scando, *I climb.*) In Algebra, a term applied by Leibnitz to quantities when the exponents of their powers are irrational. Such expressions are called *interscendent*, as holding a mean as it were between algebraic and transcendental quantities.

INTERSE'CTION. (Lat. inter, and seco, *I cut.*) In Geometry, the meeting or concourse of lines or surfaces. The intersection of two lines, or of a line and a surface, is a point; and the intersection of two surfaces is a line.

I'NTERTIE. (Lat. inter, and tie.) In Architecture, an horizontal piece of timber framed between two posts in order to tie them together.

I'NTERVAL. (Lat. intervallum.) In Music, the imaginary distance between two sounds as respects their acuteness and gravity, called by the ancients a *diastem.* Intervals are divided into *simple* and *compound;* the former being without parts or divisions, the latter consisting of several smaller intervals.

INTERVE'NTION. (Lat. inter, and venio, *I come.*) In Politics, the interposition of one state in the domestic affairs of another. The right of armed interveniton is one of the most contested portions of the public law of nations; as, although practised frequently enough by the more powerful with reference to the weak, it had never been regarded otherwise than as a permitted abuse of power until the time of the congresses of Vienna, Laybach, &c., when it was publicly recognized by the leading cabinets of Europe.

INTE'STACY. (Lat. in the sense of *without*, and testor, *I testify.*) In Law, the condition of a party who dies without having made a will. Freehold lands and tenements in which he has an estate of inheritance descend to his heir, subject to such charges as affect real estate; copyhold lands of inheritance to the heir, by the custom of the manor; chattels must be distributed (subject to debts), by the party who takes out letters of administration to the deceased's estate and effects, according to the provisions of the Statute of Distributions.

INTESTINALIA, *Intestinal Worms.* (Lat. intestina, *an intestine.*) The name by which Linnæus and Cuvier have designated the class of animals which infest the interior of other animal bodies, and which indicates their most common locality, viz. the intestinal tube.

The knowledge of the intestinal worms, as a distinct class of invertebrate animals, is of a very late date. In the twelfth edition of the *Systema Naturæ*, 1787-8, only eleven species of true Entozoa are enumerated, and of these only six are placed among the *Intestina* — *Gordius medinensis*, *Ascaris vermicularis*, *Ascaris lumbricoides*, *Fasciola hepatica*, *Fas. intestinalis*, and *Fas. barbata;* the remaining species, viz. *Hydra hydatula*, *Tænia solium*, *Tæn. vulgaris*, *Tæn. lata*, and *Tæn. canina*, are ranged with the Zoophyta. *Bloch's Treatise on the Generation of Intestinal Worms*, and the succeeding work of Goeze, entitled *Versuch einer Naturgeschichte der Eingeweidewürmer Thierischer Körper*, 1782, added largely to the number of the described species, and led to the foundation of some accurately defined groups, and better ideas of classification. Gmelin, availing himself of the labours of these authors, and combining with them the species described by Redi, Pallas, O. F. Müller, and Werner, was enabled to give two hundred and ninety-nine species of *Intestinalia*, in the thirteenth edition of *Linne's Systema Naturæ;* but of this labour it has been justly remarked, "Gmelinus, auctorum plurimorum observationes congessit, sed tam judicio et experientia quam sollertia destitutus, plurima miscuit et implicuit, ut in synonimis ab eodem perperam allegatis, extricandis, C. A. Rudolphi et Zederus multum desudaverint."

The first clear definition of the intestinal worms as a class, and their distribution into a system of orders and genera, are contained in the great work by Rudolphi, entitled *Entozoorum seu Vermium Intestinalium Historia Naturalis*, 8vo. 1808-10. In this work, Rudolphi, after dividing the great class *Vermes*, of Linnæus, into four classes, viz. *Mollusca*, *Gymnodela*, *Entozoa*, and *Phytozoa*, characterizes the third class as follows: — "Entozoa ergo classem, aut si mavis ordinem sistunt peculiarem continentem, *aliis in animalibus obvia, oculis nudis conspicua, nervis carentia, partibus internis dissimilibus instructa.*" Of the class of animals thus characterized, Rudolphi enumerates, in a subsequent work, *Synopsis Entozoorum*, 1819, upwards of eleven hundred species. At the present time, nearly double that number of Entozoa are known.

Rudolphi distributes the intestinal worms into five orders, which are characterized as follows: —

Order I. *Nematoidea* (Round-worms). — Char.: Body elongated, rounded, elastic; an intestinal canal, with a separate mouth and vent; sexes distinct.

Order II. *Acanthocephala* (Hooked-worms). — Char.: Body roundish, utricular, elastic; head with a retractile proboscis, armed with hooks or recurved spines; sexes distinct.

Order III. *Trematoda* (Fluke-worms). — Char.: Body soft, rounded, or flattened; suctorial pores; male and female organs in the same individual.

Order IV. *Cestoidea* (Tape-worms).—Char.: Body elongated, flattened, soft, continuous, or articulated; head either simply labiated, or provided with pits (*bothria*), or suctorious orifices, either two or four in number; male and female organs in the same individual.

Order V. *Cystica* (Hydatids).—Char.: Body flattened or rounded, continued posteriorly into a cyst, which is sometimes common to many individuals; head provided with two or four pits, or with four suckers, and with a circle of hooklets, or with four unarmed or uncinated tentacles; sexual organs hitherto indiscernible.

The Entozoa which are included in the last four orders of Rudolphi have no distinct intestinal canal; and Cuvier considered the presence of this structure in the *Nematoidea* of Rudolphi of sufficient importance to form the character of a primary group, equivalent to all the remaining orders combined; and he observes that the orders thus distinguished might form two classes.

The first order Cuvier terms *Cavitaires;* and he includes in it not only the Nematoid Entozoa, but also the genus *Pentastoma* of Rudolphi, and the Epizoa, or *Vers rigidules*, of Lamarck.

The organization of the *Pentastomata*, which were defined, prior to Rudolphi, by Froelich, under the name of *Linguatula*, unquestionably entitles them to rank with the highest organized Entozoa (see *Zoological Trans.*, vol. i. p.381. pl. 41.); but, with respect to the Epizoa, or the external Lernæan parasites of fishes, although they agree with the *Nematoidea* and all other Entozoa in the absence of distinct respiratory organs, yet the ciliated natatory extremities which they possess in the young state, and the external ovarian appendages of the adult, are characters which raise them above the Entozoa, and indicate their intimate relations with the Siphonostomous Crustaceans.

I have, therefore, combined the *Nematoidea* of Rudolphi with the genera *Linguatula*, *Porocephalus*, and *Syngamus*, &c., which, under the habit of Cestoid or Trematode worms, mask a higher grade of organization, to form a class under the name of *Cœlelmintha*. This class already embraces the types of three different orders, of which one is formed by the *Nematoidea* of Rudolphi; and a second has been established by Diesing, for the *Linguatula*, and other congeneric species, under the name of *Acanthotheca*. The remarkable organization of the genus *Syngamus*, as described by Siebold, clearly indicates the type of a third order of *Cœlelmintha*. (See that word.)

The four orders of intestinal worms which have no distinct intestine, but in which the digestive function is carried on in blind canals, excavated in the parenchymatous substance of the body, Cuvier combines into a group, which he terms *Vers intestinaux parenchymateux*, and for which I have proposed the name of *Sterelmintha*. (See that word.)

This group Cuvier subdivides into three families, or orders; the first corresponding to the *Acanthocephala* of Rudolphi, the second to the *Trematoda*, and the third being equivalent to the *Cestoidea* and *Cystica* combined; with the exception of the genus *Ligula* of Bloch, of which Cuvier makes a fourth order, restricting to it the application of Rudolphi's term *Cestoidea*. To this distinction it must be objected that the passage from the *Tæniæ* to the *Ligulæ* is rendered very gradual by the traces of bothria and of generative organs, which make their appearance in the higher-organized *Ligulæ* which infest the intestines of certain aquatic birds, and respecting which Rudolphi hazards the following ingenious hypothesis; viz., that these species are actually the more simple *Ligulæ* of fishes, developed into a higher grade of organization by virtue of the warmth and abundant nutriment which they enjoy in the intestines of the birds that have swallowed the fishes so infested. To the conjunction of the hydatids with the tapeworms no sound objection can be made: the structure of the *Tetrarhynchi* and *Anthocephali*, on the contrary, shows how unnatural is the separation of the Cestoid from the Cystic Entozoa. The *Cysticercus fasciolaris* may be regarded as the point of transition, or of conjunction, between the two groups. The head in *Cænurus* and *Echinococcus* presents the form and structure of that of *Tænia;* and the head of the *Tetrarhynchus*, the proboscis excepted, precisely resembles that of the *Echinococcus*, although the *Tetrarhynchi* neither inhabit a vesicle, nor terminate in a vesicle. The *Cystica* appear, in fact, to be incomplete *Cestoidea:* both consist at first of a simple cyst, like the *Acephalocyst;* but both proceed to develope therefrom a suctorious and uncinated head, from which the *Cestoidea* proceed to develope not only ova, but generative organs, in successive segments, which in some species, as the *Bothriocephalus punctatus*, seem to be annually shed and reproduced.

Thus, the intestinal worms, as at present known, form two classes, each divisible into three orders.

Class I. Cœlelmintha.

Order 1. *Nematoidea.*—Ex.: *Filaria medinensis*, *Fil. oculi*, *Fil. bronchialis*, *Ascaris lumbricoides*, *Asc. vermicularis*, *Tricocephalus dispar*, *Spiroptera hominis*, *Strongylus gigas*, *Strong. spiniger*, *Trichina spiralis*.

Order 2. *Acanthotheca.*—Ex.: *Linguatula tænioides*.

Order 3. *Syngamoidea.*—Ex.: *Syngamus trachealis*.

Class II. Sterelmintha.

Order 1. *Acanthocephala.*—Ex.: *Echinorhynchus gigas*.

Order 2. *Trematoda.*—Ex.: *Distoma hepaticum*, *Polystoma pinguicola*.

Order 3. *Tænioidea.*—Ex.: *Bothriocephalus latus Tænia solium*, *Cysticercus cellulosæ*, *Echinococcus hominis*.

The examples quoted are species which infest man, with the exception of those belonging to the orders *Acanthotheca*, *Syngamoidea*, and *Acanthocephala*, which have no representatives among the human internal parasites. For the parts of the body which these latter infest, the reader is referred to Entozoa.

INTE'STINE. The convoluted membranous and muscular tube extending from the pylorus to the anus. It is distinguished into small and large intestines: the former including the *duodenum*, the *jejunum*, and the *ileum;* the latter the *cæcum*, *colon*, and *rectum*. The small intestines have internal membranous folds, called *valvulæ conniventes;* the large have three parallel muscular bands upon their surface. The intestines admit of separation into three coats: the external, membranous or peritonæal; the middle coat, muscular; and the inner one, villous. They are attached to the body by the mesentery. The structure of the intestinal canal in different animals is wonderfully adapted to its required functions, dependent upon the nature of their food and other circumstances. Of these peculiarities the principal are adverted to under the titles of the animals in which they occur.

INTONA'TION. (Lat. in, and tonus, *a tone.*) In Music, the act of sounding with the voice the consecutive notes of the scale, or in any other given intervals. To do this correctly is the first qualification of a good singer. It is scarcely practicable without the assistance of a good ear, as well as a reference to some common idea, such as the key or mode wherein a piece is written. From the word *tone*, sometimes used in a sense almost identical with that of *key*, the word has its origin. The musical definition of this word in Todd's edition of *Johnson's Dictionary*, is absurdly given as "the act of singing together."

INTRA'DOS. The interior and lower line or curve of an arch. The exterior or upper curve is called the *extrados*. *See* Arch.

INTRE'NCHMENT. In Fortification, any work that fortifies a post against the attack of an enemy. It most usually denotes a ditch or trench with a rampart.

I'NTROIT. (Lat. introitus, *entry.*) In Ecclesiastical Antiquities, the verses chaunted or repeated at the first entering of the congregation into the church; a custom as old as the fourth century: called "ingressa" in the Ambrosian Ritual. (*Palmer*, *Origines Liturgicæ*, ii. 19.)

INTRO'RSES. (Lat. introrsum, *inwards.*) Turned inwards. A term used in describing the direction of bodies to denote their being turned towards the axis to which they appertain; thus, in most plants the anthers are introrse, being turned towards the style.

INTRU'SION. (Lat. intrudo, *I thrust upon.*) In Law, a species of injury to freehold property. It arises when a stranger intrudes between the death of tenant for life or years and the entry of the heir of a remainder-man or reversioner expectant on the estate for life or years, who had died previous to the decease of such tenant for life or years. Writ of intrusion lies only for a party who has the remainder or reversion in fee: remainder-man in tail has remedy by formedon. *See* Fee-Tail, Formedon.

INTUI'TION. (Lat. intueor, *I look into.*) In Philosophy, any act of the mind by which a truth is *immediately* perceived, and as it were *beheld*, without any previous process of analysis or ratiocination. Such, according to Kant, are the fundamental propositions of geometry; as, that "two straight lines cannot inclose a space," &c.

I'NTUSSUSCE'PTION. (Lat. intus, *within*, and susceptio.) In Anatomy, a term applied to the folding or passing of one portion of intestinal canal into another.

I'NULIN. A white powder deposited by a decoction of the roots of the *Inula helenium* or elecampane. In its chemical properties it appears intermediate between gum and starch.

INUNDA'TION. (Lat. in, and undo, *a wave.*) In Agriculture, lands which are overflowed by water from natural causes uncontrolled by art, are said to be inundated: when in consequence of the exercise of art and skill, the result is termed irrigation.

INVALI'DS. (Lat. invalidus, *weak.*) Those soldiers or sailors who, either on account of wounds or length of service, are admitted into hospitals, and there maintained at the public expense. The practice of making provision for soldiers worn out or disabled in the public service dates

from high antiquity. The liberality of Pisistratus to the Athenian soldiers is known to every scholar; and the history of ancient Rome is replete with instances of the veterans of the legions being rewarded with grants of land. It must be admitted, however, that in ancient times such recompences had not their origin in that high philanthropic feeling by which the moderns are actuated in making provision for military and naval invalids; for they were granted only after victory, and emanated more from individual power or favour than from any general or established principles of benevolence. In modern times there is no civilised country without institutions for the maintenance of invalids; but the most magnificent are, without question, the Greenwich and Chelsea hospitals in England, and in France the Hôtel des Invalides.

INVE'NTION. (Lat. invenire, *I find.*) In the Fine Arts, the choice and production of such objects as are proper to enter into the composition of a work of art. "Strictly speaking," says Sir Joshua Reynolds, "invention is little more than a new combination of those images which have been previously gathered and deposited in the memory: nothing can come of nothing: he who has laid up no materials can produce no combinations." Though there be nothing new under the sun, yet novelty in art will be attainable till all the combinations of the same things are exhausted, — a circumstance that can never come to pass.

INVE'NTION OF THE CROSS. A festival celebrated May 3d, in the Roman Catholic church, in honour of the finding of the cross on which our Saviour was executed. The search was instituted by order of St. Helena, mother of the Emperor Constantine, A. D. 326; and the cross, according to St. Cyril, was found among the ruins of Mount Calvary.

I'NVENTORY. (Lat. invenio, *I find.*) A catalogue of movables. See EXECUTOR.

I'NVERSE METHOD OF FLUXIONS. The method of finding the *fluents* of given fluxional expressions. It is the same with the integral calculus.

I'NVERSE METHOD OF TANGENTS. The method of finding the curve whose tangents are lines drawn according to some determinate law, or which fulfil some given condition. For example, suppose rays of light issuing from a luminous point to fall on the concave surface of a sphere, and to be thence reflected; the problem may be proposed to determine the nature of the curve to which all the reflected rays in any given plane are tangents. Problems of this kind require the application of the integral calculus; and hence the method by which they are solved is called the *inverse* method of tangents, as opposed to the *direct* method, viz. that of finding the tangent to a curve which is performed by the differential calculus.

I'NVERSE PROPORTION, in Algebra and Arithmetic, is the application of the rule of three, or proportion, in a reverse or contrary order. This is usually described by saying that less requires more, or more requires less. Thus, the question, "if 20 men cut down 3 acres of corn in a given time, how many men will be required to cut down 6 acres in the same time?" belongs to the direct rule, the quantity of work done being directly proportional to the number of men employed; but the question "if 20 men do a piece of work in 6 days, in what time will 40 men perform the same?" is one of inverse proportion, for more men will do the work in less time, or the number of men required is inversely as the time. The question may be stated in this manner, $\frac{1}{20} : \frac{1}{40} :: 6$; and the answer is 3.

I'NVERSE RATIO. The ratio of the reciprocals of two numbers. See INVERSE PROPORTION.

INVE'RSION. (Lat.) In Rhetoric and Philology, the transposition of words out of their natural order. Every language has a customary arrangement of its own to regulate the order of succession in which words forming part of the same sentence, member, or proposition follow each other. On the other hand, there is undoubtedly a natural or philosophical order of words following each other in the same analytical succession in which ideas present themselves to the mind, varied occasionally by that produced by the succession of sentiments or emotions; and as in every language many customary phrases, if not the general arrangement of the words, are contrary to this primitive order, every language has customary inversions of its own. Deviations from the *customary* order of words are more commonly called transpositions; but each word has, of course, a relative and somewhat arbitrary signification. As an instance of ordinary inversion, it may be observed that, according to the metaphysical or analytical order, the subject of a proposition precedes the predicate, being the first idea which presents itself to the mind. Thus, in the construction of a sentence containing a proposition (*see* LOGIC), "Solon is wise," or "Alexander reigns," we habitually follow the order of nature. But when a substantive and adjective in connection form part of a sentence, *i.e.* a subject or predicate, or a part of either, the substantive is that which seems naturally to present itself first to the mind; whereas in most modern languages it follows the adjective, while in the Greek and Latin its ordinary although not its necessary place was before it: "Who is a wise man?"—"Vir bonus est quis?" "The end of a long silence."—"Finis silentii diuturni." It is in general to be observed, that modern languages admit far less readily than ancient of transposition; but there are considerable differences in this respect between modern languages themselves. German admits much latitude, French very little. In our own language we are frequently able to vary the analytical order by following what may be termed the order of emotion, where a French writer could not do so: thus in the proposition "Great is Diana of the Ephesians," it would be impossible, in French, to give the force which is added to the expression by the transposition of the predicate to the beginning without violating the habitual rules of construction. A similar instance of inversion is to be found in the Swedish and some kindred languages, in which the article follows instead of preceding the noun.

INVERSION. In Music, the change of place between two notes of an interval; that is, placing the lower note an octave higher, or the higher note an octave lower.

INVE'RTEBRATES, *Invertebrata.* (Lat. in, priv.; vertebra, *a joint of the back-bone.*) The animals which are devoid of vertebræ, or an internal bony skeleton; and which include the Molluscous, Articulate, Nematoneurous, and Acrite sub-kingdoms. Lamarck's primary division of the animal kingdom into *Vertebrata* and *Invertebrata* corresponds with that proposed by Aristotle into *Enaima* and *Anaima.* It is, however, subject to the same objection as applies to most of the Dichotomous systems in Zoology; viz. that the two members of the division are not equivalent to each other. The *Invertebrata*, for example, contain three if not four primary divisions of the animal kingdom, each of which are equivalent to the *Vertebrata.*

INVE'RTED ARCH. In Architecture, one wherein the lowest stone or brick is the key-stone. It is used in foundations, to distribute the weight of particular points, such as A A A, over the whole extent of the foundation, and hence its employment is frequently of the first importance in constructive architecture.

INVE'STITURE. In Feudal Law, the delivery of a fief by a lord to his vassal, accompanied by peculiar ceremonies. (*See* FEUDAL SYSTEM.) The investiture of a bishop was, properly speaking, his endowment with the fiefs and temporalties of the see. Hence it became a subject of contest between the popes and emperors, and one of the principal grounds of the great quarrel of Guelfs and Ghibellines. It was conceded by the emperors to the Roman see in 1122; but the question was ended by a substantial compromise, which left the nomination in reality in the hands of the temporal prince in European monarchies under the Roman Catholic religion. (See *Hallam's Middle Ages; Raumer's History of the Hohenstauffen; Gieseler's Text Book of Ecclesiastical History*, vol. ii.; *Mosheim's Eccl. History.*)

INVOCA'TION (Lat. invoco, *I call upon*), in Literature, signifies, in a general sense, an address at the commencement of a poem, preferred to the Muses or some other Being supposed capable of giving inspiration. Thus, while the ancient poets generally addressed their invocations to some particular muse or divinity, Milton invokes the "Heavenly Muse" and the "Holy Spirit;" and, in his *Henriade*, Voltaire calls to his aid "auguste Verité." For the chief rules of poetical invocation see the *Dict. de Richelet*, and the *Dict. de la Conversation.*

INVOCA'TION OF SAINTS. In Theology. According to Protestant writers, the veneration of saints and martyrs increased rapidly throughout the 4th century; but their *invocation* as intercessors with the Divinity did not generally commence much before the 5th. (See *Mosheim*, ii. 32. 102. ed. 1826, transl.; *Gieseler*, i. 283. transl.) The followers of Origen are said to have been the first "who apostrophised the martyrs in their sermons, and besought their intercession." Prayers *for* the saints among other departed spirits were discontinued about the 5th century. on the principle laid down by Saint Augustine, "Injuria est pro martyre orare, cujus nos debemus orationibus commendari." *See* MARTYRS, SAINTS.

I'NVOICE. A list or account of goods or merchandise sent by merchants to their correspondents at home or abroad, in which the peculiar marks of each package, with their value, customs, provision, charges, and other particulars, are set forth. (See *Com. Dict.*)

INVOLUCE'LLUM. (Lat.) In Botany, the secondary involucrum surrounding one of the umbellules of an umbelliferous flower, or the florets of a capitulum.

INVOLU'CRUM. (Lat.) In Botany, a term having three significations: —

1. A ring of bracts surrounding one or many flowers.
2. In describing ferns to denote the superincumbent cuticle covering the sori.
3. In describing *Equisetaceæ*, to denote the cases of reproductive organs.

I'NVOLUTE, in the Higher Geometry, is a curve conceived to be described by the extremity of a string unwinding itself from the arc of another curve about which it has been lapped. All curves, in which the curvature is neither infinitely great nor infinitely small, may be generated in this way by the evolution of a thread from another curve, which is called the *evolute* of the new curve. *See* EVOLUTE.

The method of generating curves by evolution is a geometrical theory invented by Huygens, and given in his *Horologium Oscillatorium*, where he shows that the involute of a cycloid is another cycloid equal to the original one; and he applies this property to the practical purpose of causing a pendulum to vibrate in the arc of a cycloid; in which case, by another remarkable property of that curve, the vibrations are performed in equal times, whether the arc of vibration be great or small.

INVOLU'TION, in Arithmetic and Algebra, is the method of finding any power of an assigned quantity; and is the reverse of *evolution*, which denotes the method of finding the root of any quantity, which is considered as a power of that root.

The successive powers of any quantity are found by the continual multiplication of the quantity itself. Thus, taking the number 5, we have

$5 = 5^1$, the first power or root,
$5 \times 5 = 5^2$ or 25, the second power or square,
$5 \times 5 \times 5 = 5^3$ or 125, the third power or cube,

and so on; whence we see that the number of multiplications required to raise a number to any power is one less than the number of the index by which the power is expressed.

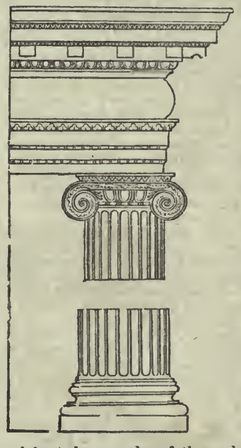
In algebra, simple quantities are involved by multiplying the exponents of the symbols by the index of the power required, and raising the coefficients to the same power. Thus the cube or third power of $2\,a^2\,x$ is $8\,a^6\,x^3$. Compound quantities are involved in the same manner as numbers by a continual multiplication of the quantity itself, or more generally and expeditiously by means of the binomial theorem.

I'ODINE. (Gr. ιωδης, *violet-coloured.*) A substance discovered in 1812 by M. Courtois of Paris. In this country it is usually prepared from kelp, which is lixiviated with water; and when the crystallizable salts have been separated, the mother liquors are mixed with sulphuric acid and black oxide of manganese. On the application of heat the iodine rises in the form of a dense violet-coloured vapour, which by condensation forms steel-grey crystals looking like micaceous iron. The specific gravity of iodine is between 4 and 5; when dry it fuses at 227°, and boils and evaporates in purple fumes at 345°. When heated with water it distils over at temperatures below 212°. The specific gravity of its vapour is about 8·7, so that 100 cubic inches would weigh nearly 270 grains. Iodine belongs to the electro-negative supporters of combustion. It has an acrid taste, and a peculiar odour somewhat like that of chlorine. It is an irritant poison; but in small doses, and cautiously administered, it has occasionally been of great service in certain forms of glandular disease. It is very sparingly soluble in water, of which it requires 7000 parts for its solution; the colour of the solution is brown: it dissolves copiously in alcohol and in ether, and forms dark-brown liquids. It possesses strong powers of combination, forming, with the metals, a class of compounds called *iodides;* with oxygen it forms the *iodic acid*, and perhaps one or more oxides. Combined with hydrogen, it forms the *hydriodic acid*. Its equivalent number is 126, and that of the hydriodic acid 127. Starch is a characteristic test of the presence of free iodine, forming with it a compound of a deep blue colour. It is so delicate that a solution of starch dropped into water containing less than a 400,000th part of iodine, is tinged blue by it; but the solutions must be cold, for the blue compound is soluble in hot water. The great consumption of iodine is in medicine; it is employed in its pure state, and in the form of *iodide of potassium*, which is obtained by dissolving iodine in a solution of pure potash, evaporating to dryness, and fusing the residue. This compound is sometimes called *hydriodate of potash.*

I'OLITE. (Gr. ιον, *violet.*) A mineral of a violet blue by transmitted light; it occurs crystallized, and in small grains and rolled masses.

IO'NIC DIALECT, the most euphonious of the four written varieties of the Greek language, was spoken by the inhabitants of the Ionian Islands, and in their colonial possessions in Asia Minor. It was originally the same as the Attic dialect, at least they boasted of a common origin; but from the extensive commercial intercourse of the Ionians with the eastern nations, their language gradually imbibed a portion of Asiatic effeminacy, which at length became its chief characteristic, forming a striking contrast to that combination of strength and harmony which distinguished the dialect of Attica. The chief writers in the Ionic dialect are Herodotus, Hippocrates, and Galen: but it is in the writings of the first that the most complete specimen is to be found.

IO'NIC ORDER. One of the five orders of architecture, whose distinguishing feature is the volute of its capital. In the Grecian Ionic the volutes appear the same in the front and rear, being connected on the flanks by a baluster-like form: through the external angles of the capitals of the corner columns, however, a diagonal volute is introduced. The Romans gave their Ionic four diagonal volutes, and curved the sides of the abacus. The Greek volute continues the fillet of the spiral along the face of the abacus, whereas in the Roman its origin is behind the ovolo. In some Grecian specimens a neck is added below the echinus, sculptured with flowers and leaves. The height of the column is about nine diameters, and the base varies considerably in different examples. When a pedestal is used it is somewhat higher and more ornamented than the Doric pedestal. The Greeks usually made the entablature of this order very simple. The architrave has two fasciæ, the frieze plain, and the cornice of few subdivisions; but the modern Ionic is seldom with less than three fasciæ, the frieze is often cushioned, and the cornice is deeper and not unfrequently modillioned, its profile being much varied. The dentil is also much used in the bed mouldings. The shaft is cut with twenty-four flutes separated by fillets. Some of the most celebrated examples of the order are the temple on the Ilyssus, of Minerva Polias at Athens and Priene, Bacchus at Teos, Apollo Didymæus at Miletus, Fortuna Virilis and the Coliseum at Rome. The profile above given is after Palladio.



IO'NIC PHILOSOPHERS. The earliest among the Greek schools of philosophy. Speculation arose in Greece, as elsewhere, in the attempt to discover the laws of outward phenomena, and the origin and successive stages of the world's development. Such an attempt, it is needless to say, must at first have been extremely rude. To the student of philosophical literature, however, no such undertaking, however unsuccessful, can possibly be otherwise than interesting; and in this instance in particular we are able to discover manifest traces of that liveliness of thought and systematic spirit which distinguish the later Greek speculations. The fathers of the Ionic school were Thales and his disciple Anaximenes. They were succeeded in the same line of thought by Diogenes of Apollonia, and Heraclitus of Ephesus. The characteristical mark which distinguishes the speculations of these thinkers is the endeavour to refer all sensible things to one original principle in nature. The two first named were satisfied with a very simple solution of the problem. Water with the one, and air with the other, were made the original materials out of which all things arose, and into which they were finally resolved. In their successors the germs of a more philosophical doctrine are apparent. They retain, indeed, the simplicity of an original element; but the *air* of Diogenes and the *fire* of Heraclitus are apparently only sensible symbols, which they used only in order to present more vividly to the imagination the energy of the one vital principle which is the ground of all outward appearances. It would indeed be a mistake to regard these philosophers as *materialists*. The distinction between objective and subjective, between a *law* operating in the universe and the corresponding apprehension of that law by reason, however obvious it may seem at the present day, seems to have required the deep meditation of numerous powerful thinkers to bring it into clear consciousness.

That the two things were confounded by Heraclitus is evident from his attributing to this universal fire the attributes of a universal reason, — the source at once of the order in the world, and of the insight into that order possessed by man. Notwithstanding this confusion, the discovery is due to him of the important truth, that "reason is common to all men." — that the ultimate principles of science derive their validity from their univer-

sality; a truth the value of which is not diminished by our finding it combined with the physical hypothesis to which we have alluded.

The philosophers enumerated above may be considered as forming one division of the Ionic school. They agree in regarding the universe as the result of the spontaneous evolution of a single principle or power; and all sensible things as modifications of this principle, real only in reference to their ultimate ground. But we meet also with a class of thinkers in whom the contrary tendency prevailed. Anaximander (B.C. 590) and Anaxagoras, the master of Pericles, agree in this respect, that they consider the world to be made up of numberless small particles, of different kinds and of various shapes, by the change in whose relative position all phenomena are to be accounted for. This hypothesis is combined by Anaxagoras with a Supreme Reason, the author of all that is regular and harmonious in the disposition of these elementary atoms. Anaxagoras may indeed be considered as the first philosopher who clearly and broadly stated the leading distinctions between mind and matter. For a statement at once luminous and accurate of the leading peculiarities of this philosopher's doctrines, and those of his predecessors, the reader is referred to Bishop Thirlwall's admirable *History of Greece*, vol. ii. chap. 12. The student who wishes for more minute information may consult Brandis and Ritter's Histories of Philosophy, of the latter of which a translation has appeared at Oxford. (See especially book iii.) See also a collection of the Fragments of Heraclitus in *Wolf and Buttman's Museum of Antiquities*, Bd. I. stck. 3; and the *Memoires de l'Ac. des Inscriptions*, vol. xvii.

IPECA'CUA'NHA. The root of the *Cephaelis ipecacuanha*. This important article of the *Materia Medica* is the produce of South America; it is in short wrinkled pieces, covered with a grey or brownish grey epidermis, and having a central woody fibre, surrounded by a pale grey cortical part, in which its virtue resides. It has a nauseous odour, and a repulsive bitterish taste. It is difficultly reducible to powder, and the dust which it throws off whilst under the process of pulverization is apt to excite great irritation of the respiratory organs. From fifteen to twenty grains of powdered ipecacuanha root taken in an ounce of water is one of the safest and surest *emetics;* in doses of from one to three or four grains it is a *nauseant;* and in smaller doses, repeated every four or six hours, as from a fourth of a grain to a grain, it is expectorant and diaphoretic. It contains from twelve to sixteen *per cent.* of *emetin*, to which its medical activity is referable. When long boiled with water its emetic power is diminished, but the decoction is aperient. There are several varieties of ipecacuanha, some of which arise from modifications of soil and climate; others appear to be the roots of distinct plants.

IRIDA'CEÆ. (Iris, one of the genera.) A natural order of herbaceous Endogens inhabiting the Cape and some other places. It differs from *Amaryllidaceæ* essentially in being triandrous, with the anthers turned outwards; from *Orchidaceæ*, in not being gynandrous; and from *Zingiberaceæ* and *Marantaceæ*, in having three perfect stamens. The species are more remarkable for their beautiful flowers than for their utility. The substance called saffron is the dried stigmata of the *Crocus sativus*. The various species of *Iris*, *Ixia*, *Gladiolus*, *Tigridia*, *Crocus*, &c., are among the favourite flowers of the gardener.

IRI'DIUM. (Lat. iris, *the rainbow*, in consequence of the variety of colours exhibited by its solutions.) A metal discovered by Dr. Wollaston, associated with the ore of platinum. It is grey, brittle, very infusible, and its specific gravity is about 18·6. It forms several oxides and chlorides, and combines readily with carbon.

IRIS. (Gr. Ἶρις.) In Grecian Mythology, the personification of the rainbow. She also performed the duties of a messenger to Jupiter and Juno.

IRIS. A name for the rainbow. *See* RAINBOW.

IRIS. In Anatomy, the anterior part of the *choroid* coat of the eye, with its central perforation, called the *pupil;* the posterior part or back of the iris is called the *uvea*. The term iris is applied to that part of the eye on account of its various colours. *See* EYE.

IRI'TIS. Inflammation of the iris of the eye.

I'RON. A metal known from remotest antiquity, of a peculiar grey colour, and possessing when polished much lustre. It is not very malleable, but extremely ductile, and very tenacious. At common temperatures it is hard and unyielding; but at a red heat it is soft and pliable, and at a high red heat it may be united to another piece equally heated by hammering them together: this process is called *welding*. The specific gravity of pure iron is about 7·7. Its texture is fibrous; it is very difficult of fusion, requiring for that purpose the highest temperature of a wind furnace. It is attracted by the magnet, and is itself susceptible of being rendered magnetic, a property possessed by no other metal except nickel. Another remarkable circumstance in the history of iron is, that it has only hitherto been found *native* (that is, in its pure metallic state), in stones and masses apparently of *meteoric origin*; for the accounts of other forms of native iron are doubtful. In combination with oxygen and with sulphur, and occasionally with other substances, it is very abundant in the mineral world, and is found in small quantities in many animal and vegetable substances. Those minerals which contain iron so combined as to be employed as sources of the metal for the purposes of the arts and manufactures are more exclusively termed the *ores of iron;* and among them the different *oxides of iron*, and the *carbonate*, either pure or in combination with various earthy matters, forming the *clay ironstone* of our coal districts, are the most important. The red oxide, and the black oxide (ferroso-ferric oxide of Berzelius), are also valuable ores. The finest Swedish iron is chiefly procured from the purer oxides, and especially from the native black oxide or *magnetic iron ore*, and is reduced by charcoal; in this country clay ironstone is chiefly resorted to, and it is reduced by coke.

There are two kinds of iron, known in commerce under the names of *cast* and *wrought* iron. There are also two principal varieties of cast iron, distinguished by the terms *white* and *grey*. The first is very hard and brittle, and when broken of a radiated texture: grey iron is softer and less brittle, and may be bored and turned in the lathe. The varieties of cast iron are also very different in their chemical composition; some much purer than others: they often contain traces of sulphur, phosphorus, silicium, calcium, manganese, and always more or less oxide of iron and carbon. The purer kinds of cast iron, which are chiefly carburets of iron, may be converted into malleable iron by heating them, surrounded by pure oxide of iron, by which the carbon is gradually extracted in the form of carbonic oxide: it is thus that horse shoes, and other articles, such even as knives, scissors, snuffers, &c., are fashioned by casting, and afterwards purified by the curious process just noticed. The cast iron manufactured in this country is converted into bar or malleable iron, chiefly by a process called *puddling*, which consists in subjecting it to the continued action of heat in a reverberatory furnace, where as soon as it melts it is stirred about till it gradually becomes less and less fusible, and at length grows tough and pulverulent. During this part of the process the mass heaves and emits a blue flame, in consequence of the burning off of some of its impurities; the fire is then so far increased as to agglutinate the metal into a mass, which, intensely heated, is transferred to a powerful rolling mill; as it passes successively through the rollers, a large quantity of impurities, chiefly its earthy ingredients, in combination with oxide of iron, are squeezed out in the form of a fluid slag, and the iron is extended into malleable bars; these are cut into pieces, placed in parcels or faggots in a very hot furnace, and again hammered or rolled into bars; they thus become more tough, flexible, and malleable, but much less fusible, and may now be considered as nearly pure iron.

When iron is heated red-hot with the free access of air, it undergoes a slow combustion; that is, it combines with the oxygen of the air, and is converted into a black fusible substance, as is seen when a bar of white-hot iron is beaten upon the smith's anvil, the scales which fly off in brilliant combustion producing the *black oxide of iron*. When a thin piece of iron is introduced red-hot into oxygen gas, or when a current of oxygen is directed upon it, it burns with great splendour, throwing off brilliant sparks, and becoming rapidly oxidized. When this black oxide or when metallic iron is exposed to air and moisture, or heated for a long time in contact of air, it becomes converted into a *brown oxide*, familiarly known as *rust of iron*. When iron is acted upon by dilute sulphuric acid, it decomposes the water of the acid, and becomes converted into a *protoxide of iron*, which is taken up by the acid, and yields a green solution; from which, on evaporation, green crystals may be obtained of *protosulphate of iron*, commonly known as *green vitriol*.

It appears from the analyses of these compounds that the number 28 may be assumed as the equivalent of iron, and that the protoxide (existing in green vitriol and in the protosalts of iron generally) is constituted of 1 atom of iron $= 28$, and 1 of oxygen $= 8$, and is consequently represented by the equivalent number $28 + 8 = 36$; that the brown or red oxide, or peroxide of iron, consists of 28 iron and 12 oxygen, and is represented by the equivalent 40; and that many of the native oxides, and, generally speaking, the scales of iron, are a definite combination of the above protoxide and peroxide, containing 2 atoms of protoxide and 1 of peroxide.

The most efficient tests of the presence of iron in water, and in solution generally, are the tincture of galls, which produces a purple or dark blue tint in liquids containing very minute proportions of iron, or a black precipitate where the metal is more abundant; and the ferrocyanate of potash, which produces Prussian blue under similar circumstances.

Of the combinations of iron, *steel* is, perhaps, the most important. It is formed by heating pure iron in contact

with charcoal, and is a compound of iron with a small proportion of carbon. *See* STEEL.

The manifold uses of this valuable metal are too well known to require being pointed out; and no one can doubt that its discovery has done more perhaps than any thing else to facilitate the advance of mankind in the career of improvement. "It accommodates itself," as Dr. Ure has observed, "to all our wants, our desires, and even our caprices; it is equally serviceable to the arts, the sciences, to agriculture and war; the same ore furnishes the sword, the ploughshare, the pruning hook, the needle, the graver, the spring of a watch or of a carriage, the chisel, the chain, the anchor, the compass, the cannon, and the bomb. It is a medicine of much virtue, and the only metal friendly to the human frame. The ores of iron are scattered over the crust of the globe with a beneficent profusion, proportioned to the utility of the metal; they are found under every latitude, every zone, and in every mineral formation; and they are disseminated in every soil. But though iron is the most common of the metals, it is by far the most difficult to obtain in a state fit for use; and the discovery of the method of working it seems to have been posterior to the use of gold, silver, and copper. It would be vain to attempt to investigate the steps by which men were at first led to practise the processes required to fuse it, and render it malleable; but that the invention of these curious arts is of a very early date is evident from the fact that Tubal Cain, but a short time after the creation, was "an instructor of every artifice in brass and iron." In most instances, the profane historians of antiquity have either attributed the discovery of iron and its uses to their divinities, or they have deified those to whom they supposed they owed the blessings of so valuable a discovery.

At what period Iron began to be made in this country there is no means of ascertaining; but there is authentic evidence to show that iron works were established by the Romans in the Forest of Dean in Gloucestershire, and in other parts of the kingdom. (*Pennant's Wales*, vol. i. p. 89. ed. 1810.) They were also established at an early period in Kent and Sussex; but it was not till after the celebrated invention of Lord Dudley in 1619, by which pit coal was substituted for timber in the smelting of iron ore, that a great impetus was given to the working of this valuable mineral; an invention which, though interrupted and clogged for a time by the devices of an ignorant rabble, at last established for itself a sure footing both in this and in every other European country. From 1740 (the period at which Lord Dudley's invention became generally adopted) the progress of the manufacture has exceeded the most sanguine expectations; and though we have no means of ascertaining the exact quantity produced, the subjoined estimates will show at once the value of the manufacture, and the unexampled rapidity of its growth during the last century. In 1740, the quantity amounted, in England and Wales only, to 17,000 tons; in 1750, to 22,000; in 1788, to 68,000; in 1796, to 125,000; in 1806, to 250,000; in 1820, to 400,000; in 1827, to 690,000; and in 1840, to upwards of 1,000,000 tons.

IRON PYRITES. *Yellow sulphuret of iron.* A bisulphuret of iron, composed of 28 iron + 32 sulphur. It is a very common and abundant ore of the metal; hitherto it has only been used for the production of sulphate of iron, or *green vitriol;* but attention has lately been turned to it as a source of sulphur.

I'RONY. (Gr. *εἰρωνεία;* from *εἴρων, a dissembler.*) In Rhetoric, the quality of style and of sentiment which Aristotle designates by the term *εἰρωνεία*, is somewhat different from that which bears the same title in modern phraseology, being, in fact, only a subdivision of it. Eironeia, in his sense of the word, is an artful representation of qualities or things as less than they really are. Thus, among the various characters of the human mind as given by him, the *εἴρων* (iron) is one who affectedly conceals or depreciates his own good qualities. Quintilian gives to rhetorical irony a far more general sense, terming it *diversiloquium*, or the use of expressions contrary to the thoughts of the speaker. He also distinguishes it into two species, treating it as a trope or figure of speech where the opposition of thought to language extends only to a few words; a figure of thought, where it extends to a whole passage or discourse. The Socratic irony is employed in argument when one speaker affects to take the positions of the other for granted, in order adroitly to lead him into self-contradiction or obvious absurdity. In the ordinary sense, irony is a more delicate species of sarcasm, by which praises are bestowed where it is intended to convey the opposite sense of disapprobation; or assent is notified where the real object is to express dissent.

IRRADIA'TION, in Physics and Astronomy, is the phenomenon of the apparent enlargement of an object strongly illuminated. The impression produced by light on the retina appears to be extended, though to an extremely small distance, round the focus of the rays concentrated by the lenses of the eye. Hence the image of a star is never a point, but a disc having a sensible diameter, and larger in proportion as the light is more intense; and hence also the luminous part of the moon at her first quarter appears larger than the other. This effect, which is termed *irradiation*, results evidently from the very nature of the organ of vision.

IRRA'TIONAL. In Arithmetic and Algebra, a term applied to numbers or quantities of which the roots are incommensurable with unity, and therefore cannot be accurately extracted. Thus, the root $\sqrt{2}$ is irrational, because it cannot be expressed by any finite number. If the side of a square $= 1$, then $\sqrt{2}$ is its diagonal; and it is proved by elementary geometry that the diagonal of a square is incommensurable with its side. Irrational quantities are also called *surds*.

IRREDU'CIBLE CASE, in Algebra, is that particular case in the solution of a cubic equation in which Cardan's celebrated formula contains an imaginary expression, and therefore fails in its application. This circumstance occasioned great embarrassment to the early analysts, and all the efforts of their successors to overcome the difficulty in a direct way have proved unsuccessful. In order to show in what it consists, let the proposed cubic equation be $x^3 + a\,x + c = 0$; then, by Cardan's rule, we have

$$x = \left(-\tfrac{1}{2}c + \sqrt{\tfrac{1}{27}a^3 + \tfrac{1}{4}c^2}\right)^{\frac{1}{3}} + \left(-\tfrac{1}{2}c - \sqrt{\tfrac{1}{27}a^3 + \tfrac{1}{4}c^2}\right)^{\frac{1}{3}}.$$

Now, if in this expression a is negative, and $\frac{1}{27}a^3$ is greater than $\frac{1}{4}c^2$; then $\frac{1}{27}a^3 + \frac{1}{4}c^2$ will be a negative quantity, and consequently the extraction of its square root will be impossible, or the expression $\sqrt{\frac{1}{27}a^3 + \frac{1}{4}c^2}$ will be imaginary. But it is known from the theory of equations that every cubic equation must have at least one real root; and it is a circumstance not a little remarkable that those cubic equations in which this imaginary expression occurs have not only one real root, but have all the three roots real.

It is possible to disengage the expression for the value of x from the imaginary quantities by expanding it by the binomial theorem; for the imaginary quantities, which will be the same in both the resulting series, will be positive in the one series and negative in the other; and therefore, on adding the series together, they will be eliminated. But the series which results from this addition will very rarely be convergent, consequently this method is of no use whatever. Various indirect methods of finding the roots have been proposed; the following is one of the simplest: —

Let $y^3 - q\,y = r$ be the proposed equation. Find in the trigonometrical tables an arc a whose natural cosine is $3\,r\sqrt{3} \div 2\,q\sqrt{q}$; then the three roots of the proposed equation are,

$$y = 2\sqrt{\tfrac{1}{3}q} \times \cos.\ \tfrac{1}{3}a,$$
$$y = -\,2\sqrt{\tfrac{1}{3}q} \times \sin.\ \tfrac{1}{3}(90^\circ - a),$$
$$y = -\,2\sqrt{\tfrac{1}{3}q} \times \sin.\ \tfrac{1}{3}(90^\circ + a).$$

These formula apply, whether r be positive or negative; but when r is negative, it is more convenient to choose the arc a such that its natural *sine* is $3\,r\sqrt{3} \div 2\,q\sqrt{q}$, and the three roots are then

$$y = 2\sqrt{\tfrac{1}{3}q} \times \sin.\ \tfrac{1}{3}a,$$
$$y = 2\sqrt{\tfrac{1}{3}q} \times \cos.\ \tfrac{1}{3}(90^\circ + a),$$
$$y = -\,2\sqrt{\tfrac{1}{3}q} \times \cos.\ \tfrac{1}{3}(90^\circ - a).$$

See the article "Algebra," by Professor Wallace, in the *Ency. Britannica.*

IRRE'GULAR CADENCE. In Music, one which does not end upon the essential chord of the mode in which a piece is composed. *See* CADENCE.

IRRIGA'TION. (Lat.) The art of watering lands artificially, and by means of surface drains or channels, as contrasted with watering by manual labour. In Britain, and in analogous climates, irrigation is almost exclusively applied to grass lands; but in warmer climates, such as those of Italy, Syria, India, &c., irrigation is considered as essential to the production of large crops in every description of field and garden culture. When any surface is to be irrigated, the supply of water which is to be used for this purpose is conducted to the highest part of that surface, and from thence it is led over it in open gutters, so as to run very slowly, and sink into the earth as it proceeds. As in general no very great extent of surface can be irrigated at once, different parts of a field or farm are irrigated in succession; and in countries where this practice is universal, it often happens that one source of of supply is common to two or more farms, the occupiers of which have it on alternate days. In the south of France and Italy, abundant crops cannot be produced without irrigation. Even the potatoe crop and madder are irrigated in the neighbourhood of Avignon; and in Tuscany wheat, maize, beans, turnips, and every other crop that can be sown in drills in the fields, is watered from artificial channels. The practice is as old as human civilization, and some of the first machines which we read of in history are those for raising water from the Nile for irrigating the lands on its banks. Water, in short, is to the agriculture of warm climates, what manure is to the

cultivator of temperate regions. It is not altogether a substitute for manure; but as in temperate regions water without manure would be of little use, so in warm regions manure without water cannot be rendered fit for being taken up by the roots of plants.

ISBRA'NIKI. In Ecclesiastical History, a name of the Russian sect of Raskolniks. (*Mosheim*, vol. v.)

I'SCHIUM. (Gr. ισχις, *the loin*.) So called from its proximity to the loin. It is one of the bones of the fœtal pelvis, and a part of the *os innominatum* in the adult.

ISCHU'RIA. (Gr. ισχω, *I retain*, and ουρον, *the urine*.) Retention of urine.

I'SINGLASS. A very pure form of *gelatine*, prepared from certain parts of the entrails of several fish. The best is derived from the sturgeon, and is almost exclusively imported from Russia, twisted up in rolls or formed into cakes, which are afterwards torn into shreds or cut into fine shavings in this country. Good isinglass should be free from smell and taste, and perfectly soluble in boiling water.

I'SIS. One of the chief deities in the Egyptian Mythology. It is difficult amidst the mass of contradictory assertions to ascertain the real origin and attributes of this divinity; for while the Egyptians themselves are said to have confined their worship chiefly to Isis and Osiris (quod vide), the Greek and Latin writers, though exceedingly discrepant in details, assert broadly that these two divinities included, under different names, the whole pagan mythology. It would be futile in this place to trace the attempt of the Greeks to identify Isis with Io, the daughter of Inachus, whom they represent to have been introduced into Egypt under the form of a cow, and in that shape worshipped by the inhabitants of the country. By the Egyptians themselves Isis was regarded as the sister or sister-wife of Osiris, who concurred with her in the endeavour to polish and civilize their subjects, to teach them agriculture, and several other necessary arts of life. Among the higher and more philosophical theologians she was made the symbol of Pantheistic divinity: see especially the remarkable passage at the end of the *Golden Ass* of Apuleius. By the people she was worshipped as the goddess of fecundity, and in her honour an annual festival was instituted which lasted seven days. The cow was sacred to her. She was represented variously, though most usually as a woman with the horns of a cow, and sometimes with the lotus in her head and the sistrum in her hand. Her priests were bound to observe perpetual chastity; but on her worship passing into foreign countries, her rites became merely a cloak for sacerdotal licentiousness, which at last reached such a pitch that they were prohibited at Rome; and Tiberius, in the hope of annihilating them for ever, ordered the images of the goddess to be thrown into the river. The worship of Isis, however, was afterwards revived, and furnished an ample theme for the indignant pen of Juvenal. The *Isiac Table* in the Turin Museum, which was so long supposed by the learned to represent the mysteries of Isis, "has been judged by Champollion to be the work of an uninitiated artist little acquainted with the worship of the goddess, and probably of the age of Hadrian." (*Creuzer's Mythol.; Plutarch's Treatise on Isis and Osiris*, &c. &c.; an Essay by De Montfaucon, *Hist. de l'Ac. des Inscr.* vol. xvi., which contains a summary of the Grecian learning on the subject; *Mem. de l'Ac. des Inscr.* xxxiv.; and *Quart. Rev.*, July, 1840.)

Isis. (*Isidos proclamos*, a marine plant, like coral, according to Pliny.) The name of a genus of jointed coral, in which the joints are composed of substance resembling horn.

I'SLAM, or ESLAM. The religion of Mohammed. The body of the faithful, and the countries wherein it is professed, are so termed by the Mohammedans. The original word is said to signify *submission to God*. All those who professed the true religion and the unity of God, before the arrival of Mohammed, are considered as comprised in the character and privileges of Islamism. The Mufti of Constantinople, or chief minister of religion in Turkey, bears the title of Sheikh-ul-Islam.

ISLAND. (Lat. insula.) A tract of land encompassed with water, whether of the sea, a river, or a lake; in contradistinction to *continent* or *terra firma*.

ISLANDS OF THE BLESSED. (Insulæ Beatorum, Fortunatæ Insulæ; Νησοι Μακαρων.) According to the Grecian Mythology, the Happy Islands, supposed to lie westward in the ocean, whither after death the souls of the virtuous were transported. In the early mythology of the Greeks, the Islands of the Blessed, the Elysian fields, and the infernal regions, were generally confounded with each other. *See* Elysium.

ISMAE'LIANS. A Mohammedan sect, who derived their name from maintaining the pretensions of Ishmail, the son of Jaafar, to the rank of Imam, to the exclusion of Moussa, who was adopted by that saint. They consequently rejected the claims of Moussa and the five subsequent Imams. The Ismaelians formed a secret association, founded in the 10th century of the Christian era by Abdallah, a Persian. From them originated the famous society of the Assassins. (*Taylor's Hist. of Mohammedanism*, p. 225.; *Mem. de l'Ac. des Inscr.* vol. xvii.; "Secret Societies of the Middle Ages," published in the *Library of Entertaining Knowledge*, 1837.)

I'SOCHROMA'TIC. (Gr. ισος, *equal*, and χρωμα, *colour*.) Having the same colours. In certain experiments with doubly refracting crystals, the decomposed light forms a double series of coloured rings or curves of different forms, arranged in a certain order, each curve in the one series having one corresponding to it both in form and colour in the other. The two curves or lines which have the same tint are called *isochromatic*. (See Herschel's Treatise on Light, in the *Ency. Metropolitana*.)

ISO'CHRONAL, or ISOCHRONOUS. (Gr. ισος, and χρονος, *time; performed in equal times*.) Two pendulums which vibrate in the same time are isochronal; or the vibrations of a pendulum in the curve of a cycloid are so, being all performed in the same time, whether the arc be large or small. *Isochronal lines* are those along which a heavy body descends with a uniform velocity.

ISO'DOMUM. (Gr. ισος, and δομη, *structure*.) In Ancient Architecture, a species of walling in which all the courses were the same height.

I'SOLATED. (Fr. *isolé*, from the Ital. isola, Lat. insula, *an island*.) In Electricity, a body is said to be isolated when it is surrounded by non-conductors, or bodies to which it cannot communicate its electric virtue, except by induction. Bodies may be isolated in various ways; by suspending them by means of silken cords; by placing them on a cake of wax, resin, or sulphur, or on a stand of glass or dry varnished wood, &c.

ISO'MERISM. (Gr. ισος, and μερος, *part*.) Compounds which contain the same elements in the same ratio, and yet exhibit distinct chemical qualities, are said to be *isomeric*. The cyanic and fulminic acids are isomeric compounds of nitrogen, oxygen, and carbon. The distinctions thus arising are probably referable to the different ways in which the same elementary atoms are gropued in the compound.

ISOMO'RPHISM. (Gr. ισος, and μορφη, *form*.) Substances which resemble each other in their crystalline forms, but differ in their component parts, are said to be *isomorphous*. Thus the phosphate and biphosphate of soda have the same form, or are *isomorphous*, with the arseniate and binarseniate of soda; and in regard to other bases, such as potash and ammonia, each arseniate has a corresponding phosphate possessed of the same form. In these cases there is necessarily an analogy in the atomic constitution of the compounds, which are observed to possess the same number of equivalents of acid, alkali, and water of crystallization, and differ in nothing except that the one series contains an atom of arsenic, and the other an atom of phosphorus.

I'SOPE'RIME'TRICAL FIGURES (Gr. ισος, and περιμετρον, *circumference*), are such as have equal perimeters or circumferences. The term isoperimetrical problems, in modern analysis, designates a very extensive and difficult class of problems, the solution of which requires the application of a peculiar analysis. The general problem is this: — Among all curves having the same length, to determine that of which some assigned property is a maximum or a minimum; for example, among all curves having the same perimeter, to find that which has the greatest area. This is the simplest question of the kind, and the curve to which the property belongs is proved by elementary geometry to be a circle.

In all isoperimetrical problems there are two conditions to be fulfilled: according to the first of which a certain property is to remain constant, or to belong to all individuals of the species; and according to the second, another property is to be the greatest or least possible. In the problems of this kind which first attracted the particular attention of mathematicians, the constant quantity was the perimeter of a certain curve; and hence the origin of the term, which is now applied to all problems indifferently in which the question is to find curves having a property of maximum or minimum, with or without the condition of equality of perimeters.

James Bernoulli was the first who discovered the true principles on which questions of this kind depend, and the circumstances which render the ordinary methods of maxima and minima inapplicable to them. The immediate subject of his researches was the problem of the Brachystochrone (see the term), or curve of quickest descent, celebrated in the early history of the calculus on account of the controversy to which it gave rise between the two brothers, James and John Bernoulli. The analysis of the former, *Analysis magni Problematis Isoperimetrici*, was published at Basle in 1701, and in the *Leipsic Acts* of the same year. Solutions were afterwards given by Taylor in his *Methodus Incrementorum*; by John Bernoulli in the *Memoirs of the Academy of Sciences* for 1718; and by Euler in the *Petersburg Memoirs*. Euler afterwards gave a complete and general solution of the problem in his *Methodus Inveniendi Lineas Curvas Maximi Minimive proprietate gaudentes*, a work of which Lagrange has said that there is perhaps no other which can be of more use

to those who wish to exercise themselves in the integral calculus. The method, however, which is followed in this work has been superseded by the invention of the *calculus of variations* by Lagrange; a most important branch of analysis, of which the subject of isoperimetrical problems is one of the most obvious applications. (Lagrange, *Leçons sur le Calcul des Fonctions*; Woodhouse, *On Isoperimetrical Problems*; Lacroix, *Traité du Calcul Différentiel et Intégral*; *Airy's Tracts*, &c.)

ISO'PODA. (Gr. *ισος*, and *πους*, *a foot*.) The name of an order of Crustaceans, comprehending those which have the legs all alike, and adapted only for locomotion and prehension.

I'SOPO'DIFORM. The larvæ of Saprophagous Hexapods are so called which have an oblong body, a distinct thoracic shield, and a vent provided with filaments or laminæ.

I'SOPYRE. (Gr. *ισος*, and *πυρ*, *fire*.) In Mineralogy, a silicate of alumina, lime, and peroxide of iron, found near the granite of St. Just, near Penzance in Cornwall. It is a black amorphous substance, occasionally variegated with grey or red spots or streaks, slightly translucent. Its specific gravity is about 3.

ISO'SCELES. (Gr. *ισος*, and *σκελος*, *leg*.) In Geometry, an isosceles triangle is that which has two equal sides. Among the properties of isosceles triangles, one is that the angles at the base are equal; and as the demonstration which is given of this proposition in *Euclid's Elements*, where it stands at the very commencement, is somewhat intricate and puzzling to beginners, the proposition has been called the *pons asinorum*.

ISOSTE'MONOUS (Gr. *ισος*, and *στημων*, *a stamen*), in Botany, in expressing the proportion that one part bears to another, denotes that the stamens are equal in number to the petals.

ISOTHE'RMAL. (Gr. *ισος*, and *θερμη*, *heat*.) In Physical Geography, *isothermal lines* are those which pass through those points on the surface of the earth at which the mean annual temperature is the same. *Isothermal zones* are spaces on opposite sides of the equator having the same mean temperature, and bounded by corresponding isothermal lines. On account of the irregular form and disposition of the continental masses, by which the climate of different places is greatly influenced, the isothermal curves are not parallel to the equator, excepting in the very low latitudes. According to Humboldt, the isothermal line which corresponds to the temperature of 32° of Fahrenheit passes between Ulea in Lapland, lat. 66°, and Table Bay on the coast of Labrador, lat. 54°. The isothermal line of 41° passes near Stockholm, lat. 59½°, and St. George's Bay, Newfoundland, lat. 48°. The line of 50° passes through the Netherlands, lat. 51°, and near Boston in the United States, lat. 42½°; that of 59° between Rome and Florence, lat 43°, and Raleigh in North Carolina, lat. 36°. In all these cases we see that the isothermal lines, in passing from the western side of the continent of Europe to the eastern coast of America, deviate very considerably towards the south; the deviation, in one case, amounting to 11½° of latitude. In passing over the American continent, they again recede to the northward; and in California, and to the north of that peninsula, along the western side of the continent, the annual temperature is nearly the same as under similar latitudes in the west of Europe. From the western to the eastern side of the old continent, the flexure of the isothermal curves and the diminution of the mean annual temperature under the same parallels are not less conspicuous. The isothermal line of 55° passes through Nantes, lat. 47°, and Pekin, lat. 39¼. Edinburgh and Kasan (in the east of Russia) have the same latitude; but the mean annual temperature of the former is 48°, while that of the second is below 38°. For the different causes which affect the parallelism of the isothermal lines, or which produce the differences of the mean annual temperature of places under the same parallel of latitude, see CLIMATE.

Humboldt gives the name of *isotheral lines* (*ισος*, and *θερος*, *summer*) to the curves passing through those places at which the mean summer heat is the same; and of *isochimenal* (*ισος*, and *χειμων*, *winter*) to those which pass through the places at which the mean temperature of winter is the same. The isotheral and isochimenal curves deviate much more from the parallels of latitude than the isothermal. The latitudes of places having the same winter temperature sometimes differ so much as 18° or 20°. The winter of Scotland is as mild as that of Milan. The mean temperature of the winter months at Edinburgh is about 38½°; of Kasan, under the same parallel, only 2°. The winter of Pekin is as rigorous as that of Stockholm. (*Humboldt's Fragmens Asiatiques*; *Murray's Geography*, Introduction.)

I'SSUANT. In Heraldry, a charge represented as issuing or coming up from another charge or bearing; also, a lion or other beast represented as rising from the bottom line of a chief.

I'SSUE. In Law, in the most ordinary senses of the word,—1. The points in dispute in a suit at law between two parties, ascertained by the pleadings, are termed the issues; and are either issues in law, to be determined by the court, or in fact, to be ascertained by a jury. In each form of action (*see* ACTION, PLEADING) there was formerly a formal trasverse, by which the whole or principal part of the allegations of the plaintiff in his declaration might be denied: this was termed the general issue. Since the adoption of the new rules of pleading (1834), there is now properly speaking no general issue; except in certain cases, where the privilege of giving special matter in evidence under it is given by statute. A *feigned issue* is a technical mode of trying some questions, supposing an imaginary wager. In the Scottish practice of trial by jury it is usual to put printed copies of the Issues into the hands of the jurors.—2. The legitimate offspring of a man.

ISSUE, in Surgery, is an artificial ulcer. It is commonly made by wounding or cutting the skin, and placing a pea upon it, which is pressed upon the part by a bandage.

I'STHMIAN GAMES. One of the four great national festivals of Greece; so called from their being celebrated on the Isthmus of Corinth. They were common to all the states, with the exception in this case of the Eleans, against whom a curse had been pronounced should they ever present themselves there. They were held near a temple of Neptune, the god who presided over them; and were celebrated every third year, according to some accounts, but others assign them a period of one or four years. The contests were the same as in the other sacred games (*see* OLYMPIC GAMES): the victors were crowned with garlands of pine leaves. (See *Potter's Grecian Antiquities*; *Wachsmuth's Historical Antiquities*, ii. 162. translation.)

I'STHMUS. In Geography, a narrow neck of land joining two continents, or a continent and peninsula. Thus, the Isthmus of Darien, joining North and South America; the Isthmus of Suez, connecting Africa with Asia.

ITALIAN ARCHITECTURE. *See* ARCHITECTURE.

ITA'LIC SCHOOL OF PHILOSOPHY, comprehends properly the Pythagorean and Eleatic systems taken together; but sometimes it is used as synonymous merely with the school of Pythagoras. Under the several heads will be found the chief features of these philosophical systems, which, comprising as they do all that can be said in reference to the Italic school, it would seem unnecessary in this place further to advert to. The Italic school has been so designated because its founder, Pythagoras, taught in Italy, spreading his doctrine among the people of Tarentum, Metapontum, Heraclea, Naples, &c.

ITCH. A disease of the skin, consisting in an eruption of minute itching vesicles, which are commonly rendered more inflamed and troublesome by scratching. They generally make their first appearance between the fingers, or about the bend of the wrist, and often spread to other parts of the body, especially where cleanliness is neglected. The itch is highly contagious, and is supposed to depend upon a minute insect burrowing in the skin; some have regarded the insect as a consequence, and not the cause, of the disease. The itch is cured by sulphur, which should be given internally, and applied externally in the form of ointment.

ITIHA'SAS. The two great heroic poems of the Hindoos, the *Ramayana* and *Maha Bharata*, are so called. They are of great antiquity; later, however, than the *Vedas*. Some, indeed, have attributed the latter poem to a period later than that of Alexander.

ITI'NERARY. (Lat. iter, *a journey*.) In Literature, a work containing notices or descriptions of the places and stations to be met with in pursuing a particular line of road; as, an Itinerary from Paris to Rome: or of the principal places and stations on the great roads throughout a country; as, Itinerary of France, Italy, &c. The Latin Itineraries which have been preserved to us consist merely of catalogues of stations; and are principally valuable to us because they contain the distance, in Roman miles, from one to another, and thus furnish us with assistance towards determining the actual site of each place mentioned.

I'TIS. This termination, added to the genitive case of the Greek name of an organ or part of the body, implies *inflammation* of that part; as, *gastritis*, inflammation of the *stomach*; *pleuritis*, of the *pleura*, &c.

I'TTNERITE. Named after Ittner. A rare mineral, which occurs massive and in rhombic dodecaedrons, of a grey or blueish colour. It consists chiefly of silica, alumina, and soda, together with some hydrosulphuret.

IU'LUS. (Lat.) A genus of Myriapodous insects, characterized as follows:—Antennæ with seven joints, slightly enlarged towards the end; mandibles two, thick, without palps, each divided into two by a middle joint; provided with imbricated teeth; an inferior lip formed by the confluence of two maxillæ; feet attached in double pairs to most of the joints; body long, cylindrical, capable of being contracted into a discoidal spire. The common gally-worm (*Iulus terrestris*) is an example of this genus.

I'VORY. The tusk of the male elephant. It is less

brittle than bone, and of a beautifully uniform texture, admitting of turning in the lathe and receiving a high polish. It consists of about 24 per cent. animal matter resembling horn, and 66 of phosphate, with a trace of carbonate of lime. The chief consumption of ivory in England is in the manufacture of handles for knives; but it is also extensively used in the manufacture of musical and mathematical instruments, chess-men, billiard-balls, plates for miniatures, toys, &c. Ivory articles are said to be manufactured to a greater extent, and with better success, at Dieppe, than in any other place in Europe; but the preparation of this beautiful material is much better understood by the Chinese than by any other people. No European artist has hitherto succeeded in cutting concentric balls after the manner of the Chinese; and their boxes, chess-men, and other ivory articles, are all far superior to any that are to be met with any where else.

The western and eastern coasts of Africa, the Cape of Good Hope, Ceylon, India, and the countries to the eastward of the Straits of Malacca, are the great marts whence supplies of ivory are derived; but the most esteemed come from Africa, being of a closer texture and less liable to turn yellow than those from the East Indies. The medium weight of a tusk is about 60 lbs., and the average importation for the three years ending 1838 was 5752 cwt., yielding a duty of 5752*l.*

I'VORY BLACK. The mixture of charcoal and phosphate of lime obtained by burning bone is sold under this name, and, like other forms of animal charcoal, is very effective in depriving certain substances of their colour.

JABI'RN. The name of a Grallatorial or wading bird belonging to the genus *Mycteria*. See that word.

JACAMA'R. A genus of Scansorial birds. *See* GALBULA.

JACA'NA. The wading birds of the genus *Parra* are so called. *See* PARRA.

JA'CCHUS. (Gr. *ιαχω, I cry aloud.*) A genus of Platyrrhine Quadrumana, or South American monkeys, with thumbs on the hind foot only; all the digits of the fore foot having the same direction, and being armed with narrow, curved, claw-like nails. The characters of the genus are, — upper middle incisors separated from and larger than the lateral ones; lower incisors elongated, narrow, and vertical, the lateral ones the longest; upper canine teeth conical, and of moderate size, but more developed than the lower ones. The species of *Jacchus* are few in number, and not very clearly defined; they are all of small size. The *Jacchus penicillatus*, which is remarkable for the radiated tuft of white hairs which projects in front of each ear, has bred in captivity in this country. It is a very delicate little animal, susceptible of cold, and provided with a long and bushy tail, which it wraps round its head and body when asleep or requiring warmth. Its food is of a mixed nature; but in the wild state the banana is said to be its principal and favourite nutriment.

JACK. In Mechanics, an engine for raising heavy weights.

Jack is also the name given to a machine in common use for turning a spit. The common roasting jack, or worm-jack, consists of a double set of wheels; a barrel, round which the chain attached to the weight or moving power is wound; a perpetual screw; and a fly, which secures a steady uniform motion. A multiplying wheel is usually added, in order that the weight may be longer in running down.

The *smoke jack* is used for the same purpose as the common jack, and is so called because it appears to be moved by the smoke of the fire. It is in fact moved by the ascending current of rarified air, which acts on a fan properly placed in the chimney. The motion may be obtained by various contrivances. Sometimes spiral flyers coiled about a vertical axis are employed, but more frequently a vertical wheel with oblique leaves like the sails of a windmill.

JACK, in Nautical language, is a flag or colours used in making signals. In the British navy, the Jack is a small union flag, composed of red and white crosses; in merchants' ships, this union is bordered by a red field.

JACK. A common name for the pike. *See* ESOX.

JACK, in Botany, is the name of the *Tsjaca* or *Actocarpus integrifolia*, a species of the bread-fruit tree, found in the Indian Archipelago.

JA'CKAL. (Ar. tschakkal; Fr. chacal.) A wild species of dog, the *Canis aureus* of Linnæus; of gregarious habits; hunting in packs; rarely attacking the larger quadrupeds, but supposed to indicate their presence to the lion by the piercing cries which the jackals set up in chorus while scenting their tracks; feeding on the remnants of the lion's prey, on dead carcasses, and the smaller animals and poultry. The jackal interbreeds with the common dog; its period of gestation is the same, and the hybrid progeny is fertile. The wild jackal emits a highly offensive odour, which is scarcely perceptible in the domesticated animal. Some are of opinion that the 300 animals, called foxes, between whose tails Samson is said to have put firebrands in order to destroy the crops of the Philistines, were jackals. The *Canis aureus* is abundant in the warmer parts of India and Africa, but is not found in the new world.

JA'CKDAW, or DAW. (*Corvus monedula*, Linn.) A common English bird, which frequents church steeples, old towers, and ruins, in flocks, where they build their nests: the female lays five or six eggs, paler and smaller than those of the crow. The daw may be readily tamed, and taught to imitate the sounds of words. Like other species of the crow genus, they have the singular habit of stealing and hiding glittering and metallic substances.

JACKS. Wooden wedges used in coal mines.

JACK SINKERS. Parts of a stocking frame.

JACK TIMBERS. In Architecture, those in a bay of timbers which, being intercepted by some other piece, are shorter than the rest: thus, in a hipped roof, each rafter which is shorter than the side rafters is called a *jack rafter*.

JA'COBINS. In French History, a political club, which bore a well-known part in the first revolution. It was first formed by some distinguished members of the First Assembly, particularly from Britanny, where revolutionary sentiments ran high. They took at first the name of Friends of the Revolution; but as at the end of 1789 they held their meetings in the hall of a suppressed Jacobin monastery in the Rue Saint Honoré, the name of Jacobins, at first familiarly given them, was finally assumed by themselves. The history of the Jacobin club is, in effect, the history of the Revolution. It contained at one time more than 2500 members, and corresponded with more than 400 affiliated societies in France. The club of the Cordeliers, formed by a small and more violent party out of the general body of Jacobins, was reunited with the parent society in June, 1791; but continued to form a separate section within its limits. The Jacobin club, which had almost controlled the first assembly, was thus, during the continuance of the second, itself divided between two contending parties; although the name of Jacobins, as a political party, is commonly given to that section which opposed the Girondists or less moderate in the club no less than in the assembly. After the destruction of the latter under the Convention, the club was again exclusively governed by the more violent among its own members, until the downfal of Robespierre. After that period it became unpopular; and its members having attempted an insurrection on behalf of the subdued Terrorists, Nov. 11. 1794, the meeting was dispersed by force, and the club finally suppressed. Some writers, such as Barruel (*Hist. du Jacobinisme*), have seen in the first formation of this and similar societies, the long-concocted operations of a conspiracy against legitimate government and religion throughout Europe. The Jacobins, and the other principal clubs of the Revolution, adopted all the forms of a legislative assembly. In the constitution of 1792, their legal existence was recognized. See the historians of the French Revolution, especially Carlyle, Mignet, and Thiers, for general views; Messrs. Buchez et Roux, *Histoire Parlementaire de la Rev. Française*, for the most complete series of details respecting the Jacobins and their meetings which has yet been made public.

JACOBINS. In Ecclesiastical History, the religious of the order of St. Dominic were so called in France, from the situation of the principal convent at Paris, near the Rue St. Jacques; also called *Frères Prêcheurs*.

JA'COBITES. In English History, that party which, after the Revolution of 1688, adhered to the dethroned monarch James I., and afterwards to his descendants. In Scotland and Ireland, where the revolution was not effected except with the assistance of arms, the Jacobite party formed one of the two great divisions of each nation; and although crushed in the latter country by conquest, they continued in the former to comprise a large proportion of the population until long after the last rebellion in 1745. But in England the revolution was effected at first with the consent of all parties; the adherents to the exiled monarch were silenced: yet, in a year or two, the Jacobite faction rose into strength, and continued to harass the government of William throughout his reign. "It seems undeniable," says Hallam (*Constitutional History of England*, vol. iii. p. 149.), "that the strength of the Jacobite faction sprung from the want of apparent necessity for the change of government." Its immediate cause, however, was to be found in the refusal of a portion of the bishops and clergy to take the oaths to the new government (*see* NONJURORS), which gave, as it were, a certain consistency and tangible ground of opposition to the friends of the dethroned monarch in general. At the same time many of William's chief advisers and officers maintained a secret correspondence with James II. at the French court, less from any attachment to his cause than with a view to secure their own interest in case of his return. After the death of James II. in France, and accession of Anne in England, the efforts of the party languished for

a time; but towards the close of her reign they revived, on the prospect of a change in the succession. We have now undeniable proofs, from the French archives, of a fact which had been long suspected, that Bolingbroke and Oxford, with others of Anne's Tory ministers, were in treaty with the son of James II., and either really or in pretence negotiating for his return. In 1715, on the arrival of George I., broke out the unsuccessful first rebellion in Scotland: its ill conduct and failure proved a considerable check to the hopes of the English Jacobites. Bishop Atterbury, the last of their bolder intriguers and adherents, was banished in 1722: after which time it is probable that no extensive conspiracy took place on their part. In Scotland, however, the party maintained its strength unabated, until the second rebellion of 1745, by its complete failure, put an end to its political existence. It is said that some of the party maintained a correspondence with Charles Edward, until his decease in 1787. The Cardinal of York, his brother, died in 1807; and it has been said that, by his death, the adhesion of the Jacobites, if any existed, was transferred to the reigning family as his next heirs. This, however, is a vulgar error; the royal house of Sardinia and other families intervening between the house of Brunswick and the crown of England, according to the strict rules of hereditary descent.

JACOBITES. In Ecclesiastical History, the monophysite Christians of Syria are so called, from Jacob Baradzi, who revived their belief and form of worship in that country and Mesopotamia, in the middle of the 6th century. Many unsuccessful attempts have been made at various times to unite them with the church of Rome. (*Gieseler's Text Book*, Transl., ii. 419., iii. 414, &c.) *See* MONOPHYSITES, EUTYCHIANS.

JA'COB'S LADDER. In Naval affairs, a rope-ladder with wooden steps or spokes.

JACOB'S STAFF. The same as *cross-staff*. An instrument used by surveyors in measuring heights and distances where expedition and little accuracy are required.

JACQUA'RD. A piece of mechanism applicable to silk and muslin looms for the purpose of weaving figured goods. The name is that of its inventor. (For a description of the loom, see *Ure's Dictionary of Arts and Manufactures*.)

JA'CQUERIE. In History, the name popularly given to a revolt of the French peasantry against the nobility, which took place while King John was a prisoner in England in 1356. *Jacques Bonhomme* was a term of derision applied by the nobles to the peasants, from which the insurrection took its name. It began in the Beauvoisis, under a chief of the name of Caillet, and desolated Picardy, Artois, and Brie, where savage reprisals were executed against the nobility for their oppressions. It was suppressed after some weeks by the dauphin and Charles the Bad, king of Navarre. A similar spirit in England produced not many years afterwards the rebellion of Wat Tyler. (See Mézeray, i. 838.; Froissart; Sismondi, *Hist. des Français*, vol. x.)

JADE. In Mineralogy, a synonyme of *nephrite*.

JAGUA'R. (*Felis onca*, Linn.) The largest and most formidable feline quadruped of the new world. It is marked with large dark spots in the form of circles, with a dark spot or pupil in the centre of each; it is generally pretty numerous in the neighbourhood of the large rivers where the capibara abounds, and preys chiefly on those large Rodents.

JA'LAP. So called from Xalapha in Mexico, whence it originally came. The dried root of the *Ipomæa jalapa*. This root occurs in irregular globular pieces of a dense and resinous texture: when reduced to powder it has a very peculiar and nauseous odour and taste. In doses of from five to twenty grains, jalap is a drastic purge: it is apt to gripe and nauseate.

JAMB. A Sea term; to squeeze tight. The opposite of jamb, applied to a rope, is *to render*.

JAMBS. (Fr. jambes.) In Architecture, the side or vertical pieces of any opening in a wall which bear the piece that discharges the superincumbent weight of such wall.

JA'MESONITE. A mineral named after Professor Jameson. It occurs crystallized and massive: it consists of sulphur, lead, and antimony.

JAMES, SAINT, OF THE SWORD, ORDER OF. A very ancient military order in Spain and Portugal. The reigning kings are grand-masters in those countries respectively. The orders in the two countries were disunited in 1288.

JA'NISSARIES, or JA'NIZARIES. (A corruption of the Turkish word *yeni tscheri*, new troops.) A celebrated militia of the Ottoman empire. The establishment of this corps has been usually attributed to Sultan Amurath I. in 1368; but the researches of Hammer (*History of the Ottoman Empire*, vol. i. p. 92.) carry it back to Orchan, the conqueror of Nicæa (1326). This new corps was blessed by a saint of that time, Hadji Bektash by name, who cut off a sleeve of his fur mantle and gave it them as a token; whence was derived the fur cap that remained their distinguishing characteristic. This irregular infantry long remained the chief military strength of the empire, and formed a kind of warlike republic within its limits. It was long supplied chiefly by the capture of young Christian slaves; and when under Mohammed IV. it began to be recruited principally from the children of the soldiers themselves, its power and importance gave signs of decay. Each regiment or oda of the Janizaries had its own soup kettle, which, in process of time, acquired a sort of prescriptive sanctity, and formed, as it were, the chief standard of the regiment; and the officers and other military functionaries drew their titles from their various supposed employments as cooks or kitchen servants. The militia of the Janizaries continued to retain a great influence in the empire itself long after it had ceased to be serviceable in the field against the armies of modern Europe. They controlled the sultans themselves, and, as it is alleged, presented a serious obstacle to all improvement, until in the year 1826 the late sultan, on the occasion of a mutiny, dissolved the whole corps, after a bloody struggle in his capital in which 20,000 of them were said to have perished; but the number is now thought to have been exaggerated. There was an official publication relating to the destruction of the Janizaries, which was translated into French (Paris, 1833). See also *Walsh's Residence at Constantinople; Duval, Deux Années a Const.* (1828); *Quarterly Review*, vol. xli.; and *Ed. Rev.* vol. l.; *Slade's Travels in Germany, Turkey, &c.* (1840).

JA'NSENISTS. A denomination of Roman Catholics in France, who followed the opinions of Jansen, bishop of Ypres, and formed a considerable party in the latter half of the 17th century. The Jansenists were Calvinistic in many of their sentiments, and in several respects approximated to the Reformed opinions. They did not, however, separate themselves from the Catholic church; nor did they long survive the decree of Alexander VII., by which certain propositions extracted from their writings are condemned as heretical. The Jansenists are chiefly celebrated for the contest they maintained with the Jesuists, by whom they were at last overcome, and subjected to the enmity both of Louis XIV. and the Pope. (See Leclerc, *Bibl. Univ.* vol. xiv.; Racine, *Histoire du Port Royal;* Fontaine, *Mémoires pour servir à l'Hist. du P. R.; Saint Simon's Memoirs;* Palmer, *Essays on the Church*, i. 320. &c.; *Hallam on the Literature of Europe*, vol. iii.; Schrökh, *Kirchengeschichte, seit der Reformation*, parts iv. and vii.; *Mosheim*, translation, ed. 1790, vol. v. 208. &c.)

JANTHI'NA. (Gr. *ιανθον, violet colour.*) A genus of Gastropodous Testaceous Mollusks, so denominated on account of the beautiful violet colour of the shell. There are but a few species of this genus known, all of which are marine, and are generally met with floating on the surface of the ocean in warm and tropical latitudes. The shell, as in all floating pelagic Testacea, is light and fragile, whence the specific name of the most common species (*Janthina fragilis*); but besides this relation of the shell to the habits and sphere of existence of the animal, each species also possesses a peculiar organ, by which it can, as it were, suspend itself to the surface of the water, and which has not hitherto been observed in any other molluscous species: this organ consists of a congeries of transparent vesicles filled with air, the parietes of the bubble-like cells being composed of a thin colourless condensed mucus, and the whole being attached to the posterior part of the foot. On account of this place of attachment, the vesicular float has been regarded as the analogue of the operculum, which otherwise is wanting; but there is an important difference connected with the float, viz. the power which the animal has, and frequently exercises, of detaching and reproducing it at will. Thus the mucous air-vesicles are cast off when the animal desires to sink: they are also made subservient to the reproductive economy of the janthina, which attaches its egg-cells to the under surface of the float, and when it is thus laden casts it off. By this means the ova are preserved in a situation where they may best receive the full influence of heat and light; and the power which the parent possesses of reproducing its float obviates the inconvenience which would otherwise result from this contribution to the well-being of its offspring. The following is the process by which the janthina has been observed to repair a mutilation purposely made in its float:—The foot was advanced upon the remaining vesicles until about two thirds of that part rose above the surface of the water; it was then expanded to the uttermost, and thrown back upon the water, like the foot of a Lymnea when it begins to swim; it next became contracted at the edges, and was formed into the shape of a hood, enclosing a globule of air, which was slowly applied to the extremity of the float; there was now a vibratory movement throughout the foot, and when it was again thrown back to renew the process the globule was found inclosed in its newly made envelope. From this it results that the membrane inclosing the cells is secreted by the foot, and

that there is no attachment between the float and the animal other than that arising from the nice adaptation and adjustment of the adjoining surfaces.

The genus *Janthina* belongs to the Pectinibranchiate order of Gastropods; the branchial cavity is capacious, and contains two pectinated gills. Cuvier places the genus between *Pyramidella* and *Nerita;* M. Roux considers it to be intermediate to *Ampullaria* and *Litiopa.*

JA'NUARY. The first month of the year. By some the name is derived from Janus, a Roman divinity; by others from janua, *a gate.* The months of January and February were inserted in the Roman year by Numa Pompilius. The Roman feast of the kalends of January seems to have been converted in the 6th century into the Christian festival of the circumcision. (Beugnot, *Destr. du Paganisme en Occident,* vol. ii.)

JA'NUS. A Latin deity, originally the same as the sun. He was represented with two faces looking opposite ways, and holding a key in one hand and a staff in the other. He presided over the commencement of all undertakings, whence the first month in the year was named after him. His temple at Rome was kept open in the time of war, and shut in peace. The warlike disposition of the Romans is manifest from the fact that this temple was only shut six times in 800 years: viz. once in the reign of Numa; at the conclusion of the first Punic war; thrice in the reign of Augustus; and once again under Nero.

JAPA'NNING. The art of covering paper, wood, or metal with a thick coat of a hard brilliant varnish: it originated in Japan, whence articles so prepared were first brought to Europe. The material, if of wood or papier-machée, is first sized, polished, and varnished; it is then coloured, or painted in various devices, and afterwards covered with a highly transparent varnish or lacquer, which is ultimately dried at a high temperature and carefully polished.

JA'RGOON. In Mineralogy, one of the varieties of *zircon.*

JARL. A word of Scandinavian extraction, signifying noble; applied in the early history of the northern European kingdoms to the lieutenants or governors appointed over each province. It appears to bear considerable analogy to the English earl (quod vide).

JASMINA'CEÆ. (Jasminum, one of the genera.) A small natural order of Exogenous plants, with monopetalous diandrous flowers of a regular figure. It contains few species, chiefly inhabiting the warmer parts of the world. The only plants of any interest are the jasmines, well known for their fragrance.

JA'SPER. A siliceous mineral of various colours; sometimes spotted, banded, or variegated. It takes a fine polish, and the variety and richness of its colours render it useful in the ornamental arts.

JAU'NDICE. A disease characterized by a yellow colour of the eyes and skin, deep-coloured urine, and pale evacuations from the bowels; it comes on with languor, loss of appetite, dyspeptic symptoms, vomiting, bitter taste in the mouth, and generally pain in the region of the liver. It is apparently caused either by obstruction of the duct that conveys the bile into the intestine by a gall stone; or by a morbid and viscid state of the bile, which prevents its flowing freely; or by spasm of the gall ducts, or by some accidental pressure: the consequence is that the bile, instead of passing off by the bowels, is absorbed into the blood, and becomes visible upon the skin, and especially in the more delicate vessels. It is an occasional consequence of pregnancy. It sometimes affects infants soon after birth; in which case it usually goes off in a few days, aided by gentle aperients. The most common cases of jaundice are probably occasioned by viscidity of bile. Aperients and small doses of blue pill, with tonics, are the most essential remedies; and where it ensues in sedentary habits, moderate walking and horse exercise are requisite. It is often a protracted and troublesome complaint, and then indicative of structural derangement. Jaundice from gall stones is often attended by excruciating pain and vomiting, owing to the passage of the stone. Opiates and such remedies as allay the irritability of the stomach are to be had recourse to, and the warm bath is useful. It is the beneficial influence of saline aperients and diluents in this disorder, that has given celebrity to the waters of Cheltenham and similar mineral springs.

JA'VELIN. (Fr. javeline.) A sort of spear or missile, anciently used both by horse and foot soldiers. It was about five feet long, with an iron head hooked and jagged at the end. The *pilum* of the Romans was of this description.

JAY. The native bird so called is a species of the genus *Garrulus,* separated by Cuvier from the genus *Corvus* of Linnæus on account of the weaker mandibles terminating in a sudden and nearly equal curve. The tail is cuneiform, not long; and the slender feathers of the forehead can be erected like a crest. The common jay (*Corvus glandarius,* Linn.) nidificates in woods, and builds a simple nest of sticks and slender twigs; the female lays five or six eggs, of a greyish ash-colour mixed with green, and faintly spotted with brown. The young associate with the parents till the following spring, when they separate to form new pairs.

JEERS. Strong tackles for *swaying up* or raising the lower yards.

JE'FFERSONITE. In Mineralogy, a species of *pyroxene.* It is found in New Jersey.

JEHO'VAH. The name by which the Deity is represented in the Hebrew Scriptures; in which language it signifies the *Self-existent,* the *I Am.* The word itself was held in peculiar veneration by the Jews, who never allowed themselves to pronounce it in the reading of their sacred books, but substituted for it wherever it occurred the term Adonai, or *Lord.* This practice is maintained even to this day; nor will they *write* the word in perfect Hebrew letters. And agreeably to this scruple they have left the word Jehovah imperfectly written over the beautiful altar-piece in the recently-erected synagogue in St. Helen's Place; making it to resemble that word, but in reality to signify *the Beloved.*

JEJU'NUM. (Lat. jejunus, *empty.*) The second division of the small intestines; so termed because when examined after death it is generally found empty or nearly so.

JELLY. *See* GELATIN.

JERBOA. *See* DIPUS and HELAMYS.

JE'SUATES OF SAINT JEROME. A religious order, founded in 1363 by Giovanni Colombino, of Sienna: of extremely ascetic habits in its origin. It was suppressed by Clement IX. in 1668.

JE'SUITES DE ROBE; applied to secular persons of high rank bound to the order of Jesuits by vows of obedience, without, however, having taken the spiritual vow.

JE'SUITS, or THE SOCIETY OF JESUS. The most celebrated of all the Romish religious orders; founded by Ignatius Loyola, a Spaniard, in the year 1534, when he, with Francis Xavier and four or five other students at the University of Paris, bound themselves to undertake the conversion of unbelievers. The first principle of the society which was then formed was implicit submission to the commands of the Holy See: in consideration of which their order was confirmed in 1540 by Pius III.; and from that time to the present, though with many alternations of success and reverse, the Jesuits have been one of the main bulwarks of the authority of Rome, and have exercised immense influence in the destinies of the Christian world. The zeal which they manifested at the period immediately succeeding the Reformation, when the Dominicans and other orders which had been founded on similar principles, and had faithfully executed their mission for many ages, had degenerated into luxury and indifference, secured for them the favour of the sovereigns and other political partisans of Rome. They soon became installed in the confessionals of all the Catholic kings of Europe, and throughout the 16th and following century were in fact the directors of their counsels and the rulers of their subjects.

In Protestant countries they acted as the emissaries and spies of the Pope; and in England, where early in Elizabeth's reign their landing upon our shores was made a capital crime, they persevered nevertheless in keeping alive the spirit of Roman Catholicism among the harassed remnant of the old faith; and passed and repassed the channel year after year, devoting their lives, with almost a certainty of eventually suffering, to the maintenance of an illegal, and often a treasonable, correspondence with the court of Rome and the enemies of the queen's government. At the same time another division of their numerous body employed themselves with the most undaunted energy, and with an apparent success such as has never crowned the efforts of any other missionaries, in converting the heathens of Asia and America. St. Francis Xavier, the Apostle, as he is called, of the Indies, planted Christianity in Hindostan and Japan; and Ricci introduced it into China. In the course of a few years the numbers of professing Christians in these countries became very large; although it cannot be denied both that the means which the missionaries took to increase the number of their conversions were little in accordance with the spirit of their religion, and that the form of Christianity which they allowed to be propagated was more degraded and idolatrous than that of Rome itself. It should be remarked, however, that the great secret of their success seems to have been the address with which they obtained the confidence of the ruling powers. In Japan and China they became the intimate advisers of the sovereign, and frequently obtained the assistance of the civil power in the furtherance of their missionary system.

The Jesuits obtained also, throughout Roman Catholic Europe, the direction of the education of youth: they founded many schools and colleges, not only for the instruction of those who were designed for members of their own order, but for that of the upper and lower classes generally, in the education of both of which they were eminently successful.

As a religious body, the Jesuits differ from their predecessors, inasmuch as, their principle being to conform as much as possible with the manners of the age, they have never adopted the austere observances and exclusive spiritual character upon which all earlier orders had grounded their claims to notoriety. They are divided into different classes; of which only *the professed* take the religious vows of poverty, chastity, and obedience to their superior. Among the novices are frequently enrolled influential laymen, as was Louis XIV. himself in his latter years; and this is one of the means which the order has employed to extend its efficiency where it would be least liable to observation. The Professed are of several ranks, the whole body being under the absolute control of the General, whose abode is fixed in Rome, and whose council consists of an admonitor and five assistants or councillors, who represent the five principal Catholic states, — Italy, Germany, France, Spain, and Portugal. To Rome, as the central seat of the order, are sent monthly communications from the superiors of the different provinces through which its members are distributed.

The Pope has conceded to the Jesuits greater indulgence than even to laymen, in exempting them from the religious observances which are enjoined to all Roman Catholics, and especially to the religious orders; and hence it is that they have been enabled to devote so great a portion of their time not only to instruction, but to many branches of learning and practice, by means of which they have insinuated themselves into the confidence and the concerns of the laity. They are remarkable also for the worldly air which when occasion serves they studiously assume, — for the ease with which they dispense with all the outward appearance of their spiritual character in places where their objects seem to be more attainable by a different behaviour; and they have been reproached at all times with allowing themselves on the same principle to make use of mental reservations and other *pious frauds* in pursuance of the peculiar ends of their society. Hence, even when their influence in Europe was at its height, great distrust was manifested towards them in many quarters. In France they were supposed to be implicated in the plots by which Henry III. fell, and the life of Henry IV. was attempted, and were indeed banished from that country by royal decree before the end of the 16th century: they were re-admitted, however, and continued in the enjoyment of their full influence in spite of the strong opposition of the Jansenists in the reign of Louis XIV. They were banished, in the course of the 18th century, from France, Spain, Portugal, and other Catholic states; and in 1773 Clement XIV. issued a bull by which he decreed the total abolition of the order. The invitation, however, of Catherine II. into Russia, and the favour of the successor of Clement, restored them in some degree; and they still exist and exercise considerable influence in Italy and Spain. From Russia they are at the present moment entirely banished; nor has Portugal re-admitted them since their expulsion in 1759. In France and Germany their presence appears to be connived at, though they have never formally been allowed to re-establish themselves in those countries. In England they have been allowed to found and maintain the Roman Catholic college at Stonyhurst, and their numbers in Ireland are supposed to be considerable. By the Roman Catholic Relief Bill, natural-born Jesuits resident in the United Kingdom are required to register themselves with the clerk of the peace in every county: foreigners must provide themselves with licences from a secretary of state.

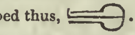
The history of the order of Jesus has often been written; but with so much exaggeration both of friends and enemies, that it is difficult to point out a fair account. The *Historia Jesuitica* of Hospinian, a Protestant, carries it down to the end of the 16th century. *Orlandi and Sacchetti's History of the Jesuits* was proscribed by the parlement of Paris; a 5th part was added to it by Souvency. Coudrette, one of the order, published a history of it just before its dispersion, 6 vols. 12mo., with Supplement, 1761-4. D'Alembert published an account of the destruction of the order in France, 1765. See also *Georget's Mémoires*, Paris, 1817. The celebrated *Léttres Provinciales* of Pascal contain a powerful exposure of the errors of the casuistical theologians of the 16th and 17th centuries, of whom a large proportion were Jesuits. (See also *Mosheim*, transl. (ed. 1790), iv.154.) The voluminous French collection, entitled *Nouvelles Ecclesiastiques*, continued from the reign of Louis XIV. to the Revolution, was under the management of Jansenists, and contains every charge which hostility could suggest against the Jesuits. *Ranke's History of the Popes of the 16th and 17th Centuries* contains much valuable matter relative to that period.

JESUITS' BARK. *See* CINCHONA, or PERUVIAN BARK.

JET. A bituminous carbon. Some varieties admit of polish, and are used for ornamental purposes.

JET D'EAU. (Fr.) A fountain which throws up water to some height in the air. According to the theory of hydrostatics, the velocity with which water issues from an orifice is equal to that which would be acquired by a heavy body in falling through a height equal to the difference between the levels of the orifice and the fountain head; whence, if the resistance of the air and other impediments were removed, the height of the jet would be equal to that of the surface of the reservoir. Among the causes which prevent the jet from obtaining the height which theory assigns to it, the following are the principal: — 1st, The resistance of the air, which is proportional nearly to the square of the velocity. 2d, The friction against the sides of the pipe and the orifice through which the water issues. 3d, The velocity of the particles diminishing at every instant as they ascend, the lower particles of the ascending column press against those next above them; and the pressure being by the nature of fluids communicated in all directions, the consequence is that the column is enlarged and proportionally shortened. 4th, The water at the top of the jet does not fall off instantaneously when its velocity is destroyed; it rests for a moment at the top of the column, where its weight opposes an obstacle to the particles next succeeding, which retards their velocity, and this retardation is communicated to the whole column. This last obstacle may be avoided by slightly inclining the jet from the vertical; and it is found by experience that a jet so inclined plays higher than one quite upright, though the effect is thereby rendered less pleasing. It is necessary that the diameter of the adjutage or orifice be considerably less than that of the pipe. (See *Desagulier's Experimental Philosophy*; Mariotte, *Mouvement des Eaux.*)

JE'TERUS. A disease of plants, where the system becomes affected with a general yellowness.

JEWS' HARP. An instrument of metal, with a flexible vibratory thin metal tongue fixed to its circular base; on which tongue the breath, acting in different degrees of force, produces something like a modulated air. Shaped thus, . The outer bars are placed between the teeth, and the central piece or tongue is set in vibration by the action of the fingers.

JEW STONE. The fossil spine of a large egg-shaped echinus.

JE'ZIDS, or DA'VASIN. A sect of religionists, long settled in the mountainous country near Mosul: said to be disciples of Yezid Ben Anisa, a Mohammedan doctor. Their religion, however, is said to be a mixture of the ancient Manichean belief of those regions with the tenets of Mohammedanism and Zendism. They appear to be on better terms with the Christians than with the neighbouring Turks, by whom they are characterized as worshippers of the Devil (Arab. *Scheitan*), whose name, it is said, no threats of punishment will force them to pronounce, and whom they only mention by periphrases, as "the great sheikh," or "he whom you know of." They live in villages, huts, and tents, and are dreaded for their ferocity and robber-like habits. They are noticed at length in a preliminary dissertation to *Sylvestre de Sacy's Description du Pachalik de Bagdad*, 1809; said to be the work of Father Garzoni, who was eighteen years a missionary in Kurdistan. (See the art. "Jeziden" in *Ersch and Gruber's Encyclopædia.*)

JIB. A large triangular sail, between the fore-topmast head and the boom (thence called jib-boom), which projects beyond the bowsprit.

The effect of this sail would seem to be to lift the ship's head; yet seamen find that as the wind freshens it causes the ship, on the contrary, to plunge, and they either *ease it in* (along the boom), or haul it down. This anomalous effect may be explained as follows: —

Let x and z be the horizontal and vertical co-ordinates of the centre of effort, the centre of gravity of the vessel being the origin: let P be the resultant of the pressures on the sail. This may obviously be resolved into three: δ the direct effort along x, λ the lateral effort along y, and ϱ the vertical effort in z. The moment to raise the bow is $x\varrho - z\delta$. If $z\delta$ exceed $x\varrho$, the effect is negative, or tends to depress the bow. In all vessels $x > z$, also $\delta > \varrho$ generally; hence the effect is not so decided as it may appear at first to be.

Let ι be the angle which P makes with the horizon, and φ be the angle between x and the horizontal projection of P; then $\varrho = \text{P} \sin.\iota$, and $\delta = \text{P} \cos.\iota \cos.\varphi$: hence the effect is

$$\text{P}\,(x \sin.\iota - z \cos.\iota \cos.\varphi).$$

When the wind is aft, $\varphi = 0$, and $\iota = 90 - \varkappa$ (the inclination of the jib-stay to the horizon nearly); and the effect is

$$\text{P}\,(x \cos.\varkappa - z \sin.\varkappa),$$

which, as $\varkappa = 45^{\circ}$, is positive or lifting.

When the wind blows fresh, the vessel being close-hauled and heeling over, the stay *sags* to leeward; and the after-leech being also slacker than the foot, the resultant P may become horizontal, or $\iota = 0$, or even negative; in which last case the effect is

$$-\,\text{P}\,(x \sin.\iota + z \cos.\iota \cos.\varphi)$$

which is altogether depressing. If now the jib be eased in, x and z are diminished. Hence, in general, the plunging effect of the jib is owing to the heeling of the ship, and to the sheet being too flat aft. The like reasoning obviously applies to staysails.

JIB DOOR. (Derivation uncertain.) In Architecture, a door so constructed that it stands flush with the adjoining face of the wall on both sides, and without dressings or architraves. Thus it appears part of the wall, the intention being to conceal even the appearance of a door.

JO'GGLED JOINTS. In Architecture, the joints of stones or other masses indented in such a way that the adjacent stones fitting into the indentations, they are prevented from being pushed away from each other by any force perpendicular to the pressures by which they are thus held together.

JO'GGLE PIECE. (Perhaps from joug, *a yoke.*) In Architecture, a truss post whose shoulders and sockets receive the lower ends of the struts.

JOHN BULL, the well-known collective name of the English nation, was first used in Arbuthnot's satire, *The History of John Bull*, usually published in Swift's works; in which the French are designated as Lewis Baboon, the Dutch as Nicholas Frog, &c.

JOI'NERY. (Fr. joindre.) In Architecture, the art of framing wood-work for the finishing of houses, such as doors, sashes, shutters, &c. The term Carpentry is applied to the rough timbering, in which the only tools used are the axe, adze, chisel, and saw.

JOINT STOCK COMPANY. In Mercantile Law, a partnership consisting of a large number of members, whose rights and liabilities are defined by certain peculiar regulations imposed by themselves, generally contained in an instrument termed a deed of settlement, and heretofore in an act of parliament passed for the purpose; but now, by 4 & 5 W. 4. c. 94., the king is enabled to grant the necessary powers by letters patent. The deed constitutes trustees, directors, and other officers; contains the necessary covenants; limits the number of shares, &c.; and details the rules to be adopted in the management of of the concern. By a clause contained in this instrument the shares are rendered transferable by each partner without the consent of the other shareholders, subject, in general, to the approbation of the directors. The act of parliament, or letters patent, enables the company to sue and be sued in the name of its secretary or other officer, &c. It concludes with the customary proviso, that nothing therein contained shall be construed to incorporate the partnership.

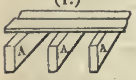
JOINT TE'NANCY, in Law, is where lands and tenements are granted to two or more persons to hold in fee-simple, fee-tail, for life, for years, or at will. It is created by particular words in a deed or devise. Its properties are said to be unity of interest, of title, of time, and of possession; and it is subject to the right of survivorship in the case of estates for life. Joint tenancy may be severed by partition, or by the alienation of any party. Personal chattels may be the subjects of a joint tenancy.

JOI'NTURE. In Law, a settlement of lands and tenements made on a woman in consideration of marriage: ordinarily an estate for life. A jointure was made a bar of dower, if granted with certain requisites, by 27 H. 8. c. 10. *See* MARRIAGE, LAW OF.

JOISTS. (Fr. joindre.) In Architecture, the timbers of a floor whereto the boards or laths for the ceiling are nailed. They either rest on the walls or on girders, or sometimes on both.

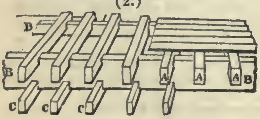
Where only one tier of joists is used, it is called *single flooring* (fig. 1.), A A A being the joists; and in this sort of flooring such joists should not exceed sixteen feet in length or bearing, and even when the length is more than eight feet they should have stiffening pieces to prevent torsion.

(1.)



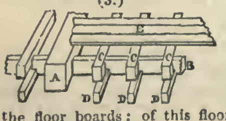
When two sets of joists are used, it is called *double flooring* (fig. 2.); in which A A are called *floor* or *bridging joists*, B B the *binders*, C C C the *ceiling* joists.

(2.)



If the binding joists be framed into girders, the floor is then properly called a *double-framed floor*, of which the subjoined is a diagram (fig. 3.); wherein A is a girder, B a binding joist, C C C are bridging joists, and D D D are ceiling joists, E being the floor boards: of this floor it is manifest that the girders are the main support.

(3.)



JO'LLY-BOAT. *See* YAWL.

JOU'RNAL. (Ital. giornale, *i. e.* diurnale.) Strictly a record or account of daily occurrences. It is more extensively employed to signify a narrative, periodically or occasionally published, of the transactions of a society, &c.; as by ourselves in the phrase "Journals of the Houses of Parliament," &c. It is also used as synonymous with *Magazine*, or other periodical publications of that class.

JU'BA. (Lat. *a mane.*) The long and thick-set hairs which adorn the neck, chest, or spine of certain quadrupeds.

JUBILA'TE. (Lat. *rejoice.*) A name given to the third Sunday after Easter; so called because in the primitive church divine service was commenced with the words of the 66th Psalm, "Jubilate Deo, omnes terræ," — "Sing to the Lord, all ye lands."

JU'BILEE. (Lat. jubilo, *I rejoice.*) The name given among the Jews to the grand sabbatical year, which was celebrated after every seven septennaries of years: whether every forty-ninth or fiftieth year is still a question among the learned. The institution of this festival is recorded in Lev. xxv. 8—17. This was a year of general release not only of all debts, like the common sabbatical year, but of all slaves, and of lands and possessions which had been alienated from their original owners. It has been commonly supposed that the jubilee was intended to be typical of the release and redemption of mankind under the Gospel dispensation; and it was with this idea that Pope Boniface VIII., at the end of the thirteenth century, proclaimed a general indulgence to all Christians who should visit the tombs of the Apostles at Rome in the secular year 1300. At this period it was intended that the same celebration should take place only every hundredth year. In consequence, however, of the enormous afflux of pilgrims which this proclamation brought together, and the gain which resulted from it, Clement VI. abridged the interval to fifty years; and the solemnity then received the name of the jubilee in imitation of the Jewish custom. The second jubilee was accordingly solemnized in 1350. In 1389, Urban V. reduced the term to thirty-three years, the number of the life of our Saviour: it was raised again by Nicholas V. to fifty; and finally, in 1470, fixed by Paul II. at twenty-five; and the jubilee has ever since been solemnized every quarter of a century, beginning on Christmas eve, when the Pope opens with great pomp the door of St. Peter's, closed except on that occasion. (*Mosheim's Eccl. Hist.*, Transl., ed. 1790, iii. 263.)

JU'DAISM. Attachments to the rites of the Jewish law. The Judaizing spirit of many of the early Christians is a subject of observation in many of St. Paul's Epistles (especially that to the Galatians), and continued for a long period to exercise much influence on the character of the religion. (See *Milman's Hist. of Christianity*, vol. i. 21. 451. &c.)

JU'DGES. (Lat. judex.) Certain supreme magistrates who presided over the Israelites from the time of Joshua to the reign of Saul, a period of about 330 years. They were so called because they formed at once the civil and the military governors of the people. The dignity was retained for life, though it was not always hereditary.

JU'DGMENT. (Lat. judicium.) In Law, the sentence of the law pronounced by the court upon the matter contained in the record. The term judgment, in English legal language, is restricted to the decisions of a court of common law: those of a court of equity are denominated decrees. Judgments are said to be of four sorts:—1. Judgments in law (on demurrer, where the facts are confessed upon the pleadings); 2. Judgments in fact (on the verdict of a jury); 3. Judgments by confession or default, *i. e.* where both facts and law are admitted by the defendant; 4. Judgments on a nonsuit or retraxit, where both fact and law are admitted by the plaintiff, who thereupon withdraws his claim. Judgments are also said to be either interlocutory, on matter arising in the course of the proceeding; or final, on the merits of the case. Judgments, when obtained, must be signed by the proper officer, and entered of record, without which they are not judgments. Arrest of judgment arises from error appearing upon the face of the record; but such error must now be, generally speaking, in substantial matter of law, and not on mere matter of form.

JU'DGMENT, in Logic, is defined to be the second of the three logical operations of the mind. It is the comparing together two of the notions which are the subjects of simple apprehension, and pronouncing that they agree or disagree with each other. Judgment, therefore, is either affirmative or negative; and the subjects of judgment are *propositions*, which are expressions of the agreement or disagreement of one term with another.

JU'DGMENT. In the Fine Arts, the faculty of selecting that which is most suitable to the purpose.

JU'DICA. (Lat. *judge.*) The fifth Sunday after Lent was so called, because the primitive church began the service on that day with the words of the 43d Psalm, "Judica me, Domine,"—"Judge me, O Lord."

JUDI'CIUM DEI. (Lat. *judgment of God.*) The

term formerly applied to all extraordinary trials of secret crimes, as those by arms, single combat, ordeals, &c.; in which it was believed that Heaven would miraculously interfere to clear the innocent and confound the guilty. (*See* ORDEAL, QUESTION.) Full particulars of the ceremonies instituted on such occasions will be found in *Ducange*.

JU'GAL BONE. (Lat. jugum. or Gr. ζυγον, *a yoke.*) The cheek bone; so called because it has a *yoke-like* articulation to the bone of the upper jaw.

JUGA'TA. Two heads represented upon a medal side by side, or joining each other.

JU'GGERNAUT. *See* VISHNU.

JU'GGLERS. (Fr jongleurs.) A general denomination for those persons who practise the arts of legerdemain, or who exhibit feats of uncommon strength or dexterity. The reader will find in *Beckman's History of Inventions* a learned and curious account of the origin and history of all the feats of this kind exhibited both in ancient and modern times.

JUGLANDA'CEÆ. (Juglans, one of the genera.) A small natural order of Exogenous trees, distributed through the temperate parts of North America and Asia. The common walnut, *Juglans regia*, is well known for its agreeable fruit, and the useful oil it yields by pressure. Hickory, a very elastic kind of timber, is the wood of *Carya alba;* and that of other species, especially *Juglans nigra* and *regia*, is valuable for cabinetmakers' work and similar purposes.

JU'GULARS, *Jugulares.* (Lat.) The name under which Linnæus comprehended all those fishes which have the ventral fins anterior to the pectorals.

JU'GULAR VEINS. (Lat. jugulum, *the throat.*) The veins which bring the blood from the head, descending upon the sides of the neck: they are divided into *external* and *internal*. By their union with the subclavian vein they form the superior *vena cava*, which terminates in the superior part of the right auricle of the heart.

JU'GULUM. (Lat. *the throat.*) In Mammalogy, it is restricted to the fore-part of the neck, which intervenes between the throat (gula) and the chest. The *fossa jugularis* is the hollow in front of the sternum at the base of the neck.

JUJU'BE. The fruit of the *Rhamnus zizyphus:* it resembles a small plum, and is occasionally used as a sweetmeat. What is sold under the name of *jujube paste* professes to be the dried jelly of this fruit, but is in fact a mixture of gum arabic and sugar slightly coloured.

JU'LIAN ÆRA. The commencement of a period invented to correspond with the cycles of the Julian year. It coincides with the 710th year before the creation of the world, according to common chronology.

JULIAN CALENDAR. The civil calendar introduced at Rome by Julius Cæsar, and used by all the Christian countries of Europe till it was reformed by Pope Gregory XIII. in 1582. Before the time of Julius Cæsar the Roman year was lunisolar; and as the pontiffs, who had a discretionary power of adjusting the calendar, followed no certain rule in their intercalations, but sometimes inserted a greater or less number of days for the purpose of prolonging or shortening the period of a particular magistracy, the civil year did not long correspond with the astronomical or the course of the seasons, and the reckoning of time fell into great confusion. With the advice of the astronomer Sosigenes, Cæsar fixed the mean length of the year at 365¼ days; and in order that the year should always commence with the commencement of a day, he decreed that three successive years should contain 365 days, and the fourth 366, and so on for ever. He also restored the vernal equinox to the 25th of March, the place it occupied in the time of Numa; and thus fixed the correspondence of the civil year with the seasons.

In distributing the days of the year among the twelve calendar months, Cæsar adopted a very commodious arrangement, which unfortunately was not long suffered to prevail. He ordained that the odd months, viz. the first, third, fifth, seventh, ninth, and eleventh, should have each 31 days, and the even months 30 days; with the exception of February, which in common years should have only 29, but in the intercalary years 30 days. This was as simple and natural a disposition as, perhaps, it is possible to make; but the whole arrangement was soon thrown into disorder and confusion, to gratify the frivolous vanity of Augustus, by giving to the month which he had named after himself the same number of days as July, which bore the name of the first Cæsar. A day was accordingly taken from February and given to August; and in order that three months of 30 days might not come together, September and November were reduced to 30 days, and 31 given to October and December. Such was the origin of the capricious arrangement which has ever since been adhered to. *See* CALENDAR.

JULIAN EPOCH. In Chronology, the epoch or commencement of the Julian Calendar. The first Julian year commenced with the 1st of January of the 46th year before the birth of Christ, and the 708th from the foundation of Rome.

JULIAN PERIOD, in Chronology, is a period consisting of 7980 Julian years. The number 7980 is formed by the continual multiplication of the three numbers 28, 19, and 15; that is, of the cycle of the sun, the cycle of the moon, and the cycle of indiction. The first year of the Christian era had 10 for its number in the cycle of the sun, 2 in the cycle of the moon, and 4 in the indiction. Now the only number less than 7980 which, on being divided successively by 28, 19, and 15, leaves the respective remainders 10, 2, and 4, is 4714. Hence the first year of the Christian era corresponded with the year 4714 of the Julian period; and hence also the year of our era corresponding to any other year of the period, or *vice versâ*, is found by the following rule:—

1. When the given year is anterior to the commencement of the era, subtract the number of the year of the Julian period from 4714, and the remainder is the year before Christ; or subtract the year before Christ from 4714, and the remainder is the corresponding year in the Julian period.

2. When the given year is after Christ, subtract 4713 from the year of the period, and the remainder is the year of the era; or add 4713 to the year in the era, and the sum is the corresponding year of the Julian period. (*Ency. Brit.*, art. "Chronology.")

JU'LIAN YEAR. The year adopted in the calendar of Julius Cæsar, and equal to 365¼ days. The Julian year exceeds the mean solar year, as determined by the best astronomical observations, by 11 minutes and 10·35 seconds, which amounts to a day in 129 years. In the course of a few centuries this error would become very perceptible, as the equinoxes and solstices would fall back towards the beginning of the year. When the Julian calendar was introduced by Cæsar the vernal equinox fell on the 25th of March; at the time of the Council of Nice, in 325, it fell on the 21st; and at the reformation of the calendar, in 1582, it had retrograded to the 11th. This observation enabled Pope Gregory to fix the length of the year more precisely, and correct the intercalations. *See* CALENDAR.

JU'LIS. (Lat. *the name of a fish.*) A genus of Labroid fishes, distinguished by the following characters. — Head smooth; cheeks and gill-covers without scales; lateral line bent suddenly downwards when opposite the end of the dorsal fin. The rainbow wrasse (*Julis Mediterranea*) has been taken on the coast of Cornwall.

JULY, so named by Mark Antony, in honour of Caius Cæsar, the dictator, whose gentile name was Julius, is at present the seventh month of the year. In the Latin calendar it was the fifth, and hence was termed *Quintilis.* The Dog-days are supposed to commence on the 3d of this month.

JU'MPING HARE. A Rodent quadruped, the largest of the family of the Jerboas (*Dipodidæ*), and the type of the genus *Helamys*, is so called. It is a native of the Cape of Good Hope, and inhabits deep burrows. *See* HELAMYS.

JUNCA'CEÆ. (Juncus, one of the genera.) A small obscure natural order of Endogenous plants, in most respects resembling *Liliaceæ*, and differing chiefly in their flowers being glumaceous; that is, thin, dry, and either brown or green in colour. There are, however, species intermediate between the two orders in this respect. None of the species are of any importance. The common rush is the usual type of this order.

JUNCA'GINACEÆ. A small natural order of Endogenous plants growing in marshes, with minute green flowers. They are considered by botanists allied to *Araceæ*, on account of the structure of the embryo; in their general aspect they are something like little rushes.

JUNE; so named, according to some, either from the Latin Junius, Juno, or Juniores (May, as was alleged, being derived from Majores). At present the sixth month of the year, but in the old Latin calendar the fourth. It consisted originally of twenty-six days, to which Romulus is said to have added four. Numa afterwards deprived it of one day; which, however, was again restored by Julius Cæsar, and it has ever since remained unaltered.

JUNGERMANNIA'CEÆ. (Jungermannia, one of the genera.) A very small natural order of Acrogenous or Cryptogamic plants, resembling mosses in appearance, and, like them, growing upon the bark of trees and in damp ground in shady places. They bear their seeds in cases containing spiral threads, which, by their elasticity, disperse the former when ripe. Until lately they were considered to form a part of *Hepaticæ*.

JU'NIPER BERRIES. The fruit of the *Juniperus communis*. They are used in medicine as a diuretic; but their principal consumption is in flavouring gin. When distilled with water they yield an essential oil, upon which their peculiar flavour depends. The resin of this tree is called juniper gum or sandarach, and is occasionally used in varnishes. When powdered it is

used under the name of *pounce*, to prevent ink sinking into paper from which writing has been erased.

JUNK. A large flat-bottomed vessel, with three masts, and a short bowsprit placed on the starboard bow, used by the Chinese. The masts are supported by two or three shrouds, which at times are all carried on the windward side; and the fore or main mast carries a sort of lug sail of cane of bamboo.

JU'NO. The Latin name of the divinity called by the Greeks Hera (Ἥρη). She was the sister and consort of Jupiter, and was held to preside over marriage, and protect married women. She was represented as the model of majestic beauty, in royal attire, and attended by her favourite bird the peacock. Her principal temples in Greece were at Samos and Argos. She was also the patroness of Veii, whence she was invited to Rome on the occasion of the last siege of the former city.

JU'NO. One of the four small extra-zodiacal planets which circulate between the orbits of Mars and Jupiter. Juno was discovered by Professor Harding of Lilienthal (near Bremen), on the 22d of September, 1804; Ceres and Pallas having been discovered previously. Juno appears like a star of the eighth or ninth magnitude, and is of a whitish colour, without nebulosity. This planet is distinguished by the great eccentricity of its orbit, exceeding that of any other planet, and amounting to ·2578, the semi-axis major being taken as unit. The effect of this eccentricity on the motion of the planet is such, that the half of the orbit which is bisected by the perihelion is described in about half the time in which the other half is described. The sidereal revolution is performed in 1592·66 mean solar days. The inclination of the orbit to the ecliptic is 13° 4′ 10″; and the greatest equation of the centre 29° 46′ 19″. The extreme smallness of the planet renders it impossible to determine its apparent diameter, and consequently its magnitude, with any degree of certainty.

JU'NTA. (Span. *an assembly*.) A grand Spanish council of state. Besides the assembly of the states or *cortes*, there were two juntas: one which presided over the commerce, the mint, and the mines; and the other forming a board for regulating the tobacco monopoly. The assembling of a junta by Napoleon in 1808, and the part they subsequently played in Spanish history, are sufficiently known to the reader. In England the term *junto* (evidently of Spanish origin) is used almost synonymously with cabal or faction.

JU'PITER. In Mythology, the Latin name of the deity called by the Greeks Zeus (Ζεύς): it is derived from that word with the addition Pater, *Father*. He was the son of Saturn, whom he deposed from his throne, and thence became the supreme monarch of gods and men. He married his sister Juno, by whom he had Vulcan; but besides this deity he had a large progeny of gods and demigods by his numerous divine and mortal paramours. The most celebrated of his children were, Minerva, who had no mother, but sprung armed from her father's forehead; Bacchus, the Muses, Venus, Apollo and Diana, Mercury, Proserpine, Hercules, Perseus, and Minos. The most celebrated Grecian temple of this god was at Olympia in Elis, where every fourth year the Olympian games were celebrated in his honour: his most revered oracle was among the oak woods of Dodona in Epirus. The Romans considered Jupiter as especially the patron of their city, in which he accordingly had some splendid temples: that in the capitol was the grandest. Of that dedicated to Jupiter Stator there are still three columns standing. Jupiter was represented as the model of dignity; grave, but mild: he is seated on a throne grasping his sceptre and a thunderbolt, and by his side stands his peculiar bird, the eagle.

It has been remarked that there is a striking similarity between *Jove* (from *Jovis*, gen. of Jupiter), and the Hebrew name of the Supreme Deity, Jehovah.

JUPITER. In Astronomy, one of the planets, and the largest in the system. The mean diameter of Jupiter is no less than 87,000 miles, or about eleven times that of the earth; consequently his bulk is about 1300 times greater than that of the earth. The distance of Jupiter from the sun is nearly 490 millions of miles, or about 5¼ times the radius of the earth's orbit; and he performs his revolution in respect of the stars in 4332 days, 14 h. 2 m. 8½ sec., which is nearly 12 years. The inclination of the orbit to the plane of the ecliptic was 1° 18′ 51″ at the beginning of the present century, and undergoes a diminution of about a fourth of a second in a year.

"The disc of Jupiter is always observed to be crossed in one certain direction by dark bands or belts. These belts are, however, by no means alike at all times; they vary in breadth and in situation on the disc (though never in their general direction). They have even been seen broken up, and distributed over the whole face of the planet; but this phenomenon is extremely rare. Branches running out from them, and subdivisions, as well as evident dark spots, like strings of clouds, are by no means uncommon; and from these, attentively watched, it is concluded that the planet revolves in the surprisingly short period of 9 h. 55 m. 50 sec. (sid. time) on an axis perpendicular to the direction of the belts.

"The parallelism of the belts to the equator of Jupiter, their occasional variations, and the appearances of spots seen upon them, render it extremely probable that they subsist in the atmosphere of the planet, forming tracts of comparatively clear sky, determined by currents analogous to our trade winds, but of a much more steady and decided character, as might indeed be expected from the immense velocity of its rotation. That it is the comparatively darker body of the planet which appears in the belts is evident from this — that they do not come up in all their strength to the edge of the disc, but fade gradually away before they reach it." (*Herschel's Astronomy*, *Cabinet Cyclopædia*, p. 281.)

The radius of Jupiter being 11 times greater than that of the earth, and the rotation on the axis being 2·4 times more rapid, the space passed over by a point on the equator of the planet will be 26 times greater than that described by a point of the terrestrial equator in the same time. Hence the centrifugal force is about 26 times greater, and we may therefore conclude that its effect in impressing a flattened form on the planet will be much greater than takes place with regard to the earth. Now observation shows this to be the case. The disc of Jupiter is evidently not circular, but elliptic, being considerably flattened in the direction of its axis of rotation; and this appearance is no optical illusion, but is authenticated by micrometrical measures, which assign 15 to 14 as the proportion of the equatorial and polar diameters. This far exceeds the compression of the earth, the ratio of the equatorial to the polar diameter of which is 302 to 301.

The annual parallax of Jupiter is less than 12°; consequently the earth, as seen from Jupiter, will never appear at a greater distance than 12° from the sun. The digressions of Mars will be 17°, those of Venus 8°, and those of Mercury only 4° 16′. An inhabitant of Jupiter would therefore probably be ignorant of the existence of Mercury, which will be almost constantly plunged in the sun's rays, and likewise diminished in splendour, on account of the greater distance.

The density of Jupiter is very nearly the same as that of the sun, and about one fourth of the mean density of the earth. The mass of the planet, compared with that of the sun taken as unity, is ·000943; but this is sufficient to produce a very sensible perturbation of the motions of some of the other planets. The proportion of light and heat received by Jupiter from the sun, compared with that received by the earth, is as ·037 to 1.

Jupiter, through the telescope, is observed to be accompanied by four moons or satellites, which revolve about the planet nearly in the plane of its equator, exactly in the same manner as the moon revolves about the earth. Their configuration changes at every instant; they appear to oscillate on each side of the planet, and their rank or order of distance is determined by the extent of their oscillations. In coming between the sun and Jupiter, the satellites throw their shadows on the planet, and produce eclipses of the sun; and when they come to the side of the planet opposite to the sun they are eclipsed in passing through the shadow. The beginnings and endings of these eclipses can be observed with great precision; and their observation furnishes the surest means of determining the sidereal and synodic revolutions of the satellites. The same observations also afford a means of determining terrestrial longitudes; and it was by means of them that astronomers discovered and measured the velocity of light. *See* PLANET and SATELLITE.

JU'RISCONSU'LT. (Juris consultus, *learned or skilled in law*.) A title given to a class of Roman lawyers, and commonly denoted by the abbreviation *ictus*. From what we know of the jurisconsults, they appear to have been a different class from the advocati or causidici who conducted causes, and to have confined themselves to the employment of giving responsa or opinions on cases put to them. (See *Mem. de l'Ac. des Inscr.* vol. xli.) From the recorded opinions of the most learned jurisconsults the *Digest*, the great work of Justinian, was chiefly compiled. *See* ADVOCATE.

JU'RISPRU'DENCE. The science of right. (From the Latin words juris prudens, *skilled in law*.) The term *civil jurisprudence* is sometimes restricted to the science of the Roman or civil law. For a literally complete list of works on this extensive subject, see *Krug's Philosophisches Lexicon*, art. "Rechtslehre."

JURY-MAST. In Naval affairs, a temporary mast erected in a ship in the room of one that has been carried away by tempest or any other accident. Jury-masts are sometimes erected in a new ship to navigate her down a river, or to a neighbouring port, where her proper masts are prepared for her.

JURY, TRIAL BY. Of the origin and progress of this institution, as far as it has been very imperfectly traced by antiquarians, some account has been given in

the historical review of the Common Law. When issue has been taken in fact in a civil suit (*see* PLEADING), the cause stands ready for trial *at bar* of the court itself (*see* LAW, SUPERIOR COURTS), unless by the fiction of *nisi prius* (ib.) it is transferred to the sittings in London and Middlesex, or the assizes in the country. (A trial at bar is now only granted on application in some special cases.) The sheriff of the county is directed by writ of venire facias to summon jurors to attend at the assizes; and by a further compulsory process, called a *distringas*, he is ordered to distrain them by their lands and goods if they make default in appearance. On motion of either the plaintiff or defendant, the court orders a *special jury* to be summoned. The list of persons liable to serve as common jurors is made out by the churchwardens and overseers in each parish, and, after being considered by justices at petty sessions, is copied into a book and delivered to the sheriff. On the return of the writs of venire facias, the sheriff annexes a *panel* or list of persons taken from this book, in number from 48 to 72; and the judges are empowered to direct the same panel to attend both for the civil and the criminal sides, amounting in all to 144. The twelve jurors who are to try the cause are chosen by ballot out of this list. The qualification of a common juror is, to be a natural-born subject (unless on trial of an alien, in which he may if he pleases have a jury *de medictate linguæ*, of which one half consists of aliens), to be free from attaint of an infamous crime, and to be between the ages of 21 and 60. All such persons (with certain privileged exceptions) possessing 10*l*. a year in freehold or copyhold lands and tenements, or 20*l*. a year in lands held on lease for 21 years, or rated as householders to the poor's rate in Middlesex for 30*l*., elsewhere 20*l*., or occupying a house with 15 windows, are liable to serve. In the city of London the juror must be a householder or occupier within the city, and have property, real or personal, to the amount of 100*l*. All persons described in the jurors' book as esquires or of a higher degree, or as bankers or merchants, are qualified to serve on special juries. If on a trial sufficient qualified jurors are not in attendance, a *tales* may be prayed; and bystanders are called in to fill up the number. This seldom occurs but in special jury cases; and in these the *talesmen*, as they are vulgarly termed, are taken from the common jury list.

The jury being summoned, the trial proceeds; unless either party *challenge* the jurors. *Challenges* are either *to the array* or *to the polls*. A challenge to the array is an objection to the whole panel, and can only be on account of default or partiality of the sheriff. Challenges to the polls, *i. e.* to individual jurors, are said to be of four kinds; *propter honoris respectum*, *propter defectum*, *propter affectum*, and *propter delictum*. 1. Where a party is exempted by statute from serving, he may challenge himself. 2. Insufficient qualification is a ground of challenge by either party. 3. On supposed bias or partiality, as by reason of kindred. Challenges to the favour are on a mere suspicion of partiality. 4. Legal infamy is the fourth ground of challenge. In a criminal case the law of challenges is the same as in a civil one; except that the prisoner for felony has the additional privilege of making *peremptory* challenges without cause assigned to any number of jurors not exceeding twenty. Challenges for cause, if *to the polls*, are tried by the court; except those to the favour, which the court appoints two jurors if sworn, if not two indifferent persons, to try. Challenges to the array are tried entirely at the discretion of the court.

According to the common course of a trial at nisi prius, the counsel for that party on which the affirmative of the issue is thrown by the pleadings (that is, except in occasional cases, the plaintiff) *opens his case* by a statement to the jury, and then calls witnesses to prove it. The counsel for the other party then replies; and if he also calls witnesses, the first speaker has a final reply. After the evidence is given and the case closed, the jurors are kept together to deliberate of their verdict. They must be without meat, drink, or fire, unless otherwise ordered by the judge; and as unanimity is necessary to a verdict, it was held at common law that if the jury could not agree, the judge might cause them to be carried round the circuit from town to town in a cart. In practice it is usual, when they cannot be brought to agreement, to discharge the jury. Although the jury in ordinary language are said to be judges of the *fact* only, yet a general verdict in a civil or criminal case ordinarily decides both the facts, and whether the law as stated by the judge is immediately applicable to those facts: *e. g.* a verdict "guilty" on a charge of murder implies both that the act was committed, and that it was committed under circumstances amounting to murder. The jury may, however, find under certain circumstances a *special* verdict, that is, a verdict in which the facts of the case are specially stated, and it is left to the court to apply the law; or they may find a general verdict, subject to a special case as to a point of law. In cases of criminal prosecution for libel, much difference of opinion formerly prevailed as to the effect of a verdict. It was held by most lawyers that the only questions for their consideration were the fact of publication, and the truth of what is technically called *the innuendos*, viz. that the passages of the libel cited did apply to such or such facts and individuals. But by 32 G. 3. c. 60. (passed through the influence of Mr. Fox) it was enacted that on every trial of an indictment or information for libel the jury may find a general verdict of guilty or not guilty upon the whole matter in issue, thus deciding whether the matter published amounts to a libel or no. As to the grand jury, see LAW, CRIMINAL.

JUST, or **JOUST**. (Ital. giostra.) A combat between two persons with lances: properly, a mere amicable contest or trial of strength. *See* TOURNAMENT.

JUSTE MILIEU. *See* MILIEU JUSTE.

JUSTICES OF THE PEACE, in Law, are descended from the ancient conservators of the peace, and are appointed to their office in every county by the king's special commission under the great seal; which appoints them all, jointly and separately, to keep the peace, and any two or more of them to inquire of or determine felonies and misdemeanours. Some justices, also, are so by act of parliament (namely, a few high ecclesiastical officers); and some by charter or grant, as the mayor and other magistrates in corporate towns. Some justices are expressly nominated in the commission, so that certain business cannot be transacted without their presence; these are said to be of the *quorum*, and all the justices are now usually included in the list. The qualification of a justice is to have an estate of 100*l*. a year free of incumbrance, or a reversion after one or more lives of 300*l*. a year; but many privileged persons may act without qualification by estate. A justice intending to act under this commission sues out a writ of *dedimus potestatem* from the clerk of the crown in chancery, and takes certain usual oaths.

The duties and powers of a justice of the peace are of two kinds; ministerial and judicial. 1. He acts in the former capacity in preserving the peace; hearing charges against offenders; examining the informant and his witnesses; binding over the parties to prosecute or give evidence; and committing, or admitting to bail, according to the nature of the offence, parties who are brought before him. The stat. 7 & 8 Geo. 4. c. 64. requires justices to take the most material part of the evidence on examinations before them in writing, to be returned to the assizes, both in charges of felony and misdemeanor. 2. An extensive jurisdiction, summary and formal, is now exercised by justices of the peace, numerous branches of judicature, both criminal and civil, having been gradually confided to their authority, either exercised by them individually, or at the petty sessions and general quarter sessions of the peace. The latter court, by 34 Ed. 3., has jurisdiction over all felonies and trespasses whatever: in practice, simple larcenies and many other felonies and small misdemeanors are tried by a jury before it. It has also by various statutes jurisdiction over several offences relating to highways and to game; it is an appellate court from many decisions of individual magistrates; and it has one large and exclusive power committed to its care by the legislature, viz. the hearing and deciding appeals from orders of magistrates relative to the imposition of the poor's rate, and to the removal of paupers from one parish to another in which they are shown to have a legal settlement. (*See* SETTLEMENT.) Justices have, either singly or jointly, summary jurisdiction in questions of contract between certain classes of masters and servants; in small illegal takings of property, whether strictly personal, or in part connected with the freehold, not exceeding 5*l*. in value; and in common assaults and batteries not causing injury exceeding 5*l*. (in the latter case two justices are required); and in certain malicious injuries to property. The proceedings are in general on a written charge, sometimes termed a complaint; but in proceedings for a penalty more generally an information: on receiving which, the justice grants a summons to cause the appearance of the party charged. An appeal to the quarter sessions from the conviction or order of justices is sustainable only where expressly given by statute; and the court of session, on hearing the case, is said either to *affirm* or *quash* the conviction or order. And the proceedings are further removable in some cases into the superior courts by certiorari.

Other summary remedies afforded by magistrates are in cases of forcible entry and detainer, and some that arise between landlord and tenant.

Justices of the peace are liable to actions at the suit of parties injured by them wilfully in the exercise of their authority. But it is provided by statute that they shall have notice of any action commenced against them, and the cause of such action, one month before the writ is sued out; and the action must be commenced within six months after the injury complained of. Persons recovering a verdict against a justice for any wilful or malicious injury are entitled to double costs. These magistrates are also punishable criminally by indictment or information.

The police justices of London and its vicinity are stipendiary magistrates, created by act of parliament.

JUSTI'CIARY, CHIEF. (Lat. magnus justiciarius, or capitalis justiciarius totius Angliæ.) An officer of high power and dignity under the Norman kings of England, who presided over all functionaries in the aula regia, or king's court, so long as it followed the person of the king; and was, says Blackstone, by virtue of his office, guardian of the realm in the king's absence. The formidable power of the chief justiciary was curbed to some extent by the provisions of the great charter, especially that which fixed the trial of common pleas at Westminster; and became altogether obsolete when the various branches of his jurisdiction were broken into distinct courts of judicature under Edward I. (*Bl. Com.* iii. 39.)

JUSTI'CIARY, THE HIGH COURT OF, IN SCOTLAND, is composed of five of the Lords of Session, added to the Justice-Clerk, the president of the court. It is the supreme court of criminal justice; with the power of advocating or suspending all sentences of inferior criminal judges. It has circuit courts twice a year; and an additional circuit is now held in Glasgow during the Christmas recess of the Court of Session. The sinecure office of Lord Justice-General was in 1831 merged in that of the Lord-President. *See* SESSION, COURT OF.

JUSTI'CIES. In Law, a special writ empowering the sheriff of a county to hold plea of an action in his court. By means of this writ all personal and many real actions may be tried in the county courts.

JUSTIFICA'TION. (Lat. transl. of the Greek word δικαιωσις.) In Theology, men are said to be justified when accounted just or righteous in the sight of God, or placed in a state of salvation. Justification is used of the state of Christians in the present life only; as in Rom. v. 9., "Being justified by his blood, we *shall be* saved from wrath through him." The doctrine of justification through faith or rather by faith (εκ πιστεως, δια πιστιν *for or by reason of faith*) is set out with peculiar distinctness in the whole Epistle to the Romans. According to the eleventh article of the Church of England, we are justified "by faith, and not for our works or deservings." The twelfth declares, that "although good works, which are the fruits of faith, and follow after justification, cannot put away our sins and endure the severity of God's judgment, yet are they pleasing and acceptable to God in Christ, and spring necessarily out of a true and lively faith, insomuch that by them a lively faith may be as evidently known as a tree is discerned by the fruit." The first of these articles is chiefly directed against the Romanist doctrine of meritorious works; the second, based on the language of St. James, that a "man is justified by works, and not by faith only" (c. 2. v. 24.), regards faith and works as inseparably connected, and is aimed principally against the doctrine of those who were termed Antinomians or Solifidians. For a summary of the opinions generally embraced by the best divines of the early Church of England on this difficult subject, see *Hoskin's Sermon on Justification;* for the views of what is called the High Church body of the present day, *Newman's Lectures on Justification.*

K.

K, a consonant, used in most ancient and modern languages. It is derived from the Greek *kappa*, or the Hebrew *koph*. It has the same sound as C before *a*, *o*, and *u*, and hence it has often been pronounced superfluous. In Latin K occurs only in a few words, though it was frequently used in the same language as an abbreviation for words beginning with C; as K.T. for capite tonsus, K. R. C. for cara civitas, &c. &c. In the French alphabet K is only used in words derived from foreign languages. As a numeral it was employed to express 250,—

K quoque ducentos et quinquaginta docebit.

KA'ABA. *See* CAABA.

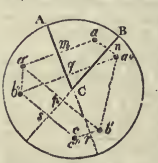
KA'KOXENE. (Gr. κακος, *bad*, and οξυς, *sharp;* so called probably from the mischief it does to the iron.) A mineral occurring in brown or red radiated crystals in the ironstone of Zbiron in Bohemia: when heated it emits a green phosphoric light. It contains phosphoric and fluoric acids, peroxide of iron, and silica.

KA'LAND. (Germ.) A lay fraternity instituted in Germany in the 13th century for the purpose of doing honour to deceased relatives and friends. The term is probably derived from kalendæ, *the first day of any month*, as the members of this society chose that day for the observance of their ceremonies. These consisted originally of prayers, followed by a slight repast, in which all the members participated; but in process of time the religious purposes of the society became wholly merged in the festivities, so that it eventually was found necessary to abolish the fraternity on account of its excesses.

KALEI'DOSCOPE. (Gr. καλος, *pretty;* ειδος, *form;* and σκοπεω, *I view.*) An optical toy invented or revived by Sir David Brewster, which, by a particular arrangement of reflecting surfaces, presents to the eye a series of symmetrical images often remarkable for their beauty. The kaleidoscope is formed by two plane mirrors or slips of glass, from six to ten inches in length, and from an inch to an inch and a half in breadth at the one end, though somewhat narrower at the other, joined together along the edges lengthwise, and inclined to each other in an angle, which must be an even aliquot part (that is to say, the sixth, eighth, tenth, &c.) of four right angles. The edges of the mirrors are kept in contact by a strip of black silk glued along the back of the plates, which, if formed of glass, must be coated with black varnish or sealing wax, to prevent reflexion from their posterior surfaces. The mirrors being adjusted at the proper angle, are placed within a tin tube, where they are kept in their proper position by pieces of cork or wood wedged in between them and the tube. One end of the tube has a small circular aperture in its centre, to which the eye is applied; in the other end two plane glasses are fixed parallel to each other, and perpendicular to the axis of the tube, and about an eighth of an inch apart. Between these glasses, which form a cell, the objects which produce the images are placed. Those which answer the purpose best are small fragments of coloured glass, beads, or other coloured diaphanous matters, of such a size that when the tube is turned round they move freely within the cell and assume new positions. In order that the eye may not be disturbed by objects without the tube, the outer glass should be slightly ground, but the inner must be perfectly transparent.

On applying the eye to the aperture of the tube the objects within the cell at the other end are seen multiplied by repeated reflexions from the two mirrors, and a succession of symmetrical images presented, all arranged round a centre, and combined into a perfect whole. As the objects are placed loosely in the cell, every motion of the tube changes their relative positions, whereby an entirely new image is produced; and it is this constant change and endless variety of new combinations which create the pleasing effect.

In order to show how this multiplication of the images is produced, let A C represent one of the mirrors, and B C the other, and suppose them to make with each other an angle of 60°: let *a* also be an object placed between the planes of the two mirrors, or one of the diaphanous bodies in the cell between the two parallel glasses at the end of the tube. Now when an object is seen reflected from a mirror, the image always appears as far behind the mirror (in a perpendicular line) as the object itself is before it; and, with relation to a second mirror, this image will have all the effect of a real object. Let, therefore, $a\,m$ and $a\,n$ be drawn perpendicular to A C and B C, and produced till $m\,a' = m\,a$, and $n\,a'' = n\,a$; then a' and a'' will be the two first images of the object *a*. Make $a'\,p$ perpendicular to B C, and $a''\,q$ to A C, and let $p\,b' = a'\,p$, and $q\,b'' = a''\,q$; then will b' and b'' be the images of *a* formed by a second reflexion. Again, draw $b'\,r$ perpendicular to A C, and $b''\,s$ perpendicular to B C, and let $r\,c' = b'\,r$ and $s\,c'' = b''\,s$; then will c' and c'' be the images of *a* formed by the third reflexion. But by the geometrical properties of the figure these two points c' and c'' coincide, or the two images are blended together, and the object will be seen in six different places symmetrically arranged in a circular field about the centre C. In like manner, if A B C had been the 8th part of 360°, the object would appear in eight positions, and so on; but if the angle at C, which is the angle of the mirrors, be the 7th or 9th, or any odd aliquot part of 360°, the images will not coincide, and the symmetrical arrangement will not be produced.



The kaleidoscope here described was first made known by Sir David Brewster, who took out a patent for it in the year 1817; but by some means or other its properties were discovered, and it had acquired great popularity as an agreeable toy, and was in the hands of every body before any number of the patent kaleidoscopes could be prepared for sale. It was also very soon remarked that the discovery was by no means new, as an instrument on the same principles had been described by Baptista Porta and Kircher; and also in a work published in England in 1810, under the title of *New Improvements of Planting and Gardening*, by R. Bradley, in which it was recommended as useful for assisting to form designs of garden plots and fortifications. In fact, the principle, so far as the multiplication of images and their general arrangement are concerned, had been long known; but in order to produce the symmetry which constitutes the principal beauty of the kaleidoscope, it is also necessary that the object and the eye have certain positions with respect to the mirrors, and the discovery of this condition seems to belong exclusively to Sir D. Brewster. See *Brewster's Treatise on the Kaleidoscope; Harris's Treatise on Optics; Brewster's Optics. Cab. Cycl.;* the *Ency. Brit.*, &c.

KA'LENDERS. (From an Arabic word signifying

pure gold.) Wandering dervises. (See *Lane's Arabian Nights' Entertainments*.)

KA'LI. An Arabic word, signifying the ashes left after the combustion of vegetable substances; hence the word *alkali*. Potassa is frequently termed *kali*, and potassium *kalium*, by the German chemists; hence they use K as the symbol for potassium.

KA'LMIA. (From Kalm, a traveller in North America.) A genus of beautiful North American plants, with a monopetalous corolla, which confines ten stamens by their anthers in the same number of niches in its sides. The flowers are white or pink, and the leaves evergreen; but the plants are said to be deleterious.

KA'MI. Spirits or divinities, the belief in which appears to have characterized the ancient religion of Japan before it became intermingled with foreign doctrines, and still constitutes its groundwork. These spirits are partly elemental, subordinate to the gods of the sun and moon, and partly the spirits of men; but in fact every natural agent or phenomenon has its spirit or genius. The human spirits survive the body, and receive happiness or punishment for the actions of the individual in life. Distinguished benefactors of their species, or men renowned for purity of life, are deified; and their *kami* become objects of worship, like the heroes of antiquity. The number of them is said at present to be above 3000. They are worshipped in temples in which no images are retained, each particular divinity being merely typified by a mirror, the emblem of purity; and all the rites of the worship appear to be symbolical of purification. The priests of these temples are styled Kami-Nusi, *i. e.* ministers of the spirits. (*Klaproth, Annals of Japan*, 1834; *Wiener Jahrbuch* for 1837.)

KAMIC'HI. The name of a Rassorial or Gallinaceous bird, remarkable for having its wings armed with two strong spurs, and its head with a long, slender, cylindrical and nearly straight horn. *See* PALAMEDEA.

KA'NGAROO. The native name of a large indigenous quadruped of New Holland; it belongs to a genus characterized by a strictly herbivorous modification of the marsupial type of the dental organs, and by a remarkably long and strong tail and hind legs. *See* MACROPUS and MARSUPIALIA.

KA'NTIAN PHILOSOPHY (known also by the name of the Critical Philosophy). A system which owes its existence to Immanuel Kant, professor of logic and metaphysics in the university of Königsberg in the latter half of the 18th century. The promulgation of Kant's doctrines forms a very marked era in the history of philosophy. Our limits will prevent us from giving an explanation of this system in any degree adequate to its importance. We must confine ourselves to a brief outline of its leading features. At the time when Kant commenced his metaphysical labours the philosophical world was divided between the sensualism of the French followers of Locke on the one hand, and the dogmatic rationalism of the disciples of Wolf and Leibnitz on the other. The former, by a species of analytical legerdemain, resolved all our mental powers into modifications of sense; while the latter, in an equally indiscriminating spirit, though with far more laudable intentions, sought to construct a system of real truth out of the abstract conceptions of the understanding. Against both of these schools Kant declared open warfare. Withdrawing himself from all ontological speculation, he sought, by a stricter analysis of our intellectual powers, to ascertain the possibility and to determine the limits of human knowledge. He divides the speculative part of our nature into three great provinces,—sense, understanding, and reason. Our perception of the outward world is representative merely: of things as they are in themselves it affords us no notices. In order to render human experience possible, two ground-forms, under which all sensible things are contemplated, are assumed, —time and space. To these he assigns a strictly subjective reality. The truth of the fundamental axioms of geometry rests on the necessity and universality of our intuitions of space in its three dimensions,—intuitions which are not derived from any one of our senses, or from any combinations of them, but lie at the ground and are the condition of all sensible human experience. The understanding, or the faculty which combines and classifies the materials yielded by sense, Kant subjects to a similar analysis. All its operations are generalized into four fundamental modes or forms of conception; which, after the example of Aristotle, he names categories. (*See* CATEGORY.) These are four in number:—1. Quantity, including unity, multeity, totality; 2. Quality, divided into reality, negation, and limitation; 3. Relation, viz. substance and accident, cause and effect, action and reaction; and 4. Modality, also subdivided into possibility, existence, and necessity. These form, as it were, the moulds in which the rude material of the senses is shaped into conceptions, and becomes knowledge properly so called. The categories in themselves are the subject-matter of logic, which is so far forth a pure science, determinable à priori. The third and highest faculty, the reason, consists in the power of forming ideas,—pure forms of intelligence, to which the sensible world has no adequate correspondents. Out of these ideas no science can be formed: they are to be regarded as regulative only, not as constitutive. The existence of God, immortality, freedom, are the objects after which the reason is perpetually striving, but concerning which it can decide nothing either one way or the other. Thus far Kant's system may be regarded as one of pure scepticism. The deficiencies of our speculative reason he conceives to be supplied by the moral faculty, to which he has given the name of practical reason, the object of which is to determine, not what is, but what ought to be. As the former determines the *form* of our *knowledge*, so the latter prescribes the form of our *action*. Obligation is not a mere feeling; it is a pure form under which the reason is compelled to regard human conduct. The personality of man, which lies at the ground of speculative knowledge, becomes in relation to action freedom of the will. It is in our moral nature that we must seek for the only valid foundation of the belief in God, the immortality of the soul, and a future state in which the demands of the practical reason shall be realized. (See *Kant's Philosophical Works; Kritik der Reinen Vernunft; Kritik der Practischen Vernunft*, &c.)

KA'OLIN. The Chinese name for *porcelain clay*. A large tract of this useful substance occurs near St. Austle in Cornwall, whence our potteries and porcelain manufactories are copiously supplied. Its essential component parts are silica and alumina; the former usually preponderates. The kaolin of Cornwall, and probably of other countries, is derived from the decomposition of the felspar of granitic rocks.

KA'RA. A Tartar word, signifying *black*, used in many of the Eastern languages as a prefix to geographical names; as Karamania, *the country of the black people*. It has also been employed in the same capacity to signify "tributary;" as kara kalpacks, *tributary kalpacks*.

KARMA'THIANS, or KARMATIANS. A Mohammedan sect which arose in Irak during the 9th century of the Christian era. It derived its name from Karmata, its founder, a poor labourer, who assumed the rank of a prophet. They maintained bloody wars with the caliphs for nearly a century. (*Taylor, Hist. of Mohammedanism*, p. 223.; *Secret Societies of the Middle Ages*, Lib. Ent. Kn. 1837.)

KA'RPHOLITE. (Gr. κάρφω, *I dry or shrivel*.) A mineral which occurs in stellated crystals of a yellowish colour and silky lustre: it is a hydrated silicate of alumina and manganese.

KARPHOSIDE'RITE. A mineralogical name of the hydrated phosphate of iron of Labrador.

KEEL. (Probably from the Gr. κοῖλος, *hollow*.) The principal piece of timber in a ship, usually first laid on the blocks in building. If we compare the body of a ship to the human skeleton, the keel seems to resemble the back bone, and the timbers the ribs. It is generally composed of several thick pieces of wood placed lengthways, which after being scarfed together, are bolted and clenched upon the upper side.—*Keelage* signifies the duty paid by a ship on coming into port.

KEEL. In Botany, a name applied in a figurative sense to the two lowest petals of a Papilionaceous corolla, which, together, have some resemblance to the keel of a boat.

KEEL-HAULING. A nautical punishment practised chiefly in the Dutch navy, by which the culprit is let down on one side of the ship, and after passing under the keel is *hauled* up on the other. This punishment was formerly not altogether unknown in the British navy; but it is not now resorted to.

KEE'LING. A name for the common cod (*Morrhua vulgaris*, Cuv.). *See* MORRHUA and GADUS.

KEEP. (Anglo-Sax. kepan.) Applied in ancient Military History to the stronghold of a castle, to which in cases of emergency the besieged inmates retreated, and there made their last efforts of defence. It is almost synonymous with *donjon* (which see).

KEE'PER OF THE GREAT SEAL, LORD, or LORD KEEPER. An officer of high dignity in the English constitution, whose office is created by the delivery of the king's great seal into his custody. He is prolocutor or speaker of the House of Lords by prescription. By 5 Eliz. c. 18. the offices of lord chancellor and lord keeper are declared to be of exactly the same authority; and when there is no chancellor the great seal is ordinarily put in commission. (*See* CHANCELLOR, SEAL. *Bl. Com.* iii. 47.) The keeper of the privy seal is styled lord privy seal.

KEEPING. (Ang. Sax. kepan, *to keep*.) In Painting, the management of the lights, shadows, colours, and aërial tints in such subordination to each other, that each object may seem to stand rightly in the place that the linear perspective has assigned to it. Objects in the nearer parts or foreground of a picture will necessarily receive the strongest lights and shadows; and as more air is interposed in nature between the eye and the objects as they

become more distant, so in the representations of them the colours must be less brilliant as they recede from the eye towards the distance wherein they are lost. This word must not be confounded with the term *effect*, though effect is doubtless the result of keeping in a picture, that word being more peculiarly applicable to the sensation produced by the combination of accidental circumstances in the disposition of light and shade.

KELP. A common term for sea weed or vraic, which consists of different species of *Fucus* (Lin.). In a strict sense, the term kelp is confined to the produce of sea weeds when burned, which consists of alkaline ashes used in the manufacture of glass and soap. It has been recently found, however, that the alkali required for these purposes can be obtained more abundantly from sea-salt, and kelp is at present chiefly used as a manure. For this purpose it is eagerly sought after by all farmers on the sea coast, and especially by those who have dry soils, the salt contained in the kelp being a powerful absorbent of moisture from the atmosphere. It has lately acquired much importance as a source of *iodine*.

KE'NNEL. Applied literally to the house in which a pack of hounds is lodged, but used metaphorically also for the pack itself. It signifies also the spot to which the fox after his nocturnal depredations retires about the dawn of day. Hence, on being found by the hounds in drawing cover, he is said to be *unkennelled*.

KE'PLER'S LAWS, in Astronomy, are the laws of the planetary motions, first discovered and demonstrated by Kepler, and which form the basis of the whole theory of gravitation and physical astronomy. They are three: — 1. That the planets describe ellipses, each of which has one of its foci in the same point, namely, the centre of the sun. 2. That every planet moves so that the line drawn from it to the sun describes about the sun areas proportional to the times. 3. That the squares of the times of the revolutions of the planets are as the cubes of their mean distances from the sun. These three laws or general facts were discovered by Kepler from a comparison of astronomical observations; and though it was by means of them that Newton established the more general law of attraction inversely as the square of the distance, they are themselves direct consequences of that hypothesis. The first law, that of the elliptic motion of the planets, was announced by Kepler in his famous work, *Physica Cœlestis tradita Commentariis de Motibus Stellæ Martis*, 1609. Kepler having computed from the observations of Tycho Brahe the distances of Mars from the sun at different points of his orbit, found that the orbit was not circular, as had always been supposed by astronomers till then, but elliptical; and that the sun occupies one of the foci of the ellipse. He afterwards discovered the same thing to be true of the earth's orbit; and thence extended it by analogy to all the other planets. Newton demonstrated in the *Principia* that if a body projected in space is acted upon by a central force varying inversely as the square of the distance, the body will necessarily describe one of the three conic sections; but whether the orbit will be an ellipse, an hyperbola, or a parabola, depends on the intensity of the force with which it is projected.

Kepler was led to the discovery of his second law by a comparison of the sectors formed by two contiguous *radii vectores* and the angles included between them. The data which he assumed were not rigorously exact; but Newton afterwards demonstrated from the theory of dynamics that the fact is necessarily true of all motions regulated by a central force, whatever the law of that force may be.

The history of the discovery of the third law is remarkable, and detailed by Kepler himself in his *Harmonices Mundi*, lib. v. He had long been persuaded that some numerical relation must exist between the periodic times of the planets and their distances from the sun. In order to discover this relation he tried successively numerous hypotheses, each of which involved a mass of tedious calculation. He began by comparing the intervals between the planetary orbits with the five regular solids; and having failed in this speculation as well as various others, he at length thought of comparing the different roots and powers of the periods and distances. After many attempts and failures, he at last perceived the analogy of which he had been so long in search.

—— "Sera quidem respexit inertem,
Respexit tamen et longo post tempore venit,"

he exclaims; and in the fulness of his delight he has recorded the year and day on which the discovery was made. It was the 15th of May, 1618; and, as Professor Playfair has remarked, "perhaps philosophers will agree that there are few days in the scientific history of the world which deserve so well to be remembered." (*Dissertation*, *Ency. Brit.* See *Kepler's Harmonices Mundi*, p. 189.)

KE'PLER'S PROBLEM. The discovery made by Kepler, that the planetary orbits are ellipses having the sun in the focus which is common to each ellipse, and that the line which joins the centres of the sun and a planet passes over equal areas in equal times, made it necessary to solve a problem which transcended the geometry of that time: — Supposing the semitransverse axis of a planet's orbit to be represented by 1, and the eccentricity by e; also the mean anomaly at any given instant of time by z, and the eccentric anomaly by x, both being reckoned from the perihelion. Kepler found the relation between the angles x and z to be expressed by the equation $z = x - e \sin. x$. When x is given, z is easily found from the trigonometrical tables; but there is no direct way, unless by infinite series, of finding x when z is given, which is the case that occurs in astronomy. The determination of x in terms of z constitutes what is called Kepler's Problem. Solutions of this important problem are to be found in most works on astronomy. They are generally tentative, depending on a combination of geometrical and trigonometrical principles; but two very elegant ones, purely analytical, are given by Professor Wallace, in the *Memoirs of the Royal Astronomical Society*, vol. ix. p. 185. The first of these solutions is as follows: —

1. Find x', a first approximation to the eccentric anomaly x, by this formula,

$$\tan. (x' - \tfrac{1}{2} z) = \frac{1 + e}{1 - e} \tan. \tfrac{1}{2} z.$$

2 Find y such that

$$\tan. (\tfrac{1}{2} x' + y) = \frac{1 + e}{1 - e} \tan. \tfrac{1}{2} x'.$$

3. Find c, a correction of x', so that

$$\sin. (y - c) = \frac{\sin. y}{\sin. x'} \cdot \frac{\sin. 1''}{e} (x' - z).$$

(Here $x' - z$ must be expressed in seconds of a degree.)

4. Then the eccentric anomaly, $x = x' + c$. The computation of the eccentric anomaly by this method is extremely simple.

KE'RATONY'XIS. (Gr. κερας, *a horn*, νυξις, *puncture*.) A term applied by the German surgeons to the operation of couching, performed by introducing a needle through the cornea or horny coat of the eye, and depressing or breaking the opaque lens.

KERI-CHETIB. (Heb.) In Philology, the name given to various readings in the Hebrew Bible. Keri signifies *that which is read*, and Chetib *that which is written*. When any such various readings occur, the false reading or chetib is written in the text, and the true reading or keri is written in the margin, with ק under it. These corrections, which are about 1000 in number, have been generally attributed to Ezra; but as several Keri-chetibs are found in the sacred books the produce of his own pen, it is more probable that they are of later date. (See *Dr. Kennicott's Dissertatio Generalis*.)

KE'RMES. (Arab. *little worm*.) An insect found in many parts of Asia and the south of Europe; the *Coccus ilicis* of Linnæus. They were long taken for the seeds of the tree on which they live, and hence called *grains of kermes*. They are used as a red and scarlet dye, but very inferior to cochineal. Previously to the introduction of cochineal, by which it is now nearly wholly superseded, kermes had been the most esteemed drug for dyeing scarlet from a remote period of antiquity. Cloths dyed with kermes are of a deep red colour; and though much inferior in brilliancy to the scarlet cloths dyed with real Mexican cochineal, they retain the colour better and are less liable to stain. The tapestries of Brussels and other parts of Flanders, which have scarcely lost any thing of their original brilliancy, even after a lapse of 200 years, were all dyed with kermes. (See *Beckmann's History of Inventions*; and *Bancroft's Permanent Colours*.)

KE'RMES MINERAL. A name given by the old chemists to the hydrosulphuret of antimony, in consequence of its reddish colour.

KE'RODON. (Gr. κεαρ, *a heart*, οδους, *a tooth*.) A genus of Herbivorous Rodents, characterized by $\frac{4 \cdot 4}{4 \cdot 4}$ molar teeth, each composed of two equal parts, of which the transverse section presents a cordiform or heart-shaped figure: the two parts are united on the external side in the upper, and on the internal side in the lower jaw. The incisors are two in number in both jaws, and present the form common to the Cavies, to which family the present genus belongs. The species are small, scarcely equalling in size the Guinea-pig. They are peculiar, with the other Cavies, to the South American continent.

KE'RSEY. (Probably a corruption of Jersey, whence it originally came.) A kind of coarse cloth, usually ribbed, and woven from long wool. It is chiefly manufactured in the North of England. *Kerseymere*, on the other hand, is a thin stuff, generally woven plain from the finest wools; and hence it has been inferred that these two terms, whose meaning is so distinct, cannot be referred to the same origin. Kerseymere is said to have derived its appellation from Cashmir, a country which

produces the finest wool, and is consequently most celebrated for the works of its looms. In England it is principally manufactured in the Western districts.

KETCH. (Ital. caicchio.) An old English term, applied to a vessel equipped with two masts, and from 100 to 250 tons burden. It was nearly synonymous with the modern term *yacht*, being used chiefly by ambassadors or other distinguished personages in voyages from one place to another, and was furnished with all the apparatus necessary for defence or aggression.

KE′TCHUP. The juice which exudes from salted mushrooms.

KEU′PER. A term applied by the German geologists to the upper portion of the new red sandstone formation.

KEY. (Sax. cæze.) In Architecture, a piece of wood let into the back of another in the contrary direction of the grain, to preserve the last free of warping.

KEY, or KEY NOTE. In Music, the principal or fundamental note in a composition, on which frequent closes or cadences are made. It is that in which the piece begins and usually ends, and is, as it were, the musical subject to which regard must be had in all the other combinations of sounds in the composition, and under whose influence they are.

KEY-BOARD. In Music, the series of levers in a keyed instrument, as a piano-forte, organ, or harpsichord, upon which the fingers press to produce percussion of the strings, or in the organ the opening of valves. It consists of short black and long white keys.

KEYSTONE. The middle voussoir in the arch of a bridge, or the arch-stone in the crown or immediately over the centre of the arch. The length of the keystone, or thickness of the archivolt at top, is allowed to be about 1-15th or 1-16th of the span by the best architects.

KHALIFF. *See* CALIPH.

KHAN. In Persia, properly speaking, the title of an officer or governor, added after his name. The sovereigns of many independent states of northern Asia are styled Khans. Khan is frequently used by our own countrymen to signify an Eastern caravansera (which see); in which travellers find a gratuitous lodging, provided their stay be limited to a single night.

KHOH. A Persian word signifying *bald*, and used as a prefix in many geographical terms. It has been suggested that the name Caucasus has been derived from Khoh Kasp, or *bald mountain*; i. e. having the summit without vegetation. But be this as it may, it is singular enough that the same metaphorical expression has been introduced into two modern languages, the French and the German; in the former of which is found *Chaumont*, and in the latter *Kahlenberg*, both indicative of a mountain *bald* or without vegetation.

KHO′TBAH (Arab.), denotes a peculiar form of prayer, used in Mohammedan countries at the commencement of public worship in the great mosques on Friday at noon. It was originally performed by the Prophet himself, and by his successors till the time of Mohammed VIII. (A. D. 936), who appointed special ministers for the purpose, on which footing it has continued to the present time. The khotbah is chiefly a "confession of faith," and a general petition for success to the Mohammedan religion. It is divided into two distinct parts, between which the officiating khatib or priest makes a considerable pause, and is regarded by the Mussulmans as the most solemn and important part of their worship. The insertion of his name in this prayer has always been considered one of the chief prerogatives of the sultan of Turkey.

KIDNA′PPING. In Law, the forcible abduction of any one from his own country into another. It is an offence at common law. By the 11 & 12 W. 3. c. 7. penalties were denounced against masters of vessels having aboard persons who had been kidnapped against their will, which was probably occasioned by the practice, not uncommon in those days, of carrying away by force or fraud labouring persons to serve in the plantations in America. This clause is repealed by 9 G. 4. c. 31., by which masters of vessels are made punishable for leaving abroad any of their men against their will, or refusing to take them back if in a condition to return. The stealing of children away from persons having the lawful custody of them (popularly termed kidnapping) is felony under the same statute.

KI′DNEYS. The organs in which the urine is secreted: there is one on each side in the loins, near the first lumbar vertebra, and behind the peritonæum. The pelvis of the kidney terminates in the ureter, and is divided into several portions called *calyces*, into each of which a papilla projects, through the minute orifices of which the secreted urine passes into the cavity called the pelvis, and thence by the ureter into the bladder.

KI′LLAS. A provincial term, applied to the clay-slate rocks of Cornwall.

KI′LLINITE. A mineral, sometimes described as a variety of spodumene, from Killiney, near Dublin. It is a hydrated silicate of alumina, containing potash and oxide of iron.

KILN. A term applied to various furnaces and stoves: as *brick* and *lime kilns*, and *hop* and *malt kilns*. (See those articles.)

KI′LOGRAM. A French measure of weight, equal to 2 lbs. 3 oz. 5 drs. avoirdupois.

KILT. A loose dress, extending from the belly to the knee in the form of a petticoat; worn in the Highlands by men, and by children in the Lowlands. The term is, according to Jamieson, unquestionably Gothic. The Highlanders designate the kilt as the *filibeg*. This singular national dress is fast hastening into disuse; and but for a few Highland regiments in which it is still maintained, it would probably long ere now have been universally superseded by the dress of the Lowlanders.

KING. A title of dignity in the languages, extinct and living, of the Gothic and Teutonic races. The term has long been considered of uncertain origin; but there can be little doubt that it is derived from the German word können, *to be able*, thus in the very threshold giving an idea of superior power or ability. In its primary acceptation it denotes a person in whom is vested the chief executive authority; but it is susceptible of as great a variety of shades of meaning as there are states or nations to be governed. Thus it is applied equally to the limited sovereign of England and the absolute sovereign of Prussia; to the chief magistrate of Poland in former times, who was *elected*, and to that of England, who succeeds by *hereditary* right; to the head of a savage tribe or barbarous horde, as well as to that of the most refined and civilized nation. It is expressed in Greek by the word Basileus, and in Latin and its cognate languages by Rex; but all the nations of Europe have adopted into their respective languages the equivalent terms in use among the people with whom they carry on intercourse. Thus we speak of the Shah of Persia, the Grand Sultan, the Pasha of Egypt, the Dey of Algiers, &c.

In countries where the kingly office is hereditary some form has always been gone through on the accession of a new king, in which there is a recognition on the part of the people of his right; a claim from them that he should pledge himself to the performance of certain duties; and generally a religious ceremony performed, in which anointing him with oil, by which a certain sacredness is thrown around his person, and placing a crown upon his head as a symbol of supremacy, are conspicuous acts. (*Penny Cyclop.*) The whole solemnity is styled the coronation. In modern Europe the Pope and the Emperor of Germany assumed as a joint prerogative the right of conferring the dignity of king. Frederic I. of Prussia was the first sovereign who assumed the title, and had it acknowledged by the other states of Europe without their authorization.

KING. The sacred books of the Chinese, containing at once the principles of their domestic and public morality and the foundation of their historical traditions. According to a learned dissertation by M. Freret, in vol. xv. of the *Memoires de l'Ac. des Inscr. et Belles Lettres*, the original books known properly under this title are only four in number; but those commonly so designated amount to thirteen, which are published together. The first four contain the writings of Confucius. (See also vols. xxxvi. xxxviii.; and *Ersch and Gruber's Encyclopedia.*)

KING AT ARMS. An officer of great antiquity, and formerly of great authority, whose business is to preside over the chapters, and to direct the proceedings of heralds. The origin of this office is involved in obscurity. There are three kings at arms in England — Garter, Clarencieux, and Norroy; the first of whom is styled *principal king at arms*, and the two latter *provincial kings*, because their duties are confined to the provinces. The name Clarencieux is said to be derived from Clarence, brother of Henry V., first king at arms for the south of England; that of Norroy (Norman French for *northern king*) is self-explanatory. There is also a Lyon king at arms for Scotland, as well as an Ulster king at arms for Ireland, whose duties are nearly analogous to those of England. (See *Noble's History of the College of Arms.*)

KING, THE, OF ENGLAND, exercises the supreme executive power, together with a share in the legislative authority jointly with the two Houses of Parliament. (For his legislative functions, *see* PARLIAMENT.) The right to the throne of England (now extended to Great Britain and Ireland) is hereditary, subject to the authority of parliament to limit the succession. This was last done by the stat. 12 & 13 W. 3., when it was fixed in the heirs of the electress Sophia of Hanover, being Protestants. The duties of the king according to the constitution are embodied in the coronation-oath, fixed by stat. 1 W. & M. Incidental prerogatives are legal exceptions in favour of the crown where its claims clash with those of a subject; relating to such matters as descents of land, debts, &c. The direct prerogatives of the crown are those which attach to his person in respect of his political authority: such as the sanctity of his person;

his prerogatives as head of the executive; the power of making war and peace; treaties with foreign powers; military and naval command; the supreme dispensation of justice through his courts; the power of erecting and disposing of offices and honours; the power of issuing proclamations binding on the subject in certain cases, with the advice of his privy council; and, lastly, the supreme government of the national church. The king's revenue is of two sorts, ordinary and extraordinary. The ordinary revenue or patrimony is such as either has subsisted in the crown time out of mind, or has been granted by parliament in exchange for such. (*See* Civil List.) The extraordinary revenue consists of the supplies annually granted by parliament. *See* Parliament, Prerogative.

KING CRAB. *See* Limule.

KING FISH. A name sometimes applied to the *opah* (*Lampris guttatus*, Retz.).

KING POST. In Architecture, the middle post of an assemblage of trussed framing for supporting, or rather suspending, the tie beam at the middle and the lower ends of the struts.

KING'S BENCH, COURT OF, in Law, originated in the ancient Aula Regia, in which the king was accustomed (as he still is supposed in the King's Bench by fiction of law) to sit in person, and which followed him in all his progresses. The judges of the court of King's Bench, as well as of the other superior courts, formerly varied in number according to the royal discretion. At a later period they were reduced to four; now increased, by stat. 1 W. 4. c. 70., to five — the chief justice, who is the highest common law judge, and four *puisné* or *younger* judges. The court of King's Bench, besides those branches of its jurisdiction which it has in common with the other two superior common law courts (*see* Courts, Superior), has also peculiar authority, or presents more advantages in some particular proceedings.

It is the preferable although not the only tribunal for discharging prisoners under the Habeas Corpus Acts. It has controul over all inferior courts by means of the process called *certiorari*, which is a writ sued out of this court, by virtue of which proceedings may be removed into it out of such inferior jurisdiction, whether in criminal or civil cases. It has also an exclusive authority (except in a few cases) to compel all inferior courts and officers, and in some instances private persons, to perform acts of a public nature, and connected with a public duty. By means of a *prohibition* it can restrain all other courts from proceeding where they exceed or misuse their jurisdiction: this is likewise a writ directed to the judge and the plaintiff in the inferior court. A writ of error in law from all *inferior courts* is, with certain exceptions, returnable in the King's Bench. This court likewise hears and determines cases stated by courts of sessions. The greater proportion of these are questions on the validity of poor's rates, or on parochial settlements. When a court of sessions entertains a doubt on a point of law arising in the argument, it will usually authorize the party against which it decides to have the judgment thus reviewed, the cases being stated in writing. The criminal jurisdiction of the King's Bench is still extensive. It has, at common law, jurisdiction by indictment over every species of criminal offence committed in Middlesex; and in practice misdemeanors, as conspiracies or perjuries, committed in the county, are still indicted in this court, and tried after term at nisi prius among the civil causes. Sometimes also trial at bar, or by the full court, is granted on special application. It has also jurisdiction by criminal information, which lies in cases of misdemeanor only; a proceeding which supersedes the necessity of an indictment found by a grand jury. An information is filed either by the attorney-general *ex officio*, as it is termed, — a proceeding generally adopted in certain misdemeanors of a public nature; or at the suit of a private party, by leave of the court.

An information in the nature of a *quo warranto* is in form a criminal, but substantially a civil, proceeding. It is granted where any subject or body politic has assumed a franchise or privilege not being legally entitled, and to the injury of some other party or the public. Any indictment, presentment, &c. found in any part of England, may be moved by *certiorari* into this court; as may be also all convictions or orders of justices of the peace, unless where such appeal is prevented by particular statutes.

KING'S EVIL. Scrofula attacking the glands, respecting which a superstitious notion long existed that it was curable by the touch of royalty.

KI'NGSTON. A name sometimes given to the angel-fish (*Squatina angelus*, Dunn.). *See* Squatina.

KING'S YELLOW. A pigment, the basis of which is *orpiment*, or yellow sulphuret of arsenic.

KI'NIC ACID. The acid with which quinia and cinchonia are combined in yellow and pale Peruvian bark. Its ultimate elements are, according to Lubig, 15 atoms of carbon, 9 of hydrogen, and 9 of oxygen.

KI'NKAJOU. The native name of a Plantigrade quadruped of South America, of arboreal habits, with a long prehensile tail, a short muzzle, and a thick coat of woolly hair. It forms the type of the genus *Potos* of Cuvier, which name Illiger changed to *Cercoleptes*. Only one species is well established, the *Cercoleptes caudivolvulus* of Illiger.

KI'NO. An Indian word, applied to an astringent vegetable extract, the source of which is doubtful; it is probably a name given to the products of different plants in Africa, and in the East and West Indies and America. The finest kino is in brilliant fragments of a deep brownish red colour, and highly astringent: it contains tannin, gum, and extractive matter.

KIOSK. A Turkish word, signifying a kind of open pavilion or summer house, supported by pillars. These ornaments have of late years been introduced to a considerable extent into the gardens of European countries.

KIRK. (Germ. kirche.) A Scottish term synonymous with church, and used chiefly to designate the form of religion established in that country. *See* Presbyterianism.

KIRK SESSION. The lowest ecclesiastical court of the kirk of Scotland. It is composed of the minister of the parish, and of lay elders. It takes cognizance of cases of scandal, of the poor's fund, and of matters of general ecclesiastical discipline. There is an appeal from its decisions to the presbytery.

KI'RSCHWASSER. (Germ. *cherry water*.) An alcoholic liquor, obtained by fermenting the small and sweet black cherry. The liquor produced is distilled, and often flavoured with hydrocyanic acid, derived from the bruised kernels of the fruit: this gives to kirschwasser, when sweetened, the character of noyau.

KIT CAT CLUB. The name of a celebrated association, instituted about 1688 by "some young men of wit and pleasure about town," originally for convivial purposes; but as its most distinguished members were Whigs in politics, it gradually assumed a political character, till in the reign of Queen Anne it came to be regarded as exclusively political in its objects. At that period it comprised above forty noblemen and gentlemen of the first rank and quality, merit and fortune, firm friends to the Hanoverian succession; among whom were Addison, Steele, Marlborough, Walpole, &c. &c. It was originally formed in Shire Lane, and derived its name from one Christopher (Kit) Kat, who supplied the members with mutton pies. The fame of this club has been transmitted chiefly by the collection of the portraits of the members painted by Sir Godfrey Kneller, himself a member, who was obliged to invent a new-sized canvass accommodated to the height of walls; whence has originated the application of the epithet *kit cat* to any portrait about three quarters in length. It was dissolved in the year 1720. (*Quart. Rev.* vol. xxvi.)

KITE. A well-known toy; first employed by Romas in France, and Dr. Franklin in America, to elevate a conductor into a thunder-cloud, whereby the identity of lightning with the electric spark was ascertained. It is formed of a slender frame of wood and pack-thread, rounded at one end and terminating in a point at the other, resembling in some measure a cross-bow, and covered with paper. A long string is attached to the frame, near its centre of gravity, by which it is held in the hand. In order that the kite may be capable of being raised, it is necessary that its flat surface be presented obliquely to the direction of the wind; a string or *tail*, carrying some light substance, is therefore attached to the sharp end of the frame, and serves by means of its gravity to maintain the proper inclination. The force of the wind, impinging obliquely on the surface, is resolved into two parts; one perpendicular and the other parallel to the surface: the first of these parts is counterbalanced by the tension of the string held in the hand, and the second is expended in elevating the kite. The position in which the wind acts with the greatest effect is when the perpendicular to the surface is inclined to the direction of the wind (that is, to the horizon) in an angle of about 54½ degrees.

Kite. The native bird so called is a species of the genus *Milvus*, separated by Bechstein from the genus *Falco* of Linnæus on account of the forked tail, length of wings, and the short and weak beak and feet in proportion to the size of the body. This deterioration of their destructive instruments renders the kite the most cowardly of the birds of prey. The common kite, or glead (*Milvus vulgaris*), preys chiefly on the smaller quadrupeds and birds, young chickens, &c.; yet the courage of the mother hen renders her more than a match for the robber, and she generally repels his attacks on his favourite prey. The female lays two or three eggs of a whitish colour, spotted with pale yellow, and of a roundish form.

The term *kite* is applied in some places, as Devonshire and Cornwall, to the brill (*Rhombus vulgaris*).

KI'VI-KIVI. The native name of the New Zealanders for their singular bird the *Apteryx australis*. *See* Apteryx.

KNEE. (Sax. cneo.) In Architecture, a naturally or artificially bent piece of timber, on which another is received to relieve a weight or strain.

KNEE PAN. A small flat heart-shaped bone placed

at the fore part of the knee joint. It is an important defence to that large joint, and also serves to increase the powers of the muscles which extend the leg. It is attached by a strong ligament to the upper end of the tibia.

KNIGHT-ERRANT. In the language of Chivalry, a knight wandering in search of adventures, sometimes under vows, for a certain period. Knight-errantry was not altogether a fiction of romance. It originated, as Mr. Turner says, partly from the frequency of private war in feudal times, which made military aid constantly acceptable to the great barons; and as a knight had, for the most part, no other tie to the soil than his duties towards his feudal superior, he was at liberty to follow his own bent whenever his services were not needed by him. Such a mode of life peculiarly suited the tastes of the men of that age, and in some degree served the exigencies of society. "Knights, therefore, were perpetually errant, or travelling in quest of adventures or employment: some from the pleasure of the expedition, and some for its expected profits. They often met the oppressed or the unsuccessful; and they cheerfully engaged themselves to redress those wrongs which laws were too feeble to remedy, and for redressing which honour, plunder, or rich donations became usually their compensation." (*Turner's Hist. of England during the Middle Ages*, ch. xiii.)

KNIGHT, KNIGHTHOOD. The word knight is undoubtedly derived in its first origin from the root "to knit," or connect; from whence also the German knecht, *slave* or *servant*. The Anglo-Saxon cnicht bore the same meaning; and this etymology points to the primitive meaning of the institution of knighthood. This may be found in the usage recorded by Tacitus and other writers of the ancient Germans, among whom the kings and chiefs were attended in war and peace by a select body of faithful companions. Kings, and great thanes, and aldermen had each among the Anglo-Saxons their attendant cnichts or military servants, who owed them a species of fealty rather personal than territorial. But the order of knighthood, in the more recent sense of the word, was introduced among us from France. Among the French and Germans, indeed, the order of knights was designated by another name — *chevalier* or *ritter*, from their serving on horseback in battle, and holding a rank above the footmen. But the Norman chevalier so completely answered to the Saxon cnicht in the peculiar attribute of being personally attached to the military service of some chieftain, that the English appellation was soon in general use, as if to express the same meaning conveyed by the French title, and by its Latin equivalent miles. The Saxons appear, indeed, to have occasionally practised, long before the Conquest, some ceremonies resembling those which became usual in later times on the creation of a knight; thus Alfred is said to have honoured Athelstan by the gift of a belt and robe, and girding him with a sword.

Like most other inquiries into the ancient usages of Europe, that into the origin of knighthood as an order, — that is, the period when the term miles or chevalier, instead of merely denoting the higher class of military companions of a chief, came to signify one enjoying a definite rank in society and admitted by certain ceremonies, — is altogether inconclusive. It is said in general that knighthood had become an established institution in the 11th century; but that the characteristic which belonged to it in later times, that of being restricted to men of noble birth, did not become general until the fourteenth. The privilege of conferring knighthood seems to have belonged originally to the sovereign, and to have been retained as his prerogative in all European constitutions, although frequently delegated to or usurped by high feudatories, generals of armies, &c.; although in later times, and when knighthood had assumed its peculiar romantic character, the most distinguished and valorous knights were allowed to confer it, and kings themselves sought for the distinction of knighthood at their hands. It was a prerogative of high value and importance; and we frequently find the states and other authorities in feudal sovereignties interfering to limit its exercise, especially before usage had absolutely restricted it to those of noble birth.

It was common to create knights on various occasions. The most honourable species of knighthood was that conferred on the field and after a battle; but the more common fashion, especially in France, the parent country of chivalrous institutions, was to make knights when a battle was expected. Five hundred were created at once in the French army before the battle of Agincourt. Some inconvenience attended this practice. For example, on one occasion in Flanders, in the 14th century, when two armies were ranged in battle order, on the eve of engagement, the French, according to their usual practice, created a great number of knights; but on the following morning the forces separated without coming to action. A hare having been seen crossing the space between the armies, the French knights made on that occasion received the nickname of Chevaliers du Lièvre. Knights were also created on other solemn occasions; as great festivals, coronations, princely marriages, &c.

In describing the ordinances of knighthood as they existed when that institution was brought to the point of imaginary perfection, the period to which we must refer is the 14th century; and the countries chiefly France, Germany, and England. In Italy and Spain, and generally in other parts of Christendom, the chivalrous customs of the first-named regions were imitated, but do not appear to have grown up spontaneously as part of the popular usages. Before this epoch, indeed, the Crusades had communicated to the institution much of its religious character; and the poems of the Troubadours and Trouveurs attest how much of gallantry had already been fancifully interwoven with the military habits of the age. But it was not, perhaps, until the epoch alluded to, when the favourite fictions of romance had begun to act strongly on the popular imagination, that the ideal usages of chivalry were completely engrafted in practice on the substantial institution of knighthood.

The orders of chivalry were three. The future knight was first educated, in general, as a page attached to the family, and especially to the ladies of some noble house: when of full age, he became a squire (écuyer). The proper office of the squire, in the theory of chivalry, was, as his name of "shield bearer" denotes, to attend on the person of a knight, to whom he was bound to render devoted and faithful service. In this capacity he was a sort of apprentice to knighthood; but as many esquires never reached the order of knighthood at all, but remained independent, the rank of esquire, in ordinary usage, became an intervening order between the knight and the simple gentleman: in which sense it is still retained in England. The order of knighthood followed this double probation. Knights, however, were often made without having passed regularly through the intervening stages; and even in the age of chivalry, the honour was occasionally conferred on mere children; although this was an evident abuse, and regarded as such. When the order of knighthood was conferred with full solemnity in the leisure of a court or city, imposing preliminary ceremonies were required of the candidate. He prepared himself by prayer and fasting, watched his arms all night in a chapel, and was then admitted with the performance of religious rites. Knighthood was conferred by the *accolade*, which, from the derivation of the name, should appear to have been originally an embrace; but afterwards consisted, as it still does, in a blow of the flat of a sword on the neck of the kneeling candidate. The oath of knighthood was previously administered, which contained at different times various fanciful clauses: in France there were twenty vows comprised in it. (See on this subject, among many other authorities, the *Memoirs on Chivalry* of the French antiquary Sainte-Palaye.)

Knighthood was an institution which served in some respects as a compensation for the inequalities of rank incident to the feudal system. All knights, from the king to the lowest bachelor, were brethren of the same order; and when chivalry was in its most flourishing state, it may almost be said that they were all of the same country. National distinctions had little place between knights, who were only enemies in time of warfare, from their feudal duties, which attached them to the banner of a particular king or suzerain. At tournaments, court festivals, &c., in time of peace, knights of all nations were admitted indifferently; and the candidate for knighthood sought that honour at the hands of the most distinguished name in chivalry rather than of a countryman. The chief distinction of rank which subsisted between knights, in France and England, was rather of a feudal than a chivalrous character; it was that of knights-bachelors and knights-bannerets. The knight-bachelor was of the lower order. His name has been variously derived. It is by some considered as a corruption of "bas-chevalier;" but others deduce the name from the barbarous Latin word "baccalare," said to signify a small fief, such as was originally considered as entitling its possessor to the honour of knighthood. But in the more chivalrous times (as in all later periods) this honour was conferred without any reference to a qualification of property. Many knights-bachelors were in fact mere adventurers, unconnected by feudal ties of any sort; who offered their services in war to any successful leader, and who found in their sword a means of subsistence, not only by pay and plunder, but by the regularly established system of ransom which every knight taken in action paid for his liberty. The "chevalier-banneret" was one who possessed fiefs to a greater amount, was obliged to serve in war with a greater attendance, and carried a banner. Under Charles VII. the bannerets of France made remonstrances against the services required of them, on the ground of their impoverishment by the English wars; and it appears that this order fell afterwards into disuse in that country. In England the distinction appears to have been of a somewhat different character. The "knights' fees," into which England was divided by the Conqueror, were such portions of land as could maintain a simple knight or

bachelor; and by a statute of Edward II. persons who had the amount of 20*l.* a year in fee, or for life, were obliged to take this order of knighthood. This statute grew into disuse, except when occasionally put in force, as it was for the last time under Charles I., as a means of extorting money, by way of fines, for not taking up the order. Bannerets, on the other hand, in England, appear to have been such knights as were made or promoted from the lower degree on the field of battle. (*See* BANNERET.) The distinction in the field between the different orders of chivalry was, at least at one period, the following: — The esquire bore the *pennoncel* or triangular streamer; the knight-bachelor the *pennon* or forked streamer (swallow-tailed), made by dividing the end of the pennoncel; the banneret a banner (which was, in strict usage, of an oblong shape, barons being entitled to the square banner). Thus, when a banneret was made on the field, the ceremony was accomplished by cutting off the forked end of his pennon and converting it into a banner. Common knights and esquires were then under his command.

The confinement of the order of knighthood to men of noble birth (on the Continent, for the strict line of demarcation between nobility and commonalty was never accurately drawn in England), although necessary in theory to the completion of the chivalric system, tended in practice to its decay. Knighthood, after the 14th century, became more and more an honorary distinction, to which birth alone gave a title, and which was not considered to represent any actual duty or service; and finally, through various steps, it became again a mere personal distinction, which it was part of the sovereign's prerogative to confer, either to military persons or any others; and by the multiplication of orders, into which nobility of birth was not always a necessary qualification for admission, this peculiar property of the knightly order became again effaced. There are, however, in most Continental countries, several orders into which nobility still constitutes a necessary title for admission.

Orders of knighthood are of two classes: either they are associations or fraternities possessing property and rights of their own as independent bodies, into which knights are admitted as members into a religious foundation; or they are merely honorary associations, established by sovereigns within their respective dominions, consisting of members whose only common tie is the possession of the same titular distinction. To the former class belonged the three celebrated religious orders founded during the Crusades, — Templars, Hospitallers, and Teutonic knights; which were societies, not belonging to any particular crown or realm, possessed of extensive property, and acting in some respects as independent republics. (See those articles.) Several of the Spanish and Portuguese orders of knighthood partake of both characters: they were originally religious, but have become secular. The kings of those countries, as grand masters, exercise the privilege of admission, and make use of it as a means of conferring distinction; but the knights, as a body, form an independent society possessed of property and privileges. (*See* ORDERS of CALATRAVA, ALCANTARA, &c.) The other class, consisting of orders merely titular, embraces most of the European orders, including all those of our own country. These were probably founded in imitation of the great military societies; although antiquarians have traced real or imaginary orders of knighthood under the reigns of princes of much more remote date, as Charles Martel, Charlemagne, &c. But these accounts are apocryphal; and no subsisting order of knighthood is of the date of the Crusades, except a few of those in Spain and Portugal, which, as we have said, were framed on the model of the great societies first mentioned. (See as to foreign orders of knighthood, the work of Carlisle, 1839.)

KNIGHT OF THE SHIRE, is the designation given to the representative in parliament of English counties at large, as distinguished from such cities and towns as are counties of themselves (which are seldom if ever called shires); and the representatives of which, as well as the members for other cities and towns, are called citizens or burgesses. It was formerly imperative on knights of the shire, as well as their choosers, either to be resident or to have a household in the county; but this regulation, which had long fallen into disuse, was formally repealed by 14 Geo. 3. c. 58.

KNIGHT SERVICE, *Servitium Militare.* The tenure by which a knight held his land. *See* FEUDAL SYSTEM.

KNIGHT'S FEE, *Feodum Militare.* In the language of English feudal usage, a portion of land held by custom sufficient to maintain a knight to do service as such for the king. William the Conqueror by his military grants is said to have created 60,000 such fees. But although William's vassals were undoubtedly bound to follow him to war, it is doubted by modern antiquarians whether feudal services, strictly so called, were attached to these grants by the Conqueror, or whether they were not peculiarities arising subsequently when the feudal system grew into vigour, and attributed to the Conqueror by the legists of later times.

KNOLL. A term used in many parts of England for the pinnacle of a small hill, or for the hill itself.

KNO'PPERN. A species of gall-nut or excrescence formed by the puncture of an insect upon several kinds of oak. They are flat, hard, and prickly: they abound in Croatia, Styria, Sclavonia, and Natolia, and are used in Austria and Germany for tanning and dyeing.

KNOT. *See* LOG.

KNOUT, THE. An instrument used in the infliction of a well-known Russian punishment. The following description is by a writer in the *New Monthly Magazine* for 1830 (vol. xxviii. p. 128.): — "The handle may be two feet long, a little more or less, to which is fastened a flat leather thong about twice the length of the handle, terminating with a large copper or brass ring; to this ring is affixed a strip of hide about two inches broad at the ring, and terminating, at the end of two feet, in a point. This is soaked in milk, and dried in the sun to make it harder; and should it fall, in striking the culprit, on the edge, it would cut like a penknife. At every sixth stroke the tall is changed. In the hands of a stranger it would be a most innocent weapon; nor could I, after a quarter of an hour's practice, make any considerable impression on the snow, while the executioner will leave a pretty fair mark on a deal plank." Notwithstanding the assertion of Dr. Granville to the contrary (*Travels to St. Petersburgh*, ii. 451.), there is no doubt of the excessive severity of the punishment.

KOA'LA. The native name of a Marsupial quadruped of New Holland. (*See* PHASCOLARCTUS.) The Mahrattas apply the same name to the jackal.

KO'BOLD. A German word signifying a spirit, or spectre, and corresponding to the English *goblin*, of which it is probably the origin. In many parts of Germany there is scarcely a house or a family to which kobolds are not said to be attached; and according to the superstitious notions of the peasantry, they preside over all domestic operations, many of which they perform. The name of the metal *cobalt* is derived from the above.

KOLPO'DES, *Kolpoda.* (Gr. κολπωδης, *sinuous.*) The name of a genus of Polygastric Infusories, characterized by their flat and sinuous figure.

KO'RAN. *See* ALCORAN.

KOSSACKS. *See* COSSACKS.

KOU'MISS, or KUMISS. A vinous liquid, obtained in Tartary by fermenting the whey of mares' milk.

KO'UPHOLITE. (Gr. κουφος, *light*, and λιθος, *a stone.*) A species of zeolite or prehnite from the Pyrenees: it occurs in small rhomboidal plates, of a pearly lustre, and of a yellowish or green colour.

KRAAL. The name given to the villages of the Hottentots.

KRA'KEN. A name applied in the fabulous epoch of zoology to a marine monster of gigantic size.

KRAMERIA'CEÆ (Krameria, one of the genera), is a small natural order of plants, allied to *Polygalaceæ*, and chiefly remarkable for the extreme astringency of their roots; one of the species furnishing the rhatany or rhatanhia root of the druggists, a substance notoriously used in the adulteration of port wine.

KRAME'RIC ACID. An acid obtained from the root of the *Krameria triandria*, or rhatany.

KREOSO'TE. *See* CREOSOTE.

KRY'OLITE. (Gr. κρυος, *ice*, and λιθος, *a stone.*) A hydrated fluate of alumina and soda. When heated it suddenly fuses; hence its name.

KRY'STALLINE. A term applied by Unverdorben to a salifiable base which forms crystallizable compounds with the acids, and which he obtains from animal empyreumatic oil.

KU'FIC. An epithet given to the ancient Arabic characters; from Kufa, a town on the Euphrates.

KU'PFERNICKEL. (Germ.) An ore of nickel of a copper colour.

KU'PFERSCHI'EFER. (Germ. *copper slate.*) A term applied by German geologists to certain laminated rocks at the base of the magnesian limestone formation of Thuringia: they are impregnated with copper, and abound in fossil remains of fishes. These rocks appear to correspond to the marl slate of Durham and Northumberland.

KY'ANITE. (Gr. κυανος, *blue.*) A mineral which occurs in long radiated crystals, and occasionally massive; it is the *disthene* of Haüy, and the *sappare* of some other mineralogists. *See* CYANITE.

KYRIOLO'GICAL, or CIVIOLOGICAL. (Gr. κυριος, *proper;* λογος, *discourse.*) A term applied by Warburton, in his *Divine Legation* (book ii. s. 4.), to that class of Egyptain hieroglyphics in which a part is conventionally put to represent a whole — *e.g.* a pair of armed hands for a battle, a scaling ladder for a siege, &c.; distinguished from the *tropical*, in which visible objects are used as emblems, or figuratively. *See* HIEROGLYPHICS.

L.

L. The first of those letters in the English and most other alphabets called liquids or semivowels; because, like vowels, they can be pronounced for any length of time, which is not the case with the consonants called mutes, as *p*, *d*, &c. It is derived from the Greek lambda, or the Hebrew or Phœnician lamed, and is found in the languages of almost all nations, excepting those of some Brazilian and Japanese tribes. In the ancient Greek, Hebrew, Phœnician, Celtic, and Latin languages, and in those derived from them, the letter L consists invariably of two strokes, though in every possible shape and combination. Thus, in the most ancient Greek alphabets it is written Λ V Λ, in the Etruscan >, in the Celtic < V, in Hebrew ל, and in Latin L. (For the interchanges which this letter has undergone, see the *Penny Cyclo.*) L, as an abbreviature, stands for Lucius, L. L. D. Doctor of Laws, and L. L. S. for a sestertium. As a numeral, L represented among the ancients, as at present, the number 50, according to the line—

Quinquies L denos numero designat habendos.

LA. In Music, the syllable by which Guido denoted the last sound in the hexachord.

LA'BADISTS, or LA'BBADISTS. A sect of religious enthusiasts in the 17th century; so called from Jean Labadie, a native of France domiciled in Holland, who was deposed from his preachership by the synod of Dort. They endeavoured to introduce among Protestants similar notions to those of the Quietists in the Roman Catholic church (see that word), and were accused of similar perversities in practice. (See *Mosheim*, transl., ed. 1790, v. 511.)

LABARRA'QUE'S DISINFECTING LIQUID. A solution of carbonate of soda impregnated with chlorine.

LA'BARUM. The standard of Constantine, which he caused to be formed in commemoration of the vision of the cross in the heavens. It is described as a long pike surmounted by a golden crown inclosing a monogram which contains the two first letters of the name of Christ, and is at the same time a representation of the figure of the cross. Ancient monuments exhibit the figure under two forms, ☧ or ☧ (*sc.* χ, ρ). The silken banner which depended from it was embroidered with the figure of Constantine and his family. The labarum is engraved on some of his medals with the famous inscription,

EN ΤΟΥΤΩΙ ΝΙΚΑ;

and it was preserved for a considerable time, and brought forward at the head of the armies of the emperor on important occasions, as the palladium or safeguard of the empire. The origin of the word is still undecided. (See Beugnot, *Hist. de la Destruction du Paganisme en Occident*, i. 57.; Milman, *Hist. of Christianity*, ii. 152.)

LA'BDANUM, or LADANUM. The resin of the *Cystus Creticus*.

LA'BEL. In Heraldry, a figure chiefly used by way of distinction or difference in the coat-armour of an eldest son during the life of the father; in which case it has three points; five points when borne by the heir-presumptive of a grandfather living, and so forth.

LABE'LLUM. (Lat.) A term given to the lower lip of a labiate corolla. It is usually differently formed from the other divisions of the corolla, and in the natural order *Orchidaceæ* assumes various grotesque appearances.

LA'BIALS. (Lat. labium, *a lip*.) The letters B, P, V, F, M, are so called, on account of the organ chiefly employed in their pronunciation.

LA'BIA'TÆ, or LAMIACEÆ. A natural order of Monopetalous Exogenous plants, consisting of many hundred species, inhabiting the more temperate regions of the earth. A two-lipped monopetalous corolla, an irregular number of stamens, and a four-lobed ovary, are the essential marks by which it is known from all others. The species are generally herbaceous, with square stems; a small number only consists of shrubs. The flowers are all colours, but pure blue is uncommon in the order. Many of the species are valued for their fragrance, as lavender and thyme; others for their stimulating qualities, as mint and peppermint; some as aromatics, as sage, basil, and marjoram; while a few are regarded as febrifuges. Numerous species are objects of great beauty, on which account the order is well known in gardens. Among the most ornamental are various kinds of sage, gardoquia, and dracocephalum.

LA'BIUM (Lat. labium, *a lip*), in Entomology, is a moveable organ, often biarticulate, which, terminating the face anteriorly, covers the mouth from beneath, and represents the under lip.

LA'BORATORY. A place properly constructed and fitted up for the purpose of carrying on chemical investigations. Those who are about to fit up a chemical laboratory will do well to consult the first section of *Mr. Faraday's Chemical Manipulation*.

LA'BOUR. (Lat. labor.) In Naval language, the action of a ship in a heavy sea when she jerks or is *uneasy*.

LA'BOUR. *See* POLITICAL ECONOMY.

LA'BOURED. In the Fine Arts, a term applied to works of art wherein are apparent the marks of constraint in the execution; and used in opposition to the term *easy* or *free*.

LA'BRADORITE. Labrador spar. A beautiful variety of opalescent felspar from the coast of Labrador: it exhibits brilliant and mutable tints of blue, red, green, and yellow, and is susceptible of a good polish. It is cut into small slabs, and employed in ornamental jewellery. It is a silicate of alumina, lime, and soda, with traces of oxide of iron.

LA'BRAX. (Lat.) A genus of Percoid fishes, dismembered by Cuvier from the Linnæan *Perca* on account of certain modifications of the gill-covers and tongue; the differences being that the opercula of the *Labrax* terminates in two spines, and the tongue, instead of being smooth, is roughened with many minute teeth.

LA'BRIDANS, LABRIDÆ, or LABROIDES. The Bream tribe. A family of Acanthopterygii, having the genus *Labrus* as the type. The fishes of this family may be recognized by their oblong scaly body; a single dorsal fin, supported in front by spines, each of which is generally furnished with membranous appendages: the jaws are covered with fleshy lips, and the pharyngeal bones are armed with numerous and strong teeth, disposed like a pavement.

LA'BRUM (Lat. labrum), in Entomology, is the usually moveable part which, terminating the face anteriorly, covers the mouth from above, and represents the upper lip.

LA'BRUS. (Lat. labrum, *a lip*.) A genus of spiny-finned fishes in the system of Cuvier, so called on account of their well-developed double fleshy lips. The fishes of this genus are termed "breams;" and are further characterized by their conical maxillary teeth, of which the middle and anterior are the longest, and by their cylindrical and obtuse pharyngeal teeth, which are arranged like a pavement, — the upper ones on two large plates, the lower ones on a single one, which correspond with the two others.

LA'BYRINTH. (Gr. λαβυρινθος.) Literally a place, usually subterraneous, full of inextricable windings. Ancient history gives an account of four celebrated labyrinths; the Cretan, Egyptian, Lemnian, and Italian. The first was built by Dædalus at the instigation of Minos, to secure the Minotaur; the second is said to have been constructed by Psammetichus, king of Egypt; the third was on the island of Lemnos, and was supported by columns of great beauty; and the fourth was designed by Porsenna, king of Etruria, as a tomb for himself and his successors. Of these labyrinths the Cretan is most celebrated in the historical and mythological writings of antiquity; but the Egyptian was by far the most important, both in extent and magnificence. The latter, which was built on the isle of Meroe, was a vast edifice, composed of twelve palaces, all contained within the compass of one wall, and communicating with each other. It had only one entrance; but the innumerable turnings and windings of the terraces and rooms of which it consisted rendered it impossible for those who had once entered within its walls to get out without a guide. It is said to have been designed either as a burial-place for the Egyptian kings, or for the preservation of the sacred crocodiles, the chief objects of Egyptian idolatry. It was partly demolished between the reigns of Augustus and Titus; but even at the period of Pliny's visit, its ruins were magnificent. (*Pliny*, lib. xxxv.) *Pococke's History of the East* (vol. i. p. 61. &c.), and *Perry's View of the Levant* (p. 381.), contain a plan and description of the modern state of this labyrinth. With regard to the labyrinth of Crete, no doubt can now remain, after the statements of Cockerell and Tournefort, that its existence was a reality, and not merely a fabulous creation of the Grecian imagination. According to these travellers, the island of Crete abounds even at the present day in extensive caverns, one of which, consisting principally of many long windings and narrow passages that can only be safely explored by means of a clue, exhibits a wonderful similarity in all essential particulars to the famous labyrinth of Dædalus. It is impossible, at this distant period, to pronounce with certainty on so difficult a question; but the substantial coincidences that exist between the ancient and modern labyrinths seem to leave little doubt as to their identity. (See *Geo. Dict.* art. "Crete.")

LA'BYRINTH. In Metallurgy, a series of troughs attached to a stamping mill, through which a current of water passes for the purpose of washing away the suspended pulverized ore, and subsequently depositing it at different distances, depending upon its state of comminution.

LA'BYRINTH. A term applied by anatomists to the internal parts of the ear, from the intricacy of their winding passages. See EAR.

LABYRI'NTHODON. (Gr. λαβυρινθος, and οδους, *a tooth.*) The name of an extinct genus of Reptiles, probably of the Batrachian order, characterised by teeth of a peculiarly complicated structure, the outer coat of enamel being inflected in complex wavy folds into the body of the tooth, and alternating with corresponding wavy plates of dentine, which give the appearance of a labyrinth to the transverse section of the tooth. The remains of the reptiles of this genus peculiarly characterise the Keuper formation of Germany, and the corresponding sandstones, as that of Warwick in England.

LAC. This substance flows from the *Ficus indica*, the *Khamnus jujuba*, and some other trees, in the form of a milky fluid, in consequence of punctures made upon their branches by a small insect, the *Coccus ficus*. The commercial varieties of lac are, *stick lac*, which is the substance in its natural state, investing the small twigs of the tree; *seed lac*, which is the same, broken off the twigs, and which when melted and formed into thin cakes constitutes *shell lac*. These varieties of lac have been examined by Mr. Hatchett (*Phil. Trans.*, 1804), with the following results: —

	Stick lac.	Seed lac.	Shell lac.
Resin - -	68·0	88·5	90·9
Colouring matter -	10·0	2·5	0·5
Wax - -	6·0	4·5	4·0
Gluten - -	5·5	2·0	2·8
Foreign bodies -	6·5		
Loss - - -	4·0	2·5	1·8
	100·0	100·0	100·0

The great consumption of lac is in the manufacture of dye stuffs, sealing wax, and of certain varnishes and *lacquers*.

LA'CCIC ACID. A peculiar acid separated from stick lac by Dr. John. It is yellow, crystallizable; and forms soluble salts with potassa, soda, and lime, and insoluble salts with the oxides of mercury and lead. It occasions no precipitate in solution of baryta or of oxide of silver.

LACCINE. A substance discovered in shell lac by Unverdorben. It remains after all the soluble matters in water, alcohol, and ether have been extracted. It is brittle, yellow, translucent; and soluble in caustic potash, and in sulphuric acid.

LAC DYE, LAC LAKE. These are two preparations of lac imported in small cubic cakes from the East Indies, and extensively used in the production of scarlet dye. They are said to be prepared by digesting lac in an alkaline solution, which produces a deep pink liquid, the colouring matter of which is thrown down in combination with alumina by the addition of a solution of alum.

LACE. (Lat. lacinia, *the hem of a garment.*) An ornamental fabric of linen or cotton thread, formerly made by hand (when it was called *pillow* or *bone* lace), but of late years produced by machinery, and generally termed *bobbin-net.*" This manufacture," says Dr. Ure, "may be said to surpass every other branch of human industry in the complex ingenuity of its machinery; one of Fisher's spotting frames being as much beyond the most curious chronometer in the multiplicity of mechanical device, as that is beyond a common roasting jack."

The costly and complicated machines by means of which bobbin-net is produced are termed *lace frames.* They are constantly undergoing improvements, and this beautiful branch of manufacture is apparently destined to become much more perfect than even at present.

A *rack of lace* is a certain number of meshes counted perpendicularly, and contains 240 meshes or holes; and such has already been the improvement in this manufacture, that the cost of labour in making a *rack*, which was twenty years ago three shillings and sixpence, is now reduced to one penny. Formerly the wholesale price of a 24-rack piece, five quarters broad, was 17*l.* sterling; the same is now sold for seven shillings. In the *Commercial Dictionary* will be found full statistical details of the value of the lace manufacture in this country, together with a learned and curious account of the origin and history of the fabric.

LACE'RNA. A long woollen military cloak, worn at first only by the Roman soldiers, but which increased so much in fashion that at the period of the triumvirate it became a favourite piece of dress with all the higher classes of Roman citizens, both civil and military, and remained so till the times of the emperors Valentinian and Theodosius, when the senators were prohibited from wearing them in the city. Martial speaks of lacernæ which cost 10,000 sesterces (80*l.*).

LACE'RTA. (Lat.) The *Lizard;* a constellation of the northern hemisphere, near Cepheus and Cassiopeia, formed by Hevelius.

LACE'RTIANS, or LACERTINE SAURIA. A name sometimes given to a primary division of the order *Sauria* of Cuvier, including all those species which differ from the Loricate or Crocodilian Sauria in having a direct communication between the ventricles of the heart, a double intromittent organ, a tongue bifurcate or emarginate at the tip, an ear-drum unprotected by an opercular fold, and a covering of scales sometimes bony, without osseous plates or scutæ.

LACE'RTIDÆ. (Lat. lacerta, *a lizard.*) A group of the order *Sauria*, forming the second family in the Cuvierian system, in which the characters are given as follows: — Tongue long, slender, extensible, and bifurcate at the extremity, as in the serpent tribe; ear-drum membranous, on a level with the surface of the head, or very slightly sunk; eyelids consisting of a production of the skin, with a longitudinal slit, closed by a sphincter, and a rudimental nictitating or third eyelid; body elongated; feet with five toes each; digits separate and unequal, particularly the hind ones, all armed with nails; scales on the belly and round the tail arranged in transverse and parallel bands. Cuvier subdivides the *Lacertidæ* into the two great genera *Monitor* and *Lacerta*, each of which have been again subdivided.

LA'CHES. (Fr. lache, *negligent.*) In Law, slackness or negligence. A term used to signify that degree of negligence which throws on the party committing it the evil consequences resulting to him from it.

LA'CHRYMAL. Relating to tears; as the *lachrymal glands*, by which they are secreted. They are placed in a depression of the frontal bone, above the external angle of the eye: the tears pass from them to the eye by the lachrymal ducts, which are six or eight in number.

LA'CHRYMATORY. A small vessel of glass or earthenware, which it was customary at Roman funerals to fill with the tears of the mourners, and deposit them with the ashes of the deceased in the sepulchre.

LACK. In Commerce, a word used in the East Indies, to denote the sum of 100,000 rupees, or 12,000*l.* sterling.

LACI'NULA. In Botany, a term given to the abruptly inflexed acumen of each of the petals of an umbelliferous flower.

LACO'NICUM. (Lat.) In Ancient Architecture, an apartment in the baths, which received its name from having been first used in Laconia.

LA'CONISM. A short and pointed saying; so termed from the celebrity which the Lacedæmonians enjoyed in antiquity for their brief and sententious mode of expressing themselves, produced by the severe discipline of their institutions, and the gravity which it engendered. When they became famous for this quality, they appear to have begun to aim at the exhibition of it in rather an affected manner, of which some curious instances are contained in Herodotus. None of the many Laconisms recorded in ancient history are more noble than the expression of the Spartan mother to her son, when presenting him with his buckler: ἢ ταν ἢ ἐπι ταν, — "either bring it back, or be brought home dead upon it." There is an essay by Puteanus, *De Laconismo*.

LA'CQUER. A yellow varnish, consisting of a solution of shell lac in alcohol, coloured by gamboge, saffron, annotto, or other yellow, orange, or red colouring matters. Lacquers are chiefly used for varnishing brass and some other metals, in order to give them a golden colour and preserve their lustre.

LACTA'RIUM. (Lat.) In Architecture, strictly a dairy house. In Ancient Architecture, it was a place in the Roman herb market, indicated by a column, called the Lactaria Columna, where foundlings were fed and nourished.

LA'CTEALS. (Lat. lac, *milk.*) The absorbents of the mesentery, which convey the milky fluid called *chyle* from the small intestines to the thoracic ducts.

LA'CTIC ACID. (Lat. lac.) The acid of sour milk. A similar acid is obtained from the fermented juice of the beet root. It appears to consist of 6 atoms of carbon, 5 of hydrogen, and 5 of oxygen, its equivalent being 81.

LACTO'METER. (Lat. lac, and metrum, *a measure.*) A term applied to a glass tube for ascertaining the proportion which the cream bears to the milk of any particular cow, or of the produce of a whole dairy. The tube is about half an inch in diameter, and a foot in height, with a graduated scale marked on the outside. It is filled with milk when newly drawn from the cow, and as it cools the cream rises to the surface, and the proportion which it bears to the milk is ascertained by counting the degrees opposite to each.

LACTU'CARIUM. The inspissated milky juice of the *Lactuca sativa*, or common garden lettuce. It possesses slight anodyne properties, and is sometimes used as a substitute for opium.

LACTU'CIC ACID. A peculiar acid, discovered by Pfaff in the juice of the *Lactuca virosa*. It bears some resemblance to oxalic acid; but differs from it in giving a green precipitate with the protosalts of iron, and a brown precipitate with sulphate of copper.

LACU'NA. (Lat.) In Botany, a term applied in describing lichens, to denote one of the small hollows or

pits on the upper surface of the thallus. Also a name given occasionally to the internal organ, commonly called an air-cell, lying in the midst of the cellular tissue of plants.

LACU'NAR. (Lat.) In Architecture, the ceiling or under surface of the member of an order. Also the under side of the larmier or corona of a cornice. The under side also of that part of the architrave between the capitals of columns. The ceiling of any part in architecture only receives the name of lacunar when it consists of compartments sunk or hollowed without spaces or bands between the panels: if it is with bands, it is called *laquear*.

LACUNO'SE. (Lat. lacuna. *a break.*) In Zoology, when a surface has a few scattered, irregular, broadish, but shallow excavations.

LACU'STRINE. (Lat. lacus, *a lake.*) Belonging to a lake. The term *lacustrine deposit* is applied by geologists to certain fresh-water formations which occur in the newer rocks. *See* GEOLOGY.

LADDER. The sea term for the staircases between the decks. Ladders are also made of rope.

LA'DY. A title said to be compounded of two Saxon words, and to signify the giver or distributor of bread; *i. e.* the mistress of a family. It properly belongs to the daughters of all peers above the rank of a viscount; and is extended, by courtesy, to the wives of knights of every degree.

LA'DY DAY. In the Calendar, the 25th of March, being the annunciation of the Holy Virgin. It is one of the immoveable festivals of the church, having relation to Christmas, or the day of the nativity of Christ, which it precedes by nine months.

LÆMODI'PODS, *Læmodipoda.* (Gr. λαιμος, *throat*, πους, *foot.*) The name of an order of Crustaceans, in which the head is confluent with the first segment of the thorax, and supports the four anterior feet. The *Læmodipods* are the only Malacostracans with sessile eyes, and in which the posterior extremity of the body exhibits no distinct branchiæ. The females carry their ova beneath the second and third segments of the body in a pouch formed of approximated scales. All the species are marine.

LA'GOMYS. (Gr. λαγως, *a hare;* μυς, *a mouse.*) The generic name of certain Rodents, called "rat-hares," now peculiar to Siberia. They differ from the hares proper in having moderate-sized ears, legs nearly equal, clavicles nearly perfect, and no tail. The fossil bones of a species of *Lagomys* have been discovered in the osseous breccia of Corsica.

LAGOO'N. (Lat. lacuna, *a morass.*) The name given particularly to those creeks extending along the coast of the Adriatic, and which are formed by water running up in the land. In some places they are deep; but generally they are so shallow as to emit noxious exhalations. They contain many islands; on sixty of which the city of Venice is built. Towards the sea these islets are secured by dams, either natural or artificial.

LAGO'PUS. (Gr. λαγως, *a hare;* πους, *a foot.*) The generic name of those birds of the grouse tribe which have a round or square tail, and whose toes are feathered as well as the legs. *See* PTARMIGAN.

LAGO'STOMA. (Gr. λαγως, and στομα, *the mouth.*) The harelip.

LA'GOTHRIX. (Gr. λαγως; θριξ, *a hair.*) A genus of South American or Platyrrhine monkeys, characterized by their round head, a thumb on the anterior hand, and the tail partly naked. The grison, or silver-haired monkey, is a species of this genus.

LAGRIMO'SO. (Ital.) In Music, a direction to the performer, when appended to a piece of music, denoting that it is to be performed in a weeping, plaintive manner.

LAIRD. A Scottish term, applied, as Libb observes, to "a landed gentleman under the degree of a knight;" but regarded by many philologists as originally equivalent to *lord* (quod vide). Anciently the title of laird was given only to those proprietors who held immediately of the crown; and this distinction is still preserved in the Highlands. The designation *tiern*, corresponding to laird and rendered by it, is given to no one whose property is not worth two or three hundred per annum, while it is withheld from another whose rental extends to as many thousands; because the former acknowledges no superior under the king, while the latter does.

LA'ITY. (Gr. λαος, *people.*) The great body of the faithful, as opposed to those who are set apart for the ministration of the services and sacraments — the clergy. This distinction is plainly observed in the writers of the third century — Origen, Cyprian, and Tertullian; and is generally supposed to have prevailed from the first foundation of Christianity. The word laity is properly a general name for the people: in the writings of the Fathers βιωτικοὶ, seculars, ἰδιῶται, private men, and λαικοὶ, laymen, are used indifferently to express this class.

LAKE. (Lat. lacus.) In Geography, a collection of water surrounded by land. Lakes are divided into four distinct classes: — 1. Those which have no outlet, and receive no running water. 2. Those which have an outlet, but receive no superficial running water, and are consequently fed by springs. 3. Those (by far the most numerous class) which both receive and discharge streams of water. 4. Those which receive streams of water, and which have no visible outlet or communication with the sea. The Caspian Sea, which receives the Wolga and several other large rivers, and Lake Aral, which receives the Amoo, belong to this class. It is a remarkable fact, that all lakes of this class are salt. Some lakes present the curious phenomena of disappearing and reappearing periodically, without regard to the rainy season. Lake Chirtunitz in Illyria is of this description. Some of them, as Loch Lomond in Scotland, and Lake Wetter in Sweden, experience violent agitations during severe weather. This may be supposed to proceed from an escape of subterraneous gases, or winds blown into some cavern with which they communicate; though a coincidence of dates leaves ground to suppose that the phenomenon was connected with earthquakes in distant countries.

LAKE. A compound of aluminous earth with the red colouring matter of certain animal and vegetable substances; thus we have cochineal and lac lakes, madder lake, &c. Sometimes the term *lake* is indiscriminately applied to all compounds of alumina and colouring matter.

LALLA'TION. The imperfect pronunciation of the letter *r*, which is made to sound like *l;* hence also the term *lambdacismus*. The imperfect pronunciation of the letter *r* is peculiar to the Chinese.

LA'MA. (Mother or pastor of souls.) Among the Mongols a title given to priests in general; among the Calmucks to the higher classes of priests only. The Dalai-Lama (*i. e.* Great Lama) is honoured as the representative of divinity, or rather as a real divinity dwelling on the earth, by various tribes of Tartaric descent. This personage resides at Lassa in Thibet, and pilgrimages are made to his residence by the inhabitants of many distant regions of Tartary. He is now chiefly dependent, in a political sense, on the Chinese empire. When the actual Dalai-Lama dies, his spirit is supposed to seek another body in which to be born again; and the new Dalai-Lama can only be discovered by a certain favoured class among the priests. The worshippers of the Dalai-Lama also pay peculiar reverence to two other subordinate Lamas (Teeshoo and Taranaut Lama). They are distinguished by the title of *Yellow Caps:* the *Red Caps*, another sect in Tartary, are under three other Lamas, styled the three *Shamonars*.

LAMA, LLAMA, or GLAMA. The name of a species of the camel tribe peculiar to South America. *See* AUCHENIA.

LAMA'NTIN. The name given by French naturalists to the manatee or sea cow. *See* MANATUS.

LAMBDOI'DAL SUTURE. The union of the parietal with the occipital bones; shaped something like the Greek letter Λ, or *lambda*.

LAME'LLA. In Botany, a term applied by some writers to the foliaceous erect scales appended to the corolla of many plants, as in *silene*. Also used in describing fungi, to denote the gills forming the hymenium of an agaric.

LAMELLIBRA'NCHIATES, *Lamellibranchiata.* (Lat. lamella, *a thin plate;* branchiæ, *gills.*) An order of Acephalous Mollusks, comprehending those which have the gills in the form of large semicircular layers disposed symmetrically, two on each side.

LAME'LLICORNS. (Lat. lamella, *a plate;* cornu, *a horn.*) The sixth and last section of Pentamerous Coleoptera of the system of Latreille, in which the antennæ are inserted into a deep fossula under the lateral margin of the head: they are always short, usually consist of nine or ten joints, and are always terminated in a club, usually composed of the three last, which are lamellar. Sometimes flabelliform, or disposed like the leaves of a book, opening and closing in a similar way; sometimes concentrically contorted and fitting into each other, the first or inferior then being semi-infundibuliform and receiving the others; and sometimes arranged perpendicular to the axis, and forming a sort of comb.

The body is generally ovoid or oval, and thick. The exterior side of the two anterior tibiæ is dentated; and the joints of the tarsi, with the exception of those of some males, are entire, and without brush or pellet beneath.

The anterior extremity of the head most commonly projects, or is dilated in the manner of an epistome. The mentum is usually large, covers the labrum, or is incorporated with it, and bears the palpi. The mandibles of several are membranous, a character observed in no other Coleopterous insects. The males frequently differ from the females, either by prominences on the thorax or head in the form of horns or tubercles, or by the largeness of their mandibles.

This family is very numerous; and with respect to the size of the body, and the variety of forms exhibited in the head and thorax, is one of the most beautiful of the order; and frequently also as regards the splendour of the metallic colours which ornament those species feeding on living vegetables. The other species, however, feed-

ing on decomposed vegetable matter, are usually of one black or brown hue. Some of the Coprophagi, however, do not yield even in this respect to the former. They are all furnished with wings, and their gait is heavy.

The body of the larvæ is long, almost semicylindrical, soft, frequently rugose, whitish, and divided into twelve annuli, with six squamous feet: the head is squamous, and armed with stout mandibles. Each side of the body is furnished with nine stigmata or breathing pores. Its posterior extremity is thicker, rounded, and almost always doubled under it; so that the back being arcuated or convex, the animal cannot extend itself in a straight line, crawls badly on a level surface, and falls backwards or on its side every instant.

Some of them require three or four years to become pupæ: they construct in their place of residence an ovoid shell, or one resembling an elongated ball, composed of earth or the remains of substances they have gnawed, the particles of which are cemented by a glutinous matter produced from their body. Their aliment consists of the dung of various animals, mould, and the roots of vegetables (frequently such as are necessary to man), of which they sometimes destroy immense quantities, to the great loss of the cultivator of the soil.

LAMELLIRO'STRALS, *Lamellirostres*. (Lat. lamella, *a thin plate;* rostrum, *a beak.*) A tribe of swimming birds, the fourth in the system of Cuvier, comprehending those in which the margin of the beaks are furnished with numerous lamellæ or dental plates, arranged in a regular series, as in the swan, goose, and duck. The birds comprised in this family pass most of their time in the fresh waters. Some come on shore to graze; others feed on aquatic plants, insects, vermes, or small fish, and reptiles, which their long neck enables them to reach or seize with facility. Some of the species dive in quest of their prey, and can remain a considerable time under water. All the Lamellirosters of Cuvier were comprised in the great genus *Anas* of Linnæus.

LA'MIA. (Gr. Λαμια.) An imaginary being, concerning which many superstitious notions were prevalent among the Greeks and Romans; sometimes represented as a species of monstrous animal, sometimes as a spectre or vampire. The Lamiæ of Pliny are animals, with the face and head of a woman and tail of a serpent, inhabiting the deserts of Africa. According to mythologists, the first Lamia was a daughter of Neptune, a malevolent goddess, who seizes and devours new-born infants in their cradles: whence Horace's caution to tragic writers against indulging in the description of unnatural horrors: —

Nec pransæ Lamiæ vivum puerum extrahat alvo.

In the well-known story of Machates and Philemon from which Goethe has borrowed his magnificent ballad of the *Bride of Corinth*), a young man is represented as marrying a Lamia, or Empusa, who sucks his blood at night. A similar tale occurs in the *Life of Apollonius of Tyana* by Philostratus. The Christian superstition of incubi, and the oriental belief in vampires, seem to bear marks of the same origin.

LAMI'DÆ. (Lat. lamia, the name of an imaginary animal in Pliny.) The subdivision or family of *Laminæ*, in which the sides of the thorax are either smooth and rounded, or tuberculate, rugous, or spiny, but not furnished with moveable tubercles or spines.

LAMI'NÆ. (Lat. lamia.) A tribe of Longicorn beetles, distinguished, according to Latreille, by their vertical head; filiform palpi, whose terminal joint is more or less ovoid and tapers to a point; maxillæ with the outer lobe slightly narrowed at the end; antennæ frequently setaceous and simple; and thorax, exclusive of the lateral spines or tubercles, nearly equal throughout. Some species are apterous, a modification which occurs in no other tribe of Longicorn beetles.

LA'MINARITES. A term applied by Brogniart to a species of fossil fucies found in the secondary strata of Aix, near La Rochelle.

LA'MMAS DAY. In the Calendar, the 1st of August. Dr. Johnson supposes this term to be a corruption of *Lattermath*, which signifies a second mowing of grass. Others derive it from a custom which once prevailed in some parts of England, of bringing a lamb alive on this day into the church at *high mass*. Others again derive it from a Saxon term signifying *loaf-mass*, so named as a feast of thanksgiving for the first fruits of the corn.

LAMP. (Gr. λαμπας.) The general term for the well-known contrivances used in producing artificial light from the combustion of liquid or other inflammable bodies. The peculiar applicability of oil to the production of artificial light, which could not fail to be discovered at a very early period, rendered the use of lamps universal among the nations of antiquity. The Egyptians, the Hebrews, Greeks, and Romans, vied with each other in the construction of these instruments; and the specimens of some that have been transmitted to our times display much taste and elegance of external design. It would seem, however, that the ancients had confined themselves merely to the external embellishment of the lamp; for it is a singular circumstance, that notwithstanding the simplicity of the invention, and its obvious capability of improvement, it is only within the last sixty years that any material improvement has been effected in its original construction. To give any thing like a complete view of the principles and structure of the numerous lamps of which the present age has witnessed the invention would be quite impracticable without a multiplicity of illustrative diagrams, which would be foreign to the purpose of this work; but a brief notice of the principle on which the action of every lamp, both simple and complicated, depends, and of some of the most celebrated improvements in their structure, may not be considered out of place.

The most simple lamp consists in a vessel of any shape filled with oil or other inflammable liquid, and having a short depression or spout on one side, in which lies a wick composed of any fibrous substance, and capable of imbibing the oil by its capillary attraction. The oil thus raised and diffused through the wick, when ignited, admits of being heated to such a degree of temperature as is capable of volatilizing the oil, the vapour of which, in a state of combustion, constitutes the flame of the lamp. The wick of a lamp serves only for the purpose of raising up the oil by capillary attraction, and thus giving a constant and adequate supply to the flame. It furnishes no part of the light by the combustion of its own substance; for the quantity consumed is too small to merit attention, and it is usually coated over with a broad deposit of carbonaceous matter, which cannot burn for want of the access of air, from which it is kept by the flame. To render the air accessible to every part of the flame in order to ensure the most perfect combustion of the oil, is one of the most essential objects in the modern improvement of lamps; and hence the texture, materials, and dimensions of the wick are matters of much importance. If, on the one hand, the wick be large, a great deal of carbon vapour remains unburnt in the interior of the flame, and breaks out in the form of smoke, producing a most disagreeable smell; and if, on the other hand, the wick be too small, though the unconsumed carbon will naturally be less, and the flame consequently clearer than those of the larger wick, it will yield but very little light, as the light diminishes with the superficies of the flame. The inconvenience of a thick wick had been long observed, and attempts were often made to remove it; in some instances by substituting two or more small wicks for one large one, and in others by making the wick flat instead of cylindrical. These experiments, though limited in their operation, were no doubt beneficial; and in houses where economy more than elegance was studied, they procured for the lamp a more extended use than it previously enjoyed. Still, however, the smoke and disagreeable smell arising from the burning of oil in common lamps, and the unsightly appearance of the whole process, had long banished the lamp from the apartments of the wealthy; and it was not till the year 1780, when M. Argand invented the well-known lamp which bears his name, that the instrument came into general use. This invention embraces so many improvements upon the common lamp, and has become so general throughout Europe, that it may be justly regarded as one of the greatest discoveries of the age. As a substitute even for the best wax candles, it combines the advantage of economy and convenience, with much greater brilliance; while even as a means of producing heat it is found to be of most essential service in chemical operations. The great principle on which the superiority of this lamp depends is the admission of a quantity of air into the centre of the flame. This Argand accomplished by making the wick of a circular form, instead of a solid cylinder as before; by which means a current of air rushes through the hollow cylinder while the wick is burning, thus admitting air into the centre of the flame. Improving upon this invention, which was found perfectly to succeed, he added a glass cylinder or chimney, open at bottom, to surround the flame at a short distance; by which another current of air is made to pass upwards on the exterior part of the flame, and between it and the glass. Thus every part of the thin circular flame is between two currents of air, which supply the combustion with such a quantity of oxygen as to create a heat sufficient to convert into a brilliant flame the smoke which escapes from an ordinary lamp.

Such is a brief account of the leading principles of Argand's invention. Various improvements have since been made on the original by the Sinumbra, the French, the Iris lamp (now in general use as a table lamp), and a variety of others, which it would be superfluous to enumerate; all of which, however, may be regarded as improvements more of *detail* than *principle*. Indeed, the great merit of Argand's invention consists in the facility with which it can be ingrafted on lamps of every variety of form and structure; while not all the beauty of design and execution witnessed in the endless diversity of the lamps at present in general use, would be sufficient

to procure for them any considerable notice, if they were destitute of the Argand principle. This facility of general application has recently been exemplified in an ingenious invention, by which lamps on the Argand principle have been made to burn the common fish oil, instead of spermaceti, which had hitherto been indispensable. This improvement, which is so desirable in an economical point of view, consists chiefly in an extension of Argand's original principle; viz. in supplying the flame with a greater quantity of oxygen than had hitherto been effected. This is accomplished by means of apertures in the sides of the lamp, and a cap with a *deflector*; but in applying this improvement to lamps on Argand's principle, a larger and coarser kind of wick must be employed, and the tubes with which the burners and the wick are supplied with oil must also be enlarged. Lamps constructed on this principle are designated *solar lamps*. The best account of lamps is to be found in *Peclet, Traité de l'Eclairage*, Paris, 1827; and in *Krünitz's Encyclop.*, art. "Lampe." See also the *Haus Lexicon*.

LA'MPADEPHO'RIA. (Gr. λαμπαδηφορία, *a carrying of torches*.) A torch race, which it was customary to exhibit at certain sacred festivals at Athens. The performers were three young men, to one of whom, chosen by lot, was given a lighted torch, which he was to carry to the goal unextinguished; or if he failed, to deliver it to the second; who, if he failed also, gave it to the third: whence a metaphor is sometimes derived by ancient writers, to be applied to persons who anxiously wait for the deaths of others. If the runners slackened their pace, they were driven on by the blows of the spectators. This ancient usage is beautifully applied by Lucretius to the succession of human generations: —

Et, quasi cursores, vitaï lampada tradunt.

LAMPBLACK. Finely divided charcoal. It is the soot obtained by the imperfect combustion of resin of turpentine; this is burned in chambers hung with old sacking, upon which the smoke collects, and is from time to time scraped off. It contains about 20 per cent. of peculiar resinous products, water, and saline matter.

LA'MPIC ACID. A term given by Mr. Daniell to the acid produced by the slow combustion of the vapour of alcohol and ether in the lamp without flame: he has since ascertained that it is acetic acid modified by the presence of a peculiar hydrocarbon.

LAMPOO'N. *See* SATIRE.

LAMP, SAFETY. *See* SAFETY LAMP.

LAMPY'RIDÆ, *Glow-worms*. (Gr. λαμπυρις, *a glow-worm*.) A family of soft-skinned Serricorn beetles, of the tribe *Lampyrinæ* (which see), characterized by antennæ closely approximated at their base; head concealed beneath the thorax, or produced in the form of a snout; eyes of the males large and globular; mouth small. In one division the abdomen of the female is luminous; and the male, which is destined to be attracted by this luminosity, has his head almost entirely occupied by his largely developed eyes, and it is not produced in the form of a snout. The luminous property of the glow-worm is confined to the two or three terminal segments of the flattened abdomen, which differ in colour from the rest, and are usually yellowish or whitish; this character is peculiar to the true glow-worms, and announces their phosphorescence. The light diffused by the glow-worm is of a lambent, electric, greenish colour: the insect can vary or suspend its luminosity at will. The light-emitting segments preserve their peculiar property for some time after being separated from the rest of the body, and manifest it even *in vacuo*, or when immersed in gases which are not supporters of combustion.

In a second division of *Lampyridæ* the females are not luminous, but are provided with wings; the head is exposed, and is mostly produced in the shape of a snout; the thorax is widened posteriorly, with pointed lateral angles. The elytra, in several, expand posteriorly, where they are sometimes strongly dilated or rounded, especially in the females. To this group belong the genera *Lycus*, *Dictyoptera*, and *Omalisus*.

LAMPY'RINÆ. (Gr. λαμπυρις, *a glow-worm*.) A Linnæan genus of Coleopterous insects, which constitutes the type of the present tribe of the soft-skinned or Malacodermous Serricorns in the system of Latreille. This tribe is characterized by the enlarged termination of the palpi, or at least of the maxillary palpi; by their soft, straight, depressed, or but slightly convex body; and by the thorax, sometimes semicircular, at others nearly square or trapezoidal, and projecting over the head, which it either wholly or partially covers. The mandibles are usually small, and terminate in a slender, arcuated, very acute point, which is generally entire. The penultimate joint of the tarsi is always bilobate, and the terminal claws have neither dentations nor appendages.

The females of some of the Lampyrine tribe are apterous, or have but very short elytra, and are luminous. All the Lampyrines, when seized, press their feet and antennæ against their body, and remain as motionless as if they were dead. *See* LAMPYRIDÆ.

LA'NATE. (Lat. lana, *wool*.) In Zoology, when a part is covered with fine, very long, flexible, and rather curling hair, like wool.

LANCASTER, CHANCELLOR OF THE DUCHY OF. The officer before whom, or his deputy, the court of the Duchy-Chamber of Lancaster is held: which is a court having special equitable jurisdiction as to lands holden of the duchy. The office has long been a sinecure, and is one of the most valuable at the disposal of the ministry of the day; the salary is 4000*l.* per annum.

LANCE. (Fr.) A weapon consisting of a long shaft with a sharp point, much used by the nations of antiquity, and also by the moderns before the invention of gunpowder. The Macedonian phalanx and the Roman infantry, as well as the most barbarous nations, all considered the lance as one of the most effective weapons; and even at the present day it is still considered of great value, though it is now almost universally borne by cavalry. Almost all the armies of Europe have now regiments of *lancers*, so called from the lance being the chief offensive weapon with which they are armed. The lances in use among the European cavalry have a shaft of ash or beech wood, eight, twelve, or in some cases even sixteen feet long, with a steel point eight or ten inches in length, adorned by a small flag, the waving of which is said to frighten the enemy's horses. The ancient lancea was a general term for missile weapons or javelins: the pilum is termed lancea in Lucan: —

Cujus torta manu commisit lancea bellum. (Lib. vii.)

For a detailed description of the lances of knights in the middle ages, see *Mem. de l'Ac. des Inscr.* vol. xx. From its being the common knightly weapon, the force of the mounted gendarmerie on its first institution in the 15th century was usually numbered by "lances," each "lance" having four or five attendants. The lance has become again a favourite cavalry weapon of late years, owing to the exploits of Napoleon's Polish lancers and the Cossacks.

LA'NCEOLATE. (Lat. lancea, *a lance*.) In Zoology, an animal or a part is so called when it is oblong and gradually tapering towards each extremity.

LAND (Germ.), in its widest acceptation is used to denote the solid matter of which the globe is composed, in contradistinction to the liquid matter, or water; but in its most restricted signification it is confined to *arable ground*. The latter is the legal meaning of the term; and in this sense it is used in all original writs, and in all correct and formal pleadings.

LA'NDAMMAN, in Switzerland, the president of the diet of the Helvetic republic. The highest magistrate in ten of the cantons also bears the title of landamman; in the others he is designated by various appellations.

LA'NDAU. The name given to a peculiar kind of carriage, which opens and closes at the top; so called from Landau in Germany, where they were originally made.

LA'NDFALL. The first land seen after a voyage is so called. A *good* landfall is when the land is seen as expected.

LA'NDGRAVE. A title taken by some German counts in the twelfth century, who wished to distinguish themselves from the inferior counts under their jurisdiction; and thus assumed the designation of land-graf, or count of the whole country. This was the origin of the landgraves of Thuringia, of Lower and Higner Alsace, the only three who were princes of the empire.

LAND-LOCKED. A term applied to a harbour or piece of water which is so environed by land on all sides as to exclude the prospect of the sea, unless over some intervening land. If a ship is at anchor in such a place, she is said to ride land-locked, and is therefore considered to be safe from the violence of winds and tides.

LA'NDMARK signifies, in a general sense, any thing by which the boundary of a property is defined. In ancient times the correct division of lands was an object of great importance; and various means were adopted to give distinctness and permanency to the boundaries of every man's property. Stones and hillocks were the most usual landmarks. The importance of this subject, among the Israelites particularly, may be judged of from the denunciation of Moses: "Cursed be he that removeth his neighbour's landmark." In naval language, *landmark* is applied to any conspicuous object which serves as a guide in entering a harbour, or avoiding a danger.

LANDREEVE. A subordinate officer on an extensive estate, who acts as an assistant to the land steward.

LANDSCAPE. The scenery presented to the eye in the country; as also, in its more common acceptation, a picture representing such scenery. A landscape in the latter sense may, however, become allegorical and historical, in the meaning applied by artists to those terms. The chief study of the landscape painter is the vegetable world, air, water, rocks, and buildings. To these he may impart an ideal beauty, and thus elevate his art

above mere topographical painting; which may be applied to his work, if he merely copies without refinement what is presented to his eye.

LANDSCAPE GARDENING. The art of laying out grounds so as to produce the effect of natural landscape. Its principles are the same as those upon which the landscape painter proceeds in composing a picture; and though it is an art of which, like many others, every body thinks he is a judge, it requires, to be properly practised, powers of a much higher order than fall to the lot of most men. Mr. Brown, commonly called Capability Brown, was the first who practised the art in this country so as to render himself worthy the name of an artist. To lay down the principles of the art would be quite impossible in this article; but this general observation contains the sum of them, — let selected and beautiful nature be constantly your model, and success must follow.

LANDSLIP. A portion of land that has slid down in consequence of disturbance by an earthquake, or from being undermined by the action of water.

LAND SPRINGS. Land springs are sources of water which only come into action after heavy rains; while constant springs, which derive their supplies from a more abundant source, flow throughout the year. All springs owe their origin to rains. In the case of land springs, the water, when it sinks through the surface, is speedily interrupted by a retentive stratum, and there accumulating soon bursts out in a spring, which ceases to flow a short period after the cause which gave it birth has ceased to operate; but the water which supplies constant springs sinks deeper into the earth, and accumulates in rocky or gravelly strata, which become saturated with the fluid.

LAND STEWARD. A person who has the care of a landed estate, and whose duties vary in different countries according to the mode in which landed property is managed. In England, where the landlord very commonly undertakes to keep the buildings and fences of his tenants in repair, the duties of the land steward are constant and multifarious; while in Scotland, where the buildings and fences are kept in repair by the tenant, the duties of the steward are limited to receiving the rents, and seeing that the covenants of the leases are duly fulfilled. In many parts of the Continent, and particularly in Italy, where the landlord is a partner with his tenant, and shares the produce with him, the duties of the land steward, or *fattore*, as he is there called, are much more onerous than in Britain. It is generally considered, both by British and Continental writers on agriculture, that one principal cause of the retardation of this art has been the employment of lawyers as land stewards; and the truth of this can hardly be denied, more especially in those countries where the tenant is bound down by his lease to particular modes of cropping, or where there is a discretionary power as to cropping on the part of the steward. The objection to lawyers as stewards is founded on their general habits of acting from precedent rather than from principle; and hence such a habit, exercised in the case of an art that is calculated to be so rapidly progressive as agriculture, must materially impede its advancement. At the same time the convenience to a landed proprietor of having a land steward who possesses legal knowledge is so great, as generally to overpower the objections that are made against them by farmers and agricultural writers.

LA'NDWAITER. An officer of the customs, whose duty it is upon landing any merchandise to taste, weigh, measure, or otherwise examine the various articles, &c., and to take an account of the same.

LA'NDWEHR. (Germ. *land-guard*.) The militia of Prussia and Austria are so called. *See* MILITIA.

LA'NGREL. A particular kind of shot formed of bolts, nails, and other pieces of iron, tied together, and forming a sort of cylinder which corresponds with the bore of the cannon from which it is discharged. It is used chiefly to destroy the masts and rigging of the enemy's ships.

LANGUAGE (Lat. lingua, *tongue*), has been defined "the expression of our ideas and their various relations by certain articulate sounds, which are used as the signs of those ideas and relations."

Whether language was originally given to man by his Creator, or is the fruit of human invention, is a subject of dispute, on which philosophy is scarcely capable of arriving at satisfactory conclusions. Among those writers who have maintained the latter thesis, three (*Lord Monboddo on the Origin and Progress of Language; Adam Smith's Considerations on the Formation of Languages;* and *Stewart's Philosophy of the Human Mind*, part 3.) are particularly deserving of attention. The first of these, in his ingenious speculation on the subject, mentions four ways in which he conceives that ideas could have been communicated before the invention of speech: viz., 1. Inarticulate cries, expressive of sentiment sand passions; 2. Gestures, and the expression of countenance; 3. Imitative sounds, expressive of audible things; and, 4. Painting, by which visible sounds are represented. And he appears to consider language to have been produced by gradual development out of the *first* of these.

Many, whether satisfied with Lord Monboddo's speculations or not, are ready to condemn the supernatural theory as "unphilosophical." But our views on this subject must materially depend on those which we may take of the kindred speculations respecting the origin of civilization. If we are led to the conclusion — once commonly adopted, with little inquiry, by philosophical writers — that the progress of man from the lowest state of barbarism to refinement has been gradual in all societies, we shall probably also believe that the formation of language accompanied this development in its course. But if we are more forcibly impressed with the strength of the *historical* difficulties which oppose this theory; that all our research only reveals to us the story of one family of civilized men (in the proper sense of that word) succeeding another; that the more barbarous races appear to have lost civilization, — to have fallen back from some better condition, instead of being at the lowest or commencing step (a notion strongly entertained by the gifted historian Niebuhr, among many others); and that the languages of some of the most savage races (such as several of the American Indians), instead of partaking in their want of refinement in other respects, are remarkable for the number and delicacy of their inflexions; — we shall probably arrive at the conclusion, that the more likely speculation is that which coincides best with the faint indications afforded by the inspired writings, and points out Revelation as the source both of knowledge and of the primary laws of human society.

Considering the phenomenon of language as it now presents itself, the most interesting philosophical questions to which it gives rise are those which concern the connection and relative antiquity of existing languages, and their comparative utility and beauty as modes of communicating ideas. The first lead the mind to consider the history of language; the latter the principles of its structure.

The former of these subjects is one of those which may be most emphatically pronounced peculiar to modern research. The affinity of the great family of European and Western Asiatic languages, those with which we are the most familiar, was scarcely studied with serious attention before the time of Adelung (whose great work, *Mithridates*, appeared, we believe, in 1804). The affinities of the Semitic and other oriental tongues had been, perhaps, earlier investigated; but their elucidation remains nevertheless still more imperfect at the present day. On a topic now pursued with great interest, especially by the learned men of Germany and Britain, we must content ourselves with indicating a few simple rules for the guidance of the student.

The importance of the coincidence of single words, as a proof of the connection of languages, is rather under than over estimated in common opinion. The late Dr. Young, whose researches into this question are of such high value, calculated that nothing could be inferred, as to the relation of two languages, from their agreement in *one* word; that the odds are only three to two against their casual agreement in *two;* but that they rise so rapidly that there are nearly 100,000 chances to one against their casual agreement in *eight*.

But, again, nothing could be inferred as to the relationship of languages from their agreement in particular words, if the nations which spoke them were neighbours, and the words such as the one might easily borrow from the other by mutual intercourse. The Latin word and the low German word for wine are the same; vinum, wyn, pronounced *veen*. But the Germans learnt the use of the thing from the Romans; and along with it they doubtless borrowed the name. No conclusion could therefore be drawn from this example, as to the connection between German and Latin. The Greek name for a lion, *lis*, is nearly the same with that used in a very different family of languages, the Semitic (Hebrew, laist; Arabic, laith). But the animal itself, although at one time occasionally found in Greece, was probably a wanderer from Asia; and the fact of its name being common to both tongues proves therefore nothing as to their relationship.

In examining the connection of languages by their agreement in words, two things are to be considered: the root, and the inflexions. The root is arrived at by striking off the inflective part of the word. Thus the termination *us* (properly *os* or *o*) is the inflective part, in the nominative, of a numerous order of masculine nouns in Latin as well as Greek. The root of "equus" is equ, or ec; the root of "albus" (white), alb. It is in these roots that we are first to look for the connection of languages; and in examining them it is necessary to acquire a knowledge of one of the most important and most difficult to ascertain among the primary facts relating to languages, the ordinary substitution of letters, especially consonants, in different cognate languages of the same family. With reference to the great class of languages already alluded to, commonly called the "Indo-European," these substitutions have been only of late classified, and that as yet

imperfectly. Thus it has been found that the Greek aspirate is often represented in Latin by *s*, ἑξ, ἑπτα, *sex*, *septem*; that the Greek π is frequently represented in the Teutonic tongues by *f*, πους, πατηρ, *foot*, *father*; that the Greek and Latin *d* is often *z* in German, *dens*, *digitus*, *decem*—*zahn*, *zehe*, *zehen*. A good list of the most common among these transformations will be found in the *Penny Cyclopædia*, art. "Language," taken from *Potts' Etymologische Forschungen*.

Correspondence in inflexions is a still closer sign of relationship. That peculiar class of Greek verbs commonly called in our grammars "verbs in *mi*" has a corresponding class in the Sanskrit, Zend, and some Sclavonic tongues.

	Greek.	Sanskrit.	Lithuanian.
I stand,	ἱστημι	Tisthâmi.	Stowmi.
Thou standest,	ἱστης.	Tisthâsi.	Stowi.
He stands,	ἱστησι.	Tisthâti.	Stow.
I give,	διδωμι.	Dadâmi.	Dudmi.
Thou givest,	διδως.	Dadâsi.	Dusi.
He gives,	διδωσι.	Dadâto.	Dusti.

In other cognate languages this mode of conjugation is either lost or much altered. Here, therefore, is an indication (not, of course, a conclusive one) of a nearer connection between these than others of the same family; Celtic and Latin, for instance.

The connection between languages being established, the mind is next led to consider their derivation one from another. And here historical assistance soon fails us. We say that Spanish and Italian are derived from Latin, because we know the fact historically; but at the earliest period of which we have any authentic account we find several independent nations using different, but strongly resembling varieties of speech, of whose historical connection we know nothing. We know little, for example, on the question in what consisted the relationship between the Latins and the Greeks; and nothing whatever as to the connection of either with the Celts or the Sclavonians. And hence it is easy to perceive the absurdity of the fashion, of which we still constantly meet with examples in dictionaries and works of reference, of speaking of words in cognate languages as "derived" from one another; for example, a Latin word as "derived" from the Greek, an English as "derived" from the German. The Romans undoubtedly, in later ages, borrowed a few words from the richer vocabulary of Greece; *e. g. historia, poema;* and the English have borrowed a very few from the Germans. But Greek and Latin, Anglo-Saxon and German, are respectively only varieties, derived alike from some ancient original which our inquiries are unable to reach.

The distinction between a separate language and a dialect is very arbitrary. We speak of Spanish and Portuguese, Swedish and Danish, as distinct languages; yet they resemble each other quite as nearly as some varieties of French, perhaps of Italian. The name seems appropriated, in ordinary usage, to every variety of speech which is in national use for purposes of government and literature.

The relative antiquity of languages is a subject involved in obscurity, and on which our conclusions are little better than conjectural. The theory that all languages are derived from a common original is difficult to be maintained; and yet there is no doubt that the tendency of modern research is, by accurate classification, to reduce the number of original tongues from which those in actual use are derivative varieties.

The following table of languages, divided into classes or groups, is given by Dr. Young, in the art. "Language," in the *Encyclopædia Britannica*.

1. Monosyllabic class: Chinese. Siamese. Avanese. Tibetan.

2. Indo-European class: Sanskrit. Zend (Median). Semitic (Arabian, Syriac, Hebrew, &c.) Lycian. Phrygian. Greek. Germanic. Celtic. Etruscan. Latin. Cantabrian. Sclavic.

3. Tartaric class.
4. African class.
5. American class.

This classification, however, is rather geographical than ethnographical, and in some respects apt to mislead. For example, those great families of languages, the Sanskrit, Greek, Latin, and Germanic, are all nearly connected with one another. The Celtic and Sclavic belong to the same division; while the Semitic languages form a very peculiar group apart, and should be excepted from the Indo-European class.

Languages have also been classed in the following manner:—

1. Languages composed of monosyllabic roots without any form of grammar. These have no inflexions, and variety of meaning is only shown by the position of words in a sentence. To this order belong the languages which Dr. Young terms monosyllabic.

2. Languages composed of monosyllabic roots with a great abundance of grammatical forms. Of these the great Indo-European family are an example.

3. Languages whose verbal roots consist, in their present form, of two syllables, and require three consonants to express their fundamental meaning. This division appears to comprehend the Semitic languages only, as far as is at present ascertained.

The comparative perfection of a language, as an instrument for the communication of thought, depends mainly on its copiousness. In order to estimate this, it must be borne in mind that the classes of words employed in a language are all reducible into two, which have been termed by some *notional* and *relational*. The former express distinct ideas or notions; the latter serve to display the relation, connection, and order of ideas. Nouns and verbs belong to the first class; prepositions, adverbs, &c., and the signs denoting the inflexions of verbs and nouns, to the latter. With respect to the former class, all languages, to be serviceable for the purposes of life, must be sufficiently copious to express all distinct notions. But the comparative richness of a language is mainly shown by the manner in which this is done. As nations advance from barbarism towards civilization new notions, and new varieties of notions, are constantly requiring utterance. In those in which this can easily be done by composition (as in Greek and German), great facilities are afforded for the easy expression of thought, comparatively with those in which it can only be effected by the laborious process of borrowing and adopting words from the vocabularies of more advanced nations.

But it is in the *relational* words, or modes in which relations of ideas are expressed, that the genius of different languages most varies. The Chinese, in their singular and obscure tongue, seem never to have reached beyond the process of varying the collocation of their unchangeable roots in the sentence, in order to express varieties of meaning. The next process should appear to be that of using auxiliary words. In many languages (our own among the number) relations are almost wholly expressed in this manner. But in others the auxiliary words have, in course of time, coalesced with the principal; so that many relations are expressed by varying the beginning, termination, &c. of the principal word. This, at least, is the most probable origin of those forms termed in grammar *inflexions*, or forms of declension and conjugation, in which Greek, Latin, Sanskrit, German, and their derivative languages are more or less rich; the Greek, for example, being more copious than the Latin or modern German, in having the dual form and additional tenses (the aorists, and the paulo-post futurum). And some languages (especially among the American Indians) are so curiously constructed as to carry the power of inflexion far beyond this point. A complex idea which, in English, would require to be expressed by a pronoun, an adverb, and an auxiliary verb (or perhaps a second auxiliary verb also, *e. g.* "I desire," or "I abstain"), together with the principal verb, would in some American languages be expressed merely by a variety of the form of the principal verb itself.

As a general rule, the power of inflexion adds greatly to the copiousness of a language; and although some enthusiasts in their admiration of our own have maintained that the process of conjugating or declining by auxiliary words and particles is more convenient, and affords more variety and harmony, than that by changes in the termination of the verb or noun, it is probable that few candid reasoners will hold the same opinion. But there are distinctions in language, arising out of relations simply imaginary, which may be pronounced unnecessary and cumbersome. Such are the genders, common to almost all languages of the Indo-European family except our own, but for which it would be difficult to assign either utility or beauty.

Another and a more substantial disadvantage of languages rich in inflexions, if the fact be true, is to be found in the greater difficulty which common people are supposed to have in framing their speech grammatically and accurately under this system than the other. The greater the niceties of a language, it has been urged, the greater the difference must inevitably be between the variety spoken and written by educated men and that in use among the uneducated; and it has been contended that in ancient Italy, for instance, the rustic language was altogether different from the written Latin. But the facts on which this reasoning rests may be pronounced extremely controvertible. There are certainly some grounds for the suspicion that there was an unusual difference between the vulgar and the polished Roman

tongue, at least in the later times of the empire; but if this was always the case, it is singular that Plautus and Terence should no where furnish us, by way of heightening the ludicrous, with instances of ungrammatical locution. The language of ancient Greece was more refined and inflective than that of Rome; and there is no appearance that there was a greater diversity between the speech of the peasant and the philosopher and rhetorician than in any modern country. In Attica the very reverse seems to have been the truth, since its most elegant writers and orators appear carefully to have modelled their language on the common dialect of their countrymen. And, finally, the wild Indian of America speaks with purity a language often surpassing in variety of inflexions those of the most civilized and illustrious nations of the Old World.

Among the numerous and valuable works which may assist the reader in acquiring a knowledge of the existing varieties of spoken tongues, may be mentioned *Vater's Linguarum Totius Orbis Index Alphabeticus*, 1815; *Marsden's Catalogue of Dictionaries, &c.*, 1796, and his *Miscellaneous Works* (as to Oriental languages); *Adelung's Mithridates*, already cited; the Works of Dr. Prichard; a very valuable article in the *Penny Cyclopædia*, of which much use has been made in the above pages.

LANGUE'NTE. (Ital.) In Music, a direction to the performer, when prefixed to a composition, denoting that it is to be performed in a languishing or soft manner.

LA'NIARIES, *Dentes Laniarii*. (Lat. lanio, *I rend.*) The long conical and sharp-pointed teeth which are placed next behind the incisors. They are also called *dentes canini* and *cuspidati*. They never exceed $\frac{1 \cdot 1}{1 \cdot 1}$ in number in the Ferine Mammalia.

LA'NIUS. (Lat. lanio.) A Linnæan genus of Passerine birds, forming the typical family of the Dentirostral division of that order in the system of Cuvier. The birds of the family *Laniadæ*, or shrikes, are characterized by a strong compressed conical beak, more or less hooked, and emarginate near the point, as in the other Dentirostres. The shrikes live in families, and fly irregularly and precipitately, uttering shrill cries; they build in trees, lay five or six eggs, and take great care of their young. They have the habit of imitating a part of the songs of such birds as live in their vicinity. The larger and stronger birds are predatory, and attack, slay, and devour smaller birds.

LA'NSQUENETS, *Lansknechts*. The German infantry first raised by the Emperor Maximilian to confront that of the Swiss, in the end of the fifteenth century. The name is derived from the German words *landes knecht*, countryman or country lad; and not, as is sometimes stated, from *lanz*, a lance or pike. The lansknechts were very irregularly armed; the greater part with pikes, but certain companies in every division with muskets. They were raised by voluntary enlistment, and their leaders passed with little reluctance into the service of any power which was willing to pay them. This infantry played a conspicuous part in the wars of Italy, in the first half of the sixteenth century, after which the name fell into disuse.

LANTA'NIUM. (Gr. λανθανειν, *to conceal.*) A metallic substance discovered by Mosander in *cerite*; it is associated with, and concealed as it were by, the oxide of cerium. The oxide of lantanium is of a brick-red colour.

LANTERN. (Fr. lanterne.) In Architecture, a drum-shaped erection, either square, circular, elliptical, or polygonal, on the top of a dome, or on that of an apartment, to give light. *See* Cupola.

LA'NTERN, MAGIC. *See* Magic Lantern.

LA'NTERN WHEEL. In Mechanics, a kind of pinion, having, instead of leaves, cylindrical teeth or bars, called *trundles*, or spindles, on which the teeth of the main wheel act. The ends of the trundles being fixed in two parallel circular boards or plates, the lantern wheel has the form of a box or lantern; whence the name.

LA'NYARD. The sea term for certain lashings, whether fixed or temporary.

LAO'COON. In Fabulous History, the priest of Apollo or Neptune during the Trojan war. While he was engaged in sacrificing a bull to Neptune, two enormous serpents sent by Minerva, in revenge for his having endeavoured to dissuade the Trojans from admitting the famous wooden horse within their walls, issued from the sea; and having fastened on his two sons, whom he vainly endeavoured to save, at last attacked the father himself, and crushed him to death in their complicated folds. Virgil has thus described the occurrence: —

——— Et primum parva duorum
Corpora natorum serpens amplexus uterque
Implicat, et miseros morsu depascitur artus:
Post, ipsum, auxiliis subeuntem ac tela ferentem
Corripiunt, spirisque ligant ingentibus: et jam
Bis medium amplexi, bis collo squamea circum
Terga dati, superant capite, et cervicibus altis.

This story has gained immortal celebrity from its forming the subject of one of the most beautiful groups of sculpture in the whole history of ancient art. The composition is pyramidal, and represents Laocoon and his two sons writhing and expiring in the convolutions of the serpents. Agony in an intense degree is exhibited in the countenance and convulsed body of Lacoon, who is attempting to disengage himself from the serpents; and the sons are represented as imploring assistance from their helpless parent. Some connoisseurs, who have ventured upon a criticism of the group, have discovered that its complexity destroys its effect; but we doubt the value of their criticism, and to counteract it give the opinion of Fuseli (no mean judge), from his *Lectures on Painting*. "In the group of the Laocoon the frigid ecstasies of German criticism have discovered pity like a vapour swimming on the father's eyes; he is seen to suppress in the groan for his children the shriek for himself; his nostrils are drawn up to express indignation at unworthy sufferings, whilst he is said at the same time to implore celestial help. To these are added the winged effects of the serpent poison, the writhings of the body, the spasms of the extremities. To the miraculous organization of such expression Agesander, the sculptor of the Laocoon, was too wise to lay claim. His figure is a class; it characterizes every beauty of virility verging on age: the prince, the priest, the father, are visible; but, absorbed in the man, seem only to dignify the victim of *one* great expression. Though poised by the artist, for us to apply the compass to the face of the Laocoon is to measure the wave fluctuating in the storm: this tempestuous front, this contracted nose, the immersion of these eyes, and above all that long-drawn mouth, are, separated and united, seats of convulsion — features of nature struggling within the jaws of death."

Of this famous group of sculpture Pliny says, that it is "*opus omnibus picturæ et statuareæ artis preferendum.*" It was discovered at Rome among the ruins of the palace of Titus, at the beginning of the 16th century; and afterwards placed in the Farnese palace, whence it found its way to the Vatican. It was executed by Polydorus, Agesander, Athenodorus, the three celebrated artists of Rhodes. The *Penny Cyclopædia* has an excellent article on this subject, to which we beg to refer.

LAPIDARY STYLE (Lat. lapis, *a stone*), denotes the style proper for monumental or other inscriptions, and is thence sometimes used to express a terse, expressive style. The rules of this style have been prescribed by Cicero: — "Accedat oportet oratio varia, vehemens, plena spiritus. Omnium sententiarum gravitate, omnium verborum ponderibus est utendum."

LAPI'LLI. (Lat. lapillus, *a little stone.*) Small volcanic cinders.

LA'PIS. (Lat.) In Roman Antiquity, literally a stone; but used among the Romans to signify a mile, at the end of which lapides or stones were erected with a mark thereon to show the distance from Rome. Hence the phrases "tertius lapis," "centesimus lapis," &c., for 3, 100, &c. miles; and sometimes even the ordinal number was used, with *lapidem* understood, as "ad duo decimum," — twelve miles distant. The Roman practice of indicating the distance of one place from another by the erection of stones has been borrowed by almost all the nations of modern Europe.

LA'PIS CAUSTICUS. Caustic potash.

LA'PIS INFERNA'LIS. Fused nitrate of silver; often called *lunar caustic*.

LA'PIS LA'ZULI. A blue mineral found in masses or nodules, consisting chiefly of silica and alumina, with about twenty *per cent.* of soda, and some peculiar combination of sulphur, to which it probably owes its colour; it is often sprinkled with yellow pyrites It furnishes the valuable pigment known under the name of *ultra marine*, and was formerly much employed in ornamental inlaid work. Persia, China, and Russia are its chief sources.

LA'PITHÆ. In Ancient Geography, a people of Thessaly, chiefly known to us from their fabled contests with the Centaurs. The battle between the Centaurs and the Lapithæ has been described by Hesiod, and by Ovid with great minuteness. (*Met.* xii.) To the Lapithæ has been attributed the invention of bits and bridles for horses.

LAPSE (Lat. lapsus, *a slip*), in Ecclesiastical Law, is the omission of a patron to present a clergyman to a benefice within six months after its being void; in which case the benefice is said to be void, and the right is lost to the patron. In England the right of presentation then accrues to the bishop, and to the sovereign by the neglect of these; and in Scotland it devolves on the presbytery.

LA'PWING. The name of a native species of the genus *Vanellus*, dismembered by Bechstein from the *Tringa* of Linnæus. (*See* Vanellus and Tringa.) The lapwing or pee-wit (*Vanellus cristatus*, Bechst.) is a constant inhabitant of this country; subsists chiefly on worms and the animalcules of the sea-shore, which it frequents

in great numbers. The female makes a simple nest by scraping together a little dry grass, and deposits thereon four eggs, of a dirty olive colour spotted with black. The young birds are covered with a thick down when hatched, and soon begin to run about: at the approach of danger they squat down, and the parent, by a curious instinct, endeavours to attract the attention of the intruder, and draw him away from the spot, by fluttering about with cries of inquietude, or even running along the ground as if lame. In October the lapwings are fat, and in good condition for the table: their eggs are considered a great delicacy.

LA'QUEAR. In Architecture. *See* LACUNAR.

LARA'RIUM. (Lat.) In Ancient Architecture, the apartment in which the lares or household gods were deposited; it also frequently contained statues of the proprietor's ancestors.

LA'RBOARD. The left-hand side of a ship to a person whose face is turned towards the head. The other side is called the *starboard*.

LA'RCENY. (Lat. latrocenium, *theft.*) In Law, a species of felony, distinguished, formerly, into simple and mixed: the latter of which was the taking of goods and chattels from the person, or from the house, if above the value of twelve-pence. But this distinction has been abolished by the statute which consolidated the laws relative to this class of offences (7 & 8 G. 4. c. 29.). Larceny is the felonious and fraudulent taking and carrying away of the goods and chattels of another. Thefts of things affixed to the freehold, if forming part of what is termed real property, are not larceny at common law; but many offences of this description have been brought within the character of larceny by enactment. Robbery, breaking into and stealing in a dwelling-house, if in the daytime, piracy, &c., are species of mixed larceny. A receiver of stolen goods is indictable either for a substantive felony, or as accessary to the theft or robbery. Many of the offences under this class are still punishable by death; but in these, and all felonies except murder, sentence of death, instead of being pronounced immediately, may be recorded, to enable the judges to pronounce eventually a discretionary sentence according to the merits of the case.

LA'RES. (Lat.) Domestic deities of the Italians, who were probably regarded as the souls of the deceased ancestors of a family. Their worship, however, was not confined to private houses; as there were lares of the city, the country, roads, &c. *See* PENATES.

LARGE. (Ital.) In Music, a character representing the greatest measure of musical quantity; one large containing two longs, one long two breves, one breve two semibreves, and so on in duple proportion.

LARGHE'TTO. (Ital. dimin. of largo.) In Music, a movement a little quicker than *largo*.

LARGO. (Ital.) In Music. *See* ALLEGRO.

LA'RIDÆ. A family of swimming birds, having the gull (*Larus*) as the type.

LARK. The common name of the native species of the genus *Alauda* of Linnæus; of which one, the *Alauda arvensis*, is distinguished as the sky-lark or lavrock; the other, *Alauda campestris*, Linn., is called the field-lark. As the species of the present genus differ from most other Insessorial birds in resting habitually and sleeping upon the ground, their feet present a singular but simple modification, which at the same time beautifully adapts them to their office of supporting the superincumbent body on a flat surface: it consists in the extreme elongation in an almost straight line of the claw of the hinder toe, which is, at the same time, proportionally robust; thus the plane of support is extended at the expense of the prehensile faculty, which the habits of the lark render of little or no value to it.

The sky-lark is universally admired for the power and melody of its song, and for the beautiful associations inspired by the circumstances under which its notes are most richly poured forth — viz. while soaring aloft to greet the rising sun. It ascends in the air almost perpendicularly, by successive flights, to an elevation at which its song becomes inaudible: its descent is generally oblique. The female builds her nest on the ground, and lays four or five eggs, which are of a greyish brown colour marked with darker spots: she sits about fifteen days, and usually rears two broods in the year. This prolific species is granivorous, and in the winter large flocks congregate together; they are very fat at this season, and are captured in great numbers for the table.

LA'RMIER. (Fr.) In Architecture, the same as *corona*, which see.

LA'RUS. (G. λαρος, *a gull.*) A Linnæan genus of aquatic birds belonging to the Longipennate division of Palmipedes in the system of Cuvier, and now raised to the rank of a family comprising several subgenera. The *Laridæ*, or gulls, are characterized by their compressed elongated pointed bill, of which the superior mandible is curved downwards near the end, and the inferior forms a salient angle beneath. The nostrils, placed near its middle, or a little more forwards, are long, narrow, and form a complete transverse perforation; the tail is ample, and sometimes pointed. (*Lestris.*) The gulls are common and numerous on the sea-coast, and feed on the different animal substances which are left on shore or float down with the ebbing tide. The black-headed gull (*Larus ridibundus*, Linn.) breeds on the marshy edges of rivers or fens; the female makes her nest, among the reeds and rushes, of heath or dried grass, and lays three or four eggs, of an olive brown colour spotted and streaked with dusky red. When the young are able to accompany the parents they all resort to the sea-shore. The other species of gulls build for the most part in the sand or the clefts of rocks.

LA'RVA. (Lat. larva, *a mask.*) A Metabolian insect in its first stage after exclusion from the egg is so called, because its real form is, as it were, masked: the same term is also applied to those reptiles which undergo a metamorphosis, as the frog, when at a corresponding period of existence.

LARVA. Spectres of the deceased were so termed by the Romans: mere empty forms or phantoms, as their name indicates; yet endowed with a sort of existence resembling life, since they were to be propitiated by libation and sacrifice. The larva of Caligula, according to Suetonius, was often seen in his palace after his decease. The larvæ are described by Seneca, and often represented in paintings and on gems under the figure of skeleton; sometimes under those of old men, with shorn locks and long beards, carrying an owl on their hands.

LARVI'PARA. (Lat. larva, and pario, *I bring forth.*) Those insects are so called which bring forth larvæ instead of eggs, the latter being hatched in the oviduct.

LARYNGI'TIS. Inflammation of the larynx. The symptoms are hoarseness, sense of suffocation, great anxiety and restlessness, and spasmodic difficulty of deglutition. The acute form of the disease sometimes terminates fatally in 24 hours. Chronic inflammation of the larynx is not an uncommon complaint, and often a very troublesome one; it is frequently met with among dram drinkers: low diet, abstinence from spirituous liquors, and astringent lozenges and gargles generally relieve it; the acute form of the disease requires local and general bleeding, and a blister on the external throat.

LARYNGO'PHONY. (Gr. λαρυγξ, and φωνη, *the voice.*) The sound of the voice as heard by applying the stethoscope over the larynx.

LARYNGO'TOMY. (Gr. λαρυγξ, and τεμνω, *I cut.*) The operation of making an opening into the larynx. *See* BRONCHOTOMY.

LA'RYNX. (Gr. λαρυγξ.) The upper extremity of the trachea. It is a cartilaginous cavity, the superior opening of which is called the *glottis*. Its various parts, anatomically considered, are extremely complex and intricate, especially in reference to its construction and physiology as the organ of voice.

LA'SCARS. The name given to the native Indian sailors, many of whom are in the service of our mercantile navy.

LA'SER. A gum resin greatly esteemed by the ancients, and obtained from the north of Africa. It is described by Dioscorides (lib. iii. c. 48.); and, under the name of *silphion*, by Theophrastus. Different names were given to different parts of the plant which affords it, the term *laser* or *lasoorn* being exclusively applied to the inspissated juice. From the representations of the plant, upon the coins of Cyrene, it appears to have been one of the *Umbelliferæ*. According to Dr. Lindley (*Flora Medica*, p. 52.), it was in all probability obtained from *Thapsia asclepium*.

LAST. In Commerce, a measure of uncertain quantity, varying in different countries and with respect to different articles. Generally, however, a last is estimated at 4000 lbs. (See *Commercial Dictionary*.)

LATEE'N SAIL. A peculiar sail having a long yard much inclined to the horizon, and used by polacres, kebecs, and other vessels navigated in the Mediterranean.

LA'TENT HEAT. Heat insensible to the thermometer, upon which the liquid and aëriform states of bodies depend, and which becomes *sensible* during the conversion of vapours into liquids and of liquids into solids. *See* HEAT.

LA'TERAL OPERATION. A surgical term applied to one of the methods of cutting for the stone.

LA'TERAN. A church at Rome, the Pope's see, and the metropolitan of the whole world, dedicated to St. John Lateran. The name is derived from the Roman family of the Laterani, who possessed a palace on this spot, which was seized by Nero, and became from his time an imperial residence. The Lateran palace was given by Constantine to the popes (see *Milman's Hist. of Christianity*, ii. 361.), who continued to inhabit it until their retirement to Avignon, when it was exchanged for the Vatican. The building was then converted into a church. Eleven councils have been held in the Basilica of this name (hence styled Lateran councils in ecclesiastical history), of which four are considered by

the Roman Catholics to be general. The last of these (or the 12th General, according to the same computation) is the most celebrated. It was held in 1215 by Innocent III., and is principally famous as establishing the Roman Catholic doctrine of the Eucharist, using for the first time the term transubstantiation for the change of the elements. This council was convoked on the occasion of the heresy of the Albigenses, and its exposition of the Catholic faith is directed principally against them. It established also some canons for the maintenance of discipline among the clergy, and that (omnis utriusque sexus) which enforces confession and communion upon all the faithful at least once a year.

LATERI'TIOUS. (Lat. later, *a brick.*) This term is applied to the reddish sediment which is often deposited by the urine.

LA'TEX. (Lat.) A term given to a peculiar fluid found in certain vessels that have been discovered by Schultz to be present in plants. It is as yet but little understood, but is described by its discoverer as a peculiar secretion having a rapid vital motion, and containing numerous granules of organizable matter. He supposes it to be analogous to the blood in cold-blooded animals. What is usually denominated the milk of plants appears to be latex.

LATH. (Sax. lætta.) In Architecture, a thin cleft piece of wood used in slating, tiling, and plastering. There are two sorts of laths, single and double; the former being barely a quarter of an inch, whilst the latter are three eighths of an inch thick. Pantile laths are long square pieces of fir on which the pantiles hang.

LATHE. A Saxon territorial division, of which the etymology is uncertain. Kent is the only county divided into lathes, each of which contains four or five hundreds. Each was originally under the jurisdiction of a lathe-reeve, subordinate to the sheriff of the county. *Lathe* is also the name of a well-known instrument or engine used in turning wood, ivory, or other materials.

LATH FLOATED AND SET FAIR. In Architecture, three-coat plasterer's work; in which the first is called pricking up, the second floating, the third or finishing is done with fine stuff.

LATH LAID AND SET. In Architecture, two-coated plasterer's work; except that the first is called *laying*, and is executed without scratching, unless with a broom. When used on walls this sort of work is generally coloured; when on ceilings it is white.

LATH PLASTERED, SET, AND COLOURED. In Architecture, the same as lath laid, set, and coloured.

LATH PRICKED UP, FLOATED, AND SET FOR PAPER. The same as lath floated and set fair.

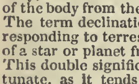
LA'TICLAVE. (Lat. lavus clavus.) The broad stripe which Roman senators and patricians were privileged to wear on their robe.

LATI'SSIMUS DORSI. A broad muscle of the back which pulls the os humeri downwards and backwards, and assists in its rotatory motion.

LA'TITUDE (Lat. latitudo, *breadth*), in Geography, signifies the distance of a place from the equator, expressed in degrees of the earth's circumference; or it is the angle which a line perpendicular to the horizon of any place makes with the plane of the earth's equator. In Astronomy the term latitude, as applied to a celestial body, has a different signification, and means the distance of the body from the ecliptic, or plane of the earth's orbit. The term declination is applied to denote the angle corresponding to terrestrial latitude; namely, the distance of a star or planet from the plane of the earth's equator. This double signification of the term is extremely unfortunate, as it tends to create a confusion of ideas; but having been introduced by the early astronomers, and being ingrafted into every existing work on the science, it is now too late to remedy the evil.

Latitude and longitude being the co-ordinates by which the positions of places on the terrestrial surface are defined, their determination forms the most important application of astronomy.

In order to give an idea of the methods of finding the latitude of a place, or of a ship at sea, it is necessary to recal some of the elementary properties of the sphere.



Let H H' be the horizon of a spectator placed at C; C P the direction of the axis of the earth's rotation; and C Z the direction of the zenith, or perpendicular to the horizon. Let C E be drawn perpendicular to C P, in the plane determined by the straight lines C P and C Z, or the plane of the meridian; then C E is the intersection of the planes of the equator and meridian; the semidiameter of the earth being neglected as infinitely small in comparison of the distances of the stars, to which C P, C Z, and C E are supposed to be prolonged.

Now, by the definition, the angle E C Z is the latitude of C; and it is this angle, therefore, which is to be determined. The observer always knows his zenith by the direction of the plumb-line; but there is no visible mark in the heavens by which he can at all times determine the place of the equator, or the position of E in the meridian, or even the meridian itself. But the angles E C P and Z C H being each right angles, E C Z is equal to P C H; that is to say, the latitude of the place is equal to the height of the visible pole. Now the pole is a fixed point in the heavens, and its position (in the northern hemisphere) is indicated nearly by a star, called the pole star, or *polaris*, which describes a small circle of the sphere within $1^{\circ}\ 40'$ of it. By observing, therefore, the height of the pole star at any place, an approximation to the latitude will be obtained within $1^{\circ}\ 40'$ of its true value. But this approximation is very far from being sufficient for any useful purpose.

The places of the principal stars being given in the existing catalogues, the observed altitude of any one of them at the time it passes the meridian will give the latitude of the place. Let S be a star on the meridian, and S P its polar distance in the catalogue, and let its altitude H' S be observed; then H' S being known, S Z, the zenith distance, is also known; and S P being also known, we have S P − S Z = Z P, the complement of the latitude. In like manner, the latitude may be found by observing the meridional altitude of the sun, or moon, or a planet, the declinations of all these bodies at any time being known. But though all the methods are equally good in theory, they are not all equally practicable, and some of them give a result attended with much greater uncertainty than others. The following are those which are chiefly employed.

1. By observing the altitude, or, which comes to the same thing, the zenith distance, of a star on the meridian. This is the simplest in practice, requiring only a single observation, and no other correction than for refraction. It is accordingly generally employed for common geographical purposes. When the sun or planets are the bodies observed, corrections must also be applied for the semidiameter of the body and for the parallax. At sea the bodies selected are the sun and moon, the observation of a star or planet being difficult on account of the motion of the vessel. To know when a heavenly body is on the meridian, it is necessary to have a pretty accurate knowledge of the time; but it may be remarked that near the meridian the altitude varies very slowly, and therefore a small error in respect of the time does not much affect the result.

2. By the altitudes of the circumpolar stars (those which never go below the horizon of the place) at their upper and lower transits. If the altitude of a star on the meridian is observed both above and below the pole, the sum of the two altitudes is equal evidently to twice the height of the pole, or twice the latitude. The only correction required is for refraction, which is not the same in the two observations.

3. The latitude may also be found by observing the greatest and least meridian altitudes of the sun in the course of a year. The sum of the altitudes of the sun at the summer and winter solstices is equal to twice the height of the equator, or twice the complement of the latitude; but this method requiring observations to be made at an interval of six months, is seldom had recourse to, excepting in fixed observatories.

4. All the preceding methods suppose the body observed to be on the meridian; but this condition, though it renders some calculation unnecessary, is not indispensable. The latitude may be determined by the observed altitude of a body out of the meridian; and indeed with more certainty, because several observations may be made successively, the mean of which will give a surer result than a single meridional observation. Let P be the pole, S the

place of the star or planet, and S Z its observed zenith distance, or the complement of its observed altitude. In the triangle P S Z, P S, the polar distance of the star, is known; S Z is given by observation; and the hour angle Z P S is given, because the time of the observation is supposed to be exactly known; therefore P Z, the co-latitude, may be found by the solution of a spherical triangle. This method, however, can only be successfully applied by observing near the meridian, and some artifices of analysis are required to adapt the trigonometrical formulæ to calculation. A method has lately been proposed by Professor Littrow of Vienna for determining the latitude by means of observations of the pole star off the meridian, which is found to be of great practical utility.

5. The last method which we shall notice for finding the latitude is one that has been proposed by Bessel, and consists in observing the eastern and western passages of a star through the prime vertical; that is, the vertical plane at right angles to the meridian. When a transit instrument is adjusted to move in this plane, and consequently has its horizontal axis in the direction of the meridian, all the stars which pass the meridian between the zenith and equator will twice enter the field of the telescope. Now let t be the time of the eastern transit, t' the time of the western transit, δ the declination of the star, φ the latitude, and P the diurnal arc corresponding

to the time $\frac{1}{2}(t-t')$; then the formula by which the latitude is determined is

$$\tan.\,\phi = \frac{\tan.\,\delta}{\cos.\,P}.$$

The advantages of this method are, that the observations may be made with a portable instrument, which can easily be oriented by means of the circumpolar stars; a small error in the adjustment will produce no sensible error in the result if the stars observed pass near the zenith; the observations are altogether independent of errors in the division of the instrument; and in determining differences of latitude. errors of declination are also eliminated by observing the same stars at all the stations. It is therefore a very convenient method for a trigonometrical survey.

LATITUDINA'RIANS. In Eccl. History, a class of English divines in the reign of Charles II., opposed alike to the high tenets of the ruling party in the church, and the fanaticism which then distinguished so many of the Dissenters. They were of course the objects of much attack; and one of their number, Fowler, Bishop of Gloucester, explained their principles in his treatise entitled "*The Principles and Practice of certain modern Divines of the Church of England, vulgarly called Latitudinarians, truly represented and defended, by way of Dialogue.* 1670." Henry More, and the other Platonizing divines of the time, were sometimes comprehended under this appellation. (See *Mosheim*, vol. v. p. 412., transl., ed. 1790.) The word has been since very generally used to designate those who hold opinions at variance with the more rigid interpretation of Scripture and church traditions, or merely as a term of party vituperation.

LA'TROBITE. A mineral found on the coast of Labrador, and also in Finland. It is translucent, of a pale red colour, and occurs both crystallized and massive. It is a silicate of alumina with lime, potash, and oxide of manganese.

LA'TTEN. (Fr. laiton.) Brass or bronze. Tinned iron is also sometimes known under this name.

LA'TUS RE'CTUM. In the Conic Sections, the same with parameter. — *Latus transversum*, the same with the transverse axis. See Conic Sections.

LAU'DANUM. (Supposed to be derived from Lat. laus, *praise*.) Different preparations of opium have been so termed: the tinctures used formerly to be called *liquid laudanum*.

LAUDICOENI (Lat.), among the Romans, were persons who (like the modern claqueurs in France, or the puffers in England at auctions) attended the performance of plays and the delivery of orations, in order to raise or to join in the acclamation. The derivation of the word would indicate that an entertainment was the chief, if not the only reward, which they obtained for their services.

LAUDS. (Lat. laudes, *praises*.) In the Roman Catholic Church, the prayers formerly used at daybreak, between those of "matins" and "prime." In later times they have become generally confounded with "matins."

LAU'MONITE. A variety of zeolite, named in honour of its discoverer, Gillet-Laumont. It crumbles when exposed to air in consequence of loss of water. It is a silicate of alumina and lime with 16 per cent. of water.

LAUNCH. The putting of a new vessel into the water. When the vessel is to be launched, a frame called *cradle* is built under her, thus: — At about one third of the extreme half breadth are laid, on each side of the keel and parallel to it, long pieces of timber, forming, as it were, two keels under the principal portion of the vessel. On these are placed vertical timbers meeting the ship's bottom, and maintained from slipping outwards by a strong plank or ribband. This apparatus, which is the cradle, rests on each side upon a platform sloping to the water; these platforms are called *the ways*, and are greased. The blocks on which the keel was laid being removed with the shores, the vessel rests on the cradle, which is kept from sliding down by a small piece or bar of wood fixed to it lying nearly horizontal, abutting against a place in the ways called the *dog shore*, which being struck downwards falls, and the vessel slides down into the water. When afloat, she is rolled from side to side by the persons on board to disengage the cradle.

Launch. A wide and flat boat, the largest carried by a man-of-war.

LAURA'CEÆ. (Laurus, one of the genera.) A natural order of arborescent Exogens, inhabiting the cooler parts of the tropics and some temperate countries. They are distinguished from all other incomplete apetalous Exogens, excepting *Atherospermaceæ*, by the peculiar dehiscence of the anthers, which open in consequence of the face of the valves rolling back; and from that order by the ovules being pendulous, not erect. The species are generally tonic and stimulant. Cinnamon and cassia are the produce of some, camphor of others, and the common sweet bay is a frequent instance of the order in the northern form. A few are so aromatic that their seeds have been used as substitutes for nutmegs.

LAU'REATE. (Lat. laureatus.) Literally crowned with laurels; applied at present to a well-known officer in the royal household. At the Certamina, or gymnastic and other contests celebrated under the Roman emperors, especially at the Quinquatria, or Feast of Minerva, poets also contended, and the prize was a crown of oak or olive leaves. But it was from some traditionary belief respecting the coronation of Virgil and Horace with laurel in the Capitol (of which, however, no record is extant) that the dignity of poet laureate was invented in the 14th century, and conferred on Petrarch at Rome by the senator or supreme magistrate of the city. It was intended to confer the same honour on Tasso, who, however, died on the night before the proposed celebration. In 1725 and 1776 it was granted to two celebrated improvisatori, the Signor Rufetti and the Signora Morelli, better known by the name of Corilla (*see* Improvisatori). In most European countries the sovereign has assumed the privilege of nominating a court poet with various titles. In France and Spain these have never been termed poets laureate; but the imperial poet, or Poeta Cesareo, in Germany, was invested with the laurel. This crown, however, was customarily given at the universities in the middle ages to such persons as took degrees in grammar and rhetoric, of which poetry formed a branch; whence, according to some authors, the term Baccalaureatus (quod vide) has been derived. In England traces of a stipendiary poet royal are found as early as Henry III., and of a poet laureate by that name under Edward IV. Skelton, under Hen. VII. and VIII., was created poet laureate by the universities of Oxford and Cambridge, and appears to have held the same dignity at court; but the academical and court honour were distinct until the extinction of the university custom; of which Henry VIII.'s reign exhibits the last instance.

Royal poets laureate are supposed not to have begun to write in English until after the Reformation. The office was made patent by Charles I., and the salary fixed at 100*l*. annually, and a tierce of Spanish Canary wine. Under Queen Anne it was placed in the control of the lord chamberlain. In the reign of George III. the annual tierce of wine was commuted for an increase of salary, and at the close of the same reign the custom of requiring annual odes from the lord chamberlain was discontinued.

LAURINE. A fatty matter of an acrid taste, contained to the amount of about 1 per cent. in the berries of the common laurel.

LA'VA. The substances which flow in a melted state from a volcano. They vary considerably in texture and composition. *See* Geology.

LAVER. (Lat. lavo, *to wash;* because washed by the waters of the ocean.) A species of *ulva* which is eaten as a delicacy.

LAW, in Latin *Lex;* derived from the verb *lego*, I collect or select.

Law, collective and particular. — We employ the term "law" to denote a body of rules, or all the rules applicable to a given subject; *e. g.* the Roman Law, the Law of Nature. We employ the term "a law" to denote an individual rule.

The idea of law, in its strictest sense, comprehends the notion of two parties; a superior imposing it, and an inferior obeying it.

Laws, improperly or metaphorically so called. — In common language it is usual to apply the word "law" to designate principles or properties which can only be thus named by analogy. Whenever certain causes invariably or generally produce like effects, this consequence of effect upon cause is popularly termed "a law." Thus we speak of the *law of nature* with reference to inanimate or irrational subjects; of the *law of gravitation*, by which bodies are mutually attracted to each other; of the *laws of motion*, of the *laws* which regulate certain processes in animal and vegetable economy, &c. In this sense, laws have been defined to mean "the necessary relations resulting from the nature of things." The analogy is nobly expounded in a well-known passage of *Hooker's Ecclesiastical Polity*, at the end of the first book.

Law defined. — Law, in its stricter sense, as applied to the voluntary actions of man, comprises the notion of a command issued by a superior imposing an obligation on a subject.

Laws, Divine and Human. — Laws are divided, according to the superior who imposes them, into divine and human: the law of God, and the law of man.

Divine Law. — The Author of our being has declared his will to mankind at various times, through the instrumentality of inspired prophets and teachers. There are also certain rules of right and wrong commonly received, which are generally supposed to have their origin in the nature of man, and to subsist independently of God's revealed will. Thus the term "divine" law signifies, 1. Revealed law; 2. Natural law.

Revealed Law. — God, as the Lawgiver of the Jewish nation, dictated to Moses a code of laws for that people, comprising both a confirmation of such laws as are

commonly considered natural by specific sanctions, and also various minute ceremonial and social observances. Thus the Jewish law is commonly said to consist of, 1. The moral law; 2. The ceremonial law; 3. The civil or political law.

Law of Christianity.— The second branch of revealed law is that which is declared to us in the New Testament.

Law of Nature. — The law of nature, however extensive in its philosophical meaning, is much more confined in that sense in which alone it is within the province of jurisprudence. Regarding it as merely applicable to the relative duties of men in a community, it is sufficient for practical purposes to observe, with Grotius, that its first principle is the sociability of man; and, consequently, that the conservation of society in its actual state, whether from the motive of mutual distrust, as Hobbes maintained, or from innate benevolence, as his adversaries contended, is the duty which it imposes on every one.

Let us suppose, therefore, that in a community such as our own there could occur at once a suspension of all civil positive law; and that, at the same time, the sanctions of God's revealed law could be withdrawn. Men would thus be restored to a state of natural liberty. The natural law is that code of duties which would then take the place of all other legislation. Every act tending to injure our neighbour in person and property, every act in any way tending to disturb or impair the frame of society, would then be prohibited by natural law, as it now is prohibited by laws human and divine. Undoubtedly the natural law, in the sense in which it is commonly used, comprehends a far wider range of objects. The duties of personal holiness, the relative duties of the members of a family, the duties of active benevolence; all these are dictated to us by conscience, as much as abstinence from positive injustice. But the province of jurisprudence is too limited to admit of the consideration of these higher parts of morality; it is with political society only that she is concerned.

Law of Nations.— The principle of natural law between individuals in a community would thus be the maintenance of the status quo, or actual condition of things, and the insuring to every one the continuance of all his possessions. This, therefore, is the elementary dogma of that only branch of natural law which can be said to exist as a definite rule of conduct; namely, the law of nations. Nations are in a state of natural liberty with reference to other nations. For, since they have no earthly superior to establish rules for them, and since the decrees of Christianity, addressed as they are directly to individuals, have been generally discarded in the practice of collective bodies, the only maxims which govern their intercourse are certain conventional arrangements, the object of which is the maintenance of the existing society and intercourse between the subjects of distinct sovereign states. All the rules of national law have this for their ultimate end. The natural law of men, to use the phrase of Hobbes, teaches the absolute duties subsisting between men and men; the natural law of nations, those subsisting between men in societies: or (in a compendious definition), national law is the law of nature applied to independent states as if they were individuals.

The law of nations, according to the comprehensive arrangement of Mackintosh, comprises "the principles of national independence, the intercourse of nations in peace, the privileges of ambassadors and inferior ministers, the commerce of private subjects, the grounds of just war, the mutual duties of belligerent and neutral powers, the limits of lawful hostility, the rights of conquest, the faith to be observed in warfare, the force of an armistice, of safe conducts and of passports, the nature and obligation of alliances, the means of negotiation, the authority and interpretation of treaties of peace."

But the law of nations, in its practical sense, widely differs from this extensive and philosophical compendium of international duties. Many of the maxims which relate to the subjects here enumerated belong rather to the the higher province of morality than to that of jurisprudence. The only punishment of which the sanction can be applied in this species of law is the hostility of other states towards that which violates it. Whoever, therefore, is powerful enough, whether from his own strength or from position and alliances, to defy such punishment, is, in a certain sense, above the law. Hence, although the law of nations, considered as a branch of that of nature, would lay down absolute rules of conduct in the highest as well as the lowest matters of policy within its reach, it may safely be said that the law of nations as a body of recognized right extends only to a portion, and that the least important, of these matters. The only maxims which can be said to subsist as laws are those which are never or rarely violated by European states; because the inconvenience of their general neglect would overbalance the particular inconvenience of adhering to them in a given instance. Thus all will acknowledge that there is a wide difference, in point of preciseness and obligation, between the principles which forbid unjust aggression or severity towards the conquered, and those which prescribe the privileges of ambassadors and the protection of peaceful aliens.

The subjects to which national law is most strictly confined are customary rules respected by the mutual consent of nations, rarely infringed by the voluntary act of a sovereign power, and of which the infringement is considered to require satisfaction and reparation.

It is to be observed, that although several of the maxims of national law (such, for example, as the sanctity of the persons of ambassadors) are usually held binding in transactions with all nations of the globe, yet the great bulk of its rules are only recognized and observed by the Christian states of Europe and America in their dealings with each other.

National law (from its defective sanction and want of a sovereign legislator as to its details) may, perhaps, be more properly termed the custom than the law of nations.

The reduction of the law of nations to a system was first made by Grotius, in a work which, as Sir J. Mackintosh has well observed, though we now indeed justly deem it imperfect, is perhaps the most complete that the world has yet owed, at so early a stage in the progress of any science, to the genius and learning of one man. To him succeeded Puffendorf; who, avoiding the inconvenient and unscientific method of Grotius, has, to use the words of the statesman already quoted, without the genius of his master, and with very inferior learning, yet treated the subject with sound sense, with clear method, with extensive and accurate knowledge, and with a copiousness of a detail sometimes indeed tedious, but always instructive and satisfactory. But, in addition to the works of these illustrious authors, the rules of national law are to be found, first, in the treatises of several other authors, who are usually regarded as authorities; of whom Bynkerschoek (*Opera Omnia*, fol. Lug. Bat. 1767; Engl. Trans., fol. 1749), Vattel, Wicquefort, Rutherforth (*Institutes*, 1779), Von Martens, and others, may be cited: secondly, in the treaties which have been at different times concluded between European states; especially those of Westphalia, 1648; Utrecht, 1713; Aix-la-Chapelle, 1748; Paris, 1763; and Vienna, 1814. A pretty complete summary of the bibliography of this subject will be found in the introductory chapter of Mr. Manning's work on the *Law of Nations* (1839). (See also Dr. Wheaton, on *International Law*, 2 vols. 8vo. Lond. 1836.)

The language of conventions and treaties has frequently given occasion to disputes. Subsequently to the revival of letters, and until the peace of Nimeguen (1679), the state language ordinarily used was the Latin; but since that period it has chiefly given way to the French, which is now commonly used between nations employing different languages in their public acts.

Law, Positive or Municipal. — This is the term usually employed to distinguish law, in its ordinary sense (the expression of the will of the supreme power in a state), from all the other species of law (improperly so called) with which we have hitherto been occupied. It is called *positive* law, because established in the form of direct and definite injunctions; *municipal*, from the Latin *municipium*, a town possessed of privileges and local laws.

Positive law is "a rule of civil conduct prescribed by the supreme power in a state." Blackstone adds, "commanding what is right, and prohibiting what is wrong." But as it is clear that the right commanded and the wrong prohibited acquire the character of right and wrong only from being so commanded and prohibited, the latter half of the definition is evidently comprehended in the first. A regulation or body of regulations, usually adhered to by men in their dealings with each other, but not commanded by the civil power nor enforced by lawful punishment, is properly called a custom; but when such regulations, whether set by men to each other on a footing of equality, or by subordinate bodies within the state to individuals, can be enforced by lawful punishment, the sovereign power allowing such punishment, the sovereign power thereby adopts the regulations, and they become laws in the strictest sense of the word.

A law is also defined, "a command of a political superior obliging the subject to a particular course of conduct." This definition comprehends most of the civil institutions with which jurisprudence is concerned; but it appears to exclude some which are nevertheless within the province of that science. For example,—

1. Many laws are enacted to explain former laws, and also to repeal former laws. Neither of these can be said, in strictness, to answer the definition of law which describes it as a command, unless we consider them as re-enacting former commands. 2. The Roman jurists applied the term "laws of imperfect obligation" to certain enactments of their law prescribing particular conduct, but without any penalty being expressed in the event of their violation. These were not commands, not being enforced, and could not be said to oblige the subject, who was at liberty to escape the obligation. Our laws recog-

nize no such rules as these. If a statute enjoins or prohibits an action without adding any express penalty, the courts of justice *presume* that a violation of the statute is punishable. Law, as the subject matter of jurisprudence, is that which obliges the subject to a particular *course* of conduct by *general* rules of action. This excludes —

1. Laws made to permit or restrain the acts of specified individuals. Such were called by the Romans *privilegia*, or, under the emperors, private rescripts; in our law, *private acts of parliament*. The sovereign body in the state, having the power to repeal and modify its own enactments, can by an expression of its will exempt particular persons from its own injunctions, or can impose new duties on particular persons. Such decrees have all the force of law; but they do not form a part of the general law of the country.

2. Laws made to suit a particular emergency, occasional or particular commands, which are distinguished from general laws by their *shorter duration*. To exemplify this difference, it has been said that should a sovereign command all his subjects to wear black as their ordinary dress, such a command would be a law; but should he order a general mourning for a stated time, such an order would not have sufficient permanence to entitle it to that appellation.

Every command given by a political superior is a law in point of force; but it is necessary to establish some distinction between occasional and general commands, as otherwise every direction of a public officer, every incidental command of a military superior must be considered as a law. An act to suspend the collection of a duty for a given time, an order in council to admit bonded goods or to issue any temporary regulations respecting trade and commerce, royal proclamations; all these are familiar instances of the species of occasional or particular commands.

Municipal law is commonly divided into two branches; that which concerns the public duties of individuals with reference to the state, and that which concerns the private relations of individuals towards each other. The division between these branches is not in all systems the same. Under the old Germanic institutions, for example, most crimes were considered as civil injuries only.

Laws, strictly so called, and forming the body of public right in each separate state, are to be found either in codes sanctioned by the authority of the state; or in decrees issued and made public by such authority; or, finally, in certain unwritten customs, to which that authority, by sanctioning them, has given the force of law.

The code of law, under all Mohammedan governments, is to be found wholly or in part in the Koran, which to Mohammedans bears the character both of revealed and civil law. Those of the Hindoos and many other nations have likewise the authority of an imaginary religious sanction.

In Western Europe the laws in force in most of its countries, although modified and republished by their several legislatures, are in great measure founded on what is termed the Roman law. This body of law is principally declared in the *Pandects*, *Code*, and *Institutes* of the Emperor Justinian; but these contain only a digest of a small portion of the laws which prevailed in the ancient Roman empire.

The Roman Law. — "Inasmuch," to use the words of our own learned judge Lord Holt, "as the laws of all nations are doubtless raised out of the civil law, as all governments are sprung from the ruins of the Roman empire, it must be owned that the principles of our law are borrowed from the civil law, therefore grounded upon the same reason in many things." — The manner in which the Roman law has been introduced into the jurisprudence of modern Europe may be said to have been twofold: first, through the prevalence of Roman usages, derived from the times of the empire, among the population of various countries, especially that part of it which was collected in towns; secondly, through the efforts of the ecclesiastics, who learnt the civil law from the *Codex* of Theodosius, and from the works of Justinian, and introduced it, as far as their authority extended, into such branches of justice as they were permitted to administer, and especially into their canon law, which the various princes of Europe permitted to be binding, to a different extent in different countries, upon their lay as well as clerical subjects. Thus the Roman law is in one sense the oldest and fundamental part of public right in many countries; in another sense, it is a comparatively recent importation, altering the character of their respective legislations. The Roman law comprises what are termed the *Institutes*, *Pandects*, *Code*, and *Novellæ*. (See these terms.) These have been collected and separately published, under the title of *Corpus Juris Civilis;* the best editions being those of Amsterdam (8vo. 1664) for the text, and of Gothofred (folio, Paris 1628) for the text and notes. The most elaborate modern work on the history of the Roman law is that of Savigny.

It would be impossible, within our limits, to give the reader any useful bibliographical notice on a subject which in foreign countries has necessarily received such abundant attention and illustration; and English treatise writers on the civil law are few, and of no great value, that law having only existed among ourselves, as we have seen, in certain limited departments.

Civil Law in England. — In England, while in the way of ancient custom there are fewer vestiges of the civil law than in any other of the provinces of ancient Rome, yet in the way of ecclesiastical jurisdiction it has been wider spread and continued longer in force than almost any where else.

Although Britain was a highly civilized province possessing 140 cities and towns in the time of the Romans, yet the numbers and violence of her invaders, especially the Saxons and the Danes, appear to have extinguished almost every relic of her provincial customs and jurisprudence. It is chiefly, therefore, to the clergy that we are to look for the prevalence of the civil law in England, and it has been introduced by them in several ways.

1. At the Norman invasion a considerable accession to the numbers and influence of the spiritual body in England took place. A century afterwards the discovery of the *Pandects* rendered the study of jurisprudence familiar chiefly among that body, who monopolized most of the learning and intelligence of the age. They introduced it into England; and, as the rude and simple justice of the Saxons was inadequate to meet the wants of the people, most of the early lawyers, who were themselves chiefly ecclesiastics, sought in the pages of their favourite works for principles to supply the defects as they arose. Hence, in the works of Bracton, Britton, and Fleta (written expressly on the common law of England, that is, the customary law of the Saxons modified by extensive introduction of Norman usages), we find constant reference not only in spirit but in words to the civil. The time during which the study of this latter was most in vogue among English lawyers appears to have been between the reigns of Stephen and Edward III. During the greater part of that period a constant struggle was carried on between the ecclesiastical lawyers, supported in many cases by the crown, and the popular party in favour of the old customary right, which was defended by the temporal nobility. The final victory of the common law, and its establishment as the rule of the land, except in particular cases, may be dated from the reign of Edward I.

2. The jurisdiction of the lord chancellor of England is a subject considered elsewhere. (*See* CHANCERY.) It is sufficient here to observe, that as most of the chancellors under the Plantagenet kings were ecclesiastics, and as the matters entrusted to their decision were such as the rules of the common law did not apply to, they generally searched for precedents in that of Rome; which has hence been largely imported into one great branch of modern English law, namely, Equity.

3. In some particular matters the rules of the civil law have always been allowed by custom to prevail in England. These are, such as were taken cognizance of by the courts of honour and chivalry, now fallen into disuse; in the High Court of Admiralty (*see* ADMIRALTY); and in the courts of the two Universities, which originally were ecclesiastical bodies.

4. The chief influence of the civil law in England has been through the canon law, which was founded upon it.

Law, Canon. — The rules which were framed by the Christian church for its own spiritual polity may be supposed to have had their origin in the very earliest periods of Christianity itself; but all the authority and force which they possessed could arise only from the mutual consent of the faithful to be bound by them, until the establishment of Christianity as a state religion entirely altered the character of its spiritual constitution. The temporal jurisdiction which was then too liberally conceded to the bishops, together with the legal force given by several emperors, Justinian in particular, to the canons of councils, gradually called into existence a new and independent body of legislation.

When the Western Empire had been overthrown, the authority of the popes, as temporal governors, was by degrees confirmed in the city of Rome and the adjacent country. At the same time the power of the ecclesiastical body was increased and extended in other countries; and the reverence attached to their authority gave to the spiritual censures with which they visited particular offences a greater force than to the sanctions of the national law. Thus, besides matters of church government, which were at first the particular subject of the pontifical law, it comprehended within its purview numerous and important branches of the civil law of persons and property.

About the year 1150, the various edicts then in force of the several popes, together with the canons of councils, and the authoritative declarations of fathers and doctors of the church, were collected together by the Monk Gratian, and reduced into a volume called the *Decretum*, and considered as the earliest authority in canon law.

In the next century, Pope Gregory IX. published five books of Decretals, collected from the Decretal Epistles of the Popes: to which Boniface VIII. added a sixth book, about the end of the same century. To these were added, at subsequent periods, the Clementine Constitutions, a seventh Book of Decretals, and a Book of Institutes. The whole of these authorities were collated and published by Gregory XIII. in 1580, under the title of *Corpus Juris Canonici*.

In matters of evidence, and as far as practicable in the forms of proceeding, the compilers of the canon law founded their system upon that of Rome, with which they were best acquainted. In all such matters of civil jurisdiction as their legislation embraced, they likewise assumed it as the basis of their structure. By the practice of all ecclesiastical courts the civil law is allowed to come in aid of and to supply the canon law, in all such cases as are there omitted. The subjects of the canon law were, 1. The hierarchy and government of the church; 2. All things relating to pious uses; 3. The wills of defuncts, the guardianship of orphans, and matters of marriage and divorce. But it was by no means permanently received, in most European countries, to its full extent. Its jurisdiction only subsisted by the toleration of princes; and therefore varied, according as the superstition or piety of these sovereigns, or their jealousy of ecclesiastical usurpation, alternately predominated. But, upon the whole, its authority became so deeply rooted, that even in countries which have rejected in later times the authority of the pope its rules are still referred to, not merely in matters relating to church benefices, but also in some cases of purely civil jurisdiction.

Nevertheless, although in early times its authority was asserted by the popes on the ground of their temporal superiority over all earthly sovereigns, its force in every country must now be said to depend upon the will of the state, which gives the force of law to its provisions.

It is supposed that the decrees and canons of the church of Rome were adopted in this country so early as A. D. 605, shortly after the introduction of Christianity among the Saxons; but they were not fully recognized by the state until after the Norman conquest. The bishops, who had in Saxon times sate with the sheriffs and landed proprietors in the county courts, then withdrew from participation with the execution in civil government. From that period the power of the bishops made rapid strides, insomuch that they have succeeded in retaining many branches of jurisdiction of which in other countries the temporal power has deprived them. In addition to the general canon law, we have in England a particular provincial law—the *constitutions* of the papal legates and councils of this country in 1237 and 1269; and a farther body of constitutions, framed in provincial synods under the authority of successive archbishops of Canterbury, from Stephen Langton in 1222 to Archbishop Chichele in 1414, and adopted subsequently by the province of York. These constitutions have been illustrated by the commentaries of distinguished ecclesiastics, and principally those of Lyndwood, who flourished in the reigns of Henry V. and VI. The canons of the Protestant church passed in the Convocation of A. D. 1603, although ratified by King James I. for himself and his successors, yet do not (as Lord Mansfield finally decided) bind the laity, except so far as they declare the older provisions of the law. The most standard work on English Ecclesiastical Law is *Gibson's Codex Juris Anglicani*. The best guides for the student are the treatise of Dr. Burn, and the recent one of Mr. Rogers (1840).

Law of England, Common Law.—This expression is used in two different senses, according to the subject under consideration. We speak of the common law in contradistinction to the civil law, or to equity; meaning a certain portion of our laws relating to a definite subject matter, and administered in courts following particular rules of evidence and modes of procedure. We also, by the common law, sometimes mean the unwritten or ancient customary law: in this sense it is opposed to the statute law, which is of positive enactment.

The constitution and laws of our Anglo-Saxon ancestors have been the subject of innumerable theories and contradictory systems, since the ingenuity of modern times has been applied to their investigation; but all the efforts of the learned have gone no farther than to establish the existence of a few principles and customs common, for the most part, to the Germanic tribes in general. The leaders of the Saxons emulated each other in assuming the kingly dignity in every district of the island, and endeavoured, as far as the independent spirit of their followers would allow, to adopt the imperial style and legislative powers which the British kings had derived from the provincial tyrants of the empire, and these from the Cæsars. The vanquished population lost its language and rights, and became bond to the invaders. These divided the land among them as partitioners equal in rights, on the system called *allodial*, or granted *benefices* to their dependents; and hence arose the principles of feudality. But for centuries England was one battle field, between the several clans of Saxons who had usurped her dominion: Mercia, Wessex, and Northumberland were divided in law and custom scarce less than in government; and when the island had at last fallen under the dominion of a prevailing Saxon dynasty, the invasion of the Danes again mixed and adulterated her blood and her institutions. Edward the Confessor reduced the customs of the country into something resembling a system of law; and although his enactments are lost, it is to his reign that we must look for the most authentic form of Saxon polity. The king was guided and controlled in his deliberations by the witan, or chief men, assembled in the gemote, or meeting; but their relative power and that of the sovereign varied according to the strength or weakness of the latter. The body of landholders held their lands by an independent tenure, which custom rather than law had rendered hereditary; but there were many who held benefices or enjoyed land under personal grants from the king, or from the great earls, who had succeeded the aldermen of the early Saxon times, or from the thanes or inferior nobility. Great part of the land was cultivated in common by the people of hamlets and tythings. Justice was administered in the county courts, where the *good men* or land owners assembled, and the bishop and sheriff presided. Questions of property were decided by ordeal, or by a tribunal of sworn witnesses. In criminal as well as civil cases the defendant sometimes freed himself by the oath of compurgators, or wager of law, as it was called when adopted by the Normans. The inhabitants of every district were mutual guarantees, by the custom of frankpledge, which was founded on two principles: the one, the liability of the lord or superior for the appearance of his vassals; the other, the collective responsibility of the tything, or hundred, for all its individual members: which was not prevalent in all England, and entirely unknown in the northern shires.

By the Norman conquest, and the division of the better portion of England between Norman proprietors holding in chief of the crown, the feudal system of law, as regarded land and its incidents, was early introduced into the country. Other portions of Norman jurisprudence were imported at a later period, through the medium of the king's courts; which, being at first confined in jurisdiction to the domains of the crown, gradually supplanted the old Saxon courts, although these long continued to be governed by their national law.

The three great institutions in which English law differs from that of other countries—the parliament; the system of tenures and their incidents, on which the law of real property is founded; and the trial by jury—may perhaps be said to have been founded on Norman jurisprudence, but to have become prevalent through their analogy to Saxon institutions. *See* PARLIAMENT.

The first consequence of the invasion of the Normans was, that different modes of trial were prevalent, according to the nation to which the contending parties belonged. Compurgation, or "wager of law," was the common mode of decision between Englishmen. In criminal cases, it was usually by the oath of eleven compurgators chosen out of an array of fourteen. In civil suits, the amount of the compurgation required seems to have been regulated by the value of the property claimed. To this peculiarly English mode of trial was added the *wager of battle*, which is first named in the laws of the Conqueror, but which either French or English and French might use. *Inquest of witnesses* was a Norman mode of trial in civil cases, by which witnesses were summoned from the neighbourhood in which the quarrel arose to declare on their oath the truth concerning the matter in question. Finally, the ancient proof of *ordeal* subsisted in criminal cases.

This diversity in the modes of trial was accompanied by a diversity of judicature. The ancient county courts received one blow by the withdrawal of the bishops, who ceased to preside in them, becoming chiefly foreigners, and who gradually established, as before shown, a separate jurisdiction of their own. A still more important wound, in its consequences, was inflicted by the increasing power and influence of the king's courts, at first only confined to causes arising within the royal demesne; in which the Norman law and modes of procedure were adopted, and in which the machine of our own common law was gradually elaborated by judicial ingenuity during successive centuries.

Henry the Second is commonly regarded as the founder of the common law. His principal contribution towards it consisted in his ordinance of the grand assize; justices in eyre, or circuit justices of the king's courts, being appointed to try causes by inquest of twenty-four witnesses, at the option of the tenant or demandant, if either party preferred to purchase this mode of trial instead of the ordinary trial by battle. Shortly after his reign the Fourth Council of Lateran, by abolishing the ordeal (A. D. 1215), gave a new impulse to the development of the jury system. Criminal cases were now tried by a jury of witnesses de vicineto; and the process by which these witnesses, both in civil and criminal cases, became con-

verted into sworn judges of the fact, has never been distinctly traced; but the intermediate steps had certainly all been passed before the reign of Edward III., possibly before the death of the first monarch of that name.

If Henry the Second was the founder, Edward I. may almost be regarded as the completer of the common law. From his time to the present no change has taken place in its general principles: all that subsequent reforms have effected has been to accommodate those principles to altered circumstances. And long may the spirit of these institutions remain unchanged amidst the march of improvement; — holding together, as they now do, the mightiest commercial community of the globe, with no less beneficial authority than they exercised six hundred years ago over the barons, peasants, and burghers of a small feudal monarchy!

The system of real property may be said to have been fixed by the statute *Quia Emptores*, 18 Edw. I. Before that time we may consider the lands of England as having been subject, in general, to the unrestricted feudal law. All land was held, mediately or immediately, of the king. The two classes of free proprietors were those who held by the military service (of Norman introduction), and those who held by the old Saxon custom. their property in their lands being retained by them, subject only to acknowledgment or fealty to the sovereign, — a less honourable, but probably a less burdensome tenure. But either of these tenants might, in his turn, create fresh tenants under him, yielding the same homage to him which he yielded to the sovereign. Below these, the only two classes of tenants recognized by the law were those who held of the king, or mesne lords, by pure villenage, or absolute and base service; and by villein socage, which was also a base service, but restricted to certain specified duties. From the tenure of pure villenage have sprung our present copyhold tenures; by which certain lands are held within *manors* (which are the old estates held in early times directly of the king) by the *will of the lord*, as it is expressed in their grant, although by long usage the will of the lord is merely nominal, and the obligations of the tenant consist only in certain specified rents and services.

The object of the statute *Quia Emptores* was to restrain the creation of fresh subordinate estates, by declaring that if any one alienated his land by sale or feoffment (which purported to convey it in perpetuity) the feoffee should hold the same, not of the feoffor, but of the feoffor's lord, whether a mesne lord or the king himself. Hence all manors must have existed prior to the reign of Edward the First; as it is essential that there should be in them tenants who hold of the lord, and such tenancies could not have been created at a later period.

When alienation of lands and tenements was made in early Norman times, the alienation was either to the donee and his heirs for ever — thus giving him an absolute unrestricted property, descendible to his heirs, whether male or female, subject only to his homage to the donor; in other words, a *fee-simple;* or it was upon condition — as, for instance, a grant to a donee, provided he had issue; under which grant, if the donee died without issue, or his issue came to fail, the land would revert to the donor. The conditional donees had devised, with the assistance of the king's judges, various ingenious methods of defeating these provisions; as by aliening as soon as they had issue, and then repurchasing the fee-simple. It was to fix the law of conditional gifts that the statute *De Donis*, 13 Edw. I., was passed; by which such a donee was absolutely prevented from aliening the tenements. Hence arose *estates in fee-tail:* in other words, estates granted to a man and to certain specified heirs; for example, the heirs male of his body. In after times, when the restraint on alienation which this statute created began to be repugnant to the more liberal feelings of the people, certain devices were invented (fines and recoveries), whereby the donee in tail was enabled to bar the entail and acquire the fee-simple, as he could have done before this statute was passed.

Besides these famous statutes, we find the reign of Edward I. distinguished by the confirmation of Magna Charta and the Charter of Forests. The first of these great constitutional acts contains few provisions of much importance in legal history, and was far more valuable as an evidence of the spirit of the country in restraining arbitrary usurpations, than, as is commonly supposed, by establishing any new franchises, or even confirming ancient ones. Perhaps its most important legal effect was the fixing to the city of Westminster the court of Common Pleas, which had formerly caused the suitors much inconvenience by following the person of the king in his numerous progresses.

It is also to Edward the First's reign that we must refer for the distinct definition of the province of that court, and of the other two superior common law courts of record, the King's Bench and Exchequer. The history of these three courts is far too intricate, and requires too much explanatory statement, to find a place in these pages. It must suffice to observe, that the King's Bench is the ancient Aula Regia, in which the king was supposed, as by fiction of law he still is, to sit in person, and which followed him in all his progresses, insomuch that in the reign of Edward I. it actually sate in Scotland. Its jurisdiction consequently extends to all matters which are of the king's prerogative: it took cognizance of criminal causes on the crown side, and of civil causes; at first those in the result of which the king was interested, and by a fiction all personal actions whatever. It was likewise a court of appeal from all inferior courts of records. The court of Common Pleas, or Common Bench, had in strictness jurisdiction in all civil causes between subject and subject. In this court only real actions, in which the right to land is tried—now nearly fallen into disuse (*see* PLEADING), but anciently the most important part of judicial business—could be adjudicated. The court of Exchequer was intended to recover the king's debts, and ordinary revenues of the crown. It acquired in process of time a jurisdiction over common personal actions, by the fiction of the complaining party being a debtor to the king; and also an equitable jurisdiction, similar in form to that of the chancellor's court.

The equitable jurisdiction of the chancellor had probably commenced long before the reign of Edward I. (*see* CHANCERY), and before his reign the original writs, by which actions were commenced, had been sued out or obtained in the chancery; the clerks of which, like the pontifical framers of the *actiones* among the Romans, had the monopoly of drawing up these magical instruments. In the reign of Edward I. (by *Statute of Westminster the Second*, 13 Edw. I.) an important change was made in this branch of law, by authorizing the clerks to frame writs adapted to particular cases which the old forms did not adequately suit. Hence originate our modern actions of *trespass on the case*. *See* PLEADING.

From the same statute the modern judges of *assize* and *nisi prius* (*see* NISI PRIUS) are chiefly derived. These were originally occasional commissioners, sent down into the counties to deliver the gaol of prisoners, or to try civil causes. By this statute the commission was first directed to be given to the king's justices, associated (as they still are in form) with one or two discreet knights of the county. The commission of assize is, strictly speaking, a commission to try disputes respecting land wherein the writ of assize (which dates, as before stated, from Henry II.) was brought, — now fallen into disuse. The commission of *nisi prius* originates in what may now be called a legal fiction. When the pleadings in an action in the superior courts (*see* PLEADING) are concluded, and an *issue of fact* is taken between the parties, the issue is appointed, by the entry on the *record* or written proceedings, to be tried by a jury from the county in which the proceedings arise at Westminster, *unless before* the day appointed (*nisi prius*) the judges shall have come to the county in question. Besides these commissions, the same judges try criminal cases by virtue of a *commission of the peace*, in which they are associated with the justices of the county; a commission of *oyer and terminer*, to hear and determine all treasons, felonies, and misdemeanors; and a commission of general gaol delivery, to try and deliver every prisoner who shall be in the gaol at their arrival in the county.

Having referred to the reign of Edward I. as the period under which a general sketch of our old common law might be most advantageously presented, we proceed to notice very briefly the chief alterations which mark its subsequent history. These alterations can be easily ascertained where they were caused by the highest legal authority, — by the parliament of the nation. But far greater changes have been wrought by the silent course of the tribunals, — by the discretionary power which our judges have assumed to extend the remedies, which they were authorized to administer, to cases unprovided for by earlier law, which either the ingenuity of practitioners, or, in many more instances, the increasing wants and more intricate relations of life had called into existence. To trace such alterations is as impossible as to note, day by day, the increase of stature by which the child grows into the man. Often, in laboriously investigating the history of our English jurisprudence, we are surprised when we look back, after perusing the events of a generation or a century, to the state of things as it existed at the beginning of that epoch, and find that although we cannot with all our diligence detect in its history the occurrence of any external changes in the subject on which our minds are fixed, yet the same forms, the same modes and circumstances, present themselves to our eyes under a totally different aspect and character.

The reigns of Henry II. and III. are principally remarkable for the gradual substitution of the king's justices of the peace for the various elective magistrates who exercised the several duties of that office before. It was in the reign of the latter prince also that the parliament is supposed to have finally acquired its present form. Under the successors of the Edwards, and during the wars of the fifteenth century, small accessions were made to the general bulk of English law; but during those

times very great changes were silently taking place in the disposition of property by means of the invention of Uses, borrowed from the civil law. This extensive and most important subject will be found briefly treated of under the head of CHANCERY.

The laws of Henry VII. had principally in view the benefit of his exchequer; and hence various more compendious modes of enforcing justice against delinquents who might be liable to fine date from his reign: methods which in unjust times were oppressive and arbitrary, although now useful instruments in the hands of justice. Such was the proceeding by information, instead of indictment, in various cases on behalf of the crown. The Statue of Fines, passed in this reign, confirmed and extended a mode already in use of barring entails. Under his successor, whose reign forms so important an epoch in political history, the laws of property were very considerably modified by the two statutes of Uses and of Wills. (For the former, *see* CHANCERY.) The latter rendered general the power of devising estates by will. The system of bankrupt laws also had its commencement under Henry VIII. His daughter Elizabeth did not add much to the essential and valuable parts of our statute book; but under her government the acts which restrained the alienation of lands by ecclesiastical bodies were passed, and also the celebrated statute respecting the poor, of which the policy forms, even at the present day, a subject of such ardent controversy. In the succeeding century, the reign of James I. witnessed the first attempt to limit the period at which actions and suits might be commenced; and the first statute of bankruptcy. But it is most remarkable for the laborious attempt to systematize our ancient law by Sir E. Coke, one of the most acute, if not philosophical jurists of any age or country. That of Charles II. forms the next marked epoch in the history of our law, after those of Edward I. and Henry VIII. His restoration was distinguished by the abolition of feudal tenures and incidents, and the reduction of all the modes by which estates of inheritance might be held (with few exceptions) to two only,—freehold and copyhold. The Statute of Frauds, a necessary protection perhaps to unwary transactors of business, but a source of endless litigation; the statute which regulates the distribution of the effects of intestates; and finally, the celebrated Habeas Corpus Act, which gave, or rather confirmed, to every person imprisoned by any authority short of the express and definite course of justice, the means of releasing himself,—are all productions of this reign.

The eighteenth century, while it gave rise to new views and widely extended discussions on jurisprudence, did not in England produce much substantial alteration by statutory enactment. It was rather a period of preparation for change, in the political as well as the legal world, than of actual reform. But it was distinguished by the learning and acuteness of several judges who occupied the seats of justice during many years, and introduced by the slow exertion of their own authority a new spirit into institutions of which the forms were preserved.

Recent years have introduced some material changes, of which the effect has not yet been fully tried. Lord Ellenborough and Lord Eldon had pursued the work of maintaining and embellishing the old institutions; succeeding judges have at last assumed in some degree the character of reformers. Sir Robert Peel's criminal statutes conferred a great benefit on the country, by removing many of the technical difficulties incident to this branch of law, although they did not materially affect its spirit; which, in the article of capital punishments, has been gradually moderated by a succession of enactments, from the beginning of the reign of George III. until that of our present sovereign. Many of the artificial distinctions, grounded on obsolete reasons, which subsisted between the practice of the different common law courts have been removed. The system of pleading (see that article) has been very materially changed. And in consequence of the general feeling in favour of local courts of justice to administer redress in trifling disputes between parties at a distance from London, some extension has been given to the authority of the sheriff's court, and some local tribunals have been constituted. Lastly, the ancient usage of imprisonment on mesne process has been abolished, and much additional power given in lieu of it to the Insolvent Court over the property of debtors.

The term Common Law is ordinarily employed in two different senses. In its legal signification it expresses the old unwritten law, established by precedent and custom; comprising, it has been said, " all recognized doctrines and customs, however introduced, which are neither to be found in the statute book, nor depend on the adjudication of courts of equity. For this floating mass of legal principles our ordinary sources are precedents, or decisions of common law judges, as contained in published reports. Where these fail us, reference may sometimes be had to more uncertain guides, the dicta of legal writers, or the general principle and tendency of our laws, for authority in deciding a particular dispute.

In its popular sense, common law is opposed to equity and ecclesiastical law; and thus comprises the whole of that law, both criminal and civil, which is administered in courts having trial by jury, and all the other subjects which are within the purview of the common law courts of Westminster Hall, and of the various local jurisdictions of the country (except so far as some of them exercise equitable authority). It has been defined " the whole of that code, whether founded on statute, usage, or precedent, which is now administered in the common law courts of Westminster Hall;" and this definition will comprehend the law administered in the various local courts in question, as these are bound to act on the decisions of the superior courts. Its peculiar characteristic is, that questions of fact arising out of its proceedings are submitted to the decision of a jury.

It is, perhaps, not very easy to assign either the history or the theoretical principles of the separation of equity from common law. The former was undoubtedly in the first instance a jurisdiction of a remedial character, intended to moderate, according to the conscience of the judge, the rigour of legal judgments; but this is a peculiarity which can scarcely be said to distinguish it in the present day. Its rules are as accurately laid down by precedents as those of the common law itself; but there are some subjects (as, trusts) which, having been created in frustration of the provisions of the common law, are out of its cognizance. Over these courts of equity have an *exclusive* jurisdiction. There are others over which both equity and law have *concurrent* jurisdiction. But the remedies applied by law to injuries committed are subject to certain inflexible rules. The power of a jury has limits from the very nature of the institution. It can award a debt sought to be recovered, or damages for an injury; but it cannot modify the remedy according to peculiar circumstances. Nor has it any means to enforce a course of action other than by imposing damages for neglecting it. To take a familiar instance:—If A. sues B. at law for breach of covenant, and judgment passes in favour of A., all that a jury can do is to award damages to A. for the breach of contract; but equity can, by a process of its own, compel B. to a specific performance of the contract under the penalties attached to a contempt of court. So, if one of several joint contractors be liable, at law, for penalties or debts incurred in respect of their joint undertaking, his only legal remedy is by an action against each; in equity, he can compel each of his partners to contribute to the extent of their liability.

LAW, MARITIME. *See* MARITIME LAW.

LAW, MARTIAL, is proclaimed by authority of parliament, on an emergency of rebellion, invasion, and insurrection. It is properly the putting under the cognizance of courts martial a great variety of subjects which by ordinary military law do not appertain to them, to be tried in a summary way. Where martial law is proclaimed all military persons, under all circumstances, are placed within its jurisdiction: even their debts are subject to inquiry before a military tribunal. It extends also to a variety of cases not relating to the discipline of the army, and offences committed by non-military persons, as plots against the sovereign, intelligence to the enemy, &c. The statute for putting into execution martial law usually gives a power to arrest and detain in custody all suspected persons, and to cause them to be brought to trial in a summary manner by courts martial, and to execute the sentence of all such courts, whether of death or otherwise; and declares, that no act done in consequence of these powers shall be questioned in any of the king's ordinary courts of law, and that all who act under the statute shall be responsible for their conduct only to such courts martial.

LAW, MILITARY, is properly that law which is administered by courts martial, under the authority of parliament and the Mutiny Act, annually passed, together with the Articles of Law. *See* COURTS MARTIAL.

LAWN. (Fr. linon.) A fine variety of cambric, formerly exclusively manufactured in Flanders. Of late the lawn manufacture of Scotland and of the north of Ireland has been brought to rival that of the Flemish weavers.

LAWN. In Gardening, a surface of grass or turf in pleasure grounds kept smoothly mown.

LA'XATIVE (Lat. laxare, *to loosen*), a gentle aperient medicine: opposed to *cathartics*, which are drastic purgatives.

LAY. (Probably the same word with the German lied, *song*.) The lyric poems of the old French minstrels, or trouvères, were termed lais; but the title appears, in modern usage, to be peculiarly appropriate to narrative poems, or serious subjects of moderate length in simple style and light metre.

LAY. In Agriculture. *See* LEA.

LAY BROTHERS. Persons received into convents of monks, under the three vows, but not in holy orders. The introduction of this class of devotees appears to have begun in the 11th century. They are dressed somewhat differently from the other monks or *brothers of the choir*, and often employed in the manual exercises necessary for

the uses of the community. The Carthusian and Cistercian orders are said to have first recognized the distinction, and their example was followed by the other orders. The same distinction exists in monasteries of females between the nuns properly so called and the lay-sisters, or sisters converse.

LAY ELDERS. In Presbyterian churches, ministers of ecclesiastical jurisdiction, not ordained as clergymen, who assist the pastor in each congregation. (*See* PRESBYTERIANS, KIRK.) The divines of that persuasion rest the appointment of lay elders in some measure on that of presbyters "in every city," by Paul and Barnabas, who, they imagine, from the manner in which they are mentioned, could not have been all preachers. (See *Hooker, Eccl. Pol.* b. vi.)

LAYERS. In Gardening, a mode of propagating plants by laying down shoots, and covering a portion of them with soil, so that the extremity of the shoot is left above ground, and the shoot itself not detached from the plant. In order to facilitate the rooting of such layers, the portion of the shoot buried in the soil is fractured by twisting or bruising, or cut with a knife immediately under a bud. This operation, by obstructing the return of the sap from the leaves, occasions its accumulation at the wounded part, when roots are there produced from the effort of nature to perpetuate life.

LAY'ING. In Architecture, the first coat on lath of plasterer's two-coat work, the surface whereof is roughed by sweeping it with a broom; the difference between laying and *rendering* being that the latter is the first coat upon brick.

LAYMAN. (Gr. λαϊκος; from λαος, *people*.) The appellation by which the rest of the community are distinguished from the clergy. (*See* LAITY.)—*Layman*, or *lay-figure*, among painters, signifies a small statue, whose joints are so formed that it may be put into any attitude for the purpose of adjusting the drapery of figures.

LA'ZAR-HOUSE, or LAZARETTO. (Ital.) A public building in the southern European states, of the nature of an hospital, for the reception of the poor and and those afflicted with contagious disorders. In some places lazarettos are set apart for the performance of quarantine; in which case only those are admitted who have arrived from countries infested by the plague, or suspected of being so. Howard's well-known account of the principal lazarettos of Europe furnishes the most detailed and interesting particulars of these establishments, and to it we refer the reader for full information.

LA'ZARISTS. In Ecclesiastical History, a body of missionaries founded by St. Vincent de Paule in 1632; so termed from occupying the priory of St. Lazarus, at Paris, as their head quarters. Their primary object was to dispense religious instruction and assistance among the poorer inhabitants of the rural districts of France. They were dispersed at the time of the Revolution, but have since re-established a congregation at Paris; and the French government has lately projected entrusting them with the spiritual care of the colony at Algiers.

LA'ZARUS, SAINT, ORDER OF. A military order of religious persons, originally an association of knights, for the purpose of maintaining lepers, &c. in lazar-houses or hospitals, especially in the Holy Land. Being driven out of Palestine in 1253, they followed St. Louis to France. In 1490, their order was suppressed by Pope Innocent VIII., and united with that of St. John; but the bull was not universally received. In 1572, they were united in Italy with the order of St. Maurice; in 1608, in France, with that of Our Lady of Mount Carmel. The knights of these united orders were allowed to marry.

LA'ZULITE. A blue mineral from Styria and the Tyrol, composed of 66 alumina, 10 silica, 18 magnesia, 2 lime, 3 oxide of iron.

LAZZARO'NI. A name given to the poorer classes at Naples, from the Hospital of St. Lazarus, which served as a refuge for the destitute in that city. Forty years ago two large sections of the people were generally comprehended under this name — the fishermen; and the lazzaroni, properly so called, who lived in the streets, and performed no other labour but that of errand porters and occasional servants. These alone were estimated at 40,000. These Lazzaroni formed a powerful community, which under Masaniello accomplished the revolution of Naples; and, in later times, overthrew the popular government, under the influence of Cardinal Ruffo and the English party. But during the French occupation of Naples they ceased to exist as a distinct class; and the name is now only used to designate in general language the mob or populace of that great city.

LEA, in Agriculture, is a term applied to lands which are kept under grass or pasturage for a short period. For example, in a rotation of fallow, wheat, clover, and rye grass, for three years. The ground, when under clover and rye grass, is said to be in lea, in Scotland; or in England, in lay.

LEAD. A metal of a bluish-grey colour. Its specific gravity is 11·38. It is very soft, flexible, and inelastic; and though ductile and malleable, is possessed of very little tenacity. It fuses at about 600°; and if air be carefully excluded, it does not appear to be volatile at a white heat. When melted in open vessels, it soon changes into a grey powder, which upon further exposure to heat and air becomes yellow, and is called *massicot;* or, when partially fused, so as to assume a scaly form, *litharge*. If massicot be heated, and stirred to prevent fusion, it gradually absorbs oxygen, acquires a red colour, and is called *red lead*. When red lead is heated in nitric acid, it is partially dissolved, and partly converted into a brown powder, which is insoluble, and is a *peroxide of lead*. Massicot, or the yellow oxide of lead, is the *protoxide*, and that which forms the salts of this metal: it is constituted of 1 atom of lead = 104, and 1 of oxygen = 8, and its equivalent is 112. The brown peroxide consists of 1 atom of lead and 2 of oxygen; and red lead is intermediate between the two extremes, consisting, probably, of an indefinite mixture of the two oxides. The protoxide of lead is soluble in the greater number of the acids, and forms a variety of salts; of these the carbonate and the acetate are the most important. *Carbonate of lead*, or, as it is commonly called, *white lead*, is the basis of white oil paint, and consequently of a number of other colours: it may be prepared by exposing sheet lead to the fumes of vinegar, by which it is gradually corroded, and its surface becomes covered with an incrustation, which, when scraped off and well levigated, is white lead. This article is also made by precipitating a solution of acetate of lead by carbonate of soda; it consists of 112 oxide of lead and 22 carbonic acid. *Acetate of lead* is made by dissolving carbonate of lead in acetic acid, for which purpose the pyroligneous vinegar is chiefly used. It crystallizes in six-sided prisms, but is generally met with in confused crystalline masses. It is soluble in about 4 parts of cold water, and the solution has a remarkably sweet taste; whence the term *sugar of lead*, usually applied to this salt. It consists of 112 oxide of lead and 51 acetic acid. The crystals include 3 atoms of water, and are therefore represented by the equivalent 190; or 163 dry acetate and 27 water. When protoxide of lead is boiled in distilled vinegar, or in a solution of acetate of lead, a dense solution of subacetate or *triacetate* of lead is obtained: it is difficultly crystallizable. This solution is often used in the chemical laboratory as a test and precipitant: and it forms the *extract of lead*, or *Goulard's extract* of pharmacy.

The most important native combination, or *ore of lead*, is the *sulphuret*, composed of 104 lead and 16 sulphur. It is the *galena* of mineralogists, and from it the commercial demands for lead are supplied: it is roasted to expel sulphur, and the lead thus oxidized is reduced by heating with charcoal. The action of water upon lead is curious and interesting, in consequence of the universal use of cisterns lined with this metal. Perfectly pure water, such as distilled water, put into a clean leaden vessel and exposed to air, soon oxidizes and corrodes it, and delicate tests discover oxide of lead *in solution* in the water; but river and spring water exert no such solvent power: the carbonates and sulphates in such water, though in very minute quantities, entirely prevent its solvent power. Hence it is that leaden cisterns are used with impunity for the preservation of common water, and that the crust which forms upon the metal effectually prevents all further action. As this crust partly consists of carbonate of lead, which is very poisonous, great care should be taken to prevent its diffusion through the water upon any occasion, as by scraping or cleaning the cistern. There is another way in which leaden cisterns sometimes prove injurious; and that is in consequence of galvanic action, where iron or zinc pipes are soldered or let into them: the lead is thus rendered electro-negative, alkaline matter is evolved upon it, and small quantities of the oxide or carbonate are thus rendered soluble. There are several re-agents by which very minute quantities of lead may be detected; among these, solution of sulphuretted hydrogen is perhaps the most effective: it produces a brown tint in water containing the minutest trace of lead, and it similarly discolours the greater number of the insoluble salts of the metal. A solution of sulphate of soda is also a sensible test of the presence of dissolved oxide of lead; it forms a white cloud in water containing the smallest traces of it: a fragment of iodide of potassium dropped into such water presently occasions in it a yellow tint, in consequence of the formation of an iodide of lead.

LEAD, BLACK. *See* PLUMBAGO.

LEAD, for Sounding. The common hand lead weighs 11 lbs. with about 20 fathoms of line. The leadsman stands somewhere on the side of the vessel, leaning against a band for the purpose: lets the lead descend near the water; then, swinging it over his head once, or twice if the ship is going fast, throws it forward. The line is marked at 5, 7, 10, 13, 17, and 20 fathoms. The numbers between are called *deeps;* thus, "by the mark 7," "by the deep nine," indicate 7 and 9 fathoms.

When the depth is great, the deep-sea lead of 28 lbs. is used. The lead is dropped from the fore part of the vessel, the line being passed outside all. It is generally necessary to heave the ship to.

LEADING NOTE. In Music, the sharp seventh of the scale.

LEADS, or SPACE LINES, are pieces of type metal cast to specific thicknesses and lengths, lower than types, so that they do not make any impression in printing, but leave a white space where placed. Their general use is to be placed between the lines when a work is not closely printed, which is considered to look better than when printed solid, and also to branch out the heads of pages and titles.

LEAF. (Sax.) An expansion of the bark at the base of a leaf-bud, prior to which it is developed; its function being at once that of respiration, digestion, and nutrition. It is a plate of parenchyma, through which spiral vessels and woody tissue ramify. Its surface is covered with stomates, which communicate with minute hollow chambers in the interior. It is in the leaf that all the peculiar secretions of a plant are prepared out of the under sap which the roots obtain from the soil.

LEAF-BUDS. Rudiments of young branches, made up of scales imbricated over each other, the outermost being the hardest and thickest, and surrounding a minute axis, which is in direct communication with the woody and cellular tissue of the stem. When stimulated by light and heat they extend into branches; or if artificially removed from the plant that bears them, they are capable of multiplying the individual from which they have been taken.

LEA'FLET. A small leaf formed by the petiole of a leaf branching out, and separating the cellular tissue of the lamina into more than one distinct portion, each of which forms a perfect lamina of itself.

LEAGUE. A measure of length, used in reckoning distances by sea. The sea league is three nautical or geographical miles, or the 1-20th of a degree, and consequently about 3·45 English miles.

The common land league is a well-known itinerary measure on the continent of Europe, chiefly in France. The French, however, have two distinct leagues: the legal posting league (*lieue de poste*), containing 2000 toises, and equal to 2·42 English miles; and a league of 25 to the degree (anciently the *lieue moyenne*), or equal to about 2·76 English miles. This last, however, can scarcely be regarded as a definite measure; and previous to the Revolution the league was different in the different provinces. The word is said to be derived from the Celtic leach, *stone;* the distances having been marked by stones in the Roman provinces. In Gaul alone of those provinces, they were marked in some instances by leagues as well as miles. The Gaulish league was considered by the Romans as equal to a mile and a half of their own measure, or as containing 1500 Roman paces. It is supposed that the league, or *leuca*, was introduced into England by the Normans, where, at an early period, it came to be reckoned as equivalent to two miles of the time; this being the sense in which the term *leuca* is used by the oldest law writers, and in most of the old English charters. *See* MILE.

LEAGUE, in Politics, appears to be in strictness an alliance between two or more powers, in order to execute some common enterprise. It is therefore more active, and less durable, than an alliance or a confederacy; both of which have some permanent object, while neither necessarily requires active co-operation. In the middle ages, the word league was used nearly in the sense now attached to these latter terms: hence we read of the Hanseatic league, and of the three leagues still subsisting in the canton of the Grisons in Switzerland; both of which were more properly confederacies. The word is of Spanish origin; and it has been said that the period of its commonest use in political language was commensurate with that during which the Spanish government exercised the greatest influence among those of Europe, — the 16th and 17th centuries.

LEAGUE, SOLEMN. *See* COVENANT.

LEAGUE, THE HOLY, or simply THE LEAGUE. In French History, a political association formed by the Roman Catholic party in France under the reign of Henry III. The project of the League is said to have been framed by one David, an advocate; or, rather, he first conceived the idea of uniting the separate associations of the Catholic party in the provinces into one great confederacy. His written scheme bears date 1575. It was ardently received, especially by the municipality and citizens of Paris and other large towns. The object of the League was at first only the overthrow of the Protestant power; but the princes of the house of Guise soon placed themselves at its head, and the leaders of the party were not slow in adopting the project of changing the succession, and placing the Duke of Guise on the throne. In 1588, the citizens, under the impulse of the League, drove Henry III. from Paris on the day of the Barricades, and formed the revolutionary government of "the Sixteen." But after the death both of the duke and the king, much division arose in the head quarters of the League at Paris as to the choice of a successor; and in 1591 the popular party, or that of the Sixteen, was put down by the citizens: which event in effect destroyed the power of this great association, although it still continued to exist, even after the abjuration of Henry IV.

LEAKAGE. In Commerce, an allowance in the customs, granted to importers of wine for the waste and damage the goods are supposed to receive by keeping.

LEA'NTO. (Span.) In Architecture, a building whose rafters pitch against or lean on another building.

LEAP-YEAR, or BISSEXTILE. A year containing 366 days. In the Gregorian calendar this occurs every fourth year, excepting years which complete centuries; in which case the intercalary day is omitted, unless the number of the year is divisible by four. The term is probably derived from the *leap* or start occasioned by the insertion of the intercalary day, and would have been more appropriate if the year had been deficient by a day instead of being redundant. *See* CALENDAR.

LEASE, in Law, is properly a conveyance of lands and tenements (usually in consideration of rent or other annual recompence), made for life, for years, or at will, but always for a less time than the lessor or party letting has in the premises. The usual words of operation are, "demise, grant, and to farm let." The conveyance by a lessee of part of his interest is properly an under-lease; of the whole, an assignment.

LEASE AND RELEASE. In Law, a mode of conveyance appropriate to estates of freehold in lands, tenements, or hereditaments. Before the Statute of Uses, 27 H. 8. c. 10., it was customary to give lands to one person for the use of another; or to devise the use of land to one party, while the common law right to the same land descended to another. In a court of equity the legal owner of the fee was compelled to cede to the *cestuy que use*, or proprietor of the use, the enjoyment of the land; and certain modes of conveyance were employed by which the use was conveyed independent of the legal estate. By that statute uses were declared to be executed; *i. e.* that if land were conveyed to one party to the use of another, the *cestuy que use* became seised of the legal estate. Hence a *bargain and sale*—*i. e.* a deed in which for a recited pecuniary sum, technically called a *consideration*, land was conveyed to A. to the use of himself or of D.—became a good conveyance; because the deed gave the use, and the statute immediately added the legal estate. To prevent secret conveyances it was consequently enacted, in the same reign, that no estate of inheritance or freehold should be conveyed by bargain and sale, unless the deed was enrolled or registered in a certain specified manner. But as this statute did not extend to bargains and sales for a less estate than of freehold, the ingenuity of lawyers soon devised a new method of secret conveyance: the land was made over to the purchaser by bargain and sale for a year, and then the purchaser received a release of all the vendor's remaining interest. Thus, by these two deeds (which are now ordinarily comprised in one), a perfect conveyance is created, which has almost superseded, in general use, the older and more solemn modes of alienation for estates in fee-simple.

LEA'THER. (Germ. leder.) The prepared skins of animals. The principal object of the art of converting skin into leather is to render it strong and tough, durable, and often water-proof, and to prevent its destruction by putrefaction. The skins are first cleansed of hair and cuticle, and then impregnated either with vegetable tan and extract, as in the production of what is called *tanned* leather, or with alum and other salts, as for *tawed* leather: these processes are sometimes combined, and tanned leather often undergoes the further operation of *currying*, or impregnation with oil. As instances of these different results, thick sole leather is tanned; white kid for gloves is tawed; the upper leather for boots and shoes is tanned and curried; and fine Turkey leather is tawed, and afterwards slightly tanned.

Tanned Leather.—For thin skins which are afterwards curried, the hide is cleansed, and soaked for a day or two in water; it is then *beamed*, or stretched upon a solid half cylinder of stone, where it is cleared of adhering fat and flesh; it is then soaked for several days in a pit of lime and water, by which the hair and cuticle are so far loosened as to admit of being scraped off upon the beam; the hide is then washed and put into the *mastering* pit, which is a mixture of water and dung, — that of hens, pigeons, or dogs is preferred, cow or horse dung not being sufficiently putrescible. When the hide has here become soft and supple, it is again thoroughly cleaned, and submitted to the tanning liquor, which is at first used very weak, and gradually strengthened till the operation is complete: this requires from two to four months for calf skins, and from twelve to eighteen months for thick ox and boar hides intended for strong sole leather; and the latter hides, instead of being limed and dunged, are generally, after having been cleaned in water, placed in heaps, where they begin to putrefy, and then the hair may be removed without lime, which would be apt to render the skin hard and harsh. The further opening of the texture, so as to prepare it for tanning, is effected by immersion in a sour liquor of fermented rye or barley, or in weak sulphuric acid.

The process is called *raising*, and immediately precedes the tanning. When fully tanned, the goods are drained, stretched upon a convex piece of wood called a *horse*, and beaten and smoothed; or the leather is sometimes passed between cylinders to make it more solid and supple: it is lastly dried, by suspension in an airy covered building. It will be obvious (*see* TAN and GELATINE) that the principal change effected in this process depends upon the combination of the gelatine of the skin with the tanning of the oak bark, or other astringent material which is used, and that great care is requisite to ensure the perfect penetration of the hide (especially where it is thick) by the tanning material: hence the necessity of using weak liquors at first, and gradually increasing their strength; for if the hide were in the first instance put into a strong infusion of bark, the exterior surfaces would become so perfectly tanned as to be impervious to the further action of the liquor, and the centre would remain untanned, and consequently soluble and putrescible; so that we judge of the completion of the process by the leather, when cut through, being of a uniform brown throughout, anything like a white streak in the centre announcing the imperfection just mentioned.

Tawed Leather, &c.—The skins are first soaked, scraped, and hung in a warm room till they begin to exhale an ammoniacal odour and the wool readily pulls off; they are then scraped and soaked for some weeks in lime water, which checks the putrefaction and hardens the texture; the skin is then again beamed, smoothed, and trimmed, and put into a vat of bran and water, where it is kept for some weeks in a state of gentle fermentation, and becomes thin and extensible, and fit for any subsequent operation: in this state it is called a *pelt*. The method of bringing kid and goat skin to the state of pelt is nearly the same as for lamb skin, except that liming is used before the hair is taken off, which is only sold to plasterers, whereas lambs' wool is more valuable, and would be injured by the lime. If the pelts are to be tawed, they are worked about in a solution of alum and salt in warm water, which again makes them thick and tough; they are then washed, and again fermented in bran and water till the thickening is reduced by the removal of some of the salts; lastly, they are stretched on hooks, and dried in a stove room, when they become a tough flexible white leather; but to give them gloss and suppleness they are again soaked in water, and trodden in a large pail containing the yolks of eggs beat up with water; they are then dried in a loft, and smoothed with a warm iron.

Morocco leather, as it is called, is chiefly prepared from sheep skins, which, after the action of lime water, are brought down by a dung bath, and reduced to the state of pelt. If intended to be dyed red, they are sewn up in the form of a sack, with the grain side outward, and immersed in a warm cochineal bath; the sac is then tanned in a bath of sumach: the skins intended to be blacked are sumached without any previous dyeing. The graining and polishing are effected as follows:—The skins are stretched upon a smooth inclined board, and rubbed over with a little oil to supple them. Those intended for black leather are previously brushed over with a solution of iron; they are then rubbed over with a glass ball cut into a polygonal surface, which polishes them, and makes them firm and compact; lastly, the grained surface is given by rubbing the leather with a grooved boxwood ball. *Curried leather* is tanned, and then softened by soaking in water and rubbing; it is then pared with a broad sharp knife, rubbed with a polished stone, and while still wet besmeared with fish oil, or a mixture of this with tallow. As it dries the oil gradually penetrates in proportion as the moisture evaporates. The grain side is blackened by iron liquor, but the flesh side with lampblack and oil.

Shammoy leather is generally sheep or doe skin, prepared as already mentioned by dressing, liming, &c., and dyed if necessary, and then finished in oil. *Russia leather* acquires its peculiar odour from birch tar. (There is an excellent abstract of the manufacture of different kinds of leather in *Aikin's Dictionary of Chemistry*, from which the above is chiefly abridged.)

The leather manufacture of Great Britain is of very great importance, being inferior in point of value and extent only to those of cotton, wool, and iron. "If we look abroad," says Dr. Campbell, "on the instruments of husbandry, on the implements used in most mechanic trades, on the structure of a multitude of engines and machines; or if we contemplate at home the necessary parts of our clothing,—breeches, shoes, boots, gloves,—or the furniture of our houses, the books on our shelves, the harness of our horses, or even the substance of our carriages; what do we see but instances of human industry exerted upon leather? What an aptitude has this single material in a variety of circumstances for the relief of our necessities, and supplying conveniences in every state and stage of life? Without it, or even without it in the plenty we have it, to what difficulties should we be exposed?" (*Polit. State of Great Britain*, xi. 176.) The number of persons engaged in all the various branches of the leather manufacture in Great Britain is estimated at between 200,000 and 300,000, the total quantity of all sorts of leather at 65,000,000 lbs., and the entire value of the manufacture at 13,500,000*l*. Leather was long subject to a duty, which necessarily placed the manufacture under the surveillance of the excise; but it was totally abolished in 1830; and as the manufacture is now relieved from every sort of trammel and restraint, its rapid increase may be confidently expected. (See *Commercial Dictionary*.)

LEAVEN. (Lat. levare, *to raise*.) A piece of sour dough used to ferment and render light a much greater quantity of dough or paste. By the law of Moses leaven was strictly forbidden during the Passover; and the Jews, taught to regard it from the vigil of the feast as unclean, with religious scrupulosity purified their houses from the contaminating influence. In its figurative sense, *leaven* is applied to any thing that powerfully but gradually deteriorates the qualities of the mind or heart; in contradistinction to the expression *unleavened*, which implies the qualities of sincerity and truth.

LEAVES. (Sax. læaꝼ.) In Architecture, ornaments imitated from natural leaves; whereof the ancients used two sorts, natural and imaginary. The former were those of the laurel, palm, acanthus, and olive; but in the representation of all of them they took great liberties.

LECTI'CA. (Lat.) A sort of couch used by the Romans for the same purpose as the sedan chair, or rather the palanquin, is employed by the moderns; with this difference, that the person carried on the lectica reclined. It was used also for the conveyance of dead bodies to the funeral pile. The persons who carried the lectica were called *lecticarii*, whose number in the Lower Empire is said to have amounted to 11,000.

LE'CTISTE'RNIUM. (Lat. lectus, *a couch*, and sternere, *to prepare*.) A religious festival or ceremony among the ancient Romans, celebrated during times of public calamity, and remarkable as a singular relic of barbarous superstition, retaining the impression of a very rude age. In this festival the gods themselves were invited to the entertainment; their statues were taken from their pedestals, laid on couches with pillows and pedestals, and placed at the table, while the servants used gravely to convey the viands to the idols' lips. The first festival of this sort, according to Livy, which took place, was held in the year of Rome 354, on the occasion of a contagious disease which committed frightful ravages among their cattle and lasted for eight successive days. On the celebration of this festival enemies were said to forget their animosity, and all prisoners were liberated.

LE'CTOR. In the early Church, a person set apart for the purpose of reading parts of the Bible and other writings of a religious character to the people. They were consecrated by prayers and ceremonies for this office, and in the third century appear to have formed proper officers of the church. It is probably from this institution that the order of preachers in parish churches in England called *lecturers* is derived, who hold a distinct office from the vicar, rector, or other ecclesiastical functionaries; they are chosen by the vestry or chief inhabitants of the parish, supported by voluntary subscriptions and legacies, and usually officiate on Sunday afternoon.

LE'CTURE (Lat. lego, *I read*), signifies generally a discourse *read*, as the derivation of the word implies, by a professor to his pupils; but it is applied in a more extended sense to every species of instruction communicated *vivâ voce*. In the Scotch and Continental universities, as well as in those recently established in England, the great business of teaching is carried on by means of public lectures, delivered at stated periods, and embracing every subject included in the curriculum of study; but at the two great English universities, as is well known, a different system is adopted. There the established mode of instruction is by private tutors; and though a few lectureships have, from time to time, been founded, and lectures are sometimes voluntarily given by active members, still these are rather to be considered as incidental appendages than as constituent parts of a regular system.

Public lectures have been adopted from the earliest ages as a convenient mode of teaching the elements of every branch of human knowledge; and it is perhaps true that if they be properly compiled, and accompanied by strict and regular examinations, few means seem better calculated to awaken the attention of the student, to abridge his labours, to guide his inquiries, and to impress upon his recollection the first principles of science. The endless diversity of subjects on which lectures have been or may be given precludes, of course, any attempt to lay down rules applicable in all cases for the guidance of individual lecturers; but there are, notwithstanding, some great leading principles that should in every case be kept steadily in view. First of all, it should be borne in mind that, a lecture being an oral discourse, if the meaning of the lecturer be at any time mistaken or not perceived, the student or hearer

cannot return, as he would do to a book, for farther explanations, and the subsequent part of the lecture may in consequence be rendered nearly useless. Hence *perspicuity of statement* is the first and highest quality of a lecturer. Perspicuity, indeed, is indispensable to all good writing and speaking; but in lecturing especially it is the one thing needful, and without it other qualities can avail little or nothing. To attain this essential quality the subjects of the lecture should be so arranged that they may follow each other naturally and easily; the sentences should be clear and distinct, neither too long nor too short; the illustrations should be apposite, and of a kind fitted to excite and keep awake the attention of the hearer; and the lecture so composed should be delivered in a plain, distinct, and impressive manner. If a lecturer be deficient in these qualities, he can be of little or no use as a teacher, how well soever he may be acquainted with the subject on which he prelects. Dr. Brown, of Edinburgh, is an instance in point. his views with respect to the philosophy of the mind are often original, sometimes just, and always ingenious; but the style in which they are expounded is as bad as possible, even in a book made for the closet, and rendered his lectures all but unintelligible to nine tenths of his students. It has been the fashion among certain parties who certainly do not owe much to the *belles lettres* to depreciate the lectures of Dr. Blair; but they may be safely referred to as all but perfect models of the style and manner in which lectures should be written.

When lectures are prepared in the way now stated by parties well versed in the subjects prelected upon, and when they are regularly followed up next day by a searching examination of the students on the various subjects treated of, and explanations are given of such difficulties as may have occurred to them, they may, perhaps, as already stated, be regarded as a pretty unexceptionable method of teaching. But lectures got up, as they generally are, not to instruct the hearer, but to exhibit the attainments or prejudices of the lecturer, and unaccompanied either by examinations or exercises, are about the least profitable exhibitions at which a student can be present.

LE'DGER. *See* Book-keeping.

LEDGER-LINE. (Dutch, leggen, *to lie.*) In Music, a line either above or below the staff, when that is not sufficient in extent to lay the notes upon. It is above the staff in ascending progressions, and in descending progressions below it.

LE'DGERS. (Fr.) In Architecture, horizontal pieces of timber used in scaffolding, lying parallel to the wall opposite to which they are erected.

LEE, LEEWARD. Sea terms, denoting generally the side or quarter not directly exposed to the wind. The *lee-side* of a ship is the opposite to that on which the wind blows when it crosses her course, and which is termed the *weather side. Leeward* is on the *lee-side;* opposed to *windward*, or on the *weather side*. A *lee-shore* is the shore on the *lee-side* of the ship, or the shore on which the wind blows; and a ship is said to be under the *lee* of the shore when the wind blows from the shore, or when she is in some measure sheltered by the shore. The names Leeward and Windward, as applied to the West India Islands, were given to them from their situation in a voyage from the ports of Spain to Carthagena or Portobello. The islands which lie to leeward extend from Portorico to Demerara.

LEE-BOARD. A small platform of planks, which being let down into the water on the lee side of flat-bottomed vessels, opposes the action of the wind to drive them to leeward.

LEECH. This name is given to those abranchiate red-blooded worms, or anellidans, which are provided with a sucker at both ends of the body (*see* Hirudo), and of which we possess a few native species; some frequenting the fresh waters, as the horse leeches (*Hæmopis sanguisorba* and *H. stagnorum*); others the ocean, where they are parasitic upon fishes, as the skate-sucker (*Pontobdella muricata*). The medicinal leech (*Sanguisuga medicinalis*) belongs to that subdivision of the family *Hirudinidæ* which is characterized by having the superior lip of the anterior cup or sucker divided into several segments, and the oral aperture transverse, triradiate, and surrounded by three cartilaginous jaws, each armed with two rows of very fine teeth. This apparatus enables the leech to penetrate the skin so as to ensure a ready flow without causing a dangerous wound. The upper lip is marked with ten small points considered as eyes. The species of the genus *Sanguisuga*, viz. *S. officinalis* and *S. medicinalis*, are most common in the south of France, whence great numbers are exported to this country. The leech-dealers of Bretagne drive horses and cows into the ponds, that the leeches may fatten and propagate more abundantly by sucking their blood. Children are employed to catch them by the hand; and the grown persons wade into the shallow waters in the spring of the year, and catch the leeches that adhere to their naked legs. They are also taken by a sort of net made of twigs and rushes, which is used in the summer when the leeches retire into the deeper waters.

The best method of preserving these valuable little animals is stated by the author of the article "Leech" in the *Penny Cyclopædia* to be that described by Fee. It is as follows: —

Into a marble or stone trough a layer of seven inches of a mixture of moss, turf, and charcoal is to be put, and some small pebbles placed above it; at one extremity of the trough, and midway between the bottom and the top, place a thin plate of marble pierced with numerous small holes, upon which there should rest a stratum of moss, or portions of the *Equisetum palustre*, or horse-tail, firmly compressed by a layer of pebbles. The trough to be filled with water only so high that the moss and pebbles should be but slightly moistened. A cloth is to be kept over the mouth of the trough. This is imitating as nearly as possible their natural condition; and the charcoal not only aids in keeping the water sweet, but appears to prevent the leeches being attacked by parasitic animals, to which they are very liable. The water should be changed about once a week, and more frequently in warm weather.

The great importance of ascertaining the best method of preserving the medicinal leech may be inferred from the extent to which the trade is carried on, and the consequent increasing scarcity of these indispensable adjuncts to medicine. Four only of the principal dealers in London import 7,200,000 annually.

LEE'LITE. A pink silico-aluminous mineral tinged by oxide of manganese. Named from Mr. Lee of Cambridge.

LEET. (Sax. leod; Germ. leute, *people.*) The court leet, or view of frankpledge, was an ancient Saxon institution answering a double purpose: 1. The administration of justice in the trial of offences and the abatement of nuisances; 2. The preservation of the peace, and the prevention of crime, by the reception and enrolment of the pledge which each man was obliged to give by becoming a member of some tything. The possession of a court leet was the characteristic of the hundred, of which the proper leet was distinct from, and subordinate to, that which was held by the sheriff on his tourn. The court leet of the hundred was usually held by a bailiff or steward of the sheriff; but it was sometimes granted, as well as the leet of a smaller jurisdiction, to private lords. A court leet also properly belonged to a borough, which ranked as a hundred; but such private and borough leets were, like the leet of the hundred, subordinate to the county leet of the tourn.

LEE-WAY, in Navigation, is the deviation of the course actually run by a ship from the course steered upon; or it is the angle formed between the line of the ship's keel and the line which she actually describes through the water. In consequence of the action of the wind or currents, a ship is generally impelled *sideways* as well as forward, whence the direction of her motion is different from that of the keel. Suppose the whole force urging the ship to be resolved into two, — one producing the motion A B in the direction of the keel, and the other the motion A C in the same time at right angles to the former;

then the ship will move in the direction of the diagonal A D, and the angle D A B is the *lee-way*. To obviate the effects of this lateral motion, the ship is laid on a course to the windward of the point to which she is bound.

LEGACY. *See* Wills. (Lat. lego, *I bequeath.*) A gift by will of personal property, as goods and chattels; a testamentary gift of real property being called a devise. Legacies are general, such as a gift of a sum of money out of the general estate of the deceased; or specific, as a gift of a particular bank note or coin, or of any other individual chattel, as a horse or a jewel; or residuary, as a gift of the residue of the estate remaining after all the debts of the deceased and general and specific legacies have been satisfied. General legacies are subject to an equal rateable abatement, if the estate is not sufficient for payment of them in full; but a specific legacy is not subject to abatement, unless it be necessary for the payment of debts. A specific legacy is, however, subject to what is called ademption, which is the consequence of the subject matter of the legacy being one identical thing in specie: thus, if a testator bequeath a particular horse, which he afterwards disposes of in his lifetime, the legacy is said to be adeemed, or taken away, because the horse bequeathed has no longer any existence as part of his property, and the legatee will not be entitled to another horse of the testator's in lieu of it. This identity of corpus is so inherent in the notion of a specific legacy, that if a 100*l*. in Consols were bequeathed, and the same sum were afterwards transferred by the testator to another stock, the transfer of itself would adeem the legacy. The mode of compelling executors to pay a legacy is by suit in equity for the administration of the testator's assets: courts of law have not, in general, any jurisdiction over such mat-

ters. Executors cannot be compelled to pay a legacy until the expiration of a year after the testator's death: they are allowed that period for ascertaining and discharging his debts; and even after a legacy has been paid the legatee must refund, if it should be necessary, for the payment of creditors who come in, although after the period above mentioned. The party to whom a legacy is bequeathed is termed legatee. For an account of the legacy duties, see art. "Taxation," *Encyc. Britannica*, (new edition).

LE'GATE. (Lat. legatus.) A high functionary, in general a cardinal or bishop, whom the pope sends as ambassador to the courts of foreign powers. Legates are,—1. A Latere, who possess the highest degree of authority; 2. De Latere: the former are such as the pope commissions to take his place in councils. 3. Legates by office are such as enjoy the titular distinction of legate by virtue of their dignity and rank in the church, but have no special mission.

LEGATION. *See* AMBASSADOR. DIPLOMACY.

LEGA'TO. (Ital. *tied.*) In Music, a term used to denote the tying one note to another, which is done by placing these marks ⌣ ⌢ above or below the notes intended to be so joined. This is also known by the name of *sycope*.

LEGATU'RA. (Ital.) In Music. *See* DRIVING NOTES.

LEGA'TUS. (Lat.) In Roman History, an officer who acted as deputy under a commander-in-chief, and whose duty it was to aid the proconsuls and propraetors in the administration of the Roman provinces. Of the number of the legati nothing certain is known; though the probability is that there was one to every legion. In the absence of the consuls and other magistrates entitled to the *fasces*, this honour was conferred on the *legati*.

LE'GEND. (Lat. legenda, *things to be read.*) A book originally used at divine service in the Romish churches, in which are recorded the lives of saints and martyrs, portions of which were selected and read for the edification of the people. These legends, which contained many ridiculous stories of the lives of the saints, were studiously perused in the refectories of cloisters, and were earnestly recommended to the perusal of the laity, as so many evidences of the truth of the Roman Catholic faith. Among these the Golden Legend (the work of Jacobus de Voragine, archbishop of Genoa in the 13th century), which is a collection of the lives of the saints, maintained its ground in the church for two hundred years; though, from the number of ridiculous stories with which it teems, it has now sunk into merited oblivion. But although many of the legends consist of tasteless and unmeaning fictions, the offspring of a childish credulity, which indeed they were intended to gratify, there are many of them of a highly poetical and striking character; and hence it is not surprising that this species of literature has often been regarded, even by persons of taste, as a verdant oasis amid the desert of imaginative writings in the middle ages. There are some sensible remarks as to the value of the early Christian legends in Beugnot, *Hist. de la Destruction du Paganisme en Occident*, i. 280. In a general sense the term legend is used to denote any fictitious or doubtful narrative; such as the exploits of heroes of the middle ages, or the history of a people or district in which truth is so mixed with fable as to be inseparable from it.

LEGEND. In Numismatics, that which is written *round* the field of a medal; opposed to *inscription*, which is written across it. *See* NUMISMATICS.

LEGERDEMAIN. (Fr. *light of hand.*) A term given to some deceptive or sleight-of-hand performances, which depend either entirely on dexterity and address, or derive but a small degree of aid from philosophical principles. *See* MAGIC.

LEGGIA'DRO. (Ital.) In Music, a direction to the performer that the music to which the word is appended is to be performed gaily or briskly.

LE'GION. A division of the Roman army, comprising ten cohorts, thirty maniples, or sixty centuries; so that if there had always been one hundred men in each century, as its name imports, the legion would have consisted of six thousand men. But the number was in fact variable.

There were usually three hundred cavalry joined to each legion, which were divided into ten troops (turmae), and each of these troops into three bodies of ten men (decuriae). The defensive arms of the legionaries were an oblong shield, a helmet, hauberk, and greaves; their offensive weapons were a sword and two long javelins. The legion was drawn up in three lines; the soldiers in each of which were distinguished by the names Hastati, Principes, and Triarii. The Hastati, who formed the first line, were young men in the flower of life, and originally used long spears, which were, however, afterwards discarded. The Principes occupied the second line, and were men in the prime of life. The Triarii were veteran soldiers, and formed the third line. In each legion there were six military tribunes, who commanded under the consul, each in his turn, usually for about a month. This was the early organization of the legion, as it is known to us chiefly from the description of Livy, at the time of the great Latin war in the fifth century of the Republic. It was materially changed in later times; and the three original lines were discarded, probably about the time of the Punic war. But it always retained its distinctive character of a separate army, as it were, provided with its complement of cavalry and light infantry; and it has been remarked, as a striking proof of the military genius of the Romans, that after so many ages of additional experience, recent captains, and particularly Napoleon, have found it advantageous to divide their armies into separate corps, each in a similar manner complete, with its own cavalry and artillery; and these, in the French imperial armies, usually averaged from 4000 to 6000 men, or about the number of a Roman legion. The organization of the legion is explained in most works on Roman antiquities, but has been nowhere so thoroughly treated as by M. Le Beau, in a long series of memoirs which appeared from time to time in the *Mem. de l'Ac. des Inscriptions et Belles Lettres*. See particularly vols. xxxv. xxxvii. xxxix. The reader may also now consult *Dr. Arnold's History of Rome*, vol. ii.

LE'GION OF HONOUR. An order instituted by Napoleon when first consul of France for merit, both military and civil. The order consisted, under the Empire, of grand crosses, grand officers, commanders, officers, and legionaries. They were divided into sixteen cohorts, each of 407 members; but the total amount was afterwards much increased. Pensions, from 250 to 5000 francs per annum, were attached to these distinctions. After the restoration of Louis XVIII. the order underwent some modifications in its constitution, and its members were limited on a smaller scale. *See* HONOUR.

LEGISLATION. *See* LAW.

LE'GISLATOR. (Lat.) One who frames or establishes the laws and polity of a state or kingdom. The term is chiefly applied to some distinguished persons of antiquity, such as Moses among the Jews; Theseus, Draco, Solon, among the Athenians; Lycurgus among the Spartans; and Numa among the Romans.

LEGISLATURE. The name given to the body or bodies in a state in whom is vested the power of making laws. Thus the king, lords, and commons of Great Britain, whose united consent is indispensable to the framing of a law, are styled *the legislature*.

LEGI'TIMACY, in Politics, signifies, in its strictest sense, the accordance of an action or of an institution with the municipal law of the land. The principle of obedience to civil authority, in whatever hands the law has placed it, is consecrated by religion as well as by sound philosophy. Resistance to, or evasion of, the legal commands of a superior, is thus an offence against the law of God as well as of man, in things in themselves indifferent as well as in things commanded by the principles of morality. How far they must be obeyed when against the conscience of the subject, is one of those questions of casuistry which never can receive a solution applicable to all cases and circumstances. In this sense it is clear that the attribute of legitimacy belongs to no particular form of government, but is equally inherent in all when lawfully established. But, looking at the subject from a higher point of view, the question arises, when and how shall a government be taken to be lawfully established? This can only be directly answered by two classes of political philosophers. The first attribute the quality of legitimacy only to hereditary monarchical government, which they conceive to be peculiarly of divine appointment, deriving it from the patriarchal form of society. This theory has the advantage of simplicity; but its advocates have never been able to show any real foundation for it in the language of Scripture, and it is of course impossible to raise it on any other basis. (*See* DIVINE RIGHT, NON-RESISTANCE.) The second class bases society on the abstract rights of man, attributes all power to the people, and considers no government legitimate except such as is founded on their consent. This theory also is plain and clear in the abstract; but has the defect of becoming impossible in application. For, 1. The principle of the *social contract*, or implied consent of the people, is a mere philosophical fiction. 2. The actual consent of the people (*i. e.* the majority of it) to any existing form of government has never been satisfactorily ascertained. This is notoriously the case in every European country; and even the representative government of the United States of America is chosen by a constituency from which *slaves*, women, and persons under twenty-one years of age (that is, in all, five sixths of the population) are excluded. Now the exclusion of any one of these classes can only be justified on grounds of expediency; and similar grounds might equally justify the adoption of other tests (*e. g.* that of property, as in England and other European countries) which would still further reduce the number of the constituency. 3. Supposing a government established by the actual voices of a majority of the whole people, the question would still arise, whether every subsequent act of that

government was legitimatized by that original validity. This question was much debated in France at the period of the trial of Louis XVI.; when the Convention, elected itself by a majority of the people, was assuming the extraordinary power of judging that monarch. The Girondins, on that occasion, contended that an appeal to the people (*i. e.* to the suffrages of a majority of the constituents) was necessary in order to ratify the act; and in a greater or less degree it must always arise, whenever an alteration in circumstances since the period of the election of the representative body has called for the adoption of extraordinary measures. Between these two classes of theoretical politicians, the greater number are content to hold that the only fundamental principle of government is expediency, and its only right that given by municipal law or peaceable possession. In their view, all government is equally legitimate so soon as it is fairly established; while they fully admit that a question, and often a very difficult one, arises on every violent change of institutions, as to how soon the new government *de facto* has acquired the character of legitimacy. In the language of modern politics this word has acquired a peculiar sense; chiefly from its employment about the period of the Congress of Vienna, when the old hereditary dynasties were termed legitimate in contradistinction to those which the French revolution and subsequent wars had founded. Hence the principle of legitimacy has been, very incorrectly, opposed to that of representative or popular government; a mere abuse of terms, but an important one, from the powerful effect which words are able to produce in political discussion.

LEGI'TIMACY. (Lat. legitimus, *lawful.*) In Jurisprudence, the state of a child born in lawful wedlock.

LEGITIMA'TION. The act by which natural children are rendered legitimate. *See* GRETNA GREEN MARRIAGES, BASTARD.

LEGU'MEN. (Lat.) In Botany, a one-celled, one or many-seeded, two-valved, superior fruit, dehiscing by a suture along both its face and its back, and bearing its seeds on the ventral suture only. It differs from the follicle only in dehiscing by two valves. Sometimes it is indehiscent, as in *Cassia fistula*, &c.; but the line of dehiscence is in such species indicated by the presence of sutures. It is very near a drupe, into which it passes in many genera, such as *Dipteryx*, &c.

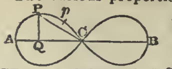
LEGU'MINO'SÆ. A very extensive natural order of Polypetalous Exogenous plants found in all parts of the world; forming large trees and huge twiners in the Tropics, and being herbaceous plants or small bushes, rarely trees, in colder countries. The order contains a great variety of useful and beautiful species, some of which, like clover, lucern, saintfoin, and vetches, are cultivated for cattle; others, as peas, beans, lentils, and various other kinds of pulse, form part of the food of man. Indigo, logwood, and many others are well-known dyeing plants; several acacias produce gum arabic; certain *Astragali* yield tragacanth; the tamarind and others bear pods whose interior is filled with an agreeable fæcula or pulp; *Cassia acutifolia* and others yield senna; *Glycyrrhiza* the liquorice root; *Ceratonia* the wild locust fruits of Scripture; finally, many are valuable tonics, and some are dangerous narcotics, among which the common laburnum is to be named. The larger part of this order consists of plants called Papilionaceous, because of a fancied resemblance between their flowers and a butterfly. Such plants have one large expanded petal, and four others much smaller, which form alæ and carina in front of the vexillum; but in others the more usual form of corolla is observed, and there are even some which, like *Ceratonia*, are apetalous. The division of the order called *Mimosa* is remarkable for having very small flowers with long stamens, and growing in balls or spikes.

LE'MMA. (Gr. λημμα, from λαμβανω, *I take or assume.*) In Geometry, a preliminary proposition, laid down for the purpose of facilitating or rendering more perspicuous the demonstration of a theorem, or the construction of a problem.

LE'MMING. A name given to a species of claviculate Rodents (*Georychus lemmus*, Ill.), very abundant in the north of Europe on the shores of the Arctic ocean. It is as large as a rat, with black and yellow fur, and is remarkable for its occasional migrations in innumerable bodies. At these periods the lemmings are said to march in a straight line, regardless of rivers or mountains; and, unimpeded by any obstacle, they devastate the country through which they pass. *See* GEORYCHUS.

LEMNI'SCATA. (Gr. λημνισκος, *a ribband.*) In Geometry, the name given to a curve of the fourth degree, having the form of the figure 8, and of which the equation is $x^2 + y^2 = a\sqrt{x^2 - y^2}$. There are many other curves of the same order having a similar form, but their equations differ from the above. The lemniscata, though a re-entering curve, is susceptible of indefinite quadrature; and its whole area is equal to the square of its semi-axis. It is a remarkable property of this curve that it is capable of being divided algebraically into equal though dissimilar portions.

The various properties of this curve are most easily derived from its polar equation.



Let C A $= a$, C Q $= x$, and P Q$=y$; the equation of the curve is $x^2+y^2=a\sqrt{x^2-y^2}$. Now let CP$=r$, and the angle P C Q$=u$; we shall have $x=r\cos. u$, and $y=r\sin. u$. Substituting these values of x and y in the equation of the curve, it becomes, after reduction, $r^2=a^2\cos. 2u$. But, by the general theory of curves, the differential of the area referred to polar co-ordinates is $\frac{1}{2}r^2\,du$; therefore in the present case d area $=\frac{1}{2}a^2\cos. 2u\,du$, and, integrating, C p P Q $=\frac{1}{2}a^2\sin. u\cos. u$. At the point C we have $r=0$; therefore $\cos. 2u=0$, and consequently $u=45°$. At this point, therefore, $\sin. u=\sqrt{\frac{1}{2}}$, and $\cos. u=\sqrt{\frac{1}{2}}$; and at the point A we have $u=0$, therefore the area comprised between C A and the curve A P p C $=\frac{1}{4}a^2$. Hence the whole area bounded by both branches (the two branches being similar) is equal to a^2, or the square of A C, which is $\frac{1}{2}$ A B.

Let P be any point in the curve, and p another point related to P by the equation cos. A C P × cos. A C $p=\sqrt{\frac{1}{2}}$; then the curvilinear arc A P is equal to Cp, which is the property above alluded to. A similar property, however, belongs also to some other curves. (See Legendre, *Exercises de Calcul Intégral*, tome i.)

LE'MONS, ESSENTIAL SALT OF. The binoxalate of potash is often sold under this name; it is chiefly used for removing iron-moulds and ink-stains from linen.

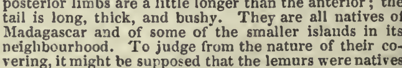
LE'MUR. (Lat. lemur, *a ghost.*) This term was applied in the Linnæan system to several of the lower Quadrumanous animals of different structure and habits; it is now restricted to those which have the inferior incisors long, compressed, straight, and sloping forwards, and the lower canines approximated, and of similar form and direction, differing only in a slight increase of size, whence they have usually been enumerated as incisors: the upper incisors are straight, and the intermediate ones are separated from each other. The long pointed canines of the upper jaw are principally opposed to the trenchant anterior false molars below. Each of the four extremities is provided with an opposable thumb; but the index digit of the hinder hand has its nail developed into a long, curved, sharp-pointed claw. The use of this claw is to clean or dislodge vermin from the long and thick woolly hair. The lemurs deviate from the typical Quadrumanes, and approximate to the ordinary quadruped in their elongated pointed head and sharp projecting muzzle; the posterior limbs are a little longer than the anterior; the tail is long, thick, and bushy. They are all natives of Madagascar and of some of the smaller islands in its neighbourhood. To judge from the nature of their covering, it might be supposed that the lemurs were natives of a cold climate; but their fur has relation to the season of their activity. They sleep by day, and move about in the night season, during which time the air is often sufficiently cold in the tropical latitudes. Their nutriment is a mixed diet of fruits, insects, and small birds; the latter they surprise while at roost.

LE'MURES. Male and female genii, or infernal gods, believed by the ancient Romans to haunt solitary rooms and silent places: they were propitiated by casting beans to them. Their feast was celebrated under the name of Lemuria or Lemuralia.

LE'MURIDÆ. (Lat. lemur, *a ghost.*) The family of Quadrumanous Mammals of which the genus *Lemur* is the type; it includes the genera *Tarsius*, *Otolicnus*, *Stenops*, *Lichanotus*, and *Lemur* proper: see those terms.

LENS. (Lat.) In Optics, a thin piece of glass or any other transparent substance, bounded on both sides by polished spherical surfaces, or on the one side by a spherical and on the other by a plane surface; and having this property, that parallel rays of light in passing through it have their direction changed, so as to converge to a given point called the *principal focus* of the lens, or to diverge as if they proceeded from that point.

Lenses receive different denominations according to their different forms. Thus,



A *spherical lens*, shown at A, is a sphere or globule of glass.

A *double convex lens*, shown at B, is a solid formed by two convex spherical surfaces; and is *equally convex*, or *unequally convex*, according as the radii of its two surfaces are equal or unequal.

A *plano-convex lens*, C, is that of which one of the surfaces is *plane*, and the other *convex*.

A *double concave lens*, D, is bounded by two *concave* spherical surfaces, which may have either the same or a different curvature.

A *plano-concave lens*, E, has one surface *plane*, and the other *concave*.

A *meniscus*, F (so called from its resemblance to a

little moon), is a lens of which one of the surfaces is *convex* and the other *concave*, and which meet if continued. The radius of the convex surface is consequently smaller than the radius of the concave.

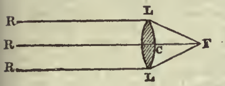
A *concavo-convex lens*, G, is that of which one of the surfaces is *concave* and the other *convex ;* but in this case the surfaces will not meet though continued, the radius of the concave surface being smaller than that of tne convex one.

The straight line M N which passes through the centres of all the curved surfaces, or is perpendicular to both surfaces of the same lens, is called the *axis* of the lens ; and it is in this line that the focus of the lens is situated.

It was observed, at an early period, that a transparent body of a spherical form has the property of collecting at the focus the parallel rays of light which fall on its surface. But it was remarked, at the same time, that the illumination at these foci was extremely feeble, in consequence of the thickness of the glass which the light had to pass through. This inconvenience is removed by taking only two small segments instead of the entire sphere ; by which means, as the refraction takes place only at the surfaces, and not in the interior of the glass, the very same refraction of the rays is produced as when the whole sphere is used ; and the thickness of the glass being greatly diminished, the rays pass through it in much greater number, and the intensity of the light in the focus is much more considerable.

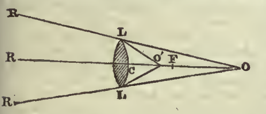
The rules for finding the focal distances of the different sorts of lenses are the following. They depend in some measure on the refracting power of the glass. We shall here suppose the index of refraction to be 1·500.

1. Rays of light, R L, R L, falling on a convex lens in directions parallel to the axis, are refracted into the point F, which is called the principal focus. In a *double* and *equally* convex lens the distance of F from C, the centre of the lens, is equal to the radius of the spherical surfaces.



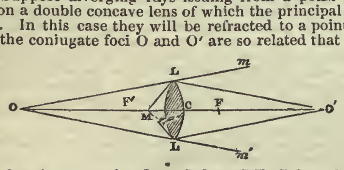
If the lens is *plano-convex*, the focal distance is equal to twice the radius of the spherical surface. If the lens is unequally convex, its focal distance is found by this rule : — Multiply the two radii of its surfaces, and divide twice that product by the sum of the radii ; the quotient will be the focal distance required.

2. When the rays falling on a convex lens whose principal focus is F converge towards a point O, their convergency will be hastened, and they will be refracted into a point O′, which is nearer the lens than the principal focus F.



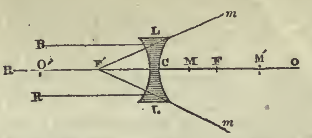
The two points O and O′ are called *conjugate foci ;* and they are related to each other in such a manner that C O′ is a fourth proportional to C O + C F, C O and C F. Hence, when the point O is given, the conjugate focus O′ will be found by this rule : — Multiply the principal focal distance C F by C O, and divide the product by the sum of those numbers. It is obvious that as the distance of O becomes greater, O′ approaches to F, and when O is at an infinite distance O′ coincides with F.

3. Suppose diverging rays issuing from a point O to fall on a double concave lens of which the principal focus is F. In this case they will be refracted to a point O′ ; and the conjugate foci O and O′ are so related that C O′



is a fourth proportional to C O — C F, C O and C F. Hence O′ is found by the following rule : — Multiply the principal focal distance C F by C O, and divide the product by the difference between C O and C F. As the point of divergence O recedes from the lens, the point O′ approaches nearer to F ; and when O is at an infinite distance, O′ coincides with F. As O approaches the lens, O′ recedes from it ; when O is at F′ (the focal distance) the refracted rays become parallel to the axis ; and when O is between F′ and C, as at M, the refracted rays diverge in the directions L *m*, L *m′*.

4. The focal distance of a concave lens is the same as that of a convex one whose surfaces have the same curvature, and the rules for finding the conjugate foci are precisely the same ; but the rays, instead of being collected, are scattered by passing through a concave lens, and the principal focus is on the same side as the point from which the rays proceed. Parallel rays R L, R C, R L, falling on the concave lens L L in the direction of the axis, become divergent, as if they proceded from F′ (the principal focus). When the rays which fall on a concave lens converge towards the point F, they are refracted in the direction parallel to the axis.



When the incident rays converge to a point O beyond F, the refracted rays diverge, as if they proceeded from a conjugate point O′, also farther from the lens than F′ ; and when the incident rays converge towards a point M, between C and F, the refracted rays will be convergent, and meet in a conjugate point M′ on the same side of the lens with M. These conjugate foci are determined by the rules which have been given for convex lenses. Lastly, when the incident rays diverge from a point O′, farther from the lens than the principal focus, the refracted rays will be more divergent, and proceed as if they emanated from a point between the principal focus and the lens. The rule is, in this case, also the same as for convex lenses.

5. The effect of a meniscus is the same as that of a convex lens of the same focal distance ; and that of a concavo-convex lens the same as that of a concave lens of the same focal distance. The principal focal distance is found by this rule : — Divide twice the product of the two radii by the difference of the radii.

6. The above rules for finding the principal and conjugate foci of the several kinds of lenses may be all expressed by two simple algebraic formulæ. Let R denote the radius of the anterior surface (or that at which the light enters), S that of the posterior surface, and let R and S be considered as positive when the surfaces, are convex, and negative when concave. Also, let F denote the distance of the principal focus, and *n* the index of refraction ; then, neglecting the thickness of the lens as inconsiderable, the formula which gives the principal focus is

$$\frac{1}{F} = (n-1)\left(\frac{1}{R} + \frac{1}{S}\right) \ldots . (1.)$$

For the conjugate foci of convergent and divergent rays, let U be the distance C O of the focus of the entering rays, and V the distance C O′ of the focus of the emerging rays ; and let U be considered as negative when the entering rays are *divergent*, and V negative when the emerging rays are *convergent ;* then,

$$\frac{1}{U} + \frac{1}{V} = \frac{1}{F}, \text{ or } V = \frac{U\,F}{U - F} \ldots . (2.)$$

the point F being determined by the formula (1.)

For the application of these formulæ to the different cases, and the correction to be made for the thickness of the lens, see *Coddington's Treatise on the Reflexion and Refraction of Light.*

In deducing the above rules it has been assumed that the focus into which the rays are refracted is a mathematical point ; but this is not strictly true, unless the rays only fall on the lens very near its centre, by reason of the *spherical aberration.* (*See* ABERRATION.) For the correction of the *chromatic aberration*, arising from the unequal refrangibility of the luminous rays, *see* ACHROMATISM. *See* also LIGHT, OPTICS, and REFRACTION.

LENS-SHAPED, or LENTICULAR, or LENTIFORM. A term used in describing the general figure of bodies, to denote their resembling a double convex lens ; as the seeds of Amaranthus.

LENT. A solemn time of fasting in the Christian church ; so called from the Anglo-Saxon signifying spring. The term of Lent comprises the forty days before Easter, by which it is determined. The period of time is intended to commemorate the fasting of our Saviour in the wilderness. *See* EASTER.

LE'NTE, or LENTO. (Ital.) In Music, a direction to the performer that the music to which the word is prefixed is to be performed slowly.

LE'NTIBULA'RIA'CEÆ. A very small natural order of Herbaceous Exogens, natives of the marshes and waters of all parts of the world. They are nearly allied to *Scrophulariaceæ*, but are distinguished by their free central placenta and minute exalbuminous embryo ; from *Primulaceæ* by their irregular flowers, their stamens, and their ovary. The beautiful *Pinguicula*, a wild plant in marshes, is one of the genera, and *Utricularia* another. They are of no known use.

LE'NTICELLES, or LENTICULAR GLANDS. A term invented by De Candolle to denote certain minute speck-like tubercles on stems. Notwithstanding the importance assigned them by this great botanist, his lenticelles appear to be nothing more than the points of roots attempting to spring from the surface of bark.

LENTI'GO. A freckle of the skin ; so named from its resemblance to a lentil seed.

LE'NZINITE. A hydrated silicate of alumina, found

at Eifield in Prussia; it is white, translucent, and falls into small hard grains when put into water.

LE'O. (Lat. *a lion.*) One of the zodiacal constellations, situated chiefly on the northern side of the ecliptic. The star *Regulus*, called also *Cor Leonis*, belongs to this constellation.

LE'O MI'NOR. The Little Lion: a constellation of the northern hemisphere, between Leo and Ursa Major. This constellation has been formed by the moderns, and is not given in Ptolemy's catalogue.

LE'ONINE VERSES. Latin verses according to the rules of ancient prosody, but rhymed. The name is said to be derived from one of the popes Leo, or, more probably, from a monk called Leoninus. The end rhymes to the middle, *i. e.* to the two last syllables before the cæsura, in hexameters; in pentameters, the two divisions are rhymed. The following distich may serve as an example:—

Dæmon languebat, monachus tunc esse volebat;
Ast ubi convaluit, mansit ut ante fuit.

LE'PADITES, *Lepadita.* (Gr. λεπας, *a shell-fish.*) Goose barnacles; an order of Cirripeds, comprehending those which have a long flexible contractile stem, fixed by its base to some solid body, and supporting at its extremity the principal parts of the animal, inclosed by a multivalve shell, or coriaceous case.

LE'PADOGA'STER. (Gr. λεπας, and γαστηρ, *stomach.*) A genus of Discobolous Malacopterygian fishes, having the following characters: pectoral fins expanded, with stouter rays at their lower edges, which curve slightly forwards, and unite with each other beneath the throat by means of a transverse membrane directed forwards, constituting the boundary of an adhesive disk, close to which there is a second, formed by the union of the ventrals; body smooth, and without scales; head broad and depressed; snout salient and protractile; branchiæ slightly cleft, and furnished with four or five rays; dorsal fin single, and opposite to the anal, which is near the tail. Of this genus we possess two native species; one of which, called the Cornish sucker (*Lepadogaster cornubiensis*), was discovered by Dr. Borlase on the coast of Cornwall; the other (*Lepadogaster bimaculatus*) has been taken on different parts of the South Weymouth coast. Both species adhere by means of their ventral suckers to rocks, stones, &c., whence the generic name: they feed principally on Crustacea.

LE'PALS. A term invented to denote stamens that are sterile. It is very rarely used.

LEPI'CENA. A term invented by Richard to denote the two empty bracts situated at the base of the locusta of a grass, and usually called glumes.

LE'PIDOIDS. A family of extinct fossil fishes belonging to the oolitic formation, remarkable for their large rhomboidal bony scales. Figures of these scales are given in *Dr. Buckland's Bridgewater Treatise.*

LE'PIDOLITE. (Gr. λεπις, *a scale*, and λιθος, *stone.*) A mineral of granular and foliated texture, moderately hard, of a pinkish colour. It contains lithia.

LEPIDO'PTERA. (Gr. λεπις, and πτερον, *a wing.*) The third order of insects in the system of Linnæus, and the tenth in that of Latreille, who has given the following concise and comprehensive description of the characters common to the insects of this most interesting, useful, and beautiful group.

The wings are four, covered on both sides with minute generally coloured scales, resembling farinaceous dust, which are removed by merely coming in contact with the finger. The oral apparatus consists principally of a proboscis, to which the name of *antlia* has been given, which is rolled spirally between two palpi, covered with scales or hairs. This forms the most important part of the mouth, and is the instrument with which these insects extract the nectar from flowers, their only aliment. It is composed of two tubular threads, representing the maxillæ, each bearing, near its external base, a very small superior palp, in the form of a tubercle. The apparent (inferior) palpi, which form a sort of sheath to the proboscis, replace the labial palpi of the mandibulated insects: they are cylindrical or conical, usually turned up, composed of three joints, and inserted in a fixed labium, which completes that portion of the buccal cavity inferior to the proboscis. Two little and scarcely distinct, corneous, and more or less ciliated pieces, situated, one on each side, on the anterior and superior margin of the front of the head, near the eyes, seem to be vestiges of mandibles. Finally, we observe, and under an equally small proportion, the labrum or upper lip.

The antennæ vary, and are always multi-articulated. Two ocelli are observable in several species, but concealed between the scales. The three segments of which the thorax is usually composed are united in one single body; the first is very short, and the two others are blended together. The scutellum is triangular, but the apex is directed towards the head. The wings are simply veined, and vary in size, figure, and position; in several the inferior ones are plaited longitudinally near the inner margin. At the base of each of the superior wings is a kind of epaulette, prolonged posteriorly, which corresponds to the piece called *tegula* in the Hymenoptera. The abdomen, composed of from six to seven annuli, is attached to the thorax by a very small portion of its diameter, and presents neither sting nor ovipositor. In several females, however, as in *Cossus*, the last rings become narrowed and extended, to form an oviduct resembling a pointed and retractile tail. The tarsi always have five joints. There are never more than two kinds of individuals, males and females.

The females usually deposit their ova, frequently very numerous, on the vegetable surfaces which are to nourish their larvæ, and soon after perish.

The larvæ of Lepidopterous insects are well known by the name of caterpillars. They have six squamous or hooked feet, which correspond to the legs of the perfect insect, and from four to ten additional membranous ones, or *propedes;* the two last of which are situated at the posterior extremity of the body. Those caterpillars which have but ten or twelve in all have been called, from their mode of progression, *geometræ.* Several of these geometers, when at rest, remain fixed to the branches of plants by the hind feet alone, whence in the form, colour, and directions of their body, they resemble a twig. They can support themselves in this position for a long time without exhibiting the slightest symptom of life. So fatiguing an attitude must require prodigious muscular force; and, in fact, Lyonnet counted 4041 *muscles* in the caterpillar of the *Cossus ligniperda.*

The body of these larvæ is generally elongated, almost cylindrical, soft, variously coloured; sometimes naked, and sometimes covered with hairs, tubercles, and spines. It is composed of twelve segments or annuli, exclusive of the head, with nine stigmata on each side. Their head is invested with a corneous or squamous dermis, and presents on each side six shining granules, which appear to be ocelli; and it is furnished with two very short and conical antennæ, and a mouth composed of strong mandibles, two maxillæ, a labrum, and four small palpi. The silk which they use is elaborated in two long and tortuous internal vessels, of which the attenuated superior extremities terminate in the lip. A tubular and conical mamilla forms the spinnaret through which the threads are spun.

Most caterpillars feed on the leaves of plants; some gnaw their flowers, roots, buds, and seeds; others attack the ligneous or hardest part of trees, softening it by means of a fluid which they disgorge. Certain species attack our woollens and furs, thereby doing us much injury; even our leather, bacon, wax, and lard, are not spared by them. Several confine themselves exclusively to a single article of diet; others are less delicate, and devour all sorts of organized matters.

Some of them form societies, and frequently live under a silken tent, spun by them in common, which even shelters them in winter. Several construct sheaths for themselves, either fixed or portable; others make their abode in the parenchyma of leaves, where they form galleries. The greater number are diurnal: the others never issue forth but at night. The severity of winter, so fatal to almost all insects, does not affect certain *Phalænæ*, which only appear in that season.

Caterpillars usually change their skin four times previously to passing into the state of a nymph or chrysalis. Most of them spin a cocoon in which they enclose themselves. A frequently reddish liquor, which Lepidopterous insects eject at the moment of their metamorphosis, softens or weakens the extremity of the cocoon, and facilitates their exit: one of these extremities, also, is generally thinner than the other, or presents a favourable issue by the peculiar disposition of the fibres. Other caterpillars are contented with connecting leaves, particles of earth, or of the substances on which they have lived, and thus forming a rude cocoon. The nymphs of the diurnal Lepidoptera are ornamented with golden spots, whence the term *chrysalis* applied to them: they are naked, and fixed by the posterior extremity of the body. The nymphs of all the Lepidoptera are swathed, or resemble mummies. Those of several insects of this order, particularly of the *Diurnæ*, undergo their metamorphosis in a few days; they even frequently produce two generations in the course of the year. The caterpillars or chrysalides of others, however, remain during the winter in one of these states, and undergo their final transformation in the ensuing spring. The Lepidoptera issue from their nymphal envelop through a slit, which is effected in the back of the thorax.

LE'PIDOPUS. (Gr. λεπις, and πους, *a foot.*) A genus of Tænioid fishes, characterized by the reduction of the ventral fins to the condition of small scaly plates. The thin and elongated body is without scales: it is furnished with a dorsal fin, which extends its whole length, and a narrow anal fin; it terminates in a well-formed caudal. The branchiostegous rays are eight in number; the head is pointed, with a single row of laniary teeth in each jaw, the largest above, and others, very small, on the

palatine and pharyngeal bones. Of this genus one native species is known, called the Scabbard-fish (*Lepidopus argyreus*). It is very rare: only four examples are recorded by Mr. Yarrell, which were taken on the southern shores.

LEPIDO'TUS. In Palæontology, the name of a fossil fish, distinguished by its large, thick, rhomboidal, enamelled scales, and its hemispherical or obtusely conical teeth: its remains are widely diffused through the wealden formation.

Lepidotus. In Botany, Latin term for leprous.

LE'PIS. (Gr. λεπις, *a scale.*) A scale or scurf, consisting of a thin transparent membrane attached by its middle, and, owing to the imperfect union towards its circumference of the cellular tissue of which it is composed, having a lacerated irregular margin. It gives origin to the adjective Lepidote.

LEPI'SMA. (Gr. λεπισμα, *decortication.*) A Linnæan genus of Apterous insects, forming the first family of Thysanourous insects in the system of Latreille. The body of these apterans is elongated, and covered with small scales, frequently silvery and brilliant; from which circumstance the most common species has been compared to a little fish. The antennæ are setaceous, and usually very long. The feet are short, and frequently have very large and strongly compressed coxæ, resembling scales. These insects run with great velocity: some of them, by means of their caudal appendage, are enabled to leap. Several species conceal themselves in the cracks of the framework of windows, in wardrobes, under damp boards, &c.: others hide beneath stones.

Lepisma. In Botany, a term sometimes applied to the cup-shaped disk of *Pæonia* and *Aconitum;* but seldom employed.

LEPI'SMIDÆ. The family of Thysanourous insects of which the genus *Lepisma* is the type. It includes the genera *Lepisma* proper, and *Machiles*. See those words.

LEPO'RIDÆ. The hare tribe, or the family of Rodents of which the genus *Lepus* is the type.

LE'PRA. (Gr. λεπρος, *rough.*) The leprosy; a disease of the skin, characterized by scaly patches, nearly of a circular form. The cuticle becomes reddish and scaly; at first upon some one spot, often the knee, and thence gradually spreads over the body, which becomes stiff and uncomfortable, and most unseemly in appearance. Friction, warm baths, sulphur baths, and afterwards slightly stimulating ointments, such as pitch ointment, or weak citrine ointment, with light and moderate diet, and careful abstinence from wine and stimulants, are the principal means of cure. This disease appears to have been of much more frequent occurrence in ancient than in modern times; but it is generally believed that the *lepers* mentioned in the sacred and profane authors were afflicted with a disease resembling more that known by the name of elephantiasis than leprosy.

LEPTOCE'PHALANS. *Leptocephalidæ.* (Gr. λεπτος, *slender;* κεφαλη, *a head.*) The name of a family of fishes characterized by the smallness of the head, of which the genus *Leptocephalus* is the type.

LEPTOCE'PHALUS. A genus of Apodal Malacopterygian fishes, in the system of Cuvier, characterized by a very small and short head, and a remarkably compressed and delicate body: the pectoral fins and branchial apertures are very small; the dorsal and anal fins are narrow, and united at the point of the tail. One species of this rare and singular genus was discovered near Holyhead, and was described by Gronovius under the generic name of *Leptocephalus*, in reference to the diminutive size of the head. The *Leptocephali* are more common in the seas of hot climates.

LEPTU'RA. (Gr. λεπτος, *slender*, οὐρα, *a tail.*) A Linnæan genus of Longicorn beetles, now the type of an extensive family (*Lepturidæ*), in which the eyes are rounded and entire, or, if slightly emarginate, with the antennæ inserted before the emargination. The head is always inclined posteriorly behind the eyes, or is abruptly contracted at its junction with the thorax, in the manner of a neck; the thorax is conical or trapezoidal, narrowed anteriorly; the elytra become gradually narrower. The term *Leptura* is now restricted to those Lepturidans in which the head is abruptly narrowed immediately behind the eyes; the antennæ inserted near the anterior extremity of the internal emargination of the eyes, the two eminences from which they rise being almost confounded in one plane. The thorax is almost always smooth, or without lateral tubercles.

LE'PUS. (Lat. *a hare.*) A genus of Rodents peculiarly distinguished by having their superior incisors double; *i. e.* each of them has a smaller one behind it. The molar teeth are also more numerous than in most other Rodentia, there being six on each side of the upper jaw, and five on each side of the lower jaw: the ears are very long, the tail short and turned up. The species of this genus are called hares and rabbits. The eyes are large and prominent, and, with the well-developed ears, serve to announce to these timid and defenceless animals remote objects and sounds of peril: the strength and proportions of the limbs, of which the hind pair is much longer than the fore, enable them to escape by rapid flight. The smaller species, as the rabbit, add to their means of safety by burrowing in the soil. Among the anatomical characters of the genus *Lepus* may be reckoned the rudimental condition of the clavicles, and the reticulate bony structure of the infra-orbital spaces.

Lepus. The Hare. In Astronomy, one of the forty-eight ancient constellations of Ptolemy, situated in the southern hemisphere.

LERNÆIFO'RMES. (Lat. lernæa, *a parasitic worm;* forma, *form.*) The name of a family of Siphonostomous Crustaceans, comprehending those with a long vermiform body.

LERNE'A. (Gr. λερναια, *a name of the hydra.*) A Linnæan genus of low-organized crustaceous animals, all of which are external parasites of fishes, and constitute the class *Epizoa* of modern systems.

LE ROI LE VEUT. (Fr. *the sovereign wills it, or assents.*) A form of words by which the royal assent is intimated by the clerk of parliament to the passing of public bills. To private bills the royal assent is expressed by *Soit fait comme il est desiré*. The dissent of the sovereign to the passing of any measure is signified by the words *Le roi s'avisera*. *See* Parliament.

LE'SSONS (Lat. lego, *I read*), are certain portions of the scriptures read in most Christian churches during divine service, the performance of which in the ancient church devolved, among other duties, on the catechumen. In the English church, the course of lessons begins with the year at the book of Genesis, and, with the omission of the two books of Chronicles, continues through the Old Testament, including portions of the Apocrypha.

In the *second* lessons, as they are called, the same course is followed with the New Testament. In the Presbyterian church the word *lesson*, in this sense, is unknown, though the practice of reading a portion of scripture is almost universally adopted; but the selection of the passage is left to the choice of the officiating clergyman.

LESTRIS. (Lat. *a robber.*) A subgenus of Gulls, separated from the *Larus* proper on account of their large membranous nostrils opening nearer the point and edge of the beak, and their tail being pointed. They pursue the small gulls with singular pertinacity and boldness to rob them of their food; and hence their name.

LE'THARGY. (Gr. ληθη, *forgetfulness.*) A heavy unnatural slumber, sometimes bordering upon apoplexy, from which persons are difficultly roused. It sometimes arises from a plethoric state of habit, in which case it requires depletion; but it often also is a symptom of over fatigue of mind, and then nervous remedies are indicated.

LE'THE. (Gr. ληθη.) In Greek Mythology, the River of Oblivion: one of the streams of the infernal regions. Its waters possessed the quality of causing those who drank them to forget the whole of their former existence. In the sixth book of *Virgil's Æneid*, the shades of the departed, after fulfilling their various destinies in the infernal regions during a thousand years, are brought to drink of the water of Lethe, as a preparation for their transmigration into new bodies.

> Has omnes, ubi mille rotam volvêre per annos,
> Lethæum ad fluvium deus evocat agmine magno;
> Scilicet immemores supera ut convexa revisant,
> Rursus et incipiant in corpora velle reverti.

The beautiful verses of Milton are well known: —

> Far off from these, a slow and silent stream,
> Lethe, the river of oblivion, rolls
> Her watery labyrinth: whereof whoso drinks
> Straightway his former sense and being forgets —
> Forgets both joy and grief, pleasure and pain.

Nor is the "slow and silent stream" less exquisitely described by Dante: —

> Tutte l'acque, che son di là più monde,
> Parrieno avere in se mistura alcuna
> Verso di quella, che nulla nasconde;
> Avvegnaché si muova bruna bruna
> Sotto l'ombra perpetua, che mai
> Raggiar non lascia sole ivi, nè luna.

Geographers have placed the river Lethe (that is, its supposed issue on the surface of the earth) in Bœotia, near Lebadea, in Crete, and on the coast of Africa. There was also a river of oblivion (limia oblivionis) in Spain, now the Lima.

LE'TTER. (Lat. litera.) A character used to express one of the simple sounds of the voice. Letters properly combined form the visible signs of those sounds by which we communicate our ideas. What letters were originally, who first invented them, and among what people they were primarily used, are still questions of profound obscurity. Philo, says the *Ency. Brit.*, attributes this great and noble invention to Abraham; St. Irenæus and others to Enoch; Bibliander to Adam; Eusebius, Clemens Alexandrinus, Cornelius Agrippa, and others, to Moses; Pomponius Mela, Herodian, Rufus Festus, Pliny, Lucan, and others, to the Phœnicians; St. Cyprian to Saturn; Plato and Tacitus to

the Egyptians; some to the Ethiopians, and others to the Chinese, who cannot possibly be entitled to this honour, since all their characters are the signs of simple ideas, and have nothing in common with letters. Various also are the conjectures concerning the different kinds of letters used in different languages. Thus, Moses is supposed by Crinitus to have invented the Hebrew letters; Abraham the Syriac and Chaldæic; the Phœnicians those of Attica; Nicostrata the Roman; Isis the Egyptian; and Vulfilas those of the Goths. All these statements, however, are purely conjectural; and it would be vain to examine the foundation on which they are based. Letters are distinguished by grammarians into vowels, and consonants (which latter are again subdivided into mutes and liquids), and diphthongs, according to the organ employed in their pronunciation. *See* ALPHABET, LANGUAGE.

LETTER, in Printing, is the usual term for an aggregate quantity of types in a printing office; as when a work is put in hand, and there happens to be a great quantity of type of the proper sort unemployed, it is usual to say "there is plenty of letter;" and, on the contrary, "there is a scarcity of letter."

LETTER OF CREDIT. A letter written by one merchant or correspondent to another, requesting him to credit the bearer with a certain sum of money. The bearer should be described with as many particulars as possible, lest the letter fall improperly into other hands.

LETTER OF LICENCE. An instrument by which creditors allow a party who has failed in his trade time for payment of debts and management of affairs.

LETTER OF ATTORNEY. A document by which a party gives another, named therein, power to do certain lawful acts in his stead, the party so authorized being called his attorney; such as to give seisin of lands; sue; or receive rents debts, and dividends.

LE'TTERS OF MARQUE. *See* MARQUE.

LE'TTERS PATENT, or LETTERS OVERT, in Law, are letters of the king, open, but sealed at the foot with the great seal of England, conferring some privilege whereby a party is enabled to do or enjoy that which otherwise he could not. Such are letters patent to make denizens, to protect inventions, &c.

LEU'CIN. (Gr. λευκος, *white.*) A white pulverulent substance, obtained by the action of dilute sulphuric acid on muscular fibre. It combines with nitric acid, forming the *nitro-leucic acid.*

LEU'CITE. (Gr. λευκος.) A crystallized mineral, of a grey or white colour, generally opake, and something resembling the garnet in form. It usually occurs in lava, especially in that of Vesuvius; hence it is also termed *Vesuvian* and *volcanic garnet.*

LEUCO'MA. A white opacity of the cornea of the eye, arising from inflammation.

LEUCOPE'TRIANS. In Ecclesiastical History, the name of a fanatical sect of Christians which sprang up in the Greek and Eastern churches towards the close of the 12th century. The tenets which they embraced were peculiarly strict; while they rejected all the outward ceremonies of religion, and spent their whole time in prayer and supplication to the Deity. They derived their name and origin from an enthusiast, Leucopetrus, of whom little is known beyond his name

LEU'COPHLEGMA'TIC. A pallid flabby state of body.

LEVA'NT (It. levante, *rising*), in Geography, is applied in a general sense to any country situated to the eastward of us, or in the eastern part of any continent or country; but, in a more contracted signification, it is given to that part of the Mediterranean sea bounded by Asia Minor on the north, Syria and Palestine on the east, Egypt and Barca on the south, and by the island of Candia and the rest of the Mediterranean on the west.

LEVA'RI FACIAS. In Law, a writ of execution directed to the sheriff, whereby he is commanded to levy a sum of money upon the lands and tenements, goods and chattels, of a man who has forfeited his recognizances. It is superseded in practice by the writ of elegit, except in cases of outlawry.

LEVA'TOR MUSCLES. Those which lift the part to which they are attached.

LE'VEE (Fr. lever, *to rise*), is the term used in court language for the ceremonial visits which distinguished personages receive in the morning; or, as the word implies, at their *rising*. It is chiefly applied in this country to the stated public occasions on which her Majesty receives visits from such of her subjects as are entitled by rank or fortune to the honour. The difference between a *lévee* and a *drawing-room* consists in this,—that while at the former gentlemen alone appear (with the exception of the chief ladies of the court), both ladies and gentlemen are admitted to the latter.

LEVEE EN MASSE. (Fr. literally *an universal rising.*) A military expression for the rising of a whole people to defend their country from invasion. In Germany it is styled landsturm, in contradistinction to the landwehr or militia (*quod vide*); and there, as in Spain and Tyrol, its efforts have often proved instrumental in rescuing the country from foreign invasion.

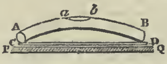
LE'VEL. An instrument which shows the direction of a straight line parallel to the plane of the horizon.

The plane of the sensible horizon is indicated in two ways: by the direction of the plummet or plumb-line, to which it is perpendicular; and by the surface of a fluid at rest. Accordingly, levels are formed either by means of the plumb-line, or by the agency of a fluid applied in some particular manner. They all depend upon the same principle, namely, the action of terrestrial gravity.

Levels in which the plumb-line forms the essential part are those most usually employed for the common purposes required by bricklayers, masons, carpenters, &c. They are constructed under many different forms; but the general principle is as follows:—A frame or board is prepared, having one edge perfectly straight, and a straight line is drawn on the frame at right angles to the straight edge. To some point of this straight line a thread carrying a plummet is attached; consequently, when the frame is placed in such a position that the thread of the plummet, hanging freely, coincides with the straight line, the straight edge of the frame, which is perpendicular to it, must be horizontal. *See* PLUMMET.

The *Artillery Foot Level*, and the *Gunner's Level*, besides the line and plummet, have a scale for showing the inclination of a straight line to the horizon. The former has two equal legs or branches placed at right angles; and from their point of junction a thread and plummet hangs, and plays over a quadrant divided into twice 45° from the middle. The plane or line on which the two ends rest is horizontal when the thread falls over the zero point of the scale; and when it falls over any other point, the degree marked on the scale indicates the inclination of the line to the horizon. The gunner's level is on the same principle, though differently constructed; the thread or plummet being replaced by a solid piece of brass, loaded at the lower end, and the legs, or rather the edges, of the brass plate making an angle of 45°. It is used in the same manner as the former.

Spirit Level.—By far the most convenient and also the most accurate level is the spirit level, represented in the annexed figure; "which is nothing more than a glass tube nearly filled with a liquid (spirit of wine being now generally used, on account of its *mobility* and not being liable to freeze), the bubble in which, when the tube is placed horizontally, would rest indifferently in any part if the tube could be made mathematically straight; but that being impossible to execute, and every tube having some slight curvature, if the convex side be placed upwards the bubble will occupy the higher part, as in the figure (where the curvature is purposely exaggerated). Suppose such a tube as A B firmly fastened on a straight bar C D, and marked at *a b*, two points distant by the length of the bubble; then, if the instrument be so placed that the bubble shall occupy this interval, it is clear that C D can have no other than one definite inclination to the horizon; because, were it ever so little moved one way or other, the bubble would shift its place, and run towards the elevated side. Suppose now that we would ascertain whether any given line P Q be horizontal; let the base of the level C D be set upon it, and note the points *a b*, between which the bubble is exactly contained; then turn the level end for end, so that C shall rest on Q, and D on P: if then the bubble continue to occupy the same place between *a* and *b*, it is evident that P Q can be no otherwise than horizontal; if not, the side towards which the bubble runs is highest, and must be lowered. Astronomical levels are furnished with a divided scale, by which the places of the ends of the bubble can be nicely marked." (*Herschel's Astronomy*, p. 92.)

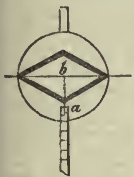


The accuracy of the indications of the level depends in a considerable degree on the regularity of the interior surfaces of the tube. They are commonly made of glass tubes in the same state as they are obtained at the glass-house; but when very great accuracy is required, as in astronomical observations, the interior surfaces are sometimes ground so as to give them a regular cylindrical, or rather spindle form, with a slight spherical curvature. The tube and bubble must be of considerable length. The larger the bubble the more freely it moves, and consequently the more sensible is the level to a small inclination. With proper care they can be executed, it is said, with such delicacy as to indicate a single second of angular deviation from exact horizontality.

LE'VELLERS. In English History, a party which arose in the army of the Long Parliament, about the time when it overawed that assembly, and transferred the king

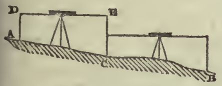
to Hampton Court, in 1647. The levellers professed, what their name implied, a determination to level all ranks, and establish an equality in titles and estates throughout the kingdom. Several of the officers belonging to this party were cashiered in 1649; and, on Cromwell's departure for Ireland in the end of that year, they raised mutinies in various quarters occupied by the army, and were put down by Fairfax with some bloodshed. John Lilburne, one of the chiefs of the faction, — of whom it was said that, "if none but he were left alive in the world, John would quarrel with Lilburne,"—published, in 1649, his *Manifestation from J. Lilburne and others, styled Levellers*. (See *Clarendon*, books x. and xii.; *Godwin's History of the Commonwealth.*)

LEVELLING STAVES. Instruments used with the spirit level, for supporting a mark, and showing at the same time its height above the ground. As constructed by Troughton, they consist of three sliding rods of mahogany, each about four feet long, and divided into feet and hundredths. They carry each a circular sliding vane, having at the lower edge a square aperture, one side of which is levelled; and a line on the levelled side denotes the reading of the staff. The face of the vane is made of white holly, with an inlaid lozenge of ebony, forming at once a conspicuous object, and one easy of bisection. In levelling, the vane must be moved up or down till the horizontal wire of the telescope bisects the acute angle of the lozenge, as shown in the figure. As the line on the levelled edge at a denotes the reading of the staff, a piece equal in length to the distance $a\ b$ is cut off from the bottom of the staff, or, rather, the divisions commence at that number of inches above zero. (*Simms's Treatise on Mathematical Instruments*, 1834.)

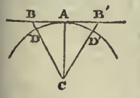


LEVELLING. A branch of surveying, which has for its object to discover how much any assigned point is higher than another assigned point above a level surface, or such a surface as water would assume when perfectly at rest.

In ordinary cases of levelling (for example, for canals, railroads, &c.) the instruments commonly employed are a spirit level attached to a telescope, and a pair of staves. (*See* Levelling Staves.) Suppose that the difference of level between A and B is to be found: the staves are placed successively at A, C, &c.; the intervals not exceeding 400 yards, on account of the curvature of the earth, and the levelling instrument placed between, at equal distances, to avoid corrections for refraction. It is then directed backwards to the first staff, A D, and next forward to the second, C E; and, at each observation, the division on the staff, or the height at which the visual ray meets it, is noted. The difference of the heights — that is, C E, A D — is the height of the higher station above the lower. The hindmost staff, and the levelling instrument, are now carried forward to a new position, and the back and fore observations repeated; and so on, till the operation is completed. Then the difference between the sum of the heights measured in the back observations, and the sum of the heights measured in the fore observations, will give the height of the one extreme station above the other.



But, in extensive surveys, it is often necessary to place the levelling staves at much greater distances from each other than 300 or 400 yards, in which case allowance must be made for the earth's curvature. Let D A D′ represent the arc of a great circle of the earth's surface, and A the place of an observer. All the points in this arc are in the same level; but the line of sight indicated by the level is a tangent to the circumference at A, and, consequently, objects B B′, in this line, will *appear* in the same level with A, though they are really elevated above it by the distances B D, B′ D′, intercepted on the radii between the arc and the tangent. Now, from the nature of the circle $AB^2 = BD\ (2\ CD + BD)$; but, in all cases of actual levelling, the arc A D is very small in comparison of the whole circumference, consequently the square of B D may be neglected, and the arc substituted for the tangent: we have then, for the value of B D, this expression, $BD = \frac{AD^2}{2\ CD}$; that is to say, the depression of the true level below the apparent level is equal to the square of the distance divided by twice the radius of the curvature of the earth. Supposing the diameter of the earth to be 7916 miles, and A D = 1 mile; we shall have B D equal to the 1-7916th of a mile, or 8·004 inches. At



the distance of 2 miles, the correction will be four times this quantity, or 32·016 inches; and so on, increasing as the square of the distance. It is most convenient to reckon both the distances and the corresponding depressions in feet and decimals of a foot; in which case the correction becomes $\frac{1}{7916 \times 5280} AD^2$, to be subtracted from the apparent or observed level, in order to obtain the true. The following table shows the depression in feet and decimals of a foot, for the different distances therein stated, the mean diameter of the earth being assumed = 7916 miles: —

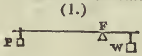
Distance.	Depression.	Distance.	Depression.
Yards.	*Feet.*	*Miles.*	*Feet.*
100	0·00215	1	0·667
200	0·00861	2	2·669
300	0·01938	3	6·006
400	0·03445	4	10·677
500	0·05383	5	16·683
600	0·07752	6	24·024
700	0·10551	7	32·699
800	0·13781	8	42·709
900	0·17441	9	54·054
1000	0·21533	10	66·733
1100	0·26055	11	80·747
1200	0·31008	12	96·095
1300	0·36390	13	112·779
1400	0·42205	14	130·796
1500	0·48449	15	150·150
1600	0·55124	16	170·836

LE′VER. In Mechanics, an inflexible rod moveable about a *fulcrum* or prop, and having forces applied to two or more points in it. The lever is one of the mechanical powers; and, being the simplest of them all, was the first that was attempted to be explained. Its properties are treated of by Aristotle; but the first accurate explanation was given by Archimedes, in his Treatise *De Equiponderantibus*.

In treating of the lever, it is convenient to distinguish the forces applied to it by different names. One is usually called the *power*, the other the *weight* or *resistance*.

Levers are commonly divided into three kinds, according to the relative positions of the power, the weight, and the fulcrum. In a lever of the first kind (fig. 1.), the fulcrum F is between the power P and the weight W. In a lever of the second kind (fig. 2.), the weight W is between the fulcrum F and the power P. In a lever of the third kind (fig. 3.), the power P is between the fulcrum F and the weight W.

(1.)



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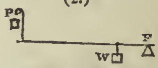

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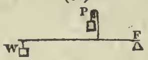


The general principle of the lever is, that when the power and weight are in equilibrio, they are to each other inversely as their distances from the fulcrum. This property is almost an obvious consequence from the principle of virtual velocities; but it may be deduced from more familiar considerations. Let A B be a cylinder or bar of homogeneous matter. If supported from the middle, O, the two ends would evidently balance each other, and the pressure at O would be the same as if the whole matter of the bar were concentrated in that point. Suppose it to consist of two parts, A C and B C, these again would be separately supported at their middle points D and E; or the whole of the matter in A C may be conceived to be concentrated at D, and the whole of that in B C at E, and the equilibrium would not be disturbed. Hence the weight of A C attached at D, and the weight of B C attached at E, would balance the inflexible line D E, if supported at O, the centre of the whole bar A B. But $OD = AO - AD = \frac{1}{2}AB - \frac{1}{2}AC = \frac{1}{2}BC$; and $OE = OB - EB = \frac{1}{2}AB - \frac{1}{2}CB = \frac{1}{2}AC$; consequently, O D is to O E as B C to A C; or O D is to O E as the weight concentrated at E to the weight concentrated at D. This demonstration is commonly ascribed to Archimedes. (*Maclaurin's Account of Newton's Principia.*)

This proposition shows the advantage obtained by using the lever as a mechanical engine. The arm P F (fig. 1.) is commonly longer than W F, and, consequently, when there is equilibrium the weight exceeds the power. The proportion in which the weight exceeds the power is called the *mechanical advantage*, or purchase. Suppose P F (figs. 1. and 2.) = 4 feet, and W F = 1 foot; then a power of 1 lb. acting at P will overcome a resistance of 4 lbs. at W.

Suppose the lever with the weights P and W to turn round the fulcrum, the two points to which P and W are attached will describe arcs proportional to the radii F P, F W; consequently the power P is to the weight W as the velocity of the weight to the velocity of the power.

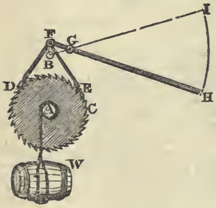
Therefore in this, as in all mechanical engines, when a small power raises a great weight the velocity of the power is much greater than the velocity of the weight; and what is gained in force is therefore said to be lost in time.

When the power and the weight do not act on the lever in directions perpendicular to its length, or when the arms of the lever are not in the same straight line, or are bent, then the power and the weight are not to each other reciprocally as the arms of the lever, but as the straight lines drawn from the fulcrum perpendicular to the respective directions in which the power and the weight take effect.

Examples of the application of the lever are of constant occurrence in the mechanical arts. The crowbar, the handspike, the poker, scissars, nippers, pincers, &c., are levers of the first kind; the toothed hammer is only a bent lever of this kind. The second kind includes the chipping knife, nutcrackers, the common door, oars and rudders, the wheelbarrow, &c. To levers of the third kind belong the sheep-shears, the treddle of the turning lathe, tongs, &c.: these have a mechanical disadvantage, but admit of a proportionally wider motion. The bones of animals are generally levers of this sort. The socket of the bone is the fulcrum; a strong muscle attached to it near the socket is the power; and the weight of the limb, with whatever resistance is opposed to its motion, is the weight. A very moderate contraction of the muscle thus gives considerable motion to the limb.

From the principle of the lever is deduced the distribution of pressure in the case of a pole bearing an intermediate weight. If the weight hang from the middle, the carriers will share the burden alike; but if a load is laid over the pole, and a vertical from its centre of gravity divides the length unequally, as will be the case on altering the inclination of the pole (for example, in climbing a hill), then the bearer nearest to whom the vertical falls suffers a greater strain than the other.

Universal Lever is the name given to a machine formed of a combination of the lever with the wheel and axle, the object of which is to give a continued rectilinear motion to a heavy body by means of the reciprocating motion of the lever. F G H is a straight line, whose centre of motion is at G. At the extremity of its shorter arm hang two bars, the former of which has a hook to catch into the teeth of the wheel A C D, while the latter has its end bent in order to slide over the outer parts of those teeth. The axle A has a cord wound round it, to the end of which is attached the weight W. Now suppose the end H of the lever to be raised from H to I, while the other end descends from F to B; the bar F E will then push the tooth E of the wheel to C, while the hook D slides over an equal space on the other side of the wheel. On bringing down again the end of the lever from I to H, the other extremity ascends through B F, and the hook D raises up the left-hand side of the wheel through a space equal to E C. Thus the reciprocating motion of the lever is made to communicate a continued rotatory motion to the wheel, and, consequently, to lift the weight W suspended from its axle by the cord. The universal lever has long been employed in saw-mills, for the purpose of drawing along the logs to the saw. (*Gregory's Mechanics*, vol. ii.)



LEVI'ATHAN. The name of a great marine animal in the Book of Job, described in chapter xli., which was covered with close-joined or confluent scales, and had the jaws, or "doors of the face," armed with terrible teeth round about. Some naturalists have supposed that the crocodile might be the subject of the sacred poet's allusions; but the "breath that kindleth coals" could scarcely be suggested by the respiratory actions of a cold-blooded reptile. The same objection applies to the opinion that the leviathan of Job was the extinct megalosaurus: with this additional difficulty, that the megalosaurus was a terrestrial reptile, as the large medullary cavities of its bones prove; while of the leviathan it is said that "He maketh the deep to boil like a pot; he maketh the sea like a pot of ointment: he maketh a path to shine after him; one would think the deep to be hoary. Upon earth there is not his like." These expressions accord well with the violent and impetuous exertions of a huge cetacean in his native element; and the verse, "Out of his nostrils goeth smoke, as out of a seething-pot or cauldron," does not inaptly figure the "blowing" of a whale. The teeth of either the cachalot or grampus might well be termed terrible; and their external epidermic covering, if considered as analogous to the scales of fishes, would have its distinguishing peculiarities correctly defined by the following expressions:—"His scales are his pride, shut up together as with a close seal. One is so near another, that no air can come between them. They are joined one to another, *they stick together, they cannot be sundered.*" (Verses 15, 16, 17.) Many persons must have witnessed the phenomena of the luminosity of the sea on our own coasts, where it is usually feeble in comparison with that produced in the warmer latitudes of the Mediterranean, or in the tropics. The phenomena which naturalists and voyagers have described as being produced by the swimming and blowing of the cetaceous animals in a phosphorescent ocean, during the night, might likewise have suggested the description of the fire and sparks that escape from the mouth of the leviathan, and of the shining path that he leaves behind him in the deep.

LEVIGA'TION. (Lat. lævus, *smooth.*) The process of reducing substances to a state of fine mechanical division, by mixing them, previously powdered, with water or some other fluid, and rubbing the paste upon a hard smooth slab, with the flat face of a stone called the muller. The paste is then often stirred into a large vessel of water, where the coarser powder first falls, and the finer remains suspended, and is afterwards collected by pouring it off with the water, and suffering it slowly to subside. In this way, by repeated subsidences, powders of very different degrees of fineness are obtained.

LE'VITES. The descendants of Levi, one of the twelve sons of Jacob, to whom no distinct territory was allotted in the land of Canaan, as to the other tribes; but who were set apart for the ministration of the religious services throughout the country, and had forty cities, situated in various parts of Palestine, peculiarly appropriated to their residence. The law of Moses commanded the tenth of the vegetable produce of the land, and also of the cattle, to be given to them; of this a tenth was set apart for the priests, whose assistants the Levites were. When God destroyed the first-born of the Egyptians, he appointed that the first-born males of the Israelites should be "set apart unto himself" (Exod. xiii.), in commemoration of the immunity from that visitation which was vouchsafed to the chosen people. Afterwards it is recorded that, upon the sons of Levi discovering an extraordinary zeal against idolatry, in the case of the golden calf (Exod. xxxii.), the religious offices of the first-born were assigned as an honourable privilege to that tribe. The priests were confined to the family of Aaron, who, with Moses his brother, were both of the tribe of Levi. For the classes of which the Levites were composed, their offices, privileges, &c., see particularly Numb. iii. iv. viii.; also 1 Chron. xxiii.—xxvi.

LE'VYNE (so called from Levy, the crystallographer). A crystallized mineral found in Ireland, Faroe, and elsewhere, closely allied to the zeolites. It is a hydrated alumino-silicate of lime and soda.

LEXICO'LOGY, or LEXIGOGRAPHY. (Gr. λεξις, *a word or phrase*, and λογος, *description.*) A word used by some writers to express that branch of philology which treats of words alone, independently of their grammatical and rhetorical uses; considering their senses, their composition, and their etymology. (*See* PHILOLOGY.) There are two useful papers in the *Quarterly Review* on Greek lexicography, vols. xxii. xliv.

LE'XICON. (Gr. λεξις.) A dictionary of words, or vocabulary; originally, and still usually, confined to dictionaries of the Greek or Hebrew tongues. The oldest Greek lexicon is the *Onomasticon*, which was written 180 years before Christ; the oldest Hebrew lexicon belongs to the 9th century. *See* DICTIONARY.

LEYDEN JAR. *See* ELECTRICITY.

LEZE-MAJESTY. In Jurisprudence, any crime committed against the sovereign power in a state. The name is derived from the Roman phrase, "crimen læsæ majestatis," which denoted a charge brought against a citizen for acts of rebellion, usurpation of office, and general misdemeanours of a political character, which were comprehended under the title of injuries to the "majesty of the Roman people." The emperors transferred to all offences against themselves the same criminal character; and offences of leze-majesty were multiplied under their arbitrary governments.

LI'AS. A provincial name, adopted by geologists, for an argillaceous limestone, which, together with its associated beds, is characterized by peculiar fossils. *See* GEOLOGY.

LIBA'TION. (Lat. libo, *I pour.*) The solemn pouring of wine and other liquids in the religious ceremonies of antiquity; in Greek σπενδειν. Libation appears (if our translation is correct) to have been used in the earliest recorded sacrifice; for Abel offered milk (Gen. iv. 4.): a daily libation of water was used by the Jews in the Feast of Tabernacles; the burnt offering instituted by Moses was of wine. (Numb. vi. 7.) The Grecian libations, in like manner, were of unmixed wine; but sacrifices to nymphs, Ceres, Proserpine, and some other deities, were attended by libations of oil and wine, &c.

The wine was poured between the horns of victims, on the altar or on the ground. The ancients had also a well-known custom of pouring out a small quantity of wine, by way of libation to the gods, at the commencement of their banquets; and libation for the emperors became common under imperial Rome. (See this art. in the *Enc. Met.*)

Te multa prece, te prosequitur mero
Defuso pateris. HORACE.

LIBA'VIUS'S FUMING LIQUOR. Bichloride of tin, obtained by distilling a mixture of 1 part of tin filings with 3 of corrosive sublimate. It emits dense white vapours when exposed to air.

LI'BEL. In the Spiritual Courts, the original declaration in a civil action is so termed. *See* LAW, ECCLESIASTICAL.

LIBEL, in Law, signifies almost any malicious publication by writing or printing, or by signs, pictures, &c. Whatever tends to render a man odious or ridiculous, or to lower him in the esteem and opinion of the world, is a libel; and may either be made the subject of a civil action for compensation in damages to the individual injured, or, as having a tendency to excite his wrath, and provoke a breach of the peace, may be proceeded against by indictment or criminal information. Where it is sought to make a party responsible in damages for a libellous publication, he may set up the truth of it as an answer to the complaint; for the plaintiff, if really guilty of the misconduct or other thing imputed to him, is not considered to suffer by its disclosure any private injury which can be a legitimate ground of compensation to him; but, when the proceeding is by criminal prosecution, the truth is no defence whatever, as being altogether immaterial; for the libellous matter may equally provoke a breach of the peace, whether it be true or false. The court, however, will, in general, before granting a rule for a criminal information, which supersedes the usual practice of a presentment by the grand jury, require the prosecutor to deny on affidavit the truth of the matters charged against him. It will be seen, however, that there is not in any case a legal foundation for the maxim vulgarly ascribed to the law, "The greater the truth the greater the libel." All publications are libels, and criminally punishable as such, which have a tendency to disturb the public peace, his majesty's government, the established religion, public morals, or the administration of justice. Before the 32 Geo. 3. c. 60. (Fox's Act), on a criminal trial for libel the jury were not allowed to take the whole question into consideration, and return a general verdict of guilty or not guilty; but could only decide upon the fact of publication, and whether the libel meant that which it was alleged in the indictment to mean; the court alone taking upon itself to determine the criminality or innocence of such meaning. Now, however, in libel, as previously in all other criminal cases, it is competent to the jury to apply their judgment to the whole question, and return a general verdict of guilty or not guilty.

Libel is deemed in law a greater offence than slander, inasmuch as written defamation is commonly the result of more deliberate malice than that which is merely spoken, and frequently inflicts more extensive and permanent injury on the object of its attack. Many words, such as "rogue," "swindler," which are not actionable when spoken, are so when written.

Libel may almost always be made the subject of an indictment, although slander seldom can; and, in an action for libel, a verdict for a farthing damages formerly gave the plaintiff his full costs, until the recent Act of Lord Denman; whereas, in slander, if the damages are found under forty shillings, the plaintiff is entitled to no more costs than damages.

LIBE'LLULINES. A genus of Neuropterous insects, of which the dragon-fly, *Libellula*, is the type.

LI'BER. (Lat. *bark.*) In Botany, the interior lining of the bark of Exogenous plants. It consists of woody tissue in great quantity, and very thick-sided, intermixed with cellular tissue. It appears to be formed annually, at the same time as the concentric zones of wood, and is intended by nature to convey downwards the secretions elaborated in the bark and leaves. It is the principal seat of laticiferous vessels.

LIBER. In Roman Mythology, a surname of Bacchus, in reference, perhaps, to the idea of his being a liberator or deliverer. Liber was originally an old divinity, who presided over fertility; and who was worshipped in connexion with Libera (a name of Proserpine, according to Cicero, *De Natura Deorum*) and Ceres.

LI'BERAL. In Politics, a cant name, which has been applied since 1815 to the party in each country which advocates constitutional institutions where they do not exist, or their extension into a more popular character where they do. As a party name, this word has been most definitely adopted in Spain, where the party of the cortes assumed the title of *liberales*, and nicknamed their adversaries by that of *serviles*.

LIBERA'LIA. A sacred festival, with games; so called from Liber, a Latin name of Bacchus, in honour of which god they were celebrated at Rome. It was on occasion of this festival that the Roman youths who had attained the age of seventeen assumed the manly dress, or *toga*.

LIBE'RTAS, in the mythology of the Greeks and Romans, was a goddess worshipped with peculiar veneration. By the former she was invoked by the synonymous title Eleutheria; and throughout all parts, both of Greece and Italy, statues, temples, and altars were erected in honour of her. At Rome, her most famous temple, built by T. Gracchus, was situated on the Aventine Mount. She was represented under the figure of a woman, holding in one hand a cap, the symbol of Liberty, and two poniards in the other. In modern times a cap is also used as a symbol of Liberty: thus, in France a red cap formed the badge of the Jacobin club. In England a blue cap with a white border is used as a symbol of the constitutional freedom of the nation, and Britannia sometimes bears it on the point of her spear.

LI'BERTINES. In Church History, a name given, in England, to the early Anabaptists, about the middle of the 16th century. (*Mosheim*, vol. iv. p. 430., transl., ed. 1790.) *See* ANABAPTISTS.

LI'BERTY. In Philosophy. *See* NECESSITY.

LIBITI'NA. An Italian goddess, patroness of funerals and undertakers; synonymous with the Venus Infera or Epithambia of the Greeks. She had a temple at Rome, in which was deposited a small coin, called Libitinai ratio, for every person who died. This custom, which originated in the desire of the Roman authorities to procure a faithful account of the number of deaths, may, perhaps, be regarded as among the first attempts to obtain an accurate census of the population.

LI'BRA. (Lat. *the balance.*) One of the zodiacal constellations, the seventh in order, beginning with Aries. Libra is one of the forty-eight ancient constellations of Ptolemy.

LIBRA denotes also the ancient Roman pound. *See* WEIGHTS.

LIBRARIES, ITINERATING. The name given to a peculiar species of circulating library, instituted a few years ago at Haddington, in Scotland, by Mr. Samuel Brown. The principle on which such libraries are formed consists, as the epithet *itinerating* implies, in the books being sent from one part or district of a country to another on the following plan: — The books are formed into divisions, consisting each of a certain number of volumes, and proportioned in number to the extent of the country intended to be supplied. Each division remains for a certain period (in some instances one or two years) in the same place, when it is removed to another locality, and succeeded by a new supply of books of the same number; by which means each locality has a fresh supply of useful reading at short stated intervals. In Haddingtonshire, which may be called the head-quarters of itinerating libraries, the books consist of 43 divisions of 50 volumes each; and on the principle above explained each volume, at an average of the 43 divisions, is read *five* times during two years, the period at which the books are changed. The system of itinerating libraries has been extended to various other parts of Scotland, to several districts of England, to Ireland, Canada, South Africa, and Jamaica. The use of the books is gratuitous, if so wished; and never more than 1*d.* per annum has been systematically taken from any reader. Voluntary contributions, however, either in books or money, are received. (See *Geo. Dict.*, art. "Haddington.")

LI'BRARY. (Lat. liber, *book.*) The name given either to a collection of books, or to the apartment or edifice in which they are kept. The oldest public library of antiquity, of which we have any credible account, is that founded by Pisistratus at Athens, which was carried by Xerxes into Persia, and recovered by Seleucus Nicanor. Whether this was the same library which Sylla (according to Plutarch) carried to Rome, and which was again restored by Hadrian, is not clear; nor is its ultimate destiny known. According to a well-known tradition, the Goths, when masters of Athens, refused to burn the public libraries, which contributed to the effeminacy of its citizens. The library of Alexandria was the most famous of antiquity. Its history has been written by Bonamy (*Mem. de l'Ac. des Inscr.* vol. ix.), Reinhard (Gotting. 1792), and many others. It was first formed by the Ptolemies. Soter, Lagides, Philadelphus, and Euergetes: the last of whom resorted to very royal measures for the accomplishment of so laudable an end; for he is said to have seized on books imported from Greece, caused them to be copied, and returned the copies to the proprietors, keeping the original for his library. The collection of Soter is said to have been deposited in a suburb called Bruchium, which was burnt by the troops in Cæsar's Egyptian war. That of Philadelphus (the smaller of the two) was preserved in the temple of Serapis, and became the nucleus of the later library, which was augmented by the great library of Pergamus (said to have amounted to 200,000 volumes), presented to it by Mark Antony. The

narrative of the destruction of this library by the fanatical Arabs, in A.D. 641, is among the popular chapters of history; and the most careful inquirers are of opinion that it is substantially, if not literally, true, notwithstanding the doubts thrown on it by Gibbon and others. The first public library at Rome was founded by Asinius Pollio, A.D. 716; the second, the Palatine, by Augustus, in 726: great part of it was consumed under Commodus; but much remained even in the time of Constantine. Reusch (1734), Eckerman (1764), and Eckhart (1799), have published separate dissertations on the libraries of the Romans. The ancient libraries of the West must have wholly perished in the convulsions which attended the overthrow of its empire. The history of those of the east is not easy to investigate. Constantinople certainly possessed, at the period of its capture, extensive remains of ancient literature; and many, but almost wholly fruitless investigations, have been made of late years in the monastic libraries of modern Greece, particularly of Mount Athos, for valuable manuscripts. (See *Walpole's Oriental Memoirs; Journal of Education*, vol. ii.) The best accounts of ancient libraries, to which we are able to refer the reader, are contained in the work of Petit Radel, *Récherches sur les Bibliothèques Anciennes et Modernes*; Heeren, *History of the Study of Classical Literature*, vol. i.; *Ersch and Gruber's Encyclopedia*, art. "Bibliotheken;" *Taylor's History of the Transmission of ancient Books in modern Times; Enc. Brit.*, Suppl., "Library."

Of modern public libraries, the greatest and most celebrated is that of Paris (Bibl. Royale). It was commenced by King John, in the middle of the 14th century, with *ten* volumes; and has been augmented by subsequent kings to the enormous number it now possesses. (Le Prince, *Essai Historique sur la Bibl. du Roi*, Paris, 1787.) Next to that of Paris in extent, and possibly in value, are the libraries of St. Petersburg and Munich. In Italy, the Ambrosian at Milan, and the Vatican at Rome, are peculiarly rich in MSS. Of British libraries, the greatest are those of the British Museum; of the two English universities, of which that of Oxford (the Bodleian) is peculiarly rich in oriental manuscripts; that of the Advocates, at Edinburgh; and of Trinity College, Dublin. Statements of the number of books contained in public libraries will be found in many works; but no statistical information is more imperfect and worthless. Some have not scrupled to say that there is no information respecting the great foreign libraries, as to the number of printed books, which can be relied upon within one half. Such scepticism may be exaggerated; but that there is some ground for it may be conjectured from the following comparison, which we have made between different statements. That of M. Panizzi is contained in the Appendix to the Report on the Brit. Mus., 1838, vol. ii. No. 6. The "Returns" are those furnished by official persons to inquiries addressed on the same occasion, and will be found in the same work. We should premise that the number of printed books belonging to the library of the Brit. Mus. was actually returned in 1833 at 218,937, and is now probably 260,000; *volumes* of MSS. in 1833, 21,900.

	Returns, 1836.		Panizzi, 1836.		Balbi.		Conv. Lexicon, 1828.		Ersch and Gruber's Ency. 1823.	
	Vols.	MSS.	Vols.	MSS.	Vols.	MSS.	Vols.	MSS.	Vols.	MSS.
Paris (Royale)	700,000	80,000	650,000	80,000	-	-	350,000	70,000	350,000	70,000
Munich	800,000	-	500,000	-	-	-	400,000	9,000	300,000	9,000
Petersburg	-	-	-	-	-	-	300,000	11,000		
Vienna	300,000	16,000	300,000	16,000	-	-	300,000	12,000	300,000	12,000
Gottingen	-	-	200,000	1,500	-	-	300,000	-	200,000	
Dresden	-	-	250,000	2,700	260,000	-	220,000	2,700	220,000	2,700
Copenhagen	-	-	400,000	15,000	-	-	130,500	3,000	200,000	
Berlin	-	-	320,000	10,000	280,000	-	250,000	4,600	200,000	2,000
Vatican	-	-	-	-	-	-	30,000	40,000	30,000	40,000
Ambrosian	-	-	100,000	4,633	40,000	-	60,000	15,000	60,000	15,000
Florence (Magliab.)	-	-	140,000	12,000	-	-	150,000	9,000	120,000	8,000

LIBRA'TION. (Lat. libra, *a balance*.) In Astronomy, a term applied to certain phenomena resulting from the moon's motion, whereby the spots very near the border of the lunar disc alternately disappear and become visible, making stated periodical oscillations, and indicating, as it were, a sort of vibratory motion of the lunar globe.

The libration is of three kinds; the libration in longitude, the libration in latitude, and the diurnal libration. The libration in longitude is occasioned by this circumstance, that the rotatory motion of the moon about her axis is not always precisely equal to the angular velocity in her orbit. If the moon's orbital motion were uniform, and performed in the same time as her rotation about the axis, the radius vector from the centre of the earth would always intersect the lunar disc in the same point, or the moon would always present exactly the same face to the earth. But the rotatory motion is sensibly uniform; while the orbital motion, being performed in an ellipse, is sometimes slower and sometimes faster than its average amount. Hence the spots near the eastern and western borders alternately disappear and reappear.

The libration in latitude is occasioned by the inclination of the moon's axis of rotation to the plane of her orbit. Supposing this axis always to have the same direction in space, the angle which it makes with the radius vector of her orbit will be acute during one part of her revolution and obtuse in another. Hence the two poles of rotation, and the adjacent parts of the surface, are alternately visible from the earth.

The diurnal libration is simply a consequence of the lunar parallax. The observer, being placed at the surface of the earth, perceives points on the moon's disc at the time of her rising, which disappear as her elevation is increased; while new ones on the opposite border, that were before invisible, come into view as she descends towards the horizon. *See* Moon.

The libration in latitude and diurnal vibration were discovered by Galileo. Hevelius first observed and explained the libration in longitude.

LI'CENCE. (Lat. licet, *it is lawful*.) In Law, a power or authority given to a man to do some lawful act, and may be by word or by deed. If a party give licence to another to do acts on his ground, which without that licence would be trespass, and the party abuses his licence, he becomes a trespasser *ab initio*. Licence is also commonly taken for the admission of an individual, by proper authority, to the right of doing particular acts, practising in professions, &c., and for the certificate of such admission.

LICE'NTIATE. A degree in some foreign universities; but not known in the universities of England, except in the instance of the degree of licentiate in medicine, which is granted at Cambridge. In the original sense of the word it appears to have been only a title applied to such as had obtained a licence to teach. It is said to be of Italian origin, and first granted at the university of Bologna. Where the degree of licentiate exists, it intervenes between that of bachelor and that of doctor.

LI'CHEN. (Gr. λειχην, *a roughness of the skin*.) In Pathology, a papulous eruption of the skin, terminating in scurfy exfoliations: it is generally symptomatic of disordered stomach and bowels.

LICHE'NIC ACID. The acid peculiar to some species of lichens. It appears to be the *malic acid*.

LI'CHENIN. A substance closely allied to starch, extracted from the *Cetraria islandica*, or Iceland moss.

LI'CHENS. Plants of a very low organization, which grow on the bark of trees or rocks, when they form a kind of incrustation; or upon the ground, when they consist of irregular lobes parallel with the earth's surface. Occasionally in all situations they are found in a branched state; but their subdivisions are generally irregular and without order. Their fructification consists of hard nuclei, called *shields*, which break through the upper surface of the *thallus* or main substance of the lichen, are of a peculiar colour and texture, and contain the reproductive particles. Lichens abound in the cold and temperate parts of the world. The greater part are of no known use; but some, as the reindeer moss (*Cenomyce rangiferina*), the Iceland moss (*Cetraria islandica*), and various species of *Gyrophora*, are capable of sustaining life, either in animals or man. The Iceland moss, when deprived of its bitterness by boiling, becomes indeed a diet recommended to invalids. Others are used as tonic medicines, as *Variolaria faginea*, and *Parmelia parietina*. There principal use is, however, that of furnishing the dyer with brilliant colours; orchall, cudbear, and perolle, with many more, are thus employed.

LICKS. A term applied in North America to sandy tracts of land, upon which common salt forms an efflorescence, and which almost all graminivorous animals resort to for the purpose of licking the surface.

LI'CTORS. (Lat. ligo, *I bind*.) Officers whose duty it was to attend the principal Roman magistrates (such as the consuls, master of the horse, and prætors) and the vestal virgins on their appearance in public, and to act as constables under their command. Their insignia were the *fasces* or bunch of rods (originally encircling an axe, which was removed by Publicola, used under the republic only by dictators, and restored under the emperor), and the *virga* or rod, which was used to touch the door of the magistrate on returning home. The number of lictors in attendance varied according to the rank of the magistrate; thus the consuls had twelve, the prætors six, and dictators, according to some, twenty-four.

LIEGE. In the Latin of the middle ages *ligeus*, from *ligare*, to bind. A liege lord, in feudal language, is a superior to whom *allegiance* is owed, and a *liege-man* he who owes such allegiance. Hence all subjects are termed *lieges* of the king. Some writers derive the word liege from the Teutonic word *leude* (modern German *leute*, people), which was used in the sense of *vassal*.

LI'EN. (Fr. lien, *bond*.) In Law, signifies the right which a creditor has to retain the property of his debtor until the debt has been paid; and furnishes one of very few instances in which a party is allowed to take the law, as it were, into his own hands. Liens are either general or particular. A general lien is the right to retain a thing for a general balance of accounts, and not for those demands only which arise in respect of the thing retained. This sort of lien is said not to be favoured by law. A particular lien, which the law is said to favour, is a right to retain a thing when the claim against the owner of it arises out of the thing retained itself; as, where a tailor has made the cloth of his customer into a coat, the tailor is allowed to retain the cloth until he is paid for his labour in making it into a coat. The payment of a simple contract debt cannot be enforced by action after six years have elapsed from the time the debt was incurred; but a party who has a lien on property may retain it for an unlimited period, until his claim has been satisfied.

LIE-TO. *See* LYE-TO.

LIEUTE'NANT. (Fr.) An officer, who, as the derivation of the word implies, supplies the place and discharges the duty of a superior in his absence.

LIEUTENANT IN THE ARMY. The officer immediately subordinate to the captain, in whose absence he takes the command of his company. In the British service the lieutenants of the Life Guards and Horse Guards, and of the three regiments of Foot Guards, have the rank of captain. In the artillery, engineers, marines, and rifle brigade, of the British service, and in all the regiments of most of the Continental nations, there being no cornets or ensigns, the subaltern officers are distinguished as first and second lieutenants. The pay of a lieutenant varies, according to the regiment or branch of the service to which he belongs, from 10*s*. 4*d*. to 6*s*. 6*d*.; and the price of his commission, according to the present regulations, is, for the Life Guards, 1785*l*.; Horse Guards, 1600*l*.; Cavalry, 1190*l*.; Foot Guards, 2050*l*.; Infantry, 700*l*.

LIEUTENANT IN THE NAVY. The next rank to that of commander, and co-ordinate with that of captain in the army. The number of lieutenants appointed to ships of war varies with their rate. A ship of the first rate carries eight lieutenants, besides supernumeraries; and those of the second, third, fourth rates, &c. have respectively one less than the number appointed to the preceding rate. The monthly pay of a lieutenant in the British navy varies, according to the ship and his duration of service, from 11*l*. 10*s*. to 9*l*. 4*s*.

LIEUTE'NANT-GENERAL OF THE KINGDOM. A dignity equivalent to that of regent, which has been occasionally held in France on temporary emergencies. The Count d'Artois (afterwards Charles X.) took this title in 1814 on entering France, and held it until the arrival of his brother, Louis XVIII. On the expulsion of Charles X., in 1830, the Duke of Orleans was constituted lieutenant-general, both by an ordinance of that prince, and by the provisory government of the Hotel de Ville, on July 29.; and retained the title until he was proclaimed king, on the 7th August following.

LIFE ANNUITY. *See* ANNUITY.

LIFE ASSURANCE. *See* ASSURANCE.

LIFE BOAT. A boat originally made at Shields, in 1789, by Mr. Greathead, for saving the crews of shipwrecked vessels. The following are the general principles: — The boat is wide and shallow; the head and stern are alike, for pulling in either direction, and raised, to meet the waves; it pulls double-banked, the oars being fir, for lightness, and fitted with thole pins and grummets, and is steered with an oar. The boat is cased round inside, on the upper part, with cork, in order to secure her buoyancy with as many persons as she can carry, even though full of water; the cork likewise assists in maintaining, or, if overset, in recovering, the position of stable equilibrium. The boat is painted white, to be conspicuous in emerging from the hollow of the sea. It is a curious fact that the smugglers paint their boats white for the contrary reason, because dark-coloured objects alone are discernible in dark nights.

LIFE BUOY. A buoy, with a mast to render it conspicuous, thrown into the sea upon a man's falling overboard. The life buoy invented by Lieut. Cooke, R. N., is furnished with a composition which is fired by the act of disengaging the buoy from its place, at night, and burns with a strong light.

LIFE GUARDS. The cavalry troops composing the body guard of a sovereign prince are so called. In England they consist of two regiments, comprising each 32 officers, 53 non-commissioned officers, and 351 privates. In Germany such troops are styled the *leib garde* (body guard); and in France the *garde du corps*. *See* GUARDS.

LIFE LINE. In a Ship, any rope stretched along for the safety of the men, as is practised in bad weather.

LIFE, MEAN DURATION OF. *See* EXPECTATION OF LIFE.

LIFE RENT. In Scottish Law, the right of enjoyment, either of an heritage or a sum of money, for the life of the life-renter. The superior proprietor of the subject, or *fee*, in which this rent subsists, is termed the fiar. *Terce* (*i. e.* dower) and *courtesy* (analogous to the courtesy of England in English law) are instances of legal life-rents.

LIFTING PUMP. *See* PUMP.

LIFTS. The ropes which support the ends of yards or booms against the weight of the men upon them.

LI'GAMENTS. (Lat. ligo, *I bind*.) Strong elastic membranes connecting the extremities of the moveable bones. When boiled in water they yield more or less gelatine, and leave a portion of insoluble albumen.

LI'GATURE. (Lat. ligo.) In Music, the tie which binds several notes of like length together, by which they appear in groups. Thus  four quavers, by means of a ligature at top or bottom, assume the form , the line connecting them being the ligature.

LIGHT. (Germ. licht.) The cause of those sensations which we refer to the eyes, or that which produces the sense of seeing. The phenomena of light and vision have always been regarded as one of the most interesting branches of natural science; though it is only since the days of Newton that they have been examined with such care as to afford grounds for any safe speculation respecting the nature of light, and the mode of its propagation through space. But the solution of these two questions is involved in very great difficulty; for notwithstanding the splendid discoveries of that immortal philosopher, and the long train of interesting and important facts which have been investigated since his time, and more particularly since the beginning of the present century, the true theory of light still remains an enigma. This does not arise from any difficulty there is in framing an hypothesis which shall afford a mechanical explanation of the various phenomena, but from the circumstance that more hypotheses than one have been imagined by which all the phenomena can be explained, not merely in a general way, but with the precision of numerical calculation.

The knowledge of the laws which regulate the phenomena of light constitutes the science of *Optics*, which is divided into a number of subordinate branches. An account of the principal phenomena will be found under the terms ABERRATION, CHROMATICS, INTERFERENCE, OPTICS, POLARIZATION, REFLECTION, REFRACTION, &c. The present article will be confined to a brief enumeration of some of the principal properties of light, and a statement of the two rival theories by which modern philosophers explain its nature and propagation.

Properties of Light. — Experiments of the simplest and most familiar kind suffice to show that light is propagated from luminous bodies in all directions. Provided nothing intervenes to intercept the light, they are seen in all situations of the eye. Thus, the flame of a lamp is visible from every part of the sphere of which it occupies the centre; and the same is the case with respect to a phosphorescent body, an electric spark, a ball heated red-hot, or light having any other source. The sun throws its light, not only on the earth, but on the planets, and comets, and every other body in the firmament.

Another property of light is, that in a homogeneous medium it is always propagated in straight lines. This is evident from various considerations. The forms of shadows correctly represent the outlines of the objects which produce them, as seen from the luminous body, which could not be unless the light proceeded in straight lines from the extremities of the objects to the borders of the shadow. If three plates of metal, each pierced with a small hole, are placed at some distance behind each other, and in such positions that the three holes are exactly in one straight line, the light will pass freely through them; but if the holes are not exactly in a straight line, no light will pass. In like manner, if a number of similar objects are placed behind each other in a straight line, the first renders all the others invisible to an eye placed in the same line. We cannot see through a bent tube.

A third property of light is that it requires time for its propagation. The velocity with which it passes from one point to another is, however, so great, that, with respect to any terrestrial distances, the passage may be considered as instantaneous. But astronomy furnishes the means, not only of detecting its propagation, but of measuring its velocity with great precision. The eclipses and emersions of Jupiter's satellites become visible about 16 min. 26 sec. earlier when the earth is at its least distance from Jupiter, than when it is at its greatest. Light, therefore, occupies above a quarter of an hour in passing

through the diameter of the earth's orbit. Now, the sun's distance from the earth being nearly 95,000,000 of miles, it follows that light must travel through space with the prodigious, though finite, velocity of 192,500, or nearly 200,000 miles, in a second of time, and consequently would pass round the earth in the eighth part of a second. Astounding as this conclusion is, no result of science rests on more certain evidence. It is also proved, by the phenomena of aberration, that the light of the sun, planets, and all the fixed stars, travels with one and the same velocity.

When light in its progress encounters an obstacle, or enters a different medium, it undergoes certain modifications, depending on the nature of the body on which it falls, or the medium into which it enters. When it falls on a smooth polished surface, a portion of it is regularly reflected; that is to say, it is returned from the surface at an angle equal to the angle of incidence, and pursues its course in a straight line as before the reflection. The quantity of light thus reflected depends on the nature and polish of the surface, and on the angle of incidence, being greatest when that angle is small; but it is calculated that even the brightest and most opaque surfaces, mercury for example, do not reflect more than three fourths of the incident light. Another portion of it enters the medium, and there (if the medium is homogeneous) pursues a rectilinear course, but differing from its former direction. In this case it is said to be refracted. The angle of refraction depends on the nature of the medium, each different medium having its own peculiar law of action on light. In many media, comprehending the liquids and most of the uncrystallized substances, the whole of the refracted light is bent from its original direction at the same angle. In many others, as in most crystallized media, part of the refracted light follows one course, and another part of it a different one; the two portions acquiring at the same time different physical properties. In this case the refraction is said to be double. A third portion of the light falling on a body is neither reflected nor refracted regularly, but is scattered in all directions; and it is this portion which renders bodies visible. All bodies on which light falls absorb a certain part of it; more or less in proportion to their opacity. In perfectly opake bodies the absorption is total, and the light does not penetrate to a sensible depth under the surface. In others it penetrates farther; but even in the most transparent it is gradually stifled and lost. A depth of only seven feet of pure water is required to extinguish one half of the incident light. *See* Reflexion.

Solar light, refracted by a prism or other body, is separated into a multitude of rays of different colours, each of which afterwards proceeds in its course independently of all the others. These differently coloured rays possess different physical properties, and different degrees of refrangibility. It is to this dispersion or separation of light by refraction that we owe all the pleasure derived from the variegated hues of natural bodies. The investigation of the laws of the dispersion of the coloured rays forms the subject of *chromatics*. One of the principal facts connected with it is, that the dispersion of the rays by different refracting substances is not proportioned to the refraction; the dispersive power of some substances being greater than that of others, while their refracting power is less. This fact led to the important discovery of the *achromatic telescope*. *See* Achromatic, Chromatics.

Light, on being regularly reflected or refracted, undergoes a modification termed *polarization*, in virtue of which it presents, on encountering another medium, different phenomena of reflection and refraction from those presented by light which has not undergone such modification. When a ray of light, having acquired this modification, is made to fall on a plane reflecting surface under a certain angle of incidence, no portion of it will be reflected; the whole is transmitted or absorbed. But, in the case of ordinary light, some portion is always reflected from a polished surface, whatever be the angle of incidence; the light has therefore acquired the property of being acted upon in a particular way; whence Malus, who first investigated this subject in a philosophical manner, gave the phenomena the name of *polarization*, from its analogy to the effect produced by a magnet on a series of needles. *See* Polarization.

The last property of light which we shall notice, as important towards forming a theory of its propagation, is that to which Dr. Young gave the name of *interference*. Under certain circumstances, the rays of light exercise a mutual influence on each other; increasing, diminishing, or modifying each other's effects according to certain laws. This mutual action of the rays on each other gives rise to a great number of the most intricate phenomena of optics, and affords a sufficiently simple explanation of them, in numerous cases where no other explanation has yet been found on other hypotheses. The phenomenon is described under the term Interference.

Theories of Light. — Two different theories have long divided the opinion of philosophers respecting the nature and propagation of light. One of these consists in supposing it to be composed of particles of excessive minuteness, projected from the luminous body with a velocity equal to nearly 200,000 miles in a second. This hypothesis was adopted by Newton, and, till recently, has been acquiesced in by the greater number of writers on optics. The other hypothesis supposes light to be produced by the vibrations or undulations of an ethereal fluid of great elasticity, which pervades all space and penetrates all substances, and to which the luminous body gives an impulse which is propagated with inconceivable rapidity, in spherical superficies, by a sort of tremor or undulation, as sound is conveyed through the atmosphere, or a wave along the surface of water. Both of these hypotheses are rendered probable by the great number of phenomena of which they afford a mechanical explanation; but they are both, also, attended with very great difficulties. Other theories have also been proposed; but they have not met with such general attention from philosophers as to make it necessary to explain them in this place.

Corpuscular Theory of Light. — Sir John Herschel, in his admirable *Essay on Light* in the *Encyclopædia Metropolitana*, states the principles of the Newtonian or Corpuscular theory as follows: —

1. "That light consists of particles of matter possessed of inertia, and endowed with attractive and repulsive forces, and projected or emitted from all luminous bodies with nearly the same velocity, — about 200,000 miles per second.

2. "That these particles differ from each other by the intensity of the attractive and repulsive forces which reside in them; and in their relations to the material world; and also in their actual masses, or inertia.

3. "That these particles, impinging on the retina, stimulate and excite vision; the particles whose inertia is greatest producing the sensation of red, those of the least inertia of violet, and those in which it is intermediate the intermediate colours.

4. "That the molecules of material bodies and those of light exert a mutual action on each other, which consists in attraction and repulsion, according to some law or function of the distance between them; that this law is such as to admit, perhaps, of several alternations or changes from repulsive to attractive force; but that when the distance is below a certain very small limit it is always attractive up to actual contact, and that beyond this limit resides at least one sphere of repulsion. This repulsive force is that which causes the reflection of light at the external surfaces of dense media; and the interior attraction that which produces the refraction and interior reflection of light.

5. "That these forces have different absolute values or intensities, not only for all different material bodies, but for every different species of the luminous molecules, being of a nature analogous to chemical affinities or electric attractions; and that hence arises the different refrangibilities of the rays of light.

6. "That the motion of a particle of light, under the influence of these forces and its own velocity, is regulated by the same mechanical laws which govern the motions of ordinary matter; and that therefore each particle describes a trajectory, capable of strict calculation as soon as the forces which act on it are assigned.

7. "That the distance between the molecules of material bodies is exceedingly small in comparison with the extent of their spheres of attraction and repulsion on the particles of light.

8. "That the forces which produce the reflection and refraction of light are, nevertheless, absolutely insensible at all measureable or appreciable distances from the molecules which exert them.

9. "That every luminous molecule, during the whole of its progress through space, is continually passing through certain periodically recurring states, called by Newton fits of easy reflection and easy transmission, in virtue of which they are more disposed, when in the former states or phases of their periods, to obey the influence of the repulsive or reflective forces of the molecules of a medium; and when in the latter, of the attractive."

Such are the postulates on which the corpuscular theory of light depends. Most of them may be admitted without difficulty; and they afford data for the application of mathematical reasoning to the phenomena, which may be investigated by the same sort of analysis with which mathematicians are already familiar in the theories of heat, capillary attraction, and other molecular forces.

Undulatory Theory.—The principles of the undulatory theory are thus stated by Sir J. Herschel: —

1. "That an excessively rare, subtle, and elastic medium, or *ether*, fills all space, and pervades all material bodies, occupying the intervals between their molecules; and either by passing freely among them, or by its extreme rarity, offering no resistance to the motion of the earth, the planets, or comets, in their orbits, appreciable by the most delicate astronomical observations; and having inertia, but not gravity.

2. "That the molecules of the ether are susceptible of

being set in motion by the agitation of the particles of ponderable matter; and that when any one is thus set in motion it communicates a similar motion to those adjacent to it, and thus the motion is propagated further and further in all directions, according to the same mechanical laws which regulate the propagation of undulations in other elastic media, as air, water, or solids, according to their respective constitutions.

3. "That in the interior of refracting media the ether exists in a state of less elasticity, compared with its density, than in vacuo (*i. e.* in space empty of all other matter); and that the more refractive the medium, the less, relatively speaking, is the elasticity of the ether in its interior.

4. "That vibrations communicated to the ether in free space are propagated through refractive media by means of the ether in their interior, but with a velocity corresponding to its inferior degree of elasticity.

5. "That when regular vibratory motions of a proper kind are propagated through the ether, and, passing through our eyes, reach and agitate the nerves of our retina, they produce in us the sensation of light, in a manner bearing a more or less close analogy to that in which the vibrations of the air affect our auditory nerves with that of sound.

6. "That as, in the doctrine of sound, the frequency of the aërial pulses, or the number of excursions to and fro from the point of rest made by each molecule of the air, determines the pitch or note; so, in the theory of light, the frequency of the pulses, or number of impulses made on our nerves in a given time by the ethereal molecules next in contact with them, determines the *colour* of the light: and that as the absolute extent of the motion to and fro of the particles of air determines the *loudness* of the sound, so the *amplitude* or extent of the excursions of the ethereal molecules from their points of rest determines the brightness or intensity of the light."

Whichever theory we adopt to explain the phenomena of light, we are led to conclusions which strike the mind with astonishment. According to the corpuscular theory the molecules of light are supposed to be endowed with attractive and repulsive forces, to have poles, to balance themselves about their centres of gravity, and to possess other physical properties which we can only ascribe to ponderable matter. In speaking of these properties it is difficult to divest one's self of the idea of sensible magnitude, or by any strain of the imagination to conceive that particles to which they belong can be so amazingly small as those of light demonstrably are. If a molecule of light weighed a single grain, its momentum (by reason of the enormous velocity with which it moves) would be such that its effect would be equal to that of a cannon-ball of 150 pounds, projected with a velocity of 1000 feet per second. How inconceivably small must they therefore be when millions of molecules, collected by lenses or mirrors, have never been found to produce the slightest effect on the most delicate apparatus contrived expressly for the purpose of rendering their materiality sensible.

If the corpuscular theory astonishes us by the extreme minuteness and prodigious velocity of the luminous molecules, the numerical results deduced from the undulatory theory are not less overwhelming. The extreme smallness of the amplitude of the vibrations, and the almost inconceivable but still measurable rapidity with which they succeed each other, were computed by Dr. Young, and are exhibited by Sir J. Herschel in the following table:—

Colours.	Length of undulation in parts of an inch.	Number of undulations in an inch.	Number of undulations per second.
Extreme Red -	0·0000266	37640	458,000000,000000
Red - -	0·0000256	39180	477,000000,000000
Orange - -	0.0000240	41610	506,000000,000000
Yellow - -	0·0000227	44000	535,000000,000000
Green - -	0·0000211	47460	577,000000,000000
Blue - -	0·0000196	51110	622,000000,000000
Indigo -	0·0000185	54070	658,000000,000000
Violet - -	0·0000174	57490	699,000000,000000
Extreme Violet	0·0000167	59750	727,000000,000000
			The velocity of light being assumed at 192,000 miles per second.

On a cursory view, it must appear singular that two hypotheses, founded on assumptions so essentially different, should concur in affording the means of explaining so great a number of facts with equal precision and almost equal facility. This, however, is the case with respect to the corpuscular and undulatory theories of light, from both of which the mathematical laws to which the phenomena are subject may be deduced, though not in all cases with the same degree of facility. So far as the corpuscular doctrine is available for the purposes of deductive explanation, it possesses all the characteristics of a good theory. It supposes the operation of a force with which we are in some measure familiar. We are accustomed to contemplate the effects of attraction in the grand phenomena of astronomy; we perceive them at every instant in the downward tendency of all heavy bodies; and though they disappear in the small bodies of nature, they are reproduced in the phenomena of electricity, magnetism, capillary attraction, electricity, and various chemical actions, where they can be not only distinctly traced, but reduced to mathematical formulæ, and submitted to accurate calculation. The undulatory hypothesis is not seized by the mind with the same facility; yet it also possesses some of the least equivocal characteristics of philosophical truth. No phenomenon has yet been discovered decidedly at variance with any of its principles. On the contrary, most of the phenomena follow from those principles with remarkable ease; and, in numerous instances, consequences deduced from the theory by a long and intricate analysis, and where no sagacity could possibly have divined the result, have been found to be accurately true when brought to the test of experiment. Hence this hypothesis begins to be generally adopted by philosophers, and, in recent times, by far the most illustrious names in the annals of optical discovery are included in the list of its supporters.

That the sensation of light is produced by the vibrations of an extremely rare and subtle fluid, is an idea that was maintained by Descartes, Hooke, and some others; but it is to Huyghens that the honour solely belongs of having reduced the hypothesis to a definite shape, and rendered it available to the purposes of mechanical explanation. Owing to the great success of Newton in applying the corpuscular theory to his splendid discoveries, the speculations of Huyghens were long neglected; indeed, the theory remained in the same state in which it was left by him till it was taken up by our countryman, the late Dr. Young. By a train of mechanical reasoning, which in point of ingenuity has seldom been equalled, Dr. Young was conducted to some very remarkable numerical relations among some of the apparently most dissimilar phenomena of optics, to the general laws of diffraction, and to the true principles of the coloration of crystallized substances. Malus, so late as 1810, made the important discovery of the polarization of light by reflection, and successfully explained the phenomenon by the hypothesis of an undulatory propagation. The theory subsequently received a great extension from the ingenious labours of Fresnel; and the still more recent researches of Arago, Poisson, Herschel, Airy, and others, have conferred on it so great a degree of probability that it may be almost regarded as ranking in the class of demonstrated truths. "It is a theory," says Herschel, "which, if not founded in nature, is certainly one of the happiest fictions that the genius of man has yet invented to group together natural phenomena, as well as the most fortunate in the support it has received from whole classes of new phenomena, which at their discovery seemed in irreconcileable opposition to it. It is, in fact, in all its applications and details, one succession of *felicities*; insomuch that we may almost be induced to say, if it be not true, it deserves to be so." (*Ency. Metr.*, "Light," § 595.)

Relations of Light and Heat.—Light and heat are so intimately related to each other, that philosophers have doubted whether they are identical principles, or merely coexistent in the luminous rays. They possess numerous properties in common; being reflected, refracted, and polarized according to the same optical laws, and even exhibit the same phenomena of interference. Most substances during combustion give out both light and heat; and all bodies, excepting the gases, when heated to a high temperature become incandescent. Nevertheless, there are many circumstances in which they appear to differ.

A thin plate of transparent glass interposed between the face and a blazing fire intercepts no sensible portion of the light, but most sensibly diminishes the heat. Light and heat are, therefore, not intercepted alike by the same substances. Heat is also combined in different degrees with the different rays of the solar spectrum. A very remarkable discovery on this subject was made by Sir William Herschel, which would seem to establish the independence of the heating and illuminating effects of the solar rays. Having placed thermometers in the several prismatic colours of the solar spectrum, he found the heating power of the rays gradually increased from the violet (where it was least) to the extreme red, and that the maximum temperature existed at some distance beyond the red, out of the visible part of the spectrum. The experiment was soon after repeated with great care by Berard, who confirmed Herschel's conclusions relatively to the augmentation of the calorific power from the violet to the red; but he found the maximum heat existed at the extremity of the red, and not beyond the spectrum. This discovery of the inequality of the heating power of the different rays led to the inquiry whether the chemical action produced by light on certain bodies was merely the effect of the heat accompanying it, or owing to some other cause. By a series of delicate experiments. Berard found that this action is not only independent of the heating power, but follows an entirely different law; its intensity being greatest in the violet ray, where the heating power is the least, and least in the red ray, where the heating

power is greatest. We are thus led to the conclusion that the solar rays possess at least three distinct powers, — those of heating, illuminating, and effecting chemical combinations and decompositions; and these powers are distributed among the differently refrangible rays in such a manner as to show their complete independence of each other.

Light acts a very important part in the vegetable economy. The green colour of plants and the hue of flowers entirely depend on it; and it is found even to influence the form of their leaves. Its effects in developing the forms of some of the lower classes of animals have also been proved by various experiments; and there are probably many other powers resident in the same wonderful agent of which we can at present form no adequate notion. (See *Sir J. Herschel's Treatise on Light; Airy's Mathematical Tracts; Brewster's Optics; Young's Lectures;* Biot, *Traité de Physique;* Pouillet, *Elémens de Physique*.)

Light. In Painting, the medium by which objects are discerned. In a picture it means the part the most illuminated. This may happen from *natural light*, as the sun or moon; or from *artificial light*, as a fire, candle, &c. The principal light is generally made to fall on the spot where the principal figures are placed, and generally near the centre of the picture. A reflected light is that which a body in shadow receives from a contiguous light object.

Light. The sea term for not laden.

LIGHTER. A strong vessel or barge for transporting goods or stores, chiefly on rivers and canals.

LIGHTHOUSE. An establishment for the exhibition of a light or landmark to direct the mariner. The use of lights for such a purpose is of very high antiquity; but their early history is involved in much obscurity. In the ancient world there were lighthouses at Ostea, Ravenna, Puteoli, Caprea, Rhodes, on the Thracian Bosphorus, &c. (*Suetonii Opera*, tom. i. p. 755.); but by far the most celebrated lighthouse in antiquity was that erected by Ptolemy Soter on the small island of Pharos, opposite to Alexandria, —"nocturnis ignibus cursum navium regens." (*Pliny*, lib. v. c. 31.) Its extraordinary height, which some authors have estimated at 500 feet and upwards, procured for it a place among the wonders of the world; and, according to Josephus, its "beaming summit" could be seen at a distance of 300 stadia,—about 42 British miles. It is said to have cost 800 talents; and its celebrity was such that Pharos rapidly became, and still continues to be in many countries, a generic term equivalent to *lighthouse*.

The most celebrated lighthouses of modern times are, the Tour de Carduan, at the entrance of the Gironde, in France; the Eddystone lighthouse, opposite to Plymouth Sound; and that more recently constructed on the Bell Rock, opposite to the Frith of Tay. The first of these was begun in 1584, and finished in 1611. It is 186½ feet (English) in height; and besides being of the highest importance to the sailor on so dangerous and frequented a coast, it forms at the same time a splendid specimen of architectural beauty. The Eddystone lighthouse, constructed by the celebrated engineer Smeaton, was completed in 1759; is regarded as a masterpiece of its kind; and, as has well been observed, bids fair to be little less lasting than the rocks upon which it stands. The Bell Rock lighthouse was built by Mr. Stevenson on the model of the Eddystone. Numerous lighthouses marking the most dangerous points, and the entrance to the principal harbours, are now erected in most civilized maritime countries. In the Baltic and the Sound they are particularly abundant; the Dutch have 20 lights on their coast, and in the Zuyder Zee; and on the northern and western coasts of France there are no fewer than 89 excellent lights. (The Admiralty has lately published lists of all these lights.) But the coasts of no country are so well provided with lighthouses as those of the United Kingdom. For England they are under the management of the Brethren of the Trinity House; for Ireland, under that of the Board for the Improvement of the Port of Dublin; and for Scotland, under that of the Commissioners of Northern Lighthouses meeting at Edinburgh. It would swell our pages to too great an extent were we to attempt to give a complete list of the various lighthouses of this country; we must therefore beg to refer the reader to the *Commercial Dictionary* for full particulars upon this subject, and shall devote what remains of our limits to a view of the different principles adopted in the construction of their important machinery.

The ancient mode of exhibiting lights as beacons to the mariner consisted in burning wood or coal in a chauffer on the top of a tower; and till the year 1807, the Eddystone light was nothing better than the feeble blaze of a few tallow candles, without any apparatus for concentrating the light or giving it any particular direction. But as rays of light proceeding from a luminous focus are equally dispersed over the surface of the sphere which has the focus for its centre, it is evident that without some means of giving the light a horizontal direction, the greater part of it must be wholly lost; for only those rays which are directed in the plane of the horizon, or at least which are depressed only a few degrees below it, can be seen by a ship at a distance. Hence the first object to be attained is to prevent the loss of light by throwing the whole of it forward in the plane of the horizon, in order that its intensity may be increased in the greatest possible degree. Now there are two principles on which this may be accomplished,—reflexion and refraction. The object is accordingly carried into effect by a catoptric or dioptric apparatus. Sometimes both principles are combined in the same apparatus.

Catoptric System.—The usual mode of applying the catoptric principle is by burning an Argand lamp in the focus of a parabolic mirror. This mode of illumination appears to have been first carried into effect at the Carduan lighthouse above mentioned, under the direction of Borda, about the year 1780. A few years later reflecting mirrors were placed in some of the English lighthouses, under the direction of the Trinity House; and in 1786 the principle was adopted in the only two beacons then existing on the coast of Scotland,—viz. the Isle of May in the Firth of Forth, and the Cumbrae Isle in the Clyde. Soon afterwards it was adopted generally in this country. Borda's reflector was formed of a sheet of copper plated with silver; those applied in Scotland were formed of small facets of mirror glass, placed in hollow parabolic moulds of plaster. The mirrors in general use in the British lighthouses at the present time are of copper lined with silver; the focal length is about 3 or 4 inches, and the diameter at the outer edge about 21 inches.

If the curvature of a reflector could be made truly parabolic, and if the light issued from a mathematical point, the rays would be reflected from the mirror exactly parallel to the axis of the generating curve, and the beam of projected light would be a cylinder having a diameter equal to that of the mirror. Such a form of the beam would render the light nearly useless, on account of the small portion of the horizon which would be illuminated; and it is accordingly necessary to give the rays a certain degree of divergence: this is practically effected by the size of the flame. The burner of the lamp is usually an inch in diameter; and the origin of the luminous rays being thus at a small distance from the focus, instead of being reflected parallel they are projected in a cone having a divergence of about 14°. The curvature of the mirror may also be so adjusted as to increase the divergence.

In order to produce a light of sufficient intensity, several parabolic mirrors, sometimes as many as eight, are placed on a frame, with their axes all parallel to each other, so that the light reflected by all of them is blended together in the same beam. To form a revolving light, the frame is attached to a horizontal axis, which is turned by means of clock machinery; and in this manner the different quarters of the horizon are successively illuminated. But as a rapid motion would be inconvenient, the frame has usually three or four sides, on each of which the same number of mirrors and lights is placed; so that the illumination is repeated three or four times in one revolution. To form a stationary light, a number of reflectors are placed round a circular frame, having their axes on the radii of the circle. This arrangement has one obvious defect; namely, that the illumination will not be equally intense at all azimuths, but strongest in the direction of the several axes, and feeblest in the direction of lines bisecting the several angles formed by each pair of contiguous axes. The defect is one which cannot be entirely remedied in a stationary light on the catoptric principle.

Dioptric System.—The introduction of lenses for the purpose of giving the light a horizontal direction is of recent date. A project for this purpose is indeed mentioned by Smeaton in his account of the Eddystone lighthouse, and about the end of the last century the method was tried at some lighthouses in the south of England; but from the imperfect figure of the lenses, and the absorption of the light caused by the great thickness of the glass, it did not succeed. But the art of grinding spherical lenses having been since brought to greater perfection, and a means of greatly diminishing the absorption, and also of constructing lenses of a much greater size, having been found in the use of polyzonal lenses (that is to say lenses formed of several pieces separately prepared and afterwards united,—*see* Polyzonal Lens), the system has been revived of late years, and in many instances carried successfully into execution. The merit of first applying such lenses to lighthouses belongs to the late Auguste Fresnel, of the Academy of Sciences of Paris. The annular lenses, constructed under the direction of Fresnel for the principal lighthouses in France, are plano-convex, having a focal distance of about 3 feet; and they are formed of crown glass, as being less liable to *striæ* than flint glass. The effective divergence of the cone of light projected by a lens is generally less than in

the case of a paraboloidal refractor, being only about 5° 9′. As the luminous cone is formed of only that portion of the light which falls on the surface of the lens, it might be supposed that an apparatus of this kind would be far inferior in its effect to a parabolic mirror; but when it is considered that, owing to the imperfections of the form and polish of the reflecting surface, more than one half of the incident light is lost in every case, and also that a larger and more intense flame may be used for illuminating the lens than can be applied to a parabolic reflector, it will easily appear that the superiority may be on the side of the lens. In fact a lens of the largest size used in the French lighthouses projects a cone of equal intensity to that of eight mirrors of the best kind.

The construction of a revolving dioptric apparatus of the first order is usually as follows:—The revolving frame which carries the principal lenses has eight sides; and there are consequently eight large lenses, so arranged that their axes are all in the same horizontal plane, and meet in the common focus, where the lamp is placed. This frame, with its lenses, consequently forms an octagonal prism. For the purpose of preventing the loss of the rays which fall above and below the principal lenses, various methods are employed. One is to place above the first frame a second frame, whose sides form the frustum of an octagonal pyramid of 50° of inclination, in each of the sides of which is placed a lens having its focus in the flame of the lamp. The rays falling on these inclined lenses are refracted into directions parallel to the axis of the lens, and are then reflected into the horizontal direction by plane mirrors placed above the second frame. Another method is to place curved reflectors above the frame containing the principal lenses. But a third and still more elegant method, proposed by Fresnel, is to substitute for the upper lenses and mirrors a series of triangular prisms, having their axes arranged in horizontal planes, and so adjusted that the light falling on the face next the flame is thrown upon the back of the prism, where it suffers a total reflexion; and a second refraction at the third side of the prism gives it the horizontal direction.

For fixed lights on the dioptric system, it is necessary to increase the number of the lenses, which in fact ought to be infinite, or to form a true cylinder, in order to produce an equal diffusion over every point of the horizon. In some of the French lighthouses the refracting apparatus consists of a polygonal belt of 32 lenses; but on establishing a dioptric apparatus at the Isle of May lighthouse, in 1836, Mr. Alan Stevenson proposed to form a true cylindric belt; and the task, though attended with much difficulty, was successfully executed at a glasshouse in Newcastle.

The dioptric system is peculiarly adapted for fixed lights; and its advantages are these:—1. A light of equal intensity is distributed round every point of the horizon. 2. The consumption of oil is less for the same intensity of light, and consequently the expense of maintaining the light is less. 3. The trouble attending it is less, as there is only one lamp to trim, and the lenses are easily kept in order; whereas the reflecting surfaces require much care and attention. On the other hand, there is more risk from accident, for the accidental extinction of the lamp leaves the whole horizon in darkness; whereas in a system of reflectors the light would be extinguished over only a small portion of it.

Fresnel published his first memoir on the subject in 1822; since that time the dioptric system has been generally adopted for all the principal lighthouses of France and Holland. In this country it has as yet been applied only at Inchkeith and the Isle of May in the Firth of Forth, and at the Star Point in Devonshire.

Lamps.—For the lights on the catoptric system the illumination is usually produced by an Argand fountain lamp, having a burner of an inch in diameter, and tipped with silver, in order that it may the better withstand the effect of the heat evolved. In the dioptric system a larger flame is requisite; and Fresnel invented a lamp, the peculiarity of which consists in its having a series of concentric burners. For lights of the first class the number is four; and they are protected from the effects of the excessive heat by a superabundant supply of oil, which is thrown up from the cistern below by a clockwork movement, and is kept constantly overflowing the wicks. A tall chimney is necessary to supply a sufficiency of air. In this country the lamp is fed with spermaceti oil; in France the oil of colza (expressed from the seed of the wild cabbage) is used; and in some parts of the Mediterranean olive oil, but the light obtained from this is comparatively feeble. In a few instances coal gas has been used for dioptric lights. All attempts to apply the Drummond light, and voltaic lights, have failed, by reason of the great practical difficulties with which those modes of illumination are attended.

Method of distinguishing Sea Lights.—An object of great importance in the establishment of lighthouses is to vary the appearances of the different lights so that each may have some distinctive character by which it may be readily recognized, and the mariner be made aware of the part of the coast he is approaching. Among the methods adopted for this purpose are the following:—1. The interposition of coloured shades before the lenses or refractors, so as to give a particular colour to the light: red is the only colour which can be used, as shades of any other colour are found to absorb too much light. 2. The time of revolution, or the length of the interval between the successive appearances of the light: this is the only mode of distinguishing lights adopted on the French coasts. 3. A *flashing light;* that is, a light of which the alternate flashes and eclipses succeed each other so rapidly as to give the appearance of a succession of brilliant scintillations. 4. An *intermittent light*, which consists of a fixed light which is suddenly eclipsed, and after a stated interval as suddenly revealed: the appearance of this light is entirely different from that of any revolving light. 5. The exhibition of a double light, which admits of other distinctions; for the one light may be placed vertically above the other, or in the same horizontal plane; or one may be white and the other red. Sometimes three lights are necessary to indicate the entrances to harbours, &c.

The average annual expense of maintaining a land light in Great Britain is about 500*l.*, and that of a floating light about 1200*l.*

(*Encyc. Brit.*, art. "Sea Lights;" Smeaton, *Narrative of the Eddystone Lighthouse*, 1793; *Stevenson's Account of the Bell Rock Lighthouse*, 1824; Id., *British Pharos*, 1831; *Brewster's Treatise on Burning Instruments*, 1812; *The Lighthouses of the British Islands*, 1836; *Report of Select Committee of the House of Commons on Lighthouses*, 1839; *Report to the Commissioners of the Northern Lighthouses*, by A. Stevenson, 1834; and *on the Inchkeith Dioptric Light*, 1836; Belidor, *Architecture Hydraulique.* tome iv.; Peclet, *Traité d'Eclairage*, Paris, 1827; Fresnel, *Memoire sur un Nouveau Système d'Eclairage des Phares*, 1822; A. Fresnel, *Description Sommaire des Phares et Fanaux allumés sur les Cotês de France*, 1837, &c.)

LI′GHTNESS. (Teut. leicht.) In the Fine Arts, a quality indicating freedom from weight or clumsiness.

LI′GHTNING. An electric phenomenon, produced by the passage of electricity between one cloud and another, or between a cloud and the earth.

The identity of lightning with electricity, though it had been previously suspected, was first directly demonstrated by the celebrated Dr. Franklin, in the year 1749, by the experiment of drawing sparks from the electric kite. Since that time the science of electricity has been greatly advanced; nevertheless, the cause of some of the appearances connected with lightning is not well explained even at the present day.

There are three phenomena in particular for which theory fails satisfactorily to account. The first is the form of the flash, which is almost always zigzag, or in broken lines, making a greater or smaller angle with each other. The second is the frequent repetition of the flashes from the same cloud, which often follow one another in quick succession, contrary to what takes place in the case of electric conductors, which generally recover their natural state or discharge the whole of their electricity at a single stroke. The third is the length of the flash, which sometimes appears to embrace a large extent of the sky. This phenomenon can be best observed from the tops of mountains reaching above the clouds from which the lightning proceeds; and observers in such circumstances agree in stating that they have seen flashes certainly extending several miles in length.

The zigzag form of the flashes is common to lightning and the electric spark: the same explanation should consequently apply to both; but this the theory has not yet been able to give. With regard to the second phenomenon, the repetition of the flashes, we may suppose that the mass of vapours constituting an electric cloud is a less perfect conductor of electricity than metallic substances; and without knowing how electricity is distributed and arranged, so as to be in equilibrium over imperfect conductors, whose surfaces, as in the case of the clouds, often extend many miles, it is easy to see that an instantaneous contact with the ground, or with another substance having an opposite electricity, would not be sufficient to effect a complete discharge; and that, consequently, a single spark would not restore them to their natural state. This we may suppose to be the cause why numerous flashes are darted from the same cloud. With respect to the third phenomenon, the great length of the flash may also be a consequence of the feeble conducting power of the clouds, and of the mobility of their constituent parts; or we may suppose parcels of vapour or air, electrified by the influences of two clouds charged with opposite electricities, to be scattered at very small intervals between the clouds, and that, at a given instant, the equilibrium is destroyed, without a transference of the electricity of the one cloud to the other, but merely from parcel to parcel,

along the whole extent of the line in which the flash appears.

The theory of an electric fluid, and the well-ascertained differences in the conducting power of different substances, suggested the idea of protecting buildings from the destructive effects of lightning by metallic rods. It has been disputed whether conductors ever have been or can be of use in any case; and the question will not probably be satisfactorily answered until the cause and nature of electric action are better understood. *See* ELECTRICITY, THUNDER.

LIGHT-ROOM. A small room from which the light is afforded to the powder magazine of a ship.

LIGHTS, NORTHERN. *See* AURORA BOREALIS.

LI'GNEOUS. (Lat. lignum, *wood.*) In Entomology, a part is so called when it is composed of a hard inelastic substance like wood.

LI'GNIN. (Lat. lignum.) The woody fibre. This most important proximate principle of vegetables exhibits itself in a variety of forms, constituting the different textures of hard and soft wood; and various fibrous products, such as hemp, flax, cotton, &c. When by fine mechanical division it is reduced to a pulpy state, it is formed into paper. When, by different reagents, all the soluble matters are extracted from wood, the insoluble residue is lignin: its ultimate components are charcoal, oxygen, and hydrogen, the latter elements being in the same ratio as in water; so that wood may be considered as a compound of carbon and water, and, according to Dr. Prout's experiments, almost exactly in equal weights. Lignin is very imperishable; but under certain circumstances it is attacked by *dry rot*, arising out of the growth of a parasitic fungus, which causes its rapid decay. Damp timber, in situations where air has not free access, is particularly subject to its attacks; and, when once it has made its appearance, the well-seasoned timber in its neighbourhood becomes liable to the same disease. The dry rot may be prevented by impregnating the timber with certain saline solutions, and of these solution of corrosive sublimate has been found most effectual: the chloride combines chemically with the lignin, and the compound is very indestructible. (*See* DRY ROT.) Lignin has also a strong attraction for alumine; and hence linen, cotton, paper, and other forms of this fibre, may be aluminized by steeping them in hydrated alumine diffused through water; or, more effectively, by soaking them in certain aluminous solutions, drying them, and afterwards washing out the excess of the salt. It is in this way that cotton goods are impregnated with alumine for the purpose of dyeing and calico printing. Other metallic oxides exhibit similar attractive powers, especially the oxide of iron.

The analogy that exists between the composition of sugar, gum, starch, and even vinegar and lignin, suggests the possibility of the conversion of those proximate elements into each other; and it has accordingly been found that, by carefully roasting pure and fine sawdust, it is rendered partially soluble in water, and that a part of it is converted into a nutritious substance, probably intermediate between sugar and starch; and which, when mixed with a little flour, yields a palatable bread, not very unlike that made by some of the inhabitants of the northern parts of Europe of the bark of trees. Mixed with sulphuric acid, lignin passes into gum; and from this sugar may be obtained by boiling it for some hours in a very dilute sulphuric acid: this sugar, when purified, much resembles grape or honey sugar. By this process rags may be converted into nearly their own weight of this peculiar saccharine matter.

The production of vinegar by the destructive distillation of wood was originally suggested, about the middle of the 17th century, by Glauber, a celebrated German chemist of that time: it has lately become a very important branch of manufacture in this country. Upon the whole, there are very few natural products equally important with lignin in their applications to the useful and ornamental arts.

LIGNIPE'RDOUS. (Lat. lignum, and perdo, *I destroy.*) Insects which destroy wood.

LI'GNITE. (Lat. lignum, and ignis, *fire.*) Wood converted into a kind of coal.

LI'GULA. (Lat. *a tie.*) In Botany, a membranous appendage at the apex of the sheathing petiole of grasses, and analogous to the corona of some Silenaceous plants. The term *ligula* is also applied to certain bodies proceeding from the base, and alternate with the horns, of the organ called the *orbiculus* in Asclepiadaceous plants.

LI'GULA. In Entomology, a name applied by Latreille to the lower lip of insects, or *labrum* of English entomologists.

LI'GURITE. A mineral found in a talc rock on the banks of the Stura in the Apennines; it occurs in yellow-green crystals, and, as a gem, resembles the chrysolite.

LILIA'CEÆ. A large natural order of Endogenous plants, with hexapetaloid hexandrous flowers, a superior ovary, and anthers which burst internally. They are familiarly known, in consequence of the asparagus, the lily, the fritillary, the harebell, the star of Bethlehem, and many other common plants, forming a part of the order; which differs from *Melanthaceæ* in having a single style, not three styles, and in the anthers opening towards the style, not towards the petals. The species are extremely varied: some, like the dragon trees, form a tall woody perennial stem, which emulates that of palm trees; others are small bulbous plants, whose stem only lives a few weeks. Almost all the order is sought after by cultivators of beautiful plants; and, in the case of the tulip and the hyacinth, innumerable varieties constitute the riches of the florist. It is the general property of Liliaceous plants to secrete a little stimulating principle; which, in different degrees of concentration and modification, gives their activity to onions, garlic, chives, and similar garden productions, and their medical value to aloes and squills.

LILIA'CEOUS. In Botany, a term invented by Link to denote a corolla, the petals of which have their ungues gradually dilating into a limb, and standing side by side. It is rarely employed.

LI'MA. (Lat. *a file.*) A genus of Lamellibranchiate Bivalves, of the tribe *Ostracea*, characterized by the length of their shells as compared with those of the nearly allied genus *Pecten*, and their more regular oval form. The ridges of the shell are most of them relieved with scales. The *Limæ* swim with rapidity by means of their valves, but in a young state they secure themselves by means of a byssus.

LIMA'CIDÆ. *See* LIMAX.

LI'MACI'NA. (Lat. dim. of limax, *a slug.*) A genus of Testaceous Pteropodous Mollusks, existing in considerable numbers in the northern seas, and forming, with the *Clio borealis* and other small marine animals, the food of the whalebone whale. The body terminates in a spirally convoluted tail, and is lodged in a very thin shell, formed by one whorl and a half, umbilicated on one side, and flattened on the other. The animal uses its light shell as a boat, and its wing-like fins as oars, and thus navigates in countless fleets the surface of the tranquil deep.

LI'MAX. (Lat. limax, *a slug.*) The name of a genus of the Linnæan *Vermes Mollusca*, of which the common slug is the type. The genus enters into the class *Gasteropoda* and order *Pulmonaria* of the system of Cuvier; and is now raised to the rank of a family (*Limacidæ*), which includes *Limax* proper; *Arion*, Fér.; *Stenopus*, Guild.; *Vaginulus*, Fér.; *Testacella*, Lam.; *Parmacella*, Cuv., &c. Each of these genera has a small scutiform rudimental shell developed in the substance of the mantle, and protecting the heart. The orifice of respiration in the true slugs (*Limax*, Cuv.) is on the right side, and not so far forward as in *Arion*. The rudimental shell is marked with fine and concentric striæ, and is calcified internally. The species of this genus are the pests of gardens and cultivated grounds. Young plants may be protected from slugs by having a coarse horsehair rope coiled round their stems, or by being plentifully sprinkled with soot; or they may be watered morning and evening with strong and fresh lime water.

LIMB, in Astronomy, signifies the border or outermost edge of the sun or moon. Also the graduated edge of a circle, or other astronomical instrument.

LI'MBERS. In Artillery, a sort of advanced train to which the carriage of a cannon is attached on a march. It is composed of two shafts, wide enough apart to receive a horse between them, joined by two bars of wood, and mounted on a pair of wheels.

LI'MBO. (Lat. limbus, *a hem or edge.*) A region supposed by some of the school theologians to lie on the edge or neighbourhood of hell. This served as a receptacle for the souls of just men, not admitted into purgatory or heaven. Such were, according to some Christian writers, the patriarchs and other pious ancients who died before the birth of Christ: hence the limbo was called Limbus Patrum. These, it was believed, would be liberated at Christ's second coming, and admitted to the privileges of the blessed in heaven. Though some have asserted that, when our Saviour went down into hell, he liberated these souls, and carried them away with him into heaven. This latter idea is probably an adorned representation of the remarkable passage in St. Peter's Epistle (i. 3. 19.), where he says that Christ preached to the spirits in prison; and, being held by certain of the later fathers, seems to have given some influence to the growing opinion in favour of a purgatory. The limbus puerorum, or infantum, was a similar receptacle allotted by some of the schoolmen to the souls of infants who die unbaptized. Dante has fixed his limbo, in which the distinguished spirits of antiquity are confined, as the outermost of the circle of his hell. The use which Milton has made of the same superstitious belief is well known. (*Paradise Lost*, book iii.)

LI'MBUS. A term applied to petals, to denote that portion which is supported by the unguis; it is the same organ in a petal as the lamina in a leaf, and is what constitutes the broad, thin, coloured part which renders many flowers so beautiful.

LIME. (Germ. leim, *glue.*) This very useful earth is

obtained by exposing chalk and other kinds of limestone, or carbonates of lime, to a red heat,—an operation generally conducted in kilns constructed for the purpose; the carbonic acid is thus expelled, and lime, more or less pure, according to the original quality of the limestone, remains. In this state it is usually called *quicklime*. When sprinkled with water it becomes very hot, and crumbles down into a dry powder, called *slaked lime*, or *hydrate of lime*. When exposed for some weeks to the air it also falls into powder, in consequence of the absorption of moisture, and of a portion of carbonic acid; so that, in this case, part of the lime gradually reverts to the state of carbonate, and loses its causticity. Pure lime may be obtained by heating powdered Carrara marble to whiteness in an open crucible. It is white, very infusible, highly luminous when heated to full redness, and of a specific gravity of about 2·3. It requires for solution about 500 parts of water, and is somewhat more soluble in cold than in hot water. But, weak as this solution is, it acts powerfully alkaline upon vegetable colours, and has an acrid taste; hence the term *alkaline earth* applied to lime. It absorbs carbonic acid by exposure to air, and as *carbonate of lime* is insoluble in water, it becomes milky in consequence; so that, from this property, lime-water is a useful test of the presence of carbonic acid. The nature of lime was first demonstrated by Davy in 1807: he showed that, like the other alkalies, it was a metallic oxide. The metallic base of lime has been termed *calcium:* its equivalent is 20, and lime, being a compound of one atom of calcium and one of oxygen, is represented by the equivalent number 28; and hydrate of lime by 28 lime + 9 water = 37. The *salts of lime* are generally obtained by dissolving carbonate of lime in the respective acids: several of them exist native. *Sulphate of lime*, selenite, or gypsum, is an abundant natural product, and may be formed artificially by adding sulphuric acid, or the soluble sulphates, to solutions of the salts of lime. It consists of 28 lime + 40 sulphuric acid, and its crystals include two atoms = 18 of water. When these crystallized sulphates of lime are heated they part with their water and fall into a white powder, called *plaster of Paris;* when this is mixed with water it again combines with it, and concretes into a white mass; hence its use for casts, busts, &c. Sulphate of lime is often contained in spring water, which is thus rendered *hard* and unfit for washing. These waters become turbid upon the addition of a spirituous solution of soap. *Phosphate of lime* is found *native*, constituting the mineral called *apatite:* this is a *subphosphate*, composed of 3 equivalents of lime = 84, and 2 of phosphoric acid = 72. The *earth of bones* is also chiefly a similar phosphate of lime. *Oxalate of lime* is very insoluble, and is precipitated whenever oxalic acid or a solution of an oxalate is added to solutions containing lime; hence it is that oxalate of ammonia is so valuable a test of the presence of lime, and is frequently used for the purpose of separating lime in analysis. When oxalate of lime is well dried, at 500°, it is anhydrous, and consists of 28 lime + 36 oxalic acid = 64 oxalate of lime. This substance is occasionally found in the human urine, and sometimes forms calculi: these are often of a reddish brown colour and a rough exterior, whence they have been termed *mulberry calculi*. When hydrate of lime is exposed to chlorine, the gas is absorbed, and a *chloride of lime* is obtained. This article is manufactured upon an extensive scale, under the name of *bleaching powder*. It evolves chlorine when acted upon by acids; and gives it out very slowly when exposed to air, in consequence, probably, of the absorption of carbonic acid. It is a most useful disinfecting material, and, when dissolved in water, forms *bleaching liquid*. *Carbonate of lime* is thrown down when alkaline carbonates are added to solutions of the salts of lime. It is a most abundant natural product, and is found pure in the varieties of calcareous spar and statuary marble. Chalk and several varieties of limestone are also nearly pure carbonates of lime. It is easily distinguished from other minerals by effervescing in dilute muriatic acid, and by yielding quicklime when a fragment is heated before the blowpipe. It is constituted of 28 lime + 22 carbonic acid: the equivalent, therefore, of carbonate of lime is 50.

The uses of lime are very numerous. Its most important application is in the manufacture of mortar and other cements used in building. It is also very extensively used in this country, and in some parts of the Continent and North America, as a manure to fertilize land. But it is a curious fact that the use of lime as a manure is entirely a European practice, its employment in this way having been never so much as dreamed of by the natives of Asia or Africa. (See *Commercial Dict.*)

LI'MESTONE. A generic term for those varieties of carbonate of lime which are neither crystallized nor earthy; the former being *calcareous spar*, the latter *chalk*. When burned they yield quicklime. *See* GEOLOGY.

LI'MIT, in Geometry, denotes a given or determinate quantity to which some other variable quantity continually approaches in value, but which it can never exceed. Thus, if we suppose a polygon to be inscribed in a circle, by increasing the number of sides of the polygon its area is increased. But the area can never exceed that of the circle within which the polygon is inscribed; and it is only when the number of its sides is conceived to be infinitely great that its area becomes equal to that of the circle. The circle is thus said to be the limit of the areas of the inscribed polygon.

Method of Limits, the same with the *method of prime and ultimate ratios;* a peculiar method of analysis employed by Newton in the *Principia*, equivalent to fluxions or the differential calculus, but preserving the form of the ancient geometry.

LIMITA'TION OF ACTIONS AT LAW. The period beyond which personal actions of trespass, or debt on simple contract, cannot be brought is defined by the stat. 21 J. 1. c. 16. They must be commenced within six years after the cause of action; with the exception of actions of assault, menace, and imprisonment, which are limited to four. But a right of action may be revived by an express acknowledgment on the part of the debtor.

Penal actions for forfeitures made by statute must be sued in general, according to the terms of the statutes, within two years or one year.

By the recent statute 3 & 4 W. 4. c. 27., all process for the recovery of land by entry and distress, or by action, whether real or mixed, must be commenced within twenty years after the right of action accrued. Persons under the disabilities of infancy, coverture, idiotcy, lunacy, unsoundness of mind, or absence beyond seas, are allowed ten years after the termination of their disability; so that forty years be in all cases the extreme limit. This statute extends both to suits in equity and actions at law. No advowson can be recovered after one hundred years. Money charged upon land, and legacies, are deemed satisfied at the end of twenty years, unless there have been some receipt or acknowledgment. Arrears of rent, or interest of money charged on land, cannot be recovered after six years. But it has been thought that this limitation has been extended by the subsequent statute 3 & 4 W. 4. c. 42., which enacts that actions of covenant and debt for rent, &c. may be brought at any time within 20 years after the cause of action has accrued.

The statutes of limitations apply to equitable remedies directly, and by the plain import of the statutes, where the equitable remedy is sought (as it may be in some cases) for a right enforceable at law; and they have been adopted by analogy in those cases where a purely equitable right is the counterpart of a legal one, as the right to mesne profits in respect of an equitable ownership, or a debt payable in equity but not in law. Where there is not this strict correspondence between the equitable and legal claims, the rule prevails that twenty years' adverse possession, which is in law a bar to the possessory action for land, shall be a bar to all equitable claim, whether the adverse right be merely equitable also or equitable and legal; such period of limitation being, as at law, capable of extension from infancy, absence, or disability. But time is not a bar to the claim of cestui que trust against his trustee, where the trusteeship was in the origin direct and express, and not coupled with any beneficial interest, as it is in the case of a mortgage; nor does a purchaser, with notice from a trustee, stand in a better situation in respect to time than the trustee himself.

LI'MNEUS. (Gr. λιμνη, *a pool.*) A genus of freshwater snails; so named from their general location in ponds, ditches, and other receptacles of stagnant water. Many species of this genus are natives of Britain.

LI'MNING. The art of painting in water colours; in which sense it is used to distinguish it from painting in oil colours.

LIMO'SA. (Lat. limus, *mud.*) A genus of wading birds, belonging to the *Longirostrus* tribe; and characterized by a straight beak, longer than that of the snipes (*Scolopax*), and sometimes slightly bent at the extremity; the nasal groove extends close to the tip, which is blunt and somewhat depressed; there is no third groove or punctation on its surface. The external toes are palmated at the base: they are longer and slenderer than in the snipes. The species of *Limosa* which, with us, are vernacularly termed Godwits, frequent salt marshes and the sea shore.

LI'MULUS. (Lat. limus.) A genus of gigantic Entomostracous Crustacea, in which the haunches of the first six pairs of feet are beset with small spines, and are so closely approximated about the mouth as to serve the office of jaws. The œsophagus, instead of proceeding backwards, is continued forwards for a short distance into the anterior part of the shield before it enters the stomach: this cavity is lined with a thick rugous cuticle, and terminates in the intestine by a long muscular and valvular projection. The heart is elongated, vasiform, and muscular; the branchiæ are supported on a series of closely-packed broad plates beneath the postabdomen. The total number of feet is twenty-two: the first ten, with the exception of the two anterior ones in the males of some species, are terminated by a didactyle forceps, and are inserted, with the two following pairs,

beneath a large semilunar shield. The species of this genus are found on the shores of the North American and Asiatic continents: they are commonly known by the names of king crabs, horse-shoe or mollusca crabs. The tail is long, straight, sharp-pointed, and of sufficient strength and size to be used as a spear-head or arrow-point by savages.

LINA'CEÆ. (Linum, one of the genera.) A small natural order of herbaceous Exogens, principally inhabiting Europe and the North of Africa; allied, according to De Candolle, to *Silenaceæ*, *Malvaceæ*, and *Geraniaceæ*. Aug. de St. Hilaire considers them to be a mere section of *Geraniaceæ*. The want of a gynobasic structure, the imbricate calyx, the regular flowers, and the small quantity of albumen in the seeds, rather point out an affinity with *Cistaceæ* and its allies. Their chief characters are the tenacity of their fibre, the mucilage of their seeds, and the beauty of their flowers. Common flax or lin (whence linseed) is the most important plant of the order.

LINE, in Military Affairs, is a term used to distinguish what may be called the regular infantry of Great Britain from other military corps or establishments. Thus all numbered infantry or marching regiments, with the exception of the Foot Guards, are designated by this term, in opposition to the cavalry, the artillery, the engineers, the marines, the militia, the yeomanry, &c.

LINE, in Fortification, signifies any extended defence; as a ditch with its parapet, a row of gabions, &c.

LINE, in Geography and Navigation, is used for the equator; as equinoctial *line*.

LINE. In Geometry, a magnitude having only one dimension. Euclid defines it to be "that which has length without breadth."

LI'NEAR. In Geometry, a linear problem is one that is solved by the intersection of two straight lines, or by an equation of the first degree, and which, consequently, admits only of a single solution.

Linear Equations, in the Integral Calculus, are those in which the unknown quantity is only of the first degree. Thus $Ax + B = O$ is a linear equation, if A and B are not functions of x; and $A\,dy + By + C = O$ is also a linear equation, when A, B, and C do not contain y.

Linear Perspective is that which regards only the positions, magnitudes, and forms of the objects delineated; as distinguished from *aërial perspective*, in which the variations of the light, colour, and shade of objects, according to their different distances and the quantity of light that falls on them, are also considered and represented.

LINEN. (Germ. leinwand.) A species of cloth woven with the fibres of the flax plant (*Linum usitatissimum*). The origin of the manufacture of linen is lost in its antiquity. In the time of Herodotus linen was an article of export from Egypt, where it had been used from time immemorial; but it is evident that in ancient times its use was limited to the noble and the rich. In modern times linen constitutes a staple manufacture in almost all European countries; but more especially in Germany, Russia, Switzerland, Flanders, England, Scotland, and Ireland. In England it has been prosecuted for a very long period; but until of late years its progress has been inconsiderable, compared at least with that made in other branches of manufacture. This seems to be partly owing to the attempts to bolster up and encourage the manufacture in Ireland, partly to the absurd restrictions that were for a lengthened period laid on the importation of foreign flax and hemp, and partly to the rapid growth of the cotton manufacture — fabrics of cotton having to a considerable extent superseded those of linen. It is only within the last fifty years that any machinery has been used in the production of linen cloth, the first mills for the spinning of flax having been constructed at Darlington about forty-eight years ago. (*See* FLAX, HEMP.) The principal seat of the manufacture is—in England, Leeds and its immediate vicinity, and in Lancashire, Dorset, Durham, and Salop; in Scotland, Dundee, which indeed may be regarded as the chief seat of the British manufacture (see *Geo. Dict.*, art. "Dundee"); and in Ireland, the province of Ulster. The entire value of the linen manufacture of Great Britain and Ireland is estimated at 8,000,000*l.*, and the total number of persons employed in it about 185,000. (*Statist. of the Brit. Empire*, vol. i. 679.)

LINE OF BATTLE, is the line formed by the ships of the fleet when ranged ahead and astern of each other, at equal distances, and close-hauled, or nearly so. It may be formed accordingly upon either tack. The line is composed of ships of not less than two decks, thence called *line-of-battle-ships*. The line is also called the *line ahead*.

LINE OF BEARING, THE, is formed by the ships of the fleet when ranged on a line six points from the wind, at equal distances, and with their heads in any direction whatever. The line is called by the name of that tack upon which if the ships were to haul to the wind together they would form the line ahead. For example: suppose the wind N., and the ships in a line W. N. W. and E. S. E. of each other; this is the *starboard* line of bearing, whether the ships are going free, or close-hauled upon the *larboard tack*.

LINE OF DIP. In Geology, the strata which form the crust of the globe are rarely horizontal, but incline to some point of the horizon, and rise to the opposite point; a line drawn through these points is called the line of their *dip*.

LI'NGUA. (Lat. *a tongue*.) In Entomology, the name of an organ situated within the labium or emerging from it, by which insects, in many cases, collect their food and pass it down the pharynx, which is situated above its root.

LI'NGUA FRA'NCA. The dialect spoken chiefly along the European and African coast of the Mediterranean. It is a species of corrupt Italian, mingled with words of other languages, and may be termed the Creole of the Mediterranean.

LI'NGULA. (Lat.) A genus of Palliobranchiate Bivalves, with two nearly flat, smooth, oblong, triangular valves, attached between the two apices to a long fleshy pedicle. The arms, or labial appendages, are spirally convoluted, as in the rest of the class.

LI'NIMENT. (Lat. lino, *I anoint*.) A semifluid ointment, or a soapy application, to rub upon painful joints. The term is also applied to spirituous and other stimulating applications for external use.

LI'NING. In Architecture, any covering of an interior surface. The linings, for instance, or boxings of window shutters, are the pieces forming the backs of the recesses into which the shutters are folded. In doorways, they are the facings on each side the aperture: to sashes, they are the vertical pieces parallel with the surface of the walls.

LI'NTEL. (Span. lintel.) In Architecture, an horizontal piece of timber or stone, over a door, window, or other opening, to discharge the superincumbent weight.

LION. (*Felis leo*, Linn.) The largest, most formidable, and most noble of the Carnivorous animals, though not the most typical of the genus at which it stands at the head. It is chiefly distinguished by the presence of a full flowing mane in the male, and by a tufted tail and the disappearance of the feline markings in both sexes before they arrive at maturity; the colour then being a nearly uniform light fulvous brown, with mane inclining to black, especially in the Central and South African races. The mane is scantier and lighter coloured in the Asiatic than in the African lions; and there exists a maneless variety in the eastern parts of Hindostan. *See* FELIS.

LION. In Heraldry, a beast, of which the figure is very commonly borne as a charge. The attitudes in which the lion is represented are very various. (*See* RAMPANT, PASSANT, REGARDANT, GARDANT, COUCHANT, SALIENT, SEJANT.) A lion passant is termed, in French heraldic language, a leopard; and hence the common notion that the lions of England were substituted for leopards.

LION OF ENGLAND. A lion passant regardant or (being the bearing of England), is frequently thus termed in heraldry.

LIP. A term applied to either of the two divisions of a Monopetalous corolla, where one portion takes a direction upwards and the remainder a direction downwards, as in *Labialæ*. It is the same as *labellum*, which see.

LI'PARIS. (Gr. λιπἀρος, *glistening*.) The name of a genus of Lepidopterous insects; also applied by Pliny to a genus of fishes. In Botany, it is the name of a genus of plants of the Orchidaceous order.

LIPOGRAMMA'TIC WORKS or WRITINGS. (Gr. λειπω, *I omit*, and γραμμα, *a letter*.) Compositions in which a particular letter is omitted throughout. The ancients produced many ingenious trifles of this description. In the *Odyssey* of Tryphiodorus there was no A in the first book, no B n the second, and so on. There are other pieces of modern invention, such as the *Pugna Porcorum*, in which all the words begin with the letter P. Odes in Spanish, containing only one of the vowels, are refinements on the same invention.

LIPO'RNA. (Gr. λιπος, *fat*.) A soft fatty tumour.

LIPPITU'DO. (Lat. lippus, *blear-eyed*.) The disease commonly called *bleared eyes*, consisting in a puriform exudation from the margin of the eyelids, which often causes them to adhere together after sleep.

LIQUEFA'CTION. (Lat. liquefactio.) The act of melting or of fusion. This term is also used synonymously with *solution*.

LI'QUIDS. In Grammar, the letters *l*, *m*, *n*, and *r* are so called.

LI'QUOR SI'LICUM. Liquor of flints. A solution of silicated potash.

LIRE'LLA. In Botany, a term used in describing lichens to denote a linear shield, with a channel along its middle, as found in *Opegrapha*.

LIST. The enclosed field or ground wherein the ancient knights held their jousts and tournaments; so called from its being encircled with pales, barriers, or

stakes, as with a list. Some of these were double, one for each cavalier, which kept them apart, and prevented them from coming nearer each other than a spear's length. Hence the expression *to enter the lists* is synonymous with engaging in contest.

LIST. The name given to the border or selvage of a piece of cloth, &c.

LIST, or LISTEL. In Architecture, the same as fillet or annulet.

LIST, CIVIL. *See* CIVIL LIST.

LI'STING. (Fr. leziere.) In Architecture, the cutting away the sappy part from the edge of a board.

LI'TANY (Gr. λιτανια, *supplication*), signifies a general supplication; and was applied by the Eastern church in early ages to a special form of prayer which was introduced into the ritual, or used on particular occasions. The term passed over into the Western church, where the words *rogatio* and *supplicatio* had before been used in the same technical sense. It is supposed by Palmer (*Antiq.* i. 269.) that the change of term was occasioned by the frequency of processional supplications from the Eastern to the Western churches, beginning in the 4th century. It appears that some of the Eastern litanies contain the supplication to saints which forms a distinguishing feature of the Roman. This is sufficient to justify the English church, even on antiquarian grounds, in rejecting these portions of the service. Our litany is mostly translated from the forms of the Western litanies previously used in this country; those of the breviary of Salisbury and York. The direction in the Prayer Book is that the litany shall be read on Wednesdays, Fridays, and Sundays: on the two former, as fastdays in the primitive church; the one as the day in which Christ was sold by Judas, the other as that of the crucifixion, and therefore periods of peculiar humiliation: on the Sunday, as the day appointed for the most complete and solemn service in the week. (See *Riddle's Christian Antiquities*, p. 623., 1839; *Palmer's Origines Liturgicæ*, i. 264.)

LITERA'TI (Lat.), denotes, in general, learned men; but is applied in China to such persons as are able to read and write their own language, and also to a particular sect, consisting chiefly of the most learned men of that country; amongst whom it is called *Jukiao*, or learned. It is from the class of the literati that the mandarins (*quod vide*) are alone capable of being selected.

LI'TERATURE (Lat. litera, *letter*), comprises, in the general sense of the word, the entire results of knowledge and fancy preserved in writing; but, in the narrower use to which ordinary custom restricts it, we draw a distinction between literature and positive science, thus exempting from the province of the former one extensive branch of our studies and attainments. And, in a still more restricted sense, the word literature is sometimes used as synonymous with *polite* literature, or the French *belles lettres* (which see).

The history of literature is a peculiar and distinct subject, comprising several subdivisions, such as histories of the literature of special ages or countries; or histories of separate branches of literature, such as poetry. For its complete execution it requires an union of bibliographical knowledge with critical acumen. It should give the reader a sufficient acquaintance with the titles, contents, and dates of remarkable books, and with the general biography of remarkable authors, together with a critical appreciation of the characters and value both of authors and books, and of the dependence, connection, and derivation of literature; that is, the mode in which opinions, taste, and style have been propagated or changed. This last, as it is the most difficult part of the subject, so is it that of which the execution has been hitherto most imperfect.

Antiquity has left us no relics of this species of history; although the constant references of such writers as Cicero, Pliny, and Quintilian, to earlier authors, accompanied by critical appreciation of their merits, show that the taste and materials for it were not wanting. A remarkable passage of Velleius Paterculus, in which he shows, by historical instances, how many of the great names of antiquity were cotemporary with each other, in limited periods of time, clustering, as it were, together in particular seasons and places, is one of the earliest instances we have of that spirit of generalization from literary phenomena which is now so common as to leave little room even for the display of originality.

In the following brief notices of the principal works of general literary history which the student has it now in his power to consult, we shall follow, in great measure, the criticisms of Mr. Hallam, in the Preface to his *Introduction to the Literature of Europe in the Fifteenth, Sixteenth, and Seventeenth Centuries*. The oldest work of this description (if such it can be called) is that of Polydore Virgil, *De Inventoribus Rerum*, 1499. Conrad Gesner, who has been termed the "father of literary history," published his *Bibliotheca Universalis* at Zurich, 1545-55. Notwithstanding these and a few other meagre attempts, Lord Bacon, says Mr. Hallam, was justified in denying that, up to his time, any real history of letters had been written: "and he compares that of the world wanting this to a statue of Polyphemus wanting his single eye." The next in order of time is *Lambuc's Prodromus Historiæ Literariæ*, 1659; a work pursued on a great plan, but scarcely begun. But *Morhof's Polyhistor Literarius*, first published in 1688, and much enlarged by subsequent editors, "is still found in every considerable library." Andrès, a Spanish Jesuit, published his *Origine, Progresso, e Stato Attuale d'ogni Letteratura*, from 1782 to 1799; a very extensive, and, in some respects, valuable work, though without much display of taste, and no signs of genius. In the present century, no writers, except of Germany, have attempted a field which has become of such enormous extent; but *Eichhorn's Literary History*, in six volumes, 1805, 1811, appears to be now, on the whole, the most complete and valuable work of this kind extant. *Waehler's Manual of Literary History*, in four volumes, appeared at Leipsig in 1833.

But besides these general compendia, much assistance is to be derived from general biographers. Of these the well-known Dictionary of Bayle, first published in 1697, is the earliest of any value. It is characterized by Hallam (p. xi.) in a manner perhaps too depreciating. That of Niceron, *Mémoires pour servir a l'Histoire des Hommes illustres de la République des Lettres*, 43 vols. 12mo. 1733, 1745, is extraordinarily copious, and useful in biographical details, but in other respects of no great value. The *Biographie Universelle* (of which the original edition was in 52 volumes, and a supplement is now in course of publication which has reached the letter H) stands incomparably first among this class of works. *Chalmers's Biographical Dictionary* scarcely deserves mention as a literary work; but its historical details are sometimes minute and useful, though not unfrequently most so in the obscurest names.

Of *partial* works on literary history some of the most remarkable and useful are, 1. According to subjects — History of Philosophy, Brucker, Buhle, Tennemann (abridged by Victor Cousin). To these we may add, brief as they are, the Introductory Essays of Stewart and Playfair to the *Encyclopedia Britannica*. Of Belles Lettres, generally, Bouterwek, 12 vols. 8vo. Poetry, Quadrio, *Storia d'ogni Poesia*; a work of remarkable industry, though strangely defective in point of critical taste. 2. According to countries — French: Laharpe, *Cours de Litterature Française*; a performance of considerable, but in parts superficial and showy, talent. Italian: *Tiraboschi, Storia della Letteratura Italiana;* a work of extraordinary value, in which the history of Italian literature has been traced, with the greatest care and the most elaborate research, from the earliest times down to the last century. It has been abridged, but with some original criticism, by Ginguené, in his *Histoire Litteraire de l'Italie;* Corniani, *Secoli delle Letteratura Italiana dopo il suo risorgimento*, 1804, 1813. *Sismondi's Litterature de Midi de l'Europe* is most valuable, also, in its Italian chapters, although those on Spanish and Portuguese literature touch on subjects less generally known. In England, as Mr. Hallam observes, "we cannot claim for ourselves a single attempt of the most superficial kind. *Warton's History of Poetry* contains much that bears on our general learning; but it leaves us about the accession of Elizabeth." 3. According to ages: — The recent work of Mr. Hallam, which comprehends the literary history of Europe from 1400 to 1700; a work almost approaching to universal in its character. Its peculiar excellences are a philosophical spirit, manliness and candour of judgment, great honesty in the execution, and a taste unusually cultivated and correct. It is, however, as might be expected from a work of so comprehensive a character, unequal both in the space which it allots to different subjects and authors, and in point of execution.

The love of literature is, perhaps, the most remarkable and characteristic form in which advancing civilization exhibits itself. From being the absorbing passion of the learned few, it becomes, with the progress of education, the delight and favourite occupation of numbers; losing, perhaps, in intensity what it gains in universality. For, without joining in the views of the indiscriminate eulogisers of past times, it cannot, we think, be fairly denied that the engrossing devotion to study which characterized the learned men of the first two centuries after the revival of knowledge, especially in the branches of philology and divinity, rarely finds a counterpart at the present day. More diversified subjects of interest now present themselves to the inquiring mind: objects in themselves of inferior character, such, for example, as the establishment of correct rules of classical composition, are less appreciated, because we have daily opportunities of discussing topics of much higher interest, from which it is difficult to carry back the faculties to pursuits of special investigation. That all this has some disadvantages it were vain to deny. Some imagine that not only extent and minuteness of knowledge, but real depth of learning and

power of mind, are more rare among the literati of the present day than heretofore; that we have lost in profundity, to use the common expression, what we have gained in surface. Of that opinion we are not. But we imagine ourselves to trace, both in the composition and tone of thinking of the day, a want of finish and harmony of tone — a want of those qualities which are the result of patience, and of that complacent dwelling of the mind on some favourite object of study which was so common in former ages. The powers of men of ability are too much dissipated, both by the vast variety of subjects pressing on their attention, and by the temptation to satisfy the cravings of the public by hasty execution.

On the other hand, in the four literary countries of the present day — France, Germany, England, Italy, and especially the three former — the number of persons to whom literature furnishes the sole and beloved *recreation* has increased, within the last century, we may add the last generation, to an amount perfectly surprising. Were it possible to calculate the number of individuals more than half of whose waking hours are spent in reading, and writing on literary subjects, the result would be startling. In Germany the number of books published has nearly trebled since the peace of 1815. The great bulk of the increase belongs to literature specially so called. In France and England the accumulation is scarcely less. And by the process, common in all these countries, of circulating libraries, the same copy of a book performs an infinitely greater quantity of service, passing under the eyes of many more readers than heretofore. It is curious, among ourselves, to trace the decline of the favourite amusements of our ancestors. The theatres are almost deserted by the ranks which used to frequent them. The public assembly rooms of the rich, the suburban places of resort for nightly entertainments, once so common among the middle classes, are alike falling into comparative disuse. Of the increased infrequency of play, or even games of skill, in society, every one can judge. Of wine the consumption has certainly not increased one half in a century, while the number of consumers has probably been quintupled or sextupled. All these things afforded a certain quantity of *occupation;* and the substitute for one and all has been the same — literature.

It is plain, therefore, how far more important a part than heretofore literature must perform in modelling the public mind of nations. There have been times when it scarcely represented the national disposition at all; but merely that of a class by which it was encouraged. Any one who were to judge of the social state of England under Charles II. by its literature, would pronounce that the nation comprised a learned class of great knowledge, but visionary and unpractical habits of mind; and a frivolous, coarse, debauched community. Yet, in truth, the great bulk of the nation was staid, sober, religious, and of a plain and business-like character. The literature of the latter part of Louis XIV.'s reign is grave, decorous, even rigorous in tone; because such was the affectation of the court. The people are not represented in it at all. Such anomalies are now impossible. The floating literature of the day is and must be the real expression of the popular mind.

Now the effect of literature on the moral habits of man is incalculable. It is the remark of a profound religious writer of the present day, that we frequently read a literary work without acquiring any positive knowledge at all, or forgetting it as soon as acquired; but very rarely without receiving some moral impression. And in this view we regard the predominance of literary habits in a nation as advantageous. For, unless public taste is very far corrupted indeed, the tone of morality in the ordinary literature of the day, to meet approval, must be good: not solidly good perhaps — superficial, it may be, and occasionally false; but still more right than wrong. And such a tone of literature, reacting on the minds of the public, will tend to preserve and augment right feelings in the reading classes. The more special tendencies of literary habits seem to be to soften the disposition, — to melt down rancorous feelings, — to encourage benevolence of sentiment, and a ready sympathy with generous conduct. That they serve essentially to promote self-denial and self-devotion, and virtue of the higher order, we do not contend; but we see no ground for the suspicion which some entertain that they are incompatible with the sterner stuff of these more serious qualities, or tend to weaken the main springs of thought and action. On the other hand, although a prevalence of literary habits may render the success of an utterly corrupt style of literature more improbable; yet, when such success does occur, its effects must be infinitely more noxious and destructive. Were such a taste as French lighter literature has of late exhibited likely to obtain a real ascendency in that country, there could not be a more powerful cause, as well as decisive symptom, of national degeneracy; but, in truth, it will prove only a temporary extravagance.

One more effect of the spread of literary habits remains to be noticed — the enormously increased importance of what may now be justly termed the literary profession. Such fortunes as that of Sir Walter Scott are phenomena belonging to this age alone. At this moment (November, 1840) the two contending party leaders in France, on whom the eyes of Europe are fixed, are writers by profession, who have risen to their present eminence through literary distinction; and of the most noted public men on both sides, several belong to the same class. Spain has had a play-writer for her prime minister. In Germany, when a national movement is attempted against an alleged act of usurpation on the part of a sovereign, those who assume the lead are the professors of an university. In England, the less excitable nature of the people, and the great influence of wealth and aristocratic distinction, have kept the great men of the press hitherto in a state of comparative subordination. But a little attention to the signs of the times will lead us to suspect that, if the frame of our society were shaken by any sudden impulse, men of this class would assume a more marked position than they have hitherto occupied. This is the brilliant side of the picture. On the other hand, the multiplication of a body of men whose employment is essentially precarious, their remuneration irregular, their education high, their tastes luxurious, their wants numerous, their success requiring a constant strain upon the spirits and activity of the brain, is in some respects a thing to be regretted. In ill-governed and restless communities they form the most dangerous class; in orderly and flourishing ones they contribute greatly to the brilliancy of society, but at the expense of much of their own peace and happiness. We have outlived the days when the ideas of poverty and learning were habitually associated, and the custom of the humiliating dependence of intellect on wealth, —

Toil, envy, want, the *patron* and the gaol;

but the young aspirant to literary distinction may be usefully reminded of the words of a great writer of our day. "Never" (that is, with a free choice before you) "pursue literature as a profession. It would be a sort of irreligion, and scarcely less than a libel on human nature, to believe that there is any established and respectable profession or employment in which a man may not contrive to act with honesty and honour; and doubtless there is likewise none which may not at times present temptations to the contrary. But wofully will that man find himself mistaken who imagines that the profession of literature or, to speak more plainly, the trade of authorship, besets its members with fewer or with less insidious temptations than the church, the law, or the different branches of commerce. Let literature be an honourable augmentation to your arms, but never fill the escutcheon." (*Coleridge, Autobiographia Literaria.*)

LITHA'RGE, *Lythargyrum*. (Gr. λιθος, *a stone*, and αργυρος, *silver;* probably from its silvery appearance.) Fused oxide of lead. *See* LEAD.

LI'THIA. (Gr. λιθειος, *lapideous.*) A rare alkaline substance, discovered in 1818 by M. Arfwedson in a mineral called *petalite;* it has also been found in some other lapideous bodies. It is distinguished from potassa and soda by the difficult solubility of its carbonate; from baryta, strontia, and lime, by the solubility of its sulphate and oxalate; and from magnesia by the alkalinity of its carbonate. It is the oxide of a white metal which has been named *lithium;* the equivalent of which is 10, and that of lithia 18.

LITHI'ASIS. (Gr. λιθος, *a stone.*) The disease of stone in the bladder or kidney.

LITHIC ACID. (Gr. λιθος.) The substance generally termed *uric acid:* it forms the commonest variety of urinary calculus.

LITHODENDRON. (Gr. λιθος, and δενδρον, *a tree.*) Corals have been thus designated, from their frequent arborescent appearance.

LITHODE'RMIS. (Gr. λιθος, and δερμα, *skin.*) A genus of Apodal Echinoderms, in the system of Cuvier; characterized by an oval body compressed posteriorly, of which the surface is covered with a layer of calcareous granules, which form an extremely indurated crust.

LI'THODOMES, *Lithodoma*. (Gr. λιθος, and δεμω, *I build.*) This term is applied to those bivalves which are found in rocks and stones, inhabiting cavities, which they form for that purpose. A particular genus is called *Lythodomus*.

LITHO'DOMI. (Gr. λιθος, and Lat. domus, *a house.*) Molluscous animals which bore into rocks and lodge themselves in the holes.

LITHO'GRAPHY. *See* ENGRAVING.

LITHOLO'GICAL. (Gr. λιθος, and λογος, *a discourse.*) A term expressing the stony structure or character of a mineral mass. We speak of the *lithological* character of a structure, as distinguished from its *zoological* character.

LI'THOMANCY. (Gr. λιθος, and μαντεια, *prophecy.*) A species of divination practised by the ancients. Their oracular stones appear to have returned audible answers to those who consulted them. Modern conjurors have

another species of lithomancy, — the inspection of the surface of smooth agates or crystals. Such was the divination of the notorious Dr. Dee and his assistant Kelly in the reign of Queen Elizabeth.

LI'THOMARGE. Stone-marrow. A variety of talc of various colours, and generally associated with magnesian minerals.

LI'THONTRI'PTICS. (Gr. λιθος, and τριβω, *I carry away.*) Remedies which are supposed to dissolve stone in the bladder, or which prevent the deposition of calculous matter in the urine.

LI'THONTRI'PTOR. (Gr. λιθος, and θρυπτειν, *to break.*) An instrument for breaking calculi in the bladder, so as to reduce them to small particles which may admit of being passed along with the urine, and thus render the operation of lithotomy unnecessary.

LITHO'TOMY. (Gr. λιθος, and τεμνω, *I cut.*) The operation of cutting into the bladder for the removal of a stone.

LITHO'TRITY. (Gr. λιθος, and τειρω, *I break down.*) The operation of breaking a stone in the bladder into small pieces capable of being voided by urine: it is effected by the introduction of instruments by the urethra.

LI'TMUS. In Chemistry, a blue pigment obtained from the lichen *Rocella*, which grows in the Canary Islands: it is often called *turnsol*, and yields the dye called *archil*. Paper tinged blue by litmus is reddened by the feeblest acids, and hence is used as a *test* of the presence of acids; and litmus paper which has been reddened by an acid has its blue colour restored by an alkali.

LI'TOTES. (Gr. λιτοτης.) In Rhetoric, a figure, according to the Greek and Latin rhetoricians, in which an affirmative is expressed by the negative of the contrary: it is, therefore, a species of irony in the ancient sense of the word (*see* IRONY), in which less is expressed than what is intended to be conveyed to the mind of the reader or hearer. Thus, "a citizen of no mean city" means "of an illustrious city." It is a figure constantly employed to soften what might otherwise appear obnoxious in self-commendation.

LI'TRE. The French standard measure of capacity in the decimal system. The litre is a cubic decimetre; that is, a cube, each of the sides of which are 3·937 English inches: it contains 61·028 English cubic inches, and is therefore rather less than our *quart*. Four and a half litres are a close approach to the English imperial *gallon*.

LI'TTLE. (Sax. lytel.) In the Fine Arts, a term denoting that a work is void of those qualities that tend to raise the feelings of the spectator in contemplating a work of art. It is a term always used in a condemnatory sense.

LITTORI'NA. (Lat. litus, the *sea shore.*) A genus of Pectinibranchiate Mollusks of the tribe *Trochoida;* characterized by its thick shell, of which the aperture presents a small angle, and is without a ridge. The common periwinkle of our coasts (*Turbo littoreus*, Linn.) is a species of the present genus.

LI'TURGY. (Gr. λειτουργια.) An office at Athens, by which persons of considerable property were bound to perform certain public duties, or supply the commonwealth with necessaries at their own expense. The persons on whom this office was imposed were usually among the richest inhabitants; and if any one selected to fill it could find another more wealthy than himself who was exempt from public duty, he could insist on being released from his charge, which then devolved on the party denounced. This obnoxious institution was abolished on the proposition of Demosthenes. (See *Boeckh's Public Economy of Athens.*) It is from this term that the English *liturgy* (quod vide), in ecclesiastical meaning, has been derived; the sense having been contracted from public *ministry* or service in general to the ceremonies of religious worship.

LITURGY. The ritual according to which the religious services of a church are performed. In the writings of the ancients the name is restricted to the service of the Eucharist, which afterwards came to be distinguished in the Western church by the term *missa*, or mass.

There still exist in Greek, Latin, and some Oriental languages, various rituals by which the Eucharist was celebrated in very early ages. Some have supposed that all these may be referred to one original liturgy, which may have been universally adopted in the primitive church. Palmer, the latest English writer on this subject (*Antiq.* vol. i. p. 8.), conceives that the number of original liturgies may be reduced to four, but not lower. These he entitles the great Oriental liturgy, the Alexandrian, the Roman, and the Gallican; each of which was extensively used from the apostolic age in the quarters from which he assigns them their names, and became the parents of many other rituals, such as were used, with constantly diverging variations, in the different patriarchates of the empire.

The earliest period at which any liturgical forms were consigned to writing is the end of the third or beginning of the fourth century; at least the liturgy called of St. Basil can be traced as high as the latter period. This practice, also, seems frequently to have been applied only to certain parts of the service. We find, therefore, great differences in the MSS. which now exist; and it becomes very difficult to ascertain what the contents of the primitive rituals were, and trace the periods at which many rites and ceremonies have been introduced into the service.

The liturgy of the church of England is a liturgy in the wider and more usual acceptation of the term, comprehending the whole of the various services used on ordinary and extraordinary occasions throughout the year. For the history of this liturgy, see COMMON PRAYER. See also Assemanni, *Codex Liturgicus;* Muratori, *Liturgia Romana Vetus; Breff's Collection of Liturgies; Palmer's Origines Liturgicæ; Riddle's Christian Antiquities*, pp. 369. 377. As to the reforms in the English liturgy, which were seriously contemplated a few years ago by various classes of the church, see *Quart. Review*, vols. xlvii. l.

LITUUS. (Lat.) In the geometry of curve lines, the name given by Cotes to a spiral; of which the characteristic property is that the squares of any two radii vectores are reciprocally proportional to the angles which they respectively make with a certain straight line given in position, and which is an asymptote to the spiral. Let r and u denote any two radii vectores drawn from the pole to the curve, and let φ and ψ be the measures of the angles they respectively make with the asymptote; then $r^2 : u^2 : : \psi : \varphi$. If we take the angle $\psi = 57{\cdot}29578^\circ$ (or such that the arc is equal to the radius), and call a the corresponding value of u, the above proportion becomes $r^2 : a^2 : : 1 : \varphi$; whence we have for the equation of the curve, $r^2 = a^2\varphi^{-1}$

Among the properties of the curve are the following: — 1. The radius vector is reciprocally proportional to the circular arc intercepted between its extremity and the asymptote. 2. The area included between the two radii vectores a and r and the curve is equal to a^2 log. $(u \div a)$; or proportional to the logarithm of the ratio of u to a.

For the properties of the lituus see Varignon, *Mem. Acad. Paris*, 1704; Cotes, *Harmonia Mensurarum*, p. 85.; *Peacock's Examples to the Diff. and Integral Calculus*, p. 183.

LI'TUUS. Among the Romans, a crooked staff, resembling a crozier, made use of by the augurs in quartering the heavens. It is affirmed by Dr. E. D. Clarke, that the use of the *augural* lituus, as it was called, is much posterior to that of the *regal* or *quirinal* lituus, which was instituted by Romulus, and used as a sceptre by the Roman kings; and that they had nothing in common except the name. The origin of the word is uncertain. (See *Clarke's Observations on the "Lituus," in the Archæolog.* xix. p. 386.)

LI'VER. (Germ. leber.) The viscus in which bile is secreted. It is situated in the right hypochondriac region under the diaphragm; and in the human body is divided into two lobes, of which the right lobe is the largest. There is between them a smaller lobular process, called the *Lobulus Spigelii*. The ultimate arrangement of the different blood-vessels of the liver is very peculiar. It has been ably investigated by Mr. Kiernan, by whom it is described in the *Philosophical Transactions*.

LI'VER OF SULPHUR. Fused sulphuret of potassium: so called from its *liver colour*.

LI'VERY. (Fr. livree.) A word derived, probably, from the clothes *delivered* by masters to their servants, in which sense it still continues to be used. At tournaments the cavaliers used to distinguish themselves by wearing the livery or badge of their mistresses; and persons of distinction formerly gave liveries to persons unconnected with their own household or family, to engage them in their quarrels for the time being. The *liverymen* of London are a number of men belonging to the freemen of the ninety-one companies, which embrace the different trades of the metropolis; and are so called because they are entitled to wear the livery of their respective companies. By this body are elected the common-councilmen, sheriffs, aldermen, and some other superior officers of the city; and, down to the passing of the Reform Bill in 1832, they had the exclusive privilege of voting at the election of members of parliament.

LI'VERY OF SEISIN. In Law, a delivery of possession in lands, tenements, and hereditaments, to one that has a right to the same: a ceremony at common law used in the conveyance of lands, whereby an estate of freehold passes by feoffment. *See* FEOFFMENT.

LIVE STOCK. The quadrupeds and other animals kept in a farm for the purpose of being employed in farm labours, for breeding, for being fattened, or for other purposes of profit. In the farming of Britain and similar climates the principal descriptions of live stock are horses, cattle, sheep, and swine; but to these are generally added poultry, and sometimes goats, rabbits, fish, and bees. In warmer climates the silkworm may be considered as part of the live stock; and under particular circumstances, both in England and on the Continent, deer, and even hares and pheasants, are bred for sale.

LIVING FORCE. *See* FORCE.

LI'VRE. (Lat. libra, *a pound.*) An ancient French

coin, which appears as early as 810 A.D. It was at first divided into 20 *solidos*, and afterwards into 20 *sous*. At the French revolution the *franc* was substituted for the livre.

LIXI'VIUM. A term employed by the old chemists to signify an alkaline ley or solution.

LIZARD. *See* LACERTA.

LLOYD'S LIST. A well-known periodical publication, which contains a full account of shipping intelligence. It derives its name from Lloyd's coffee-house, so long celebrated as the resort of all classes connected either with the mercantile or shipping interest; and its importance in supplying full, trustworthy, and early maritime information cannot be easily overrated. It has been in existence since 1716.

LOA'DSTONE. The same with *magnet*, which see.

LOA'MY SOIL, in the language of practical agriculturists and gardeners, is one in which clay prevails: it is called heavy or light, as the clay may be more or less abundant; and sandy, gravelly, or calcareous, according as these earths predominate in the composition. In general, loamy soils are more fertile than sand or chalk; but the fertility of any soil is always to a certain extent relative to the nature of the subsoil, and to the local climate.

LO'BATE. (Lat. lobus, *a lobe*.) A term applied by Linnæus to the feet of those birds, as the grebe, which were furnished at their sides with broad-lobed membranes.

LO'BBY. (Ger. laube, *an arbour*.) In Architecture, a hall or passage serving as an ante apartment for communication to rooms.

LOBE'LIA INFLATA. Indian tobacco. The leaves of this plant have been used in medicine as an expectorant and emetic: it quiets the action of the heart, and relaxes the muscles. It has been found of great use in allaying the paroxysms of spasmodic asthma, and as a relaxant in hooping-cough.

LO'CAL PRO'BLEM (Lat. locus), in the ancient Geometry, is a problem which admits of an infinite number of solutions, or which can be solved not only by a single point, but by all points situated in some line which may be found. *See* LOCUS.

LOCH. The Scotch term for *lake*, which see. See also LOUGH.

LOCK, in Internal Navigation, is a part of a canal included between two floodgates, by means of which a vessel is transferred from a higher to a lower level, or from a lower to a higher. *See* CANAL.

LOCK. (Saxon, loc.) An instrument composed of springs and bolts, used to fasten doors, drawers, chests, &c. A good lock is the masterpiece in smithery, and requires much art and delicacy in contriving and varying the wards, springs, bolts, and other parts whereof it is composed, so as to adjust them to the places where they are serviceable and to the various occasions of their use. The structure of locks is so varied, and the number of inventions of different sorts so extended, that we cannot attempt to enumerate them. Those placed on outer doors are called *stock* locks, those on chamber doors spring locks, and such as are hidden in the thickness of the doors to which they are applied are called *mortice* locks. The padlock is too well known to need description. We here add the conditions which, to Mr. Nicholson, appear necessary in a lock of the most perfect kind: — 1. That certain parts of the lock should be variable in position through a great number of combinations, one only of which shall allow the lock to be opened or shut. 2. That this last-mentioned combination should be variable at the pleasure of the possessor. 3. That it should not be possible, after the lock is closed and the combination disturbed, for any one, not even the maker of the lock, to discover, by any examination, what may be the proper situations of the parts required to open the lock. 4. That trials of this kind shall not be capable of injuring the works. 5. That it shall require no key; 6. And be as easily opened in the dark as in the light. 7. That the opening and shutting should be done by a process as simple as that of a common lock. 8. That it should open without a key, or with one, at pleasure. 9. That the keyhole be concealed, defended, or inaccessible. 10. That the key may be used by a stranger, without his knowing or being able to discover the adopted combination. 11. That the key be capable of adjustment to all the variations of the lock, and yet be simple. 12. That the lock should not be liable to be taken off and examined, whether the receptacle be open or shut, except by one who knows the adopted combination. These considerations involve a mechanical problem of great difficulty; but much towards its accomplishment has been effected in various inventions that have been promulgated, and more especially in those of Bramah, Chubbs, Taylor, &c.

LO'COFO'COS. The name by which the ultra democratical or the tory party in America has been distinguished since the year 1834. The term originated in the following incident. Some of that party having had a meeting at Tammany Hall, near New York, the lamps were accidentally extinguished; and on the hall being relighted with lucifers (which in America are termed *locofocos*, probably from the Lat. loco foci, *instead of a fire*), the word was adopted as a distinguishing appellative, and is now of universal application.

LO'COMO'TION. (Lat. loci motio, *change of place*.) Such motion as is attended by change of place in the body which moves, in contradistinction to motions which a body may have which is stationary. Thus, a clock, a mill, a lathe moves; but no change of place of the machine is produced: such *motion* is not locomotion. A steam engine which, being fixed in its position, impels other bodies is a stationary engine; but one which travels with the bodies which it drives is called a *locomotive* engine.

LOCOMOTIVE ENGINE. Any engine which, being employed to draw loads in transport overland, travels with the load which it draws.

Since the improvement and extension of iron railways, this term has been exclusively applied to the steam engines, by which loads are drawn upon them. Although, strictly speaking, the steam engine by which a ship is propelled is a locomotive engine, it is not usual to apply that term to it; such an engine is called a marine engine. (*See* STEAM NAVIGATION.) The term locomotive engine must, therefore, as at present used, be understood to express the travelling steam engine by which trains are drawn on railways.

History of the Locomotive Engine.—The first practical application of the steam engine as a locomotive power took place in 1804, on a railroad at Merthyr Tydvil, in South Wales. The engine was constructed by Messrs. Trevethick and Vivian, under a patent obtained by them two years previously. This engine, in several respects, resembled in its form and structure those which have been since used for a like purpose.

The boiler was a cylinder, with flat circular ends placed upon its side. A large tube entered it at one end, and, being carried near the other, was there received and carried back parallel to its first direction; its course through the boiler resembling the letter U. The two mouths or openings of this tube were therefore placed at the same end of the boiler. One of the mouths of this tube communicated with the chimney, the base of which was flanged upon it, and the other contained the grate and furnace. The flame and heated air were drawn through the curved tube, and up the chimney. The engine was worked by high-pressure steam without condensation; the steam being admitted to the cylinder, and withdrawn from it, by the well-known mechanical contrivance called a four-way cock. The cylinder was placed on its side; and in one position of the cock a communication was opened between the boiler and one end of the cylinder, while another communication was opened between the other end of the cylinder and a tube leading to the chimney. Steam was thus admitted to act on one side of the piston, and allowed to escape from the other side to the chimney. When the piston attained the end of the stroke, the position of the cock was reversed, and the steam which had just driven the piston in one direction was allowed to escape to the chimney, while steam from the boiler was admitted on the other side of the piston, to impel it in the contrary direction; and in this manner the piston was continually driven backwards and forwards, in a horizontal direction, and parallel to the direction of the load. The piston rod was moved through a hole, corresponding with it in magnitude, in the cover of the cylinder, in which it was rendered steam-tight by a stuffing box properly lubricated. This piston rod acted by means of a connecting rod on a crank, which it kept in revolution in the same manner as the crank in a common double-acting steam engine is moved. (*See* STEAM ENGINE.) On the axle of this crank was placed a cogged wheel, which, by means of ordinary gearing, conveyed motion to the axle of the hind wheels of the engine, so as to keep that axle in constant revolution. The wheels being keyed upon that axle, so as not to be capable, like the wheels of a common carriage, of turning upon it, were necessarily made to revolve with it; and, so long as their pressure upon the road was sufficient to prevent them from slipping, a progressive motion of the carriage was the necessary consequence of their revolution.

The early projectors of locomotive engines were all impressed with a notion that the adhesion of the driving wheels with the rails must be insufficient to enable the power applied to these wheels to give progressive motion to the carriage; and, without thinking it necessary to ascertain by actual experiment, whether such were really the case or not, they expended much ingenuity and capital in devising means of overcoming this difficulty, which, after all, turned out to be merely imaginary. Engineers were, in fact, impressed with a notion that if any power compelled the wheels to revolve, they would merely slip upon the rails, and that the carriage or engine would remain stationary. To provide against this, Messrs. Trevethick and Vivian proposed to make the external rims of the wheels intended for common roads rough and uneven, by surrounding them with projecting

heads of nails or bolts, or by cutting transverse grooves in them. Seven years afterwards Mr. Blinkensop, of Leeds, obtained a patent for a method of surmounting his imaginary difficulty, by the substitution of a rack rail for the ordinary smooth rail, and constructing teeth on the driving wheels to work in the teeth of this rack. Various other ingenious contrivances were subsequently produced for the same purpose, until about the year 1814, when experience at length forced upon engineers the knowledge of the fact, that the adhesion of the tires of the wheels with the rails was amply sufficient to propel the engine, even when drawing after it a great load.

In 1814, an engine was constructed at Killingworth colliery, near Newcastle, having two cylinders with a cylindrical boiler, and working two pair of wheels by cranks placed at right angles, so that, when one was in full operation, the other was at its dead points. By these means the propelling power was always in action. The cranks were maintained in this position by an endless chain, which passed round two cog wheels placed under the engine, and fixed on the same axles on which the wheels were placed. The wheels in this case were fixed on the axles, and turned with them.

In an engine subsequently constructed by Mr. Stevenson for the same railway, the mode adopted of connecting the wheels by an endless chain and cog wheels was abandoned, and the same effect was produced by connecting the two cranks by a straight rod. This method is still used in the coupled engines which are applied to draw the trains of merchandise on the present railways.

The next stimulus which the progress of this invention received arose from the project of constructing a railway between Liverpool and Manchester, for the purposes of general traffic. When this project was undertaken it was not decided what moving power was most eligible—whether horse power, stationary steam engines, or locomotive engines; but the first, for many obvious reasons, was soon rejected, in favour of one or other of the last two.

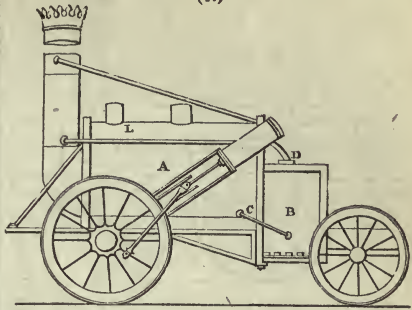
The steam engine may be applied to move carriages on a railway by two distinct methods. By one, the engine is fixed, and draws a train of carriages towards it, by a rope extending the whole length of the road on which the engine works. By this method the line of road is divided into a number of short stages, at the extremity of each of which an engine is placed. The waggons or carriages, when drawn by any engine to its station, are detached, and connected with the extremity of the rope-work by the next stationary engine, and thus the journey is performed from station to station by separate engines. For a more detailed account of this method of working a railway, see STATIONARY ENGINE. By the other method, each load transported along the line is drawn by an engine which travels with it as horses travel with a carriage on a common road.

To enable them to decide which of these two methods of working the proposed railway it would be most advisable to adopt, the directors of the Liverpool and Manchester line employed Messrs. Stevenson and Locke, and Messrs. Walker and Rastrick, experienced engineers, to visit the different railways then in operation, to obtain the results of the experience which they afforded as to these two methods of applying steam power to transport, and to report their opinion on the relative merits of the two methods. After an elaborate inquiry, the decision of the directors was given in favour of locomotive power.

Until the period to which we now advert, railways had been almost exclusively confined to the transport of mineral products from the mines up to the places of shipment, and to this purpose exclusively had the locomotive engine been applied; but the ends to be attained by a railway of thirty miles in length, connecting the largest manufacturing town, in the greatest manufacturing country in the world, with the greatest, most active, and most opulent commercial port, were of a nature so much more extensive and important, that it was considered that more than ordinary means should be resorted to to obtain a moving power commensurate with the traffic which might be expected under such circumstances. Prizes were therefore proposed to be given, under certain stipulations, to those who would construct the most effective locomotive engines for the purposes of the road.

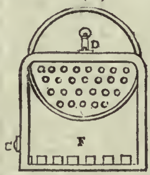
This proposal produced, as was anticipated, much competition; and the spirit of emulation being roused, a trial was appointed, which took place on the railway in October, 1829. Engines of several forms were produced; and the prize was awarded to one, called the *Rocket*, constructed by Mr. Robert Stevenson, the son of Mr. George Stevenson, the engineer of the railway. In the first trial, this engine attained the then astonishing speed of twenty-nine miles an hour; and when, unhappily, at the ceremony of the opening of the railway, the accident occurred which deprived the country of Mr. Huskisson, his wounded body was conveyed, by the same engine, a distance of about fifteen miles in twenty-five minutes, being at the rate of thirty-six miles an hour. This engine, which involved in its construction all those mechanical arrangements to which the extraordinary speed and power of the locomotive engine of the present day are due, is represented in elevation in fig. 1.; and a cross section

(1.)



of the boiler and furnace is represented in fig. 2. It is supported on four wheels, the weight being principally thrown on the larger pair worked by the engine. The boiler is a cylinder 6 feet long, having the chimney at one end, and the fire-box B at the other. This box is surrounded with a hollow casing, which communicates with the bottom of the boiler by a tube C, and with the top by a tube D. The water in the boiler, therefore, flows into the casing, and fills it to the same level as that which it has in the boiler. When the engine is at work, the boiler is kept about half filled with water, and, consequently, the casing round the furnace is completely filled. Steam is abundantly generated in this casing, exposed as it is on every side to the radiant heat of the fire: this steam rises in bubbles, and passes through the tube D into the boiler. The lower part of the boiler is traversed by a number of copper tubes, the ends of which appear in fig. 2. The flame and heated air proceeding from the burning fuel pass through these tubes, and, after traversing the whole length of the boiler, escape into the chimney, imparting, on their passage, heat to the water in the boiler. The necessary draught through the furnace is maintained by causing the cylinders to discharge the waste steam into a pipe, which is presented up the chimney, and is called the blast pipe. There are two cylinders placed outside the engine, on either side of it, as represented in fig. 1.: they are placed in a diagonal position, and their rods move in guides; the end of the piston rod is connected with one of the spokes of the wheels by a connecting rod, and the piston, as it is driven by the steam in each direction in the cylinder, causes the wheels to revolve.

(2.)



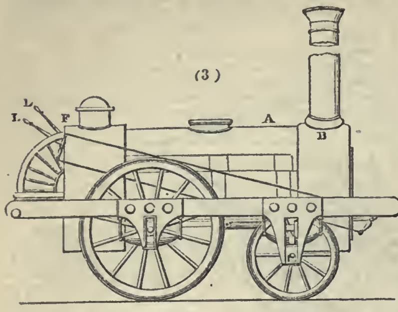
The circumstances in this mechanical arrangement, on which the rapid production of steam depends, are two-fold: first, the extensive surface exposed to the radiant heat of the fire, by the casing surrounding the fire box, and by the tubes, twenty-five in number and only three inches in diameter, by which the flame and heated air are conducted through the boiler from the fire box to the chimney; and, secondly, by the powerful draught maintained in the furnace by the current of steam constantly discharged up the chimney. It has been mainly by bringing these principles more fully into operation, that all the improvements since made in the locomotive engine have been effected.

The railway was not not long in operation, when the arrangement of the tubes in the boiler was improved; their number was increased from twenty-five to one hundred and upwards, and their diameters diminished from three inches to an inch and a half. This change alone produced an increased efficiency of the fuel, in the proportion of nearly two to one; the consumption of coke in the Rocket having been very nearly $2\frac{1}{2}$ pounds per ton per mile, while, by the change above mentioned, the consumption of fuel in the new engines was reduced to $1\frac{1}{4}$ pound per ton per mile. The position of the cylinder was also advantageously changed. Instead of being placed, as in the Rocket, outside the boiler, and exposed to the cold air, through which the engine passed with such a velocity, they were now placed in that part of the engine called the *smoke box*, an enclosed space at the base of the chimney, into which the flame and heated air escaping from the tubes passed. By this arrangement the cylinders were always maintained as hot as the air which issued from the flues, and all condensation of steam by their exposure prevented.

X x

The engine in this improved form is represented in fig. 3. As the cylinders were now placed between the

(3)

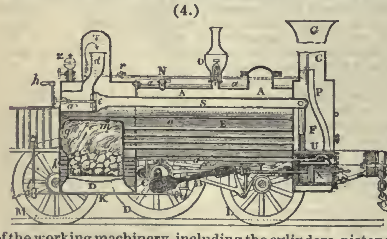


wheels, their operation could not be effected in the same manner as in the Rocket. The connecting rods were accordingly made to act on two cranks, constructed upon the axle of the wheels, placed at right angles to each other, so that one may always be at its dead point, while the other was in full action. This double-cranked axle was, from the weakness consequent upon its form, liable at first to fracture; but improved methods of forging them subsequently gave them sufficient strength, and now the fracture of a cranked axle rarely occurs.

The two chief improvements in the locomotive engine, which succeeded those now explained, and which brought that machine to its present state of efficiency, consisted, first, in the substitution of brass for copper tubes; and, secondly, in the addition of another pair of wheels to support the engine. It was found, by continued experience, that the copper tubes, from some peculiar action of the fire upon them, which has never been explained or understood, were subject to rapid decay; and in the year 1833, after an experience of about three years of the working of these engines, it occurred to Mr. Dixon, then one of the superintendents of the engineering department of the Liverpool and Manchester railway, to try the effect of brass tubes. The experiment was eminently successful: they were found to last six or eight times as long as copper tubes of the same dimensions. Having now brought down the history of the locomotive engine to the present time, we shall give a description of one of these machines in its most improved form.

Description of the most improved Locomotive Engine in operation in 1840. — A longitudinal vertical section of a locomotive engine is represented in fig. 4.; and a plan

(4.)



of the working machinery, including the cylinders, pistons, eccentrics, &c., which are under the boiler, and by the operation of which the engine is driven, is represented in fig. 5. These and the other cuts referred to in the pre-

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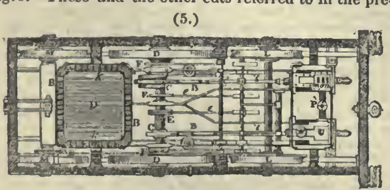


sent article have been taken, with the permission of the author and publishers, from the 7th edition of Dr. Lardner's work on the Steam Engine; to which the reader is referred for a more detailed account of the history, the structure, and the operation of the locomotive engine, than the limits of the present article will allow us to supply.

The boiler, as has been explained in the engines already described, is a cylinder placed upon its side; the fire box consists of two casings of metal, one within the other, bolted together by rivets, represented at *k*; the fire grate is represented at D. The fire door is represented at *g*, opening upon the platform where the engineer stands. It will be perceived in the section fig. 4., as well as in the plan fig. 5., that the fire box is on every side surrounded by the water contained between the two casings, the level of the water in the boiler being above the roof of the fire box. The tubes by which the flame, and the products of combustion, are drawn from the fire box into the smoke box are represented at E, fig. 4. The smoke box containing the cylinders and blast pipe, and supporting the chimney, is represented at F. In the engine from which this drawing was taken the boiler is a cylinder 7½ feet long and 3½ feet diameter; it is clothed with a boarding of wood, represented at *a*, and bound round by iron hoops screwed together at the bottom. Wood being a slow conductor of heat, this covering has the effect of keeping the boiler warm and checking the condensation of steam.

The external casing of the fire box, B B, is nearly square in its plan, as seen in fig. 5., being 4 feet wide, and 3 feet 7½ inches long: it is constructed of wrought-iron plates, and descends two feet below the boiler, as seen in fig. 4.; the top being semi-cylindrical, of a diameter greater than that of the boiler, and concentrical with it. The inner casing, *k k*, fig. 5., is similar in shape to the external; but it is lower, and flat at the roof, as seen in fig. 4. The space between the two casings is from 3 to 4 inches in width. This internal fire box is made of copper plates.

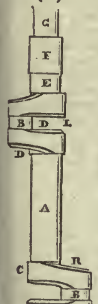
As the top of the fire box would be liable to be destroyed by the action of the fire if the level of the water in the boiler were suffered to fall below it, so as to leave it uncovered, a leaden plug *m* is inserted in it, which would melt out before the copper would become injuriously heated, and the steam rushing out at the aperture would cause the fire to be extinguished. The tubes E, which serve to conduct the flame through the boiler to the smoke box, are made of the best rolled brass, $\frac{1}{13}$th of an inch thick, and $1\frac{5}{8}$ of an inch in external diameter; they are 124 in number, and the distance between tube and tube is three quarters of an inch. The number of these tubes is at present seldom less than 90, and varies between that and 150. The tubes act as stays, connecting the ends of the boiler to strengthen them; but besides these there are rods of wrought iron, represented at *o*, fig. 4., which extend from end to end of the boiler, above the roof of the fire box. The smoke box F, containing the cylinders, steam pipe, and blast pipe, is 4 feet wide, and 2 feet long: it is formed of wrought-iron plates, rivetted in the same manner as those of the fire box. From the top of the smoke box, which, like the fire box, is semi-cylindrical, rises the chimney G, 15 inches diameter, made of ⅛-inch iron plates, rivetted and bound round by hoops. Near the bottom of the smoke box the working cylinders are placed side by side, in a horizontal position, with the slide valves upwards, as seen in fig. 5.

At the top of the external fire box, fig. 4., a circular aperture is formed 15 inches in diameter; and upon this aperture is placed the steam dome T, 2 feet in height, and secured to the aperture by nuts. The steam dome is made of brass, nearly half an inch thick. A funnel-shaped tube *d*, with its wide end upwards, is flanged upon the side of the great steam pipe S, and is carried upwards, so that its mouth is near the top of the steam dome T. In order to pass into the steam pipe S, the steam which fills the upper part of the boiler A must ascend the steam dome and enter the funnel *d*, as indicated by the bent arrow in fig. 4. This arrangement prevents, in a great degree, the effect of priming, by which word is expressed technically the spray of water which rises from the water of the boiler, and is mixed with the steam in the upper part of it: as the steam ascends the steam dome this spray falls back, and nothing but pure steam enters the funnel *d*. The wider part of the great steam pipe S is flanged, and screwed at the hinder end to a corresponding aperture in the back of the fire box, where the engineer stands: this opening is covered by a circular plate, secured by screws, having a stuffing box in its centre, of the same kind as is used for the piston rods of steam cylinders. Through this stuffing box the spindle or rod *a′* of the regulator passes; and to its end is attached a winch *h*, by which the spindle *a′* is capable of being turned. To the other end of this spindle, at *e*, is attached a plate, which moves upon apertures formed in the cover of the end of the great steam pipe S; so that, by turning the winch *h* more or less, this plate *e* may be removed more or less from over the openings; and thus the steam may be allowed to enter the steam pipe S from the steam dome T in greater or less quantity, or may be shut off altogether. The steam pipe S, being enclosed within the boiler, is maintained at the same temperature as the steam in the boiler; and therefore the steam, in

passing through it, is not liable to condensation. The steam pipe, passing through the tube plate at the front of the boiler, is turned down at right angles in the smoke box, where, dividing into two branches, one is conducted to each of the valve boxes of the cylinders. The lower ends of these branches are flanged to the valve boxes at the ends of the cylinders nearest to the boiler: by these pipes the steam is conducted into the valve boxes, or steam chests, from which it is admitted by slide valves to the cylinders to work the pistons. On the upper sides of the cylinders are the steam chests U, communicating with the passage; *m*, fig. 5., leading to the top of the cylinder, *n* leading to the bottom, and *o* leading through the side pipe P′ to the blast pipe. These openings are governed by a slide, so that, when steam is admitted through *m*, the communication shall be opened between *n* and *o*. Thus, when steam is admitted to the top of the cylinder, the steam from the bottom will flow from *n*, through *o*, into the blast pipe. When the piston reaches the bottom of the cylinder, then the slide opens a communication between *n* and the steam pipe, and between *m* and *o*. Thus steam will be admitted to the bottom of the cylinder, while the steam from the top will escape from *m*, through *o*, to the blast pipe. In this way, by the alternate shifting of the slide, steam is admitted alternately to each end of the cylinder, and allowed to escape from the other end, and the alternate motion of the piston and the cylinder is thereby maintained. The pistons used in locomotive engines are of the kind called metallic pistons, and, from their horizontal position, they have a tendency to wear unequally in the cylinders, their weight pressing them on one side only; but, from their small magnitude, this effect is found to be imperceptible in practice. The cross pipe P′, which communicates with the eduction passage *o*, in each of the valve boxes, has an opening in the centre presented upwards, as seen in fig. 5. To this opening is flanged the base of the blast pipe *p*, fig. 4., which rises in a direction slightly curved, and has its mouth presented upwards in the centre of the chimney G. The steam which is discharged at each stroke of the pistons from the cylinders passes through this pipe, and escapes up the chimney by puffs. When an engine is moving slowly, these puffs are distinctly audible, resembling the coughing of a horse; but when at full speed, they succeed each other so rapidly that the ear can scarcely distinguish their intervals. It is this stream of waste steam, continually rushing up the chimney, that maintains the necessary draught in the fireplace; the upper current thus produced in the funnel causes a corresponding current into the smoke box F, through the tubes E; and there is this excellence in the arrangement, that the force of the draught in the chimney being proportional to the quantity of steam produced, it must be therefore proportional to the quantity of fuel necessary to be consumed.

The force of the steam thus impressed upon the pistons is communicated by the piston rods Y, fig. 4., the cross heads of which move in guides to the connecting rods B, which are attached to the crank pins of the working axle C; so that, as the piston rods are driven backwards and forwards in the cylinders, the working axle is made to revolve. This axle, with the two cranks formed upon it, is represented in fig. 6., where the two cranks must be understood to be in a position at an angle of 45° with the plane of the figure, and therefore at an angle of 90° with each other. As this axle is the instrument by which the impelling force is conveyed to the load, and as it has to support a great portion of the weight of the engine, it is constructed with great strength and precision. Its length is 6½ feet, and its diameter 5 inches. At the centre part A it is cylindrical, and is increased to 5½ inches at C, where the cranks are formed. The sides D of the cranks are 4 inches thick; and the crank pins B, which are truly cylindrical, are 5 inches in diameter and 3 inches in length. Upon the parts F, which are 7½ inches long, the great driving wheels D, fig. 4., are firmly fastened, so as to be prevented from turning or shaking upon the axle. Brasses are fixed on the outside frame of the engine, which rest upon these projections G of the axle; and upon these brasses the weight of the engine is supported.

(6.)



The strength and accuracy of construction necessary for these axles render them expensive: they cost about 50*l*. each. They are seldom broken, but sometimes bent when the engine escapes from the rails.

The method by which the slides are made to govern the admission and escape of the steam to and from the cylinders is nearly the same as in the steam engine used for the general purposes of manufacture; and for a general description of the method see Steam Engine. Meanwhile it may be here briefly stated, that this is effected by two circular plates called eccentrics, fixed at E E, fig. 5., on the great working axle. These eccentrics are circular plates or rings, formed upon or attached to the axle so as to revolve in their own plane, forming, in effect, a part of the axle itself; but they are so placed that their centres do not coincide with the centre of the axle, and, consequently, as they revolve with the axle, their centres are alternately thrown backwards and forwards, as they pass on the one side or the other of the axle. These circular plates are surrounded by rings, within which they revolve, but which do not revolve with them. These rings are alternately thrown backwards and forwards by the play of the eccentrics; and to these rings are attached rods *e e*, which communicate motion to the arms which drive the rods of the slides. Thus the alternate motions of the eccentrics backwards and forwards proceed from the working axle, produce a corresponding backward and forward motion in the slides, and thereby govern the admission and escape of the steam to and from the cylinders. When it is required to reverse the motion of the engine, or to make it move backwards, the motion of the slides, and therefore the positions of the eccentrics on the working axle, must be the contrary of that necessary to produce a progressive motion. Sometimes this is effected by shifting the position of the eccentrics on the working axle; but more commonly it is effected by a second pair of eccentrics, represented at F F, fig. 5., placed on the axle in a position contrary to the others. When the engine is driven backwards, the eccentrics E E are thrown out of gear, and the eccentrics F F are brought into action.

As all the moving parts of the engine require to be constantly lubricated with oil, to diminish the friction and keep them cool, oil cups for this purpose are fixed upon them. In some engines these oil cups are attached separately to all the moving parts; in others they are placed near each other in a row on the side of the boiler, and communicate by small tubes with the several parts to be lubricated.

The tender is a carriage attached behind the engine, and close to it, carrying coke for the supply of the furnace, and a tank containing water for the boiler. The feed for the boiler is conducted through a curved pipe proceeding from the tank, and carried first downwards, and afterwards in a horizontal direction, as represented at K, fig. 4., under the boiler. It communicates with a forcing pump, which is worked by an arm driven by the cross head of the steam piston. By this pump water is constantly forced into the boiler, so long as the pump is kept in communication with the tank; but this communication may be opened and cut off by a cock *l*, governed by the engineer. As the feed of the boiler by the introduction of cold water checks the activity of the evaporation, it is the custom not to feed the boiler regularly and constantly, but to throw on the feed when the work on the engine is light and the consumption of steam small, and to shut it off when much steam is required. The circumstances of a railway naturally suggest this. When the engine is ascending an incline all the steam which the boiler is capable of producing is required, and therefore the activity of the boiler is stimulated by shutting off the feed; but in descending an incline less power is required, and the feed is put on.

Until within the last few years, locomotive engines were supported on only four wheels. It is now, however, the general practice to place them on six, the driving wheels being in the middle, as represented in fig. 4. To give greater security to the position of the engine between the rails, it is usual to construct flanges on the tires of all the six wheels. Mr. Stevenson, however, has been in the practice of constructing the driving wheels without flanges, and with tires truly cylindrical, depending on the flanges of the two pairs of smaller wheels to maintain the engine between the rails. The wheels of the engine represented in fig. 4. are constructed in this manner. The driving wheels D are fixed on the cranked axle C, and are constructed with cylindrical tires without flanges. They are 5 feet in diameter. The wheels L are 3 feet 6 in. in diameter, and have conical tires with flanges. They are placed immediately behind the smoke box. The wheels M are precisely similar to L, and are placed immediately behind the fire box.

When an engine is required for the transport of very heavy loads, such as those of merchandise, the adhesion of one pair of working wheels is insufficient; and, in such cases, one of the two pairs of wheels L or M is made of the same diameter as the driving wheels, and a bar is attached to points on the outside of the wheels, at equal distances from their centre, connecting them in such a manner that any force applied to make one pair of wheels revolve must necessarily impart the same motion to the other pair. By such means the force of the steam is made to drive both pairs of wheels, and consequently a proportionally increased adhesion is obtained.

The speed which an engine is capable of imparting depends on the rate at which the pistons are capable of

being moved in the cylinders. By every motion of each piston backwards and forwards one revolution of the driving wheel is produced; and by each revolution of the driving wheels, supposing them not to slip upon the rails, the load is driven through a distance equal to their circumference. As the two cylinders work together, it follows that a quantity of steam sufficient to fill four cylinders must be supplied by the boiler to the engine, to move the train through a distance equal to the circumference of the driving wheels; and in accomplishing this each piston must move twice from end to end of the cylinder, each cylinder must be twice filled with steam from the boiler, and that steam must be twice discharged from the blast pipe into the chimney. If the driving wheels be 5 feet in diameter, their circumference will be 15 feet 7 inches. To drive a train with a velocity of 30 miles an hour, it is necessary that the engine be propelled through 45 feet per second; and to accomplish this with 5 feet wheels they must make nearly three revolutions per second; and as each revolution requires two motions of the piston in the cylinder, it follows that each piston must move three times forwards and three times backwards in the cylinder in a second; that steam must be admitted six times per second to each cylinder, and discharged twelve times per second through the blast pipe: the motion of the slides and other reciprocating parts of the machinery must consequently correspond.

This rapid reciprocating motion being injurious to the machinery, attempts have been made to diminish it by the adoption of larger working wheels, and the driving wheels on several of the great lines have been accordingly increased to 5½ and 6 feet in diameter. Such engines have not been yet sufficiently long in use to afford a practical estimate of the effects of this change. Experiments of a much bolder kind have been tried on the Great Western Railway, where driving wheels of 10 feet in diameter have been worked. From a course of experiments, however, made by Dr. Lardner with those engines, it did not appear that they had any advantage over those constructed with smaller and lighter wheels. Experience appears to have since confirmed this, as they are now for the most part abandoned. The pressure of steam in the boiler is usually limited by two safety valves, — one represented at N, under the control of the engineer; and the other at O, which cannot be approached by him. The safety valve at N is held down by a lever *r*, which is attached to a spiral spring, and which may, by an adjusting screw, be made to press on the valve with any required force. The second valve O is pressed by several small elliptical springs, placed one above another over the valve, and held down by a screw, which turns in a frame fixed into the valve seat. By this screw the pressure on the valve can be adjusted.

In order to give notice of the approach of the train, a steam whistle Z, fig. 4., is placed immediately above the fire box at the back of the engine. This is an apparatus composed of two small hemispheres of brass, separated one from the other by a small space. Steam is made to pass through a hollow space formed in the lower hemisphere, and escapes from a very narrow circular opening round the edge of that hemisphere. The edge of the upper hemisphere presented downwards encounters this steam, and an effect is produced similar to the action of air in organ pipes. A shrill whistle is produced which can be heard at a great distance, and, differing from all ordinary sounds, never fails to give notice of the approach of a train.

It is not usual to express the power of locomotives, in the same manner as that of other engines, by the term *horse power*. Indeed, until the actual amount of resistance encountered by these machines shall be more certainly ascertained, it is impossible that their efficiency can be estimated. The quantity of water evaporated supplies a major limit to the power exerted; but even this necessary element is not ascertained. Mr. Stevenson states that an engine such as that above described is capable of evaporating only 77 cubic feet of water per hour; but Dr. Lardner found that the mean evaporation obtained by a very accurately conducted experiment over 200 miles of railway, with an engine called the Hecla, similar to the above, was 90 cubic feet per hour very nearly.

But a still greater evaporating power than this is found among the large engines working on the Great Western Railway. In an experiment made by Dr. Lardner with the North Star, drawing 110½ tons gross, at 30½ miles an hour, the evaporation was 200 cubic feet per hour.

On the evaporating power of the engines, other things being the same, must ultimately depend the speed of railway traffic. For it must be apparent that no modification which can be made in the mechanism of the engine, no change in the magnitude of the driving wheels, nor any other expedient of the same kind, can add any thing to the real working power of the machine. Mechanism is the means by which power is modified and conveyed to the working points, not the agent by which it is produced. The real and the only source of power in the steam engine is to be found in the phenomena which are evolved in the conversion of water into vapour (for an account of which phenomena see STEAM); and therefore the limit of railway speed must always depend on the rate at which the locomotive boiler is capable of evaporating water. The experiments above explained show the actual evaporating powers possessed by the boilers now in use, and every addition to such evaporating power will produce a corresponding, though not a proportionate, augmentation of the speed of railway trains.

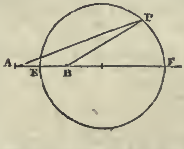
Nothing can be more absurdly exaggerated than the accounts which have been put in circulation of the speed attained on railways. No reliance whatever can or ought to be placed on such reports, unless they are attested by competent persons accustomed to that kind of inquiry, and who have been themselves witnesses of them. In the extensive courses of experiments which, for several years back, have been conducted by Dr. Lardner, he has never in any instance, even with an unloaded engine, exceeded a speed of 45 miles an hour; nor was that speed ever maintained for any considerable distance. With the best and most powerful engines on the Great Western Railway at their disposal, Mr. Nicholas Wood and Dr. Lardner were unable to attain a speed in their experiments exceeding 45 miles an hour. The question, however, of most interest to the public is, not the speed which can be obtained in experiments for short distances with engines put into racing order, but the average speed which can be maintained in the general working of a road. The returns of the railway companies, so far as they have been made public, do not supply the means of determining this; but it is known that the first class trains between London and Birmingham, a distance of 112 miles, cannot make the journey, under ordinary circumstances, in less than 5½ hours: this would give an average speed, including stoppages, of 20 miles an hour. On the Grand Junction line between Liverpool and Birmingham the journey, including stoppages, is usually made in 4⅘ hours, and the distance is 97 miles: this again is at the rate of about 20 miles an hour. No other lines of railway have yet been constructed of sufficient length to afford a fair estimate of average speed; and it may therefore be assumed that the present rate of railway travelling, for long distances with first class trains, stoppages included, is 20 miles an hour.

On the railway between Liverpool and Manchester the average speed of first class trains is greater. The railway is only 30 miles in length; and there is but one stoppage at Newton, which is so arranged as to be attended with very little loss of time. The journey is very frequently made in an hour, and seldom exceeds 80 minutes; the average speed for the fastest trains on that line is therefore probably not less than 25 miles an hour, including stoppages. (For further details respecting the locomotive engine, see *Lardner on the Steam Engine*, 7th edit. 1840.)

LOCOMOTIVE POWER, in contradistinction to stationary power, is any kind of moving power applied to the transport of loads on land which travels with the load which it draws. Horses employed to draw carriages or carry loads are locomotive powers. *See* LOCOMOTIVE ENGINE.

LO'CULICI'DAL. In Botany, a term applied to the dehiscence of a fruit when it takes place through the back of the cells. It is what botanists formerly called a dehiscence with the valves opposite the dissepiments.

LO'CUS (Lat. *place*), in the Geometrical Analysis, is the line traced by a point which varies its position according to some determinate law. For example, let this problem be proposed: To find a point P such that its distances from two given points, A and B, shall have a given ratio. If the line joining A and B be divided in E, so that A E is to E B in the given ratio, then a point is found which fulfils the conditions of the problem.



But this is not the only point which has this property; for let F be taken in the prolongation of A B, so that A F is to B F in the given ratio, and on E F as a diameter let a circle be described; then, if straight lines be drawn from A and B to any point whatever, P, in the circumference of this circle, A P will have to P B the same ratio as A E to E B, or as A F to F B, that is, the ratio given. The circle E P F is hence called the *locus* of the point P.

When the locus of the variable point is a straight line or a circle, it was called by the ancient geometers a *plane locus;* and when one of the conic sections, a *solid locus.*

The *plane loci* formed a branch of the ancient analysis, which, according to the account of Pappus, was treated of by Apollonius in two books which have been lost. They were partly restored by Schooten, a Dutch geometer, who flourished in the 17th century, and by Fermat; but afterwards in a complete manner by Dr. Simson of Glas-

gow, whose treatise, *De Locis Planis*, published in 1749, is a model of geometrical elegance. The principal propositions may be found in *Leslie's Geometrical Analysis*.

The moderns distinguish the loci into orders, according to the dimensions of the algebraic equations by which they are represented. Thus the equation $ax + by + c = o$ is a locus of the first order; $ax^2 + by^2 + cxy + dx + ey + f = o$, a locus of the second order, and so on. The loci of all equations of the second degree are conic sections or circles. (See *Maclaurin's Algebra*.)

LO'CUST. From the Latin word signifying a crayfish; but now the common name of a species of insects, forming a group or subgenus of the *Gryllus* of Linnæus. They have coloured elytra, and large wings, disposed when at rest in straight fan-like folds, as in other Orthoptera, and frequently exhibiting bright blue, green, or red colours. The thorax is capacious, to afford room for the powerful muscles of the wings, and is marked in many species with one or more crests or wart-like prominences. The locusts fly by starts, but frequently rise to a considerable height. Certain species, called "migratory locusts," unite in incalculable numbers, and emigrate, resembling in their passage through the air a dense cloud: wherever they alight all signs of vegetation quickly disappear, and cultivated grounds are left a desert. But the mischief does not end here; for when dead the mass of decomposing bodies is so great that the air becomes poisoned by the fetid exhalations. The 2d chapter of Joel gives a powerful description of the devastation committed by these destructive insects.

M. Miot, in his translation of Herodotus, has given it as his opinion that the heaps of bodies of winged serpents which that historian states that he saw in Egypt were nothing more than masses of this species of locust. These insects are eaten in various parts of Africa, where the inhabitants collect them both for home consumption and for commerce. They take away their elytra and wings, and preserve them in brine. One species (*Acridium migratorium*, Latr.) occasionally commits devastations in the south of Europe and Poland; and stragglers have occasionally reached our own coasts. In the United States the term "locust" is applied to a species of *Cicada*, which by their numbers and voracity are almost as destructive as the true locusts of the old world.

LOCU'STA. In Botany. If that form of inflorescence called a spike consist of flowers destitute of calyx and corolla, the place of which is occupied by bracteæ, the rachis is flexuose and toothed, and does not fall to the ground with the flowers, as happens in grasses, each part of the inflorescence so arranged is called a *locusta*, the structure of which is as follows:—At the base are two opposite empty bracteæ called glumes, one of which is attached to the rachis a little above the base of the other; above the glumes are several florets sitting in denticulations of the rachis; each of these consists of one bractea, sometimes with the midrib quitting the lamina a little below the apex, and elongated into a bristle; and of another bractea, facing the first, with its back to the rachis, bifid at the apex, with no dorsal vein, but with its edges inflexed, and a rib on each side at the line of inflexion; and, lastly, within these bracteæ are situated two extremely minute fleshy scales, which are sometimes connate, and stand at the base of the sexual organs.

LODE. A term used by miners, generally synonymously with metallic or mineral *vein*. The lodes containing metallic ores are said to be *alive*; others which merely contain lapideous matters are called *dead lodes*.

LODGE. (Fr. logis.) In Architecture, a small house situated in a park or domain, subordinate to the mansion; also, the cottage situated at the gate of the avenue that leads to the mansion.

LODGE. *See* FREEMASONRY.

LODI'CULA. In Botany, a term given by Palisot de Beauvois to the two minute, colourless, fleshy, hypogynous scales which are situated beneath the ovary of grasses.

LOESS. A German geological term, applied to a tertiary alluvial deposit which occurs in patches between Cologne and Basle. The term is often used by English geologists in reference to that peculiar yellow loam with calcareous concretions.

LOG, LOG-LINE. In sea language, the log is a piece of wood, in the form of a sector of a circle (usually a quadrant) of five or six inches radius. It is about a quarter of an inch thick; and so balanced, by means of a plate of lead nailed to the circular part, as to swim perpendicularly in the water, with about two thirds immersed under the surface. The log-line is a small cord, one end of which is fastened to the log, while the other is wound round a reel in the gallery of the ship. The log thus poised keeps its place in the water, while the line is unwound from the reel as the ship moves through the water; and the length of line unwound in a given time gives the rate of the ship's sailing. This is calculated by *knots* made on the line at certain distances, while the time is measured by a sand-glass of a certain number of seconds. In order to avoid calculation, the length between the knots is so proportioned to the time of the glass that the number of knots unwound while the glass runs down shows the number of miles the ship is sailing per hour. Thus, suppose the glass to be a half-minute one, it will run down 120 times in an hour. Now, distances by sea are reckoned by nautical miles of 60 to a degree; so that each mile contains about 6100 feet, the 120th part of which is 51 feet. If, therefore, the knots (which are pieces of coloured cloth) are fastened to the log-line at distances of 51 feet, the number of knots unwound from the reel in half a minute is the number of miles the ship runs in one hour. If the glass runs down in less than half a minute, the intervals between the knots must be diminished in proportion. The first knot is placed about five fathoms from the log, to allow the latter to get clear of the ship before the reckoning commences; and the part of the line between the lead and the first knot is called the *stray-line*.

LO'GAN STONES. *See* ROCKING STONES.

LO'GARITHM. (Gr. λογος, in the sense of *a proportion*, and αριθμος, *number*.) The logarithm of a number is the exponent of the power to which another given invariable number must be raised in order to produce the first number. Thus, in the common system of logarithms, in which the invariable number is 10, the logarithm of 1000 is 3, because 10 raised to the third power is 1000. In general, if $a^x = y$, in which equation a is a given invariable number, then x is the logarithm of y. All absolute numbers, whether positive or negative, whole or fractional, may be produced by raising an invariable number to suitable powers. The invariable number is called the *base* of the system of logarithms: it may be any number whatever, greater or less than unity; but, having been once chosen, it must remain the same for the formation of all numbers in the same system. Whatever number may be selected for the base, the logarithm of the base is 1, and the logarithm of 1 is 0. In fact, if in the equation $a^x = y$ we make $x = 1$, we shall have $a^1 = a$, whence, by the definition, log. $a = 1$; and if we make $x = 0$, we shall have $a^0 = 1$, whence log. $1 = 0$.

From the nature of the exponential equation, by which logarithms have been defined, it is easy to discover some of the principal properties and uses of those artificial numbers. Suppose that we have a series of numbers, y, y', y'', y''', &c., to be multiplied together. Let a be the base of the system of logarithms (supposed to be calculated), and let x, x', x'', x''', &c. be the logarithms of y, y', y'', y''', &c. respectively. We have then, according to the definition, the series of equations

$$y = a^x,\ y' = a^{x'},\ y'' = a^{x''},\ y''' = a^{x'''},\ \&c.$$

Multiplying the corresponding members of these equations into each other, we get

$$y\,y'\,y''\,y'''\ \&c. = a^{x + x' + x'' + x''' + \&c.};$$

whence log. $y\,y'\,y''\,y'''$ &c. $= x + x' + x'' + x''' +$ &c. $=$ log. $y +$ log. $y' +$ log. $y'' +$ log. $y''' +$ &c.: whence we infer this chief property of logarithms, namely, that the logarithm of a product is equal to the sum of the logarithms of its factors.

Again, let there be two numbers, y and y', to be divided the one by the other, and let x and x' be their logarithms. We have, as before, the equations $y = a^x$, and $y' = a^{x'}$; whence $\frac{y'}{y} = a^{x' - x}$, and therefore log. $\frac{y'}{y} = x' - x =$ log. $y' -$ log. y; that is to say, the logarithm of the quotient of a division is equal to the difference between the logarithm of the dividend and the logarithm of the divisor.

These properties of logarithms are of very great importance in facilitating the arithmetical operations of multiplication and division. For if a multiplication is to be effected, it is only necessary to take from the logarithmic tables the logarithms of the factors, and add them into one sum, which gives the logarithm of the required product; and on finding in the table the number corresponding to this new logarithm, the product itself is obtained. Thus by means of a table of logarithms the operation of multiplication is performed by simple addition. In like manner, if one number is to be divided by another, it is only necessary to subtract the logarithm of the divisor from that of the dividend, and to find in the table the number corresponding to this difference, which number is the quotient required. Thus, the quotient of a division is obtained by simple subtraction.

Logarithms apply with equal advantage to the formation of powers and extraction of roots. Let y be a number to be raised to the power m (m being any number, whole or fractional, positive or negative). As before, we have $y = a^x$; and, on raising both sides of the equation to the power m, $y^m = a^{mx}$: whence, by the definition, log. $y^m = m\,x = m$ log. y; that is, the logarithm of the power of a number is equal to the product of the logarithm of the number by the exponent of the power.

If in the equation log. $y^m = m$ log. y we make $m = \frac{1}{n}$, we shall have log. $y^{\frac{1}{n}}$ (or log. $\sqrt[n]{y}$) $= \frac{1}{n}$ log. y; that is to say,

the logarithm of any root of a number is equal to the logarithm of the number divided by the index of the root.

From these two last results it is obvious that by means of a table of logarithms numbers may be raised to any power by simple multiplication, and that the roots of numbers may be extracted by simple division.

The properties which have now been demonstrated are true of every system of logarithms which may be adopted; but their application to numerical computations supposes the construction of a table, including on the one hand the natural numbers, and on the other the logarithms of those numbers calculated for a given base. The tables usually employed are those of which the base is 10, and their construction is equivalent to the solution of the algebraic equation $10^x = y$. Hence, making y successively equal to the numbers 1, 2, 3, 4, &c., we have to resolve the equations

$$10^x = 1,\ 10^x = 2,\ 10^x = 3,\ 10^x = 4, \text{ \&c.}$$

The labour of computing the tables is greatly abridged by the circumstance that it is only necessary to calculate the logarithms of the prime numbers; for, as all the other numbers may be obtained by the multiplication of prime numbers into each other, their logarithms, according to what has been already shown, may be found by the addition and subtraction of the logarithms of the prime numbers. Hence a table containing merely the logarithms of the prime numbers is all that is strictly necessary for effecting computations by logarithms.

When a table of logarithms has been calculated for any given base, it is easy to find by means of it any other system of logarithms corresponding to a different base, without having again recourse to the solution of exponential equations. Thus, supposing a system of logarithms has been calculated of which the base is a, or, which is the same thing, that the value of x has been found for every different value of y in the equation $a^x = y$, and that it is required to construct another table of which the base is b, or to find the values of v corresponding to every different value of y in the equation $b^v = y$, we may proceed as follows:—Taking the logarithms of both members of this last equation from the table supposed already calculated, of which the base is a, and recollecting that $\log. b^v = v \log. b$, we have $v \log. b = \log. y$; whence $v = \frac{\log. y}{\log. b}$. But because $b^v = y$, it follows that v is the logarithm of y in the system of which the base is b; therefore, denoting the logarithms in this new system by L, we have $L\,y = \frac{\log. y}{\log. b}$. Hence it appears that, in order to find the logarithm of any given number y in the new system, it is only necessary to multiply its logarithm in the system already calculated by the constant number $\frac{1}{\log. b}$. This constant number, by means of which we pass from the one table to the other, is called the *modulus* of the new table with reference to the old.

In the common system of logarithms of which the base is 10, those numbers only which are perfect powers of 10 (that is, 100, 1000, &c.) can have commensurable logarithms. The logarithms of all other numbers are incommensurable, and can only be obtained to a certain degree of approximation. In general, the approximation will be sufficient if carried to the seventh decimal figure, and accordingly the ordinary tables contain the logarithms only to seven places of decimals; but where very great accuracy is required, as in some astronomical calculations, it may be necessary to use logarithms exact to ten places. In Vlacq's tables they are computed to this extent.

The relation between a number and its logarithm in the common system being $10^x = y$ (where y is the natural number and x its logarithm), if we make successively

$$x = 0, 1, 2, 3, 4 \ldots . n,$$

we shall have for the corresponding values of y

$$y = 1, 10, 100, 1000, 10000 \ldots . 10^n;$$

and if we make

$$x = 0 - 1 - 2 - 3 - 4 \ldots . - n,$$

we shall have

$$y = 1, \frac{1}{10}, \frac{1}{100}, \frac{1}{1000}, \frac{1}{10000} \ldots \frac{1}{10^n}.$$

From these series it is evident that the logarithms of all numbers greater than unity are positive, and that the logarithms of all fractions are negative. It is also evident that the logarithm of every number between 0 and 10 is a decimal, of every number between 10 and 100 is 1 + a decimal, of every number between 100 and 1000 is 2 + a decimal, and so on. But the digits in any number between 10 and 100 are 2, between 100 and 1000 are 3, and so on; therefore the common logarithm of any number is expressed by the number of its digits diminished by unity, with a certain decimal fraction added. For example, the number 73594, comprised between 10000 and 100000, or between 10^4 and 10^5, has for its logarithm 4, with a decimal added. This integral part of the logarithm, which is common to all numbers beween two successive powers of 10, is called the *characteristic*, because it shows at once of how many digits the natural number corresponding to the logarithm to which it is prefixed is composed. If, then, we know the logarithm of any number, we have only to add 1, 2, 3, &c. to its characteristic, in order to have the logarithm of a number 10 times, 100 times, or 1000 times, &c. as great. Thus we have

$$\begin{aligned} \log.\ 73594 &= 4{\cdot}8668424 \\ \log.\ 7359{\cdot}4 &= 3{\cdot}8668424 \\ \log.\ 73{\cdot}594 &= 1{\cdot}8668424 \\ \log.\ 7{\cdot}3594 &= 0{\cdot}8668424 \\ \log.\ {\cdot}73594 &= \bar{1}{\cdot}8668424 \end{aligned}$$

In this last example the negative sign is placed over the characteristic, this only being negative. But it is more usual and convenient to substitute for the negative characteristics their arithmetical complements; thus,

$$\begin{aligned} \log.\ {\cdot}73594 &= 9{\cdot}8668424 \\ \log.\ {\cdot}073594 &= 8{\cdot}8668424 \\ \log.\ {\cdot}0073594 &= 7{\cdot}8668424 \end{aligned}$$

Regard must be had to this substitution in the final result; but no mistake is likely to arise, for its effect would be to carry the decimal point 10 digits to the right or left of its true place—an error which would at once be evident. In modern tables the characteristic is properly omitted; the logarithm to which it would be prefixed belonging, in fact, not only to one particular number, but also to all multiples or sub-multiples of that number by 10.

The methods employed by the first computers of the logarithmic tables were founded on the successive extraction of roots, and involved calculations of very great labour; but analysts have since discovered series by which the computations are rendered much more expeditious and easy. Let it be required to find the logarithm of any number x by means of a converging series. Assume

$$\log. (1 + x) = A\,x + B\,x^2 + C\,x^3 + D\,x^4 + \text{\&c.} \ldots (1)$$

in which A, B, C, D, &c. are coefficients to be determined. Taking another number z, we shall have, in like manner,

$$\log. (1 + z) = A\,z + B\,z^2 + C\,z^3 + D\,z^4 + \text{\&c.} \ldots (2)$$

Subtracting equation (2) from (1) we get

$$\log. (1 + x) - \log. (1 + z) = A\,(x - z) + B\,(x^2 - z^2) + C\,(x^3 - z^3) + \text{\&c.} \ldots (3).$$

But, by the nature of logarithms, $\log. (1 + x) - \log. (1 + z) = \log. \frac{1 + x}{1 + z} = \log. \left(1 + \frac{x - z}{1 + z}\right)$; and, on developing this expression in the same manner as $\log. (1 + x)$ in the equation (1), we have

$$\log. \left(1 + \frac{x - z}{1 + z}\right) = A \frac{x - z}{1 + z} + B \left(\frac{x - z}{1 + z}\right)^2 + C \left(\frac{x - z}{1 + z}\right)^3 +, \text{\&c.}$$

Substituting this development for $\log. (1 + x) - \log. (1 + z)$, in the equation (3), and dividing both sides by $(x - z)$ there results

$$A \frac{1}{1 + z} + B \frac{x - z}{(1 + z)^2} + C \frac{(x - z)^2}{(1 + z)^3} +, \text{\&c.}$$
$$= A + B\,(x + z) + C\,(x^2 + x\,z + z^2) +, \text{\&c.}$$

Now, as this equation is true independently of any particular values of x and z, let us suppose $x = z$, and it becomes

$$A \frac{1}{1 + x} = A + 2\,B\,x + 3\,C\,x^2 + 4\,D\,x^3 + \text{\&c.},$$

which, on expanding the quantity $\frac{1}{1 + x}$ by division, gives $A\,(1 - x + x^2 - x^3 + x^4 -, \text{\&c.}) = A + 2\,B\,x + 3\,C\,x^2 + 4\,D\,x^3 +, \text{\&c.}$ Therefore, by the theory of indeterminate coefficients, we must have the separate equations $A = A$, $-A = 2\,B$, $+A = 3\,C$, $-A = 4\,D$, &c.; and on substituting the resulting values of B, C, D, &c., in terms of A in equation (1), we get

$$\log. (1 + x) = A\left(\frac{x}{1} - \frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{4} + \frac{x^5}{5} -, \text{\&c.}\right)$$

The quantity A, which is still indeterminate, is the modulus; and on assigning to it a particular value, we characterize the system which we wish to consider.

Let us suppose $A = 1$, and denote the particular system of logarithms resulting from this supposition by L; we shall then have

$$L\,(1 + x) = x - \tfrac{1}{2}\,x^2 + \tfrac{1}{3}\,x^3 - \tfrac{1}{4}\,x^4 +, \text{\&c.}$$

This series in its present form is unfit for the calculation of the logarithms of whole numbers, for when x is greater than unity it is divergent; but it may be easily transformed into others having the required properties. On substituting $-x$ for x, it becomes

$$L\,(1 - x) = -x - \tfrac{1}{2}\,x^2 - \tfrac{1}{3}\,x^3 - \tfrac{1}{4}\,x^4 -, \text{\&c.}$$

And on substracting this from the former series, we have,

since $L(1+x) - L(1-x) = L\left(\frac{1+x}{1-x}\right)$,

$$L\frac{1+x}{1-x} = 2\left(\frac{x}{1} + \frac{x^3}{3} + \frac{x^5}{5} + \frac{x^7}{7} +, \&c.\right).$$

Let us now suppose $\frac{1+x}{1-x} = 1 + \frac{1}{z}$, or $x = \frac{1}{2z+1}$;

then, since $L\left(1+\frac{1}{z}\right) = L\frac{z+1}{z} = L(z+1) - Lz$,

the last series becomes, by substitution, $L(z+1) - Lz$

$$= 2\left(\frac{1}{2z+1} + \frac{1}{3(2z+1)^3} + \frac{1}{5(2z+1)^5} +, \&c.\right)$$

This series gives the difference between the logarithms of two consecutive numbers, and it converges with sufficient rapidity. Supposing successively $z = 1, 2, 3, 4$, &c., it gives

$$L\,2 = 2\left(\frac{1}{3} + \frac{1}{3\cdot3^3} + \frac{1}{5\cdot3^5} + \frac{1}{7\cdot3^7} +, \&c.\right)$$

$$L\,3 - L\,2 = 2\left(\frac{1}{5} + \frac{1}{3\cdot5^3} + \frac{1}{5\cdot5^5} + \frac{1}{7\cdot5^7} +, \&c.\right)$$

$$L\,4 - L\,3 = 2\left(\frac{1}{7} + \frac{1}{3\cdot7^3} + \frac{1}{5\cdot7^5} + \frac{1}{7\cdot7^7} +, \&c.\right)$$

It will be observed that as the values of z increase the series becomes much more rapidly convergent. Suppose, for example, $z = 100$; we have then

$$L\,101 = L\,100 + 2\left(\frac{1}{201} + \frac{1}{3\cdot201^3} + \frac{1}{5\cdot201^5} +, \&c.\right)$$

The logarithm of 100 being supposed known, the first term of this series will give the logarithm of 101 true to seven places of decimals.

The series now found gives the logarithms of the particular system of which the modulus is 1, and which is called the *Napierian system*, because it is that according to which logarithms were first computed by their inventor, Baron Napier. But, as has already been shown, when the logarithms have been found in any one system, they may be transferred into those of any other system by means of a constant factor. In the common system the base is 10, and the Napierian logarithm of any number is consequently transformed into the common logarithm of the same number by multiplying by the modulus $\frac{1}{L\,10}$.

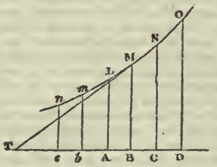
This number, which is of great importance in the computation of the logarithmic tables, is found to be 0·4342944819, &c., the Napierian logarithm of 10 being 2·30258509, &c. It may also be remarked that this modulus 0·4342944819 is the ordinary logarithm of the base of the Napierian system; for, calling e this base, we shall have $e^{L\,10} = 10$, whence, taking the ordinary logarithm of both sides of the equation, $L\,10 \times \log. e = \log. 10 = 1$; therefore $\log. e = \frac{1}{L\,10}$ $= 0{\cdot}4342944819$. On passing to numbers we find $e = 2{\cdot}7182818284$.

The Napierian logarithms are sometimes called the *natural logarithms*, on account of the modulus of the system being unity; and more frequently *hyperbolic logarithms*, because they represent the area of a rectangular hyperbola between its asymptotes.

Logarithms were invented by Lord Napier, Baron of Merchiston in Scotland; and made known in a work published by him in 1614, under the title *De mirifici Logarithmorum Canonis Constructione*. Henry Briggs, a contemporary of Napier, and professor of geometry in Gresham college, constructed another system, having for its base the number 10, which, corresponding with our system of numeration, is much more convenient for the ordinary purposes of calculation. Briggs calculated the logarithms to 14 places, besides the index, of all numbers between 1 and 20,000, and between 90,000 and 100,000, and published them in his *Arithmetica Logarithmica* in 1624. Adrian Vlacq, a native of Holland, computed the logarithms of the numbers from 20,000 to 90,000, and thus completed what had been begun and partly accomplished by Briggs; but he reduced the tables to 10 decimal places. Vlacq's *Arithmetica Logarithmica* was published at Gouda in 1628, and contained the logarithms of all numbers from 1 to 100,000, calculated to 10 decimals; as also the logarithms of the sines, tangents, and secants of every minute of the quadrant. Vlacq afterwards, in 1633, published another most valuable work, his *Trigonometria Artificialis*, containing the logarithmic sines, cosines, tangents, and cotangents for every ten seconds of the quadrant, calculated from the natural sines, &c. of the *Opus Palatinum* of Rheticus. In the same year another work of the same kind, the *Trigonometria Britannica*, was published at Gouda, containing the logarithmic sines and tangents for the 100th part of every degree of the quadrant, together with a table of natural sines, tangents, and secants. These had been computed by Briggs.

Logarithms being of constant use in astronomical and trigonometrical calculations, the tables which have been published are very numerous. The most complete are those of Vlacq, already mentioned, to ten decimals; but they are very scarce, and can with difficulty be procured. There is an edition of them by Vega, in 1797, also scarce. *Gardiner's Logarithms*, printed in 1742, in 4to., and another edition of them at Avignon in France in 1770, are to seven decimals. *Callet's Logarithms*, in 8vo., like Gardiner's, contain the logarithmic sines, &c. for every 10 seconds. *Taylor's Logarithms*, in 4to., and also *Baguay's*, have them to every second. *Hutton's Logarithms*, and *Babbage's Logarithms of Numbers*, are well known. The latter was carefully collated, and is very accurate and convenient. *Hulsse's Sämmlung Mathematischer Tafeln* (8vo. Leipsig, 1840) deserves to be mentioned as a very useful collection. The above (excepting Vlacq's and Vega's) are all to seven decimal figures; but for many purposes logarithms to a less number of decimals are sufficiently accurate. For navigation and surveying, tables to six figures are the most convenient, as they give in general the trigonometrical lines correct to single seconds. The best tables of this kind are *Farley's Tables of Six-figure Logarithms* (12mo. 1840). For many auxiliary computations in astronomy it is sufficient to have the logarithms to five places. The reprint of *Lalande's Five-figure Table* by the Useful Knowledge Society (18mo. 1839) is convenient, and may be relied on for accuracy.

LOGARITHMIC or LOGISTIC CURVE. In the higher Geometry, a curve line having this property, that its abscissa are proportional to the logarithms of the corresponding ordinates. It is contructed in the following manner:—On the straight line A D let the parts A B, A C, A D, &c. be taken in arithmetical progression (or such that A B = B C = C D = &c.), and from the several points A, B, C, D, &c. let the perpendiculars A L, B M, C N, D O, &c. be erected, forming a geometrical progression, or such that A L : B M = B M : C N = C N : D O = &c.; then their summits L, M, N, O, &c. will mark the logarithmic curve. The curve is ascending or descending, according as it is continued from L upwards towards M, or downwards towards m.

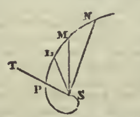


The equation of the curve is $x = a \log. y$; and hence its principal properties are easily deduced. Taking the differential of the equation, we get $dx = a\frac{dy}{y}$; whence $y\frac{dx}{dy} = a$. Now in any curve $y\frac{dx}{dy}$ is the expression of the subtangent: therefore the subtangents of the logarithmic at different points are all equal. The constant a to which the subtangents are equal is the modulus of the system of logarithms represented by the particular curve When the subtangent (B T for example) is equal to A L, the primary ordinate which represents unity, the curve will exhibit the natural or Napierian logarithms.

From the equation $dx = a\frac{dy}{y}$ we have $y\,dx = a\,dy$; but $y\,dx =$ the differential of the area, therefore the area $= \int a\,dy = ay +$ const. Making first $y =$ D O, and then $y =$ C N, we have the area C N O D $= a$ (D O $-$ C N); that is to say, the area contained between two ordinates is equal to the rectangle under their difference and the constant subtangent.

The logarithmic curve was proposed by Gregory of St. Vincent soon after the discovery of logarithms, and its leading properties were investigated by Huygens and others. Great use is made of it in various applications of physical science, and particularly in exhibiting the relations of elastic fluids. (See *Keill's Tract on Logarithms*; *Euler's Introd. in Anal. Inf.*, vol. ii.; *Leslie's Geometry of Curves*, &c.)

LOGARITHMIC SPIRAL, or LOGISTIC SPIRAL. A curve line, which is generated as follows:—Let the line S T revolve uniformly about a fixed point S, while another point P advances or recedes on S T with a velocity always proportional to its distance from the centre S; then the point P will trace out the logarithmic spiral.



From this definition of the curve it follows that radiants S L, S M, S N, &c., making equal angles with each other, are continued proportionals; and that the angles about the pole S are the logarithms of the ratios of the successive

radiants: whence the curve has its name. Let $SL = 1$, $SM = y$, the angle $LSM = z$; then $z = a \log. y$, where a is a constant quantity. The curve is consequently analogous to the common logarithmic, the difference being that the abscissa are in the latter taken as straight lines, whereas in the case of the spiral they may be conceived to be taken as the arcs of a circle.

The logarithmic spiral has many remarkable properties. One of them is, that the curve intersects all its radiants at the same angle; and this angle is the modulus of the system of logarithms which the particular spiral represents. Another of its properties is that its involute and evolute are the same curve with itself. Newton proved that if the force of gravitation had been inversely as the *cube* of the distance, instead of the *square*, the planets would have shot off from the sun in logarithmic spirals. (*Principia*, lib. i. prop. ix.)

LOGEI'ON. (Gr. λογεῖον.) In ancient Architecture, the Greek name for *proscenium* (which see). By the Romans it was called the *pulpitum*.

LO'GIC (Gr. λογίκη (τέχνη understood; from λόγος, *speech*, *discourse*, or *calculation*), has been defined the science, and also the art, of reasoning. It is a science, because it investigates those principles on which reasoning proceeds: it has been termed an art, as furnishing rules whereby the formal part of an argument may be constructed. Logic was highly valued, perhaps overvalued, among ancient philosophers. The Stoics, in particular, were celebrated for their application of its principles to their own favourite metaphysical discussions. From the abuse of logical knowledge arose the celebrated fallacies of the Sophists, who, according to the satirical representations of Athenian writers, were hired to furnish their pupils with the means of defending right or wrong positions with equal facility. Zeno of Elea is called the father of logic, or dialectics, according to the ancient appellation of the science: but we are not well acquainted with the discipline which he taught; although it can hardly have consisted, as more recent writers have represented, of a mere manual of captious fallacies. But it is to the master mind of Aristotle that the science owes, as far as we are able to ascertain, not only its first exposition, but its complete development; for although logic has been extensively interwoven in later times with the subtleties of metaphysics and of rhetoric, yet, as far as the limited province of the pure science extends, little has been done besides placing in a clearer light the discoveries of the Stagyrite. When, in the middle ages, the Aristotelian logic became the foundation of the scholastic philosophy (which was little better than a revival under another form of that of the Athenian sophists), attempts were made, especially one by the famous Raymond Lullius, to throw the science into a new form, but without success. In consequence of the various misapplications and perversions which the system had undergone in the hands of later dialecticians, it fell into great disrepute in modern times; and many of our first metaphysical writers, as Locke, for example, have treated it with very unmerited contempt. Confined to that narrow limit to which alone its rules really extend, it is a serviceable exercise for the mind, and affords an accurate insight into the formal part or machinery of reasoning.

However multifarious the subjects to which reasoning may be applied, and however complicated its details may become, the process by which all reasoning is conducted is one and the same. Whoever seeks to prove that because one thing is thus, therefore another thing is so, whether he be a philosopher pursuing a recondite truth, or a labourer commenting on the events of his daily life, cannot travel out of the bounds of the Aristotelian syllogism. In analysing the process in question, we find, in the first place, that every truth or apparent truth, arrived at by reasoning, technically termed a conclusion, is deduced from two other propositions, technically termed premises, either both expressed, or one expressed and the other implied. In many instances it is at once evident to the mind of one capable of reasoning that if the two premises be true, the conclusion must follow. Thus, if I wish to prove the mathematical truth, that every A is equal to B, I find a third quantity, C, which is equal to both; and my argument then assumes the following shape — whatever is equal to C is equal to B; but every A is equal to C, therefore every A is equal to B. Here the connection between the conclusion and the premises is at once evident and true; but there are many cases in which there is an apparent connection which is in reality false: in other words, from two premises a conclusion is deduced, which, admitting the truth of those premises, does not in reality follow from them. The following, for example, is an instance of a conclusion incorrectly deduced from its premises, which, nevertheless, might at first sight pass current for reasoning: "Every rational agent is accountable; brutes are not rational agents, therefore brutes are not accountable." To explain the reason why the first of these two arguments is sound, and the latter unsound, requires not the examination of truths in mathematics or in natural religion, but simply of the common process of reasoning; and it is the means of making such an analytical investigation which are afforded by logic.

The first of these arguments is a correct, the latter a false or apparent, syllogism (*see* SYLLOGISM); and the validity of the first, and invalidity of the latter, depend upon the necessary or unnecessary connection between the premises and the conclusion; the rules for ascertaining which will be found compendiously given under the head SYLLOGISM. A single sentence may often be found to contain, elliptically expressed, and compressed into a narrow compass, a whole chain of separate syllogisms; but every single conclusion has been arrived at by this process, and by this only.

The principle of the syllogism is contained in the famous maxim termed in the schools of the middle ages the "dictum de omni et nullo,"— viz. that "whatever is predicated (*i.e.* affirmed or denied) universally of any class of things, may be predicated, in like manner (*i.e.* affirmed or denied) of any thing comprehended in that class." Thus, for example, in the instance previously given of a valid argument, if it can be predicated of the whole class of things which are equal to C that they are also equal to B; if I find any thing equal to C, I may predicate of it that it is equal to B also. Hence my second premise, A is equal to C, serves to bring me, logically, to the required conclusion — that A is equal to B. This, therefore, is the general principle on which that process is conducted which takes place in every syllogism.

In order that reasoning may be contemplated simply as reasoning, without any reference to the essential truth or falsehood of the propositions contained in it, which have nothing to do with the science we are now considering, and also with a view of furnishing brief and expressive forms, like those of algebra, instead of words at length, a set of arbitrary symbols are employed in logic, to denote the quantity and quality, as they are termed, of propositions. Every proposition either affirms or denies a fact; every proposition also predicates (*i.e.* affirms or denies) that a certain attribute belongs either to a whole class, or to some members of a class, of objects: propositions are therefore, in quality, either affirmative or negative; in quantity, universal or particular. Thus the four symbols of propositions in logical manuals are, A, universal affirmative; I, particular affirmative; E, universal negative; O, particular negative. And the form of a syllogism, according to the character of each of its premises and of the conclusion, is expressed by three of these letters. Thus the syllogism first given, consisting of three universal affirmatives (for it will be found, on examination, that each proposition predicates a certain attribute of all the members of a class), will be designated by A A A; a syllogism termed in logical language *barbara*. *See* SYLLOGISM.

It is also found, on farther analysis, that a syllogism embraces three separate objects or notions, two of which are compared with the third, and, in consequence of that comparison, pronounced to agree or disagree with each other. Thus, in the syllogism "No dishonest man is a good citizen: Caius is a dishonest man; therefore Caius is not a good citizen." The individual object, "Caius," and the class of objects, "good citizens," being compared with a third class, "dishonest men," are found, the one to agree, the other to disagree, with that class; and hence it inevitably follows that they disagree with each other, — *i.e.* the conclusion of the syllogism is negative. These three objects or terms, as they are called in logic, occur in every syllogism. The predicate of the conclusion,—*i.e.* that term which, in the conclusion, is predicated of the other, in this instance "good citizen"— is called the major term; the subject of the conclusion—*i.e.* that term of which the other is predicated (Caius)—is the minor term; and the term with which the other two are respectively compared, "dishonest man," is the middle term.

But every word, or combination of words, is not capable of constituting a term — *i.e.* something which may be predicated of another thing, or of which another thing may be predicated. In the first place, adverbs, prepositions, nouns in any inflection from the nominative case, &c., can only form parts of a term; in logical phrase, they are syncategorematic: adjectives, also, have always, impliedly, a nominative subjoined, when employed as terms. Verbs are mixed words, being resolvable into a term employed as a predicate, united to the *copula* or auxiliary verb (*is* or *is not*). Thus, nouns in the nominative case alone are simple terms or categorematics; these, again, are either the name of an individual or the name of the class: the former (singular terms) may be subjects, but cannot be predicates; the latter may be either. Thus, in the proposition "Crassus is rich," the singular term, "Crassus," is the subject of which it is predicated that he is rich — *i.e.* a rich man.

A common term, being a word equally applicable to a number of individuals, expresses a notion formed by the faculty of abstraction. When, for example, we contem-

plate several individual oak trees, and abstract from each its separate peculiarities of height, growth, &c., we form the notion of an oak. Contemplating a number of trees of mixed species, and abstracting from each its specific peculiarities of leaf, fruit, &c., we next arrive at the common notion tree. These common notions or terms are then the *predicables* which can be affirmed or denied of other objects.

Predicables are divided into several kinds, although the division is, perhaps, strictly, rather appertaining to metaphysical than logical science. Every predicable is said, according to this division, to express either the genus, species, difference, property, or accident, belonging to an individual. (See these heads, and PREDICABLE.) But it is to be remembered that a predicable may be referred to one or other of these several kinds, according to the point of view from which it is contemplated. If I say of Cæsar that he is a "man," I express his species, considering him in those respects in which he differs from other animals. If I say that he was "brave," I express a property. If I predicate of him the several circumstances in which he absolutely differed from all other men, I express that property or that bundle of united properties which forms his "difference." Every predicable, with a little attention, may be ranged under one or the other of these five classes, although it must be confessed that the distinction seems occasionally arbitrary and unphilosophical.

In this hasty outline of some leading features of the art of logic, as taught at Oxford (where alone, we believe, pure unapplied logic forms a branch of study), we have chiefly made use of the Archbishop of Dublin Dr. Whately's valuable *Elements of Logic*.

The following passage is cited by Mr. Hallam from the *Port Royal Logic*, as giving a juster view of the value of the Aristotelian method than its admirers are wont to entertain:—"Cette partie, que nous avons maintenant à traiter, qui comprend les règles du raisonnement, est estimée la plus importante de la logique, et c'est presque l'unique qu'on y traite avec quelque soin; mais il y a sujet de douter si elle est aussi utile qu'on se l'imagine. La plupart des erreurs des hommes viennent bien plus de ce qu'ils raisonnent sur de faux principes, que de ce qu'ils raisonnent mal suivant leurs principes. Il arrive rarement qu'on se laisse tromper par des raisonnemens qui ne soient faux, que parceque la conséquence en est mal tirée; et ceux qui ne seraient pas capables d'en reconnaitre la fausseté par la seule lumière de la raison, ne le seraient pas ordinairement d'entendre les règles que l'on en donne, et encore moins de les appliquer. Néanmoins, quand on ne considéreroit ces règles que comme vérités spéculatives, elles serviraient toujours à exerçer l'esprit." (*Esprit de Penser*, part 3.) "To represent this portion of logical science as the whole," adds the same writer, "appears to me almost like teaching the scholar Euclid's axioms, and calling this the science of geometry." (*Introduction to the Literature of Europe*, vol. iii. p. 221.) All that can be said in answer is, that the more general meaning of the term logic is undefined, and that it is employed by various writers and schools in the most arbitrary manner; while this portion, though it may be but a small one, is so clearly marked out, and forms so distinct a body, that it has occupied in common language the character of the whole science.

LOGO′GRAPHY. (Gr. λογος, *speech*; γραφω, *I write*.) A system of taking down the words of an orator without having recourse to short-hand, which was put in practice during the French revolution. Twelve or fourteen reporters were seated round a table. Each had a long slip of paper, numbered. The writer of No. 1. took down the first three or four words, and as soon as they were spoken gave notice to his neighbour by touching his elbow, or some other sign; No. 2. passed the sign to No. 3., and so on, until the first line of each slip was filled; No. 1. then began the second line: thus all the 12 or 14 slips, when filled, being arranged parallel to each other, formed a single page. This mode required great attention and quickness, and was not found to answer well in practice. It was introduced in the National Assembly in October, 1790, the expenses being paid by the civil list; and continued until the 10th August, 1792, when Louis XVI. and his family, taking refuge from insurrection in the assembly, occupied the box of the logographe. After that time it was not used. (*Dictionnaire de la Conversation*.)

Logography is also used to denote a method of printing in which whole words in type are used instead of single letters. This method was at one time introduced into the printing of *The Times* newspaper; but after a short trial was abandoned as inconvenient.

LO′GOGRYPH. (Gr. λογος, and γριφος, *a net*.) A species of riddle proposed for solution, in order to exercise the mind, is so called. The word is used by Ben Jonson.

LO′GWOOD. The wood of the *Hæmatoxylon campechianum*, a tree growing in many parts of the West Indies and on the adjoining continent. It is employed in dyeing and calico-printing for the production of reds, blacks, drabs, and several compound colours. Its colouring principle has been termed *hæmatine*. An extract of logwood is used in medicine as an astringent. The price of logwood varies from 5*l*. 10*s*. to 7*l*. per ton; and the quantity imported into Great Britain in the three years ending 1839 averaged 15,000 tons.

LOI′MIC. (Gr. λοιμος, *contagious matter*.) Relating to the plague or contagious disorders.

LOK. In Northern Mythology, the name of a malevolent deity; corresponding to the Ahriman of the Persians, who is represented to be at war with both gods and men, and originating all the evil with which the universe is desolated. In the *Edda* (the great poem of the Norwegian nations) he is described as the great serpent which encircles the earth (supposed to be emblematical of sin or corruption), and as having given birth to Hela, or Death, the queen of the infernal regions.

LO′LLARDS. A class of persons in Germany and the Netherlands who professed, in the 14th century, to undertake spiritual offices in behalf of the sick and dead, and succeeded in attracting the attention and love of the mass of the people when they were in a great measure alienated from the secular and regular clergy by their general indifference and neglect. The origin of the name has been much disputed; but the inquiries of Mosheim seem to lead to the result that it is compounded of the German words *lallen* (identical with the *lallare* of the Romans and the *lull* of our own language, signifying to sing in a murmuring strain) and *hard*, a common affix, as in the somewhat similar word *beghard*. A Lollard, therefore, meant one in the habit of singing to the praise of God, or funeral dirges and the like, as was the custom of the early professors of this holy manner of life. The Lollards, however, were accused—probably through the envy and spite of the mendicant friars and others whose neglected duties they so zealously performed—of holding many heretical opinions. It is not impossible that there might have been some degree of enthusiasm mixed up with so ardent and unworldly a devotion; but the charges of violent reforming views, still more those of practical vice, appear to rest upon no authentic grounds. In process of time the term was applied by the partizans of the church to the heretics and schismatics of the day generally; and the followers of Wicliffe in England are frequently stigmatized under the name of Lollards. (See *Gieseler's Text-book*, transl., vol. iii. pp. 99. 128.)

LO′MBARD. A term anciently used in England for a banker or money-lender. The name is derived from the Italian merchants, the great usurers or money-lenders of the middle ages, principally from the cities of Lombardy, who are said to have settled in London in the middle of the 13th century, and to have taken up their residence in a street in the city which still bears their name. Stowe, in his *Survey of London*, says, "Then have ye Lombarde Street, so called of the Longobards and other merchants, strangers of diverse nations, assembling there twice every day. The meeting of which merchants there continued until the 22d of December, in the year 1568; on the which day the said merchants to make their meetings at the Bursse, a place then new builded for that purpose, in the ward of Cornhill, and was since, by her majesty Queen Elizabeth, named the Royal Exchange." (P. 202.)

LOME′NTUM. A fruit similar to a legume, excepting that it is contracted in the spaces between each seed, and there separates into distinct pieces; or is indehiscent, but divided by internal spurious dissepiments, whence it appears at maturity to consist of many articulations and divisions. It occurs in the genera *Ornithopus*, *Hedysarum*, &c.

LONG. A musical character of this form ꟼ, whose length in common time is equal to four semibreves, and consequently eight minims.

LO′NGICORNS, *Longicornes*. (Lat. longus, *long*; cornu, *a horn*.) The fourth tribe of Coleopterous insects in the system of Latreille; so called on account of the length of the antennæ, which are rarely shorter than the body, and commonly surpass it in length. But this conspicuous character is not the only one which the Longicorn beetles possess in common. In all of them the under part of the three first joints of the tarsi is furnished with a brush; the second and third are cordiform; the fourth is deeply bilobate; and there is a little nodule, resembling a joint, at the base of the last. The *ligula*, placed on a short and transversal *mentum*, is usually membranous, cordiform, emarginate, or bifid; but sometimes is corneous, and forms the segment of a very short and transverse circle. The antennæ are either filiform or setaceous: they are sometimes simple in both sexes, and sometimes serrate, pectinate, or flabelliform in the males. The eyes in some species are rounded and entire, or but slightly emarginate, and in these species the thorax is trapezoidal or narrowed anteriorly; but in most of the Longicorns the eyes are reniform and surround the base of the antennæ.

As the larvæ of a very great proportion of the Longicorns live in the interior of trees, or under their bark, they are destitute of feet, or have but very small ones.

Their body is soft, whitish, thickest anteriorly; and the head squamous, and provided with stout mandibles. They do much injury to trees, the large ones particularly, perforating them very deeply, and sometimes drilling them in every direction. Some of them attack the roots of plants.

The abdomen of the female Longicorns is terminated by a tubular and horny ovipositor. These insects produce a small sharp sound, by rubbing the pedicle of the base of their abdomen against the interior of the parietes of the thorax.

LO′NGIPALPS, *Longipalpi.* (Lat. longus, *long;* palpus, *feeler.*) The name of a family of Brachelytrous Coleopterans, or short-winged beetles, which have the maxillary feelers almost as long as the head.

LON′GIPE′NNATES, *Longipennes.* (Lat. longus, and penna, *a wing.*) A family of swimming birds, comprehending those in which the wings reach as far as or beyond the tail; as the tropic bird, albatross, &c. They are all denizens of the high seas, and from their powers of flight are to be met with in various latitudes. The hind toe is free or wanting. The beak is hooked or pointed at the tip.

LONGIRO′STERS, *Longirostres.* (Lat. longus, and rostrum, *a beak.*) The name of a tribe of Grallæ, or wading birds, including those in which the beak is remarkable for its length and tenuity, and by the high sensibility of its tip is well adapted for searching or probing in mud or sand for worms or insects. The different gradations in the form of the bill serve to divide the Longirosters into families and genera.

LONGI′SSIMUS DORSI. A muscle of the back, which assists others in keeping the spinal column erect.

LO′NGITUDE, in Astronomy, has two different significations, according as it is applied to a celestial or terrestrial object. The longitude of a heavenly body is the arc of the *ecliptic* intercepted between the vernal equinox and a great circle perpendicular to the ecliptic passing through the body. It is reckoned eastward all round the sphere, from 0 to 360°. The longitude and latitude of a celestial object, having reference to the ecliptic, and not to the plane of the earth's diurnal motion, cannot be directly observed. The elements necessary for determining a star's place, which are given directly by observation, are its right ascension and declination, from which the longitude and latitude must be calculated by the rules of spherical trigonometry. In the planetary theory, however, it is convenient to refer the motion of a planet to the plane of the earth's orbit, or to make the longitude and latitude the co-ordinates of its motion. But the places of the stars are always defined, by modern astronomers, by means of their right ascensions and declinations.

The longitude of a place on the earth is the arc of the *equator* intercepted between the meridian of the place and some conventional fixed meridian, which is regarded as the origin from which the measures are reckoned. Terrestrial longitudes and latitudes correspond to right ascensions and declinations in the heavens: with this distinction, however, that the right ascensions are always reckoned from the vernal equinox, or point in which the equator intersects the ecliptic; whereas the longitudes are reckoned by different geographers from different points, selected for some local reason, there being nothing connected with the earth's diurnal rotation which can render one point of the equator more convenient than another. Right ascensions are also reckoned in the same direction (eastward) round the complete circumference; while geographical longitudes are reckoned both eastward and westward, 180° each way.

The parallels of latitude on the earth are distinctly marked out by the diurnal circles described by the stars, and consequently latitude can always be determined by direct observation of the heavens: but the case is entirely different with respect to longitude; for to observers situated under the same parallel of latitude, but under different meridians, the heavens present exactly the same aspect, and there is nothing whatever to indicate any difference of locality. Longitude, therefore, cannot be measured by direct observation; it can only be inferred from the measurement of intervals of time to which it is proportional. In the course of a sidereal day the rotation of the earth brings successively every different meridian under the same star; and, the rotation of the earth being perfectly uniform, it follows that the angular distance of any two meridians will be the same part of 360° that the interval of time which elapses between their coming to the same star is of twenty-four hours. For example, if a star pass the meridian of a place A at a certain moment, and that of B exactly one hour of sidereal time later; then the difference of longitude between A and B is the twenty-fourth part of 360°, or 15°, and the longitude of B is 15° west of A. The determination of longitudes consequently resolves itself into the measurement of time; and as the time, or the instant of mean noon, at any place can always be found without difficulty, if an observer at one place can by any means determine the precise hour it is at any oth place *at the same instant*, he has then determined t difference of longitude between the two places.

Of the various methods by which differences of lo gitude may be determined, the simplest and most obvio is that of transferring chronometers from one place another. Suppose two observers, at the distant station A and B, each to regulate his clock according to the tr sidereal time of his station; and suppose a chronomete also regulated to true sidereal time, to be compared wi the clock at A, and then transported, without sufferi any change of rate, to B—the difference of the two cloc would thus be exhibited; and this difference is exact the time occupied by the equinoctial point, or by any st in passing from the meridian of A to that of B; or it is t difference of longitude of the two places expressed in sid real hours, minutes, and seconds. Were chronomete perfect, nothing more complete and convenient could b desired; but this unfortunately is even now very far fro being the case, and until within a comparatively ver recent time the practical determination of the longitud by means of chronometers could not be attempted.

Another method of determining the difference of lo gitude between two places, independently of astron mical observations, is that by telegraphic signals. Th method, though, from its nature, of limited application, susceptible of great accuracy. The explosion of a rocke the flash of gunpowder in an open dish, the extinctio of a bright light, &c., are instantaneous phenomen which can be seen at great distances and noted with th utmost precision. A signal of this kind, made at a sta tion visible from two observatories, must be seen at th same absolute instant of time from both; and the tim marked by the clock of each observatory at this instan being noted, the difference of their local times, and con sequently the difference of their longitudes, become known. This method is chiefly practised in connectio with geodetical operations for measuring degrees of lon gitude on the earth's surface, and is perhaps the bes that can be adopted for determining the difference o longitude between two observatories situated at no ver great distance from each other. By means of inter mediate signals, and observers suitably disposed betwee each, it may also be applied to transfer the time fron one place to another, when the distance is too great t allow an artificial signal of any kind to be seen fron both. (See *Phil. Trans.*, 1826.)

When the distance between two places is very consi derable, artificial signals cannot be employed, and i becomes necessary to have recourse to the methods fur nished by astronomy. These are principally the follow ing:—

1. *Eclipses of the Moon.*—The instant of time at whic the moon's disk enters or quits the earth's shadow i independent of the position of the observer; and there fore, if the phenomenon could be accurately observed would give the longitudes of all places from which th eclipse is visible. But the penumbra of the earth ren ders it impossible to determine the precise instant a which the disk enters into the true shadow: the ob servation, in fact, is uncertain to the amount of a minut of time, which corresponds to a quarter of a degree of lon gitude; and therefore this method, which was propose and employed by Ptolemy, is now altogether abandoned

2. *Eclipses of Jupiter's Satellites.*—These phenomen also occur at the same instant of absolute time to al places on the earth; but they are not susceptible of bein observed with much exactness, for the same reaso which renders the lunar eclipses uncertain, namely, th penumbra of the planet. The uncertainty is least i the case of the first satellite, on account of its quic motion; and as the eclipses of this satellite occur muc more frequently than those of the others, the observa tions are chiefly confined to it. The times of the eclipse of the three first satellites are given in the *Nautica Almanac;* so that an observer at any part of the world who observes one of these eclipses, has only to compar his local time with that assigned to the phenomenon i the almanac in order to determine the distance of hi meridian from that of Greenwich. But, on account o the uncertainty of the observation, the longitude obtaine by this method may be considerably in error.

3. *Occultations of Fixed Stars by the Moon.*—This method, which is one of the readiest and most useful on land, though it can seldom be practised at sea, consists in observing accurately the time at which a certain fixed star disappears behind the disk of the moon, or reappears after having been occulted. The first of these phenomena is called the immersion of the star, the second the emersion. But, on account of the moon's parallax, the immersion or emersion of a star behind her disk does not take place at the same absolute instant to observers on different parts of the earth; a calculation is therefore necessary to clear the observation of parallax, or to determine the time at which the phenomenon would have occurred if it had been seen from the centre of the earth. This reduction being made, the moon's apparent

semidiameter at that instant must be calculated; by means of which, after applying the proper corrections for parallax, refraction, &c., the exact distance of the star from the moon's centre at the moment of the immersion becomes known. Now, suppose the same occultation to have been observed at another place, and the true distance of the star from the centre of the moon computed in the same manner; or, without a corresponding observation, suppose the time at the second place (Greenwich, for example) to be computed, for which the star's distance from the moon was the same as observed at the first place, the comparison of those times will show the difference of the longitudes of the places. The length of the calculations by which the longitude is deduced is a disadvantage which attaches to this method. *See* OCCULTATION.

4. *Eclipses of the Sun.*—The longitude is deduced from the observation of solar eclipses, in the same manner, and by precisely the same sort of calculations, as from the occultation of fixed stars. An eclipse of the sun is, in fact, an occultation; but these phenomena occur so seldom at any particular place that they afford little assistance in the determination of longitudes. It may be remarked that the irregularities of the border of the moon's disk render the instant of the commencement or end of a solar eclipse, as also of the immersion or emersion of a fixed star, somewhat uncertain. But this uncertainty is corrected, or rather avoided, by measuring with a micrometer the distance between the two cusps, which, shortly after the commencement of the eclipse, appear as brilliant points, sharp and well defined. Knowing the distance of the cusps, or length of the chord, and also the semidiameters of the two bodies, the true distance of their centres at the instant the measure was taken can be calculated without much difficulty. As this measurement can be executed with much precision, and can also be repeated frequently during the progress of the eclipse, the phenomenon of a solar eclipse affords one of the most certain methods of determining a longitude which can be practised. *See* ECLIPSE.

5. *Transits of the Moon.* — This method is founded on the moon's rapid change of place among the stars, which becomes very sensible even in short intervals of time. Suppose an observer at the station A to determine the sidereal time of the transit of the moon's centre over his meridian; and suppose another observer at B, to the west of A, also to note the sidereal time of the same transit: if the moon's right ascension had in the interval undergone no change, the sidereal times marked by the two observers would have been the same; but as the right ascension has increased, while the moon was passing from the meridian of A to that of B, the sidereal time of the transit at the latter place will be increased; and, supposing the change of right ascension to be uniform, the difference of the times of transit will be proportional to the difference of meridians. The chief objection to this method is, that any minute error in the adjustment of the transit instrument or rate of the clock is thrown upon the longitude, on which it produces a very sensible effect. The method can, therefore, only be safely practised at fixed observatories with the best instruments.

6 *Moon-culminating Stars.*—This method has been proposed for the sake of eluding the effect of minute instrumental errors, which render the method last described so difficult. A star is chosen which *culminates* (that is, comes to the meridian) at nearly the same time with the moon, and which has very nearly the same declination; so that it may be seen in the field of view without altering the position of the transit instrument. The transit of the star, as well as the transit of the moon's limb, is observed at both stations (or at least observed at the one station, and calculated for the other whose meridian is known), and the difference of sidereal time between the two transits noted at each. This difference, in consequence of the moon's motion in right ascension, is not the same at both stations; and its variation gives the difference of the longitude. By this means any error of the position of the transit instrument affects the star and the moon both alike: but it is erroneous to suppose that the method is independent of accuracy in the adjustment of the transit instrument; for if the instrument is out of the meridian, the resulting longitude will be in error by the amount of the moon's variation in right ascension during the corresponding interval. This method is now much practised.

7. *Lunar Distances.*—None of the methods which have yet been described (excepting that by chronometers) can be applied to the very important problem of determining the longitude of a ship at sea. In this case, no fixed or meridian instrument can be employed; and the observer can only measure the apparent distance of the moon's limb from a fixed star or planet with a sextant, or some reflecting instrument which can be held in the hand. For the purpose of rendering this method available to seamen, the distance of the moon from certain fixed stars is computed (several years previously) for every three hours of Greenwich time, and published in the *Nautical Almanac.* The moon's distance from one of these stars being observed on board a ship, and corrected for refraction and parallax, and the apparent time at the place and moment of observation being determined in the usual manner by the altitude of the sun or a known star, the difference between the apparent time of the observation and the apparent time at Greenwich *corresponding to the same distance*, interpolated from the *Nautical Almanac*, gives the longitude of the ship. *See* LUNAR METHOD.

In the projection of maps and charts it is necessary to assume a point of the equator as the origin of the longitudes. The meridian passing through this point is called the *first meridian;* and as its selection is perfectly arbitrary, it has been placed by different geographers at various parts of the earth: a circumstance which occasions some inconvenience in consulting works of geography. Modern geographers usually assume the meridian of the capital of their own country as the first meridian. English writers generally adopt the meridian of the Greenwich Observatory, for which the *Nautical Almanac* is computed; the French that of the Observatory of Paris. (*See* MERIDIAN.) Ptolemy, and the most celebrated of the ancient geographers, placed the first meridian at the Fortunate Islands (now the Canaries), which they conceived to be the utmost boundary of the habitable earth. The Arabian astronomers also counted the longitude from the Fortunate Islands; and many of the modern geographers have counted from the island of Ferro, one of the most westerly of the Canaries. The reason for fixing on this point was probably that as there was no land known to the west of the first meridian, the longitudes of all places would be reckoned in the same direction, or there would be no west longitude. The discovery of America destroyed the force of this reason. The inconvenience of counting in two directions is not very great; but it might be avoided by reckoning the longitude all round the circle to 360°, which would undoubtedly be an improvement on the present method.

Degrees of Longitude. — The figure of the earth being spheroidal, the degrees of longitude diminish as we proceed from the equator towards either pole. For the law of their variation, and their lengths on the different parallel circles, see DEGREE.

Geocentric Longitude is the longitude of a planet as seen from the earth; that is, the point of the ecliptic to which it perpendicularly corresponds as seen from the centre of the earth.

Heliocentric Longitude is the longitude of a planet as seen from the sun. See the terms GEOCENTRIC and HELIOCENTRIC.

LO'NGUS CO'LLI. The name of a pair of muscles of the neck: when one contracts, it moves the neck to one side; when they both act, the neck is bent forwards.

LOOM. The well-known machine for producing cloth by the interweaving a series of parallel threads which run lengthwise, called the warp or chain, with other threads thrown transversely with the shuttle, called the woof or weft. Under the head WEAVING will be found a notice of the history of the loom, and the numerous improvements that have taken place in its construction from the earliest times down to the invention of Jacquard.

LOO'MING. The indistinct and magnified appearance of objects seen in particular states of the atmosphere. *See* MIRAGE.

LOO'PHOLES. In Fortification, apertures formerly made in the battlements, or in the walls of fortified places, for discharging arrows and javelins against the assailants. Since the invention of gunpowder, and the substitution of cannon for such missiles, loopholes have necessarily been discontinued in the construction of fortresses, the assailants of which are now sought to be driven back by guns fired through apertures of a different character, designated *embrasures*, which see.

LO'PHOBRA'NCHIATES, *Lophobranchii.* (Gr. *λοφος, a tuft; βραγχια, gills.*) An order of Osseous fishes, comprehending those in which the gills are in the form of small tufts, and disposed in pairs along the branchial arches; as in the pipe-fish and hippocamp.

LO'PHOTES. (Gr. *λοφος.*) A genus of Tænioid fishes, characterized by a short head, surmounted by a high osseous crest, to the summit of which a long and stout spine is attached, bordered behind with a membrane and a low fin, of which the rays are nearly all simple, and which extends from the occipital spine to the point of the tail; this is terminated by a distinct but very small caudal fin.

LOPHY'ROPODS, *Lophyropoda.* (Gr. *λοφυρος, crested; πους, a foot.*) The name of a section of Entomostracous Crustaceans, comprehending those species with cylindrical or conical ciliated or tufted feet.

LO'PPING. Cutting off all the branches of a tree for the sake of the profit to be derived from them; as contrasted with pruning, by which some of the branches are cut off for the sake of the tree. The lopping of a tree, however, does not include the cutting off of the crop or

leading shoot; and hence when timber trees are sold the purchaser bargains to take them either with or without the lop and crop, as the case may be.

LORANTHA'CEÆ. (Loranthus, one of the genera.) A natural order of parasitical Exogens, principally inhabiting the equinoctial regions of Asia and America. They are distinguished from *Caprifoliaceæ* and all other orders by their parasitical habit, and by the stamens being opposite to the petals. Brown suggests their relation to *Proteaceæ;* and, upon the whole, the structure of this order appears to be rather that of a polypetalous or apetalous than of a monopetalous order. Schleiden has lately made the startling assertion that they are gymnospermous. The bark is usually astringent. Their chief peculiarity is their power of rooting in the wood of other plants. They effect this when they first germinate by fixing their root upon the bark, and then by slow degrees introducing it into the tissue till they reach the wood, between the wedges of which they slightly insinuate themselves, thus placing their abortive roots in the line of the current of ascending sap. They are generally beautiful plants, but are scarcely capable of cultivation. Misletoe is the most northern species of the order.

LORD. A title of honour; said to be derived from two Saxon words signifying a giver or distributor of bread. It may be said to be either a title of hereditary dignity (as lord of parliament); or a title expressing certain powers, as lord of a manor, lord chancellor, lord of the treasury, &c. The eldest sons of earls, and all the sons of dukes and marquises, are styled lords by courtesy.

LORD-ADVOCATE OF SCOTLAND. *See* ADVOCATE.

LORD-KEEPER. *See* KEEPER, CHANCELLOR.

LORD-LIEUTENANT OF IRELAND. The chief executive officer of the Irish government, representing in some respects the person of the king. The first viceroy or lieutenant of Ireland appears to have been appointed in the reign of Henry II.; and by acts of parliament passed in the reigns of Richard III. and Henry VIII. provision was made for the election of a governor by the chancellor, treasurer, and other high officers of the government, on the death or resignation of a lieutenant, until the king's pleasure were known. The chief officer in Ireland has been variously styled at different times; as custos or keeper, justiciary, warden, procurator, seneschal, constable, deputy, and lieutenant. He is appointed by letters patent durante bene placito. He has a council, composed of the great officers of the crown in Ireland and others appointed by the crown. He corresponds with the secretary for the home department; but the management of the affairs of the Irish government in London is chiefly entrusted to the secretary for Ireland, who is also chief secretary of the lord-lieutenant. He has also a household, consisting of a private secretary, steward, comptroller, chamberlain, gentleman usher, master of the horse, and subordinate officers. His salary has been usually 20,000*l*. per annum.

LORD-LIEUTENANTS OF COUNTIES. In England and Wales, officers appointed by the king, and entrusted by parliament with full power and authority to call together, arm, and array the militia, and cause them to be trained and exercised once every year. Each may appoint twenty or more deputy lieutenants, who must have 200*l*. a year freehold estate; except in the Welsh and some small English counties, where the qualification is only 150*l*. The lord-lieutenant also nominates officers in the militia and yeomanry: but the names both of deputy-lieutenants and officers must be laid before the king; and if he, within fourteen days, expresses disapprobation, the commissions do not issue.

LORD PRIVY SEAL. *See* SEAL.

LORDSHIP. *See* LEET.

LORE (Lat. lorum, *a strap*), in Ornithology, signifies the space between the bill and the eye, which is bare in some birds, as the great crested grebe; but is generally covered with feathers. In Entomology the term is applied to a corneous angular machine observable in the mouth of some insects, upon the intermediate angle of which the mentum sits, and on the lateral ones the cardines of the maxillare, and by means of which the trophi are pushed forth or retracted, as in the Hymenopterous insects.

LORI'CA. (Lat. lorum, *a thong*.) A cuirass or crest of mail, made of leather and set with plates of metal in various forms, chiefly in rings like a chain, used by the Roman soldiers.

LO'RICATES, *Loricata*. (Lat. lorica, *a coat of mail*.) The name given by Merrem to an order of reptiles dismembered from the *Sauria* of Cuvier, and including those species, as the crocodile, which are protected by an armour of bony plates.

LORICA'TION. (Lat. loricare, *to crust over*.) A term of old chemistry, signifying the application of a lute or coating to glass and other vessels.

LORIS. *See* STENOPS.

LOSS. In Geology. *See* LOESS.

LOTE TREE (of the Ancients). Of this there were two kinds: the one a small plant, from which the *Lotophagi* derived their name; the other a tree with cut leaves and very hard wood. The former was the *Zizyphus lotus*, the latter the *Altis australis*. In the Hindoo mythology, the lote tree is regarded as the symbol of creation. *See* LOTOPHAGI.

LO'THIAN. A name common to that part of Scotland which stretches along a considerable part of the southern shores of the Frith of Forth, and comprehends the three counties, Haddingtonshire, Edinburghshire, and Linlithgowshire; otherwise called East, Mid, and West Lothian. The etymology of the name is doubtful. Lothian was taken possession of by the Saxon invaders A. D. 450, and became the scene of contest between the Saxon-Gaels and Scoto-Irish, and was at length ceded to Malcolm II. in 1020. Lothian was considered as a country wholly distinct from Scotland in the reign of David I., and the period of its incorporation with the rest of the country is assigned to the 11th or 12th century.

LO'TION. (Lat. lotum, supine of lavare, *to wash*.) A mixture of different ingredients, or a solution of various medicinal substances, in water or other menstrua, designed for external application. Indolent ulcers and tumours require stimulating lotions; whereas sedative and narcotic mixtures are used to alleviate pain.

LOTO'PHAGI. (Gr. λωτος, and φαγειν, *to eat*.) A name given to a people of ancient Africa who inhabited the Regio Syrtica (*Iber*. iv. 177.); so called from the lotus berry forming their principal food. They were represented as a mild hospitable race of men. The food with which they were nourished, among other peculiar qualities, is said to have had the power of obliterating all remembrance of one's native country.

LO'TTERY (Germ. loos, *lot*), is defined as a game of hazard, in which small sums are ventured for the chance of obtaining a larger value, either in money or other articles. Lotteries are formed on various plans; but in general they consist of a certain number of tickets drawn at the same time, with a corresponding number of blanks and prizes, by which the fate of the tickets is determined. The invention of lotteries has been ascribed to the Romans; by whom, however, they seem to have been resorted to as a means chiefly of amusing and gratifying the people. In modern times this species of gaming has been sanctioned at different periods by most of the European governments, as a means of raising money for public purposes. It would be difficult to give a complete account of the various changes which have taken place in the regulation of lotteries in different countries; but the subjoined summary of their history, from their origin down to their suppression in England, may not be uninteresting. The earliest English lottery of which there is an authentic record was drawn in 1569, when 400,000 tickets were sold at 10 shillings each. The prizes consisted chiefly of plate, and the net profits were intended to be appropriated to repairing the harbours of the kingdom and other public works. In the year 1612 a lottery was drawn for the benefit of the English colonies; and, in the course of the same century, the desire for embarking in speculations of this kind increased to such a degree, and gave rise to such an infinity of private undertakings, many of which were formed on the most delusive and fraudulent principles, that, in the beginning of Queen Anne's reign, parliament found it necessary to suppress *private* lotteries "as public nuisances." The year 1709 saw the birth of the first state or parliamentary lottery; and from that time down to 1823 they were annually licensed by act of parliament, under a variety of regulations and modifications. In the very early part of last century the prizes were paid in the form of terminable annuities. Thus in 1746 a loan of 3,000,000*l*. was raised on 4 per cent. annuities, and a lottery of 50,000 tickets, at 10*l*. each; and in the following year 1,000,000*l*. was raised by the sale of 100,000 tickets, the prizes in which were founded in perpetual annuities at the rate of 4 per cent. per annum. During the same century government constantly availed itself of this means to raise money for various public works, of which the British Museum and Westminster Bridge are well-known examples. But at the commencement of the present century a great repugnance began to be manifested in parliament to this method of raising any part of the public revenue, in consequence of the spirit of gambling which it tended to foster in the great body of the people; and notwithstanding the influence of the acts of 1778 and 1793, which were confessedly attended with much good, the evils to which it gave birth at last became so palpable that, in the year 1823, the legislature at last consented to the entire abolition both of state and private lotteries. It would be superfluous to enter into any argument to point out how prejudicial all such establishments must be to public morals, by giving the countenance of government to systematic gambling, no less than by diffusing a spirit of speculation by which the mind is misled from habits of continued industry to delusive dreams of sudden and enormous wealth, which, in the great majority of instances, must end in poverty and ruin. Those who

wish to see the melancholy results of this system of finance exhibited in its true colours, will find ample information in the two parliamentary reports presented to the House of Commons on the subject of lotteries in 1808; but we cannot refrain from inserting a paragraph from the *Wealth of Nations*, which illustrates their principle and operation with great brevity and effect:—

"The world neither ever saw, nor ever will see, a perfectly fair lottery, or one in which the whole gain compensated the whole loss; because the undertaker could make nothing by it. In the state lotteries, the tickets are really not worth the price which is paid by the original subscribers, and yet commonly sell in the market for twenty, thirty, and sometimes forty per cent. advance. The vain hope of gaining some of the great prizes is the sole cause of this demand. The soberest people scarce look upon it as a folly to pay a small sum for the chance of gaining 10 or 20,000 pounds; though they know that even that small sum is perhaps 20 or 30 per cent. more than the chance is worth. In a lottery in which no prize exceeded 20*l*., though in other respects it approached much nearer to a perfectly fair one than the common state lotteries, there would not be the same demand for tickets. In order to have a better chance for some of the great prizes, some people purchase several tickets, and others small shares in a still greater number. There is not, however, a more certain proposition in mathematics, than that the more tickets you adventure upon the more likely you are to be a loser. Adventure upon all the tickets in the lottery, and you lose for certain; and the greater the number of your tickets, the nearer you approach to this certainty." (See also *Degerando's Bienfaisance Publique*, l. ii. ch. 6.)

State lotteries were abolished in France in 1836, along with the gambling houses, from which a great revenue had been derived. They still exist in several of the German states. That of Hamburg is established on a comparatively fairer principle than was adopted either in France or England; the *whole* money for which the tickets are sold being distributed among the buyers, except a deduction of 10 per cent. made from the amount of the prizes at the time of their payment. See *Penny Cyclo*.

LOUGH. An Irish term, synonymous with the Scotch *loch*, but not with the English *lake*; for loch and lough are applied to designate arms of the sea, as well as collections of fresh water, which lake is not.

LOUIS D'OR. A gold coin under the old system of France, first struck under Louis XIII. in 1641, from whom they derived their name. The louis d'or, says Kelly, coined before 1726, which passed then for 20 livres, were coined at the rate of 36¼ per French mark of gold 22 carats fine. From the year 1726 to 1785 louis d'ors were coined at the rate of 30 to the mark of gold; and about this period all the gold coins in France were ordered to be brought to the mint to be melted down; and a new coinage then took place, at the rate of 32 louis d'ors to the mark of the same degree of fineness, with a remedy of 15 grains in the weight, and $\frac{12}{32}$ of a carat in the alloy. The intrinsic value of this new coin was 18*s*. 9¼*d*. sterling. Louis d'ors were formerly regarded as a current coin in all parts of the Continent; but in England they are sold merely as merchandise, and their value has fluctuated from 18*s*. 6*d*. to 21*s*. sterling. The term louis d'or is still given to the gold coinage of the present dynasty of France, though they are also often called 20-franc pieces.

LOUIS, SAINT, OF FRANCE. A royal military order, founded by Louis XIV. in 1693. The badge is a cross of eight points, with fleur-de-lis, and bearing a circular shield containing the effigy of Saint Louis.

LOU'VRE. One of the most ancient palaces of France. It existed in the time of Dagobert as a hunting seat, the woods then extending all over the actual site of the northern portion of Paris down to the banks of the Seine. The origin of its name has not been satisfactorily ascertained. It was formed into a stronghold by Philip Augustus, who surrounded it with towers and fosses, and converted it into a state prison for confining the refractory vassals of the crown. It was then without the walls of Paris; but, on their extension in the latter part of the 14th century, it was included within their circuit. Charles V. made additions to it. That part of the palace now called the *Vieux Louvre* was commenced under the reign of Francis I., after the designs of Pierre L'Escot, abbot of Clugny. When Charles IX. resided in the Louvre, he began the long gallery which connects it with the Tuilleries, and in which is now deposited the celebrated collection of pictures. It was finished under Henry IV. Louis XIV., from the designs of Lemercier, erected the peristyle which forms the entrance to the Vieux Louvre from the side of the Tuilleries. That monarch also gave a beginning to the remainder of the present modern edifice, from the designs of Claude Perrault. The edifice has never been finished; though, under the reigns of succeeding monarchs, and especially during that of Napoleon, it has slowly advanced towards completion. The eastern front, though not finished even now, exhibits a façade of surpassing beauty,—perhaps, in its kind, never equalled. The quadrangle of the Louvre is a perfect square on the plan. Three of its sides were from the designs of Perrault, above mentioned. An immense expenditure will be necessary to connect the Louvre with the Tuilleries, to which it is joined at present only on the river side by the great gallery above mentioned; but preparations are in progress to effect this object, and on the side next the Rue St. Honoré about 1400 feet have been executed. Besides the gallery above adverted to, which contains some of the finest pictures in the world, the Louvre contains a museum of sculpture, antiquities, and other specimens of art, equally valuable.

LOVE, FAMILY OF. A sect of fanatics in the 16th century, holding tenets resembling those of the early Anabaptists. There is a proclamation against them by Queen Elizabeth, dated from her manor of Richmond, 1580.

LOVE FEASTS. A species of religious ordinanee held quarterly by the Methodists, to which members of their church alone are admitted, and that only on presenting a ticket or a note from the superintendent. They are a relic of the *Agapæ* (which see) held by the early Christians.

LOWER CHALK AND GREENSAND. *See* GEOLOGY.

LOWER EMPIRE. The Roman empire, from the removal of the imperial seat to Constantinople, and its successor, the Byzantine empire, down to the capture of that city by the Turks, are frequently joined together under this name by modern historians.

LOW SUNDAY. In Ecclesiastical Antiquities, the Sunday next after Easter has been popularly so called in England; perhaps by corruption for *close* (Pascha clausum, *close of Easter*, one of the many names by which it was known in the Christian church). (*Riddle's Christ. Ant.* 640.)

LO'XIA. (Gr. λοξος, *crooked*.) A genus of Conirostral Passerine birds, characterized by having a compressed beak, and the two mandibles so strongly curved that their points cross each other, sometimes on one side, sometimes on the other. The crossbill (*Loxia curvirostra*) is the type of this genus.

LOXODRO'MIC CURVE or SPIRAL (Gr. λοξος, *oblique*, and δρομος, *course*), is a kind of logarithmic spiral traced on the surface of a sphere: the meridians which it intersects all under the same angle being regarded as the radii of the spiral. It is the path which a ship sailing always on the same rhumb, or making the same angle with the meridians, describes on the surface of the terrestrial sphere. The properties of the curve are analogous to those of the common logarithmic spiral. It always approaches the pole, but never reaches it; so that a ship, by following always the same oblique course, would continually approach the pole of the earth without arriving at it. To find the equation of the loxodromic, let φ be the arc of the meridian intercepted between any point of the curve and the pole, and λ the longitude of that point; then the infinitely small arc of the parallel of latitude corresponding to an increment of the curve is $d\lambda$ sin. φ, and the differential of the co-latitude is $d\varphi$; but, because the curve cuts all the meridians under the same angles, the variation of the parallel of latitude corresponding to an increment of the curve is proportional to the variation of the co-latitude; consequently $a\,d\lambda \sin.\varphi = d\varphi$, or $a\,d\lambda = \frac{d\varphi}{\sin.\varphi}$, which is the differential equation of the loxodromic, a being a constant quantity.

LO'ZENGE. An oblique-angled parallelogram, or rhombus, formed by construcrting two equal isosceles triangles upon opposite sides of the same straight line.

LOZENGE. In Heraldry, a bearing in the shape of a parallelogram, with two obtuse and two acute angles. The arms of maidens and widows are borne on shields of this shape.

LOZENGE. In Pharmacy, a medicinal substance made up into a small cake gradually to be dissolved in the mouth. Sugar, gum, and starch are the usual inert parts of lozenges; and minute quantities of active substances are added, according to the purposes for which they are intended: such as ipecacuanha or squills, for pectoral lozenges; extract of poppies or opium, for sedative lozenges; kyan pepper as a stimulant; oil of peppermint as an antispasmodic, &c.

LUCA'NIDÆ. (Gr. λυκος, *a wolf*; also the name of an insect.) A family dismembered from the Linnæan genus *Lucanus*, and including those insects which, in addition to the comprehensive characters of the original genus, present antennæ strongly geniculate, glabrous, or but slightly pilose; the labrum very small, or confounded with the epistome; maxillæ terminated by a membranous or coriaceous, silky, pencilliform lobe; edentate, or with one tooth; and a ligula either entirely concealed or incorporated with the mentum, or divided into two narrow, elongated, silky lobes, extending more or less beyond the mentum. The scutellum is situated between the

elytra. The stag-beetle, *Lucanus cervus*, &c., is the type of this family. The sub-genera are *Œsalus*, *Lamprina*, *Sinodendrum*, &c.

LUCA'NUS. (Gr. λυκος.) A Linnæan genus of Coleoptera, forming the type of a tribe of Lamellicorn beetles (*Lucanina*), in the system of Latreille, by whom it is thus characterised:—Antennæ composed of ten joints, the first of which is usually much the longest; the antennal club has its leaflets or teeth arranged perpendicularly to its axis, in the manner of a comb. The mandibles are always corneous, and most commonly exhibit a sexual superiority of development and peculiarity of form in the males. The maxillæ are generally terminated by a narrow, elongated, and silky lobe; but sometimes are entirely corneous and dentated. The ligula in most of the *Lucanines* is formed of two small silky pencils, projecting more or less beyond an almost semicircular or square mentum. The anterior legs in the greater number are elongated, and their tibiæ dentated along the whole of their outer side. The tarsi terminate in two equal and simple hooks, with a little appendage with two setæ between them. The elytra cover the whole of the upper part of the abdomen. The insects thus characterised were first divided by the immediate successors of Linnæus into two genera, *Lucanus* proper and *Passalus*, both of which are now elevated to the rank of families, and subdivided into numerous subgenera. *See* Lucanidæ and Passalidæ.

LU'CERES. (Lat.) In Roman antiquities, a body of horse composed of Roman knights, first established by Romulus and Tatius. It is said to have received its name either from an Etrurian, who aided the Romans against the Sabines; or from the Lat. *lucus*, a grove, where Romulus had instituted an asylum for all fugitives, slaves, and homicides, in order that he might people his infant city: but it is difficult to account for the real origin of the word.

LUCE'RN. (*Medicago sativa.*) A well-known plant of the Linnæan class Diadelphia, and order Decandria, and of the natural family of the *Leguminosæ*. There are many species of the Medicago, but of these the artificial grass, called Lucern, is most deserving of notice. This plant was in high estimation among the ancients; and its nutritious qualities, easy cultivation, rapid growth, and luxuriant properties, have placed it in the first rank of vegetable food for cattle, even in the present times. Lucern, says an old writer, is commended for an excellent fodder. . . . There is not any pulse or other feeding which is more agreeable or more precious for feeding beasts than lucerne: so that it may seem to spring out of the earth. . . as a more especial favour from God, not only for nourishing and fattening herds of cattle, but also to serve as a physic for beasts that are sick. (*Country Farm*, 3d edit. fol. 1616, p. 364.) Those who wish to see the properties of this plant fully developed at once from the author's personal experience, and the concurrent testimony of the best agricultural writers both ancient and modern, and its history traced from its discovery during the Persian expedition under Darius to its subsequent introduction successively into Greece, Italy, Spain, France, Germany, and, in fact, wherever the art of husbandry has made any progress, down to its arrival in England, will find ample details in the learned *Essays on Husbandry* by the Rev. Walter Harte (London, 1770), to which we beg to refer. The origin of the term lucern is involved in obscurity. Some authors have derived it, naturally enough, from the canton in Switzerland of that name; but from the account given by Mr. Harte of the history of this plant, it does not appear either that Switzerland was particularly famous for producing it, or that the northern and western nations of Europe received it thence.

LUCERNA'RIA. (Lat. lucerna, *a lamp.*) A genus of fleshy polypi (*Polypi carnosi*) in the system of Cuvier, characterised by a long and slender pedicle supporting a radiated disc, which sends off numerous tentacula united in bundles. The *Lucernariæ* Cuvier regards as being nearly allied to the *Actineæ* or *sea-anemones;* but their substance is softer. They emit phosphorescent light.

LU'CIFER. (Lat. lux, *light;* fero, *I bring.*) The morning star. A name given to the planet Venus, when she appears in the morning before sunrise. When Venus follows the sun, or appears in the evening, she was called *Hesperus*, the evening star. These names no longer occur except in the old poets.

Lu'cifers. Matches tipped with a mixture of chlorate of potash and sulphuret of antimony: they are inflamed by friction upon a piece of emery paper.

LUCIFE'RIANS. The name of an ancient sect of heretics, so called from Lucifer, bishop of Cagliari, in the 4th century, whose opinions they embraced. The Luciferians considered the soul to be of a carnal nature and to be transmitted from father to child; but the chief occasion of the schism of Lucifer arose from his refusal to hold any communion with the clergy who had conformed to the Arian doctrines, and whom a synod at Alexandria, A.D. 352, had determined to re-admit into the church on condition of an open acknowledgment of their errors. The number of this sect was never considerable, and it was extinct in the time of Theodoret; but it deserves notice from being considered by the Roman Catholics as one of the great schisms in their church. *See* Schism.

LUCI'NA. In Roman Mythology, the goddess who presided over the birth of children. Her name is derived either from *lucus* or *lux*, according to Ovid's explanation,—

> Gratia Lucinæ, dedit hæc tibi nomina lucus;
> Aut quia principium, tu, Dea, lucis habes.

She is said to be the daughter of Jupiter and Juno; and has frequently been confounded with Diana and Juno, both of whom presided over childbirth. She was called Ilithya by the Greeks.

LUCU'LLITE. A black limestone, often polished for ornamental purposes, to which it is said first to have been applied by Lucullus, the Roman consul.

LU'ES. (Lat.) A poison or pestilence; a plague.

LUFF. The foremost edge or leach of a fore-and-aft sail. *To luff*, to bring the ship's head nearer the wind.

LU'FFER BOARDING. (Fr. louvre.) In Architecture, boards in an aperture placed above each other at regular distances, and inclined to the horizon at an angle of forty-five degrees, so as to admit air without allowing the rain to penetrate.

LUG-SAIL. A four-sided sail bent to a yard, which is slung about one fourth from the lower end.

LU'MACHE'LLA. Shell marble; the fragments having a pearly lustre, it is sometimes termed *fire marble*.

LUMBA'GO. *See* Rheumatism.

LUM'BAR A'BSCESS. An abscess of the loins formed upon the psoas muscle: it is frequently mistaken for nephritic or rheumatic disease, and, when it forms a swelling in the groin, for hernia.

LUMBRICAL MUSCLES. (Lat. lumbricus, *an earthworm.*) Small muscles of the hand which assist in bending the fingers.

LU'MBRICUS. (Lat.) A Linnæan genus of Vermes, now the type of a family (*Lumbricinæ*) which ranks as the first of the Setigerous Abranchian Anellidans in the system of Cuvier. All the species of this family—the earthworms, as they are commonly called—are characterized by a long cylindrical body, divided by rugæ into a great number of rings, and by an edentate mouth. The common earthworm (*Lumbricus terrestris*, Linn.) attains nearly a foot in length, and is composed of upwards of one hundred and twenty rings. This species is extremely abundant: they traverse the soil in every direction, swallowing quantities of earth, together with portions of roots and ligneous fibres, and other organized substances, which they assimilate for their own nutriment. Their castings constitute a rich soil.

LUNA. (Lat. *the moon.*) In Mythology, the daughter of Hyperion and Terra, usually confounded with Diana, which see. The heavenly bodies were favourite objects of worship among the ancients; and as they considered the sun to be sacred to Apollo, whom they worshipped as Sol, so they consigned the moon to the guardianship of his sister Diana, whom they worshipped under the name of Luna.

LU'NA CO'RNEA. Fused chloride of silver; so called from its horn-like appearance, luna being the term by which the old chemists designated silver.

LU'NACY, in Law, is strictly the condition of an insane person who has lucid intervals, which in former times were supposed to depend on the phases of the moon; whence such persons were styled *lunatici*. But, for convenience, the term is commonly used as embracing the condition of all those who are under certain legal disabilities on account of mental deficiency: such as idiots, fatuous persons, &c.; all, in short, who are of unsound mind. The chief of these disabilities are, incapacity to make contracts, either personal or affecting the estate; to sue or defend in courts of justice; to perform offices and duties; to make devises or bequests. By ancient legal maxim, the sovereign has the custody of lunatics. This is in practice delegated to the keeper of the great seal, by virtue of the sign manual, countersigned by two secretaries of state. Applications for a commission of lunacy are consequently directed to him. When he determines that such a commission is proper, it issues to certain commissioners, appointed by the same authority. They summon a jury to try the fact of lunacy. If the party is found lunatic by its inquisition, the inquisition may still be avoided by a traverse; on which the record goes into the King's Bench, which either gives judgment or grants a new trial on it. If the lunatic recover, the inquisition may be superseded. On the return of the inquisition, the custody of the lunatic's person and estate devolves on the crown; and the chancellor, on petition, appoints *committees* to have the custody of either or both. These may be whoever the chancellor thinks fit, although next of kin are ordinarily preferred. Lunatics are maintained by an allowance out of their own estate: when they have none, by statute, in public asylums. The custody of lunatics by private individuals is under the contro of the provisions of the stat. 3 & 4 W. 4. c. 36., by

which visitors are empowered once a year to inspect their condition. Licensed houses for the reception of lunatics, under the keeping of medical men, are within the regulations of 2 & 3 W. 4. c. 107., under the inspection of licensing commissioners. Persons of unsound minds who are paupers, and those who have been tried for offences and found insane, and also lunatic convicts, are usually confined in county lunatic asylums, wherever these are established. As to the statistics of lunatic hospitals or asylums, see *Degerando, de la Bienfaisance Publique*, vol. iv. part 3. book 3.

The incapacity of a person of unsound mind to commit a crime depends, it is said, upon his irresponsibility, moral and legal. The general mode of directing a jury has been to acquit the prisoner, if satisfied that he was incapable of knowing right from wrong; or, as some eminent judges have worded it, if he was unconscious that the act was a crime against the laws of *God and nature*. On acquittal taking place on evidence of lunacy, the jury are now required, by 39 & 40 G. 3 c. 94., to find specially whether the person was insane at the time of commiting the offence; and on that finding he is taken into public custody.

LU'NAR BONE. One of the bones of the wrist.

LU'NAR CAUSTIC. Fused nitrate of silver.

LU'NAR CYCLE. The period of time after which the new moons return on the same days of the year. *See* CYCLE.

LU'NAR DI'STANCE. In Navigation, the distance of the moon from the sun, or from a fixed star or planet; by means of which the longitude of a ship is found.

LU'NAR ME'THOD. In Astronomy and Navigation, the method of determining the longitude of a place or ship from the observation of *lunar distances*. This problem, which is of the very highest importance, on account of its being the only astronomical method of finding the longitude practicable at sea, resolves itself into two parts. The first is to ascertain the distance of the moon's centre from one of the principal planets or fixed stars at a given moment; and the second, to find the Greenwich time to which, according to the tables, that distance corresponds. The general method of procedure may be explained as follows: — Six or eight observations of the star's distance from the nearest point of the moon's limb are taken with a sextant as quickly in succession as possible, and the corresponding time at each observation noted: the mean of the observed distances, at the mean time, gives a single distance corresponding to a known instant of time. The true apparent time is here supposed to be given by the chronometer, the rate and error of which are determined by observations of altitude. Contemporaneously with the observations of distance two assistants are employed in taking the altitudes both of the moon and star, for the purpose of applying the proper correction for refraction. The remainder of the operation consists in making the requisite calculations. In the first place, the moon's semidiameter is added to the observed distance, whereby the true apparent distance is found. In the next place, the corrections are applied for refraction and parallax, and the apparent distance reduced to the centre of the earth. This part of the operation is technically called *clearing the distance*. The computer then turns to the *Nautical Almanac*, in which the distances of the moon from some of the principal stars and planets is given for every three hours. Having found in the almanac the distances next less and greater than the true distance deduced from the observations, their difference gives the change of distance in three hours; whence, by interpolation, the Greenwich time is obtained at which the distance was exactly the same, and consequently the Greenwich time corresponding to the apparent time at the instant of the observation.

This method of finding the longitude at sea was first proposed by John Werner of Nuremberg so early as 1514, and recommended by several other astronomers who lived during the same century; but the theory of the lunar motions was then, and for a long time after, by far too imperfect to allow of its practical application. Besides, previously to the invention of Hadley's quadrant, there was no instrument by which the distances could be measured with the requisite precision. The advancement of astronomy, and the perfection of instruments of observation, have obviated all difficulties; and the method of lunar distances is now mainly relied on by the mariners of all countries.

LUNAR MONTH. The time in which the moon completes a revolution about the earth, and returns to the same position relatively to some celestial body, or point in space, with which her motion is compared. But the moon's period may be determined in relation to several objects, — as the sun, the equinoctial points, a fixed star, the perigee or nodes of her orbit; and accordingly there are as many different lunar months as there are assumed points of comparison, provided these points have different motions in the heavens.

1. The proper *lunar month* is the same as the *lunation* or *synodic month*, and is the time which elapses between two consecutive new or full moons, or in which the moon returns to the same position relatively to the earth and sun.

2. The *periodic month*, or *synodic month*, is the revolution with respect to the moveable equinox.

3. The *sidereal month* is the interval between two successive conjunctions with the same fixed star.

4. The *anomalistic month* is the time in which the moon returns to the same point (for example, the perigee or apogee) of her moveable elliptic orbit.

5. The *nodical month* is the time in which the moon accomplishes a revolution with respect to her nodes, the line of which is also moveable.

The exact *mean* lengths of these different lunar months are as follow: —

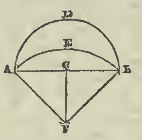
	days.	h.	m.	sec.
Synodic month - -	29	12	44	2·84
Tropical month - -	27	7	43	4·71
Sidereal month - -	27	7	43	11·54
Anomalistic month - -	27	13	18	37·40
Nodical month - -	27	5	5	35·60

These *mean* motions are not uniform, but are subject to periodic and secular variations. *See* MOON.

LU'NAR YEAR, is the period of twelve synodic lunar months, and consequently contains 354 days; the lunar months in the calendar being alternately 29 and 30 days. The exact period of 12 lunar months is 354 days, 8 hours, 48 min. 34 sec.; so that the lunar year of the calendar requires to be adjusted by intercalation every third year. *See* CALENDAR.

LUNA'TION. The period of a synodic revolution of the moon, or the time from one new moon to the following, being that in which the moon passes through all her phases.

LUNE, or LU'NULA. A geometrical figure in form of a crescent, bounded by two arcs of circles intersecting at its extremities. The lunula of Hippocrates, of Chios, is celebrated on account of a remarkable property discovered by that geometer; namely, that it can be exactly squared, though the quadrature of the whole circle has baffled the ingenuity of mathematicians of all ages. Let A D B be a semicircle whose centre is at C, and A E B a quadrant of another circle whose centre is at F (C F being perpendicular to the diameter A B); then the space contained between A D B and A E B is the lune of Hippocrates, and it is equal to the area of the triangle A F B. For the square of A F being equal to the squares of A C and C F, or twice the square of A C, and circles being to one another as the squares of their radii, the whole circle of which A F is the radius is equal to twice the circle of which A C is the radius; and consequently the area of the quadrant A E B F is equal to the semicircle A D B. Take away the common space A E B A, and there remains the triangle A B F, equal to the lune.



LUNE'TTE. (Fr.) In Fortification, an enveloped counterguard or elevation of earth, made beyond the second ditch, opposite to the place of arms; differing from the ravelins only in situation. *Lunettes* are also works made on both sides of a ravelin. *See* FORTIFICATION.

LUNETTE. In Architecture, an aperture for the admission of light in a concave ceiling; such are the upper lights to the naves of St. Peter's at Rome and of St Paul's at London.

LUNGS. (Germ. lungen.) The viscera by which respiration is carried on. The right lung is divided into three lobes, the left into two. They are, as it were, suspended in the chest by the *trachea*, and separated by the *mediastinum*; they are also attached to the heart by the pulmonary vessels. They are nourished by the bronchial artery, which is a branch of the aorta; and the pulmonary artery carries the venous blood through them from the heart, to subject it to the action of the air in their cellular structure: the blood when arterialized returns to the heart by the pulmonary veins, the four trunks of which enter the left auricle. The bronchial veins terminate in the vena azygos. The nerves of the lungs are from the eighth pair and great intercostal.

LU'NISO'LAR. (Lat. luna, *the moon*, and sol, *the sun*.) Combining the motions of the sun and moon. A lunisolar period is that after which the eclipses again return in the same order. (*See* CYCLE.) The Dyonysian period of 532 years, formed by multiplying together the solar and lunar cycles of 28 and 19 years, has sometimes been called the lunisolar year.

LUPERCA'LIA. A Roman festival in honour of Pan, celebrated in February; when the Luperci ran up and down the city naked, having only a girdle of goat's skin round their waist, and thongs of the same in their hands, with which they struck those they met, particularly married women, who were thence supposed to be rendered prolific. The name is derived from lupus, *a wolf*; because Pan protected cattle from that animal.

The indecencies and excesses attending the processions of the Lupercals, which had degenerated from high religious rites to vulgar superstitions, provoked the indignation of Christians in the 4th and 5th centuries. It is commonly, but erroneously, supposed that pope Gelasius caused them to be abolished. (*Gibbon*, vol. vi.) Beugnot has shown the contrary. (*Destr. du Paganisme en Occident*, book xix. ch. 2.)

LUPE'RCI. The Roman priests of Pan, and most ancient religious order in the state, having been instituted, according to tradition, by Evander, king of Pallantium, a town that occupied the Palatine Hill before Rome was built. There were three companies of them; viz. the Fabiani, Quintiliani, and Julii — the last of whom were founded in honour of Julius Cæsar. For the derivation of the word see LUPERCALIA.

LU'PINITE. A bitter substance, extracted from the leaves of the white lupin.

LU'PULIN. The active principle of the hop; it is more properly called *lupulite*.

LU'PUS. (Lat.) The wolf. One of the southern constellations, situated on the south of Scorpio.

LU'PUS. In Pathology, a disease which eats away the parts attacked by it with great rapidity.

LU'SIAD. The name given to the great epic poem of Portugal, written by Camoens, and published in 1571. The subject of this poem is the establishment of the Portuguese empire in India; but whatever of chivalrous, great, beautiful, or noble, could be gathered from the traditions of his country, has been interwoven into the story. Among all the heroic poets, says Schlegel, either of ancient or modern times, there has never, since Homer, been any one so intensely national, or so loved or honoured by his countrymen, as Camoens. It seems as if the national feelings of the Portuguese had centered and reposed themselves in the person of this poet, whom they consider as worthy to supply the place of a whole host of poets, and as being in himself a complete literature to his country. Of Camoens they say,

> Vertere fas; æquare nefas; æquabilis uni
> Est sibi; par nemo; nemo secundus erit.

The great defects of the *Lusiad* consist in its preposterous mythological machinery, and its clumsy management; but in all the qualities of versification and beauty of language it is perfect, and may be regarded as the "well, pure and undefiled," of the Portuguese language.

Few modern poems have been so frequently translated as the *Lusiad*. Mr. Adamson, whose *Memoirs of the Life and Writings of Camoens* must be familiar to the reader, notices one Hebrew translation of it, five Latin, six Spanish, four Italian, three French, four German, and two English. Of the two English versions one is that of Sir R. Fanshawe, written during Cromwell's usurpation, and distinguished for its fidelity to the original; the other is that of Mickle, who, unlike the former, took great liberties with the original, but whose additions and alterations have met with great approbation from all critics — except, as indeed was to be expected, from the Portuguese themselves. (See the *Quarterly Review*, vol. xxvii.)

LUSTRA'TION. (Lat. lustro, *I purify*.) In Roman Antiquities, a sacrifice by which the Romans purified their cities, fields, armies, or people, defiled by any crime or impurity. There were various manners of performing this ceremony, according to the nature of the lustration. When Servius Tullius had numbered the Roman people, he purified them, as they were assembled in the Campus Martius, by causing a young pig, a sheep, and a bull, just sacrificed, to be paraded round them. Before the celebration of the Ludi Seculares, which took place only once in a century, the *populace* was purified by a little sulphur, bitumen, and perfume, fixed to a piece of fir called *tæda*, which was lighted, and which thus circulated the smoke around them. The *army* was purified by causing the soldiers to defile between the two quivering halves of a victim, while the priest offered up certain prayers. The lustration of a funeral pile was effected by making the spectators march round it before the fire was kindled. (See *Memoires de l'Ac. des Inscriptions*, vol. xxxvi.) *See* AMBARVALIA.

LU'STRUM. (Lat.) In Roman Antiquities, a space of about five years: at the end of which period the feast called Lustralia was celebrated, in which the censor purified the people by several sacrifices and ceremonies; among others, the *suovetaurilia*, or sacrifice of a hog, sheep, and goat. It appears that rather more than five years usually elapsed between one lustralia and the next; but the word lustrum is usually employed for the exact quinquennial period. The derivation of the word is uncertain. Lustrare, in Latin, signifies to purify by a solemn ceremony: and many other lustral ceremonies were in use; as, for example, the *dies lustrales*, or lustral days, being the fifth, or according to some writers the eighth, day after the birth of a child, on which it was purified with certain solemnities, named, and placed under the protection of the gods of the family; the *lustration* of sheep in April, the crops in May, &c., of which so many are continued in the Roman Catholic worship of modern times. Sea-water was the most ordinary article used in lustrations. Varro derives the word lustrum from luere, *to pay*; because, according to the custom ordained by Servius Tullius, who first instituted the census (566 B.C.), the tribute imposed by the censors was paid at the beginning of every fifth year, the last of the lustrum. (See an Essay in the *Mémoires de l'Ac. des Inscr.* vol. xxxix.; and *Niebuhr's History*.)

LU'SUS NATURÆ. (Lat. *a sport of nature*.) A term applied to any thing unnatural in the physical world.

LUTE. (It. liuto.) A musical stringed instrument of the guitar species, and played in a similar way; but in form more resembling the section of a pear, with a back in ribs, like those of a melon.

LUTES, in Chemistry, applications by which the junctions of vessels are rendered tight. A glass retort is said to be *luted* when smeared over with clay, so as more perfectly to resist the effects of heat, and to prevent its fusion. Common lute is a mixture of pipe-clay, linseed meal, and water, and is spread upon paper and applied to the joinings of stills and of retorts and receivers. *Fat lute* is a mixture of pipe-clay and linseed oil.

LU'THERANS, or FOLLOWERS OF LUTHER. The denomination of Christians whose religious system had its origin in the preaching of Luther. This system in some respects approaches nearer to Romanism than that of any other of the reformed churches. The notions of Luther upon the nature of the Eucharist are known under the name of consubstantiation, or the coexistence of the body and bread, the blood and the wine, at the same time. It encourages also the private confession of sins, makes use of wafers in the administration of the Lord's Supper, and allows of images in churches. It insists, however, very strongly upon Luther's cardinal doctrine, the justification of man by faith, and not by any merit in human actions. With respect to the divine decrees, it holds that God foreknows the dispositions of men, whether they will be good or bad, and predetermines their salvation or rejection accordingly; differing therein from the tenet of the Calvinists, which represents the Supreme Being as making his decrees by his own mere will. The dogmas of the Lutheran church are carefully set forth in various symbolic books: the *Confession of Augsburg*, the *Articles of Smalcald*, the Shorter and Larger Catechisms of Luther, and the *Form of Concord*. The principle, however, of this church, which considers Christians as accountable to God alone for their religious opinions, allows its teachers, at the present day, an unbounded liberty of dissenting from these decisions. The Lutheran church predominates in the north of Germany, in Prussia, Norway, Denmark, and Sweden: there are congregations also of the same denomination in England, Holland, Russia, and America. In the Prussian dominions it has been remodelled under the late king, and is called the Evangelical Church. *See* CHRISTIANITY.

LU'THERN. (Fr.) In Architecture, the same as *dormer*, which see.

LU'TRA. (Lat. *an otter*.) A genus dismembered by Storr from the Linnæan *Mustela*, and now raised to the rank of a family (*Lutridæ*).

LUXA'TION. (Lat. luxare, *to put out of joint*.) A dislocation of a bone.

LYCA'NTHROPY. (Gr. λύκος, *a wolf*, and ἄνθρωπος, *a man*.) Herodotus relates that the Neurians, a Scythian tribe, were supposed to be changed, for a certain number of days every year, into wolves, and then to resume their former shape; and a similar superstition is noticed by Virgil in his *Eclogues*, by Pliny, Pausanias, and other writers. The same superstition, of the power possessed by men of converting themselves into wolves, remained in more modern times; but that which the classical ancients had believed to be effected by the power of herbs, or by innate powers, was by Christians considered as a species of sorcery. These human wolves were called loup-garoux by the French, were-wolves by the Anglo-Saxons, wehrwölfe by the Germans: words of the same derivation, and bespeaking that the superstition in those countries was of Teutonic origin. They were believed to be extremely ferocious, and to devour not only beasts, but human beings; but if they were pursued and wounded, the spell was frequently dissolved, and the sorcerers were found mutilated in those limbs in which they had received the wound in their wolfish shape. From the prevalence of these superstitions in the minds of an ignorant peasantry originated the hideous species of madness termed *lycanthropy*, in which the patient believed himself to be a wolf, and frequently imitated the actions and howl of that animal. In France, in the 16th century, numbers of these unfortunate beings were executed, like witches, on their own confession; and in the avowals which they made, of having killed and devoured mankind, they were probably not always under a delusion. Some of these maniacs declared that they were actually wolves; but that in them the hair grew inside, or between the skin and the flesh. Oribasius, who lived in the fifth century of our era, mentions lycanthropy by its true cha-

racter as a species of madness, and describes the symptoms and the cure. This species of insanity seems to have gradually died away along with the superstition which gave it birth. (See a curious article in the *Enc. Metropolitana.*)

LYCE'UM. An academy at Athens was so termed, from its situation near the temple of Apollo Lyceus. It was frequented, according to tradition, by Aristotle. Preparatory schools for the universities, in which the Aristotelian philosophy was formerly taught, hence received on the Continent the name of Lyceum.

LY'CHNITES. An ancient name of marble; from λυχνος, its quarries being worked by lamp-light.

LY'COPO'DIA'CEÆ. (Lycopodium, one of the genera.) A natural order of Acrogens, inhabiting all parts of the world, but abounding chiefly in hot humid situations. They are intermediate, as it were, between ferns and coniferæ on the one hand, and ferns and mosses upon the other. *Lycopodium rubrum* is a violent cathartic; *clavatum* and *selago* excite vomiting; and the powder contained in the seed-vessels of all the species is so highly inflammable as to be employed occasionally in the manufacture of fireworks. They are propagated by spores formed in two-valved cases axillary to the upper leaves.

LY'COPO'DIUM. A fine yellow dust or powder, being the seed of the *Lycopodium clavatum*, or club moss: when thrown into the flame of a candle, or of spirit of wine, it burns with a bright flash. It is much sought after for producing theatrical lightning, and is an excellent substance to sprinkle upon pills to prevent their adhering.

LYCO'SA. (Gr. λυκος, *a wolf.*) A genus of spiders, in which the eyes form a quadrilateral group, as long as or longer than it is wide; the two posterior eyes not placed on an elevation. The first pair of legs is evidently longer than the second, but shorter than the fourth, which is the shortest of all. The internal extremity of the jaws is obliquely truncated. Almost all the *Lycosæ* keep on the ground, where they run with great swiftness. They inhabit holes in the ground, which they line with silk, and enlarge in proportion to their growth. Some establish their domicile in chinks and cavities in walls, where they form a silken tube, covered externally with particles of earth or sand. In these retreats they change their tegument; and, as it appears, after closing the opening, pass the winter in a state of torpidity. The females, when they go abroad, carry with them their eggs enveloped in a cocoon attached to the abdomen by threads. On issuing from the egg, the young ones cling to the body of the mother, and remain there until they are able to provide for themselves. The *Lycosæ* are extremely voracious, and courageously defend their dwelling. The famous Tarantula spider is a species of this genus.

LY'DIAN STONE. A silicious slate, used by the ancients as a touchstone, from Lydia.

LY'ING PANELS. In Architecture, those in which the fibres of the wood lie in an horizontal direction.

LYING-TO. A nautical term, denoting the state of a ship when the sails are so disposed as to counteract each other, and thereby retard or destroy the progressive motion of the vessel. The fore and main staysails and mizen trysail serve very well for this purpose, as they cause but little way, and have sufficient power to keep the ship heeled over, and therefore steady, with her decks turned from the sea. When the sea runs very high, the lower sails are liable to be becalmed by the waves, and therefore to suffer the ship to roll to windward; the main-topsail is then used.

LYMPH. (Lat. lympha, *water.*) The liquid contained in the lymphatics.

LYMPHA'TICS. Absorbent vessels, which carry lymph from all parts of the body, and terminate in the thoracic duct.

LYNCH LAW. The irregular and revengeful species of justice administered by the populace in some parts of the United States, is said to have been so called from a Virginian farmer of the name of Lynch, who took the law into his hands on some occasion, by chasing a thief, tying him to a tree, and flogging him with his own hands. Some observers have thought that this barbarous system was, to a certain extent, palliated by the difficulty of enforcing regular law; which Captain Marryat (*Diary in America*) attributes, with what justice we know not, to the inadequate pay of the judicial establishment in the newly settled districts, and the bad character of many of the judges, raised to the bench by electioneering politics. He instances the case of a single town in Georgia, with 3000 inhabitants, in which there were in one year fifty-nine assassinations, as a proof of the occasional utility of some irregular acts of justice on the desperadoes of such a population. But it must surely contribute to brutalize and occasion crime, far more than to repress it. One of the most signal and violent acts of popular resentment, under the show of summary justice, was the mock trial and execution of a number of professed gamblers, at Vicksburg, on the Mississippi, four years ago. Miss Martineau's work on America contains some fearful pictures of the persecution carried on, under the same pretences, against missionaries or supposed missionaries of the anti-slavery party, in the southern states. Indeed, she received a hint that she ran herself some danger of being "Lynched," if she visited them; which, however, did not affect her resolution. Lynch law may be called a democratic imitation of the old feudal Vehm-gerichte, or self-constituted tribunals in Westphalia and elsewhere, which assumed the right of controlling the violent actions of the nobles, and have been the subject of so much romantic fiction.

LYNX. A constellation of the northern hemisphere, formed by Hevelius.

LYNX. A name given to the different species of a group of the *Cats* (*Felidæ*), distinguished by short tails, and generally tufted ears. The lynxes have been long famed for their sharp sight;—a quality which, in all probability, they derived, together with their name, from Lynceus, one of the Argonauts, to whom, on their perilous expedition, his quick sight was of essential service in enabling them to steer clear of rocks and sand-banks. The lynx was consecrated to Bacchus.

LY'RA. (Lat.) The Harp: one of the forty-eight constellations of Ptolemy. It is situated in the northern hemisphere.

LY'RA. A portion of the brain, the medullary fibres of which are so arranged as to give it somewhat of the appearance of a lyre.

LYRE. A musical instrument of the greatest antiquity among the Egyptians and Greeks. Tradition attributes its invention to the accident of finding on the banks of the Nile a tortoise, whose flesh was entirely decomposed, but whose tendons, having been dried and stretched by the sun's rays, were capable, on being struck, of yielding musical sounds. Hermes, the finder of this tortoise, having made an instrument in imitation of it, is supposed thus to have been the inventor of the lyre. The Greeks attribute the invention to their Hermes (Mercury), the son of Jupiter and Maia. It is generally considered that the original Egyptian lyre was only of three strings, and that the Greek Mercury improved upon the invention; that the Muses clubbed together to add one string, Orpheus, Linus, and Thomyris adding one each, thus forming it altogether into an heptachord, or seven-stringed lyre. At a later period the lyre consisted of eleven strings, which were made of the sinews of animals; its body was hollow to increase the volume of tone; and it was played with the *plectrum* or lyre-stick of ivory or polished wood, and sometimes with the fingers like the harp. It went by the different names of lyra, phorminx, chalys, barbitos, barbiton, cithara.

LYRE BIRD, or LYRE PHEASANT. *See* MENURA.

LYRIC. *See* ODE.

LYTHRA'CEÆ. (Lythrum, one of the genera.) A natural order of Polypetalous Exogenous plants, with long, tubular, striated calyxes, in the orifice of which are inserted the petals, while the stamens grow nearly at the base. They are little known in cultivation; but some of them, belonging to the genera *Lagerstrœmia*, *Diplusodon*, *Lafoensia*, &c., are objects of striking beauty. The rosewood of the cabinetmaker is the trunk of *Physocalymna floribunda*; and the henna, employed in the toilet of oriental ladies, is obtained from *Lawsonia inermis*.

M.

M. The labial letter of the liquid series. It is susceptible of various interchanges, more especially in the Greek and Latin languages. (See *Penny Cyclo.*) In writing two M's successively the Germans frequently drop one, and replace it by a stroke over that which they retain; thus, $\bar{m}$. As an abbreviation M stands for Marcus, Manlius, Martius, and Mucius; M.A. for Magister Artium, MS. for Manuscript, and MSS. for Manuscripts. M, or, more properly, a symbol somewhat resembling it, was used by the Romans to denote 1000; and the moderns have also adopted that letter.

MAB. The name given by the English poets of the 15th and succeeding centuries to the imaginary queen of the fairies. The passage in *Romeo and Juliet*, in which her qualities and attributes are so beautifully set forth, is familiar to all.

MAC. A Scotch term, signifying son, prefixed to many surnames, as *Mac* Donald, &c. It is synonymous with *Fitz* in England, and *O* in Ireland.

MACA'CUS. A genus of Catarrhine or Old World monkeys, characterized by having a fifth tubercle on their last molars; ischial callosities and cheek pouches; comparatively short and thick limbs; a projecting muzzle, and prominent superciliary arches. They have generally a

pendant tail; but in some it is short, as in the pig-tailed baboon (*Macacus rhesus*). When they cry out, they inflate a membranous sac, which communicates with the larynx above the thyroid cartilage.

MACARO'NIC VERSE. Verse in which the words of a modern language are ludicrously distorted into Greek or Latin inflections and metre. Theophilo Folengo, who wrote under the name of Merlinus Coccaius, in Italy, in the 16th century, and calls himself the inventor of this sort of burlesque composition, informs us that its name is derived from the Italian macaroni, eatables composed of flour, cheese, and butter; and that it expresses the gross and rustic characters appropriate to its words and sentiments. *Drummond's Polemo Middinia*, a Scottish burlesque, is perhaps the best known macaronic form of our language.

MACCABEES, BOOKS OF THE. The two last books in the arrangement of the Apocryphal writings enumerated by our church. The first is a Greek translation (as is supposed) from a Chaldaic original. The second appears to be a compilation from various sources. The two books are not connected: the former comprehends the events of Jewish history for nearly 40 years, B. C. 176 to 139; the second begins about B. C. 187, and extends over about 16 years. Neither has ever been reckoned by the Jews in their catalogue of sacred writings; but they are received into the canon of Scripture by the church of Rome, with the title of *3d and 4th Chronicles*. There are two other books, commonly called *3d and 4th Maccabees*, which were never received by any church.

MACE. A word of doubtful etymology, signifying sometimes a club of metal, and sometimes a military weapon appropriated to the cavalry. About the period of Edward II. maces were generally used in England, both in battles and tournaments; and they remained so till the time of Elizabeth, when they were displaced by the pistol. Maces are still used by the Turkish cavalry. The mace, as an ensign of authority, is often borne before magistrates. By the old English writers it is used synonymously with sceptre.

MACE, the external envelop of the seed of the nutmeg, is a particular form of what botanists call *arillus*. It is aromatic, but less so than the nutmeg; and is chiefly used in cookery or in pickles, and not, like the latter, in confectionary.

MACEDO'NIANS. In Ecclesiastical History, a sect which derives its name from a bishop of Constantinople, who, in the 4th century, denied the distinct existence and Godhead of the Holy Spirit, which he conceived to be merely "a divine energy diffused throughout the universe," "while the Father and Son together constitute the one existing Deity." These opinions were condemned at the second general council held at Constantinople in 381. *See* PNEUMATOMACHI.

MACERA'TION. The steeping of substances in any cold liquor.

MACHAIRODUS. (Gr. μαχαιρα, *a sabre*, and οδους, *a tooth*.) An extinct mammal, allied to the bear.

MACHE'TES. (Gr. μαχητης, *a combatant*.) The generic name under which Cuvier has distinguished the ruffs and reeves from the sandpipers, godwits, and other allied Grallæ. The ruffs have the bill and carriage of the genus *Calidris*; but the membrane between their external toes is nearly as extensive as in *Limosa*. Our native species (*Machetes pugnax*, Cuv.) is somewhat smaller than a snipe, and celebrated for the furious combats that take place among the males in their nuptial season. At this period the head is partly covered with red papillæ; the neck is surrounded with a thick collar of feathers, which often varies in different individuals.

MA'CHIAVELISM. A name given to the system of governing which is propounded in the general writings of Machiavelli, and particularly in his treatise called *The Prince*. The term is still used in a disparaging sense, notwithstanding the different construction which has of late been given to the motives and purposes for which Machiavelli wrote his work.

MACHI'COLATED. (Fr. machicoulis.) In Gothic and castellated Architecture, a building whose parapets project beyond the faces of the walls, and are supported by arches springing from large corbels or consoles.

MACHI'NE (Gr. μαχανη), in a general sense, signifies any thing which serves to increase or regulate the effect of a given force. Machines are either *simple* or *compound*. The simple machines, otherwise called the *simple mechanical powers*, are usually reckoned six in number; namely, the *lever*, the *wheel and axle*, the *pulley*, the *wedge*, the *screw*, and the *funicular machine*. See the respective terms.

Compound machines are formed by combining two or more simple machines. They are classed under different denominations, according to forces by which they are put in motion, as *hydraulic* machines, *pneumatic* machines, *electrical* machines, &c.; or the purposes they are intended to serve, as *military* machines, *architectural* machines, &c.

Although there are no limits to the combinations and adaptations of machinery, there are certain general principles which may be applied in estimating the effects of any machine whatever. When a machine attains its state of uniform motion, the momentum of the power is equal to that of the resistance, and is the same that would be *in equilibrio* with the resistance if there were no motion at all. From this principle, and from the consideration that in all machines the work done is to be estimated not merely from the quantity of resistance which is overcome, but from the quantity overcome in a given time, we can ascertain the relation that ought to subsist between the velocity and the load or resistance in order that the effect of the machine may be a maximum. This maximum effect is produced when the two following conditions are fulfilled: 1. When the load, or resistance, is about four ninths of that which the power, when fully exerted, is just able to balance, or that which would keep the machine at rest altogether; and, 2. when the velocity of that part of the machine to which the power is applied is one third of the greatest velocity of the power. These conditions are deduced from the following empirical expression, which is adopted by Euler and other writers to represent the law of the moving power: Let P = the power applied (or weight which the power, when fully exerted, is just able to overcome); R = the resistance, or load, or weight to be overcome; c the greatest velocity, or that at which the power ceases to act; v = any other velocity: then the law of the moving power is

$$R = P\left(1 - \frac{v}{c}\right)^2.$$

The variables in this expression are R and v, and the effect is represented by the product Rv; on making which a maximum, the rules of the differential calculus give $v = \frac{1}{3}c$; whence the formula becomes $R = \frac{4}{9}P$.

From these expressions it follows, that when the moving power and the resistance are both given, if a machine be so constructed that the velocity of the part to which the power is applied is to the velocity of the part to which the resistance is applied in the ratio of 9 R to 4 P, the effect of the machine will be a maximum, or it will work to the greatest possible advantage. The above conditions apply equally to machines impelled by animal force and the agents of nature, as running water, steam, the force of gravity, &c. An animal exerts itself to the greatest advantage, or performs the greatest quantity of work in the least time, when it moves with about one third of the utmost speed with which it is capable of moving, and is loaded with four ninths of the greatest load which it is capable of putting in motion. It has been supposed in the above remarks that the friction of the parts of the machine is included in the resistance. (See Coriolis, *De l'Effet des Machines*; Navier, *Leçons sur l'Application de la Mécanique*; Belidor, *Architecture Hydraulique*; *Gregory's Mechanics*; *Moseley's Mechanics applied to the Arts*, &c.)

MACHI'NERY. A general term by which the works of the complex machines are designated.

MA'CIGNO. (Ital.) A hard silicious sandstone.

MA'CLE. A mineral; called also *chiastolite*. It forms prismatic crystals, white externally and grey within, which are found embedded in clay-slate. Its principal component parts are silica and alumina, with a little oxide of iron.

MACLU'REITE. A mineral named after Dr. Maclure, from New York and New Jersey. It occurs in roundish embedded masses, imperfectly crystalline. It is a silicate of magnesia, with traces of potash, oxide of iron, and fluorine.

MACMILLANITES. A religious sect in Scotland, the successors and representatives of the Covenanters in the 17th century, and more recently denominated the Reformed Presbytery. On the first settlement of presbytery as the established church of Scotland at the Revolution in 1688, a small body of the people, the remnant of the Covenanters, condemned the principles on which that act was founded as Erastian. They insisted not only that the church, though endowed by the state, should be entirely independent of civil authority, and uncontrollable and supreme in itself, but that the revolution government should not be recognized, inasmuch as it was not founded on the Solemn League and Covenant, and did not restore presbytery as it had obtained during what they called the "Second Reformation," or between 1638 and 1649, at the death of Charles I. Though reduced to a very small number at the era of the Revolution, and deserted by their pastors, who, in 1689, gave in their accession to the judicatories of the established church, they maintained their principles with unshaken firmness, and would accept of no conditions of which these were not the basis. They also continued zealously to maintain those praying societies (hence they were sometimes called Society people) which they had formed in the time of Charles II., when deprived of religious ordinances from the paucity of clergymen. A regular correspondence between these various fraternities was maintained, in order to ascertain the

state of matters throughout the body at large, and to cultivate a closer acquaintance with each other.

Thus they remained without a pastor for sixteen years; and as they were a small, so they were generally regarded as a fanatical and illiberal sect, enemies equally to the ecclesiastical and civil authorities. Meanwhile, Mr. John M'Millan, who had been ordained parochial minister of Balmaghie, in the stewartry of Kirkcudbright, in 1701 adopted and publicly avowed their principles; and was, in consequence, deposed in 1704 from the office of the ministry. He did not, however, renounce his ministerial character; but continued to officiate both among his former people, who almost to a man adhered to him, and others who favoured his views. In 1706, having received a unanimous call from the scattered societies to be their minister, he accepted the invitation; and in a short time he was joined by Mr. John M'Neil, a licentiate of the established church, who, like himself, had been deprived of all connection with that church. The high veneration which Mr. M'Millan and Mr. M'Neil entertained for presbyterian government, prevented any attempt being made to obtain ordination for the latter in an irregular way. Neither would they compromise their principles to gain the co-operation of other ministers who, like themselves, but for somewhat different opinions, had been expelled from the establishment. They renewed the Covenant in 1712, and never ceased to bear public testimony against what they regarded the defections and corruptions of the church of Scotland.

On the death of Mr. M'Neil, which took place not long afterwards, Mr. M'Millan was joined by the Rev. Thomas Nairn, who had been driven from the church, and had for some time been connected with the Secession. The prospects of the *M'Millanites*, as this sect had long been called in honour of their eminent leader, now began to brighten. Their two clergymen and some lay elders (formerly ordained) constituted a presbytery, in 1743, at Braehead, near Carnwath, Lanarkshire, and gave their body the name of the Reformed Presbytery, — a designation which has superseded, in a great measure, that of M'Millanites. They are also called Mountain or Hill people; because, having at first no chapels, they conducted public worship, in imitation of their persecuted ancestors in the reigns of Charles II. and his brother, in the open air, generally on the side of a hill.

From the time they were constituted into a presbytery, their number has gradually but slowly increased. In 1809 they had sixteen congregations; but their highest ecclesiastical court was a presbytery. They now form a synod, consisting of six presbyteries; the number of congregations being thirty-five. In the days of persecution, some of their adherents took refuge in the north of Ireland; and the M'Millanites there form four presbyteries, embracing twenty-one congregations. The sect prevails also in the United States to the extent of eight or ten congregations. Some of their congregations in Scotland are very small, and none of them are large. They have a professor of divinity belonging to their own body. In doctrine they profess the highest Calvinism; and may be characterized as the strictest sect of Presbyterians. They still hold substantially the same sentiments as the alleged Erastianism of the established church, or what they regard as her unscriptural subjection to the civil power. Some of their extreme opinions, however, on the subjects of the covenant and presbytery have of late been somewhat modified. They generally, if not universally, use public prayers for the sovereign and for civil magistrates; an act which they from conscience avoided for about a century after their organization under Mr. M'Millan. Wherever their numbers are sufficiently large, they have built chapels; and public worship, in any circumstances, rarely takes place out of doors. They have not thought it expedient to renew the Covenant since 1745. In short, they have become a comparatively liberal and enlightened sect of Christians, and are eminently characterized by piety and moral strictness. (See *Adam's Religious World Displayed*, vol. iii. 157—169.; *The Testimony of the Reformed Presbyterian Church*, Paisley, 1837; *Historical Part of the Testimony*, Glasgow, 1839; *A short Acc. of the Old Presbyterian Dissenters*, Glasgow, 1824; *Acts of Gen. Assembly apud Ann.* 1704, 1708, 1715: also the articles CAMERONIANS and COVENANTERS in this work.)

MACRODA'CTYLI. (Gr. μακρος, *long*; δακτυλος, *a finger*.) A tribe of wading birds, comprehending those in which the toes are remarkable for their extreme length; as the jacanas.

MA'CROPUS. (Gr. μακρος, *long*; πους, *foot*.) The generic name of the kangaroo; also applied to a genus of beetles.

MACROU'RANS, *Macroura*. (Gr. μακρος, *long*, and ουρα, *a tail*.) A section of Decapod Crustaceans, including all those which have the tail, or post abdomen, as long or longer than the body.

MA'CULÆ. (Lat. *spots*.) Dark spots on the surfaces of the sun and moon, and on some of the planets. The solar spots are very variable as to form and continuance. They were first observed by Galileo in Italy, and Harriot in England, soon after the invention of the telescope, and unknown to each other. The spots on the moon are permanent, and are caused by the shadows of its mountains, and the unequally reflecting materials of which parts of it are composed. The planets have some permanent maculæ, as the belts of Jupiter; and some variable, especially Mars and Venus, and frequently, also, Jupiter. These maculæ have led to many fanciful conjectures respecting the constitution and atmospheres of the bodies of the solar system. *See* SUN, MOON.

MA'DDER. The prepared root of the *Rubia tinctorum*. It is extensively used as a red dye stuff; its infusion is of a dirty red colour; but it is rendered bright and permanent by an aluminous mordant. Its colouring principle has been termed *alizarine*.

MA'DIA. (Gr. μαδος, *bald*.) A genus of Composite plants, inhabiting South America and California, and important because of the utility of the fruit as a source of vegetable oil. From some German reports it appears that it is the most productive of all oil plants.

MADO'NNA. (Engl. *my lady*.) An Italian term applied to the Virgin Mary. Hence pictures of the Italian school representing the Virgin are generally designated as "Madonnas."

MA'DREPO'RA. (A hybrid compound of the French madré, *spotted*, and the Latin porus, *a pore*.) The word appears to have been first used by Imperati to designate a genus of Lithophytes, in which the calcareous axis has its whole surface beset with small lamellate and stellate depressions.

The genus was adopted by Linnæus, who placed it among his *Vermes Zoophyta*, and characterized it as follows: — "*Animal* resembling a medusa; *coral* with lamellate star-shaped cavities." It is scarcely necessary to observe that the animal, especially in the larger madrepores, as the *Fungia*, most closely resembles the *Actinia* in its general organization. Cuvier places the madrepores in the tribe *Lithophyta*, of the family of *Polypi corticati*. The Lithophytes having the common character of the Linnæan genus are now subdivided into the genera *Fungia*, Lam.; *Turbinolia*, Lam.; *Cyclolythus*, Lam.; *Caryophyllæa*, Lam.; *Oculina*, Lam.; *Pœcillopora*, Lam.; *Serialopora*, Lam.; *Astrea*, *Explanaria*, *Porites*, *Meandrina*, Cuv.; *Pavonia*, Cuv.; *Hydrophora*, Fischer; *Agaricina*, Cuv.; *Sarcinula*, Lam.; *Stylina*, Cuv.; and *Madrepora* proper.

MA'DREPORITE. A species of columnar carbonate of lime found in Norway and Greenland.

MA'DRIER. In Military Engineering, a thick plank covered with plates of iron, and having a cavity sufficient to receive the mouth of a petard, with which it is applied against a gate or any other obstacle intended to be broken down. Also, the flat beams laid in the bottom of a moat or ditch to support the wall. There are also madriers lined with tin and covered with earth, to form roofs over certain portions of military works, in order to afford protection against fires in lodgments, &c.

MA'DRIGAL. One of the lesser kind of poems, usually consisting of fewer verses than the sonnet or roundelay. In its composition the fancy and convenience of the poet are not subjected to very strict rules, rhymes and verses of different species being often intermixed. The subjects are mostly of a tender and gallant nature; the character often quaint, the expressions marked with great simplicity. Sometimes, however, a loftier and sublimer train of thought finds its way into these compositions, especially among those of the English school, as in the following celebrated specimen, set to music, and perhaps written, by Orlando Gibbons, in 1612: —

> Oh! that the learned poets of this time,
> Who in a lovesick line so well can speak,
> Would not consume good wit in hateful rhyme,
> But with deep care some better subject find;
> For if their music please in earthly things,
> How would it sound if strung with heav'nly strings!

Of a lighter and more regular sort, the following may serve for a specimen: —

> When Thoralis delights to walk,
> The fairies do attend her;
> They sweetly sing and sweetly talk,
> And sweetly do commend her.
> The satyrs leap and dance around,
> And make their congés to the ground;
> And evermore their song is this,
> "Long may'st thou live, fair Thoralis!"

Grassineau, in his *Musical Dictionary*, describes the madrigal as "a little piece of poetry, the verses whereof were free and easy, usually unequal: it borders on a sonnet and an epigram; but has not the briskness of the one, nor the poignancy of the other."

It is extraordinary that the etymology of this word, though introduced but little more than three centuries ago, is now altogether lost. We subjoin the conjectures that have been raised upon it. Rengifo (*Arte Poetica*) says that it is corrupted from the word mandrial, *a sheepfold*. Cardinal Bembo seems to think with the last-named

author, and defines it as a pastoral love-song; adding, moreover, that it is of Provençal origin. Huet brings it from *Martegaux*, the name of a people of Provence. "Ces martegalles et madrigaux," he observes, "ont pris leur noms des Martegaux, peuple Montagnards de Provence: de mesme que les Gavots, peuple Montagnards du pays de Gass, ont donné le nom à celle que nous appellons gavotte." (*Traité des Romans*, p. 124.) Covarruvias (*Trésor de la Langue Castellan*) derives it from *mandra*. So that there is much testimony in favour of its pastoral origin. But the most curious, perhaps, of all the etymologies is that of Ferrari, in his *Origine de la Langue Italienne*, who derives the word from the Spanish verb madrugar, *to rise in the morning;* which Menage in his *Dict. Ety.* says is naught. This last-named author throws out a suggestion that it may have had its origin in a town called Madrigal (of which name, indeed, there are two in Old Castile), in Spain; as from Vallée de Vire has been formed the word Vaudeville (p. 464.). Others, supposing that the earliest specimens of this sort of poetry were addressed to the Virgin (*alla madre*), have thence derived madrialle and madrigale; and go on to say that having afterwards been applied to poems of love and gallantry, the original meaning was lost. The words of a very large proportion of the madrigals of the sixteenth century, a period when they were most in favour, are certainly compositions indicating addresses to the mother of love and gallantry (*alla madre galante*) rather than to the Virgin. At this period, moreover, the composers called their motels *madrigali spirituali*. We regret that we cannot guide the reader with any certainty upon this subject, in which we must leave him to a choice among the etymologies here set down, or to find one of his own that he may think more germane to the matter.

We will now endeavour to define this word in a musical sense; and we do not think we can better accomplish that object than in the quaint language of old Charles Butler (*Principles of Music*, London, 1636). He says, "The madrigal is a chromatic mode in discant, whose notes do often exceed the number of the syllables of the ditty, sometimes in duple, sometimes in triple proportion, with quick and sweet reports and repeats, and all pleasing varieties of art, in four, five, or six parts; having in one or more of them one or more rests, especially in the beginning, to bring in the points begun in another part." Choron calls it a species of composition resembling the fugue, but the style of which, being less dry, is susceptible of every kind of expression. The simple madrigal is for voices only; the accompanied madrigal, as its name imports, is with an accompaniment of one or more instruments, mostly the organ. To Arcadelt, a Flemish composer, has, but without foundation, been attributed the honour of composing the first madrigals. They, however exist by more ancient composers, even by those of the Flemish school; and to our readers who are at all conversant with the subject, the name of Adrian Willaert will doubtless occur as one of the composers alluded to. The fact is, that simple madrigals appeared about the beginning of the 16th century, during which, and the whole of that following, the style was particularly cultivated and encouraged, and may be considered to have now passed away, unless we are allowed to consider the English glee an offset from it. The first madrigals were in a style of music very much resembling that of the church; but they afterwards assumed a character peculiar to themselves, which is strikingly exemplified in those of Luca Marenzio (soon after the time that Palestrina flourished), and after him in the works of Gesualdo, the Prince of Venosa, Monteverde, and Mazocchi. It is in their madrigals that the restraints which laboured counterpoint imposed were abandoned, to make way for imitations, canons, and fugues. The style was indeed that of the age, but the subjects were free; and the tender and impassioned poetry adopted was well expressed in the affections of the harmonies employed. The original character gradually became more free, and was carried to its utmost limit in the compositions of the celebrated Alessanbro Scarlatti. In England, during the reign of Elizabeth, the composition of the madrigal attained a very high degree of excellence, perhaps the highest. Our composers were in no respect inferior to those of Italy and the Netherlands. It is hardly necessary to observe that among them are to be found the names of Orlando, Gibbons, Dowland, Wilbye, Ward, Bennett, and Morley.

MAESTO'SO. (Ital.) In Music, a direction to the performer that the music to which the word is prefixed is to be performed slowly and with grandeur.

MAGAZINE. (Fr. magazin.) A receptacle for military stores, but especially for gunpowder, in a fortress.

Magazine. An apartment below, in the after part of the ship, in which the powder is kept. As lights are not allowed to be burnt here, the light is received from another apartment, called the light-room.

Magazine. In Literature, the general designation for the periodical literature of a country, exclusive of the newspaper and review. The peculiar province of the two latter seems to be to communicate information — the one on politics and passing events, the other on literary and scientific subjects; while that of the magazine is of a more miscellaneous character, embracing all the features of the newspaper and review, but at the same time containing, in the form of tales, sketches, and poetry, &c., a great variety of what may be peculiarly termed *original* matter, the introduction of which would be foreign to the purposes of the others. The earliest publication of this kind in England was the *Gentleman's Magazine*, which still exists. It appeared in 1731; and the success which so deservedly followed its establishment immediately called into the field a host of competitors, which have so increased in number and variety as to form an era in literary history. See Periodicals, Review.

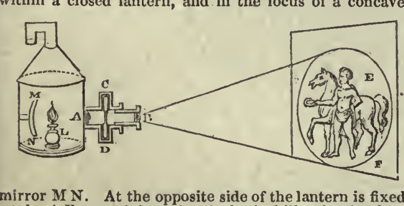
MAGELLA'NIC CLOUDS. Three nebulæ in the southern hemisphere, first recorded by the navigator Magellan, and named after him; two of them about 12° or 13° from the south pole, and the third more distant. Whether they be resolvable into stars by means of the larger telescopes, has not been yet ascertained; but, from their distinctness as nebulæ, they probably are.

MA'GIANS. The caste of priests (hereditary) among the Persians and Medians are so termed by ancient Greek historians. The name has been derived by modern orientalists from *mog* or *mag*, signifying priest in the Pehlevi language. Zoroaster is designated as the great reformer of the order; but the history and the very existence of that celebrated character are enveloped in complete obscurity. He is generally supposed to have lived at no long period before the age of Cyrus. The most remarkable feature of his doctrine consisted in the two principles of Good and Evil (Oromasdes and Arimanes), who were held to divide the dominion of the world, in alternate periods, during its whole predestined duration of 12,000 years. The books termed the *Zendavesta*, brought to Europe in the last century by Anquetil du Perron, are supposed by some to contain the essential doctrines of this religion; but their authenticity has been the subject of much discussion. The fire-worshippers of Persia and India still hold them in reverence. (*See* Zendavesta, Guebres.) Our amplest resources for the study of the religion and character of the ancient magi are to be found in the learned researches of Anquetil. (See especially *Mémoires de l'Acad. des Inscriptions*, vol. xxxiv.)

MA'GIC. (Lat. ars magica, *the art of the Magi;* because those Persian philosophers were ranked by the Romans among the highest professors of supernatural powers, through intercourse with the genii or intelligences with which their universe was peopled.) Common as the superstitious belief in the possession of such powers has been among all nations hitherto discovered on the globe, the Romans were, perhaps, the most superstitious in this and other respects of all people. No American tribe has a more implicit faith in its rude "medicines" or "mysteries," than this great and civilised people had in its auguries and divinations; and it is a remarkable feature in their character, that while their religion prescribed these rites, the popular imagination was always searching after fresh excitement from others, which were not only unauthorized, but condemned by their laws, — the practices of the Thessalian witches, the magi, the sorcerers of Egypt and Phrygia, and the numberless other foreign nations with which their dominion brought them in contact. Against these the emperors were continually renewing their ineffectual edicts; and it seems to have been mainly from this circumstance that the idea of magic, as a black and forbidden art, became rooted in the minds of the people of modern Europe. For the northern conquerors held such supernatural power in high respect; and in the East, the favourite land of sorcery and magic, the professors have from time immemorial been regarded rather as venerable than as hateful. As to ancient magic, see *Mém. de l'Acad. des Inscr.* vol. xxxix. Hence, if any systematic account can be attempted of matters which have their foundation in the strange caprices of popular credulity, it may be thought that, in the superstition of the middle ages, *white* magic or *celestial* magic, according to Cornelius Agrippa's division, originated in the North or East; *superstitious* or *diabolical* magic from Roman notions engrafted on Christianity; while *natural* magic arose merely from the disposition among the scientific of those days to take advantage of the vulgar propensity to attribute every thing extraordinary to supernatural causes. It is to be observed that among the crusaders, and other Christian warriors of the middle ages, magic was regarded as a peculiar ally of the eastern and northern infidels with whom they were in contact. The inhospitable North was peopled by their imagination with enchanted castles and spectral illusions (see *Scott's Dæmonology and Witchcraft*, letter v.); and Froissart gives a most picturesque account of the spells which were resorted to by Mahometan warriors in their conflicts with the soldiers of the cross. In the romances founded on these historical encounters there are usually a good magician or witch (not the degraded witch of vulgar superstition, but the French fée, Italian fata) enlisted in the Christian party; evil necromancers in that of the infidels. Thus,

in *Ariosto*, Malagigi and Melissa aid the one side, and Atlas the other. The notion of *white witches*, or beneficent wizards, was assiduously kept up by those impostors who wished to profit by the public credulity, and yet avoid the penalties awarded by the church; and in the church itself there was a contest continually maintained, whether magic, practised through laborious research and study of the celestial influences or intermediate spirits, was lawful. But the public opinion always inclined the other way; and the magicians of highest pretensions were always in danger of being classed with the hated necromancers who derived their power from compact with the devil. Among the earliest fables respecting the higher order of European magicians is that of Virgil, the Latin poet, turned into a wizard by popular belief, which dates as high as the 11th or 12th century. Robert of Lincoln (Grossetête), Michael Scot, Albertus Magnus, and the famous Roger Bacon, all lived in the 13th. Of these the first was a church reformer, who seems to have lain under the imputation of magic merely on account of the displeasure with which he was regarded by the orthodox. Michael Scot is almost wholly a traditional personage; that is, his real history is scarcely known: the European reputation which he had achieved as a wizard is proved by the high mention of him in the *Inferno* of Dante, who condemns all magicians indiscriminately to eternal punishment. It is difficult to say that Roger Bacon ever gave any cause by pretensions of his own, like so many other eminent natural philosophers of early time, to those charges of magic to which his high genius subjected him. Perhaps Sir F. Palgrave, in his amusing fiction (*The Merchant and Friar*), is not far wrong in representing him as partly dazzled by an inability to comprehend the real extent of those extraordinary discoveries which were opening upon him, and partly owing his magical reputation to the impostures practised by his servants in his name. Albertus Magnus, a Dominican, and a celebrated magician in his time, lies more justly open to the charge of quackery. It seems to have been after this time, about the 14th century, that magic rose for a season into high repute as a lawful art, and sovereigns had professed magicians and astrologers attached to them. The extraordinary tales related of some of these point evidently to results effected by means of legerdemain: the feats of Ziito, sorcerer to Wenceslas, king of Bohemia (Godwin, *Lives of the Necromancers*, p. 273.), are exactly a counterpart of what Tavernier saw at the court of the Great Mogul. The higher order of magicians maintained their pretensions with difficulty after the revival of letters. Yet the three most famous of all belong to the commencement of that era: Doctor Faustus (if that personage be not altogether traditional), Cornelius Agrippa, and Paracelsus. It will, however, be evident, to any one who reads their history, that the belief in *celestial* magic was with difficulty maintained in their days, while that in *necromancy* and *witchcraft* was becoming more prevalent than ever. There is a good deal of mystery about the character of the famous Dr. Dee; and it does not appear distinctly how far he pretended to those powers which are ascribed to him in that dreary work entitled, *A True Relation of what passed between Dr. Dee and some Spirits*, published by Meric Casaubon, in 1659. In 1634, the French curate, Urbain Grandier, was burnt for sorcery at Loudun; in 1640, the pretender, Dr. Lamb, was murdered by the London mob: and these are nearly the latest instances of distinguished magicians, while the degraded belief in witchcraft lasted much longer. As to *natural magic*, or the production of singular phenomena by natural means, see *Brewster's Letters on Nat. Magic*; *Quart. Rev.* vols. xlviii. lix.

MAGIC LANTERN. An optical instrument, by means of which small figures, painted with transparent varnish on slides of glass, are represented on a wall or screen considerably magnified. It is generally used as a toy, and affords amusement from the grotesque character of the figures; but is also employed to enlarge the diagrams employed in astronomical lectures, so as to be seen by an audience: for which purpose it is well adapted, both by its portability and the small cost of the whole apparatus. The principle of its construction is very simple. A lamp L, with a powerful Argand burner, is placed within a closed lantern, and in the focus of a concave



mirror M N. At the opposite side of the lantern is fixed a tube A B, containing a hemispherical illuminating lens A, and a convex lens B; and between A and B is a slit C D, through which the sliders of painted glass are introduced. In this manner the picture is placed in the axis of the tube, and strongly illuminated, in consequence of the light being concentrated upon it by the mirror. The picture being also in one of the conjugate foci of the lens B, an enlarged image of it is formed upon a wall or screen E F at some distance behind. The tube A B is made to pull out, so that the distance of the lens B from the slider can be increased or diminished at pleasure, and consequently an image formed of any size within moderate limits. The magic lantern was invented by Athanasius Kircher.

MA'GIC SQUARE. A term used to denote a series of numbers in arithmetical progression, arranged in the equal cells of a square in such a manner that the vertical, horizontal, and diagonal columns give the same sum. For example, let the first sixteen numbers be arranged as in the annexed table, and a magic square will be produced; for the numbers in each vertical column, in each horizontal column, and in the two diagonal columns, being added together, give the same sum, namely, 34. This is, however, only one of a great number of ways in which the same numbers may be arranged so as to fulfil the conditions. Frenicle (*Divers Ouvrages*, Paris, 1693) has shown that there are 878 such arrangements.

1	16	11	6
13	4	7	10
8	9	14	3
12	5	2	15

Emanuel Moscopolus, a Greek author of the 14th or 15th century, is the first who is known to have treated of magic squares, and to have given rules for their construction. The principal authors who have written on the subject are Stifels, Leibnitz, Bachet, Poignard, Lahire, Ozanam, Franklin, &c. For the history of the subject, see *Montucla*, vol. i. p. 346., or *Hutton's Dictionary*; and for the methods of constructing them, *Ozanam's* or *Hutton's Mathematical Recreations*.

MAGILP. When linseed oil and mastic varnish are mixed together they produce a gelatinous compound known under the above name, and used by artists as a vehicle for colours.

MA'GILUS. A name given by Montfort to a genus of Tubulibranchiate Gastropods in the system of Cuvier, chiefly remarkable for the form, length, and solidity of their shell. The modifications of this dermal production are due in the present instance, in great measure, to the accidental circumstances of the locality in which the growth of the individual proceeds. The young *Magilus* commences its career in a bed of lithophytous coral, and during the early and rapid stages of its development, secretes its calcareous covering in the ordinary form of a spiral univalve; but soon the growth of the surrounding madrepore surpasses its own, and it is compelled to bring its oral and respiratory orifices, by the most direct route, to the level of the surrounding coral. While this change of place is being effected the mollusk continues to secrete fresh layers of shell coextensive with its own advance, and to fill up the deserted part of the shell with a solid deposit of a dense, semivitreous, and subtransparent carbonate of lime, and finally produces an elongated, slightly wavy, tubular shell, with the apex sculptured in the form of a spiral univalve, and the opposite end excavated for a certain depth for the lodgment of the animal. The tube is characterized by being longitudinally carinated.

MAGI'STER (contracted Mister or Mr.). An appellation given, in the middle ages, to those persons who had attained some degree of literary or scientific eminence, — in scientiâ aliquâ præsertim literariâ. It was equivalent to the modern title of doctor.

MAGISTER EQUITUM. An officer among the Romans subordinate to the dictator, by whom he was usually elected. *See* DICTATOR.

MA'GISTERY. The old chemists generally applied this term to *precipitates* produced by the dilution of certain solutions with water: such as magistery of *bismuth*, which is an insoluble subnitrate, obtained by pouring nitrate of bismuth into water.

MA'GISTRATE. (Lat.) A general designation of those public officers to whom the executive power of the law is committed, either wholly or in part. It is almost impracticable to give any definition of this term so comprehensive as to include within it all the offices, both in ancient and modern times, to which this appellation has been given. Under the various heads, the reader will find a notice of the principal magistrates of all ages and countries.

MAGMA. (Gr. μασσω, *I blend together.*) A thick ointment or confection.

MA'GNA CHARTA. *See* CHARTA, MAGNA.

MA'GNATES. In Hungary at this day, and formerly also in Poland, the title of the noble estate in the national representation. (*See* STATES.) The Hungarian magnates are divided into greater and lesser; certain high state officers belonging to the first class, the counts and

barons of the kingdom to the second. The title is of Latin derivation.

MAGNE'SIA. A white, tasteless, earthy substance, usually obtained by exposing its hydrated carbonate to a red heat. Its specific gravity is 2·3. It is almost insoluble; but when moistened and put upon turmeric paper it reddens it: this sometimes depends upon a trace of lime. It is an oxide of a brilliant white metal, which has been called *magnesium*, and which may be obtained by heating chloride of magnesium with potassium: they act intensely upon each other, chloride of potassium is formed, and magnesium separates: it may be washed with water and dried. Heated to redness in the air, it burns with great brilliancy into magnesia; 12 parts of the metal combining with 8 of oxygen to form 20 of magnesia. In commerce, pure magnesia is generally distinguished by the term *calcined magnesia*; and the hydrated carbonate of magnesia, obtained by precipitating a solution of sulphate of magnesia by carbonate of soda and washing and drying the precipitate, goes by the name of *magnesia*, or *magnesia alba*. The chief use of magnesia and its carbonate is in medicine. *Sulphate of magnesia* is obtained by evaporating the residue of sea-water after the common salt has been separated, or by adding sulphuric acid to *bittern* and evaporating, so as to obtain the resulting sulphate of magnesia. This salt is also obtained by the action of dilute sulphuric acid on magnesian limestone, and it is not uncommon in mineral waters: it was formerly procured from certain springs near Epsom, in Surrey, and was hence termed *Epsom salt*. It crystallizes in four-sided prisms with dihedral summits. Its crystals are soluble in their weight of water at 60°, and in three fourths their weight at 212°. They melt when heated, and gradually lose their water of crystallization. They consist of 20 magnesia, 40 sulphuric acid, and 63 water. This salt is a useful purgative in medicine, and is the chief source of the other forms of magnesia. All the magnesian salts have a peculiar bitterish flavour. Magnesia is found native in the state of hydrate and carbonate; it exists as a component part of several minerals, and many of them are soft or soapy to the touch.

MAGNE'SIAN LIMESTONE. An extensive series of beds lying in geological position immediately above the coal measures; so called because the *limestone*, which is the principal member of the series, contains *magnesia*. *See* GEOLOGY.

MAGNESITE. Native magnesia.

MAGNESIUM. The metallic base of magnesia; which see.

MAGNE'TIC COMPASSES. *See* COMPASS.

MAGNETIC COMPENSATOR. A contrivance devised by Mr. Barlow for eliminating the influence of a ship's guns and other iron in deranging the bearings of the compass. It consists of a plate or combination of plates of iron placed near the binnacle, so as to counteract, by an equal and opposite attraction, that of the rest of the iron on board the vessel. Mr. Airy (*Phil. Trans.* 1839) has investigated the law of disturbance in the case of vessels built of iron, and shown that the disturbing force consists of a very large force of permanent magnetism in the rolled and hardened plates employed in the construction of the vessel, and a very small force of induced magnetism, which changes with the place of the ship, or rather with the varying circumstances of terrestrial magnetism by which it is produced. Mr. Airy has given a set of practical rules for correcting the disturbing forces by means of two powerful magnets placed at right angles to each other below the compass, and a box of small iron chain, which is used instead of Barlow's correcting plate.

MA'GNET, NATURAL. One of the numerous oxides of iron; possessed, however, of properties peculiar to itself, if we except the metals nickel and cobalt, which possess it also in a very slight degree. The magnet consists chiefly of two oxides, together with a small portion of quartz and alumine. Its colour varies in different specimens, according to minute differences in the ratios of the two oxides, and the nature of the foreign substances with which they are found united; but it is usually of a dark-grey hue, and has a dull metallic lustre. It is found in considerable masses in the iron mines of Sweden and Norway; in the Isle of Elba; in different parts of Arabia, China, Siam, and the Philippine Islands. Small magnets are also occasionally, though rarely, met with among the iron ores of this country. The properties are,—

1. It attracts iron in all its states except the oxides.

2. If formed into a bar, and suspended freely by a hair, or on a pivot passing through its centre, it will turn itself round, and, after a few pendulous vibrations, settle into some one position; which it will retain if left undisturbed, or if disturbed will, after a few similar vibrations, return to it again as before.

3. By rubbing on a bar of steel it will give the bar the same properties; and a bar of soft iron will, while contiguous to it, even when not touched by it, obtain the same properties, which, however, the iron does not, like the steel, retain upon removal.

4. The position of rest is different at different places, and different at the same place at distant periods of time.

A great number of amusing toys have been formed of this substance, and the phenomena are often at first sight very surprising; but its application to the purposes of navigation renders it one of the most important discoveries ever made. The earlier navigators believed that it pointed always to the north pole of the world; and that therefore by means of it they could always at once tell the direction of their meridian, and consequently in what *direction* they were sailing. It was hence called the *loadstone*, or *leading stone*.

The employment of the loadstone itself for the purposes of navigation has long been laid aside; as *artificial magnets* can be constructed having a much greater intensity of directive power. *See* MAGNETISM.

MAGNETIC NEEDLE. An instrument suspended by its centre, and magnetized, which shows the direction of the resultant of the magnetic forces at the place of observation. *See* COMPASS and DIPPING NEEDLE.

MAGNETIC PYRITES. Native black sulphuret of iron: it attracts the magnetic needle.

MA'GNETISM. The science which investigates the phenomena presented by natural and artificial magnets, and the laws by which they are connected. The following brief explanation of it under both aspects will serve to render the subject generally intelligible; but it is impossible to give more than the essential phenomena and the general laws, without descending to the detail of particular cases. For further information reference may be made to the excellent compendium of Dr. Roget, in the *Library of Useful Knowledge*; to *Mr. Barlow's Magnetic Attractions* (2d ed.), and *Treatise on Magnetism* in the *Encyclopædia Metropolitana*; *Sir D. Brewster's Treatise on Magnetism* in the *Encyc. Britannica*; Gilbert, *De Magnete*, 1600, folio; *Robison's Mechanical Philosophy*; Biot, *Traité de Physique*, tom. iii.; Pouillet, *Elémens de Physique*; Becquerel, *Traité d'Electricité et du Magnétisme*; and various papers in the *Transactions of the Royal Society of London and Edinburgh*. To the work of Dr. Roget we have been under great obligations in drawing up the present abstract.

Phenomena of Magnetism. — Phenomenon 1. If a nicely balanced piece of steel be suspended from its middle by a piece of untwisted silk, or allowed to rest upon a pivot, free to turn in all directions, both horizontally and vertically; and if it be then magnetized by any of the methods hereafter described, it will turn itself into one particular position, and if disturbed by any means it will return invariably to the same as its position of repose. The horizontal angle which it makes with the meridian is called its *variation*, or its *declination*; and the vertical angle which it makes with the horizon its *dip* or *inclination*.

Phenomenon 2. Both these angles (dip and variation) continually change at the same place of observation; sometimes the latter very rapidly; the former, so far as has yet been observed, very slowly at all places. Thus, about 1659, at London, the needle pointed in the direction of the geographical meridian: before that time it had pointed eastward of it; but from that time till about 1818 it had continually made an angle more and more westward, till it arrived at a variation of 24½°. Since then its motion has again been retrograde, and it is now little more than 23¾° west. (*See* COMPASS.) The dip has also undergone similar variations: at London in 1773 it was 72° 19′, and in 1830 it was 69° 38′.

Phenomenon 3. The observation of navigators shows that there is a curve line on the surface of the earth, at every point of which the needle will take a horizontal position. This is called the *magnetic equator*. It seems to cross the geographical equator in four points; and its form and position are also undergoing continual changes. M. Morlet and M. Hansteen have investigated this subject with great care; and the former thinks it changes only its position, not its form, which is contrary to what theory would lead us to expect.

The lines at which the dip is the same number of degrees are called *magnetic parallels* of that degree, or more properly *lines of equal dip*; and the points at which the needle takes a vertical position the *poles*, *poles of convergency*, or more properly *poles of verticity*. The points at which the variation is any given number of degrees constitute lines on the earth's surface, called *lines of equal variation*, or (after Dr. Halley, who made a considerable number of observations on them) *Halleyan lines*; and the vertical circle whose plane coincides with the needle in its free position at any place is called, though improperly, the *magnetic meridian* of that place.

Phenomenon 4. If the same needle, whether compelled by its form or by loading one end of it with a weight sliding as an armature to keep a horizontal position, or free to take its own proper dip at each place successively, be made to vibrate by being drawn from its natural position, and then liberated, it will perform its vibrations more rapidly in some places than in others, and in the same place at different distant periods. Its

places of most rapid horizontal vibration are not to be considered as those at which the most rapid vibrations of the freely suspended needle take place. Hansteen has very laboriously investigated, from observations made by himself and others, the curves where the horizontal vibrations are the same; and he thinks there are four poles at which it is more rapid than at any points immediately near them. But the rate of vibration of the free needle has as yet been observed at very few places with sufficient care to justify any general conclusion respecting such poles of vibration. The velocity of vibration indicates the variation of the *intensity* of the vibrating force, the needle itself acting as a pendulum.

Phenomenon 5. The intensity itself varies at different times of the day, and under all variations of temperature in the surrounding medium; the place of observation being the same. This was first observed more than a century ago; but its laws and circumstances have been only recently investigated by Mr. Christie, and subsequently by M. Küpffer. (See *Phil. Trans.* 1824; *Annales de Chimie*, 1826; and *Mr. Christie's Report on the Present State of our Knowledge respecting Terrestrial Magnetism*, in the *Reports of the British Association.*) The variation also undergoes similar changes, and it is believed the dip also; but this has not been well established by observation.

It is the opinion of Mr. Christie, Sir David Brewster, and others, that the places on the earth where the temperature is lowest are precisely those where the magnetic intensity is the greatest, accordant with what Mr. Christie's experiments on the influence of temperature would lead us to expect; but till we have more certain knowledge of the state of magnetic intensity at those places we cannot affirm this to be the case, probable as it may seem to be.

In the following phenomena the place is supposed to be chosen, and the dip, variation, and intensity to be fixed thereby. It may be any place whatever on the surface of the earth. We shall suppose it to be London (and there is comparatively little variation of these elements in the British Isles). The point of the needle which dips below the horizon, and points to the westward of the meridian, is called the *north pole* of the needle, and the elevated one the *south pole*. When the horizontal needle is used, the same terms apply; the end which varies westward being the north pole, and the other the south pole.

Phenomenon 6. If either pole of a magnet be brought near any small piece of soft unmagnetized iron, it will be found to attract it. Iron filings, for instance, are immediately collected together when a magnet is placed among them; and they adhere to it when lifted up, and more especially about the poles of the magnet, in thick clusters. About the intermediate parts the number that adhere is much less than nearer the ends; and in every magnet there is a part to which the filings have no tendency to adhere at all. It thus appears that the magnetic forces, whatever be their nature, are situated near the extremities of the magnet; but it has been long questioned whether they be resident in two isolated points, or diffused for considerable distances round those points, but in a state of less intensity as they recede from those centres.

Phenomenon 7. When, instead of fragments of iron, we substitute a rectangular or cylindrical bar of soft unmagnetized iron, the magnet and the iron will be mutually attracted towards each other. The best mode of exhibiting this is to suspend them by threads of untwisted silk at the appropriate distances, as the friction they would undergo in sliding on a table is thus removed. It will be found that the ends which are nearest to each other will tend to coalesce; and that the other ends will tend to coalesce or recede, according as the remote end of the iron happens to be situated with respect to the body of the magnet.

If another iron body be brought near the former in this state of the apparatus, the first iron will be found to be converted into a *temporary* magnet also; and, in like manner, the second piece of iron may be proved to have become also a temporary magnet; and then the third, and so on. The intensity of attraction and repulsion is, however, weaker in each in succession, till it at length becomes insensible. This is prettily exhibited by attaching a key to a magnet, a nail to the key, a smaller nail to that, a sewing needle to the smaller nail, and so on, as long as there is sufficient magnetic force developed, to sustain the concatenation in a state of suspension. Some magnets will sustain a considerable weight; others, of course, are capable of exerting very little force.

The iron is said to be converted into a magnet; or, more briefly, to be *magnetized by induction*; or, to use the French term, to be *magnetized by influence*.

Phenomenon 8. If two magnets be suspended, as in the last experiment, it will be found that the two north poles repel each other, and the two south poles repel each other: but the north pole of the one and south pole of the other mutually attract each other. They will, in consequence of this mutual action upon each other, take positions *generally* different from those which they would each take in the absence of each other.

Phenomenon 9. If the poles of the successive induced magnets spoken of in Phen. 8. be examined as to their nature, by means of their action on the poles of a small magnetic needle, it will be found that each of them is a distinct magnet, each consecutive pair of them having their dissimilar poles in contact. This is known at once by observing which end of the needle is attracted before the next piece of iron is put on, and which after it is added, the needle being applied near the untouched end of the iron.

If, moreover, the pieces of iron be laid on a table, and not in contact, the same phenomena will be observed on the application of the trial needle near their extremities.

When two or more magnets are employed to act by influence on the same piece of iron, the phenomena become more complex, and the operation is called *complex induction*. The phenomena are very curious and interesting.

Phenomenon 10. If the iron be removed it instantly ceases to be magnetic, and may have its position reversed with precisely the same effect as before, each phenomenon taking place now at the end opposite to that where it was exhibited before; and this will be the case, however long the apparatus has been allowed to remain in the position spoken of. If, however, pieces of steel be employed, the inductive influence is less than in the iron: whilst, instead of losing its magnetism instantaneously, as the iron did, it retains a portion of it, and becomes itself a permanent magnet. There are indeed few, if any, pieces of iron and steel in which the magnetic force is wholly lost or wholly retained upon removal; but we here speak of the sensible and approximate circumstances of the phenomena.

Phenomenon 11. If a magnet be broken or any way severed, it is converted into two separate magnets; the two ends of the fragments at which the fracture was made being of opposite kinds to the two ends of the whole bar respectively, as if they had been but two magnets united by opposite poles.

Phenomenon 12. If two magnets be brought near each other, their intensity of action on the vibrations of a needle are affected according to the relative positions of the poles, indicating not only that the direction of the quiescent state of the needle is affected (Phen. 8.), but that the intensity of the magnetic force is also altered. This shows that the magnetized bar itself is affected by the inductive power of the other bar, as soft iron is.

Phenomenon 13. If a mass of soft iron be brought into the vicinity of a magnetic needle, the needle will be *generally* deflected from its natural position in various degrees and directions, according to the form and position of the needle and the mass. When an iron sphere is employed, as a cannon ball, the investigation of the order of the phenomena becomes more simple and easy; and it was by remarking that in this case there was a certain plane in any point of which the needle may be placed with respect to the sphere where the needle would not be at all deflected, that Mr. Barlow was led to prosecute his celebrated experiments on this subject. Mr. Christie remarked that this plane was the plane passing through the centre of the ball, perpendicular to the *natural* direction of the needle itself.

There are also lines on the iron sphere in which if the needle is placed the deflection will be a given quantity.

The same phenomena, however, are exhibited, whatever be the form of the mass. Mr. Barlow experimented on a gun 58 cwt., and found it so. He also found that the action did not depend upon the mass itself, but upon the surface of the mass; as the same effects were produced by a ten-inch ball, a ten-inch shell, and a globe of sheet iron of the same diameter. If, however, the sheet iron was less than $\frac{1}{10}$th of an inch in thickness, the effects were diminished; but up to that degree of thinness they did not seem to vary, whilst after they varied very rapidly, and soon became insensible.

Phenomenon 14. If disks of various metals be put into rapid rotation, they will also deflect the magnetic needle from its natural position. That this is not owing to vibration or vorticity produced in the air is rendered evident by the same effects taking place in a more intense degree in vacuo than in the open air. The phenomenon itself was first observed by Arago in France; but it has been chiefly investigated in this country by Messrs. Herschel, Babbage, Christie, Barlow, Faraday, and Harris, to whose memoirs on the subject, in the *Philosophical Transactions*, the reader is especially referred.

Phenomenon 15. Bars that have long stood in a vertical position, as iron railings, &c., are found to have become permanently magnetic. A bar of soft iron, placed in the natural direction of the magnetic needle, acquires temporary magnetism; and if a bar of steel be left there for a sufficient time, it becomes a permanent magnet. These facts show that the earth itself is a great magnet, and converts the others into magnets by induction. This was

observed so far back as the time of Dr. Gilbert; and it is remarkable that, whilst his great cotemporary Lord Bacon was preceptively urging the new organon in philosophy, Gilbert was actually putting it into the most careful practice. The doctrine of terrestrial induction, as taught by Gilbert, is the doctrine of the present hour, and with scarcely a single improvement in the whole range of the theory.

The foregoing contain the most important phenomena of magnetism which depend upon terrestrial influence merely: those which depend upon electrical influence will be found under the head ELECTRO-MAGNETISM.

Laws of Magnetic Action. — Law 1. The intensity of the attractive force exercised by the north pole of one magnet on the south pole of another, and its repulsive force on the north pole of the second, varies inversely as the square of the distance of those poles; and the like occurs when we consider the action of the south pole of the first magnet on the north and south poles respectively of the other. The same law, precisely, holds with respect to the attraction of a corpuscle of unmagnetized iron.

This is the fundamental law of the science, and may be considered as the source from which the others flow by mathematical reasoning. It has been determined with great care by several philosophers, but especially Michell and Coulomb, by means of the torsion balance. Other laws were, in the earlier state of the science, conjectured to obtain; as, for instance, Newton supposed the forces to vary as the cubes of the distances, and some recent inquirers have contended for the simple inverse of the distances; but Newton's opinion was founded upon insufficient experiments, and that of the authors referred to upon an oversight in their mode of estimating the intensity of the forces. Not the slightest doubt, however, now remains upon the minds of those who are competent to form an opinion of the truth of the law stated above.

Law 2. When the needle is very short in comparison with the distance and length of the magnet, and has its centre fixed immoveably, but is otherwise at liberty to take any directive position, it will so arrange itself that its line of direction will be in the plane drawn through the two poles of the magnet and its own (the needle's) centre of rotation; and the line of the needle's direction, being produced to meet the magnetic line (or line drawn through the poles), will divide the latter into segments estimated from the poles, which are in the ratios of the cubes of the distances of the poles from the centre of the needle. When the needle is not small in comparison, as above, the law becomes more complicated.

Law 3. If two magnetic needles be made to vibrate, the intensities of their magnetic forces are as the squares of their number of vibrations made in the same time. This is true, whatever be the planes in which they vibrate, so far as the force is effective in that plane; but for a direct comparison of the ratio of the intensities without further computation, the vibrations of both needles must, in both cases, be made in the *same plane*. The planes most commonly used for vibration are — the horizontal plane; the plane which has been called the magnetic meridian, or that vertical plane which passes through the natural direction of the needle at the place of observation; and the vertical plane at right angles to this.

Law 4. If the needle be allowed to move vertically in a plane making any angle with the magnetic meridian, the dip in that case is equal to the dip in the magnetic meridian multiplied by the cosine of the inclination of the two planes; and if two planes be taken at right angles, in which the dip is observed, the square of the cotangent of the natural dip at that place is equal to the sum of the squares of the cotangents of the observed dips.

Law 5. The intensity of the horizontal force is equal to the intensity of the whole force multiplied by the cosine of the dip. If, therefore, the same needle be used in all the experiments, and observations be made to determine the dip and horizontal intensity at several different places, the relative intensities of the terrestrial magnetic force can be deduced from those observations by the three last laws for each of the places.

The laws according to which magnetic force is influenced by temperature have been chiefly investigated by Coulomb, Kupffer, Barlow, and Christie. It appears, generally, that between the temperature of $-3°$ and $+127°$ of Fahrenheit, the intensity of magnets decreases as the temperature increases; and that at temperatures above 100° a part of the power of the magnet is permanently destroyed. The effects produced on soft iron by changes of temperature appear to be directly the reverse of those produced on magnets, an increase of temperature causing an increase of magnetic force.

On the Formation of Artificial Magnets. — 1. If a steel bar be held in the natural direction of the needle, and two or three smart blows be given at the upper end with a hammer, it will become a permanent magnet.

2. If the end of a steel bar be placed in contact with one of the poles of a magnet, it will become permanently magnetic by induction. A better plan is to place the needle in a line between the opposite poles of two magnets of equal intensity.

3. Lay the bar flat on a table, and draw another magnet (placed upright upon it) several times from one end to the other, always the same way. Or take two magnets, and lay them horizontally upon the bar to be impregnated, having their dissimilar ends in contact over its middle; and slide each towards the end of the bar. This must be repeated several times. Or, again, instead of laying them horizontally, hold them in any angle of inclination (each in the same angle, estimated from the perpendicular to the middle of the bar), and draw them several times along towards the ends, without varying their inclinations.

The above methods were those originally employed; but when the principles of magnetic induction came to be better understood, more complicated but more effective processes were invented, for the explanation of which reference must be made to works expressly on the subject. (See *Brewster's Treatise on Magnetism.*) Those more complicated processes may be greatly simplified by the substitution of a magnet in the form of a horseshoe for the compound magnets. If placed at once in the middle of the needle to be magnetized, with the poles turned in a direction the reverse of the poles intended to be given to the needle, and then moved backwards and forwards along the surface of the needle, taking care to pass over each half of it an equal number of times, and repeating the same operation on the other side, the needle is speedily and effectually rendered magnetic. This is by far the simplest mode of magnetizing; and it may be considered as a method by induction, the induction being accelerated by the friction.

On the subject of terrestrial magnetism, which at the present time is occupying so much of the attention of scientific men, reference may be made, in addition to the works above cited, to the following: — Hansteen, *Untersuchungen über der Magnetismus der Erde*, 4to. Christiana, 1817; Barlow, *Phil. Trans.* 1833; *Allgemeine Theorie des Magnetischen Vereins im Jahre* 1838, by Gauss and Weber, Leipzig, 1839 (a translation of which will be found in *Taylor's Scientific Memoirs*); *Intensitas Vis Magneticæ Terrestris ad Mensuram Absolutam revocata*, Auctore E. F. Gauss, Gottingæ, 1833; *Major Sabine's Report to the Seventh Meeting of the British Association*, 1838; *The Report of the President and Council of the Royal Society on the Objects of Scientific Inquiry*, 1840; and to an excellent popular abstract of the present state of our knowledge on the subject in the *Quarterly Review* for June, 1840.

MAGNETISM, ANIMAL. This pretended influence, or agent, had its origin in Vienna about the year 1776, when a person of the name of Anthony Mesmer published a thesis *On the Influence of the Planets on the Human Body*. About the same time a Jesuit, called Father Hehl, imagined that by the help of a loadstone and certain steel plates rendered magnetic he had cured several diseases; and being struck with the analogy of Mesmer's views to his own, they entered into a kind of partnership as joint practitioners, and attracted considerable notice; so that, although they soon quarrelled, their system of treatment had acquired some notoriety and many powerful advocates. Hehl continued to practise this new and occult science in Germany; and Mesmer, in 1778, went to Paris, and in the course of a short time performed such wonderful cures, and took care to have them so satisfactorily attested, that his apartments were daily thronged with patients of all ranks, and fees and reputation poured in from all quarters. He here, however, unluckily associated himself with a M. d'Eslon, a medical man, who being more skilful in the art of pleasing patients than his master, contrived to gain the ascendency, and so to disgust Mesmer that he was induced to quit Paris for Spa; where he soon contrived, under the pretence of initiating others in the secrets of his trade, to raise about 14,000*l.*, with which he retired to his native place (Mersburg in Suabia), and left magnetism and the magnetizers to their own resources.

As the jargon of Mesmer has been revived in our own days, it may be worth while to give his own definition of his art, which is quite as intelligible as some of the later versions of it which have recently appeared in London; for, in this "hotbed of quackery," Mesmerism, as it is called, has occasionally taken root, and at one time, but for an accident, which we shall presently notice, threatened to thrive and prosper.

"Animal magnetism," says Mesmer, "is a fluid universally diffused; it is the medium of a mutual influence between the heavenly bodies, the earth, and animated bodies; it is continuous, so as to leave no void; its subtilty admits of no comparison; it is capable of receiving, propagating, communicating, all the impressions of motion; it is susceptible of flux and of reflux. The animal body experiences the effects of this agent; by insinuating itself into the substance of the nerves, it affects them immediately. There are observed, particularly in the human body, properties analogous to those of the mag-

net; and in it are discerned poles equally different and opposite. The action and the virtues of animal magnetism may be communicated from one body to other bodies, animate and inanimate. This action takes place at a remote distance, without the aid of any intermediate body; it is increased and reflected by mirrors; communicated, propagated, augmented, by sound; its virtues may be accumulated, concentrated, transported. Although this fluid is universal, all animal bodies are not equally susceptible of it; there are even some, though a very small number, which have properties so opposite that their very presence destroys all the effects of this fluid on other bodies.

"Animal magnetism is capable of healing diseases of the nerves immediately, and others mediately. It perfects the action of medicines; it excites and directs salutary crises in such a manner that the physician may render himself master of them; by its means he knows the state of health of each individual, and judges with certainty of the origin, the nature, and the progress of the most complicated diseases; he prevents their increase, and succeeds in healing them, without at any time exposing his patient to dangerous effects or troublesome consequences, whatever be the age, the temperament, and the sex. In animal magnetism nature presents a universal method of healing and preserving mankind."

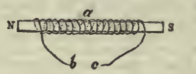
Many of our readers have probably witnessed the silly and disgraceful exhibitions in this line of practice which have lately been tolerated in London, and are therefore aware of the means by which the magnetized are brought under the "influence." It is always necessary that the magnetizer himself should be charged with the fluid, and that the *magnetizees* should be susceptible of its influence, which, be it observed, all persons are not; nor can all persons be magnetizers: some want power, and others faith; in short, there must be a due share of folly or of imposture, or both, on the one hand, and of credulity, cunning, or morbid irritability on the other, and then all goes right. The magnetizer, with his wand of office, performs certain antics before the patient; and the patient either falls asleep or into a fit, or is dumb, or deaf, or garrulous and painfully sensitive to sounds, as the case may be. But it is by no means necessary that the doctor and the person magnetized should see each other: a skilful artist, well charged, can magnetize a fit subject in another room, house, street, or town; and can moreover tell by his own sensations to what extent the influence is communicated, and how the persons receive it.

Mesmer availed himself of certain aids, which our modern practitioners have rejected; such as boxes of steel bars, magnetized water, and musical instruments imbued with the magnetic influence: he also frequently tied his customers together, or made them link their thumbs, when several were to be magnetized at once. When patients are in the crisis, or under the full influence of the power, they can be immmediately roused out of it by certain looks, gestures, and touches of the adept.

To ascertain how far the pretensions of the animal magnetizers were entitled to any attention or support, the French government very properly appointed a committee of scientific and unprejudiced persons to investigate its merits, among whom were Bailly, Franklin, and Lavoisier; and it is curious that their report, which was translated into English, and published here in 1785, is not more often quoted. "This pretended agent," say they, "is not magnetism; for on examining the grand reservoir of the fluid by a needle and electrometer, neither magnetism nor electricity could be detected. We tried it upon ourselves and others without effect; and on blindfolding those who professed great susceptibility of its influence, all its ordinary effects were produced when nothing was done but when they imagined they were magnetized, while none of its effects were produced when they were really magnetized but imagined nothing was done. So also when brought under a magnetized tree; nothing happened if they thought they were at a distance from it, while they immediately went into violent convulsions when they thought they were near the tree, though really not so. The effects, therefore," say the commissioners, "are purely imaginary; and although they have wrought some cures, they are not without danger, for the convulsions sometimes spread among the feeble of body and mind, and especially among women. And, finally, there are parts of the operations which may readily be turned to vicious purposes; and in fact immoral practices have already actually grown out of them."

Some years ago a great animal magnetizer arose in this country, called Perkins, who invented what he called "metallic tractors, for collecting, condensing, and applying animal magnetism;" but Dr. Falconer and Dr. Haygarth of Bath soon put an end to his pretensions, by performing all manner of cures and wonders with a pair of wooden tractors; and as those cases were well attested, they proved, as every person of common sense before knew, that all Perkins's results were imaginary or assumed, and so animal magnetism fell into oblivion. Within the last five years some lamentable attempts have been made to revive it in London; not by quacks and impostors, but by regular practitioners, and even by persons who enjoyed no inconsiderable share of public respect and favour. They have unfortunately reaped the bitter fruits of their credulity and folly; and the mania has again subsided, and will now probably remain dormant.

MAGNE'TO-ELECTRICITY. Under the term Electro-magnetism will be found the description of certain magnetic phenomena produced by electricity. It has been demonstrated by Faraday that electric phenomena may be produced by magnetism, and to these the term *magneto-electricity* has been applied. Let *a* represent a hollow helix of copper wire covered by silk, the ends *b c* of which are connected with a delicate galvanometer; and N S a powerful bar magnet, which can easily be thrust into and withdrawn from the spiral or helix: it will then be found that every time the magnet is pushed into the helix the galvanometer is deflected in one direction, and each time it is withdrawn it is deflected in the opposite direction. On repeatedly threading the helix with the magnet, the deflection also takes place. Now, as the deflection of the galvanometer can only be produced by the motion of electricity in the helix, it is obvious that an electric current is produced each time that the magnet moves through it: hence as, on the one hand, electricity in motion produces magnetism; so, here, magnetism in motion produces electricity. By causing the pole of a powerful magnet to revolve before a coil of wire, or, what amounts to the same thing, if the coil be made to revolve opposite to the pole of a magnet, an electric current will be established in the coil, which may be made sensible by sparks, shocks, and chemical effects.



MA'GNETO'METER. An instrument for measuring the intensity of terrestrial magnetism. The three elements sought to be deduced from magnetic observations are, the declination, the inclination or dip, and the absolute intensity, together with the variations to which they are subject; and each of these elements requires for its determination a peculiar apparatus. A detailed account of the construction and various adjustments of the instruments made use of in the magnetic observatories recently established, and of the methods of observing, will be found in the *Report of the President and Council of the Royal Society on the Objects of Scientific Inquiry in Physics and Meteorology*, 1840. The first accurate measurements of magnetic force were made by Coulomb with the torsion balance; but the more precise method which is now generally adopted, and which depends on the dynamical principle of observing the number of vibrations made by a needle in a given time, was proposed by Graham so long ago as 1722.

MAGNETOMO'TOR. (Lat. lit. *magnet-mover*.) A term applied to a voltaic series of two or more large plates, which producing a great quantity of electricity of low tension is well adapted to the exhibition of electro-magnetic phenomena.

MA'GNITUDE. (Lat.) Size, extent, quantity. This term was originally employed to designate the space occupied by any figure; or, in other words, it was applied to objects strictly termed geometrical, and of three dimensions, — length, breadth, and thickness: then it was extended to designate the quantity of any one of these, and also of angular space, or the inclination of two lines to one another; or, again, the compound idea of a solid angle formed by any number of planes meeting in a point. The amount of any one of these, taken in reference to some standard of the same kind of quantity as that spoken of, was called its magnitude. The term was gradually enlarged in its signification, so as to apply to every kind of quantity that admits of exhibition or mensuration, or of which greater or less can be predicated; and in this sense it was used by Euclid.

MAGNITUDE, APPARENT. The angular space (plane or solid) under which a body appears when viewed from some distant point. The term is chiefly used in speaking of the celestial bodies; and is then employed to express the plane angle subtended by the diameter of the visual disc of the body. It is also used in many branches of optical science, but always with the same *general* meaning.

MAGNOLIA'CEÆ. (Magnolia, one of the genera.) A natural order of Exogenous plants, consisting of trees or shrubs of great beauty, usually with evergreen leaves, and large fragrant flowers. They inhabit the temperate parts of America and Asia, as well as the tropics, and are universal objects of cultivation. The bark of the tulip tree, and of some of the true magnolias, has the reputation of being a good febrifuge.

MA'GPIE. A common species of the Crow tribe, *Corvus pica* of Linnæus; now the type of a distinct genus, *Pica caudata*. They continue in pairs throughout the year, and prey on a variety of food, chiefly animal, as the young of hares, rabbits, and feathered game, young poultry, eggs, carrion, and insects; lastly, fruit and grain.

The magpie is celebrated for its crafty instincts, its power of imitating words, and the propensity which it has in common with other species of the crow tribe to purloin and secrete glittering articles. The nest of the magpie is admirably constructed for strength and warmth, and is commonly defended by a dome. It lays six or seven eggs early in spring, of a yellowish white spotted with brown and cinereous. In winter magpies will assemble in great numbers to roost in some coppice towards the evening, but separate again on the approach of day.

MAHA'BARATA. The name of one of the great Indian epic poems, the subject of which is a long civil war between two dynasties of ancient India, the Kurus and Pandus. This poem embraces the whole circle of Indian mythology; but it is still more valuable as embodying an immense number of historical fragments, which will be of great importance to the future historian of India. Many episodes from the *Mahabarata* have been ably translated by some of our most celebrated orientalists; and parts of the original have been published at different periods in Germany. The period at which the *Mahabarata* was written is wholly unknown, and it has no less baffled all the researches of the learned to discover the date at which it assumed its present methodical form. The *Penny Cyclopædia* contains an able analysis of this poem. *See* RAMAYANA.

MA'HADO. A name of one of the Indian deities, from whom the sacred Ganges is fabled to spring. He is incorrectly used in Goëthe's well-known poem, *Der Gott und die Bajadere*, which begins "Mahadö, du Herr der Erde" (Lord of Earth), as synonymous with Siva.

MAHOMETANISM. *See* MOHAMMEDANISM.

MAI'A. In Grecian Mythology, — 1. The daughter of Atlas and Pleione, one of the Pleiads, who became mother of Mercury by Jupiter: 2. A daughter of the god Faunus, and wife of Vulcan; frequently confounded by mythologists with the former personage.

MAI'DÆ. A family of crabs (Brachyurous Crustaceans), of which the genus *Maia* is the type. The form of the shell is ovoid: the manus and the preceding joint are nearly of the same length. The species called *Maia squinado* is occasionally taken on our own coasts, as well as those of France and of the Mediterranean: it is commonly called the "sea spider."

MAI'DEN. The name given in Scotland to a sharp-edged instrument, formerly used for the beheading of criminals. It resembles in its construction the *guillotine* of the French. *See* GUILLOTINE.

MAIDEN HAIR. The *Adiantum capillus veneris;* a fern found in many parts of Europe on damp shaded rocks. It formed an ingredient in the syrup of capillaire of old pharmacy.

MAIL. (Fr. maille.) A small piece of metal or money, but used collectively to defensive armour formed of iron rings or round meshes. *See* HAUBERK.

MAIL, signified originally the bag which contains letters forwarded by government for the public convenience; but it was soon afterwards extended to the letters themselves, and it is now used also for the conveyance in which they are forwarded. *See* POST OFFICE.

MAILS, or MAILLS. In Scottish Law, the rents of an estate. (Silver halfpence, in England, were anciently called mailes.) In the northern counties of England, and in Scotland, payments made by the occupiers or owners of lands to persons in league with the various classes of freebooters who infested the country were termed *black mail*. To take it was made a capital felony by stat. 43 Eliz. c. 13.

MAIM, or MAYHEM. In old English Jurisprudence, a wound by which any one was so disabled as to be less fit to defend himself in fight; and therefore distinguished from an injury which merely disfigured. Appeal of mayhem was abolished, with other criminal appeals, by 59 G. 3. c. 46. Cutting and stabbing, "with intent to murder," and with intent to maim or disfigure, are now distinct offences, under 9 G. 4. c. 31. s. 11. and 12. The latter was thereby made a capital felony only in such cases in which if death had ensued it would have been murder.

MAI'NTENANCE, in Law, is defined to be an officious intermeddling in a suit that in no way belongs to one, by maintaining and assisting either party with money or otherwise to prosecute or defend it. The punishment by common law is fine and imprisonment, and by 32 H. 8. c. 9. a forfeiture of ten pounds.

MAI'NTENANCE, CAP OF. A cap of dignity, anciently belonging to the rank of a duke; termed by the French *bonnet ducal*. The lord mayor's fur cap is also called a cap of maintenance.

MAIZE (Mais, the American name), a kind of corn extensively cultivated for food, is the grain of the plant named by Linnæus *Zea mays*. Like other corn, it is a species of grass, whose albumen is sufficiently large and farinaceous to be ground into flour. In this plant the grains are unusually large, compressed, and packed closely in regular parallel lines along the sides of a receptacle many inches long. In the young state each grain is tipped with a long slender style as fine as a thread of silk; and many hundreds of such styles being collected together from each receptacle, the whole resemble a silken tassel hanging down from the orifice of the sheathing leaves in which the inflorescence is enwrapped. When ripe the corn is still covered by the sheathing leaves, and is only to be discovered when the latter are stripped back. The male or barren flowers grow in a loose panicle at the end of the stem. There are many varieties of maize; some with stems seven or eight feet high, others not exceeding the stature of two feet; some requiring a long summer to ripen their grain, others coming to perfection in a couple of months. The colour of the grain is also variable; chocolate-coloured, red, crimson, yellow, white, and variegated, are all known to the American planter. This kind of corn is not grown exclusively for the sake of the ripe grain; the young female inflorescence, which is sweet and tender, is boiled or cooked in other ways as a delicate vegetable, and the young stems are occasionally given to cattle. Many attempts have been made to cultivate maize in England as a field crop, but without success. It does not thrive north of the basin of the Mediterranean, and requires a higher summer heat than we experience in these islands.

MA'JESTY. This title of honour is derived from the Romans, among whom it stood for the collective power and dignity of the sovereign body; as majestas populi Romani. Hence treason was termed crimen læsæ majestatis, an injury offered to majesty. Majesty was the attribute of consuls, prætors, &c. only as representing the public; and hence, in later times, when it was transferred to the emperors along with the sovereign power, inferior magistrates were entitled, in ceremonial language, by the appellation of dignitas. Majesty is now the conventional title of European emperors and kings. (The Sultan of Turkey has no more elevated title in our ceremonial than Highness.) It appears to have been first assumed by the German emperors, who were considered as representing the imperial dignity of Rome; then by the French king, Henry II.: in England, by Elizabeth. The Emperor of Austria has the title Majesty, with the prefix K. K. (Kaiserliche, Königliche; *i.e.* Imperial, Royal.)

Apostolical Majesty. — A title bestowed on Stephen, duke of Hungary, about A. D. 1000, by Pope Sylvester II. Re-conferred on the empress-queen Maria Theresa in 1758.

Catholic Majesty. — A title bestowed on Ferdinand and Isabella of Spain by Pope Alexander VI. in 1491, in memory of the conquest of the Moors: it had, however, been borne by earlier Spanish monarchs.

Most Christian Majesty. — A title borne by the kings of France; first solemnly conferred on Louis XI. in 1469 by Pope Paul II.

Most Faithful Majesty. — The title of the kings of Portugal; bestowed by Benedict XIV. on John V.

MA'JOR. In the art Military, a field officer next in rank above a captain, and immediately inferior to a lieutenant-colonel. His chief duties consist in superintending the exercises of his regiment or battalion, and of putting in execution the commands of his superior officer. This class of field officers did not exist till the beginning of the 17th century. The prices of a major's commission and his pay in the British army are as follow: — In the regiments of the line, 3200*l.*; pay, 16*s.* per diem: in the dragoons, 4575*l.*; pay, 19*s.* 3*d.* per diem: in the life and royal horse guards, 5350*l.*; pay, 1*l.* 4*s.* 5*d.* per diem: and in the foot guards (with the rank of colonel), 8300*l.*; pay, 1*l.* 3*s.* This appellation of major does not exist either in the artillery or engineers. *Brigade-major* is a staff officer, who performs for a brigade, or in a garrison, duties equivalent to those of a major in a regiment or battalion. *Major-general* is an officer next in rank below a lieutenant-general, whose functions he has to discharge in the absence of his superior officer.

MAJOR AND MINOR. In Music, terms applied to imperfect concords differing from each other by a semitone minor. They are used in the same sense when applied to discords.

MAJORA'T. In modern legal phraseology, as employed by several Continental nations, the right of succession to property according to age. It is defined "a fidei-commissum gradual, successive, perpetual, indivisible, made with a view to preserve the name, arms, and dignity of a family, and destined for ever to the eldest member of it." In the German empire and in Spain this species of entails is of great antiquity. *See* MAYORAZGO.

MAJORAT, in the French Law, expresses the property, landed or funded, which by virtue of several decrees of the empire might be reserved by individuals enjoying hereditary titles of honour, and attached to the title so as to descend with it. The German and Spanish laws of majorat had no exact equivalent in old France; but a species of majorat existed in the case of the Duchés-Pairies, abolished at the Revolution, with other feudal institutions. The general rule of French law, that children succeed equally to their parents' property, is only modified by the regulations respecting what is termed a "portion disponible." (*Cod. Civil,* art. 913. &c.) A per-

son who leaves one child only can dispose, by will or donation, of half his property; one who leaves two one third, and so on: a person who dies without descendants, but leaving "ascendants," one half or three fourths, according to certain rules; if he leaves only collaterals, he may dispose of the whole.

MA'JOR DOMO. (Lat. major domus, *greater officer of the house.*) In the courts of those kingdoms which were formed out of the fragments of the Western Empire, three different offices seem to be designated by this title, —1. The maître d'hotel, or chief officer of the prince's table, præfectus mensæ, architriclinus, dapifer, &c.; 2. The mayor of the palace (æconomus, *steward*); 3. The first minister, prefect of the palace, count of the palace, &c. Charles Martel is termed major domus by some ancient historians. This title became in later times confounded with that of seneschal. In Germany, under the Othos and the house of Swabia, the dapifer was an officer of high rank, who bore, amongst other duties, the standard of his sovereign. The count palatine was dapifer of the empire: the elector of Bavaria, arch-dapifer. In England he was a personage of less distinction, and his subscription generally appears last among the attesting witnesses to ancient charters.

MAJO'RITY. In Politics, the age at which the sovereign, in hereditary monarchies, becomes capable of exercising supreme authority. *See* MINORITY, REGENT.

MA'JOR TERM, in Logic, is, in a syllogism, the predicate of the conclusion. The major premise is that which contains the major term. In hypothetical syllogisms, the hypothetical premise is called the major.

MAJU'SCULÆ, or CAPITALES LITERÆ. In Diplomatics, capital letters. The Latin manuscripts of the classical age which we possess (those found at Pompeii, and a few parchment MSS. of very early date) are written in capital letters. Few instruments or books of a later date than the sixth century are in capital letters.

MA'LACHITE. (Gr. μαλαχη, *the mallow flower;* or μαλαχος, *soft;* hence, also, called *velvet* copper ore.) The *blue* and *green* carbonate of copper.

MALA'CIA. (Gr. μαλακιον, *a ravenous fish.*) A depraved appetite.

MA'LACODERMS, *Malacodermi.* (Gr. μαλακος, and δερμα, *skin.*) The name of a tribe of Serricorn beetles, including those with a soft and flexible body.

MA'LACOLITE. (Gr. μαλακος.) A variety of *augite* of a dark-green colour.

MALACO'LOGY. (Gr. μαλακια, the Aristotelian name of the Mollusca of the moderns; and λογος, *a discourse.*) The science of the Mollusks. (See that word for their general characters.) Cuvier, the great reviver of this branch of natural history, divides the Mollusks into six classes.

I. *Cephalopoda.*—Mantle in form of a sac, open anteriorly, containing the branchiæ and abdominal viscera; head protruding from the mantle, well developed, and crowned by fleshy productions, by means of which they crawl and seize various objects.

II. *Pteropoda.*—Mantle closed; appendages of the head either wanting or extremely reduced. The principal organs of locomotion are two membranous fins, like wings, situated on the sides of the neck.

III. *Gastropoda.*—These crawl by means of a fleshy disk on their belly. The mouth is supported by a head.

IV. *Acephala.*—The mantle encloses the branchiæ and viscera; the mouth opens within its cavity, and is not supported by a distinct head. The mantle may be open throughout its length, at both ends, or at one extremity only.

V. *Brachiopoda.*—These are also enclosed in a mantle without an apparent head; but have a pair of long, fleshy, ciliated arms, which are spiral when retracted.

VI. *Cirrhopoda.*—This class Cuvier defines as being similar to the other Mollusks in the mantle, branchiæ, &c.; but as differing from them in having numerous horny and articulated limbs, and a nervous system more nearly resembling that of the Articulata.

Since the early form and metamorphoses of the *Cirrhopoda*, or, more properly, *Cirripedia*, were known, most zoologists have regarded them as members of the Articulate sub-kingdom.

The classification of the Mollusca has been much perfected by those zoologists who have been attracted to the study of this department of the animal kingdom by the beautiful and diversified coverings of the testaceous species. Among these Lamarck ranks deservedly the chief; and his system is still that which mainly guides the conchologist in the arrangement of his shells.

The following is the outline of the Lamarckian system:—

In the system of Lamarck, the natural primary group of animals to which the science of malacology relates constitutes the 11th and 12th classes of his Invertebrata. The first of these classes, under the name of *Conchifera*, is equivalent to the Testaceous *Acephala* and *Brachiopoda* of Cuvier; and these low-organized headless Mollusca have their external shelly defensive covering rendered the more complete by way of compensation for the slight development of the nervous centres to which the impressions of external objects are referred, and from which the acts of volition emanate. Instead of one shell, they are therefore provided with and generally completely covered by two shells, which are technically called "valves;" and the *Conchifera* of Lamarck thus include the Mollusks with bivalve shells. These are divided into two orders, *Dimyaria* and *Monomyaria.*

Class I. CONCHIFERA.

Order 1. *Conchifera Dimyaria.*—Char.: Two muscles of attachment at least; shell internally with two muscular impressions, which are separate and lateral.

(1.) Shell regular, generally equivalve.

(A.) Shell gaping in general at the lateral extremities, its valves being approximated.

(*) *Crassipede Conchifers.*—Mantle with its lobes united anteriorly, either entirely or partially; foot thick: gape of the shell wide.

Family 1. *Tubicolidæ.*—Shell either contained in a tubular sheath distinct from its valves, or entirely or partially incrusted in the wall of its sheath, or projecting externally. (*Aspergillum, Clavagella, Teredo,* &c.)

Family 2. *Pholadidæ.*—Shell without a tubular sheath, either furnished with accessory pieces or gaping very much anteriorly. (*Pholas, Gastrochæna.*)

Family 3. *Solenidæ.*—Shell without accessory pieces, and gaping at the lateral extremities only; ligament external. (*Solen, Panopæa, Glycymeris.*)

Family 4. *Myidæ.*—The same characters of the shell, with the ligament internal. (*Mya, Anatina.*)

(**) *Tenuipede Conchifers.*—Mantle with its lobes not united, or hardly united anteriorly; foot small, compressed; gaping of the shell often considerable.

Family 5. *Mactridæ.*

a. Ligament internal only. (*Mactra, Crassatella, Erycina, Lutraria.*)

b. Ligament partly internal, partly external. (*Ungulina, Solemya, Amphidesma.*)

Family 6. *Corbulidæ.*—Shell inequivalve; ligament internal. (*Corbula, Pandora.*)

Family 7. *Lithophagidæ.*—Ligament partly external, partly internal; shells without accessory pieces or any particular sheath, more or less gaping at their anterior side. (*Saxicava, Petricola, Venerupis.*)

Family 8. *Nymphidæ.*—Two cardinal teeth at most in the same valve; shell often gaping a little at the lateral extremities; ligament external; nymphæ in general gaping outwards. (*Sanguinolaria, Psammobia, Tellina, Corbis, Lucina, Donax, Capsa, Crassma.*) *See* CONCHOLOGY.

(B.) Shell closed at the lateral extremities when the valves are shut.

(***) *Lamellipede Conchifers.*—Foot flattened, lamelliform, not posterior.

Family 9. *Conchidæ.*—Three cardinal teeth at least in one valve, with as many or less in the other; lateral teeth sometimes.

1. *Fluviatile Conchidæ.*—Shell with lateral teeth, and covered with a false epiderm. (*Cyclas, Cyrena, Galathea.*)

2. *Marine Conchidæ.*—No lateral teeth in the greater number; rarely an epidermis, which covers the whole shell except the umbones. (*Cyprina, Cytherea, Venus, Venericardia.*)

Family 10. *Cardiidæ.*—Cardinal teeth irregular either in their form or situation, and accompanied in general by one or two lateral teeth. (*Cardium, Cardita, Isocardia,* &c.)

Family 11. *Arcidæ.*—Cardinal teeth small, numerous, intrant, and disposed in each valve on a line, which is either straight or arched or broken. (*Cucullæa, Arca, Pectunculus, Nucula, Trigonia,* and *Castalia.*)

Family 12. *Naiidæ.*—Fluviatile shells, whose hinge is sometimes furnished with an irregular cardinal tooth, which is simple or divided, and with a longitudinal tooth, which is prolonged under the corselet; and sometimes without any tooth at all, or is furnished along its length with irregular granulous tubercles. Umbones with the epidermis peeled off, and frequently eroded. (*Unio, Hyria, Anodon,* and *Iridina.*)

Family 13. *Chamidæ.*—Shell irregular, inequivale; a single cardinal tooth, oblique and subcrenate, inserted into a little pit in the opposite valve; muscular impressions distant, lateral; external ligament depressed. (*Dicras, Chama, Etheria.*)

Order 2.—*Conchifera Monomyaria.*—Only one muscle of attachment, which seems to traverse their body.

Shell with an internal subcentral muscular impression.

(*) Ligament marginal, elongated on the border, sublinear.

Family 14. *Tridacnidæ.* — Shell transverse, equivalve, with an elongated muscular impression bordering the upper limb. (*Tridacna, Hippopus.*)

Family 15. *Mytilidæ.*—Shell longitudinal or subtransverse, with a muscular impression contracted into an isolated space without bordering the limb; hinge with a subinternal ligament, which is marginal, linear, very entire. (*Modiola, Mytilus, Pinna.*)

Family 16. *Malleidæ.* — Ligament sublinear, either interrupted by serial teeth or simple; shell subinequivalve, foliated. (*Crenatula, Perna, Malleus, Avicula.*)

(**) Ligament not marginal, contracted into a short space under the umbones, and not forming a tendinous tube under the shell.

Family 17. *Pectinidæ.* — Shell regular, compact, not foliated. (*Pedum, Lima, Plagiostoma, Pecten, Plicatula, Spondylus, Podopsis.*)

Family 18. *Ostreidæ.*

a. Ligament partly external; shell foliated, but nevertheless often acquiring great thickness. (*Gryphæa, Ostrea, Vulsella.*)

b. Ligament internal; shell delicate, papyraceous. (*Placuna, Anomia.*)

(***) Ligament either wanting or represented by a tendinous chord which sustains the shell.

Family 19. *Rudista.* — Shell very inequivalve. (*Sphærulites, Radiolites, Calceola, Birostrites, Discina, Crania.*)

Family 20. *Brachiopoda.* — Shell adherent, either immediately or by a tendinous chord; mantle bilobate, the lobes separated anteriorly, enveloping the body; two opposed, elongated, fringed arms, near the mouth, rolled spirally when retracted. (*Orbicula, Terebratula, Lingula.*)

Class II. Mollusca.

Order 1. *Pteropoda.* — Char.: No foot for creeping, nor arms for progress or seizing the prey; two fins, opposed and similar, proper for natation; body free and floating; some naked; others with thin, semitransparent, symmetrical shell. (*Hyalæa, Clio, Cleodora, Limacina, Cymbulia, Pneumodermon.*)

Order 2. *Gasteropoda.* — Animals with a straight body, never spiral, nor enveloped in a shell which can contain the entire body; a foot or muscular disc along the whole length of the under part of the body, serving for creeping; some naked; others protected by a dorsal shell not imbedded; and others containing a shell more or less hidden in their mantle.

Section 1. *Hydrobranchiata.* — Branchiæ, whatever be their position, developed either in the form of a network, in laminæ, in a pectinated form, or in a ribbon-like shape. The Gastropods of this section breathe water only.

Family 21. *Tritonidæ.* — Branchiæ external, placed above the mantle, either on the back or on the sides, and not being in any particular cavity. (*Glaucus, Eolis, Tritonia, Scyllæa, Tethys, Doris.*)

Family 22. *Phyllididæ.* — Branchiæ placed under the border of the mantle, and disposed in a longitudinal series around the body, or on one side only, not being in any particular cavity. (*Phyllidia, Chitonellus, Chiton, Patella.*)

Family 23. *Semiphyllididæ.* — Branchiæ placed under the border of the mantle, and disposed in a longitudinal series on the right side of the body only. (*Pleurobranchus, Umbrella.*)

Family 24. *Calyptræidæ.*— Branchiæ placed in a particular cavity upon the back, situated anteriorly near the neck; shell always external, and covering the soft parts. (*Parmophorus, Emarginula, Fissurella, Pileopsis, Calyptræa, Crepidula, Ancylus.*)

Family 25. *Bullidæ.* — Branchiæ placed in a particular cavity towards the posterior part of the back, and covered either by the mantle or by an opercular escutcheon. (*Bulla, Aplysia, Dolabella.*)

Section 2. *Pneumobranchiata.* — Branchiæ creeping, in in the form of a vascular network, on the wall of a particular cavity, the aperture of which is small, and can be contracted or dilated at will. The Gastropods of this section breathe nothing but air.

Family *Limacidæ.* (*See* Limax.)

Order 3. *Trachelipoda.* — Body spiral in its posterior part, which is separated from the foot, and always lodged in a shell; the foot free, flattened, attached to the lower base of the neck or to the anterior part of the body, and serving for creeping; shell spirivalve and sheathing.

Section 1. *Phytiphaga.* — Trachelipods without a projecting siphon, and respiring in general by means of a hole; the greater part phytiphagous, and furnished with jaws; shell with the aperture entire, having at its base neither dorsal subascending notch nor canal.

(*) Breathing air only; shell spirivalve, unarmed, not distinctly nacreous.

Family 26. *Helicidæ.*

a. Four tentacles. (*Helix, Bulimus, Achatina,* &c.)

b. Two tentacles. (*Auricula, Cyclostoma.*)

Family 27. *Limnæidæ.* — Amphibious; living in the water, but coming to the surface to breathe; shell with a sharp edge to the lip. (*Planorbis, Physa, Limnæa.*)

(**) Breathing water only; branchiæ projecting in form of filaments, laminæ, or tufts in the branchial cavity; shell often nacreous, and often also having protuberant parts on the surface.

(*a.*) Shell fluviatile, operculated, the left border of which does not resemble a demi-partition.

Family 28. *Melanidæ.* — Shell with disunited borders. (*Melania, Melanopsis, Pirena.*)

Family 29. *Peristomidæ.* — Shell with united borders. (*Valvata, Paludina, Ampullariæ.*)

(*b.*) Shell fluviatile or marine, the left border resembling a demi-partition.

Family 30. *Neritidæ.* — *Navicella, Neritina* (fluviatile), *Nerita, Natica* (marine).

(*c.*) Shell marine, the left border not resembling a demi-partition.

Family 31. *Janthinidæ.* — Shell floating at the surface of the water. (*Janthina.*)

Family 32. *Macrostomidæ.* — Shell not floating, having the aperture very wide; no columella. (*Sigaretus, Stomatella, Haliotis.*)

Family 33. *Plicacidæ.*—Aperture of shell not very wide; plaits on the columella. (*Tornatella, Pyramidella.*)

Family 34. *Scalaridæ.*—Borders of the aperture united circularly; no plaits on the columella. (*Vermetus, Scalariæ, Delphinula.*)

Family 35. *Turbinidæ.* — Borders of the aperture disunited. (*Solarium, Rotella, Trochus, Monodonta, Turbo, Planaxis, Phasianella, Turritella.*)

Section 2. *Zoophaga.* — Trachelipods with a projecting siphon, and which only breathe water, which reaches the branchiæ by means of this siphon. These feed on animal substances only, are marine, have no jaws, and are furnished with a retractile proboscis. Shell spirivalve, sheathing the soft parts, with an aperture which is either canaliculated, or notched, or turned up at its base.

(*a.*) Shell with a canal more or less long at the base of its aperture, and the right border of whose lip does not change with age.

Family 36. *Canalifera.*

1. No constant process on the right lip of the shell. (*Cerithium, Pleurotoma, Turbinella, Cancellaria, Fasciolaria, Fusus, Pyrula.*)
2. A constant process on the right lip in all the species.

α. No processes on the spire. (*Struthiolaria.*)

β. Processes on the spire. (*Ranella, Murex, Triton.*)

(*b.*) Shell with a canal more or less long at the base of its aperture, and the right border of whose lip changes its form with age, and has a sinus inferiorly.

Family 37. *Alata.* — Wing shells. (*Rostellaria, Pteroceras, Strombus.*)

(*c.*) Shell with a short canal ascending posteriorly, or with an oblique notch at the base of its aperture, this demicanal being directed towards the back.

Family 38. *Purpurifera.*

1. Canal ascending or recurved towards the back. (*Cassis, Cassidaria.*)
2. An oblique notch directed backwards. (*Purpura, Ricinula, Monoceras, Concholepas, Harpa, Dolium, Buccinum, Eburna, Terebra.*)

(*d.*) No canal at the base of the aperture, but a subdorsal notch, and plaits on the columella.

Family 39. *Columellidæ.* — *Columbella, Mitra, Voluta, Marginella, Volvaria.*

(*e.*) Shell without a canal; but having the base of its aperture notched or versant, and the whorls of its spire large, compressed, and enrolled in such a manner that the last whorl nearly entirely covers the others.

Family 40. *Convolutidæ.* — *Ovula, Cypræa, Terebellum, Ancillaria, Oliva, Conus.*

Order 4. *Cephalopoda.* — Mantle in form of a sac, containing the lower part of the body; head projecting from the sac, surrounded by arms, which are not articulated [but furnished with suckers, and which environ the mouth; two sessile eyes; two horny mandibles to the mouth; three hearts*]; sexes separate.

Division 1. *Polythalamous Cephalopods.* — Shell multilocular, enveloped completely or partially, and which is inclosed in the posterior part of the animal, often with adherence.

Family 41. *Orthoceratidæ.* — Shell straight, or nearly so, with simple or not sinuous chambers. (*Belemnites, Orthoceros, Nodosaria, Hippurites, Conilites.*)

Family 42. *Lituolitidæ.* — Shell partially spiral; last

* The characters included within brackets apply only to the 2d division of Lamarck's order.

whorl continued in a straight line. (*Spirula*, *Spirulina*, *Lituola*.)

Family 43. *Cristacidæ.* — Shell semidiscoid; spire eccentric. (*Renulina*, *Cristellaria*, *Orbiculina*.)

Family 44. *Spherulidæ.* — Shell globulose, spheroidal, or oval, with enveloping whorls or partitions united *en tunique*. (*Miliola*, *Gyrogona*, *Melonia*.)

Family 45. *Radiolididæ.* — Shell discoid, with a central spire, and partitions radiating from the centre to the circumference. (*Rotalia*, *Lenticulina*, *Placentula*.)

Family 46. *Nautilidæ.* — Shell discoid, with a central spire, and partitions which do not extend from the centre to the circumference. (*Discorbis*, *Siderolites*, *Polystomella*, *Vorticialis*, *Nummulites*, *Nautilus*.)

Family 47. *Ammonitidæ.* — Shell multilocular, with chambers sinuous at the edges. (*Ammonites*, *Orbulites*, *Ammonoceras*, *Turrilites*, *Baculites*.)

[From regard being only had to the characters afforded by the shell, the Polythalamous Cephalopods of Lamarck form the least natural of his groups. Many of the genera, especially the microscopic species, belong to a different primary division of the animal kingdom; and one genus, *Gyrogona*, to another kingdom of nature, it being a fossil seed. The genera *Belemnites* and *Spirula*, which are true Cephalopods, have been removed to the higher-organized or Dibranchiate order of Cephalopods.]

Division 2. *Monothalamous Cephalopods.* — Shell unilocular, entirely external, and enveloping the animal.

Family 48. Genus *Argonauta*.

Division 3. *Sepiary Cephalopods.* — No shell, either internal or external; a solid free cretaceous or horny body, contained in the interior of the greater part of the animals.

Family 49. Genera *Octopus*, *Loligopsis*, *Loligo*, *Sepia*.

Order 5. *Heteropoda.* — Body free, clongated, swimming horizontally; head distinct; two eyes; no arms surrounding the head; no feet under the belly or under the throat for creeping; one or more fins without any regular order, and not disposed by pairs.

Family 50. Genera *Carinaria*, *Pterotrachea*, *Phylliroe*.

Modifications of more or less importance in the classification of the Mollusca have been proposed by Oken (*Naturgeschichte*, Jena, 1816), Ferussac (1819), De Blainville (1814 and 1825), J. E. Gray (*London Medical Repository*, 1821), Des Hayes, Rang, and others. For an account of the structure and growth of shells, see Conchology.

MALACOPTERY'GIANS, *Malacopterygii*. (Gr. μαλακος, and πτερυξ, *a wing*.) The name of a division of the class of fishes comprehending all those which, with an internal osseous skeleton, have the rays supporting the fins soft, except the first ray of the dorsal and pectoral fins.

MALACO'STRACANS. (Gr. μαλακος, οστρακον, *a shell*.) The name of a division of the class Crustaceans, including those which are covered with a crust softer than the shell of the Mollusks, but firmer than the covering of the Entomostracans. (See that word.) The term *Malacostraca* was first applied by Aristotle to the *Crustacea* of the moderns, being used by him in a comparative sense, as contrasted with the *Ostracoderma*, which are the modern *Testacea*.

MALÆIC ACID. An acid obtained by distilling malic acid at a temperature of about 400°. When malic acid is exposed for a longer time to a moderate heat, it becomes modified into *paramalæic acid*.

MALA'GMA. (Gr. μαλασσειν, *to soften*.) A poultice.

MALA'RIA. (Ital. mal' aria, *a bad air*.) The exhalation of marshy districts, which produces intermittent fevers. This term has now become of general application; but it was long restricted to that district of Italy extending from Leghorn to Terracina in one direction, and from the sea to the Apennines in another. Even in the time of Horace Rome was deserted two months in the year, on account of the dangers of the malaria.

MA'LIC ACID. (Lat. malum, *an apple*.) A peculiar acid contained in the juice of the apple and several other fruits: it may be obtained also from the berries of the *Sorbus aucuparia*, or mountain ash, and has hence been called *sorbic acid*.

MA'LICE (Lat. malitia), in the English Law, does not necessarily bear the signification of particular ill feeling towards an individual, but is a term directly importing wickedness in the commission of an act, and excluding a just cause or excuse. (*See* Murder.) Malicious injury to property is in some instances a felony, in others a misdemeanour; punishable, in some, on summary conviction: the law respecting which is consolidated in one of the statutes commonly called Peel's Acts (7 & 8 G. 4. c. 30.). By sect. 25. of this act it is expressly declared that the word malice, in relation to these injuries, bears its legal and not its popular signification; it being there declared that the act applies, "whether the offence shall be committed from malice conceived against the owner of the property, or otherwise." In civil actions for injuries to which malice is essential, *e.g.* slander, libel, &c., the question of the existence of malice is one, in general, for the jury; but, under certain circumstances, it may be implied by the court from the absence of reasonable and probable cause, as in actions for malicious prosecution.

MALLEABI'LITY. (Lat. malleus, *a hammer*.) The property of being susceptible of extension under the blows of a hammer. It is especially characteristic of some of the metals, and in this quality gold exceeds all the others: common gold leaf is not more than a two hundred thousandth part of an inch in thickness; five grains may be thus extended so as to cover a surface of more than 270 square inches. *See* Ductility.

MA'LLEUS. (Lat. *a hammer*.) One of the small bones of the internal ear, attached to the *membrana tympani*, somewhat in shape resembling a hammer.

Malleus. A genus of Ostracean Bivalves, characterized by having, in addition to the simple pit for the ligament, a notch on the side of the ligament for the passage of a byssus. The species of this genus are called "hammer-oysters." The most noted is the *Ostrea malleus* of Linnæus, which has the cardinal region of the shell forming something like the head of a hammer, of which the elongated valves, extended transversely, represent the handle. It is a native of the Indian archipelago, and still ranks among the number of rare and high-priced shells.

MA'LLOW (Lat. malva.), is a weed common by hedgerows and waysides in Europe. It has mucilaginous properties, and has been employed in the preparation of emollient poultices, in the same way as the marsh mallow. Its fruit is a depressed disk, and is called by the country people "cheeses" (Fr. *Fromageon*).

MA'LLUM. The public assembly or meeting of the people according to the usage of the old Teutonic nations. Under the Carlovingian monarchs the mallum appears to have been summoned by the missus, or deputy of the sovereign. There is a separate mallum for every leading state or kingdom which composed the empire; and it was attended by the notables of all the various races of inhabitants (Roman, Frankish, Gothic, &c.), and in some instances by the Scabini or Echevins, who represented the communities of the towns.

MALMSEY. A strong and fine-flavoured sweet wine, made in Madeira of grapes which have been allowed to shrivel upon the vine; it is of a deep golden hue. It contains between 16 and 17 per cent. of alcohol.

MALT, is used to designate grain which has become sweet in consequence of incipient germination. Malt forms the principal ingredient in the manufacture of beer, and is not used for any other purpose. Three different kinds are employed: 1. pale or amber malt, which yields the saccharine or fermentable extract; 2. brown or blown malt, which is not fermentable, but is used to impart flavour; 3. roasted or black, or as it is sometimes called patent malt, which is employed instead of burnt sugar merely as a colouring matter. The process followed in the manufacture of malt is very simple, and has been carried on for a very long period nearly in the same manner in which it is conducted at present. (See *Thomson's Chemistry*.)

The manufacture of malt has been carried on in England to a great extent from a very early period; but it is singular that notwithstanding the products obtained from it have always formed the principal beverage of the great bulk of the people, the consumption of malt varied very little from the beginning of the last century till within the last half dozen years! This extraordinary result, so different from what would have been *à priori* anticipated, is ascribable partly to the increased duties laid on malt, but still more to the greater increase of those laid on beer, its principal product. No doubt, however, it has been partly, also, occasioned by the change that has taken place in the mode of living by the introduction and universal use of tea, coffee, and other articles substituted in the place of beer. But the increase that has taken place in the consumption of malt since the reduction of the duty on it in 1822, and the repeal of the beer duty in 1830, seems to prove that the duties were at least quite as instrumental in checking the consumption as the introduction of the articles alluded to. Malt was first made to contribute to the public revenue in England in 1697, in Scotland in 1713, and in Ireland in 1785. From the period at which the duty was first levied on malt down to the present time, it has been subject to numerous changes, a succinct account of which will be found in the *Penny Cyclopædia*. The present duty on malt from barley is 2*s*. 7*d*. per bushel, and from bere or bigg 2*s*. The quantity of malt charged with duty in the United Kingdom during the three years ending 1838, averaged 418,148,811 bushels; and the revenue derived from it averaged, in the same period, 5,282,972*l*.

MA'LTHA. A mineralogical term applied to *mineral pitch*; an inflammable bituminous product, probably de-

rived from the exsiccation of mineral tar. A cement containing mineral pitch was used by the ancients for plastering their walls, and was composed of pitch, wax, plaster, and grease. Another sort, with which the Romans used to plaster the interior of their aqueducts, was made of lime incorporated with melted pitch. The various bituminous pavements which have lately come into use are similar combinations.

MALVA'CEÆ. (Malva, one of the genera.) A natural order of mucilaginous Exogenous plants, with polypetalous flowers and monadelphous stamens. The species are herbs, bushes, or trees, and are found all over the temperate and tropical parts of the world, especially the latter. Their flowers are in many cases large and handsome; but the order is chiefly interesting from the *Gossypium*, or true cotton plant, forming a part of it. Another species is the marsh mallow, or *Althæa officinalis;* and some yield a fibre fit for manufacture into cordage.

MA'MELUKE. (Arabic, memalik, *a slave.*) A name applied to the male slaves imported from Circassia into Egypt by the master of that country. In the 13th century, when the countries in the vicinity of Mount Caucasus were ravaged by Gengis Khan, Nojmedden, sultan of Egypt, purchased several thousands of the natives of those regions, especially Turks, and formed them into an armed body of guards. These guards, or Mamelukes, in the sequel, seized on all the power of the country, murdered the sultan Touran Shah, A.D. 1258, and made Ibeg, one of their own number, his successor. After that period the Mamelukes, whose numbers were continually enriched by importations from their own country, governed Egypt 263 years. (See *Gibbon*, vol. xi.) This military sovereignty was destroyed by Selim I., the Turkish sultan, who took Cairo in 1517. Nevertheless, the Mamelukes, under their 24 beys, continued for 200 years more to exercise a power scarcely inferior to that of the Turkish pachas, whom, in the 18th century, they reduced to mere ciphers in the government. Their power was again considerably broken by the French invasion under Buonaparte, to which they offered a determined opposition. After the abandonment of Egypt by the French, the struggle between the beys and the pachas was renewed: finally, in 1811, the present pacha, Mohammed Ali, having invited the principal leaders of the Mamelukes to a banquet, slew 470 of them by treachery, and compelled the remainder to submission.

MA'MERTINE PRISONS. *See* PRISONS.

MAMMA'LIA. (Lat. mamma, *a teat.*) The most highly organized class of animals, at the head of the great scale of organized nature. They possess mammary glands, and suckle their young; the fœtus is developed in the womb. Their external distinguishing marks are a covering of hair, and teats or nipples; but to the manifestation of these two characters there are a few exceptions. The principal anatomical character is the condition of the lungs, which are suspended freely in a thoracic cavity, separated by a perfect diaphragm from the abdomen. The entire tissue of the lungs is occupied by extremely minute air-cells, with highly vascular parietes, so that the air inspired is rapidly decomposed, and breathing can be safely suspended only for a short time. The whole mass of circulating blood is transmitted to the lungs by the mechanism of a pulmonary auricle and ventricle, equally perfect, and inferior only in power to the systemic auricle and ventricle, which subsequently propel the aërated blood to the general system: the heart consequently consists of four distinct cavities.

The upper jaw of the Mammalia is fixed; the two rami of the lower jaw consist each of a single bony piece, and are articulated by a convex or flat condyle to the base of the zygomatic process, and not the tympanic element of the temporal bone. With a few exceptions, the jaws of the Mammalia are armed with teeth: these are arranged in a single row, are lodged in sockets, sometimes by two or more fangs, and are never anchylosed to the substance of the jaw. A deciduous tooth is never succeeded by more than one corresponding tooth in the vertical direction. The tongue is fleshy, well developed, with the apex more or less free. The posterior openings of the nasal passages are protected by the "soft palate," and the larynx, or opening of the wind-pipe, by an "epiglottis." The alimentary canal varies with the nature of the food, but the "cœcum coli" is usually single. The rectum commonly terminates by a distinct aperture behind the urinary and generative orifices.

The bodies of the vertebræ have their articular surfaces more or less flattened, and always joined together by a series of concentric ligaments with interposed glairy fluid. The cervical vertebræ, with one or two exceptions, are seven in number. The atlas is articulated by two surfaces to two occipital condyles, developed from the ex-occipital elements. With two exceptions, the coracoid bone appears as a small process or appendage of the scapula. The sternum is narrow, and consists of a simple longitudinal series of bones.

The brain presents its highest state of development in the Mammalia: it consists of a cerebrum, which is generally more or less convoluted, a cerebellum with lateral lobes, and a medulla oblongata with a distinct "tuber annulare." The optic lobes are solid, divided by a transverse fissure, and hence called "bigeminal bodies:" they are situated on the upper part of the crura cerebri, and are generally concealed by the overlapping posterior cerebral lobes. The rudiment of the "corpus callosum," or great cerebral commissure, first begins to be distinctly recognizable in the Implacental Mammalia; and in a state of normal development, or where it bears a direct proportion to the size of the corpora striata or hemispheres of the brain, it is peculiar to the Placental Mammalia.

The eyes of the Mammalia are never complicated with a pecten or marsupium, a choroid gland, or sclerotic bony plates.

The organ of hearing acquires in the Mammalia a fully developed cochlea with a "lamina spiralis:" there are three distinct ossicles in the tympanum; the drum, or membrana tympani, is usually concave towards the meatus, which generally commences with a more or less complicated external ear, supported by a distinct fibro-cartilage.

The Mammalia, without exception, bring forth their young alive; hence they were termed by Aristotle *Zootoca.* This phenomenon is, however, by no means peculiar to the present class; but it was supposed that they differed from other viviparous animals, as the viper, in the development of the germ by means of a placenta. Such, however, is not the case with the marsupial animals, and probably not with the Monotremes; and as the absence of the placenta is associated with several important modifications of structure in the species so developed, by which they approximate to the characters of the oviparous classes, the class Mammalia may be primarily divided into two great sub-classes, called *Placentalia* and *Implacentalia.*

Before, however, the subdivisions of these groups are characterized, it may be advantageous to trace the principal steps by which the present views of the affinities and classification of the Mammalia have been acquired.

Aristotle, although he has left no evidence of a systematic arrangement of the Mammalia in which the succession and subordination of the orders and families are methodically laid down, was nevertheless the first who indicated the larger groups into which the Mammalia resolved themselves, according to their natural affinities.

We may infer, *e. g.*, from one part of the *Historia Animalium*, that the *Zootoca* would be divided, according to the nature of their locomotive organs, into three sections: —1st, *Dipoda*, or bipeds; 2d, *Tetrapoda*, or quadrupeds; and, 3d, *Apoda*, or impeds. Man is cited as the type of the first, and the whale tribe is included in the last of these primary groups; the second embraces all the rest of the class, which, in common language, are called quadrupeds. These Aristotle subdivides into two great natural groups, according to the modifications of the organs of touch. In the first a part of the digits is left free for the exercise of the tactile faculty, the nail or claw being placed upon one side only; in the second group the extremities of the digits are enclosed in hoofs.

The first of these subdivisions is acknowledged to be natural, and has been retained by modern mammalogists under the name of *Unguiculata.* The following families were characterized in it by Aristotle: — 1st, those which have the front teeth trenchant, and the back teeth flattened, as the *Pithecoida* or apes, and the *Dermaptera* or bats; 2d, those with acuminated, trenchant, or carnivorous teeth, which Aristotle calls *Karcharodonta;* 3d, the Rodent quadrupeds, which are indicated by a negative dental character. With respect to the hoofed or "ungulate" quadrupeds, Aristotle points out subordinate groups, and characterizes them by modifications of the feet. Thus, the 1st are the *Polyschidæ* or multungulate quadrupeds, as the elephant; the 2d are the *Dischidæ* or bisulcate quadrupeds, as the Ruminants and hog; the 3d are the *Aschidæ*, or solidungulate quadrupeds, as the horse and ass. From the imperfect mode in which the zoological writings of the Stagyrite have been handed down, we have not the means of knowing whether Aristotle viewed any of the groups thus defined in their relation of subordination to each other, or in the spirit of modern classification; for although they agree in relative value with those termed *Classes*, *Orders*, *Families*, *Genera*, yet Aristotle applies to each of them the same denomination, viz. *genos*, or genus.

The honour of having formed an original scheme for the classification of quadrupeds, in which the subordination of characters and of groups is attended to, is due to our great countryman Ray. From Aristotle to his time the classification of the Mammalia received no improvement worthy of notice. Ray's arrangement is given in a tabular form, in his *Synopsis Methodica Animalium Quadrupedum;* and is as follows: —

A Table of Viviparous Four-footed Animals.

Viviparous hairy animals or quadrupeds are, —

- *Ungulate;* and these either
  - *Solidipedous*, as the Horse, Ass, Zebra.
  - or *Bisulcate*, which are
    - *Ruminants* with horns, that are
      - Persistent, as in the Ox, Sheep, Goat;
      - or Deciduous, as in the Stag.
    - or *Not Ruminants*, as the Hog.
  - *Quadrisulcate*, as the Rhinoceros, Hippopotamus.
- or *Unguiculate*, whose feet are either
  - *Bifid*, as in the Camel, or
  - *Multifid*, which are
    - With *digits* adhering together, and covered with a common integument, so that the extremities alone are visible at the margin of the foot, and are covered with obtuse nails, as in the Elephant.
    - With *digits* in some measure distinct, and separable from each other, the nails being
      - *Depressed*, as in Apes;
      - or *Compressed*, where the incisor teeth are
        - *Many*, in which group all the animals are carnivorous and rapacious, or at least insectivorous, or subsist on insects, with vegetable matter.
          - *The larger ones* with the
            - *Muzzle short*, and head rounded, as the Feline tribe; or with the
            - *Muzzle long*, as the Canine tribe.
          - *The smaller ones* with a long slender body, and short extremities, as the Weasel or Vermine* tribe.
        - or *Two very large*, of which tribe all the species are phytivorous, as the Hare.

"The anomalous species," he afterwards observes, "among the viviparous quadrupeds, with a multifid foot, are the hedgehog, the armadillo, the mole, the shrew, the tamandua, the bat, and the sloth. The first five of these species agree with the *canine* and *vermine genera* in their elongated muzzle, but differ from them in the form and disposition of the teeth; the tamandua, indeed, is altogether destitute of teeth: the remaining two anomalous species have the muzzle shortened."

Linnæus defines the class Mammalia as follows: — *Heart* with two auricles and two ventricles; blood warm; *lungs* respiring reciprocally (*pulmones respirantes reciproce*); *jaws* incumbent, covered, armed with teeth in most; penis intrans; generation viviparous, lactiferous; *senses*, tongue, nostrils, eyes, ears, tactile papillæ; *covering*, hairs few in tropical, very sparing in aquatic, mammals; *support*, four feet, except in those which are entirely aquatic, in which the posterior feet are bound together in the fin of the tail; a *tail* in most.

Linnæus, like Aristotle and Ray, founds his primary divisions of the class Mammalia on the locomotive organs; but his secondary divisions or orders are taken chiefly from modifications of the dentary system. The following is the scheme of his arrangement: —

Mammalia.

Unguiculate	Front teeth, none in either jaw	*Bruta.*
	Front teeth, *cutters* 2, laniaries 0	*Glires.*
	Front teeth, *cutters* 4, laniaries 1	*Primates.*
	Front teeth, *piercers* (6, 2, 10), laniaries 1	*Feræ.*
Ungulate	Front teeth, in both upper and lower jaw	*Belluæ.*
	Front teeth, none in the upper jaw	*Pecora.*
Muticate	Teeth variable	*Cete.*

(From the *Systema Naturæ*, ed. 16. Holmiæ, p. 24.)

On comparing the three preceding systems, it will be found that the most important errors of arrangement have been committed, not by Aristotle, but by the modern naturalists. Both Ray and Linnæus have mistaken the character of the horny parts enveloping the toes of the elephant, which do not defend the upper part merely, as is the case with claws, but embrace the under parts also, forming a complete case or hoof.

With respect to Linnæus, however, it must be observed, that although he has followed Ray in placing the elephant in the unguiculate group of quadrupeds, he has not overlooked the great natural divisions which the latter naturalist adopted from Aristotle, as is evident from the table above quoted. He erred, perhaps, in not giving names to those primary divisions.

From the manner in which Linnæus has arranged his orders in this table, it would seem that he had the circular progression of affinities in view. The walrus among *Bruta* connects the commencement of the chain with *Cete*, which forms the last link; but whether or not he had perceived the affinity of *Elephas* to the *Glires*, and intended it as the transitional genus to that order, as Cuvier has subsequently shown, is less certain.

Pallas, in his great posthumous work, entitled *Zoographia Rosso-Asiatica*, has given the following outline of a *Systema Mammalium:* —

Classis Lactantia.

Ordo I. *Feræ.* — 1. Felis; 2. Canis; 3. Ursus; 4. Méles; 5. Viverra; 6. Mustela; 7. Phoca.

Ordo II. *Semiferæ.* — 1. Simia; 2. Lemur; 3. Didelphys; 4. Vespertilio; 5. Talpa; 6. Sorex; 7. Erinaceus.

III. *Glires.* — 1. Hystrix; 2. Castor; 3. Lepus; 4. Arctomys; 5. Spalax; 6. Cricetus; 7. Mus; 8. Myoda; 9. Myoxus; 10. Dipus; 11. Sciurus.

IV. *Ruminantia.*—1. Camelus; 2. Moschus; 3. Cervus; 4. Ægoceros; 5. Bos; 6. Antilopes.

V. *Anomalopoda.* — 1. Equus; 2. Sus; 3. Rhinoceros; 4. Hippopotamus.

VI. *Belluæ.* — 1. Elephas; 2. Rosmarus.

VII. *Cetacea.* — 1. Manatus; 2. Delphinus; 3. Physeter; 4. Balæna; 5. Ceratodon.

We shall now proceed to the arrangement of the Mammalia proposed by Cuvier in the last edition of the *Règne Animal;* and this is the more interesting, as, in giving the outline of this method, Cuvier develops the principles on which his divisions are founded.

"The characters by which Mammalia differ most essentially one from another are derived from the organs of touch, from which results their degree of dexterity; and from the organs of mastication, which determine the nature of their food; and upon these very closely depends not only every thing which is connected with the digestive functions, but a variety of other circumstances relative even to their degrees of intelligence.

"The perfection of the organs of touch is estimated by the number and mobility of the digits, and the extent to which they are enclosed in a claw or in a hoof. A hoof which completely encloses that part of the digit which touches the ground precludes the exercise of it as an organ of touch or of prehension. The opposite extreme is where the nail, in the form of a simple lamina, covers only one side of the end of the digit, leaving the other side in possession of all its delicacy of tact.

"The kind of food is indicated by the molar teeth, to the form of which the articulation of the jaws invariably corresponds.

"For cutting flesh, the molar teeth must be trenchant and serrated; and the jaws fitted together, so as to move like the blades of a pair of scissars, simply opening and closing in the vertical direction.

"For bruising grains and roots, the molar teeth must have flattened crowns, and the jaws a horizontal motion: and further, that the grinding surface may be always unequal, like a millstone, the teeth must be composed of substances of different degrees of density, and consequently wearing down in different proportions.

"The ungulate quadrupeds are all of necessity herbivorous, or with flat-crowned molares, because the conformation of their feet does not permit them to seize living prey.

"The unguiculate animals are susceptible of more variety. They are not limited to one kind of food; and besides the consequent variation in the form of their molares, they differ materially from each other in the mobility and sensibility of their digits. There is, moreover, a characteristic which prodigiously influences their dexterity, and gives variety to their modes of action: it is the faculty of opposing a thumb to the other fingers, so as to seize the smallest objects, which constitutes a

* Genus *Vermineum*, from their wormlike form.

hand, properly so called. This faculty is carried to its highest degree of perfection in man, in whom the whole anterior extremity is free, and can be exclusively employed in prehension. These different combinations, which strictly determine the nature of the several mammiferous animals, have formed the grounds for their distribution into the following orders: —

"Amongst the unguiculate animals, the first is man, who, in addition to his peculiar privileges in every other respect, is distinguished, zoologically, by possessing hands on the anterior extremities alone; the posterior extremities being destined to sustain him in an erect position.

"The order which comes nearest to man — that termed *Quadrumana* — has hands on the four extremities.

"Another order, termed *Carnivora*, has not the thumb free and opposable on the anterior extremities.

"These three orders possess, likewise, severally, the three kinds of teeth; viz. molars, laniaries, and incisors.

"The quadrupeds of the fourth order, viz. the *Rodentia*, have the digits differing little from those of the *Carnivora*; but they want the laniary teeth, and have the incisors of a form and disposition altogether peculiar to themselves.

"To these succeed the animals whose digits now bebecome much cramped, being sunk deep in large and, most commonly, crooked claws. They are further defective in the absence of incisor teeth; some of them even want the laniaries, and others are altogether destitute of dentary organs. We shall comprehend them under the term *Edentata*.

"This distribution of unguiculate animals would be perfect, and would form a very regular chain, if New Holland had not lately furnished us with a small collateral chain, composed of the *Marsupial* animals, all the genera of which, while they are connected by a general similarity of organization, at the same time correspond, in their dentition and diet, some to the *Carnivora*, others to the *Rodentia*, and a third tribe to the *Edentata*.

"The ungulate animals are less numerous, and present fewer variations of form.

The *Ruminantia*, by their cloven feet, their want of upper incisors, and their complicated stomach, form a very distinct order.

"All the other quadrupeds with hoofs might be united into a single order, which I would call *Pachydermata* or *Jumenta*; the elephant excepted, which might form an order of itself, having some remote affinities to the order *Rodentia*.

"Last of all come the Mammalia which have no hinder extremities, and whose fish-like form and aquatic life would induce us to form them into a separate class, if their economy was not in every other respect the same as in the class in which we shall leave them. They are the warm-blooded fishes of the ancients, or the *Cetacea*, which, combining the powers of other Mammalia with the advantage of being sustained upon the watery element, include the most gigantic forms to be found in the whole animal creation." (*Règne Animal*, 2d ed. p. 65.)

The proofs that the small collateral chain of mammals which New Holland has principally furnished form a distinct primary group in that class, have been successively established in the memoirs by Mr. Owen on the Generation, the Structure of the Brain, the Osteology, and the Classification of the Marsupial Animals, and on the Mammary Glands, the Ovum, and the Young of the Ornithorhynchus, published in the *Philosophical* and *Zoological Transactions*. In the latest classifications of the Mammalia (Charles Lucien Buonaparte, *Systema Vertebratorum*; Martin, *History of Mammalia*), the binary division of the class Mammalia, founded on the anatomical and physiological facts detailed in those memoirs, has been adopted.

The first of these divisions, which we have proposed to call subclass PLACENTALIA, includes the following orders: —

I. *Bimana.* — Ex.: Man.
II. *Quadrumana.* — Ex.: Ape, Monkey, Lemur.
III. *Cheiroptera.* — Ex.: Bat.
IV. *Insectivora.* — Ex.: Shrew, Mole, Hedgehog.
V. *Carnivora.* — Ex.: Dog, Civet, Cat, Weasel, Bear, Seal.
VI. *Cetacea.* — Ex.: Porpoise, Whale.
VII. *Pachyderma.* — Ex.: Manatee, Hippopotamus, Elephant, Hog, Horse.
VIII. *Ruminantia.* — Ex.: Camel, Deer, Antilope, Ox.
IX. *Edentata.* — Ex.: Sloth, Anteater, Manis, Armadillo.
X. *Rodentia.* — Ex.: Rat, Squirrel, Rabbit, Guinea-pig.

The second division, or the subclass IMPLACENTALIA, includes the orders,

XI. *Marsupiata.* — Ex.: Wombat, Kangaroo, Opossum.
XII. *Monotremata.* — Ex.: Ornithorhynchus.

Besides the modification introduced into the Cuvierian system in the binary subdivision of the class, there are a few minor differences in the above classification on which some explanation is requisite.

From Pallas's great group of *Semiferæ*, the families of which he conceived to be linked together by an uninterrupted series of affinities, the *Simiæ* and *Opossums* are removed, in the Cuvierian system, to form the types of two distinct orders: we conceive that the modification of the locomotive system, by which the bat is enabled to fly, is as cogent an argument for regarding it as the type of an order, as the hinder hands are in the case of the ape and lemur. The *Insectivora*, also, in their continuous dental series, comparatively feeble canines, and generally perfect clavicles, seem to claim equivalency of rank with the remaining *Carnassiers* of the Cuvierian system, which will thus correspond with the *Feræ* of Pallas. From the seals, with their largely developed brains, acuminated teeth, and rudimental hind fins, the transition seems most natural to the piscivorous *Cetacea*. The herbivorous *Cetacea*, for reasons given at length in the *Proceedings of the Zoological Society*, 1838, we propose to remove to the *Pachyderma*, between which and the true *Cetacea* they unquestionably form transitional links. No linear arrangement of the orders of a class can ever express more than a part of their mutual affinities. If we were to place them according to their natural relations, the *Quadrumana* would occupy the centre of the class, as from these the greatest number and variety of affinities seem to radiate. Thus, the genus *Galeopithecus* leads to the *Cheiroptera*, the *Lemur* to the *Carnivora*, the *Loris* to the sloths among the *Edentata*; while with the *Rodentia* the *Lemurs* claim close alliance through the *Cheiromys* or *Aye-aye*. The *Insectivora* closely approach one extreme of the implacental group, while the *Edentata* join the other. The *Rodentia* approach still more closely to the marsupial wombat. The *Rodentia*, again, by the *Capybara* and the extinct *Toxodon*, evidently merge into the *Pachyderma*; and the Patagonian hare seems to lead them to the small musk-deer among the *Ruminantia*. The *Edentata* have lost in the mailed *Glyptodon* a transitional step to the thick and tubercular-hided rhinoceros. The twofold affinity of the *Cetacea* to the seals on the one hand, and to the manatee and the hippopotamus on other, has been already alluded to.

In this reticulate interweaving of affinities, under which image the true relations of the Mammalia, as at present known, can alone be impartially and faithfully expressed, it will be observed that, as the series diverge from the *Quadrumana*, they likewise descend; so that the scheme may be likened to a cone, of which Man is the culminating point.

From different points at the base of this cone the connection may be traced with the inferior classes: the most direct transition appears to be made by the Monotremes to the class of Reptiles. The extinct *Enaliosauria* once formed a transition, perhaps not less close, from the crocodiles to the *Cetacea*. The *Pterodactyles* seem to have connected the *Cheiroptera* with the flying ovipara. The Mammalia which present the closest relations to birds are the marsupial *Petaurists*, and the arboreal *Rodents*; but the hiatus is great. Between mammals and fishes, the reptiles interpose at all points; the extinct *Ichthyosaurus* seems to have been the transitional step from the *Cetacea* to the true fishes.

MAMMA'LOGY. (Lat. mamma, *a teat*; Gr. λογος, *a discourse*.) The science of Mammals: the doctrine of their organization, habits, properties, and classification. *See* MAMMALIA.

MA'MMIFERS, *Mammifera*. (Lat. mamma, *a teat*; fero, *I bear*.) A term synonimous with Mammals, or Mammalia.

MAMMI'LLARY. (Lat. dim. mammilla.) In Geology, a surface studded over with rounded projections.

MA'MMON (Syr.), used in scripture to signify either riches, or the god thereof. By poetic licence Milton makes Mammon one of the fallen angels, and has pourtrayed his character in some admirable lines, which are too well known to be cited here.

MA'MMOTH. A word of Tartar origin, applied in Siberia to burrowing animals. It is commonly applied to an extinct species of elephant (*Elephas primigenius*, Blum.). The remains of this animal occur pretty frequently in the newer tertiary deposits in England, the continent of Europe, and Asia. In Siberia an entire animal has been discovered, with the soft parts preserved in the frozen soil of the banks of a Siberian river. The particulars of this remarkable discovery are as follow: — In 1799, a Tungusian, named Schumarhoff, who generally went to hunt and fish at the peninsula at Tamut, after the fishing season of the Lena was over had constructed for his wife some cabins on the banks of the lake Opcoul, and had embarked to seek along the coasts for mammoth horns (tusks). One day he saw among the blocks of ice a shapeless mass, but did not then discover what it was. In 1800 he perceived that this object was more disengaged from the ice, and that it had two projecting parts; and, towards the end of the summer 1801, the entire side of the animal and one of his tusks were quite free from ice.

The summer of 1802 was cold; but, in 1803, part of the ice between the earth and the mammoth, for such was the object, having melted more rapidly than the rest, the plane of its support became inclined, and the enormous mass fell by its own weight on the bank of sand. In March, 1804, Schumarhoff came to his mammoth, and, having cut off the tusks, exchanged them with a merchant for goods of the value of fifty rubles. Adams gives the following account of this remarkable occurrence. "Two years afterwards, or the seventh after the discovery of the mammoth, I fortunately traversed these distant and desert regions, and I congratulate myself in being able to prove a fact which appears so improbable. I found the mammoth still in the same place, but altogether mutilated. The prejudices being dissipated, because the Tungusian chief had recovered, there was no obstacle to prevent approach to the carcass of the mammoth; the proprietor was content with his profit from the tusks, and the Jalutski of the neighbourhood had cut off the flesh, with which they fed their dogs during the scarcity. Wild beasts, such as white bears, wolves, wolverines, and foxes, also fed upon it, and the traces of their footsteps were seen around. The skeleton, almost entirely cleared of its flesh, remained whole, with the exception of one fore-leg, the spine, from the head to the os coccygis, one scapula: the bones of the other three extremities were still held together by the ligaments and by parts of the skin. The head was covered with a dry skin: one of the ears, well preserved, was furnished with a tuft of hairs. All these parts have necessarily been injured in transporting them a distance of 11,000 wersts (7330 miles); yet the eyes have been preserved, and the pupil of the eye can still be distinguished. This mammoth was a male, with a long mane on the neck, but without tail or proboscis." (The places of the insertion of the muscles of the proboscis are, it is asserted, visible on the skull; and it was probably devoured, as well as the end of the tail.) "The skin, of which I possess three fourths, is of a dark-grey colour, covered with a reddish wool and black hairs. The dampness of the spot where the animal had lain so long had in some degree destroyed the hair. The entire carcass, of which I collected the bones on the spot, is 4 archines (9 feet 4 inches) high, and 7 archines (16 feet 4 inches) long, from the point of the nose to the end of the tail, without including the tusks, which are a toise and a half (9 feet 6 inches), measuring along the curve: the distance from the base or root of the tusk to the point is 3 feet 7 inches in length; the two together weighed 360 lbs. avoirdupois; the head alone with the tusks weighs 11 poods and a half (414 lbs. avoirdupois). The principal object of my care was to separate the bones, to arrange them, and put them up safely, which was done with particular attention. I had the satisfaction to find the other scapula, which had remained not far off. I next detached the skin of the side on which the animal had lain, which was well preserved. This skin was of such extraordinary weight, that ten persons found great difficulty in transporting it to the shore. After this I dug the ground in different places, to ascertain whether any of its bones were buried, but principally to collect all the hairs which the white bears had trod into the ground while devouring the flesh. Although this was difficult, from the want of proper instruments, I succeeded in collecting more than a pood (36 pounds) of hair. In a few days the task was completed, and I found myself in possession of a treasure which amply recompensed me for the fatigues and dangers of the journey, and the considerable expenses of the enterprise. The place where I found the mammoth is about 60 paces distant from the shore, and nearly a hundred paces from the escarpment of the ice from which it had fallen. The escarpment occupies exactly the middle between the two points of the peninsula, and is three wersts long (two miles); and, in the place where the mammoth was found, this rock has a perpendicular elevation of 30 or 40 toises. Its substance is a clear pure ice; it inclines towards the sea; its top is covered with a layer of moss and friable earth, half an archine (14 inches) in thickness. During the heat of the month of July, a part of this crust is melted, but the rest remains frozen. Curiosity induced me to ascend two other hills at some distance from the sea: they were of the same substance, and less covered with moss. In various places were seen enormous pieces of wood of all kinds produced in Siberia; and also mammoths' horns (tusks), in great numbers, appeared between the hollows of the rocks: they all were of astonishing freshness. How all these things could become collected is as curious as difficult to resolve. The inhabitants of the coast call this kind of wood *adaincina*, and distinguish it from the floating pieces of wood which are brought down by the large rivers to the ocean, and collect in masses on the shores of the Frozen Sea: the latter are called *macheina*. I have seen, when the ice melts, large lumps of earth detached from the hills mix with the water, and form thick muddy torrents, which roll slowly towards the sea. The earth forms wedges which fill up the spaces between the blocks of ice. The escarpment of the ice was 35 to 40 toises high; and, according to the report of the Tungusians, the animal was, when they first saw it, seven toises below the surface of the ice, &c. On arriving with the mammoth at Boschaya, our first care was to separate the remaining flesh and ligaments from the bones, which were then packed up. When I arrived at Jakutsk I had the good fortune to repurchase the tusks, and from thence expedited them to St. Petersburg. This skeleton is now in the museum of the academy, and the skin still remains attached to the head and feet." A part of the skin, and some of the hair of this animal, were sent by Mr. Adams to Sir Joseph Banks, who presented them to the museum of the Royal College of Surgeons. The hair is entirely separated from the skin, excepting in one very small part, where it still remains attached. It consists of two sorts — common hair and bristles; that remaining fixed on the skin is of the colour of the camel, an inch and a half long, very thick set, and curled in locks: it is interspersed with a few bristles, about three inches long, of a dark reddish colour. The skin when first brought to the museum was offensive; it is now quite dry and hard, and where most compact is half an inch thick. Its colour is the dull black of the living elephant's skin.

MAN. (Germ. mann; probably from the Lat. *humanus* or *mens.*) Of all living beings on the surface of this planet the first is man; who, in addition to his peculiar privileges in every other respect, is distinguished zoologically by possessing a hand on the anterior extremities only, the posterior or lower limbs being destined to sustain him in an erect position. He is, however, naked, and without natural defensive or destructive weapons. It is the modifications of the bones and muscles of the lower extremities, and especially of the feet, that constitute the most striking anatomical characters of the human species; but with these are associated many other characteristic conditions of the general frame-work of the body, which, as they have been nowhere so accurately, truly, and eloquently set forth as in the lectures of Professor Green, we shall take the liberty to give in the words of that philosophic anatomist and accomplished writer. "In a comparison of the frame and capabilities of man with those of the inferior animals, if we take the human frame as the ideal standard of form, it will be found that all others present so many declensions from the idea by exaggeration or defect; and it will be found from this survey that man is unquestionably endowed with that structure, the perfection of which is revealed in such a balanced relation of the parts to a whole as may best fit it for a being exercising intelligent choice, and destined for moral freedom. It is not, therefore, an absolute perfection of the constituents singly, but the proportional development of all, and their harmonious constitution to One, for which we contend; — a constitution which implies in a far higher degree than in any other animal a balanced relation of the living powers and faculties, and which requires, therefore, in man pre-eminently the endowment of rational will as necessary for the control and adjustment of the balance. Man has not the quick hearing of the timid herbivorous animals; but it was not intended that he should catch the sound of distant danger, and be governed by his fears: he has not the piercing sight of the eagle, nor the keen scent of the beast of prey; but neither was man intended to be the fellow of the tiger, or a denizen of the forest. Hence the departure from the perfect proportion of man which we observe in the inferior animals may be regarded as deformities by exaggeration or defect, dependent upon a preponderance of a part that necessitates a particular use, or the absence of a part that deprives the animal of a power, and in both instances alike abrogates that freedom for which provision is made in the balanced relation of the constituents of the human fabric, which permits the free choice of means, and the adaptation to any purpose determined by an intelligent free-will. Dilate the head, and you have a symptom of disease; protrude the jaws, you have a voracious animal; lengthen the ears, timidity is expressed; let the nose project, and the animal is governed by its scent; enlarge the belly, and you are reminded of the animal appetites: long arms may fit him for an inhabitant of the trees, and a fit companion for the ape; and predominant length of legs are infallibly associated with the habits of the wading or leaping animals. In all, regarding man's form with reference to his destination as the ideal standard, the means become ends; deformity prevails, and becomes the badge of unintelligent slavery to the mere animal nature.

"This may be further illustrated by a general and brief comparison of the components of the skeleton in the vertebrated animals with that of man. In considering the skull, it will be found that man, of all animals, has the largest and roundest cranium. From the ape to the fish the brain-case decreases in capacity, in correspondence with a proportionably diminishing development: but in the same ratio the parts allotted to the senses, and the parts merely subservient to the preparation of the food, increase in size. In looking at the head of the

horse and the dog, it will be readily observed how much the cranium recedes and the jaws protrude; but in birds, reptiles, and fish, the proportions are so altered by the diminution of the cranium that the whole head appears almost to consist of the jaws: witness the mandibles of the stork and pelican, and the enormous jaws of the crocodile and shark. And we may add, that man is the only animal that has a prominent chin. This distinguishing character of the human skull, found in the proportion of the brain-case to the jaws when compared with the same in the inferior animals, the ingenious Camper devised the method of more accurately determining by means of what has been called the 'facial angle.' It consists in drawing one line from the most prominent part of the forehead to the sockets of the upper incisor teeth, and a second, which describes the ground plane of the cranium, through the external *meatus* of the ear and lower edge of the nose, and which, cutting the first on the upper jaw, forms with it a determinate angle; and it is evident that this angle will be greater in proportion to the development of the forehead and recession of the superior *maxilla*, less or more acute in proportion to the projection of the upper jaw and recession of the forehead. According to this mode of relative admeasurement, it appears that the facial angle in the European exceeds that in the negro; and it is worthy of notice that the Greek sculptors, who were careful to mark strongly, or even exaggerate those circumstances which peculiarly mark the human character, have often exceeded the right angle in the ideal anatomy of their deities, though at the same time with the discriminative taste which prevented them from exceeding the limit beyond which the form would have become a symptom of disease. It follows, then, that the size of the brain-case in man, proportionate to the development of the brain, indicates the predominance of this organ over those of the senses, which may be regarded as the measure of the subserviency of the animal to the outward excitants, and over the organs for the preparation of the food, the preponderance of which marks the subjugation of the creature to the mere animal needs, — that the predominant development of the cranium, I say, is the mark, symbol, and condition of man's characteristic excellence, as preeminently gifted with mind."

"If we compare the lower limbs of man with the hinder extremities of quadrupeds, we find the peculiar character and perfection of the former in their adaptation and appropriation to maintain the balance of the body in the erect posture. In some, indeed, the hinder limbs are so formed as to permit the creature to obtain for a time the free use of the fore extremities; but the endowment serves but to mark, as in the monkey, that it was intended for a climbing animal, and the extraordinary length and strength of the legs of the kangaroo show only its aptitude to leap. And if, in birds, the support of the body is effected by two legs, it leaves the interior extremities free only for the purpose of aiding in, and of executing, a different mode of locomotion. In man alone the lower extremities, providing wholly the means of support and progression, leave the upper limbs as instruments, the use of which is entirely at the choice of the agent. And, in aid of this purpose, we find in man the most perfect upper extremity. From the ape to the fish the different components diminish in number, development, and variety of motion. This is especially noticeable in the hand; which, in consequence of the length of the fingers, the number of articulations, and the multiplicity of their movements, especially in consequence of the capability of opposing the thumb to the fingers, becomes an instrument fitted for the most delicate and varied operations directed by the skill and intellect of man. Compare, in this respect, this flexible and modifiable apparatus with the single digit of the extremity of the horse, on the horny tip of which the weight of the animal (by an admirable mechanism indeed) is supported and carried; or with the abortive hand of the whale, sufficiently like the human to be so called, but retracted, enveloped in skin, and degenerated into a fin, that merely serves as an oar in propelling the animal through the water. It might be said, perhaps, that the hand of the monkey claims the praise of as great perfection as that of man; but the dwindled thumb marks its imperfection for handling and for touch: and the arms even of the anthropoeid orang-outan, lengthened to deformity, irresistibly prove their use to be little else than for grasping and climbing.

"In the contemplation of the human skeleton its most striking characteristic, however, and that which contradistinguishes it from the bony fabric of all other animals, is its adaptation to the erect position; an attribute not only peculiar to man, but without which his structure could not correspond to his spiritual endowments, since it is at once the need and symbol of a being raised above the servile condition of the mere animal nature.

"Thus the skull is poised, with only a slight preponderance anteriorly, at the top of the vertebral column; and a plumb-line dropped from the point of its support falls through the centre of gravity between the feet, which present the base of support to the whole towering fabric. We remark, however, that the supporting parts do not range with this line.

"The spine is bent like an italic *S*: it recedes at the chest, in order to give room to its cavity; and at the same time is harmoniously inflected forwards at the loins and neck, in order to facilitate its balance over the points of support; and it cannot be doubted that these curves contribute to the capability of bending and changing the position of the trunk, without endangering the loss of balance. But the balance of the body is also greatly aided by the breadth of the human pelvis, which supplying a broad base of support, permits the inclinations of the trunk without the necessity of altering the position of the lower limbs. The lateral breadth of the pelvis, however, throws the heads of the thigh bones, upon which the weight of the body is transmitted, to some distance on each side of the line that falls through the centre of gravity; and in order to provide a compensating adjustment, the thigh bones are placed obliquely, inclining towards each other; so that in the upright posture with the feet together they touch at the knees, and the weight is then received upon the heads of the leg bones or *tibiæ*, which stand perpendicularly under the centre of gravity: and these again are planted upon the arch of the foot or instep, on which the whole weight of the body securely rests. Then, in order to secure in the foot the requisite firmness in standing, we find that it is articulated with the leg at right angles, so that both the heel and toes touch the ground; and the joint is placed nearer the posterior than the anterior part of the foot, so as to increase the base of support in that direction towards which the body tends most to fall: besides which, the weight is here received on the inner side of the foot, where it is most arched, thereby offering not only the advantage of a strong support, but one which is highly elastic, yielding without injury in alighting upon the feet, and acting as a spring in progression. Thus the majestic column of the human form is raised and built up upon its pedestal; and the living pillar, readily maintaining its equipoise, bears aloft its capital, whilst the upper limbs are left free to adlibitive motion. Thus the place of the head, as the corporeal representative of that which perceives and wills; the disposition of the senses therein as the *media* of intelligence, and of the organs of speech as the interpreters of thought; and the arrangement of the upper limbs as instruments of volition, no longer subservient to mere animal needs, — all impress us with the conviction that even the skeleton cannot be intelligible to us without admitting that the human bodily frame was designed for the instrument and dwelling of a being contradistinguished from, and elevated above, all other animals —

> A creature, who not prone
> And brute as other creatures, but endued
> With sanctity of reason, might erect
> His stature, and upright, with front serene,
> Govern the rest, self knowing.

"Man alone is erect. It is to this posture that the body of a man owes the character, impressed on the whole frame, of its emancipation from subserviency to the mere animal needs, and becomes expressive of mind and of free and intelligent action. It will be seen that the lower limbs, answering the purposes of support and locomotion, have alone any obvious or necessitated utility; while the upper extremities are, in consequence, left at liberty, as the ready and facile instruments of his will. Hence too, the senses are best freed from their servitude to the bodily wants, and the countenance is raised as the expressive exponent of thoughts and feelings, which the mouth declares and interprets by words. And thus, as the stem bears the corolla, the head is carried on high as the most noble part of the frame which it surmounts; all the rest of the body seems as if intended to carry it; and when considered in its fitness for expression, it may be said to be the representative of the whole man.

"If principally connected with erect posture the body is admirable, and acquires its human character, we shall no less find, in directing our attention to the organs of motion in man, the aptitude and capabilities of a being designed for intelligent freedom. We find in man the organic structure adapted for the greatest variety of motion. It is true, indeed, that many of the Mammalia are so constituted as greatly to excel man in particular kinds of locomotion; but we shall in vain look for the same combination and mastery of his powers which the erect posture implies. The monkey climbs and jumps with a facility truly extraordinary; but it is with difficulty, or only for a short time, that he raises himself into the erect position. Dogs, horses, deer, excel man in swiftness; but they cannot climb nor walk erect. The otter, the beaver, and the seal swim well; but it is their only boast above creatures of their own kind. And whales, or other cetaceous animals, though admirably adapted for swimming, have no other means of locomotion. Man, on the other hand, stands and walks erect; runs, jumps, climbs, swims. Man alone can so modify his frame that it is in his power to waive the high privilege of

the harmony and balance of his faculties; and, by concentering his volition to any one property or perfection, we have reason to believe that he might equal or excel the beast most characterized by that perfection, — outrun the deer, outwrestle the bear, climb with the monkey. In short, man has the most modifiable organs of motion, and is most capable of subjugating them to his will, and of rendering them the instruments of his varied purposes.

"The capability of varied motion in man depends greatly upon the facility with which the different parts of the body, especially the limbs, move at the same time in opposite directions, — a power which not only permits variety of movement, and confers an aptitude of expressive action, but likewise gives pre-eminently a character of suppleness, ease, and freedom to the total motion. But it is the equipoise of his body, in connection with the erect position, which gives the unity to any totality of movement, and determines the attitude or carriage necessary to preserve its balance. In order to balance the body, whether at rest or in motion, it is necessary that the man should exert an incomparably greater number of muscles than the inferior animals; and for the same reason a far greater effort of his volition is required for adjusting the proportional action of each, and for combining and harmonizing the actions of all; in short, of all animals, man must be the master of his own body.

"It is further deserving of notice, that the inflections of the trunk, the motions of the limbs, and the play of the several joints, all tend to the circular and curvilineal in their movements; a circumstance which mainly tends to confer on human motion the character of beauty. And it may be safely affirmed that, under all the varieties of expressive movement, the very structure and mechanism of the body tend to reduce its motions to the form of the beautiful, or resolve them into grace; a fact of which we may convince ourselves in watching the sinuous movements of the dance, wherein, aided by the totality of motion in the dancer, they present a harmony by continuity — a problem of grace which is ever solving and ever beginning anew.

"Beauty of attitude and grace of carriage are, however, intimately connected with the maintenance and equipoise of the body. No attitude can be beautiful in which the idea of rest is not conveyed by that permanence and security which result from a perfectly felt balance. 'Grace of carriage requires not only a perfect freedom of motion, but also a firmness of step, arising from a constant bearing of the centre of gravity over the base of support.' (*Arnott's Physics*, p. 128.) It includes ease and security. And in both, whether it be motion becoming fixed as attitudes, or attitudes presenting themselves in the shaping flow of motion, beauty and grace reveal themselves in self-command, and in freedom made manifest by self-control. In short, look at the body in any position or attitude, in any of the incidental or casual forms arising out of the free and unconstrained movements of man healthy in frame and unshackled by conventional usages, and the truth will force itself on your conviction. Pass in review the ponderous strength of the Hercules, the agile Mercury, the graceful ease of the Antinous, the reclining Ilyssus, all the animated forms of the frieze of the Parthenon — whatever Greek art has signalized or modern genius realized; witness the sports of children, or go even to the wild denizens of the American forest, and proof will no longer be needed that grace and beauty are inherent in, not accidents of, the human body, as the fit instrument of human freedom and intelligence, and the translucent medium, as it were, of man's proper and spiritual being." (*Green's Vital Dynamics*, 1840, p. 60.)

The main points of internal anatomy in which man differs from or excels the lower animals are the following: — First of all in the magnitude of the brain, which is relatively greater than the spinal chord and nerves in him than in any other animal. This superiority is chiefly due to the great development of the hemispheres of the cerebrum, which are likewise characterized in man by the number and depth of the convolutions, by which the cineritious and vascular surface is augmented. The parts which are most evidently superadded to the human brain are the posterior lobes of the cerebrum, the corresponding horn of the lateral ventricle, and the lesser hippocampus.

Of the external senses, that of smell is the least developed; but both this and the other organs are well balanced, and in their organization most delicate and perfect. The two eyes are directed forward; and thus, though man does not see on two sides at once, like many quadrupeds, there is more unity in the result of his vision, and he can concentrate his attention more closely on the objects of his scrutiny. The external ear, having little mobility or extent, does not increase the intensity of sounds; notwithstanding which, Cuvier well remarks that man best distinguishes their intonation. So also with respect to the organ of smell: though most animals excel man in their power of scent for particular objects, there are none perhaps which can distinguish so many varieties of, or which are so uniformly affected by, unpleasant, odours. In the discrimination and delicacy of taste man has unquestionably the advantage over the lower animals; and in no species is the hand so framed, or the tactile extremities of the digits so expanded, or endowed with such an exquisitely sensitive and discriminative integument, as in man.

"Man," says Cuvier, "has a particular pre-eminence in his organs of voice: he is the only mammal that can articulate sounds; probably on account of the form of his mouth and the great mobility of his lips. Hence results his most valuable mode of communication; for of all signs that can be conveniently employed for the transmission of ideas, varied sounds are those which can be perceived at the greatest distance, and in most directions simultaneously."

The position of the heart, which rests obliquely on the diaphragm, and on which depends the absence of the azygos lobe of the right lung, and of the thoracic inferior cava, — both which exist in most of the inferior Mammalia, — relates to man's erect position.

The alimentary organs of man indicate his natural destination for a mixed diet of animal and vegetable substances; but the prehensile faculty of his hands, and the intelligence which governs its application, permitted the teeth to remain of such forms and proportions as might simply serve to divide and crush the food which the hands carry to the mouth. Thus the canine teeth, though present and with crowns shaped for piercing, do not exceed the adjoining teeth in size, and no interval in the dental series of one jaw is required to receive a produced tusk of the opposite jaw when the mouth is closed: thus the dental series in man is not only equable, but unbroken. The fore teeth are framed for dividing*; the back-teeth have flat and tuberculate crowns for bruising: the short and but moderately strong jaws hardly admit of the mastication of herbage, or the devouring of flesh that has not been previously prepared by cooking.

The organs of digestion conform with those of manducation; the stomach is simple; the intestinal canal of mean length; the small intestines are provided with numerous transverse folds of the secreting and absorbing mucous membrane, called *valvulæ conniventes*: the large intestines are well marked; they commence by a short and wide cæcum, provided with a long, slender, and vermiform appendage.

The period of gestation is nine months: in general there is only one child at a birth; twins are born once in about five hundred cases of parturition, and more than that number is extremely rare. The fœtus of seven months is eleven inches in length; that of nine months eighteen inches. Those which are born prior to the seventh month usually die. The first, or milk-teeth, begin to appear a few months after birth, commencing with the incisors; at two years the entire deciduous series, twenty in number, is attained. These are shed successively from about the seventh year, to be replaced by others. The eight deciduous incisors are succeeded by eight permanent ones; the four deciduous canines by four permanent ones; the eight deciduous molares by the eight bicuspides. Of the twelve true or posterior molars, which are permanent, there are four — one on each side of both jaws — that make their appearance at four years and a half; four more at nine years; the last four being frequently not cut until the twentieth year. The fœtus presents one fourth of the adult stature when born; it has attained one half of it at two years and a half, and three fourths at nine or ten years. Between the seventeeth and twenty-first years the growth almost entirely ceases. Man rarely exceeds six feet, and seldom remains under five. Woman is ordinarily some inches shorter. When the full stature is attained the body generally begins to increase in bulk: fat is accumulated in the cellular tissue; afterwards the solids become rigid; the fat is commonly absorbed; the before smoothly-filled integument falls in wrinkles; and old age arrives, with decrepitude, decay, and death. Man rarely lives beyond a hundred years; and most of the species, either from disease, accidents, or merely old age, perish before that term.

"The child," says Cuvier, "needs the assistance of its mother much longer than her milk; whence results an education intellectual as well as physical, and a durable mutual attachment. From the long period of infantile weakness results domestic subordination, and, consequently, the order of society at large; as the young persons which compose the new families continue to preserve with their parents those tender relations to which they have been so long accustomed. This disposition to mutual assistance multiplies to an almost unlimited extent those advantages previously derived by isolated man from his intelligence: it has assisted him to tame or repulse other animals, to defend himself from the effects of climate, and thus enabled him to cover the earth with his species. Circumstances, more or less favourable, have restrained the social condition within limited degrees, or

* The intermaxillary bones, in which the incisors are developed, are anchylosed to the maxillaries at an early period of fœtal existence.

have promoted its development. The glacial climates of the north of both continents, and the impenetrable forests of America, are still inhabited by the savage hunter or fisherman; the immense sandy or salt plains of Central Asia and Africa are covered with a pastoral people and innumerable herds: these half-civilized hordes assemble at the call of every enthusiastic chief, and overrun the cultivated countries that surround them, in which they establish themselves but to become enervated, and to be subjected in their turn to the next invaders. This is the true cause of that despotism which, in every age, has crushed the industry called forth under the fine climates of Persia, India, and China. Mild climates, soils naturally irrigated and rich in vegetables, are the natural cradles of agriculture and civilization; and when their position is such as to afford shelter from the incursions of barbarians, talents of every kind are mutually excited. Such were formerly (the first in Europe) Greece and Italy; and such is at present nearly all the happy portion of the earth's surface."

The influences of climate, and of the different habits and social conditions thence resulting, are associated with differences of form, stature, features, and colour of the skin; not greater, however, than the corresponding differences which indicate varieties of a species in the lower Mammalia: and accordingly naturalists have distinguished, and have characterized with more or less success, different races or varieties of man. As the races and varieties of the domesticated quadrupeds, so also those of the human species, blend imperceptibly with each other; and the absence of well-defined boundaries depends not only on the gradual subsidence and change of those physical causes which probably gave rise to the original varieties, but also to the faculty common to the individuals of different varieties of the same species to produce, by their union, individuals capable of propagating the intermediate variety. Hence has arisen the difficulty of defining the primary races of man, and the discrepancy which exists in the conclusions of those naturalists who have devoted the greatest attention to this important and most interesting branch of zoology. Cuvier considers that *three* varieties are eminently distinct, — the white, or *Caucasian;* the yellow, or *Mongolian;* the black, or *Æthiopian.*

"The Caucasian," he observes, "to which we belong, is distinguished by the beauty of the oval which forms the head; and it is this one which has given rise to the most civilized nations, — to those which have generally held the rest in subjection: it varies in complexion and in the colour of the hair.

"The Mongolian is known by his projecting cheekbones, flat visage, narrow and oblique eyebrows, scanty beard, and olive complexion. Great empires have been established by this race in China and Japan, and its conquests have sometimes extended to this side of the Great Desert; but its civilization has always remained stationary.

"The Negro or Æthiopian race is confined to the southward of the Atlas chain of mountains; its colour is black, its hair crisped, the cranium is contracted, and the nose flattened. The projecting muzzle and thick lips evidently approximate it to the apes: the hordes of which it is composed have always continued barbarous."

To the three primary races characterized by Cuvier Blumenbach adds the *Malayan* and *American* races. Of the Malays, however, Cuvier asks, "Can they be clearly distinguished from their neighbours on both sides, the Caucasian Indians and the Mongolian Chinese?" And with regard to the Americans, he states, "They have no precise or constant character which can entitle them to be considered as a particular race. Their copper-coloured complexion is not sufficient. Their general black hair and scanty beard would induce us to approximate them to the Mongols, if their defined features, their nose as projecting as ours, their large and open eyes, did not oppose such a theory, and correspond with the features of the European." Dr. Pritchard, however, considers that there are seven classes of nations which may be separated from each other by strongly marked lines.

The *first* class corresponds with Cuvier's Caucasian variety, but which Dr. Pritchard prefers to call *Iranian.*

The *second*, which he terms *Turanian*, is equivalent to the Mongolian variety.

The *third* class are the native American races, excluding the Esquimaux and some tribes which resemble them more than the majority of inhabitants of the new world.

The *fourth* class comprises only the Hottentot and Bushman races.

A *fifth* class includes the Negros.

The *sixth* class consists of the Papuans, or woolly-haired natives of Polynesia.

The *seventh* class includes the Alfourou and Australian races.

A study of the resemblances and differences of human speech in various regions and various ages has added much and will contribute more to the true knowledge and definition of the primitive races of the human species. It has already led to the establishment of the following families of languages: — The *Semitic*, to which belong the Hebrew, Arabic, Chaldean, Syrian, Phœnician, and Ethiopian; the *Indo-Europæan*, which includes Sanskrit, Persian, Greek, Latin, German, and Celtic; the *Monosyllabic* languages, as Chinese, Thibetan, Birman, Siamese; the *Polysynthetic* languages, a class including most of the American Indian dialects. The combination of zoological, anatomical, and glossological characters, is still wanting to establish the exact characters and limits of the human races.

MANATE'E. A herbivorous Cetacean, forming the type of a distinct genus, *Manatus.* See that word.

MANA'TUS. (Lat. manus, *a hand.*) The name given by Cuvier to a genus of his herbivorous Cetaceans, including the species usually called sea-cows. They have an oblong body, terminated by a lengthened oval fin; their grinders, which are eight on each side of both jaws, have square crowns marked by two transverse ridges. There are no incisors or canines in the adult; but when very young there are two very small pointed teeth in the intermaxillary bones, which soon disappear. Vestiges of nails are visible on the edge of their swimming paws, which they employ with some address in carrying their young; hence the comparison of these organs with hands, and the name *Manatee* and *Manatus* applied to the animal. There are two species of Manatee in America, and one in Africa; they inhabit the mouths of the great rivers, and browse on the herbage that clothes the banks.

MANCHINEEL. (Mancinella, the Spanish name.) A tree inhabiting the West India islands, and celebrated for its poisonous qualities. It is asserted that to sleep beneath its shade is to poison; and that the land-crabs found in the groves of manchineel become poisonous from feeding on its seeds. Although there is doubtless much exaggeration in these stories, no doubt exists of the deadly effects of manchineel juice when introduced into the system.

MANDA'MUS. In Law, a prerogative writ, in the form of a command, issuing from the Court of King's Bench, directed to any person, corporation, or inferior court of judicature within the king's dominions, requiring them to perform various duties. It is grounded on the suggestion of a party injured by the acts or omissions of such persons or bodies; and lies, for instance, to compel the admission or restoration of a party applying to an office or franchise which has been illegally withheld, for the production of public papers, to compel the holding of courts, &c.

MANDARI'N. The Portuguese term for a member of the official order of nobility in China. Mandarins are either civil or military: of the former there are nine classes, of the latter five. Although the mandarins are inferior in dignity to the higher class of nobility, whose dignity partakes of a personal character, they form the effective ministry and magistracy of the country. The Chinese equivalent of *mandarin* is *kouon*, which signifies literally *a public character.*

MA'NDIBLE, *Mandibula.* (Lat. mandibula, *a jaw.*) In Zoology, this term is applied to the lower jaw of mammals, and to both jaws of birds (except by Illiger, who restricts its appellation to the lower jaw in this class also). In insects it is applied to the upper or anterior pair of jaws.

MANDI'BULATES, *Mandibulata.* (Lat. mandibula, *a jaw.*) The name of a grand section of insects, including all those which preserve their organs of mastication in their last or perfect stage of metamorphosis.

MA'NDISC. The American name of the plant which is otherwise called *cassava*, and which is most extensively cultivated within the tropics of America, for the sake of the nutritive fæcula contained in its stems. It is the *Jatropha manihot* of botanists. The substance called tapioca is one of its products. In its raw state the whole plant is poisonous; but by the preparation and torrefaction of the fæcula the poisonous principle, which is volatile, is driven off.

MA'NDRAKE, or MANDRAGORA. A herb of fabulous character, concerning which there existed many singular superstitions. The herb mentioned in Genesis, ch. xxx., which our translation renders mandrake, was, probably, some flower or root to which common belief attached value as a philter. The mandrake of modern as well as classical superstition is a herb supposed to have a resemblance to the shape of a man. Those who tear it from the ground are obliged to do so with peculiar ceremonials (according to some, dogs must be employed to do so, which die instantly after): shrieks and groans are heard to issue from it, which have the power of injuring the unwary person who hears them. Its favourite habitat was believed to be the ground under a gallows on which a criminal was hanging. When plucked, it was said to be useful in conjurations, for the transformation of men or beasts; and was also believed to enable the

possessor to acquire riches at play, and to discover hidden treasures. (*Encyc. Metropol.*)

MA'NDREL. (Fr. mandrin.) In Machinery, a revolving shank to which turners affix their work in the lathe.

MA'NDRILL. (Eng. *man*, and *drill*.) A baboon. The name of the Catarrhine monkeys of the genus *Papio*, Cuv. They are the largest, most brutal, and ferocious of the baboons. The mandrill proper is the great blue-faced baboon of our menageries — *Simia mormon* and *maimon* of Linnæus. It is of a greyish-brown, inclining to olive above, with the cheeks blue and furrowed. The nose in the adult male becomes red, and even inclines to a fine scarlet at the end. It is difficult, says Cuvier, to imagine a more hideous or extraordinary animal. The male attains the size of a man, and is a terror to the negroes of Guinea and the other parts of Africa, of which this species is a native.

MANE'GE (Fr. from the Ital. maneggio), is used in England to signify either the art of horsemanship or of training horses.

MA'NES. A word of uncertain etymology, applied generally by the Romans to souls separated from the dead. There is some obscurity, however, about the precise meaning of this term. According to Apuleius, the Manes were originally called Lemures, and consisted of two classes, — the *Lares* and the *Larvæ;* the former of whom were the souls of those who had led virtuous lives, and the latter of those who had lived improperly; and, at a later period, the term *Manes* came to be a general designation for both. On the other hand, St. Augustin maintains that *Manes* was, from the first, a term applied to the spirits of deceased men when no definite opinion could be formed of their merits: — "Animas hominum dæmones esse, et ex hominibus fieri Lares, si meriti boni sint; Lemures sive Larvas, si mali; manes autem cum incertum est bonorum eos, sive malorum esse meritorum." In the month of February, annually, the Manes were propitiated at their sepulchres during twelve days. It was the duty of the pontifex maximus to see that proper ceremonies were observed. The stones in the Roman burial-places, and their funereal urns, were generally inscribed with the letters D. M. S. (Dis Manibus Sacrum).

MANGANE'SE. This name is generally given to a black mineral, originally described in the year 1774, by Scheele, as a peculiar earth; and which was afterwards shown by Gahn to be the oxide of a metallic substance which he called *magnesium*. This term, however, having been applied to the metallic base of magnesia, the word *manganese* has been adopted to designate the metal; and the ore above alluded to has been called black, or peroxide of, manganese. The metal itself has a specific gravity of about 8. It is grey, hard, brittle, and very difficult of fusion, and has not been applied to any use. The black oxide, on the contrary, is largely employed as a source of oxygen, and is especially important from the use which is made of it in the decomposition of common salt for the production of chlorine. Manganese may be represented by the equivalent 28; and the black oxide, being a compound of 1 atom of manganese and 2 of oxygen, has the equivalent 44 (28 + 16). There is also a protoxide of manganese, composed of 28 metal + 8 oxygen, which is the basis of the salts of this metal. When hydrate or carbonate of potassa, or nitre, are fused with peroxide of manganese in an open vessel, a dark-coloured compound is obtained, long known under the name of *chameleon mineral*, in consequence of its yielding in cold water a solution which is at first green, then blue, purple, red, brown, and ultimately deposits a brown powder, and becomes colourless. This substance has since been termed *manganate of potash*, and has been proved to contain a compound of 1 atom of manganese and 3 of oxygen, which has been called *manganic acid*, and is represented by the equivalent 52. In the pink solution, which is produced at once by the action of hot water, manganese exists in a still higher state of oxidizement, forming the *per-manganic acid;* in which 2 atoms of manganese are combined with 7 of oxygen. Both these compounds are very easy of decomposition. Some of the proto-salts of manganese have lately been used in calico-printing as the source of brown colours, and occasionally as deoxidizing agents.

MANGE. An eruptive disease which attacks several domestic animals, especially the dog. It is said to resemble the itch, and, like that disease, to be produced by a minute species of acarus which burrows beneath the cuticle. It is stated that the fluid discharged from the eruption of mange, in horses and dogs, has produced the itch upon the human skin. It is commonly produced by confinement and want of cleanliness, and bad or insufficient food.

MA'NGEL WURZEL. The root of the *Beta hybrida*. This German name is translated *root of scarcity;* the root being large, and used as a substitute for bread. It is cultivated for the food of cattle.

MA'NGER. The trough in which is placed the corn or other short food given to live stock, and more especially to horses. *See* RACK.

MA'NGER. The space near the hawse holes, bounded on the upper side by a partition across the bows, called the *manger board*, to receive the water while it enters the hawse holes and prevent it from flooding the deck.

MA'NGO (Mangos marum, in the Tamul language of India), is a very large fruit tree, inhabiting the tropical parts of Asia, throughout all which it is as extensively cultivated as the apple and pear trees are in Europe. Old specimens have been seen with a trunk from ten to fifteen feet in circumference. The fruit is something like a nectarine; but more compressed, longer, and more curved. It contains a large stone, covered with coarse fibres, which lose themselves in the succulent flesh. The wild and inferior varieties of this fruit taste so strongly of turpentine as to be wholly unfit for use by Europeans; but in the fine varieties this flavour is replaced by a rich sugary quality, which renders it very delicious. In this country the mango has rarely ripened its fruit; but it is common in the shops in a pickled state. The fruit of the *Mangifera Indica*, a tree cultivated in Asia, is also called *mango*.

MA'NGOSTEEN. The fruit of the *Garcinia mangostana*, growing in Java and the Molucca Islands: it is of the size of an orange, and of a delicious flavour.

MANGROVE (probably an abbreviation of *mangle* grove, the former being the Malay name), is a tree inhabiting the shores of the tropical parts of the world in either hemisphere, and well known to navigators on account of the dense groves it forms even down into the water itself. It belongs to the genus *Rhisophora*, and is principally remarkable for its seeds germinating before they leave the case in which they were generated on the branches. The young radicle grows downwards through the humid air till it reaches the mud, in which it fixes itself, and then the leaves and new stem unfold at the opposite end. The *white* mangrove, another shore plant of the tropics, is *Avicennia tomentosa*, quite a different genus from the genuine plants of that name.

MA'NIA. (Gr. μαινομαι, *I rage.*) Madness. It is defined to be delirium, unattended by fever, in which both judgment and memory are impaired, and the irritability of the body diminished so as to resist many morbid causes. There is a false perception of things, marked by incoherence or raving, and resentment of restraint. It is divided into melancholic and furious: the former marked by dejection of spirits; the latter by violent exertion of strength, malice to particular individuals, and repugnance to scenes and places before agreeable. Dissection has shown that in cases of madness there is usually effusion of water into the cavities of the brain, or appearances of previous inflammation of its membranes, or hardness of its substance, or peculiar thickness of the skull; and it has lately been stated that chemical analysis has shown an excess or deficiency of phosphorus in the composition of the brain in cases of madness and idiotcy.

MANICHE'ISTS. The followers of Manes, an oriental heretic of the 3d century, who, having been ordained a Christian presbyter, attempted to effect a combination between the religion which he was appointed to preach and the current philosophical systems of the East. He pursued herein the same course as the Valentinians, Basilidians, and many others, whose leading ideas may be denominated Gnostic. He maintained a dualism of principles governing the world, and a succession of dualisms generated from them, like the Gnostic æons. All things were effected by the combination or repulsion of the good and the bad; men had a double soul, good and evil; even their bodies were supposed to be formed the upper half by God, the lower by the Devil. The Old Testament was referred to the inspiration of the evil principle, the New to that of the good. In the letter, however, Manes proposed many alterations, and maintained also the authenticity of various apocryphal scriptures. A great part of his system related to cosmogony and psychology, in which fields of speculation he expatiated with the most arbitrary freedom. Like most other oriental systems, the Manichean heresy was celebrated alike for the austerities which it enjoined, and for the scandalous excesses which were attributed to its most zealous votaries. The charge of Manicheism, which in later times becomes scarcely intelligible, was frequently brought against the early reforming sects, such as the Albigenses, Waldenses, Picards, &c. (See Mosheim (transl.), ed. 1790, i. 303. &c.; Beausobre, *Hist. Critique de Manichée et du Manichéisme*, Amst. 1734; *Gieseler*, vol. i. 150. (transl.), ii. 151., iii. 340.; Milman, *Hist. of Christianity*, ii. 322.)

MANIFE'STO. In Politics, a declaration of motives publicly issued by a belligerent state, or by a general acting with full powers, previously to the commencement of hostilities. They are in the form of letters, with a superscription or heading addressed to the public in general, and signed with the name of the sovereign who sends them forth. The usage of issuing manifestos is said to date so far back as the 14th century. The term is probably derived from the Latin words "manifestum est," with which such documents usually commenced.

MA'NIOC. The Indian name of amylaceous products of the shrub called *Jatropha manihot*.

MANI'PULATION, in Chemistry, embraces the manual and mechanical operations of the laboratory; and in the delicate details of analysis, as well as in the exhibition of class experiments, great skill and practice in manipulation are required to ensure success. The processes of weighing, measuring, filtering, distilling, precipitating, dissolving, using the blowpipe, &c. all come within the meaning of manipulation. Mr. Faraday has published an excellent treatise upon this subject.

MANI'PULUS. (Lat. manus, *hand*.) In Roman Military Antiquities, a subdivision of the cohort: so called from the handful of grass, straw, &c. which formed its original standard. A maniple of triarii consisted of 60 men, one of hastati and principes of 120, when the number of the legion was 300. (See M. le Beau's Eighth Dissertation on the Roman Legion, *Mem. de l'Ac. des Inscr.* vol. xxxii.)

MA'NIS. The name of a genus of Edentate Mammals, singularly characterized by being covered with large, strong, imbricated, horny scales, like the Lacertine reptiles, and hence commonly called scaly lizards, and figuring in old zoological works among that class of animals. The manises, or pangolins, are, however, true warm-blooded mammals, and rank in the system of Cuvier among the Edentate order; of which they may be regarded as typical forms, being wholly destitute of teeth, and provided with a tongue of extraordinary length, with associated glands for preparing an abundance of adhesive lubricous mucous. By this organization they are peculiarly adapted to prey on ants, termites, &c.; and certain of their claws are extraordinarily developed, to enable them to break through the walls of the habitations of these social insects. The manises are confined to the warmest regions of Asia and Africa, where they play a corresponding part with that assigned to the true anteaters (*Myrecophagæ*) in South America.

MANITRUNK, *Manitruncus*, in Entomology, is a term given to the anterior segment of the trunk, in which the head inosculates, or on which it turns.

MA'NNA. (Syrian mano, *a gift;* it being a term applied to the food given by God to the children of Israel in the wilderness.) What we now call *manna* is a saccharine substance which exudes from the bark of the *Fraxinus ornus*, and some other species of ash, natives of the south of Europe, especially Sicily and Calabria. Manna is used in medicine as a mild aperient. It differs remarkably from common sugar in not being susceptible of vinous fermentation; so that, if mixed with common sugar and yeast, and subjected to the process of fermentation, the sugar becomes converted into alcohol, but the manna remains unaltered in the liquor. When manna is dissolved in boiling alcohol, the solution, as it cools, deposits it in flaky and acicular crystals, often arranged in concentric groups. Manna, thus purified, has been chemically designated by the term *mannite*.

Various opinions have been entertained respecting the precise nature of the manna on which the Israelites were sustained, and attempts have been made at various times to account for its miraculous appearance on natural causes; but, in our opinion, without any success. The Syriac word *mano* means a *gift*, referring to this circumstance, and is no doubt derived from the Hebrew *man-hu*, the Scripture explanation of which is certainly the best. The word asks a question, and signifies "*What is this?*" "for they wist not what it was." (Exodus, xvi. 15.) And if they did not know *then* "what it was," it is not likely we should know now. They could see that it was a little round grain, or something like a grain, of the size of coriander-seed, and white as the hoar frost on the ground; but it had no component parts such as they could describe. And even admitting, as has been frequently maintained, that it exuded from the bark of the ash, or some other tree, it is incredible that it could be supplied in such abundance in the deserts of Arabia as to give sustenance to 500,000 Israelites for 40 years, without the miraculous intervention of Providence.

MA'NNER. (Fr. maniere.) In the Fine Arts, a peculiarity of treating a subject, or of executing it, by which individual artists are distinguished: the latter arising out of a particular mode of using the media and implements of art, the former out of a singular method of observing nature. (See *Sir J. Reynolds's Sixth Discourse.*)

MAN-OF-WAR, MERCHANT-MAN. The common terms for ship-of-war, merchant-ship.

MANO'METER, or MA'NOSCOPE. (Gr. μανος, *rare*, and μετρον, *a measure*, or σκοπεω, *I view*.) An instrument for measuring the *density* of the air, or rather its *elastic force*, to which the density is supposed to be proportional. *See* PNEUMATICS.

MA'NOR (Lat. maneo, *I reside;* from the residence of the lord), signifies a district subject to the jurisdiction of a court baron. In the feudal ages, a grant of lands from the king carried with it a right of dominion; and the grantee or baron had power to make laws, and hold a court of justice for his dependents within the territory, which was called a manor. The baron might also, by subinfeudation, parcel out the land so granted to others, to hold of him, as he held of the king, by military service or other tenure. These again further subdivided the land by grants to others, and so on, increasing manors by this process ad infinitum. The services due to the lord of the fee were, in consequence, very negligently performed; and, to meet this inconvenience, the statute of Ed. I., called Quia Emptores, was passed, which enacted that the buyers of lands should hold them by the same services, and of the same lord, as they were before held by when in the hands of the seller. This put a stop to the increase of manors; and every manor, therefore, now in existence, must have existed in the time of Ed. I., and before the enactment above mentioned.

MA'NSARD ROOF. (So called from the name of its inventor, a celebrated architect.) In Architecture, the same as *curb roof*, which see.

MA'NTELET. A moveable parapet, constructed of boards covered with tin, iron, or leather, to serve as a protection to the miners in carrying a sap or a trench towards a besieged place. Mantelets are of various forms, adapted to the peculiar circumstances of the approach.

MA'NTIS. (Gr. μαντις; applied by Theocritus (*Idyl.* x. 18.) to the cicada.) A Linnæan genus of Orthopterous insects, characterized by having the head exposed, and the body narrow and elongated; the palpi short, and terminating in a point; the ligula quadrifid; the tarsi five-jointed, and the wings simply plaited longitudinally, and not ray-wise, like a fan. The true mantises,—sometimes called *praying insects*, on account of the position of the anterior pair of legs, which differ from the rest,—are found only in tropical and temperate climates: they are diurnal, and remain almost stationary on plants and trees; frequently resembling, in a remarkable degree, their leaves and branches in both the form and colour of the wings and body, and thus they deceive the smaller insects on which they prey. Their eggs are usually enclosed in a capsule formed of some glutinous substance, which hardens by exposure to the air, and is divided internally into several cells. It is curious to trace the correspondence with the vegetable kingdom already noticed in the wings and body continued into the form of the egg-capsules, which in many species closely resemble a seed receptacle of a plant, presenting regularly disposed ridges and angles, or even being bristled with little spines. The female attaches it by an adhesive secretion generally to the stem of a plant.

A second group of mantises, characterized by having the anterior legs like the following ones, now form a distinct subgenus, *Spectrum*, and are generally called *spectre insects:* they feed exclusively on vegetables, of which they singularly resemble the dried twigs. The progress of entomology has required further subdivisions of both the above groups.

MANTI'SSA. The decimal part of a logarithm is sometimes called the *mantissa* of the significant digits, the integral part being the *characteristic*. Thus, in log. $900 = 2{\cdot}95424$, the characteristic of the logarithm of the number is 2, and 95424 is the mantissa, which belongs equally to the numbers 9, 90, 900, ·9, &c.

MA'NTLE. (Fr. manteau.) In Architecture, the piece lying horizontally across from one jamb of a chimney to the other. In Malacology, the external fold of the skin of the mollusks.

MA'NUAL (Lat. manus, *the hand*), was applied originally to the Roman Catholic service book, from its convenient size (being such as might be carried in the hand); but it now signifies any small work used chiefly for the purpose of reference.

MANUFA'CTURE. (Lat. manus, *a hand*, and facio, *I make*.) In Political Economy, a term employed to designate the changes or modifications made by art and industry in the form or substance of material articles, in the view of rendering them capable of satisfying some want or desire of man. Hence the perfection of manufacturing consists in the being able to effect the wished-for changes in the raw material with the least expenditure of labour, or at the least cost.

With the exception of fishing, hunting, mining, and such branches of industry as have for their object to obtain possession of material products in the state in which they are fashioned by nature, all other branches may, in fact, be comprised under the term manufacture. Generally, indeed, it is applied only to those departments of industry in which the raw material is fashioned into desirable articles by art and labour without the aid of the soil. But there is no really good foundation for any such limitation; which, unless explained, is apt to make it be supposed that businesses which are substantially identical not only differ from, but are opposed to, each other. It is obvious, indeed, on the slightest consideration, that agriculture in nothing but a manufacture; for the business of the agriculturist is so to dispose of the soil, seed, manure, and other materials, that they may supply him with other and more desirable products. Manufacturing industry consists, in fact, in

the *application of art, science, and labour to bring about certain changes or modifications of already existing materials;* and its varieties depend wholly on the modes in which this application is made. The manufacture of any particular article usually derives its name from the raw material manufactured, modified, or wrought up into a new shape. Thus the terms woollen, cotton, and hardware manufacture, mean the working up of wool, cotton, or metals into useful or desirable articles; shipbuilding is the manufacture of timber and iron into ships; agriculture (*ager* and *colo*) is the production of corn, beef, and other products, by the adaptation of the soil and the vegetative powers of nature to their manufacture, and so on. The knowledge of the means by which art and labour may be most successfully employed in each of these departments forms the peculiar business of the woollen, cotton, and hardware manufacturers, ship-builders, agriculturists, &c.

It would far exceed our limits to attempt to enter into any details with respect to the application of labour in the separate departments of manufacturing industry; but considering the vast importance of manufactures to mankind, and especially to the British nation, we may, perhaps, be excused for endeavouring shortly to state some of those conditions and circumstances that seem, in a general point of view, most essential to success in manufactures.

These are partly of a moral and political, and partly of a physical description. Of the former class, the most important seem to be, the security and free disposal of property; the absence of monopolies, and the non-interference of government in industrious undertakings; the diffusion of knowledge amongst the people; the cordial reception of foreigners; and the emulation and energy inspired by inequality of fortune, and by the gradual increase of taxation. Among the more prominent of the physical circumstances conducive to the progress of manufactures are supplies of the raw materials to be manufactured, with the command of power; that is, of coals, waterfalls, &c. A good deal, also, of the progress of manufactures seems to depend on the advantageous situation of a country for commerce, and on the nature of its climate. We shall briefly notice some of the more prominent of these circumstances.

1. *Moral Circumstances contributing to the Progress of Manufactures.*—1. It is unnecessary to take up the reader's time by enlarging on the necessity of security, and of the free disposal of property, to success in manufacturing industry, or indeed in any laborious undertaking. Without security there can be neither industry nor invention. No man will engage in any employment, or exert either his bodily or mental powers, unless he be well convinced that he will be allowed to reap all the advantages accruing from his labour, skill, or genius. Any doubt as to this is sure to paralyse his exertions. And if, owing to the weakness or ignorance of government, the prevalence of a revolutionary spirit, or any other cause, the security of property were materially impaired, all sorts of industrious undertakings that did not promise an immediate return would be forthwith abandoned; and every person possessed of property would endeavour to convey it out of the country. The want of security is, in fact, the greatest of public calamities. In its absence we find nothing but the most abject poverty and barbarism; and, supposing other things to be equal, the wealth and civilization of nations will be pretty nearly proportioned to the security of property they respectively enjoy. Every other circumstance conducive to the advancement of industry may exist in a country; but, without security, these can be of no material service. A high degree of security will compensate for many deficiencies, but nothing can make up for its want; it is a *sine quâ non* of manufacturing and national prosperity.

2. The absence of monopolies, and the non-interference of government in industrious undertakings, undoubtedly conduce in no ordinary degree to the progress of industry. Every man is always exerting himself to find out how he may best extend his command over the necessaries and conveniences of life; and sound policy requires that he should, so long as he does not interfere with the rights and privileges of others, be allowed to pursue his own interest in his own way. That individuals are, generally speaking, the best judges of what is most beneficial for themselves, is now universally admitted to be the only principle that can be safely relied on. It is the duty of governments to preserve order; to prevent one individual from injuring another; to maintain, in short, the equal rights and privileges of all. But it is not possible for them to go one step further without receding from the principle of non-interference, and laying themselves open to the charge of acting partially by some and unjustly by others.

The most comprehensive experience corroborates the truth of this statement. Since the passing of the famous act of James I. in 1624, for the abolition of monopolies, full scope has been given in Great Britain to the competition of the home producers; and though the various resources of talent and genius have not been so fully perhaps, or at least so early developed, as they would have been had there been no restrictions on our intercourse with foreigners, they have been stimulated in a degree unknown in most other countries. France, previously to the Revolution, was divided into provinces, having each peculiar privileges and separate codes of revenue laws; and, in consequence, the intercourse between them was subject to the most oppressive restrictions. In Germany and Spain the same miserable system prevailed; so that they were not only deprived of the freedom of foreign, but even of internal commerce. The inhabitants of each province being in a great measure isolated from the rest, there was comparatively little competition; and, instead of invention and active exertion, there was nothing but routine and sluggish indifference. Holland and the United States have been almost the only countries that have enjoyed the same degree of internal freedom as Great Britain; and the former, notwithstanding the unfavourable physical circumstances under which she is placed, has long been, and still is, the richest country in Europe; while the latter, whose condition is in other respects more favourable, is advancing with giant steps in the career of improvement.

It is sometimes said that restrictions on industry and commerce cannot be so injurious as has been represented, seeing the progress we have made notwithstanding they have always existed amongst us. The previous details show the weight to be attached to this allegation. The restrictions referred to have been confined to some branches of foreign trade; and, luckily, the freedom allowed to all sorts of industry at home would have insured our advance even had our foreign trade been a good deal more fettered and restrained than it actually has been. But to imagine, as many have done, that these restrictions contributed to accelerate our progress, is the climax of folly. Their influence is, in every case, distinctly and completely the reverse; but though considerable, even in Great Britain, it has been insufficient to countervail the advantages resulting from the freedom we otherwise enjoyed.

3. The ability to read, and the diffusion of instruction among all ranks and orders of the people by the general circulation of books and journals, the establishment of mechanics' institutes, &c., have had a material influence over the advancement of arts and industry. They have had the double advantage of multiplying the means and chances of improvement, and of preventing any invention or discovery, when made, from being lost or engrossed by a few. An uninstructed people, though surrounded by all the means and capacities required for the manufacture of commodities and the accumulation of riches, being unable to apply them, are necessarily poor and destitute; but an intelligent people, though placed in a comparatively unfavourable situation, never fail, by availing themselves of the powers and energies of nature, and making them subservient to their purposes, to attain to distinction as manufacturers, and so become rich and prosperous. That "knowledge is power" is true in manufactures as well as in morals. The more familiar our acquaintance with and the more complete our command over natural agents, the greater, of course, must be our ability to modify rude products, and to make them minister to our wants and the gratification of our desires. In tracing the causes of our success in manufactures and industry, it is not possible to appropriate to each circumstance the portion belonging to it of a result which is the joint effect of the whole; but if this could be done, it would be found that no inconsiderable share is fairly ascribable to the extraordinary diffusion amongst us of scientific information.

4. For a lengthened period the reception given to foreigners in England was any thing but cordial. In most countries, indeed, not in an advanced state of civilization, strangers are uniformly the objects of popular dislike; and this feeling seems at one time to have prevailed quite as much in England as any where else. But notwithstanding the various legal disabilities laid on foreigners, and the ill-treatment they often experienced, their settlement here has been productive of the most advantageous results. The Flemings, invited over and protected by Edward III., gave the first great impulse to the woollen manufacture; and the immigrations from the Low Countries during the persecutions of the Duke of Alva, and from France subsequently to the revocation of the Edict of Nantes, materially forwarded our commerce and many branches of manufactures. During the last century the prejudice against aliens lost much of its force; and several of the disabilities under which they formerly laboured have been removed. But in all that respects the treatment of foreigners, our policy has been less liberal and enlightened than that of the Dutch. In Holland they have always been received with open arms; and a short residence in the country, and a small payment to the state, have entitled them to all the privileges

enjoyed by natives. The highest authorities agree that this was one of the main causes of the extraordinary progress made by the republic in commerce and wealth. "It has always been our constant policy to make Holland a perpetual, safe, and secure asylum for all persecuted and oppressed strangers; no alliance, no treaty, no regard for nor any solicitation of any potentate whatever, has at any time been able to weaken or destroy, or make the state recede from protecting, those who have fled to it for their own security and self-preservation. Throughout the whole course of all the persecutions and oppressions that have occurred in other countries, the steady adherence of the republic to this fundamental law has been the cause that many people have not only fled thither for refuge, with their whole stock in ready cash, and their most valuable effects, but have also settled and established many trades, fabrics, manufactures, arts, and sciences, in this country, notwithstanding the first materials for the said fabrics and manufactures were almost wholly wanting in it, and not to be procured but at a great expense from foreign parts." (Memorial by Dutch Merchants, presented to the Prince of Orange in 1751.)

5. We incline to think that the great inequality of fortune that has always prevailed in this country has powerfully contributed to excite a spirit of invention and industry among the less opulent classes. It is not always because a man is absolutely poor that he is perseveringly industrious and economical; he may have already amassed considerable wealth, but he continues with unabated energy to avail himself of every means by which he may hope to add to his fortune, that he may place himself on a level with the great landed proprietors, and those who give the tone to society in all that regards expense. No successful manufacturer or merchant ever considers that he has enough till he be able to live in something like the same style as the most opulent landlords. Those immediately below the highest become, as it were, a standard, to which the class next to them endeavour to elevate themselves; the impulse extending, in this way, to the very lowest classes, individuals belonging to which are always raising themselves by industry, address, and good fortune to the highest places in society. Had there been less inequality of fortune amongst us, there would have been less emulation, and industry would not have been so successfully prosecuted. It is true that the desire to emulate the great and the affluent, by embarking in a lavish course of expenditure, is often prematurely indulged in, and carried to a culpable excess; but the evils thence arising make but a trifling deduction from the beneficial influence of that powerful stimulus which it gives to the inventive faculties, and to that desire to improve our condition and to mount in the scale of society which is the source of all that is great and elevated. Hence we should disapprove of any system, which, like that of the law of equal inheritance established in France, had any tendency artificially to equalize fortunes. To the absence of any such law, and the prevalence of customs of a totally different character, we are inclined to attribute a considerable portion of our superior manufactures, wealth, and industry.

6. We are also disposed to believe, how paradoxical soever such a notion may appear, that the taxation to which we are subject has hitherto at least been favourable to the progress of industry. It is not enough that a man has the means of rising in the world within his command: he must be placed in such a situation that unless he avail himself of them, and put forth all his energies, he will be cast down to a lower station. Now this is what our taxation has effected: to the desire of rising in the world, implanted in the breast of every man, it superadded the fear of being thrown down to a lower place in society; and the two principles combined produced results that could not have been produced by either separately. Had taxation been carried beyond due bounds, it would not have had this effect. But though considerable, its increase was not such as to make the contributors despair of being able to meet the sacrifices it imposed by increased skill and economy; and the efforts they made in this view were far more than sufficient for their object; and consequently occasioned a large addition to the public industry and wealth, that would not otherwise have existed.

II. *Physical Circumstances contributing to the Progress of Manufactures.* — 1. Supplies of the raw material may be classed among the more prominent of this description of circumstances. Those who reflect on the value and importance of our manufactures of wool; of the useful metals, such as iron, tin, lead, copper, &c.; of leather, flax, and so on,— will readily admit that our success in them has been materially facilitated by our possessing abundant supplies of the raw material. It is of less consequence, when the material of a manufacture possesses considerable value in small bulk, whether it be furnished from native sources or be imported from abroad; though even in that case, the advantage of having an internal supply, which cannot be withdrawn through the jealousy or hostility of others, is far from immaterial. But no nation can make any considerable progress in the manufacture of bulky and heavy articles, the conveyance of which to a distance necessarily occasions a large expense, unless she have supplies of the raw material within herself. Had we been destitute of iron ore, lead, and tin, we could never have distinguished ourselves by the magnitude and value of our manufactures of these articles; and any one who reflects on the signal advantage resulting to every branch of manufacturing industry from being able to procure abundant supplies of iron at the cheapest rate, will be convinced that we are under any thing but slight obligations to our exhaustless stores of this mineral.

2. But of all the physical circumstances that have contributed to our extraordinary progress in manufactures and industry, none have had so much influence as our possession of the most valuable coal mines. These have conferred advantages on us, not enjoyed in an equal degree by any other country. Our extraordinary success in the manufacture of iron, copper, &c. is not owing so much to our possessing the ores, as to our possessing the coal by the aid of which they have been smelted and refined. The paramount importance of coal as a manufacturing agent has, however, been principally manifested since the invention of the steam-engine. Without a cheap and abundant supply of fuel, the engine, as now constructed, would be of comparatively little use. It is, as it were, the hands by which the most gigantic results are effected; but coal is the muscle by which the hands are set in motion, and without which their all but illimitable power and dexterity could not be called into action, or made subservient to any useful purpose. Our coal mines may thus, in truth, be regarded as vast magazines of hoarded or warehoused power; and unless some such radical change should be made on the steam-engine as should very decidedly lessen the quantity of fuel required to keep it in motion, or some equally serviceable machine, but moved by different means, be introduced, it is not at all likely that any nation should come into successful competition with us in those departments of manufacturing industry in which steam-engines, or machinery moved by steam, may be advantageously employed.

3. The advantageous situation of a country for commerce, and the nature of its climate, have also a powerful influence over manufacturing industry. Owing to the facilities afforded by the insular situation of Great Britain for maintaining an intercourse with all parts of the world, our manufacturers have been able to obtain supplies of foreign raw materials on the easiest terms, and to forward their own products wherever there was a demand for them. Had we occupied a central or internal situation in any quarter of the world, our facilities for dealing with foreigners being so much the less, our progress would have been comparatively slow; but being surrounded on all sides by the sea, that is, by the great highway of nations, we have been able to deal with the most distant as well as with the nearest people, and to profit by the peculiar capacities of production enjoyed by each. Under such circumstances, it would have been singular had we not shot ahead of most of our competitors in the race of improvement; and it will require some powerful counteracting agency to neutralize or overcome these advantages.

4. Our climate is peculiarly favourable for all sorts of exertion and enterprise: without being too severe, it is sufficiently so to render comfortable clothing and lodging indispensable; and consequently gives rise to wants that are either unknown, or less sensibly felt, in more genial regions. Its inequality too, by requiring incessant care and attention on the part of the husbandmen, or manufacturers of corn, makes them vigilant and active, as well as industrious; and the qualities that are thus naturally impressed on this great class are, through their example, universally diffused.

The author of a valuable article on English statistics in the *Edinburgh Encyclopædia*, when enumerating the causes of our extraordinary success in manufactures, lays the greatest stress on the superiority of our machinery, the magnitude of our capital, and the extent to which the division of labour is carried amongst us. But this is to mistake effects for causes. These, in fact, are the means and instruments by which manufacturing industry is immediately carried on; and the real inquiry is, what are the circumstances that have rendered us so abundantly supplied with these means? We have endeavoured briefly to answer this inquiry, by stating what appear to be the most prominent causes of that extraordinary accumulation of capital, and of that universal employment of improved and powerful machinery and subdivided labour, which mark our eminence as a manufacturing people. Still, however, we are inclined to think that a good deal must in these matters be ascribed to chance, or to some lucky contingency, that could not *à priori* be looked for. Had Hargreaves, Arkwright, Watt, or Wedgwood not existed, or been born abroad, it is impossible to say how much it might have affected the state of industry here; but there seem to be sufficient grounds for thinking that it

would have been, at this moment, materially different from what it actually is. A good deal, too, depends on priority. A country, town, or district, that has already established and made a considerable progress in any manufacture, acquires, in consequence, an advantage that may enable it successfully to contend with competitors placed under what are naturally more favourable circumstances; its merchants are already in possession of the markets; its inhabitants, being trained to the business, have acquired that peculiar sleight of hand that is necessary to form expert workmen; and they are in this way frequently able to preserve their ascendency for a lengthened period, and sometimes even to drive those from the field who have a preponderance of natural advantages on their side.

It seems to be the peculiar good fortune of England that, as respects all the great branches of manufacture, she has at once the advantages of priority and of acquired skill and dexterity on her side, as well as the natural advantages already noticed of abundant supplies of the raw material, of inexhaustible beds of coal, and of situation. Cotton is not an exception; for though the raw material be the product of other countries, the freight upon it is not very considerable, and is but a trifling deduction from the other circumstances that seem to insure our superiority in this department. To excel in machine-making is to excel in what is certainly the most important branch of manufacturing industry. Superiority in any single branch, except this, may exist simultaneously with great inferiority in many others; but eminence in the manufacture of machinery is almost sure to lead to eminence in every other department.

Considerable, though not, as it appears to us, too much stress, has been laid on the practice generally adopted in Great Britain, of paying workmen, wherever it is practicable, by the piece, or by the work done, and not by the day. This system gives the workmen an interest in being industrious, and makes them exert themselves to execute the greatest quantity of work in the least space of time; and in consequence of its prevalence, this practice materially influences even the day labourers, who, to avoid invidious comparisons, make exertions unknown in other countries. Hence a given number of hands in Great Britain perform much more work than is executed by the same number of hands almost any where else; in fact, if we regard wages in their proper light, that is, if we look upon them as a compensation for work done, and not for the time spent in doing it, they will, we believe, be found to be cheaper in Great Britain than in most other countries. (For farther particulars, see the section on Manufactures in the *Statistical Account of the British Empire*, whence this article has been partly abstracted.)

MANUMI'SSION, or ENFRANCHISEMENT. (Lat. manus, and mitto, *I send away.*) The grant of liberty to a slave. Ancient charters containing such grants were frequently termed chartæ ingenuitatis. (See a law of William the Conqueror, *Lamb. Archai.* 126.) The term manumission is derived from a practice adopted by the ancient Romans in enfranchising their slaves. The master seized the hand of the slave, and dismissed him with the words "hunc hominem liberum esse volo." Among the Romans there were two classes of manumission, called perfect and imperfect; the former of which were effected in three different ways. The enfranchisement was perfect — 1. Per censum; by which the name of the slave was, at the master's request, placed in the register of free citizens. 2. Per vindictam; when the slave was led before the prætor, and, the master having demanded his liberty, that magistrate laid the vindicta (or rod of office) on his head, with the words "aio te liberum esse more quiritium." 3. Per testamentum; by will. It was imperfect when the slave was enfranchised at private entertainments, or by letter. *See* CLIENT.

MANU'RES. Substances added to the soil, with a view of accelerating vegetation, and increasing the production of the crops. Animal, vegetable, and mineral substances are used for this purpose. Decomposing animal matter of any kind forms one of the most powerful manures, and in many instances accelerates the decay and decomposition of inert vegetable matters mixed with it; as in the mixture of dung and straw which forms the common offal of stables. All animal excrements are also powerful manures, and, when duly applied to the soil, soon exhibit their influence by the luxuriance of the crop. It, however, often happens in respect to esculent vegetables that their quality is deteriorated, and that they acquire a coarse and rank flavour, if over-manured; as is the case with much of the produce of the market-gardens near London, where, in consequence of the vicinity of the metropolis, manure is abundant, and luxuriant and fine-looking vegetables in great request for the table.

In all cases where animal manures are used care should be taken that they are brought into action upon the soil as soon as they begin to decompose, or as soon as possible afterwards, and not suffered to rot, and exhale their best constituent parts whilst lying in the farmyard. The drainings and the exhalations of a common dung-heap contain its most effective ingredients; and these are often suffered to go to waste, or to contaminate the air and collect in pools of filth. The fresh and the old manure of this decomposition are known to farmers under the terms *long* and *short* dung: the advantages and economy of the former, when properly applied, cannot be doubted. Those animal manures which are slow of decomposition are most durable, and generally most effective in their operation. Of these the best is ground bones, the animal part of which is very gradually dissolved out by moisture; so that their effect is long-continued, and their earthy matter is also probably beneficial, at least to many crops. Vegetable manures are often very effective, especially as in the case of ploughing in a green crop, where all the soluble matters are brought into action; and inert vegetable substances may be rendered active by mixture with those which easily putrefy, or with animal matter. Some vegetables, such as cabbages and many other cruciform plants, approximate to animal matter in their composition, and are proportionately good manures. Mineral manures act in two ways: either by their causticity, as is the case with quicklime, by which they decompose most organic bodies, such as roots, fibres, &c., and render them soluble and nutritious to the growing crop; or they alter the texture of the soil. Thus, sand may be called a manure for clayey lands, and clay and loam for those that are sandy. Upon the same principle, stiff soils are improved by paring and burning, by which a superficial sandiness is produced, and the texture of the soil rendered more appropriate for vegetation.

MA'NUSCRIPTS. (Lat. manu scriptum, *written by the hand.*) Literally writings of any kind, whether on paper or any other material, in contradistinction to such as are printed. Books were generally written upon vellum, after the papyrus used in classical times had become obsolete, until the general introduction of paper made from rags, about the 15th century after Christ; and the finest and whitest vellum is generally indicative of great age in a manuscript. The dearness of this material gave rise to the practice of using old manuscript books on which the writing had been erased (*see* PALIMPSEST), and also to that of abbreviations. These were carried to excess in the 12th century, and from that time until the invention of printing; and for a long period subsequent to that invention abbreviations were still in common use: in Greek printing they were usual until within the last fifty years. Of Latin MSS. those prior to the reign of Charlemagne (A. D. 800) are considered ancient. Manuscripts of the early classical age were written on sheets rolled together. *Illuminated manuscripts* are such as are embellished with ornaments, drawings, emblematical figures, &c. illustrative of the text. This practice was introduced at a very early period; for we find the works of Varro, Pomponius Atticus, and others adorned by illuminations. But it was chiefly employed in the breviaries and prayer book of the early Christian church. The colours most employed for this purpose were gold and azure. Illuminations were in a high state of perfection between the 5th and 10th centuries; after which they seem to have partaken of the barbarism of the middle ages, which threw their chilling influence over every description of art. On the revival of the arts in the 15th and 16th centuries many excellent performances were produced; but the art did not take deep root, and we believe the last specimen of illumination executed in this country was Cardinal Wolsey's *Lectionary*, at Christ Church, Oxford. *See* CODEX, DIPLOMATICS, PALÆOGRAPHY.

MAP. (Lat. mappa.) A delineation of some portion of the surface of the sphere (terrestrial or celestial) on a plane. Terrestrial maps are *geographic* or *hydrographic*, according as they denote a portion of the land or of the sea; the latter, however, are usually called *charts.* (*See* CHART.) A map representing a small extent of country is called a *topographical map*.

Terrestrial Maps. — The object of a terrestrial map is to exhibit the boundaries of countries and the relative positions of their several parts. A perfect representation of a country should present all its parts, not only in their true relative positions, but also in their just proportions. This may be accurately done on a globe; but as the earth's surface is spherical, it is impossible to represent any considerable portion of it on a plane so that the distances of places shall retain the same proportions which they have on the sphere, and geographers have accordingly had recourse to various methods of delineation, all of which have their peculiar advantages in particular cases.

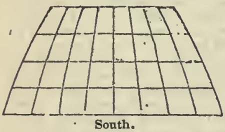
One method is to represent the points and lines of the sphere according to the rules of perspective, or as they would appear to the eye, having some assigned position relatively to the sphere and the plane of representation. This method gives rise to the different modes of *projecting* the sphere, of which the three principal are the orthographic, the stereographic, and the central. The method of projection answers very well when the surface to be represented is small, and the eye is placed perpendicularly over it; but when it embraces a considerable

portion of the sphere, the parts near the extremities of the map are much distorted. See PROJECTION.

A second method is to suppose the surface to be represented to be a portion of the surface of a cone, whose vertex is somewhere in the polar axis produced, and which either touches the sphere at the middle latitude of the surface to be represented, or falls within the sphere at the middle latitude, and without it at the extreme parallels. The conical surface is then supposed to be developed on a plane (which it admits of being); whence this method is called the method of development. Of this method there are various modifications: as that of Murdoch, who supposes the side of the cone to be parallel to the tangent of the meridian at the middle latitude, but to penetrate the surface of the sphere between the middle latitude and the extremities of the projected arc; that of De Lisle, who assumed the cone such as to intersect the sphere in the two parallels equally distant from the extreme and middle latitudes; that of Euler, who placed the apex of the cone at a determinate distance beyond the pole.

A third method is to lay down the points on the map according to some assumed mathematical law, the condition to be fulfilled being that the parts of the spherical surface to be represented, and their representations on the map, shall be similar in their small elements. Of such methods the best known is *Mercator's Chart* (which, however, may be produced also by development), in which the meridians are equidistant parallel straight lines, and the parallels of latitude are also straight lines perpendicular to the meridians; but of which the distances from each other increase in going from the equator in such a proportion as always to show the true bearings of places from one another. See MERCATOR'S CHART.

Celestial Maps. — For the construction of his maps of the stars, the astronomer Flamsteed adopted the following method: — All the parallels on the sphere are represented by straight lines, and likewise one of the meridians; namely, that which passes through the middle of the map, as in the annexed diagram. The parallels which are all perpendicular to this meridian have the same relative lengths as on the sphere, and consequently the degrees of longitude are represented in their just proportions; that is, are proportional to the cosine of the latitude. If, therefore, the parallels be each divided into the same number of equal parts, a curve line drawn through the points of division will represent the meridians. By this method any distance in the direction of the parallels is equal to the corresponding distance on the sphere; but it is evident that the map is much distorted towards the extremities, in consequence of the oblique directions of the meridians. Flamsteed's method is sometimes used in geography for representing countries which lie on both sides of the equator, in which case the distortion is less. A modification of it, which consists in substituting arcs of circles for the straight lines representing the meridians, whereby their obliquity is diminished, is extensively employed in the construction of maps. The Society for the Diffusion of Useful Knowledge has adopted the gnomonic projection for laying down their maps of the stars.



For details respecting the general construction of maps, we refer the reader to the work of Mr. Jamieson on the subject; *Malte Brun's Geography; Malte Brun's and Balbi's Systems of Geography Abridged; Murray's Encyclopedia of Geography; De Morgan's Explanation of the Gnomonic Projection of the Sphere;* and particularly the *Traité de Topographie d'Arpentage et de Nivellement* of Puissant.

MARANA'THA. (Syr.) A form of anathematizing among the Jews, which was viewed as a tremendous denunciation. (See 1 Cor. xvi. 22.) It signifies "the Lord will come;" *i. e.* to take vengeance.

MARANTA'CEÆ (Maranta, one of the genera), form the natural order of Endogenous plants, from which the most genuine kind of arrow-root is prepared. This substance is the starch contained in the tubers of *Maranta, Arundinacea,* and some other species, and of certain kinds of canna. *Marantaceæ* are very nearly the same as *Zingiberaceæ;* from which they differ in the flowers being more irregular, and the anther having but one lobe instead of two.

MARA'SMUS. (Gr. μαραινω, *I waste away.*) Emaciation; atrophy.

MA'RBLE. (Fr. marbre.) A term limited by mineralogists and geologists to the several varieties of carbonate of lime which have more or less of a granular and crystalline texture. In sculpture, the term is applied to several compact or granular kinds of stone susceptible of a very fine polish. The varieties of it are extremely numerous. The most valuable sorts used by the ancients were the *Pentelican,* which was white, and obtained from Mount Pentiles in Attica: the *Parian,* also called *Marpessian,* obtained from the island of Paros, was of a white colour, as was that from Mount Hymettus in Attica. Thasus and Lesbos also produced white marbles, which were in much repute. A place called Luna, in Etruria, produced a marble whose whiteness exceeded that from Paros. Of the white marbles were those from Mount Phelleus; from the neighbourhood of Coralios, in Phrygia; from Cyzicus, in Asia Minor; and the Marmor Phrygium, found near Synnada in Phrygia. The black marbles most used were from Tænarus, and the Numidian. The Chium Marmor, from the island of Chios, was of a black transparent chequered colour. The Obsidianum, procured from Ethiopia, was black. The Proconesian marble was with black veins. Mount Taygetes afforded the Marmor Laconicum, which was green, and is better known by the name of Verde Antique. A marble of mingled green was obtained from Carystus. The Atrician marble, from Mount Atrax in Thessaly, was a mixture of black, white, blue, and green. The Tiberian and Augustan marbles were green, and brought from Egypt. The Marmor Memphites was green, and is what we call serpentine. Corinth produced a yellow marble. The Marmor Phengites was white, with yellow spots; the Rhodian was marked with spots of a golden colour, and that of Milos yellow. In modern times the quarries of Carrara almost supply the world with white marble. Of variegated marbles there are many sorts found in this country of singular beauty. See ELGIN MARBLES: see also GEOLOGY.

MARCH. The first month of the Roman year, and the third of the English. In the ecclesiastical calendar used in England till the change of style in 1752 this was also the first month, as it was in the Roman. It is named Martius, in honour of Mars, the reputed father of Romulus. There is an old proverb still prevalent in Scotland, which represents March as borrowing three days from April, which have thence come to be designated the borrowed days. They will be found noticed in the *Complainte of Scotland.* Upon this subject Dr. Jamieson observes, "Those who are much addicted to superstition will neither borrow nor lend on any of these days. If any one would propose to borrow of them, they would consider it as an evidence that the person wished to employ the article for the purpose of witchcraft against the lenders."

MARCH. In Music, a military air, played by inflatile and pulsatile instruments, to regulate the steps and to animate the minds of soldiers. The march, however, has long been adapted to every species of musical instrument, and some of the most celebrated compositions of the greatest masters are in this style; as the March of the Priests in Mozart's *Zauber-flöte,* the Peasant's March in Weber's *Freischutz,* and above all Beethoven's Funeral Marches. In the Supplement to the First Edition of the *Encyclopædia,* it is truly said that a march should be always composed in common time, with an odd crotchet or quaver at the beginning. It is usually quick for ordinary marching, and slow for grand occasions; but no general rules can be laid down for its composition.

MARCH, in Military language, signifies the motion of a body of troops from one place to another. It consists of three measures: 1. ordinary time, in which about 75 paces are taken in a minute; 2. quick time, in which about 108 steps are taken in a minute; 3. the quickest, or as it is called *wheeling* time, at the rate of 300 feet in the same space.

MA'RCHES. The name given to the borders or frontiers of any district; but more especially applied to the boundaries between England and Wales, and England and Scotland. The term is derived from an old Anglo-Saxon word signifying a mark, and is to be found in every language of Teutonic descent. Several titles of dignity both in this and other countries derive their origin from their possessors having been appointed governors of the *marches* or frontiers of their respective countries; of these marquis in England and markgraf in Germany are the most prominent. The title Earl of March, now enjoyed by the Duke of Richmond, was originally bestowed on Mortimer, a member of the family so celebrated in English history, because he was the governor or superintendent of the Welch marches. In the middle ages, the name *marchers* was given to the noblemen who lived on the marches of Wales and Scotland. According to Camden they had once their own laws, and even the "power of life and death like petty kings;" but these privileges were abolished by Henry VIII. There was formerly a court of the marches of Wales in existence, where pleas of debt, or damages not above the value of 5*l.*, were tried and determined.

MA'RCIONITES. The followers of Marcion, a heretic of the 2d century, who adopted the Oriental notion of the two conflicting principles, and imagined that between them there existed a third power, neither wholly good nor evil, the Creator of the world and the God of the Jewish dispensation. The object of the Good Principle, or Supreme God, is to restrain the ambition of

these two powers, which wage a constant war against each other as well as himself. For this purpose it was that he sent his son Jesus Christ to destroy the Evil Principle on the one hand, and to counteract and coerce the power of the Jewish Deity on the other. The Marcionites were a branch of the great Gnostic heresy. Their opinions are found in the writings of Irenæus, Epiphanius, and Tertullian against them.

MARCO'SIANS. An early sect of Christians, a branch of the Gnostics, who derived their name from an Egyptian called Marcus, and reputed a magician. The Marcosians had a great number of apocryphal books which they held to be canonical; and many of their fables are still in use and credit among the Greek monks.

MA'REKANITE, is a variety of obsidian, found at Marekan in Siberia in small spherules.

MARGA'RIC ACID. (Gr. *μαργαριτη, a pearl.*) The substance into which the margarine, or concrete portion of certain oils, is converted by the action of alkalies. It has a pearly lustre, and is insoluble in water; but readily soluble in hot alcohol, which deposits it as the solution cools. It fuses at 140°, and reddens betimes. It closely resembles stearic acid.

MA'RGARINE. The solid fatty matter of certain vegetable oils has been thus termed by Lecanu, from its pearly lustre. The purest margarine is obtained from the concrete portion of olive oil.

MARGARI'TIC ACID. A distinctive term applied to one of the fatty acids which result from the saponification of castor oil. By the same process this oil also yields the ricinic and the elaiodic acids.

MARGARO'NE. When margaric acid is mixed with quicklime and distilled, a peculiar fatty product, which crystallizes in pearly scales, is obtained, which has been distinguished by the above term from other analogous substances.

MA'RGIN (Fr. marge), in Printing, is the arrangement of the pages in a sheet at proper distances from each other, according to the size of the paper; so that when the sheet is printed and folded, the border of white paper round them shall be regular and uniform in every leaf of the book.

MA'RGIN OF A COURSE. In Architecture, that part of the upper side of a course of slates which appears uncovered by the next superior course.

MARGI'TES. The title of a satirical poem attributed, but with little probability of truth, to Homer; if by him is meant the author of the *Iliad* or *Odyssey*. The subject of the poem, which has not come down to us, was the character of a silly empty-headed man (*μαργίτης*).

MA'RGRAVE, or more properly MARKGRAVE. A title of rank formerly used in Germany, and equivalent to the English marquis. Both words spring from a common origin. *See* Marquess.

MARI'A THERE'SA, ORDER OF. A military order of Austria, consisting of grand crosses, commanders, and knights: founded in 1757.

MARI'NES. A corps of men enlisted to serve as soldiers on board of ships of war in naval engagements, and on shore under certain circumstances. They sometimes assist, particularly in the British service, in performing some naval duties on board of ship. The period at which a distinct corps was embodied for this department of the British service is unknown. In 1684 mention is made of the Duke of York's maritime regiment of foot; and in the reign of Will. III. several regiments were placed on the establishment: these, however, were subsequently disbanded. In the beginning of Queen Anne's reign, six regiments of maritime soldiers were raised; and though these were again disbanded in 1749, six years afterwards, 130 companies were raised on the recommendation of Lord Anson, consisting in all of above 5000 men. Since the commencement of the present century great additions have been made to this corps; and at present its strength amounts to 9000 men. The men are clothed and armed in the same manner as the infantry of the line. The corps is commanded by a lieutenant-general and a major-general, who are naval officers, holding, in addition to their rank as such, these military titles: there are, also, four colonels commandants of divisions, besides four colonels and second commandants. No commissions in the corps are obtained by purchase; and the officers of marines rise in it by seniority, without, however, being able to obtain higher rank than that of colonels commandant. (See *Penny Cyclopædia.*)

MARIOTTE'S LAW. In Pneumatics, a general property of elastic fluids, first established by Mariotte; namely, that the elasticity or pressure is directly proportional to the density; or, which is the same thing, inversely proportional to the space which the fluid occupies. *See* Pneumatics.

MA'RITIME LAW, signifies the laws relating to harbours, ships, and sailors. It forms an important branch of the commercial law of all trading nations, and embraces an infinite variety of subjects, most of which have been defined under their respective heads. The most celebrated codes of maritime law have been, in classical times, that of Rhodes; in modern times, the *Consolato del Mare*, a compilation supposed to have been framed at Barcelona as early as the 9th century; the laws of the Isle of Oleron, in the time of Richard I. of England; the laws of Wisby in the island of Gothland, to which some northern jurists have assigned an earlier origin than the laws of Oleron, but which there can be little doubt were merely a compilation from those above specified. But by far the most complete and well-digested system of maritime jurisprudence that has ever appeared is that comprised in the *Ordonnance de la Marine*, issued by Louis XIV. in 1681, by which maritime law was elevated to the rank of a regular system, and has formed the basis of many of the subsequent decisions of English, American, and other foreign courts. This excellent code was compiled under the direction of M. Colbert, by individuals of great talent and learning, after a careful revision of all the ancient sea laws of France and other countries, and upon consultation with the different parliaments, the courts of admiralty, and the chambers of commerce of the different towns. It combines whatever experience and the wisdom of ages had shown to be best in the Roman laws, and in the institutions of the modern maritime states of Europe. In the preface to his treatise on the *Law of Shipping* Lord Tenterden says,—"If the reader should be offended at the frequent references to this ordinance, I must request him to recollect that those references are made to the maritime code of a great commercial nation, which has attributed much of its national prosperity to that code: a code composed in the reign of a politic prince; under the auspices of a wise and enlightened minister; by laborious and learned persons, who selected the most valuable principles of all the maritime laws then existing; and which, in matter, method, and style, is one of the most finished acts of legislation that ever was promulgated." The ordinance of 1681 was published in 1760, with a detailed and most elaborate commentary by M. Valin, in 2 vols. 4to. *See* Admiralty, Court of. (See also the *Commercial Dict.*)

MARK. An old coin current in England and Scotland, valued 13*s.* 4*d.* A piece of money so called is at present used in Hamburgh; it is equal to 1*s.* 4*d.* sterling.

MA'RKET. (Mod. Lat. mercheta, from merx.) In Law, the liberty or franchise whereby a town is enabled to set up and open shops, &c., at a certain place within its limits, for buying and selling, and better provision of such victuals as the subject wanteth. The establishment of a market, with the grant of the tolls thereunto belonging, is one of the king's prerogatives; and can only be effected by virtue of the king's grant, or supported on long and immemorial usage and prescription which presuppose such a grant. The general rule of law is, that all sales and contracts of any thing vendible in fairs or markets overt (*i.e.* open) shall not only be good between the parties, but valid against all claim by others having any right or property in the subject.

MA'RKING INK. An indelible ink used for marking linen; it effectively resists washing and almost all chemical agents: its basis is oxide of silver, which has a strong affinity for the fibre of linen and cotton, and acquires by exposure a black colour. A good marking ink is prepared by dissolving a drachm of fused nitrate of silver in half an ounce of distilled water, and colouring it with a little sap-green; but as this is apt to run if written with upon the unprepared linen, the place to be written upon is commonly prepared for its reception by the previous application of *liquid pounce*, which is made by dissolving two drachms of carbonate of soda and two drachms of gum arabic in four ounces of water: this also effectively precipitates the oxide of silver upon the vegetable fibre, and prevents any injury from the corrosive action of the salt of silver. A solution of ammonio-nitrate of silver, thickened by a little gum, forms a marking ink which may be used without any previous preparation.

MA'RKING NUT, in Botany, is the seed or nut of the *Semicarpus anacardium* a tropical tree, related to the cushew nut. It derives its name from the juice contained in its fruits staining linen of a deep and indelible black colour.

MARK, ORDER OF SAINT. A Venetian order of knighthood; St. Mark the Evangelist having been the patron of that republic. The knights were elected by the doge and senate.

MARL, is composed of carbonate of lime and clay in various proportions, and in different degrees of compactness and friability. In some marls the proportion of clay is small, in which case the marl, as a manure, acts on soils much in the same manner as lime; but where clay is the predominant ingredient of marl, it acts on the soil partly as lime, but principally by altering the texture of the soil. Hence all sandy soils are improved by marl, in consequence of its increasing their compactness and capacity for retaining moisture; while argillaceous marls applied to clays are of little or no use. From these long-established facts has arisen the old adage,—

Who marls sand shall bury land,
Who marls clay throws all away.

Marl is found in almost every country; not like limestone, in protruding rocks, but, from its friable nature, which moulders down into a comparatively earthy mass, under or near the surface of the soil, whence it is dug out and spread on the surface. Hence, while limestone is quarried, chalk and marl are dug out of pits. Marl has been in use in Europe since the time of the Romans: it is very generally employed as a manure in France and Germany, and in England it is most employed in Norfolk.

MA'RLINGSPIKE. An iron bolt tapering to a point for opening the strands of rope.

MA'RLY, MACHINE OF. A celebrated piece of mechanism, one of the most complex perhaps ever constructed, for raising water from the Seine to supply the town of Marly, as well as Versailles and Trianon. Its mean produce was from 30,000 to 40,000 gallons per hour; and was attended with an expense of about a farthing for 15 gallons. It was erected in 1682 by Runnequin, upon very unscientific principles, but still with considerable skill in its details. It was, as such complicated machines always are, often out of repair; and Hachette reports of it that, after 128 years, it fell into total ruin. Details of its construction may be seen in Belidor, *Arch. Hydraulique; Gregory's Mechanics*, vol. ii., and other places.

MARMORA'TUM. (Lat.) In Architecture, a cement formed of pounded marble and lime well beaten together.

MA'RMOT. The Rodent animal so called is the type of a genus (*Arctomys*) nearly allied to the squirrels, being characterized by having five molar teeth on each side of the upper and four on each side of the lower jaw, all bristled with points, and indicative of a somewhat mixed diet. The marmots, however, in their general form are nearly the reverse of the squirrels, being heavy, with short legs, a middle-sized or short tail, and a large flat head. They pass the winter in a state of torpor, concealed in deep holes, the entrance of which they close with a heap of dried grass. They are natives of Europe and North America, live in societies, and are easily tamed.

MA'RONITES. The followers of Maro, inhabitants of the mountains Libanus and Antilibanus in Syria, who adopted in the 7th century the opinions of the Monothelites; they continued to form a separate sect until the 12th century, when they became reconciled to the see of Rome. The Maronite writers, however, have always maintained their freedom from the errors imputed to them, and declare themselves to have been uniformly attached to the doctrines of the Catholic church. (*See* MONOTHELITES. (*Mosheim*, transl., ed. 1790, ii. 196.)

MAROO'NS. (Supposed to be derived from a word used in Spanish America, signifying *hog-hunters*.) A name given in Jamaica to runaway negroes. When Jamaica was conquered from the Spaniards a number of negroes, abandoned by their former masters, occupied some of the mountainous parts of the island, and caused great trouble to the colonists. About 1730 they became extremely formidable; but after a war of eight years at length submitted to a capitulation, by which they were allowed to retain their free settlements in the heart of the island; in 1795 a portion of them again rose in arms, but were speedily put down, and transported to a new settlement in Nova Scotia. (See *Dallas's History of the Maroons*.)

MARQUE, LETTER OF. A commission granted in time of war to a private person commanding a vessel to cruise at sea and make prize of the enemy's ships and merchandise: the ship so commissioned is sometimes called by the same name. (*See* REPRISALS, LETTER OF.) The word is derived from mark (Germ. *frontier*), as being a right of capturing property beyond the limits or frontiers of another prince.

MA'RQUESS. (Germ. mark, *a limit* or *frontier*.) A title of dignity in England, France, and Italy, next in rank to that of duke. It is of German origin; those military chieftains in the Teutonic kingdoms and empires which arose on the fall of the Western empire, who were entrusted with the defence of districts on the frontiers, having been styled mark-grafen, counts of the marches or frontiers (in Latin, marchiones). Many of these officers were appointed by Charlemagne, although he was not, probably, the first creator of the office. According to the ordinary cause of the development of feudal institutions, these chiefs, from military governors appointed for life, became territorial potentates, holding their lands by hereditary right; and, on the decay of that system, this honour, like others, became merely titular. In England, the first marquess was Robert de Vere, Earl of Oxford, created by Richard II., in 1387, Marquess of Dublin for life. The next creation was of John de Beaufort, Earl of Somerset, raised to the rank of marquess in 1397; which dignity he afterwards refused to bear, as a strange and novel one. (See Nicolas, *Introduction to the Peerage*, lxxvi.) After that period the title fell into disuse, until the reign of Edward VI.

MA'RQUETRY. (Fr. marquetrie.) In Architecture, inlaid work consisting of different pieces of divers coloured woods of small thickness glued on to a ground usually of oak or fir, well dried and seasoned, which, to prevent casting and warping, is composed of several thicknesses. The early Italian builders used it in cabinet work, and John of Vienna and others of his period by its means represented figures and landscapes; but in the present day it is chiefly confined in its use to floors, in which the various pieces of wood are usually disposed in regular geometrical figures, and are rarely of more than three or four species.

MA'RRIAGE, LAW OF. Marriage, in its legal sense, is a civil contract binding parties to certain reciprocal obligations; and the general principle of law respecting this, as well as other contracts, is, that it is to be held valid according to the usage of the country wherein it is made. Thus a marriage between English subjects in Scotland according to the formalities of Scottish law is binding, and the children of such parents are legitimate in England. A marriage between English subjects in France according to the ceremonies in the church of England would not be valid, according to the principles of general law, unless registered before the civil magistrate according to the provisions of the French code. But, by the statute 4 G. 4. c. 91. marriages between English subjects, solemnized abroad by ministers of the church of England in the chapel of a British ambassador or British factory, are valid in the United Kingdom.

Previous to the passing of the first Marriage Act in 1754, the law of England was governed by the canon law; and, consequently, an agreement to marry, followed by consummation, formed, as it now forms in Scotland, a sufficient union. That statute first rendered necessary the preliminaries of the publication of banns, or the obtaining a licence. It was amended by 4 G. 4. c. 17. But that act imposed so many additional restrictions on parties wishing to become husband and wife, that it was found necessary to repeal it in all haste, and another statute was passed (4 G. 4. c. 76.), by which English marriages were next regulated.

By this act the banns of marriage are to be published three Sundays in a parish church, or public chapel of the establishment, in the parish wherein both, or the parish wherein each, of the parties dwell. A licence is a dispensation by virtue of which marriage may be solemnized without the publication of banns. It is granted by *surrogates*, or persons having authority from the bishop. No licence can now be obtained, unless upon affidavit that the parish or district in which the marriage is to be solemnized has been the usual place of residence of one of the parties for fifteen days immediately preceding the granting of the licence. The affidavit must also declare that there is no impediment of kindred or alliance, nor any other lawful cause of hinderance.

A special licence dispenses with all restrictions as to time and place of marriage. By a regulation of Archbishop Secker it is not to be granted except to persons of a specified rank; but in practice the privilege is extended as a matter of favour. *See* REGISTRAR.

The power of parents and guardians, in restricting the marriage of minors under their tutelage, is now confined within the following limits. The publication of banns is void, if the parent or guardian of either party declare, or cause to be declared, their dissent in public at the time of the proclamation. In case of marriage of a minor by licence, the father or guardian, or if none the mother, or the guardian appointed by the court of chancery, must give consent, and such consent must be notified in the affidavit on application for the licence. If consent be unreasonably withheld, the only resource of lovers against the flinty hearts of parents or guardians is by petition to the lord chancellor, who may, if he pleases, interpose his judicial authority in favour of their union.

Marriage is void if solemnized knowingly and wilfully (by either party) in an unlawful place, or without banns or licence, or by any person not in holy orders. So if the banns be published, whether wilfully or accidentally, in a wrong name; unless it be a name by which the party is generally known. Marriages are also void where there is a prior existing marriage, and in case of lunacy or incapacity.

But if the marriage of a minor be duly solemnized, but by false oath or by fraud the necessary consent is dispensed with, such marriage is not void; but the party so offending shall forfeit, upon complaint of the parent or guardian, all property which might have accrued to such party by the marriage.

Proof of a marriage is by the evidence of a party who was present at the celebration; or by production of the parish register, and showing the identity of the parties.

The ecclesiastical courts have the direct cognizance of questions respecting the legality of a marriage; but as the common law courts decide in questions of property, and others in which the fact of marriage may be incidentally called in question, they can require proof of it without resorting to the assistance of the former.

Marriage is voidable by suit in the ecclesiastical court, where such marriage has been contracted under a ca-

nonical impediment; namely, consanguinity or affinity, or bodily incapacity of either of the parties. Marriages solemnized by force are also voidable, and such as are contracted in error under certain circumstances. A voidable marriage is good to all intents until rendered void by a sentence of the court.

Other matrimonial causes in these courts are—1. Jactitation of marriage. When one party gives out or reports that he or she is legally married to another, the person injured may *libel* the other (*see* ECCLESIASTICAL COURTS, under the head of LAW) in the spiritual court; and unless the defendant proves marriage, silence is enjoined, which is the only remedy the spiritual court can give.

1. Adultery, as a public crime, is left to the cognizance of the spiritual courts: as a civil injury, it is pursued by the husband in an action of trespass for damages against the adulterer in those of common law.

2. In suits on the ground of adultery in the spiritual court the remedy prayed is a separation, or divorce *à mensâ et thoro*, from bed and board. And it may be obtained by either party; but will be refused in case the other party recriminates and mutual unfaithfulness is proved, or in case other circumstances are shown which, in the opinion of the court, disentitle the complainant to the remedy he prays for.

A divorce *à vinculo matrimonii*, that is, the annulment of marriage, can only be conferred by act of parliament. Evidence must be given on applying for the bill that there was judgment for the plaintiff on an action for damages against the seducer; or sufficient cause shown why such action was not brought or such judgment obtained.

3. Another ground on which the spiritual courts will grant a separation is cruelty; but the cruelty for which such relief can be granted is only such as directly endangers the life or health of the injured party.

4. A suit for restitution of conjugal rights is to compel mutual cohabitation. And no deed of separation or mutual agreement, nothing short of a sentence by the court, can bar the complainant of his or her right to promote this suit; but cruelty or adultery may be pleaded in reply, as constituting lawful grounds for separation.

5. Alimony is that legal proportion of the husband's estate which, by the decree of the ecclesiastical court, is allotted to the wife for her maintenance during the pendency of a suit between them; or after a sentence of divorce *à mensâ et thoro* by reason of the cruelty or adultery of the husband, the permanent allowance to be paid to the wife during their separation. The quantum of alimony is decided by the court on a statement of the husband's property (called *an allegation of faculties*) and his answer thereto.

Marriage, its Effect on Property.—The consideration of the legal effect produced by marriage on the property of the parties contracting it divides itself into,—

1. The law of husband and wife, as it respects property acquired by either before marriage.

2. As it respects property acquired by either after marriage.

3. As its dispositions are affected by separation or divorce.

(1, 2.) As to real property. If the wife is seised of lands or tenements in an estate of inheritance, and dies having had issue born living, the husband is entitled to the lands or tenements for his life, being tenant, as it is termed, by the courtesy of England; and this, whether the lands be held by a legal or equitable title.

Dower is now, since the statute 3 & 4 W. 4. c. 115., the wife's right to one third part, for life, of all estates of inheritance which her husband dies entitled to or seised of in possession. It formerly attached to all estates of inheritance of which he was at any time possessed, so that he could not defeat her title by alienation, but to legal estates only. Since the 1st January, 1834, the period on which the above-mentioned act came into operation, equitable estates are also subject to it. It has long been customary to bar this right to dower by various complicated processes, which the law has permitted to defeat the wife's claim; and especially by settlements before marriage, giving a jointure or provision in lieu of dower. It may now be barred by the husband's alienation in his lifetime; or by his will; or by a declaration in the deed of conveyance of the land to the husband. Anciently a *feme covert* could only alienate real property by the public solemnity of a *fine*; now, by a deed executed after her examination by commissioners, to show that no control is exercised by the husband.

All the *personal* property to which a woman is entitled vests in her husband by marriage. Her *chattels real*, that is, leasehold property for a term of years, will revert to her if she survive him; and although the husband may alienate them in his lifetime, he cannot dispose of them by will. But should he survive her, they are his absolutely. Her *chattels personal*—money and goods—are his without restriction, to give or bequeath as he pleases even in her lifetime. Her *choses in action* (that is, property of which there is no immediate occupation, as debts due to her, money in the funds, &c.) are the husband's property *conditionally*; that is, if he reduce them into possession by exercising his rights over them during her life. If not, they survive to her absolutely; and should she die first, he only takes them as her administrator, which he is by right.

If the husband die intestate, the wife is entitled to half his personal property if there be no issue, and to one third if there be issue.

The husband is liable for all his wife's debts and engagements made while unmarried; but not for such as she may have contracted during a former marriage. But he is released from his liability by her decease; and if he die first, she only is responsible. For debts contracted by the wife during marriage the husband is not liable unless they have been contracted with his consent, express or implied; and this implied assent gives rise, as may well be supposed, to numberless questions in courts of law.

As to the acts of husband and wife before marriage:—The will of a bachelor or widower not having children is revoked by his subsequent marriage and birth of issue. A warrant of attorney given by an unmarried woman is revoked by her marriage. So is her will, in every case; but there are others of her acts—such as the grant of a lease at will—which are not revoked, but merely revocable.

Settlements or articles, made in contemplation of marriage, are contrivances to modify the effects which would be produced by the mere act of law on the rights of the respective parties; and also to ensure an alienable provision for issue. It is usual to vest the property of both parties in trustees; generally for the benefit of the husband during their joint lives, then for the benefit of the survivor, after his or her death for the benefit of the children, in such proportions as the nature of the property or circumstances of the family may dictate. But it is usual to give authority to the parents by means of a *power* to vary these relative proportions. A jointure, although, in the strict sense of the word, a joint estate to husband and wife, is in practice a separate estate to the wife in lands and tenements, to take effect immediately on the husband's death, and to secure a competent provision for her during her life at least: it is usually provided by settlement, and bars dower. Pin-money is an annual income settled gratuitously before marriage by the husband on the intended wife; usually by means of trustees.

But in other cases, and especially when the casualties of a trade render it desirable to secure a certain protection, the wife is provided for in the settlements by vesting her own property, or a portion of it, in trustees for her sole and separate use. In this case the sums so secured are wholly independent of her husband's control. Where bequests are made to a married woman for her separate use, and no trustees are named to protect them, a court of equity will consider her husband a trustee for her. She may sue him, or any other person, in those courts, in respect of such property. Her savings out of it are likewise hers in separate right. But savings made by a wife out of an allowance for her private expenditure are not in every case her separate property.

A married woman has also a claim, in a court of equity, to a provision out of her own property in several cases, especially where the husband deserts or ill-treats her, or where, being a ward of chancery, she is clandestinely married.

(3.) On a divorce *à vinculo matrimonii* dower is gone: and if such divorce be on account of pre-contract, consanguinity, or affinity, the children are illegitimate, and the wife's property is restored to her. But a divorce *à mensâ et thoro* does not bastardize the children or bar dower.

Adultery during a voluntary separation entitles the aggrieved party to a divorce *à mensâ et thoro* as much as during cohabitation; and frees the husband from all debts of his wife, or claims by reason of her.

A husband is not held liable for debts contracted by his wife, even for necessaries, if he have turned her out of doors for adultery; or if, after being turned out, she commit adultery; or if she depart from him without his consent; or if she elope with an adulterer; or if the husband and wife separate by mutual agreement, in cases where the wife has separate means, or is provided for by separate maintenance.

Bigamy, or polygamy, is a felonious offence, punishable by transportation for seven years; and is now (since the statute 9 G. 4. c. 31.) equally punishable, although the second marriage took place out of the jurisdiction of English law.

A wife committing any felony, except murder or manslaughter, in company with her husband, is not responsible for the offence; but she is indictable for high treason so committed.

In both civil and criminal cases (with the exception of treason), husband and wife are not allowed, except under particular circumstances, to give evidence for or against each other.

MARS. In the Solar System, one of the old planets, and the fourth in the order of distance from the sun. The mean distance of Mars from the sun is 1·5236923, the mean distance of the earth from the sun being 1: it is, consequently, about 142,000,000 of miles. Mars performs his mean sidereal revolution in 686·9796458 mean solar days, and his synodical revolution (that is, returns to the same position in respect of the earth and sun) in 779·936 days. His orbit, at the beginning of the present century was inclined to the ecliptic in an angle of $1^\circ 51' 6''$; and its eccentricity is ·093307, half the major axis being unit. His apparent diameter varies from $3{\cdot}6''$ at his greatest, to $18{\cdot}28''$ at his least distance from the earth. At his mean distance the apparent diameter is $6{\cdot}29''$; whence the true diameter is found equal to ·517, that of the earth being unit, or about 4100 miles. Mars has a rotation about his axis which is performed in 24 h. 39 m. 21 sec. The inclination of the axis to the ecliptic is $30^\circ 18'$. When the opposition of Mars takes place at the time he is near the aphelion of his orbit he is then at his least distance from the earth, and presents an interesting appearance when seen through a powerful telescope. "In this planet," says Sir John Herschel, "we discern, with perfect distinctness, the outlines of what may be continents and seas. Of these the former are distinguished by that ruddy colour which characterizes the light of this planet (which always appears red and fiery), and indicates, no doubt, an ochrey tinge in the general soil, like what the red sandstone districts on the earth may possibly offer to the inhabitants of Mars, only more decided. Contrasted with this (by a general law in optics) the seas, as we may call them, appear greenish. These spots, however, are not always to be seen equally distinct, though, when seen, they offer always the same appearance. This may arise from the planet not being entirely destitute of atmosphere and clouds; and what adds greatly to the probability of this is the appearance of brilliant white spots at its poles, which have been conjectured, with a great deal of probability, to be snow; as they disappear when they have been long exposed to the sun, and are greatest when just emerging from the long night of their polar winter." (*Astronomy*, *Cab. Cyc.*) See PLANET.

MARS, or MAVORS. The Latin names of the deity called by the Greeks Ἄρης. He was fabled to be the son of Juno, conceived by means of the virtue of a certain plant; and was worshipped as the God of War. At Rome he was honoured as the progenitor of Romulus, the founder of the city, of which he was held to be the protector; and it was to the honour of this divinity that the Latin husbandmen used to offer up a peculiar sacrifice, called *suovetaurilia*, which, as the derivation of the word implies, consisted of a pig, a sheep, and a bull. The priests of Mars were called *salii*, and to their care was intrusted the sacred shield (*ancile*), which was said to have fallen from heaven during the reign of Numa. See SALII, ANCILE.

MARSEILLAISE HYMN. The name popularly, though erroneously, given to the national anthem of the French. The origin of this song, which has played so important a part in the revolutions not only of France but of other continental states, was long involved in obscurity; and we scarcely think it will be considered out of place to embody in our pages the following statement respecting it, which may be relied on as authentic: — The *Marseillaise Hymn* was the production of Rouget de Lille, a French officer of engineers, who was quartered at Strasburg in the year 1791, when Marshal Luckner commanded the army, at that time entirely composed of young conscripts. The marshal was to march the following morning of a certain day; and, late in the evening previous, he inquired if there were any men of a musical or poetical genius in the army who could compose a *soul-inspiring* song to animate his young soldiers. Some one mentioned Captain Rouget de Lille, who was immediately ordered into the presence of the marshal to receive his commands on the subject; which having been given, and a promise made by De Lille that a song would be ready the following morning, he went to his quarters, and during the night he not only wrote the song in question, but also set it to music; and next morning the army marched to its tune, and carried every thing before it with an enthusiasm only to be equalled by absolute frenzy.

The song is said to have been styled the *Marseillaise Hymn* from a body of troops, on their march from Marseilles, having entered Paris playing that tune at a time when it was little known in the capital. The *original* of the *Marseillaise* is said to be in the possession of Louis Philippe.

MARSH. A flat surface, the soil of which is so far saturated with water throughout the year as to be unfit for culture by the spade or plough; but not so much as to prevent it from producing coarse grasses, and other kinds of herbage. Marshes are generally situated in bottoms, where they are kept moist by the water which descends from the surrounding lands; or along the banks of rivers or lakes, where their humidity arises from their being nearly on the same level with the adjoining water. Where a marsh is situated so as to be occasionally overflowed by the sea, or by a river up which the tide flows, it is called a salt marsh; and the herbage produced by such lands is found highly conducive to the health of animals which pasture on them for a certain portion of the year, from the alterative effect of its saline properties.

MA'RSHAL. A title of honour in many European countries, applied to various dignities and high offices. The derivation of the word, and its early use, are extremely uncertain. The title of Marshal of England is now hereditary in the family of the Dukes of Norfolk. William Fitz-Osborn and Roger de Montgomery are said to have been marshals to William the Conqueror: their successors for some time are not accurately known; but the office was held in 1138, in fee, by the family of Clare, and thence descended to the Earls of Pembroke, and thence to Roger de Bigod, Earl of Norfolk, who surrendered it to Edward I. After being granted for life, and during pleasure, to several successive marshals, the dignity, with the title of Earl Marshal, was given to Mowbray, afterwards Duke of Norfolk; in whose family the dignity subsisted until it reverted to the crown in the reign of Edward IV. Richard III. granted it to his favourite, Howard, Duke of Norfolk; after whose death and attainder it passed through many hands; but was by Charles I. granted for life to his descendant, Thomas Howard, Earl of Arundel; and finally his grandson, Henry Howard, Earl of Norwich, was constituted hereditary earl marshal of England in 1672, with remainder to the issue male of the Earl of Arundel aforesaid; in which latter line it now subsists. The earl marshal is eighth in rank among the great officers of state in England. He has the same jurisdiction over the court of chivalry which was formerly exercised by the constable and marshal jointly.

Marshal of the King's Household, or Knight Marshal.— An officer whose office is said to be to hear and determine pleas of the crown, and suits between those of the king's household and other persons within the verge. The marshal of the King's Bench has the custody of the King's Bench prison in Southwark.

Marshal of France is the highest military rank in the French army. This officer appears first in history under the reign of Philip Augustus, as commander-in-chief of the royal armies. The number of marshals was increased by several successive sovereigns: in the reign of Henry IV. the states of Blois limited it to four, but this restriction was not observed; and, in the reign of Louis XIV., there were at one period no less than twenty. In the same reign officers of the navy as well as the army received the rank of marshal. The marshals bore two batons or marshal's staffs — azure, semés of fleur de-lys or, saltier-wise — as the token of their dignity. After the deposition of Louis XVI. the dignity of marshal ceased; but was revived by Napoleon, with the title of Marshal of the Empire.

MA'RSHALLING. In Heraldry, the arrangement and distribution of coats in a shield so as to denote the several matches and alliances of the family. See BLAZONRY.

MA'RSHALSEA. In Law, the court or seat of a marshal. The King's Bench prison, in Southwark, is said to be so called because the marshal of the king's house was wont to sit there, or to keep his prison. The Marshalsea, or Knight-marshal's Court, commonly called the Palace Court, was created by Charles I.; and has jurisdiction of personal actions within a circuit of twelve miles round Whitehall.

MARSH MIASMA. The infectious vapours which rise from certain marshes and marshy soils, and which tend to the production of intermittent and remittent fevers.

MARSU'PIALS, *Marsupialia*, or *Marsupiata*. (Lat. marsupium, *a pouch*.) An order of Implacental Mammiferous quadrupeds, of which the females have a portion of the abdominal integument folded inwards, forming either a depression containing the mammæ, or a pouch serving also as a temporary abode for the young; and the males have a corresponding portion of the abdominal integument extended outwards, forming a scrotum or pedunculate bag for the testes. In both sexes two supplementary trochlear bones are developed in the internal pillars of the abdominal rings, and are articulated to the anterior part of the brim of the pelvis, around which bones plays the muscle supporting and compressing the testes in the male, and the mammary glands in the female: the trochlear ossicles, from their connection by means of these muscles with the pouch, are called "marsupial."

The quadrupeds associated together by the common external and osteological characters above defined so far resemble the oviparous animals that a placenta is not organized, and the chorion of the fœtus contracts no adhesion with the parietes of the uterus. The fœtus is prematurely born after a gestation of only thirty-eight

days, in the great kangaroo, in which it does not exceed an inch in length. It is then received into the pouch, and adheres to the nipple for many months before it quits the pouch. The generative organs themselves, both male and female, offer several striking peculiarities common to all the Marsupials, and by which they differ from the ordinary Mammalia. Cuvier accordingly, in 1816, separated the marsupial from the other unguiculate quadrupeds, to form a distinct group, which he describes as forming with the Monotremes a small collateral chain; all the genera of which, while they are connected together by the peculiarities of the generative system, at the same time correspond in their dentition and diet, some to the Carnivora, others to the Rodentia, and a third tribe to the Edentata. M. de Blainville, in the Tables of the Animal Kingdom which he published in the same year, 1816, constituted a distinct subclass of Cuvier's "small collateral chain" of mammals, and gave to the subclass the name of *Didelphes*, in antithesis to that of *Monodelphes*, by which he distinguished the Placental Mammalia.

Many acute and sound-thinking naturalists refused their assent to these views, which, as they were supported by a knowledge of the conformity of organization of only the generative system in the Marsupials, were unquestionably defective in the evidence essential to enforce conviction. The best arguments for returning to the older views of classification, and for distributing the marsupial genera, according to the affinities indicated by their dental and locomotive systems, among the different orders of the Placental Mammalia, were advanced by Mr. Bennett, the accomplished author of *The Gardens and Menagerie of the Zoological Society delineated* (vol. i. p. 265.); and these have been repeated with approbation, and adopted by later classificators, as Mr. Swainson.

The discovery of the true affinities of the Marsupialia could only flow from an insight into their whole organization; and the question which Mr. Bennett proposes, with reference to the genus *Phascolomys*, "What is there of importance in the structure of the wombat, except this solitary character of the marsupium, to separate it from the Rodent order?" — a question which he might, in 1831, have asked with equal force in reference to any other marsupial genus — could only be answered satisfactorily by the anatomist who had submitted the Marsupialia in question to a thorough dissection.

Although the Marsupials present modifications of the dental system corresponding with the carnivorous, omnivorous, and herbivorous types, yet they agree with each other, and differ from the analogous Placental Mammalia in having four instead of three true molars, *i. e.* four molars which are not displaced and succeeded by others, in the vertical direction.

In the locomotive organs it is true that we see some of the Marsupials having a hinder thumb, like the Placental Quadrumana; others are digitigrade, with falculate claws, like the Placental Feræ; a third, as the wombat, has the feet adapted for burrowing; a fourth, like the Cheironectes, is aquatic, and has webbed feet; yet all these Marsupials agree with each other in having a rotatory movement of the hind foot, analogous to the pronation and supination, which, in the placental quadrupeds, are limited, when enjoyed at all, to the fore feet; and they manifest, moreover, a peculiar modification of the muscles of the hind leg and foot, in relation to these rotatory movements. In those Marsupials, as the kangaroos, potoroos, and perameles, in which the offices of support and locomotion are devolved exclusively or in great part upon the hind legs, these are strengthened at the expense of the loss of the rotatory movements of the feet; but in the enormous development of the two outer toes, and the conversion of the two inner ones into unguiculate appendages, useful only in cleansing the fur, these Marsupials differ from all Placentals, whilst the same peculiar condition of the toes may be traced through the Pedimanous group of Marsupials. Thus the locomotive organs, notwithstanding their adaptation to different kinds of progression, testify to the unity of the marsupial group in the two remarkable peculiarities of structure above cited.

The vascular system gives evidence to the same effect. All the Marsupials present the following peculiarities in the structure of the heart; viz. the right auricle manifests no trace of either *fossa ovalis* or *annulus ovalis*, and receives the two *venæ cavæ superiores* by two separate inlets. This generalization is, however, less urgent in the present question than the preceding, because the modification, as regards the separate entry of the superior *venæ cavæ* obtains in a few placental species, as the elephant and certain Rodents; but as the first-cited cardiac character is common and peculiar to the Marsupial Mammalia, and as the second, while it is universal in the Marsupials, occurs only as an exceptional condition in the placental series, the arguments which they afford to the unity of the marsupial group cannot be overlooked in a philosophical consideration of the affinities of the Mammalia.

With respect to the nervous system, it has been shown that, in the structure of the brain, the Marsupialia exhibit a close correspondence with the Ovipara in the rudimental state of the *corpus callosum:* the difference which the most closely analogous placental species offer in this respect is broadly marked. (*Owen on the Brain of the Marsupial Animals, Phil. Trans.* 1837, p. 89. pl. vi.)

These coincidences in the Marsupialia of important organic modifications of the dental, locomotive, vascular, cerebral, and reproductive systems, establish the fact that they constitute a natural group, inferior, on the whole, in organization to the Placental Mammalia.

The following is a tabular view of the subordinate divisions of the Marsupialia regarded as an order of the Implacental subclass of Mammalia: —

Classification of the Marsupialia.

Tribes.	Families.	Genera.	Subgenera.
SARCOPHAGA.			
Three kinds of teeth; canines long in both jaws; a simple stomach; no *intestinum cæcum*.	*Dasyuridæ* -	Thylacinus. Dasyurus. Phascogale.	
Extinct transitional forms - - - -	- -	Phascolotherium Thylacotherium	Fossil.
ENTOMOPHAGA.			
Three kinds of teeth in both jaws; a simple stomach; a moderately long *intestinum cæcum*.	*Ambulatoria* -	Myrmecobius.	
	Saltatoria -	Chæropus. Perameles.	
	Scansoria -	Didelphys - -	Didelphys. Cheironectes.
SARCOPHAGA.			
Anterior incisors large and long in both jaws; canines inconstant; stomach simple, or with a special gland; a very long *intestinum cæcum*.	*Phalangistidæ* -	Phalangista - -	Cuscus. Pseudocheirus. Tapoa.
		Petaurus - -	Petaurista. Belidia. Acrobata.
	Phascolarctidæ -	Phascolarctus.	
POEPHAGA.			
Anterior incisors large and long in both jaws; canines present in the upper jaw only, or wanting; a complex stomach; a long *intestinum cæcum*.	*Macropodidæ* -	Hypsiprymnus. Macropus.	
RHIZOPHAGA.			
Two scalpriform incisors in both jaws; no canines; stomach with a special gland; *cæcum* short, wide, with a vermiform appendage.	*Phascolomyidæ*	Phascolomys.	
		Diprotodon -	Fossil.

MART. *See* FAIR and MARKET.

MARTE'LLO TOWERS. The name given to the circular buildings of masonry which were erected along different parts of the British coasts at the commencement of the present century, intended as a defence against the meditated invasion of Napoleon. The origin of the name is usually supposed to be derived from a fort in Mortella (Myrtle) Bay, Corsica, which, after a determined resistance, was at last captured by the British in 1794. These towers were provided with vaulted roofs, and consisted of two stories, — the lower for the reception of stores, the upper, which was shell-proof, for the casement of troops; and the wall of the building terminated in a parapet, which secured the men in working the pieces of artillery,

which besides were constructed on moving pivots, so as to be fired in any direction. In most places of England these towers have been dismantled; those that remain either serve as stations for the use of the coast blockade force, or, like that near Leith, are not employed for any purpose.

MARTINE'T. A cant phrase for a severe military disciplinarian; probably derived from a certain Colonel Martinet, who served in the French army under Louis XIV., who was the inventor of a peculiar whip, called by his name, for the purpose of military punishment, and also (if Voltaire may be believed) of the bayonet.

MA'RTINGALE. In Naval affairs, a rope leading downwards from the jib-boom end, to keep the jib-boom down against the force of the sail and stay. In the manége, martingale is applied to a thong of leather fastened at the end of the girths under the belly of a horse, and at the other end to the musrol, passing between the legs to keep him from rearing.

MA'RTLET. In Heraldry, a fanciful bird, shaped like a martin or swallow, but depicted with short tufts of feathers in the place of legs. It is the difference or distinction of a fourth son.

MA'RTYR. (Gr. *μαρτυρ*, or *μαρτος*, *witness:* in which sense the word is used by the writers of the N. Test. when speaking of themselves, in reference to the testimony they bore to the actions of Christ.) When the members of the Christian church were subjected to persecution under the Roman emperors, the persons accused were questioned as to their belief; and, in undergoing punishments and death, were said to bear witness of their master before the world. A distinction was also made between those who, although they boldly asserted their belief, were yet not visited with extreme punishment, who were designated under the name of *confessors*, and those who actually suffered death, who alone were dignified with the title of martyrs, and said to obtain the crown of martyrdom. Martyr, in its ordinary signification, denotes a person who suffers death or persecution on account of his belief. (See *Mosheim's Eccl. History* (transl.), ed. 1790, i. 77.; *Gieseler* (transl.), c. 8. 14. 71. &c. As to the intercession of martyrs, *Ib.* 109. 162.)

MA'RTYRO'LOGY. (Gr. *μαρτυς*, and *λογος*, *a description.*) The name given to that department of ecclesiastical history which relates to the acts and deaths of martyrs. It also signifies a calendar or register kept in religious houses, wherein were inserted the names and donations of their benefactors, and the days of their death. As specimens of this species of works, we may mention the *Martyrology* of Eusebius, which was so celebrated in the early church, but which is lost; and *Fox's Book of Martyrs*, the most valuable record of the sufferings of the English reformers. Many of the accounts in the early martyrologies are purely fabulous. See *Ruinart's Acta Martyrum;* Baronii, *Martyrologium Romanum;* and *Middleton's Free Inquiry.* Gallonius, *De Sanctorum Martyrum Cruciatibus*, 1598, and subsequent editions, is a book which has had great popularity on the Continent.

MASCA'GNIN. A mineralogical name of the native sulphate of ammonia of volcanic districts; named after Mascagni, who first discovered it.

MA'SCLE. In Heraldry, a bearing in the form of a lozenge perforated; supposed to represent the meshes of a net.

MA'SONRY. (Fr.) The science of combining and joining stones for the formation of walls and other parts in constructing buildings. The science, when applied in the construction of domes, groins, and circular arches, is difficult and complicated, depending on a thorough knowledge of descriptive geometry. Hence the various methods of obtaining the requisite lines for the artificer would require a space and diagrams which cannot be given here; but the reader who desires acquaintance with that part of the subject may consult Rondelet, *Traité Théorique et Pratique de l'Art de Bâtir*, Paris, 1829-30, 4to., with the certainty of finding all the information he requires. Vitruvius mentions several kinds of masonry among the ancients, which were distinguished from each other by the different modes of arranging the stones. The principal are, 1. The *Reticulatum*, which is arranged in diagonal courses, like the meshes of a net; whence its name. 2. The *Incertum*, wherein the rising courses are so laid, without any *certain* sizes of the stones, as that the vertical joint above always falls over the middle of the joint below. The appearance of this work is not perhaps so pleasing as that of the first, but the work itself is stronger. 3. The *Isodomum*, in which all the courses are of equal height, as its name imports. 4. The *Pseudisodomum*, which received its name from the courses being unequal in height. 5. The *Emplectum*, in which the faces of the work were wrought, and the centre of the wall filled up with rubble work, in which species of work the Greeks employed *diatoni* or bond stones, running in one piece through the thickness of the wall to tie it together. The first principles to be attended to in building stone walls are, that the vertical joints in any course should not fall over the vertical joints in the course immediately below it; and that where the thickness of the wall consists of two or more pieces of stone, bond stones or blocks which run through the whole wall transversely, if possible in one piece, should be introduced as frequently as possible for the purpose of binding the whole mass together. The different species of masonry in present use may be reduced to four:— 1. *Bond masonry*, wherein the stones of each succeeding course are laid so that the joint that mounts and separates two stones always falls directly over the middle of the stone below. 2. That of *brickwork*, where the bodies and projections of the stones enclose square spaces or panels, &c. formed with bricks. 3. That called by the French *de moilon*, or small work, wherein the courses are equal, well squared, and their edges or beds rusticated. 4. That wherein the courses are unequal, and filled up in the middle with small stones and mortar.

MASONRY. *See* FREEMASONRY.

MASQUE, or MASK. A species of drama. It originated from the custom in processions, and other solemn occasions, of introducing personages in masks to represent imaginary characters. Many of these characters, even in the religious shows of Italy, &c., were of a grotesque description, and the performance often intermixed with dancing and buffoonery. By degrees, in England, something of a dramatic character was added to these exhibitions. At first, as in the well-known progresses of Queen Elizabeth, monologues or dialogues in verse were put into the mouths of the masked performers; and, in the reign of James I., they had ripened into regular dramatic performances: sometimes, as in the *Tempest* of Shakspeare, introduced by way of interlude in regular plays; at other times acted as separate pieces, with much machinery and decoration. Ben Jonson was the first, and indeed almost the only classical English writer (with the exception of Milton, in the solitary and noble specimen of *Comus*) who devoted much labour and taste to this department of the drama. His masques were represented at court: the queen of James I., and after her the accomplished Queen Henrietta Maria, did not disdain to take part, at least as silent dramatis personæ, in some of these pageants. The taste for them died away in the reign of Charles I.; and after the interruption given to the progress of dramatic art and literature by the civil wars, they were not again brought into fashion.

MASQUERA'DE. (Ital. mascherata.) An amusement practised in almost every civilized country of modern times, consisting of a ball and other festivities, in which only those who are masked or disguised can participate. This species of amusement had its origin in Italy, where, according to *Hall's Chronicle*, they had become fashionable so early as the beginning of the 16th century. Of its introduction into England Hall thus speaks:—"On the date of the Epiphaine, at night (A. D. 1512-13), the king (Henry VIII.) with eleven others were disguised after the manner of Italie, called a maske, a thing not seen afore in England; they were apareled in garmentes long and brode, wrought all with golde, with visers and cappes of golde; and after the banket doen, these maskers came in with the six gentlemen disguised in silk" (in all probability the *domino* of more recent times), "barynge staffe torches, and desired the ladies to daunce: some were content; and some that knew the fashion of it refused, because it was not a thing commonly seen. And after thei daunced and commoned together, as the fashion of the maskes is, thei toke their leave and departed, and so did the quene and all the ladies." The invention of masquerades is ascribed to Granacci, who died in 1543.

MASS. (Lat. missa.) The name by which the Roman Catholics designate the celebration of the Lord's Supper after the forms of their church. The term is derived from the phrase, "Ite, missa est, concio" (i. e. *Go, the assembly is dissolved*); by which the priest, in the primitive ages, signified to the catechumens that all that part of the service of the church was concluded which it was allowed to all believers indiscriminately to attend. The communion of the eucharist was extended only to the higher class, the *fideles*, who had completed the period of initiation and instruction: and, after the pronunciation of these words, the offering of the body and blood was made. It was to this offering itself that the term missa came to be applied. The service of the mass, as it is still retained throughout Catholic countries, was the work of Gregory I. in the 6th century. It consists of three parts: the offertorium, or offering of the elements upon the altar; the consecration, by which they are supposed to undergo the transubstantiation into the real body and blood of Christ; and the sumption, or actual participation in them by the communicants. These ceremonies are accompanied by the recitation of various prayers; and the priests go through numerous evolutions, which are supposed to represent the circumstances attending the passion of our Lord. High mass is the performance of this service accompanied with music.

MASS. (Germ. masse.) The quantity of matter of which any body is composed. The mass is directly as

the product of the volume of the body into its density. The mass multiplied into the constant force of gravity constitutes the weight; and hence the mass of any body is rightly estimated by its weight. *See* MECHANICS.

MASS. In the Fine Arts, a large quantity of matter of light or shade. It is generally applied in painting to light and shade brought upon objects proper for their reception, and grouped or arranged so as to give repose and pleasing variety both of one and the other without being scattered.

MASSA'LIANS. *See* EUCHITES.

MA'SSETER. (Gr. μασσαομαι, *I chew.*) A short thick muscle which raises the lower jaw, and assists in moving it backwards and forwards in the act of chewing.

MA'SSICOT. Yellow oxide of *lead*.

MA'SSORA, or MASORA. A critical work among the Jews, containing remarks on the verses, words, letters, and vowel-points of the Hebrew text of the Bible. As the sacred books were originally written without any breaks or divisions into chapters or verses or even words, the Jews found it necessary to establish a canon to fix and ascertain the reading of the Hebrew text. This rule or canon is designated *Massora*, or tradition, in which the verses, letters, words, &c., are all numbered; and by this means the slightest variations can be detected. The Jewish rabbis who drew up this work are styled Massorites. *See* BIBLICAL HISTORY, &c.

MAST. A long piece or system of pieces of timber, placed nearly perpendicularly to the keel of a vessel to support the yards or gaffs on which the sails are extended. When a mast is one entire piece, it is called a *pole-mast;* but in all large vessels it is composed of several lengths, called *lower*, *top*, and *top-gallant* masts: sometimes a fourth, called a *royal* mast.

The method of supporting each mast on the one next below it is peculiar. On the sides of the lower mast, some feet below the head, are placed cheeks: on these are fixed horizontally two short pieces of wood, fore and aft, called *trestle trees*. Across these at right angles are laid, before and abaft the mast, two or more longer and lighter pieces, called *cross trees*, which give the name to the entire system. On the mast head itself is a *cap*.

The topmast being placed up and down, the fore side of the lower mast is *swayed up* between the trestle trees, and through the round or foremost hole in the cap. When raised so high that the *heel* of the topmast is nearly up to the surface of the cross trees, a piece of iron, called the *fid*, is put through the hole in the heel for the purpose; and on this fid, of which the ends are supported on the trestle trees, the topmast rests. When fidded, the topmast is *stayed*, and the rigging or shrouds *set up* to the *dead eyes* in the ends of the cross trees. These dead eyes pull from the lower rigging below, and thus the cross trees serve merely to extend the rigging. The topgallant is supported in the same manner on the topmast. When the mast is to be taken down, it is first raised to relieve the fid; which being drawn out, the mast is lowered.

The masts are supported by a strong rope, leading forward, called the *stay;* by others, leading aft on each side of the ship, called, in general, *backstays;* and by others abreast, called *shrowds*, and also *breast backstays*.

Large lower masts are composed of pieces, and have for some years been made of several lengths, about a foot or so square, and the whole supported merely by hoops at intervals.

The *main-mast* is near the middle of the vessel, the *fore-mast* is that which is nearest the fore part, and the *mizen-mast* is abaft the mainmast.

The old rule for the length of the main lower mast is to take $\frac{1}{2}$ the sum of the length of the lower deck and extreme breadth: the fore-mast is $\frac{8}{9}$ths of the main-mast, the mizen-mast considerably smaller. The top-mast is about $\frac{3}{5}$ths of the lower-mast. These rules, as well as others for the thicknesses, &c., are merely for convenience, based on no mechanical principle, and are by no means strictly followed.

MA'STER. (Lat. magister.) A title frequent among the Romans: as magister equitum (master of the horse, the lieutenant or second in command to a dictator), magister peditum, magister census, &c. Magister militiæ (master of the army, or of military affairs) was a title under the later Roman emperors. *Grand master*, in modern times, is the common title of the chief of the orders of knighthood, and of some fraternities, as the Freemasons. The eldest sons of some noble landed proprietors are designated as masters in Scotland; as the master of Gray, master of Douglas, &c.

MASTER. In the Universities, a degree in arts; the most ancient of all the academical titles. In the university of Paris, where this as well as the other learned distinctions appears to have originated, it was originally a mere title, belonging to those who taught in the schools (magistri, doctores). Thus every master was, of necessity, a lecturer. In process of time (and probably about the middle of the 13th century) the title became a degree, attainable by all after a certain amount of residence and proficiency; while the duty of lecturing was confined only to a certain number of masters, termed *regents*. About the same period the separation of the degrees of master and doctor took place. In the English universities, the degree of master of arts follows that of bachelor. A master becomes a regent after a short period; and, according to the old academical constitution, is supposed to read lectures during the year of his regency. On becoming a regent, he becomes a member of the governing body of the university; having a vote in congregation and convocation at Oxford, in the senate at Cambridge. In our universities the degree of master is the highest in the faculty of arts; but subordinate to that of bachelor of divinity. Elsewhere the faculty of arts is synonymous with that of philosophy, in which the degree of doctorate is conferred, superior to that of master.

MASTER, otherwise called Captain, in Commercial Navigation, the person entrusted with the care and navigation of a ship. His duties are very important. In some countries no one can be appointed to this office who has not been declared to fill it by a legally constituted board; but in this country the owners are left to their own discretion as to the skill and honesty of the master; and although he is bound to make good any damage that may happen to the ship and cargo by his negligence or unskilfulness, he cannot be punished as a criminal for mere incompetence. No one is qualified to be the master of a British ship unless he be a natural-born British subject, or naturalized by act of parliament; or have become a subject to his majesty by conquest, cession, &c., and have taken the oaths of allegiance; or a foreign seaman who has served three years in time of war on board of his majesty's ships.

MASTER. In the Royal Navy, the officer who has the charge of the navigation of the ship, with other duties: his rank is next to lieutenant.

MASTER ATTENDANT. The officer next in rank to the superintendent of the royal dock-yard.

MASTER AT ARMS. A petty officer of the navy, who is, in fact, the head of the police of the ship: his assistants are called ship's corporals.

MASTER OF THE CEREMONIES. An officer attached to all European courts, whose duty consists in regulating all matters of etiquette and state ceremony. (*See* CEREMONIES, &c.) The name is also applied to any individual who is appointed by general consent to preside over the arrangements of a public ball, with the power of deciding all disputes that may arise therein.

MASTER OF THE HORSE. The third great officer in the British court. When not put in commission, this office is always filled by a nobleman. He has the management of all the royal stables and bred horses, with authority over all the equerries and pages, coachmen, footmen, grooms, &c. In solemn cavalcades he rides next the sovereign. Salary, 1276*l*. 13*s*. 4*d*. per annum. The queen dowager's household has also a master of the horse and three equerries.

MASTER OF THE HOUSEHOLD. An officer employed under the treasurer of the household to survey accounts.

MASTER OF THE MINT. *See* MINT.

MASTER OF THE ROBES. An officer of the royal household, in the lord chamberlain's department. His salary is 800*l*. per annum.

MASTER OF THE ROLLS. *See* MASTERS IN CHANCERY.

MASTERS IN CHANCERY, are assistants to the lord chancellor. The masters in ordinary are twelve in number, of whom the master of the rolls is chief. To them are referred interlocutory orders for stating accounts, computing damages, &c. They also administer oaths, take affidavits and acknowledgments, and examine bills in chancery with reference to their propriety. The masters are also employed by the house of peers in carrying messages to the commons. Masters extraordinary are appointed to act in the country beyond twenty miles from London. By 3 & 4 W. 4. c. 94. s. 16., the appointment of masters in ordinary is taken from the lord chancellor, and vested in the crown.

MA'STER-SI'NGERS. A class of poets who flourished in Germany during the 15th and part of the 16th century. They were confined to a few imperial towns, and their chief seat was the city of Nuremberg. They were generally of burgher extraction; and formed regular corporations, into which proficients were admitted by the ordinary course of apprenticeship. Their poetry (generally confined to devotional or scriptural pieces, legendary tales, with some admixture of satire and of amatory lyrics) was subjected to a peculiar and pedantic code of laws, both composition and versification; and a board of judges (styled merker) assembled to hear the poems recited, and *mark* the faults which might be committed in either particular: he who had the fewest faults received the prize. Hans Sachs, the famous cobbler of Nuremberg, was a member of these societies; although his genius was of too independent a character to submit to the trammels of their poetical regulations.

MA'STIC. (Gr. μαστιχη, *a species of gum.*) In Architecture, a cement of recent introduction into England,

employed for plastering walls. It is used with a considerable portion of linseed oil, and sets hard in a few days. From this latter circumstance, and from its being fit for the reception of paint at an early period, it is much used in works where great expedition is requisite.

MASTIC. A peculiar resin which exudes from the *Pistacia lentiscus*. Its chief use is in varnishes.

MA'STICOT. (Fr. massicot.) In Painting, a yellow colour, being an oxide of lead.

MASTI'TIS. (Gr. μαστος, *the breast*.) Inflammation of the breast in women: it commonly terminates in suppuration.

MA'STODON. (Gr. μαστος, *a nipple*, and οδους, *tooth*.) A genus of extinct fossil quadrupeds allied to the elephant; so called from the conical projections upon the surfaces of the molar teeth.

MA'STOID. (Gr. μαστος, and ειδος, *form*.) Certain *nipple-like* protuberances of the bones.

MASTOTHE'CA. (Gr. μαστος, and θηκη, *a receptacle*.) A name sometimes used for Marsupium, and applied to the abdominal pouch of the marsupial animals.

MATE. In a Merchant Ship, the deputy of the master, taking in his absence the command. There are sometimes only one, and sometimes two, three, or four mates in a merchantman, according to her size; denominated 1st, 2d, 3d, &c. mates. The law, however, recognizes only two descriptions of persons in a merchantman — the master and mariners; the mates being included in the latter, and the captain being responsible for their proceedings.

In men-of-war, the officers immediately subordinate to the captain are called lieutenants. But the *master*, or officer whose peculiar duty it is to take charge of the navigation of the ship, has certain mates under him, selected from the midshipmen. The boatswain, gunner, carpenter, &c. have each their mates or deputies, taken from the crew.

The officers subordinate to the commander in the ships belonging to the East India Company were called 1st, 2d, 3d, &c. officers. East Indiamen had no sailing masters, the commanders performing that duty. (*Falconer's Marine Dictionary*, &c.)

MATÉ. The Paraguay name of a plant called *Ilex paraguensis* by botanists, whose leaves are used extensively in that country as a substitute for tea. It has the property of turning milk blackish when mixed with it.

MATE'RIAL. Any thing composed of matter, or possessing the fundamental properties of matter. See MATTER.

MATE'RIALISM. That metaphysical theory which is founded on the hypothesis that all existence may be resolved into a modification of matter, including, of course, the conscious subject. Materialists, of one sort or other, have abounded in every stage of philosophical thought. They have consisted, in the main, of persons accustomed to the exclusive pursuit of merely physical or empirical science, who have transferred the habits and prejudices thus engendered to the higher sciences of metaphysics and physiology. The most celebrated materialists were, among the ancients, Democritus and his later disciples; Epicurus and his sect; to whom may be added, though in a somewhat different sense, the Stoics: among the moderns, Gassendi, Hobbes, Hartley, and Dr. Priestley. Most schemes of materialism rest on the assumption that all that is real in nature consists in the minute particles from the juxtaposition of which all sensible objects arise. This is what is variously designated as the atomic, the mechanical, or the mechanico-corpuscular theory, and has met with supporters chiefly in France. Among ourselves, in very recent times, Dr. Thomas Brown has eloquently maintained that part of this system which relates to physical phenomena; though he has combatted, with the utmost subtlety and ingenuity, the portion of it which includes the nature of the mind itself. (Compare sect. v—ix. with sect. xii—xiv. See also *Priestley's Disquisitions on Matter and Spirit*, 1777; and his *Three Dissertations on the Doctrine of Materialism and Philosophical Necessity*. Also, *Price's Letters on Materialism and Philosophical Necessity*.) The latest and boldest defence of materialism that has appeared in England is to be found in the celebrated lectures of Mr. Lawrence, who maintained that the brain is to be conceived as secreting thought, in the same sense in which the liver secretes bile or the stomach the gastric juice.

MATE'RIA MEDICA. This term implies the various substances, natural and artificial, which are used in the cure of disease, and which are usually called *medicines*. They are frequently arranged into classes dependent upon their virtues or effects, or upon their constituent parts: but perhaps the most convenient arrangement is the alphabetical.

MATHEMA'TICS. (Gr. μαθησις, *learning*.) The science which investigates the consequences which are logically deducible from any given or admitted relations between magnitudes or numbers. It is usually divided into two parts: *pure*, where geometrical magnitude or numbers are the subject of investigation; and *mixed*, where the deductions thus made are from relations which are obtained by observation and experiment from the phenomena of material nature, and which constitutes what is otherwise called *physics*, or physical science.

The first object of mathematical science was geometry, and this received its highest degree of cultivation amongst the Greeks. Several of their works are come down to our own times, but all have undergone more or less of mutilation; and some of the most interesting are either wholly lost, as the *Porisms* of Euclid, or known to us only through the medium of Arabic translations, as the *Sectio Rationis* of Apollonius. See GEOMETRY.

The next object of research that comes under the denomination of pure mathematics is number, the science of which constitutes arithmetic. By reason of their defective system of notation, the Greek geometers were under the necessity of employing very complicated methods for performing ordinary arithmetical calculations; and for investigating the more abstruse properties and relations of numbers they had recourse to geometrical constructions. The moderns have, however, discovered a much more simple and direct system of processes, constituting *algebra;* and this has also been applied with great success to the solution even of geometrical problems and thorems, which by purely geometrical methods had never been effected. The differential calculus and the calculus of functions are also branches of algebra. See ARITHMETIC and ALGEBRA.

Of the various branches of the mixed mathematics, or applied mathematics, astronomy is by far the most advanced towards perfection; and next to it the doctrine of optics, which has been cultivated as subservient to astronomy. This has depended chiefly on the simplicity of the *laws* which connect the phenomena, and the consequent simplicity of the mathematical investigations which are necessary for a development of their consequences. Nevertheless, simple as those laws are, and relatively simple as the investigations to which they lead also are, their perfect development is beyond the present powers of mathematical science, which in numerous cases can only furnish approximate results.

MA'TINS. In the Roman Catholic church, the earliest of the canonical hours of prayer. See HOURS.

MA'TRASS. A chemical vessel employed in sublimations, and in digesting solutions in a sand heat. It is superseded in the modern laboratory by a flask.

MATRI'CULA. (Lat. mater, *mother*.) A register kept of the admission of persons into any body of society, of which a list is made. In the Romish church there was a *matricula clericorum*, a list or catalogue of the officiating clergy; and *matricula pauperum*, a list of poor persons to be relieved. Hence, when a student is entered in the register of the universities, he is said to be *matriculated*.

MATRIMONY. See MARRIAGE.

MA'TRIX. (Lat.) In Medallurgy, the stony substance in which crystalline minerals and metals are embedded is frequently termed their *matrix* or *gangue*. In dyesinking the *matrix* is the indented mould from which impressions are taken in relief. Type-founders apply the term to the iron moulds in which the letters are cast.

MA'TTER. (Lat. materies.) Substance. Of the intimate nature of matter the human faculties cannot take cognizance; nor can data be furnished, by observation or experiment, on which to found an investigation of it. All we know, or ever can know of matter, is its *sensible properties*. Some of these are the foundation of physical science; others of the different subordinate sciences, as, for instance, of chemistry.

Matter is divisible by abrasion and other means into small fragments, which, when the division is carried to any considerable extent, are called particles. It is supposed, however, and many reasons appear to justify the hypothesis, that it is capable of reduction into particles (called atoms) of particular forms, and each class having its own proper magnitude and peculiar properties; that determinate numbers of atoms of one kind admit of combination with some determinate number of another kind, or of several kinds, and of thereby forming compounded atoms, having properties peculiar to that combination, and different from the *known* properties of their elemental atoms. These solutions and combinations result from properties inherent in the atoms themselves; but whether the simple classes of atoms that are believed to exist are themselves really primary and elemental is not known, and probably never can be with certainty.

In larger masses, or in masses of aggregated atoms, so classed that their peculiar properties are mutually neutralized, phenomena are exhibited which bear a great resemblance to one another through considerable classes of such compounds, whose elements we have reason to believe differ very considerably; and other properties are found to exist in all, and differing only in degree or intensity. These last are the subjects of *physical* investigation: they are called emphatically the properties of matter; and the laws of their mutual influences are the foundation of *mechanical philosophy*. These properties

may be regarded as either essential or contingent. The essential properties of matter are usually reckoned the following: —

1. *Divisibility*, or the property which every known substance possesses of being separable into parts, and these again into smaller parts, and so on until the parts become inappreciable to our senses; nor can any limit be placed to the subdivision.

2. *Impenetrability*, or a resistance exerted by every body to the occupation of its place by another. This resistance is of various degrees of intensity, dependent on the state and atomic composition of the bodies; but no two bodies can simultaneously occupy the same place.

3. *Porosity*, or the separation of the particles or atoms from each other by intervals or pores. Every substance with which we are acquainted is more or less porous.

4. *Compressibility*, or the property in virtue of which the volume of every body may be contracted into smaller dimensions.

Among the essential properties of matter may also be included *extension* and *figure;* but these belong also to space, and form the subject of geometry.

The contingent properties of matter are *mobility* and *weight*. Matter in every form is capable of being moved from one place to another; and every substance gravitates towards the centre of the earth. But motion has reference to space, and weight to the attraction of other matter.

The above are the general properties of matter, upon which physical investigations depend. There are, however, various other qualities belonging to particular substances, or to matter in particular states, the consideration of which is important in mechanical philosophy. Among these the principal are *elasticity*, *fluidity*, *hardness*, *rigidity*, *solidity*, — for which see the respective terms.

MAU'NDRIL. In Coal Mines, a pick with two shanks.

MAUNDY THURSDAY. The Thursday preceding Easter, on which the sovereign of England distributes alms to a certain number of poor persons at Whitehall; so named from the maunds or baskets in which the gifts were formerly contained. (*See* SHERE THURSDAY.) This custom is of very great antiquity; and, according to Ducange, it derives its origin from St. Augustine. (See *Nare's Glossary; Fosbrooke's Encyc. of Antiquities*, p. 702.)

MAUR, SAINT, CONGREGATION OF. A learned body of religious of the Benedictine order; so called from a village near Paris, where they were established in 1618. On the request of Louis XIII., Gregory XV. gave this order his approval by an apostolical brief, dated 17th of May, 1621; and it obtained new privileges from Urban VIII., by a bull dated 21st of Jan. 1627. The fame of this body attracted the attention of many other religious orders, several of which were induced to submit to its rules; and at last it numbered upwards of a hundred religious houses. The literary world owes to them a series of very valuable editions of ancient Greek authors, chiefly fathers, during the 17th century. Among the most eminent of its members during that period may be mentioned Jean Mabillon, Thierri Ruinart, Hugh Menard, and Bernard de Montfaucon, &c. &c. (See Mosheim, *Eccl. Hist.* vol. v.)

MAUSOLE'UM. A sepulchral building; so called from Mausolus, king of Caria, to whose memory it was raised by his wife Artemisia, about 353 B.C.: hence all sepulchral structures of importance have obtained the name of mausolea. From its extraordinary magnificence it was esteemed the seventh wonder of the world. According to Pliny, it was one hundred and eleven feet in circumference, and one hundred and forty feet high. It is said to have been encompassed by thirty-six columns, and exceedingly enriched with sculpture.

MAXI'LLA. (Lat. maxilla, *a jaw.*) In Anatomy, this term is applied to the bones supporting the teeth of both jaws. In Zoology, it is restricted to the upper jaw in Mammalia, and to the inferior pair of horizontal jaws in articulate animals.

MA'XIM. Synonymous with *axiom*, which see.

MA'XIMA AND MINIMA. Terms employed in analysis to signify not the absolute greatest and least values of a variable quantity, but the values it has at the instant when it ceases to increase and begins to decrease, or *vice versâ*. A variable quantity may therefore have several maxima and minima. The theory of maxima and minima forms a part of the differential calculus, and is accordingly given in all works on that subject.

MAY. The fifth month of our year, but the third of the Roman. The name is supposed to be derived from Maia, the mother of Mercury, to whom the Romans offered sacrifices on the first day of the month; but various other derivations have been assigned to it. *See* CALENDAR.

MAY DAY. The 1st of May is usually so called in England, by way of eminence, in commemoration of the festivities which from a very early period were till recently, and in many parts of the country are still observed on that day. It would be out of place in this work to give any detailed account of them, as they are universally known; but a few words as to their origin may not be out of place. In looking at the nature of these rites, which are to a certain extent common to every place in which they are observed, it is evident that they had their origin in the heathen observances practised in honour of the Latin goddess Flora; but it is impossible to fix with accuracy the precise period at which they were introduced into England. The earliest notice of the celebration of May-day may be traced to the Druids, who on May-eve were accustomed to light large fires on eminences in gratitude and joy for the return of spring. At a later period the observance of this day appears not to have been peculiar to any class of society, for the most exalted as well as the lowest persons took part in it. In his *Court of Love* Chaucer says, that on this day "forth goeth all the court, most and least, to fetch the flowres fresh, and braunch and bloom;" and it is well known that Henry VIII. and Katherine and all their court partook in the diversion. The *maypole*, which is still visible in many of the English villages, and *Jack in the green* are still relics of this custom. (Some interesting remarks on this subject are to be found in *Grimm's Deutsche Mythologie*, pp. 448—451.)

MAYOR. (Lat. major, meaning the first or senior alderman.) The title of the chief municipal officer of a borough, to whom it appears to have been first given by charters granted some time after the Conquest. But the title and office of portreeve or boroughreeve still continued, in some few places to the exclusion of, and in some others in conjunction with, that of mayor, until the passing of the Municipal Reform Bill, 5 & 6 W. 4., by which the latter title was applied universally and exclusively to every borough. The chief magistrates of London and Dublin are designated Lord Mayor.

MAYOR. (Maire.) In France, the first municipal officer of each commune, according to a general system established by the law of 14th Dec. 1789, which created municipalities. Since 1831 they are selected by the crown out of the municipal council, which is chosen by the electoral body. The maire has one or more *adjuncts* or assessors, according to the population of the commune, chosen in the same manner. The maire keeps the registers of births, marriages, &c. of the commune; he acts as a magistrate in the apprehension and commitment of offenders; he has also a judicial power over certain minor offences. He is also the principal agent of the general administration for his commune, and the executive authority to carry into effect the ordinances of the municipal council.

MAYORA'ZGO. (Span., from Lat. magistratus. *See* MAJORAT.) Strictly, the right possessed by the eldest born in noble families to inherit certain property on condition of transmitting it entire to those possessed of the same right on his decease. Five distinct species of mayorazgo, or right of hereditary succession, are now known in Spanish law. Property held in virtue of the right cannot be alienated or disposed of. The mischievous effects of this strict system of entail on agriculture and national wealth, and on the character of the higher classes of Spain, have been long insisted on by political philosophers.

MAYOR OF THE PALACE. (Lat. major domus regiæ.) In early French History, the title of the chief officer of state under the Merovingian kings. After the death of Dagobert I., A.D. 638, and in the subsequent decay of the royal authority, these functionaries by degrees usurped almost the entire power of the state. The first of those mayors who exercised this kind of sovereignty was Grimoald, under Sigebert III., king of Austraria. Pepin, son of Charles Martel, having succeeded his father in the office of mayor of the palace, afterwards ascended the throne in 752; after which time the office lost its importance, or was altogether abolished. (See Turner, *Hist. of England in the Middle Ages*, vol. i. p. 8.)

MEAD. (Dutch, meede.) A vinous liquor made by dissolving one part of honey in three of boiling water, flavouring it with spices, and adding a portion of ground malt and a piece of toast dipped in yeast, and suffering the whole to ferment. The Scandinavian mead is flavoured with primrose blossoms. Mead formed the ancient, and for centuries the favourite beverage, of the northern nations. It is frequently mentioned in *Ossian.*

MEA'DOW. A flat surface under grass, generally on the banks of a river or lake; but so far above the surface of the water as to be considerably drier than marsh land, and, consequently, to produce grass and herbage of a superior quality. The soil of meadow lands is generally alluvial, and more or less mixed with sand; and it is kept in a state of fertility by the depositions made on its surface, in consequence of being occasionally overflowed by the adjoining river or lake. The produce of meadows is generally made into hay, which, though not equal in quality to that produced on drier grass lands, is yet superior to what is obtained from marshes.

MEAN. In Mathematics, a quantity having an inter-

mediate value between several others which are formed according to any *assigned law* of succession.

The *arithmetical mean* of several quantities is simply the *average* formed by dividing the sum of all the quantities by their number. In physical inquiries, where a great number of values of a quantity have been determined by observation or experiments, of which the error is as likely to be in excess as defect, the average or arithmetical mean is the most probable result.

The *geometrical mean* between two quantities, or the *mean proportional*, is a quantity which forms the middle term of a duplicate ratio, or continued proportion of three terms: viz. such that the first given term is to the quantity sought as that quantity is to the other given term. In arithmetic, it is the square root of the product of the two given terms.

The *harmonical mean* is such a number that, the first and third terms being given, the first is to the third as the difference of the first and second is to the difference of the second and third: or, if a, b, c be the numbers, b being the mean,—

$$b=\frac{2\,a\,c}{a+c}, \quad \text{or} \quad \frac{2}{b}=\frac{1}{a}+\frac{1}{c}.$$

ME'ASLES. *See* RUBEOLA.

MEA'SURE. (Lat. mensura.) In Geometry, a magnitude or quantity taken as unit, and employed to express the relations of other magnitudes or quantities of the same kind. Euclid defines the measure of a quantity to be that which, being repeated a certain number of times, becomes equal to the quantity measured. Thus, in Arithmetic, the *measure of a number* is any number which divides the given number without leaving a remainder; but this definition rather corresponds to the notion of *aliquot part*.

In a general sense, the term measure is applied to that by which any thing is compared in respect of quantity. Thus, we have measures of extension, of weight, time, force, resistance, temperature, &c.; in short, of every thing of which greater and less can be predicated; and it frequently happens that the unit or measure is not taken in the thing or property which is the immediate subject of consideration, but in something else which depends on it, or is proportional to it. Angular space, for example, is measured by an arc of a circle; time, by the rotation of the earth about its axis, or its revolution about the sun; force, by the quantity of motion it impresses on a body; degrees of heat, by the expansion of metals or other substances; muscular strength, by the resistance of a spring, &c. *See* ANGLE, CHRONOLOGY, GRAVITY, THERMOMETER, DYNAMOMETER, &c.

By measure, in an absolute sense, is understood the unit or standard by which we measure extension. We have, therefore, measures of length, of superficies, and of volume or capacity; but, as the two latter may be deduced in all cases from the former, it is only necessary to establish a unit, or standard of length. The choice of such a standard, and the different multiples and parts of it taken for the uses of society, form a metrical system, or system of metrology.

Standards of Measure.—As no precise notion can be formed of the magnitude of a line in any other way than by comparing it with another line of a known length, the necessity of having recourse, for the interchange of ideas, to measures not entirely arbitrary, but fixed by nature, and intelligible alike to all mankind, seems to have been perceived in the earliest ages. Hence originated the *foot*, the *cubit*, the *span*, the *fathom*, the *barleycorn*, the *hair's-breadth*, and other denominations of measure, taken from parts of the human body, or from natural objects, which, though not of an absolute and invariable length, have a certain mean value sufficiently definite to answer all the purposes required in a rude state of society. But, as civilization advanced, the necessity of adopting more precise standards would be felt, and the inadequacy of such measures as the foot, the cubit, &c. (referred only to the human body) to convey accurate notions, would be rendered most apparent in their application to itinerary measures, or the estimation of great distances; where differences of the fundamental measure, of no account when one or two units only are taken into consideration, would amount, by repeated multiplication, to enormous quantities. In order to avoid this inconvenience, recourse was had to other methods of estimation; but which, in fact, amounted only to descriptions more or less vague, and not to measures. Thus, in ancient authors, we frequently read of a day's journey, a day's sail, and so forth; and in many parts of the continent of Europe, even at the present time, it is the custom of the peasantry to reckon itinerary distances by hours.

On looking among the objects of nature for a standard of measure perfectly definite, and, at the same time, invariable, and accessible to all mankind, a very slender acquaintance with geometry and natural philosophy will suffice to show that the subject is beset with innumerable difficulties. In fact, nature presents only two or three elements which, with the aid of profound science and a refined knowledge of the arts, can be made subservient to the purpose; and none at all which are applicable without such aid. The earth is nearly a solid of revolution, and its form and absolute magnitude are presumed to remain the same in all ages: hence the distance between the equator and the pole is an invariable quantity; and any assigned part of that distance, as the 90th, or a degree of the meridian, is constant, and will furnish a precise and unalterable standard of measures, fit for the purposes of metrology, provided we have the means of comparing it with the rods or scales which must necessarily be used in comparing distances, or the magnitudes of bodies. The force of gravity at the earth's surface is constant at any given place, and very nearly the same at all places under the same parallel of latitude and at the same height above the level of the sea; hence the length of a pendulum which makes a given number of oscillations in a day is also constant at a given place, and, with proper skill and precautions, may be determined in terms of any assumed scale. These two elements, the length of a degree of the meridian, and the length of the seconds' pendulum, are the only ones furnished by nature which have yet been used as the basis of a system of measures. One or two others have been suggested, as the height through which a heavy body falls in a second of time, determined, like the length of the pendulum, by the force of gravity; or the perpendicular height through which a barometer must be carried till the mercurial column sinks a determinate part—for example, a 30th of its own length; but, for reasons which it is unnecessary here to state, these distances are not so susceptible of being accurately determined as the terrestrial degree, or the length of the seconds' pendulum.

It has been supposed (Paucton, *Metrologie;* Bailly, *Histoire de l'Astronomie ancienne*) that some ancient nations referred their measures of length to a unit chosen from an aliquot part of the earth's circumference, and that the different *stadia* were only different aliquot parts of the same great unit; but the supposition is altogether improbable, for the ancients had no means of determining the magnitude of the earth with any tolerable precision, and do not themselves make any reference to such a standard. Mouton, an astronomer of Lyons, about 1670, proposed as a universal standard of measure a *geometrical foot*, of which a degree of the earth's circumference should contain 600,000; and remarked that a pendulum of this length would make $3959\frac{1}{3}$ vibrations in a half hour. In 1671 Picard proposed a similar idea; and Huygens first suggested the pendulum as the unit or standard of measures. Condamine, one of the French academicians engaged in the measurement of the terrestrial arc in Peru, proposed that the equatorial pendulum ought to be adopted, as being the most natural measure, and independent of the pretensions of different countries. No attempt, however, was made to establish a regular system of measures on any of these standards until the time of the French revolution, when a system of weights and measures, referred to the terrestrial degree, and accommodated to our arithmetical scale, was adopted in that country.

English Standard Measures.—The unit of lineal measure in this country is the yard, all other denominations being either multiples or aliquot parts of the yard. But as this is an entirely arbitrary measure, and, until the year 1824, was never strictly defined by the legislature, great perplexity has often arisen in attempting to ascertain the exact portion of space it was meant to represent. For the purpose of preserving some degree of uniformity among the ordinary measures of the kingdom, certain standards were preserved in the exchequer, with which all rods were required to be compared before they were stamped as legal measures. The oldest of these standards in existence dates from the reign of Henry VII.; but it has long been disused; and that which, till the year 1824, was considered as the legal standard, was a brass rod, of the breadth and thickness of about half an inch, placed there in the time of Elizabeth. There was another similar rod of the same date, called an *ell*. The ell, however, does not appear ever to have been established as a legal measure; but was conventionally considered as equal to a yard and a quarter. To these rods belonged a brass bar, on one edge of which was a hollow bed or matrix fitted to receive the square rod of a yard, and on another a like bed fitted to receive that of an ell; and into these beds were fitted the yard and ell measures brought to be examined and stamped with the standard marks. All rods so stamped became standard measures. It is abundantly obvious that measures determined in this coarse manner could have no strict claim to be considered as *accurate* copies of the original standard; but it would seem that the standard itself was incapable of affording any definite or correct measure. It is thus described by Mr. Baily, in his Report on the new Standard Scale of the Royal Astronomical Society:—"I have had an opportunity of seeing this curious instrument, of which it is impossible, at the present day, to speak too much in derision or contempt. A common kitchen poker, filed at the ends in the rudest manner, by the most bungling

workmen, would make as good a standard. It has been broken asunder, and the two pieces been dovetailed together, but so badly that the joint is nearly as loose as that of a pair of tongs; and yet till within the last ten years, to the disgrace of this country, copies of this measure have been circulated all over Europe and America, with a parchment document accompanying them, certifying that they are true copies of the English standard." (*Memoirs Roy. Astr. Soc.* vol. ix.)

Such being the condition of the legal standard, it was obviously impossible that any measure could be found in terms of it, where great accuracy and minuteness were necessary; for instance, that of the seconds' pendulum, or a degree of the meridian. In fact, it was utterly inapplicable to any scientific purpose whatever. In the year 1742 some Fellows of the Royal Society, and Members of the Academy of Sciences at Paris, proposed to have accurate standards of the measures and weights of both nations made and carefully examined, in order that a means might be provided of comparing the results of scientific experiments in England and France. The committee who undertook the matter, besides the legal standard in the Exchequer, found some others which were considered of good if not equal authority. At Guildhall they found two standards of long measure, which were only two beds or matrices, one of a yard, and the other of an ell, cut out of the edges of a substantial brass bar, like that at the Exchequer. Another, preserved in the Tower of London, was a solid brass rod, about 7-10ths of an inch square, and 41 inches long; on one side of which was the measure of a yard, divided into inches. Another, belonging to the clockmakers' company, delivered to that corporation by indenture from the Exchequer in 1671, was a brass rod of eight sides, nearly half an inch thick, on which the length of the yard was expressed by the distance between two upright pins, or small checks, filed away to the proper quantity. The committee selected the standard in the Tower, as being the best defined, and consequently the best adapted to their purpose; and Mr. George Graham (a celebrated clockmaker), at their desire, laid off from it, with great care, the length of the yard on two brass rods, which were then sent to the Academy of Sciences at Paris, who in like manner set off thereon the measure of the Paris half toise. One of these was kept at Paris, the other was returned to the Royal Society, where it still remains: but, unfortunately, it was not stated at what temperature the toise was set off; and, consequently, the comparison is now of little or no value.

In 1758 a committee of the House of Commons was appointed to inquire into the original standards of weights and measures in the kingdom. The committee entered very fully into the subject, and presented to the house an elaborate report, in which they recommended that a rod which, at their order, had been made by Mr. Bird from that of the Royal Society, and marked "Standard Yard, 1758," should be declared the legal standard of all measures of length. This rod consisted of a solid brass bar, 1·01 inch square and 39·06 inches long. At about 1½ inch from each end a gold pin or stud is inserted; in which pins, at the distance of 36 inches, are two points, intended to designate the length of the yard. It was proposed that this rod should be carefully laid up in safe custody, to be used only occasionally; and, for the ordinary sizing of yards, another rod was prepared by the same artist, furnished with cheeks, and divided into inches and parts, for the easier adjusting of any comparative measure.

In the following year another committee was formed on the subject. It concurred in the recommendation of the former committee, that Bird's standard yard should be the only unit of lineal measure; and at the same time recommended that a copy of it should be made, for security against accidents, and deposited in some public office. Accordingly, a second standard was constructed by Bird, in 1760, similar to the former, of which, indeed, it was intended to be a copy. This last standard (of 1760) was declared by the act of 1824 to be the legal standard of the kingdom.

Notwithstanding these two parliamentary reports, no legislative enactment was passed, and the subject remained for a long time in the same state of uncertainty. In 1796 a scale was constructed by the celebrated Troughton, for Sir George Shuckburgh, which has been much referred to in scientific treatises, in consequence of its having been used in the experiments made by Captain Kater for determining the length of the pendulum; and also carefully compared with all the other standards, and with the French mètre. Troughton at several times made various other measures; but, as they never possessed any legal authority, it is unnecessary to allude to them farther than to state that they were all copies, as nearly as could be made, of a scale that had been constructed by Bird, and had belonged to Mr. Harris, assay-master at the Mint.

In 1814 the subject of standard measures and weights was again brought under the consideration of parliament; and a committee of the House of Commons made a report, which, however, was attended by no result. In 1819 a commission was named by the prince regent, consisting of Sir Joseph Banks, Sir George Clerk, Mr. Davies Gilbert, Dr. Wollaston, Dr. Young, and Captain Kater, who first recommended that, for the legal determination of the standard yard, the yard which had been employed by General Roy, in the measurement of a base on Hounslow Heath as a foundation of the trigonometrical survey, should be adopted; but in a subsequent report, made the following year (1820), they proposed the standard which had been made by Bird in 1760, on account of its being, as they stated, "both laid down in the most accurate manner, and as best agreeing with the most extensive comparisons which have been hitherto executed by various observers and circulated throughout Europe, and in particular with the scale employed by the late Sir George Shuckburgh." This last report having been approved by a committee of the Commons, an act was at length passed, in June, 1824, in which the unit of measure was for the first time defined, and in the following terms:—

"The straight line or distance between the centres of the two points in the gold studs in the brass rod, now in the custody of the clerk of the House of Commons, whereon the words and figures *Standard Yard*, 1760, are engraved, shall be, and the same is hereby declared to be, the original and genuine standard of that measure of length or lineal extension called a yard; and that the same straight line or distance between the centres of the said two points in the said gold studs in the said brass rod, the brass being at the temperature of 62° of Fahrenheit's thermometer, shall be and is hereby denominated the *Imperial Standard Yard*, and, shall be and is hereby declared to be, the *unit* or only standard measure of extension." And the act further declared, that if at any time hereafter the said imperial standard yard shall be lost, or shall be in any manner destroyed, defaced, or otherwise injured, it shall be restored by making, under the directions of the lords of the treasury, a new standard yard, bearing the proportion to a pendulum vibrating seconds of mean time, in the latitude of London, in a vacuum, and at the level of the sea, as 36 inches to 39·1393 inches.

The recommendation of the commissioners, on which this enactment was founded, has been severely criticised; and, in point of fact, so far as the exact length of the yard is concerned, the subject remained in the same doubtful state in which it was before the act was passed. That the standard which was adopted was not an original measure (it was, in fact, a copy of Bird's standard of 1758, which was a copy of that of the Royal Society, which again was a copy of that in the Tower) was of little consequence, provided the measure had been laid down on it with such precision as to leave no doubt as to its exact length; but so far was this from being the case, that when it came to be compared with a new standard scale made for the Royal Astronomical Society, it was found to be utterly impossible to ascertain the centres of the points in the gold studs within distances perfectly appreciable by the methods of observation now practised. Mr. Baily, in his report above cited, says the mean diameter of each of the holes was nearly 100th of an inch; and they by no means presented any thing like a circular shape. In fact, not only did different persons differ in their estimate of the centres, but the same persons also differed at different times, according to the degree or direction of the light that impinged on the sides of the holes. And he adds, "How the legislature of the present day, when the art of making mathematical instruments has arrived at such a state of perfection, could have sanctioned the adoption of such an imperfect and undefinable measure as this for a standard, must always be a matter of astonishment; more especially when we consider that the French had recently set us a laudable example, in the great pains and labour taken in the execution of a new set of standard weights and measures of superior accuracy and precision." (*Mem. R. A. S.* vol. vii.)

This scale was destroyed by the fire which consumed the two houses of parliament in 1834; so that the country is at the present time without a legal standard, for the provision of the act relative to its restoration by comparison with the seconds' pendulum is perfectly nugatory. Its restoration could not be thus effected with any tolerable certainty. The length of the seconds' pendulum is one of those constants of nature which it is possible to determine only within certain limits; very narrow indeed, but still too wide for the purpose in question. Besides, the standard adopted by the legislature had never been directly compared with the pendulum; and the relation between them assigned in the act, namely, 36 to 39·1393, is now known to be incorrect, on account of the neglect of certain precautions in the determination of the length of the pendulum which subsequent experiments have shown to be indispensable. Accident has, however, given the means of effecting what the legislative enactment would have failed to do. Early

in the year 1834 a most laborious and minute comparison of the different standard measures was made with a new scale constructed for the Royal Astronomical Society. The length of the legal standard, as nearly as it could be determined, is known in terms of this scale, and may therefore be recovered; but, as a new act is necessary in any case, the legislature may probably be advised to do now what ought to have been done in the first instance, namely, cause a standard to be made in a more skilful manner, and authenticated copies of it, or rather other measures having ascertained relations to it, to be deposited in several public places, and only to be used in cases of emergency. The evil in this, as in many other instances, has arisen from legislating too much. All that is required is that two very fine points be struck in a strong rod of platinum, or a block of cast iron, at any convenient distance; and to declare that the distance between those points, at a given temperature of the metal, shall be the standard of measure, and that so many parts of this standard shall constitute the yard or unit: all the rest may be safely left to experimental philosophers and mathematical-instrument makers.

English System of Lineal Measures.—The unit of measure, as already stated, is the yard. The yard is divided into 3 feet, and the foot subdivided into 12 inches. The multiples of the yard are the pole or perch, the furlong, and the mile; $5\frac{1}{2}$ yards being a pole, 40 poles a furlong, and 8 furlongs a mile. But the pole and furlong are now scarcely ever used, itinerary distances being reckoned in miles and yards. The relations of these different denominations are exhibited in the following table:—

In.	Feet.	Yards.	Poles.	Furlongs.	Miles.
1	0·083	0·028	0·00505	0·00012626	0·0000157828
12	1	0·333	0·06060	0·00151515	0·00018939
36	3	1	0·1818	0·004545	0·00056818
198	16·5	5·5	1	0·025	0·003125
7920	660	220	40	1	0·125
63360	5280	1760	320	8	1

Measures of Superficies.—In square measure the yard is subdivided as in general measure into *feet* and *inches;* 144 square inches being equal to a square foot, and 9 square feet to a square yard. For land measure the multiples of the yard are the *pole*, the *rood*, and the *acre;* $30\frac{1}{4}$ (the square of $5\frac{1}{2}$) square yards being a pole, 40 poles a rood, and 4 roods an acre. Very large surfaces, as of whole countries, are expressed in square miles. The following are the relations of square measure:—

Sq. Feet.	Sq. Yards.	Poles.	Roods.	Acres.
1	0·1111	0·00367309	0·000091827	0·000022957
9	1·	0·0330579	0·000826448	0·000206612
272·25	30·25	1	0·025	0·00625
10890	1210	40	1	0·25
43560	4840	160	4	1

Measures of Volume.—Solids are measured by cubic yards, feet, and inches; 1728 cubic inches making a cubic foot, and 27 cubic feet a cubic yard. For all sorts of liquids, corn, and other dry goods, the standard measure is declared by the act of 1824 to be the *imperial gallon*, the capacity of which is determined immediately by weight, and remotely by the standard of length, in the following manner:—According to the act, the imperial standard gallon contains 10 pounds avoirdupois weight of distilled water, weighed in air at the temperature of 62° Fahrenheit's thermometer, the barometer being at 30 inches. The pound avoirdupois contains 7000 troy grains; and it is declared that a cubic inch of distilled water (temperature 62°, barometer 30 inches) weighs 252·458 grains. Hence the contents of the imperial standard gallon are 277·274 cubic inches. The parts of the gallon are *quarts* and *pints;* 2 pints being a quart, and 4 quarts a gallon. Its multiples are the *peck*, the *bushel*, and the *quarter;* the peck being 2 gallons, the bushel 4 pecks, and the quarter 8 bushels. The following are the relations:—

Pints.	Quarts.	Gallons.	Pecks.	Bushels.	Quarters.
1	0·5	0·125	0·0625	0·015625	0·001953125
2	1	0·25	0·125	0·03125	0·00390625
8	4	1	0·5	0·125	0·015625
16	8	2	1	0·25	0·03125
64	32	8	4	1	0·125
512	256	64	32	8	1

For an account of the various other measures used in commerce, see the *Commercial Dictionary;* or *Colonel Pasley's Observations on the Measures, Weights, and Money used in this Country* (London, 1834), where a full description is given.

French System of Measures.—The French system of measures, introduced during the Revolution, has for its standard the length of a quadrant of the earth's meridian. The unit of measures of length is the *mètre*, which is a ten-millionth part of the quadrant. This length, deduced from the great trigonometrical measurement of the meridian from Dunkirk to Barcelona, is marked by two very fine parallel lines drawn on a bar of platinum, and preserved in the archives of the Academy of Sciences. From a comparison of the standards of this country with a copy of the mètre in the possession of the Royal Society, Captain Kater found the length of the mètre to be 39·37079 inches of the English standard. (*Phil. Trans.* 1818.) Mr. Baily found the length of the mètre to be 39·3696786 inches of the Royal Astronomical Society's scale (*Mem. R.A.S.*, vol. ix. p.133.), from which, by reducing to the imperial standard yard by the data given in the same memoir, the true length of the mètre is 39·370091 inches of the imperial yard. The comparison is, however, attended with some degree of uncertainty, from the circumstance that a reduction must be made for the expansion of the metals; the standard temperature of the English measures being 62° Fahrenheit, and that of the French measures 32°, or the temperature of melting ice.

In the French system the unit of superficial measure is the *are*, a surface of 10 mètres each way, or 100 square mètres. The unit of measures of capacity is the *litre*, a vessel containing the cube of a tenth part of the mètre, and equivalent to 0·220097 parts of the British imperial gallon. The standard temperature is that of melting ice. All the divisions and multiples of the units are decimal; and the principle of nomenclature adopted was to prefix the Greek numerals to the decimal multiples, and the Roman numerals to the decimal subdivisions.

The measures of length are,

Myriamètre	=	10000 mètres.
Kilomètre	=	1000
Hectomètre	=	100
Mètre	=	1
Décimètre	=	0·1
Centimètre	=	0·01
Millimètre	=	0·001

The measures of surface are,

Hectare	=	10000 sq. mètres.
Are	=	100
Centiare	=	1

The measures of capacity are,

Kilolitre	=	1000 litres.
Hectolitre	=	100
Decalitre	=	10
Litre	=	1
Decilitre	=	0·1
Centilitre	=	0·01

The unit of solid measure is the *stere* or cube of the mètre, equal to 35·31658 English cubic feet.

No system of metrology hitherto invented can be compared with this of the French in a scientific point of view; nevertheless the decimal subdivisions have been found unsuited to the purposes of retail traffic, to which, in fact, only a binary system, or the division of the unit into halves and quarters, seems applicable. Accordingly, it has been found necessary to permit a modified system for such purposes; so that there are, in fact, at present in France three different systems of measures: the ancient, which was never wholly abandoned; the decimal system; and a binary system, or *système usuel*, having the decimal standards for its basis, with binary divisions, to which the names of the ancient weights and measures are given, the word *usuel* being annexed to prevent confusion.

Of the different measures of length used in European countries, the foot is the most universally prevalent. We subjoin the relation between the foot of different countries and the English foot:—

			English foot.
Russian foot	-	-	= 1
Paris foot	-	-	= 1·065765
Prussian and Danish foot		-	= 1·029722
Bavarian foot	-	-	= 0·957561
Hanoverian foot	-	-	= 0·958333
Saxon foot	-	-	= 0·929118
Austrian foot	-	-	= 1·037128

Comparative tables of the measures used in different countries are given in various works: one of the most complete and convenient will be found in *Hulsse's Sämmlung Mathematischer Tafeln*, Leipzig, 1840. For further information on the subject of this article, see *Paucton's Metrologie ou Traité des Mésures*, Paris, 1780; *Kelly's Universal Cambist*, 1821. See also LEAGUE, MILE; and on the subject of weights, see WEIGHT.

MEA'SURE. In Music, the interval or space of time between raising and depressing the hand in a movement; being the same as *bar*. The measure is regulated according to the different values of the notes of a piece, by which the time assigned to each note is expressed. Semibreves, for instance, occupy one rise and one fall, called a whole measure.

MEA'SURES. In Geology, sometimes used as synonymous with beds or strata; as *coal measures*.

MECHANICAL CURVE. A curve of such a nature that the relation between the absciss and the ordinate cannot be expressed by an algebraic equation. Such curves are now more commonly called *transcendental curves*. See CURVE.

MECHA'NICAL PHILOSOPHY. The science of mechanics applied to physical inquiries.

MECHA'NICAL POWERS. *See* MACHINE.

MECHA'NICAL SOLU'TION OF A GEOMETRICAL PROBLEM. In the constructions of pure geometry only the ruler and compasses are allowed to be used; or, in other words, the constructions are required to be effected by means of straight lines and circles only. The ancient geometers soon discovered that there were many problems (as the duplication of the cube and the trisection of an angle, for instance) which could not be constructed by these means. They hence had recourse to other instruments (*machinæ*) to effect this purpose; and such solutions were distinguished from the geometrical ones by the term *mechanical*.

MECHA'NICS (Gr. μηχανη, *machine*), in Natural Philosophy, is the science which treats of forces and powers, and their action on bodies, either directly or by the intervention of machinery.

The theory of mechanics, which is a branch of mixed mathematics, is founded on an axiom or principle called the *law of inertia*, or Newton's *first law of motion*; namely, that a body must remain for ever in a state of rest, or in a state of uniform and rectilineal motion, if it be not disturbed by the action of an external cause. Theoretical mechanics is therefore divided into two parts: *statics*, which treats of the equilibrium of forces; and *dynamics*, which is the science of accelerating or retarding forces, and of the actions they produce. When the bodies under consideration are in the fluid state, these become respectively *hydrostatics*, and *hydrodynamics*, which are comprehended under *hydraulics*; and sometimes the terms *ærostatics* and *ærodynamics* are used to denote the corresponding divisions of pneumatics; but all these divisions are more frequently included under the general term *mechanics*.

Practical mechanics, or a knowledge of the effects of some of the mechanical powers, must have existed to some extent from the earliest ages of the world; but of the machines used by the ancients in their constructions, the oldest account which we possess is contained in the *Architecture* of Vitruvius. Archimedes, in his *Treatise De Æquiponderantibus*, first investigated theoretically the principles of equilibrium; and the same philosopher is celebrated for the mechanical contrivances by which, in the siege of Syracuse, he so long frustrated the efforts of the Roman army under Marcellus. During the eighteen centuries which succeeded the age of Archimedes, the theory of mechanics remained in the same state. Galileo laid the foundations of modern dynamics by his discovery of the law of accelerating forces, and by reducing the propositions of that science to mathematical formulæ. In the hands of Newton mechanics assumed a new form; and the discovery of the new analysis enabled mathematicians to complete what had been begun by Galileo, and to express all the effects of the actions of bodies on each other by analytical equations.

For points connected with the theory, see ACCELERATION, DYNAMICS, FORCE, STATICS, &c.; and for details, LEVER, PULLEY, WHEEL AND AXLE, &c. The best treatise on the subject is that of Poisson, *Traité de Mécanique*, 2d ed. 1833.

MECHA'NICS' INSTITUTES. The name given to the means by which instruction is communicated to tradesmen and mechanics in large towns throughout the British empire. These institutes may be safely said to owe their origin to Dr. Birkbeck, who, in 1800, delivered a course of lectures on natural philosophy and its application to the arts to an audience composed entirely of the mechanics of Glasgow; though it was not until after the lapse of twenty years that his idea was followed up. Institutions of this sort are at present established in almost every town in England whose population amounts to 10,000, and in some of much smaller number. They are supported partly by contributions, and partly by the subscription of the members. Short courses of lectures, illustrated with experiments, are given on the most popular and interesting branches of natural philosophy, and occasionally on departments of literature, moral philosophy, political economy, &c. Reading rooms are attached to the greater number of these institutions, which, speaking generally, are well attended. On the whole, we believe these establishments have been productive of considerable advantage. The instruction they supply is, no doubt, very flimsy and superficial; but it notwithstanding serves to expand and inform the minds of the auditors, and is probably the most suitable for them. An improvement in the system of school education, by qualifying the members of mechanics' institutes the better to appreciate accurate scientific discussions, would be the most likely, or rather perhaps the only means, by which to improve the lectures given at the institutions in question. (See *Stat. of Brit. Empire*, vol. ii. p. 359.)

ME'CHANISTS. Those philosophers who refer all the changes in the universe to the effect of merely *mechanical* forces, such as *impact*, *weight*, and the like. They are opposed to the dynamical philosophers, or those who assume a living and spontaneous power in nature, antecedent to and different from the phenomena present to the senses. *See* MATERIALISM.

MECHLO'IC ACID. A compound of meconia and chlorine.

MECHO'ACAN. (From the province of Mexico, whence it is brought.) The root of the *Convolvulus mechoacauna*: it is a purgative, and was formerly used as a substitute for jalap.

MECO'NIC ACID. (Gr. μηκων, *the poppy*.) The peculiar acid with which morphia is combined in opium. When pure, it forms small white crystals. Its aqueous solution forms a deep red colour with the persalts of iron, which therefore are good tests for it, both free and combined. The salts of this acid are termed *meconates*; those of lime, baryta, lead, and silver are white, and soluble in nitric acid. Meconic acid is constituted of 7 atoms of carbon = 42, 2 of hydrogen = 2, and 7 of oxygen = 56: its equivalent therefore is 100.

ME'CONIN. (Gr. μηκων.) A white fusible substance, procured from opium, and supposed to be a distinct principle. It is said that not more than from two to three grains of it are contained in a pound of opium; it seems doubtful whether it be an educt or a product.

MECO'NIUM. (Gr. μηκων.) Opium. The term is also applied to the excrement found in the lower part of the fœtal intestines.

ME'DAL. (Fr. medaille.) A piece of metal, in the shape of a coin, engraven with figures or devices, struck and distributed in memory of some person or event. Ancient coins, although intended for the purpose of circulation, are also commonly termed medals. *See* NUMISMATICS.

MEDA'LLION. (Fr.) In Numismatics, this name is appropriated to coins struck in Rome, and the provinces under the empire, which, in gold or silver, exceed in size the largest coins of which the name and value are known in those respective metals; viz. the aureus in gold, and the denarius in silver. It has been doubted whether they were intended for the purpose of circulation, or merely struck, like modern medals, to commemorate persons or events. *See* NUMISMATICS.

ME'DALLURGY. (Fr. medaille, and Gr. εργον, *work*.) The art of making and striking medals and coins. *See* NUMISMATICS.

ME'DIÆ. (Gr. μεδαι, *middle*.) The three letters *b*, *g*, and *d* (beta, gamma, delta) are so called in the Greek alphabet, as holding respectively a middle place between their several *tenues*, *p*, *k*, *t* (pi, kappa, tau), and aspirates, *ph*, *ch*, *th* (phi, chi, theta).

ME'DIANT. (Lat. medius.) In Music, the chord which is a major or minor third higher than the key note, according as the mode is major or minor.

ME'DIASTI'NUM. The duplicature of the pleura, which divides the cavity of the thorax into two parts.

ME'DIATISA'TION. The annexation of the smaller German sovereignties to larger contiguous states, which took place, on a large scale, after the dissolution of the German empire in 1806. The same thing had been done on various occasions during the continuance of the empire; and the dominions so annexed were said to be mediatised, *i. e.* made mediately instead of immediately dependent on the empire. The term was retained when the abolition of the German union had rendered it in strictness inappropriate. A few more were mediatised after the peace of 1815. See *Conv. Lex.*; and *Hawkins's Germany*, 1838, which contains a chapter on this subject.

MEDIA'TOR. A term applied to Jesus Christ, as interceding between God and man, and obtaining for the latter the remission of the punishment due to original and contracted sin. The divinity of our Saviour is argued from his mediatorial character: it seeming impossible to conceive that a mere man could efficaciously intercede by the sacrifice of himself for the sins of his fellow men. Those reasoners, therefore, who have arrived at the conclusion of the mere humanity of Christ, either expressly deny or essentially modify the idea of his mediatorial character.

ME'DIUM. In Physics, the substance or matter in which bodies exist, or through which they move in passing from one point to another. The resistance which different mediums oppose to bodies in motion is proportional to the respective densities of the mediums. Newton supposed the existence of a universal medium, or ether, infinitely more rare and subtile than air, and diffused through the whole creation. The modern discoveries of the propagation of light by undulation, and of the acceleration of some of the small comets, give great probability to this supposition.

ME'DLAR. (Corruption of Mespilar?) The fruit of the *Mespilus germanica*, a plant found wild in several parts of Central Europe. It is remarkable for the austerity of its fruit when first gathered, and for its total loss of that quality after a few weeks, when it becomes soft, brown, and sweet, — a condition which the French call *blessi*. Of the garden varieties the Dutch medlar is the finest as to size, and the Nottingham the most delicate

in flavour. In the eyes of a botanist the medlar is only a hawthorn berry of large size.

MEDU'LLARY RAYS. (Lat. medulla, *marrow.*) The vertical plates of cellular tissue which radiate from the centre of the stem of Exogenous plants, through the wood to the bark. They cause that appearance in timber which carpenters call silver grain, or flower of the wood.

MEDU'LLARY SHEATH, is a thin layer of vessels which surround the pulp of Exogenous plants, and thence extend into the leaves and parts of fructification.

MEDU'LLARY SUBSTANCE. The interior white portion of the brain. The *medulla oblongata* is a part of the brain, lying upon the basiliary process of the occipital bone, and formed by the junction of the crura of the brain and cerebellum: it terminates in the spinal marrow.

MEDU'LLIN. That form of *lignin* which constitutes the pith of certain plants, as the pith of the sunflower.

MEDU'SA. In Mythology, the chief of the Gorgons (which see); according to Hesiod, the eldest daughter of Celo and the sea god Phorcus. Various stories are related of this mythological personage; but her chief peculiarity was the power she possessed of turning all who looked upon her into stone. She was slain by Perseus, who placed her head in the shield of Minerva, where it continued to retain the same petrifying power as before.

MEDU'SA. In Zoology, a name given by Linnæus to a genus of marine animals, now forming an extensive tribe (*Medusaria*) in the class *Acalepha* of the Cuvierian system. The body is in the form of a gelatinous disk, more or less convex above, called the "umbel," from the centre of which, and from the margin, there depend in most of the species processes or filaments more or less numerous, and more or less elongated; whence the resemblance to the fabled monster which suggested the original generic term. The *Medusæ* are commonly known by the name of "sea-blubber," "jelly-fish," &c. They have a stomach or digestive cavity excavated in the centre of the disk, and opening externally either by a central and inferior crucial mouth, or continued into branched appendages, and receiving the nutriment by innumerable minute pores, analogous to the "stomata" of plants, or those root-like appendages. The digested fluid is conveyed by vessels from the stomach to an exquisite network or plexus situated on the under surface of the border of the disk, where it receives the influence of the atmosphere, and is fitted for assimilation. Some species, as the *Medusa aurita*, have also intestinal canals leading from the stomach to separate anal outlets. Traces of a nervous system and rudimental organs of vision have been discerned in some of the *Medusæ*. They swim by muscular contraction of the margins of the disk. They are of distinct sexes, which congregate together chiefly in the autumnal months. The male and female organs much resemble each other, and are situated, in both sexes, in corresponding cavities, generally four in number, on the under surface of the disk. The ova are received when impregnated in marsupial sacs appended to the arms (in *Medusa aurita*), whence they escape in the form of ciliated infusoria, afterwards assume the structure of eight-armed polypes, pass the winter in this state, and undergo their final transformation in spring. Notwithstanding the complication of the organic machinery, functions, and generative economy of the *Medusæ*, their solids form so small a proportion of their frame that, of a Medusa of ten pounds weight, what remains upon the filter through which its fluid parts, chiefly sea-water, have escaped, does not exceed two drachms. A great number of the *Medusæ* are phosphorescent, shining in the gloom of night like globes of fire; but the nature and the agents of this wonderful property remain to be discovered. Most of the *Medusæ* at certain seasons sting and inflame the hand that touches them; but the cause of this property is equally unknown.

MEE'RSCHAUM. (Germ. *foam of the sea.*) A silicated magnesian mineral found in various parts of Europe, but chiefly in some parts of Greece and Turkey. It is light and soft, and is employed in the Turkish dominions as fuller's earth. In Germany it is extensively used in the manufacture of tobacco pipes, which are prepared for sale by being soaked first in tallow, then in wax, and finally by being polished with shave grass. Imitation meerschaum pipes are sold in large quantities, and the greatest caution is necessary to guard against deception. To the connoisseur, the best criterion is the beautiful brown colour which the genuine meerschaum assumes after being smoked some time.

MEGALE'SIAN GAMES. (Gr. *μέγας, great.*) One of the most magnificent of the Roman exhibitions of the circus; in honour of Cybele, the mother of the gods.

MEGALI'CHTHYS. (Gr. μεγας, and *ιχθυς, a fish.*) An extinct genus of fishes, including species of great size; one of which, the *Megalichthys Hibberti*, has left its teeth and other parts in the channel coal of Fifeshire, and the Edinburgh coalfield.

MEGALO'NYX. (Gr. μεγας, and *ονυξ, a claw.*) A large fossil mammalian, the remains of which were found in a cavern in the limestone of Virginia in America.

MEGALO'PTERANS, *Megaloptera.* (Gr. μεγας, and *πτερον, a wing.*) A name given by Latreille to a family of Planipennate Neuropterous insects, comprehending those which have large wings horizontally folded.

MEGALOSAU'RUS. (Gr. μεγας, and *σαυρος, a lizard.*) The generic name applied by Dr. Buckland to an extinct genus of gigantic Saurians, discovered by him in the oolitic slate of Stonesfield, near Oxford. The species on which the genus is founded included individuals measuring from forty to fifty feet in length; they partook of the structure of the crocodile and monitor. The entire skeleton has not as yet been found. The femur and tibia measure nearly three feet each; and a metatarsal bone has been found of the length of thirteen inches. The bones of the extremities have large medullary cavities. The generic character is principally founded on the teeth, which Dr. Buckland thus graphically describes:—"In the structure of these teeth we find a combination of mechanical contrivances analogous to those which are adopted in the construction of the knife, the sabre, and the saw. When first protruded above the gum, the apex of each tooth presented a double cutting edge of serrated enamel. In this stage its position and line of action were nearly vertical, and its form like that of the two-edged point of a sabre, cutting equally on each side. As the tooth advanced in growth, it became curved backwards, in form of a pruning knife, and the edge of serrated enamel was continued downwards to the base of the inner and cutting side of the tooth; whilst on the outer side a similar edge descended but to a short distance from the point, and the convex portion of the tooth became blunt and thick, as the back of a knife is made thick for the purpose of producing strength. In a tooth thus formed for cutting along its concave edge, each movement of the jaw combined the power of the knife and saw; whilst the apex, in making the first incision, acted like the two-edged sabre. The backward curvature of the full-grown teeth enabled them to retain, like barbs, the prey which they had penetrated." (*Bridgewater Treatise*, i. p. 238.) These formidable teeth, which sufficiently bespeak the carnivorous and predatory nature of the extinct monster, were arranged in a pretty close series, in sockets, along the alveolar border of the jaws.

MEGANY'CTERANS. (Gr. μεγας, and *νυκτερις, a bat.*) The first division or tribe of the order *Cheiroptera*, including the largest species of bats, or "flying foxes;" which, however, are exclusively vegetable feeders, living mostly on soft fruits, and having the molar teeth adapted to that kind of food by their broad simple crowns. The tribe is also distinguished from the animal-feeding bats, whether bloodsuckers or insect catchers, by having the two innermost fingers armed with hook-shaped claws, and by the simple structure of the nose and ears. The alimentary canal, and especially the stomach of the great frugivorous bats, are likewise more complicated than in the other tribes. The meganycterans are distributed over the warmer parts of Asia, Africa, and the Polynesian Isles, but do not exist in America.

MEGA'RIAN SCHOOL OF GREEK PHILOSOPHY, founded at Megara by the disciples of Socrates, who retired thither after his death, and distinguished in later times by its logical subtlety. Its most celebrated names were those of Euclides, Eubulides, and Stilpo.

ME'GASCOPE (Gr. μεγας, and *σκοπεω, I view.*) An optical instrument proposed by M. Charles, of the French Academy of Sciences, for the examination of bodies of considerable dimensions. It is a modification of the solar microscope, and has been used for determining the curvature of the different parts of the eye. *See* Microscope.

ME'GASTOMES, *Megastoma.* (Gr. μεγας, and *στομα, mouth.*) The name of a family of Univalve shells, comprehending those which are not symmetrical, and which have a very large aperture or mouth.

MEGATHE'RIUM. (Gr. μεγας, and *θηριον, beast.*) The name given by Cuvier to a genus of extinct Edentate quadrupeds, including and represented by one of the most gigantic of terrestrial mammalia. The haunches of the *Megatherium Cuvieri* were more than five feet wide, and its body twelve feet long and eight feet high; its feet were a yard in length, and terminated by formidable compressed claws of immense size; its tail was of great length, and probably much larger than that of any other extinct or living terrestrial mammal. The head of the megatherium was relatively small: the cranium presents many of the peculiarities of that of the sloth. The upper jaw was armed with five teeth on each side, the lower jaw with four on each side: all the eighteen teeth belong to the molar series. They were perpetually growing, like the incisors of the Rodents; but had their grinding surface traversed by two transverse ridges, and their texture composed, as in the teeth of the sloth, of a central body of coarse ivory, a thick outer coating of cæmentum, and a thin intermediate layer of fine and dense ivory, which forms the prominent terminating ridges of the crown.

Nothing certain is known of the nature of the integuments of this singular and enormous animal; but the

fossil bony armour which has been conjectured to have appertained to the megatherium unquestionably belongs to another species of gigantic Edentate, more nearly allied to the armadillo. *See* GLYPTODON.

ME'GRIM. (Fr. migraine; probably from Gr. ἡμι, *half*, and κρανιον, *the skull.*) A violent intermitting pain affecting one side of the head.

MEI'ONITE. A mineral found in grains or small shining crystals, chiefly at Mount Somma, near Vesuvius. The name is from μειων, *less*; implying the *lowness* of the terminating pyramids of its crystals, and the consequent shortness of the axis of the primitive form.

MELÆ'NA. (Gr. μελας, *black.*) The black vomit. When blood is thrown up from the stomach it is generally black, in consequence of the presence of acid.

ME'LAM. A substance formed during the distillation of a mixture of sal-ammoniac and sulphocyanuret of potassium. It is said to consist of 12 equivalents of carbon, 11 of nitrogen, and 9 of hydrogen.

ME'LANCHOLY. (Gr. μελας, *black*, and χολη, *bile.*) A disease of the mind, chiefly characterized by ungrounded fear and apprehension of evil.

MELA'NIA. (Gr. μελας.) A genus of fluviatile Pectinibranchiate Gastropods, having a moderately thick shell, with an aperture longer than it is wide, enlarging opposite the spire, and the columella without folds or umbilicus: the length of the spire is various. They have long tentacula, with the eyes on their external side, and at about the third of their length from the base.

ME'LANITE. (Gr. μελας.) The black garnet.

MELANO'SIS. (Gr. μελας.) A malignant disease, characterized by deposition of a black matter in various parts of the body.

MELA'NTERITE. (Gr. μελας.) A mineralogical name of the native sulphate of iron.

MELANTHA'CEÆ. (Melanthium, one of the genera.) An order of Endogenous plants, with a regular six-parted inferior perianth, and six stamens with the anthers looking outwards. The number of species included in it is inconsiderable; but among them are the *Veratrum*, or white hellebore, and *Colchicum*, or meadow saffron, the poisonous qualities of which indicate the general properties of the order.

ME'LAS. (Gr. μελας.) A disease endemial in Arabia: it consists in the formation of dark brown or black spots upon the skin.

MELAS'MA. (Gr. μελας.) A disease of aged persons, in which a black spot appears upon the skin, which soon forms a foul ulcer.

ME'LASOMES, *Melasoma.* (Gr. μελας, and σωμα, *body.*) A tribe of Heteromerous Coleopterous insects, comprising those which are of a uniform black or grey colour.

MELASTOMA'CEÆ. (Melastoma, one of the genera.) A natural order of Exogenous plants, with polypetalous flowers and strongly ribbed leaves, inhabiting tropical countries in great numbers, but unknown in Europe in a wild state, and only occurring very sparingly in the temperate parts of America. In the equatorial regions of this continent they are extremely numerous; and some of the species bear berries, the juice of which stains the mouth black, whence their name (μελας, and στομα, *a mouth*). Their most characteristic mark is to have the anthers bent downwards and prolonged into a horn, which is held fast in sockets of the ovary before the flower expands. Many of the species are ornamental, none are useful.

MELCHI'SEDE'CIANS. In Ecclesiastical History, several sects of early heretics have been so termed, from the opinions entertained by them respecting the character and office of Melchisedec, arising from the language of St. Paul in the Epistle to the Hebrews. The Theodotians, in the 3d century, are said to have regarded him as superior to Christ. A sect of visionaries in Phrygia, who appear to have been a branch of the Manicheans, are reported to have made Melchisedec an object of adoration. Many divines of later times have entertained the belief that the Son of God appeared to Abraham under the form of Melchisedec. (Cuneus, *De Rep. Hebræorum.*)

ME'LCHITES. (Syr. malek, *king.*) In Ecclesiastical History, the Eutychians, when condemned by the council of Chalcedon, gave this name (royalists, imperialists) to the orthodox, who endeavoured to put the order of the Emperor Marcian into execution against them. Among Oriental Christians it now designates in a general manner all those who are neither Jacobites nor Nestorians, including the Maronites, Catholic Greeks, and non-Catholic Greeks, of the three Eastern patriarchates. (Mosheim, *Eccl. Hist.* vol. ii.)

MELEA'GRIS. (Gr. *a guinea-hen.*) A term employed by Linnæus to designate the genus of which the turkey is the type. The head and upper part of the neck is invested with a plumeless and carunculated skin: there is a cutaneous appendage of a similar construction under the throat, and another of a conical form on the forehead, which in the male, when under excitement, can be distended and elongated so as to hang over the point of the beak. From the lower part of the neck of the adult male hangs a tuft or tassel of stiff hairs. The coverts of the tail are shorter and stiffer than in the peacock, but can be erected and displayed in the same way. The tarsi of the male are armed with weak spurs. The common turkey (*Meleagris gallopavo*, L.) was introduced into Europe in the 16th century. Its size, and the excellence of its flesh, led to its being cultivated with peculiar care: it is now common, and widely dispersed. Its wild original of the American woods is of a greenish colour, with a copper gloss. A second, and much more beautiful species (*Meleagris ocellata*, Cuvier), has been discovered in Honduras: its domestication is greatly to be desired.

MELES. (Lat. meles, *a badger.*) A genus separated by Storr from the Linnæan *Ursus*, and characterized by Mr. Bell as follows: — Second incisor in the lower jaw placed behind the others; molars $\frac{5-5}{6-6}$, arranged in an uninterrupted series; feet plantigrade; a glandular pouch underneath the tail, having a transverse orifice. Since the extirpation of the common bear the badger, *Ursus meles* of Linnæus, which is a typical species of the present genus, is the sole representative of the Ursine family in our indigenous zoology. The habits of this quadruped are nocturnal, inoffensive, and slothful; its food consists of roots, earthnuts, fruits, the eggs of birds, insects, reptiles, and the smaller quadrupeds: its noxious qualities are consequently few and of slight moment, and by no means justify the exterminating war unremittingly waged against it. The muscular strength of the badger is great, its bite proverbially powerful; and a dog must be trained and encouraged to enter willingly into a combat with this species. The long claws of the fore feet enable the badger to dig with effect; and he habitually dwells in burrows, which he digs by choice in declivities covered by thick coppice, or concealed in the recesses of woods. The female prepares a nest of moss and grass, and brings forth her litter of three or four blind young in the summer season.

MELE'TIANS. In Ecclesiastical History, the partisans of Meletius, bishop of Lycopolis in Egypt, deposed in a synod at Alexandria about 306, on the charge of having sacrificed to idols during the persecution by Diocletian. He was supported by numerous adherents; and thus a schism began, which was partially concluded by the submission of Arsenius, chief of the party, to Athanasius in 333, but does not seem to have been wholly extinct for 150 years. (*Mosheim*, vol. i.)

MELICE'RIS. (Gr. μελι, *honey*, and κηρος, *wax.*) An encysted tumour, the contents of which resemble honey.

MELILO'TUS. (Lat mel, *honey*, and lotus, *a leguminous plant.*) A honey-scented plant, with an erect stem and long erect racemes of small yellow or white flowers, resembling those of clover, of which it was formerly regarded as a species. In some parts of Europe two or three species are cultivated as annual fodder-plants.

MELITŒ'A, or MELINŒA. (From Μελιταῖα, a state in Thessaly; or Μελιναῖα, a name of Venus, derived from μελι, *honey.*) In Zoology, a genus of beautiful corals, and also a genus of butterflies.

MELLI'PHAGANS, *Melliphagidæ.* (Gr. μελι, *honey*; φαγω, *I eat.*) A family of Tenuirosters, comprising the birds which feed on the nectar of flowers.

MELLITE, or MELILITE. (Gr. μελι, and λιθος, *a stone.*) A yellow crystallized mineral, composed of mellitic acid and alumine. It is very rare, and was first observed in the beds of brown coal in Thuringia. The term *melilite* has also been applied to a yellow mineral which occurs in very minute crystals in the fissures and cavities of lava. It fuses into a glass before the blowpipe, but its composition has not been determined.

MELLI'TIC ACID. The peculiar acid of the mellite or honeystone of Thuringia. According to Liebig the ultimate elements of this acid are 4 equivalents of carbon = 24, 4 of oxygen = 32, and 1 of hydrogen = 1.

ME'LLON. A lemon-yellow substance composed of 6 equivalents of carbon and 4 of nitrogen, obtained by heating dry bisulphuret of cyanogen.

MELOCA'CTUS. (Melon-cactus.) Round-stemmed, ribbed, succulent plants, covered with spines on the ridge of the ribs, and producing the flowers among wool, on a hairy head or cap, which is protruded from the top of the stem. They were included by Linnæus in his genus *Cactus*; and they are, in fact, scarcely distinguishable from those dismemberments of the genus to which the modern names of *Cereus* and *Echino cactus* are applied. For the sake of their grotesque form, they are often cultivated by persons curious in collecting singular vegetables.

MELODRA'MA. (Gr. μελος, *song*, and δραμα, *drama.*) A short drama in which music is introduced; but differing from the opera, as the greater part of the words are recited, and not sung. In Germany, the melodrama is a short dramatic piece in lyrical verse; but among ourselves, and in France, its character is chiefly that of being a vehicle for gorgeous decoration and scenery, with an insignificant plot, usually of a serious or romantic description.

ME'LODY. (Gr. μελῳδια; from μελος, *a song.*) In Music, the arrangement in succession of different sounds

for a single voice or instrument, being distinguished from harmony, which is the result of the union of two or more concording musical sounds.

ME'LOË. (Gr. μηλη, *a probe.*) A genus of Coleopterous insects, of the section *Heteromera*, tribe *Trachelides*, and family *Cantharidæ*, in the system of Latreille. In this genus the antennæ are composed of short and rounded joints, the intermediate of which are the largest, and sometimes so disposed that these organs present in this point, in several males, an emargination or crescent. The wings are wanting; and the elytra, oval or triangular, with a portion of the inner margin, crossing each other, only partially cover the abdomen, particularly in the females, in which this segment of the body is extremely voluminous. The meloës crawl along the ground, or upon low plants, on the leaves of which they feed. A yellowish or reddish oleaginous liquid exudes from the articulations of their legs. In some districts of Spain these insects are used in the place of the true blister-flies (*Cantharides*); they are also employed by the farriers. Latreille is of opinion that the modern meloës were the *Buprestes* of the ancients, — insects to which they attributed very noxious properties, supposing them to be fatal to the oxen that swallowed them.

MELOLON'THIDANS, *Melolonthidæ.* The family of Coleopterous insects, of which the May-chaffer (*Melolontha vulgaris*) is the type.

MELPO'MENE. (Gr. μελπομαι, *I sing.*) The muse who presides over tragedy; represented usually with a mask in one hand, a club or dagger in the other, and with buskins on her feet.

MELUSI'NE. In the mediæval Mythology of France, a beautiful nymph or fairy, whose history occupies a large space in the popular superstitions of that country. She is represented as the daughter of Helmas, king of Albania, and the fairy Persine; and as having married Raymund, count of Toulouse, who built her the magnificent castle of Lusignan (originally called Lusineem, the *anagram* of Melusine). Like most of the fairies of that period, she was doomed to a periodical metamorphosis, during which the lower part of her body assumed the form of a fish or a serpent. On these occasions she exerted all her ingenuity to escape observation; but having been once accidentally seen by her husband in this condition, she swooned away, and soon afterwards disappeared, none knew whither. But her form is said to be seen from time to time on the tower of Lusignan, clad in mourning, and uttering deep lamentations; and her appearance is universally believed to indicate an impending calamity to the royal family of France.

MELY'RIS. (Gr. μηλουρις, an insect mentioned by Nicander.) A Fabrician genus of Coleopterous insects, belonging to the section *Pentamera*, subsection *Serricornes*, tribe *Malacodermi*, and constituting the family *Melyridæ* in the system of Latreille; in which it is characterized as follows: — Palpi commonly short and filiform; mandibles emarginated at the point; body usually narrow and elongated; head covered at the base by a flat or slightly convex thorax; joint of the tarsi entire, and the terminal hooks unidentate or bordered with a membrane; antennæ usually serrate, and in the males of some species even pectinate.

MEMBRA'NA TYMPANI. The membrane which separates the internal from the external ear. The drum of the ear.

ME'MBRANE. The expansion of any of the tissues of the body into a thin layer. Anatomists generally enumerate three kinds of membrane; namely, the *mucous*, the *serous*, and the *fibrous*. The mucous membranes are those which line the canals of the body which are exposed to the action of air or foreign matters, — such as the lining of the nose, trachea, æsophagus, stomach, intestines, &c. The serous membranes form the lining of the sacs or closed cavities, as of the chest, abdomen, &c. The fibrous membranes are tough, inelastic, and of a tendinous character; such as the dura mater, the pericardium, the capsules of joints, &c.

ME'MNON. In Greek Mythology, a fabulous king of Ethiopia, son of the goddess Aurora, who is said to have assisted the Trojans in the siege of Troy, and to have been slain by Achilles. Several Egyptian kings of this name are also mentioned by different Greek writers. But the name is, in fact, supposed to be a general appellation or epithet (Mei-amun, *beloved of Ammon*) borrowed by the Greeks from the Egyptian language, and erroneously applied by them to particular individuals. The famous statue called by the Greeks Memnon, at Thebes in Upper Egypt, which possessed the real or imaginary property of emitting a sound like that of a harp, at the rising of the sun, is supposed to have been in the building called by M. Champollion the Rhamesseion, from its founder Rhameses, or Sesostris, of which the stupendous ruins are still seen between Medinet-Habou and Kournah. (See Champollion, *Lettres écrites d'Egypte et de Nubie*, p. 261.) The statue of black granite in the British Museum, already styled the brother of the younger Memnon, was found in the Rhamesseion. The real Memnonium was, however, probably the temple erected by Amenoph, or Amenothph. (Champollion, *ib.* p. 303.)

ME'MOIR. In Literature, two different species of composition are popularly designated by the terms Memoir and Memoirs. A short biographical notice of an individual, or a short essay on a particular subject (especially to accompany and explain a map, view, facsimile, or other representation of a curious object in art, &c.) is called a Memoir. This name is particularly appropriated to papers read before scientific or literary societies. The account, by an individual, of his own life, accompanied with narratives and remarks respecting the personages and events of the times in which he lived, is termed his Memoirs; being supposed, as the name denotes, to have been drawn up with the object of assisting his memory in reflecting on past events. In modern but incorrect diction the life of a person by another is also termed his Memoirs, if drawn up with a somewhat less regular arrangement, and containing more matter not immediately connected with the subject than the species of narration which we term a Life. The French were the earliest, and have always been by far the most successful writers, in this branch of literature. Their historical memoirs, partly autobiographical, and partly the works of authors who had access to the papers and memorials of those whose lives they illustrated, form a complete series from the 16th century to the present time, and throw the greatest light on some portions of history; while their memoirs of celebrated individuals in the ranks of literature and fashion are still more numerous and interesting. In the last century this branch of literature became so popular, that any distinguished individual who did not leave authentic memoirs of himself was sure to become the subject, after his death, of fabricated memoirs, published under his name; and this species of falsification, of which Voltaire then complained, appears to be now carried on as extensively as at any former period. The collections of historical memoirs recently edited in Paris contain three series of historical memoirs relating to French history, and one of English memoirs, translated, illustrating the period of our great civil war and revolution. The latter undertaking was conducted by M. Guizot.

MEMO'RIAL. In Diplomacy, a species of informal state paper much used in negotiation. Memorials are said to be of three classes. 1. Memorials in the form of letters, subscribed by the writer, and speaking in the second person as addressed to another. 2. Memorials proper, or written representations, subscribed by the writer, and with an address, but not speaking in the second person. 3. Notes, in which there is neither subscription nor address. Species of the first class of memorials are, circulars from the bureau of foreign affairs sent to foreign agents; answers to the memorials of ambassadors; and notes to foreign cabinets and ambassadors.

ME'MORY (Lat. memini, *I remember*), is defined to be the power or capacity of having what was once present to the senses or the understanding suggested again to the mind, accompanied by a distinct consciousness of past existence. The term is also employed, though more rarely, to denote the act or operation of remembering, or the peculiar state of the mind when it exercises this faculty, in contradistinction to the faculty itself. Various opinions have been propounded by metaphysicians respecting the nature and origin of the faculty of memory. Upon this point, however, it is not our intention to enter into any details, as this question is so mixed up with that of other faculties of the mind, such as perception and association, and such metaphysical questions, as personal identity, &c., as to be inseparable from them; and to these heads we must refer the reader for information. We may, however, remark, that the ancient Platonists and Peripatetics ascribed the faculty of memory to the common theory of ideas; that is, of images in the brain, or in the mind, of all the objects of thought; and in this opinion they were supported, with slight modifications, by many other philosophers of antiquity. But Dr. Reid, who has examined this question with great acuteness, has satisfactorily demonstrated the theory of the ancients to be very defective. The more modern theories of Locke, Hume, and other philosophers, also meet with little consideration from the same acute metaphysician, who, after exposing their fallacies, sums up in these words: — "Thus, when philosophers have piled one supposition on another, as the giants piled the mountains in order to scale the heavens, it is all to no purpose — memory remains unaccountable; and we know as little how we remember things past as how we are conscious of the present." (*Reid on the Human Mind*, p. 159. 185.)

MENA'CHANITE. Ferruginous oxide of titanium, found in the Vale of Menachan, in Cornwall.

MENDICANT FRIARS. *See* ORDERS, MENDICANT.

MENDI'CITY. (Lat. mendico, *I beg.*) The condition of habitual beggars. One of the greatest curses which can afflict a civilized society is the prevalence of mendicity; and it is very much to be regretted that the prejudices of excellent and humane persons have so constantly interposed, and still interpose, difficulties in the

way of the adoption and enforcement of correct principles on this subject. For there are too many who persist in seeing in mendicity only the natural expression of that indigence into which numbers are unhappily thrown by the inequality of property and uncertainty of employment prevailing in almost all communities; and who forget that the encouragement of it affords a premium to the idle, the artful, the criminal, — to all or any, in short, except those really deserving sufferers whom it is the object of true charity to relieve. (For the law of England, past and present, respecting mendicity, see VAGRANCY.) Under the operation of this law, of the national provision of the poor laws, and far more than either the activity of English industry, mendicity has long been less extensive and public in England than perhaps in any other country. And, owing to that very circumstance, it is perhaps worse in England than in any other country; that is, the established mendicants are more connected with the criminal part of the population. (See the recent report of the Constabulary Force Commission.) Ireland has long been unhappily celebrated for the prevalence of mendicity. The number of "destitute persons" in the island was estimated by Mr. Stanley in 1837 at about 80,000. (*Mr. Nicholl's Report on Poor Laws in Ireland*); the number of street mendicants in Dublin at nearly 1000, or almost *one twentieth* of the population. Mr. Lewis, following the evidence adduced before the Irish Poor Law Commission, divides the habitual mendicants into,—1. Wandering beggars, chiefly cripples, blind, maimed, &c. 2. Professional strolling beggars, who have no fixed domicile, and live constantly by mendicancy. 3. Town beggars, who live by mendicancy, but have a fixed domicile: these, he says, "are generally known by those who relieve them, and their character is not on the whole very bad." 4. Poor housekeepers, who are relieved by three or four neighbours, to whom their wants are known, but who would not resort to general begging. (*On Local Disturbances in Ireland*, 1835.) "Mendicancy and wretchedness," says Mr. Nicholl, "have become too common to be disgraceful." And he compares with truth the effects of indiscriminate alms-giving in Ireland to those of indiscriminate legal relief in England. What effect the new system of poor laws may have on this and other evils of that country, time must show. In France, *depôts de mendicité* were first founded in 1767; a kind of half way between prisons and hospitals for mendicants. Their situation was rendered dependent on their good behaviour. These receptacles held 6000 or 8000 persons in 1789. In 1808. by a new law, "vagabonds," mere vagrants, were distinguished from "beggars,"—*i.e.* disabled persons, or other persons begging within their own arrondissement: the former were sent to "maisons de détention." There are now two gaol depôts for Paris, at St. Denis and Villers Coterets. In 1838 the prefet of police reported that they had manifestly diminished mendicity at Paris. (Dégerando, *De la Bienfaisance Publique*, iii. part 3. b. 1.) "The road to mendicity," says M. Sismondi, "is now too wide and too easy; instead of calling on religion to smooth it, we should multiply as far as possible the resources of the poor, in order to prevent their being dragged into it." *See* POOR LAWS.

ME'NILITE. A mineral somewhat resembling semi-opal, found at Menil Montant, near Paris.

MENI'SCUS. A lens convex on one side and concave on the other. *See* LENS.

MENISPE'RMIC ACID. An acid contained in the berries of the *Menispermum cocculus* (*Cocculus indicus*), where it exists in combination with the vegetable alkali called *pierotoxia*.

MEN'NONITES. The title by which the Anabaptists of Holland came to be distinguished, after they had put themselves under the guidance of Menno, a native of Friesland, who undertook to moderate the extraordinary fanaticism of those sectarians. (*Mosheim*, transl., ed. 1790, v. 490.) *See* BAPTISTS, ANABAPTISTS.

MENOBRA'NCHUS. (Gr. μενω, *I remain*, βραγχια, *gills*.) A Perennibranchiate amphibian, which retains the external gills.

ME'NOPOME, *Menopoma*. (Gr. μενω, and πωμα, *a lid*.) A Perennibranchiate amphibian, which retains the opercular aperture, but not the external gills.

ME'NORHA'GIA. (Gr. μην, *a month*, and ῥεω, *I flow*.) Flooding; immoderate menstrual discharge; hæmorrhage from the uterus.

ME'NSTRUUM (Lat. mensis, *a month*), signified, in the language of the old chemists, some preparation or drug which could only operate effectually at a particular period of the moon or month; but it is now used for any fluid substance which dissolves a solid body.

MENSURA'TION. Though this term literally signifies the act of measuring, it is usually employed to denote the branch of practical geometry which teaches the methods of calculating the dimensions and areas of figures, the volumes of solids, &c., from the measurement of certain lines or angles of the figures or solids, which supply the requisite data.

Every rectilineal plane figure may be decomposed into triangles; and hence the mensuration of such figures resolves itself into the determination of the sides or area of a triangle. (*See* TRIGONOMETRY.) Solids bounded by planes may in like manner be resolved into pyramids, and their contents consequently determined by the methods of elementary geometry. (*See* PYRAMID.) The determination of the lengths of curve lines, the areas of figures bounded by curves, and of solids bounded by curve surfaces, requires the application of the integral calculus. (*See* QUADRATURE, RECTIFICATION.) For the areas and volumes of the most usual geometrical figures, see the respective terms, as CIRCLE, ELLIPSE, &c.

ME'NTUM. (Lat. *the chin*.) In Mammalogy, the term is restricted to the anterior and inferior margin of the mandible, or lower jaw. The *mentum prominulum* is that which extends beyond the perpendicular line dropped from the upper margin of the lower jaw; the *mentum absconditum* is that which cannot be distinguished.

MENU, INSTITUTES OF. The name given to the most celebrated code of Indian civil and religious law; so called from Menu, Menou, or Manu, the son of Brama, by whom it is supposed to have been revealed. The Hindoos themselves ascribe to this system the highest antiquity; and many of the most learned Europeans are of opinion that of all known works there is none which carries with it more convincing proofs of high antiquity and perfect integrity. Sir W. Jones assigns the date of its origin somewhere between Homer and the Twelve Tables of the Romans; and Schlegel asserts it as his belief that it was seen by Alexander the Great in a state not materially different from that in which we possess it. The Institutes of Menu are of a most comprehensive nature: they embrace all that relates to human life; the history of the creation of the world and man; the nature of God and spirits; and a complete system of morals, government, and religion. The work, says Sir W. Jones, contains abundance of curious matter, interesting both to speculative lawyers and antiquaries, with many beauties which need not to be pointed out, and with many blemishes which cannot be justified or palliated: it is a system of despotism and priestcraft; both, indeed, limited by law, but artfully conspiring to give mutual support. But, notwithstanding these and other defects, as has frequently been remarked, the most striking features by which the code of Menu is distinguished are the rigour and purity of its morals. Many of its maxims have all the sublimity of the precepts of Christianity; to which, in fact, they bear a close resemblance, not only in the style of thought but of expression. Thus, "Let not a man complain, even though in pain; let him not injure another in deed or in thought; let him not even utter a word by which his fellow-creatures may suffer uneasiness." Again, "Let him bear a reproachful speech with patience; let him speak reproachfully to no man; with an angry man let him not in return be angry; abused, let him answer mildly." The inspired words of the Psalmist, "The fool hath said in his heart there is no God," are thus almost verbally rendered, "The wicked have said in their hearts no one sees us: yes, the gods distinctly see them, and so does the spirit within their breasts." The Institutes of Menu have been translated into the English and French languages: into the former by Sir W. Jones in 1794, the latter by Des Longchamps in 1830 (Strasburg). An edition of the original Sanscrit, together with Sir W. Jones's translation, was published at Calcutta in 1822-25 by Sir Graves Haughton.

MENU'RA. (Gr. μενος, *strength*, and ουρα, *a tail*.) A name invented by Dr. Shaw for a genus of birds peculiar to Australia, the true affinities of which have been the subject of much discussion and diversity of opinion among ornithologists. Cuvier observes that the *Mænuræ*, or lyre-pheasants, evidently belong to the order *Passerinæ*, and approach the thrushes in their beak, which is triangular at the base, elongated, slightly compressed, and emarginate at the point. Only one species is at present known, and this is chiefly peculiar for an extraordinary sexual development of the tail feathers of the male. Of these there are three kinds: the twelve common ones, with very fine and widely separated barbs; two more in the middle, of which only one side is furnished with thickly-set barbs; and two external ones, curved in the figure of an *S*, or like the arms of a lyre, whose internal barbs, large and thickly set, form a kind of broad riband, while the external ones are very short, becoming longer only near the tip. The female has only the twelve ordinary quills.

MENYA'NTHES. (Gr. μηνος, and ανθος, *flower*.) A genus of Gentianaceous plants with powerful tonic properties. The *M. trifoliata*, a wild aquatic plant, with white flowers densely crested with hairs, is employed in medicine as a bitter, emetic, tonic, and diaphoretic.

MENY'NGES. (Gr. μηνιγξ, *a membrane*.) The membranes which cover the brain are so called.

MEPHI'TIS. (Lat.) Any noxious exhalation; but more particularly applied to carbonic acid gas. Mephitis was the name of a Latin goddess who was invoked by the Romans as their protectress against noxious vapours.

MERCA'PTAN. A liquid composed of sulphur, car-

bon, and hydrogen, which has received the above name from its energetic action on mercury — *corpus mercurium captans*. (Zeise, *Annales de Chimie et Physique*, lv. 87.)

MERCA'TOR'S CHART, or PROJECTION. A representation of the sphere on a plane, in which the meridians are represented by equidistant parallel straight lines, and the parallels of latitude also by straight lines perpendicular to the meridians. This projection, which is universally adopted for nautical charts, by reason of the facilities which it affords in navigation from the circumstance that the rhumb, or sailing course between two points, is represented by a straight line, was invented by Gerard Mercator (his true name was *Kauffman*, of which Mercator is the Latin equivalent), a native of Rupelmonde, in East Flanders, born in the year 1512. But, though Mercator gave his name to the projection, it does not appear that he knew the law according to which the distance of the parallels from the equator increases. The true principles of the construction were found by Edward Wright, of Caius College, Cambridge, who explained them in his treatise, entitled *The Correction of certain Errors in Navigation*, published in 1599, and are as follows:—Suppose one of the meridians on the globe to be divided into minutes of a degree; one of these, taken at any parallel of latitude, will be to a minute of longitude, taken on that parallel, as the radius of the equator to the radius of the parallel; that is, as radius to the cosine of the latitude, or as the secant of the latitude to radius. This proportion holds true on the map in this sense, that if a minute of the equator be taken as the unit of a scale, and that unit be considered as the radius of the tables, then the representation of a minute of latitude will be expressed by the number in the trigonometrical tables which is the secant of that latitude. Hence, in the map, while the degrees of longitude are all equal, the degrees of latitude marked on the meridian form a scale of which the distances go on increasing from the equator towards the poles, each being (approximately) the sum of the secants of all the minutes of latitude in the degree. The numbers resulting from the addition of the secants of the successive minutes reckoned from the equator form a scale of meridional parts, which is given in all books of navigation. The very remarkable property of this projection, namely, that the divisions of the meridian are analogous to the excesses of the logarithmic tangents of half the respective latitudes augmented by 45°, above the logarithm of the radius, was discovered by Bond about the year 1645; but was first demonstrated by James Gregory, in his *Exercitationes Mathematicæ*, published in 1668. (See the *Scriptores Logarithmici*, vols. ii. and iv.)

MERCURIA'LE. The first Wednesday after the great vacation of the parliaments, under the old French régime. On that day they met to discuss grievances and deficiencies, and to reprimand members for misconduct. Hence, an harangue of reproof is popularly termed in French a *mercuriale*.

ME'RCURY. (Probably from the Lat. merx, *merchandise*.) The Latin name of the Grecian Hermes. He was the son of Jupiter and Maia, and discharged the office of the messenger of the gods. Part of his duty was also to conduct the shades of the dead to the infernal regions. He presides over eloquence, profit, good fortune, and theft; in which he was himself so great a proficient that, on the day of his birth, he stole fifty kine from the herds of Apollo, whom he repaid by the gift of his invention, the lyre. (See the Hymn ascribed to Homer, with the beautiful translation of it by Shelley.) His attributes, exploits, and insignia are briefly enumerated by Horace (Ode I. 10.):—

> Mercuri facunde, nepos Atlantis,
> Qui feros cultos hominum recentum
> Voce formasti catus, et decoræ
> More palæstræ,
> Te canam, magni Jovis et Deorum
> Nuntium curvæque lyræ parentem
> Calidum, quicquid placuit jocoso
> Condere furto.

Between which passage and the lines of Ovid (*Fasti*, v. 663—669.) a curious coincidence will be found. Mercury was represented as a youth lightly clad, with the *petasus*, or winged hat, and wings at his heels. In his hand he bears the emblem of his herald's office, the *caduceus*, a rod with two serpents twined about it. The more ancient statues of Mercury were square blocks of stone, with a rudely carved head on them. They were set up in great numbers in the streets of Athens.

ME'RCURY. In the Solar System, the planet nearest the sun. The mean distance of Mercury from the sun is 0·3870981, the radius of the earth's orbit being taken as unit; it is consequently little more than a third of the earth's distance, and equal to about 36,000,000 of miles. His mean sidereal revolution is performed in 87·969258 mean solar days, and his successive oppositions or conjunctions take place at intervals of 115·877 mean solar days. The orbit is inclined to the ecliptic in an angle of 7° 0′ 9″; and its eccentricity is greater than that of any other of the old planets, being 0·205515, the major axis being unit. Mercury being an inferior planet always appears in the neighbourhood of the sun; his greatest elongation, or angular distance from the sun, amounts only to 28° 48′; so that he is very seldom visible to the naked eye. His apparent diameter varies from 5″ at his superior conjunction when at his greatest distance from the earth, to 12″ at his inferior conjunction when nearest the earth. At a distance equal to the mean distance of the sun from the earth, the apparent diameter is 6·9″. His true diameter, compared with that of the earth taken as unity, is ·398, or about 3140 miles. On account of the smallness of the planet and its proximity to the sun, it is difficult to distinguish any variety on the surface. The disk is round, and, in a good telescope, exhibits phases; and the planet is supposed to revolve about its axis in the space of 24 h. 5 m. 28 sec. Mercury is sometimes seen to pass over the sun's disk. This can only happen when he is in one of his nodes nearly at the same time that he is at his inferior conjunction. The phenomena are of more frequent occurrence than the transits of Venus, but of far less astronomical importance. The five next transits will be visible in this country, and will occur at the following dates:—1845, May 8.; 1848, Nov. 9.; 1861, Nov. 11.; 1868, Nov. 4.; 1878, May 6. *See* PLANET.

ME'RCURY. This metal is found chiefly in the state of *sulphuret*, which is decomposed by distillation with iron or lime. It is also found *native*. Mercury is the only metal which is liquid at common temperatures; it is white and very brilliant. It freezes and assumes a crystalline texture at 40° below zero. Its specific gravity is 13·5. It boils at 660°, and its vapour condenses upon cool surfaces in minute brilliant globules. It is not altered by exposure to air at common temperatures, but when kept in vessels to which air has access, at a temperature near its boiling point, it gradually becomes converted into a deep red crystalline substance, which is the *peroxide*, or *red oxide*, *of mercury*. When mercury is dissolved in cold dilute nitric acid, the pure alkalis throw it down in the form of *black protoxide*. The same oxide is also obtained by triturating calomel with solution of caustic potash. These are the only definite oxides of mercury. The equivalent of this metal is about 200, and the oxides, consisting respectively of 1 atom of mercury and 1 of oxygen, and 1 and 2, are represented by 200 + 8 = 208, and 200 + 16 = 216. Mercury is represented in chemical formulæ by *hg.*, from the Latin *hydrargyrum*, literally signifying *water silver*. The symbol of the protoxide will then be (*hg.* + *o.*), and of the peroxide (*hg.* + 2 *o.*). Each of these oxides combines with the acids, and produces the *protosalts* and *persalts* of mercury.

Mercury and Chlorine.—There are two *chlorides of mercury*; a *protochloride* or *calomel*, and a *perchloride* or *corrosive sublimate*. Calomel may be obtained by mixing 60 parts (1 equivalent) of common salt, or chloride of sodium, with 248 parts (1 equivalent) of protosulphate of mercury, and exposing the mixture in a proper subliming vessel to a red heat; the chlorine of the salt combines with the mercury of the sulphate to form protochloride of mercury (consisting of 200 mercury and 36 chlorine); and the sodium of the salt uniting with the oxygen of the oxide of mercury becomes soda, which, with the sulphuric acid, forms sulphate of soda. Calomel may also be obtained by mixing 200 parts of mercury with 272 of corrosive sublimate, and subliming the mixture. When thoroughly washed and levigated, calomel is a tasteless white powder; its specific gravity is 7·2. When heated it acquires a yellow colour; and at a temperature below redness it rises in dense white fumes, which are deposited in the form of a white powder upon cold surfaces. It is insoluble in water. When hastily sublimed it often becomes a crystalline horny mass, and occasionally forms beautiful prismatic crystals. It is sometimes found native; forming, however, a very rare ore, called, from its appearance, *horn quicksilver*.

Perchloride of mercury, or corrosive sublimate, is obtained by sublimation from a mixture of 120 parts of common salt (or 2 equivalents), and 296 (or 1 equivalent) of persulphate of mercury. It rises in the form of a white crystalline substance, of an acrid metallic taste, highly poisonous, soluble in 20 parts of cold and in 2 of boiling water. Its specific gravity is 5·2. When heated it evaporates in acrid fumes, at a temperature below that required for the volatilization of calomel. Corrosive sublimate is a compound of 1 equivalent of mercury and 2 of chlorine. In the above process for preparing it the chlorine is furnished by the chloride of sodium, and sulphate of soda is the other product.

Bisulphuret of Mercury, known also by the name of cinnabar or vermilion, is prepared artificially by heating together 100 parts of mercury with about 20 of sulphur; they form a black compound, which, when strongly heated, rises in the form of a deep crimson-coloured sublimate; this, reduced by long trituration into a fine powder, acquires a brilliant red colour. It is tasteless, and insoluble in water; it consists of 200 mercury and 32 sulphur, or (*hg.* + 2 *s.*) A black *protosulphuret of mercury* (*hg.* + *s.*) is precipitated by sulphuretted hydrogen from a solution of the protonitrate. When a mixture of equal weights of

finely-powdered peroxide of mercury and Prussian blue is boiled in water till the blue colour disappears, the solution yields, when filtered and evaporated, a crop of straw-coloured prismatic crystals, which are *bicyanuret of mercury* : 2 *cy*. + *hg*.

Mercury is found in various parts of the world. Among the principal mines are those of Almaden, near Cordova, in Spain; Idria, in Carnolia; Wolfstein and Morsfield, in the Palatinate; Guancavelica, in Peru. It is stated by Dr. A. T. Thomson, in his *Dispensatory*, that most of the mercury used in this country is brought from Germany. But, whatever may have been the case formerly, this is not certainly true at present. On the contrary, of 314,286 lbs. of quicksilver imported in 1831, none was brought from Germany; 269,558 lbs. were brought direct from Spain, and 13,714 lbs. from Gibraltar; of the latter a part was derived from Carniola, and a part from Spain; 31,014 lbs. were brought from Italy. Only 192,310 lbs. were retained for home consumption in 1831. (*Parl. Paper*, No. 550. Sess. 1833.) Quicksilver is produced in several of the provinces of China. During the war, when the intercourse between Europe and America was interrupted, the price of quicksilver rose to such a height in the latter that it answered to import it from China; but since the peace it has been regularly exported to the latter. At an average of the 14 years ending with 1828, the imports of quicksilver by the English and Americans into Canton amounted to 648,085 lbs. a year, worth 340,262 dollars. (*Lords' Report of* 1831, p. 657.) Besides its uses in medicine, mercury is extensively employed in the amalgamation of the noble metals, in water-gilding, the making of vermilion, the silvering of looking-glasses, the making of barometers and thermometers, &c.

ME'RGER, in Law, is the destruction of a lesser estate in lands and tenements by the acquisition of a greater estate in the same immediately succeeding by the same party and in the same right. Thus an estate for years is said to merge, or sink, in an estate for life, if there be no other estate vested in another person intervening between the two; and an estate for life in an estate of inheritance. There is no merger of an estate tail.

ME'RGUS. (Lat. mergus, the name of a sea-bird, supposed to apply to the cormorant.) A Linnæan genus of Anserine birds, characterized by a beak thinner and more cylindrical than that of the ducks, and with each mandible armed at its margins with small pointed teeth directed backwards, like those of a saw; the upper mandible is curved downwards at its extremity. The goosander (*Mergus serrator*) and the merganser (*Mergus merganser*) are examples of this genus.

MERI'DIAN. (Lat. meridies, *mid-day*.) In Astronomy, a great circle of the sphere passing through the earth's axis and the zenith of the spectator. It is the circle on which the latitudes of places are reckoned, commencing from the equator, which it intersects at right angles. The terrestrial meridian is the great circle (or rather ellipse) formed by the intersection of the surface of the earth with the plane passing through the poles and the place of the spectator. *See* DEGREE.

MERI'DIAN ALTITUDE. The altitude, or height above the horizon, &c. in degrees, of any celestial object, when it crosses the meridian of a place.

MERI'DIAN, FIRST. The meridian from which longitudes are reckoned. The choice of the first meridian is entirely arbitrary; and most nations reckon the longitudes from their capital, or meridian passing through their principal observatories. Thus, in English works, the longitude is reckoned from Greenwich; in French, from Paris; in Russian, from St. Petersburg, &c. Ptolemy employed the Canary Islands, the French formerly reckoned from Ferro, and the Dutch from the Peak of Teneriffe. Mercator chose the island Del Corvo. *See* LONGITUDE.

MERIDIAN LINE. A line traced on the surface of the earth, coinciding with the intersection of the meridian of the place with the sensible horizon.

MERIDIAN OF A GLOBE, OR THE BRASS MERIDIAN, is a graduated circular ring, within which the globe is suspended and revolves, and by means of which it is connected with the frame bearing the horizontal scale. Meridian lines are also traced on the globe itself, usually at 15° distance, or a difference of longitude corresponding to an hour of time. It is probable that these, with the parallels of latitude, suggested to Descartes the idea of *co-ordinates*, which he applied so successfully to connect algebra with geometry.

MERI'NO SHEEP. A breed of sheep till lately peculiar to Spain, but now reared in Saxony, England, and more particularly in Australia, chiefly for the superior fineness of their wool. The word *merino* signifies an overseer of pasture lands, and is applied to this breed of sheep, because, in Spain, they are kept in immense flocks, under a system of shepherds, with a chief as a head, and with a general right of pasturage all over the kingdom. The best flocks of Spanish merinos are found in Leon and Castille: of the Saxon variety, at Stolpen and Rochsburg; but merinos are to be found in North America, the Cape of Good Hope, and above all in New South Wales, which promises to be one of the principal woolgrowing countries in the world. *See* SHEEP.

ME'RLON. In Fortification, the part of the parapet or epaulement included between two embrasures.

ME'RMAID. (Germ. meer, *sea*, and magd, *maid*.) A fabulous creature; the fore part woman, the hinder half fish. The species of actually existing animals that, viewed at a distance in the sea, may have originated the idea of mermen and mermaids, are the cetaceous *dugong* and *manatee*: these have their fore fins rudely fashioned like arms and hands, and terminate behind in a fish-like tail. The nipples are pectoral; and they are often seen ascending to the surface to breathe, clasping their suckling young to the breast.

MERO'PIDANS, *Meropidæ*. The family of Insessorial birds of which the bee-eater (*Merops*) is the type.

ME'ROS. (Gr.) In Architecture, the plane face between the channels in the triglyphs of the Doric order.

MERU'LIDANS, *Merulidæ*. The family of Dentirostral perchers, of which the thrush (*Merula*) is the type.

MESE'MBRYA'NTHEMUM (Gr. μεσος, *the middle*, βρυω, *I grow*, and ανθος, *a flower*), is a very large genus of succulent Cape plants, of which many species are conspicuous for the beauty of their flowers, which expand in sunshine, and close up in gloomy weather. They are chiefly interesting on account of the hygrometical quality of their fruit, which when wetted opens out into numerous radiating valves, and when dry contracts with force into a compact and apparently solid body. This fruit is sometimes called the fig-marigold.

ME'SENTERY. (Gr. μεσος, and εντερον, *an intestine*.) The membrane by which the intestines are attached to the vertebræ; it is formed of a duplicature of the peritonæum, and supports the nerves and vessels of the intestines.

ME'SMERISM. *See* MAGNETISM, ANIMAL.

MESNE PROCESS. Such process as intervenes between the beginning and end of a suit. It is opposed to final process, or that which takes place by way of execution after judgment. Imprisonment for debt on mesne process was effected by the bare affidavit of one person, stating that another owes him 20*l*. It is abolished, under certain exceptions, by 1 & 2 Vict. c. 110. *See* ARREST.

MESOCO'LON. (Gr. μεσος, and κωλον, *the colon*.) The mesentery of the colon: it is an extensive duplicature of the peritonæum.

ME'SOLABE. (Gr. μεσος, and λαμβανω, *I take*.) An instrument employed by the ancients for finding two mean proportionals between two given lines, which were required in the problem of the duplication of the cube. (See *Eutocius on the Works of Archimedes*, and the 3d Book of *Pappus*.)

ME'SOLYTE. (Gr. μεσος, and λιθος, *a stone*.) A hydrated silicate of alumina, lime, and soda. It is also called *needle-stone*.

MESOPHY'LLUM (Gr. μεσος, and φυλλον, *a leaf*), is the parenchymatous tissue forming the fleshy part of a leaf between the upper and lower integuments.

MESOTHO'RAX (Gr. μεσος, and θωραξ, *the chest*), in Entomology, is the posterior segment of the alitrunk, which bears the posterior pair of wings and the third or posterior pair of legs.

ME'SOTYPE. (Gr. μεσος, and τυπος, *form*.) A hydrated silicate of alumina and soda. It has also been called natrolite. It occurs in trap rocks and in the ancient lava of Vesuvius.

MESS, in Military Language, signifies the public dinner prepared either for the officers of the same regiment, or for those of different regiments, if in garrison, and to the support of which they are bound to contribute a portion of their pay. Generally speaking, only married officers are exempted from contributing to, and dining at, the mess; the rest preside over it in rotation, without respect to military rank.

ME'SSENGER. In Naval Language, a hawser or small cable of about sixty fathoms in length, wound round the capstan, and having its two ends lashed together. When the anchor is to be weighed this rope is attached to the cable by the *nippers*, and thus acts as an endless rope. Chain messengers are sometimes employed.

ME'SSENGERS, KING'S. Certain officers employed in the secretary of state's department to convey despatches, either at home or abroad. They were formerly employed in serving the secretaries' warrants for the apprehension of parties charged with high treason, or other grave offences; and in such cases it was not unusual for them to detain their prisoners at their own houses. In the year 1713 the ambassador of the emperor of Morocco was taken into custody by a king's messenger, and released only after a lapse of six months.

MESSI'AD. The name given to the only modern epic poem of Germany; the subject of which is, as the name implies, the sufferings and triumph of the Messiah. It is written in hexameter verse, for which, as we have elsewhere observed, the German is better fitted than any modern language, and consists of 20 books. The publication of this poem procured for its author unbounded

reputation; but posterity does not appear to sanction the high award pronounced on it by contemporaneous writers. Schlegel, indeed, maintains that the modern literature of Germany may be said to date from the *Messiad;* but this high praise must be understood as referring chiefly to its having been among the first productions in which the power and resources of the German language were developed, rather than to its innate merits as an epic poem, or to the influence it has exercised over the national poetry of Germany. The reputation of Klopstock among his own countrymen rests chiefly on his Odes; and it must be admitted that in all those parts of his epic poem into which a lyric spirit could be infused,—in other words, whenever the feelings or the sympathies were to be excited,—there are few poets, either ancient or modern, to whom he deserves to be postponed; but, on the other hand, the dignity and sublimity of his sentiments are not unfrequently disfigured by the pedantry and affectation of his style, and the tediousness of his episodes.

MESSI'AH. An old Hebrew word, signifying the anointed or sacred, corresponding with the Greek word *χριστος;* and in this sense applied to the Saviour, as it was anciently applied by the Jews to their prophets, priests, and kings, it being customary to anoint all these high personages when they assumed their office. We read in Psalm ii. 2., "The kings of the earth set themselves against the Lord and against his *anointed*" (*i. e.* his Messiah); and in Psalm xlv. 7., "Therefore God, even thy God, hath *anointed* thee with the oil of gladness above thy fellows." This *anointing*, therefore, was not a sensible unction with external oil or ointment, but a symbol of it; a spiritual, an internal unction of grace, given by the Holy Ghost—"And God gave not the spirit by measure unto him." St. Luke tells us that our Saviour applied this *anointing* to himself at the time when he entered the synagogue of Nazareth. In the synagogue service there is a pause for any one to speak or read who can enlighten or instruct the people: when this period came our Saviour stept forward, took up the Hebrew roll, and opened it at the book of the prophet Isaiah, and read aloud this passage:—"The spirit of the Lord is upon me, because he hath *anointed* me to preach the gospel to the poor," &c.; and he closed the book, and he gave it to the minister, and sat down. The eyes of all them that were in the synagogue were fastened on him; and he said, "This day is this scripture fulfilled in your ears; and all bare him witness, and wondered at the gracious words which proceeded out of his mouth." (Luke, iv. 17. &c.)

ME'SSUAGE (modern Lat. messuagium), in Law, is said to be properly a dwelling-house with a small portion of land adjacent, or the site of the manor. It is now one of the general words used in the legal description of dwelling-houses with the land attached.

MESTI'NO. In Spanish America, the child of a Spaniard or creole and a native Indian. *See* MULATTO.

METABO'LIANS. (Gr. *μεταβολη, change.*) A subclass of insects, including all those which undergo a metamorphosis.

METACA'RPAL. (Gr. *μετα, between,* and *καρπος,* in the sense of *the wrist.*) Belonging to the metacarpus, or that part of the hand which is between the wrist and fingers.

METACE'NTRE. (Gr. *μετα,* and *κεντρον, centre.*) A term first applied by Bouguer to that point of a floating body in which, when the body is disturbed from the position of equilibrium, the vertical line passing through the centre of buoyancy meets the line which when the body is at rest passes through the centre of buoyancy and centre of gravity. In order that the body may float with stability, the position of the metacentre must be above that of the centre of gravity. *See* HYDROSTATICS.

METAGA'LLIC ACID. When gallic acid is rapidly heated up to about 480°, carbonic acid and water are evolved, and a black product remains soluble in the alkalies, and forming insoluble compounds with many of the metallic oxides. This product has been termed *metagallic acid;* its ultimate elements are 12 atoms of carbon = 72, 3 atoms of oxygen = 24, and 3 atoms of hydrogen = 3, making its equivalent = 99.

METALLOI'DS. (Gr. *μεταλλον, a metal,* and *ειδος, form.*) A term sometimes applied by chemists to the inflammable non-metallic bodies, such as sulphur, phosphorus, &c. The metallic bases of the fixed alkalies and alkaline earths have also been by some called metalloids, in consequence probably of their low specific gravity.

ME'TALLURGY. (Gr. *μεταλλον,* and *εργον, a work.*) The art of separating metals from their ores. The principal metallurgic processes are described under the respective metals.

ME'TALS (Gr. *μεταλλον*), are distinguished by their very peculiar lustre, arising out of their opacity and reflective power in regard to light. They conduct electricity and heat; and they have not been resolved into other forms of matter, so that they are regarded as simple or elementary substances. When their compounds are electrolysed the metals appear at the negative surface, and are hence considered as electro-positive bodies. They are enumerated in the following table, together with the names of the chemists by whom they were discovered, the date of the discovery, their specific gravities, melting points, equivalent or atomic weights, and symbolic abbreviations. For their individual distinctive characters see the respective metals. Lantanum is omitted, inasmuch as its properties and combining weight have not been accurately examined.

Names of Metals.	Authors, and Dates of their Discovery.	Specific Gravity.	Melting Points.	Equivalent Weights.	Abbreviations or Symbols.
			Fahr.		
1. Gold - - - ☉	(Known to the ancients, and represented by the annexed planetary symbols, with which they were supposed to be mysteriously connected.)	19·25	2016°	200	au.
2. Silver - - ☽		10·47	1873	110	ag.
3. Iron - - - ♂		7·78	2800? s. f.*	28	fe.
4. Copper - - ♀		8·89	1996	64	cu.
5. Mercury - - ☿		13·56	39	200	hg.
6. Lead - - - ♄		11·35	612	104	pl.
7. Tin - - ♃		7·29	442	58	sta.
8. Antimony - - -	Basil Valentine - - - 1490	6·70	- -	65	an.
9. Bismuth - - -	Agricola - - - 1530	9·80	497	72	bi.
10. Zinc - - - -	Paracelsus? - - - 1530	7·00	773	32	zn.
11. Arsenic -	Brandt - - - 1733	5·88	- -	38	ar.
12. Cobalt - - -		8·53	2810?	30	cob.
13. Platinum - - -	Wood - - - 1741	20·98	oh. bp. †	96	pla.
14. Nickel - - -	Cronstedt - - - 1751	8·27	2810?	28	nic.
15. Manganese - -	Gahn - - - - 1774	6·85	s. f.	28	man.
16. Tungsten - - -	D'Elhuiart - - 1781	17·60	- -	100	tu.
17. Tellurium - -	Müller - - - - 1782	6·11	620?	32	tel.
18. Molybdenum - -	Hielm - - - 1782	7·40	oh. bp.	48	mol.
19. Uranium - - - -	Klaproth - - - 1789	9·00	oh. bp.	217	ur.
20. Titanium - - -	Gregor - - 1791	5·30	oh. bp.	24	ti.
21. Chromium - -	Vauquelin - - - 1797	- -	oh. bp.	28	chr.
22. Columbium - - -	Hatchett - - - - 1802	- -	oh. bp.	185	col.
23. Palladium - - -	Wollaston - - - - 1803	11·50	- -	54	pal.
24. Rhodium - -		- -	oh. bp.	45	rh.
25. Iridium - - -	Tennant - - - - 1803	- -	oh. bp.	96	ir.
26. Osmium - -		- -	oh. bp.	100	os.
27. Cerium - - -	Hisinger - - - - 1804	- -	- -	48	ce.
28. Potassium - -	Davy - - - - 1807	0·86	136	40	po.
29. Sodium - - -		0·97	190	24	so.
30. Barium - - -		-	- -	70	ba.
31. Strontium - -		-	- -	44	str.
32. Calcium - - -		-	- -	20	cal.
33. Cadmium - - -	Stromeyer - - - - 1818	8·60	442	56	cad.
34. Lithium - - -	Arfwedson - - 1818	- -	- -	10	li.
35. Silicium - -	Berzelius - - - - 1824	- -	- -	8	si.
36. Zirconium - -		- -	- -	30	zir.
37. Aluminum - -	Wöhler - - - 1828	- -	- -	10	al.
38. Glucinum - - -		- -	- -	18	gl.
39. Yttrium - -		- -	- -	32	yt.
40. Thorium - - -	Berzelius - - - - 1829	- -	- -	60	th.
41. Magnesium - -	Bussy - - - - 1829	- -	- -	12	mag.
42. Vanadium - - -	Seftström - - - - 1830	- -	- -	68	va.

METAMECO'NIC ACID, is produced by boiling the aqueous solution of meconic acid. It evolves carbonic acid, and becomes brown. Two atoms of meconic acid are thus resolved into 1 of metameconic acid and 2

* Smith's forge.

† Oxyhydrogen blowpipe.

of carbonic acid. It is represented by 12 *car.* + 4 *h.* + 10 *ox.*

METAMO'RPHOSIS. (Gr. μετα, indicating *change*, and μορφη, *form*.) Transformation. The heroic poem of Ovid, in which he recounts the most celebrated mythological narratives respecting the gods of Greece and Rome, and the changes of this description effected by their supernatural power, is called the *Books of Metamorphoses*.

METAMO'RPHOSIS. In Entomology, the change of form which the Metabolian insects and some other animals undergo in passing from one stage of existence to another; in each of which they manifest different habits, and have a different organization. The three stages of a Lepidopterous insect are *larva*, *pupa*, and *imago*.

ME'TAPHOR. (Gr. μεταφερω, *I transfer*: indicating the substitution of one word for another of similar meaning.) In Rhetoric, a figure by which a word is transferred from the subject to which it properly belongs, and applied to another which has some similitude to its proper subject, with a view to give energy to the expression of the former. A comparison or simile (*see* COMPARISON) appears to be only a metaphor with the addition of a sign denoting that it has been thus transferred. Thus "the silver moon" is a metaphorical expression; the "moon, bright as silver," a comparison. As language advances from the mere indication of sensible objects by names to the expression of the feelings and wants of a complicated mode of life, it becomes more and more metaphysical in character, until it is found that a very large proportion of the words in common use are either metaphors, or are words derived from foreign languages, and whose primary sense as derivatives is the same with their secondary or metaphorical sense in the language from which they came. Thus, the English word "character," used a few lines above, is drawn from the metaphysical use of the Greek χαρακτηρ, which in its primary signification denoted something engraven on a hard substance. Metaphors have been divided, by writers on rhetoric, into several classes; but the most appropriate are those which are termed analogical, and which derive their force, not from any actual resemblance between two objects, but from a resemblance between the relations which they bear respectively to certain other objects. Thus "the sea of life" is a common and appropriate metaphor; not from any resemblance between the idea of the visible sea and the complex notion of that abstraction which we term human life, but because there is a fancied similarity between the position of navigators in an uncertain voyage and that of human beings engaged in the manifold scenes of life.

ME'TAPHOSPHO'RIC ACID. A term by which some chemists designate the dry flaky acid obtained by burning phosphorus under a bell glass of air or oxygen.

METAPHY'SICS. (Gr. μετα, *after*, and φυσις, *nature*.) A word employed, in popular usage, to denote all those inquiries which are conversant about objects other than merely physical and sensible. It is an observation of Sir James Mackintosh, that "the term *metaphysics* affords a specimen of all the faults which the name of a science can combine. To those who know only their own language it must, at their entrance on the study, convey no meaning. It points their attention to nothing. If they examine the language in which its parts are significant, they will be misled into the pernicious error of believing that it seeks something more than the interpretation of nature. It is only by examining the history of ancient philosophy that the probable origin of this name will be found, in the application of it as the running title of several essays of Aristotle, which were placed in a collection of the manuscripts of that great philosopher *after* his treatise on physics." The censure thus conveyed we cannot, with all deference for so eminent an authority, regard as more than partially correct. Though the account of the origin of the word is, as far as it goes, the true one, it does not comprehend the whole truth.

If Sir James Mackintosh had examined the contents of those treatises of Aristotle to which he adverts, he would have found that the title *metaphysics* was prefixed to them, not, as his words imply, merely because they happened, according to the arrangement of the compiler, to follow the physical treatise; but *also* because there was the best possible reason for their being so placed, in the fact that the inquiries which compose them were conceived by Aristotle himself to admit of a general distinction from that department of inquiry which he included under the name of physics. The first few chapters of the τα μετα τα φυσικα are devoted to the elucidation of this very distinction, and to the endeavour to clear up the popular confusions on the subject, by marking at once the objects of the highest philosophy, and the faculty whereby they were to be apprehended. Admitting, therefore, as we most readily do, that great misapprehensions are popularly entertained with regard to the nature of metaphysics, we shall endeavour, as far as the limits of the present article will permit us, to remove such mistakes, by distinguishing the science of metaphysics from other sciences, with which, as they are closely connected with it, it has too frequently been confounded.

Metaphysics we understand to be the science which regards the ultimate grounds of being, as distinguished from its phenomenal modifications. As a means of attaining this end, it considers the correlative of being, knowledge; and knowledge, not merely in reference to its *form*, as it is capable of law and regulation, for that is the province of logic — nor in regard to its history, and the successive stages of its development, which are the objects of psychology, or mental philosophy — but knowledge as it is in relation to being, or objective reality. Philosophers have not been satisfied with marking the resemblances of the appearances in nature, and the order in which they succeed each other, whether those appearances were outward and sensible, or internal and revived by observation of their own mental processes; they have not even been content with the discovery that their knowledge of phenomena was self-consistent, and obeyed certain determined or determinable canons or forms; they have felt that the highest end of science could then only be attained when all knowledge was perceived to depend on a one ultimate principle, which should demonstrate at once its consistency with itself and its absolute foundation in reality. That the science of this ultimate unity is that to which the greatest philosophers have with more or less distinctness assigned the name of metaphysics, we may safely appeal to the history of philosophy for a sufficient demonstration.

Whether the object thus proposed were one which the human faculties are capable of reaching is itself the first problem of metaphysics, and enters not, therefore, into that with which we have at present to do,—a definition of the word. We may, indeed, with Hume and his followers, reject all such attempts as chimerical, and endeavour to resolve the speculations to which they have led into the delusions of association or caprice; or we may, with Kant, confine ourselves to the *critique* of our mental laws, and, as the result of our investigation, pronounce that we possess no faculty capable of reaching outward reality. In the first case, if we have been careful to ascertain that our analysis has at every step been legitimate, we are bound to admit, not that metaphysics is an impossible science, but that it does not yet exist *as* a science. In the second instance, we are constrained to allow that all reality is subjective only; and that we can only know things in relation to our own modes of knowing; and this is itself a metaphysical principle, preclusive of further inquiry. In defiance, however, alike of the sneers of the sceptic, and the yet profounder scepticism of the critical philosophy, our own days have witnessed the rise, in Germany and France, of more than one professed system of metaphysical science. The frequency of such endeavours as these, undertaken, as they are, by men of such acknowledged acuteness and philosophical insight as Fichte, Schelling, and Hegel, even if they inspire us with no hope of a nearer approximation to the objects which they pursue, may at least serve to convince us that the propensity to such speculations constitutes an inalienable and indestructible instinct of our intellectual and moral nature.

ME'TAPLASM. (Gr. prep. μετα, signifying *change*, and πλασσω, *I form*.) In Grammar, a general term, comprehending all those figures of diction which consist in alterations of the letters or syllables of a word; taking place in three ways,— by augmentation, diminution, or immutation. 1. Augmentation at the beginning, *prosthesis;* in the middle, *epenthesis;* at the end, *paragoge;* to which may be added *diæresis*, adding to the number of syllables by the resolution of a diphthong. 2. Diminution at the beginning, *aphæresis;* in the middle, *syncope;* at the end, *apocope;* by contraction of two vowels, *synæresis* or *crasis*. 3. Immutation, *antithesis*, signifying the change of one letter for another; *metathesis*, transposition of the order of letters. (See those respective heads.)

META'STASIS. (Gr. μετα, and στασις, *station*.) The transference or translation of a disease from one part of the body to another.

METATA'RSUS. (Gr. μετα, and ταρσος, *heel*.) The instep is so called by surgical writers.

META'THESIS. (Gr. μετα, and θεσις, *position*.) In Grammar, the transposition of the letters of a word; a figure of uncommon occurrence in modern orthography, but which very ordinarily takes place in the gradual formation of the dialects of a language: *e.g.* German, ross; English, horse. *See* METAPLASM.

ME'TATOME. (Gr. μετα, and τεμνω, *I cut*.) In Architecture, the space between one dentil and the next.

META'YER. (Fr.; in Italian, mezzaiuolo; Lat. colonus medietarius.) In France and Italy, a farmer holding land on condition of yielding half the produce to the proprietor, from whom he receives tools and stock. Land thus occupied is said to be held in *métairie*. The conditions of the contract, however, vary essentially in different countries and districts. The antiquity of this mode of letting land is very great: it is probably the same which was called by the Romans *locatio in partibus* (see

Plin. Epist.); and the farmer thus holding was also termed *colonus partiarius*. It now prevails extensively in the south and middle of France, throughout Italy, in parts of Spain, and, it is said, in the East. For a very valuable summary of the character and effects of this agricultural system, the reader may be referred to Mr. Jones's *Essay on Wealth*; and for a highly-coloured view of the state of the peasantry under it in some parts of Italy, to *M. Sismondi's Etudes sur l'Economie Politique*.

METE'MPSYCHO'SIS. (Gr. μετα, *change*, and ψυχη, *soul*.) A Greek word denoting the migrations of the soul through different successive bodies. The doctrine of the transmigration of souls has existed in the belief of various religious and philosophical sects from the remotest antiquity. It formed the leading doctrine of one of the most celebrated schools of philosophy in the whole heathen world (*see* PYTHAGOREAN PHILOSOPHY); it was said too to have found numerous adherents in Egypt; but it is chiefly among the Indians that this doctrine has taken deep and permanent root. With them it appears to have been an article of faith from the period at which we can first perceive any trace of their existence as a nation; and it is not going too far to say that not only all the opinions, but even all the manners of the Indians, are at this hour built upon this doctrine. The Indian doctrine of *metempsychosis* rests on the supposition that all beings derive their origin from God, and are placed in this world in an altogether degraded condition, from which they all, but more particularly the human race, must either decline into still lower degradation, or rise gradually to a higher state more accordant with their divine original, according as they give ear to the vicious or the virtuous suggestions of their nature. It must be remarked, however, that the Indians make a wide distinction between the future destiny of those who have passed through life tainted by the usual vices and infirmities of human nature, and those whose lives have been spent in the constant discharge of religious duties. In the latter case, the soul does not pass through different stages of existence; "but proceeds directly to reunion with the Supreme Being, with which it is identified, as a river at its confluence with the sea merges therein altogether. His vital faculties, and the elements of which his body consists, are absorbed completely and absolutely; both name and form cease; and he becomes immortal, without parts or members." (See Mr. Colebrooke's translation of Extracts from the *Brahma-Sutras*, in the *Transac. of the Roy. As. Soc.*, vol. ix.)

METEMPTO'SIS. *See* PROEMPTOSIS.

METEORO'LOGY. (Gr. μετεωρος, *aërial*, and λογος, *discourse*.) The science of meteors, or the science which explains the various phenomena which have their origin in the atmosphere. Under the term meteorology, it is now usual to include, not merely the observation of the accidental phenomena to which the name of meteor is applied, but every terrestrial as well as atmospherical phenomenon, whether accidental or permanent, depending on the action of heat, light, electricity, and magnetism. In this extended signification, meteorology comprehends climatology, and the greater part of physical geography; and its object is to determine the diversified and incessantly changing influences of the four great agents of nature now named, on land, in the sea, and in the atmosphere. *See* ATMOSPHERE, CLIMATE, and the various terms referred to under METEORS.

ME'TEORS. (Gr. μετεωρα.) A name given to any phenomena of a transitory nature which have their origin in the atmosphere. Meteors are of various kinds. Some are produced simply by a disturbance of the equilibrium of the atmospheric fluid, and are called *aërial meteors*. (*See* WINDS, WHIRLWINDS.) A second class arise from the deposition of the aqueous particles which the atmosphere holds in solution, and which are precipitated in consequence of a diminution of pressure or temperature, sometimes in a fluid and sometimes in a concrete form. These are called *aqueous meteors*. (*See* DEW, FOGS, HAIL, RAIN, SNOW, VAPOUR, &c.) A third class of meteors, or atmospherical phenomena, are caused by the action of the aqueous particles dispersed in the atmosphere on the rays of light. These are called *luminous meteors*. (*See* FATA MORGANA, HALO, MIRAGE, PARHELIA, RAINBOW.) A fourth class are the *igneous meteors*, comprehending those which present the phenomena distinctive of combustion. *See* AEROLITE, AURORA BOREALIS, FIRE BALLS, LIGHTNING, SHOOTING STARS, &c.

METHE'GLIN. (Germ. meth, *mead*.) A beverage made of honey and water, fermented by the addition of yeast.

ME'THOD. From the Greek word μέθοδος, which signifies a journey undertaken in quest of any object, or a way of attaining any end: hence, in Logic, it denotes a mode of investigating truth. Thus we have the dialectic method, the inductive method, the analytical method, &c. *See* DIALECTICS, INDUCTION, ANALYSIS.

ME'THODISTS. The body of Christians to whom this name is chiefly applied are the followers of the late John Wesley, the founder of this numerous sect; hence called Wesleyan Methodists. But the term bears a more extensive meaning, being applied also to several bodies or sections of Christians who have seceded or withdrawn from the Wesleyan denomination.

The origin of the Methodist society took place at Oxford in 1729. After the Revolution, when the principles of religious toleration were recognized amidst the progress of free inquiry, the clergy of the established church were thought by some to have sunk into a state of comparative lukewarmness and indifference. This alleged degeneracy was observed with pain by John Wesley and his brother Charles, when students at the University of Oxford; and being joined by a few of their fellow-students who were intended for the ministry in the established church, they formed the most rigid and severe rules for the regulation of their time and studies, for reading the scriptures, for self-examination, and other religious exercises. The ardent piety and rigid observance of system in every thing connected with the new opinions displayed by the Wesleys and their adherents, as well as in their college studies, which they never neglected, attracted the notice and excited the jeers of the various members of the university, and gained for them the appellation of *Methodists*; in allusion to the *methodici*, a class of physicians at Rome who practised only by theory. (Celsus, *in Prefat. de Medicina*.)

In the mean time Wesley took orders in the established church, and acted for a few months as assistant to his father, who was rector of Epworth, in Lincolnshire. After the death of the latter he was induced (1735), in company with his brother Charles and two other friends, to accept of an offer to go to Georgia in North America, to preach the gospel to the Indians. On his return to England in 1737, Wesley officiated in several churches of the establishment. But the higher ranks were offended at his declamatory and enthusiastic mode of preaching; and the clergy having disclaimed some of his doctrines, the churches in general were soon shut against him. It was his desire, however, to be allowed to officiate in the pulpit of his native church. His object, in truth, was to effect a reformation in the church, not to recede from connection with it; and the rules he observed himself, and imposed upon his followers, were designed as supplementary to the established ritual, not as superseding it. But the circumstances to which we have referred threw his labours into a different, and ultimately an opposite channel; and in short, without having at first intended it, he became the founder of the most numerous class of Dissenters in Great Britain.

Being thus virtually expelled from the established church, he preached in Dissenting chapels in London and other places where he could obtain admission. In course of time, and owing to the vast multitudes that crowded to listen to his ministrations, he adopted the expedient of officiating in the open air, and commenced field-preacher. He first formed his followers into a separate society in 1738, the year after his return from America, though he referred the establishment of Methodism to a prior date. (See *Wesley's Eccles. Hist.* vol. iv. p. 175.) Wesley, from this date, devoted his time and his great talents exclusively to the propagation of what he regarded the doctrines of the gospel, and to the extension of that sect of which he was the founder. His labours were chiefly confined to England; but he also paid visits to Scotland and Ireland,—in the former of which his success was inconsiderable. (*Sir H. Moncreiff's Life of Dr. Erskine*, cap. vii.) But while he confined his own labours to Great Britain and Ireland, he was not inattentive to the spiritual necessities of other countries, and, by means of a succession of missionaries, propagated his doctrines to a very great extent in America and many of the West India islands.

The unparalleled success which attended his great missionary exertions was not gained without much obloquy and persecution, particularly in the United Kingdom. Owing to the intelligence and liberality of the age, neither himself nor any of his missionaries were exposed to stripes and imprisonment; but all of them met with violent opposition on the part not merely of clergymen, both established and dissenting, and the wealthier classes, but also of the people; and some of them were beset with mobs, assailed by showers of stones and other missiles, and sometimes dragged through the streets as raving enthusiasts and as disturbers of the public peace. It must, at the same time, be confessed that the imprudence of some of his followers contributed somewhat to the reproach which they experienced.

Finding his societies rapidly increasing, and having been refused assistance from the established clergy, Wesley was induced to have recourse to lay preachers; an expedient which he was at first exceedingly averse to adopt, but which he afterwards found most efficient in promoting the triumph of his views. He was thus enabled to exercise superintendence over all his followers, and greatly to extend his sphere of action.

Though Wesley objected to his adherents being called Dissenters, and required them to attend the established church when they had no opportunity of hearing their own preachers, yet his creed is professed Arminianism,

and differs, therefore, in many points from what is generally understood to be the doctrine of the Thirty-nine Articles. He denied the doctrine of election; though he admitted that *certain* persons and churches have been elected, and that *great* events have been foreordained. He differed from the system of Calvin in regard to the extent of the atonement, which he maintained was for all men. He held that repentance preceded faith. He taught that, by virtue of the blood of Christ, and the operation of the Holy Spirit, it was the privilege of Christians to arrive at that maturity in grace and participation of the divine nature which excludes sin from the heart, and fills it with perfect love to God and men. (*Wesley's Plain Acc. of Christian Perfection.*) These and other minor opinions in which he differed, or seemed to differ, from the creed of the established church, are still retained by the Methodists. (In addition to Wesley's works, particularly his *Sermons*, see *Benson's Apology for the Methodists;* and *Myles's Chronol. Hist. of the Methodists.*) Wesley and his followers, we may here observe, continued long after their separation from the church to read the service of that church; nay the practice was continued, in a few instances, after his death. The great body of the Wesleyans, though they are now classed among Dissenters, are in favour of a national establishment of religion, and give the benefit of their support to the established church of England. There is, in truth, a pretty large body who fluctuate between Methodism and the national creed.

But while this is the case, the Methodists have adopted a system of church discipline and government quite distinct from those of the establishment, and which seems to partake as much of presbytery as of any other polity. Of this system, which is considerably complicated, the following are the leading features: — 1. Each society or congregation is divided into smaller bodies, called *classes*, each class embracing from twelve to twenty persons, one of whom is styled the *leader*. Each society has also a body of men called *stewards*, whose office is similar to that of deacon in the established church. The duties of leaders — namely, visiting the sick and holding religious intercourse with the members belonging to their class — are, in many respects, akin to those of lay-elders in the Presbyterian Church of Scotland. The leaders, stewards, and minister meet once a week (and this is called a *leaders' meeting*), on the religious business of the society; and to account for the funds received from the members in support of schools or of the gospel.

A number of these societies united constitutes a *circuit*, which is large or small as the circumstances of each locality require. One of the ministers within the district is termed the *superintendent*. The ministers officiating in the circuit meet all the classes quarterly, and speak personally to each member. Those whose conduct is devoid of reproach receive a ticket, the chief use of which is to prevent imposture. After the conference with the classes another meeting (called a *quarterly meeting*) is held, consisting of all the ministers, leaders, and stewards in the circuit. On this occasion the stewards deliver their collections to a *circuit steward;* and every thing relating to secular matters is publicly settled. At this meeting, also, the candidates for the ministry are proposed; and the stewards, after a definite period of service, are changed.

From five to ten or fifteen of the circuits, according to their extent, form a *district*, the ministers in which meet annually; the meeting being termed a *district meeting*. This assembly has authority "to try and suspend ministers who are found immoral, erroneous in doctrine, or deficient in ability; to decide concerning the building of chapels; to examine the demands from the circuits respecting the support of clergymen; and to elect a representative to attend and form a committee, four days before the meeting of the annual conference, in order to prepare a draught of the stations for the ensuing year. (*Myles, ut suprà.*) The circuit stewards are present at this meeting during the settlement of all financial matters. The judgment of the assembly is conclusive until the meeting of the conference, to which an appeal is allowed in all cases.

The *conference*, which is the supreme judicatory, and whose decisions are final, consists, strictly speaking, only of a hundred of the senior itinerant preachers, in terms of a deed of declaration executed by Wesley and enrolled in chancery. In this deed the meeting is termed "the Conference of the people called Methodists." But the conference is generally composed of the preachers elected at the previous district meetings to be their representatives, of the superintendents of the circuits, and of every minister who chooses to attend; all of them being allowed the same right of voting as the hundred, or legal conference. From this body all authority emanates; and by them all regulations to be observed throughout the whole Methodist connection are framed. In their name are levied all the funds required for carrying on the operations of the body. Ministers are by them appointed to the stations they are respectively to occupy; they nominate the superintendents of the various districts; they decide on all cases of appeal; and, generally speaking, the whole state of the connection comes under their review and controul. All their deliberations are carried on with closed doors, so that the people have no check over their proceedings; but the results of their discussions are annually published after each meeting, under the title of *Minutes of Conference*, which embody the laws of the society. The gradation of courts, and the supreme authority being vested in the conference, are somewhat similar in spirit and operation to the various judicatories of the Church of Scotland, in which, like the conference of the Methodists, the general assembly is supreme; the chief exception being that the latter judicatory is composed of certain relative proportions of lay elders and clergymen, while the Methodist conference is confined exclusively to ministers. (*General Rules of the Methodist Society; Adam's Religious World*, vol. iii. pp. 113—119.)

At the death of Wesley, in 1791, there were, in Great Britain and Ireland, about 300 itinerant preachers in connection with the new sect, and 1000 of what are called local preachers, — some of them, however, having very small congregations, — and 80,000 members. But the Wesleyan Methodists have established foreign stations in Australia, Van Diemen's Land, Gibraltar, Malta, Germany, &c.; and so rapidly have they increased that the number of Wesleyan Methodists in 1840, both at home and abroad, amounted to 1,137,424; and the total number of preachers, regular and supernumerary, was 5031.

Various offshoots have taken place from the Wesleyan Methodists at various times: among the most important of which may be reckoned the followers of Whitfield, formerly the coadjutor, and afterwards the most powerful and eloquent opponent of Wesley, and supporter of Calvinism; the Methodists of Lady Huntingdon's connection, in whose chapels service is performed according to the ritual of the church of England; the Welsh Calvinistic Methodists; the Primitive Methodists, or Ranters (which see); the New Connection Methodists (which see); the Independent Methodists; Bryanites, Warrenites, &c. Some of these sects, particularly the Whitfieldians, are nearly allied in church government and discipline to the Independents; and it is not unlikely that a coalition may take place between them and this latter denomination. (In addition to the works already quoted, see *Journal of John Wesley; Lives of Wesley*, by Coke, Moore, &c., but particularly that by Southey; *Nightingale's Portraiture of Methodism; Mosheim's Church History*, vol. vi. pp. 281—288.)

ME'THYLENE. (Gr. *μεθυ*, *wine*, and *υλη*, *wood.*) When wood is subjected to destructive distillation, there is formed along with the tar, acetic acid, and other products, a highly volatile and inflammable liquid, which, when purified by distillation off quicklime, was called spirit or alcohol of wood, or pyroxilic spirit. The hydrocarbon, which forms the basis of this form of alcohol, and to which the term *methylene* has been applied, is presumed to consist of 1 atom of carbon = 6, and 1 atom of hydrogen = 1: its density (in reference to hydrogen) being just half that of olifiant gas, or = 7. The alcohol of wood is a *hydrate* of this hydrocarbon; or a compound of 1 atom of methylene = 7, and 1 atom of water = 9: the equivalent, therefore, of the alcohol of wood is $7 + 9 = 16$.

ME'TOCHE. (Probably from *μετεχω*, *I partition.*) In Architecture, the space between two dentils.

METŒ'CI. (Gr. *μέτοικοι*, *sojourners.*) The resident aliens, who formed a large class of the inhabitants of Athens. They were distinguished from the few full citizens by many disabilities and burdens. They had no share in the administration of the state, and were precluded from the power of possessing landed estates. Each was compelled to purchase the shelter he received from the state by the payment of a small annual sum (*μετόικιον*), and to place himself under the guardianship of a citizen (*προστάτης*), who was his formal representative in the courts of law. They were generally engaged in mercantile and mechanical business.

METO'NIC CYCLE. So called from Meton, its inventor (B. C. 432.). A cycle of nineteen years, or, more accurately, of 6940 days; at the end of which time the new moons fall on the same days of the year, and the eclipses return in nearly the same order. The reason of this is, that in 19 solar years there are 235 lunations (with a difference of a few hours), and very nearly one complete revolution of the moon's nodes. The cycle was corrected by Calippus. *See* CALIPPIC PERIOD, CYCLE.

METO'NYMY. (Gr. *μετωνυμία;* derived from the preposition *μετα*, *change*, and *ὄνομα*, *a name.*) In Rhetoric and Composition, a figure by which the name of an idea or thing is substituted for that of another, to which it has a certain relation. Thus, the effect is frequently substituted for the cause — "grey hairs" stands for "old age:" the abstract for the concrete — "What doth gravity" (*i.e.* the grave person) "out of his bed at midnight?" — substance for quality, precedent for subsequent, &c.

The term *Metonomasia* (of the same origin as metonomy) was invented during last century by the French to designate a practice which prevailed to a great extent among the literati of the Continent; viz. of adopting some name in preference to their own.

METO'PA. (Gr. μετα, *between*, and οπη, *a hole*.) In Architecture, the square space in the frieze between the triglyphs of the Doric order. It is left either plain or decorated, according to the taste of the architect. In the most ancient examples of this order, the metopa was left quite open, as is manifest from a passage alluded to in the art. ARCHITECTURE.

METOPO'SCOPY. (Gr. μέτωπον, *a forehead*, and σκοπεω, *I view*.) The art of divination by inspecting the forehead, treated of especially by the famous Cardanus. The signs of the forehead are chiefly its lines; but moles and spots are also supposed to have their particular meaning. The lines are under the dominion of their several planets.

ME'TRE. (Gr. μετρον, *measure*.) In the classical sense of the word, a subdivision of a verse. The Greeks measured some species of verses (the dactylic, choriambic, antispastic, Ionic, &c.) by considering each foot as a metre; in others (the iambic, trochaic, and anapæstic) each *dipodia*, or two feet, formed a metre. Thus, the dactylic hexameter (the heroic verse) contains six dactyls and spondees: the iambic, anapæstic, and trochaic *trimeter*, six of those feet respectively. A line is said to be *acatalectic* when the last syllable of the last foot is wanting; *brachycatalectic*, when two syllables are cut off in the same way; *hypercataleptic*, when there is one superfluous syllable.

ME'TRONOME. (Gr. μετρον, and νομος, *a law*.) An instrument for measuring musical time. It is contrived on the principle of a clock having a short pendulum, whose bob being moveable up and down on the rod, is thus capable of increasing or decreasing the length of a note or bar as required by the character of the music. The length or duration of a note is often expressed at the head of a piece of music by stating that a pendulum of a given length in inches will vibrate a minim, crotchet, or other note, as the case may be.

METRO'POLIS. (Gr. μητηρ, *mother*, and πολις, *city*, or *state*.) 1. A parent state from which colonies have sprung, in which sense the word is uniformly employed by ancient Greek writers. 2. The chief city of a province in the later ages of the Roman empire. The Christian church having adopted the secular division of the Roman empire into provinces, the episcopal seat established in every such city, and the bishop of it himself, were termed metropolitan. 3. In modern usage, the chief or capital city of an independent state.

METROPO'LITAN, in early Ecclesiastical History, was a title applied to the archbishop, or chief ecclesiastical dignitary, resident in a city. The establishment of metropolitans took place at the end of the third century, and was confirmed by the council of Nice. In some of the Protestant states of Germany the title exists to the present time, and the person in possession of it has rank equivalent to the bishops of the English church.

ME'ZZANINE. (Lat. mezzano, *middle*.) In Architecture, a story of small height introduced between two higher ones.

ME'ZZO SOPRA'NO. (Ital.) In Music, a high counter-tenor, having the *C sol ut* clef on the second line.

MEZZOTI'NTO. (Ital. *half tinted*.) A particular method of engraving on copper. *See* ENGRAVING.

MIA'SMA. (Gr. μιαινω, *I infect*.) Infectious or contagious matter. The term is generally applied, under the name of *marsh miasma* (malaria of the Italians), to the infectious emanations from marshy lands and stagnant waters, which are peculiarly characterized by producing various forms of intermittent and remittent fevers.

MI'CA. (Lat. mico, *I shine*.) A mineral generally found in thin *elastic* laminæ, soft, smooth, and of various colours and degrees of transparency. Silica, alumina, potash, and oxide of iron are its principal components. It is one of the constituents of granite. In some parts of Siberia and elsewhere it forms an article of trade, often known under the name of *Muscovy glass*.

MI'CA SLATE. One of the lowest of the stratified rocks, composed of quartz and mica. *See* GEOLOGY.

MI'CHAELMAS. The feast of St. Michael the Archangel. It falls on the 29th of September, and is supposed to have been established towards the close of the fifth century; Brady says in 487. In England, Michaelmas is one of the regular periods for settling rents; and an old custom is still in use of having a roast goose to dinner on that day, probably because geese are at that period most plentiful, and in the highest perfection. (See *Brand's Pop. Antiq*.)

MI'CHAEL, SAINT. A French order of knighthood, instituted by Louis XI. in 1469, in honour of St. Michael, the supposed ancient protector of France. The motto of this order was "Immensi tremor oceani." It was at first and for some time after its institution in high repute; but under Catherine of Medicis, who lavished it indiscriminately, it came to be held of no account, from which state it never recovered.

MI'CROCOSM. (Gr. μικρος κοσμος, *little universe*.) Man has been called so by some fanciful writers on natural philosophy and metaphysics, by reason of a supposed correspondence between the different parts and qualities of his nature and those of the universe.

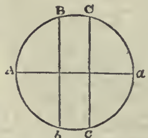
MICRODA'CTYLUS. (Gr. μικρος, and δακτυλος, *a digit*.) A name proposed by M. Geoffroy for the short-toed genus of wading birds called by Illiger *Dicholophus*. See that word.

MI'CRODON. (Gr. μικρος, and οδους, *a tooth*.) The name of a genus of extinct fishes, belonging to the thick-toothed or Pycnodont family, in the Ichthyological system of Agassiz.

MICRO'METER. (Gr. μικρος, and μετρον, *measure*.) An instrument applied to telescopes and microscopes for measuring very small distances, or the diameters of objects which subtend very small angles. A great number of contrivances of various kinds, and depending on different principles, have been employed for this purpose; but it will be sufficient to give a general description of some of the most useful or remarkable ones.

Wire Micrometer.—This instrument, when placed in the tube of a telescope, at the focus of the object glass, presents the appearance represented in the annexed figure (fig. 1.). A *a* is a spider's web line, or very fine wire fixed to the diaphragm; and B *b* and C *c* are similar wires stretched across two forks, each connected with a milled-headed screw. By means of these screws the two wires, B *b* and C *c*, which are exactly parallel to each other, are moveable in the direction perpendicular to A *a*; and, in order that the wire A *a* may be placed in any direction relatively to the meridian, there is an adjusting screw, which works into an interior toothed wheel, and turns the apparatus round in its own plane perpendicular to the axis of the telescope.

(1.)



The method of using the micrometer is as follows:—Suppose the object to be accomplished were the measurement of the *angle of position* and distance of two very close stars; the telescope being set and kept on the objects, the micrometer is turned by its adjusting screw until the spider line A *a* coincides with the line joining the two stars, or *threads* them both at the same moment. The milled heads of the screws, which carry the two moveable wires, are then turned until B *b* bisects one of the two stars, and C *c* bisects the other. The observation is now completed, and it only remains to ascertain the position and distance indicated by the micrometer. For the first of these purposes, the circumference of the micrometer is divided into degrees and minutes, and read by two verniers: this reading gives the position of A *a* in respect of the horizontal and vertical planes, and consequently the angle of position of the two stars. To find their distance, the head of the screw which carries one of the moveable wires, for instance C *c*, is turned until C *c* coincides with B *b*; and the number of revolutions, and parts of a revolution, required to effect the coincidence, gives the distance of the stars when the value of the *scale* of the micrometer is known; that is to say, when the number of seconds of space which correspond to one revolution of the screw is known. The screws must be made with great accuracy, and their heads are usually divided into 60 equal parts, representing seconds.

The value of the scale, or of a revolution of the screw, is obtained in the following manner:—Set the two wires, B *b* and C *c*, apart to a certain number of revolutions, and place them in the direction of the meridian. Observe the transits of several stars of known declination over the wires; then multiply each interval of seconds by 15, and by the cosine of the star's declination; and, taking the mean, you have the seconds of space which correspond to a known number of revolutions of the screw. (See Appendix, by the Rev. R. Sheepshanks, to *Professor De Morgan's Explanation of the Gnomonic Projection of the Sphere*.)

Circular Micrometer.—This instrument, which differs entirely from the above, was first suggested by Boscovich, in the *Leipzic Acts* for 1740, and used by Lacaille in observing a comet in 1742; but seems afterwards to have fallen into disuse, until it was revived by Dr. Olbers, about 1798. The principle may be explained as follows: If the field of a telescope be perfectly circular (which may be effected by means of a diaphragm turned in a lathe), and if its diameter be determined from observation, the paths of two celestial bodies across the field may be considered as two parallel chords, which are given in terms of a circle of known diameter. The differences of the times at which two stars arrive at the middle of their paths will be their ascensional differences; and the distance between the chords, which is readily computed

from their lengths, gives the difference of the declinations of the two bodies.

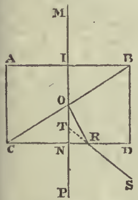
The most approved construction of the annular micrometer is that of the late Fraunhofer. It consists of a disc of parallel plate glass (fig. 2.), having in its centre a round hole of about half an inch in diameter, to the edges of which a ring of steel is cemented, and afterwards truly turned in a lathe. The disc being mounted in a brass tube, so that it may be accurately adjusted in the focus of the eye-piece, and applied to a telescope, the steel ring is alone visible, and appears as if suspended in the atmosphere, whence the instrument is called the *suspended annular micrometer*. The advantage of this construction consists in the accuracy with which the moment of ingress or egress is determined, from the body being seen in the field of view before it comes up to the edge of the steel ring. The annular micrometer is conveniently used for comparing the place of a small star or a comet with that of a known star in nearly the same parallel of declination. (*Astronomische Nachrichten*, b. iv.)

(2.)

Divided Object Glass, or Double Image Micrometer.— This instrument is formed by dividing the object glass of a telescope or microscope into two halves, the straight edges being ground smooth, so that they may easily slide by one another. A double image of an object in the field of view is produced by the separation of the segments; and, by bringing the opposite edges of the two images into contact, a measure of the diameter of the object is obtained in terms of the extent of the separation. From its being used to measure the diameter of the sun, this is usually called the *heliometer* (*see* HELIOMETER). Instead of a divided object glass, Ramsden preferred a divided lens in the eye-tube, which form of the instrument is called the *dioptric micrometer*. The double image micrometer was suggested by Roemer, about 1678; but first brought into use by Bouguer, about 1748.

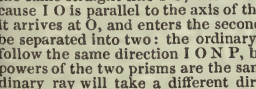
Micrometer by Double Refraction.— The Abbé Rochon conceived the ingenious idea of applying the principle of double refraction to micrometrical measurement. Conceive two prisms, A B C and B C D (fig. 3.), formed of the same crystal, and so disposed that the face A B of the first is perpendicular to the axis of the crystal, while, in the second, the axis is parallel to the line of the intersection of the two faces C B and C D, so that the axes of crystallization of the two prisms are at right angles to each other. The prisms are placed in perfect contact, and cemented by mastic; and together form a plate of which the opposite sides are parallel. Now, suppose a ray of light M I to fall perpendicularly on the face A B; it will proceed through the prism A C B, in the same straight line I O, without being separated, because I O is parallel to the axis of the crystal. But when it arrives at O, and enters the second prism B C D, it will be separated into two: the ordinary ray will continue to follow the same direction I O N P, because the refracting powers of the two prisms are the same; but the extraordinary ray will take a different direction O R (towards B D, if the crystal is attractive, as rock crystal; but towards A C, if the crystal is repulsive, as Iceland spar), and, on emerging from the prism at R, will be refracted in the line R S. The angle P T S of the inclination of the two rays after their emergence from the prism is constant for the same crystal, and must be determined by experiment.

(3.)



Let us now conceive this apparatus to be placed in the tube of a telescope, of which O (fig. 4.) is the object glass and F the focus, and the telescope directed upon a distant object at D (as a planet), the diameter of which, $m\ n$, is to be measured. Suppose the double prism at T′: two images will be formed; the ordinary image at a, and the extraordinary image at b'. By sliding the prisms along the tube towards O the distance between the images will be increased; and by sliding them towards the focus F, it will be diminished; and if placed exactly in the focus, the two images will coincide. Let V denote the visual angle or apparent magnitude of the object, f the focal distance F O of the telescope, U the constant angle a T b depending on the prism, and D the distance F T: we shall then have the diameter of the image $= f$ tan. V, and the distance $a\,b =$ D tan. U. Now, if the apparatus be slid along the tube from T′ to T, where the two images are in contact, then the diameter of the image will be equal to the distance $a\,b$; and we have, consequently, f tan. V = D tan. U. Here the quantities f and U are found by experiment; whence V, the angular magnitude of the object, becomes known in terms of D.

(4.)



The prism micrometer, when constructed in the manner now described, has this important defect, that the extraordinary image is accompanied by the prismatic colours, especially if the angle to be measured exceeds a few minutes; and hence Rochon found that he could not use it for measuring the diameters of the sun and moon. But this defect has been ingeniously remedied by M. Arago, by simply altering the arrangement of the apparatus, and giving the double prism a fixed position out of the tube and before the eye glass. By this disposition two images are formed at the focus, the centres of which are fixed points, whose distance depends on the refracting power of the crystal; and the contact of the images is produced by increasing or diminishing the magnifying power of the eye-glass, instead of altering the position of the prism. The magnifying power thus becomes the measure of the visual angle subtended by the diameter of the observed object.

Various modifications of the three principles now explained have been proposed; for details respecting which we refer to *Brewster's Treatise on New Philosophical Instruments*, or to the article "Micrometer," in the *Ency. Brit.*, by the same author; and to *Dr. Pearson's Introduction to Practical Astronomy*.

The micrometer is an instrument of the utmost importance in astronomy, and one, in fact, to which that science is as much indebted as to the telescope itself. From a paper by Mr. Townley, in the *Phil. Trans.* for 1667, it appears certain that a micrometer with a moveable wire was first constructed by our countryman Gascoigne about the year 1640, and used by him for measuring the diameters of the moon and some of the planets; but as Gascoigne, who was killed in the civil wars in 1644, published no account of his invention, the instrument was entirely forgotten, and the merit of reinventing it, and bringing it into general use, belongs to the French astronomer Azout, who published a description of it in 1667. Huygens, a few years previously, had contrived to measure the diameter of a planet by inserting in the tube of a telescope, at the focus of the object-glass and eye-glass, a slip of metal which covered exactly the image of the planet, and then deducing the diameter from the breadth of the slip, compared with the diameter of the field; and Malvasia had employed for the same purpose a reticle or network of fine silver wires, crossing each other at right angles, and dividing the field of the telescope into a number of equal squares. (For the history of the invention and successive improvements of the micrometer, see the notes by Mathieu to *Delambre's Histoire de l'Astronomie au* 18*me Siècle*, pp. 616. and 645.)

MI′CROPHONE. (Gr. *μικρος*, and *φωνη*, *a voice.*) An instrument for increasing the intensity of low sounds, by subjecting a more sonorous body than that which emits the sound to be affected by the vibrations of that body, and thereby also sounding itself.

MI′CROPYLE (Gr. *μικρος*, and *πυλη*, *a gate*), in Botany, is a perforation through the skin of a seed, over against the apex of the nucleus. It is what was the foramen or exostome of the ovule.

MI′CROSCOPE. (Gr. *μικρος*, and *σκοπεω*, *I view.*) An optical instrument which enables us to see and examine objects which are too minute to be seen by the naked eye. Microscopes are single or compound, according to the nature of their construction; a single microscope being one through which, whether it consists of a single lens or a combination of lenses, the object is viewed directly; and a compound microscope one in which two or more lenses are so arranged that an enlarged image of the object formed by one of them is magnified by the second, or by the others, if there are more than two, and seen as if it were the object itself.

Single Microscope.— This instrument is, for the most part, simply a lens or sphere of any transparent substance, which refracts the rays of light issuing from a small body placed in its focus, and gives them such a degree of convergency as is necessary for distinct vision. In order that the rays of light issuing from the several points of a very small body may produce a sensible impression on the retina of the eye, it is necessary that the object be brought very near the eye; but when this is done, the rays coming from its different points are so divergent as to produce only a confused image. Now, if a convex lens be interposed between the object and the eye, and so placed that its distance from the object is a little less than its focal distance, the diverging rays issuing from the object are refracted by the lens, and enter the eye placed behind it, either parallel, or so nearly parallel as to afford distinct vision. The object is then seen in the direction of the refracted rays, and at the distance at which it could be distinctly seen by the naked eye; and consequently magnified in the ratio of the distance of distinct vision to the focal distance of the lens. This

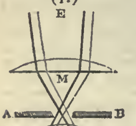
ratio is called the *magnifying power* of the lens; hence, for single microscopes, the magnifying power is equal to the distance at which a small object can be seen distinctly by the naked eye, divided by the focal distance of the lens; and, as the distance of distinct vision is constant (at least for the same individual), the magnifying power is inversely as the focal distance. If we suppose the distance which limits distinct vision, in respect of minute objects, to be 5 inches (which is about the average for good eyes), and the focal distance of the lens to be 1 inch, the object will be magnified 5 times in linear dimensions, and 25 times in superficial. If the focal distance is one tenth of an inch, the magnifying power will be 50 in linear extent, and 2500 in superficial.

A single microscope may be obtained very easily by piercing a small circular hole in a slip of metal, and introducing into it a drop of water, which will assume a spherical form on each side of the metal. The substance commonly used for microscopic lenses is plate glass; but they are sometimes formed of rock crystal, which is better. Flint glass, by reason of its great dispersive power, is unfitted for the purpose. The precious stones, as the garnet, ruby, sapphire, and diamond, have been proposed; but the numerous and skilful attempts of Mr. Varley and Mr. Pritchard have proved that the advantages arising from the greater refractive power of those substances are more than counterbalanced by their colour, reflective power, double refraction, and heterogeneous structure. The crystalline lenses of minnows and other small fishes give a very perfect image of minute objects.

When the object to be examined is of such magnitude as to subtend an angle of some degrees, the requisite distinctness cannot be given to its whole surface by an ordinary lens, in consequence of the confusion occasioned by the lateral rays; unless, indeed, the rays are only permitted to enter the lens through a very small aperture, whereby the quantity of light is greatly diminished. In order to remedy this inconvenience, Dr. Wollaston contrived a form of lens, to which he gave the name of *periscopic lens*. Its construction is as follows: — two plano-convex lenses or hemispheres are ground to the same radius, and between their plane surfaces a thin plate of metal, with a circular aperture, is introduced. The aperture which appeared to give the most distinct image was about 1-5th of the focal length in diameter; and, when the aperture was well centered, the visible field was as much as 20° in diameter. A lens of this kind possesses the double advantage of having a very short focal distance, and very little spherical aberration. Dr. Wollaston's contrivance may, however, be improved upon in various ways; for example, by filling up the central aperture with a cement of the same refractive power as the lenses, whereby the loss of light from the double number of surfaces is avoided; or by grinding away the equatorial parts of a sphere of glass, so as to leave a deep groove all round it, in the plane of a great circle perpendicular to the axis of vision, and filling the groove with opake matter. This last construction is called the *Coddington lens* (from the name of its proposer); and when executed in garnet, and used in homogeneous light, it is considered by Sir David Brewster to be the most perfect of all lenses, either for single microscopes, or the object lenses of compound ones.

In using a single lens as a magnifier, it is always necessary that the light be made to pass through a very small aperture, in order that the object may be seen distinctly and without distortion. This necessity arises, both from the spherical aberration and the chromatic dispersion of the light falling on the surface of the lens under an angle of considerable obliquity; and the consequence is that the quantity of light admitted to the eye is so much diminished that the object cannot be clearly seen. To remedy this inconvenience, Dr. Wollaston proposed a combination of two lenses, called, in consequence, *a microscopic doublet*, the optical part of which may be described as follows: — M and N (fig. 1.) are two plano-convex lenses, whose focal lengths are in the ratio of 3 to 1, or nearly so, and placed one over the other, so that their plane sides are towards the object. The adjustment of the distance between the lenses is best accomplished by trial; and they must, accordingly, be mounted so that the distance can be varied at pleasure. A B is a diaphragm or stop for limiting the aperture. Though it does not appear that the stop was contemplated by Dr. Wollaston, who makes no allusion to it, the performance of the microscope depends much on its nice adjustment. It is obvious that as each of the pencils of light from the extremities of the object is rendered eccentric by the stop, and made to pass through the two lenses on opposite sides of the common axis, they are affected by opposite errors, which, in some degree, serve to counteract each other. This doublet, when correctly made, is infinitely superior to any single lens, and will transmit a pencil of from 35° to 50° without any very sensible errors. The original description, by Dr. Wollaston, is given in the *Philosophical Transactions* for 1829.

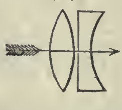
(1.)



The above construction has been improved upon by subtituting two plano-convex lenses for N in the doublet, the plane side of the one being in contact with the convex side of the other, and the stop being retained between them and the third. This combination is called a *triplet*; and its advantage is, that the errors of the doublet are still further reduced by the greater approximation to the object, in consequence of which the refractions take place nearer the axis.

Another form of doublet, proposed by Sir John Herschel, is represented in the annexed figure (2). It consists of a double convex lens, whose radii of curvature are as 1 to 6; and of a plano-concave, whose focal length is to that of the other as 13 to 5, placed in contact with the flatter surface of the former, and having its concavity turned towards the object. Many other combinations have been proposed, but those which have now been described appear to be the most useful.

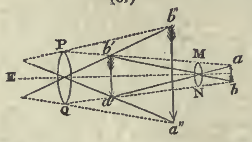
(2.)



When the magnifying power of the lens is considerable, and consequently its focal distance very small, it requires to be placed at the proper distance from the object with great precision; and, as it cannot be held in the hand with sufficient steadiness for any length of time, it requires to be mounted in a frame having a rack and screw, by means of which its distance from the object can be adjusted with accuracy. Mirrors for collecting the light and throwing it upon the object are also necessary for many purposes.

Compound Microscope. — The simplest kind of compound microscope is formed by the combination of two converging lenses, whose axes are placed in the same straight line. The arrangement of the lenses, and the path of the rays, will be readily understood from the annexed diagram (fig. 3.) M N is the object glass, which has a very short focal distance, and P Q the eye-glass. A small object $a\,b$ being placed before the object-glass, a little farther from it than the focus of parallel rays, a reversed and enlarged image $a'\,b'$ will be formed at some distance behind M N. The lens P Q is placed at such a distance from M N that its principal focus is in the line at $a'\,b'$; consequently the rays of light from every point of the image $a'\,b'$ emerge nearly parallel from P Q, and to the eye at E the image $a'\,b'$ is magnified, as if it were a real object, into $a''\,b''$, and appears at a distance equal to the limits of distinct vision, which, as stated above, is about 5 inches.

(3.)



The magnifying power of this microscope, or the ratio of $a''\,b''$ to $a\,b$, is found as follows: — In the first place, if we assume d to denote the distance of the first image $a'\,b'$ from M N, and f the distance of $a\,b$ from M N, or the focal distance of M N, we have this proportion, $a'\,b' : a\,b :: d : f$. In the second place, if l denote the limit of distinct vision, or distance of the second image $a''\,b''$ from P Q, and f' the focal distance of P Q (or distance of $a'\,b'$ from P Q), we shall also have $a''\,b'' : a'\,b' :: l : f'$. These two proportions, being multiplied together, give $\dfrac{a''\,b''}{a\ \ b} = \dfrac{d \cdot l}{f \cdot f'}$; which, therefore, is the magnifying power of the microscope. It thus appears that the magnifying power is inversely as the product of the focal distances of the two lenses, and directly as the distance between them. The magnifying power will therefore be increased by increasing the distance between the object-glass and eye-glass; but a limit is soon placed to this increase by the indistinctness of the image, and, in practice, it is not advisable to make the distance of $a'\,b'$ from M N more than from 5 to 7 inches. Suppose the focal distance of M N to be $\frac{1}{4}$th of an inch, and the distance of $a'\,b'$ from M N to be 5 inches, then $a'\,b'$ will be 20 times greater than $a\,b$; and if the focal distance of P Q be half an inch, and the distance of $a''\,b''$ from P Q be 5 inches, then $a''\,b''$ will be 10 times greater than $a'\,b'$, and, consequently, 200 times greater than $a\,b$; or the magnifying power is 200.

The great defects of the microscope, when constructed in the manner now described, consist in the smallness of the field of view, and want of achromatism in the object-glass, in consequence of which the images $a'\,b'$ and $a''\,b''$ are fringed with the prismatic colours. For the sake of enlarging the field of view, a third lens, larger than either

of the others, and called the field glass, is usually interposed between the image $a' b'$ and the object-glass.

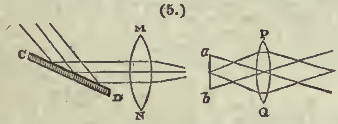
Reflecting Microscope.—The principle of the reflecting microscope is very simple, and easily conceived. Suppose M N (fig. 4.) to be a concave speculum, and a small object to be placed before it at *f*. A reflected image of the object will be formed at F, where the rays issuing from each point of the object intersect each other, and magnified in the proportion of F M to *f* M. If the image at F is viewed with the naked eye, the instrument is a single reflecting microscope; but if the image is viewed through a refracting lens P Q (or a combination of lenses forming an eye-piece), by which the rays are made to converge towards the eye at E, it becomes a compound reflecting microscope.

(4.)

The reflecting microscope was first proposed by Sir Isaac Newton in the form now described; but, on account of the impracticability of illuminating the object, it was long disused. It has, however, been recently revived, under a modified form, by Professor Amici of Modena, who places the object outside the tube of the microscope, below the line N F; and, in order that an image may be formed in the speculum, the rays issuing from the object fall upon a small plane mirror placed at *f*, inclined to the axis of the speculum in an angle of 45°, whereby they are thrown upon the speculum in the same manner as if the object itself were placed at *f*. By this means the object can be illuminated with perfect facility. The concave speculum M N is ground into an ellipsoidal surface; the diagonal mirror is placed at the nearest focus *f*, and the image is consequently formed at the other focus F. The image at F is viewed with a single or double eye-piece, as in other microscopes.

Solar and Oxyhydrogen Microscopes. — The solar microscope is composed essentially of a mirror and two converging lenses. The plane metallic mirror, C D (fig. 5.), reflects the sun's rays upon the lens M N, by

(5.)



which they are concentrated upon the object *a b* placed in its focus. The object, being thus strongly illuminated, is placed before a second lens P Q (a little before the principal focus), by which the rays are rendered still more convergent, and produce a magnified image of the object upon a screen suitably placed at a distance of some feet behind the lens. The object is here supposed to be transparent; if opake, the light must be thrown upon it in such a manner as to be reflected by it to P Q. The mirror and lens M N are placed in the hole of a window shutter in a darkened room; and the mirror must be moveable, in order that the sun's rays may always fall upon it under a proper angle to be reflected to the lenses. But the solar microscope is now almost entirelysuperseded by the *oxyhydrogen microscope;* so called because the illumination, instead of being produced by the sun's rays, is produced by burning a small piece of lime or marble in a stream of oxyhydrogen gas. In this case the plane mirror C D becomes unnecessary; and instead of the lens M N a concave speculum is employed, in front of which the ball of lime is placed, and an intense light thus thrown upon the object *a b*, the rays from which are brought to foci upon the screen by the lens P Q. For full details respecting the management of this apparatus, which forms a very popular exhibition, the reader is referred to *Goring and Pritchard's Micographia*. For descriptions of the various kinds of microscopes, see *Brewster's Treatise on New Philosophical Instruments;* or the *Ency. Brit.*, art. "Microscope."

MI'DDLE AGES. (In French, *moyen age*.) A term usually employed to denote, somewhat vaguely, a space of several centuries in European annals, intervening between what are called the ancient and modern periods of history. The centuries between the ninth or tenth and the end of the fifteenth after Christ are generally comprehended under this loose denomination. In the work of Mr. Hallam on the *Middle Ages*, that historian has assumed as his period of commencement the conquest of Gaul by the Franks, about A. D. 500; and, for his conclusion, the invasion of Italy by Charles VIII., about 1500; and with reference to the affairs of the Greeks and their oriental neighbours, he places, as the most convenient limit between ancient and modern history, the era of Mohammed.

MI'DDLE CADENCE. In Music. *See* CADENCE.

MI'DDLE LATITUDE SAILING, in Navigation, is a method of converting the departure (or distance on the parallel) into difference of longitude, and the difference of longitude into departure, when the ship's course is oblique to the meridian. It is founded on this principle, which, however, is only approximately true in any case, and not even approximately in high latitudes, when there is also considerable difference between the latitudes left and arrived at; namely, that the departure may be accounted an arc of a parallel of latitude midway between the two extreme latitudes. Its rules are,—

radius : cos. middl. lat. : : diff. longitude : departure,
cos. middl. lat. : tan. course : : diff. lat. : diff. long.

See NAVIGATION.

MI'DDLE RAIL. In Architecture, the rail of a door level with the hand, on which the lock is usually fixed.

MI'DDLE TERM of a Categorical Syllogism, in Logic, is that with which the two extremes of the conclusion are separately compared. *See* SYLLOGISM.

MI'DSHIPMAN. In the Navy, the step next above volunteer of the first class, which is generally the commencement. At nineteen years of age the midshipman passes one examination in seamanship, and another in navigation, when he becomes eligible for a lieutenant's commission.

MIDSHIPS. The middle of the ship, with reference to length or breadth.

MI'EMITE. A magnesian carbonate of lime of a green colour from Miemo, in Tuscany.

MIGRA'TION. (Lat. migro, *I migrate.*) This word is used in Zoology to signify the transit of a species of animals from one locality or latitude to another. The passage is usually to and fro between a temperate and a cold climate, or a temperate and a warm climate; and this periodical change of abode is most general in the arctic species of animals, and least prevalent in the tropical species. The most remarkable, rapid, and extensive migrations are performed by birds, in virtue of their preeminent locomotive powers, and of their ability to maintain a long and rapid flight through a medium which offers the least opposition to their progress. The inequalities and alternations of land and water upon the surface of the earth, and the presence of enemies and other dangers, would appear to form insurmountable obstacles to any general or extensive migration of quadrupeds; yet the musk-ox, the rein-deer, the arctic fox, &c., are driven southward by the rigours of the polar winter, and return to the extreme latitudes in the summer season. Less regular, but not less general migrations, take place among the quadrupeds which range the tropical continents in seasons of unusual drought. Countless herds of oxen, goaded by intolerable thirst, are thus impelled in an irresistible course over vast tracts of the South American Pampas in quest of water. The valleys of the warmer parts of Africa are occasionally traversed by numerous assemblages of the wild quadrupeds of that continent, migrating under the same stimulus. Lions and other carnivora have on these occasions been seen mingled with, and absolutely hemmed in by, the countless assemblage of antelopes, gnus, and other herbivorous species which constitute their prey. The Scandinavian lemming, however, is the species of quadruped that is most remarkable for its migration. But the migratory periods are not regular; nor are the immense bodies that travel in a given direction ever known to return. In this respect the migration of the lemmings resembles rather that of the locusts among insects than the true and regular migration of birds. The ordinary residence and breeding-place of the lemmings appear to be the shores of the arctic ocean. Here, when their numbers exceed the means of subsistence, they congregate together, and commence a migratory course southward, moving in a straight line, crossing rivers, climbing mountains; and while no insurmountable obstacle impedes their progress, they devastate the country through which they pass. The migration of birds appears to be influenced mainly by the necessity of providing sufficient food for their young, and by the temporary continuance of such food in the climates best suited for propagation.

The arctic and northern seas, which teem with life during the long unbroken day that constitutes the summer season of such latitudes, are resorted to by numerous aquatic birds during the breeding season; and these birds regularly migrate southward when the severities of winter set in. In temperate latitudes, as those of England, certain spring and summer months are peculiarly favourable to the production of insects in their different stages; and our island is accordingly frequented by many insectivorous birds, which leave warmer latitudes during these months to breed and rear their young with us. As a general rule, it may be stated that birds migrate southward in the northern hemisphere for food principally; but that they migrate northward both to feed and breed. The most remarkable summer immigrants that visit England from the south and breed in this island are the swifts, swallows, cuckoo, nightingale, and many other insectivorous Passerine birds; and it is remarkable that the males of the song birds always precede the other sex in their vernal flight.

The winter immigrants from the north are the species of wild swan; many species of wild duck; the smews, merganser, and other aquatic birds; the woodcock, &c. It occasionally happens that a winter immigrant remains with us the whole summer, and breeds. Thus the woodcock's eggs and young have occasionally been taken in our woods; but this is an exceptional or individual case. It is a rare occurrence when a summer immigrant prolongs its sojourn into the winter months, as happens when by late hatching, or debility produced by accident or disease, a swallow or martin has been prevented from joining the main body of autumnal emigrants of its own species, and is seen flying about when an unusually mild day may have called some insects abroad in the months of November or December.

The season of migration is that of association, both in birds and other animals. The swifts congregate for their departure about the middle of August; the swallows assemble together for the same purpose in September. Their powers of flight are more than equivalent to the extent of space they have to traverse to reach the warmer latitudes, as the Mediterranean shores of Africa, where they have been seen in those months when they have disappeared from us. Yet there have not been wanting naturalists who have believed that the life of the swallow was maintained during the absence of its insect food in England by the same torpidity which enables the bat and hedgehog to exist through the winter, and resume their vital functions in spring. The burrows of the sand-martin have been explored in winter with this view; but neither there nor in any other hiding-place has a torpid martin or swift been ever found. It was next conjectured that these birds went under water in autumn, and passed the winter not only torpid, but submerged. The supporters of this theory, however, have neither explained how the difference of specific gravity which makes the body of a swallow float upon water was overcome, nor how the extravascular plumage was preserved undecomposed and fit for use after six months' soaking in water.

The short migrations of the cuckoo and nightingale are unquestionable: why should the longer migrations of summer-breeding birds of greater powers of flight be doubted? The direct observation of swallows in the act of migrating, and the slowly acquired but certain knowledge of their winter resort, have finally put to rest the scepticism as to the migration of the swallow tribe, which only the authority of such eminent naturalists as White of Selborne could have so long rendered excusable in works of Zoology.

MI'LDEW. This term is generally applied to a particular mouldy appearance on the leaves of plants, which is produced by innumerable minute fungi, which, if not checked in their growth, will occasion the decay and death of the parts on which they grow, and sometimes of the entire plant. In agriculture, this appearance is frequently termed rust, and sometimes blight. It is common on wheat, and on the hop; and in gardens on the leaves of the peach, the nectarine, and other fruit trees. The causes favourable to the production of mildew are a rich soil and a moist atmosphere, without a free circulation of air or sunshine. In agriculture, this parasitical disease is generally considered without remedy; but, in gardening, it may be checked by the application of powdered sulphur to the leaves covered by the fungi, which is found to destroy them without greatly injuring the leaf. Dry-rot is only mildew of a more formidable kind.

MILE. (Lat. mille passuum, *a thousand paces.*) The Roman pace being 5 feet, and a Roman foot being equal to 11·62 modern English inches, it follows that the ancient Roman mile was equivalent to 1614 English yards, or very nearly 11-12ths of an English statute mile.

The English statute mile was defined (incidentally, it would seem) by an act passed in the 35th year of the reign of Queen Elizabeth, by which persons were forbidden to build within three *miles* of London; and the mile was declared to be 8 furlongs of 40 perches of 16½ feet each. The statute mile is, therefore, 1760 yards, or 5280 feet. *See* MEASURES.

The mile is used as an itinerary measure in almost all countries of Europe, particularly those which were formerly under the sway of the Romans; but it is very difficult to conjecture the causes which have given rise to the great diversity of its values. It has been supposed that in some countries the Roman mile was confounded with the ancient Celtic league.

The following table, given on the authority of *Kelly's Cambist*, shows the length of the modern mile, and also the league, of various countries, and their relation to the English statute mile.

	Yds.	Stat. Miles.
Modern Roman mile	1628	·925
English statute mile	1760	1·000
Tuscan mile	1808	1·027
Ancient Scottish mile	1984	1·127
Irish mile	2240	1·273
French posting league	4263	2·422
Spanish judicial league	4635	2·634
Portugal league	6760	3·841
German short mile	6859	3·897
Flanders league	6864	3·900
Spanish common league	7416	4·214
Prussian mile	8237	4·680
Danish mile	8244	4·684
Dantzic mile	8475	4·815
Hungarian mile	9113	5·178
Swiss mile	9153	5·201
German long mile	10126	5·753
Hanoverian mile	11559	6·568
Swedish mile	11700	6·648

According to the same authority, the Arabian mile is 2148 yards, the Persian parasang 6086 yards, the Russian werst 1167 yards, and the Turkish berri 1826 yards. The English geographical mile is 1-60th of a degree of latitude, or about 2025 yards; the geographical league of England and France is 3 such miles, or 6075 yards; and the German geographical mile is equal to 4 English geographical miles, or 8100 yards. See an excellent disquisition on the history of the English mile in the *Penny Cyclopædia*.

MILIA'RIA. (Lat. milium, *millet seed.*) A disease attended by an eruption resembling millet seed. Miliary fever.

MILIEU (JUSTE)—PARTY OF THE. A French party nickname, arising, it is said, out of a casual expression of King Louis Philippe, but which has obtained a notoriety rather greater than such ephemeral phrases usually acquire. It has served to denote the great party opposed to the Carlists, or Legitimists, on the one hand; and to the extreme left section of the Chamber of Deputies, with its allies the Republicans, on the other. After the overthrow of the feeble ministry of Lafitte in March, 1831, Casimir Périer was authorized to form a new cabinet; and his administration seems to have realized more than any other the ideal of a government of the Juste Milieu. Under its rule the hereditary peerage was abolished; the continual street disturbances which had almost controlled the will of the previous ministry quelled; Ancona seized; and the foundation of the successful intervention of France in the Hollando-Belgic quarrel laid. Périer died of cholera on the 16th of May, 1832. After a short interval he was succeeded by Soult; who has been perhaps, since that time, more identified with the Juste Milieu party than any other minister: Molé, Guizot, Dupin, Thiers, Barrot, the most eminent statesmen of France, having each of them adopted a line and formed to a certain extent a party of his own, alternately aided and opposed by the great body of the partisans of the Juste Milieu.

MILI'OLA. (Lat. milium, *a millet-seed.*) The generic name applied by Lamarck to an extinct mollusk, or zoophyte, which has left its small forameniferous multilocular shell in great numbers in the strata of many quarries in the neighbourhood of Paris.

MILI'TIA. A body composed of citizens regularly enrolled, and trained to the exercises of war; but not permanently organized in time of peace, or, in general, liable to serve out of the country in time of war. Such an establishment exists in most European countries under different names. (*See* GUARD, NATIONAL.) In Austria and Prussia it is called landwehr; and in the latter country receives full pay during a certain part of every year when it is in exercise. Various and unsuccessful efforts were made by German sovereigns, during the wars of the last century, to organize bodies of troops which should be as cheaply raised as militia, and yet be serviceable in foreign war. Frederick the Great used such troops for garrison service. The militia of England and Scotland now consists of a certain number of men in every county, drawn by lot to serve for five years, and liable to be called out and embodied, on danger of rebellion or invasion, by proclamation of the king in council, and with notification to parliament, if that body is sitting. During the late war, the militia was kept constantly on foot and might be sent to any part of the kingdom; so that it differed little from the regular army, except that it could not be sent abroad, and that it was recruited by ballot. But, in addition to the above, a militia called local, or fencibles, in many instances raised and supported entirely at the expense of some great landed proprietor, was established in every county. After the peace of 1815 the militia was disembodied; but, as we remarked above, it is still liable, if it be considered necessary, to be called out. In Prussia every man who has served his three years, or a single year in certain cases, of lawful service in the standing army, belongs to the first class of the landwehr until his thirtieth year; and from that time until his fortieth to the second class.

MILK. (Germ. milch.) A fluid secreted by peculiar glands in the breasts of the class of animals called *Mammalia*, and destined for the nourishment of their young.

The obvious components of milk are cream, curd, and

whey, — 1000 parts of cream (of cow's milk), of the sp. gr. 10244, consist, according to Berzelius, of

Butter	45
Curd	35
Whey	920
	1000

The remaining skimmed milk has a specific gravity of about 1033, and consists of

Water	929
Curd with a trace of butter	28
Sugar of milk	35
Lactic acid, lactate of potash, and a trace of lactate of iron	6
Muriate and phosphate of potash and earthy phosphates	2
	1000

If we subtract the curd, the remaining substances constitute whey. The *curd* of milk, or *caseous matter*, partakes in many of its chemical properties of the nature of albumen; in others it resembles vegetable gluten, more especially in the fermentation which it undergoes when kept in a moist state. *Sugar of milk* is obtained by evaporating whey. When purified it has a sweet taste, and requires 7 of cold and 4 of boiling water for solution, and is insoluble in alcohol: when digested with nitric acid it is partially converted into mucous, or *saccholactic acid*, and not, like common sugar, into oxalic acid. This, therefore, though an animal product, closely resembles the vegetable proximate principles; and milk may hence be considered as partaking of the nature of vegetable as well as animal food. *See* Dairy.

MILK FEVER. *See* Puerperal Fever.

MILK TREE, so called from its trunk yielding a milky fluid when wounded, is a name applied more particularly to those species in which the fluid is harmless and fit for food; an uncommon circumstance among lactescent plants, whose secretions are generally dangerous. In the Caraccas there is one sort, the *palo de vaca*, or cow tree of Humboldt, whose milk is a common article of diet among the natives; this is the *Galactodendron utile*. In that and other countries, plants of the Sapotaceous order, especially species of Achoas, also furnish such a secretion. In Ceylon has been found the Kiriaguni plant, or *Tabernæmontana utilis*, which is used by the Cingalese in a similar manner.

MILK VESSELS, in Plants, are the anastomosing tubes lying in the bark, or near the surface of plants, in which a white turbid fluid is secreted. They are one of the forms of the *vital veins* of Schultz, which see.

MI'LKY WAY, or VIA LACTEA, or GALAXY. A broad and irregular zone of stars that surround the heavens, so distant that their united light gives but an indistinct and undefined whitishness to the whole appearance — whence its name. *See* Galaxy.

MILL. (Gr. *μυλη*; Lat. mola.) This term seems to have signified originally an engine for grinding corn, but it is now used in a general sense to denote a great variety of machines, whose action depends chiefly on circular motion. The particular purpose is usually indicated by a prefix; thus, bark-mill, cotton-mill, flour-mill, oil-mill, saw-mill, spinning-mill, &c.

The machinery by which it is necessary to accomplish the ultimate objects of the mill must obviously vary almost indefinitely. Many voluminous works on this subject have been published, as well as separate accounts of particular structures. See Brewster's edition of *Ferguson's Lectures*; *Gray's Experienced Millwright*; *Buchanan on Millwork*, by Tredgold; *Banks on Mills*; *The Repository of Arts*, &c. A catalogue of the principal works on the subject of mills is given in *Gregory's Mechanics*, vol. ii.

MILL, BARKER'S. *See* Centrifugal Machine.

MILLE'NNIUM. (Lat. mille anni, *a thousand years*.) The reign of Christ with his saints upon earth for the space of a thousand years; an idea derived from a passage in the 20th chap. of the Apocalypse, and not uncommonly entertained by Christians in all ages, but especially in the times of the primitive church. The opinion seems to be traced as far back as to Papias, a father of the second century. It is the subject of much discussion among the writers of that and the succeeding ages; was maintained by Justin Martyr, Irenæus, Tertullian, and many others, and powerfully refuted by Origen. (See the work of *Alstedius*, translated by Bruton, 1643; *Gibbon*, ch. xv., with Milman's notes; Bertholdt, *Christologia Judæorum*; Eisenmenger, *Das Entdeckte Judenthum*; *Lightfoot*; *Mosheim*, vol. i.)

MI'LLEPORES, *Millepora*. (Lat. mille, *a thousand*, porus, *a pore*.) A tribe of Lithophytous Polypes, including those in which the calcareous axis is perforated by extremely numerous pores.

MI'LLET. (Lat. milium; Fr. millet.) A plant classed by botanists among the grasses, though some of its species attain a height of from 16 to 20 feet in favourable situations. There are many species of this plant; of which the principal are the Polish, the common or German, and the Indian millet. In several parts of Europe it is cultivated as a grain, and is sometimes employed as a substitute for rice or sago by the poorer classes, but more frequently it is used for feeding chickens and domestic animals. It is cultivated to a considerable extent in France, Switzerland, Southern Germany, and most extensively in Egypt, Syria, Nubia, China, and Hindostan; but the climate of England is not sufficiently dry and warm to allow of its being cultivated here.

MI'LLION. A thousand thousand, or, as often defined, ten hundred thousand. *See* Numeration.

MILLSTONE GRIT. A geological term applied to a group of strata which occur between the mountain limestone and the superincumbent coal formations; it is a coarse-grained quartzose sandstone.

MI'LVINES, *Milvini*. A family of Raptorial birds, of which the kite (*Milvus*) is the type.

MIME. (Lat. mimus; Gr. *μιμος*, from *μιμεομαι*, *I imitate*.) The name given by the ancient Greeks and Romans at once to a species of dramatic entertainment, and to the authors and actors by whom it was respectively composed and performed. It consisted chiefly of a rude representation of common life, and resembled the modern farce or vaudeville in its character and accompaniments. Sophron of Syracuse, who lived about 400 years before the Christian era, is considered the inventor of this species of composition. His pieces were read even with pleasure by Plato, who is said to have introduced this kind of dramatic entertainment into Athens. (The *Museum Criticum*, No. 7., contains several fragments of mimes by Sophron.) At what period mimography was first practised at Rome cannot be precisely ascertained; but in the time of the emperors, and even under Augustus, this species of entertainment had attained a high degree of popularity. Among the Romans, it was of a still more farcical character than among the Greeks, from whom it was borrowed, and bordered more upon such mountebank representations as *Punch and Judy* among ourselves, and the *Fantoccini* of the Italians. Mimes originally formed a part of the usual theatrical exhibitions; but they were soon introduced by the wealthy Romans into their private entertainments to divert their guests. At Rome they also held a prominent place at funerals, on which occasions their duty consisted in praising the virtues and exposing the defects of the deceased. It is, however, very probable that less licence of caricature was then admissible; but the highest rank was not exempt from the practice. Thus, Suetonius tells us that the archmime Favo was present at the funeral of Vespasian: — "Sedet in funere Favo archimimus, personam ejus ferens, imitansque, ut mos est, facta et dicta vivi."

MI'MUS. (Lat. *a mimic*.) A genus of Passerine birds, separated by Boié from the thrushes (*Turdus* of Linnæus) on account of the more elongated form of the body, and particularly of the tail, the shorter wings, and more curved upper mandible. The type of this genus is the celebrated mocking-bird. See that word.

MI'NA. (Gr. Μνᾶ.) A weight and coin in use among the Greeks, but which was different in different states. The Attic mina, which is that most frequently mentioned, was heavier than the Roman pound by about four drachmæ. Each mina contained 100 drachmæ, and was itself contained 60 times in an Attic talent. The coin was worth a little more than 3*l*. of our money.

MI'NARET. (Arab. menarah, *a lantern*.) A slender and lofty turret in the mosques of Mohammedan countries, used for the purpose of summoning the people to prayers, and consequently answering the purpose of the belfry in Christian churches. They are usually surrounded with projecting balconies, and are crowned with spires surmounted by a crescent. Before the hour of prayer the criers of the mosques ascend the minarets, whence they summon the people to prayers with the words, "Come, ye people, to the place of rest and integrity; come to the asylum of safety."

MINDERE'RUS'S SPIRIT. Solution of acetate of ammonia, first recommended as a febrifuge by Raymond Mindererus, a physician of Augsburg.

MINE. The name given generally to every system of subterraneous work or excavation which has for its object the discovery and extraction of the metallic ores or other mineral produce. But, in addition to the underground works which constitute the mine properly so called, the term usually comprehends also the ground on the surface, together with the numerous appendages which are required there; as steam-engines, water-wheels, and other machinery for drainage, the extraction of the ores, and their mechanical preparation, with various buildings and erections. The subject of mines is one of the most important within the whole range of human knowledge: their contents constitute the main-springs of civilization; and the means employed to obtain them are to be ranked among the most extraordinary instances of human enter-

prise, patience, and ingenuity. The art of mining has been practised from the earliest antiquity, and has formed a branch of industry to the most barbarous as well as the most civilized communities. It is true that we can scarcely dignify by the name of mining the operation by which the savage merely collects grains of gold in the sands of rivers, or extracts it by pounding, when mechanically combined with other substances; but even this simple operation becomes interesting, when viewed as the first link in the chain of those elaborate and scientific processes now employed in the extraction of metallic and other mineral substances from the bowels of the earth. In England, mining had a very early origin, compared with the progress of other arts in the country. It was, in all probability, the first source of trade to these islands; and so celebrated was British tin over the whole of the then known world, that the Phœnicians traded to Cornwall for this metal. At that early period, however, and indeed for centuries afterwards, the art of mining was necessarily in a comparatively rude and imperfect state, arising from the want of an effective means of drainage and of blasting implements; and it was not until hydraulic machines were applied to raise the waters which accumulated in mines of every description that metals could be followed to any considerable depth, and not until gunpowder had furnished the means of splitting the hardest rock that the miner was enabled to surmount the obstacles which the most indurated strata opposed to his progress. These inventions, therefore, may be regarded as most important epochs in the history of mining: but the *present* comparatively perfect state of the art is mainly owing to the invention of the *steam engine* and the improved manufacture of iron, which took place in the latter part of last century. The former gave to the miner a power capable of universal application, and of an effect that added, as it were, new regions of subterranean country to his control; while the latter has proved no less important in contributing to the same result, by the improved machinery and apparatus it has placed within his reach.

The art of mining embraces such an infinity of topics and processes, differing from each other in proportion to the difference of the locality of the lodes, the habits of the population, and the character and the resources of the country in which it is practised, many of which, besides, are of so abstruse and complicated a nature as to be utterly unintelligible without the most lengthened details, and the introduction of numerous diagrams that would have been foreign to the object of this work, that we shall refrain from entering upon a subject which it would be impossible for us to treat satisfactorily in this place. We must therefore refer the reader to *Ure's Dict. of Arts, &c.*, which contains full details upon the numerous processes connected with this most important art, and content ourselves with subjoining the following tables: the one made up from the *Geo. Dict.*, containing an estimate of the mineral produce of Great Britain on an average of years and prices; the other being a Comparative Table of celebrated Mines in Europe and America, which we have borrowed from the *Quarterly Mining Review* for July, 1835, p. 60. (The various mining terms, as *shaft*, *lode*, &c., will be found defined under their respective heads; and the different metallurgical processes explained under the separate metals.)

Estimate of the Mineral Produce of Great Britain, on an Average of Years and Prices.

	Quantity.	Value.
Silver	10,000 lbs. troy	£30,000
Copper	13,000 tons	1,300,000
Tin	5,500	550,000
Lead	46,000	950,000
Iron	1,250,000	10,000,000
Coal	32,000,000	12,000,000
Salt, alum, and other minor produce more than		1,000,000
Total value probably exceeds		£25,830,000

COMPARATIVE TABLE of celebrated Mines in Europe and America. By J. Burt, Esq.

	CONSOLIDATED AND UNITED MINES. (At present the richest mines in Cornwall.)	VETA GRANDE MINES. (At present the richest mines in Mexico.)	MINE OF VALENCIANA. (Richest of the Mexican mines at the beginning of the present century.	MINE OF HIMMELSFURST. (Richest of the Saxon mines at the beginning of the present century.
Situation	Two miles east of Redruth.	Four miles north of Zacatecas.	One mile north of Guanaxuato.	Two miles south-east of Freyberg.
Elevation	Elevation of the surface above the level of the sea, from 200 to 300 ft. Depth of the bottom of the mine below the level of the sea, about 1370 feet.	Elevation of the surface above the level of the sea, supposed to be about 6000 feet. Elevation of the bottom of the mine above the level of the sea, probably near 5000 feet.	Elevation of the surface above the level of the sea, 7617 feet. Elevation of the bottom of the mine above the level of the sea, 5730 feet.	Elevation of the surface above the level of the sea, 1346 feet. Elevation of the bottom of the mine above the level of the sea, 263 feet.
Nature of the rock	Primary clay slate resting immediately on granite, a short distance westward of the mines. The clay slate is intersected by numerous channels of porphyry, which have nearly the same direction as the mineral veins, and are often of considerable width. The porphyry sometimes appears also to form large irregular masses in the clay slate. Both rocks are traversed by veins of quartz and clay intersecting the metalliferous veins.	Transition clay slate, alternating with dolomite, and occasionally with greywacké. This clay slate is sometimes decomposed; it rests on syenitic rocks, and is in some places covered with porphyry.	The *Veta Madre* of Guanaxuato, upon which this mine is worked, traverses both clay slate and porphyry, but it is most productive in the former rock. The clay slate is considered by Humboldt to belong to the transition class, but situate near the limits of primary formations. This rock in depth passes into chlorite slate, and talc slate. It contains subordinate beds of syenite, hornblende slate, and serpentine. The porphyry rests upon the clay slate, and is conformable to it, both in direction and stratification.	The rock prevailing in the neighbourhood of Freyberg, in which this and most of the other mines are situate, is a formation of primary gneiss.
Nature of the metalliferous deposits	In the consolidated mines, the eight following lodes are extensively worked:—Wheal Fortune lode, Cusvea lode, Deeble's lode, Old lode, Taylor's lode, Tregonning's lode, Martin's lode, and Glover's lode. In the united mines, the principal workings are upon the Old lode, and about five or six others are more or less productive. Numerous smaller lodes or "branches" occur also in both mines. The principal lodes are from 2 or 3 to 7 or 8 feet wide; the "branches" are generally 12 or 18 inches wide. The direction of the lodes varies from nearly east and west to about 20 degrees north of east and south of west. The underlie of the principal lodes is from 2 to 3 feet per fathom north, that of the smaller ones about the same south.	One principal vein (the *Veta Grande*), which is generally separated into 3 branches, and sometimes into four. When ramified, the width extends to 60 or 70 feet; when united, it varies from 8 or 10 to 20 or 30 feet. The branches are generally about 10 or 12 feet wide, and the upper one is most productive. The direction of the Veta Grande is from 30 to 40 degrees south of east, and north of west, and its underlie, from two to three feet per fathom south. Other veins of less size occur in the neighbourhood of the Veta Grande, which cross it at an acute angle. One of these appears to heave the vein for about 700 feet, being the most remarkable derangement of the kind on record.	One Veta (the *Veta Madre*), which is often separated into three branches, extending from 130 to 160 feet in width. When not ramified, its width varies from 20 or 30 to 60 or 70 feet, but is more commonly from 40 to 50 feet. The direction of the vein is north-west and south-east; its underlie is south, and about 5 or 6 feet per fathom.	There are five veins worked in this mine. The principal vein (*Teichflache*) is from 1 foot 6 inches to 3 feet in width; the others are from 6 to 12 inches wide. The direction of this vein is nearly north and south; its underlie is west, and about 3 feet per fathom. Some of the other veins intersect it.

TABLE — *continued.*

	CONSOLIDATED AND UNITED MINES. (At present the richest mines in Cornwall.)	VETA GRANDE MINES. (At present the richest mines in Mexico.)	MINE OF VALENCIANA. (Richest of the Mexican mines at the beginning of the present century.)	MINE OF HIMMELSFURST. (Richest of the Saxon mines at the beginning of the present century.)
Ores - -	Chiefly copper ore, occasionally native copper, blue and green carbonate of copper. Tin, or oxide of tin, also occurs, but not in very great abundance.	Chiefly red silver, native silver, sulphuret of silver, and argentiferous pyrites.	Sulphuret of silver, native silver, prismatic black silver, red silver, native gold, argentiferous galena.	Argentiferous sulphuret of lead, native silver, sulphuret of silver, red silver.
Produce of the ores -	9½ per cent. of fine copper; average produce in 100 parts of ore.	3½ oz. per quintal.	Four ounces of silver per quintal of 100 lbs. Equivalent to 2½ parts of metal in 1000 of ore, or ¼ per cent.	Six to seven ounces of silver per quintal of 100 lbs. Equivalent to from 3¾ to 4⅜ parts of metal in 1000 of ore, or from 3-8ths to nearly ½ per cent.
Veinstone - -	Chiefly quartz, of which many varieties occur.	Chiefly quartz, occasionally amethyst, carbonate of lime, and sulphate of barytes.	Quartz, amethyst, carbonate of lime, pearlspar, and hornstone.	Quartz, pearlspar, and calcareous spar.
Mineral substances accompanying the ores - - -	The ores are generally accompanied by "gossan"* in the backs of the lodes, by blende, and by iron, and arsenical pyrites in depth.	The ores are generally accompanied by blende, sulphuret of antimony, and iron pyrites.	The ores are accompanied by blende, spathose iron, copper and iron pyrites.	The ores are accompanied by blende, spathose iron, and a little iron and arsenical pyrites.
Depth of the principal shafts - -	*Woolf's engine-shaft*, 248 fathoms; Pearce's *engine-shaft*, 275 fathoms. Some of the other engine-shafts are scarcely inferior in depth.	*Tiro General*, 182 fathoms; *Gallega* shaft, 138 fathoms.	*Tiro General*, 310 fathoms.	*Frankenschacht*, 180 fathoms.
Depth of adit at the principal shafts -	At Woolf's engine-shaft, 13 fathoms. The average depth of the adit at the other engine-shafts is about 30 or 40 fathoms.	There is no adit to this mine.	There is no adit to this mine.	The adit at the shaft called *Frankenschacht* is 47 fathoms in depth.
Quantity of water -	Varies from 2000 to 3000 gallons per minute.	About 80 gallons per minute.	The Valenciana was a dry mine from its commencement in 1760 to 1780, when it first became troubled with water, in consequence of some of the workings being inadvertently communicated with the adjoining mine of Tepeyac; which, although upon the same vein, was extremely wet. The quantity of water raised during the late working appears to have been about 110 gallons per minute, but the regular influx was much less.	50 gallons per minute.
Height to which the water is raised -	About 230 fathoms at the Consolidated Mines; at the United Mines about 110 fathoms.	On an average about 150 fathoms.	310 fathoms.	133 fathoms.
Power employed in drainage - -	9 steam-engines; 3 of 90-inch cylinder, 3 of 85, 1 of 80, and 2 of 65. A water wheel 48 feet in diameter.	Usually 10 malacates.†	A steam engine of 30-inch cylinder, and 7 malacates.	Two water wheels, each 42 feet in diameter.
	Average of the last Ten Years.	Average of the last Six Years.	Average year at the end of the Eighteenth Century.	Average at the end of the Eighteenth Century.
Probable equivalent in acual horse-power - -	1500 constantly at work, or a total number of above 4500.	32 horses constantly working, or a total number of about 100 horses.	65 horses constantly at work, or a total number of about 200.	16 horses constantly at work, or a total number of about 50.
Average annual expense in drainage	12,700*l.*, taking the average of the last ten years.	20,000*l.* per annum.	About 40,000*l.* per annum.	Cannot be ascertained, but evidently very small.
Quantity of ore annually produced -	16,400 tons of copper ore, a few tons of tin ore.	21,380 tons of silver ore.	32,500 tons of silver ore.	630 tons of silver ore.
Produce in metal -	1517 tons of fine copper, a little tin.	153,000 lbs. troy of silver.	221,900 lbs. troy silver.	6160 lbs. troy of silver.
Total returns, or value of the above	119,800*l.*	423,400*l.* per annum.	About 600,000*l.*	About 18,000*l.*
Total costs of the mine - - -	93,500*l.* exclusive of lord's dues; 98,500*l.* including lord's dues.	252,170*l.* per annum.	197,900*l.* per annum.	9500*l.* per annum.
Clear profit to the proprietors -	21,000*l.* per annum.	171,240*l.* per annum.	118,750*l.* per annum.	3560*l.* per annum.
Amount of capital invested - -	75,000*l.*	130,000*l.*	Cannot be ascertained, but known to have been very small.	Cannot be ascertained, but probably very small.
Interest on capital invested - -	280 per cent. after paying back the original capital.	Nearly 700 per cent. after paying back the original capital.	Not known, but certainly many hundred per cent.	Not known, but probably very high.
Proportion of costs to returns - -	Costs exclusive of lord's dues, 78 per cent.	About 59½ per cent.	Costs 60 per cent. In the nine years following the proportion was 80 per cent.; at the end of that time the working of the mine was stopped by the revolution in the year 1809.	Costs 73 per cent.
Number of men employed - -	About 2500 persons, of whom about 1450 are employed under ground.	About 900, of whom nearly 600 are employed under ground.	3100 Indians and Mestizoes, of whom 1800 are employed under ground.	700 miners, of whom 550 are employed under ground.
Wages of the miners per day - -	Probably about 3 shillings on an average.	About 8 or 9 shillings per day.	From 4 to 5 shillings.	About 1*s.* 6*d.* per day.
Quantity and expense of powder	- - -	- - -	1420 cwt.; value 15,830*l.*	240 cwt.; value 1070*l.*
Manner in which the ores are disposed of - -	Sold to the smelting companies, and smelted by them at Swansea, in South Wales.	Chiefly reduced by the company at the Hacienda of Sanceda, by smelting and amalgamation.	Sold to the *Rescatadores*, and reduced by smelting and amalgamation at Haciendas, in the neighbourhood of Guanaxuato.	Delivered to the Government reduction works in the neighbourhood of Freyburg, where they are partly smelted, and partly amalgamated.

* Gossan, or Gozzan; oxide of iron and quartz.   † Malacate; a horse whim.

Mines and Minerals, Law of. By the law of England all minerals are part of the freehold of the soil under which they are found, with the exception of gold and silver, which are said to belong to the crown. But, by 1 W. & M. c. 50., no mine of copper or lead is adjudged a royal mine, though silver be extracted. A lease of land, with mines mentioned, conveys, it is said, the right to carry on open mines only, and not open new ones, unless expressly reserved; but that, if there are no open mines, the lessee may then dig new ones, as otherwise the grant would be of none effect. But, unless the lessee be authorized, to dig mines is waste. Mines are not rateable to the relief of the poor, with the exception of coal mines; the latter being expressed in the statute of Eliz., the former are held to be excluded by implication. But quarries are rateable; and the distinction between a mine and a quarry is taken to be, not the nature of the mineral extracted, but the mode of working: thus, a mine of limestone worked by a shaft is not rateable. The law of mines and minerals is subject to a variety of local customs, of which those of Devon and Cornwall are the most remarkable. *See* Stannaries.

Mine. In Fortification, a subterraneous passage leading to a chamber underneath any place intended to be blown up by gunpowder. See *Müller's Art of War*, and other works on military engineering of subsequent date.

MI'NERAL ADIPOCERE. A greasy bitumen, found in the argillaceous ores of iron. *See* Hatchetine.

MI'NERAL CAOUTCHOUC. The elastic bitumen found at Castleton in Derbyshire.

MI'NERAL CHAMÆLEON. *See* Manganese. A manganesate of potash, obtained by fusing a mixture of nitre and black oxide of manganese. So called from the variety of colours which its aqueous solution successively exhibits.

MI'NERAL GREEN. Carbonate of copper, obtained by precipitating a hot solution of sulphate of copper by carbonate of soda.

MINERALI'ZERS. The substances with which metals are combined in their ores. Thus, in the native oxides, oxygen is called the mineralizer; sulphur is also a very common mineralizer, as in the ores of copper, lead, &c.

MINERA'LOGY. A branch of physico-chemical science, which teaches the properties, composition, and relations of mineral bodies, and the art of distinguishing and describing them.

"There is no branch of science," says Sir J. Herschel, "which presents so many points of contact with other departments of physical research, and serves as the connecting link between so many distant points of philosophical speculation, as this. To the geologist, the chemist, the optician, the crystallographer, it offers especially the very elements of their knowledge, and a field for many of their most curious and important inquiries; nor, with the exception of chemistry, is there any which has undergone more revolutions, or been exhibited in a greater variety of forms. To the ancients it could scarcely be said to be at all known; and, up to a comparatively recent period, nothing could be more imperfect than its descriptions, or more inartificial and unnatural than its classifications. The more important minerals in the arts, indeed,—those used for economical purposes, and those from which metals were extracted,—had a certain degree of attention paid to them for the sake of their utility and commercial value, and the precious stones for that of ornament; but until their *crystalline forms* were attentively observed, and shown to be determinate characters, on which dependence could be placed, no mineralogist could give any correct account of the real distinction between one mineral and another. It was only, however, when chemical analysis had acquired a certain degree of precision and universal applicability, that the importance of mineralogy as a science began to be recognized, and the connection between the external characters of a stone and its ingredient constituents brought into distinct notice."

In the above quotation, the two characters of minerals upon which their classification is founded are adverted to, namely, their *structure* and their *composition*; and, pursuing these as their leading objects, mineralogists have of late discarded a number of other qualities upon which much stress was formerly laid, but which are so variable and indefinite as to be really of little value; such, for instance, as weight, colour, touch, and other sensible qualities, which often vary in different specimens of the same mineral.

There are so many disadvantages belonging to any mineralogical arrangement founded exclusively on crystalline form, or on chemical composition, that, for all practical purposes, it is necessary to blend the two; but since the chemical theory of definite proportionals, or, as it is commonly called, the atomic theory, has been shown to be applicable to the greater number of mineral combinations, the chemical arrangement of mineral substances has assumed a new and important aspect: it being of course necessary, in describing a mineral, that its crystalline form and modifications should in all cases form an essential part of such description, where at least it can be attained; for it must be recollected that there are many cases in which minerals do not occur crystallized, and where that characteristic, therefore, would be totally at fault. It has been well observed by Dr. Thomson (*System of Chemistry*, Part III., Introduction), "that if mineralogy were to be confined to mere crystallized bodies, it would be divested of the greatest part of its utility; for a very great proportion of those minerals that are of the greatest utility to man, and which, therefore, it is peculiarly important to be able to distinguish from others, are seldom found in the state of regular crystals. How often do the ores of copper, tin, lead, and iron occur in an amorphous state? And were a mineralogist incapable of distinguishing them from each other, and from other minerals, except in the rare cases when they assume a regularly crystallized form, his knowledge would be useless, as far as the important arts of mining and metallurgy are concerned."

Mineralogical analysis, as connected with the atomic theory, has made no inconsiderable progress in the skilful and industrious hands of Berzelius; but it is still quite in its infancy as regards the foundation of a mineral arrangement; and, before it can be successfully adopted as such, many new analyses, and much laborious revision of former researches, will be requisite. One of the latest authors on mineralogy, who has adopted an arrangement founded upon the chemical composition of minerals, is Dr. Thomas Thomson. He divides minerals into three classes: —

Class I. *Acid Bases.* (Those bodies which become acids when combined with oxygen.)

	Species.
Genus I. Carbon	11
II. Boron	1
III. Silicon	7
IV. Phosphorus.	
V. Sulphur	1
VI. Selenium.	
VII. Tellurium	1
VIII. Arsenic	5
IX. Antimony	5
X. Chromium.	
XI. Molybdenum	1
XII. Tungstein.	
XIII. Columbium.	
XIV. Titanium.	
XV. Vanadium.	

Class II. *Alkaline Bases.*

I. Ammonia	2
II. Potassium	1
III. Sodium	7
IV. Lithium.	
V. Barium	5
VI. Strontium	6
VII. Calcium	30
VIII. Magnesium	37
IX. Aluminum.	
1. Pure, or combined with bases	7
2. Simple salts	24
3. Double anhydrous salts	39
4. Double hydrous salts, soluble in water	3
5. Double, insoluble in water, and phosphates	4
6. Double hydrous aluminous silicates, or zeolites	39
7. Triple aluminous salts	15
8. Quadruple aluminous salts	12
X. Glucinum	4
XI. Yttrium	6
XII. Cerium	8
XIII. Zirconium	5
XIV. Thorinum	1
XV. Iron.	
1. Uncombined, or united to a simple substance	13
2. Oxygen salts of iron	22
Double ditto	19
Triple ditto	6
3. Sulphur salts of iron	2
XVI. Manganese.	
1. Combined with simple bodies	11
2. Simple oxygen salts	5
3. Double oxygen salts	5
4. Triple oxygen salts	1
XVII. Nickel.	
1. Combined with simple bodies	5
2. Oxygen salts	1
3. Sulphur salts	2
XVIII. Cobalt.	
1. Combined with simple bodies	5
2. Oxygen salts	2
3. Sulphur salts	1

		Species.
XIX. Zinc.		
	1. United to simple bodies - -	4
	2. Oxygen salts - - -	6
	3. Sulphur salts - - -	1
XX. Lead.		
	1. Native, or united to simple bodies	7
	2. Oxygen salts of lead.	
	a Simple - - -	7
	b Double - - -	10
	c Triple - - -	2
	3. Sulphur salts - - -	5
XXI. Tin - - - - -		2
XXII. Bismuth.		
	1. Native, or combined with simple bodies - - - -	6
	2. Oxygen salts - - -	2
	3. Sulphur salts - - -	1
XXIII. Copper.		
	1. Native, or combined with simple bodies - - - -	6
	2. Oxygen salts - - -	19
	3. Chlorine salts - - -	1
	4. Sulphur salts - - -	5
	5. Selenium salts - - -	1
XXIV. Mercury - - - -		5
XXV. Silver.		
	1. Native, or combined with simple bodies - - - -	10
	2. Oxygen salts - - -	1
	3. Sulphur salts - - -	6
XXVI. Uranium - - - -		5
XXVII. Palladium - - - -		2

Class III. *Neutral Bases.*

I. Gold - - - - -		3
II. Platinum - - - -		1
III. Iridium - - - -		1

We have given the above as a specimen of a chemical mineralogical arrangement; and except, perhaps, that the last class is unnecessarily separated from the preceding, it is sufficiently simple and explicit. The individual characters of each species, such as colour, fracture, hardness, specific gravity, and crystalline forms, constitute, of course, a necessary part of their description.

One of the most useful *practical* works on Mineralogy, and, in our language at least, the most available for the use of the student, is Mr. Allan's edition of the elementary introduction to that science of the late Mr. William Phillips. In this work the following order of arrangement is adopted; and the annexed tables give the distinctive constituents of the respective species.

N. B.—The proportions are indicated by figures, where ascertained; when doubtful, are marked thus —.

EARTHY MINERALS.

Silica.	Silica.					
		Alumina.				
Quartz - -	100					
Opal - - -	—					
Flint - -	98	2				
					Iron.	
Calcedony - -	84	16				
Jasper - -	—	—			—	
Hornstone - -	74	16			10	
			Lime.	Water.		Mangan.
Leelite - -	75	22				3
Karphollite - -	37	29		11	3	20
Alumo-calcite -	86	3	7	4		
Garnet - -	43	16	20		21	
Cinnamon-stone -	40	23	32		5	
Idocrase - -	40	33	22		5	
Gehlenite - -	29	24	35	5	7	
Prehnite - -	44	28	20	5	3	
Stilbite - -	58	17	9	16		
Heulandite - -	59	15	12	14		
Dipyre - -	62	25	11	2		
Davyne - -	45	34	13	8		
Laumonite - -	50	22	12	16		
Zoisite - -	43	31	22		4	
Epidote - -	40	28	15		17	
Axinite - -	50	16	17		9	8
Isopyre - -	48	14	16		22	
Indianite - -	43	38	15		4	
Xanthite - -	35	14	38		13	
						Magnesia.
Anthophyllite -	63	14	4	2	13	4
Amphodelite -	46	36	10	2	1	5
Smaragdite - -	50	21	13		13	3
Anorthite - -	45	34	15		1	5
Clays - -	75	10	5		3	2
Kerolite - -	39	13		31		17
Pyrophyllite -	60	30		5	1	4
Fahlunite - -	48	29		13	5	5
Chiastolite - -	67	30				3
Iolite - -	50	34			5	11
Sordawalite - -	50	15		5	19	11
			Bar. and Strontia.			
Harmotome - -	47	18	20	15		
Brewsterite -	54	17	15	13	1	
			Lithia.			
Petalite - -	78	17	5			
Spodumene - -	66	25	8		1	

EARTHY MINERALS—*continued.*

	Silica.	Alumina.	Lime.	Water.	Iron.	Mangan.
Jeffersonite - -	58	2	16		10	14
Tabular spar -	52		46		2	
Okenite - -	57		27	16		
				Titan.		Magnesia.
Mellilite - -	40	3	20	4	14	19
Gismondine - -	43	3	48		4	2
Augite - -	53		22		17	8
Diopside - -	58		17		6	19
Babingtonite.						
Bucklandite.						
Hornblende - -	59		14		7	20
Arfwedsonite.						
Hypersthene -	56	3	1		26	14
				Water.		
Schiller spar - -	43		1	13	14	29
Bronzite - -	60				8	32
Thulite - -	47	28	23			2
Alumina.	Alumina.	Water.	Silica.	Iron.		
Corundum - -	98			2		
Diaspose - -	85	14		1		
Gibbsite - -	65	35				
Calaite - -	74	19		7		
Hydrate of alumina	45	40	15			
Allophane - -	34	42	24			
Scarbroite - -	43	48	8	1		
Halloysite - -	34	26	40			
Worthite - -	54	5	41			
Fibrolite - -	58		38	4		
Sillimanite - -	55		43	2		
Kyanite - -	64		34	2		
Staurolite - -	52		30	18		
		Magnesia.			Fluor. A.	Ox. of Zinc.
Automalite - -	60	3	4	9		24
Fluellite - -	—				—	
Topaz - - -	58		35		7	
Chrysoberyl - -	81		19			
Spinel - -	74	8	15	3		
Sapphirine - -	64	17	15	4		
Pleonaste - -	67	14	3	16		
						Lime.
Turnerite - -	—	—		—		—
Magnesia.	Magnesia.	Water.				
Hydrate of magnesia	70	30				
Chrysolite - -	43		38	19		
Olivine - -	38		50	12		
Ligurite.						
Forsterite - -	—		—	—		
Condrodite - -	56		38	6		
Humite.						
Tautolite - -	—		—	—	Alumina.	
Serpentine - -	40	15	42	3		
Soapstone - -	25	19	46	1	9	
Steatite - -	32	7	59	2		
Potstone - -	30	3	49	12	6	
Nephrite - -	31	3	50	6	10	
Nemalite - -	52	29	13	6		
Marmolite - -	42	15	42	1		
Picrolite - -	38	12	41	9		
Picrosmine - -	35	8	55	2		
Zirconia.	Zirconia.					
Zircon - -	69		29	2		
Ostranite.						
Glucina.	Glucina.					
Euclase - -	22		44	3	31	
Emerald - -	15		68	1	16	
Yttria.	Yttria.	Glucina.			Cerium.	
Gadolinite - -	38	5	25	16	16	
Thorina.	Thorina.	Lime.		Iron, &c.	Water.	
Thorite - -	58	3	20	9	10	

ALKALINO-EARTHY MINERALS.

Potash.	Potash.	Silica.	Alumina.	Water.	Magnesia.	Iron.
Mica - {	10	46	14		10	20
	8	48	25	4		15
					Lime.	
Rubellane - -	10	45	10	5	10	20
Margarite - -	2	40	42	1	10	5
Leucite - -	21	56	23			
Herschellite.						
Andalusite - -	4	36	55			5
Bucholzite - -	2	46	50			2
Phillipsite - -	7	48	23	16	6	
Apophyllite - -	5	52		18	25	
Dysclasite - -	2	58		14	26	
					Magnesia.	
Nacrite - -	18	50	26		1	5
				Sulp. A.		
Hauyne - -	16	38	19	13	12	2
				Water.		
Weissite - -	6	55	23	4	9	3
Pearlstone -	4	76	12		5	3
Giésèckite -	7	48	36	5		4
Pinite - -	9	56	25			10
Pyrargyllite -	3	44	29	16	3	5
Felspar - -	14	67	19			

ALKALINO-EARTHY MINERALS — *continued.*

Potash.	Potash.	Silica.	Alumina.	Water.	Lime.	Iron.
Latrobite - -	7	45	37	2	9	
Agalmatolite -	7	56	29	5	2	1
					Magnesia.	
Chlorite - -	7	52	10	6	12	13
Killinite - -	6	56	27	8		3
					Lime.	
Couzeranite -	10	53	24		13	
Glaucolite - -	5	52	29		14	
				and Flu. A.	Lithia.	
Lepidolite - -	9	50	29	5	5	2
Soda.	Soda.			Water.	Lime.	
Mesotype - -	16	48	27	9		
Thomsonite -	5	38	30	13	14	
Mesole - -	8	42	28	11	11	
Needlestone -	6	47	26	12	9	
Brevicite - -	10	44	29	10	7	
Gmelinite - -	5	50	20	21	4	
Comptonite.						
			Magnesia.			Phos. A.
Ledererite - -	4	50	22	9	12	3
			Alumina.			
Hypostilbite - -	2	53	18	19	8	
Epistilbite -	2	59	17	14	8	
Spherostilbite -	1	56	17	17	9	
	and Potash.			Magnesia.		
Erlamite - -	3	54	15	5	15	8
Humboldtilite -	5	44	11	6	31	3
Lapis-lazuli -	9	51	12	6	17	5
Nepheline - -	20	44	34		2	
				Water.		
Ittnerite - -	14	34	30	12	10	
Elaolite - -	21	46	32			1
Nuttalite - -	8	38	26	8	19	1
	Soda.			Mur. A.		
Sodalite - -	26	36	32	6		
Cancrinite - -	26	41	33			
				Sul. A.		Iron, &c.
Spinellane - -	18	41	29	5	2	5
Pericline - -	10	70	20			
Labradorite - -	4	56	27		11	2
Albite - -	11	70	19			
				Water.		
Analcime - -	14	55	23	8		
Sarcolite.						
Pitchstone - -	3	73	12	8	1	3
Pumice - -	3	77	18			2
Obsidian - -	10	75	12			3
Spherulite - -	4	79	12	2		3
				Magnesia.		
Saussurite - -	6	49	24	3	10	8
				Water.		
Scapolite - -	1	45	35	2	17	
Ekebergite -	5	47	29	3	14	2
Pectolite - -	10	51	1	4	34	
Chabasie - -	2	51	18	19	10	
Levyne.						
				Bor. A.	Magnesia.	
Tourmaline -	3	36	35	4	6	16
					Lime.	
Meionite - -	2	40	32		24	2
Edingtonite -	3	54	14		21	8
				Water.	Magnesia.	
Krokydolite - -	8	51		4	3	34
Achmite - -	11	56				33
Cummingtonite -	9	59		2		30
			Zirconia.		Lime.	
Eudyalite - -	14	54	11	3	10	8

ACIDS.

	Sulphur.	Oxygen.
Sulphuric acid - - -	40	60
	Boron.	Oxygen.
Boracic acid - - - -	26	74

ACIDIFEROUS EARTHY MINERALS.

Alumina.	Sul. A.	Alumina.	Water.			
Subsulphate of alumina -	24	30	46			
Sulphate of alumina - -	36	16	48			
	Phos. A.					
Wavellite - -	35	37	28			
				Silica.	Iron.	
Kakoxene -	18	10	26	10	36	
						Lithia.
Amblygonite -	54	39				7
Childrenite -	—	—			—	
						Magnesia.
Azurite - -	43	35	6	3	3	10
Lime.	Carb. A.	Lime.				
Carbonate of lime	44	56				
						Strontia.
Arragonite - -	44	54	1			1

ACIDIFEROUS EARTHY MINERALS — *continued.*

Lime.	Carb. A.	Lime.	Water.			Magnesia.
Bitter spar -	50	34	2			14
					Iron.	
Ankerite -	35	50			3	12
						Lead.
Plumbo-calcite -	43	54				3
	Phos. A.					
Apatite - -	44	56				
Herderite.						
	Fluor. A.					
Fluor spar -	28	72				
	Sul. A.					
Anhydrite -	58	42				
Gypsum - -	46	33	21			
	Nit. A.					
Nitrate of lime -	66	34				
	Bor. A.			Silica.		
Datholite - -	22	36	5	37		
	Arsen. A.					
Pharmacolite -	50	26	24			
Haidingerite -	57	29	14			
	Tung. A.					
Tungstate of lime	80	20				

Magnesia.	Carb. A.	Magnesia.	Water.		
Carbonate of magnesia	50	48	2		
				Iron.	
Breunnerite - -	49	42		9	
					Lime.
Conite - -	49	33		3	15
	Sul. A.				
Sulphate of magnesia -	33	16	51		
	Nit. A.				
Nitrate of magnesia -	72	28			
	Phos. A.				Fluor. A.
Wagnerite - -	42	47		4	7
	Borac. A.				
Boracite - -	69	31			
					Lime.
Hydro-boracite -	50	11	26		13
Baryta.	Carb. A.	Baryta.			
Witherite - -	22	78			
Baryto-calcite - -	31	51			18
	Sul. A.				
Barytes - - -	34	66			
Strontia.	Carb. A.	Strontia.			
Strontites - -	30	70			
			Sul. A.	Baryta.	Lime, &c.
Barystrontianite -	22	48	9	18	3
	Sul. A.				
Celestine - -	44	56			
Yttria.	Phos. A.	Yttria.			Iron.
Phosphate of yttria -	35	63			2

ACIDIFEROUS ALKALINE MINERALS.

Potash.	Nitric Acid.	Potash.	
Nitrate of potash -	54	46	
	Sulp. Acid.		
Sulphate of potash -	46	54	
Soda.	Carbon. Acid.	Soda.	Water.
Carbonate of soda -	35	50	15
Trona - -	39	38	23
	Sulph. A.		
Sulphate of soda -	45	35	20
	Nitric A.		
Nitrate of soda -	63	37	
	Boracic A.		
Borate of soda -	37	15	48
	Muriatic A.		
Muriate of soda -	47	53	
Ammonia.	Sulph. A.	Ammonia.	
Sulphate of ammonia	53	23	24
	Muriatic A.		
Muriate of ammonia	51	32	17

ACIDIFEROUS ALKALINO-EARTHY MINERALS.

Potash.	Sul. A.	Potash.	Alumina.		Water.	
Alum - -	34	10	11		45	
Alum-stone -	36	10	40		14	
				Lime.		Magnesia.
Polyhallite -	53	15		19	6	7
Soda.	Fluor. A.	Soda.				
Cryolite - -	44	32	24			
	Sul. A.					
Glauberite - -	57	22		21		

ACIDIFEROUS ALKALINO-EARTHY MINERALS—*continued.*

Soda.	Sul. A.	Potash.			Mur.A.	Magnesia.
Reussite - -	57	29			2	12
Soda-alum - -	38	8	Alumina. 12		Water. 42	
Gaylussite - -	Carb. A. 29	20	1	Lime. 18	32	
Native carbonate of lime and soda -	37	9		39	10	Iron, &c. 5
Ammonia.						
Sulphuret of alumina and ammonia - - -	Sul. A. 37	Ammonia. 5	12		45	Magnesia. 1

METALLIFEROUS MINERALS.

Iron.	Iron.	Sulphur.				Nickel.
Native iron -	97					3
Iron pyrites -	47	53				
White iron pyrites -	46	54				
Magnetic iron pyrites	61	39				
Arsenical iron -	36	21				Arsen. 43
Oxydulated iron - -	72	Oxygen. 28				
Specular iron -	69	31				
			Water.	Silica.	Lime.	
Red hæmatite - -	65	29	3	2	1	
Franklinite -	46	30			Mangan. 10	Zinc. 14
Hydrous oxide of iron	57	26	14	2	1	
Goethite -	61	28	11			
Brown hæmatite -	—	—	—			
Stilpnosiderite - -	56	25	16	3		
Cronstedtite	42	18	11	22	2	Magnesia. 5
Pinguite -	25	11	26	37		1
Anhydrous silicate of iron - -	51	19		29	1	
Chloropal -	24	11	18	44	2	Alumina. 1
Chamoisite -	42	19	17	14		8
Siderochisolite -	53	20	7	16		4
Hisingerite -	37	15	12	29	1	6
Yenite -	39	16	1	30	2	Lime. 12
Pitchy iron ore - -	24	11	29		Sulph. A. 10	Arsen. A. 26
Pyrosmalite -	24	10		36	Mur. A. 7	Mangan. 16
Spathose iron	46	14			Carb. A. 40	
Phosphate of iron - -	32	10	27		Phos. A. 31	
Hétéposite -	32	11	—		48	9
Karphosiderite -	—	—	—		—	
Sulphate of iron - -	19	7	45		Sulph. A. 29	
Botryogene -	25	10	33		32	
Misy - -	—	—	—		—	
Arseniate of iron -	29	13	20		Arsen. A. 38	
Oxalate of iron -	41	13			Oxal. A. 46	
Tungstate of iron -	14	9		2	Tung. A. 71	4
Manganese.	Mangan.					
Hausmannite	78	22				
Braunite -	68	29	1			Baryta. 2
Pyrolusite -	66	31	2	1		
Grey oxide of manganese	68	22	10			
Psilomelane	55	23	6			16
Wad - -	48	21	17	Silica, &c. 10	Iron. 4	
Cupreous mangan. -	53	23	20	1	Copper. 3	
Helvine -	34	8	Sulph. A. 5	38	Iron. 6	Glucina. 9
Siliciferous oxide of manganese	36	17	Water. 8	40	4	

METALLIFEROUS MINERALS—*continued.*

Manganese.	Mangan.	Oxygen.	Water.	Silica.		
Hydrosilicate of manganese -	—	—	—	—		
Knebelite -	27	15		33	Iron. 25	
Bustamite -	28	8		49		Lime. 15
Sulphuret of manganese	66	18		Sulphur. 5		Carb. A. 11
Carbonate of manganese	39	17		1	38	Lime. 5
Pelokonite -	—	—	—			
Huraulite -	24	14	16		Iron. 8	Phos. A. 38
Phosphate of manganese	25	14		Lime. 2	25	34
Molybdena.	Molybd.	Sulph.				
Sulphuret of molybdena	60	40				
Oxide of molybdena -	85	Oxygen. 15				
Tin.	Tin.					
Oxide of tin -	79	21				
Sulphuret of tin - -	36	Sulph. 26	Copper. 36	Iron. 2		
Tungsten.	Tungst.	Oxygen.				
Oxide of tungsten -	86	14				
Titanium.	Titan.		Iron.	Silica.		
Anatase -	—	—				
Rutile -	—	—				
Iserine -	45	16	36	3		
Brookite -	—	—	—			
Crichtonite -	—	—	—			
Ilmenite -	59	10	30			Mangan. 1
Mohsite -	—	—	—			
Sphene -	33			34	Lime. 33	
Pyrochlore -	Tit. A. 63	10	Water. 4	Cerium. 5	13	Uran. 5
Æschynite -	56	4	Iron, &c. 4	12	4	Zircon. 20
Polymignite	53		12	and Yttria. 16	4	15
Cerium.	Cerium.		Silica.	Water.		Iron.
Cerite - -	54	15	18	10	2	1
Silicate of cerium -	—	—	—			
Allanite -	19	15	33	3	and Alum. 26	4
Torrelite -	11	8	33	4	28	16
Orthite -	16	6	36	8	and Yttria. 24	10
Pyrorthite -	12	4	11	27	5	and Carbon. 41
Carbonate of cerium -	60	16		13	Carb. A. 11	
Yttro-cerite	14	4	Lime. 47		Fluor. A. 25	Yttria. 10
Fluate of cerium - -	66	17			16	1
Uranium.	Uran.		Silica.	Iron.		Sulp. Lead.
Pitchblende	82	5	5	3		5
Uranite -	55	7	Lime, &c. 7	1	Water. 15	Phos. A. 15
Chalkolite -	55	8		Copper. 6	15	16
Carbonate of uranium -	—	Carb. A. —				
Johannite -	—	Sulp. A. —			—	
Tantalum.	Tantal.	Oxygen.	Iron.	Mangan.	Yttria.	
Tantalite -	81	10	4	5		
Yttrotantalite - -	51	4	4		37	Lime. 4
Fergusonite	44	5	Cerium. 3	Tin, &c. 3	42	Zirconia. 3
Chrome.	Chr.		Iron.			
Oxide of chrome -	70	30				
Chromate of iron - -	39	28	26			Alumina. 7
Bismuth.	Bismuth.	Sulphur.	Copper.	Lead.		
Native bismuth -	100					
Sulphuret of bismuth -	81	19				
Cupreous bismuth -	49	13	38			
Needle ore -	43	15	12	30		
Oxide of bismuth -	90	Oxygen. 10				

METALLIFEROUS MINERALS—*continued.*

Bismuth.	Bis-muth.	Oxygen.	Silica.	Iron.		Phos. A.
Bismuth-blende -	62	9	23	2		4
				Tellur.	Sulphur &Selen.	Silver.
Telluric bismuth - -	64			31	3	2
Arsenic.	Ar-senic.		Iron.			Anti-mony.
Native arsenic -	96		1			3
Oxide of arsenic -	76	24				
		Sulph.				
Sulphuret of arsenic -	70	30				
						Nickel.
Arsenical pyrites -	65	5	28			2
Cobalt.	Cobalt.	Ar-senic.	Sul-phur.		Iron.	
Bright white cobalt -	34	44	20		2	
Tin-white cobalt -	22	75			3	
						Bis-muth.
Bismuth cobalt ore -	10	78	3		5	4
						Copper.
Sulphuret of cobalt -	44		39		4	13
		Oxygen.		Water.		
Earthy cobalt	61	16		23		
			Arsen. A.			
Cobalt bloom	31	9	38	22		
					Lime.	Mag-nesia.
Roselite -	—	—	—	—	—	—
			Sulph. A.			
Sulphate of cobalt -	23	6	30	41		
Nickel.	Nickel.	Sulph.				
Sulphuret of nickel -	65	35				
			Anti-mony.			
Antimonial nickel -	28	16	56			
			Ar-senic.			
Arsenical nickel -	44	1	55			
		Oxygen.	Arsen. A.			
Nickel ochre	30	8	37	25		
			Silica.		Alu-mina.	Lime, &c.
Pimelite -	13	3	35	38	6	5
Silver.	Silver.					
Native silver	100					
			Anti-mony.			
Antimonial silver -	84		16			
			Tellur.			
Telluric silver - -	63		37			
		Sul-phur.				
Sulphuret of silver -	87	13				
				Iron.		
Flexible sulphuret of silver -	—	—		—		
Sternbergite	33	33		34		
			Antim.			
Brittle sulphuret of silver -	68	16	14	2		
Sulphuret of silver and antimony.						
					Copper.	Arsenic.
Polybasite -	65	17	5		9	4
Red silver {	60 65	23 20	17			15
Miargyrite -	37	22	40		1	
Sulphuret of silver and copper -	53	16			31	
			Bis-muth.			Lead.
Bismuthic silver -	15	17	28	6		34
		Sele-nium.				
Seleniuret of silver -	69	26				5
						Carb. A. &c.
Seleniuret of silver and copper -	39	28			24	9
		Iodine.				
Iodic silver -	—	—				
			Anti-mony.			Carb. A.
Carbonate of silver -	73		15			12
						Mur.A.
Muriate of silver -	72			6		22
						Arsen. A.
Gänseköthigerz - -	—			—		—
Copper.	Copper.					
Native copper - -	100					
		Sul-phur.	Iron.			
Sulphuret of copper -	78	19	3			
Kupferindig	65	33	2			
Bi-sulphuret of copper -	67	33				
				Ar-senic.		
Purple copper - -	62	23	15			
Grey copper	48	13	25	14		

METALLIFEROUS MINERALS—*continued.*

Copper.	Copper.	Sul-phur.	Iron.			
Copper pyrites - -	33	36	31			
				Selen.		
Seleniuret of copper -	60			40		
		Oxygen.				
Red oxide of copper -	89	11				
Black copper	80	20				
				Carb. A.	Water.	
Blue carbonate of copper - -	55	14		26	5	
Green carbonate of copper - -	57	15		19	9	
						Silica.
Chrysocolla -	35	9			20	36
Dioptase -	38	11			14	37
				Sulph. A.		
Sulphate of copper -	25	7		32	36	
						Tin, &c.
Brochantite	53	15		17	12	3
						Zinc.
Kupfersammterz -	—	—	—	—		—
				Mur. A.		
Muriate of copper -	57	15		11	17	
				Phos. A.		
Phosphate of copper -	51	14		28	7	
Hydrous phosphate of copper -	50	13		22	15	
				Arsen. A.		
Arseniate of copper -	29	8		28	35	
Euchroite -	38	10		33	19	
						Carb. of Lime.
Kupferschaum -	37	9		26	18	10
						Alu-mina.
Erinite -	47	12		34	5	2
Skorodite -	18	10	21	32	19	
Gold.	Gold.					
Native gold -	100					
Platina.	Platina.					
Native platina -	100					
Palladium.	Palla-dium.					
Native palladium -	100					
Iridium.	Iri-dium.					
Native iridium -	100					
		Os-mium.	Rho-dium.	Iron.		
Iridium and osmium -	47	49	3	1		
Tellurium.	Tellu-rium.	Gold.	Silver.			
Native tellurium -	92	1		7		
				Lead.		
Graphic tellurium -	58	28	12	2		
Yellow tellurium -	45	27	8	20		
					Sulph.	Antim.
Black tellurium -	16	6		63	11	4
Antimony.	Anti-mony.	Sulph.	Iron.			
Native antimony -	100					
Berthierite -	53	31	16			
Sulphuret of antimony -	74	26				
Jamesonite -	35	23	2	40		
Plagionite -	38	22		40		
Zinkenite -	45	23		32		
					Oxygen.	
Red antimony -	75	20			5	
Oxide of antimony -	84				16	
						Water.
Antimonial ochre -	—					—
Antimonphyllite -	—					
Lead.	Lead.					
Native lead.						
Sulphuret of lead - -	84	16				
					Antim.	Copper.
Bournonite -	41	20			26	13
				Arsen. &c.		
Prism. copper glance	33	10		18	19	20
Native minium.						
		Selen.		Cobalt.		
Seleniuret of lead -	70	28		2		
		Oxygen.	Water.	Alu-mina.		
Plombgomme -	40	3	19	38		
					Carb. A.	
Carbonate of lead -	74	10			16	

METALLIFEROUS MINERALS — *continued.*

Lead.	Lead.				Carb. A.	Sulp. A.
Sulphato-carbonate of lead -	82				4	14
Sulphato-tri-carbonate of lead -	88				5	7
				Copper.		
Cup. sul. carbonate of lead -	72			7	6	15
						Mur.A.
Muriate of lead -	—				—	—
Cotunnite -	75					25
		Oxygen.				
Murio-carbonate of lead -	80	6			6	8
Phosphate of lead -	76	6			16	2
			Water.			Magnesia.
Polysphärite	—	—	—	—	—	—
				Arsen. A.		Mur.A.
Arseniate of lead -	72	6		13	7	2
					Sulph. A.	
Sulphate of lead -	65	7	2		26	
				Copper.		
Cupreous sulphate of lead -	56	4	5	15	20	
					Molyb. A.	
Molybdate of lead -	57	4			39	
					Chrom. A.	
Chromate of lead -	63	5			32	
Melanochroite	71	6			23	
Vauquelinite	57	6		9	28	
					Tung. A.	
Tungstate of lead -	44	4			52	
					Vanad. A.	
Vanadiate of lead -	—				—	—
Zinc.	Zinc.	Sulph.	Iron.	Silica.		
Sulphuret of zinc -	63	33	4			
		Oxygen.				
Red oxide of zinc -	74	18	8			

METALLIFEROUS MINERALS — *continued.*

Zinc.	Zinc.	Oxygen.	Iron.	Silica.	Water.
Siliceous oxide of zinc	54	13		25	8
Carbonate of zinc -	—	—	—		
				Carb. A.	
Willelmine -	52	13		35	
				Sulph. A.	
Sulphate of zinc -	22	6		30	42
Hopeite -	—				—
Mercury.	Mercury.	Silver.			
Native quicksilver -	100				
Native amalgam -	85	15			
		Chlorine.			
Muriate of mercury -	85	15			
		Iodine.			
Iodic mercury -	—	—			

COMBUSTIBLE MINERALS.

	Sulphur.			
Sulphur - -	100			
	Carbon.	Iron.		
Diamond - -	100			
Plumbago - -	92	8	Silica.	
Anthracite -	72	4	24	
		Hydrogen.	Oxygen.	
Naphtha - -	88	12		Azote.
Bitumen - -	53	7	40	
Coal - - -	75	6	5	14
Dysodile - -	—	—		
Amber - -	81	12	7	
Hatchetine -	—	—		
Schererite - -	76	24		
Ozokerite - -	—	—		
	Mel. A.	Alumin.	Water.	
Mellite -	41	15	44	
Retinasphalt.				
Fossil copal.				

MI'NERAL PITCH, *Maltha*. A solid, softish bitumen. Sp. gr. about 1·5.

MI'NERAL TAR. The bituminous substance called *petroleum*. It is brown, viscid, and unctuous. Its specific gravity is 0·88. It is found in Britain, and on the continent of Europe, in the West Indies (Barbadoes tar), and in Persia. It may be resolved by distillation into naphtha and petroleum.

MI'NERAL WATERS. This term is applied to certain spring waters containing so large a proportion of foreign matter as to be unfit for ordinary use.

Mineral waters may, in most cases, be artificially prepared by the skilful application of the knowledge derived from analyses, with such precision as to imitate very closely the native springs. When the various earthy or metallic constituents are held in solution by carbonic acid, or sulphuretted, they should be placed along with their due proportions of water in the receiver of the aerating machine, and then the proper quantity of gas should be injected into the water. Sufficient agitation will be given by the action of the forcing-pump to promote their solution. (See *Ure's Dict. of Arts, &c.*)

The following table shows the composition of several of the principal mineral springs of Europe.

TABULAR VIEW of the Composition of the Principal Mineral Waters of England. One Pint (Wine Measure) contains the following Ingredients: —

Waters.	Gases.			Carbonates.			Sulphates.			Muriates.			Oxide of Iron.	Silica.	Temperature.	Total of Saline Contents.	Authority.
	Nitrogen, C.I.	Carbonic Acid, C.I.	Sulphuretted Hydrogen, C.I.	Carbonate of Soda.	Carbonate of Magnesia.	Carbonate of Lime.	Sulphate of Soda.	Sulphate of Magnesia.	Sulphate of Lime.	Muriate of Soda.	Muriate of Magnesia.	Muriate of Lime.					
Sulphurous.				grs.	grs.	grs.	grs.	grs.	grs.	grs.	grs.						
Harrowgate	0·8	1·	2·3	-	0·7	2·5	-	1·3	-	77·	11·	1·5	-	-	cold	94·	Garnet.
Moffat -	0·5	0·6	1·2	-	-	-	-	-	-	4·5	-	-	-	-	do.	4·5	Ditto.
Cheltenham sulphur spring -	-	-	1·5	-	-	-	23·5	5·	1·2	35·	-	-	0·3	-	do.	65·	Parkes & Brande.
Saline.																	
Cheltenham pure saline	-	-	-	-	-	-	15·	11·	4·5	50·	-	-	-	-	do.	80·5	Ditto.
Bristol - -	-	3·5	-	-	-	1·5	1·5	-	1·5	0·5	1·	-	-	-	74°	6·	Carrick.
Buxton -	0·2	-	-	-	-	1·3	-	-	0·3	0·2	-	-	0·03	-	82°	1·83	Pearson.
Bath - -	-	1·2	-	-	-	0·8	1·5	-	9·	3·3	-	-	a trace	0·2	116°	14·6	Phillips.
Scarborough	-	-	-	-	-	a trace	20·	-	9·	-	-	-	ditto	-	cold	2·9	Saunders.
Kilburn -	-	3·5	8 5 ?	-	0·5	1·	12·	37·	5·5	2·5	5·5	0·2	ditto	-	do.	64·2	Schmeisser.
Leamington New Bath	0·4	a trace	a trace	-	-	-	19·	-	14·	53·	1·5	-	0·8	-	do.	88·3	Lambe.
Leamington Old Bath -	0·3	-	ditto	-	-	-	7.5	7·	18·	41·	-	-	-	-	do.	73·5	Ditto.
Chalybeate.																	
Tunbridge -	0·59	1·	{a trace of oxygen}	-	-	0·03	-	-	0·17	0·30	0·03	0·05	0·28	.	do.	0·56	Scudamore.
Cheltenham chalybeate	-	2·5	-	0·5	-	-	22·7	6·	2·5	41·3	-	-	0·8	-	do.	73·8	Parkes & Brande.
Brighton -	-	2·2	-	-	-	-	-	-	4·	3·	0·75	-	1·4	0·14	do.	9·29	Marcet.

TABULAR VIEW of the Composition of the Principal Mineral Waters of Germany.

Ingredients found in 16 oz. of Water in a dry state, in grains.	Carlsbad.	Ems.	Marienbad. Kreutzbr.	Auschowitz. Ferdinands-brunnen.	Eger. Franzensbr.	Pyrmont.	Spa.	Geilnau.	Selters.	Seidschutz.	Pullna.
Carbonate of soda - -	9·695	10·750	8·26	6·197	5·00	-	0·7375	6·6210	6·155		
Sulphate of soda - -	19·695	-	39·72	22·544	25·50	2·14566	0·0375	0·0420	-	23·4960	123·8
Muriate of soda - -	7·975	7·634	12·45	8·996	7·96	-	0·44949	0.5430	17·292		..
Sulphate of potash -	-	0·540	0·93	-	0·93	0·04194	0·07909	0·2872	0·397	4·8940	4·8
Muriate of potash -	-	0·045	-	-	-	-	-	-	0·358		
Carbonate of lime -	2·37	1·1407	4·1300	4·016	1·847	5·98824	0·9850	2·9705	2·1870	6·8060	0·77
Sulphate of lime - -	-	-	-	-	-	7·22132	-	-	-	1·5050	2·6
Sub-phosphate of lime - -	0·0017	-	-	-	0·014	-	0·01366	-	-	0·0156	0·0035
Fluate of lime	0·024	0·00192	-	-	-	-	-	-	0·0018		
Carbonate of magnesia -	1·369	0·7887	3·0560	2·4	0·600	0·32352	1·12278	2·1709	1·3780	1·0980	6·406
Sulphate of magnesia -	-	-	-	-	-	2·69752	-	-	-	83·1380	93·086
Muriate of magnesia -	-	-	-	-	-	1·12664	-	-	-	1·6300	19·666
Nitrate of magnesia -	-	-	-	-	-	-	-	-	-	7·9070	
Alumina -	-	-	0·0075	-	-	-	-	0·0247			
Sub-phosphate of alum -	0·0024	0·0018	-	-	-	0·01478	0·00851	-	0·0027	0·0117	
Carbonate of strontian -	0·007	0·0107	-	-	-	-	-	-	0·0192		
Sulphate of strontian -	-	-	-	-	-	0·02063	-	-	-	0·0468	
Carbonate of barytes -	-	0·0029	-	-	-	-	-	-	0·0019		
Silica - -	0·577	0·4139	0·8800	0·669	0·568	0·49689	0·4985	0·2695	0·302	0·1200	0·176
Carbonate of iron - -	0·0278	0·026	0·1760	0·4	0·350	0·42846	0·3751	-	-	0·0127	
Carbonate of manganese	0·006	0·0037	0·0065	0·092	0·006	0·04852	0·0519	-	-	0.0042	
Total -	41·9239	21·35932	69·616	45·314	42·775	20·55412	4·35903	12·9288	28·0946	130·6845	251·3075
Carbonic acid gas in 100 cubic inches -	58	51	125	149·56	154	160	136	163·3	130	6·4	6·9
Temperature (Fahr.) -	Sprud. 165° Neub. 138° Mühl. 128° Ther. 122°	Kess. 117° Krän. 84°	53°	49°	53°	56°	50°	51°	58°	58°	58°
Analyzed by	Berzelius.	Struve.	Struve.	Steinmann.	Struve.	Struve.	Struve.	Struve.	Struve.	Struve.	Struve.

MI'NERAL YELLOW, or PATENT YELLOW. A compound of oxide and chloride of lead, obtained by digesting powdered litharge in a solution of common salt, washing, drying, and fusing the product. It is used as a pigment.

MINE'RVA. The Latin goddess corresponding to, and confounded with, the Grecian Pallas (Παλλὰς), or Athena (Α'θήνη). She was fabled to have sprung in full armour from the forehead of her father Jupiter. Minerva was worshipped as the goddess of wisdom, and the patroness of industry and the arts. Athens, the city to which she gave name, was her favourite spot; and there her worship was celebrated with great splendour, and the magnificent temple the Parthenon erected to her honour. But she was also worshipped at Rome with peculiar veneration. There she had three temples: one on the Capitol, which she shared with Jupiter and Juno; a second on the Aventine; and a third on the Cælian mount, in which she was worshipped as *Minerva Capta*, an epithet said to have been applied when her statue was transported from Falerii, after the capture of that city by Camillus. At Rome there were also two great festivals celebrated annually in her honour; the one called Quinquatrus or Quinquatria, the other Quinquatria Minora. (See these words.) The origin of the name of Minerva has long puzzled etymologists. Cicero says she is called "Minerva, quia minuit or minatur;" but it has been also fancied that the word is a shortened form of Meminerva (from memini, *I remember*), she being the goddess of memory. It is possibly from the same root as the Lat. mens, *mind*, which is expressed so clearly in many languages wholly unallied, of which the Germ. mann (whence the English *man*), and the Hindostan mena, may serve as examples. But the Tuscan name of the goddess is Menrfa, which seems the immediate source. She was represented as a young woman, with a grave and noble countenance, clothed in armour. *See* PALLAS.

MI'NIATURE. (Fr.) A representation of nature on a very small scale. *Miniature Painting* is generally executed on ivory; and is, as to composition, drawing, and finishing, subject to the same laws as Painting (which see). The outline is traced upon the ivory with a silver point or pencil, and must be extremely light and delicate. This is afterwards drawn in with thin carmine as correctly as possible; the corrections being made with finely powdered pumice-stone, rubbed on with a paper or leather stump. The dead colouring then proceeds, wherein the shadows are left delicate and the lights strong, the full effect being afterwards produced by dotting. The artist usually begins the shades with vermilion and carmine, giving the strongest touches to the most prominent parts, and to those where separations are marked out in shades that are obscure. Indigo is afterwards used for the bluish shades on such parts as recede from the light. Yellow tints, composed of ochre and vermilion, are usually employed on the sides of the nose towards the bottom, under the eyebrows, underneath the cheeks, and on other parts rising towards the light. The backgrounds, if dark, are commonly composed of bistre, umber, or Cologne earth, with black and white; others of a yellow cast by the use of ochre. The grey back-grounds are formed by black, white, and a little indigo. When of a green or olive hue, Dutch pink, white, and black are the ingredients. The back-grounds are formed in two coats, first laying on a light thin tint, and afterwards a darker one of the same colour, evenly and smooth. The dotting is performed by separate dots, or by short notching strokes crossing each other every way so as to have the appearance of being dotted.

MI'NIM. (Lat. minimus.) In Music, a character 𝅗𝅥 equal in duration to two crotchets, or half a semibreve.

MI'NIM. The smallest liquid measure, generally regarded as about equal to one drop. The fluid drachm is divided into sixty minims.

MI'NIMS, or MINIMI, ORDER OF THE. A religious order instituted by St. Francis De Paulo in the fifteenth century. The name is derived from the Lat. minimus, *the least*; by which the founder meant to indicate that humility should be the distinguishing feature of the order. In conformity with this design the rules he prescribed were of the strictest kind. Besides the three usual vows of poverty, continence, and obedience, the most rigid abstinence was inculcated. Except in cases of illness, the members were prohibited not only from touching animal food, but even butter, milk, or cheese, or indeed any kind of sustenance in the composition of

which such materials were used. Their dress was of the coarsest and meanest kind; the colour being black, like that of the Franciscans. Long before the death of its founder, this order had attained so high a degree of celebrity for sanctity that it could boast of monasteries in Italy, France, Spain, and Germany; and at no very distant period it counted no fewer than 450 religious houses scattered throughout Europe and Asia. (See the *Dict. de la Conversation.*)

MINISTER. In Politics, a servant of the sovereign executive power in a state: generally speaking, the head of a department or branch of government. Usage, in different countries, fixes very differently the limits of that higher class of servants to which the term is applied. In the British empire, none but the heads of administrative departments are termed ministers: part of whom belong to the cabinet, and part are not included in it. The cabinet ministers have varied under different administrations; and as our government is of mixed organization, partly to serve the actual necessities of state, and partly retaining ancient distinctions of office founded on usage only, some of the ministers hold merely sinecure appointments. In France, where the forms of government are established more on the principle of utility, there are eight ministers so called: 1. of the interior; 2. of finance; 3. of justice; 4. of public instruction and ecclesiastical affairs; 5. of commerce and public works; 6. of the marine and colonies; 7. of war; 8. of foreign affairs. In England, ministers sit and vote in either house of parliament,—by hereditary right, if peers; as representatives only, if commoners. In France, the same regulation prevails; but ministers have also, by virtue of their office, a right to sit and take part in the debates in either chamber. In the United States, no minister (or secretary, in the language of that government) can be chosen either representative or senator. In some European countries (as Russia), a distinction is established between the private affairs of the sovereign and foreign affairs, on the one hand, which form the combined duties of the cabinet ministers; and the affairs of the interior, which are entrusted to ministers of state. There are also in some governments honorary or *conference* ministers, without any real department of duty. The representatives of minor sovereigns at foreign courts are usually styled *ministers*, instead of *ambassadors*. The term *minister* is also frequently used in a sense synonymous with *clergyman*.

MI'NIUM. (Lat.) In Painting, a red colour, being a calx of lead: according to Pliny it was the common red lead. *See* LEAD.

MI'NNEHÖ'FE. (Germ.; literally *courts of love.*) The name given by the Germans to the cours d'amour, so famous in the history of chivalry. The subjects brought before these courts were chiefly connected with the Romantic gallantry of the period, and consisted either of questions proposed with the view to entrap the judges into some awkward decision; or of serious complaints, resulting from affaires du cœur, which were discussed and decided upon with all the formality of a court of law. These minnehöfe were for a long period looked upon as forming an indispensable part in all chivalrous exercises. Knights, ladies, and poets participated alike in their proceedings; and large collections of their decisions are still extant. A certain number of ladies, remarkable at once for personal and mental attractions, acted as judges in these courts: the fair sex also conducted the proceedings as counsel, attorneys-general, and solicitors-general, &c.; and they were attended by a numerous train of nobles, knights, and others, who were invested by the court with gradations of rank and precedency analogous to those conferred by the sovereign. These courts were held periodically at Signes, Avignon, Lille, and Pierrefeu. The last regular court of this kind was celebrated by Charles VI. and his wife Isabella of Bavaria; but they were now and then renewed at irregular intervals, and the last on record took place as late as the reign of Louis XIV. at Ruelle, at which the princess Maria of Gonzaga presided, and Mademoiselle de Soudey represented the advocate-general. We subjoin a few specimens of the questions proposed in these courts for debate and decision; from which it will be evident that although at the present day there would be little difficulty in deciding upon them, they could not fail at that romantic era to excite considerable discussion. 1. Which is harder to bear,—the infidelity or the death of the beloved? 2. Whether does a man whose wife, or a lover whose betrothed is unfaithful, suffer most? 3. Who is more culpable,—the man who boasts of favours from a lady which he never received, or he who having really received them makes it known? (See the *Damen Lexicon*, Adorf, 1837.)

MI'NNESÆNGERS. The most ancient school of German poets, whose name is derived from the old German word minne (*love*). The songs and fame of the Provençal troubadours appear to have penetrated into Germany under the first emperors of the house of Hohenstauffen; in whose time the crusades and the frequent Italian wars combined to bring their nation, seated as it is in the centre of Europe, in closer communication with those surrounding it. The minnesængers imitated in German the strains of those early poets, and, like them, made love their principal subject; which was celebrated with much of pedantry and false conceits, but, at the same time, not without generous and chivalric feeling. The verses of the minnesængers are in the old Swabian dialect of the high German, which, under the Hohenstauffens, themselves of Swabian race, was the court language. As was the case with the troubadours, the minnesængers belonged to two different classes: there were among them many knights, princes, and even sovereigns; while there was also another class of more professional poets—wandering minstrels, who attached themselves to the persons of distinguished chiefs, or wandered from court to court. The oldest of the minnesængers known to us is Henry of Veldeck, about 1170. During the remainder of the 12th and first half of the 13th century this school of poets flourished; afterwards it gradually declined, and was succeeded by the less chivalrous and homelier school of the master-singers. We possess the names of more than 300 poets, and pieces of the composition of a large proportion of them, who sang during the short period in question. The German amatory poets had their high and low minne, like the celestial and popular Venus of the ancients; the former an abstract and chivalric devotion to a beloved object, the latter a less elevated passion. The ancient German national epic, called the *Niebelungen-Lied*, and the heroic poetry of the *Heldenbuch*, belong to the same period and dialect, and were works of the same race of poets; as were also other poetical romances, founded on the foreign traditions of France, Britanny, and classical antiquity.

MI'NNOW, or MINIM. (Lat. minimus, *least.*) The name of a species of Cyprinoid fish (*Leuciscus phoxinus*, Cuv.), and the smallest of the British species of that family. It inhabits many of the fresh water streams and canals in England, and spawns in June, when each female is attended by two males.

MI'NOR. In Music. *See* MAJOR.

MINO'RITY. In Politics, the period during which the sovereign in an hereditary monarchy is incapacitated from exercising the supreme authority by reason of not having attained the age prescribed by law; also the state of such incapacity. The royal authority, in hereditary monarchies, never dies; and when a sovereign deceases leaving a successor below age, it passes immediately to the person or persons whom the constitution has invested with the authority of regent; as it also does when a king becomes subject to any other incapacity. The term of royal minority is variously regulated by the constitution of different countries. The legal majority of a king of France was fixed at fourteen by an ordinance of Charles V., which has been since followed in that country; but, as a year commenced is reckoned as accomplished, the actual period at which a king of France begins to govern is the age of thirteen years and a day. The same period is fixed by the laws of Spain and Portugal. By the constitution of Great Britain the sovereign is of full age at eighteen years, as far as can be collected from the statutes passed at several times to empower the king to name a regent whenever it has been apprehended that the crown was in danger of devolving on a prince under age.

MINORITY. In Law, the state of an individual of either sex who has not attained the age prescribed by law at which civil rights can be exercised. In England and in France majority is attained on the completion of the 21st year; in Germany on the 25th. The distinctions made by the Roman law between different periods of minority are unknown to our law.

MI'NOR TERM, of a Categorical Syllogism, in Logic, is the subject of the conclusion. The minor premise is that which contains the minor term. In hypothetical syllogisms, the categorical premise is called the minor.

MI'NOS, in Mythological History, was son of Jupiter and Europa, and king of Crete, and so celebrated as a lawgiver on earth that after his death he was appointed judge of the infernal regions, in which office he was associated with Æacus and Rhadamanthus.

MI'NOTAUR. (Gr. Μινως, and ταυρος, *a bull.*) A fabled monster of classical antiquity, half man and half bull, frequently mentioned by the poets. He was said to be the son of Pasiphäe, wife of Minos II. king of Crete, by a bull (ταυρος); hence the term Minotaur. He lived on human flesh; hence Minos shut him up in the famous labyrinth of Dædalus, feeding him with criminals, and afterwards with youths and maidens sent from Athens. As is well known, Theseus, by the assistance of Ariadne, succeeded in destroying him, and thereby rescued the Athenians from the obligation of sending their children to be devoured. The *Dict. de la Conversation* gives an ingenious explanation of this mythological story. See also *Schwenk's Mythologische Andeutungen*, p. 65.

MI'NSTER (Germ.), was anciently applied only to the church of a monastery or convent; and forms the

termination of the name of many places in England in which such churches formerly existed, as Westminster, Leominster, &c. It is sometimes, but incorrectly, used in common language to signify a cathedral church.

MI'NSTRELS. (Fr. minestral, or old Germ. minne, *love*.) Defined by Percy as an order of men in the middle ages who subsisted by the arts of poetry and music, and sang to the harp verses composed by themselves or others. They appear to have been the successors of the minnesængers, scalds, and bards of different European nations, who, even after the age of chivalry had passed, attempted to gain a subsistence by practising those arts which at an earlier period had procured fame and honour for their predecessors. The origin, character, and decline of the minstrels, are thus ably traced in vol. lxxiii. of the *Edin. Review*. In the piping times of peace the minstrel, "*omnis luxuriæ interpres*," as Pliny said of Menander, sang of mimic war to the dull barons of dungeon castles, who had ears, although they could not read — who, doubly steeped in the ennui of wealth and want of occupation, listened greedily, like other great men, to their own praises. Minstrelsy supplied the lack of a more refined intellectual entertainment and of rational conversation, as professional gentlemen do now at civic banquets: their harpings lulled the rude Sauls to sleep, which is now done by quarto epics. The person of the minstrel was sacred; his profession was a passport; he was "high placed in hall a welcome guest:" the assumption of his character became the disguise of lovers of adventure. These advantages raised pseudo-laureates, "idle vagabonds," according to the act of Edward I., "who went about the country under the colour of minstrelsy;" men who cared more about the supper than the song; who, for base lucre, divorced the arts of writing and reciting, and stole other men's thunder. Their social degeneracy may be traced in the dictionary: the chanter of the *gests* of kings, — "gesta ducum regiomque," — dwindled into a "gesticulator," a jester; the honoured joglar of Provence into the mountebank, the juggler, "the jockie," or doggrel balladmonger.

Beggars they are by one consent,
And rogues by act of parliament.

They descended by the usual stages of things of mere fashion: at first the observed of all observers, and therefore then imitated, until they became common — vulgar; which is but one step, and the test at once of merit, universal acceptance, and the forerunner of disgrace: no sooner taken up by the οἱ πολλοι than rejected by the exclusive. In Spain, particularly, this occurred very soon. The really good clergy were shocked at their abuses, while the interested grudged the money earned by rivals who interfered with their monopoly of instructing the people in pious prose, or of amusing them with alexandrine legends. Their Latin synonyme for "scald rhymers" — *scurra mimus*, &c. — will outlive their sculptured caricatures; when mendicant monks, minstrels, fools, monkeys, and beasties are pilloried on pinnacle and gargoyle, in cloister and cathedral. The itinerant monks and mountebanks repaid all this, like Falstaff, by showing up the irregularities of regulars and seculars, "in ballads to be sung to filthy tunes." They undermined their influence. Preachings and songs take part in all national changes; for doctrines precede actions. They were the popular press of the time; opposed by the privileged orders, and watched by statesmen, as Burleigh afterwards employed agents to listen to street songs, — the thermometer of the people's temper. In all these alterations for the worse, the primitive principle "to entertain" remained unchanged. To this the original ballad was sacrificed; passing from one to another, each minstrel begged, borrowed, or stole from all quarters. The originals were corrupted and remodelled; they got their bread by pleasing, — "*magister artis ingenii que largitor venter*." As late as the beginning of last century the houses of many leading families, especially in the northern parts of the empire, were provided with minstrels, who were employed in various duties; all of them, however, in some degree connected with their original occupation. *See* Bard, Scald, Minnesængers, Ballad.

MINT. (Germ. müntze.) The place in which the coin of the realm is manufactured. The whole of the British coin is issued from and manufactured in the Royal Mint in London. The general details of the business of the Mint are briefly stated under the article Coinage.

The Royal Mint received its constitution of superior officers in the 18th year of the reign of Edward II., and continued nearly as then established to carry on its operations within the Tower of London.

Between the years 1810 and 1815 the present magnificent and commodious building was erected on Tower Hill, at the suggestion of a committee of the king's privy council, appointed in 1798 "to take into consideration the state of the coins of the kingdom, and the establishment and constitution of the Mint;" and in 1815 a new constitution was introduced, founded upon a report drawn up by the present Lord Maryborough, who was then master.

The chief officers of the mint are the master, the deputy master, the comptroller, the king's (or queen's) assay masters, the clerk of the papers, and the clerk of the irons and superintendent of machinery: these constitute "the mint board," and meet every Wednesday, or as often as may be required, to transact all the general business of the establishment. The manufacture of the coin is carried on under the direction of the company of moneyers. The other officers are the master's assayer, the melter, the chief engraver, the weigher and teller, the surveyor of the meltings, and the solicitor. The duties of these officers are fully set forth in the "mint indenture." As relates to the general history of the coinage, the reader is referred to the new edition of *Ruding's Annals of the Coinage*. The article "Coinage," in the *Encyclopædia Britannica*, gives an abstract of the duties of the respective officers, and is especially valuable as containing the only extant account, illustrated by engravings, of the machinery employed in the mint: this account, though scanty and imperfect, is tolerably correct. A mass of valuable information, and details respecting the whole establishment, will be found in the *Parliamentary Report of the Select Committee on the Royal Mint*, and its Appendix, published by order of the House of Commons, 30th June, 1837.

Mint. (Lat. mentha.) A name given to several herbaceous aromatic plants belonging to the natural order *Labiatæ*, and genus *Mentha*. Spearmint, or *Mentha viridis*, is that which is so generally used in this country, mixed with vinegar and sugar, as a sauce. Peppermint, or *Mentha piperita*, yields the stimulating oil of the same name. Horsemint and others are also species of the same genus.

MINT, MASTER OF THE. An officer in the English administration, generally removeable with a change of ministry. His salary is 2000*l*. a year. *See* Mint.

MI'NUET. (Fr.) A species of dance performed in slow time and with measured steps, formerly of great celebrity, but now rarely if ever met with.

MI'NUTE. (Lat. minutum.) The sixtieth part of an hour of time, and the sixtieth part of a degree of angular space. In modern astronomical works minutes of time are denoted by the initial letter *m*, and minutes of space by the dash or acute accent, which was first used by Ptolemy.

Minute. In Architecture, the sixtieth part of the diameter of a column; by which subdivision architects measure the smaller parts of an order.

MINUTE GUNS. Guns fired at intervals of a minute, as a signal from a vessel in distress. Also in mourning for great persons.

MI'NUTES. Originally the rough draft of a public instrument drawn up by a notary; so termed because usually written in a smaller character than the instrument itself. The term is now applied to a brief report of the proceedings of a society drawn up by the clerk or secretary: in which sense it is nearly synonymous with *protocol*, which see.

MI'OCENE. (Gr. μειων, *minor*, and καινος, *recent*.) A term applied by Mr. Lyell, in his *Elements of Geology*, to geological formations containing a *minority of fossil shells of recent species*.

MI'QUELETS. In Modern History, a species of partisan troops raised in the north of Spain, and chiefly in Catalonia. The Miquelets became first known in the wars between Spain and France in the 17th century. At several periods (in 1689, 1789, and again in the wars of Napoleon) the French have endeavoured to organize similar corps, to oppose to the Miquelets in the mountain warfare of those districts.

MI'RACLE. (Lat. miror, *I wonder*.) According to the definition of Dr. Johnson, "something beyond human power;" which, though in itself evidently vague and insufficient, may be explained by the addition of "a deviation from the established laws of nature." A miracle must be not only superhuman, but preternatural. Some writers add the "immediate interference of God" as another condition of a miracle; but this assumes a point which is open to controversy, inasmuch as it precludes the agency of evil spirits in such interruptions of the course of nature, which is still a question among theologians. With respect to the credibility of miracles, the most popular argument against them is that of Hume, who considers no weight of particular testimony credible when balanced against our universal experience of the constancy of the laws of nature. "No testimony," he says, "is sufficient to establish a miracle, unless the testimony be of such a kind that its falsehood would be more miraculous than the fact it endeavours to establish." If the words *incredible* or *contrary to experience* be substituted for *miraculous* in this passage, the startling effect of this statement of the argument, in which its efficacy resides, will disappear, and the question will be left upon the very grounds which the believer would choose for his own position. Hume was answered by Dr. Campbell, in his *Dissertation on Miracles*. (See also *Rutherford's Discourse*, 1757; *Douglas's Criterion*;

Locke's Discourse on Miracles; Lardner's Credibility; Middleton's Free Inquiry; Price's Nature of Miracles; some very valuable remarks of Paley, in his *Evidences of Christianity; Hooker's Eccl. Polity*, b. vii. "on Miracles as the Tests of a Supernatural Mission;" *Bentham's Rationale of Evidence.*)

MIRA'GE. (Fr.) An optical illusion very common at sea, and especially in high latitudes, and sometimes also witnessed on land, particularly in Egypt and Persia, and on the margin of rivers and lakes, or on the sea-shore. It arises from unequal refraction in the lower strata of the atmosphere, and causes remote objects to be seen double, as if reflected in a mirror, or to appear as if suspended in the air. When the effect is confined to apparent elevation, the English sailors call it *looming;* when inverted images are formed, the Italians give it the name of *Fata Morgana* (see the term). Ships in the whale fisheries are often descried, and sometimes known, by means of the mirage, at considerable distances. Captain Scoresby recognized his father's ship at the distance of more than 30 miles, and consequently when below the horizon, by its inverted image in the air, though he did not previously know that it was cruising in that part of the fishery. The mathematical theory of the phenomenon is given by Biot, in the *Memoires de l'Institut* for 1809. (See also *Caddington's Optics; Biot's Traité de Physique*, tome iii.; *Brewster's Optics, Cabinet Cyclopedia.*)

MI'RROR. (Fr. miroir.) A speculum or looking-glass, or any other polished body capable of reflecting the images of objects, rays of light from which fall upon them. Silver is considered to be the most powerful reflector; but the speculum metal, as now prepared, is scarcely inferior, if at all so, and in some cases even better. In the very early ages of the world, polished metallic specula were employed as mirrors by the Jewish and Egyptian women, especially of brass; but in modern times, quicksilvered plates of glass are alone used as mirrors.

Concave mirrors are used to concentrate the rays of the sun in a single point, and thereby produce intense heat. The surfaces formed by the revolution of the ellipse, parabola, and hyperbola, are such as reflect them accurately to one point; provided they emanate from one point, are parallel to one another (as the solar rays), or would converge to a more remote point than the one which it is desirable to use. The great difficulty of constructing these has led to the employment of spherical segments, which, though not accurate, yet, under proper restrictions are approximately so. For the mathematical theory, see REFLECTION; see also BURNING GLASS, SPECULUM TELESCOPE.

MIRZA. (A corruption of the Persian title Emir-Zadeh, *sons of the prince.*) The common style of honour in Persia, when it precedes the surname of an individual. When appended to the surname, it signifies prince.

MISA'NTHROPY (Gr. μισος, *hatred*, and ανθρωπος, *a man*), signifies a general dislike or aversion to man and mankind; in contradistinction to *philanthropy*, which means the love of our species.

MI'SCELLANY. (Lat. misceo, *I mix.*) A word usually applied to a collection of literary works or treatises. The most celebrated collection of works known by this name is *Constable's Miscellany.*

MI'SCHNA. The text of the Jewish Talmud, on which the *Gemara*, or second part, is a commentary. It consists of traditions and explanations of scripture. The former are supposed by the Jews to have been delivered to Moses on the mount, and from him to have passed, through the keeping of a succession of prophets and sages, to Rabbi Juda of Tiberias, who committed them to writing. Their compilation is supposed by modern commentators to have taken place about A. C. 150 or 190. (See Prideaux, *Connexion*, vol. ii.; and Lardner, *Collection of Jewish and Heathen Testimonies*, vol. i.)

MISDEMEA'NOR, in Law, is any offence which is the subject of indictment and punishment, not of a felonious character; such are seditious acts, perjury, battery, libels, conspiracies, attempts, and solicitations to commit felonies, &c. Over these offences the justices of the peace at quarter sessions have a general jurisdiction, although they may be removed by certiorari to the King's Bench; and in the trial the defendant has had for a long period of time one remarkable privilege, viz. that his counsel might address the jury, which was equally the case in treason, but not until the year 1837 in any sort of felony. The ordinary punishment of misdemeanors are by fine and imprisonments; sometimes, by statute, transportation. Misdemeanors have been sometimes termed *misprisions;* although this word, in its more restricted signification, is applied to concealments of felony, or treason.

MI'SELTOE, or MISSELTO. A parasitical plant inhabiting the branches of many kinds of trees in the north of Europe. It is the *Viscum album* of botanists. Its connection with Druidical ceremonies is well known; but, as tradition tells us that the priests of that superstition only employed the miseltoe of the oak, some doubt has been entertained of the plant now so called being really that of our ancient chronicles, because it had not been found upon the oak for many centuries. It has, however, been recently discovered upon that tree in the west of England; and this leaves no doubt upon the subject. The powder of the leaves or shoots of the misletoe has been used in epilepsy.

MISERE'RE. The 50th Psalm, 4th of the Penitential Psalms, is that designated by the Roman Catholic church under this word, on account of its first words (in the Vulgate translation, "miserere mei Deus, secundum magnam misericordiam tuam"). It is the usual psalm appointed for acts of penitence and mortification.

MI'SERE'RE MEI. A name given to the iliac passion.

MI'SERICO'RDIA. A narrow-bladed dagger; so termed in the middle ages because it was the weapon used by a knight against a dismounted adversary when he enforced him to cry for mercy.

MISNO'MER. In Law, the description of a person by a wrong name. In grants by deed such mistakes may, in some instances, be corrected by the courts, if the party be sufficiently pointed out in the instrument itself. In grants by will such construction will be more liberally exercised. It is said that the law is not so precise as to surnames as with respect to Christian names. The proper mode for the defendant to avail himself of a misnomer in an action was formerly by plea of abatement; but now the court will amend on motion (3 & 4 W. 4. c. 42.). In criminal cases, the court had the power to amend still earlier (6 G. 4. c. 64.) where the defendant was misnamed. But if the prosecutor be misnamed in an indictment, the variance is fatal, and the defendant must be acquitted. It is to be observed that mere misspelling is no misnomer, if the name have the same sound with the real one.

MISPRI'SION. (From the Fr. mespris, *contempt*, or *negligence.*) In Criminal Law, in its larger sense, it is used to signify every considerable misdemeanor which has not a certain name given to it in the law; and it is said that the offence of misprision is involved in every treason or felony whatsoever. Generally, however, by the word misprision is understood the contempt or neglect, that is, the non-disclosure or concealment, of any treason or felony, committed or to be committed, which a man is cognizant of, but has never assented to; for if he expressly assented, this makes him, in a case of treason, a principal, and, in a case of felony, either a principal or accessory, according to circumstances. Misprision of treason is punished by loss of the profits of lands during life, forfeiture of goods, and imprisonment for life. Misprision of felony in a public officer is punished by imprisonment for a year and a day; in a common person, by imprisonment for a less discretionary time; and in both by fine.

MI'SSAL. The book containing the ritual for the celebration of the various masses of the Roman communion. The missals in use in different churches are not identical in all respects; but the most important part of them, the canon of the mass, as delivered in the Sacramentary of Gregory the Great, which was taken from that of Pope Gelasius in the 5th century, and which is affirmed by Roman Catholics to be a faithful representation of the ritual of the primitive church, is common to all.

MI'SSIONARIES. In ordinary language, ministers who go abroad to preach the gospel to infidel nations. The following table of the present condition of some of the more remarkable missionary societies now existing in England is taken from the *Penny Cyclopedia:*—1. Society for the Propagation of the Gospel in Foreign Parts: receipts, 1837, 43,000*l.*; expenditure, 56,000*l.*; subscribers, about 12,000. This society is conducted on the principles of the Church of England, and was incorporated in 1701, chiefly with a view to our then American possessions. 2. Baptist Missionary Society, founded 1786: receipts, 1837-8, 22,000*l.*; expenditure, 20,000*l.* The operations of this society are chiefly carried on in the East and West Indies. 3. London Missionary Society, founded 1795, now chiefly supported by the Independents: receipts, 1838, 70,000*l.*; expenditure, 77,000*l.* Much connected with the East Indies and the South Seas. 4. Church Missionary Society, founded 1804, "for Africa and the East;" but which has recently sent out missionaries extensively to New Zealand: receipts, 72,000*l.*; expenditure, 91,000*l.* 5. Wesleyan Missionary Society, founded 1817: receipts, 85,000*l.*; expenditure, 100,000*l.* Its most extensive field of labour is in the West Indies. 6. Missions of the Church of Scotland: chiefly India. 7. Missions of the United Brethren, or Moravians, who have been distinguished in this line of exertion since 1731. The Danish missions are among the oldest Protestant; those of the United States are now among the most extensive. The history of Roman Catholic missions in the East is detailed in many works. See *Duhalde*, for China. The rise and fall of Christianity in Japan is narrated by Charlevoix (1715); those in America are slightly noticed in the article immediately following this.

MISSIONS. Stations of missionaries in infidel countries. In Geography, the extensive districts formerly under the control of missionaries of the church of Rome, on the borders of the Spanish and Portuguese settlements in America, were so called. These missionaries chiefly belonged to the orders of the Capuchins, Dominicans, and Jesuits; but the latter were the most celebrated and the most successful. Their settlements in Paraguay comprehended a vast province, which they governed with independent authority: in Brazil they had also extensive districts under their control. The downfal of the order was followed by the destruction of these settlements: those of Paraguay were wholly ruined; those of Brazil, by regulations of the Marquis de Pombal, taken from their spiritual governors and placed on a new footing. The missions of the other orders still continue to subsist on the banks of the Upper Amazon and Orinoco, and in California; but they have undergone severe losses from the revolutionary wars. The success of the experiment of governing the American Indians by missionaries has been the subject of much controversy. It is certain that the Jesuits succeeded better than any other governors have done in rendering them industrious, and subjecting them to discipline. But it is contended that this was only effected by an artificial system, which rendered them the servile and childish dependents of their spiritual masters, and that this slavish state was injurious to them, not only in a moral but a physical point of view, inducing premature decay; insomuch that, it is said, the population of all the missions was continually decreasing, although endeavours were made to keep it up by violent seizures of free natives, who were brought by force within their boundaries. See Charlevoix, *Hist. du Paraguay;* the *Lettres Edifiantes;* Raynal, *Histoire des Indes;* and *Southey's History of Brazil:* the two last writers especially for philosophical views on the subject, although the latter is perhaps too favourable; *Humboldt's Personal Narrative,* for those on the Orinoco; *Forbes's California,* for a very unfavourable view of the condition of those in the latter country. American missionaries have established a government, somewhat similar to those of the Roman Catholic orders, in some of the South Sea Islands. See *Ellis's Polynesian Researches;* the *Voyages* of Capt. Beechey, Capt. Fitzroy, and others.

MITES. A tribe of minute Acaridan Condylopes, which do not suck their food. *See* ACARUS.

MI'THRAS. The grand deity of the Persians, supposed to be the sun or the god of fire, to which they paid adoration as the purest emblem of the divine essence. The Romans also raised altars to the honour of this divinity, with the inscriptions *Deo Soli Mithræ,* or *Soli Deo invicto Mithrae.* As to the introduction of this oriental worship in Rome, see *Mem. de l'Ac. des Inscr.* vol. xvi. p. 270. It was one of those which resisted Christianity the longest. See Beugnot, *Destruction du Paganisme en Occident; Milman's Hist. of Christianity.*

MI'THRIDATE. A celebrated medicinal confection, invented by Damocrates, physician to Mithridates, king of Pontus, and supposed to be an antidote to all effects of poison and contagion; its active ingredient was opium.

MI'TRAL VALVES. The valves of the left ventricle of the *heart.*

MI'TRE. (Gr. μιτρα, *a head band, or diadem.*) The pontifical ornament worn on the head by the pope, cardinals, and in some instances by abbots, in the Roman catholic church, and in the Protestant episcopal church by archbishops and bishops, upon solemn occasions. It appears to have been a hierarchal head covering from the earliest ages of antiquity. Pellerin says, it was that worn by the regal pontiffs of the Hebrews, and, with a few slight modifications, was afterwards adopted by the oriental kings and pagan high priests under the name of *cidaris.* Among the Romans the mitre was originally a sort of head-dress worn by ladies; and Servius makes it a matter of reproach to the Phrygians that they were dressed like women, inasmuch as they wore mitres. There is every reason for supposing that in England the mitre was worn by the bishops on the first introduction of Christianity into the island; and it is supposed in *Gough's Sepulchral Monuments* (vol. i. p. 153.) that the practice was borrowed from the apex or tutulus of the Flamen Dialis in ancient Rome. As an heraldic ornament the mitre of a bishop is surrounded by a fillet set with precious stones: the archbishop's mitre, on the other hand, issues from a ducal coronet.

MITRE. In Architecture, a junction of two pieces of wood or other material at an interior or exterior angle by diagonal fitting.

MI'TTIMUS. (Lat. *we send.*) In Law,—1. a writ for transferring records from one court to another; 2. a precept under the hand and seal of a justice of peace committing an offender to his charge. *See* COMMITMENT.

MIXED CADENCE. In Music. *See* CADENCE.

MIXED FEVER. A fever intermediate between inflammatory and low or typhus fever.

MI'ZZEN MAST. The name given to the mast which supports the after sails, being nearest the stern of the ship.

MNEMO'NICS. (Gr. μνήμη, *memory.*) The art of refreshing the memory of particular things by artificial aids. The common processes of tying a knot in a handkerchief, &c., will exemplify the simplest species of mnemonics, in which we endeavour to connect certain arbitrary acts with peculiar associations, so that the memory of the former may call up the latter. Some persons have taken the precaution, before delivering an address by heart, of entering the room in which it was to be spoken, and connecting in their own minds particular portions of their intended language with certain visible objects in the room. The well-known solemnities observed on the perambulation of parish boundaries, &c., form another instance of practical mnemonics, the object being to fix the memory of particular spots in the mind of those present. For the purpose of facilitating the remembrance of dates, names, &c. various methods have been devised by different writers (especially Feinagle and Gray in England) under the names of Memoria Technica, or Artificial Memory.

MNEMO'SYNE. (Gr. μνημοσυνη.) In Classical Mythology, the goddess of memory: daughter, according to the genealogists, of Uranus (Heaven) and Gaia (Earth), and mother, by Jupiter, of the Nine Muses. Her statues usually have the figure enveloped in long and ample drapery, and the right hand raised towards the chin.

MOAT. A ditch made round the old castles, and filled with water. In some cases this still remains, as at Lickhill Castle; whilst in others they are drained and planted, as at the palace of the Black Prince at Eltham. For the most part, however, all traces of them have disappeared.

The moat surrounding a military fortress of modern construction (or the *ditch*) is left dry; but where it is capable of inundation at pleasure, this circumstance is considered an advantage to the system of defence.

MOBI'LITY. (Lat. moveo, *I move.*) One of the general properties of matter, in virtue of which every body at rest can be put in motion by the action of a force adequate to overcome its inertia. *See* MATTER.

MOCHA STONE. A species of agate.

MO'CKING BIRD. A name given to one of the family of thrushes, the *Turdus polyglottus* of Linnæus, on account of the surprising facility and accuracy with which it can imitate almost any sound; it is also the finest of natural song-birds, and the vocal organs, which are well developed in all the thrush tribe, find their highest perfection and complication in the mocking bird.

This species, in modern ornithological systems, forms the type of a genus (*Mimus* of Boié): it includes other species besides the *M. polyglottus,* all of which are natives of America.

MODE. (Lat. modus.) A term used by Locke to denote "such complex ideas, which, however compounded, contain not in them the supposition of subsisting by themselves, but are considered as dependences on or affections of substances." Of these modes there are two kinds — *simple* and *mixed.* Simple modes are "only variations or different combinations of the same simple idea, without the mixture of any other, as *a dozen* or *a score,* which are nothing but the ideas of so many distinct units added together." *Mixed modes* are those "compounded of simple ideas of several kinds put together to make one complex one, — e. g. *beauty;* and consisting of a certain composition of colour and figure, causing delight in the beholder." It need hardly be said that this distinction is founded on a very imperfect and false analysis. The term is now universally laid aside by writers on mental philosophy.

MODE. In Music, the melodious constitution of the octave, as consisting of seven essential and natural sounds besides the key or fundamental. It is not any single note or sound, but the order of the concinous degrees of an octave, the fundamental note whereof may, in another sense, be called the key, as it signifies the principal note which regulates the rest. The difference between a mode and a key is, that an octave with its natural concinous degrees is called a mode with respect to the manner of dividing it, whilst as regards its place in the scale of music or pitch it is called a key.

MO'DEL. (Lat. modulus.) In Mechanics, a small or miniature representation of the structure of a machine, so as to exhibit its mode of working, &c. Owing to the effect of increased mass in making the machine itself, the results obtained from the model exceed those of the machine in a greater ratio than the linear dimensions of the two works.

MODEL. In the Fine Arts, that which is an object of imitation. In Painting and Sculpture, it is the individual whom the artist procures for getting up his proportions, details, play of the muscles, &c. Also in Sculpture, it is a term applied to the small sketch in wax or clay for a work of art. In Architecture, it is a small pattern in relief, either of wood, plaster, or other material, of the building proposed to be executed.

MO'DELLING. In the Fine Arts, the art of making a mould from which works in plaster are to be cast; also used for the forming in clay of the design itself.

MODERA'TORS, SENIOR and JUNIOR. In the University of Cambridge, two public officers appointed annually to perform various duties. They are ex officio examiners in the senate house. Their name is derived from another of their duties; viz. that of moderating or presiding in the opponemies, or exercises publicly performed in the schools between undergraduates candidates for the degree of bachelor of arts. These disputations, relics of the old university system, are now reduced to little more than matters of form. *Moderator* is also the name applied to the president for the time being of the General Assembly of the Church of Scotland, and of the other inferior church courts, the synods, and presbyteries.

MODI'LLION. (Fr. modillion.) In Architecture, an ornament sometimes square on its profile, and sometimes scroll-shaped, thus , with the intervention of one or two small horizontal members placed at intervals under the corona in the richer orders. They should stand centrally over columns when the latter are employed. They are simplest in the Ionic and Composite orders, more carving being bestowed on them in the Corinthian order. The mutule of the Doric order, which should always stand over the centre of a triglyph, is the same sort of thing, and occupies the same place in the entablature as the modillion.

MO'DULATION. (Lat. modulor.) In Music, the act of moving through the sounds in the harmony of any particular key to those of another; or the transition from one key to another.

MO'DULES. (Lat. modulus.) In Architecture, a measure equal to the semidiameter of a Doric column. It is a term only applied in the Doric order, and consists of thirty minutes.

MO'DULUS. In Analysis, the constant coefficient or multiplier in a function of a variable quantity, by means of which the function is accommodated to a particular system or base. Thus, in the theory of *logarithms*, it is the number by which all the logarithms in one scale of notation must be multiplied to adapt them to the same number in another scale. The only scales or bases actually used in calculation are those of the hyperbolic (or Napierean) and of the common logarithms; and the modulus of conversion is 0·43429448. For *modulus* of elasticity, see ELASTICITY.

MO'DUS (Modus decimandi, or special manner of tithing), in Law, is when lands, tenements, or some certain annual sum or other profit, hath been given time out of mind to a parson and his successors in full satisfaction and discharge of all tithes in kind. It is in some cases a pecuniary compensation, in others compensation in work and labour. *See* TITHES.

MOGRA'BIANS, or MEN OF THE WEST. A name formerly given to a species of Turkish infantry composed of the peasants of the northern parts of Africa, who sought to ameliorate their condition by entering into foreign service.

MOG'UL, GREAT. The name by which the chief of the empire so called, founded in Hindostan by Baber in the 15th century, was known in Europe. The last person to whom this title of right belonged was Shah Allum; and the Mogul empire having terminated at his death in 1806, his vast possessions fell chiefly into the hands of the East India Company.

MOHAIR. (Gr. mohr; Fr. moire; It. moerro; Sp. mue, muer.) The hair of a variety of the common goat, famous for being soft and fine as silk, and of a silvery whiteness. It is not produced any where but in the vicinity of Angora, in Asia Minor. The exportation of this valuable and beautiful article, unless in the shape of yarn, was formerly prohibited; but it may now be exported unspun. The production, preparation, and sale of mohair have long engrossed the principal attention of the inhabitants of Angora; and it used to form an important article of Venetian commerce. It is manufactured into camlets and other expensive stuffs. Hitherto but little has been imported into England.

MOHA'MMEDANISM. One of the most celebrated systems of religion in the world; so called from Mohammed, its author and founder, who was born at Mecca, in Arabia, in May, 571. This founder of a new religion and of a political power, which even in his lifetime extended over his native country, and which under his successors threatened to embrace the empire of the world, traced his genealogy in a direct line through eleven descents from Koreish, the founder of the powerful tribe that bore his name, and who again was affirmed to be in direct descent from Ishmael, the son of Abraham. The future prophet sprung, therefore, from the noblest tribe of the Ishmaelitish Arabs; and his grandfather was at the time of his birth sovereign of Mecca, and guardian of the *Caaba* (which from time immemorial had been identified in the minds of the Arabs with every sacred feeling); consequently, from the sanctity of his territory and his office, a prince of great power and influence. But though descended from so powerful a family, Mohammed's early life was spent in comparative dependence. His father was a younger son of Abdol Motalleb; and having in his early infancy lost both his parents, his only inheritance was five camels and a female slave. On his paternal grandfather was devolved the guardianship of the future prophet; but of this protector he was deprived by death when only eight years of age. In a dying charge Motalleb confided this tender plant of the ancient stock of the Koreish to the hands of Abu Taleb, his eldest son, and the successor of his authority, who amply redeemed the trust reposed in him by continuing throughout life the steadfast friend of his ward amid all the difficulties and dangers to which the latter was exposed in the promulgation of his doctrines. His education, however, is said to have been extremely scanty; and at the early age of thirteen, being intended for a commercial life, he accompanied his uncle's trading caravan into Syria. He afterwards entered into the service of Khadijah, a rich widow of Mecca, to whom his skill in commerce or his other accomplishments so far endeared him that at the end of three years she bestowed upon him her hand and fortune, — an alliance which restored him to the station of his family. At this period he was twenty-five, and his wife forty years of age.

During the first thirteen years of his marriage little or nothing is known of his history; but at the termination of that period he withdrew from society, — resorted to a cave in the neighbourhood of Mecca, where he gave himself up to contemplation, and laid the foundation of that bold and hazardous project which afterwards raised him to glory and dominion. It was in this retirement he gave out that for two years he was in daily communication with the Deity.

In his 40th year he assumed the prophetic office, and displayed his views and principles to his domestic circle. His first convert was Khadijah, whom he always regarded with affection, and even reverence, and whom he placed, after her death, among the only *four* perfect women the world ever saw; the other three being Miriam, the sister of Moses; the Virgin Mary; and Fatima, the youngest of his own daughters. The progress of the new sect was at first very slow. Three years were silently employed in the conversion of fourteen (some say nine) proselytes; but in the fourth year he extended the theatre of his preaching, and proclaimed his doctrines publicly to his fellow-citizens. The faith which, under the name of Islam (*i. e.* salvation), he preached, was compounded substantially of two great principles, which, as Gibbon says, involves an eternal truth and a necessary fiction; namely, that "there is only one God, and that Mohammed is his prophet — the last and greatest of the prophets." He did not, however, aim so much at founding a new religion as reforming the old, as declared by the former prophets, Adam, Noah, Abraham, Moses, and Christ, by putting an end to those superstitions and idolatries by which the true faith had been corrupted. Being urged to confirm the reality of his divine mission by miracles, he wisely declined the attempt, appealing to the internal evidence of his doctrines, and declaring that miracles would depreciate the merit of faith. The only miracle which he professed to have accomplished is a nocturnal journey from Mecca to Jerusalem, and thence through the heavens, on an imaginary animal called Borack, *i. e.* lightning; but the words of the *Koran* are often regarded as figurative and allegorical. He persevered with assiduity in the public exercise of his mission. The citizens of Mecca listened to the exposition of his principles with patience till he attacked the idols of the Caaba. This, however, raised such a storm against him, particularly on the part of the Koreishites, that notwithstanding the protection of Abu Taleb, who, though not converted to Islamism, continued the warm and steadfast protector of his nephew, many of his followers fled to other countries, chiefly to Ethiopia. This happened in the sixth year of his mission, and is called the *first Hegira*, or flight.

In the tenth year of his mission he lost both his wife Khadijah and his uncle Abu Taleb. The death of the latter being the severest blow that the new faith had yet sustained, this year is known in the Mohammedan annals as "the year of mourning." The death of Abu-Taleb removed the only check to the virulent enmity of the Koreishites; and a stranger having succeeded to the sovereignty of Mecca, after a troubled residence of three years, marked, however, by the accession of many proselytes, Mohammed, on the invitation of a deputation from Medina, fled to that city; and instantly, as if by magic, the proscribed and condemned exile became a powerful, and, as it soon appeared, an all but invincible monarch. The flight from Mecca to Medina, which is called the *second Hegira*, or *par excellence* THE HEGIRA, is the epoch from which the Mohammedans date their æra. It occurred in the 53d year of Mohammed's age, and 13th of his mission, and coincides with the 16th July, A. D. 622.

Hitherto Mohammed had used only the mild words of persuasion and argument in propagating his religion. Throughout the eighty-five chapters of the *Koran*, published at Mecca, so far from the use of any species of coercion being recommended to be employed in support of his faith, he exhorts his followers to bear with meekness the injuries to which their principles might expose them, declaring that he had no authority to compel any one to embrace his creed. In the eighteen chapters published at Medina, on the contrary, he taught a very different doctrine, and announced that God had commanded him to extirpate idolatry by force of arms, and to force universal submission to his authority. The enjoyments of paradise were promised to "those who fight for the cause of God, whether they be slain or not." (Sur. 11. 4 9.) Nor were those mere words of course; they were soon reduced to practice. Mohammed, soon after his arrival in Medina, assumed the exercise both of the sacerdotal and regal office. The option of friendship, or submission, or battle, was proposed to the enemies of Islamism. His petty excursions for the defence or attack of a caravan prepared his troops for the conquest of Arabia. But what established his power, and laid the foundation of future conquests, was the issue of the battle of Bedr, near Medina, fought in the second year of the Hegira, between the troops of Abu Sophian, the new sovereign of Mecca, and his own, in which the latter, though only a third of the number of the enemy, gained a complete victory, with the loss of only forty men. From this period the progress of Mohammed, if not a complete triumph (for he sustained some defeats), affords an example of perhaps the most rapid success on record; and at the lapse of six years, in the eighth Hegira, his victorious troops entered the city of Mecca, — an epoch from which may be dated the final establishment of the Mohammedan faith in Arabia. The few contests that followed were merely the last struggles of an expiring opposition, and were mostly terminated by Mohammed's generals; while the prophet himself was employed in destroying the idols enshrined in the Caaba, and in consecrating the temple to the worship of the sole God. The year following is known in Mussulman history as the "year of embassies;" because missions were sent to the prophet from a majority of the Arabian tribes, giving in their adhesion to his creed, and recognizing his authority, both sacred and civil.

But while his religion was thus triumphant, and was destined still farther to spread, and to remain, the prophet's own days were drawing to a close. About three years before his death his health had been declining, in consequence of poison that had been administered to him by a Jewess of Chaibor, in order to test the validity of his divine knowledge. But his death was occasioned by a fever of fourteen days, on the 6th June, 632, in the 10th Hegira, in the 63d year of his age. His remains were buried in Medina, in the very room in which he breathed his last; and though the house itself has long since disappeared, a simple unadorned monument marks the spot where his body reposes. The pilgrim, on his way to Mecca, increases the worth of his pilgrimage if he turn aside to visit also the city which contains the ashes of Mohammed.

During the life of Khadijah, Mohammed did not avail himself of the right of polygamy: after her death, however, the restraints which policy or conjugal affection had imposed on him were laid aside, and the utmost license marked his subsequent career. While he limited the number of wives to four in the case of others, he claimed an exemption to himself on divine authority; and married no fewer than seventeen according to some authorities, and nine according to others: strangely enough, all widows except one, —Ayesha, the daughter of Abu Beker. By Khadijah he had four sons, and as many daughters; and by an Egyptian concubine a fifth son: but his sons all died in infancy; and of ten daughters none survived him except Fatima, who was married to her cousin Ali. From this marriage sprang an illustrious offspring; the ancestors of the numerous existing scherifs, or sons of the prophet.

The religion of the supposititious prophet is contained in the *Koran* (*i. e.* book), the contents of which, according to Mohammedan belief, are uncreated and eternal, subsisting in the essence of the Deity, and inscribed with a pen of light on the table of the everlasting decrees, and communicated at different times to Mohammed by the angel Gabriel. The *Koran*, which is written in the purest Arabic, is, with some exceptions, a work characterized by great richness and sublimity. To the beauty of its style, indeed, its author appeals as a proof of its inspiration; but Gibbon has remarked, that "his loftiest strains must yield to the sublime simplicity of the book of Job" (chap. iv.). Its boldest flights, and its general scope, are borrowed from the sacred volume. Indeed, the object of Mohammed seems to have been to recal the inhabitants of the populous country of Arabia to the worship of the only God, and to unite idolaters, Jews, and Christians in the same creed. He taught that the chain of inspiration was prolonged from Adam to the promulgation of the *Koran;* that Christ did not die on the cross, but that a phantom, or a criminal, was substituted in his place, and that he was translated to the seventh heaven; that Christ rejoiced in the assurance of a future prophet more illustrious than himself; and that the promise of the *Paraclete*, or Holy Ghost, was prefigured in the name, and accomplished in the person, of Mohammed, the last and greatest of the prophets. He taught the existence of angels, good and bad, and of the Devil or *Eblis;* describing the latter as having been expelled from heaven, without hope of recovery, for refusing to pay homage to Adam at the divine command. As to the inspired writings, he acknowledged the Pentateuch, the Psalms, and the Gospel. The doctrine of the resurrection and the day of judgment formed part of his faith. He taught that every man shall be judged according to his works; but that the believers in Islamism shall not be subjected (like the wicked idolaters or infidels) to eternal condemnation, but that, after undergoing a purifying punishment, they shall be translated into the regions of bliss. He inculcated the absolute and unalterable predestination of all things. He called prayer "the pillar of religion," and "the key of Paradise;" and he prescribed five different stated periods of prayer daily, accompanied with as many ablutions or purifications of the body. During prayer he first insisted that the face should be turned to Jerusalem, in compliment to the Jews; but afterwards bestowed that honour on Mecca. Alms, fasting, and pilgrimage to Mecca, are the remaining duties of practical religion enjoined on all good Mussulmans. Of the last the most holy was that of Ramadan, instituted in honour of the month in which Gabriel appeared to him in Mecca. Friday was ordained as the Moslem sabbath, because it was on that day he made his flight to Medina. He continued the rite of circumcision in compliment to the prejudices of his countrymen. He condemned usury, and forbade the drinking of wine.

The grossly sensual character of Mohammed's paradise constitutes, perhaps, the greatest blemish in his religious system, and has exerted a debasing influence over all the countries where it has acquired an ascendency.

To the history of Islamism after the death of its illustrious founder we cannot do more than allude. The rival pretensions of Abu Beker and Ali, the latter of whom called himself "the first believer," to succeed Mohammed in the empire he had founded, both gave a temporary check to the progress of the religion, and produced a schism which exists till the present day. *See* SONNITES, SCHIITES.

Notwithstanding the high pretensions of his competitor, Abu Beker was elected to the office of supreme head of the Mussulman religion and power, under the title of "Caliph," or "Khalif," *i. e.* successor of the prophet. Under his sway, and that of his two immediate successors, the most brilliant success attended the Arab arms. Indeed, by the 20th Hegira, or within ten years of the death of the prophet, Syria, Persia, and Egypt, being conquered, adopted the new faith. Ali was chosen the fourth khalif, but achieved nothing very memorable. At his death, which took place by the hands of an assassin, the throne was usurped by a son of Abu Sophian, whose descendants are called the Omayzade race of khalifs. They held the sovereignty for nearly 100 years; during which time the whole of Africa was overrun, and so far colonized by tribes of Bedouins that it has since remained, as to language, manners, and religion, an Arab country. The Islam faith prospered nearly as rapidly in the East; at least within 80 years from Mohammed's death it embraced all the countries between the Indus and the Atlantic, and from the Indian Ocean to the steppes of Central Asia. It has since penetrated even into China, and found its way into many of the islands in the Indian Archipelago. Spain was taken in 711. The Arabs were, for a short time, masters of the South of France, but were finally driven across the Pyrenees in 732. The Omayzade khalifs were, in the 133d Hegira (A. D. 750), superseded by the descendants of Abbas, one of the uncles of Mohammed. This last dynasty is known in history as that of the Abbasside khalifs.

Meanwhile the seat of the khalifat was removed from Medina to Damascus, and latterly to Bagdad. Nor was the khalifate itself of very long standing. It had been tottering for years; but it fell in the 656th Hegira (A. D. 1258); a Tartar army having taken Bagdad, and put an end to the nominal, sacerdotal, and regal power of the khalifs, the real power having, for a long time, resided in the Turkish sultans of Asia Minor. The title of khalif is now recognized as one of the attributes of the grand segnior as successor of Mohammed, and of the sophi of Persia as successor of Ali; but it no longer implies the discharge of any religious functions.

But neither the foreign conquests of the Mussulmans, nor the downfall of the khalifat, made any essential change in the political state of Arabia. The people adhere to Mohammedanism as the true faith, but otherwise

are divided into petty tribes and communities, as before the birth of the pretended prophet. Of two attempts made in Arabia to reform the Moslem faith; all traces of the first (A. D. 890), the object of which was to rescind the prohibition of wine, and to prevent the pilgrimages to the holy ashes, have disappeared. The other took place in more recent times; namely, in the beginning of last century. It was made by Addul Waheb, who proclaimed himself a prophet sent by God to reform the abuses which gradually had been engrafted on the religion of Mohammed. The chief of the Wahabee doctrines, so called from their author, was, that God was to be worshipped in the strictest unity; and that no adoration should be paid to Mohammed, or any created being. (*See* WAHABEEISM.) But while these doctrines were rapidly spreading, and while the cities of Mecca and Medina had fallen into the hands of the new sect, Mehemet Ali, in the name of the sultan, gave an effectual check (1813) to their farther progress, and restored the holy cities to the nominal authority of the Porte. The Wahabee tenets have since been at a stand, or are on the decline, even in Nedsjed, the native province of the founder. (See *Abulfeda, in vita Mohammed; Prideaux' Life of Mohammed*, 8vo. 1710.; *Adam's Relig. World Displayed; D'Herbelot, Bibliotheque Orient.; Green's Life of Mahomet;* the *Travels* of Niebuhr and others; *Burckhardt's Notes on Bedouins and Wahabees; Rycaut's Present State of the Ottoman Empire; Lives of Mohammed by Boulainvillier and Gagnier; Mill's Hist. of Moham.; Forster's Moham. Unveiled;* and especially *M'Culloch's Geog. Dict.*, art. "Arabia.")

MOIDORE. A Portuguese gold coin, value 27*s*. sterling.

MOI'NEAU. (Fr.) A small flat bastion, raised in front of an intended fortification to defend it from the approaches by means of small arms.

MOIRE'E METALLIQUE, called in this country crystallized tin-plate, is a variegated primrose appearance, produced upon the surface of tin-plate by applying to it in a heated state some dilute nitro-muriatic acid for a few seconds, then washing it with water, drying, and coating it with lacquer. The figures are more or less beautiful and diversified, according to the degree of heat and relative dilution of the acid. This mode of ornamenting tin-plate is much less in vogue now than it was a few years ago. (*Ure's Dict. of Arts, &c.*)

MO'LARS, *Molares*. (Lat. mola, *a mill*.) Teeth generally having a flattened triturating surface, and situated behind the incisors, and laniaries when these are also present. In some Mammals, as the Cape ant-eater, all the teeth are molars. They are generally of two kinds; viz. those which are liable to be displaced and succeeded by others in the vertical direction; and those which are succeeded, and sometimes, as in the elephant and kangaroo, displaced by others developed at the back of the mouth, and advancing forwards horizontally: the first are termed false molars, the second kind true molars.

MOLA'SSE. A provincial name used in Switzerland for a soft green sandstone belonging to the Miocene tertiary period. *See* GEOLOGY.

MOLA'SSES. (Port. melasses.) A brown viscid uncrystallizable sugar. (*See* SUGAR.) It is sometimes used in England in preparing the coarser sort of preserves, and on the Continent extensively in the manufacture of tobacco. It has a burned but not a disagreeable taste.

MOLE. A species of the genus *Talpa* (which see), common in this country and other parts of Europe. This quadruped exhibits in perfection that modification of structure by which the Mammiferous animal is adapted to a subterranean life. Its head is long, conical, and tapering to the snout, which is strengthened by a bone, and by strong gristles worked by powerful muscles. The body is almost cylindrical, thickest behind the head, and gradually diminishes to the tail. There is no outward indication of a neck, that part being enlarged to the size of the chest by the massive muscles which act upon the head and fore-legs. These, which are the principal instruments by which the mole excavates its long and intricate burrows, are the shortest, broadest, and strongest, in proportion to the size of the animal, which are to be met with in the Mammiferous class. The rapidity with which the mole can make its way through a favourable soil is such, that it may be said to swim in the earth; and, since it must displace matter so much denser than water, so do its fore-limbs display a mechanism correspondingly superior in strength to the analogous extremities or pectoral fins of the dolphin. The food of the mole consists of worms and insects: its voracity is great, and it soon perishes if food be scarce or wanting. The ardour of the sexual appetite is not less intense and characteristic of this curious quadruped. The sense of sight is very feeble, the eyes being minute and rudimental; but the other faculties of smell and hearing, as being more serviceable in its dark retreat, are extremely acute.

The female prepares a nest of dry herbage, roots, and leaves, in a chamber commonly formed by excavating and enlarging the point of intersection of three or four passages. The young are brought forth to the number of four or five in April, and sometimes later.

The farmer views the operations of the mole as destructive to his crops by exposing and destroying their roots, or by overthrowing the plants in the construction of the mole-hills; his burrows, moreover, become the haunts and hiding-places of the field-mouse and other noxious animals. The mole is also accused of carrying off quantities of young corn to form its nest. Hence, every means are devised to capture and destroy it, and men gain a livelihood exclusively by this occupation. Some naturalists, however, plead that the injury which it perpetrates is slight, and that it is more than counterbalanced by the benefit which it produces by turning up and lightening the soil, and especially by its immense destruction of earth worms, and many other noxious animals which inhabit the superficial layer of the ground, and occasion great injury to the roots of grass, corn, and many other plants. The soundest practical conclusion lies probably in the mean of these opinions; and the enlightened agriculturist, while he takes prompt measures to prevent the undue increase of the mole, would do well to reflect on the disadvantages which might follow its total extermination.

MOLE. In Engineering, a massive work formed of large stones placed in the sea by means of coffer-dams, extended either in a right line or an arch of a circle before a port, which it serves to close, and to defend the vessels in it from the impetuosity of the waves, &c. It is sometimes used synonymously with *harbour*.

MO'LECULE. (Lat. molecula.) A corpuscle or atom, single or compound. Molecules are the elementary particles into which all bodies are supposed to be resolvable.

MO'LINISM. In Roman Catholic Theology, a system of opinions on the subjects of grace and predestination somewhat resembling that advocated by the Arminian party among Protestants. It derived its name from the Jesuit Louis Molina, professor of theology in the university of Evora in Portugal, who laid down a series of propositions on these debated questions in his work, entitled *Liberi arbitrii cum gratiæ donis, &c, concordia*, which appeared in 1588. He was attacked by the Dominicans on the charge of having advocated in it Pelagian or Semi-Pelagian sentiments, and accused before the Inquisition: he appealed to Rome, and the cause was debated for twenty years in the congregations, and left at last undecided by a decree of Paul V. in 1687. Since that period Molinism has been taught as an opinion which believers are free to embrace in Roman Catholic schools, and generally supported by the Jesuit and attacked by the Jansenist party. It must not be confounded with *Molinosism*, — a name which the doctrine of the Quietists has received from the work of a Spanish enthusiast (Molinos) on Mystical Life, condemned in 1687 by Innocent XI. The French Quietists professed to abjure and oppose the errors of Molinos. (*Mosheim*, 17th Cent. 14. 2. part i.) *See* QUIETISTS.

MO'LISITE. A mineralogical name of the crystallized titaniate of iron of Dauphiny.

MO'LLAH. The title of the higher order of judges in the Turkish empire. After the three first magistrates of the empire (the two cadil-askers of Roumi and Anatolia, and the istambol-cadissy or chief ordinary judge of the capital) follow fourteen mollahs, who preside over the fourteen principal seats of justice in the empire; among these, the mollahs of Mecca and Medina have the highest rank. The place of mollah, like all others in the Turkish empire, is held only at the will of the sovereign, and is now granted annually (see *D'Ohsson, Tableau de l'Empire Ottoman*, vol. iv.); but displaced mollahs preserve their rank in the Ulema above their successors. The Turkish mollah must not be confounded with the Tartar *mulla*, which see.

MO'LLE. (Ital.) In Music, a sound that is flat as com- to another half a tone higher, thence called sharp.

MOLLUSKS, *Mollusca*. (Lat. mollis, *soft*.) The name applied by Cuvier to the great primary division of the animal kingdom which includes all those species having a gangliated nervous system, with the ganglions or medullary masses dispersed more or less irregularly in different parts of the body, which is soft and inarticulate. The pulmonary or branchial circulation is separate and distinct, but is aided by the direct propulsion of a heart in one class only. There is always a heart for the systemic circulation, and it mostly consists of one ventricle and one auricle. Some of the mollusks breathe air, but the greater part respire through the medium of salt or fresh water. The blood of the mollusks is white or blueish. In one class only is there a rudiment of an internal skeleton giving attachment to a part of the muscular system; in the rest it is absent, and the muscles are attached to various points of the skin. Their contractions produce inflexions and extensions of their different parts, and, alternating with relaxations, enable the species to creep, climb, swim, burrow, and seize upon various objects, according as the form of these parts may

permit; but as the locomotive organs are not supported by articulated and solid levers, the mollusks cannot leap or advance rapidly on dry land. Many of the aquatic species are encumbered with a heavy shell. Nearly all the mollusks have an extensive fold of the skin reflected over their body, which it covers like a mantle; it is sometimes produced into a breathing-pipe, or extended and divided in the form of fins. When the mantle is simply membranous or fleshy, or when a horny or testaceous rudiment of a shell is developed, but remains concealed in the substance of the mantle, the mollusk is said to be *naked*. When the shell is so much enlarged that the contracted animal finds shelter beneath or within it, the species is said to be *testaceous*. (*See* CONCHOLOGY.) The masticatory or oral organs present all the various modifications for predatory, omnivorous, or herbivorous habits; and the stomach may be simple, multiple, or complicated with a peculiar armature. Some of the mollusks are unisexual, others androgynous, a few diœcious.

With few exceptions, their habits and economy present comparatively little variety or interest, and they are only preserved by their fecundity and vital tenacity. *See* MALACOLOGY.

MO'LOCH. The name of the chief God of the Phœnicians, frequently mentioned in Scripture as the God of the Ammonites, and probably the same as the Saturn of the Syrians and Carthaginians. Human sacrifices were offered at the shrine of this divinity; and it was chiefly in the valley of Tophet, to the east of Jerusalem, that this brutal idolatry was perpetrated. Solomon built a temple to Moloch upon the Mount of Olives, and Manasseh long after imitated his impiety by making his son pass through the fire kindled in honour of this horrid king.

Milton has described the character of Moloch in the following well-known lines: —

First Moloch, horrid king, besmear'd with blood
Of human sacrifice and parents' tears;
Though for the noise of drums and timbrels loud
Their children's cries unheard, that passed through fire
To his grim idol. Him the Ammonite
Worshipt in Rabba and her watery plain,
In Argob and in Basan, to the stream
Of utmost Arnon. Nor content with such
Audacious neighbourhood, the wisest heart
Of Solomon he led by fraud to build
His temple right against the temple of God,
On that opprobrious hill; and made his grove
The pleasant valley of Hinnom, Tophet thence
And black Gehenna call'd, the type of Hell.

MOLO'SSUS. In Greek and Latin poetry, a foot consisting of three long syllables, as χαιρόντων, *regnabant*. It is said to derive its name either from a favourite dance of the Molossi, a people of Epirus; or from Jupiter Molossus, in whose honour odes were composed in which this foot had a great share.

MOLYBDE'NUM. (Gr. μολυβδος, *lead*.) This name was originally applied to the native sulphuret of molybdenum, which was considered to be an ore of lead; it was afterwards shown to be the ore of a peculiar metal, to which the name molybdenum was given. It is white, brittle, very infusible, and of a specific gravity about 8·6. It forms two oxides and an acid. The equivalent of the metal is about 48; and the *molybdic acid* consists of 1 atom of molybdenum and 3 of oxygen, and is represented by the equivalent 72. The compounds of this acid are called *molybdates*. The molybdate of lead has been found native.

MO'MENT. (Lat. movere, *to move*.) A small but indefinite period of time. Sometimes the word *instant* is used synonymously with moment.

MOMENT, MOMENTUM. These terms have been used by writers on mechanics, in various senses. Galileo, in his *Dialogues*, uses the phrase *momentum of a power*, or *of a weight*, applied to a machine, to denote the action, energy, or impetus of the power to move the machine; so that an equilibrium subsists between two powers when their moments to move the machine in opposite directions are equal: and he shows that the *momentum* is proportional to the power multiplied into the virtual velocity. This notion of momentum was also adopted by Wallis, in his *Mechanics*, published in 1669; and when the term is used with respect to a weight, it is synonymous with the phrase *quantity of motion*, that is, the product of the mass by the velocity.

The product of the mass by the *square* of the velocity, or the *living force* (*see* FORCE), is sometimes called the *moment of the moving force*, or the *moment of activity;* and the product of the mass by the velocity and by a line (or, which is the same, by the square of the velocity and by a time) is called the *moment of the quantity of motion*, or *quantity of action*. (Carnot, *Principes de l'Equilibre et du Mouvement*.)

Modern writers use the phrase *moment of a force with respect to a point*, to denote the product of the force into the perpendicular let fall from the point upon the line of its direction; and *moment of a force with respect to a plane*, to denote the product of the force into the perpendicular drawn from its point of application to the plane. These two moments are entirely distinct. The first depends upon the direction of the force, and is independent of its point of application; the latter depends upon the point of application, and is independent of the direction. (See Poisson, *Traité de Mécanique*.)

MOMENT OF INERTIA, in Dynamics, denotes the sum of the products of all the material elements of a revolving body, each multiplied into the square of its distance from the axis of rotation. It is the integral of the expression $\int r^2\,dm$; in which dm is the element of the mass, and r its distance from the axis. *See* ROTATION.

MO'MIERS. (From the Fr. momerie, Ang. *mummery*.) The name by which certain religionists of the so-called Evangelical party have been designated in Switzerland, and some parts of France and Germany, since 1818. They appear originally to have borne a considerable resemblance to the Methodists of our own country; for, like the latter, they at first embraced no tenets distinct from those of the established church, and were only distinguished from its members by a more habitual indulgence in devotional contemplation and religious exercises. But they did not long continue to harmonize with the preachers of the establishment. One of the most vehement of the party, in a pamphlet published in 1818, accused the latter of denying the divinity of our Saviour, and of a thorough backsliding from the doctrines of Calvinism; and the Geneva clergy (*la venerable compagnie*) having, in the view of allaying asperities, passed a resolution prohibiting any theories of the doctrinal points of religion from being propounded in the pulpit, and having counselled the clergy to avoid disputed points as much as possible in their discourses, the smouldering embers of their hostility to the established church burst into a flame. They now began to attack the clergy in the pulpit and in pamphlets, accusing them of having abandoned all gospel truth, and denying their right to be regarded as ministers of the establishment. But all their efforts to bring the latter into contempt were unsuccessful: the Genevese remained faithful to their pastors; and in the year 1835 the Momiers possessed only about 200 adherents.

In other parts of Switzerland, however, and more especially in the canton de Vaud, the zeal of these sectaries was attended with more success. After a few years' toleration of their preaching and proselytizing, during which it was alleged the Momiers had sown the greatest discord and discontent among the inhabitants of the canton, the government at last saw the necessity of interference; and in the year 1824 promulgated some vigorous ordinances to put them down. These enactments, as might have been expected, failed of their effect. The enthusiasm of the Momiers was redoubled: they were now surrounded with the glory of martyrdom; and many who before had viewed their zeal with indifference or contempt now deeply sympathized in what they could not but regard as an undisguised attack upon the liberty of conscience. In consequence of the general disgust that ensued on their promulgation, these ordinances were at first gradually relaxed, then suffered to lie dormant, and at last repealed in 1831. Since that period the number of the Momiers has gradually diminished; and in 1839 the clergy of this canton resolved by a large majority to revert to the ancient *regime* of the church. (See the *Conversations Lexicon der Gegenwart*. See also the *Edin. Review*, vol. xlii., which contains an interesting account of the rigorous enactments passed against this sect, with some severe remarks on their violence and absurdity.)

MO'MUS. (Gr. μῶμος, *derision*.) The god of raillery and ridicule, and said by Hesiod to have been the progeny of light.

MO'NACHISM, MONK, MONASTERY. (All derived from the Gr. μόνος, *alone*.) Words indicative of certain important features in ecclesiastical history. Monachus, or monk, properly signifies one who lives a solitary life, and was applied in the first instance to the numerous individuals who began in the second and third centuries to retire from the occupations of the world, and devote themselves in the deserts of Egypt and Syria to a contemplative and religious life. It was not till the middle of the third century that the monkish system, properly so called, was established, by which many persons were congregated together, and bound by vows to the performance of various religious duties and abstinence from wordly enjoyments. These monks are distinguished by the appellation of Cænobites, or Associates, from the ascetics, anchorites, and hermits, who lived apart not from the world only, but from each other. The monkish system originated in Egypt, where St. Anthony founded several associations of this kind. The inmates of the primitive monasteries were bound by the profession of four objects: solitude, labour, fasting, and prayers. They renounced all temporal possessions, and supported themselves entirely with their own hands. Fasting was practised in moderation only; nor do the early monks appear to have affected piety or regularity by the extravagant austerities of later times. For an useful list of books on the subject, see this article in the *Penny Cyclopædia*.

For an account of the progress of this practice, and the

rules to which the professors of Monachism were subjected in later times, see ORDERS (RELIGIOUS).

MO'NAD. (Gr. *μονας, an unit.*) In Metaphysics, this word has been used by Leibnitz and his followers, partisans of what has been called the Monadic Theory. "After studying," says Stewart, "with all possible diligence, what Leibnitz has said of his *monads* in different parts of his works, I find myself quite incompetent to annex any precise idea to the word as he employed it." He then quotes the following as "some of his most intelligible attempts to explain his meaning:"—"A simple substance has no parts: a compound substance is an aggregate of simple substances, or of monads." "Monads, having no parts, are neither extended, figured, nor divisible. They are the real atoms of nature; in other words, the elements of things." "Every monad is a living mirror, representing the universe, according to its particular point of view, and subject to no regular laws, as the universe itself." "Every monad with a particular body makes a living substance." (*Enc. Brit.*, Preliminary Dissertation, note c. c.) The groundwork of the monadic theory is to be found in the different philosophical systems of Zeno, Leucippus, Democritus, and Epicurus; but Leibnitz was the first who reduced it to a system, and its chief supporters since his death have been M. Wolf and Madame Duchâtelet.

MONADE'LPHONS. (Gr. *μονος*, and *αδελφια, a fraternity.*) A botanical term applied to stamens the filaments of which are combined into a single mass, as in the common mallow. It is the name of some of the classes in the Linnæan system.

MONA'NDROUS (Gr. *μονος*, and *ανηρ, a man*), is a flower having but one stamen. It is the name of the first class in the Linnæan system.

MO'NARCHY. (Gr. *μοναρχία;* derived from *μόνος, single*, and *ἄρχειν, to rule.*) The government of a single person. Monarch and monarchy are equivalent in common speech to king and kingdom; so that we often read of the Spartan monarchs, &c., although the government of Sparta was under a double race of kings reigning at the same time. Monarchies are usually said to be of four kinds,—*absolute*, *limited*, *hereditary*, and *elective*, which are self-explanatory terms. The only elective monarchy in Europe was that of Poland. All absolute and limited monarchies have adopted the hereditary principle.

MO'NAS. (Gr. *μονας.*) A genus of extremely minute polygastric Infusores.

MO'NASTERY. (Gr. *μονος.*) The general name for those religious houses appropriated to the reception and maintenance of monks and nuns, but especially of the former. (*See* NUNNERY.) For an account of the origin and object of monasteries, see MONACHISM, and the authorities there referred to; and for the habits, rules, and peculiarities of the different orders of monks and nuns, see the respective articles, but more especially ORDERS, RELIGIOUS. The English term *monastery* was variously rendered by the Greek fathers; thus we find it expressed not only by *μοναστηριον* and *μονη*, but by *σεμνειον, a holy place, μανδρα, an inclosure, φροντιστηριον, a place of meditation*, &c. The suppression of monasteries was one of the first consequences of the Reformation in all the countries that abandoned the Popish faith. But even in Roman Catholic states, with the exception of Italy, they have long been on the decline; and though since the relaxation of the penal laws several nunneries have been established in various parts of Great Britain, there is no reason to suppose that these establishments will ever attain even an approximation to their pristine vigour.

MO'NDAY. The second day of the week is so called, and means, literally, the *day of the moon*. Its equivalents in Fr. and Germ. are respectively Lundi and Montag, signifying also *day of the moon*.

MO'NEY.* In Political Economy, the name given to the commodity adopted to serve as the *marchandise bannale*, or universal equivalent of all other commodities; and for which individuals readily exchange their surplus products or services.

Without the use of money of some sort or other exchanges must have been greatly embarrassed, and the division of employments never could have been carried to any considerable extent. Innumerable difficulties would occur in attempting to carry on trade by barter. A., for example, has a quantity of corn which he wishes to exchange for cloth belonging to B.; but the latter being already sufficiently supplied with corn, no exchange can take place between them. A. must therefore, if he continue anxious to get possession of the cloth, learn what commodity B. will accept in exchange for it; and having learned this, he must seek out some third person willing to part with the equivalent demanded by B. in exchange for corn. It might not, perhaps, be possible for A. to get his purpose effected so easily as has here been supposed, or without negotiating several subsidiary exchanges; but what has now been stated is sufficient to evince the extreme difficulty of carrying on commerce in this way.

Individuals so placed would naturally endeavour, in seeking their own advantage, to obviate, in as far as practicable, such inconveniences; and it would require but little sagacity to perceive that the best way of accomplishing this would be to acquire some portion of that article, whatever it might be, which was observed to be most in demand, or which passed most readily from hand to hand in exchange for others; because, when possessed of it, one would be able, with comparatively little difficulty, to get whatever else he wanted. Now, this generally desirable article, whether it be corn, salt, cowries, hides, or whatever else, is in fact money. But though this grand instrument of exchange may be one thing in one country and one state of society, and another thing in another country and another state of society, it is never the result of invention or contrivance. It originates in the circumstances natural to society; and is changed, improved, and perfected, according as experience serves to make individuals better acquainted with its nature and functions.

An article that has been adopted from a sense of its suitableness to serve as the ordinary equivalent for other things, or as the common medium of exchange, comes in the course of time to be used also as a *measure of value*, or as a standard by which to compare and estimate the values of other things. Thus, instead of saying that an individual is worth 1000 sheep, 1000 quarters of wheat, or 1000 acres of land, these are rated or estimated at their value in money; and it is said that their owners are worth certain amounts of the latter. Not only, therefore, does the introduction of money contribute in the most effectual manner to the facilitating of exchanges, but it also gives precision to statements as to values that would otherwise be all but unintelligible. The statement, for example, that an individual was worth 1000 head of cattle, or 1000 packs of wool, would convey no clear idea even to dealers in these articles, as their qualities differ so very widely; and supposing these to be ascertained, there are very few individuals who know anything of the value either of cattle or wool. But by rating them in money, all these difficulties and ambiguities vanish in an instant; reference is then made to a measure with which every body is familiar, and every one has a distinct idea and full knowledge of the value of the articles, or wealth of the parties referred to.

Qualities required in a Commodity fitted to serve as Money.—An immense variety of commodities have been adopted to serve as money in different countries and states of society; but, in the course of no very long period, it is ascertained that no commodity can be advantageously employed as money unless it possess certain properties. First, it should be easy of transportation, and, therefore, should possess great value in small bulk: 2d, it should admit of being rubbed and carried about without losing much from the wear, and it should admit of being hoarded or kept for an indefinite period without loss: 3d, as the products to be exchanged for money are of very different value, it should also admit of being divided into the smallest portions without injury: 4th, the commodity used as money should be perfectly homogenous; that is, a given quantity of money in London should be precisely identical with the same quantity in Edinburgh, Dublin, and every where else: and, 5th, the value of money or its power of exchanging for or buying other things should be as invariable as possible, or should change only by slow degrees. These seem to be the qualities most essential to any commodity adopted to serve as money; and the money of any country may be said to be good or bad according to the degree in which it possesses or wants these qualities.

Now, it will be found that the precious metals possess all the qualities enumerated above in a far higher degree than any other products with which we are acquainted; and this has doubtless formed the irresistible reason that has led all civilized communities to adopt them as money. The cost of their production, especially of gold, is so very considerable that they possess great value in small bulk; their firm and compact texture makes them difficult to wear, and they may be kept for any length of time without deteriorating; they are divisible into any number of parts, and have the valuable property of being easily reunited by means of fusion without loss; they are perfectly identical, the physical qualities of an ounce of pure gold or silver taken from the mines in any part of the world being precisely the same with those of an ounce taken from the mines in any other quarter; and though their value be not invariable, it changes, speaking generally, only by slow degrees, and is less susceptible of fluctuation than that of most other articles. No wonder, therefore, when almost all the qualities necessary to constitute money are possessed in so eminent a

* Etymologists differ respecting the derivation of the word money. Some contend that it comes from monere (*to admonish, to inform*), because the stamp impressed on coins indicates their weight and fineness. Others contend that it originates in the circumstance of silver being originally coined at Rome, in the temple of admonishing Juno, or *Juno Moneta.*

degree by the precious metals, that they have been used as such in civilized societies from a very remote æra. They became universally money, to use the words of Mr. Turgot, "not in consequence of any arbitrary agreement among men, or of the intervention of any law, but by the nature and force of things."

Introduction of Coined Money.—When first brought to market, gold and silver, like copper, iron, or any other metal, were in the shape of bars or ingots; and were exchanged or bartered for other commodities exactly as these would have been bartered for anything else. The parties having agreed upon the quantity of the precious metals to be given for certain goods, the quantity was next delivered by weight. Nor is this a mere conjectural statement, advanced in a later age to explain appearances, and resting on probability only. Aristotle (*Polit.* lib. i. cap. 9.) and Pliny (*Hist. Nat.* lib. xxxiii. cap. 3.) tell us that such was, in fact, the method by which the precious metals were originally exchanged for other things in Greece and Italy; and the sacred writings furnish a striking example of the prevalence of the same primitive practice in the East. It is there stated that Abraham weighed 400 shekels of silver, and gave them in exchange for a piece of ground he had purchased from the sons of Heth. (Genesis, xxiii. 16.) It is also mentioned that this silver was "current money with the merchant," an expression which evidently refers to its quality only; for, had the silver been coined, it would have been unnecessary to have weighed it. But the weighing of gold and silver whenever they happened to be exchanged for commodities, and their adjustment to the agreed on weight, must have been a very difficult and troublesome process. There can, however, be no doubt that the greatest obstacle to the use of the precious metals as money would, at first, be found in the difficulty of determining their purity or fineness with sufficient facility and accuracy. It is, indeed, most probable that when they originally began to be used as money their quality would be inferred from their weight and colour. But the extreme inexactness of the conclusions derived from such loose and unsatisfactory data would soon become obvious; and the devising of some method by which the weighing of the metals in exchanges might be dispensed with, and their quality be easily and accurately determined, would be seen to be indispensable to their general use as money. Luckily such a method was not long a desideratum. It was early discovered that to ascertain its purity, and to obviate the trouble and expense of weighing the metal, all that was necessary was to form it into *coins;* that is, to mark each piece with a public stamp or authoritative impress declaring its weight and fineness. Such appear to have been the steps that led to the formation and introduction of gold and silver coins (*Goguet*, *De l'Origine des Loix*, i. 269. 4to ed.); the employment of which has been of the very greatest utility, and has perhaps contributed more than anything else to facilitate commerce, and to accelerate the progress of civilization and the arts.*

"Without some article of known exchangeable value, such as coin, readily received as an equivalent for other things, the interchange of commodities must have been very limited, and consequently the divisions of labour very imperfectly established. Now money obviates these evils, and by a twofold operation augments production. In the first place, it saves all that time and labour which, while the intercourse between man and man is carried on by barter, must frequently intervene before a person can be supplied with the quantity of the commodity which he wants; in the second place, and in consequence of its saving the time and labour which must otherwise be spent in effecting exchanges, it multiplies the transactions of mercantile industry, and thus allows the divisions of employment to be more thoroughly established. By the first operation it disengages a very considerable portion of labour from an unproductive occupation, and enables it to receive a more useful direction; by the second it increases in a very high degree the productive powers of the labour already usefully employed. It assists every man in availing himself of the skill and dexterity which he may have acquired in any particular calling, and promotes cultivation in a manner suitable to the climate and soil of different districts and different countries. And by both these operations coins increase to an extent, not easy to be calculated, the wealth of civilized communities." (*Torrens on the Production of Wealth*, p. 305.)

But, however great and obvious the advantages attending the use of the precious metals in the shape of coin, it is necessary to bear in mind that the nature of exchanges, and the principle on which they are made, are not thereby at all affected. Equivalents are still given for equivalents. The exchange of a quarter of corn for an ounce of pure unfashioned gold bullion is as much a barter as if it were exchanged for an ox, or a barrel of beer; and, supposing the metal to be formed into a coin, or marked with a stamp declaring its weight and fineness, that circumstance could, it is obvious, make no change in the terms of the barter. The coinage would save the trouble of weighing and assaying the bullion, but it would do nothing more. A coin is merely a piece of metal of a known weight and fineness, and the commodities exchanged for it are uniformly held by the parties to be of equal value; and yet these obvious considerations have been very generally overlooked. The notion was long entertained that coins were merely the *signs* of values! But it is clear that they have no more claim to this designation than bars of iron or copper, sacks of wheat, or any other article. Coins exchange for other things because they are desirable articles, which having been produced by an expenditure of capital and labour, possess real intrinsic worth. A draft, cheque, or bill may not improperly, perhaps, be regarded as the sign of the money or coin to be given for it; but that coin is itself a valuable commodity. A sovereign is not a sign,—it is the thing signified.

Privilege of Coining. Legal Tender.—In order to obviate the endless confusion and inconvenience that could not fail to arise were individuals permitted to coin money, from the circulation of coins of all weights and degrees of purity, the government of every civilized country has prohibited the issue of coins by private parties, and has itself supplied those in circulation. Generally, also, very severe penalties have been inflicted on the forgers of coin, or on those who fabricate counterfeit coins, or coins of less weight than the standard, or made up in whole or in part of some baser or less valuable metal. It is obvious, indeed, that the extensive practice of this offence, by necessarily generating a feeling of insecurity and suspicion, would check the circulation even of genuine coins, and would consequently in so far deprive society of the advantages resulting from their employment. It is found, however, that the improvement of the fabric of the coins, by the perfecting of the dyes and otherwise, is a more effectual means than even the utmost severity of punishment for the prevention of forgery; though some very considerable degree of the latter is, of course, always indispensable.

Where the use of coins has once been adopted, all values in contracts and other engagements are rated or estimated in money; and it is usual in almost all countries to enact that coins of the legal or standard weight and purity shall be *legal tender*, and to declare that no legal proceedings of any kind shall be instituted on account of any debt or pecuniary obligation against any individual who has offered to liquidate the same by payment of an equivalent amount of the recognized coin of the country. A pound troy, or 12 oz. of the metal of which English silver coins are made, contains 11 oz. 2 dwts. pure silver, and 18 dwts. alloy. This pound is coined into 66 shillings; so that each shilling contains 80·727 grains fine silver, and 87·27 grains standard silver; and the money pound, consisting of 20 shillings, contains 1614·545 grains pure silver, and 1745·454 grains standard silver. From 1600 down to 1816, the pound weight of standard silver bullion was coined into 62 shillings. All the English silver coins have been coined out of silver of 11 oz. 2 dwts. fine, from the Conquest to this moment, except for the short period of sixteen years from the 34th Henry VIII. to the 2d Elizabeth.

The fineness of gold is estimated by carat grains equivalent to $2\frac{1}{2}$ dwts. troy; gold of the highest degree of fineness, or pure, being said to be 24 carats fine. The purity of our present gold coins is 11 parts fine gold and one part alloy. The sovereign, or twenty-shilling piece, contains 113·001 grains fine gold, and 123·274 grains standard gold. The pound troy of standard gold is coined into 46 sovereigns and $\frac{89}{120}$ths of a sovereign, or into 46*l.* 14*s.* 6*d.* The mint or standard price of gold is therefore said to be 46*l.* 14*s.* 6*d.* per pound troy, or 3*l.* 17*s.* $10\frac{1}{2}$*d.* an ounce. The alloy in coins is reckoned of no value; it is allowed in order to save the trouble and expense that would be incurred in refining the metals to their highest degree of purity, and because when its quantity is small it renders the coins harder, and less liable to be worn or rubbed. Were the quantity of alloy considerable, it would lessen the splendour and ductility of the metals, and would add too much to the weight of the coins.

Before the art of metallurgy was well understood, the baser metals were frequently used as money. Iron was the primitive money of the Lacedæmonians, and copper of the Romans. But both iron and copper deteriorate by being kept; and, besides this defect, the rapid improvement of the arts, by lowering their price, rendered their bulk too great in proportion to their value to permit of their continuing to be used as money. Copper, indeed,

* The Roman jurists have given a clear and concise account of the circumstances that led to the use of money, and of its functions:—"*Origo emendi vendendique a permutationibus cœpit: Olim enim non itd erat nummus; neque aliud merx, aliud pretium vocabatur; sed unusquisque, secundum necessitatem temporum ac rerum, utilibus inutilia permutabat, quandò plerumque evenit ut quod alteri superest alteri desit. Sed quia non semper, nec facile concurrebat, ut cum tu haberes quod ego desiderarem, invicem haberem quod tu accipere velles, electa materia est, cujus publica ac perpetua æstimatio difficultatibus permutationum æqualitate quantitatis subveniret; eaque materia formâ publicâ percussa, usum dominiumque, non tam ex substantia præbet quam ex quantitate; nec ultra merx utrumque, sed alterum pretium vocatur.*" (*Digest*, lib. xviii. tit. I. de Contr. Empt.)

is still used in the form of tokens, convertible into silver in very small payments. In this country, copper pence and halfpence are rated at about 72 per cent. above their real value; but as their issue is exclusively in the hands of government, and as they are only legal tender to the extent of *one shilling* in any one payment, this overvaluation is not productive of any bad effect. The use of copper in other countries is limited in much the same way; gold and silver being every where the only metals made use of in the manufacture of the coins used in considerable payments.

Variations of the Standard. — The value of all sorts of property being estimated, and the stipulations in almost all contracts for its purchase, sale, or hire being made in money or coins, it is plain that no change can take place in the value of such money or coins without virtually subverting these estimates and contracts, and enriching the debtor portion of society at the expense of the creditor portion, or *vice versâ*. As the cost of producing all commodities is liable to vary from improvements in the arts, the exhaustion of the present or the discovery of new sources of supply, none can be selected to serve as money or coin that may not vary in its *cost* or real value. It is believed, however, that the precious metals vary less than any material that could be suggested; and, with the exception of the extraordinary fall in their value caused by the discovery of the American mines, it seems to have been remarkably constant at other periods.

But, in addition to the fluctuations naturally inherent in the value of coins, arising from variations in the cost of the metal of which they are made, their standard has been repeatedly changed. Notwithstanding that money or coin, from its being universally used as a scale by which to compute the value of all commodities, and as the equivalent for which they are commonly exchanged, is by far the most important of all the measures used in society, and should, consequently, be preserved as invariable as possible, there is none that has been so frequently altered. The necessities or extravagance of governments have forced them to borrow; and, to relieve themselves of the incumbrances thus contracted, they have almost universally had recourse to the disgraceful expedient of degrading the coin; that is, of *cheating* those who lent them money to the extent of the degradation, and of enabling every other debtor in their dominions to do the same.

The ignorance of the public in remote ages facilitated this species of fraud. Had the names of the coins been changed when the quantity of metal contained in them was diminished, there would have been no room for misapprehension. But, although the weight of the coins was undergoing perpetual and their purity occasional reductions, their ancient denominations were almost uniformly preserved; and the people who saw the same names still remaining after the substance was diminished, — who saw coins of a certain weight and fineness circulate under the names of florins, livres, dollars, and pounds, — and who saw them continue to circulate as such after both their weight and the degree of their fineness had been lessened, began to think that they derived their value more from the *stamp* affixed to them by authority of government than from the quantity of the precious metals they contained. This was long a very prevalent opinion; but the rise of prices which invariably followed every reduction of the standard, and the derangement that was thereby occasioned in every pecuniary transaction, undeceived the public, and taught them and their rulers the expediency of preserving the standard of money inviolate.

The standard may be reduced by simply raising the denomination of the coin; by ordering, for example, that a half-sovereign should pass for a sovereign, and the latter for a double sovereign, &c. If injustice be resolved upon, this is the least mischievous way in which it can be perpetrated, inasmuch as it saves all the trouble and expense of a recoinage. But as it renders the fraud obvious and glaring, it has rarely been resorted to; and most reductions have been effected either by diminishing the weight of the coins, or by increasing the proportion of alloy in the metal of which they are made, or both.

Originally the coins of all countries seem to have had the same denominations as the weights commonly used in them, and contained the exact quantity of the precious metals indicated by their name. Thus, the *talent* was a weight used in the earliest period by the Greeks, the *as* or *pondo* by the Romans, the *livre* by the French, and the *pound* by the English and Scotch; and the coins originally in use in Greece, Italy, France, and England bore the same names, and weighed precisely a talent, a pondo, a livre, and a pound. The standard has not, however, been preserved inviolate, either in modern or ancient times. It has been less degraded in England than any where else; but even here the quantity of silver in a pound sterling is less than the *third* part of a pound weight, the quantity it contained in 1300. In France, the livre current in 1789 contained less than *one sixty-sixth* part of the silver implied in its name, and which it had actually contained previously to 1103. In Spain and some other countries, the degradation has been carried still further.

From 1296 to 1355 the coins of England and Scotland were of the same weight and purity; but at the last-mentioned epoch the standard of Scotch money was, for the first time, sunk below that of England; and by successive degradations the value of Scotch money, at the union of the crowns in 1600, was only a *twelfth* part of the value of the English money of the same denomination. It remained at this point till the union of the kingdoms cancelled the separate coinage of Scotland.

The gold and silver coins of Ireland have been for a considerable period the same as those of Great Britain; but until 1825 they were nominally rated $8\frac{1}{3}$ per cent. higher. This difference of valuation, which was attended with considerable inconveniences, was put an end to by the act 6 Geo. 4. c. 79., which assimilated the currency throughout the empire.

Mint or Government Valuation of Gold and Silver Coins. — If both gold and silver coins be made legal tender, it is obviously indispensable that their value with respect to each other should be fixed by authority; or that it should be declared that individuals shall be entitled to discharge the claims upon them by payments either of gold or silver coins, according to some regulated proportion, — a practice which was long adopted in England.

But the value of each of the precious metals is liable to perpetual changes; and hence, how accurately soever their proportional value, as fixed by the mint regulations, may correspond with the proportion which they actually bear to each other in the market when the regulation is made, the chances are ten to one that it will speedily cease to express their relation to each other. The moment, however, that such a change takes place, it becomes the obvious interest of every one who has a payment to make to make it in the *overvalued* metal; which, consequently, becomes the sole, or nearly the sole, currency of the country. Hence the reason why the coins of some countries are almost wholly of silver, and others almost wholly of gold. It is estimated, for example, that when it was fixed, in 1717, that the guinea should exchange for 21 shillings, gold was overvalued as compared with silver to the extent of $1\frac{19}{31}$ per cent. (*Liverpool on Coins*, p. 85.); and as the real value of silver with respect to gold continued to increase during the greater part of last century, the advantage of paying in gold in preference to silver became more decided, and ultimately led to the universal use of gold in all large payments, and to the fusion or exportation of all silver coins of full weight. (*Liverpool, loco cit.*)

In France a different valuation of the metals has had a different effect. Previously to the recoinage in 1785, the *Louis d'or* was rated in the mint proportion at only 24 livres, when it was really worth 25 livres 10 sols. Those, therefore, who should have discharged the obligations they had contracted by payments of gold coin instead of silver, would plainly have lost 1 livre 10 sols on every sum of 24 livres. In consequence very few such payments were made; gold was almost entirely banished from circulation, and silver became almost the only species of metallic money used in France. (*Say, Traité d'Economie Politique*, tom. i. p. 393.)

In 1816 a new system was adopted in this country; it being then enacted (56 Geo. 3. c. 68.), *that gold coins only should be legal tender in all payments of more than* 40 *shillings*. The pound of silver bullion that had previously been coined into 62 shillings was then also coined into 66 shillings, the additional *four* shillings being retained by government as a *seignorage* or duty (amounting to $6\frac{14}{31}$ per cent.) upon the coinage. To prevent the silver coins from becoming redundant, government has retained the power to issue them in its own hands. Under these regulations, silver has ceased to be a standard of value, and forms merely a subordinate or subsidiary species of currency, or change, occupying the same place in relation to gold that copper occupies in relation to itself. This system has been found to answer exceedingly well.

A good deal of difference of opinion has existed as to whether gold or silver coins are best fitted for being made a legal tender. It does not seem that the one possesses any very striking advantage over the other; none, certainly, that would justify a change, after a selection has been made and acted upon for any considerable period.

Down to 1626, a seignorage or duty upon the coinage was usually charged upon the gold and silver coins issued by the mint; and it may be easily shown that the imposition of such a duty, when it is not carried to an undue height, is advantageous. A coin is more useful than a piece of uncoined bullion of the same weight and purity; the coinage fitting it for being used as money, while it does not unfit it for being used for any other purpose. When, therefore, a duty or seignorage is laid upon coin equal to the expense of coinage, it circulates at its real value; but when this charge is defrayed by the public, it circulates at *less* than its real value, and is consequently

either melted down or exported whenever there is any demand for bullion in the arts, or any fall in the exchange. It is, indeed true that were a seignorage to be laid on gold coins, it would be necessary, to prevent an enhancement of the value of the currency, that their weight should be proportionally reduced; and it is on this account better, perhaps, to let them remain on the present footing. But when a seignorage was laid on the silver coins, in 1816, it was not necessary to take the circumstance now alluded to into consideration; for as they were made subordinate to gold, and were intended to serve as change merely, its imposition had no tendency to raise the value of the currency, at the same time that it was calculated effectually to prevent the fusion of the coins, and to yield a small revenue to government.

The exportation and importation of gold and silver coins was formerly prohibited; but in 1819 it was enacted (59 Geo. 3. c. 49.), that they might be freely exported and imported, without being liable to any charge or duty whatever; and they may be imported without being either reported or entered at the custom-house. This regulation has rendered it next to impossible to ascertain the value of the bullion imported.

Paper Money. — But, how great soever the advantages resulting from the employment of gold and silver as money, we are not to suppose that these are obtained gratuitously. The use of a metallic currency is accompanied by a heavy expense; and there is a much greater difficulty in effecting payments by the agency of coins than one might, at first, be disposed to believe. If the currency of the United Kingdom consisted wholly of gold, it would certainly amount to at least 60 millions sterling; the expense of which, allowing ¼th per cent. for the wear and tear and loss of coins, could hardly be estimated at less than *three* millions a year. But this heavy expense is really a far less serious obstacle to the exclusive use of the precious metals as money than their weight, and the trouble and expense attending the carrying them about. The weight of 1000 sovereigns exceeds 21 lbs. troy; so that it would be necessary to employ a waggon to make a large payment even in gold. It is also very difficult to employ it in the making of small payments, provided they have to be made at any considerable distance, inasmuch as the expense of sending gold by post, and the premium to guarantee it against loss, amount to a considerable sum. Hence it is that all commercial nations endeavour to fabricate a portion of their money of some less valuable and more portable material than bullion; and hence also the origin of bills of exchange, cheques, and other devices for economising the use of money.

Of the substitutes that have been resorted to instead of gold and silver coins, *paper notes*, payable on demand, have been by far the most generally adopted, and are in all respects the most eligible. Intrinsically they are almost destitute of value, so that their employment and their loss costs next to nothing *; and they may be carried about or transmitted by post with the utmost facility. But though in these respects the employment of pieces of paper instead of coins leaves nothing to be desired, it is plain that having no value in themselves their value must depend entirely on artificial means or regulations. They are commonly issued as a substitute for or representative of coin, the issuer being bound to pay their value, or the sums they profess to represent, in coin of the standard weight and purity, the moment it is demanded; and so long as this regulation is really and *bonâ fide* complied with, no inconvenience can result from their employment. Practically, however, it is found no easy matter to carry these regulations into effect; and this, and indeed every country in which paper money has been issued, has repeatedly sustained the greatest injury from its being issued in excess or on unsound principles. Paper money, in fact, can never be either securely or beneficially employed, unless the quantity of it in circulation vary exactly as the quantity of gold or silver coins to be substituted in its stead would do were it withdrawn. But having elsewhere inquired into the means by which this identity between the value of coins and paper notes may be best maintained, we beg to refer the reader to the article BANKS in this Dictionary for a farther discussion of this important branch of the subject.

I. ENGLISH COINS. — Account of the English Silver and Gold Coins; showing their Value, the Seignorage or Profit upon the Coinage, and the Price of the Pound Troy of Standard Gold and Silver, from the Conquest to the present Time.

A. D.	Anno Regni.	Silver. 1. Fineness of the Silver in the Coins.		2. Pound Weight of such Silver coined into	3. Profit or Seignorage on the Coinage.	4. Equal to the Mint Price for Standard Silver of 11oz. 2dwts. fine, Troy Weight.	Gold. 5. Fineness of the Gold in the Coins.		6. Pound Weight of such Gold coined into	7. Profit or Seignorage on the Coinage.	8. Equal to the Mint Price for Standard Gold of 22 Carats fine, Troy Weight.
		Oz.	dwts.	L. s. d.	L. s. d.	L. s. d.	Crts.	grs.	L. s. d.	L. s. d.	L. s. d.
1066	Conquest	11	2	1 0 0							
1280	8 Edward I.	—	—	1 0 0	0 1 0	1 0 3¼					
1300	28 ———	—	—	1 0 3	0 1 2½						
1344	18 Edward III.	—	—	1 0 3	0 1 3	1 0 3¼	23	3½	13 3 4	0 8 4	12 10 8
1349	23 ———	—	—	1 2 6	0 1 3	1 2 8	—	—	14 0 0	0 11 8	13 3 9
1356	30 ———	—	—	1 5 0	0 0 10	1 5 9⅓	—	—	15 0 0	0 6 8	14 8 4
1394	18 Richard II.	—	—	1 5 0	0 0 10	1 5 9⅓	—	—	15 0 0	0 5 0	14 9 11
1401	3 Henry IV.	—	—	1 5 0	0 0 10	1 5 9⅓	—	—	15 0 0	0 5 0	14 9 11
1421	9 Henry V.	—	—	1 10 0	0 1 0	1 10 11¼	—	—	16 13 4	0 5 0	16 2 9
1425	4 Henry VI.	—	—	1 10 0	0 1 0	1 10 11¼	—	—	16 13 4	0 5 10	16 1 11
1464	4 Edward IV.	—	—	1 17 6	0 4 6	1 15 2¼	—	—	20 16 8	2 10 0	18 0 5
1465	5 ———	—	—	1 17 6	0 4 6	1 15 2¼	—	—	22 10 0	1 0 10	21 1 10
1470	49 Henry VI.	—	—	1 17 6	0 2 0	1 17 10½	—	—	22 10 0	0 13 0	21 9 7
1482	22 Edward IV.	—	—	1 17 6	0 1 6	1 18 4¾	—	—	22 10 0	0 7 6	21 15 0
1483	1 Richard III.	—	—	1 17 6	0 1 6	1 18 4¾	—	—	22 10 0	0 7 6	21 15 0
1485	1 Henry VII.	—	—	1 17 6	0 1 6	1 18 4¾	—	—	22 10 0	0 7 6	21 15 0
1509	1 Henry VIII.	—	—	1 17 6	0 1 0	1 18 11¼	—	—	22 10 0	0 2 6	22 0 0
†1527	18 ———	—	—	2 0 0	0 1 0¾	1 18 11¼	—	—	24 0 0	0 2 8	22 0 0
——	———	—	—	2 5 0	0 1 0	2 4 0	—	—	27 0 0	0 2 9	
——	———	-	-	- -	- -	- -	22	0	25 2 6	0 3 0	24 19 6
1543	34 ———	10	0	2 8 0	0 8 0	2 4 4¾	23	0	28 16 0	1 4 0	26 8 0
1545	36 ———	6	0	2 8 0	2 0 0	2 11 9¼	22	0	30 0 0	2 10 0	27 10 0
1546	37 ———	4	0	2 8 0	4 4 0	2 15 6	20	0	30 0 0	5 0 0	27 10 0
1547	1 Edward VI.	4	0	2 8 0	4 4 0	2 15 6	20	0	30 0 0	1 10 0	31 7 0
1549	3 ———	6	0	3 12 0	4 0 0	2 19 2½	22	0	34 0 0	1 0 0	33 0 0
1551	5 ———	3	0	3 12 0							
——	———	11	0	3 0 0	- -	- -	23	3½	36 0 0		
——	———	-	-	- -	- -	- -	22	0	33 0 0		
1552	6 ———	11	1	3 0 0	0 1 0	2 19 3¼	23	3½	36 0 0	0 2 9	
——	———	-	-	- -	- -	- -	22	0	33 0 0	0 3 0	32 17 8
1553	1 Mary	11	0	3 0 0	0 1 0	2 19 6½	23	3½	36 0 0	6 3 0	33 0 8
1560	2 Elizabeth	11	2	3 0 0	0 1 6	2 18 6	23	3½	36 0 0	0 5 0	
——	———	-	-	- -	- -	- -	22	0	33 0 0	0 4 0	32 16 0
1600	43 ———	—	—	3 2 0	0 2 0	3 0 0	23	3½	36 10 0	0 10 0	
——	———	-	-	- -	- -	- -	22	0	33 10 0	0 10 0	33 0 0
1604	2 James I.	—	—	3 2 0	0 2 6	2 19 6	22	0	37 4 0	1 10 0	35 14 0
1626	2 Charles I.	—	—	3 2 0	0 2 0	3 0 0	—	—	41 0 0	1 1 5	39 18 7
‡1666	18 Charles II.	—	—	3 2 0	0 0 0	3 2 0	—	—	44 10 0	- -	44 10 0
1717	3 George I.	—	—	3 2 0	0 0 0	3 2 0	—	—	46 14 6	- -	46 14 6
1816	56 George III.	—	—	3 6 0	0 4 0	- -	—	—	46 14 6	- -	46 14 6

* The loss of a note is no doubt as severely felt by the holder as the loss of an equivalent amount of coin; but as the issuer of the note is benefitted by its loss to the same extent that the holder is injured, the society is plainly neither the better nor the worse for the occurrence.

† 1527 — Henry VIII.] The Saxon or Tower pound was used at the mint up to this time, when the pound troy was substituted in its stead. The Tower pound was but 11 oz. 5 dwts. troy; so that, from the Conquest to the 28 Edward I., 20 shillings in tale were exactly a pound in weight.

‡ 1666 — 18 Charles II.] The seignorage on the coinage was at this time given up, and the gold bullion brought to the mint has ever since been coined free of expense. A seignorage of $6\frac{14}{31}$ per cent. was imposed on the coinage of silver by 56 Geo. 3.

II. Account of the Contents or Weight, and of the Value in Sterling, of the principal Gold Coins of different Countries.

Coins.	Contents in pure Gold.	Value in Sterling.	
	grains.	s.	d.
Austrian Dominions:			
Souverain	78·6	13	10·92
Double ducat	106·4	18	9·97
Bavaria:			
Max d'or, or Maximilian	77·	13	7·44
Ducat	52·8	9	4·12
Cologne:			
Ducat	52·6	9	3 70
Denmark:			
Christian d'or	93·3	16	6·14
England:			
Sovereign	113·1	20	0·
Half sovereign	56·55	0	10
France:			
Louis, or piece of 20 francs	89·7	15	10·5
Hamburgh:			
Ducat (double in proportion)	52·9	9	4·35
Hanover:			
George d'or	92·6	16	4·66
Ducat	53·3	9	5·19
Holland:			
Ducat	52·8	9	4·13
Malta:			
Louis	108·	19	1·37
Milan:			
Sequin	53·2	9	4·98
Doppia or pistole	88·4	15	7·74
40 Lire piece of 1808	179·7	13	9·64
Naples:			
Six ducat piece of 1783	121·9	21	6·89
Three ducat piece, or oncetta, of 1818	58·1	10	3·40
Netherlands:			
Gold lion, or 14 florin piece	117·1	20	8·69
Ten florin piece (1820)	93·2	16	5·93
Portugal:			
Dobraon of 24,000 rees	759·	134	3·96
Dobra of 12,800 rees	401·5	71	0·70
Moidore or Lisbonnine (½, &c. in prop.)	152·2	26	11·24
Prussia:			
Frederick (double) of 1800	184·5	32	7·84
Frederick (single) of 1800	92·2	16	3·42
Rome:			
Scudo	367·	64	11·43
Russia:			
Ducat	53·2	9	4·98
Imperial	181·9	32	2·31
Sardinia:			
Carlino (½ in proportion)	219·8	30	8·10
Saxony:			
Ducat	52·9	9	4·34
Spain:			
Pistole	90·1	15	11·35
Sweden:			
Ducat	51·9	9	2·22
Switzerland:			
Pistole	105·9	18	8·91
Tuscany:			
Zecchino or sequin	53·6	9	5·83
United States:			
* Eagle (½ and ¼ in proportion)	246·1	43	6·66
Venice:			
Zecchino or sequin (½ and ¼ in prop)	53·6	9	5·83
East Indies:			
Mohur of 1770	186·8	33	0·72
Mohur, half (1787), ¼ in proportion	94·	16	7·64
Mohur Sicca of Bengal	189·8	30	1·04
Rupee, Bombay (1818)	164·7	29	1·78
Rupee of Madras (1818)	165·	29	2·42
Pagoda star	41·8	7	4·77

III. Account of the Contents or Weight, and of the Value in British Standard Silver at 5*s*. 2*d*. an ounce, of the principal Silver Coins of different Countries.

Coins.	Contents in pure Silver.	Value in Sterling.	
	grains.	s.	d.
Austria:			
Rixdollar, or florin, *Convention*	179·6	2	1·07
Copftsuck, or 20 creutzer piece	59·4	0	8·29
Halbe copf, or 10 creutzer piece	28·8	0	4·01
Baden:			
Rixdollar	358·1	4	2·
Bavaria:			
Rixdollar of 1800 (½ in proportion)	345·6	4	0·25
Copftsuck	59·4	0	8·29
Brunswick:			
Rixdollar, *Convention*	359·2	4	2·15
Half rixdollar	179·6	2	1·07
Denmark:			
Ryksdaler	388·4	4	6·23
Half ryksdaler	194·2	2	3·11
Mark, specie, or ⅙ ryksdaler	64·4	0	7·59
England:			
Crown (*old*)	429·7	5	0·
Half crown	214·8	2	6·
Shilling	85·9	1	0·
Sixpence	42·9	0	6·
Crown (*new*)	403·6	4	8·36
Half crown	201·8	2	4·18
Shilling	80·7	0	11·27
Sixpence	40·3	0	5·63
France:			
Franc	69·4	0	9·69
Demi franc	34·7	0	4·84

Silver Coins — *continued.*

Coins.	Contents in pure Silver.	Value in Sterling.	
	grains.	s.	d.
Genoa:			
Scudo, of 8 lire	457·4	5	3·87
Hamburgh:			
Rixdollar, specie	397·5	4	7·49
Double mark, or 32 schilling piece (single in proportion)	210·3	2	5·36
Piece of 8 schillings	50·1	0	6·99
Hanover:			
Rixdollar, *Constitution*	400·3	4	7·89
Florin, or piece of ⅔, fine	200·3	2	3·96
Holland:			
Florin or guilder (½ in proportion)	146·8	1	8·49
12 Stiver piece	92·4	1	0·90
Florin of Batavia	141·6	1	7·77
Lubec:			
Rixdollar, specie	391·9	4	6·72
Mark	105·1	1	2·67
Lucca:			
Scudo	372·3	4	3·98
Malta:			
Ounce of 30 tari of Emmanuel Pinto	337·4	3	11·11
2 Tari piece	17·7	0	2·41
Milan:			
Scudo of 6 lire (½ in proportion)	319·6	3	8·62
Lira	52·8	0	7·37
Modena:			
Scudo	287·4	3	4·13
Naples:			
Ducat, new (½ in proportion)	295·4	3	5·24
Piece of 10 Carlini	295 1	3	5·20
Netherlands:			
Florin	148·4	1	8·72
Half florin (with divisions in prop.)	75·	0	10·46
Poland:			
Florin, or gulden	84·	0	11·72
Portugal:			
New crusado (1809)	198·2	2	4·67
Seis vintems, or piece of 120 rees	46·6	0	6·50
Testoon	42·5	0	5·93
Tres vintems, or piece of 60 rees (1802)	23·3	0	3·25
Half testoon (1802)	20·4	0	2·84
Portuguese Colonies:			
Piece of 8 macutes, of Portuguese Africa	159·8	1	10·31
Ditto of 4 ditto	78·1	0	10·90
Prussia:			
Rixdollar, *Convention*	359·	4	2·13
Florin, or piece of ⅔	198·4	2	3·70
Rome:			
Scudo, or crown	371·5	4	3·87
Mezzo scudo, or half crown	185·7	2	1·93
Paolo	37·2	0	5·19
Russia:			
Rouble	312·1	3	7·58
Rouble of Alexander (1805)	278·1	3	2·83
20 Copeck piece (1767)	62·6	0	8·74
5 Copeck piece	15·3	0	2·13
Sardinia:			
Scudo, or crown (½ and ¼ in prop.)	324·7	3	9·34
Saxony:			
Rixdollar, *Convention* (½ and ¼ in prop.)	358·2	4	2·01
Sicily:			
Scudo (½ in proportion)	348·2	4	0·62
Spain:			
† Dollar, of late coinage	370·9	4	3·79
Half dollar, ditto	185·4	2	1·88
Sweden:			
Rixdollar	388·5	4	6·28
Switzerland:			
Ecu of 4 franken	407·6	4	9·18
Turkey:			
Piastre (1818)	67·7	0	9·45
Tuscany:			
Lira	53·4	0	7·45
United States:			
Dollar	370·1	4	3·68
Wirtemberg:			
Rixdollar, specie	559·1	4	2·14
Copftsuck	59·8	0	8·35
East Indies:			
Rupee Sicca, coined by the East India Company at Calcutta	175·8	2	0·54
Calcutta (1818)	175·9	2	0·56
Bombay, new, or Surat (1818)	164·7	1	11·01
Company's rup. (1835)	165	1	11
Fanam, Cananore	32·9	0	4·5
Bombay, old	35·	0	4·88
Pondicherry	22·8	0	3·18
Ditto, double	39·	0	5·44
Gulden of the Dutch E. I. Co. (1820)	148·4	1	8·72

Ancient Coins. — We subjoin, for the convenience of such of our readers as may have occasion to consult works in which reference is made to ancient coins, the following tables of those that were principally current among the Jews, Greeks, and Romans. They were calculated by Dr. Arbuthnot (*Tables of Ancient Coins, Weights, &c.*, 4to ed. Lond. 1754), and do not differ materially from the tables of Paucton, whose *Métrologie* (4to, Paris, 1780) is the most complete and elaborate work that has ever been published with respect to ancient monies, weights, and measures. At the same time we confess we should not be disposed to place much reliance on these tables, and we have elsewhere stated our reasons for holding this opinion. — (Art. "Money," New Edit. *Encyc. Britannica.*)

* This value of the American eagle is taken from average assays of the coins of twelve years.

† This is the coin which is universally circulated under the name of the Spanish dollar.

Jewish Coins.

Names and Proportions.					Value in Sterling. L.	s.	d.
Gerah					0	0	$1\frac{59}{160}$
10	Bekah				0	1	$1\frac{11}{16}$
20	2	Shekel			0	2	$3\frac{3}{8}$
1,200	120	50	Maneh, Mina Hebraica		5	14	$0\frac{3}{4}$
60,000	6,000	3,000	60	Talent	342	3	9
Solidus aureus, or sextula, worth					0	12	$0\frac{1}{2}$
Sicius aureus, worth					1	16	6
A talent of gold, worth					5475	0	0

Grecian Coins.

											s.	d.	qrs.
Lepton											0	0	$0\frac{31}{336}$
7	Chalcus										0	0	$0\frac{31}{48}$
14	2	Dichalcus									0	0	$1\frac{7}{24}$
28	4	2	Hemiobolum								0	0	$2\frac{7}{12}$
56	8	4	2	Obolus							0	1	$1\frac{1}{6}$
112	16	8	4	2	Diobolum						0	2	$2\frac{1}{3}$
224	32	16	8	4	2	Tetrobolum					0	5	$0\frac{2}{3}$
336	48	24	12	6	3	$1\frac{1}{2}$	Drachma				0	7	3
662	96	48	24	12	6	3	2	Didrachma			1	3	2
1,324	112	96	48	24	12	6	4	2	Tetradrachma		2	7	0
1,660	384	120	60	30	15	$7\frac{1}{2}$	5	$2\frac{1}{2}$	$1\frac{1}{4}$	Pentadrachma	3	2	3

Of these, the drachma and didrachma were of silver; the rest, for the most part, of brass.

The drachma is here, with the generality of authors, supposed equal to the denarius: though there is reason to believe that the drachma was somewhat the weightier.

	Value in Sterling. L.	s.	d.
The Grecian gold coin was the stater aureus, weighing 2 Attic drachms, or half of the stater argenteus; and exchanging usually for 25 Attic drachmas of silver	0	16	$1\frac{3}{4}$
But according to our proportion of gold to silver it was worth	1	0	9
There were likewise the stater Cyzicenus, exchanging for 28 Attic drachmas, or	0	18	1
The stater Philippicus, and stater Alexandrinus, were of the same value.			
Stater Daricus, according to Josephus, worth 50 Attic drachmas, or	1	12	$3\frac{1}{2}$
Stater Crœsius, of the same value.			

Value and Proportion of the Roman Coins.

						Sterling. s.	d.	qrs.
Teruncius						0	0	$0\frac{775}{1000}$
2	Sembella					0	0	$1\frac{55}{106}$
4	2	Libella, As				0	0	$3\frac{1}{10}$
10	5	$2\frac{1}{2}$	Sestertius			0	1	$3\frac{3}{4}$
20	10	5	2	Quinarius, Victoriatus		0	3	$3\frac{1}{2}$
40	20	10	4	2	Denarius	0	7	3

	L.	s.	d.
The Roman gold coin, or aureus, weighed generally double the denarius; its value, according to the proportion of gold to silver mentioned by Pliny, was	1	4	$3\frac{3}{4}$
According to the proportion that now obtains amongst us	1	0	9
According to the decuple proportion mentioned by Livy and Julius Pollux	0	12	11
According to the proportion mentioned by Tacitus, by which the aureus exchanged for 25 denarii, its value	0	16	$1\frac{3}{4}$

MO'NEYERS, COMPANY OF. This company, which is of very ancient origin, are officers of the Royal Mint, under whose superintendence and responsibility the various moneys of the realm are manufactured. They receive the bars of standard metal from the *melter*, and under their direction these are rolled down, cut into blanks, and coined: these processes are described under the word COINAGE. The connection of the Company of Moneyers with the other officers of the mint will be evident from the duties of the other officers, which are stated under the word MINT. (See also Mr. Atkinson's account of the origin and constitution of the Company of Moneyers, in the Parliamentary Report of the Select Committee on the Royal Mint, 1837, p. 119.)

MONOCA'RPONS (Gr. μονος, *single*, and καρπος *fruit*), is a term invented by De Candolle to designate what gardeners call annual plants, and a few others which, like the American aloe, although they may live for many years, yet perish as soon as they have once borne fruit.

MO'NOCHORD. (Gr. μονος, and χορδη, *string*.) In Music, an instrument consisting of a single string stretched between two bridges standing on a graduated rule, for the purpose of measuring the variety and proportion of musical sounds. The monochord is called the harmonical canon, or the canonical rule.

MONOCHROMA'TIC LAMP. When a solution of common salt is added to spirit of wine, the mixture burns with a flame in which yellow predominates almost to the exclusion of the other coloured rays; the consequence is, that objects viewed by this light are all either yellow or black, and deficient in the tints which they exhibit when seen by solar light, or by that of our ordinary combustibles. (See Sir David Brewster, in the volume of the *Family Library* on "Natural Magic.") The term *Monochromatic* is of the same origin as —

MO'NOCHROME. (Gr. μονος, and χρωμα, *colour*.) A painting executed in a single colour. *See* PAINTING.

MO'NOCOTYLE'DONS. (Gr. μονος, and κοτυληδων, *a lobe*.) A class of plants having but one cotyledon or seed-lobe in the embryo. They are now more generally called *Endogens*, which see.

MO'NODELPHS, *Monodelphi*. (Gr. μονος, and δελφυς, *a womb*.) A name given by De Blainville to the first sub-class in his binary division of Mammalia, comprehending those which have no supplementary external pouch or marsupium, but which bring forth the young in a state sufficiently mature not to require such additional protection. It is antithetical to *Didelphs*.

MO'NODON. (Gr. μονος, and οδους, *a tooth*.) The generic name of the narwhal, signifying its supposed peculiarity of having but one tooth, which projects like a horn from the fore-part of the head; a second tooth, however, is always to be found concealed in the adjoining jaw, where it remains in a rudimental state. In the female both tusks are rudimental.

MO'NODY. (Gr. μόνος, and ᾠδη, *a song*.) A species of poem of a mournful character, in which a single mourner is supposed to bewail himself: thus distinguished from those pastoral elegies (like the *Daphnis* of Virgil) which are in the form of dialogues.

MONŒ'CIA. (Gr. μονος, and οικος, *a house*.) In Botany, the twenty-first class in the system of Linnæus, comprising the Androgynous plants, or those whose structure is both male and female.

MO'NOGRAM. (Gr. μονος, and γράμμα, *letter*, or *writing*.) An abbreviation of a name by means of a cipher composed of two or more letters intertwined with each other. Monograms were used on coins in very ancient times, being found on Greek medals of the age of Philip and Alexander of Macedon. The Greek monogram of the name of Christ, which resembles P placed perpendicularly in the middle of an X, thus ☧, is found on coins of the age of Constantine. By far the greater number of the ancient monograms are still unintelligible; though the labour and research which have been expended in endeavouring to decipher their meaning have in many instances been rewarded with success. Among others whose researches on the ancient monograms may be consulted with advantage are, Montfaucon, *Palæographia Græca*; Froelich, *Annal. Reg. Syr.*; Combe, *Museum Hunterianum*; Torremuzza, *Description des Monnaies de Sicile*; Pellerin, *Recueil des Villes, des Peuples, et des Rois*; Mionnet, *Traité de la Numismatique*. Monograms are frequently found on coins and maps of the middle ages; and they are also to be met with as a substitute for the signature of the princes of that period. This class of monograms is of great importance in illustrating the monuments of antiquity, and their investigation constitutes a distinct and peculiar branch of diplomatics. In later times monograms were frequently employed by printers and engravers to record their names at the end or on the title-page of a book, or in some portion of an engraving. A great deal of attention has likewise been bestowed upon this branch of monogrammatic writing, and with considerably more success. The Abbé de Marolles, in 1667, was the first who directed attention to this subject; and to him succeeded Florent Lecomte (*Cabinet des Singularités d'Architecture, &c.*); Orlandi (*Abecedario Pittorico*); Fr. Chrüt (*Anzeige und Auslegung der Monogrammatum*); De Virloy (*Dictionnaire d'Architecture*); and Bartsch (*Peintregraveur*, a work of great accuracy and research). But the most complete and accurate information on this class of monograms is to be found in the *editio optima* of Brulliot (*Dictionnaire des Monogrammes, &c., avec lesquels les Peintres, &c., ont designé leurs Noms*, 2 tom. 4to. Munich, 1832; a work which is founded on the principle of considering

the *first* letter of the monogram as the key to its explanation.

A monogram is said to be *perfect* when it contains all the letters of the word it is intended to represent. (*Dict. de la Conversation, &c.*)

MO'NOGRAPH (Gr. μονος, and γραφω, *I write.*) A treatise or memoir on a single subject of a limited description. Such, for example, are the greater part of the memoirs which are read before learned societies.

MONOGY'NIA. (Gr. μονος, and γυνη, *a female.*) In Botany, the name given by Linnæus in his system to the first order or subdivision in each of the first thirteen classes of plants, comprising such as have one pistil or stigma only in a flower.

MO'NOLITH. (Fr. monolithe; from Gr. μονος, and λιθος, *a stone.*) A term recently introduced into England, to signify a pillar or other large substance consisting of a single stone. Herodotus speaks of a huge rock of this sort in front of the temple of Minerva at Sais, which was scooped out, and contained an apartment 18 cubits in length, 12 in breadth, and 5 in height. It was said to have been transported from the town of Elephantine by order of king Amasis, and to have occupied 3000 men for three years in conveying it. Some remarkable monoliths have been found in Egypt; of these the zodiac of Denderah, and the obelisk of the Luxor, both of which have been removed to Paris, are well-known examples.

MO'NOLOGUE (Gr. μονος, and λογος, *a discourse*), or SOLILOQUY (Lat. solus, *alone*, and loquor, *I speak*), is, as its name imports, a speech uttered by one of the dramatis personæ of a play when alone, or, as it is vulgarly termed, speaking to himself. The introduction of the soliloquy is obviously a very unnatural contrivance in the dramatic art; yet its obvious necessity reconciles the spectator to it. In the drama of ancient Greece soliloquies are rare; for the passages at the commencement, or "prologues" of plays, where the first actor comes forward and explains his own character and something of the subject of the piece to the audience, can hardly be termed soliloquies. The speech of Ajax before his death is a celebrated exception.

MO'NOMA'NIA. (Gr. μονος, and μαινομαι, *I rage.*) Insanity upon one particular subject, the mind being in a sound state in reference to other matters.

MO'NOME, or MONOMIAL. (Gr. μονος, and νομη, *a part.*) In Algebra, an expression composed of a single term, or a series of factors, all which are single terms.

MONOME'RANS, *Monomera.* (Gr. μονος, and μηρος, *a limb.*) A section of Coleopterous insects, including those in which the tarsi were supposed to be formed of a single joint.

MO'NOMY'ARIES, *Monomyariæ.* (Gr. μονος, and μυων, *muscle.*) All those bivalves or conchifers which have only one adductor muscle, and consequently but one muscular impression on each valve.

MONONEU'RANS, *Mononeura.* (Gr. μονος; νευρον, *nerve.*) A term applied by Rudolphi to the series or primary division comprehending the animals which he believed to have only the ganglionic system of nerves, as the Mollusks and Insects.

MONOPE'TALOUS (Gr. μονος, and πεταλον, *a petal*), in Botany, is applied to a corolla, the petals of which cohere by their contiguous margins, so as to form a tube.

MONOPHY'LLUS (Gr. μονος, and φυλλον, *a leaf*), in Botany, is applied to a calyx the sepals of which cohere by their contiguous edges into a kind of tube or cup.

MONO'PHYSITES. (Gr. μονος, and φυσις, *nature.*) A name given in the 5th century to certain heretics who, in the language of the Athanasian creed, "confounded the substance," that is, the divine and human substance, which are united in Christ, but neither absorbed into the other. *See* INCARNATION, EUTYCHIANS, NESTORIANS. (Mosheim, *Eccl. Hist.* vol. ii.)

MO'NOPLEU'ROBRA'NCHIANS. (Gr. μονος, and πλευρα, *a side*, βραγχία, *gills.*) A name given by De Blainville to an order of his class *Paracephalophora*, comprehending those species which leave the branchiæ more or less completely covered by a part of the mantle, and situated on the right side of the body.

MONO'POLY (Gr. μονος, and πωλεω, *I sell*), in Law, is defined by Sir E. Coke (3 *Inst.* 181. c. 5.) "an institution or allowance by the king, by his grant, commission, or otherwise, to any person or persons, bodies politic and corporate, of or for the sole buying, selling, making, working, or using of any thing, whereby any person or persons, bodies politic or corporate, are sought to be restrained of any freedom or liberty that they had before, or hindered in their lawful trade." The practice of granting monopolies, giving to one or a few individuals the sole privilege of producing, importing, or dealing in certain articles, has been acted on to a greater or less extent in all countries, and was carried to an oppressive and ruinous extent in England in the reign of Elizabeth and the earlier part of that of James I. At length the grievance became quite insupportable; and notwithstanding the strenuous opposition of the crown, it was finally abolished by the famous statute of the 21 Jas. 1. cap. 3. Its provisions did not extend to patents for new inventions, nor to grants by act of parliament to corporations, &c. But it suppressed all private monopolies; and by giving full freedom to industry and invention, contributed more perhaps to accelerate the progress of improvement than any other act in the statute book.

MONOPO'LYLOGUE. (Gr. μονος, πολυς, *many*, and λογος, *a discourse.*) A term recently invented to designate an entertainment in which a single actor sustains many characters.

MONO'PTERAL. (Gr. μονος, and πτερον, *a wing.*) In Architecture, a temple or circular enclosure of columns without a cell.

MO'NORHYME. (Gr. μονος, and ῥυθμος, *measure.*) A composition in verse, in which all the lines end with the same rhyme. This species of composition is said to owe its invention to Benin, who wrote in Latin, and dedicated his monorhymes to Pope Alexander III.

MONO'STOMA. (Gr. μονος, and στομα, *a mouth.*) The name of a genus of Trematode Entozoa, including those which have only a single pore, serving at once for nutrition and adhesion.

MONOTHA'LAMANS. (Gr. μονος, and θαλαμος, *a chamber.*) This term is applied to those univalve shells which have only one chamber.

MO'NOTHEISM. (Gr. μονος, and θεος, *a god.*) The doctrine of, or the belief in, the existence of one God; in contradistinction to Polytheism, the belief in a plurality of Gods. The Jewish, Christian, and Mohammedan systems of religion are the only pure specimens of Monotheism in existence. It has often been supposed that the Jews alone, of all the nations of antiquity, had conceived the truth of there being only one God; but there can be little doubt that there are no well-founded reasons for this opinion. In the arcane theology of Egypt, not only was the unity of the Deity acknowledged, but he was even adored, not as the God of any particular religion, but as the eternal and omnipotent Governor of the Universe. In support of this assertion the testimony of various heathen writers might be cited; but the following passage from Jablonski may supersede the necessity of adducing any other authority. "Those men," he observes, "who were most distinguished for wisdom among the Egyptians, acknowledged God to be a certain unbegotten Eternal Spirit, prior to all things which exist; who created, preserves, contains, pervades, and vivifies everything; who is the Spirit of the Universe, but the Guardian and Protector of men." That many of the priests and poets and philosophers of Greece were not ignorant of the same truth, is not less evident. In one of the *Orphic Fragments*, preserved by Proclus, we find it expressly declared, that "there is One Power, One Deity, the great Governor of all things." The verses which, according to Bishop Warburton, were sung in the Eleusinian Mysteries, contained the following passage: — "Pursue thy path rightly, and contemplate the King of the world: He is One, and of himself alone, and to that One all things have owed their being. He encompasses them. No mortal hath beheld him; but he sees everything." In some verses which have been often cited by the fathers from a tragedy now lost, Sophocles has said, "There is in reality only One God, who made the heavens and the remote earth, the blue waves of the ocean and the strength of the winds." That Pythagoras admitted the unity of the Deity must be evident to all who have considered his philosophy; and his monotheism is further attested not only by the eclectic philosophy, but in distinct terms by St. Justin and St. Cyril. Euclid of Megara and Socrates were both Monotheists: Plato was in all probability one likewise. His Trinity, like that of the Magi and the Egyptians, was not a trinity of beings, but of modes of being in the Divine Nature. "When," says he, "I speak fairly in my epistles, I commence with *God;* — when I do not, my letters begin with *gods.*" But if any further proof were wanting in support of this opinion, the following passage from Origen must be held to be conclusive: — "Many of the old philosophers have said that there is one God, who created all things; and in this they agree with the law: but some say in addition, that God hath made and governs all things by his Word; and that it is the Word of God by which all things are regulated. In this they write consonantly not only with the law, but with the Gospel." (*Edin. Review*, vol. vii. pp. 97, 98.)

MONO'THELITES (Gr. μονος, and θελω, *I will.*) A sect of heretics, who, while they avoided the error of the Eutychians, and allowed the two natures of Christ to coexist distinctly in the unity of the person, conceived the influence of the divine will so to predominate over the human substance as to leave to the latter no action or efficiency of its own.

The origin of this doctrine is ascribed to the emperor Heraclius, who, in the year 630, attempted to reconcile the Eutychians or Monophysites to the Catholic church by a middle course of this nature, and published an edict under the advice of some theologians of the day in assertion of it. This opinion was condemned by some provincial and one general council; and, on the other

hand, was maintained by the edict of several succeeding emperors. Nor was the question finally settled, though silence was frequently commanded upon it, until it was forgotten in the louder disputes of the Iconoclasts and their opponents. (Combefils, *Monothelit. Hist.*, 2 tom. 1648.)

MONO'TONY. (Gr. μονος, and τονος, *a sound.*) An irksome sameness either in speaking or composition.

MONOTRE'MES, *Monotrema.* (Gr. μονος, and τρημα, *a hole.*) A tribe of ovo-viviparous Mammalia, of which only two genera are known to exist; viz. the *Platypus* or *Ornithorhynchus*, and the *Echidna*, both peculiar to Australia. The term is indicative of the common cloacal outlet for the excremental and generative products.

MO'NOTRI'GLYPH. (Gr. μονος, and τριγλυπτος, *thrice cut.*) In Architecture, such an intercolumniation in the Doric order as brings only one triglyph over it.

MONSEIG'NEUR. A title of courtesy in France, which was prefixed to the titles of dukes and peers, archbishops, bishops, and some other exalted personages, and used in addressing them. *Monseigneur* simply was, before the Revolution, the title given to the dauphin. *Monsieur* is now the common title of courtesy and respect in France; and previously to the revolution in 1830, *Monsieur* simply was the title of the eldest brother of the king.

MONSOO'NS. (From a Malayan word signifying *seasons.*) In Physical Geography, the name given to a certain modification or disturbance of the regular course of the trade winds which take place in the Arabian and Indian seas. Between the parallels of 10° and 30° south latitude the eastern trade wind blows regularly; but from the former parallel northwards the course is reversed for half the year, and from April to October the wind blows constantly from the south-west. During the other six months of the year the regular north-east trade wind prevails. The south-west monsoon is supposed to be occasioned by the great rarefaction of the atmosphere over the extensive regions of Eastern Asia during the summer months. *See* TRADE WINDS.

MO'NSTER. (Lat. monstrum.) Any thing out of the common order of nature is occasionally designated by this term; but it is physiologically employed under a more limited acceptation, and applied to animals in which one or more parts of the body present some congenital malformation. This is sometimes apparent externally, and then must amount to something exceeding any ordinary deformity; or it may be confined to internal organs. Buffon, Blumenbach, and Meckle have treated on monstrosity, classifying its modifications under three heads: the first including cases in which parts of the body are increased in number; the second those where certain organs are deficient; and the third including cases in which size, situation, and structure are concerned. Other writers, such as Geoffroy St. Hilaire (*Histoire des Anomalies*), have adopted more comprehensive arrangements; arising, however, out of the general subdivision of monsters into simple and compound: the former including all cases in which the elements of a single individual only are concerned; the latter those in which the constituent parts of two or more individuals are united. Simple monsters have again been distributed into three classes. The first including such varieties of malformation as chiefly affect one organ or system of organs, without materially interfering with any vital function: these anomalies are extremely numerous, and have been further subdivided into cases where size, form, or structure is affected, and those in which the malformation affects the arrangement, connection, or number of parts. The second class in this arrangement includes cases of extensive malformation, attended by great deformity and by disturbance of vital functions. The third class is limited to malformations of the organs of generation, including among others the various cases miscalled hermaphrodites. The history of individual cases of monstrosity would be here misplaced; several of the most remarkable are detailed in various volumes of the *Philosophical Transactions;* in the *Transactions of the Medico-Chirurgical Society;* and in the *Penny Cyclopædia*, art. "Monster."

MO'NSTERS, or CHIMERICAL FIGURES. In Heraldry, a species of bearings, of which some are very common in English coats of arms, and others common in foreign, although not often used in our own. The sagittary or centaur, man-tiger, sphinx, harpy, triton, and mermaid, are monsters compounded of the human and bestial shape. Of monstrous beasts, the most common in armorial bearings are the dragon, the griffin (a compound of the eagle and the lion), the wyvern (a two-legged dragon): besides these, there are the unicorn, the heraldic antelope, tiger, and ibex (which are chimerical figures, but representing the natural beast), the musimon (an animal between the goat and the sheep), and the salamander. Monstrous birds are the phœnix, cannet, martlet, allerion, cockatrice, &c.

MONTA'NISTS. Heretics of the second century, who derive their name from their founder Montanus, a Phrygian, who pretended to inspiration, and declared himself to be a prophet sent from God to complete the Christian scheme, and advance it to its highest state of perfection. He affirmed himself to be the Paraclite or Comforter, whose mission was supposed by various sectarians of the early centuries to be distinct from that of the Holy Spirit, which was promised to the apostles, and was expected to put the finishing stroke to the revelation of Jesus Christ. The characteristics of this sect were similar to those which are known by the general name of Gnostic, and consisted principally in great austerity of manners, and a belief in the possibility of an advance from the obvious and literal interpretation of the word of God to a state of interior and spiritual knowledge coincident with a participation in the divine nature itself.

MO'NTANT. (Fr.) In Architecture, any upright piece in a system of framing.

MONT DE PIÉTÉ. (Ital. Monte di Pieta.) The name given on some parts of the Continent to certain benevolent institutions, established for the purpose of lending money to the poor at a moderate rate of interest. They originated under the papal government in the 15th century, and were intended to countervail the exorbitant usurious practices of the Jews, who formed at that period the great money-lenders of Europe. These institutions were afterwards introduced into many of the Continental states; and similar establishments existed, and in some cases still exist, at Paris, Madrid, Brussels, Ghent, Antwerp, &c., *Monti frumentarii* are public granaries, from which corn is sold to the necessitous Italians, on a principle somewhat analogous to that on which sums are lent by the Mont de Piété.

MO'NTEM. The name given to an ancient custom still prevalent among the scholars of Eton, which consists in their proceeding every third year on Whit Tuesday to a tumulus (Lat. *ad montem*, whence the name), near the Bath road, and exacting money for *salt*, as it is called, from all persons present or passers by. The sum so collected is given to the *captain*, or senior scholar of the school, and is intended to assist in defraying the expenses of his residence at the university, to which he is about to proceed. The origin of this ceremony dates from the establishment of the foundation of Eton College; but it was at first held on the 6th of December, the festival of St. Nicholas, the patron of children; and it is only since 1759 that the present was substituted for the original period of its celebration. It has been the almost invariable practice of the sovereign, the court, and a large portion of the nobility to honour this festivity with their presence; and so liberal have been their contributions that the *salt money* has been known to approach nearly 1000*l.* (See *Huggett's MS. Collections*, for a history of Windsor and Eton colleges, in the British Museum; and *Brand's Popular Antiquities.*)

MONTH. (Germ. monat.) The twelfth part of our calendar year. It is so called from its being the period of the moon's revolution round the earth. *See* CALENDAR.

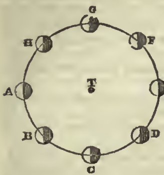
MO'NUMENT. (Lat.) A memorial for perpetuating the remembrance of an event; also a cenotaph in memory of the dead. The productions of architecture and sculpture intended to transmit to posterity the memory of individuals and events are most generally called monuments. Among those in honour of individuals are tombs and sepulchral edifices or columns. The most ancient are the obelisks and pyramids of Egypt; and perhaps, contemporary with these, the tombs of the Persian kings, still visible in the ruins of Persepolis. Greece abounded with monuments of this nature. Buildings in that country were frequently raised in commemoration of distinguished persons or events; and of this class were the Choragic monuments, in honour of those who had received the prize as *choragi* in the theatrical and musical games. Of these the most splendid is the choragic monument of Lysicrates, vulgarly called the Lantern of Demosthenes. Among the monuments of this class of the Romans, the triumphal arches are in the first rank. The column called the Monument of London, and the Duke of York's monument, illustrate respectively the definition above given.

MOOD. (Lat. modus.) In Grammar, the designation by the form of the verb of the manner of our conception of an event, or fact; whether as certain, contingent, possible, desirable, or the like. *See* GRAMMAR.

MOOD OF A CATEGORICAL SYLLOGISM, in Logic, is the designation of its three propositions in the order in which they stand, according to their quantity and quality.

MOON, (Gr. μηνη, Germ. mond.) The satellite of the earth. The moon, after the sun, is not only the most conspicuous, but, in an astronomical point of view, the most interesting of the celestial bodies. The variety of her phases, her eclipses, and the rapidity with which she changes her place among the fixed stars, drew the attention of the earliest observers of the heavens; and in modern times the important application of the theory of her motions to navigation and the determination of terrestrial longitudes, has given the *Lunar Theory* the first rank among the objects of astronomical science.

Phases of the Moon. The different phases of the moon were probably the first celestial phenomena that received a correct explanation. By observing them attentively during the course of a single revolution, it would be inferred that they are occasioned by the reflection of the sun's light from the spherical surface of the moon; and accordingly the fact had been recognised by the earliest astronomers. Let T be the place of the earth, and A B C D E F G H successive portions of the moon in her orbit, the sun being supposed to be situated in the straight line T A, and at so great a distance that lines drawn from it to every part of the moon's orbit may be regarded as parallel. When the moon is at A, she is in *conjunction* with the sun, and passes the meridian at the same time; and her illuminated hemisphere being then turned directly away from the earth, no portion of her disk is visible.



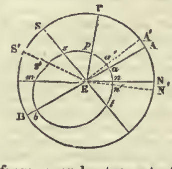
A few days after the conjunction the moon begins to appear on the eastern side of the sun at B, having the form of a crescent, the horns of which are turned away from the sun. When she arrives at C, or 90° from her conjunction, the earth is in the plane of the great circle of her orb, which forms the boundary between her dark and illuminated hemispheres, and consequently half the disk is visible. The moon is then in her *first quarter*. At D more of the illuminated hemisphere is turned towards the earth, and she appears gibbous. At E she is in opposition to the sun; the illuminated side is turned directly to the earth, and the disk appears round or *full*. After passing E the disk begins to wane, and from E to G appears gibbous. When at G, or 270° from the conjunction, she is in the *third quarter*. From this point to the conjunction the moon again appears as a crescent, becoming narrower as she approaches to A; but the horns of the crescent are now turned westward, that is, away from the sun. The straight line which joins A and E is called the line of the *syzygies;* that which joins C G is the line of the *quadratures;* and the points B D F H, situated at equal distances from those lines, are called the *octants*. The magnitude of the illuminated portion of the disk is thus seen to depend on the position of the moon relatively to the sun and the earth, and is easily determined by a geometrical construction. The mean period of time in which a revolution of the phases is completed, or in which she passes from one conjunction to the following, is 29 days, 12 h. 44 m. 2·8 sec.

Distance and Magnitude of the Moon. — The moon's distance from the earth is found from her horizontal parallax, which may be determined either by simultaneous observations at stations very distant from each other, or by means of the occultations of fixed stars by the moon. From such observations it is found that the amount of the parallax varies considerably at different times. Its mean value gives the average distance of the moon from the earth, equal to 59·9 of the earth's equatorial semidiameters, or about 237,000 miles, which is upwards of 400 times less than the distance of the sun. Combining this result with the apparent magnitude (31′ 26″) of the moon's diameter, when at her mean distance, it results that the diameter of the moon is to that of the earth in the proportion nearly of 3 to 11; whence the volume of the moon is only about 1-49th of the volume of the earth.

Inclination and Nodes of the Lunar Orbit. — The moon's orbit is inclined to the ecliptic under an angle of 5° 8′ 47″·9; but the line in which it intersects the ecliptic, or the *line of the nodes*, does not maintain a fixed position on the plane of the ecliptic. It is observed that the moon passes from one of the nodes to the opposite one in less time than is required to pass through 180° of longitude; hence the line of the nodes has a retrograde motion on the ecliptic; and its motion is so considerable that it completes a revolution, or returns to its former position, in a period of 6798·28 days, or about 18·6 years. This period is remarkable, as being that after which the eclipses of the sun and moon again return nearly in the same order. The cause of the regression of the line of the nodes is the attractive power of the sun, which is always tending to draw the moon into the plane of the ecliptic, and which would at length cause her orbit to coincide with that plane, were the tendency not counteracted by the angular motion of the moon round the earth. By reason of the angular motion the mean inclination remains the same, and the resulting effect is the retrograde motion of the nodes. But as the sun's distance from the earth is a variable quantity, the effect of the solar action in displacing the moon's orbit is also variable. Hence, and also on various other accounts, the motion of the nodes, and the inclination of the lunar orbit to the ecliptic, are subject to certain periodical changes, all which must be accurately appreciated and computed in the formation of the lunar tables. *See* PERTURBATIONS.

Eccentricity of the Lunar Orbit. — The general orbit of the moon is an ellipse, having the earth at one of its foci; but on account of the disturbing force of the sun, and the difference of the intensities of this force when the moon is differently situated relatively to the earth and sun, the ellipse is constantly changing its form and position on the plane of the orbit; and hence the numerical values assigned to all its elements are to be considered only as average or mean values. The distance of the moon from the earth when in *apogee*, or at her greatest distance, is 63·842 semidiameters of the earth; and when in *perigee*, or at her least distance, 55·916 semidiameters; whence the eccentricity, or distance of the focus form the centre, is about 0·066, half the major axis being taken as unity. According to the best tables, it is 0·0548442. On comparing the positions of the major axis, which is called the line of the *apsides*, at different times, in respect of the fixed stars, it is found to have a rapid motion eastward, completing a whole circuit in 3232·57 mean solar days, or nearly nine years. But this mean motion is subject to inequalities of considerable magnitude. The different situations of the line of the apsides with respect to the line of the syzygies gives rise to the inequality of the lunar motion, called the *evection*. *See* EVECTION.

Different Species of Lunar Months. — As the principal points of the lunar orbit — the syzygies, the nodes, the apsides,—are in a state of rotation with different velocities, and in different directions, it follows, that the period of time in which the moon completes a revolution with respect to any of these points, or to the fixed stars, will be different in each case. These periods, which are called lunar *months*, may be explained as follows: — Let E be the centre of the earth, *a s b t* the orbit of the moon, *a b* the transverse axis or line of the apsides, *s t* the line of the syzygies, *n m* the line of the nodes, and A S B N the great circle of the sphere in the plane of the ecliptic. Also, let P be a fixed point on this circle; and suppose the moon to be at *p*, or seen in the direction E P.



The time which elapses while the moon passes from *p*, and returns to the same point of the ecliptic, is called the *tropical* revolution, and differs only about seven seconds from the time in which the moon returns to the same fixed star, or performs a *sidereal* revolution. Suppose now the moon to be at *s*, in the line of the syzygies; when the moon advancing from *s*, in the direction *m b n*, has again come round to the same point of the ecliptic, she will not now be in conjunction; for, in the interval, the sun has advanced from S to S′ (nearly a twelfth of the circumference), and consequently the moon must go on to *s′*, till she overtakes the sun, before she returns to her conjunction. The interval from conjunction to conjunction is the *synodic period*, and exceeds the tropical period by two days and about five hours. Next, suppose the moon to be at her perigee *a*, or seen in the direction E A; while the moon, after leaving *a*, is describing her orbit, the line of the apsides E A revolves through the angle A E A′, and consequently the moon, after coming into the line E A, must continue to advance till she comes to *a′* before she arrives again at her perigee. The interval from perigee to perigee is called the *anomalistic period;* and it is also longer than the tropical period, though much shorter than the synodic, inasmuch as the line of the apsides requires about nine years to complete its revolution, while that of the syzygies is completed in one year. Lastly, suppose the moon at *n* in the line of the nodes. While the moon is advancing round her orbit, the line of the nodes, E N, moves backward into the direction E N′; consequently the moon will have come up to her node at *n′* before she has completed a revolution on the ecliptic. The interval from node to node is called the *nodical period*, and is shorter than any of the other periods. The following table exhibits, in mean solar days, the mean lengths of the different lunar periods or months: —

	Days.
Synodic revolution - - -	29·53059
Sidereal - - -	27·32166
Tropical - - -	27.32158
Anomalistic - - -	27·55460
Nodical - - -	27·21222

Acceleration of the Moon's mean Motion. — On comparing observations of the moon made at distant times, it has been discovered that her mean motion has been undergoing a constant acceleration since the earliest times. This acceleration is, however, extremely small, amounting only to 10″ in a century, and therefore is in-

sensible for any moderate interval of time, though it becomes discernible after a few centuries. Being measured by centuries, it is called the *secular acceleration* of the mean motion. Its physical cause was found by Laplace to be a diminution of the eccentricity of the earth's orbit.

Eclipses of the Moon. — The diameter of the sun being much greater than that of the earth, the earth must project behind it in space a conical shadow, the axis of which is in the plane of the ecliptic, and in the straight line joining the earth and sun. On computing from the relative magnitudes of the earth and sun and the distance of the two bodies the length of this shadow, it is found that it reaches to about 216 times the radius of the earth, and consequently far beyond the orbit of the moon. It is found also that the apparent diameter of the conical shadow, at the mean distance of the moon, is about 1° 23′. But the greatest apparent diameter of the moon being only 33′ 31″, or about a third of this distance, it follows that if the moon happens to be situated in the plane of the ecliptic when she is full, or in opposition with the sun, the whole lunar disk will be enveloped in the earth's shadow; and as the moon requires about an hour to pass over a space equal to her own breadth, the whole disk may be involved in the shadow, and the moon remain invisible during a space of about two hours. This phenomenon is a *total eclipse* of the moon; and it is evident that if the moon's orbit coincided with the ecliptic, a total eclipse would take place every lunation. In consequence, however, of the inclination of the orbit to the ecliptic, the moon at the time of her opposition is in general so far from the ecliptic that her disk does not come into contact with the earth's shadow, and consequently no eclipse takes place. The occurrence of the eclipse, therefore, depends on the distance of the moon from her node at the time of the opposition; and it results, from the computation of the different circumstances influencing the phenomenon, that the eclipse *may* take place if the moon is within about 12° of her node, and *must* take place if the distance from the node is not greater than 7°.

Eclipses of the Sun by the Moon. — A solar eclipse is occasioned by the moon's body coming between the spectator and the sun, and thereby intercepting the rays coming from the whole or a part of his visible disk. This phenomenon, like an eclipse of the moon, can only happen when the moon is near one of her nodes; but a total obscuration does not necessarily take place, even when the moon is in the ecliptic at the time of her conjunction; for the magnitude and distance of the moon are so related that the apex of her conical shadow sometimes falls short of the earth's surface, though at other times it would reach as far as the earth's centre. When the umbra extends beyond the earth's surface, its intersection with the surface marks out a circular spot, within which no part of the sun's disc is visible, and there is a total eclipse. For some distance around this spot, that is to say, within the *penumbra*, a part only of the sun will be visible, or there will be a partial eclipse. When the apex of the shadow does not extend to the earth, there will be no total eclipse at any part of the earth; but a spectator situated in or nearly in the prolongation of the axis of the cone, will see the whole of the moon on the sun, though not large enough to cover it; that is to say, he will witness an *annular* eclipse. For the method of calculating eclipses of the sun and moon, see ECLIPSE.

Rotation and Libration of the Moon. — From the observation of the lunar spots, it is ascertained that the moon has a motion of rotation about an axis nearly perpendicular to the plane of her orbit; and, what is very remarkable, the period of rotation is *exactly* equal to that of her sidereal revolution about the earth. Hence, the same hemisphere of the moon is always turned towards the earth; but as the rotation is uniform, while the motion of revolution about the earth is sometimes faster and sometimes slower than the mean, the line which joins the centres of the earth and moon does not intersect the lunar surface always at the same point, but fluctuates a little to the eastward and westward of its mean place, whence the spots near the eastern and western borders of the disk alternately disappear and are brought into view. This phenomena is called the *libration in longitude.* Moreover, as the moon's orbit is inclined to the ecliptic in an angle of 5° 8′ 47·9″, while the plane of her equator makes with the ecliptic an angle of only 1° 30′, the axis of rotation is not exactly perpendicular to the plane of the orbit, whence her poles come alternately into view for a small space round the northern and southern borders of the disk. This is the *libration in latitude.* There is also a *diurnal libration*, occasioned by the moon's being seen from the surface instead of the centre of the earth. *See* LIBRATION.

Appearance and Physical Constitution of the Moon. — On looking at the moon with the naked eye, her disk appears diversified by dark and bright patches, which, on being examined with a good telescope, are discovered to be mountains and valleys. That the whole surface of the moon is covered by such inequalities is evident from the circumstance that the line of separation between the illuminated and dark hemispheres, which, if the surface were even, would be a sharply defined ellipse, is at all times extremely ragged, and indented with deep recesses and prominent points. The mountains near this line cast behind them long black shadows (like mountains on the earth when the sun is in the horizon), from the micrometrical measurement of which the height of the mountains may be calculated. According to Sir J. Herschel, some of the highest of them exceed 1¾ English miles in perpendicular altitude. Tycho, the bright spot in the south-east quarter from which the rays seem to run, is apparently a volcanic crater, 50 miles in diameter and 16,000 feet deep, surrounded by broad terraces within, and with a central mountain about 5000 feet high. Schroeter has estimated the average height of the lunar mountains to be upwards of 5 English miles; but it is easy to see that the measurement is not susceptible of much accuracy.

"The generality of the lunar mountains," says Sir J. Herschel, "present a striking uniformity and singularity of aspect. They are wonderfully numerous, occupying by far the larger portion of the surface, and almost universally of an exactly circular or cup-shaped form, foreshortened, however, into ellipses towards the limb; but the larger have for the most part flat bottoms within, from which rises centrally a small, steep, conical hill. They offer, in short, in its highest perfection, the true volcanic character, as it may be seen in the crater of Vesuvius; and, in some of the principal ones, decisive marks of volcanic stratification, arising from successive deposits of ejected matter, may be clearly traced with powerful telescopes. What is, moreover, extremely singular in the geology of the moon is, that although nothing having the character of seas can be traced (for the dusky spots which are commonly called seas, when closely examined, present appearances incompatible with the supposition of deep water), yet there are large regions perfectly level, and apparently of a decided alluvial character." ("Astronomy," *Cabinet Cyclopædia*, p. 229.)

The moon has no atmosphere, or at least none of sufficient density to refract the rays of light in their passage through it. There is consequently no water on her surface; and no animal similarly constituted to those which inhabit the earth could subsist there. Her surface presents no appearance of vegetation, or of variation which can be ascribed to a change of seasons. Every thing appears solid, desolate, and unfit for the support of animal or vegetable life. Whether the materials of which the lunar substance is composed are of the same nature as those which compose the earth there are no means of knowing. From the effect of the moon's gravitation in producing the nutation of the earth's axis, the mass of the moon is determined to be very nearly 1-80th of the mass of the earth; whence, as her volume is only 1-49th of the earth's volume, it results that her density, as compared with the mean density of the earth, is ·615, or a little more than one half.

MOO′NSTONE. A variety of *adularia*, or resplendent felspar; it occurs massive and crystallized. Select specimens are sometimes cut into ring and brooch stones.

MOOR. An uncultivated surface without trees, and with few grasses or other herbage fit for pasture; and generally containing scattered plants of heath, with a dark peaty soil. Moor lands are generally the least fitted for culture of any description of surface not rocky or mountainous. Moors are covered with a very thin layer of soft, black, sterile soil; and the subsoil is generally gravel, or retentive ferruginous clay. By the destruction of the heath, or other bad herbage, and by sowing down with grass seeds, they may be improved. In many cases, also, trees will grow on drained moors; in which case the soil ultimately becomes ameliorated by the fall and decay of the leaves.

MOOR, in Navigation, signifies generally to fix a vessel by two anchors in nearly opposite directions, so that she *rides* by either in certain winds, or partly by both in other winds. Also to secure a vessel to weights or chains sunk in harbours for the purpose. These weights are called *mooring blocks*, and the whole apparatus *moorings*.

MOO′RISH ARCHITECTURE. *See* ARCHITECTURE.

MO′PLAHS. The Mahometan inhabitants of Malabar, descended from Moors and Arabians who have settled on that coast and married Malabar women. They are said to form a fourth of the population. They are commercial and industrious on the coast, but a furious race in the interior. (Forbes, *Oriental Memoirs*, p. 258.)

MORAI′NE. The name given in Switzerland and Savoy to the longitudinal deposits of stony detritus which are found at the bases and along the edges of all the great glaciers. The formation of these deposits are explained by Professor Agassiz as follows: — The glaciers, it is well known, are continually moving downwards, in consequence, probably, of the introduction of water into their fissures, which, in freezing, expands the mass; and the ice being thus loosened or detached from the rocks below, is continually pressed forward by its own weight.

In consequence of this motion the gravel and fragments of rocks which fall upon the glaciers from the sides of the adjacent mountains are accumulated in longitudinal ridges, or *moraines*. From the existence of such deposits in many places where there are now no glaciers, combined with the polished appearance of the surfaces of the rocks on the sides of valleys, supposed to have been produced by the friction of moving glaciers, Professor Agassiz infers that the extent of glaciers was formerly much greater than it now is, and that they covered the great valley of Switzerland, with the whole chain of the Jura. (Agassiz, *Etudes sur les Glaciers de la Suisse; Reports of the British Association for* 1840.)

MORALS. *See* ETHICS.

MORA'NA. The old Bohemian goddess of winter and of death: the Maryana of Scandinavia. A grand yearly festival was celebrated in honour of this goddess in the month of March. Her image was conveyed solemnly to the nearest brook or rivulet, and thrown into it amid the rejoicings of the people. This festival was called "Das Joden-Austreiben, das Sommer gewinnen;" and, as the words imply, was intended to be symbolical of the end of winter and the return of spring. (See *Grimm's Deutsche Mythologie*, p. 446.)

MORA'SS. Moor lands saturated with water to such an extent as not to bear the tread of cattle. A morass is to a moor what a marsh is to a meadow. It is evident that the drainage of morasses and moors, by lessening the evaporation of water from their surfaces, must tend to improve the local climate.

MORAVIAN BROTHERS. *See* HERRNHUT.

MORBIDE'ZZA. (Ital.) In Painting, a softness and delicacy of style. Its opposite is a style whose lines are harsh and angular.

MO'RDANT. A substance used to fix colouring matters upon different stuffs. (*See* DYEING.) Alumina and oxide of iron are the most important mordants.

MORDE'LLA. (Lat. mordeo, *I bite.*) A Linnæan genus of Coleopterous insects, the type of a family (*Mordellidæ*) of Latreille's *Heteromerans*, distinguished by the general form of the body, which is elevated and arched; with the head low; the thorax trapezoid or semicircular; the elytra very short, or narrow and pointed at the tips, as well as the abdomen. They are distinguished from their nearest congeners, as the *Pyrochroidæ*, by their extreme agility, the firm texture of their integuments, and their tenacious and painful bite. The subgenera of the *Mordellidæ* are *Ripiphorus*, *Myodites*, *Pelecotoma*, *Anaspis*, and *Mordella* proper: to the last subgenus are now restricted the species of the present family, which have the antennæ of equal thickness throughout, and slightly serrated in the males; the eyes not emarginate, and the abdomen terminated by a long point.

MORDE'NTE. (Ital.) In Music, a grace in use by the Italian school, which is effected by turning upon a note without using the note below.

MO'REL. (Germ. morchel.) The *Morchella esculenta* is one of the few fungi found in this country which may be used as food with safety. It occasionally occurs in woods and orchards, whence it finds its way to the markets; but it is of comparatively rare occurrence. It has a hollow stalk an inch or two high, and a yellowish or greyish ribbed head two or three inches deep.

MORE'SQUE. (Fr.) In Painting, a species of ornamental painting, in which foliage, fruits, flowers, &c. are combined, by springing out of each other, without the introduction of the human figure, or that of any animals; and receiving its name from having been much used by the Moors, who, however, were not the inventors of it.

MORGANA'TIC MARRIAGE, or LEFT-HANDED MARRIAGE. (Said to be derived from the Gothic word morgjan, *to shorten.*) A marriage between a man of superior and a woman of inferior rank, in which it is stipulated that the latter and her children shall not enjoy the rank or inherit the possessions of her husband. Such marriages are not uncommon in the families of sovereign princes, and of the higher nobility, in Germany; but they are restricted to personages of these exalted classes.

MORGUE. (Fr.) The name given to a place in many French towns where the bodies of persons found dead are exposed in order to be recognized and owned by their friends. The clothes in which they were found are placed near the bodies, for their better identification. The Parisian morgue is built on the left bank of the Seine, in one of the most populous neighbourhoods of the city, and presents one of the most disgusting spectacles that can be witnessed anywhere.

MO'RMON. (Gr. μοϱμων, *a mask.*) The generic name for the short-winged web-footed birds, usually called Puffins, the singular beak of which gives the head the appearance of a grotesque mask. The depth of the base of the bill equals that of the entire head, and frequently the length of the bill itself: the mandibles are compressed, arched, obliquely channelled, and notched towards the tip. The eggs and young birds are sought after and taken in great numbers in the Orkneys and Faroe Isles.

MORMY'RUS. (Gr. μοϱμυϱος, a name given by the Greeks to a shore-frequenting fish of a variegated colour, probably the *Sparus mormyrus* of Linnæus.) The name was applied by Linnæus to a genus of abdominal fishes placed in the Malacopterygian order, between the *Lucioid* and *Siluroid* families in the system of Cuvier. The *Mormyri* differ from the pikes in little else save in the small size of their mouth, of which the angles are formed by the maxillary bones; and a corresponding modification of the alimentary canal, the intestines being longer, and complicated by two cæca. The *Mormyri* are confined to the rivers of Africa, and are reckoned the best-flavoured fishes that are caught in the Nile.

MORO'CCO. (Fr. maroquin.) A species of goatskin leather, originally imported from the Levant and Barbary states. It is extensively used in the binding of books. *See* LEATHER.

MO'ROXITE. (Lat. morus, *the mulberry tree.*) A mineralogical name applied to one of the varieties of native phosphate of lime of a mulberry colour.

MOROXYLIC ACID. An acid discovered by Blaproth, combined with lime, in the bark of the *Morus alba*, or white mulberry tree.

MO'RPHEUS. In Ancient Mythology, the god of dreams; the son of Ὕπνος or Somnus, who presided over sleep, with whom he is frequently confounded. The chief distinction between them appears to be this — Morpheus had the power of assuming only the human shape, while the transformations of Somnus were unlimited. He is generally represented as a beautiful youth, with a bunch of poppies in his hand.

MO'RPHIA. (Lat. Morpheus, the god of dreams.) The narcotic principle of opium. It may be separated from opium in the form of white prismatic crystals almost insoluble in water, but soluble in boiling alcohol; it combines with the acids and forms salts, all of which are powerful sedatives, and have proved of great value as medicines. Of these the muriate of morphia is perhaps the best. It is composed of about 288 morphia (which is its equivalent) and 37 muriatic acid. One of the most characteristic chemical properties of morphia and its salts is that they decompose iodic acid, and consequently immediately discolour its aqueous solution. The ultimate elements of morphia are carbon, oxygen, hydrogen, and nitrogen.

MO'RPHNUS. (Gr. μόϱφνος, a name applied by Aristotle to the osprey.) This term is restricted by Cuvier to a genus of *Accipitres* called eagle-hawks, having wings shorter than the tail, but with long and slender tarsi and comparatively feeble toes. Some species have the tarsi naked and scutellated, as the *Morphnus guianensis*.

MORPHO'LOGY. (Gr. μοϱφη, *form*, and λογος, *description.*) That department or division of the science of botany which treats of the metamorphosis of organs. It appears, from the comparison of one kind of organ with another, that notwithstanding the differences between them, there are so many close analogies, and so much identity of structure, as to render it probable that they are all formed upon one common plan, modified according to the purposes for which they are severally destined. The leaf, which is the most universal of the external organs, is taken as the best representation of this type; and with the more reason, because all the other parts are found to have a tendency to assume the organization of a leaf, when any disturbing cause interferes with their development. According to morphological writers, the scale of a leafbud is a rudimentary leaf; the petal is a leaf reduced in size, and thinned or coloured, or both; the stamen is a leaf, whose petiole is represented by the filament, while the two lobes of the anther are the two sides of its lamina; and the pollen is the disintegrated mesophyll, and so on. These conclusions were for a long time ridiculed by many writers; but they gradually gained ground with philosophical botanists, and are now the foundation of comparative anatomy in plants. At the present day the question is indeed no longer speculative, but is decided by the evidence of our eyes; for all those transformations, the necessity of which morphologists assumed by mere force of reasoning, have now been witnessed by Schleiden and many others, who have traced the development of the organs of plants from their earliest condition, through all their modifications, up to the period of complete development, and have found that they are all deviations from a common type subsequent to the first stage of their growth.

MO'RRIS DANCE. A peculiar kind of dance practised in the middle ages. It is supposed to have been first introduced into England from Spain by Edward III., when John of Gaunt returned from that country; but few traces of it are found earlier than the times of Henry VIII.; and it is more probable that it was borrowed either from the French or the Flemings. In the morris dance bells were fixed to the feet of the performer, and the great art consisted in so moving the feet as to produce something like concord from the various bells.

MORS. In Ancient Mythology, the daughter of Night without a father, and goddess of death. The most sub-

lime representation of death personified is to be found in the *Paradise Lost*.

MORTA'LITY, BILLS OF. Bills of Mortality are extracts from parish registers, showing the numbers who have died in some fixed period of time, as a year, a month, or a week; and hence they are called yearly, monthly, or weekly bills. In general, they also contain the numbers of baptisms, and sometimes the numbers of marriages.

The keeping of parish registers was begun in England in the year 1538, in consequence of an injunction issued by Lord Cromwell, the king's vicegerent in ecclesiastical affairs, after the abolition of the papal authority in the kingdom. In Germany they appear to have been introduced at a somewhat earlier period, for Sussmilch has given extracts from the Augsburg bills which go back to the year 1501; and they were established in most countries of Europe about the beginning of the seventeenth century.

The London bills, containing the records of the baptisms and deaths, were begun in the year 1592, but were not kept regularly till after the plague which prevailed in 1603; since which time they have continued weekly, and an annual bill has been also regularly published. Their value, however, was very little understood; nor do they seem to have attracted much notice until 1662, when Graunt published his *Natural and Political Observations on the Bills of Mortality*, a work of great merit, considering the time at which it was written. The ages at which the deaths took place were not inserted in the bills till 1728. Throughout the country the registers were kept, generally speaking, with very little care; but the recent act for the registration of births, marriages, and deaths, which came into operation in 1836, has introduced an incomparably better system; and, as the sex, ages, and causes of death are now recorded, the public will soon be in possession of far more authentic information than has yet existed on some of the most interesting questions of social statistics. (See article "Mortality," in the *Encyc. Brit.*; Preface to the *Population Returns for* 1831; *Annual Reports of the Registrar General of Births, Deaths, and Marriages in England*, 1839, *et seq.*)

MORTA'LITY, LAW OF. By this term is usually understood a mathematical relation subsisting among the numbers of persons living at the different ages of life; such that, having given the number of persons living at any assigned age, the number of them who remain alive at every subsequent age, and consequently the mortality which takes place in the interval, will be expressible by that relation. It must be obvious that, in speaking of a law of this kind, we can only have regard to the averages of large numbers. In respect of a single individual, or a small number of persons, the uncertainty of the duration of life is proverbial; but the case is entirely changed when multitudes are concerned; and there are few classes of contingent events of which the results can be predicted with so little risk of departure from the truth as the average age to which the lives of a considerable number of persons will be prolonged.

The circumstances which affect the mean duration of human life depend upon a great number of different causes; as climate, the facility of obtaining subsistence, the state of civilization, the manner of living, progress of medical science, &c., all of which vary in different countries and at different times. The law of mortality, therefore, must vary with these circumstances; and consequently, if expressible by any mathematical function, it must be one affected by numerical coefficients depending on the particular circumstances, and of which the values can only be determined by observation. The simplest expression which has been proposed for representing the course of mortality is that which is derived from the celebrated hypothesis of Demoivre; namely, that, if a number of individuals be taken in any given year of age, the number of deaths which take place among them will be the same every year until the whole are extinct. In this hypothesis only one numerical quantity requires to be determined, which is the average extreme age. Demoivre adopted 86; and his hypothesis may therefore be simply enunciated as follows: — Out of 86 infants born, 85 will be alive at the end of the first year, 84 at the end of the second, and so on to the extremity of life, the decrement being one in each year. For a considerable number of years, about the middle ages of life, this hypothesis of equal decrements represents the observed facts with tolerable accuracy; and, as it affords considerable facilities in various calculations, it was formerly much used in the computation of life contingencies.

If we suppose a straight line to be divided into a number of equal parts, representing the ages of human life, and perpendiculars to be drawn through the points of division proportional to the number of survivors at each age out of a given number taken at a previous age; a curve line drawn through the extremities of all those perpendiculars will represent the law of mortality as indicated by the observations, and the equation of the curve will be the relation between the age and the mortality. Now it is possible to draw an algebraic curve through any number of points; but, in the present case, this method of proceeding is attended with no advantage; for if the number of points be great, as it necessarily must, the equation is of a high order, and its numerical computation impracticable. Lambert, of Berlin, who appears to have been the first who exhibited the law of mortality by a curve line, constructed a somewhat complicated empirical formula, which represented the mortality observed in London during some part of the last century with considerable accuracy, and which may be adapted to any other set of observations by giving suitable values to its numerical coefficients. But the most ingenious attempt which has been made to deduce a formula from *à priori* considerations is contained in a paper by Mr. Benjamin Gompertz, published in the *Philosophical Transactions for* 1825. Mr. Gompertz assumes as a principle that there is a power in human life to resist the effects of disease, or oppose destruction, which loses equal proportions of its intensity in successive equal small intervals of time; and from this he derives an expression which gives the number of survivors (y) of any number of individuals, taken at any given age, at the end of any number of years (x) counted from that age, in terms of three constants, which may be determined from observations. The formula may be given under this form: —

$$\log. y = \log. l \pm \text{No. whose log. is } (\log. \log. p + x \log. q),$$

l, p, and q being the constants to be determined. On assuming three ages, and taking the corresponding values of x and y from the Carlisle table, and determining the constants by means of the three equations so formed, the formula is found to agree with the table through all the ages, within limits which may be fairly supposed not to exceed the errors of the observations.

On account of the multitude of causes which influence the rate of mortality among the inhabitants of a country, it is plain that any formula deduced from *à priori* considerations can only be trusted so far as it is found to agree with experience; and therefore, for all practical purposes, recourse is had to a table showing for each year of age the number of deaths which are observed to take place out of a large number of persons who enter upon that age. The ratio of those two numbers is the measure of the probability that an individual entering upon that age will not survive the year, and may be assumed as the law of mortality in respect of that age. The table may be exhibited under different forms: the most usual is a table of decrements, which is constructed by supposing a large number of persons, as 10,000, for example, to start together in the same year of age (the year of birth is usually assumed), and to write down in the same column the number of them who remain alive at the end of each successive year. From this the number who die in each year, and the chances of surviving a year, or any number of years, are easily found. For some purposes a table of the probabilities of living over a year at each age, or of dying in the course of the year, is more convenient; but either form can be readily reduced to the other.

The oldest table of mortality we possess is published in the *Philosophical Transactions for* 1693, and was constructed by Halley from the mortuary registers of the town of Breslaw, in Silesia. This town was selected, because the number of births having been nearly equal to the number of deaths for some years, it might be assumed that the population had remained in a nearly stationary state during that time, — an assumption which affords the means of determining the ratio of the number who die at each age to the number who entered upon that age; for it is evident that in a place so circumstanced, and supposing also there is no migration, the number who survive or complete any year of age within a given period is equal to the sum of the deaths at all the greater ages during the same period. For the sake of facilitating calculations from the table, he reduced the numbers proportionally to 1000, by which number he represented the infants of one year of age.

This method of determining the mortality from the mortuary registers, or *bills of mortality*, has been frequently adopted, particularly by Dr. Smart, in the formation of a table showing the mortality in the city of London about the middle of the last century; by St. Maur, in respect of Paris; and by Dr. Price, for the celebrated Northampton table, presently to be described. But it is evident that as the population of a large town or district of country can never be absolutely stationary, and as migration must be constantly taking place to a greater or less extent, the method is not absolutely correct; and, in fact, the results to which it leads must be attended with great uncertainty. In order to obtain accurate results, it is necessary to know the numbers who actually enter upon each year of age, as well as the numbers who die in that age, during the period included in the observation; and hence, in addition to the mortuary register, an enumeration in each year, or at short intervals,

of the community in the several ages of life, is requisite for the accurate solution of the problem. But, although great attention has been given of late years to the statistics of life, in various countries of Europe, it is only in a very few instances that sufficiently accurate data for the construction of a mortality table have been obtained from observations embracing indiscriminately all the different classes of the inhabitants. Of these few, the principal (if not the only) instances are the observations made in Sweden and Norway; those of Dr. Heysham, at Carlisle; and more recently by Dr. Cleland, at Glasgow.

In consequence of the migration which is constantly going on among the inhabitants, it is very difficult to obtain with certainty the data necessary for determining the mortality of any town or district, even where the registers of births and deaths are accurately kept; but there are various associations of individuals with respect to which precise data exist. Such, for example, are the religious houses in Catholic countries; the tontines which were established in different countries of Europe during the last century; the annuitants of the British government; and especially the assurance companies, which are now become so numerous. In all such associations, the numbers who enter upon and die in each year of age can be ascertained with precision from the records of the association, which, therefore, afford the data requisite for determining the rate of mortality at the different ages, without hypothesis of any kind. Tables were thus constructed by Kersseboom, from Dutch registers of annuitants; by De Parcieux, from the lists of the nominees in the French tontines, chiefly of 1689 and 1696, and from the mortuary registers of the Benedictines, and of the nuns in several convents in Paris; and by Mr. Finlaison, from six different classes of annuitants in English and Irish tontines. Of the assurance offices, the Equitable Society is the only one which has as yet published its experience; but there is little doubt that several of the others have accumulated valuable masses of observations.

We shall now give a comparative view of the mean duration of life at the different ages, computed from some of the best known tables, premising a short account of each table. For the method of making the computation, see EXPECTATION OF LIFE.

1. *Northampton Table.* — This table, which perhaps is better known in this country than any other, on account of its having been adopted by the greater number of the assurance offices as the basis of their tables of premiums, was constructed by Dr. Price, from the bills of mortality from 1735 to 1780 of the parish of All Saints, in the city of Northampton. It cannot be considered as possessing much authority, either on account of the accuracy of the data, or the number of lives of which it embraces the history; and the hypotheses made use of in its formation, — namely, that the number of the inhabitants, and the number of annual deaths, remained the same during the forty-six years included in the observations, and also that the migrations all took place at the age of twenty years,— tend further to render it of doubtful value. It differs from the other tables in giving a much lower expectation of life at the younger and middle ages; and although this may be in part owing to an increase in the average duration of life since the middle of the last century, it is probably owing in a much greater degree to the inaccuracy of the observations. For the history of this table, see *Price on Reversionary Payments*, 4th ed. 1783.

2. *Carlisle Table.* — This was constructed by Mr. Milne, from registers kept by Dr. Heysham of the births and deaths which took place in the city of Carlisle and its environs in the nine years from 1779 to 1787, the number of inhabitants having been determined by two enumerations which were made during that interval. On account of the accuracy of the data, and the skilful manner in which they were made use of, this table is of great value, and probably gives the most correct view of the mortality among the inhabitants of England generally which has yet been obtained. (*Milne's Treatise on Annuities, &c.*, 1815.)

3. *Government Tables.*—These tables, as already mentioned, were computed by Mr. Finlaison, from observations of the mortality among the nominees of life annuities granted by the British government. Mr. Finlaison has given twenty-one tables of the probabilities of life; but the recorded facts are contained in only six of them, the others being formed by combinations of these six. The two columns in the subjoined table, for males and females respectively, are deduced from the rate of mortality adopted by the government for determining the values of life annuities. (*Finlaison's Report to the Lords of the Treasury*, published by order of the House of Commons, 1829.)

4. *Equitable Society's Table.* — This table, which was prepared by Mr. Arthur Morgan, and published in 1834, exhibits the mortality which took place in the society from its establishment in 1760 to the end of the year 1829. By reason of the great number of lives contained in it, and the certainty of the data, this is a document of great importance. It will be seen from the subjoined table that, for ages under fifty, it gives a rather more favourable expectation of life than the government table for males, and agrees nearly with the Carlisle table; but for ages above fifty it gives a less favourable expectation than either of those tables. The observations commence at the age of ten.

5. *The Friendly Society's Table.* — This table was prepared by Mr. Ansell, from materials collected by the Society for the Diffusion of Useful Knowledge. It may be considered as representing the mortality of the labouring classes in England. The observations were from 1823 to 1828. (*Ansell's Treatise on Friendly Societies*, 1835.)

For the sake of avoiding decimal points, the numbers in the subjoined table show the mean duration of life for ten individuals, or the number of years enjoyed by ten individuals collectively. In respect of a single individual, the mean duration of life is the tenth part of the number given in the table.

Age.	Northampton.	Carlisle.	Government. (Males.)	Government. (Females.)	Equitable Society.	Friendly Society.
0	252	387	502	555		
5	408	513	489	542		
10	398	488	456	511	483	
15	365	450	418	472	450	413
20	334	415	384	440	417	376
25	309	379	359	408	381	342
30	283	343	332	376	345	309
35	257	310	302	343	309	276
40	231	276	270	311	274	246
45	205	245	238	278	239	216
50	180	211	203	244	204	187
55	156	176	172	208	170	159
60	132	143	144	173	139	133
65	109	118	116	140	111	109
70	86	92	92	110	87	86
75	65	70	71	85	66	65
80	48	55	49	65	48	48
85	34	41	31	48	34	34
90	24	33	20	28	26	24
95	8	35	12	16	11	8

There are many questions of great interest respecting the law of mortality which cannot yet be satisfactorily answered, from the want of sufficient data. The Carlisle table gives only an indication of local mortality; but it may be asked, whether the mortality is the same in different parts even of the same country, or the same in cities as in rural districts? Now, the government annuitants resided in all different parts of the kingdom; and the same may be said of the members of the Equitable Society, though, perhaps, a majority of the latter were resident in London. But the three tables—namely, the Carlisle table, the table computed from the government male annuitants, and the Equitable Society's table — present a remarkable agreement; and, so far as their evidence goes, we cannot draw any positive conclusion, either in favour of a particular district or a select class of individuals.

It seems to be established beyond doubt that the rate of mortality, at least in England, has undergone a very sensible diminution within a century, especially in respect of children and aged people. This may be ascribed in some degree to the discovery of vaccination; but more especially to the general diffusion of comfort, and the improved mode of living, among the labouring classes of the community.

Another question of great importance is, whether the law of mortality is the same for both sexes? In the above table it will be seen that there is a remarkable disparity between the male and female annuitants in favour of the latter. This indication of the greater longevity of females is confirmed by the observations of De Parcieux on the monks and nuns in the French convents; of Kersseboom, on the Dutch annuitants; of Dr. Price, on the mortality at Chester; and also by the tables constructed from the mortality in Sweden, at Montpellier in France, and in the cities of Amsterdam and Brussels. It is still, however, open to doubt whether the superiority shown in the above instances holds generally true. Over the whole population of Belgium, the greater part consisting of peasantry and labourers, it is found that the lives of females are shorter than those of males; while in the towns the advantage is on the side of the females. We believe the experience of some of the assurance offices shows no superiority in the duration of female life.

The following table, showing the proportion of deaths to the population in the principal states of Europe, according to the latest observations, is extracted from a paper in the *Revue Encyclopédique* for July and August, 1833. We cannot vouch for its accuracy, but it is probably not far from the truth.

Countries.	Periods or Epochs.	Ratio of Mortality to Population.
Sweden and Norway	1821–1825	1 in 47
Denmark	1819	1 45
European Russia	1826	1 44
Kingdom of Poland	1829	1 44
British Islands	1818–1821	1 55
Netherlands	1827–1828	1 38
Germany Proper	1825–1828	1 45
Prussia	1821–1826	1 39
Austrian Empire	1828	1 40
France	1825–1827	1 39
Switzerland	1827–1828	1 40
Portugal	1815–1819	1 40
Spain	1801–1826	1 40
Italy	1822–1828	1 30
Greece	1828	1 30
Turkey in Europe	1828	1 30
Northern Europe		1 44
Southern Europe		1 36
The whole of Europe		1 40

For an accurate description of the various mortality tables which have hitherto been published, the reader is referred to the excellent article on the subject, by Mr. Milne, in the *Ency. Britannica.*

MO'RTAR. (Dut. mortar.) In Architecture, a cement for the junction of stones and bricks, made of lime, sand, and water. In the composition of it stone lime is preferable to that burnt from chalk, and river to pit or road sand.

MORTAR. A short wide piece of ordnance for throwing shells, bombs, grape-shot, &c. It is the most ancient kind of cannon.

MORTAR. In Pharmacy, a vessel made either of iron, stone ware, or glass, &c., according to the use to which it is applied, in which substances are either pulverized or dissolved by means of a pestle. In fine chemical processes recourse is often had to mortars made of agate, flint, or porphyry.

MO'RTGAGE. In Law, a mortgage-deed is in effect a conveyance, by which a party grants his interest or a portion of it to another, with a condition that if a sum of money is paid by a stipulated day the grant shall be void. Thus the grantee has a conditional estate, whether of fee-simple or otherwise, according to the terms of the conveyance. During the continuance of this estate the mortgagor, though in possession, is in contemplation of law only tenant-at-will to the mortgagee; and on failure of payment the estate of the mortgagee would become absolute at law. But in equity the mortgagee's estate is subject to an *equity of redemption*, or right to redeem on the part of the mortgagor; and a mortgage is thus redeemable so long as the relation of debtor or creditor appears to subsist between the parties, and for twenty years after the last acknowledgment of that relation by the mortgagee, unless upon his application the right be previously foreclosed by a decree of the court.

MORTIER. (Fr.) The name given to a cap of state of great antiquity worn by the first kings of France, and the form of which is still preserved in the cap worn by the president *de la cour* of Paris.

MORTIFICA'TION. (Lat. mors, *death*, and facio, *I cause.*) Local death, gangrene. When any portion of the body loses its vitality, a process of separation takes place between it and the living parts that surround it; and when this happens in certain parts or organs it is necessarily fatal. The symptoms that attend mortification of the viscera are generally loss of pain, diminution of fever, small sinking pulse, hiccup, delirium, cold sweat, and fainting, which precedes death.

MORTIFICATION, in Scottish Law, is nearly synonymous with mortmain in English. By an act of 1587, land vested in the church was declared to be given for superstitious purposes, and to belong to the crown; and thus the spoliation of the richly endowed church of that country prior to the Reformation was finally legalized.

MO'RTISE (Fr. mortaise), in Architecture, is the junction of two pieces of wood or other material, the cavity cut in one piece being the receiving correspondent portion of the wood of the other, which is called a tenon.

MO'RTMAIN. In Law, an alienation of lands, tenements, or hereditaments, to any corporation, sole or aggregate, guild, or fraternity. The foundation of the statutes of mortmain is Magna Charta; by which it was rendered unlawful for any one to give his lands to a religious house, &c. in order to take them back again to hold of the same house; which was extended, by interpretation, so as to annul gifts of lands which religious houses did not give back to the donor to his own use, but kept in their own hands after taking. A great number of statutes were afterwards passed in order to restrict alienations to religious persons and houses, and various devices formed for the purpose of eluding them; of which the system of uses, which has become in some sort the foundation of our law of real property, was one. (*See* REAL PROPERTY, TRUST.) But during the whole of this time the king had the power of dispensing with the statutes of mortmain by granting licences of alienation; and this power was confirmed to the crown by stat. 7 & 8 W. 3. c. 37. Alienation to charitable uses are exempted from the statutes of mortmain; but they are subjected to particular forms and solemnities by the last mortmain act, 9 G. 2. c. 36. The term mortmain is derived from the Latin words mortua manus (*dead hand*), because the lands so alienated are said to fall into a dead hand; *i. e.* one incapable of performing the usual services required of tenants.

MO'RTUARY. In Law, a fee paid to the incumbent of a parish, by custom peculiar to some places, on the death of a parishioner. It appears to have been a very ancient usage to present the priest, on the solemnization of a funeral, with some personal chattel of the deceased, or a sum of money in lieu of it: under the various titles of pecunia sepulchralis, sedatium; in Saxon *soul-shot*, &c. It had become a legal custom as early as the reign of Henry III., when the reservation of a mortuary appears to have been essential to the validity of a testament of chattels. The amount was fixed by 21 H. 8. c. 6. according to an *ad valorem* taxation of the goods of the deceased. Mortuaries (where due by custom) are recoverable in the ecclesiastical courts; and it should appear, since the statute, at common law; although such actions have not hitherto been brought.

MO'RUS (Lat. *the mulberry tree; Celtic* mor, *black*), is a small genus of plants, containing some species valuable for their foliage, and others for their fruit. The latter is our mulberry tree, *Morus nigra*, whose well-known black juicy berries are a favourite autumn production; the former are *M. alba, philippensis*, and others, which constitute the best of all food for silkworms. The latter are found occasionally in plantations; but they are too tender to bear our climate well, and cannot be usefully cultivated even in the midland country of England.

MOSA'IC, or MUSAIC. (Gr. μουσαικον, *polished, elegant;* from μουσα, as being *fine or ingenious?*) In Painting, a species of representation of objects by means of very minute pieces of stones or pebbles of different colours, carefully inlaid upon a ground generally of metal. In St. Peter's at Rome are to be seen some works of this sort on a magnificent scale. This art was practised at a very early period, and was reintroduced to Italy by the Byzantine Greeks.

MOSA'IC GOLD. Bisulphuret of tin; a yellow flaky substance, sometimes employed in ornamental japan work. This term has lately been applied to a superior kind of brass, and to a yellow alloy of copper, zinc, and gold.

MOSA'IC WORK. In Architecture, the inlaying pavements, walls, &c. with small dies of different-coloured stones or glass, in regular figures, or to represent historical or other subjects.

MOSLEM. *See* MUSSULMAN.

MOSQUE (Arab. medsched.) A Mohammedan place of religious worship. The principal interior decoration of mosques consists in the lamps, which are numerous, and singularly disposed; the floor is covered with carpets: the direction of Mecca is denoted by a niche, or by a tablet inscribed with verses of the Koran, called the Kebla. The principal Arabian and Syrian mosques are most remarkable for their vast quadrangles, surrounded with numerous columns; those of the Turks for the elegance of their cupolas. The original places of worship of the Arabians were the temples dedicated to the religion of the different nations whom they subdued: such, for instance, as the temple of Jerusalem, the temple of Minerva at Athens, and innumerable others in Spain, Asia, and Egypt. It was not until they had consolidated their power that the Arabians devoted themselves to the cultivation of the arts, and gave any indication of that original architectural genius which afterwards displayed itself in the structure of mosques. At the entrance of almost every mosque there is a large court planted with bushy trees, in the centre of which, or under a vestibule paved with marble, are fountains for the prescribed ablutions of the Mussulmans; and to these courts is usually attached a small gallery, on which the apartments of the ministers of religion, &c. abut. But besides mosques for public worship there are others set apart for the instruction of young men in the science of legislation, and the doctrines of the Koran; and to this class belong the so called *royal* mosques, or *jamis*, of Constantinople. Most of these mosques have hospitals for poor, the sick, or deranged persons attached to them. Their revenues are often considerable, and are derived chiefly from endowments in landed property. The term *mosque* is found, with slight variation, in all European languages. The Turkish equivalent is meschil, which is supposed to be derived from the Arabic mesgiad, *a place of adoration;* and from this are derived respectively the Fr. mosquée, the Germ. moschee, the Span. mequita, the Ital. meschcta, and the Eng. mosque. *See* MINARET.

MO'SSES, in common language, are any minute,

small-leaved Cryptogamic plants. Thus club moss is a lycopodium; Iceland and reindeer mosses are lichens; and the numerous species of Jungermannia are all comprehended under the same term. But in systematical botany no plants are considered mosses except such as belong to the natural order *Bryaceæ* or *Musci*. Such plants are simple-leaved; without spiral vessels or stomates; with a distinct axis of growth; and with the spores or reproductive matter enclosed in cases, called sporangia or thecæ, covered by a cup or calyptra. The structure of the sporangia is as complex as that of the stems and leaves is simple. Each sporangium is closed by a lid or operculum; below which is a transverse membrane, closing up the urn left after the fall of the operculum. The edge of the urn is furnished with one or more rows of teeth, in all cases some multiple of 4; in the centre is a columella or column, and between the latter and the sides of the urn are the spores. It is not a little singular that such plants should have cases called staminidia, containing powdery matter; among which are found animalcules, not distinguishable from such as are called spermatic, and which swim about freely in water. None of the mosses are of any known use.

MOSS LAND. Land abounding in peat moss, but not so much saturated with water as to become peat bog, or morass.

MOSS-TROOPERS. In English and Scottish History those inhabitants of the borders of the respective countries who were banded together in clans and lived by rapine received this denomination, from the character of the country over which they "trooped" in their excursions. These banditti were little heard of after the union of the two crowns, but not absolutely suppressed until the union of the kingdoms a century afterwards.

MOTES, among the Anglo-Saxons, were public courts or conventions of the people assembled for municipal or legislative purposes. They were of various kinds; as Wittenagemote, Folkmote, Burgemote, &c. (See these separate articles.) *Moteer* was a customary service or payment at the mote or court of the lord, from which certain persons alone were exempted by charter or other privilege.

MOTE'T. (Ital. motetto.) In Music, a composition consisting of from one to eight parts, of a sacred character.

MO'THER OF PEARL (Fr. nacre de perles; Germ. perlen-mutter), is the hard, silvery, brilliant internal layer of several kinds of shells, particularly oysters, which is often variegated with changing purple and azure colours. The large oysters of the Indian seas alone secrete this coat of sufficient thickness to render their shells available to the purposes of manufactures. The genus of shell fish called *Pentadinæ* furnishes the finest pearls, as well as mother of pearl; it is found in greatest perfection round the coasts of Ceylon, near Ormus in the Persian Gulf, at Cape Comorin, and among some of the Australian seas. The brilliant hues of mother of pearl do not depend upon the nature of the substance, but upon its structure. The microscopic wrinkles or furrows which run across the surface of every slice act upon the reflected light in such a way as to produce the chromatic effect; for Sir David Brewster has shown that if we take, with very fine black wax, or with the fusible alloy of D'Arcet, an impression of mother of pearl, it will possess the iridescent appearance. Mother of pearl is very delicate to work; but it may be fashioned by saws, files, and drills, with the aid sometimes of a corrosive acid, such as the dilute sulphuric or muriatic; and it is polished by colcothar of vitriol. (*Ure's Dictionary of Arts, &c.*)

MO'THER WATER. A term applied by chemists to saline solutions from which crystals have been deposited, and which when poured off and re-evaporated furnish a second crop.

MO'TION. (Lat. motio.) In Mechanical Philosophy, motion is the change of place; that is, of the part of space which the body occupies, or in which it is extended. Motion is *real* or *absolute* when the moving body changes its place in absolute space; it is *relative* when the body changes its place only with relation to surrounding bodies; and it is *apparent* when the body changes its situation with respect to other bodies that appear to us to be at rest. All the phenomena of motion are derived by mathematical deductions from the three following laws of motion of Newton:—

1. A body must continue for ever in a state of rest, or of uniform motion in a straight line, if it be not disturbed by the action of an external cause.

2. Every change of motion produced by any external force is proportional to the force impressed, and in the direction of the straight line in which the force acts.

3. Action and reaction are equal and in contrary directions; that is, equal and contrary changes of motion are produced on bodies which mutually act on each other.

For the formulæ which express the relations between the moving force, the spaces passed over, and the times when bodies move in straight lines or curves, with uniform or accelerated velocities, see FORCE AND VELOCITY. For elementary illustrations of the above three laws, we refer to Maclaurin's Account of *Newton's Principia*.

MOTION. (Lat. motio.) In Painting and Sculpture, the change of place or position which from certain attitudes a figure seems to be making in its representation in a picture. It can be only implied from the attitude which prepares the animal for the given change, and differs from *action*, which see. Upon motion, in art, depends that life which seems to pervade a picture when executed by a master.

MOTION. In Music, the manner of beating the measure so as to hasten or retard the pronunciation of the words or notes.

MO'TION IN COURT. In Law, an occasional application to the court, by the parties or their counsel, for the purpose of obtaining some rule or order of court which becomes necessary in the progress of a cause. Motions are either of a criminal nature, as motions for an attachment for a misbehaviour; or of a civil nature. A motion in the courts of common law is either for a rule absolute, *i. e.* to take effect immediately; or it is for what is termed a rule nisi, or a rule to show cause—*i. e.* a rule to take effect, unless cause be shown against it by a certain day, when, if no cause be shown, the rule is made absolute on a second motion. Motions are accompanied by affidavits stating the facts on which they are grounded, and generally preceded by a notice to the opposite party.

MOTION, QUANTITY OF. This term is used by writers on mechanics to denote the product of the mass or moving body by the velocity. *See* MOMENTUM.

MOTIVE FORCE. The force which tends to produce motion. It is the same with momentum.

MO'TOR, MOVER. A term applied by anatomists to certain muscles, &c.

MO'TTO (Ital.), is used to signify a word or sentence added to a device; and when put upon a scroll it is commonly employed as an external ornament of coat armour. The use of mottos for this purpose is very ancient. The term motto is also applied as a sentence or quotation prefixed to any writing or publication.

MOULD. Soil composed of decayed vegetable matter in a state of minute division, more or less mixed with garden earth. The kinds of mould most in use in horticulture are leaf-mould, formed from the decayed leaves of trees; rich mould, formed of thoroughly decayed stable dung; heath mould, found on the surface of heath lands; and peat mould, formed of thoroughly decomposed peat. In general moulds are distinguished from soils by containing a much greater portion of vegetable matters than of earths.

MOULD. (Span. molde.) In Sculpture, the matrix or hollowed wrought form into which the liquid or plaster, wax or metal, is run in casting works of art.

MOU'LDING. (Fr. moule.) In Architecture, the members of an order, which are shaped into various curved or flat forms, of which there are eight sorts. The fillet, which is square in profile (1); the astragal (2);

the torus (3), being larger than the astragal; the scotia (4); the echinus (5), or quarter round; the inverted cyma, talon, or ogee (6); the cyma, cyma recta, or cymatium (7); and the cavetto or hollow (8).

MOULD LOFT. A large room in a dockyard in which the several parts of the ship are drawn out in their proper dimensions.

MOU'LTING. The fall of the plumage of birds. It may be either partial or total: the complete moult generally takes place annually; the partial moult occurs at the change of plumage to which some species of birds are subject at the breeding season. The moult is always accompanied by the development of a new plumage, which may be of a different colour from that which is lost. *See* INDUMENTUM.

MOU'NTAIN LIMESTONE. A series of limestone strata, the geological position of which is immediately below the coal measures, with which they also sometimes alternate. *See* GEOLOGY.

MOU'NTAIN MILK. A very soft spongy variety of carbonate of lime.

MOUNTAIN. (Lat. mons.) In Geography, the term applied to designate the principal elevations on the earth's surface. Mountains and hills, says Bakewell, are relative terms with respect to each other; the highest elevations being denominated mountains, and the lower hills. In the vicinity of Mont Blanc and Mont Rosa, which are more than 5000 yards high, the mountains in Cumberland and North Wales would be called hills; though Snowdon rises more than 1100 yards, and Skiddaw and Helvellyn more than 1000 above the level of the sea. In England, if hills rise abruptly, and are more than 400

yards above the surrounding country, they are generally called mountains. *See* GEOLOGY.

Arrangement of Mountains. — Mountains are seldom found insulated or detached: sometimes, though rarely, they exist in aggregate groups, branching from a common centre, and not externally connected; but most commonly they are extended in ranges or mountain chains, traversing extensive regions. A single continuous chain is of rare occurrence: in general a number of chains is associated; though there does not seem to be any predominating form of aggregation or direction, at least with reference to the whole surface of the globe. In some instances there is a principal or central chain, with secondary groups branching off from it; in others, several chains are associated, to no one of which the rest can be said to be subordinate; and in others again, as the Cordilleras, a series of chains succeed each other, all running in one constant direction. It has been surmised that the direction of the principal mountain chains is that of the line of greatest length of the continent or region to which they belong; but this idea, though rendered plausible by some remarkable instances, can scarcely be said to be borne out by the facts. In a very general view it may be stated that the predominating direction of the great mountain chains of the old world is from west to east; while those of America range from north to south. *See* GEOGRAPHY.

Another generalization, which seems to be liable to fewer exceptions, is, that mountain chains or ranges present the steepest acclivities on the sides nearest the sea. This arrangement is particularly observable on the shores of the Mediterranean: the mountains of Armenia present their precipitous sides to the Euxine, and those of Caucasus and Mozanderan to the Caspian. The western Ghauts face the Indian ocean; and the whole range of the Cordilleras, with their prolongation to the Arctic ocean, presents its escarpments to the great Pacific. On the hypothesis that the continents and mountain masses have been upheaved by a force acting in the interior of the earth, these peculiarities of configuration afford scope for curious speculation respecting the prodigious efficacy of the subterranean agencies through which the crust of the earth has assumed its actual form.

Altitude of Mountains. — On taking a general view of the surface of the earth, the elevation of the loftiest mountain chains, enormous as it appears to be, is insignificant in comparison of the dimensions of the globe. The radius of the earth is nearly 4000 miles; while the height of the highest peaks above the mean level scarcely exceeds 5 miles: the ratio is accordingly 1 to 800; so that on a 16-inch globe the corresponding inequality would only amount to the hundredth part of an inch. Mountains, however, exercise a very great influence on the climate of a country: and hence it is of great importance in geography to ascertain their altitude and configuration. The methods by which the measurement is effected have been explained under the term HEIGHTS, MEASUREMENT OF.

The following are the altitudes of a few of the most elevated peaks in the four quarters of the world. The most extensive list which we have seen is given in *Gehler's Physicalisches Lexicon*, art. "Höhenpunckte," where the authorities for the different measures are also stated.

Europe. — Mont Blanc, Alps, 15,781 ft.; Mont Rosa, 15,555 ft.; Ortler Spitze, Tyrol, 15,430 ft.; Jungfrauhorn, 13,720 ft.; St. Gothard Pass, 9,975 ft.; Hospice, Great St. Bernard, 8,040 ft.; Mont Perdu, Pyrenees, 11,283 ft.; Le Pic Blanc, do., 10,205 ft.; Monte Corno, Appenines, 9,523 ft.: Lomnitz, Peak of Carpathians, 8,640 ft.; Parnassus, 8,000 ft.; Mulahacen, Sierra Nevada, Spain, 11,673 ft.; Ætna, Sicily, 10,963 ft.; Sneehattan, Norway, 8,115 ft.; Snaefell, Iceland, 6,860 ft.; Helvellyn, England, 3,055 ft.; Ben Macdui, Scotland, 4,418 ft.; Macgillicuddy's Reeks, Ireland, 3,410.

Asia. — Dhawala-giri, Himalaya, 26,862 ft.; Jamautri, do., 25,500 ft.; Elburz, Caucasus, 18,500 ft.; Mouna Kaah, Sandwich Islands, 18,400 ft.; Demavend, Mazanderan, 14,700 ft.; Soomoonang, Thibet, 14,500 ft.; Ophir, Sumatra, 13,842 ft.; Italitzkoi, Altai, 10,735 ft.; Ararat, Armenia, 9,500 ft.; Lebanon, 9520 ft.; Sinai, 5,000 ft.; Tangai, Ural, 4,912 ft.

Africa. — Mountains of Geesh, 15,000 ft.; Peak of Teneriffe, 12,236 ft.; Atlas, 11,400 ft.; Niewveldt, Cape of Good Hope, 10,000 ft.; Gros Morne, Isle of Bourbon, 9,600 ft.; Trigo, Canaries, 7,400 ft.; Tuivo, Madeira, 5,162.

America. — Sorata, Bolivia, 25,000 ft.; Illimani, Peru, 24,450 ft.; Chimborazo, Andes, 21,440 ft.; Antisana, 19,150 ft.; Catopaxi, 18,890 ft.; Volcan de Popocateptl, Mexico, 17,716 ft.; Potosi, 16,000 ft.; Nevado de Mexico, 15,700 ft.; Lake of Titicaca, 12,000 ft.; City of Rio Bamba, 10,800 ft.; White Mountains, Massachusetts, 6,230 ft.

MOU'RNING, may be defined generally as an external indication or manifestation of grief for the death of a friend or relative. Certain usages in regard to mourning have been in force among all nations, barbarous and civilized, from the earliest ages; but except in the grief of which they are intended to be the symbol, no customs exhibit fewer marks of uniformity. Thus, the Chinese mourn in white; the Turks in blue or in violet; the Egyptians in yellow; the Ethiopians in grey. In ancient Rome and Lacedæmon the ladies mourned in white. In Eastern countries it was regarded as a peculiar mark of affliction to cut the hair; and at Rome, on the contrary, to let it grow. The Greeks adopted the Eastern practice, and bestrewed the tombs of those for whom they mourned with their hair. The peculiarities of the ancient Jews in time of mourning are well known; and the various customs of which so minute an account is contained in the Pentateuch are still maintained on these occasions by their descendants. From the commencement of the Christian era the general colour adopted for mourning throughout Europe has been, with very few exceptions, black. The kings of France mourn in violet. Tue duration of the period of mourning differs in different countries, but in all is usually regulated by the nearness of relationship between the survivors and the deceased. Thus in France the period prescribed by usage is, for a husband, one year and six weeks; for a father, mother, wife, or child, six months; for a grandchild four months and a half; for a brother or sister two months; for an uncle or aunt three weeks; for a cousin-german fifteen days, &c. The rules that determine the forms and duration of *court mourning* emanate from the sovereign, but these do not extend beyond the court; and though on the demise of the crown or a relation it is expected, in the language of the *Gazette*, that the people "put themselves into decent mourning," this is seldom generally complied with, except when the character of the deceased has been such as to secure wide popularity. (The art. "Deuil," in the *Encylopedié des Gens du Monde*, gives a very complete view of the chief modes of mourning in use in ancient and modern times.) *See* SEPULTURE, RITES OF.

MOUSE. (Lat. mus; probably from the Greek μυειν, *to hide.*) The pretty but annoying little Rodent quadruped which infests human dwellings and granaries is usually understood by this word; the other small species of the genus *Mus* being distinguished by some prefix, as harvest mouse, field mouse; and the larger species of the same genus being termed "rats." (For the generic characters of the mouse, see MUS.) The common mouse, like the rest of the genus, and indeed the whole of its order, is remarkable for its fecundity; it produces ordinarily five or six young ones at a birth, and this several times in the course of the year. In a fortnight the young are able to leave the mother and assume an independent existence, and these are soon again able to reproduce. The harvest mouse (*Mus messorius*) is the smallest of known mammals; the length of the head and body is two inches and a half. Its nest is beautifully and elaborately constructed of the panicles and leaves of three stems of the common reed interwoven together, and forming a roundish ball suspended on the living plants at a height of about five inches from the ground. The field mouse is about the size of the house mouse, but is distinguished by its larger eyes and ears. Many small mouse-like quadrupeds are commonly termed "mice" which really belong to a different genus, or even order; as the dormouse, the field vole, the shrew, &c.

MOUSE. In Naval Affairs, a hump or knot worked on a rope, to prevent a noose from slipping.

MOUTH. (Sax. muð.) In Architecture, the same as cavetto, which see.

MO'VEABLE FEASTS. Certain festivals held in commemoration of different events recorded in the Gospels and the Acts of the Apostles, and connected with the personal circumstances of Christ during the last year of his earthly life, and after his death. As they are reckoned backward and forward from his resurrection, and as the celebration of that day depends on the time of new moon, which varies at different times through the space of a month, these dependent festivals also vary in the same way. Easter is always the first Sunday after the first new moon after the 21st of March; and from this all the others are reckoned for each year.

MO'VEMENT The train of wheel work of a clock or watch. *See* HOROLOGY.

MOVEMENT. In Politics, an expression that has been adopted of late years into the political vocabulary of most European nations, signifying that party in a state whose principles consist in a restless endeavour to obtain such concessions in favour of popular rights as will ultimately place the chief functions of government in the hands of the people. It is opposed to the Conservative party, or the *parti de resistance*.

MOW. A mass of corn in the sheaf, built up in one end of the barn preparatory to being threshed.

MOW'ING. The act of cutting down grass, herbage, or corn with a scythe. Mown grass, or herbage, is either given to horses and cattle in a green state, or dried and

stacked for winter use. When corn or pulse are mown, they are dried and stacked till a convenient season occurs for separating the corn or pulse from the straw or haum by threshing.

MO'XA. A soft woolly substance made in Japan from the leaves of the *Artemisia Chinensis*, or Chinese mugworts. It is used as an actual cautery, by placing a small cone of it upon the skin and setting fire to it, when it burns down to the part and makes a sore, which is kept open if requisite.

MOYA. Mud poured out from volcanos.

MUCI'VORA. (Lat. mucus, *slime*, voro, *I devour*.) A name applied to a family of Dipterous insects, comprehending those which feed on the mucus or other juices of plants or of decomposing animal bodies.

MUCK, RUNNING A. A phrase which has been adopted into the English language to signify an indiscriminate attack upon friends and enemies; as in the well-known verse,

> Who runs a *muck*, and tilts at all he meets.

This expression is derived from the Javan word amok, which means *to kill*; the inhabitants of Java, and many other of the Asiatic islands, being remarkable for an irresistible phrenzy resulting from a desire of vengeance, which leads them to aim at indiscriminate destruction, and thus to subject themselves to be treated like wild beasts which it is impossible to take alive. These fits of desperation were long considered peculiar to the class of slaves in the islands above mentioned; but there are many instances on record where whole villages, and even armies, have under the influence of a *mok* devoted themselves to inevitable destruction to avenge an injury or an insult. The accounts of the wars of the Javans, says Raffles, in his *History of Java*, as well as of the Maláyus, abound with instances of warriors running *amok*; of combatants, giving up all idea of preserving their own lives, rushing on the enemy, committing indiscriminate slaughter, and never surrendering themselves alive. The cause of these fits of desperation has been attributed to an intemperate indulgence in opium-eating.

MU'COUS MEMBRANE. The membranous lining of the canals and cavities of the body which are exposed to the contact of air or other inorganic substances. The basis of this membrane is compact cellular tissue, not gelatinous or adipose, and having a peculiar cuticular covering, beset in some cases with abundant nervous papillæ, in others with the orifices of secretory glands.

MU'CUS. (Lat.) The secretion of the mucous membranes, the most characteristic of which is that from the nasal membrane. Mucus is viscid, and acquires apparent fluidity in water, without being actually dissolved; but gives a ropiness to it when present to a less amount than 1 per cent. With pure water of the temperature of 95°, this appearance ensues in a few hours; but if the apparent solution be filtered, the mucus remains upon the paper and gradually thickens. It may be repeatedly dried and moistened without material change of properties; it, however, becomes less transparent, yellow, and at length has a purulent appearance. When boiled in water it does not harden and shrink, but becomes tough, and on cooling is found to retain its former characters. When dried it is yellow and translucent; and subjected to distillation, it yields carbonate of ammonia and empyreumatic oil, and phosphate and carbonate of lime and carbonate of soda are found in the ash. It is soluble in dilute sulphuric acid, and blackened by the concentrated acid; it is not soluble in acetic acid, but yields but a trace of albumen. According to Henle, mucus consists of the scales of the epithelium which covers the open cavities of the body. This epithelium or cuticle consists of minute cells of various forms, which are continually wearing off and being renovated; it thus yields scales which mix with the watery secretion, and constitute mucus.

MU'DAR. The Indian name of *Calotropis gigantea*, a plant of the Asclepiadaceous order; a substance used medicinally in that country, with great effect in scrofulous cases, but not admitted into the Materia Medica of Europe. It gives its name to *mudarine*, a peculiar chemical principle, having the singular property of softening by cold and hardening by heat.

MUE'ZZIN, in Mohammedan countries, is the general appellation of those officers, or clerks of the mosques, whose duty it is to proclaim the ezam or summons to prayers, at the five canonical hours; viz. at dawn, noon, 4 o'clock P. M., sunset, and nightfall.

MUFFLE. An arched vessel with a flat bottom, in which substances may be exposed to a red heat without coming into contact with the fuel. *See* ASSAYING.

MU'FTI. The Turkish title of a doctor of the law of the Koran; derived from *fetvas*, a rescript or answer to a question of law addressed to the competent authority; which fetvas it is the province of the mufti to issue. The mufti of Constantinople, or Sheikh-ul-Islam, is the chief functionary of the Turkish church, and represents the sultan in spiritual matters, as the grand vizier does in temporal.

MUGGLETO'NIANS. A sect of Christians who sprung up in England in 1561, and derived their name from one Muggleton, a tailor, who, together with an associate called Reeves, gave themselves out for the two last and greatest prophets of Jesus Christ, and asserted that they had power to save or to ruin in a future state whomsoever they pleased. Notwithstanding the absurdity of their pretensions, they obtained many adherents; and the belief in their inspiration has been maintained, though by a comparatively insignificant number, from the period of their first promulgating their opinions down to the present time. A collection of the writings of Muggleton and Reeves, together with other Muggletonian tracts, was published in 3 vols. 4to. in 1832, in which the reader will find the singular doctrines of this sect fully, but, as appears to us, not very intelligibly set forth. In the religious controversy to which the promulgation of their doctrines gave rise, their chief opponents were the Quakers, and among these were George Fox and William Penn.

MU'GILOIDS. (Lat. mugil, *a mullet*.) A family of Acanthopterygian fishes in the system of Cuvier, characterized by having an almost cylindrical body covered with large scales, and furnished with two separate dorsals, the first of which has but four spinous rays. The mouth is either edentulous, or is provided with teeth of extremely minute size. This family includes the genera *Mugil*, *Tetragonurus*, and *Atherina*: it is included in the Cycloid order in the system of Agassiz.

MULA'TTO. A term in general use in American countries, in which there exists a mixed population of different races and colours, for the offspring of a union between a white and a negro.

In our West Indian possessions the offspring of a white and a mulatto is called a *quadroon*, or one quarter black; of a white and quadroon a *muster*, or one eighth black; of a white and muster a *mustafina*, or one sixteenth black; after which they are said to be *whitewashed*, and are considered as Europeans. On the other hand, the offspring of a mulatto and a negro is called a *cabre*; of a cabre and negro a *griffe*; and, generally speaking, after this there is no distinctive appellation but negro. All this is sufficiently simple; but in the Spanish and Portuguese colonial possessions, the intermixture of Europeans with negroes, mulattoes, &c., and these again with other classes, has given rise to a multiplicity of denominations sufficiently vague and indefinite even in these languages, but wholly untranslateable into English. It must be admitted, however, that great ingenuity has been displayed in tracing the amount of European and negro blood that flows in the veins of the mixed races, as the following list of terms (which might be considerably augmented) will prove: — Zambi, quatralvi, tresalvi, saltatras, coyote, zambaigi, cambusos, giveros, puchuelas, albarassados, barrinos, &c. All these again may be multiplied in arithmetical progression, thus forming a host of modifications, each, however, retaining more or less his original characteristics in proportion to the relation in which he stands to his original stock.

In Spain, the term Mulatto has been employed to designate persons having a tincture of Moorish blood.

MU'LBERRY. The so called paper mulberry is the *Broussonetia papyrifera*, and not a morus; its tenacious pliable inner bark furnishing a valuable material for the dress of the South Sea Islanders and Chinese. The yellow dye wood called fustick is the produce of another species of this genus, the *Broussonetia tinctoria*. *See* MORUS.

MU'LBERRY CA'LCULUS. An urinary concretion, consisting chiefly or entirely of oxalate of lime. Many of these calculi in form and colour somewhat resemble the fruit of the mulberry.

MULCH. Straw or litter half rotten. In Horticulture when this material is applied round the roots or stems of plants to protect them from the drought or from frost, they are said to be mulched.

MULL. A term used in Scotland almost synonymously with Cape, which see; and applied to various projecting portions of the island, as the Mull of Galloway, of Cantyre, &c.

MU'LLAS. The priests of Tartary are so called. They form one of the three grand classes into which the Tartars are divided; the other two being the *murzas* or nobility, and the peasantry. Their chief duty consists in reading the Koran; but their stock of knowledge is generally so scanty, that they are seldom able to interpret the Arabic in which the office of the mosque is performed. The village mullas are generally decently behaved and respectable men; "a little too much given to sell charms for the ague, but living for the most part among their neighbours a quiet and charitable life, the arbitrators as well as curates of their sequestered valleys; and frequently possessing, in addition to these weighty charges, the sinecure office of parish schoolmaster." (*Quart. Rev.* vol. xxix. p. 129.) The Tartar *mulla* and the Persian *mollah* (which see) have evidently a common origin; but their rank and offices are wholly distinct.

MU'LLET, in Heraldry, represents the rowel of a

spur. In English blazonry it is depicted of five points: in French of six. It is used as the filial distinction of the third son. *See* DIFFERENCE.

MULLET. The name of the fishes of the genus *Mugil*, which, in addition to the family characters of the Mugiloids, have the middle of the under jaw produced into an elevated angular point, adapted, when the mouth is closed, to a corresponding groove in the upper jaw; the number of the branchiostegous rays is six. Of this genus there are three British species; viz. the grey mullet (*Mugil capito*, Cuv.); the thick-lipped mullet (*Mugil chelo*, Cuv.); and the short mullet (*Mugil curtus*, Yarrell); of these the first species is the least rare. The red mullets (*Mullus surmuletus*, Cuv.; and *Mullus barbatus*, Linn.) belong to a different family of fishes: the former of these species was the fish so greatly esteemed by the ancient Romans, and for which such extravagant prices were given when it had attained an unusually large size.

MU'LLION, or MANNON. In Architecture, the upright post or bar dividing two lights in a window.

MULTA'NGULAR FIGURES, MULTILATERAL FIGURES, or POLYGONS. Rectilineal figures of more than four sides, and each specially denoted by the number of its angular points; as a pentagon, hexagon, decagon, &c., which have five, six, ten sides or angles respectively.

MU'LTIARTI'CULATE (Lat. multus; articulus, *a joint*), in Zoology, is applied to the antennæ of insects, and to the legs of Crustaceans and Cirripeds, when they are composed of a great number of joints; also to bivalve shells which have numerous teeth in the hinge.

MULTICARI'NATE (Lat. multus, carina, *a keel*), in Conchology, is applied to a shell which is traversed by many keel-like ridges; as the *Fusus multicarinatus*, *Terebratula multicarinata*.

MULTIDE'NTATE. (Lat. multus; dens, *a tooth*.) In Zoology, when a part is armed with many teeth or tooth-like processes. A family of Nereids is hence termed *Multidentatæ* by De Blainville, on account of the structure of their horny jaws.

MULTILO'CULAR. (Lat. multus; loculus, *a lodge*.) In Conchology, this term is applied to those shells which, like the nautilus, have their cavity divided into many chambers.

MULTINO'MIAL. (Lat. multus; nomen, *name*.) In Algebra, an expression consisting of several terms (more than two), which are connected by the signs of addition or subtraction, + or —. Sometimes it is called a polynomial; and in modern works, after the French writers, a *polynome*.

MULTINOMIAL THEOREM. A theorem discovered by Demoivre for forming the numeral co-efficients which arise in raising any multinomial to any given power without the trouble of actual involution. The binomial theorem of Newton is a particular case of this; viz. that in which the number of terms is only two.

MU'LTIPLE. (Lat. multiplex.) Any quantity which contains another an exact number of times without a remainder is a *multiple* of the latter, and the latter is a *submultiple* or part of the former.

MULTIPLE POINTS. In Analytical Geometry, when two or more branches of a curve pass through the same point it is called a multiple point.

MULTIPLE VALUES, in Algebra, signify symbols which fulfil the algebraical conditions of a problem when several different values are given them; as the roots of an equation, certain functions of an arc or angle, &c.

MU'LTIPLICA'ND, in Multiplication, is the number or quantity that is to be repeated the number of times denoted by the multiplier.

MULTIPLICA'TION. In Arithmetic, an abbreviated process by which, when a number is to be repeated several times, a result equal to the sum arising from all the repetitions is obtained. (*See* ARITHMETIC, and FRACTIONS.) A considerable abbreviation of this is effected by the use of logarithms (*see* LOGARITHMS); and other methods of shortening the work or lessening the degree of attention requisite in performing it have at different times been devised, as Napier's rods, and the logarithmic slide rule of Gunter. *See* NAPIER'S RODS.

MULTISPI'RAL. (Lat. multus; spira, *a spiral turn*.) In Conchology, this term is applied to those opercula of univalve shells which exhibit very numerous and narrow spiral coils round a submedian centre.

MULTISTRI'ATE. (Lat. multus; stria, *a streak*.) In Zoology, when an animal or part is marked with many streaks.

MULTIVA'LVE. (Lat. multus; valva, *a valve*.) In Conchology, when a shell consists of several calcareous pieces; as that of the chiton or barnacle.

MULTO'CA. The name given to the code of laws by which the Turkish empire is governed; consisting of the precepts contained in the Koran, the oral injunctions of Mohammed, and the decisions of the early caliphs and doctors. It relates to every subject of life, and comprises various matters appertaining to government, the sultan being the sole judge of its application to particular cases. (*See* SULTAN, VIZIR. See also *Edin. Review*, vol. x. p. 259.)

MULTU'NGULATE. (Lat. multus; ungula, *a hoof*.) In Mammalogy, when a quadruped has the hoof divided into more than two parts corresponding with three or more digits; as the elephant, rhinoceros, &c. Ray so denominated a family of hoofed quadrupeds corresponding with the *Polyschidæ* of Aristotle.

MU'MMIFORM. (Lat. mumia, *a mummy*; forma, *form*.) In Entomology, the nymphs of certain Lepidoptera are so called which resemble an Egyptian mummy.

MU'MMY. (Arab. mumia; from mum, *wax*.) The name given to the dead bodies of men or animals which are by any means preserved in a dry state from the process of putrefaction. Mummies have usually been divided into two classes — natural and artificial; the former arising from peculiar conditions of soil and atmosphere, which permit the drying of the animal tissues to be effected with such rapidity that the body is preserved; the latter embracing the various means that have been employed from the earliest ages to preserve dead bodies from corruption. Of the former or natural class of mummies some well-known instances are to be found in the vaults of several Continental churches, particularly at Strasburg, Toulouse, and Bordeaux.

The *art* of embalming owes its origin to the extreme veneration with which the ancient Egyptians regarded the corpses of their relatives, and was practised with such success that at the lapse of 3000 years the mummies found in the numerous catacombs of Egypt are still objects of admiration. But it was not to the dead bodies of the human species alone that the ancient Egyptians restricted their reverence; they practised embalming also on all the animals which their religion held sacred, and of these upwards of fifty different species have been found embalmed.

The art of embalming was practised also to a considerable extent by the ancient Jews, Greeks, and Romans, though it never attained such celebrity or perfection among them as among the people from whom it was borrowed. It was also adopted as a national custom by the Guanches, the ancient inhabitants of the Canary Islands; a full account of which is to be found in the *Essai sur les Isles Fortunées*, by M. Bory de St. Vincent.

The account which Herodotus has left us of the Egyptian process of embalming is so minute, and has besides been so amply confirmed in the most essential particulars, not only by the subsequent writers of antiquity, but in still more recent times (see the *Memoir* of M. de Rouyer), that we cannot refrain from embodying it in our pages. There are, says he, persons resident in Egypt who make this art their profession. When a dead body is brought to them, they show the bearers three wooden models of mummies imitated in painting, the most elaborate of which are said to be of him (Osiris) whose name I do not think it right to mention on this occasion. The second which they show is simpler and less expensive; and the third is the cheapest of all. They then demand of the bearers which model they wish to be adopted; and the latter having decided upon the price, depart. The most expensive preparation is as follows: — First they extract the brain through the nostrils by means of a hooked iron instrument, — partly by pulling it out, and partly by the infusion of drugs. They then with a sharp Æthiopian stone make an incision in the side in order to extract all the viscera, which they wash with palm wine and purify with pulverized perfumes. Having next filled the belly with pure ground myrrh, cassia, and all other odoriferous herbs except frankincense, they sow it up; and rubbing the whole corpse with natron, bury it for 70 days, — a longer period not being admissible. At the expiration of the 70 days they wrap the whole corpse in bandages of fine linen, and smear it all over with gum, which the Egyptians are in the habit of using instead of glue. The friends of the deceased, on again receiving the body, have a wooden case made in the form of a human figure, in which they place it; and having shut it up, deposit it in a sepulchral building, setting it upright against the wall.

For those again who, on account of the great expense of this mode of embalming, adopt the middle course, the bodies are thus prepared: — They fill all the intestines with cedar oil, without either cutting into the body or extracting the viscera; and, taking means to prevent the egress of the injected liquid, they salt the body for the prescribed number of days. The cedar oil is then taken out; and such is the power with which it operates that it brings with it the bowels and all the viscera in a state of dissolution. The natron also destroys the flesh of the body, leaving only the skin and the bones. The body is then returned.

The third mode of embalming is that practised on the poor. In this case they inject into the body a mixture of salt and water, wrap it up in natron for 70 days, and then deliver it to the relatives. (*Herod.* b. 2. c. 186.)

It was long a matter of uncertainty what became of the intestines after they had been removed from the body of those embalmed according to the first process. Porphyry and Plutarch have both asserted that they were thrown into the Nile; but modern discoveries in the tombs leave no doubt of the fact that they were embalmed separately, and deposited in four vases in the coffin. (See *Sir G. Wilkinson's Manners and Customs of the Ancient Egyptians*, vol. ii. p. 467. 2d Series.)

Diodorus mentions three different classes of persons who assisted in preparing the body for the funeral: the scribe, who regulated the incision in the side; the *paraschistes* *, or cutter; and the embalmers. To these may be added the undertakers, who wrapped the body in bandages, and who had workmen in their employment to make the cases in which it was deposited. Many different trades and branches of art were constantly called upon to supply the undertakers with those things required for funereal purposes: as the painters of mummy cases; those who made images of stone, porcelain, wood, and other materials; the manufacturers of alabaster, earthenware, and bronze vases; those who worked in ivory; the leather cutters, and many others.

With regard to the question, when the custom of embalming the body ceased in Egypt, some are of opinion that it ceased at an early time, when Egypt became a Roman province. But this has been fully disproved by modern discoveries; and it not only appears that the early Christians embalmed their dead, but, according to St. Augustine, mummies were made in his time, at the end of the 5th century. The origin of this opinion is perhaps to be sought for in the circumstance that at the period of the Roman invasion of Egypt the custom may not have been universal; and Sir G. Wilkinson maintains that it in all probability gradually fell into disuse, rather than that it was suddenly abandoned from any accidental cause connected with change of custom, or from religious scruple.

Since the commencement of the present century, the attention of the learned in the chief countries of Europe has been particularly directed to the subject of embalming the dead; and the researches of numerous travellers from Belzoni downwards to Sir G. Wilkinson, aided by the scientific manipulations of Pettigrew and others, have cleared up many points that were formerly obscure in reference to this art, which was so general in ancient, though wholly unknown in modern Egypt. The following observations, borrowed from *Dr. Nuttall's Classical and Archæological Dictionary, &c.*, will at once exhibit briefly the state in which the mummies are found at the present day, and serve as an appropriate commentary on the description of the process of embalming, as detailed above. The practice of embalming upon the immense scale of the population of a country such as Egypt involves a problem of the highest interest. If to those numberless pits and catacombs of human corpses are also conjoined the mummies of the ibis, dog, ape, cat, and crocodile; the bull Mnevis, Apis, and Isis; the ram, the fox, and horned asp; in short, of every reptile of the land, — we are lost in surprise and amazement how such a process could be established; and if by resins, drugs, or spices, from whence such profuse quantities could be procured and supplied. These bodies, also, are often enveloped in silks and bandages of stained linen of surprising brightness (and sometimes measuring 1000 yards in length —*Sir G. Wilkinson*); they are ornamented with gilding as fresh as when first laid on; with pieces of coloured glass imitative of the finest gems, evidencing their knowledge of staining and cutting them in a manner which merits notice, as well as their enamels also. All these ornaments found around the mummies are highly preserved, and, as well as the sycamore chests, resist all the injuries of time, and subsist fresh and perfect for the examination of the curious. They usually have the Nubian cast of countenance; the outline figure traced in black; and the colours, four in number — blue, red, yellow, and green — laid on without any mixture of shading, but altogether forming a composition of very considerable interest. These chests usually have within them small scarabæi, or the idols of Isis and other deities, in clay and coloured glass and beautiful enamels. One scarabeus, mentioned in *Greaves's Pyramidographia*, was of magnet, which, although 3000 years since it was taken from the rock, its natural bed, still retained its attractive magnetic virtue. The recent discoveries of M. Belzoni add also to our stock of information upon the articles of the wrappers, and prove in this also the science and the labour of their embalming, by evincing that there were distinct modes of preservation and of envelopes for every caste, — that of the priesthood particularly, with a scrupulosity of minute detail that astonishes and marks their high privileges. Upon examining mummies that have been brought to Europe, a decided similarity of ornament is observable: the better-conditioned being covered with glass ornaments, cut as precious stones, and disposed with the same arrangement of colours, and offering the same construction as the other mummies that are painted; testifying that the ornaments which were costly were preserved for principal personages, while the inferior classes contented themselves with tracing the decorations in paintings.

It has been frequently maintained that the doctrine of metempsychosis formed part of the ancient Egyptian creed; but it would seem that the practice of embalming the dead is wholly irreconcileable with such a doctrine. Others have explained this Egyptian usage as if it proceeded from a belief in materialism; but it can surely never be argued that unbelievers in the immortality of the soul would be most anxious to guard against the dissolution of the body. On the contrary, as Schlegel has well observed, this usage seems rather to set forth an indistinct feeling that this apparently dead matter is still important, — some mistaken and imperfect presentiment that the bond between the soul and matter is not altogether dissolved, and shall yet one day be restored, — and that even this matter shall have its portion in immortality, and be again animated and awakened.

MUMPS. This term is generally applied to inflammation of the parotid glands. It is seldom attended by fever or constitutional symptoms, but is occasionally translated to other glandular parts. A gentle dose of physic, and the application of a piece of flannel dipped in warm salt water or in solution of acetate of ammonia, is generally all the treatment required. From the way in which this complaint sometimes spreads in families or schools, there is some reason to believe it to be contagious or infectious.

MU'NDIC. A Cornish name for iron pyrites.

MUNDI'FICANT. (Lat. mundare, *to cleanse*.) A term applied in old pharmacy to certain healing and cleansing ointments and plasters.

MUNI'CIPAL, MUNICIPALITY. The word *municeps*, in the language of early Roman jurisprudence, signified a person capable of holding an office or dignity (from munus or munium, *an office*, and capio, *I take*). It was appropriated in its more particular meaning to those who, by the constitution of Rome, were admissible to certain privileges and honours, but not to the right of suffrage or magistracy, in consequence of not being full citizens. These were the strangers who in various ways became incorporated with the Roman people without acquiring the right of citizenship. The jurisconsult Paulus (as cited by Festus) notices three sorts of municipes:—1. Free strangers settled in Rome; 2. Citizens of commonwealths which became absorbed in that of Rome by conquest or submission (quarum civitas universa in civitatem Romanam venit); such were Aricia, Cere, Anagnia; 3. Citizens of allied commonwealths, who retained their citizenship at home while at the same time they became municipes of Rome: such were Tibur, Pisa, Arpinum. It is plain that this last is the sense in which the citizen of one state was said to be municeps of another. Towns of the last two descriptions (if the passage of Paulus is correctly understood) were probably comprehended by the Romans under the title of *municipia*; *i.e.* towns which possessed their own rights, and the burgesses of which were also municipes of Rome. Such burgesses often acquired full Roman citizenship and even dignity, but seem to have been always (in the republican times) regarded as of recent and comparatively ignoble franchise: as in the passage of Juvenal respecting Cicero (ignobilis et modo Romæ municipalis eques); *i.e.* one coming from the municipium of Arpinum. By later writers, municipia are sometimes confounded with colonies. The word municipal and its derivatives have passed into modern usage in two different senses: 1. The local government of a small district, especially of a town, and particularly if elective, is termed a municipality: such are municipal corporations in England; 2. Every Latin municipium had its own customary law (*jus municipale*). Hence with later jurists municipal law came to signify the law of particular towns, districts, and provinces. In this latter sense the customs of the French cities and provinces were called municipal laws. And among modern publicists the word has received a still greater extension; the positive law of a country (in opposition both to natural or moral law and to the law of nations) being often called its municipal law. The same term is also sometimes used rather vaguely in contradistinction to the constitutional or political law of a state; as where crimes are divided into offences against the state and municipal offences.

MU'NIMENTS. A common name, in legal phraseology, for deeds, charters, &c., chiefly those belonging to public bodies: great ecclesiastical corporations have generally a "muniment-room" in which these are kept.

* The office of *paraschistes*, or dissector, was held in infamy. "As soon," says Diodorus, "as the paraschistes has made his incision, he runs away, being pursued by those who are present, who throw stones at him amidst bitter execrations, as if to cast upon him all the odium of this necessary act." For the Egyptians look upon every one who has offered violence to, or inflicted a wound or any other injury upon a human body, to be hateful; but the embalmers, on the contrary, are held in the greatest consideration and respect, being the associates of the priests, and permitted free access to the temples as sacred persons.

Derived from Lat. munio, *I defend;* because, as it is said, these evidences serve to defend the title.

MURÆ'NOIDS. (Lat. muræna, *a species of eel.*) The name of a family of Apodal fishes, including the true eels (*Anguilla*), and the eels without pectoral fins (*Muræna*). The fishes of the latter genus are more voracious, and have their jaws armed with more formidable teeth than the *Anguillæ*. One species (*Muræna Helena*) was much esteemed by the ancients, who fattened it in ponds expressly constructed for the purpose. The history of Vædius Pollio, who caused his transgressing slaves to be flung into these ponds as food for the *Murænæ*, is well known.

MU'RAL ARC, or ARCH (Lat. murus, *a wall*), is a segment of a large circle fixed in the meridian against the wall of an observatory, for the measurement of the meridian altitudes or zenith distances of the heavenly bodies.

MU'RAL CIRCLE, MURAL QUADRANT, in Astronomy, is an instrument, generally of a large size, attached to a stone wall or pier of solid masonry, and fixed in the meridian for the purpose of measuring the distances of stars from the pole or the zenith. The first mural quadrant, or rather arch, used at Greenwich, was erected by Flamsteed in 1689, and divided by Abraham Sharp. There are still two quadrants in the Observatory, each about eight feet radius: one of them was erected by Graham in 1725, for the observations of Halley, and was redivided by Bird in 1753; the other was constructed by Bird in 1750, and is the instrument with which Bradley and Maskelyne made their most important observations. Experience having shown that entire circles are susceptible of much more accurate division, and much less liable to derangement than quadrants, a mural circle was constructed by Troughton, and placed in the Observatory in 1812. Since that time the advantages of this construction have been fully appreciated; and a mural circle is now regarded as the principal fixed instrument in all the great public observatories.

Troughton's mural circle is six feet in diameter. It is formed of brass, and fixed by means of sixteen conical radii, concentric to and at right angles with a conical axis nearly four feet long, seven inches in diameter at the extremity at which the circle is fixed, but only half as much at the other extremity. The axis rests and turns in two collars, one towards each end of the cone, fixed at the front and back of a stone pier about four feet in depth. The degrees are cut into five spaces, on a narrow ring of white metal composed of gold and palladium. The divisions are read by six micrometers, placed at equal distances round the circle, and securely fixed to the stone pier. The telescope is fixed at right angles to an axis which works within the conical axis of the circle. It consequently moves in the plane of the circle, and can be clamped in any position, so that the readings may be made on different parts of the circle. In order that the circle may move easily round its axis, and that the lower side of the front socket may be relieved from the load of the instrument, two large friction wheels are suspended in front of the pier from the arms of two levers, which, by means of counterpoises, may be made to support the whole or any part of the weight. The details of construction, however, admit of being varied in many different ways.

The use of the mural circle is to measure angular distances in the meridian. The axis must therefore be placed exactly horizontal, and the plane of the circle vertical and in the meridian, and the line of sight at right angles to the axis and parallel to the plane of the circle. Small errors, however, in the adjustments, scarcely affect the results. The advantages of the mural above all other astronomical circles consist in the permanence of the microscopes, and the facilities for observing stars by reflection. (For a detailed description of this instrument see *Pearson's Practical Astronomy;* also *Dr. Robinson's Description of the Mural Circle of the Armagh Observatory*, in vol. ix. of the *Memoirs of the Royal Astron. Society.*)

MU'RCHISONITE. A variety of crystallized felspar found in the new red sandstone near Exeter: its component parts are silica 686; potash 148; alumina 166: so called from its discoverer, Mr. Murchison.

MURDER, in the English law, is defined to be the killing any person under the king's peace, with malice prepense or aforethought, either express or implied by law. The word is of the same origin with the German *mord*, Fr. *meurtre;* in law Latin, *murdrare*, — to which word, in an indictment, an exception was taken by a prisoner in the reign of W. 3. as not being of good Latinity, which was overruled with contempt. The malice prepense is the chief characteristic which distinguishes murder from other species of homicide; and it is the great office of the jury to determine whether or not such malice has been shown: either express, as evinced by outward circumstances; or *implied*, as where one deliberately kills another without provocation the law implies malice. Malice is also *implied* where persons having authority to arrest or imprison using the proper means for that purpose are resisted in so doing, and killed, which offence is murder. Killing in the prosecution of an unlawful act, when the act is done deliberately and with intention of mischief, either indiscriminately or to particular individuals, is likewise murder, whether or not there was a premeditated design of killing the individual slain. So where particular malice against an individual is wreaked, by mistake, against another. Whenever, also, death ensues on an unlawful act done in prosecution of a *felonious* intention, it is murder; as where a man is killed by a shot discharged at an animal with intent to kill and steal it; or where the intent is only to do some great bodily harm, and death ensues. When several assemble to commit a breach of the peace forcefully, and happen to kill a man in the prosecution of such intention, they are all guilty of murder. In some cases, also, murder may be the consequence of a lawful act criminally or improperly performed, as by duress in a gaol.

The execution, in cases of murder, by 25 G. 2. c. 37., was to take place the next day but one after sentence, unless staid by the discretion of the judge; with an exception for Sunday, by 9 G. 4. c. 31.: and it was usual to sentence on Friday, in order that the Sunday might intervene before execution. But by 6 & 7 W. 4. c. 30. the time before execution was made the same as in other capital offences. It happened, at a trial for murder at the Devonshire assizes, only a few days after the passing of this act, when two men were convicted, that during the interval which elapsed sufficient doubt was raised as to the identity of one of the prisoners to prevent the execution.

By the French code pénal of 1810, the several kinds of homicide are accurately defined; and the crimes of "assassinat, parricide, infanticide, and empoisonnement," are capital. But the power given to the jury by the code of 1808, of pronouncing *under what circumstances* a criminal act has been committed, materially modifies the severity of the law. If extenuating circumstances are found by the jury, the punishment is diminished.

MU'REX. (Lat. murex, *a shell-fish.*) A name applied by Linnæus to a genus of the Vermes Testacea having a univalve spiral shell, with an oval aperture ending in an entire, straight, or slightly ascending canal. The Mollusks thus characterized form a family (*Muricidæ*, or rock-shells) in the Buccinoid tribe of Pectinibranchiate Gastropods of the system of Cuvier, and include the following genera: — *Murex* proper, *Brontis*, Montf.; *Typhis*, Montf.; *Chicoracea*, Montf.; *Aquilla*, Montf; *Lotorium*, Mart.; *Tritonium*, Montf; *Trophona*, Montf.; *Ranella*, Lam.; *Apolles*, Montf.; *Fusus*, Lam.; *Lathira*, Mart.; *Struthiolaria*, Lam.; *Pleurotoma*, Lam.; *Clavatula*, Lam.; *Pyrula*, Lam.; *Fulgur*, Montf.; *Fasciolaria*, Lam.; *Turbinella*, Lam.

MU'RIACITE. An anhydrous sulphate of lime, containing a little common salt.

MURIA'TIC ACID, or HYDROCHLORIC ACID. This acid was originally discovered by Glauber, and called by him *spirit of salt.* In its pure or gaseous form it was first obtained by Priestley in 1774; and its true composition was shown by Davy in 1809, who proved it to be a compound of hydrogen and chlorine; hence it has been termed *hydrochloric acid.* Muriatic acid gas is procured by acting upon common salt (which is a chloride of sodium) by concentrated sulphuric acid: the water of the acid is decomposed, and its hydrogen combines with the chlorine of the salt to form muriatic acid; whilst the oxygen is transferred to the sodium, which is thus converted into soda, and this unites to the sulphuric acid to form sulphate of soda. 60 parts of common salt, and 49 parts of concentrated sulphuric acid, afford, by this mutual action, 37 parts of muriatic acid, and 72 of sulphate of soda. Muriatic acid gas may also be formed by passing an electric spark through a mixture of equal volumes of chlorine and hydrogen; or by exposing such mixture to the sun's rays, or inflaming them by a taper, they burn with explosion, and form a volume of muriatic acid equal to the united volumes of the gases. As the specific gravity of hydrogen is to that of chlorine as 1 to 36, the specific gravity of the resulting muriatic acid gas compared with hydrogen will be 18·5, and 100 cubic inches of it will weigh 39·3 grains. Muriatic acid gas is rendered liquid under a pressure of 40 atmospheres of the temperature of 50°; it extinguishes flame, and is intensely sour, powerfully reddening vegetable blues. Water absorbs it with much violence, taking up about 480 times its volume. This is the state in which muriatic acid is generally used. Its specific gravity is about 1·19, and it is commonly obtained by distilling a mixture of equal weights of salt, sulphuric acid, and water. When muriatic acid acts upon metallic oxides, it generally happens that a mutual decomposition of the oxide and acid ensues; the oxygen of the oxide unites to the hydrogen of the acid to form water, and the metal to the chlorine to form a metallic chloride. Thus it is that soda and muriatic acid form a chloride of sodium or common salt. The most effective test of the presence of muriatic acid is nitrate of silver, which forms an insoluble chloride

of silver in all solutions containing muriatic acid or muriates.

MU'RICATE. (Lat. muricatus, *thorny.*) In Zoology, where a surface is armed with short, but not close-set cones, having a sharp apex.

MURI'DÆ. (Lat. mus, *a mouse.*) The family of Rodents of which the genus *Mus* is the type: by some naturalists it is restricted to the genera *Mus*, *Hesperomys*, *Dendromys*, *Gerbillus*, *Hydromys*, *Hapalotis*, and *Pseudomys*; by other naturalists it is extended to include the *Jerboidæ*, *Myoxidæ*, and *Castoridæ*.

MU'RINES. (Lat. mus, *a mouse.*) The name of a tribe of Rodent quadrupeds, of which the genus *Mus* is the type: it includes the families *Muridæ*, *Aroicolidæ*, and *Sciuridæ*, and is the most widely distributed of all the Rodent tribes.

MURRA'IN (Fr.), is the popular term of a malignant epizootic influenza to which cattle are subject, and which has at various times made terrible havoc among them. It appears to have been long known; and, from the accounts handed down, does not seem to have changed its characters materially.

This disease extensively raged on the Continent from 1710 to 1746 (Lancisi, *Disputatio Historica de Bovilla Peste*); and serious visitations of the malady were also witnessed during the years 1730 and 1731, and from 1744 to 1746: at that time many written descriptions were produced of this pest, among which the work of Sauvages, the celebrated professor of medicine at Montpelier, stands pre-eminent. It produced, in 1757, an extreme fatality among the cattle of this country; an account of which was published in an excellent work by Dr. Layard, a physician of London.

This disease, as it is met with in England, may be characterized as an extremely malignant inflammatory œdema, attacking, and indeed confining itself for the most part to one of the hind quarters of the animal. It is most common in the seasons of spring and autumn, and affects principally young cows. The most prominent features are tumefaction and a discolouring of the side affected, with consequent lameness and inability to move; a peculiar emphysema of different parts of the body, but particularly over the region of the spine; and all the symptoms of putrid fever present in diseases of a typhoid character. It speedily runs on to gangrene, and few animals survive an attack of this kind more than ten or a dozen hours.

Although the English murrain is somewhat modified in its virulence by season, locality, and the condition of the sufferer, it is nevertheless generally looked upon as incurable. When, however, remedial measures are had recourse to, extensive scarification, or rather incisions of the affected side, fomentations, and purgatives are most likely to effect the desired object.

It may be necessary also to remark, that this malady is known to farmers and others in the different counties of England by a variety of terms, none of which are either elegant or expressive; and, on the other hand, that diseases different altogether from the one under consideration have received the same name: indeed the word murrain is often used to denote any epizootic affection in cattle. The one just described may, however, be looked upon as the true murrain of this country.

The murrain which broke out in England about two years ago, and has ever since committed such havoc among the cattle, is travelling steadily northwards; but the disease has lost much of its original virulence, as almost always happens in the case of epidemics travelling from one country to another. Accidental circumstances aggravate the complaint, but in a general way it runs its course now in a few days; and to all appearance, condition lessened, or "taking-on" stayed, exceeds not from a fortnight to three weeks. Much depends upon the condition of the animal, and in numerous instances the distemper touches rather than skaithes. The doctoring process has been generally discontinued; and the best of all recipes is the warmth communicated by sheltered fields or sheds, rest, and the absence of disturbing influences.

The prevention of this disease is even perhaps more important than the medical treatment, and consists in allowing a free access of air to all the buildings, stalls, &c., with daily fumigation of them by chlorine or chloride of lime. Care should be taken to examine three or four times a day the cattle on every farm, so as to remove as speedily as possible the healthy ones from those that are affected.

MU'RRHINE. (Lat. murrhina vasa, Gr. μοῤῥινος.) Murrhine vases were a species of ware often mentioned by writers of the Roman empire, the material of which has been much disputed by modern antiquaries. They came from the East, and, according to Pliny, were made of some precious stone found chiefly in Parthia; but some have conjectured that this was an erroneous opinion prevalent among the Romans, and that they were in reality of porcelain, of which the manufacture was unknown to the western nations. (See *Plin. Hist. Nat.* l. 37.; and a memoir in the 43d vol. of the *Mem. de l'Ac. des Inscr.*; and *Maurice's Indian Antiquities*, vol. vii.)

MU'RRY, or SANGUINE. In Heraldry, a dark red; one of the colours or tinctures employed in blazonry. It is expressed in engraving by opposite diagonal lines crossing each other: reckoned a dishonourable colour; rarely to be met with in English coats of arms.

MU'RZAS. The name given to the hereditary nobility of the Tartars, or, more strictly perhaps, to the second class of their nobility; the first or principal class being designated beys. This titular appellation is also sometimes conferred on the descendants of public officers; but the latter are looked upon as upstarts by the older nobility, and regarded as an inferior race. The Murzas have from the earliest ages been distinguished for their bold and refractory character; and the peculiar privileges they formerly possessed supplied them with the means of giving effect to their turbulent dispositions. Since the conquest of Tartary, they have sunk into comparative insignificance; though many of them retain a large share of their former property, and have considerable influence among their own countrymen. (See *Quart. Rev.* vol. xxix. p. 128.) The Tartar *murza* is evidently of the same origin with the Persian *mirza*; with which, however, it must not be confounded. *See* MIRZA.

MUSA'CEÆ (Musa, one of the genera), constitute a small but very important natural order of plants, related to the orders yielding ginger, arrow-root, and similar substances; but differing in having several stamens instead of one only. The plantain (*Musa sapientum*), the most valuable product of the vegetable kingdom in hot countries, in consequence of the abundance of nutritious food yielded by its fruit, and the application of its leaves to the purposes of thatching, and of thread obtained from its petioles in the manufacture of the finest muslins, is the representative of the order. Another species is the *Musa paradisiaca*, or banana; and the singular plants called Strelitzias, with their orange and blue flowers, are also members of *Musaceæ*.

MU'SCA. (Lat. *a fly.*) A Linnæan genus of Dipterous insects, now expanded into a family (*Muscidæ*) of the fifth tribe (*Athericera*), of the order *Diptera* in Latreille's system. It is distinguished by a proboscis always very apparent, membranous, and bilabiate, generally bearing two palpi, and capable of being entirely withdrawn into the oral cavity; and a sucker of two pieces. The antennæ always terminate in a plate with a lateral setæ. The *Muscidæ* are divided into the subfamilies *Creophilæ*, which includes the meat-fly (*Musca vomitoria*), and the common house fly (*Musca domestica*); the *Anthornyzæ*, the *Hydrornyzæ*, the *Scatornyzæ*, the *Dolichocera*, the *Leptopoditæ*, the *Caprornyzæ*, the *Gymnornyzæ*, and the *Hypocera*.

MU'SCHEL KALK (German), signifies shell-limestone. This name is applied by some English geologists to a limestone formation belonging to the red sandstone group: it has not yet been found in England.

MUSCI. *See* MOSSES.

MUSCI'CAPA. (Lat. musca, *a fly*; capio, *I take.*) A genus of Dentirostral Passerine birds, characterized by a depressed beak, furnished with hairs at its base, and with the point more or less hooked and emarginate. The genus is now split into various subgenera; as *Tyrannus*, *Gymnocephalus*, *Muscipeta*, and *Muscicapa* proper, &c., included in the family name of *Muscicapidæ*. Their general habits are cruel and predatory, like those of the shrikes; and, according to their size and strength, they live on small birds or insects. The smallest and weakest of the *Muscicapidæ* gradually approach the form of the wagtails.

MUSCI'DÆ. The family of Dipterous insects, of which the fly (*Musca*) is the type.

MUSCIFO'RMES. (Lat. musca, *a fly*; forma, *form.*) The name of a tribe of *Tipulidæ*, or crane-flies, comprehending those which have a stout body and short legs, resembling the common flies.

MU'SCLE BAND. In Coal-mines, the black shale containing embedded muscle shells.

MU'SCLE. (Lat. musculus, diminutive of mus, *a mouse*, from its resemblance to a flayed mouse.) Fleshy fibres susceptible of contractions and relaxations. Some of the muscles are obedient to the will, and therefore called *voluntary*; others, such as the heart, are independent of the will, or *involuntary*; and others, as the diaphragm and muscles of respiration generally, have a *mixed* action, being to a certain extent only dependent upon the will. Muscles are aggregates of minute muscular fibres, which appear to be composed of small globules; but we are, in fact, ignorant of the ultimate structure of the muscles, and of the causes on which their wonderful powers depend. They are enveloped in and penetrated by cellular membrane, and abundantly supplied by nerves, blood-vessels, and lymphatics.

Their principal constituent or proximate elementary structure consists of albumen, besides which gelatin and fat are derived from their cellular membrane; and hæmatosin, osmazome, and other constituents of the blood are

also found in them: they therefore constitute the most nutritious species of animal food. *See* ALBUMEN and GELATIN.

All the muscles are under the immediate influence of the brain and nerves; and consequently when this influence is abstracted, as by the division of the nervous trunks by which they are supplied, the powers and functions of the muscles, whether voluntary or involuntary, are in the first instance disturbed, and afterwards cease altogether. Electricity is capable to a certain extent of recalling the action of the muscles, provided it be applied before rigidity ensues; hence the supposed identity of that power of matter and certain properties of the nerves. The arrangement of the fibres of muscles is infinitely various, and adapted to the particular purposes which each has to fulfil. In the voluntary muscles the fibres are generally parallel, or nearly so; but in the involuntary muscles they are more or less interwoven and interlaced. When muscles contract, they become shorter, harder, and thicker, and their bundles of fibres are thrown into undulated lines, with a tremulous or vibratory motion, most rapid where the contraction is most powerful, and producing a distinct sound, which may be most easily heard when the tip of the finger is put into the ear; it occasions a noise like that of carriages rumbling over a distant pavement. (Wollaston, *Philos. Trans.*, 1809.) The number of these vibrations amount to between twenty or thirty in a second: these muscular sounds are importantly concerned in the diagnosis of certain diseases through the medium of the stethoscope.

MUSCOVA'DO. The name given to unrefined or moist sugar.

MU'SES. (Gr. Μοῦσαι, Lat. *Musæ*.) In the Greek and Roman Mythology, nymphs or inferior divinities, distinguished as the peculiar protectresses of poetry, painting, rhetoric, music, and generally of the *belles lettres* and liberal arts; with which, indeed, they are sometimes identified: — *Quis est omnium, qui modo cum Musis, id est cum humanitate et cum doctrina, habeat aliquod commercium, qui*, &c. (Cicero, *Tusculan.* lib. v. cap. 23.) Helicon and the region round Parnassus was the favourite seat of the Muses, where they were supposed, under the presidency of Apollo, to be perpetually engaged in song and dance, and in elevating the style and conceptions of their favoured votaries. It appears probable that the early Grecian poets, struck with the beauty and sublimity of the scenery in this part of Greece, ascribed the humanizing influence it was so well fitted to exercise over the mind to the agency of the nymphs and other tutelary deities of the place, to whom they gave the name of Muses. Originally there appear to have been only three of these divinities *; and their names — *Mneme*, *Melete*, and *Aœde*, or Memory, Reflection, and Song — sufficiently show the nature of the faculties over which they were supposed to preside. According as the fine and liberal arts were cultivated and expanded, the province of each muse seems to have been more restricted; and additions were made to their number, which ultimately was fixed at nine. Their names and functions are succinctly stated in the following verses of Ausonius: —

> CLIO gesta canens, transactis tempora reddit.
> MELPOMENE tragico proclamat mœsta boatu.
> Comica lascivo gaudet sermone THALIA.
> Dulciloquos calamos EUTERPE flatibus urget.
> TERPSICHORE affectus citharis movet, imperat, auget.
> Plectra gerens ERATO, saltat pede, carmine, vultu.
> Carmina CALLIOPE libris heroica mandat.
> URANIA cœli motus scrutatur, et astra.
> Signat cuncta manu, loquitur POLYHYMNIA gestu.
> Mentis Apollineæ vis has movet undique Musas.
> In medio residens complectitur omnia Phœbus.
>
> EDYLL. 20.

MUSE'TTE. A name sometimes given by the Continental nations to the bagpipe. The itinerant performers on the musette, who were formerly very numerous in many European countries, were called *musars*.

MUSE'UM. (Gr. *μουσειον*; from *μουσα, a muse.*) A collection of curious objects in nature and art; but, in most instances, the former. The name denotes a temple or place sacred to the Muses; and is said to have been first given by Ptolemy Philadelphus to that part of the royal palace at Alexandria in which he placed the famous library. In England, the museum at Oxford is the most ancient institution bearing the name. It was founded in 1679, and enriched, in the first instance, chiefly by the contributions of Elias Ashmole; but want of room and of funds has prevented it from affording an adequate exhibition of the various classes of objects for which it was originally destined, and which modern discoveries have so greatly augmented. The foundation of the British Museum, in London, was laid by Sir Richard Cotton's presenting to it his collection of manuscripts. Since that period the library has been increased by the addition of the Harleian, Lansdowne, Egerton, and several other collections of MSS.; by extensive purchases out of funds afforded by government; by the deposit of copies of newly published works, according to the legal right conferred on this institution; and by the donations of George III. and IV., the latter of whom presented to it his father's library. In sculpture, the British Museum possesses the collection of marbles brought by Lord Elgin from Greece, together with that called the Townley marbles, and a fine assemblage of Egyptian works of art. It contains also the Hamilton vases, and the famous Barberini or Portland vase. In several departments of natural history, especially in mineralogy, it is extremely rich. It was founded by Sir Hans Sloane in 1733, and fills the mansion known by the name of Montague House, together with adjoining buildings more recently erected. The most celebrated museum in Italy is the Vatican, at Rome; next to it, that of Florence; and the Museo Borbonico, at Naples. In France, as well as in Italy, galleries of pictures are considered as within the meaning of the general term "musée;" and the museum of the Louvre is chiefly remarkable for its contents of this description.

MU'SHROOM (Fr. mousseron, a kind of agaric used in sauces), is, properly speaking, the *Agaricus compositis*, or eatable agaric, — a species common in pastures, and well known for its excellence as an ingredient in sauces; but the term is generally used in a more extended sense, and applied indiscriminately to all firm fleshy species of the genus *Agaricus*, whether eatable or not.

MUSIC. (Gr. *μουσικη*.) The art of combining sounds agreeable to the ear. This art becomes a profound science when we investigate the principles on which its combinations are founded, and the causes of the emotions it produces.

Hebrew Music. — Notwithstanding the great labours of the early fathers of the church, and of many other learned men, there are few materials, even in the Scriptures themselves, for a very satisfactory account of the music of the Jewish nation, whose restricted intercourse with other nations prevents our receiving any illustration of it from contemporary writers. All that can be done is to cite a few passages from holy writ relative to the first ages of the world; from which it will be seen that, from a very early period, the art constantly ministered to the religious ceremonies of the Hebrews. Moses (*Gen.* iv. 21.) tells us that Jubal, sixth in descent from Cain, was "the father of all such as handle the harp and organ." The organ here mentioned, according to the commentators, was the syrinx, or a species of Pan's pipes. This must have been but a short period after the deluge. Six hundred years after this period Laban reproaches Jacob thus: "Wherefore didst thou flee away secretly, and steal away from me? and didst not tell me, that I might have sent thee away with mirth and with songs, with tabret and with harp?" So that at this time vocal and instrumental music was not unusual. For two hundred and fifty years after this period nothing occurs relative to music, when we find Moses, after the passage of the Red Sea, singing with the Israelites on the occasion. Miriam, Aaron's sister, "took a timbrel in her hand; and all the women went out after her with timbrels and with dances." There seems ground for conjecturing that Miriam, by birth Egyptian, and educated in Egypt, might have learnt the use of the timbrel and the dance in that country. The instruments mentioned, during the administration of Moses, appear to have been confined to the trumpet and tambourine. After the siege of Jericho, where the rams' horns that were blown were rather military signals than instruments of music, we have no record of music till the appearance of the canticle of Barak and Deborah, which seems to have been sung in dialogue without instruments, excepting the timbrel and the trumpet before mentioned. From several passages music appears to have been united with prophecy. Samuel (b. 1. ch. x. v. 5.) says to Saul, "Thou shalt meet a company of prophets coming down from the high place, with a psaltery, and a tabret, and a pipe, and a harp before them." These prophets were doubtless poets or psalmodists, improvisatori of verses which they sung to the accompaniment of an instrument; and many of the fathers have supposed that the Jews had a college or school of prophets, which was also a school of music, for they almost universally accompanied themselves, or were accompanied by others, with musical instruments. David, who had cultivated music from his infancy, seems to have been destined by his family to the profession of a prophet; and Saint Ambrose says that he was chosen by God, above all the other prophets, to compose the Psalms. The power that the harp of David had upon Saul, when he was tormented with the evil spirit, is an example, among many others, of the influence of music on the maladies of the mind, and especially in cases of melancholy. Under the reign of David music was much esteemed. He appointed a great corps of musicians for the celebration of the religious ceremonies, and his patronage necessarily extended its influence. David, on all occasions, seems to have been interested in the solemnities of his time: we find him continually dancing and

* Cicero says four (*De Nat. Deorum*, iii. cap. 21.); but in this he is at variance with the Greek authorities. (*Pausanias*, lib. ix.)

playing before the Lord, with songs, harps, psalteries, timbrels, cymbals, cornets, and trumpets. As in Egypt, the musicians were confined to one family, that of Levi, which was exclusively consecrated to the service of the Lord and the cultivation of music. When Solomon was made king, four thousand were the number "which praised the Lord with instruments." Dr. Burney calls the reign of Solomon the Augustan age of the Jews; and though Solomon, unlike his father, was not himself a performer, and ranked "men-singers and women-singers, and the delights of the sons of men, such as musical instruments," among the vanities of the world, yet he continued the priests and Levites in his employ. In the reign of Jehoshaphat, the Levites were useful in the field of battle, and were, by their songs, the cause of the victory that was gained; and indeed this was not the only instance in which they were similarly serviceable. Some time before the destruction of the temple and the first Babylonish captivity, music and the sacred rites had met with interruption, both on account of war, and by their intercourse with foreign nations. The captivity was a mortal blow to the endeavours they had made to recover their music; and sixty-six years, the period of its duration, was sufficient to efface all from their remembrance. This oblivion is feelingly deplored in the 137th Psalm, "How shall we sing the Lord's song in a strange land?" Re-established, but soon afterwards captives a second time; again delivered, and then conquered by the Egyptians, Persians, and Romans successively, — the unfortunate Jews had no leisure to cultivate the arts; and it appears probable that their music, which scarcely deserved the name till the reign of David, even at its best epoch, depended for effect more upon the number of the performers than upon any refined knowledge of the art.

Among the modern Jews, instrumental as well as vocal music was excluded from the synagogue from the time of the destruction of Jerusalem. The singing they allow at the present day is a modern innovation; for, according to a passage of their prophets, the Jews consider it contrary to their law, or at least improper, to sing or rejoice until the coming of the Messiah. The German are the only Jews in the present day who have a regular musical establishment in their synagogues. They sing in parts, and have preserved traditional melodies, which are considered very ancient. At Prague an organ is used to accompany the singing.

Egyptian Music. — The opinion of the ancients was pretty general that Pythagoras was indebted to the lessons of the Egyptian priests for nearly all the science he possessed, and especially that of music. Though Diodorus Siculus assures us that the Egyptians were not allowed to cultivate music, and that they considered it useless and even injurious to society, and the cause of effeminacy; yet Plato, who had visited Egypt, observes, in one of his Dialogues, that none but excellent music was allowed where the youth were assembled. Though he admits others of their habits were bad, he excepts the music. Strabo tells us that the youth were instructed at the earliest age in music, that the songs were fixed by law, and that the sort of music used was established by the government exclusive of every other sort. The Greeks even attributed the invention of some of their musical instruments to the Egyptians; such as the triangular lyre, the single flute, the drum, and the systrum. Herodotus says the Dorians were of Egyptian extraction; and as the three most ancient modes of Grecian music were the Dorian, the Phrygian, and the Lydian, it is probable that the Egyptian colony that peopled that province carried thither the music and instruments of their country. Like all other professions in Egypt, that of music was hereditary. A similar custom, as we have above stated, prevailed among the Jews; and Herodotus tells us that the inhabitants of Lacedæmonia, who were Dorians, resembled their ancestors, the Egyptians, in this, that their musicians were all of the same family; and that their priests, like those of Egypt, were taught medicine, and the art of playing upon stringed instruments, when they were initiated into the mysteries of religion. The same author mentions that in the processions of Osiris the Egyptians carried statues of the god, singing his praises, and were preceded by a flute. There is a singular proof of the antiquity of this art to be met with at Rome, on the Guglia Rotta, which Augustus brought to Rome, being one of the largest obelisks that was removed from Egypt, and which was thrown down and broken at the sacking of the city, in 1527, by the constable of Bourbon. It is, among other hieroglyphics, the representation of an instrument, as here given, very like the

colascione (a species of guitar) still in use in Naples. From the pegs it is evident two strings were employed; and the length of the finger board, if the strings were tuned at a great interval from each other, would afford a very considerable scale of notes. This instrument alone proves to what extent music was cultivated in Egypt, and that its inhabitants were acquainted with the method of repeating the scale. Hermes, Toth, or the ancient Mercury Trismegistus, to whom is ascribed the invention of writing, astronomy, religious rites and ceremonies, has the credit also of having invented the lyre with three strings, which, it is pleasantly said, were types of the three seasons of the year, there being a fourth season neither in Egypt nor among the ancient Greeks. The lowest chord, say they, was the type of winter, the middle one of spring, and the highest of summer. The following, according to Apollodorus, was the origin of the invention:—The Nile, after its inundation on one occasion, left on retiring a quantity of dead animals, and among the rest a tortoise. The flesh soon perished and dried up, from the heat of the sun; nothing but the shell and the cartilages were left, and from their contraction they had become sonorous. Mercury, strolling on the banks of the river, struck his foot against this tortoise-shell, and was agreeably surprised by the sound it produced; and this furnished him with the first idea of a lyre. He gave his instrument the general form of the shell, and strung it with the dried tendons of animals, resembling the gut-strings of the present day. The single flute, however, *monaulos*, also invented in Egypt, seems to have greater claims to antiquity than the lyre itself. It was called *photinx*, or curved flute, by the Egyptians; its form being something like that of a bullock's horn.

Apuleius, describing the mysteries of Isis, tells us the form of this instrument, as well as the manner in which it was held; and all the representations of it show that it resembled the bullock's horn. Indeed, there can be no doubt that, in the remotest period, the horns themselves were made use of. But it is certain that the Egyptians had instruments much more susceptible of inflection than those whereof we have been speaking; for on the ceilings and walls of the chambers of the tomb of Osymandyas,

at Thebes, which are described very circumstantially by Diodorus, are, amongother decorations, several representations of musical instruments; one of which, from Denon, we here subjoin, for the purpose of showing the reader that the harp of the present day is in general form not very dissimilar to that then in Egyptian use, and that performance upon it must have required considerable skill. Other representations of harps occur; one has been given by Dr. Burney. There is one at Ptolemais, a city built by Ptolemy Philadelphus, with fifteen strings, or two complete octaves: this, however, is more triangular in shape, and much more similar to the modern harp. The instruments in Abyssinia were found by Mr. Bruce to have a close resemblance to those of Egypt. The arts which flourished in this nation at so early a period would doubtless have continued to do so under their own kings; but after the subjugation of the nation by Cambyses, 525 years before Christ, the arts and sciences under a foreign yoke disappeared, or rather ceased to be indigenous in Egypt. The Ptolemies, indeed, encouraged them; but under their reigns the professors of the arts were chiefly Grecian. The Egyptians had degenerated from the knowledge of their ancestors, whose hieroglyphics they themselves no longer understood. It is probable, however, that music was cultivated under these princes; for at a feast of Bacchus, given by Ptolemy Philadelphus, Athenæus says that the choir was composed of six hundred musicians, and of that number one half were performers on the cithara. According to the same author, under the seventh Ptolemy, Egypt abounded with musicians; and at this period the practice of music was so common in the country, that there was not a peasant or labourer in the vicinity of Alexandria that was unable to play on the lyre and flute. The father of Cleopatra, who was the last of the Ptolemies, from his skill on the flute took the title of Auletes; that is, player upon the flute. Strabo says that notwithstanding the debauched life he led, he found time to apply himself particularly to the practice of this instrument. He thought so highly of his talent in this respect that he established musical competitions in his palace, and himself disputed the prize with the first musicians of the day. Such was the flourishing state of the art in Egypt up to the time of Cleopatra's misfortunes; — an event which ends the history of the empire, and that of the Egyptians. Among the modern Egyptians no remains or traces of the ancient state of the art are now to be found. Still they are passionately fond of music; and there are, according to Savary, to be found among them both male and female musicians who sing and accompany themselves. This author describes them as most successful in their plaintive music; to which, he says, even

the Turks themselves, the enemies of art, will pass whole nights in listening.

Grecian Music. — The fables of mythology are so mixed up with the ancient history of all the arts that it is difficult to separate fact from fable. Hence the most celebrated authors of the history of music, after delivering faithfully what the ancients have recorded on the subject, have left the reader to shift for himself in analyzing the mass. Burney, of whose history in the two previous articles we have largely availed ourselves, we propose to follow in the following short account of Grecian music. The Phœnicians came into Greece with Cadmus, the son of Agenor: amongst them were a class of men well versed in the arts and sciences of their country, who were called Curetes. These established themselves in Phrygia, where they were called Corybantes; in Crete, where they received the name of Dactyli: they spread also into Rhodes, Samothracia, and other places. In these places writing and music were the arts principally taught by them. Cadmus, in Samothracia, took to wife Harmonia (sister of Jasius and Dardanus), who was so skilled in music that the Greeks gave her name to the art. Diodorus, in describing the marriage feast of the parties, makes the gods themselves guests. Mercury came with his lyre, Apollo brought a similar instrument, Minerva assisted with a flute, and the Muses also brought their flutes; Electra, the mother of the bride, celebrated the mysteries of Cybele with dancing, tambourines, and cymbals. How Diodorus was informed of these particulars he does not condescend to tell his readers; but it seems probable that the story was founded on ceremonies which the priests, at certain festivals, performed in honour of Harmonia and Cadmus. Jupiter, they say, was born at the epoch of the arrival of the Phœnicians; and the Curetes, it appears, brought him up. At that time they were not acquainted with any musical instruments, save those of percussion: they could not, therefore, have taught the Greeks more than the use of these, and they could convey no musical notions except those of rhythm. The inferior divinities — Minerva, Mercury, Apollo, and the Muses — afterwards became the protectors of the art, and invented wind and stringed instruments.

These two circumstances are, as the reader will perceive, irreconcileable; and Diodorus committed an anachronism, which may be accounted for if his description was taken from some religious spectacle. The flute with holes, by stopping which many notes were produced, was certainly a more ingenious instrument than the pipes of Pan. This was the invention of Minerva, who performed upon it until she was derided by Juno and Venus for the grimace and wry faces consequent on playing it, when she renounced it in favour of the lyre. The employments assigned to Mercury by the Greeks may be learnt from the pleasantry of Lucian. The same personage as the Hermes of the Egyptians, he had the credit of having invented music, and in those days its principal instrument, the lyre. In Greece the lyre he invented had seven strings, whereas that which he gave the Egyptians had three only. Apollo was another of the Grecian deities whose origin was in Egypt. He was a performer on the lyre; and there is no necessity to repeat in this place his contest with Pan, and the decision of Midas, under whose form the silly king of Phrygia was represented by some neglected poet. Marsyas was another of Apollo's unfortunate victims; upon him he wreaked his vengeance with such cruelty that he himself was afterwards ashamed of his conduct, and actually threw aside his lyre for a considerable period, which, it is said, retarded the progress and perfection of that instrument. Fortunio Liceti, a modern writer, thus explains the story of the flaying Marsyas alive by Apollo. Before the invention of the lyre, the flute was considered the most important instrument, and its practice enriched the performers on it. As soon as the lyre was heard, it was so captivating that nobody listened to flute-players, and they fell into discredit and were ruined. Now the money of those days, being made from leather hides, gave rise to the story that Apollo had stripped Marsyas of his hide. The priestess of Apollo at Delphi delivered, says Plutarch, her oracles to the sound of the flute. Afterwards, when her oracle was in the greatest renown, there were attendant choirs and instruments, and dancing and singing. At first the Muses were nothing more than a band of singers and musicians in the service of Osiris, or the Egyptian Bacchus, under the superintendence of his son Osiris. The Greeks made them the daughters of Mnemosyne by Jupiter. Those who make them the daughters of Pierus, king of Thrace, do not alter the first account; for the female musicians of Osiris, before they were taken into his service, had been celebrated in Thrace under the name of Muses, and the daughters of that Pierus who initiated them became celebrated under the same name. Bacchus has been so celebrated in the musical world that we cannot leave him out. Diodorus makes him the inventor of theatrical representations and schools of music, in which those who excelled were exempt from military service. Hence the author says that musical societies have since enjoyed many privileges. Certain it is that the Dithyrambi, who originated dramatic representations, were as ancient as the worship of Bacchus. In Athens and in Rome all persons who appeared on the stage, singing, dancing, or reciting verses for the amusement of the people, were called servants of Bacchus; and at all the processions, triumphs, and ceremonies instituted by the ancients in honour of the god, music entered largely into the programme. This is constantly seen in the bas-reliefs that have come down to us; for wherever there are fauns, satyrs, and bacchanals, we always find a certain set of musicians of some sort in attendance.

Pan seems to enjoy the first rank in the second class of divinities who patronised music. The Egyptians, however, ranked him higher than did the Greeks. Pan, say some, was the inventor of the flute called the syrinx. The fable is pretty which gave rise to the invention. Syrinx, a nymph, being pursued by Pan, flies to the banks of a river, whose nymphs she implores to save her. Pan thinks to catch her, but embraces only the reeds. Under this new form, Syrinx, shaken by the winds, emits certain melodious tones. The god, pleased with the sound, makes an instrument from the reeds, to which he gives the name of Syrinx. Pan is the companion and counsellor of Bacchus. Shepherd, musician, dancer, hunter, and warrior, he directs the movements of the bacchanals; but the perfection with which he plays the flute is such that Bacchus is never happy without him. The satyrs follow in Pan's train. Silenus was the inventor of several instruments. Like Marsyas, he was bold enough to challenge Apollo; with better fortune, however, as regards the result.

Such was the state of music in Greece under the gods and demi-gods; that is to say, in those primitive times when every one who had signalized himself by a useful invention was deified after his death, and considered the protector of the art he had invented. The heroic age followed this; and, divesting the subject of fable as much as possible, we shall now proceed to the music of that period. Amphion, Chiron, Orpheus, Linus, were at once the first poets and the first civilizers of Greece. Amphion is the first Theban musician mentioned in the history of the art. Homer, however, is silent on his wonderful skill in music, and of his having erected the walls of Thebes by the aid of the lyre. Pausanias thinks his musical reputation was acquired by his alliance with Niobe, and Pliny is of the same opinion. Both of them allege that Amphion learnt the art in Lydia, and that, having brought it into Greece, he was thence accounted the inventor of the Lydian mode. Chiron, whom Plutarch calls the wise centaur, accounted the son of Saturn and Philyra, was born among the centaurs in Thessaly; that is, among the people of Greece who first trained and rode the horse. With the reputation of inventor of medicine, botany, and surgery, he lived at the foot of Mount Pelion, in a cavern, which his science made the principal and most frequented school of Greece. Plutarch makes him the instructor of Hercules in music, medicine, and law; though Diodorous says that Linus was his master. And here let it be observed that ancient authors always considered music among the indispensable accomplishments of their heroes. "Nec fides didicit nec natare" was anciently a reproach to any one above the commonest class. Achilles was the most renowned pupil of Chiron, who bestowed much of his time to instruct him in this art, as the means of not only softening the impetuosity of his character, but of exciting him to heroic actions. One of the most beautiful paintings of Herculaneum represents Chiron teaching the young Achilles to play upon the lyre. After Chiron, Linus and Orpheus appear to have been the first poets and musicians of Greece; but it is difficult to decide which was the pupil of the other. Diodorus says that Linus has the priority, and that he added the chord lichanos to the lyre of Mercury, and invented rhythm and melody. The majority of the ancients make him the instructor of Hercules, whom, say they, he found so stupid and obstinate, that having on one occasion given him a blow, the young hero seized his preceptor's instrument and beat his brains out with it. Orpheus, however, whether before or after Linus, acquired the greatest name in Greece. His reputation was fully established at the time of the Argonautic expedition, in which he was one of the adventurers. Apollonius Rhodius observes, that he not only excited his comrades by the sound of his lyre, but that he also silenced the syrens by the superiority of his singing. The fables universally say that Orpheus travelled in Egypt, where he was instructed in the mysteries of religion, theology, and poetry, and that he was the first who transplanted them to the Grecian shores. According to the custom of the time, he united with the knowledge of music that of the sublime sciences. Preferring the lyre to all other instruments, of which before him the flute seems to have been the principal, those who followed were content to be his imitators. We pass over the story of his losing Eurydice, his wife, the effect his lyre had upon Cerberus and the god of the infernal regions, as known to every reader.

The instrument that produced these effects was but a seven-stringed lyre; two strings having been added by himself, by which addition the second tetrachord was completed.

Obloquitur numero septem discrimina vocum. — VIRG.

From the little power which such an instrument possessed, compared with those of modern times, we may infer that it must have been the novelty of the art or the beauty of the poetry which produced such extraordinary impressions, or perhaps both acted upon a very susceptible race of people. The mastery which Orpheus possessed over the Thracians made the women of that country jealous of him; and by them, history relates, he was massacred. In the time of Plutarch, the females of Thrace continued to be reproached with this barbarity. The fable says that his lyre, at the time of his murder, fell into the river Hebrus, down which it floated to Lesbos, where it was deposited in the temple of Apollo. Neanthus, who afterwards purchased it of the priests of the temple, thought, like the nobleman who bought Punchinello, that the possession of it would inspire him: no sooner had he begun to use it than the dogs of his neighbourhood tore him to pieces. After the Argonautic expedition, the most important event in Grecian history is that of the siege of Troy. Homer, who sang three centuries after this period, is the only historian from whom we can extract knowledge respecting the art. He has preserved the names of several musicians; and these are the only ones known from the time of Orpheus up to the time of celebrating the Olympic games.

The instruments mentioned by Homer, in the *Iliad* and *Odyssey*, are the lyre, the flute, the syrinx, or Pan's pipes. The lyre is by him called φορμιγξ, κιθαρα, and χελυς; Aristophanes being the first Greek poet who calls it λυρα. Though Homer speaks of the trumpet, it is thought that this instrument, though common in his time, was unknown to the Greeks at the siege of Troy. With Homer music and poetry are inseparable: *αοιδος, a singer*, is the word used by him to express a poet. By him Achilles and Paris are both exhibited as playing the lyre; but the former does it to console himself for the insult that had been offered to him; whilst the latter exercises his skill to forget the disgrace of having sought safety in flight. Achilles sings the deeds of heroes. The song of Paris was more "to the lascivious pleasing of the lute," in recounting tales of love. The earliest poet who united music with his art was Tiresias: he was also gifted with prophecy, and was a priest. Thamyris receives from Homer the appellation *κιθαριστης, one who sang to the lyre*. Plutarch, in his Dialogue on Music, says that he was born in Thrace, the country of Orpheus; that his voice, though loud, possessed the quality of softness; but that he was punished with blindness for daring to contend with the Muses in poetry and singing; and that to this punishment was also added the loss of voice, and the talent of touching the lyre. This circumstance is mentioned in the catalogue of the ships. (Lib. ii. v. 594.) According to Diodorus, Thamyris was of the school of Linus, and Suidas places him eighth of the epic poets who preceded Homer. Clemens of Alexandria says he was the inventor of the Dorian mode; but he is probably wrong, inasmuch as this had before his time been imported into Greece by the Egyptians, who invaded that part of Greece which bore the name of Doria. In the eighth book of the *Odyssey*, Homer gives an eminent place to Demodocus, whom he describes in his character of poet and singer as the glory of the human race. Some have thought that under this name the poet was painting his own portrait. He places him on a throne, a herald announces him, and he has a private table, and in every circumstance speaks of the honours that were paid to him. Like Tiresias and Thamyris he paints him blind, which it will be recollected was his own case. The blindness of these great poets did not escape Milton, who likens himself to them in this respect, and the coincidence is certainly very singular. The last musician celebrated by Homer is Phemius, who, according to Eustathius, had been his master. He is immortalized in the *Odyssey*. The poets and musicians of Greece appear to have much resembled the Celtic bards. They wandered about, singing their works in great cities, and usually found admission to the palaces of princes, where they were treated as though endued with inspiration. Hyagnis and Olympus were also celebrated, before the time of Homer, for their musical talents: the first, according to the Arundelian marbles, flourished 1506 years B.C. He was the inventor of the Phrygian flute, and the airs or *nomes* that were sung to the mother of the gods, to Pan, Bacchus, and other divinities of the country. The second is honourably mentioned by the Greek writers. Two musicians of antiquity bore the name of Olympus. The most ancient was the most celebrated. He was a native of Mysia, and the disciple of Marsyas. Burney, in speaking of him, remarks that religion only can impart permanence to any system of music; and he conjectures that the airs that were sung in the temples in the time of Plutarch were then of the same relative antiquity as to us is the plain chant of the beautiful hymns of the Catholic church. Plato, Porphyry, Athenæus, and the scholiast of Pindar, speak highly of the talents of Thaletas of Crete, the next poet and musician after Hesiod and Homer. There were two of this name, of the same country too. If we are to credit Plutarch, Archilochus contributed more than any other to the advancement of poetry and music. Herodotus makes him the cotemporary of Candaules, and of Gyges, king of Lydia, 724 years before Christ; but modern chronologists place him much later. He was a native of Paros.

Without entering into particulars, it is sufficient to mention that at this period melody was strictly confined by the measure of the verse. A different set of feet in a verse necessarily required new airs in the music. Hexameter was the most ancient species of measure, and so continued till the introduction of lyric poetry. If Archilochus was the inventor of music different to that which suited the hexameter verse, he was indeed the inventor of lyric poetry, which after his time became a species of versification totally distinct from that of the heroic. Archilochus is generally allowed to have been one of the first conquerors at the Pythian games. Tyrtæus, who was a soldier as well as musician, was particularly celebrated for his military songs or airs. The scholiast of Horace makes the Lacedæmonians indebted to him for a victory gained by them, in which he led them on to the sound of the military flute, for which they rewarded him with the rights of citizenship. The authors who have written on the progressive state of the Grecian music unanimously celebrate the talents of Terpander; but neither the exact time of his appearance, nor the place of his birth, can be ascertained. According to the Arundelian marbles, the former was 671 years before Christ. Many have given him the credit of having added the three strings to the lyre: it, however, appears clear that he was the first who used the seven-stringed lyre among the Lacedæmonians, by which he gave great offence to the people. The Spartans disliked innovation, and Plutarch relates that the Ephori fined him for his invention. The Arundelian marbles state that he obtained the first prize in music at the games instituted at Sparta to avert the anger of Apollo for the murder of one of his priests by the Dorians. Plutarch says that no other proof of his skill could be wanting, seeing that his name appears four times on the register of the Pythian games, where he carried off successively four of the prizes. At the Grecian games music formed a principal part of the ceremony: the combats were to the sound of music. In the dramatic representations, the declamation was accompanied by an orchestra, and there were moreover particular prizes allotted to the professors of the art. The Olympic games were established in honour of Jupiter Olympius, from which, or from being celebrated near the temple of Olympia, they took their name. They were not at first celebrated at stated intervals, but, after the year 776 B.C., on the second month after the expiration of every fourth year. At first music had but little share in them, but at a later period prizes were given to successful competitors in this art. It is well authenticated that, at a comparatively late period, Nero appeared at them, and of course carried off the prize. The Pythian games, founded for preserving the remembrance of Apollo's victory over the serpent Python, were at first confined to poetical and lyrical contests; but in these music was afterwards admitted to her share of the prizes; and, in the year 559 before Christ, a crown was decreed to the best performer on the lyre, or, rather, on an instrument with strings. The prize was nothing more than a laurel crown, in memory of the love of Apollo for Daphne; though afterwards the apple, a fruit consecrated to Apollo, was added. At these games a peculiar musical composition was performed of considerable length, in allusion to the contest of the god with the serpent: it was composed by Sacadas, and sung for the first time by him at Delphi. The other musicians and poets who distinguished themselves at these games were Alcman of Sardis; Alcæus of Mitylene, the cotemporary of Sappho (to the latter of whom Aristoxenus and Plutarch attribute the invention of the Mixolydian mode, of which Plato, the advocate of simplicity in music, much complains); Mimnermus, famous for his performances on the flute, in the 6th century before the Christian era; Hesichorus (a sobriquet), whose right name was Tisias; Simonides, born at Ceos, 538 B.C., the master of Pindar; Pindar himself, born at Thebes, in Bœotia, about 520 years before our era; Myrtis, and Astinous. The Pythian games were held at Miletus, Magnesia, and other places, as well as at Delphi, and music and poetry were the chief subjects of contests in them. The Nemæan games, which took their name from Nemæa, a village in Arcadia, were of such high antiquity that their true origin was unknown even to the ancients. The contests were somewhat similar to those at the Olympic games, and it is known that those in music formed a portion. It was at these games that the musician Pylādes, of Megalopolis, sang, accompanied by the lyre, an air composed by Timotheus, in which the

words were so suited to the circumstances of the battle of Mantinea, that the audience immediately turned their eyes to Philopœmen, who was present, and interrupted the singer by shouts and acclamations of applause. Timotheus, born at Miletus, 446 B. C., was one of the most celebrated poets and musicians of antiquity. Pausanias tells us that to the seven strings of the lyre he added four more; though Suidas says that he added but two, the tenth and the eleventh: the consequence whereof was that for the innovation he was banished from Sparta, and ordered to cut off the additional strings, that he might not corrupt the ears of the youth with too great a variety of notes. We have above stated that the Spartans behaved in an equally barbarous manner to Terpander. This Timotheus, who died two years before the birth of Alexander, must not be confounded with the celebrated flute-player who was so great a favourite with that prince, and whose tones animated him to arms. The Isthmian did not differ from the games already described: they received their name from being celebrated on the Isthmus of Corinth. Other games existed in different cities, as, for instance, the Panathenaic at Athens. Music was cultivated at all, and held in much esteem.

At Athens, in the time of Pericles, music was considered so necessary a part of education, that not to understand it nor play any instrument was considered a disgrace. Pericles was especially zealous in his patronage of music. Besides regulating the form and increasing the number of musical competitions at the Panathenaic festivals, he built an edifice called the Odeum, for the express purpose of rehearsals previous to performance in the theatre. It was during his era that Antigonides and Dorion, the two most eminent flute-players, flourished. So great appears to have been the passion for flute-playing, that as much as three talents (upwards of 600*l.*) were given for a single flute; fortunes were realized in manufacturing them; and the performers lived in a splendid and magnificent style. Even the women were performers on the flute. Of these the most renowned was Lamia, to whom, for the benefits she had prevailed on Demetrius to confer upon the city, the Athenians rendered divine honours, and dedicated a temple to her, under the name of Venus Lamia. It seems that execution on this instrument was carried to a great extent; for Aristotle cries out against the difficult passages that used to be practised, and even against music generally. The people, however, who, as a mass, are never disposed to give up the pleasures of sense for those of the mind, continued to encourage these novelties and their authors; and, from being the handmaid, music became the mistress of poetry. The justice of the complaints of Plato and Aristotle on this point is confirmed by Aristoxenus himself, well skilled in the art; and Plutarch frequently laments that the theatre had ruined music: though what the latter says must be taken with some allowance, seeing that he was a priest of Apollo, and anxious, doubtless, to confine music to the service of religion. After the complete subjugation of the Greeks, like the rest of the arts, music fell to decay. They continued, indeed, to cultivate music under the Roman emperors, and under their own: even afterwards, under the Turks, it was one of their amusements; but so barbarous is it in the present day, that it is difficult to conceive that the same nation ever possessed a music which drew down the admiring plaudits of thousands. To form any idea of the ancient Greek music is now past all hope: materials upon which we could judge have long since passed away; but we will add, in conclusion to this section, the opinion of M. Ginguené on the subject. "We see in the poetical works of the Greeks the variety and liveliness of their passions, and these same passions could not be expressed in music without an equal variety of air and modulation. I do not mean by that to say that Greek music was entirely similar to our own: to decide that point it would be necessary to hear and compare the one with the other. I maintain only that Greek music was full of harmony; that it admitted that variety of modulation which alone can give pleasure to cultivated minds; and that to suppose that the Greeks were pleased with a music that comprehended but four notes is one of the greatest follies that can be imagined."

Roman Music.—It is scarcely possible for any nation to exist without some sort of music; and it appears that, at a very remote period, such was not the case with the Romans. At its commencement rude and barbarous, their intercourse with the Etruscans, who were much farther advanced in the arts than themselves, would soon have had effect upon it. Strabo and Livy affirm that public music, as used at sacrifices, was especially learnt by this nation of the Etruscans. Servius Tullius, 600 years before Christ, in his division of the people into classes or centuries, directed that two entire centuries should consist of trumpeters, horn-players, and those who sounded the charge, which proves at least the number of military musicians. One hundred and fifty years afterwards, the marshal at funerals was, by the laws of the twelve tables, directed to provide six flute-players. Among the Romans, as was also the case with the Greek music (see above), music and the drama were inseparable. In the end these exhibitions became offensive; but the further notice of these is unnecessary in this place. Music, however, was for a long period confined to sacred uses; and it was only after the defeat of Antiochus the Great that the Asiatic custom was introduced of having female musicians,—*psaltriæ*,—to play at festivals and private banquets. The Etruscan music, which we have already slightly mentioned, was cultivated with success; for all the instruments of the Greeks, which are known to us from their bass-reliefs, are to be found in paintings on Etruscan vases: so that it may be safely assumed that the Romans were accustomed to the best music that the age afforded. Under Augustus, who was not a great patron of the art, music was not much esteemed: it is possible he might not have had much taste for it; and yet, when he was getting into years, he engaged a musician to regulate the intonation of his voice. Tiberius banished musicians from the city, which under him became as sad as in the days of Augustus it had been lively. Caligula, however, recalled them. Claudius, though he patronized gladiatorial fights in preference to music, still encouraged the art; but under Nero it shone in all its ancient splendour. Such was this emperor's delight in it, that he passed a great portion of his time in taking lessons of Torpus, the most skilful harpist and lyrist of his day. We have before stated his ardour in the pursuit of the art to have been so great that he contended at the Grecian games. Nero's successors were patrons of the public games, and of dramatic and musical exhibitions throughout the empire. Adrian had always been attached to the arts of Greece. He instituted new games, which his successor Antonine continued. Commodus, whose disposition was similar to Nero's in cruelty, resembled him also in an intense passion for the stage, on which he delighted to appear as a singer and dancer. The fall of the empire necessarily induced the fall of the arts, and music, of course, among the rest: in short, it disappeared with them—with them to spring into new life and surpass all its former glory, after centuries had passed away, and all art seemed to have been lost for ever.

Italian Music.—Italy has been to the rest of Europe in modern times what ancient Greece was to Rome. Though we cannot so well trace the art of music in its early restoration as we can the arts of design, we know that to the religion and church which brought them forward we are indebted for the foundation of all that is good in the musical art. The plain chant of the Catholic church, the foundation to which we allude, is said to owe its origin to Ambrosius, archbishop of Milan, in the fourth century. He, it is generally understood, brought it into form and based it upon rules. Two centuries afterwards Pope Gregory carried it to such perfection that, up to the present hour, it has needed no improvement, indeed seems incapable of improvement, and remains one of the noblest monuments that the art has produced. The music of Italy, aided by a language which Metastasio called *musica stessa*, notwithstanding the revolutions it at first underwent, at length became the guide for the rest of Europe. Even out of the church, as early as the 13th century, music was cultivated; for Prince Conrad, in 1268, went out against Charles I. of Sicily with a female choir singing, accompanied by cymbals, drums, flutes, violins, and other instruments; and it is known that all the courts of Italy were filled with musicians, for the amusement of their sovereigns. At Florence is still in existence a manuscript collection of sacred songs, entitled *Laudi Spirituali*, in honour of God, the Virgin, saints and martyrs, which as early as 1310 used to be sung by a society called the *Laudisti*. A society of this sort existed when Dr. Burney was at Florence in 1770; and he states that he often heard them singing about the streets in three parts, accompanied by a portable organ. When Petrarch was crowned with laurel at Rome, in 1341, music was introduced to grace the ceremony; and from the account of that ceremony, printed at Padua in 1549, it appears that it consisted of instrumental as well as vocal music. To return back a little, it appears that, in 1022, Guido, a Benedictine monk of Arezzo, was the first who imagined the scheme of designating by points, distributed upon lines and spaces, the different sounds of the octave. The French have claimed for Hubald and Odo the credit of this invention, a century before the time of Guido, but we do not think the claim established.

Guido gave to the notes the names ut, re, mi, fa, sol, la, taking them from the first syllables of the hymn of St. John the Baptist, in which they are certainly found:—

> *Ut* queant laxis *re*sonare fibris,
> *Mi*ra gestorum *fa*muli tuorum,
> *Sol*ve polluti *la*bii reatum.

The syllable *si* was afterwards added by a musician called Le Maire. From a manuscript in the Vatican dedicated to Charles, king of Sicily, above mentioned, it appears that Marchetto of Padua had improved the art; for the MS. proves that he was acquainted with dissonances and chro-

matic counterpoint. That the science was making vast strides from the old plain chant is clear from the bull of Pope John XXII., in the early part of the 14th century, wherein complaint is made of what he was pleased to call the abuse of descant, whereby the principles of the antiphonal and gradual had fallen into such contempt that the singers could no longer recognize the foundations upon which melodies were established, and that it exceeded the bounds which the ecclesiastical tones prescribed. Without particularizing the steps by which it continued to advance, the *Ars contrapuncti* of John de Muris, in 1330, laid down laws of harmony, some of which are observed in composition at the present hour. He says that, in the scale of the octave, there are six species of consonances, — three perfect and three imperfect. Of the first sort are the unison, the octave, and the fifth ; of the second sort, the two thirds, major and minor, and the sixth major. It is curious that he did not place the minor sixth among the number of consonances, since it is but an inversion of the major third, which he admits to be a consonance. Prosdoscimus, in 1412, speaks of the fourth, of which no mention is made by De Muris, and treats it as a dissonance ; though, he says, it is less so than the second and the seventh, and that it may be placed in a middle class, between consonances and dissonances. Advanced, however, as the science became at this period, it was not until the middle of the 15th century that the laws of harmony were fixed on that foundation that still bears the superstructure of the refined combinations of even modern music. The first treatise on music that was printed in Italy was towards the end of the 15th century, by John Tinctor ; but that published a few years afterwards, by Franchino Gafforio (printed in 1496 at Milan), excelled its precursor. The claim of the Italians to the invention of counterpoint has been disputed in favour of the Flemings, and also of the English. There is no doubt that the former contributed much to its advancement and perfection ; but the works that are extant, if we are to judge from them, satisfy us that the claim cannot be maintained. In the compositions of this period there is a want of melody which all the display of science and curious combinations they contain could not atone for ; but in the 16th century melody and counterpoint were united by the splendid genius of Palestrina, and some of his cotemporaries and disciples ; and the art was enriched by the treatises of Peter Aaron, Zarlino, Artusi of Bologna, the Venetian Zacconi, and many others, which spread throughout Europe, and left scarcely more to be desired on the first principles of music as a science. Palestrina, the principal cause of this revolution, began his career by a diligent study of the masters who had preceded him, making himself familiar with their difficulties and with their styles. Applying himself to the simplification and purification of harmony, and to the discovery of more flowing and natural melodies, he nevertheless paid a degree of homage to the preceding school, whose pedantry and obscurity he knew how to correct.

The Gothic style of composing masses and motetts on a canto fermo, which he practised in his early compositions, he entirely abandoned after 1570. His style, upon which he was continually refining, became at last the model of the age ; and after his time, for a considerable period, the best ecclesiastical compositions were honoured by being called *alla Palestrina*. Nanino, his fellow student and intimate friend, Cifra, his disciple, Luca Marenzio, and many other masters of the Roman school, gloried to tread in his steps ; whilst Zarlino at Venice, Costanzo Porta at Padua, Orazio Vecchi and Monteverde at Mantua, Bottrigari and Orturi at Bologna, endeavoured, and with considerable success, to build their counterpoint with the clearness, purity, and elegance of the great master of modern music. Among these, Monteverde is particularly to be noticed, for his passing beyond the master whom he followed. He was the first who used double discords, such as the ninth and fourth, the seventh and ninth, and the seventh and second ; as also the unprepared false fifth and seventh. This at the time created great disputes in the republic of music. Monteverde, in prefaces and letters, defended his practice ; but his best defence was to be found in the progress he made. The licences he took, far from being offensive to the ear, were soon adopted by others who had abused them. The passion for fugues, canons, and other difficult compositions of that nature, requiring the highest degree of science, continued in the 17th century, which produced many learned musicians. One of the most extraordinary of these was Francesco Soriano, who published 110 canons upon the hymn *Ave Maria Stella*, for four, five, six, seven, and eight voices ; but Pietro Valentini went far beyond him, and has left, it is to be apprehended, all future canonists in a hopeless condition. He wrote one to the words *Illos tuos misericordes oculos*, &c. resolved in more than two hundred different ways, for two, three, four, and five voices ; another for ninety-six voices ; a third for twenty voices only, but with four different subjects going at the same time. Other masters employed themselves in a similar manner. Of the Roman school, also, Luca Marenzio merits special mention here : though great in church music, he is best known and admired in the exquisite madrigals he composed, which still continue to be performed in this country. Marenzio died at Rome, in 1599. At the head of the Venetian school, the Italians themselves place Adrian Willaert, a Fleming. To him Zarlino attributes the invention of composition for more than one choir. He was maestro di capella of the church of St. Mark at Venice. The works he left are voluminous : his disciples were Cipriano Rore, Zarlino, and Costanzo Porta. The Neapolitan school was one of the most celebrated in Italy, and was established in the 15th century, under the reign of Ferdinand of Arragon, a great patron of all the arts. It was at Naples that Gafforio and Tinctor, whom we have before alluded to, Guarnerio, and many others, distinguished themselves. Church and madrigal music there flourished. In the latter branch, Carlo Gesualdo, Prince of Venosa, showed in an eminent degree the powers of that style of writing. The Lombard school registers the names of Costanzo Porta, its head ; Gastoldi, Guiseppe Biffi, and Paola Cima, of Milan ; Pietro Ponzio of Parma ; Orazio Vecchi of Modena ; and Claudio Monteverde, before alluded to. The most celebrated disciples of Porta were Balbi and Piccioli. Orazio Vecchi was among the first composers of dramatic music, and for a considerable time maestro di capella at Mantua. The Bolognese school comprises few writers in the 16th century, though in that following its professors equalled those of the first rank throughout Europe. Andrea Rota may be considered the head of it. Florence in music seems to take no distinguished place : we know of Alessandro Striggio and Francesco Cortuccia only who enjoyed much reputation.

Dramatic music appeared in Italy in the 15th century, a musical tragedy having been acted at Rome in 1480 ; but the real epoch of the music of the drama can scarcely be dated before 1597, and its first appearance was at Florence. Ottavio Rinuccini is recorded as the poet, and Peri as the musician, both Florentines, and the name of the piece *Daphne*. This priority is, however, disputed in favour of Vincenzo Galileo, the father of the celebrated astronomer, who, desirous of recovering the musical declamation of the Greeks, imagined a recitative applied to the episode of Ugolino in Dante. Up to the middle of the seventeenth century the drama was principally recitative, when, in 1649, Cavalli began to introduce more airs than had hitherto been used, which practice was further extended in the *Doria* of Cesti, composed in 1663 ; after which, for some time, it degenerated so much into *spectacle*, that, in the works represented about the end of the 17th century, neither poet, composer, nor singers are recorded, but the machinist and decorator only. Among the composers were, however, men of great knowledge and genius, such as Gasparini, Perti, Colonna, Lotti, and Alexander Scarlatti, who is said to have been the inventor of the obligato recitative. Great improvements were introduced in the beginning of the 18th century by the pupils of Scarlatti ; viz. Leo, Vinci, Sarro, Hasse, Porpora, Feo, Abos, and particularly Pergolese. About the middle of the century appeared Jomelli, Piccini, Sacchini, Guglielmi, Traetta, Anfossi, and others, whose names are not less celebrated than their predecessors, and the century closes with Paisiello and Cimarosa. It remained, however, for a Bohemian, Gluck, to accomplish the revolution which has brought the opera to its present state in Europe. The great improvement in instrumental music towards the end of the last century induced operatic accompaniments with all the richness of the symphony, which, under Haydn, Mozart, Cherubini, Spohr, Weber, and many others, seems to have reached almost the height of power and effect that music can give.

Europe is as much indebted to Italy for the introduction of instrumental as for that of vocal music : the Italians have been the instructors in both. Violin music was cultivated by Corelli and Tartini, and their pupils, before other nations had thought of it ; and the same may be said of the harpsichord, from Frescobaldi to Clementi. So, in concerted pieces, Boccherini introduced the quintett ; and indeed, short of the symphony, which we owe to the Germans, their early superiority cannot be disputed. In our time a sensible decay is visible in Italian music ; the art seems to have left its ancient seat to abide in Germany, where it has been cultivated with an ardour and success perfectly astonishing.

German Music. — Like all other nations, the Germans owe their music to the Italians. They received the Gregorian chant from Italy ; and, though they may not have equalled their masters in vocal melody, they have greatly surpassed them in instrumental music. It is certain that, at the beginning of the 17th century, the music of Germany was greatly inferior to that of Italy ; and it was not till the end of this century that the Germans began to evince high and successful talent for the art. We are not acquainted with any of the earlier music of the German church, — similar in character, we mean, to that produced by the school of Palestrina in Italy ; but in later times the

writings for that church, by Graun, Haydn, and Mozart, have never been surpassed nor equalled; and though these very much partake of the symphony and drama, there is a pathos and sublimity about them calculated in the highest degree to inspire devotion. In the madrigal style we believe they exhibit no specimens, which is the more remarkable, from the circumstance of the German school having been considered by some to have been of as early an origin as the Flemish. Their oratorios possess the greatest beauties: we need only name the *Ascension* and the *Israelites*, by Bach; the *Death of Jesus*, by Graun; and the *Messiah*, by Handel. Though not so old as that of Italy, the German theatre is nevertheless of early origin; but until Keyser appeared to compose for the theatre at Hamburg, about the end of the 17th century, it was without celebrity. During the whole of the last century, the German composers bred in the Neapolitan school carried their style into Germany, where it became predominant, and the model of the country. John Adolphus Hasse had the principal share in the transference of this style, which, improved by Graun, Neumann, Gluck, and carried still further by Haydn and Mozart, has travelled back to Italy, to shine second-hand in Rossini and others, but without the lustre of the Germans. Gluck, of whom we have spoken above, though by birth a German, belongs properly to France; for, strange to say, he was not properly appreciated by his own countrymen, though in later years they found out their error, and acknowledge it still by the rapture with which his works are now received. Germany derives its greatest reputation from the success with which it has cultivated instrumental music. In harpsichord and piano-forte music, it may be safely said they have surpassed all other nations; for it would be difficult to place names in that respect of equal reputation by those of J. S. Bach and his children, of Haydn, Kozebech, Mozart, Dussek, Cramer, and a host of others. The music of wind instruments seems to belong now almost exclusively to Germany: their organists are excellent, and their orchestras well regulated. In musical literature they are superior to every other nation: witness the works of Fux, Mattheson, Marpurg, Kirberger, E. Bach, Albrechtsberger, Forkel, Koch, and a host of others, most of them of the 18th century. In the present day, it is by no means surprising that the success of the Germans should be so extraordinary, seeing that there is no school *for the education of youth in the country* at which music is not taught and cultivated, even down to those where children receive gratuitous instruction.

Flemish Music.—The Flemish have been frequently confounded with French musicians; so that it is rather difficult to separate, at times, the one from the other. Louis Guicciardini (*Descrizione di tutti i paesi bassi*, published 1556) gives a list of all the musicians born in the Low Countries, who were then dispersed in different parts of Europe, which robs the French catalogue of some of its most distinguished names. From the 15th century Flanders, from its commerce, and wealth, and superfluous riches, was enabled to patronise the fine arts; and most especially was that the case in the times of Charles V. and Francis I. Upon these monarchs, who lived less in their own capitals than elsewhere, the arts seem every where to have been attendant; and when we recollect their frequent sojourn at Brussels, Antwerp, and other cities of Flanders, we are not surprised at the number of excellent musicians that Flanders produced. The John Tinctor of whom we have heretofore spoken flourished about 1474: he was a native of Flanders, and maestro di capella to Ferdinand of Arragon, King of Sicily and Naples. He is the earliest theoretician whose name has reached us. Soon after, or contemporary with him, was John Okenheim, the first composer of music in parts. From the fragments which have been preserved by Glareanus, he appears to have been a learned writer, whose works seem more calculated to please the eye than the ear; and from the authors of the following century who notice him, we learn that he was the writer of a motett in 36 parts. Josquin, or, as the Italians call him, Josquino del Prato, was Okenheim's most celebrated scholar. The laws and difficulties of canon, fugue, augmentation, diminution, inversion, and other practices of church music, were by him observed and overcome in the most felicitous manner; and he has by some been dignified with the title of father of modern harmony, inasmuch as his era is nearly a century before that of Palestrina, Orlando di Lasso, &c. It is proper to state that Guicciardini claims Josquin as an Italian; and, at least, there can be no doubt he was educated in Italy, inasmuch as he was a singer in the chapel of Sextus IV. His compositions were extremely numerous, and as often executed in the beginning of the 16th century as those of Handel were in England fifty or sixty years ago. His death took place at Brussels; and his monument is still to be seen in the church of St. Gudula. Hobrect, or Obrect, was a good composer of this period, and adds to his talent the honour of having been selected by Erasmus to instruct him in the principles of his art. We must pass shortly over the names of Pierre de la Rue, or Petrus Platensis, as he was sometimes called, Jean Mouton, Verdelot, Nicolas Gambert, maestro di capella of Charles V., Jacques de Wert, Pevernage, Lupi, Waelrent or Wraelrent, Verdonk, Arkadelt, and others, many of whom are still known to the musical antiquary by their madrigal compositions, though they were called only songs for parts in Flanders. Between 1544 and 1555 there were more than twenty collections of these *chansons* or madrigals published at Antwerp and Louvain, by Tylman, Susaro, and Pierre Phalaise, who were themselves good composers; as were, in the same century, the publishers Rhau at Wittenberg, Gardano and Scotto at Venice, Ballard in France, and Tallis and Bird in England. After Clemens (non papa), an elegant and exquisite, though not voluminous writer, and Cypriano Rore, a pupil of Adrian Willaert, must be recorded the name of Orlando di Lasso, one of the most diligent and celebrated writers of the 16th century. He was born at Mons in 1520, and died at Munich in 1593. Living to a great age, the number of his works exceed those even of Palestrina. Fifty collections of his different works are still extant, consisting of masses, motetts, passions, psalms, and songs or madrigals, printed in Italy, Germany, France, and the Low Countries. Such was his reputation, that the following verse was written for his epitaph:—

Hic ille Orlandus Lassum, qui recreat orbem.

M. Ginguene, to whom we are much indebted for the account of the restoration of music, speaking of Cypriano Rore and Orlando di Lasso, says, "These two Flemings, having passed the greater portion of their lives in the courts of princes, had acquired a lighter style, and a species of melody more appropriate to secular music, than that of Palestrina, who, residing at Rome, and writing principally for the church, exhibits in all his productions a gravity belonging to the species." And again, "They were two masters of harmony; and, the church excepted, they prepared the colours and set the palettes of musicians with many new tints of harmony and modulation, which were exceedingly serviceable to those who came after them." These were the two first masters who ventured upon chromatic passages, and upon accidental flats and sharps. From the epoch of these men Flanders ceased to have a school of music especially belonging to itself.

French Music.—We have stated, in another place, that Hubald de St. Amand and Eudes de Cluni have been named by the French writers as having preceded Guido in the knowledge of the scale; but, as we are not in a condition to decide between the claimants, we shall content ourselves with the declaration of our conviction, from all that we have read, that France, as respects the art and science of music, was much advanced at a very early period, and that the country certainly boasted of many church musicians between the 8th and 11th centuries; for, besides the two we have named, we have Remi, a monk of St. Germain d'Auxerre, Gerbert le Scholastique, and others whose knowledge is well authenticated. In the 14th century Philippe de Vitry, archbishop of Meaux, applied himself to music and poetry with considerable success. A manuscript preserved in the Vatican proves him to have been well informed upon counterpoint, as far as it was then known and practised: he not only applied himself to church music, but wrote motetts; but these are lost, and perhaps would, if we had them, be now difficult to decipher. Belonging to this century, also, we have, by the assiduity of the Abbé le Bœuf, the account of a manuscript by Guillaume de Machau. This MS. consists of two volumes of French and Latin poems, and a great number of *lays*, *virelays*, *ballades*, and *rondeaux*, all set to music; some for a single voice, others in three and four parts,—triplum, tenor, contra-tenor, and a part without title. In the second volume is an entire mass, including the *Credo*, in four parts, which it is believed was sung at the coronation of Charles V. in 1364.

During the 15th and 16th centuries, the art made but little progress in France. Under Francis the First not near so many musicians were to be found in France as in Italy, Germany, England, and the Low Countries. The works of Claude de Jeune, who probably ought to be placed with the Flemish school, and of Orlando di Lasso, seem to have been admired and performed at this period in the country in which Josquin was also a favourite. The dearth of writers on the science at this period is no less remarkable. There is, however, one singular work of this period, by Clement Jaunequin, entitled *La Bataille ou Defaite des Suisses a la Journée de Marignan*, in which imitations of the sounds of battle occur. He published a collection in 1544, called *Inventions Musicales a quatre et cinq Parties*. The masters about this period were Didier Lupi, Guillaume Belleu, Philibert Jambe-de-fer, Sauterne, and Noë Faignent. It is extraordinary that some of the bloodiest tyrants have been great patrons of music and its professors: to Nero and our Henry VIII. may be added, for France, Charles IX., about whom were constantly good musicians. Of them, Claude Gondimel did not escape, in the massacre of the Protestants at Lyons in 1572. At the end of the 16th century were some minor

artists, such as Jean de Castre, Louis Bisson, Nicholas Duchemin, Francois Roussel, Jean Peroin, and others, by whom are collections of madrigals. Francois Eustache de Caurroy, born in 1549, called, by his cotemporaries, "le prince des professeurs de musique," was maestro di capella to Charles IX., Henry III., and Henry IV., and enjoyed considerable reputation; his works, however, are but little above mediocrity. Jacques Mauduit was a similar instance of mediocrity rising into celebrity. He composed the requiem for the funeral of the celebrated Ronsard, which was afterwards performed at that of Henry IV., whose reign was too short to allow the arts of peace to make much progress in France. His son, who came to the throne at the early age of six years, was a great friend to music, and appears to have kept up what might be called a considerable band for that period. During the reign of Louis XIII., Jean Baptiste Boesset wrote several part songs, as they were called. About the middle of the 17th century Michael Lambert, who died in 1696, appears to have attracted many scholars by his skill in composition. Dramatic music was introduced into France about 1645. In 1660, at the celebration of the marriage of Louis XIV., the opera of *Ercole Amanti* was produced, and the foundation of the French opera was thus laid. At this period Lulli, of Florentine birth, had been patronised by the Chevalier de Guise, through whose offices he was put under the best masters of the time. Till the year 1686, in which his last opera was brought out, he seems to have been the idol of the court, and to have been considered in France the *ne plus ultra* of composers. Compared, however, with the Italian opera of the same epoch, his compositions are not far behind, though it was a misfortune for the country that, for so long a period, every thing which was not an imitation of the style of Lulli was considered an inferior production. Instrumental music made but little progress in the 17th century. The most distinguished organists were, the three Bournonvilles, and the three Couperins; Charbonieres, who died in 1670; Dumont, a good composer of church music, who first introduced violin accompaniments into France; the Abbé de la Barre; and, lastly, Lalande, the most celebrated French composer of ecclesiastical music, at the end of the 17th and beginning of the 18th century. Rameau, born at Dijon in 1683, was destined to rouse the French nation, which seemed to have slept since their loss of Lulli. In the space of twenty-seven years after 1733 he produced 22 operas, and became so great a favourite with the people that it was dangerous to criticise his works. The time has, however, passed in which his operas would be listened to; and but for his theoretical works, the only solid base of his glory, he would long since have been forgotten. Rameau died in 1767. His school lasted till about 1775, though since 1750 the comic opera has been on the Italian model. Under this, with Dauvergne, le Borde, Floquet, J. J. Rousseau, Duni, and Philidor, French melody has regenerated; and Monsigny, Gossec, and Gretry completed its improvements. The reform thus effected prepared the French for the reception of the *Iphigenie* of Gluck, in 1774, at which time he had Piccini and Lucchini for rivals. These musicians have been succeeded by a school which comprises the names of Berton, Mehul, Boildieu, Kreutzer, and others; and among the Italians who joined their ranks are found those of Cherubini, Spontini, and Winter. In instrumental composition the French have not been so original, though latterly they have considerably advanced. France is considered deficient in musical literature, and does not attend to its cultivation with that ardour that is so manifest in Italy and Germany. Their conservatory, however, is an establishment likely to do honour to the nation; and the work of Choron, — entitled *Principes de Composition des Ecoles d'Italie, adoptés par le Gouvernement Français, pour servir à l'Instruction des Eleves des Maîtrises de Cathedrales. Ouvrage classique, formé de la Reunion des Modeles les plus parfaites en tout genre*, in 3 vols. fol., — is alone sufficient to redeem the French from the accusation of wanting musical literature.

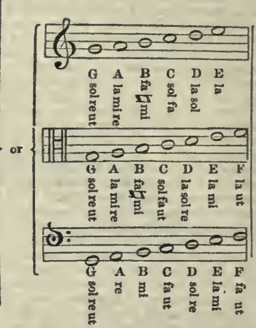
English music.—We are not acquainted with writers in this country of earlier date than those of Italy; but, for the honour of this country, however much we may have been behind Italy in the restoration of other arts, in that of music we were formerly quite on a par with the Continent; and it is singular that in later years we should have lost our character, and we fear deservedly, among other nations. It is certain that England can boast masses in four, five, and six parts, written by natives, as ancient as those of the Italians themselves; we have also secular music in two and three parts, and in good counterpoint, in the latter end of the 15th and beginning of the 16th century, about which period to the English musician the names of William of Newark, Sheryngham, Turges, Tudor, Banester, Browne, and others, are familiar. The first named was one of the musicians of Henry VI.; and the compositions of Tudor are known from Prince Henry's (Hen. VIII.) music-book. Henry VIII. is known as a composer, from a beautiful anthem in Boyce's collection of cathedral music; and his patronage of Christopher Tye, the composer of *Laudate Nomen Domini*, a motett frequently sung at madrigal meetings in the present day, shows that good music was then first esteemed as it ought to be. Marbeck, in 1550, published the whole of the reformed cathedral service to musical notes, and for his exertions as a reformer he had nearly been brought to the stake. During the reign of Elizabeth the talents displayed by our countrymen appear to have been surpassed in no other country, and music here was then indeed in its palmy state. Tallis, Bird, Morley, Dowland, and Bull, were the principal composers of the reign: Elizabeth herself could have been no mean performer, if she was able to play the pieces in her virginal book. Though it does not appear that James I. took much delight in music, it nevertheless continued to prosper during his sway; indeed, the compositions of Gibbons were, as pieces of church music, perhaps never surpassed in any age or nation: neither are his secular pieces of inferior character. This reign as well as the preceding was fruitful in madrigal writers as well as composers for the church; among the former of whom were Michael and Thomas Este, Bateson, Ward, Litchfield, Pilkington, Wilbye, Bennett, Farmer, Ford, and others; and among the last Tomkins, Elway Bevin, and Dr. Nathaniel Gyles. In the time of Charles I. instrumental music was coming into vogue; the monarch was a pupil of Cooper (who was wont to be called Coperario), and used to practise the viol-di-gamba. He had a band of performers, eighteen of whom are known, including Nicholas Laniére, who was the master of it. The most celebrated men of this reign were Dr. Wilson, William and Henry Lawes, and Dr. Child, who died in 1697, aged 90, after having been organist of St. George's chapel, Windsor, during the extraordinary period of sixty-five years. So intent was Charles upon advancing music, that he granted a charter to the most eminent musicians of that day, with many great privileges. The art had been sinking for some years, but its fall was accelerated by the suppression of the cathedral service in 1643; and the only persons of whom we hear during the time of Cromwell were William and Henry Lawes. Though these men were favourites of Milton, and the subject of some of his verses, they were sadly inferior to Tallis, Bird, and Gibbons. During the interregnum the musical flame was chiefly fed at Oxford; but even there, from the year 1646, in which the king was forced to leave the city, after the battle of Naseby, until 1656, it was nearly extinguished. At the Restoration it appeared again to flourish: Child, Christopher Gibbons, Rogers, and Wilson, were made doctors of Oxford; the choirs again obtained good masters; and the organs, which had been destroyed by the fiend-like rage of the Puritans, were again set up, though with difficulty, from the scanty supply of organ-builders. Among the musicians who were attached to the court of Charles II. was Henry Purcell, of whom Dr. Burney says, that he, "during a short life, and in an age almost barbarous for every species of music but that of the church, manifested more original genius than any musician under similar circumstances, that any inquiries into the history of the art have yet discovered in any part of Europe." This truly great man died Nov. 21. 1695, in the thirty-seventh year of his age; his principal contemporaries were Dr. Blow, his master, Pelham Humphreys, and John Weldon. After Purcell's death some skilful men appeared as amateurs in the service of the church; namely, Doctors Holder, Aldrich, and Creyghton: among the professors were Jeremiah Clarke, Goldwin, and Doctors Croft, Green, Boyce, and Nares. Croft of all these was undoubtedly the greatest; he, like Purcell, was a disciple of Blow: always elegant and simple in his strains, frequently grand and masterly, he has not left a composition that does not exhibit great learning. His death occurred in 1727, in the fiftieth year of his age. Dr. Boyce occupied the void which Croft's death had created; he was a good musician, always pleasing, but rarely grand in his compositions. His contemporary, Jonathan Battishill, wrote some fine compositions for the church, and prepared the way in glee writing for a race of English musicians who are an honour to their country. The reader will recognize the truth of this assertion when he glances at the names of Alcock, Arne, Attwood, W. Beale, Callcott, Dr. Cooke, Robert Cooke, Crotch, Danby, James Elliott, Harington, Horsley, Thomas Linley, the Earl of Mornington, Shield, Stafford Smith, Spofforth, the Wesleys, &c. In dramatic and symphony writing, we regret to say, England is still in her infancy.

Chinese Music.—The Chinese have had a system of music from a most remote period, and in its scale it seems to have more resemblance to the Grecian than any other to which it could be compared. From the time of Yao and Chun, which their chronology would carry back two-and-twenty centuries before Christ, they have had what they call eight species of sounds: 1st, The sound of dried skins, such as drums; 2d, The sound emanating from stone, called *king;* 3d, That of metal, as bells; 4th, That of baked earth, called *hiven;* 5th, That from silk, called *kin* and *che;* 6th, That from wood,

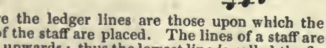
called *ya* and *tihou;* 7th, That from bamboo, such as flutes, called *koan;* 8th, That from the gourd, called *cheng*. Their scale consists of 14 notes, of which the seven middle notes correspond to our gamut from *f* upwards. They seem unacquainted with harmony, and we ought, perhaps, to apologise for saying so much of it.

Hungarian Music.—About the 9th century the Hungarians left Asia to settle in Europe, when they conquered the country that bears their name. Like all the Asiatics, they were attached to music, and at first, doubtless, used only Asiatic instruments: these were nearly all wind instruments, and consisted of the trumpet, the flute, the cymbal, and several others. Till the time of Mathias Corvin it was in a state of mediocrity; he incited the Hungarians to vie with other nations in sciences and arts, of which he himself was particularly fond. Under Ladislas and Louis II. music was cultivated with great care; their national songs were, however, the only vocal music they possessed till the time of Stephen, king of Hungary, when the ecclesiastical chant appears to have been introduced. In a diploma of Bela III., A.D. 1192, it appears that prince sent an envoy to Paris to be instructed in melody; perhaps induced to do so by his second wife Margaret, who was daughter of Louis VII. of France.

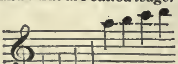
All musical ideas are expressed by means of *notes* on a *staff;* that is, five equidistant horizontal lines, on or between which the notes are placed. The *gamut* is a table whereon these notes are placed; and their relative situations as to acuteness or gravity of tone is ascertained by *clefs*. The names of the notes, which are six in number, are *ut, re, mi, fa, sol, la*, the lowest of these being the gamma of the scale. Modern musicians have used as equivalents the first seven letters of the alphabet. The arrangement in question is exhibited in the diagram below, a note having been added by the moderns to complete the octave.



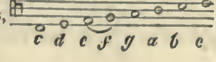
From this diagram it will be seen that the bass clef, also called the F fa ut clef, on whatever lines placed, makes the notes on the line between the dots F or fa ut, whence reckoning is made upwards or downwards; that the tenor or C sol fa ut clef makes all the notes on the line between the cross or horizontal bars or sol fa ut; and that the treble or G sol re ut clef makes all the notes on the line round which the character turns G sol re ut; and it is to be observed that these several clefs may be put on any lines of the staff notes, which then take the name F, C, or G, as the case may be. Thus,



One of the most important ends gained by the use of these clefs is the avoidance of notes running off the staff, which they otherwise would do, and what are called *ledger* lines would be wanted; thus,

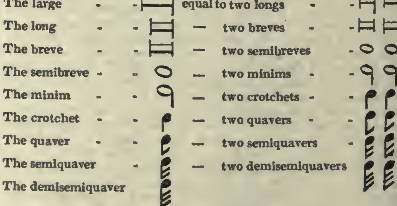


where the ledger lines are those upon which the notes out of the staff are placed. The lines of a staff are reckoned upwards; thus the lowest line is called the first, the lowest but one the second, and so on. When the F clef is placed on the third line, it is called the *barytone* clef; when on the fourth, the *bass* clef. When the C clef is placed on the first line, it takes the name of the *soprano* clef; when on the second, the *mezzo soprano;* when on the third, the *alto* or *countertenor* clef; and when on the fourth, the *tenor* clef. The G clef is rarely or never now placed on any but the second line, and is then called the *treble* clef. It may be sometimes seen in old books placed on the first line; when so found, it is called the *high treble* clef. In keyed instruments the C nearest the middle of the instrument is the note of the tenor or C clef; the G above it to the right is the treble or G clef; and the F below to the left is the F or bass clef note. When to the seven primary notes (see diagram) another is added above, the arrangement is called an octave; thus,

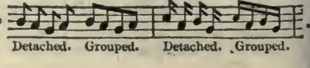


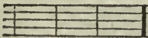
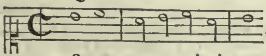
After which, if more be added either upwards or downwards, it will be but a return to similar notes either more acute or more grave in pitch; that is, an octave above or below them respectively. This, which is called the *scale*, has between its notes seven intervals, of which those between *c* and *d*, *d* and *e*, *f* and *g*, *g* and *a*, and *a* and *b* are equal, and are called *tones* or *whole tones;* whilst those between *e* and *f* and *b* and *c* are *semitones*. To inquire how nature has implanted on the ear dissatisfaction from any other position of these semitones in the scale of the octave, is not the object of this treatise. That it is so is certain; and the most uneducated whistler could not avoid it without exertion. The scale is also divided into two *tetrachords*, from *c* to *f* and from *g* to *c:* each of these consists of two tones and a semitone. There is not a strict mathematical equality between these fourths; but for our purpose here—and the difference indeed is imperceptible except to the finest ear—that equality may be assumed. As all *melody* or *air*, which is an artful succession of tones, depends on a right perception of the places of the semitones, the above preliminaries must be well understood by the student.

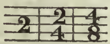
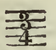
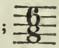
By the particular form of a note its duration, or length of time it is to be held on, is known. There are nine of these forms, which are exhibited in the subjoined table, in which the two first are now rarely used, though in old ecclesiastical music they are constantly met with.



The notes with hooks appended to their tails are frequently grouped together; this does not alter their value, but it assists the eye in reading off the proportions of the notes. Thus,

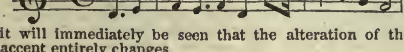


If a dot be added to the right hand of any note, thus ♩·, it increases its duration exactly one half. The duration of a note is measured by the musician from habit, and is regulated by *beating time;* that is, by the elevation and depression of the hand or foot quicker or slower according to the nature of the music performed. A musical piece is divided into *measures*, which are equal portions of time; and the vertical lines which so divide it are called *bars*, single lines taking merely that name; and the two thick ones at the end of a strain *double bars*. Thus, . Every measure must contain a certain number of notes according to the time marked at the beginning of the movement; and that time is of two sorts, — *common time* and *triple time*, — in which two all others originate. The first is of two sorts: 1st, that in which each bar is equal to a semibreve in duration; 2d, that in which a minim in duration is equal to a bar. Those common times in which a semibreve is the measure are marked by a C after the clef at the beginning of the staff; thus, . When the C has a bar through it, thus , it denotes a quicker measure, thus 

, and is called *alla breve*, but it is now usually written by dividing the breve into halves. There is another sort of movement now very rarely used; it is very quick, and it is thus marked, . The other characters of common time are ; signifying that there are two crotchets in the bar, of which (the denominator) four make a semibreve. Triple time is so called from the bars being divisible into three parts: it is beat with the hand down at the beginning of the bar, raised a little in the middle, and quite up at the close of it. In this time the denominator of the figures placed at the beginning of the staff is a measure of a semibreve: thus, if 2 be the denominator, the measure is a minim, because two minims make a semibreve; if 4, the measure is a crotchet; and so on. Hence  signifies three minims in a bar;  three crotchets;  three quavers. So again with multiples of 3 for the numerator:  signifies three crotchets;  six quavers;  nine quavers;  nine semiquavers;  twelve quavers. Other sorts of triple time are used; but if the reader keep in mind that the denominator always expresses the division of the semibreve, and the numerator the number of those divisions in each bar, no mistake can ever arise.

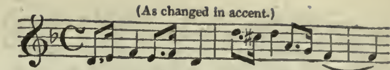
There is a certain stress laid on some part or parts of every bar, which is called *accent;* hence each bar or measure is divided into accented and unaccented parts: the accented are the principal, and those on which the pathos and spirit mainly depend. The beginning and the middle, or the beginning of the first half of the bar and the beginning of the latter half, in common time, and the beginning or first of three notes in triple time, are universally accented parts of the measure; so the first and third crotchet of the bar are on the accented part of the measure in common time. In triple time, where the notes, as we have explained, go by threes, the note in the middle is unaccented, and the first and last accented; the accent, however, on the first is so preponderant, that the last is almost accounted as though it had none. It is on account of accent that it is frequently necessary to begin a movement with only part of a measure. Thus in the Welsh tune *Griffith ap Cwnan*, —

(As written.)



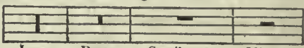
it will immediately be seen that the alteration of the accent entirely changes

(As changed in accent.)



the character of the air. When the last note of a bar (as in the last bar of the lower example) is connected with the first of the following bar, so as to make only one note of both, it is called *syncopation*. This is also sometimes used in the middle of a measure; also when a note of one part ends in the middle of a note of the other: the latter, however, is called *binding* or *legature*.

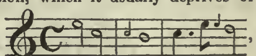
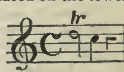
A *rest* is a pause or interval inserted when silence is required in the part to which it is written, which silence is to be preserved during the time denoted by the species of rest used. The following are the rests that are used: —

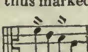
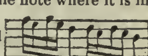


Long. Breve. Semibreve. Minim.

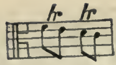
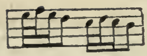
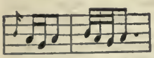
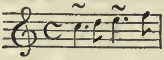
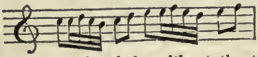
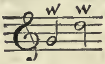
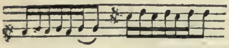
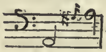
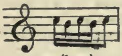
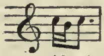
Crotchet. Quaver. Semiquaver. Demisemiquaver.

It has been already noticed that in the ascent of a note to an octave, there are between the third and the fourth note, and between the seventh and the octave, semitones instead of whole tones; and this is what is called the *diatonic scale*. It must therefore be evident, from this inequality, that supposing it were necessary, for the sake of the voice's compass or any other cause, to commence a piece of music higher or lower than it was originally written, the mere shifting the notes higher or lower on the lines and spaces would not represent the same relative proportions in all the intervals; because the places of the semitones would remain the same on the staff, whilst their position with respect to the notes would be altered. An expedient is therefore wanted by which the places of the notes may be raised or depressed the value of a semitone. The former, that is raising them, is effected by placing sharps before them, thus ♯; and the latter by means of flats, thus ♭. If we want to restore any note that has been thus treated to its original place, it is effected by means of a natural, thus ♮. Two other characters are also used, — the double sharp, thus ×, which raises a note two semitones; and the double flat ♭♭, which equally depresses it. Upon keyed instruments, such as the pianoforte and organ, these sharps and flats are represented by the short black keys, and there is no distinction between D♯ and E♭, and such want of distinction is an imperfection in the instrument; for, as we have before hinted, there is not a strict mathematical equality between the semitones of the diatonic scale. The number of these flats and sharps at the beginning of a staff affect all the notes of the line or space on which they are placed, and are termed the *signature*. If, in addition to these, in the course of a movement any other occur, they are termed *accidental*, and only affect the notes which they immediately precede, and those also in the same bar; but if in the same bar any note after having been accidentally raised, on being repeated is preceded by a natural, such natural restores it to its original place.

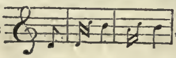
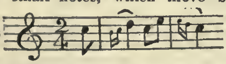
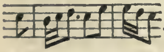
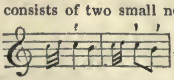
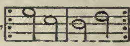
The ornaments of musical melody are called *graces;* the principal of which are the *appoggiatura*, the *shake*, the *turn*, and the *beat;* with the *mordente*, *beat*, *slide*, and *spring* peculiar to the Germans: those of musical harmony are the *arpeggio*, the *tremando*, &c. The appoggiatura, which always occurs on the accented part of the measure, is a small note placed before a large one of longer duration, which it usually deprives of half its value; thus, , wherein the small notes are appoggiaturas. Occasionally, the appoggiatura is only one quarter of the note it precedes. The shake is a quick alternate repetition of a note with the note above it, the mark *tr* being placed on the lower, and the upper one not expressed; thus 

, performed . When there are a series of ascending or descending shakes, the Italians call it *una catena di trilli*. What the Germans call the *passing shake* is thus marked over the note where it is intended, thus , performed 

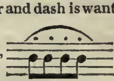
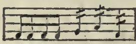
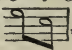
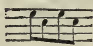
The mordente of the Italian school is used similarly;

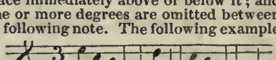
thus , performed . The turn employs the note above and that below in the following way, ; performed . The inverted turn, thus marked ~, turns from the note below that marked instead of above it. Turns on dotted notes are very frequently used; they are written as follows  performed . The beat is the reverse of the shake without the turn, and is generally made at the distance of the semitone below; hence all the natural notes, except C and F, require the note below them to be accidentally sharpened for the beat; thus , performed . The half-beat is most frequently used in the bass, and is very similar to the acciacatura of the Italians. The inferior note is struck only once, and at the same time with the principal note; but is immediately quitted, as . The Italians use the degree above. The German mordente is a beat commencing with the note itself, and is either long or short; thus,  . This differs

(long) (short)

from the mordente we have already described by being made with the next degree below. The Italians use the degree above. The German beat consists of two small notes, forming a skip, descending one degree upon the principal note; written thus , performed . Naumberger calls this grace a double appoggiatura. The German slide consists of two small notes, which move by degrees; written thus , performed . The German spring, like the Italian mordente, consists of two small notes, sounded distinctly; thus , performed . It is the practice of the composer to mark, where necessary, the occasional alteration of these graces by sharps, flats, or naturals. The graces that belong to harmony are, the *tremolo*, or reiteration of one of a chord; the *tremando*, or general trembling of the whole chord; and the *arpeggio*, which is an imitation of the harp, the notes of the chord being struck in quick and repeated succession. The following characters are also used in Music:—the *pause* 𝄐, which, placed over a note, signifies that a long continuance of the sound is to be made on that part of the measure, and is equally effective when placed over a rest; the *repeat* 𝄋, which is a sign placed to show where the performer must return to repeat the passage,—the Italians call it *il segno*; the *direct* w, always placed at the end of the staff on the line or space which the following note occupies. The dots which are found in the inner side of bars show that the measures or bars included by them are to be repeated; thus, , shows that these two bars are to be played twice over, the same object being sometimes effected by writing the word *bis* over them.

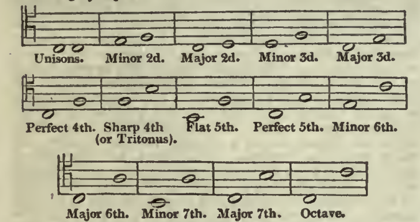
We have already mentioned the single and double bar; all that we have to add on them here is, that as every bar or measure contains a certain number of notes, so every *strain* consists of a certain number of measures, which are terminated by the double bar.

Expression, in music, is indicated by the following marks:—The *tye*, which is a convex line over ⌒ or a concave line under ‿ two notes on the same line or space, uniting them into one. It is also used to express syncopated notes where the bar divides them. The *slur* is a similar line, used over notes not on the same lines or spaces, showing that such notes are to be played smoothly; and in vocal music it also means that all the notes connected by it are to be sung to the same syllable. The *dash* is a small vertical stroke ǀ placed over notes that are to be distinctly marked. Sometimes, instead of this, the *point* is used, though it is mostly employed to distinguish those notes from which an intermediate effect between the slur and dash is wanted, yet uniting the one and the other; thus, . The other marks of expression are the *crescendo* <, by which the sound is to be increased from soft to loud; the *diminuendo* >, which is exactly the converse of the last,—the union of these two <> indicating that the first part is gradually increased from soft to loud in the middle, and then to soft again; and the *rinforzando*, for which smaller marks of the same sort are used > <, which increase or diminish the sound so marked. In order to save time in writing and copying music, the following abbreviations are used:—A single stroke placed over or under a semibreve, or through the stem of a minim or crotchet, divides it into quavers, a double stroke into semiquavers, and a triple stroke into demisemiquavers; thus, . The other kind of abbreviation is much used in modern music, and is effected by grouping the stems of minims like those of quavers; thus , performed .

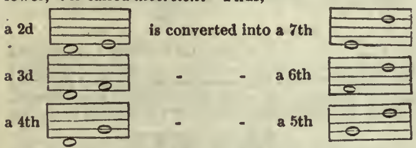
Melody, which will be perhaps better understood by the term *a tune*, is a particular succession of sounds in a single part, and is produced by the voice or an instrument. The artful manner of introducing the notes of different lengths, and succeeding one another at intervals pleasing to the ear, is one of the desiderata of the musician; the other being the successful accompaniment of these single sounds by others, according to the laws of harmony. As respects tune or air, melody has two motions,—either by degrees or by skips: by the former when it moves to the line or space immediately above or below it; and by skips when one or more degrees are omitted between the preceding and following note. The following example shows each motion .

The distance between any two notes is called an interval, and it is customary to measure it from the lower of the two notes which by their names indicate the number of degrees whereof the interval consists; remembering that in the diatonic scale whole tones are divisible into semitones. It may be as well to explain here the term *diatonic*. It is derived from two Greek words, *δια*, *through*, and *τονος*, *a tone;* because, through the majority of notes in this scale, it proceeds by whole tones, five out of the seven being of that description, and the other two being semitones. And again, that the notion of an interval between sounds may be properly acquired and felt, we would hint that it may be comprehended by stretching a string between two fixed points so that upon being struck its vibrations are free and will yield a sound. Now a string half the length similarly stretched will yield a sound exactly one octave higher; the intermediate lengths, therefore, between 1, which we will assume the first string to have been, and ½, the length of the second at a certain place, according to a certain ratio, will yield the different sounds of the octave: thus we may acquire a distinct notion of intervals of sound by absolute intervals of length. To return, then, to different intervals in the octave. If we count from the lower note to its octave, there will be found the following intervals:—First, the *unison*, which in harmony is

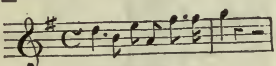
accounted an interval, though it be the same identical sound. Second, the *minor second*, sometimes called the *flat second*, is the interval formed by two sounds at the distance of a diatonic semitone from each other. Third, the *major second*, consisting of a whole tone. Fourth, the *minor third*, containing a whole tone and a diatonic semitone. Fifth, the *major third*, consisting of two whole tones. Sixth, the *perfect fourth*, containing two tones and a diatonic semitone. Seventh, the *sharp fourth*, containing three whole tones, and called thence by the ancients the *tritonus*. Eighth, the *flat fifth*, containing two tones and two semitones; which, however, are not equal to three whole tones, but rather to two minor thirds. Ninth, the *perfect fifth*, containing three tones and one semitone, equal to a major and a minor third. Tenth, the *minor sixth*, consisting of three tones and two semitones. Eleventh, the *major sixth*, which consists of four tones and one semitone. Twelfth, the *minor seventh*, containing four tones and two semitones, or ten semitones. Thirteenth, the *major* or *sharp seventh*, composed of five tones and one semitone, or eleven semitones. Fourteenth and last, the *octave*, consisting of eight degrees. The above fourteen intervals are given in the following synopsis:—



By inserting the semitones between these intervals, the number which we have above stated in each will be easily discovered. When the lower note of any interval is placed an octave higher, or the higher note an octave lower, it is called *inversion*. Thus,



By this operation major are converted into minor intervals, and the converse; for instance, the sharp fourth becomes a flat fifth, and the unison becomes an octave. We will here mention an ancient division of melodies, which at least ought to be understood by a student,—namely, into that of *authentic* and *plagal* melodies. The former are those whose principal notes are between the key note and its octave, of which the following is the example given by Calcott, in his Grammar, from Handel's *Jephtha*,—



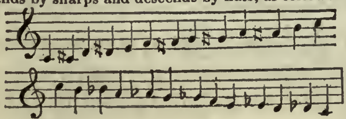
(Waft her, angels.)

The latter, on the contrary, have their principal notes contained between the fifth of the key and its octave, or twelfth; as,

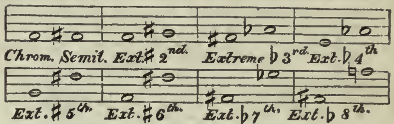
(Streams of pleasure.)

from Handel's *Theodora*.

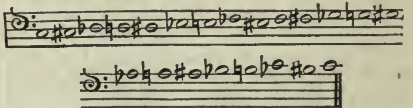
There are three scales occasionally used in music: the *diatonic*, which has already been explained; the *chromatic*; and the *enharmonic*. The chromatic,—which, according to some, takes its name from the Greek word χρῶμα, *colour*, because they suppose the Greeks distinguished it by different-coloured characters; according to others, because holding the mean place between the diatonic and enharmonic system, it was like colour between black and white; or, as others say, because, like colours in painting, it embellishes the diatonic by its semitones,—usually ascends by sharps and descends by flats, as follows:—



From this it appears that the chromatic scale consists of thirteen tones, with twelve intervals between them, whereof we have already, among the diatonic intervals, described seven; the other five form a distinct species of intervals called *chromatic*. First, the *chromatic semitone* is the interval between any note and the same depressed by a flat or raised by a sharp. Second, the *extreme sharp second*, which consists of a tone and a chromatic semitone, being composed of two degrees. Third, the *extreme flat third*, which contains two diatonic semitones, consisting of three degrees; or it is the minor third diminished by a chromatic semitone. Fourth, the *extreme flat fourth*, containing a tone and two diatonic semitones, and consisting of four degrees; or it is the perfect fourth diminished by the chromatic semitone. Fifth, the *extreme sharp fifth*, which is the perfect fifth increased by the chromatic semitone. Sixth, the *extreme sharp sixth*, or the major sixth increased by the chromatic semitone, consisting of five degrees; it is divisible into a major third and sharp fourth. Seventh, the *extreme flat seventh*, or the minor seventh diminished by a chromatic semitone; it is composed of four tones and two diatonic semitones, and is divisible into three minor thirds. Eighth, the *extreme flat eighth*, or octave diminished by the chromatic semitone. This is never used in melody. The above intervals are exhibited in the subjoined synopsis.



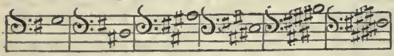
The enharmonic scale, so called from the augment εν, and signifying extremely harmonious, or well knit together, is a series formed by uniting the ascending and descending scale of the chromatic genus. It contains intervals smaller than the semitone: not, indeed, exactly half the semitone; but, from their near approximation to it, called the *diësis*, a Greek word signifying *a division*. We have before hinted that there is not a strict mathematical equality between the tones in an octave. Our limits do not permit to pursue that question further than to say, that that tone which is between the fourth and fifth of the scale is divided into nine small parts, called *commas;* whilst that between the fifth and sixth of the major scale contains only eight commas. The diatonic semitone contains five commas; and the chromatic semitone three or four, according to the magnitude of the tone. Now the enharmonic scale divides each tone into two chromatic semitones and a quarter tone; but we subjoin a diagram of it.



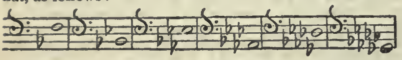
In this scale we have inserted the intervals E♭ and and E♮; also C♭ and B♮; but they do not properly belong to the scale, as their distance is less than a quarter tone. We have omitted above to state that there is another interval, which, by calculation, is found to be a comma and a half, and is called *hyperoche*, or an *excess*.

As in oratory there is a principal subject whereon the speaker constantly dwells, and to which, after diverging from it, he always returns; so in music there is one sound in which the piece begins and ends, which regulates the rest, and to which regard must be had in all the other sounds of the piece; and this sound is called the *key*, and the principal note the *key note*, or *tonic*. From the diatonic scale we have seen that the semitones lie between E and F, and B and C; the key note being C. Now if we wish to make G the key note, it is clear that without some contrivance the writing the notes from G to its octave will throw one of the semitones out of its place; namely, that between E and F, which, instead of being, as it ought to be, between the seventh and the octave, is between the sixth and the seventh. It is obvious, then, if we raise the natural F a semitone by means of a ♯, we shall restore the semitone to a situation similar to that which it held in the key of C. By comparing the subjoined scales, this will be more distinctly seen.

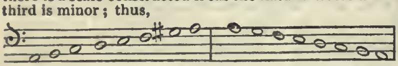
Now if D be taken as the key note, we shall find it will be necessary to sharpen the C as well as the F, in order to bring the semitones into the places they ought to occupy in the octave; and we shall have two sharps. In order to save the constant repetition of these sharps, it is usual to put them at the beginning of the staff, where they are called *signatures;* thus,



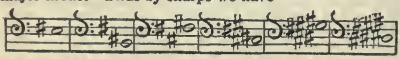
In the same way the keys bearing flats are marked, saving that the seventh of the original key bears the first flat, as follows:—



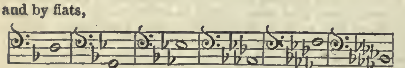
Besides these scales, which are all constructed with the major third, and are therefore called major keys, there is a scale constructed from the natural notes whose third is minor; thus,



In which it must be observed, first, that the places of the semitones are different; and, second, that the ascending scale always requires the seventh to be sharpened, though it is not sharpened in the descending scale. The sharp in question is, however, always omitted in the signature, and marked accidentally where the melody requires it. It must be here noted, that between the F♮ and G♯ a harsh chromatic interval, called an *extreme sharp second*, occurs; to avoid which the sixth is sharpened, by which the scale of the minor mode has two notes different from the signature; but in the descending scale no accidentals are required. The minor modes, whether proceeding by sharps or flats, have exactly the same signatures as the major mode. Thus by sharps we have



and by flats,

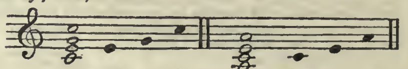


Major and minor scales which have the same signatures are denominated *relative*. Thus the relative minor keys of A is E ♮; in which case the tonic or key note of the minor mode is found to be the sixth note ascending of the major scale bearing the signature; and the tonics are always one degree below the last sharp of the signature, but in flat signatures always the third degree above the last flat.

The change of a melody from its original to a higher or lower pitch is called *transposition*, and this may be effected by altering the signature according to the pitch of the new tonic or key note. This alteration may be also accomplished in every minor melody. If a melody is performed in the relative or tonic minor being originally major, the change is not called transposition, but *variation*. *Modulation* is the motion of the melody on the key in which it has commenced, and the alteration by new flats and sharps of the original scale. Modulation comprehends the regular progression of several parts through the sounds that are in the harmony of any particular key, as well as the proceeding naturally and regularly from one key to another. Every scale is immediately connected with two others: oneon the fifth above, which adds a sharp to the signature; the other on the fifth below or fourth above, by which a new flat is added to the signature. These were called by Dr. Boyce *attendant keys*. Minor scales have in like manner their attendant keys.

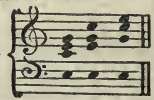
We here subjoin, from the late Dr. Callcott's excellent Musical Grammar, the names given to certain notes in the scale as peculiarly marking their character, though we do not intend to use them in the following part of this short essay. 1st, The *tonic*, or key note, is the chief sound upon which all regular melodies depend, and with which they all terminate. All its octaves above and below are called by the same name. 2d, The *dominant*, or fifth above the key note, is that sound which from its immediate connection with the tonic is said to *govern it;* that is, to require the tonic to be heard after it, at the final cadence in the bass. 3d, The *sub-dominant*, or fifth below the key note, is also a species of governing note, as it requires the tonic to be heard after it in the plagal cadence. It is the fourth in the regular ascending scale of seven notes, and is a tone below the dominant; but the term arises from its relation to the tonic, as the fifth below. These three principal sounds are the radical parts of every scale, of the minor as well as the major; and all melodies are derived from them. 4th, The leading note, or sharp seventh of the scale, is in Germany called the *subsemitone* of the mode; it is always the major third above the dominant, and therefore in the minor scales requires an accidental sharp or natural whenever it occurs. 5th, The *mediant*, or middle note between the tonic and the dominant ascending, varies according to the mode; being the greater third in the major scale, and the lesser third in the minor scale. 6th, The *submediant*, or middle note between the tonic and subdominant descending, varies also according to the mode; being the greater sixth in the major scale, and the lesser sixth in the minor scale. 7th, The *supertonic*, or second above the key note, has seldom been distinguished in England by this or any other appellation. In theory it is considered as a *variable* sound, being a comma higher in the major scale than when the mode changes to the relative minor.

Harmony consists in the combination of two or more sounds or melodies heard at the same moment, the intervals between such sounds having been already defined. A *concord* is an agreeable relation of two sounds as respects the ear, such sounds which are agreeable compounds singly being agreeable also in succession, subject to certain laws. Concord is therefore included under the term harmony, though more properly applied to the agreeable effect of two sounds in consonance; whereas harmony involves the agreement of a greater number of sounds than two. When two sounds either in consonance or succession are disagreeable to the ear, the relation between them is called a *discord*. The concord then may be called a harmonical interval, and the discord an inharmonical one; yet by the proper interposition of discords the harmonies of a passage receive a lustre and value from the contrast. They must, however, as we shall presently show, be properly *prepared* and *resolved*, as it is technically called. The union of any sound with its third (major or minor) and its perfect fifth is called a *common chord;* to which if the octave to the sound be added, we have a combination of four sounds in the harmony; thus,



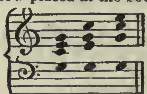
Major. Minor.

So long as in these chords the C or the A remain the lower note, the chord is called the common chord of C or A respectively; but the moment the position of the lower note is changed, the name of the chord also changes. Thus if E of the common chord of C be used as the lowest or bass note, thus



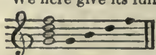
, the chord is called a *sixth;* because the key note is then the interval of a sixth upwards from the bass note, and that sixth has for its accompaniment a minor third from E to G.

If G be now placed at the bottom and used as the bass note, thus

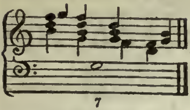


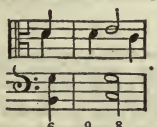
, the key note is an interval of a fourth above the bass, and the chord is called a *fourth*, and, as the example shows, is accompanied by a sixth. From this it is manifest that the sixth and fourth are no more than inversions of the common chord, having the same note C for their expressed or understood bass, which is called the *fundamental bass*, because it is that on which they are founded; and the same arrangement equally exists in the common chord with a minor third. The common chord is expressed shortly thus, $\begin{smallmatrix}3\\5\\8\end{smallmatrix}\begin{smallmatrix}5\\8\\3\end{smallmatrix}$, or $\begin{smallmatrix}8\\3\\5\end{smallmatrix}$; but they are frequently omitted. The second example, or chord of the sixth, is merely figured with a 6; and the third example, where G is the lowest note, is denoted by the figures $\begin{smallmatrix}6\\4\end{smallmatrix}$.

Of discords the most simple is the minor seventh, or, as some call it, the *dominant seventh;* because it occurs only on the fifth or dominant of the key, and requires that part in which it occurs always to descend one degree. We here give its full accompaniment of four real parts



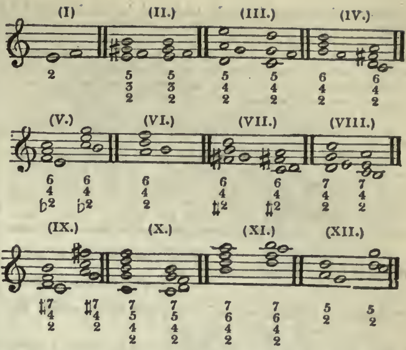
. As in the common chord either of these four sounds may be placed as the bass or lower note of the chord, yet as with C in the common chord the fundamental note of it will be G; B being a

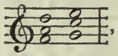
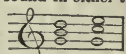
third, D a perfect fifth, and F a minor seventh; thus, ; in each of which cases it would carry the figure 7 below it. Sometimes, however, it is figured below, $\substack{3\\5\\7}\ \substack{7\\5\\3\\8}\ \substack{5\\3\\7}\ \substack{3\\7\\5}$; such positions containing the tenth, twelfth, and fourteenth of the root, when the octave is removed. When B becomes the bass note, as  the chord by inversion consists of a minor third, an imperfect flat or false fifth, and a minor sixth, and is, as in the example, figured $\substack{6\\5}$. If D be next taken as the bass note, thus , the chord consists of a minor third, perfect fourth, and major sixth, and is, as in the example, figured thereunder $\substack{4\\3}$. If F be used for the lower or bass note, thus , the chord is composed of a major second, sharp fourth, and major sixth, and is figured $\substack{4\\2}$.

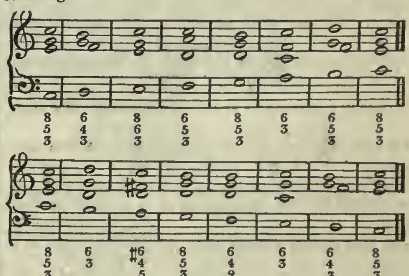
From these observations it appears, therefore, that the three last chords are properly called derivatives of the minor seventh when accompanied with a major third and perfect fifth. By some authors these three chords are called the syncopated fifth, the syncopated third, and the syncopated second respectively. Besides the chords within the compass of the octave, there is the *ninth*, which is usually accompanied with a third and fifth; thus, . When used in a composition of four parts, and marked by a single 9, it has the accompaniment of a third and fifth; thus, . Frequently, however, it is accompanied by a fourth and fifth, and then is marked with a double row of figures; thus, 

When the composition is in only three parts, the fifth is not used. With the third and fifth as an accompaniment the ninth becomes then an appoggiatura, continued in the place of the eighth. The ninth has two inversions: one of them figured with a seventh on the third of the fundamental note; the other figured with a fifth and a sixth on the fifth of the fundamental note.

When the figures 4 and 6 are dashed, thus $\not 4\ \not 6$, it indicates that they represent a sharp fourth and a sharp sixth. It will perhaps be useful, in this place, to place before the reader a synopsis of all the discords: from the seventh upwards they are all inversions of the seventh sharp or flat, with major or minor thirds.

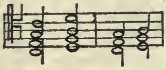
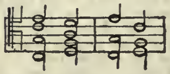


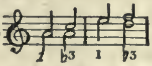
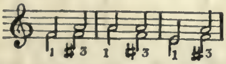
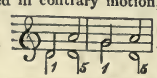
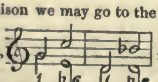
In the above table, I. is the second, and it is the lower note which is the discord; II. contains four real parts without octaves or unisons, and its use is to retard the $\substack{6\\4\\3}$ or $\substack{6\\5}$; IV. is also with four real parts, three of which form a common chord above the bass, which note is the discord; VI. is the imperfect common chord, with a whole tone added below; VII. is the major second, perfect fourth, and minor seventh, and is used to retard the common chord by an appoggiatura in the bass; X. is called the chord of the eleventh, of which the figure 4 is the representation, sometimes called the sharp seventh; XI. is the chord of the thirteenth, — the sixth may be either major or minor; in XII. the fifth must be perfect, the second either major or minor, and either the one or the other may be doubled. The above is a concise view of the *figured* or *thorough bass*, called by the Italians *basso continuo;* and the reader will recollect that all chords may be reduced to the fundamental bass by bringing them to the form of the perfect chord, or to that of the seventh. Chords are called *relative* or *irrelative*, according as a sound is or is not common to both. Thus in , these two chords, which are irrelative, it will be seen there is no sound in either that is common to both; in the chords , the G being found in both chords, they are relative. If in proceeding from one chord to another any note of the previous chord is kept in that which follows, the process will produce correct harmony. The discords, where they appear, must of course be *prepared* and *resolved*, whereof we shall hereafter speak; and care must be taken to avoid progressions of fifths and octaves between the extreme parts when both move the same way. Before leaving this part of the subject, we subjoin, as properly belonging to it, what is called the harmony of the scale; that is, the accompaniment which it carries in ascending and descending: —

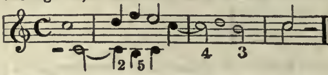
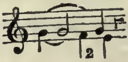


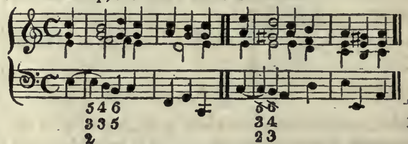
Composition is the art of joining and combining concords and discords in such a manner that their succession and progression may be agreeable to the ear. It may be here mentioned that melody being chiefly the business of the imagination, its rules serve only to prescribe limits to it; beyond which the imagination in searching out the variety and beauty of the airs ought not to go. But harmony is the work of the judgment; and its rules are more certain and extensive, and more difficult in

practice. A person, indeed, unskilled in music may by chance make a piece of good melody; but a person of judgment does it with certainty. In harmony, the invention has not so much to do; for the composition is conducted from a nice observation of its rules, assisted also by the imagination. It is not to be expected that in the compass of this article space can be afforded for a complete treatise on this part of the subject; all that we propose is to present to the reader some of the leading rules of the science.

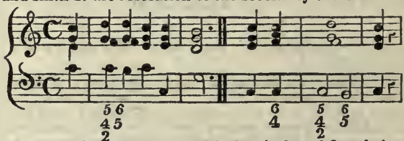
The different motions of the parts which constitute harmony are *direct* and *contrary*. In the former the parts move the same way, ascending or descending. There is also a third motion, according to some, called *oblique motion;* but that may be classed under contrary motion. In direct motion, the parts move the same way, ascending or descending, . In contrary motion, one of the parts rises whilst the other falls, . The use of these motions enables the composer to avoid harmonical irregularities in the use of octaves and fifths, and in other points. The following are the leading rules of harmony, as regards the motions and successions of concords:— First, octaves and fifths must not be consecutive in direct motion. For instance, , where the motion is direct, may be avoided by giving the passage contrary motion; thus, 

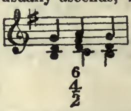
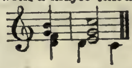
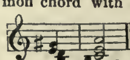
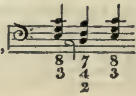
Second, unnecessary and distant skips must be avoided as much as possible, and the chords should be kept as close and as much connected as may be. Third, false relations, such as the extreme sharp second, must be avoided, unless the same be required for the purpose of expressing some particular effect. Fourth, the regular motion of the different parts in harmony must be observed: sharp intervals should ascend after the sharp, whilst minor or flat intervals must descend after the flat. In observing this rule, however, that of avoiding consecutive octaves and fifths must nevertheless be observed: neither is to be strictly observed where certain effects are required. It is customary for compositions to begin with one of the perfect concords of its key note, namely, the octave or fifth; and it should end in the key note with its common chord for the harmony. It should not begin or end with a sixth, though it sometimes may with a third. To these we may add, that you must not go from an imperfect concord to a perfect concord by similar motion; such passages being said to contain *hidden* octaves or fifths, which will be seen by filling up the diatonic degrees through which one of the parts is conceived to pass. With these prefatory remarks, we shall now proceed to some few details of the laws of harmony. In proceeding from the unison, when both parts move, it is better to go from it to the third minor than the third major. We may go to the minor either by oblique or contrary motion, ; but to the major it must be by oblique or by similar motion, the first being the best, . A fifth after a unison by similar motion must be avoided: it is good in oblique motion, and is allowed in contrary motion, one part moving a single degree, . From the unison we may go to the sixth minor by contrary motion, : it is not good by the other motions, because of the large leap. But from the unison to the sixth major is forbidden. An octave after a unison except by oblique motion must be avoided, inasmuch as in two unisons or two octaves it is but the division of a large note into smaller.

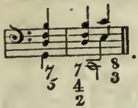
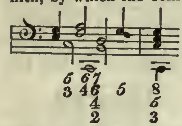
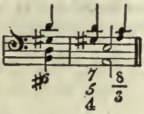
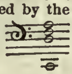
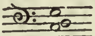
In the *second*, the lowest note is the discord. It may be *prepared* in any concord, and *resolved* in any but the eighth; it must therefore descend to the resolution, . The *preparation of a discord* is effected by taking care that the note which is the discord is heard in the preceding harmony, its resolution being its descent either a tone or a semitone, according to the mode, after it has been struck. Those seconds are called *transient* which are introduced without preparation on the accented part of the bar, thus ; and if these transient seconds be removed to the accented part of the bar, they then become appoggiaturas. When the second is attended by the fifth and third, it becomes a chord of four real parts, and retards the chord of $\begin{smallmatrix}6\\4\\3\end{smallmatrix}$ or the $\begin{smallmatrix}6\\5\end{smallmatrix}$; and if the third be sharp, the minor mode is indicated.

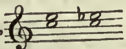
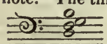


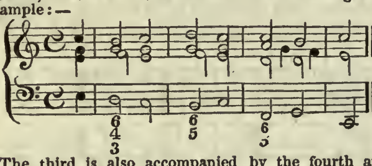
A chord is said to have four real parts when it contains four sounds without octaves or unisons: a concord can only have three real parts. When the second is attended by the fourth and fifth, either the fifth or the fourth must be prepared; and it becomes the chord of the fifth and sixth at the resolution of the second by the bass.

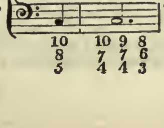


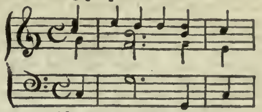
The second accompanied with the sixth and fourth is a chord of four real parts, three of them forming a common chord above the bass, which being the discord must be resolved by a descent to the next degree: the sharp fourth usually ascends, but it sometimes remains stationary, . This chord with the minor second, perfect fourth, and minor sixth, is produced by adding a minor semitone below any common chord with a major third; and also by placing a note one tone below the imperfect common chord, a major second, perfect fourth, and minor sixth; but in all these the second is resolved by descent. The extreme sharp second with the sharp fourth and major sixth is a tone and major semitone below the imperfect common chord. The second major with a perfect fourth and minor seventh retards the common chord with a major third by an appoggiatura in the bass; thus, . The minor second, perfect fourth, and minor seventh retard the common chord with a minor third in a similar manner, . The second is also accompanied with the fourth and sharp seventh, which, when introduced upon a resting bass, allow all the intervals when struck to ascend, . When, however, the

bass moves, it is usual to prepare the upper parts, . The fourth may indeed be used without preparation; but it falls to the resolution. Both the major and minor sixth are used in the chord with or without preparation; but they fall to the fifth, by which the common chord preserves its fulness, . The second may or may not fill up the chord. If the fifth is taken in the chord for the fifth part, it is suspended, and may or may not be in the preceding chord. You obtain the last sixth perfect by it, and retain four single parts in the places where the second is omitted, . The second accompanied with the fourth, fifth, and seventh, , by some is called the chord of the eleventh, the fourth being the representative of that interval, which is always perfect, as well as the fifth; but the second and seventh are major. Accompanied by the seventh, sixth, and fourth, the second is called the chord of the thirteenth, in which the thirteenth is figured by the sixth, which may be either major or minor, . When the second is accompanied by the fifth, , the latter must be always perfect; but the second may be either major or minor.

The third major or minor, , is an agreeable concord; of which it is to be noted that two minor thirds in succession are better than two majors, but mixed thirds in succession are most pleasant to the ear; indeed an octave of major thirds is extremely unpleasant. It is best to begin a regular ascent with a major third, and a descent with a minor, ; and in two parts it is not well to end in a third above the key note. The third is accompanied by a fourth and sixth, , and is generally called the small sixth. That species of it wherein the third is minor, the fourth perfect, and the sixth major, is elegant in effect, as the seventh, from which it is derived. The following is an example:—

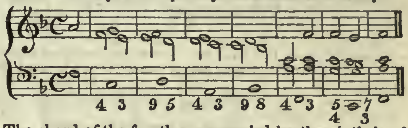


The third is also accompanied by the fourth and seventh; but when the third or the tenth is at the top of the chord, it is generally followed by the $\begin{smallmatrix}9\\7\\4\end{smallmatrix}$, which fourth, seventh, and ninth ought all to descend to the resolution; thus, . The third accompanied by the sixth and seventh is generally followed by the chord of the seventh; hence the sixth is the only interval wanting preparation.

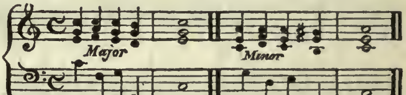


The fourth should not be used alone: it should be associated with the sixth and octave; thus, 

Accompanied by the fifth, the fourth is a discord much used. When introduced on a resting bass, it resolves into the third; and its effect is so similar to that of the ninth, that they are frequently introduced alternately.

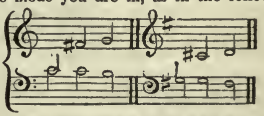


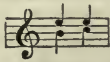
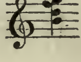
The chord of the fourth accompanied by the sixth is of great use in harmonical progressions; and when preceded by the common chords to the key note and fourth of the key, and succeeded by the common chords to the fifth of the key and the key note, forms one of the terminations to a musical period called the fourth and sixth cadence; thus,



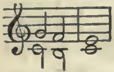
When the seventh accompanies the fourth, and that is followed by the chord of the third, fifth, and seventh, either the fourth or seventh, or both, should be in some part of the chord preceding it. In the following example both the fourth and seventh are prepared and resolved:—

When, however, the chord of the fourth and seventh is followed by the fourth, sixth, and eighth, it is frequently used without preparation in either of the positions. The fourth and seventh descend to the resolution, and generally resolve after each other.

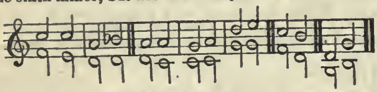
The interval of the sharp fourth, which has been before mentioned, is a minor semitone more than the perfect fourth, and a major semitone less than the perfect fifth. Its natural resolution is that the bass shall fall a degree, and the upper part rise one, by which the two parts meet in a minor sixth. It is of very great use in modulation, as you can, by introducing it upon the key note, always change the mode you are in, as in the following examples:—  In four parts the sixth and second are taken with it.

The interval of the imperfect fifth is a minor semitone less than the perfect fifth, and a major semitone more than the perfect fourth. In using this chord the highest note falls and the lowest one rises, so that they meet in a major third; thus, . In four parts it is accompanied by a third and sixth, .

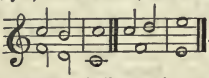
The fifth is the next interval which we have to consider; of this we have already said that two fifths cannot follow each other, except by contrary motion. From the fifth to the unison is good by oblique motion, and also by contrary motion, one part moving a single degree; but by similar motion it is bad. From a fifth to either of the thirds is allowed by all the motions, but it is best by the oblique; next to the oblique, the best way to the third minor is by contrary motion, and to the third major by similar motion, and both by single degrees. A false fifth may succeed a perfect fifth, provided it be also immediately succeeded by a third and by contrary motion,



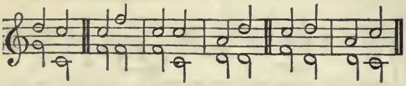
. From the fifth to either sixth is best by oblique motion; but it is allowed by similar motion if one part move a single degree: it is also allowed ascending, but not descending, to go by leap from the fifth to the sixth minor, but not to the major.



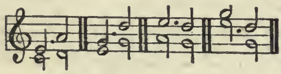
In passing from the fifth to the octave through a sixth, the sixth must be major, never minor; and it must be by contrary motion,



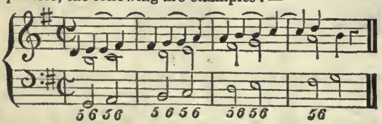
. An octave after a fifth by leap in similar motion must be avoided. By oblique and contrary motion, it is good and allowable by similar motion, one part moving a single degree, as follows:—

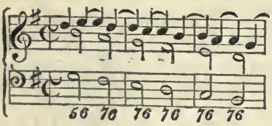


When a third or a sixth moves to a fifth in similar motion, there is said to be a *hidden fifth* in the passage. The reader will, in the following example, see by the dots where these lie.

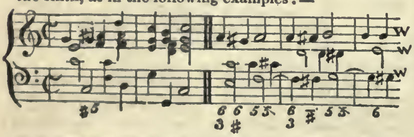


In a regular ascent, it is common for a fifth to be succeeded by a sixth, as in a descent it is for the seventh to be succeeded by a sixth. Of both these, which are termed *sequences*, the following are examples:—



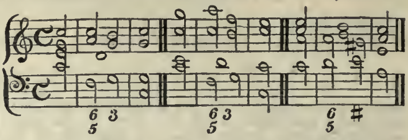


The chord of the extreme sharp fifth, which consists of two major thirds placed above each other, is generally preceded and succeeded by a common chord, or that of the sixth, as in the following examples:—

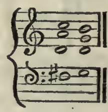


It is here seen that the extreme sharp fifth to the bass, whether it be in the middle or at the top of the chord, always rises to the resolution. It is called a *transient chord*.

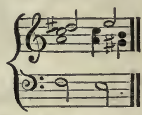
The sixth, by inversion, becomes a third; and it often happens that the bass which accompanies sixths will harmonize equally well with thirds. When accompanied with the fifth, the fifth is treated as a discord; which we will illustrate by two or three instances.



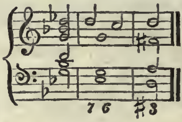
Some have given the name of the *great sixth* to this chord when the sixth is major and the fifth perfect. If the fifth is imperfect and the sixth minor, it is called the *chord of the false fifth*. It will be seen above that the chord of the great sixth is used on bass notes which ascend a tone to the perfect chord, and that of the false fifth to those which ascend a semitone,



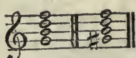
. The species of this chord chiefly used in minor keys consists of a perfect fifth, an extreme sharp sixth, and major third; and the bass of it generally descends,



The minor seventh accompanied with a third major and perfect fifth is one of the most agreeable of the discords; it should be heard in the chord which precedes it when used with a minor third and perfect fifth,

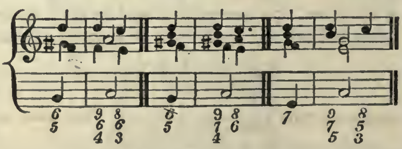


. By raising the lower note of a minor seventh a minor semitone, the chord of the diminished or extreme flat seventh, also called the *equivocal chord*, is produced,



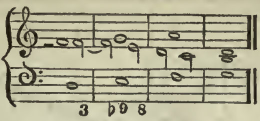
Minor 7th. Diminished 7th.

. This is called the equivocal chord, from the uncertainty of the key note into which it may lead. The preparation of a major seventh is a third, a fifth, a sixth, or an eighth; its resolution is a third, a sixth, and a fifth from the concords in which it is prepared. The ninth major consists of a whole tone, and the minor ninth a semitone major above the octave. The major ninth is prepared by a third, a fifth, and occasionally by a sixth, never by an eighth; and is resolved by a third, a sixth, or an eighth from each of the concords in which it is prepared. When the ninth is used in four parts, the third and fifth must be taken with it. Besides the above resolutions of the ninth, it may be resolved by the fifth if the bass rise a fourth or fall a fifth when the upper part falls one degree for its resolution. It must be accompanied at the resolution by an eighth, if the piece be in four parts. We subjoin a few examples:—



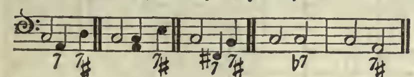
The minor ninth is prepared in the third only, and resolved in the eighth if the bass hold on till the resolution is made;

but it is resolved in the third if the bass descend a third on the resolution,

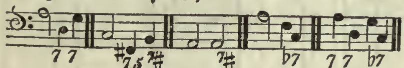


The ninth may have other discords mixed with it, as the fourth; in which case the fourth must be prepared and resolved as a discord. The seventh may be also mixed with it; in which case the seventh must be also separately prepared and resolved.

We have before defined the word *modulation:* our intention here is to add a few observations on the mode in which it is accomplished, premising that the laws of modulation are dependent on those of harmony. If you desire to keep in the key, you are to use all the sounds of the scale as much as possible, uniting them in good melody, and dwelling chiefly on those which carry the essential chords; that is, the chords of the seventh and key notes will be frequently wanted varied so as to avoid monotony. You must take cadences or pauses on these two chords only, or at furthest on that of the fourth of the key. You are never to alter the scale, because the introduction of a flat or a sharp not belonging to it indicates that the key is abandoned. To modulate into other keys formal cadences are not required; if they are, they are usually made at the end or in the middle of a piece. We subjoin the methods for passing from one key to another, which are five in number for the major and four for the minor keys; and these alone can be considered legitimate, unless through the medium of enharmonic modulation: leaving the major key of C,



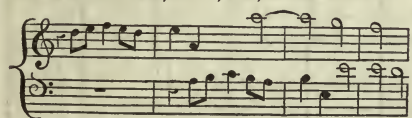
leaving the minor key of A,



Our limits prevent extending this part of the subject to greater length: those who would learn more on this point are recommended to *Frike's Guide to Harmony*, Lond. 1793.

A *fugue* consists in the repetition of a melody in the different parts at different intervals of time, each repeating, according to certain rules, what the preceding one has performed; the part which leads being called the *guide*, and that which repeats the *answer*. The answer is conducted by the same intervals as the guide.

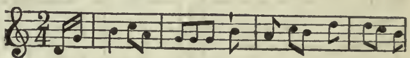
Imitation differs from fugue, says Brossard, because in the former the repetition must be a second, third, sixth, seventh, or ninth, or indeed any interval above or below the first voice or guide; whereas in fugue the repetition must be in the unison, fourth, fifth, or octave: —



The principal rules in writing fugues are — First, to prefer the key note and its fifth before any other for the first and last notes of the fugue; in which case the melody is to be contained within the octave to the key. Second, if one part begin or end with the key note, the other begins and ends with the fifth, taking care that the different relative intervals between the notes be regularly preserved. Thirdly, as in diatonic progression either ascending or descending from the key note to its fifth, and the converse, there is one note difference, you are at liberty to make one of those two notes in conjoint degree of that progression that contains the greater number to agree with the progression which is unavoidably used, wherein there is one note less, and that in the middle of the melody. These are the leading rules of the fugue.

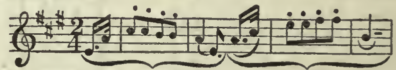
The *canon* is a species of fugue, which may be infinitely repeated; it is taken up at the fifth, and at the ourth. When this is done, the whole of the melody must be arranged, and accidental sharps and flats added to those notes where the use of the natural degrees would prevent the air from being exactly similar; whence its difficulty. The well-known canon of *Non Nobis Domine* is a fine specimen of canon composition.

Rhythm, in music, is the accommodation of the long and short notes to the syllables to which the music is set in such a manner as to separate the words properly, and to make the accented syllables of each word so conspicuous that what is sung may be clearly comprehended. In instrumental music, it is the adaptation of the expression to the sentiment. It is mostly used to signify the duration of several sounds heard in succession, whether musical by voices and instruments, or without inflexion of tone, as by the beating of a drum, &c. Here we nave only to speak of that which is connected with musical melody. Rhythm depends on *accent* principally, the *musical phrase*, *section*, and *period*. Of accent we have before spoken at nearly the beginning of this article, and we do not think it necessary to add to it in this place, further than to state that in the beating of time by the hand or foot, as there mentioned, the elevation of the hand is called by the technical name *arsis*, a Greek word signifying a lifting up; and the depression of it by the name *thesis*, signifying the action of laying down expressions, — which are also applicable in another sense, as, for instance, when a point or passage is inverted or turned, that is, rises in one part and falls in another, or the converse, it is said to move *per arsin et thesin*. Emphasis is frequently obtained for particular expressions by throwing the accent on the weak part of the measure, or by the different grouping of the quavers, semiquavers, &c., and also by the mark of emphasis, RF (signifying rinforzando), placed over a note where the composer is desirous of marking the weak part of a measure with more than its share of importance. Of this the following passage from a favourite symphony of Haydn is an example —



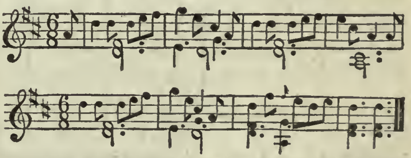
(Emphasis.)

on the note marked with a dash over it. Dr. Callcott thus distinguishes between accent and emphasis: — "Accent always requires pressure (on a pianoforte) immediately after the note is struck, and emphasis requires force at the very time of striking the note." A phrase is a short melody, usually formed of two measures in simple time, though with the ancient writers it is often contained within the bar. Of the common phrase the following is an example: —



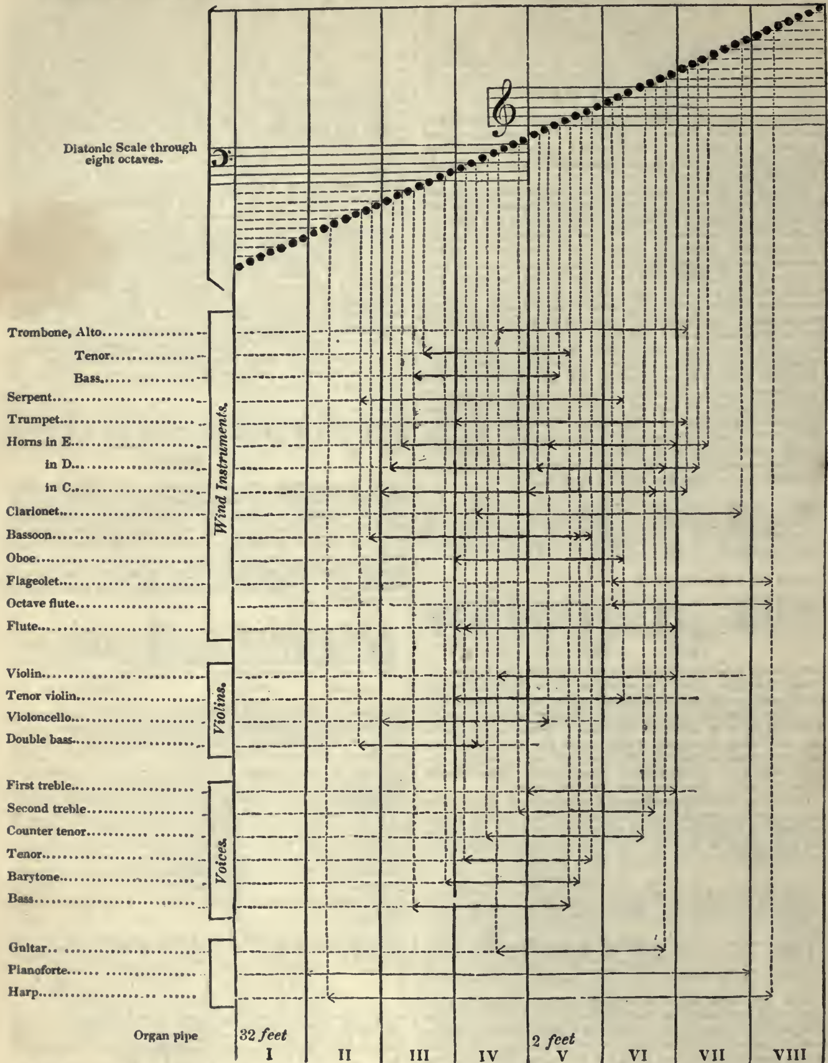
Andante. Phrase. Phrase.

Phrases in melody are formed by air; in harmony they are formed by sequences of chords and discords terminating with a cadence, which is more or less perfect as the passage is more or less finished. The well weaving together of the phrases whereof a strain is composed, so that their proportions may be symmetrical and form a beautiful whole, is one of the tests of a fine composer. Though musical punctuation, unlike that in writing, is without visible characters to mark the ends of phrases, and the periods whereof phrases are composed, yet such division does actually exist; and as an example of punctuation will better than words assist the reader in understanding it, we present to his notice the following well-known passage from the opera of *Don Giovanni*, by Mozart: —



In the four distinct parts into which this melody is divided three of them belong to the chord of the dominant or fifth of the key; and the other, which is the last, to the tonic or key note. The seventh of the dominant is upon the three first parts; but to avoid monotony, and yet to punctuate the first part, he has only got the A in the bass at the end of the second part. In the other two he has a pedal point (or holding on of the bass) of the key note, on which the chord of the seventh of the dominant is struck. A passage consisting of two regular phrases, the last ending with a cadence, is called a *section;* and one or more of these sections constitutes a *period*. When a period or more than one is terminated by a double bar, the whole is called a *strain*. We close this article with a synoptical view of the different pitches of the instruments of an orchestra, and of the human voice, from Choron's celebrated work, to which our acknowledgments are due; as well as to *Callcott's Musical Grammar;* the admirable art. "Music," by Momigny, in the *Encyc. Methodique;* and to *Shield's Introduction to Harmony*.

SYNOPTICAL VIEW of the different Pitches of the Instruments of an Orchestra, and of the Human Voice.



MU'SICAL GLASSES. A musical instrument consisting of a number of glass goblets, resembling finger glasses, which are tuned by filling them more or less with water, and played upon with the end of a finger damped. There are few persons at a dinner table who have not tried their skill in producing the sound which the vibration of a finger glass will yield in the way above described. The less the quantity of water in glasses of similar forms and equal capacity, the lower will be the tone of the scale; hence the facility of forming a complete scale by the quantity of water contained in each.

The skill, or rather knack, of operating upon the sets of glasses for the production of melodies and harmonies, is that of procuring instantly the required vibration by a gentle and rapid action of the finger upon their edges, and so quickly from one to another as to be able to introduce harmonies to the sounds of the air or melody before the vibrations of its glasses have ceased. A touch of the finger on the edge of a glass puts of course a stop to its vibration, and thus prevents confusion.

MUSK. A peculiar concrete substance, the produce of the *Moschus moschiferus*, or musk deer, an animal which inhabits the mountains of eastern Asia. Behind the navel is a bag, which in the adult animal is filled with musk. These bags are imported from China, Bengal, and Russia. Musk is originally a viscid fluid, but dries into a brown pulverulent substance, of a strong, peculiar, and highly diffusible odour. Its chief use is as a perfume: it has been employed in medicine as a stimulant antispasmodic, but much difference of opinion exists as to its efficacy; and its high price, and extreme liability to adulteration, are circumstances against its use.

MUSKAT. A rich sweet wine made in the south of France of over-ripe muscadine grapes.

MUSK DEER. (*Moschus moschiferus*, Linn.) The type of a distinct genus of Ruminants, with canine teeth and without horns. This species is especially remarkable for the large preputial glandular pouch which secretes the well-known substance called musk.

MUSKET. (Fr. mousquet.) The fire-arm used by the regiments of the line. (*See* GUN.) A great number of very curious ones, of various dates and countries, from

the earliest period of their use, may be seen in the repository of the Royal Artillery at Woolwich.

MU'SKETOON. A species of musket, shorter, but thicker and wider in the bore, than the ordinary musket. The musketoon, or *mousquetoon*, was of French invention, and is described by De Gaya, in 1688 (*Traité des Armes*), as differing from the carabine in being furnished with a fire-lock instead of a wheel-lock.

MU'SLIN. A fine thin kind of cotton cloth with a downy nap on the surface. The name is derived from the town Mosul, in Asia, where it was originally manufactured. The first muslin was imported from India into England in 1670; and twenty years afterwards it was manufactured in considerable quantities both in France and England. Muslins are now manufactured in immense quantities at Manchester and Glasgow, in France, Germany, and Switzerland, of a fineness and durability that rival those of India, at the same time that they are considerably cheaper. The fineness of some Indian muslins is such that when laid on grass upon which a little dew has fallen, they are scarcely visible. See COTTON.

MUSO'PHAGA. (Gr. *μουσα*, the generic name of the banana, and *φαγω*, *I eat.*) A genus of Scansorial birds, characterized by the base of the beak forming a disk which partly covers the forehead. The species of this genus are called "plantain eaters," because their principal food is the fruit of the banana.

MUSQUI'TO. The American name for the species of gnat (*Culex*). They abound in damp situations, both in the warmer climates and during the summer months in high northern latitudes. They pierce the skin with a lancetted proboscis, and discharge a venomous liquor into the wound; they can only be guarded against at night by enclosing the bed with a musquito curtain. The Laplanders drive them away by fire, and by coating the naked parts of the body with grease.

MUSSEL. *See* MYTILUS.

MU'SSITE. A pale green mineral from Mussa in Piedmont; it is a variety of *augite*.

MU'SSULMAN. The general appellation for all who embrace the faith of Mohammed. The term signifies "resigned to God;" and is the dual number of the singular *moslem*, of which *muslimim* is the plural. The appellation is said to have been first given to the Saracens.

MUST. The expressed juice of the grape before its conversion into wine by the process of fermentation.

MU'STARD. (Fr. moutarde.) The seed of the *Sinapis alba* and *nigra*, ground into powder, and freed from the husks: it is the well-known condiment of the shops, or at least a part of it; for, in order to reduce the strength of the pure mustard, there is generally a considerable quantity of wheaten flour added. Brown mustard should be the flour of *Sinapis nigra* exclusively, which is much more pungent than the other. A dessert spoonful of coarsely powdered mustard-seed, taken in a glass of water, generally operates as an emetic; it is also aperient. A mustard poultice, or *sinapism*, is sometimes a useful stimulant.

MUSTE'LA. (Lat. mustela, *a weasel.*) The generic name under which Linnæus comprehended the Vermine or Vermiform quadrupeds of Ray, or the carnivorous Mammalia, which are distinguished by the length and slenderness of their bodies, and are thus enabled to wind, like worms, into very small crevices and openings, whither they easily follow the little animals that serve them for food. The otters, skunks, polecats, and weasels were included in this genus, and still constitute the natural family *Mustelidæ;* and the genus *Mustela* is now restricted to the true weasels, which differ from the polecats in having an additional false molar above and below, and in the existence of a small internal tubercle on the lower "carnassial" or sectorial tooth; two characters which, Cuvier observes, somewhat diminish the cruelty of their nature.

MUSTER-ROLL. A specific list of the officers and men in every regiment, troop, or company, made out by the adjutant, and delivered to the inspecting field officer or paymaster, &c., by which they are paid, and their strength and condition known.

MUTE. In Grammar, a vowel (or consonant) is said to be mute when written but not pronounced; as the vowel *e* at the end of many English words, in some of which it effects a change in the pronunciation of the preceding vowel, as in *wife, life, place*, &c., rendering it long; in others it has no effect, as after a diphthong—*house, pronounce*. In old English, the mute *e* was very generally added at the end of words, especially nouns; and in versification the *e* often ceased to be mute, as is constantly the case in the poems of Chaucer.

MUTE, in Law, is said of a person who refuses to plead to an indictment for felony, &c. By stat. 12 Geo. 3. c. 20. such a person is to be considered as pleading guilty, and to be punished as upon conviction; but formerly a plea was extorted from him by the inhuman and disgusting process *peine forte et dure*, which see.

MUTE. A dumb officer of the Seraglio, whose duty it is to act as executioner of persons of exalted rank who have incurred the grand seignior's displeasure. The term mute is also applied to persons employed by undertakers to stand before the door of a house in which there is a corpse for a short time previously to the funeral.

MUTI'CA. (Lat. muticus, *maimed.*) A name applied by Linnæus to the third of his primary divisions of Mammalia, including the whale tribe, as being maimed, or deprived of the hinder pair of extremities; also given by Storr to an order of quadrupeds comprehending those which want either a certain kind of teeth, or are wholly edentulous.

MU'TINY, in Law, is the offence, in a person under military or naval authority, of resisting or refusing obedience to that authority. The Mutiny Act is a statute annually passed since the reign of William and Mary (April, 1689), by which the crown is vested with power to form articles of war, and to constitute military courts martial. *See* COURTS MARTIAL.

MUTULE. *See* MODILLION.

MU'ZARAB. Christians living under the government of the Moors in Spain; so called, it is said, from an Arabic word signifying imitators or followers of the Arabs. The denomination is now chiefly remembered in consequence of the celebrated disputes between the supporters of the Muzarabic liturgy, which was preserved by the Christians of Spain during their subjection to the Mahometans, and those of the Roman, introduced by the see of Rome about the 10th century. During the following age this dispute was warmly carried on, and well-known legendary tales of miracles operated in favour of the ancient ritual were long current in Spain. It was, however, gradually superseded by the Catholic. It is said that mass is still celebrated according to the Muzarabic ritual in one chapel at Toledo. A brief but excellent account of the different phases of the Muzarabic controversy is to be found in the *Dict. de la Conversation*. See also the *Penny Cyclopædia*, and the authorities there referred to.

MU'ZZLE LASHING. The lashing by which the muzzle of a gun in a ship is secured to the upper part of the port.

MY'A. (Gr. *μυων*, *a muscle.*) A name applied by Linnæus to a genus of the *Vermes testacea*, including those having a bivalve shell, characterized by a hinge with broad, thick, and strong teeth, seldom more than one, and not inserted into the opposite valve; shell generally gaping at one end. The Mollusks thus characterized form the first family (*Myacea*) of the tribe *Inclusa*, among the Acephalous Testacea of Cuvier. They have been subdivided into the genera *Mya* proper, *Lutraria*, Lam, *Anatina*, Lam., *Solemya*, Lam., *Glycimeris*, Lam., *Panopæa*, Lam., *Pandora*, Lam. The true *Myæ* include that species of the genus *Unio*, Brug., which is celebrated by Tacitus for producing pearls, and which is indigenous in some of the rivers of Scotland and England.

MYCE'LIA. (Gr. *μυκης*, *a fungus.*) The young flocculent filaments of fungi.

MYDRI'ASIS. (Gr.) A paralytic affection of the iris of the eye.

MY'ELENCE'PHALA. (Gr. *μυελος*, *marrow*, and *εγκεφαλον*, *brain.*) The name indicative of the condition of the nervous system of the primary division of animals, comprehending those which have a brain and spinal chord: it is synonymous with *Vertebrata*.

MY'ELONEU'RA. (Gr. *μυελος*, *marrow*, and *νευρον*, *nerve.*) A name given by Rudolphi to a group of animals corresponding to the Articulata of Cuvier, viz. Crustacea, Insects, and Anellides, which have a gangliated nervous system, forming a chord considered to be analogous to the spinal marrow of Vertebrates.

MY'LO. (Gr. *μυλη*, *a grinder tooth.*) Names compounded of this word are applied to certain muscles attached near the grinder teeth, as *mylohyoideus*, *mylopharyngeus*, &c.

MYO'LOGY. (Gr. *μυων*, *a muscle; λογος*, *a discourse.*) The doctrine of the muscles. In the Fine Arts, the term is applied to a description of the muscles of animals.

MY'OPS. (Gr. *μυωψ*; from *μυω*, *I wink*, and *ωψ*, *the eye.*) A person who is purblind or near-sighted. This defect usually arises from too great convexity of the cornea causing the rays to come to a focus before they arrive at the retina. It is corrected by the use of glasses which increase the divergency of the rays before they enter the cornea, and thereby throw their focus further back, so as to fall on the retina.

MY'RIAD. (Gr. *μυριας*.) Ten thousand. Often used as expressive of an indefinite multitude.

MYRIAME'TRE. A French measure equal to ten thousand meters; it is the equivalent of two leagues of the old measure. *See* MEASURES.

MY'RIAPODS, *Myriapoda*. (Gr. *μυριας*, *ten thousand*, and *πους*, *foot.*) The name of a class of Articulate animals, including those which have an indeterminate number of jointed feet, equalling that of the articulations of the body.

MYRI'CIN. That portion of wax which is insoluble in alcohol. The wax of the *Myrica cerifera* affords it.

MYRIOLI'TRE. A French measure of capacity equal to ten thousand litres, or 610280 cubic inches.

MYRISTICA'CEÆ. (Myristica, one of the genera.) A natural order of arborescent Exogens inhabiting the tropics. This has been placed, on account of its apetalous flowers, in *Lauraceæ;* from which it is distinguished by the structure of the calyx, anthers, and fruit. Brown places it between *Proteaceæ* and *Lauracæ;* but the order appears rather to be an apetalous form of *Annonaceæ*, with which the trimerous flowers, arillate seed, runcinated albumen, minute embryo, and peculiar properties almost identify it. The bark generally abounds in an acrid juice, which is viscid and stains red. The rind of the fruit is caustic; the aril and albumen of *Myristica moschata*, the former known under the name of *mace* and the latter of *nutmeg*, are important aromatics, abounding in a fixed oil of a consistence analogous to fat, which, in a species called *Virola sebifera*, is so copious as to be extracted easily by immersing the seeds in hot water.

MYRMECO'BIUS. (Gr. μυϱμηξ, *ant;* βιὸς, *life.*) A genus of Marsupial quadrupeds which feed on ants. The only known species, *Myrmecobius fasciatus*, is a native of Australia.

MYRMECO'PHAGA. (Gr. μυϱμηξ, and φαγω, *I eat.*) The name of a genus of Edentate quadrupeds which feed on ants, and are called *ant-eaters.* They are peculiar to the continent of South America.

MYRMELEO'NIDES. (Gr. μυϱμηξ, and λεων, *lion.*) The family of insects commonly called *ant-lions*, having the genus *Myrmeleon* as the type.

MY'RMIDONS. In Classical Mythology, a people on the southern borders of Thessaly, who accompanied Achilles to the Trojan war. Their name is derived by the mythologists from μυϱμηξ, *an ant;* and they were said to have arisen from ants, or pismires, in answer to a prayer of Œacus, king of the country, to Jupiter, after his kingdom had been depopulated by a pestilence.

MYRMILLO'NES. In Roman Antiquity, a species of gladiators, who fought completely armed against the Ectiarii. Their arms consisted of a sword, headpiece, and shield. On the top of the headpiece they wore a fish embossed, called μιϱμυϱος, whence, in all probability, their name is derived. The Myrmillones were also termed *Galli*, from their wearing Gallic armour; and *Scutatores*, from the shield by which they were defended.

MYRO'BALANS. (Gr. μυϱος, *an ointment*, and βαλανος, *a nut;* because formerly used in the preparation of unguents.) A bitterish austere fruit, brought from India, the produce of several species of *Myrobalanus.* Myrobalans are used by the Hindoos in calico printing and medicine; they were also formerly employed in Europe (though to a comparatively trifling extent) in the arts and pharmacy.

MYRRH. This gum resin is imported from Turkey: it is in irregular tears and lumps, of a reddish brown colour, a fragrant odour, and a warm but bitter taste. It is probably the produce of a species of *Amyris*, said to be a native of Abyssinia and Arabia Felix. It is a good stimulating tonic medicine, and is given in doses of from five to twenty grains.

MYRTA'CEÆ (Lat. myrtus), are an important natural order of Polypetalous Exogenous plants, of a woody texture, and frequently forming small trees, found in all tropical and temperate countries, where they are often cultivated for the sake of their valuable aromatic properties. The spices *cloves* and *pimento* are produced by some species; the agreeable fruits called *guava, jamrosade*, and *rose-apples* are yielded by others; while the enormous *gum-trees*, or *Eucalypti*, of New Holland, and the *Melæuca*, which furnishes the stimulating green oil of *cajeput*, also belong to the order. *Myrtaceæ* are nearly related to the Onagraceous order, from which they differ in having an indefinite number of stamens; and to *Melastomaceæ*, which have rostrate inflected anthers and ribbed leaves. Their most essential characters are to have polypetalous calycifloral flowers, indefinite stamens, round erect anthers, inferior fruit, and dotted leaves with an intra-marginal vein.

MYRTLE. (*Murt*, the Persian name, whence μυϱτος.) An evergreen fragrant bush, inhabiting all the warmer parts of the basin of the Mediterranean and of the west of Asia. It was considered sacred to Venus, and is at this day regarded with superstitious reverence by the Persian peasant. In the latitude of London the myrtle will endure the climate only in the warmest and most sheltered spots.

MYSTACI'NEÆ. (Gr. μυσταξ, *moustache.*) The name of a family of Infusories of the tribe *Trichoda*, including those which have superficial cilia, or fine hair-like processes, disposed in groups. Many species of animals derive their trivial name from the same root, as the *Vespertilio mystacinus*, or whiskered bat; the *Caprimulgus mysticalis*, or bearded goat-sucker; the *Cypselus mystaceus*, or bearded swift, &c.

MYSTERIES, SACRED. (The word mystery has been by some traced to the Hebrew סתר, to hide, whence *mystar*, a thing concealed; formed from which is the Gr. μυστηϱιον, old French *mestier* — English *mystery*, and old English *mistar*, a trade or *craft*, the learning of which was something occult and mysterious; but the more direct derivation appears to be from the Gr. μυεω.) The word mystery is primarily used in speaking of certain truths set forth in the Old and New Testament, to the full understanding of which human reason cannot attain. Thus all the Old Testament figures and prophecies were mysteries to the greater part of the Jews, until they received their accomplishment in Christ. Among the mysteries set forth in the New Testament the most prominent are, the doctrine of the satisfaction of Christ, the forgiveness of sins for the sake of his sufferings, and eternal life in a future world; the spiritual union between Christ and his church; the grace of Jesus Christ in its operation on our hearts; and the resurrection from the dead.

But the greatest of sacred or scripture mysteries is doubtless the incarnation of the Son of God:— the advent of Christ in the fulness of time, of the seed of Israel, and his participation in our nature, according to the flesh; "being in the likeness of man," and "found in fashion as a man," but "very God of very God," "God over all, blessed for ever." "The Word was *with* God and *was* God," says John; "and the Word was made flesh." This is the mystery, and, "without controversy, great is the mystery of godliness" (or God-*likeness*), God, manifest in the flesh," or "God *was* manifest in the flesh," as the most correct reading is held to be—Θεος εφανεϱώθη εν σαϱκι.

These are some of the numerous mysteries scattered throughout the Old and New Testament, and which rightly come under the denomination of *sacred* mysteries. For an account of *profane* mysteries, see *infra.*

MYS'TERIES, PROFANE. In the religions of Pagan antiquity, the secret rites and ceremonies performed by a select few in honour of some divinity were so called. "Each of the Pagan gods," says Bishop Warburton, "had, besides the public and open, a secret worship paid them, into which none were admitted but those who had been selected by preparatory ceremonies, called initiation; and this secret worship was termed *the mysteries.*" The first mysteries of which we have any account were those of Isis and Osiris in Egypt; whence they were introduced into Greece and Italy, and in process of time disseminated through the northern and western nations of Europe.

A very clear and concise account of the Egyptian mysteries has been given by Sir G. Wilkinson, in his *Manners and Customs of the Ancient Egyptians*, of which the following abstract will convey their peculiarities and importance:— "The Egyptian mysteries consisted of two degrees, denominated greater and less; and to become qualified for admission into the higher class the aspirant must have passed through those of the inferior degree. The priests alone could arrive at a thorough knowledge of the greater mysteries; but so sacred were these secrets held that many members of the sacerdotal order were not admitted to a participation in them at all, and those alone were selected for initiation who had proved themselves virtuous and deserving of the honour." "The Egyptians," says Clement of Alexandria, "neither intrusted their mysteries to every one, nor degraded the secrets of divine matters by disclosing them to the profane, reserving them for the heir-apparent * of the throne, and for such of the priests as excelled in virtue and wisdom." But there can be little doubt that at a later period the same liberality as to the admission of the laity which characterized the Eleusinian and other mysteries prevailed in Egypt, and that many laymen, and even some foreigners, were admitted to the lesser mysteries.

Of the origin of the Orphean and Eleusinian mysteries we have already spoken briefly, under their respective heads; but it has occurred to us that a more detailed account of the nature and ceremonies of the latter, more especially as with a few modifications, arising from the different habits of different nations, they constitute the great models on which all succeeding mysteries were formed, might not be considered out of place. These festivals were instituted at Eleusis, in honour of Ceres and Proserpine; the former of whom was believed to have taught the inhabitants the art of agriculture and the holy doctrine, — a doctrine which was said not only to purify the heart from sin, and expel ignorance from the mind, but to insure also the favour of the gods, and to open the gates of immortal felicity to the initiated. The mysteries, like those of Egypt, were of two kinds, — the less and the greater,—held at two different periods of the year, and at two different places: the lesser, which were introductory to the greater, being celebrated at Agræ, on the banks of the Ilyssus; the greater at Eleusis. The

* The kings of Egypt were the high priests of the nation, and by virtue of this office were partakers of these secrets; but if previously to ascending the throne they had been, which was frequently the case, members of the military class (one of the four great castes into which the Egyptians, like the Hindoos, were divided), they were required by the law to be admitted into the sacerdotal order, and instructed in all the secret learning of the priests, previously to exercising their priestly office.

celebration of the greater mysteries occupied nine days, chiefly devoted to sacrifices, processions, and other acts of worship; and during this period the judicial tribunals were closed; an armistice was proclaimed; private enmities were hushed; and death was decreed by the Athenian senate against any one, how high soever in rank, who should disturb the sanctity of the rites. The ceremonies of initiation into both the lesser and greater mysteries were conducted by four priests of the most illustrious families of Greece, called Hierophant, Dadouchos, Hierokeryx, and Epidomias; and these again were assisted by numerous inferior functionaries, to whom various appellations were given indicative of their several duties. The examination of those who had been purified by the lesser mysteries, and who were preparing for the greater, was apparently rigorous. All foreigners, all who had even involuntarily committed homicide, who had been declared infamous by the laws, or had been guilty of a notorious crime, were excluded; but these regulations were not immutable, for various instances might be produced to show that homicides and robbers were sometimes initiated.* Women and children were admissible; and a child, styled *the child of holiness*, whose innocence, it was believed, of itself endowed him with capacity to fulfil the requirements of the mysteries, was selected to conciliate the deity in the name of the initiated.

Of the ceremonies which attended the initiation we know little; since every postulant was required, under the most dreadful oaths, to conceal whatever he saw or heard within the hallowed precincts; and he who violated the oath was not only put to death, but devoted to the execration of all posterity. Yet the priests of ancient, like the Freemasons of modern times, could not prevent the disclosure of *some* facts. Crowned with myrtle, and enveloped in robes, which from this day were preserved as sacred relics, the novices were conducted beyond the boundary impassable to the rest of men. The hierophant, with his symbols of supreme deity, and his three assistants, representing the three other gods, were carefully visible. Lest any should have been introduced not sufficiently prepared for the rites, the herald exclaimed, "Far from hence the profane, the impious, all who are polluted by sin!" If any such were present, and did not instantly depart, death was the never-failing doom. The skins of new-slain victims were now placed under the feet of the novices, the ritual of initiation was read, and hymns were chanted in honour of Ceres. The novices moved on, while a deep sound rose from beneath as if the earth itself were complaining; the thunder pealed; the lightning flashed; and spectres glided through the vast obscurity, moaning, sighing, and groaning. Mysterious shades, the messengers of the infernal deities,—Anguish, Madness, Famine, Diseases, and Death,—flitted around; and the explanations of the hierophant, delivered in a solemn voice, added to the horrors of the scene. This was intended as a representation of the infernal regions, where misery had its seat. As they advanced, amidst the groans which issued from the darkness were distinguished those of the suicides—thus punished for cowardly deserting the post which the gods had assigned them in this world. But the scenes which the novices had hitherto beheld seemed to be a sort of purgatory, where penal fires and dire anguish, and the unutterable horrors of darkness, were believed, after countless ages of suffering, to purify from the guilt acquired in this mortal life. Suddenly the bursting open of two vast gates with a terrific sound dimly displayed to their sight, and faintly bore to their ears, the torments of those whose state was everlasting,—who had passed the bounds beyond which there is no hope. On the horrors of this abode of anguish and despair a curtain may be dropped; the subject is unutterable. Onwards proceeded the novices, and were soon conducted into another region; that of everlasting bliss, the sojourn of the just—of those whose hearts had been purified and whose minds had been enlightened by "the holy doctrine." This was Elysium—the joys of which were equally unutterable, equally incomprehensible, to mortals not admitted into these mysteries. Here a veil was in like manner thrown over *this* scene. (*Cab. Cyclop.*, vol. 61.)

Like most other questions of this nature, the origin and purpose of these religious institutions are involved in the deepest obscurity; and all the efforts of the learned that have been directed to the elucidation of this question in all ages, but more particularly in modern times, have ended only in unprofitable conjecture. Referring to the dissertations of Bishop Warburton and Dr. Leland for the chief views that have been entertained respecting them, we may here briefly observe, that though the mysteries seem to have been instituted for the purpose of enlightening the initiated as to the hidden meaning of religious doctrines and usages of which the great mass of the people were kept in ignorance, there are no means of approximating even to a conjecture as to the real nature of the doctrine taught in the mysteries, or the advantages of initiation. Were this the place for such discussions, we think it might be satisfactorily proved that mysteries must form an indispensable part in the religious ceremonies of every people who have attained to a certain degree of civilization. The mythological systems of antiquity were too gross, and the fables of which they were composed too senseless, to be believed by any one into whose mind the light of philosophy had dawned; and accordingly we find that many of the most distinguished persons embraced and inculcated in private (*see* MONOTHEISM) the most heterodoxical opinions respecting the national faith. These opinions were well known to the priests, many of whom were too enlightened to credit the delusions of which they were the ministers, and who might well tremble for the further spread of doctrines which must inevitably prove fatal to their influence. It became, therefore, a matter of state policy to divert into another channel those feelings of religious infidelity which, if communicated to the vulgar, might have ended in popular disturbances; and hence, in all probability, mysteries were instituted, which, while they ministered to the pride and vanity of human reason by elevating the initiated above the prejudices of ordinary persons, and gave as it were the sanction of the state to the entertainment of heterodoxical opinions, no less gratified the vulgar by the splendid shows and ceremonies of which they were the vehicle, at the same time that they held out the prospect of initiation to all who might be deemed worthy of the honour. (In addition to the works already quoted, see *Sir G. Wilkinson's Ancient Egyptians*, vol. ii. pp. 322—332., 2d Series; and the authorities there referred to.)

* It has been said that the division of the Eleusinian Mysteries into the lesser and great arose from the expiatory ablutions and other ceremonies which were imposed upon Hercules, when he aspired to initiation after killing the centaurs; but it is more probable that this division, which, as we have remarked above, was common to them with the Egyptian mysteries, was coeval with their introduction into Greece.

MY'STERIES. In Modern Literature, a species of dramatic composition, with characters and events drawn from sacred history. Saint Gregory Nazianzen composed the earliest sacred dramas extant, on the model of the Greek tragedies, but with Christian hymns substituted for the ancient chorus. The mysteries of the middle ages are thought by some to have been first introduced by pilgrims returning from the Holy Land. They originated among, and were probably first performed by, ecclesiastics. However serious and solemn the events which were represented in these singular compositions, there were invariably, in the later mysteries, two characters introduced to make sport for the multitude: namely, the Devil and the Vice,—a personage accoutred in a long jerkin, a cap with ass's ears, and a dagger of lath. He is now best remembered by the allusions to his character and office in the plays of Shakspeare. Miracles, or miracle-plays, were a species of mystery: they are usually said to have represented the martyrdoms of saints. In the 16th century, the mysteries were succeeded by moralities; which were much in vogue about the time when the Reformation made its chief progress in England. The characters in moralities were allegorical personages. Several of these performances, some by no means destitute of poetical merit, remain to us. They may be considered as the last step in the progress made by the dramatic art in modern Europe, before it reached the station and character which it has ever since retained.

MY'STICISM. In Religion, a word of very vague signification, applied, for the most part, indiscriminately to all those views or tendencies in religion which aspire towards a more direct communication between man and God, not through the medium of the senses, but through the inward perception of the mind, than that which is afforded us through revelation. Thus, the Pantheism of the ancient philosophers and many modern religionists, which supposed a God existing in all space and matter, and revealed to us in the outward manifestations of things; the Quietism of Madame Guyon, Fénélon, &c., who sought for direct revelation from the Divinity to the believer in a species of ecstasy; the Pietism of Molinos, &c.; the doctrines of the Illuminati in Germany; the visions of Swedenborg; and some of the notions prevalent among the Methodists and other sects among ourselves—all approximate to mysticism. See, as to the early Christian mystics of the East, the first volume of *Mosheim*; as to those of the West, the third (transl. ed. 1790, p. 352.).

MYTHO'LOGY. (Gr. μυθος, *fable*, and λόγος, *discourse*.) By the mythology of a people, we understand the collective body of its traditions respecting its gods and other fabulous preternatural beings. The classical mythology, *i.e.* that of ancient Greece and Rome, being the best known, is most frequently intended, when the word is used without a distinctive addition; but the mythologies of the ancient Egyptians, of the Hindoos, and of the northern nations of Europe, have also been sedulously examined by modern scholars, and reduced into systems pretty generally known. The learned although singular work of Bryant, *Analysis of Ancient Mythology*,

is a rich repertory of traditions and doctrines, though arranged with a view to the author's own far-fetched theory. *Keightley's Mythology of Ancient Greece and Italy* is perhaps the most useful manual of those subjects. The work of Creuzer, *Symbolik der Alten Völker, besonders der Griechen*, may be considered among the most erudite and valuable of all books on classical antiquities. An outline of the chief mythological systems of antiquity will be found under the article POLYTHEISM, to which we beg to refer; and the chief mythological personages are noticed under their particular heads.

MYTILA'CEANS, *Mytilacea*. (Gr. μυτιλος, *a mussel.*) The name of the family of Lamellibranchiate Mollusks, having the genus *Mytilus*, or common mussel, for its type, and characterized by the mantle being open anteriorly, and by having a foot either sufficiently developed for the office of progressive motion, or serving to draw out, direct, and fix the byssus.

MY'TILUS. (Gr. μυτιλος, *a mussel.*) A name applied by Linnæus to all those testaceous Vermes having a bivalve shell, rough, and generally affixed by a byssus, with a hinge, mostly without teeth, generally with a subulate, excavated, longitudinal line. The species comprehended under the above phrase are placed by Cuvier in the Testaceous order of Acephalous Mollusks, and have been subdivided into the genus *Mytilus* proper, of which the common edible mussel (*Mytilus edulis*) is an example; *Modiolus*, Lam.; *Lithodomus*, Cuv.; *Anodonta*, Brug.; *Avicula*, Brug.; *Meleagrina*, Lam., which produces the most precious pearls. Extensive establishments are maintained at Ceylon and other places for the express purpose of collecting the *Meleagrina margaritifera*, or pearl oyster.

MY'XINE. (Gr. μυξα, *mucus.*) The name of a genus of Cyclostomous fishes, remarkable for their mucous slippery integument: the species called glutinous hag (*Myxine glutinosa*) is a native of the British seas. Its habits are parasitic, and it is most commonly met with in the interior of a cod upon whose flesh it has been preying.

N.

N. One of the liquid series of letters. It is common to all known languages, and is interchangeable, more particularly in the Latin and Greek languages and those derived from them, with a variety of letters. As an abbreviation N is used for *north*, *numero*, &c.; N. B. for *nota bene;* N. L. for *non liquet* (*i.e.* the cause is not clear enough to pass sentence on); N. P. for *notarius publicus*, &c.

NA'BLUM. One of the most famous musical instruments among the Hebrews; but one whose form and nature are so little known that Calmet thinks it was a harp, Kircher a psaltery or stringed instrument of percussion played on by sticks, and Harmer (*Observations on Scripture*) hints at its being a bagpipe. Bythner (*Lyra*) says the *nebel* (נבל) was like a leathern bottle, explaining his meaning to be that it bore a resemblance to the ancient Greek and Roman lyre, whose body was made of the shell of the tortoise. The authority of Josephus (*Ant. Jud.* lib. vii. c. 12.), if to be relied upon, distinctly shows it was not an instrument of percussion, but played upon with the fingers; his words are, "Ηδε ναβλα δωδεκα φθογγους εχουσα, τοις δακτυλοις κρουεται. Its having twelve sounds, without telling how those sounds were produced, whether by strings or wind, leaves the matter so doubtful that the reader must decide for himself.

NABO'B. (A corruption of nawâb, from naib, *a deputy.*) The title of the governor of a province or commander of an army, in India, under the domination of the Moguls. The nabob was, properly speaking, a subordinate provincial governor under the subahdar; *i. e.* governor of a subah, or larger province. In the decay of the Mogul empire, many of the nabobs became virtually independent, until their dominions were reduced by the English. The term nabob is vulgarly applied to those Europeans who have amassed a large fortune in the East Indies, and live in eastern splendour.

NA'CARAT. (Span. nacar, *mother of pearl.*) A term applied to a pale red colour with an orange cast. The *nacarat* of Portugal is a crape or fine linen fabric, dyed fugitively of this tint, which is used by ladies to give their countenances a roseate hue. The brightest red crapes of this kind are manufactured by the Turks of Constantinople. (*Ure's Dictionary of Arts.*) *See* ROUGE.

NA'CREOUS. (Fr. nacré, *pearl.*) In Zoology, when the surface of a shell or other part reflects iridescent light.

NA'CRITE. (Fr. nacré.) A mineral of a pearly lustre, found crystallized in granite. It is a silicate of alumina and potassa.

NA'DIR. (Arab. nazeer, *opposite.*) In Astronomy and Geography, the point of the heavens diametrically opposite to the zenith. The zenith and nadir are the two poles of the horizon.

NÆ'NIA. In Roman Antiquities, a funeral dirge sung to the music of flutes. It is also the name of the Roman goddess who presided over lamentations.

NÆ'VUS. A natural spot or mark upon the skin of children at birth.

NAI'ADS. (Gr. ναιω, *I inhabit*, or ναω, *I flow.*) In the ancient Roman and Greek Mythology, female deities who presided over fountains, rivers, brooks, &c. The number of these goddesses was indefinite. In his *Georgics* (book iv.) Virgil enumerates 16; and Ovid, in his *Elegies* (book iii. 64.) speaks of at least 100 in the river Anio. The most beautiful of the Naiads is said to have been Aigle (*Virg.*, Ec. 6.). Many of the Homeric heroes are represented to have been the offspring of these deities.

NAILS. (Germ. nägel.) This term is given to the terminal horny appendages of the fingers and toes when they are in the form of flattened or depressed plates, serving to support a broad tactile surface, as in the human fingers. When these appendages are compressed, curved, pointed, and extended beyond the digit, they are called "talons," or "claws;" when they encase the extremity of a digit like a box, they are called "hoofs."

NA'IS. (Gr. ναϊας, *a naiad.*) The name of a genus of minute Abranchiate Anellides, or red-blooded worms, remarkable for their powers of reproducing parts of the body when mutilated; and for procreating their kind by spontaneous separation of the hinder segments of the trunk.

NAI'VETÉ (Fr.), is applied to a certain indescribable grace in the female character, resulting from a union of great natural shrewdness, unaffected simplicity, and, to a certain extent, a disregard of the conventional forms and usages of society.

NA'KED FLOORING. In Architecture, the timber work of a floor, which supports the boarding or ceiling, or both.

NAME. (Lat. nomen; Germ. nome; Fr. nom.) The designation by which any individual is known. The custom adopted in personal nomenclature has been based on some uniform principle since the earliest ages; modified, however, by the varying circumstances of different countries, and according to the more or less advanced state of civilization of every people. Thus in the early state of society of the Jews, Egyptians, Persians, Greeks, Romans, Germans, Gauls, Britons, and indeed of every nation, no individual had more than one name; but in a more advanced or refined period one or more additional names were given, in order to mark the different families to which individuals belonged, as well as to distinguish members of the same family from each other. To effect these objects the ancient Romans, at least those of good family, generally used three names,—the *prænomen*, the *nomen*, and the *cognomen;* the first, which was given on the assumption of the *toga virilis*, marked the individual, like our Christian name; the second distinguished the *gens* (which see), and the third the *familia* (which see), to which he belonged. To these, however, was sometimes added a fourth name, called the *agnomen*, which was derived from some distinguishing peculiarities in each individual's character or condition; thus Publius Cornelius Scipio was named *Africanus*, from his exploits in Africa. The mode of designation adopted in all the countries of modern Europe is founded on a principle somewhat analogous to that of ancient Rome; with this prominent difference, that in the former no *nomen* or *clan* appellation intervenes between the *prænomen* (or Christian name) and the *cognomen* (or surname). It would be difficult to give any satisfactory reasons for the adoption of the Christian and surnames most commonly met with among ourselves. Those who are inclined to prosecute inquiry into this comparatively untouched subject, will find some ingenious hints for their guidance in the *Penny Cyclopædia* (art. "Names, Proper"), to which we beg to refer. *See* SURNAME.

NA'NDU. The name of the American ostrich (*Rhea Americana*). *See* RHEA.

NANKEE'N. A yellowish or buff-coloured cotton cloth, largely manufactured at Nankin, in China. Its colour is that of the cotton wool of which it is manufactured. They are sometimes bleached, and then are called *white nankeens*. Imitation nankeens are manufactured at Manchester; but it is admitted these are of an inferior quality to the Chinese, neither lasting so long, nor holding their colour so well.

NANTES, EDICT OF. *See* EDICT.

NA'OS, or NAVE. (Gr. ναος, *a temple*, or ναυς, *a vessel.*) In Architecture, that part of a temple enclosed by the walls. The part in front of it was called *pronaos*, and that in the rear *posticum*. In modern architecture, it is the middle part or alley of a church, between the aisles or wings.

NA'PHTHA. A limpid bitumen, which exudes from the earth upon the shores of the Caspian and some other Eastern countries. Near the village of Amiano, in the state of Parma, there exists a spring which yields this

substance in sufficient quantity to illuminate the city of Genoa, for which purpose it is employed. It has a peculiar odour, and generally a yellow colour, but may be rendered colourless by distillation. Its specific gravity is about 0·75. It boils at about 160°. It is highly inflammable, burning with a white smoky flame. It appears to be a compound of 36 of carbon with 5 of hydrogen, and is therefore a pure hydro-carbon. A liquid very similar to mineral naphtha is obtained by the distillation of coal tar. It has sometimes been used in lamps, but is apt to smoke. This variety of naphtha is in great request as a solvent for caoutchouc.

NA'PHTHA'LAMIDE. A compound obtained by distilling napthalate of ammonia.

NAPHTHA'LIC ACID. A crystalline product, resembling in appearance benzoic acid, obtained by Laurent from naphthaline.

NA'PHTHALINE. A substance formed during the destructive distillation of pit-coal for the production of gas. It is obtained by re-distilling the coal tar. It is a white crystalline substance, heavier than water, and of a peculiar aromatic odour. It is extremely volatile, fusing at 180°, and its vapour condenses in large white flaky crystals. It burns with much smoke, and dissolves in alcohol and ether. It consists of 60 carbon, 4 hydrogen, and is therefore a hydro-carbon. It combines with sulphuric acid to form the *sulpho-naphthalic acid*.

NAPIER'S RODS, or BONES. An instrument contrived by the celebrated Lord Napier, the inventor of the logarithms, for the purpose of performing mechanically the arithmetical operations of multiplication and division. Napier's rods consist of small squared pieces of bone or ivory, box or silver, about 3 inches long, and 3-10ths of an inch in breadth, the faces of which are divided into nine little squares or cells, each of which is parted by a diagonal into two triangles. On these cells are engraved the successive columns of the common multiplication table, in such a manner that the units, or right-hand figures, are found in the right-hand triangle, and the tens, or left-hand figures, in the left-hand triangle. Thus: —

1	1	2	3	4	5	6	7	8	9	0
2	/2	/4	/6	/8	1/0	1/2	1/4	1/6	1/8	/0
3	/3	/6	/9	1/2	1/5	1/8	2/1	2/4	2/7	/0
4	/4	/8	1/2	1/6	2/0	2/4	2/8	3/2	3/6	/0
5	/5	1/0	1/5	2/0	2/5	3/0	3/5	4/0	4/5	/0
6	/6	1/2	1/8	2/4	3/0	3/6	4/2	4/8	5/4	/0
7	/7	1/4	2/1	2/8	3/5	4/2	4/9	5/6	6/3	/0
8	/8	1/6	2/4	3/2	4/0	4/8	5/6	6/4	7/2	/0
9	/9	1/8	2/7	3/6	4/5	5/4	6/3	7/2	8/1	/0

As an example of the manner in which the rods are used, let it be required to multiply the numbers 6795 by 4876. Select the rods which have the figures of the multiplicand inscribed at the top, and place them in their order, with the index rod before them, when they will stand as in the table annexed. Then, opposite to the several figures of the multiplier, 4876, on the index, but proceeding backwards, take the numbers in each horizontal column; add the pair of digits in each rhombus formed by the adjacent triangles of two contiguous cells; and, finally, collect into one sum the rows of the products corresponding to each digit of the multiplier, transcribed and properly disposed, as under: —

1	6	7	9	5
2	1/2	1/4	1/8	1/0
3	1/8	2/1	2/7	1/5
4	2/4	2/8	3/6	2/0
5	3/0	3/5	4/5	2/5
6	3/6	4/2	5/4	3/0
7	4/2	4/9	6/3	3/5
8	4/8	5/6	7/2	4/0
9	5/4	6/3	8/1	4/5

40770	6
47565	7
54360	8
27180	4
33132420	

Here, opposite to 6, the last digit of the multiplier, and proceeding from the right along the horizontal column, there occur the figures — first, 0, then 3 and 4, or 7; 5 and 2, or 7; 4 and 6, or 10; and lastly, writing down the cipher, and carrying 1 to the 3, we get 4. These collected together give 40770 for the product of 6795 by 6. In the same manner the other rows are formed, which, being added in the usual manner, the product of the two given numbers is obtained. It is obvious that this method of calculation is much too tedious to be of any real use.

NA'PLES YELLOW. A celebrated yellow pigment, formerly made by a secret process at Naples, and used not only in oil painting, but as an enamel colour; it is said to be a mixture of the oxides of antimony, lead, and zinc.

NAPOLEON, CODE OF. It was in 1802, during the temporary calm of the Peace of Amiens, that Napoleon, then First Consul, undertook the great task of forming a civil code. It was entrusted to a commission of the council of state; of which Tronchet, Rœderer, Portalis, Thibaudeau, Cambacérés, Lebrun, were the leading members. "Tronchet" (said Napoleon himself to Las Casas) "was the soul of the code." (*Memoirs*, part 3. 234.) And Portalis has also the credit of a very important share in its composition. But Napoleon himself took great interest in the subject, and mingled eagerly in the discussions of the commission, as appears by the procès-verbal of those discussions. After all allowances made for the unparalleled flatteries of the Napoleonists, his observations are said to show great intuitive sagacity, much readiness, and a peculiarly inquiring disposition, which often led him to the principles of things, while men of less natural power and trained in a different school were busying themselves unprofitably with the matters on the surface. "I had at first fancied," he says, "it would be possible to reduce all laws to simple geometrical demonstrations, so that every man who could read and connect his ideas together would be able to decide for himself; but I became convinced almost immediately after that this idea was absurd." (*Las Casas, Mem.*, part 6. 263.) Still, according to himself, he continued to cherish the scarcely less absurd idea that no other laws might be necessary than those inserted in the code. The second volume of the work of Thibaudeau (*Sur le Consulat et l'Empire*) is perhaps the most useful to consult for the history of these discussions. According to him, the secretary Locré did not in any degree improve the speeches of the First Consul in his report. Although the ideas of Napoleon himself are said to have entered largely into the composition of the code, it does not appear clearly in what important particulars this was the case; except in one singular instance, that of the law of divorce (book 1. title 6.), the liberty of which he is said to have greatly promoted. The Code Civil is composed of a great number of laws, dated from the "14 Ventose, an 11" (March, 1803), to 24 Ventose, an 12 (March, 1804), in which latter month they were united in a single code; and which was republished under the empire in 1807. The "Code de Procédure Civile" was put in force on the 1st January, 1807; the Code of Commerce dates from the same year; the "Code d'Instruction Criminelle" from November, 1808; the "Code Pénal" from February, 1810; which last is a revision of the "Code Pénal" and "Code des Délits et des Peines" of the Revolution. But the "Code Civil" is that to which the term "Code Napoleon" is in common language particularly applied. It consists of three books; the first "of persons," subdivided under eleven titles; the second "of goods (biens), and the different modifications of property," comprising four titles; the third "of the different manners in which property is acquired," with twenty titles. These last are again subdivided into chapters and sections; and the whole code consists of articles numbered in arithmetical order through the whole, in all 2281. The most important provisions of the code as to the civil state of persons are those relating to marriage and divorce. With regard to property, its fundamental law is that of equal succession by heirs, the abolition of most distinctions between landed and moveable property, and the restraint imposed by it on the testamentary power: making in all a system "fundamentally at variance with that of all the other states of Europe, and of which the ultimate consequences are destined to be more important than any of the other changes brought about by the Revolution." (*Alison's History of the French Revolution*, vol. vi.) But in this respect the Code Napoleon merely consolidated the revolutionary laws already existing. *See* CODE.

NA'POLITE. A blue mineral from Vesuvius.

NARCE'IA. (Gr. *ναρκη*, *torpor*.) A vegeto-alkaline base, contained in opium, and discovered by Pelletier in 1832. Its salts have the peculiarity of being blue in a certain degree of concentration, and on adding successive quantities of water to them the colour changes to violet and red, and lastly disappears. By this character, and by its easy fusibility (at 198°), it is distinguished from the other principles with which it is associated. Its medical virtues have not been ascertained, nor has its equivalent number been determined.

NARCI'SSUS. In Mythology, the beautiful son of Cephesus and the nymph Liriope, whose history formed one of the most favourite topics with the poets of classical antiquity. Though beloved by all the Grecian nymphs, he treated them with contemptuous indifference; but having accidentally seen his own image reflected in a fountain, he became so enamoured of it that he languished till he died, and thus realized the prophecy of Tiresias, that he should live until he saw himself. After his death the gods, moved with compassion for his fate, changed him into the flower which bears his name.

NARCISSUS. In Botany, a genus of Endogens belonging to the natural order of *Amaryllidaceæ*, "among which it is known by its flowers growing upon a scape, and having a cup at their mouth," the stamens opposite the sepals being longer than the others. The species are very numerous; and from their delicate shape, soft and various colour, and sweet scent, have long been favourite objects of cultivation, especially the daffodils, jonquils, and tazzettas. Some of the more hardy species grow wild in our woods and under our hedges; but the finer sorts are natives of more southern latitudes.

NARCO'TICS. (Gr. ναρκη, *torpor.*) Medicines which produce drowsiness, sleep, and stupor. They appear, in the first instance, to act as stimulants, quickening the pulse, and rousing the energy of the nervous system, and, in very small doses, this is their most obvious operation. In larger doses these effects are followed by a tranquil state of mind, torpor, and even coma. Considerable skill and experience are required in the successful administration of these medicines, both as regards the cases in which they are to be prescribed, the doses in which they are to be given, and the peculiarities of habit which often interfere with and modify their usual effects. They are to be distinguished from *sedatives*, which do not produce preliminary excitement. Opium is a narcotic, henbane a sedative.

NARCO'TINE. (Gr. ναρκη.) A crystallized substance, obtained by digesting the aqueous extract of opium in ether, and evaporating the ethereal solution. It was discovered in 1803 by Derosne, and supposed to be the narcotic principle of opium; but this has since been shown to reside more exclusively in *morphia*, and narcotine is possessed rather of stimulant qualities, and is the cause, perhaps, of the excitement which opium occasions. It consists of 65 carbon, 5·50 hydrogen, 2·50 nitrogen, and 27 oxygen.

NARRA'TION. (Lat. narro, *I tell.*) In Rhetoric, the term usually applied to the second division of an oratorical discourse, in which the facts of the case are set forth from which the orator intends to draw his conclusions. This part of a discourse should be characterized by the greatest simplicity of style, as well as by absence of all rhetorical ornaments.

NARWHAL. The common name of the species of Cetacean which has a single long protruded tusk. *See* MONODON.

NA'SAL. (Lat. nasus, *nose.*) A nasal pronunciation is given in some languages to particular letters, as in French to the letters *n* and *m* in certain positions. The only sound approaching to nasal in English is that of the double consonant *ng;* as in *thing*, *ring*, &c.

NASALIS. *See* SEMNOPITHECUS.

NA'SCENT STATE. Chemists generally apply this term to gaseous bodies at the moment of their evolution, as it were, from liquids or solids, and before they have assumed the aëriform state. There are numerous cases in which bodies having no tendency to combine under ordinary circumstances readily unite when presented to each other in their nascent states. Hydrogen and nitrogen gases, for instance, when mixed together, show no disposition to combine; but when certain organic bodies containing those elements are heated, they are evolved in their nascent states, and combine so as to form ammonia; it is in this way that ammonia is abundantly produced during the destructive distillation of many kinds of animal matter, and of pit coal.

NASI'LUM (Lat.), among the ancient Romans signified *freight*, whence it was used for a piece of money put into the mouths of deceased persons to enable them to pay Charon for ferrying them over the Styx. A similar custom prevailed among the Greeks.

NA'SUA. (Lat. nasus, *a nose.*) A genus of Plantigrade Mammalia, so called from the remarkable elongation and upward curve of the nose. The species of this genus, *N. rufa*, or red coati, and *N. fusca*, or brown coati, are both natives of South America. They climb trees in pursuit of birds, and to rob their nests; they burrow for shelter at the foot of large trees, and often undermine them to such an extent that they are liable to be overturned even by a slight wind.

NASU'TA. (Lat. nasus.) A term in Zoology, signifying the prolongation of the muzzle into the form of a nose, as in the *Perameles nasuta*, *Pleuronectes nasutus*, *Truxalis nasutus;* or the development of the integument of the face above the muzzle, forming a true nose, as in the proboscis monkey, *Simia nasuta*. Illiger called a family of Multungulate quadrupeds with the nose prolonged beyond the jaws, and moveable, as in the tapir, *Nasuta*.

NATA'LIS DIES, *Birthday*. A day celebrated with much ceremony by the ancients. Of these there were four, which all Roman citizens were bound to observe; viz. those of the gods, of their emperors, of distinguished persons, and their own. On such occasions every Roman was arrayed in white, and in all his ornaments; among which a ring, called by way of eminence the *annulus natalis*, was conspicuous. Sacrifices were offered to the *genius* (which see) of the person; and the day concluded with a sumptuous entertainment, to which friends and kindred were invited.

NATATO'RES. (Lat. nato, *I swim.*) Swimming birds. The name of the order of birds including those in which the toes are united by a membrane, whence the order is also termed *Palmipedes*. The legs are placed behind the equilibrium, and the body is covered with a thick coat of down beneath the feathers.

NA'TATORY. (Lat. nato.) In Zoology, when a locomotive extremity, or other part, is provided with a membrane, or with close-set hairs, by which it is adapted for displacing water.

NA'TION. (Lat.) A collective appellation for a people inhabiting a certain extent of territory under the same government. The word is also used in some universities, by way of distinguishing students of different districts or countries, as the case may be. This latter meaning is borrowed from the custom that was adopted in the University of Paris previously to the institution of faculties, when those who resorted to it from different countries lived under the same institutions and masters, a *common country*, however, being the only bond of union.

NATIONAL DEBT. In Political Economy and Finance, the amount of the sums or obligations owing by a nation or state.

In modern times, it has been customary in most countries, on the occurrence of any circumstances that occasion any considerable increase of expense, to borrow either the whole or some portion thereof, paying a certain stipulated interest for the same. In this country, the practice of borrowing money, in order to defray part of the war expenditure, was introduced in the reign of William III. And how much soever opinions may differ as to the policy of borrowing or funding in ordinary times, it could not, at its introduction into Great Britain, be dispensed with. The Revolution involved us in a bloody and expensive contest with Louis XIV., then in the zenith of his power, who espoused the cause of the exiled family of Stuart. But, though great and imminent, the danger from without was inferior to that from within. A numerous and powerful party were favourable to the views of the Pretender; and the imposition of such additional taxes as would have been required to defray the heavy cost of the contest we were forced to wage for our liberties and religion would have given a violent shock to industry, and afforded the Jacobites the means of traducing the new government, fomenting popular discontent, and most probably of overturning the revolutionary establishment. Under such circumstances, the contraction of debt was not really a matter of choice, but of necessity. The error, if there have been any, consisted in continuing the system of loans after the new government was firmly established, and when either the whole or a larger portion of the war expenditure might have been defrayed by taxes raised within the year.

In the infancy of the funding system, it was customary to borrow upon the security of some tax, or portion of a tax, set apart as a fund for discharging the principal and interest of the sum borrowed. This discharge was, however, very rarely effected. The public exigencies still continuing, the loans were, in most cases, either continued, or the taxes were again mortgaged for fresh ones. At length the practice of borrowing for a fixed period, or, as it is commonly called, upon *terminable* annuities, was almost entirely abandoned, and most loans were made upon *interminable* annuities; that is, government undertake to pay the lenders of any given sum a certain annuity in all time to come, or till they find it convenient to pay off the principal; but the lenders have no right or title to demand payment of the latter, that being a matter entirely at the option of government, who may either pay it or not, as they think fit.

In the beginning of the funding system, the term fund meant the taxes or funds appropriated to the discharge of the principal and interest of loans; those who held government securities, and sold them to others, selling, of course, a corresponding claim upon some special fund. But after the debt began to grow large, and the practice of borrowing upon interminable annuities had been introduced, the meaning attached to the term fund was gradually changed; and instead of signifying the security upon which loans were advanced, it has for a long time signified the principal of the loans themselves.

During the reigns of William III. and Anne, the interest stipulated for loans was very various. But in

the reign of George II. a different practice was adopted. Instead of varying the interest upon the loan according to the state of the money market at the time, the rate of interest was generally fixed at 3 or 3½ per cent.; the necessary variation being made in the principal funded. Thus, suppose government were anxious to borrow, that they preferred borrowing in a 3 per cent. stock, and that they could not negotiate a loan for less than 4½ per cent., they effected their object by giving the lender, in return for every 100*l*. advanced, 150*l*. of 3*l*. per cent. stock; that is, they bound the country to pay him or his assignees 4*l*. 10*s*. a year in all time to come, or otherwise to extinguish the debt by a payment of 150*l*. In consequence of the prevalence of this practice, the principal of the debt now existing amounts to nearly 2-5ths more than the sum actually advanced by the lenders.

This system of funding has been in the last degree injurious, though some advantages are either derivable or supposed to be derivable from it. No doubt it renders the management of debt, and its transfer, more simple and commodious than it would be, did it consist of a number of funds bearing different rates of interest; and it is contended that the greater field for speculation afforded to the dealers in stocks bearing a low rate of interest has enabled government to borrow, by funding additional capitals, for a considerably less payment, on account of interest, than would have been necessary had such increase of capital not been made.

In point of fact, however, these advantages are inconsiderable, while the disadvantages inseparable from the practice of funding a large amount of stock at a low rate of interest are great and signal. During war, especially if any considerable portion of its expenditure be defrayed by means of loans, the rate of interest uniformly rises, and is usually much higher than during peace. If, therefore, loans were funded in stocks bearing a rate of interest equivalent to the market rate when they were contracted for, the charge on their account might be reduced soon after the return of peace, according to the fall in the rate of interest; whereas, when loans are funded in stocks bearing a low rate of interest, with a corresponding increase of capital, it becomes impossible to take advantage of the fall of interest at the return of peace, and the country is burthened with the war interest in all time to come! It is not easy to exaggerate the injury we have sustained by overlooking this plain principle. In 1815, to specify only one of many similar instances, government bargained for a loan of 27,000,000*l*., it being stipulated that every subscriber of 100*l*. should be entitled to 174*l*. 3 per cent. stock, and 10*l*. 4 per cent. stock, making the interest paid on the loan 5*l*. 12*s*. 4*d*. per cent. The great improvidence of this transaction is obvious. Had from 5*l*. 15*s*. to 6*l*. per cent. of interest been paid for the loan, it might have been obtained without funding any additional capital; and had that been done, we should have been able, within two or three years, in consequence of the fall of interest after the peace, to reduce the charge on account of the loan to 3 or 3½ per cent.; but, owing to the way in which the contract was made, we have not had and will not have any means of reducing the exorbitant charge on account of this loan, so long as the market rate of interest is above 3 per cent., except by paying 174*l*. for every 100*l*. originally received, exclusive of the 10*l*. of 4 per cent. stock! But this, as already stated, is only one instance out of many of the same sort. We believe, indeed, that we are within the mark, when we affirm, that, owing to this erroneous method of funding, the country is at present paying from 6,000,000*l*. to 7,000,000*l*. a year on account of the public debt more than it would have had to pay had the same sums been borrowed and funded without any increase of capital.

We have said that an interest of from 5*l*. 15*s*. to 6*l*. per cent., instead of the stipulated interest of 5*l*. 12*s*. 4*d*. per cent., would have enabled the loan of 1815 to be funded without any increase of capital. Now, this is not a hypothetical statement. In the year in question, 11,000,000*l*. of exchequer bills were funded in a 5 per cent. stock, at the rate of 117*l*. stock for every 100*l*. exchequer bills. This was equivalent to an interest of 5*l*. 17*s*. per cent., being only 4*s*. 8*d*. more than the interest paid on the loan, though the subscribers to the latter had 84*l*. of artificial capital created for every 100*l*. advanced, and the holders of the bills only 17*l*. of artificial capital. But, in point of fact, the differences in the rates of interest, after allowing for certain circumstances connected with the loans, amounted to only 2*s*. 2*d*. per cent. This shows how little the saving in the charge on account of interest, by funding increased capitals, deserves to be considered as at all detracting from the great public loss occasioned by indulging in so wasteful a practice. (For a further and full discussion of this subject, see the *Edinburgh Review*, No. 93. art. iii.)

That this improvident system should have been so extensively acted upon by our finance ministers during the American and French war is the more surprising, seeing that experience had already demonstrated the advantages of funding limited capitals at a comparatively high rate of interest. Owing partly to the scarcity of capital, but much more to the supposed instability of the revolutionary establishment, the loans during the reigns of William III. and Anne were mostly contracted at a very high rate of interest. The stock created was the exact amount of the loans, the interest on it being increased according to the supposed insecurity of the government, the scarcity of floating capital, &c. Now, mark the consequences of this: so early as 1716, Sir Robert Walpole, availing himself of the greater facility with which money was procured after the treaty of Utrecht, and of the greater stability of the government, was able, by offering to pay off the creditors, to reduce the charge on account of the debt from 1,598,602*l*. to 1,274,146*l*., being a saving of 324,456*l*., or about one fifth part of the entire charge. And in 1749, during the administration of Mr. Pelham, the interest was again reduced from 4 to 3 per cent.; a measure which produced a fresh saving of 565,000*l*. a year.

Happily the practice of funding in a 5 per cent. stock was not entirely abandoned during the late war. In 1822, the total British and Irish 5 per cent. stock amounted to about 150,000,000*l*.; and, by offering to pay it off, a reduction of interest was then effected to the extent of about 1,200,000*l*. a year. And since that period, further savings have been effected by the reduction of the interest on the 4 and 4½ per cent. stock. But, unfortunately, the far greatest proportion of the debt created during the late war, and that with the American colonies, was funded in the 3 per cents.; and, as already stated, the charge on that portion has, in consequence, been hitherto, and will most probably continue to be, unsusceptible of diminution.

Payment of National Debt. Sinking Fund. — The payment of the national debt can be effected only by applying to that purpose such surplus revenues as the treasury may have to dispose of. But it was contended by the founders of the sinking fund, established in 1716, and still more strongly by Dr. Price and Mr. Pitt, the founders of the sinking fund of 1786, that if a sinking fund were formed, by applying a certain amount of revenue to buy up stock, and if the dividends on the stock so bought up were afterwards uniformly applied to the same object, such sinking fund would increase at *compound interest*, so that the largest amount of debt might be defrayed almost without an effort. Dr. Price illustrated the operation of this principle by calculating the number of *globes of gold* to which a penny, laid out at compound interest at the birth of Jesus Christ, would now amount to! But though a calculation of this sort be theoretically true, it is practically false and absurd. The truth is, that no sinking fund, even though it consisted of a clear surplus revenue, ever really operates at compound interest. It is true that, by constantly applying the same original amount of free revenue and the dividends accruing on the stock purchased by it to buy up fresh stock, the reduction of the debt is effected in the *same way* as if the free surplus revenue had been increasing, by an inherent energy of its own, at compound interest; but it is essential to know that though the *modus operandi* be the same, the means are radically and totally different. The debt is reduced because a portion of the produce of the taxes is systematically applied to pay it off, and it can never be reduced by any other means. To make capital increase at compound interest, it must be employed in some sort of productive industry; and the profits, instead of being consumed as income, must be regularly added to the principal, to form a new capital. It is unnecessary to say that no such sinking fund has ever existed. Those that have been set on foot in this and other countries have all been supported either by loans or by the produce of taxes, and have never paid off a single farthing of debt by their own agency.

It is clear, from this statement, that when there is no surplus revenue, there can be no sinking fund. Dr. Price, however, did not scruple to lay it down broadly, that to suspend the sinking fund during war, though the expenditure might then greatly exceed the income, would be the greatest imaginable folly. (*Appeal to the Public on the Subject of the National Debt*, p. 17. ed. 1774.) And inconceivable as it may now appear, all parties in parliament concurred in the soundness of this opinion, and approved the policy of keeping up the sinking fund machinery during the whole of last war. Hence the loans for the service of the year had to be increased by the entire amount of the sums placed at the disposal of the sinking fund commissioners; so that for every shilling's worth of stock transferred to them by this futile proceeding, an equal amount of *new debt* had to be contracted, exclusive of the loss incurred through the expense of management, &c.

For upwards of twenty years this contemptible juggle was kept up; parliament and the nation believing, notwithstanding the most decisive experience to the contrary, that it was rapidly diminishing the public debt. Dr. Hamilton of Aberdeen has the merit of having dissipated this delusion, the grossest, certainly, that ever im-

posed on any people. He showed, in his work on the National Debt, published in 1813, that the sinking fund, instead of diminishing, had really added to the debt; and he proved to demonstration that the *excess of revenue above expenditure* is the only sinking fund by which any part of the national debt can be discharged. "The increase of revenue," he observes, "or the diminution of expense, are the only means by which the sinking fund can be enlarged, and its operations rendered more effectual; and all the schemes for discharging the national debt, by sinking funds operating at compound interest, or in any other manner, unless in so far as they are founded upon this principle, are completely illusory."

The entire amount of the debt contracted from 1792 to 1816, both inclusive, amounted to 584,874,557*l.*; but of this no less than 188,522,350*l.* was made over to the commissioners of the sinking fund to be laid out in the paying off debt. But it must not be supposed that the influence of the sinking fund was negative merely, or that it was confined to the futile operation of making money be borrowed with the one hand that it might be paid off with the other. It is clear that a process of this sort could not take an atom from the public debt; but, in point of fact, it added considerably to its amount. Had the sinking fund not existed, the amount of the loans contracted during the war would have been fully a third less than they really were; and, as the rate of interest is always greater on large than on smaller loans, it follows, had this miserable juggle not been kept up, that the money borrowed from 1792 to 1816 would have been obtained at a reduced charge, at the same time that the expenses of its management would have been saved. The sinking fund has, therefore, been a costly as well as a delusive piece of quackery. The loss it entailed on the country during the war has been estimated, apparently on reasonable grounds, at above 600,000*l.*

At length the folly of contracting debt, for no other purpose but to pay it off, became obvious to every one; and the nominal amount of the sinking fund began to be diminished after the close of the war. In 1819, it was attempted to form a real sinking fund of 5,000,000*l.*; that is, to maintain a real surplus revenue of that extent. But as this could not always be done, after various modifications an end was put to the entire system in 1829; the act 10 Geo. 4. c. 27. having enacted, that the sum applicable in future to the reduction of the national debt should be the surplus, if any, of the total revenue beyond the total expenditure of the kingdom.

Distribution of the Dividends, or Interest on the National Debt. — It appears, from the subjoined account of the number of dividend warrants issued during the half year ending the 5th of January, 1833, that they amounted in all to about 280,000, and the number has not materially varied in the interval. The large number (87,176) of holders of stock not producing above 5*l.* of half yearly dividend is principally, we believe, ascribable to the circumstance of the Bank of England and the London private banks not allowing interest on deposits.

We may observe, by the way, that the number of persons having a direct interest in the funds is much greater than it would appear to be from this account. The dividends upon the funded property belonging to the Bank of England and other banks, to the Equitable and other insurance companies, &c., are paid upon single warrants, as if they were due to so many private individuals; whereas they are really paid to these individuals only because they act as factors or trustees for a vast number more. It is, consequently, quite absurd to pretend, as is sometimes done, that any interference with funded property would affect only 280,000 individuals out of a population of 25,000,000. Any attack upon the dividends would really be destructive, not merely of the interests of those to whom dividend warrants are issued, but of all who depend on them: it would destroy our whole system of banking and insurance, and overspread the country with bankruptcy and ruin. Not only, therefore, is every proposal for an invasion of the property of the fundholders bottomed on injustice and robbery, but it would, were it acted upon, be little less ruinous to the community than to the peculiar class intended to be plundered.

I. STATE of the Public Funded and Unfunded Debt of Great Britain and Ireland, and the Charge thereon, on the 5th January, 1841.

PRINCIPAL.

	Capitals Unredeemed. L.	s.	d.
GREAT BRITAIN.			
Debt due to the South Sea Company, at 3 per ct.	3,662,784	8	$6\frac{1}{2}$
Old South Sea Annuities, at 3 per ct. - -	3,497,870	2	7
New South Sea Annuities, at 3 per ct. -	2,460,830	2	10
South Sea Annuities, 1751, at 3 per ct. -	523,100	0	0
Debt due to the Bank of England, at 3 per ct. -	11,015,100	0	0
Bank Annuities created in 1726 - -	825,251	19	0
Consolidated Annuities, at 3 per ct. - -	362,542,977	8	$0\frac{1}{4}$
Reduced Annuities, at 3 per ct. - -	125,861,030	7	10
Total at 3 per ct. -	510,388,944	8	$9\frac{3}{4}$
Annuities at $3\frac{1}{2}$ per ct. anno 1818 - -	10,159,721	17	1
Reduced $3\frac{1}{2}$ per ct. Annuities - -	66,256,849	12	9
New $3\frac{1}{2}$ per ct. Annuities	145,225,865	13	2
New 5 per ct. Annuities	428,076	15	4
Total, Great Britain -	732,462,458	7	$1\frac{3}{4}$
IN IRELAND.			
Irish Consolidated Annuities, at 3 per ct. -	3,272,607	7	1
Irish reduced Annuities, at 3 per ct. - -	115,197	10	10
L.$3\frac{1}{2}$ per ct. Debentures and Stock - -	14,567,562	7	2
Reduced $3\frac{1}{2}$ per ct. Annuities - - -	926,633	7	3
New $3\frac{1}{2}$ per ct. Annuities - - -	12,390,823	18	10
Debt due to the Bank of Ireland, at 4 per ct. -	1,615,384	12	4
New 5 per ct. Annuities	5,672	19	0
Debt due to the Bank of Ireland, at 5 per ct. -	1,015,384	12	4
Total, Ireland -	33,909,266	14	10
Total, United Kingdom	766,371,725	1	$11\frac{3}{4}$
Exchequer Bills outstanding 5th Jan. 1841	22,076,575	1	4
Total Funded and Unfunded Debt, 5th Jan. 1841 - - -	788,447,900	3	$3\frac{3}{4}$

ANNUAL CHARGE.

		In Great Britain. L.	s.	d.	In Ireland. L.	s.	d.	Total Annual Charge. L.	s.	d.
Due to the Public Creditor.										
Annual Interest on Unredeemed Capital - - -		23,090,662	9	$4\frac{3}{4}$	1,193,278	1	$11\frac{3}{4}$			
Long Annuities, expire 1860 -		1,294,140	16	2	352	2	10			
Annuities per 4 Geo. 4. c. 22., expire 1867 - - -		585,740	0	0						
Annuities for a limited term of years, per 59 Geo. 3. c. 34., 10 Geo. 4. c. 24., and 3 Will. 4. c. 14., which expire at various periods, viz.										
Granted up to 5 Jan. 1841	L.1,607,829 18 6									
Deduct, expired and unclaimed up to ditto, including 106,100*l.*, Waterloo Annuities, 59 Geo. 3. c. 34.	292,901 19 3	1,314,927	19	3						
Payable at the National Debt Office.										
Life Annuities, per 48 Geo. 3. c. 142., 10 Geo. 4. c. 24., and 3 Will. 4. c. 14., viz.										
Granted up to 5 Jan. 1841	L.1,681,709 3 6									
Deduct expired and unclaimed up to ditto	823,852 8 0	857,856	15	6						
Tontine and other Life Annuities, per various Acts - - -	English	19,969	14	4						
	Irish -	34,230	8	7	6,823	7	3			
		27,197,528	3	$2\frac{3}{4}$	1,200,433	12	$0\frac{3}{4}$			
Management - - -		158,365	3	$9\frac{1}{4}$						
Annual Charge on account of Public Funded Debt - -		27,355,891	7	0	1,200,433	12	$0\frac{3}{4}$			
Interest on Excheq. Bills (1840)		642,997	7	9						
Total Annual Charge, exclusive of 48,364*l.* 11*s.* $1\frac{1}{4}$*d.*, the Annual Charge on Capitals and Long Annuities standing in the Names of the Commissioners on account of Stock unclaimed 10 years or upwards, and of unclaimed Dividends, and also on account of Donations and Bequests -		27,998,888	14	9	1,200,433	12	$0\frac{3}{4}$	29,199,322	6	$9\frac{3}{4}$

II. Account of the Principal and Annual Charge of the Public Debt at different Periods since the Revolution.*

	Principal, Funded and Unfunded.	Interest and Management.
	L.	L.
Debt at the Revolution, in 1689 - - - - - - - -	664,263	39,855
Excess of debt contracted during the reign of William III. above debt paid off - -	15,730,439	1,271,087
Debt at the accession of Queen Anne, in 1702 - - - - - - -	16,394,702	1,310,942
Debt contracted during Queen Anne's reign - - - - - - -	37,750,661	2,040,416
Debt at the accession of George I., in 1714 - - - - - -	54,145,363	3,351,358
Debt paid off during the reign of George I. above debt contracted - - -	2,053,125	1,133,807
Debt at the accession of George II., in 1727 - - - - - - -	52,092,238	2,217,551
Debt contracted from the accession of George II. till the peace of Paris in 1763, three years after the accession of George III. - - - - - - -	86,773,192	2,634,500
Debt in 1763 - - - - - - - - -	138,865,430	4,852,051
Paid during peace, from 1763 to 1775 - - - - - - -	10,281,795	380,480
Debt at the commencement of the American war, in 1775 - - - -	128,583,635	4,471,571
Debt contracted during the American war - - - - - -	121,267,993	4,980,201
Debt at the conclusion of the American war, in 1784 - - - - - -	249,851,628	9,451,772
Paid during peace, from 1784 to 1793 - - - - - - -	10,501,380	243,277
Debt at the commencement of the French war, in 1792 - - - - -	239,350,148	9,208,495
Debt contracted during the French war - - - - - -	601,500,343	22,829,679
Total funded and unfunded debt on the 1st of February, 1817, when the English and Irish exchequers were consolidated - - - - - - - -	840,850,491	32,038,174
Debt cancelled from the 1st of February, 1817, to 5th of January, 1841 - - -	52,402,591	2,838,852
Debt, and charge thereon, 5th of January, 1841 - - - - - -	788,447,900	29,199,322

* This account has been made up partly from the table in Dr. Hamilton's work on the National Debt (3d ed. p. 100.); partly from the *Parl. Paper*, No. 165. Sess. 1834; and partly from the *Annual Finance Book* for the year ending 5th of January, 1841, p. 105., &c.

III. An Account of the Total Number of Persons to whom a Half Year's Dividend was due at the last Half-yearly Payment thereof, on each Description of Public Stock, and on each Description of Terminable Annuities; distinguishing the Number respectively of those whose Dividends for the Half Year did not exceed 5*l*., 10*l*., 50*l*., 100*l*., 200*l*., 300*l*., 500*l*., 1,000*l*., 2,000*l*., 3,000*l*., 4,000*l*., 5,000*l*., and the Number of those whose Dividends exceed 5,000*l*.; distinguishing also, in those above 1,000*l*., the Dividends due to any Public Company, or to more than a single Name. — (*Parl. Paper*, No. 202. Sess. 1833.)

	Not exceeding														5,000*l*. and upwards.	Total.
	5*l*.	10*l*.	50*l*.	100*l*.	200*l*.	300*l*.	500*l*.	1,000*l*.	2,000*l*.	Co. & Joint Accts.,3,000*l*.	3,000*l*.	Co. & Joint Accts.,3,000*l*.	4,000*l*.	Co. & Joint Accts.,4,000*l*.		
Number to whom dividends were payable																
On 3*l*. per cent. reduced annuities -	10,347	4,745	11,681	3,473	2,175	742	453	231	53	24	9	5	5	3	12	33,958
On 3*l*. 10*s*. per cent. reduced annuities - - - - -	7,019	4,362	10,173	2,909	1,561	411	251	112	15	21	5	4	nil	1	5	26,849
On 3*l*. 10*s*. per cent. annuities, 1818	† 198	162	399	211	127	57	38	30	3	3	nil	nil	nil	1	3	1,232
On 4*l*. per cent. annuities, 1826 -	1,601	993	2,044	512	312	92	59	15	4	1	2	1	nil	nil	nil	5,636
On long annuities - - -	9,078	4,212	8,361	1,516	725	187	99	34	4	1	1	1	1	1	nil	24,221
On annuities for terms of years -	1,519	787	1,632	351	178	56	32	20	4	nil	2	nil	nil	nil	2	4,583
On 3*l*. per cent. consolidated annuities - - - - -	28,722	13,749	32,601	9,612	6,286	2,141	1,424	709	153	18	16	20	7	13	21	95,555
On 3*l*. per cent. annuities, 1726 -	‡ 120	74	180	40	27	4	2	nil	nil	nil	nil	nil	nil	nil	nil	447
On new 3*l*. 10*s*. per cent annuities -	26,881	14,698	29,370	6,648	3,129	765	431	204	28	20	4	1	2	4	9	82,194
On new 5*l*. per cent. annuities -	35	31	107	36	20	3	4	nil	1	nil	nil	nil	nil	nil	nil	237
On annuities for terms of years -	1,656	833	1,757	333	161	37	34	12	1	nil	1	3	nil	1	8	4,839
Totals -	87,176	44,648	98,305	25,641	14,701	4,495	2,827	1,367	266	151	40	35	15	24	60	279,571

† Dividends payable 10th of October.

‡ Dividends payable on 5th of January.

NATIONS, LAW OF. *See* Law.

NATI'VITY. A word used by way of eminence to signify the birthday of our Saviour, and of saints and other canonized persons. In Astrology, the word nativity is synonymous with *horoscope*, which see.

NA'TRIX. The subgenus of the Linnæan *Colubri*, of which our common harmless snake, *Coluber natrix*, Linn., is the type.

NA'TROLITE. A mineral which occurs in small rounded fibrous masses of a yellowish colour; it is by some called *prismatic zeolite*. It is chiefly found in Suabia in amygdaloidal basalt. It is a hydrated silicate of soda and alumina.

NA'TRON. The German name applied to soda; hence, also, the German chemists call sodium *natrium*. It is probably from the ancient term *νιτρον*, *nitron*, or fossil alkali; hence *nitre*. It is found in sandy soils of various countries, but more especially in Egypt, where it was anciently employed to a great extent in the art of embalming. *See* Mummy.

NA'TURAL. In Music, a character marked thus ♮, whose office is to contradict the flats or sharps placed at the beginning of a stave or elsewhere, and by the use of which the note to which it is prefixed returns to the diatonic scale.

NA'TURALIZATION. In Law, the process by which an alien is placed in the same civil condition as if he had been born under the dominion of the state. In England, this can only take place by act of parliament; and it is provided by stat. 1 G. 1. c. 4. that no bill for naturalization can be received without certain clauses incapacitating the party from sitting in parliament, or being a member of the privy council, &c. *See* Alien.

NATURAL HISTORY, may be defined to be the history and description of the natural products of the earth, whether minerals, vegetables, or animals, together with a scientific development of their causes and effects. The reader will find all the branches of this wide and interesting subject treated at considerable length under their respective heads.

NATURAL ORDERS OF PLANTS, are groups of genera which are supposed to bear a greater resemblance to each other than to any thing else. They may be said to be coeval with our knowledge of plants; for the old ideas of grasses, trees, herbs, corn, fruit trees, indicate a natural perception of the existence of some such groups. When systematical botany first assumed the semblance of science we find the Umbelliferous, Leguminous, Liliaceous, Labiate, and Composite orders, more or less distinctly defined. It is, however, chiefly by the labours of botanists posterior to the days of Linnæus, especially to Jussieu and his followers, that the present improved limitation of natural orders is owing. It must, however, be confessed that they are still in great need of regulation, which can scarcely, however, be anticipated until something precise shall have been settled concerning the relative value of differences in organization. The most

complete account of them in English is that in *Lindley's Natural System of Botany*, ed. 2., in which 289 natural orders are enumerated.

NA'TURAL PHILOSO'PHY, or PHYSICS, is the science which treats of the properties of natural bodies, and their actions on each other. *See* PHYSICS.

NATURE, LAW OF. *See* LAW.

NAU'CA. In Botany, a seed in which the scar of the helum occupies one third part of the external surface, as in the horse chesnut.

NAUMA'CHIA. (Gr. ναυς, *a ship*, and μαχη, *a fight*.) Among the Romans, a representation of a naval engagement, which took place most usually in theatres (called also naumachiæ) made especially for the purpose. These exhibitions were originally instituted for purposes of naval discipline; but, in process of time, only malefactors or captives whose lives had been forfeited participated in them. They appear to have been conducted on a scale of such magnificence as almost to exceed belief. Within the places set apart for them whole fleets went through their evolutions without inconvenience or confusion, and all the appliances of human ingenuity were put in play to give an air of reality to the representation. We are told by Suetonius that in an exhibition of this sort given by Nero sea monsters were seen swimming about in the artificial lake; and in the sea-fight on the lake Fucinus, given by Claudius, there are said to have been no fewer than 19,000 combatants. Julius Cæsar appears to have first given a naumachia on an extensive scale: his example was followed by many of his successors on the imperial throne; and at last they were frequently exhibited at the expense of private individuals, as a means of increasing their popularity. The seats for the convenience of spectators were arranged in a manner somewhat similar to those in the amphitheatres. *See* AMPHITHEATRE.

NAU'SEA. (Gr. ναυς, *a ship*.) A sensation of sickness, similar to that produced by the motion of a ship at sea. An inclination to vomit.

NAUTILI'DÆ. (Gr. ναυτιλος, the name of the argonaut in Aristotle.) The family of Cephalopods with siphoniferous shells, of which the *nautilus* is the type.

NAU'TILUS. (Gr. ναυτιλος.) The name of a genus of Tetrabranchiate Cephalopods, including those which have a chambered shell with simple septa, perforated in the centre, concave towards the outlet of the shell, and with the last chamber the largest, and containing the body of the animal.

NA'VAL ARCHITECTURE. In the small space we can assign to this subject we shall merely endeavour to convey a general notion of the principles and process of construction.

Ships are built in different forms, according to the service they are intended for and the burdens they have to carry. It is in men-of-war, which, besides possessing in an eminent degree the general qualities of a ship, have to support a heavy armament of cannon, and which are destined to severe and long-continued service, that the principles of construction have been carried to the greatest perfection. The form of the ship, her strength, or the scantling necessary for the services required of her, are, from our imperfect knowledge of hydrodynamics, the results of experience alone.

When a ship is to be built, her form is projected in three different planes perpendicular to each other.

1st. The *sheer draught*, which is the side view, or projection on the plane of the keel. On this are laid off the length, the heights of all the parts from the keel, the position and rake of the stem and sternpost, the principal frames or timbers of the sides, the ports, decks, channels, place of the greatest breadth or midship frame, stations of the masts, &c.

The frames before the midship frame are distinguished by letters; abaft it, by numbers.

The midship frame is not exactly in the middle of the length, but rather before it.

2d. The *body plan*, or end view. This shows the contour of the sides of the ship at certain points of her length; and since the two sides are exactly alike, the left half represents the vertical sections in the after part of the body, and the right hand half those in the fore part. The base of the projection is the midship, or largest section, called also the *dead flat*, within which the other sections are delineated. On this are exhibited also the beams of the decks.

3d. The horizontal or floor plane, called also the *half breadth plan*. The base of this is the section made by the horizontal surface of the water and the outside surface of the ship, and is called the *upper water line*, or *load water line*. If the ship now be supposed to be lightened uniformly, she will exhibit another water line, and thus any number of like parallel sections at equal distances down to the keel.

On this projection the water lines appear as curves, on the sheer draught as straight lines parallel to the keel.

These three sections correspond to each other upon the same scale; and any point in one is immediately referable to the other two projections.

The several parts are drawn from these plans in their full size on the floor of the mould loft, and worked from the moulds or models so taken.

The place in which the ship is built is called a *slip*. In the middle, and leading to the water, is a row of piles of stout pieces of wood called the *blocks*, having a declivity towards the water of about 1 inch in 1 foot. On these the keel, which is of elm, is laid, and its component lengths scarfed together. Under the keel is placed the false keel for defence. At the end furthest from the water is raised the *stem*, which is in fact the keel continued upwards. Inside the stem, and just above the keel, is the *apron*, a curved timber connecting both. On each side of the upper part of the stem is fixed an upright timber; these are called the *knight heads*, and the bowsprit lies between them. At the other end of the keel is the sternpost, at which the planking finishes abaft, and on which the rudder is hung. Inside (or before this) are the *inner post* and other pieces for strength. Upon the keel is fixed a layer of timber of the same breadth, and rising forward and aft, called the *dead wood;* on this are placed the *floor timbers:* these consist of one which crosses the keel to which it is coaked, and the two parts of a like timber firmly joining it, and projecting beyond its ends. The several pieces are got into their places by shifting shears.

The *frames* consist of pairs of timbers composed of pieces of different lengths, joining the floor timbers, and carried upwards. The length joining the floors is called the first futtock, the next the second futtock, and so on, ending in the *top timbers*. The pairs are bolted by iron bolts; and of late adjacent pairs have been thus connected. The frames are supported temporarily by being fixed to the *cross spalls*,— long fir planks laid horizontally about the height of the gun deck.

Those frames whose planes are perpendicular to the keel are called *square frames;* at the head and stern these planes incline towards the extremities, and are called *cant frames*. These divisions of the ship are called accordingly *square* and *cant bodies*.

When the framing has assumed its form the *ribands* are fixed; these are thick narrow planks at wide intervals, extending the length of the vessel, marking the direction of the planks; they are firmly shored, and removed when the planking comes on. The *riband lines* appear on the half breadth plan as diagonal lines.

Upon the keel, and over the floor timbers, to which it is scored, is laid the *kelson*, which is, in fact, a second keel over the first.

The stern of square-sterned ships is formed upon the *wing transom;* the uppermost of the horizontal pieces of timber called *transoms* crossing the sternpost inside.

The wing transom is secured to the timbers of the side by a strong horizontal knee.

When the framing is complete, the outside planking is laid on. The *wales*, thick planks above the water, are first secured to the ribs. The *clamps* are thick planks inside, to support the ends of the beams of the decks.

The *beams* support the decks, rest on the clamps, and are secured to the side by *knees*.

The *breast hooks* are strong curved pieces of timber crossing the stem, and joining the bows. The *deck hooks* are the same, being at the decks. The *crutches* answer a like purpose below in the after part.

The *port sills* are the upper and lower edges of the ports.

The *spirketting* is the plank of the side between the water way and the port sill.

The *chain wales* are thick planks of the outside to receive the chains and preventer bolts for the support of the rigging.

The *foot waling*, or *ceiling*, is the plank lining the inside of the ship below.

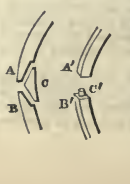
The *limber boards* are short thick pieces of wood resting against the kelson for the convenience of keeping a clear passage to the well.

The *knee of the head*, also called the *cutwater*, is the projecting part of the head; it is secured to the bows by knees called *cheeks*.

In order to bend wood into the necessary curvature it is steamed in places for the purpose. When the planking is all complete, the ship is caulked and painted.

The fastenings of timber are effected by bolts, treenails, or coaks. The present method of framing ships of war is chiefly due to Sir Robert Seppings. We shall describe it here generally: for particulars, see the *Phil. Trans.* 1814, and the published reports on the subject.

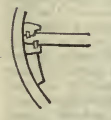
As the timbers or ribs cannot be procured entire, or of the proper curvature, various methods have been used for joining the several pieces together. A method used till lately consisted of an angular chock C, fastened by treenails to the ends A B of the timbers. By this plan all stress upon the joint, in whatever direction, falls on the treenails; and when the chock decays, no support is afforded in any sense whatever.



At present the square ends, A′ B′, are brought together, while a *coak* C′, or small oak cylinder, is let into each.

By this plan the two faces resist any effort by pressure from without to close the timbers, and the coak itself resists the effort (perpendicular to this last) to make one timber slide past the other by the whole force necessary to cut it off flush with the section. In the single case of lifting one face exactly perpendicularly off the other, the coak offers no resistance; this effort, which is that produced by the strain of the rigging on the sides, is opposed by other numerous connections. The method is very ancient, being used in the construction of the pillars in the temple at Balbec; the advantage of its application to shipbuilding is seen in the frames, which undergo no change of form while hoisting into their places. The efficiency of the plan, however, does not appear in a single length, but in the system of frames, each joining of which is placed near the middle of the next piece.

A *shelf piece*, coaked and bolted to the timbers or ribs, and resting on short vertical pieces of timber called *chocks*, and sometimes scored to the ribs, is carried like a hoop entirely round the ship. On this the beam ends are coaked; and over these again is laid a strong water way scored to the beams, and coaked. Besides these the beam end is clasped by two arms of an iron knee, of which the third, which is vertical, is bolted to the chock.



The shelf binds firmly the ends and sides of the ship together, and resists like an arch all external pressure.

The spaces between the timbers below are filled up by dry wood driven in tight, and caulked, thus rendering the bottom solid and water-tight, independently of the planking.

One of the most important improvements is the diagonal framework below. Instead of the former planking in the hold are placed *braces*, crossing the ribs, to which they are coaked, at an angle of 45°; those in the fore body incline (or rake) aft, and those in the after body forward. They butt against the kelson, and extend nearly to the water; they are in general placed under every other beam, but closer at the extremities.

Longitudinal pieces of timbers are laid nearly parallel to the keel over the heads or joinings of the timbers, and bolted through; these, crossing the diagonals, form a series of rhomboidal figures, across which, inside, are firmly driven *trusses*, lying the opposite way from the diagonals: these are bolted through, and, when necessary, are further tightened by driving in thin iron plates at the ends. The diagonals act by the *tension* of the fibres, the trusses by the *thrust*, and the whole thus resists every effort to change the figure of the ship.

The system was first put into complete practice in the Tremendous, 74, in 1810; which ship evinced, in several severe trials, a firmness and dryness not known before.

M. C. Dupin has shown (*Phil. Trans.* 1817) that the principle of diagonal framing had suggested itself, and been tried by several French engineers, but as often abandoned. The merit, therefore, of Sir R. Seppings, in reducing to practice a system which to others had been attended with insuperable difficulties, more than compensates the want of novelty in the idea itself.

The ancient square, massive, but weak sterns, have been replaced by Sir R. Seppings by round sterns, corresponding in construction, and therefore in strength, to the bow. These have again undergone various alterations, tending to combine the strength of the new with the imposing appearance of the former stern.

It is only now by contrasting the solid and immoveable frame with the former weak and unconnected structure, that we can fully perceive the inefficiency of the ancient construction. The timbers, instead of forming an independent system, were often supported in part by the planking itself, as is the case in boats. The masts, resting only upon their steps, instead of strong platforms which diffuse the pressure on all sides, and pressed downwards by their weight, and by the enormous strain of the rigging, arising from the wind on the sails, forced the keel down, and made the ship leaky. The timbers and framework, being at right angles, without mutual support, the whole stress of the ship came on the fastenings; and, lastly, the safety of the ship depended entirely upon that of the outside plank, the part most exposed to injury.

The planks of the decks have also sometimes been placed diagonally; and lately iron diagonal straps have been added to the upper works inside.

The extremities being unsupported below by the water droop, or the ship *hogs*, a three-decker formerly drooped at once, on being launched, 9 inches at each end, which increased with her length of service; at present, such a ship droops only $3\frac{1}{2}$ inches, which, when the materials are set, suffers little or no increase.

Within the last few years considerable changes have been made by Sir W. Symonds in increasing the beam of the ships, and therefore their stability, and otherwise in the forms. Several improvements have also been introduced by Sir O. Lang.

Exposure to moisture being a cause of the decay of timber, building under cover has long been practised. This also protects the men from the weather.

The wood usually employed in shipbuilding is oak. Elm, which does not split readily, is employed for the keel, and for the caps. East India teak, a very heavy durable wood, which does not shrink, nor is liable to splinter from shot, is now very much used. African teak is also much used. Fir is used for light works, masts, &c.

The bottoms of ships are liable to become covered with weeds and shells, and to be eaten through by worms. To prevent these evils, the bottoms were formerly covered with a thin sheathing of wood, which was replaced when worn. Lead has also been used. Ships are now sheathed almost universally with thin sheets of copper.

For further information on this subject, reference may be made to the following works: — Bouguer, *Traité du Navire;* Clairbois, *Traité Elementaire, &c.*; *Chapman's Naval Archit.*, with Notes by Dr. Inman; *Steel's Elements*, with an Appendix by J. Knowles, F.R.S.; *Fincham's Outlines of Shipbuilding;* the article "Shipbuilding" in the new edition of the *Ency. Britannica*.

NAVAL CROWN. Among the Romans, a crown of gold or silver, resembling the prow of a ship, awarded to him who first boarded a hostile vessel. *See* CROWN.

NAVE. *See* NAOS.

NAVE. In Mechanics, the middle part of the wheel, from which the spokes radiate.

NAVIGA′TION (Lat. navis, *a ship*), is that branch of science by which the mariner is taught to conduct his ship from one part or place to another.

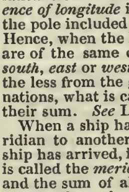
To understand the principles of navigation, and their practical application, it is necessary that the mariner should be acquainted with the form and magnitude of the earth, the relative situations of the lines conceived to be drawn on its surface, and have charts of the coasts and maps of the harbours which he may have occasion to visit. He must also understand the use of the instruments by which the direction in which a ship is steered and the distance which she sails are ascertained; and be able to deduce from the data supplied by such instruments the situation of his ship at any time, and to find the direction and distance of any place to which it may be required that the ship should be taken.

A curve passing through any two places on the earth, and cutting every intervening meridian at the same angle, is called a *rhumb line;* the angle which such a curve makes with each meridian is called the *course* between any two places through which the curve passes; and the arc of that curve intercepted between any two places is called their *nautical distance*. This distance is more than that measured on the arc of a great circle passing through the two places, unless both places are on the same meridian, or both on the equator, when the rhumb line and great circle coincide.

The *difference of latitude* between any two places is an arc of a meridian intercepted between the parallels of latitude on which the places are situated; and the *difference of longitude* is the arc of the equator, or the angle at the pole included between the meridians of the places. Hence, when the latitudes or the longitudes of two places are of the same denomination with respect to *north* or *south*, *east* or *west*, the difference is found by subtracting the less from the greater; but when of different denominations, what is called their difference is found by taking their sum. *See* LATITUDE, LONGITUDE.

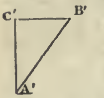
When a ship has sailed on a rhumb line from one meridian to another, the arc of the parallel at which the ship has arrived, intercepted between the two meridians, is called the *meridian distance* which the ship has made; and the sum of all the intermediate meridian distances, computed on the supposition that the distance sailed on the rhumb line is divided indefinitely small equal parts, is called the *departure*.

In the annexed diagram, let P represent the north pole; D E an arc of the equator; P D, P F, P G, and P E meridians, and A B a rhumb line passing through A and B; A S, K H, L I, and B C, arcs of parallels of latitude at the points A, H, I, and B respectively; and let A H, H I, I B, &c. be so small and so numerous that neither they nor A K, K H, H O, I O, &c. may differ sensibly from straight lines. Then if a ship sail from A to B, B C is called the meridian distance; if from B to A, A S is called the meridian distance; and in either case the sum of K H, O I, N B, is called the *departure;* and A K + O H + I N, &c., which is always equal to A C or B S, is the *difference* of latitude.



Now, A K H, O H I, N I B, &c., may be considered as identical right-angled plane triangles; and if in the an-

nexed plane triangle, right-angled at C′, A′ B′ be taken equal to A B in the preceding figure, A′ C′ to A C, or to its equal A K + H O + I N, and the angle B′ A′ C′ to B A C, or O H I, or N I B, then C′ B′ in this figure would accurately represent K H + O I + N B, &c. in the preceding one. That is, in the plane triangle A′ B′ C′, right-angled at C′, if A′ represent the course from one place to another, A′ B′ the distance of the two places measured on the rhumb line passing through them; then A′ C′ will be their *difference of latitude*, and C′ B′ the *departure* made in sailing from the one to the other.



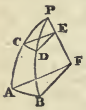
On these principles depend what is called *plane sailing;* and it is evident that if any two of the four elements, *course*, *distance*, *difference of latitude*, and *departure*, be given, the others may be found by the resolution of a right-angled plane triangle. The formulæ are,

$$\begin{aligned} \text{dep.} &= \text{dist.} \times \text{sin. course}, \\ \text{diff. lat.} &= \text{dist} \times \text{cos. course}, \\ \text{dist.} &= \text{dep.} \times \text{cosec. course}, \\ \text{dist.} &= \text{diff. lat.} \times \text{sec. course}, \\ \text{tan. course} &= \frac{\text{dep.}}{\text{diff. lat.}}. \end{aligned} \qquad \text{(A.)}$$

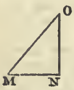
When a ship sails on a meridian, the diff. lat. is the same as the nautical distance, and the *latitude* only, not the longitude, is changed; and when a ship sails on a parallel of latitude, the departure is the same as the nautical distance, and the *longitude* only, not the latitude, is changed: but in sailing in any other direction, both the latitude and longitude are changed.

For finding the change of latitude corresponding to any course and distance, the principles of plane sailing, already explained, are sufficient; but to find the change of longitude corresponding to any given change of place requires considerations of a different kind.

Let a ship sail on a parallel of latitude, as from C to D, and let P C A, P D B, be two meridians passing through C and D, and meeting the equator in A and B; then A B, or the angle A P B, is the difference of longitude, corresponding to the distance C D sailed on the parallel in the latitude A C or D B. And if F be the centre of the sphere, A F B, C E D, portions of the planes of the equator and parallel respectively, we have, by similar sectors, C D : A B : : D E : B F : : cos. lat. : rad. : : 1 : secant of lat.; therefore A B = C D sec. lat.



Hence, again, if in the annexed plane triangle M N O, right-angled at N, the angle M be made equal to the number of degrees and minutes of the latitude of the parallel on which the ship is sailing, and M N be equal to C D, MO in this figure will be equal to the arc A B in the preceding one, and will consequently represent the difference of longitude; for



$$\text{M O} = \text{M N sec. M} = \text{C D sec. lat.}$$

Therefore, in sailing on a parallel, the properties which connect the latitude of the parallel, the distance sailed upon it, and the corresponding diff. long. are all found in a right-angled plane triangle; the base representing the distance sailed on the parallel, the hypotheneuse the diff. long., and the included angle the latitude of the parallel.

When a ship sails on an oblique rhumb, two methods have been proposed for connecting the other elements with the diff. long.: one called the *middle latitude* method; and the other, from the name of its inventor, *Mercator's sailing.*

Middle latitude sailing is a compound of plane and parallel sailing. Referring to the first figure in this article, it is evident that K H is greater than C M, but less than A Q; that O I is greater than M N, but less than Q R; and that K H + O I + N B will not differ greatly from the meridian distance midway between the parallels C B and A S.

The departure corresponding to course c, and distance d, being therefore found from dep. $= d$ sin. c, and this being taken as a meridian distance in the latitude $\frac{1}{2}(l + l')$, the middle latitude between the latitude l sailed from and that l' arrived at, the diff. long. is found approximately from the principles of parallel sailing, from the formula,

$$\text{diff. long.} = \text{dep. sec.} \tfrac{1}{2}(l + l').$$

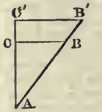
From this, and from the first and last of the formulæ (A.), we immediately deduce the following for middle latitude sailing, viz.:—

$$\begin{aligned} \text{diff. long.} &= \frac{\text{dist.} \times \text{sin. course}}{\text{cos. mid. lat.}} \\ \text{tan. course} &= \frac{\text{diff. long.} \times \text{cos. mid. lat.}}{\text{diff. lat.}} \\ \text{dep.} &= \text{diff. long.} \times \text{cos. mid. lat.} \end{aligned} \qquad \text{(B.)}$$

In *Mercator's sailing* the globe is conceived to be extended from the equator towards the poles, so as to form a cylinder whose diameter is that of the equator; the corresponding elementary parts of the meridians and parallels, as projected on the cylindric surface, bearing the same proportion to each other as the like corresponding parts do on the spherical surface; the projected rhumb lines being straight lines, and the poles vanishing in infinite distance. Such a cylinder, unrolled on a plane, is called a *Mercator's chart*. Now, considering the earth as a sphere, the meridians and the equator are equal great circles, and therefore any small portion of a parallel is to a like portion of the meridian in the same proportion as the radius of the parallel to the radius of the equator; that is, as the cosine of the latitude to the radius of the tables, or as radius to the secant of the latitude. If, therefore, m represent the length of an elementary portion of the meridian at latitude l, and m' be the projection of m on Mercator's chart; then, generally, $m' = m$ sec. l.

It follows from this that in Mercator's projection the degrees of latitude, which at the equator are equal to those of longitude, increase with the distance of the parallel from the equator proportionally to the secants of the latitudes. The parts of the meridian thus increased are called *meridional parts;* and it is a property of the projection that the meridional parts of any given latitude are equal to the sum of the secants of the minutes in that latitude. (*See* MERCATOR'S CHART.) The sum of the secants being computed for every minute up to any latitude l, and tabulated, forms what is called a table of *meridional parts;* and the difference, or the sum of the meridional parts corresponding to the latitudes of any two places, is called the meridional diff. lat. of those places, the *difference* being taken when the latitudes are of the *same*, and the *sum* when of *different* denominations.

It is likewise a remarkable property of Mercator's projection, that any small triangle on the sphere is represented on the chart by a similar triangle, the angles of the original triangle and its representation being equal. Hence the ship's path on the sphere and its projection on the chart cut the meridians under the same angle. If, therefore, A B C be a triangle on the sphere, A C being a portion of the meridian, and A B′ C′ its projection; then A B′ and A C′ will be in the same direction with A B and A C, and B′ C′ will be parallel to B C. In these triangles, therefore, the course A is an angle common to both; A C is the diff. lat., A C′ the meridional diff. lat., C B the departure, C′ B′ the diff. long., A B the distance run, and A B′ the distance as projected on the chart, the same scale being used for measuring all the lines in the diagram. Hence, from such parts of these triangles as may be determined by observation, or taken from tables, the others may be computed.



The following formulæ are obvious consequences of this construction:—

$$\begin{aligned} \text{diff. long.} &= \frac{\text{dep.} \times \text{mer. diff. lat.}}{\text{diff. lat.}} \\ \text{tan. course} &= \frac{\text{diff. long.}}{\text{mer. diff. lat.}} \\ \text{distance} &= \text{diff. lat.} \times \text{sec. course.} \end{aligned} \qquad \text{(C.)}$$

The course of a ship at sea is determined by the *compass* (for the description of which *see* COMPASS). The needle generally rests in a position pointing northerly and southerly; and the angle which its direction makes with the true north and south line is called the *variation of the compass*, the variation being denominated *easterly* or *westerly*, according as the north end of the needle is to the east or west of the true north. The amount of this deviation differs greatly in different situations; and it is by no means a constant quantity even at the same place. There are, however, simple astronomical means of finding it at any place; so that, by applying a correction for the variation, either the true course may be gained from an observed compass one, or the compass course from a computed true one.

Besides the general *variation* to which we have here adverted, it is found that in ships which have large masses of iron on board, the compass is sensibly attracted, and the effect varies with the direction of the ship's head. Mr. Barlow has devised a remedy for this cause of derangement, which consists in placing a small disk of iron in such a situation behind the compass that its single effect exactly counterbalances the combined force of the more distant masses. *See* MAGNETIC COMPENSATOR.

The velocity of the ship, or the *rate* of sailing, is determined experimentally, at the end of every hour, by heaving the *log*. (*See* LOG.) For changes of velocity between the times of heaving the log, the officer on duty makes the best estimate he can.

When the wind is adverse or changeable, it is often requisite to sail on different courses; and the crooked line which the ship then describes is called a *traverse;* and the method of finding a single course and distance equivalent to such a compound one is called *resolving a traverse.*

This may be done by a geometrical projection, but it is generally effected in practice by the aid of the traverse table. From this table the *diff. lat.* and *dep.* corresponding to each course and distance is taken, and entered in an appropriate table, having columns headed N. S. E. W.; namely, N. and S. for diff. lat., and E. W. for departure. The difference between the sums under N. and S. shows the diff. lat., as does the difference between the sums under E. and W. the departure; and in either case the difference is of the same denomination as the larger sum. The course and distance required are then either found by inspection in a traverse table, or by the formulæ (A.).

When a ship makes considerable way through the water, and the wind is on the beam, abaft it, or even a little before it, she generally moves forward in the direction of the fore and aft line; but in rough weather, with the wind forward, she will generally be driven more or less to leeward, as will be shown by the direction of the wake, or the ripple formed by the waves closing behind her. The angle which this ripple makes with the direction of the keel is called the *leeway;* and it must be applied as a correction to the course shown by the compass, and always allowed *from* the wind, — that is, to the left, if the wind is on the right-hand side of the ship, and to the right, if on the left. *See* LEEWAY.

All matters relating to the navigation of a ship are entered in a systematically ruled book, called the *log-book;* and what day after day is so recorded is called the ship's journal. The principal columns in the log-book are for the hour of the day, the course, rate of sailing, leeway, and winds; one for general remarks, and for entering the particulars and results of celestial observations, for notes on the weather, and memoranda as to all important points of duty in the ship, the sails set, and the manner in which the crew are employed. To this is daily appended the latitude and longitude of the ship at noon, both as deduced from celestial observations, and as computed from the course and distance since the time when the place was last ascertained. The place determined from the course and distance is called the place by *dead reckoning*. The bearing and distance of the land first expected to be seen, and the course and distance made on the whole, during the day, are also added.

If the course and distance could always be accurately determined, the place of the ship could be computed with corresponding exactness from the principles of which we have above given a concise account. But these data can only be obtained in a roughly approximative form. The effect of unknown currents, unavoidable imperfections in steering, and numberless other sources of error, render the place of the ship, as estimated from the reckoning, very doubtful; and, in fact, when the mariner is obliged to rely for several days on these data only, he often finds that his expected and his true place are considerably distant from each other.

In the modern practice of navigation, therefore, the course and distance are only used to enable the seaman to assign approximately the place of his ship between the times at which it is determined, independently, by celestial observations.

This branch of nautical knowledge, which is generally and properly included in every system of navigation, is called *nautical astronomy;* and the improvements which have been introduced in its modern application constitute the chief difference between navigation as practised in our own and former times.

For a minute explanation of the processes by which the place of a ship on the wide ocean may be determined, from the observed situation of celestial objects with respect to each other and to the horizon, we must refer to works expressly devoted to the subject. But we shall give a short account of the most useful practical methods of finding the *latitude*, the *longitude*, and the *variation of the compass*, which are the three principal problems in nautical astronomy.

Reduction of Altitudes. — Before the altitudes of celestial objects as observed at sea can be employed in the solution of astronomical problems, they must be corrected for the effects of dip and parallax; and for semidiameter, when the altitude of the upper or lower border, instead of that of the central, has been observed, as in the case of the sun or moon.

If $A =$ the altitude of the upper or lower border, $s =$ the semidiameter, d the dip of the horizon (that is, the angle through which the sea horizon appears depressed in consequence of the elevation of the observer), r the refraction corresponding to the alt. A, and p the horizontal parallax taken from the *Nautical Almanac* for the time of observation, and $A' =$ the true altitude: then

$$A' = A - d \mp s + p \cos. (A - d \mp s) - r.$$

In practice, the corrections to be applied to A to obtain A′ are taken from tables, and the process of reduction is short and simple.

To find the latitude from the observed meridian altitude of a known celestial object: —

Let z be the complement of the true altitude, as deduced from the observed one, D the object's declination, and L the latitude; and call z north when the zenith is north, and south when it is south of the object: then $L = z \pm D$; a formula in which D is + when z and D are of the same, and — when of different denominations, and L is of the same denomination as the greater of z and D.

To find the latitude from two observed altitudes of the sun, with the time elapsed between the observations: —

Let $t =$ the half elapsed time in degrees, p the sun's polar distance at the middle instant between the observations, $s =$ half the sum, and $d =$ half the difference of the two corrected altitudes; then compute the angles A, B, C, D, and E, in succession, from the following formulæ: —

$$\sin. A = \sin. t \cdot \sin. p.$$
$$\cos. B = \sec. A \cdot \cos. p.$$
$$\sin. C = \text{cosec.} A \cdot \cos. s \cdot \sin. d.$$
$$\cos. D = \sin. A \cdot \sin. s \cdot \cos. d \cdot \sec. C.$$
$$E = B \mp D.$$

And the expression for the latitude is,

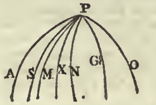
$$\sin. \text{lat.} = \cos. D \cdot \cos. E.$$

There are many other methods by which the latitude may be found, but the two which we have given are those most generally used by seamen.

We pass on to a consideration of the principles on which the methods of finding the longitude astronomically at sea are founded.

The longitude is found by comparing the *time* at the first meridian with the *time of the same denomination* at the place of observation, allowing 15° of longitude for every hour in the *difference* of the times.

In the annexed diagram, let P A represent the meridian passing over the first point of *Aries*, P S that passing over the true and P M that passing over the mean place of the sun, and P X that passing over any other celestial object X. Let also P G be the meridian of Greenwich, P N a meridian in *west* longitude, and P O a meridian in *east* longitude.



Then, for that instant of absolute time, A P G represents the *sidereal*, S P G the *apparent*, and M P G the *mean* time at Greenwich; twenty-four hours of time being represented by four right angles. A P N, S P N, and M P N, are the sidereal, apparent, and mean time at the meridian P N; and A P O, S P O, and M P O, the like times at the meridian P O.

Now N P G, the longitude of the meridian P N, = A P G − A P N = S P G − S P N = M P G − M P N; and G P O, the longitude of P O, = A P O − A P G = S P O − S P G = M P O − M P G.

Therefore, the longitude of any place represented in time is equal to the difference of the relative times at the first meridian and the meridian of the place; the times being both sidereal, both apparent, or both mean time, and both reckoned from the same noon, — *west* when the Greenwich time is *greater*, and *east* when it is *less* than the time at the place of observation.

The angle X P G, reckoned westerly from P G, is called the meridian distance of the object X from the meridian P G, and X P N its meridian distance from the meridian P N. A P X is its right ascension, A P S the right ascension of the sun, and S P M the *equation of time*, or the difference between mean and apparent time.

Now, if a be the altitude of an object X, as observed in a given latitude l, say on the meridian P N, and $p =$ P X, its polar distance; then, if we put $s = \frac{1}{2}(a + l + p)$, the angle X P N may be determined from this expression,

$$\sin.^2 \tfrac{1}{2}(XPN) = \sqrt{[\sin. (s - a) \cdot \cos. s \cdot \sec. l \cdot \text{cosec.} p.]}$$

And X P N + A P X − A P S $\pm$ S P M = M P N, the mean time at the meridian P N.

P X, A P X, A P S, and S P M, are furnished by the *Nautical Almanac;* and it is evident, therefore, that from an observed altitude of a celestial object, with the data supplied by the *Nautical Almanac*, the *mean time* at the place of observation may be found.

With respect to the corresponding Greenwich time, it may be found by means of a chronometer, whose error and rate are ascertained before it is taken to sea. For example, if on May 4th the chronometer be 4 m. fast for Greenwich time, and on May 14th 4 m. 50 s. fast for Greenwich time; then, if on May 30th, at sea, an altitude be observed to determine time at the place of observation, when this chronometer shows 5 h. 46 m. 12 s., then the true mean time at Greenwich is 5 h. 40 m. 2 s.; and if the mean time at the place deduced from the observation be 3 h. 57 m. 48 s., the longitude of the place will be 5 h. 40 m. 2 s. − 3 h. 57 m. 48 s. = 1 h. 42 m. 14 s. = 25° 33′ 30″ *west*.

The Greenwich time may also be found by considering the moon in the heavens as the pointer of a Greenwich clock, and her distances from the sun and certain stars as indicating the Greenwich times to which they cor-

respond. These distances are computed, and published beforehand in the *Nautical Almanac*, for every third hour of Greenwich time; so that if at any moment we ascertain the moon's distance from some such celestial object, the Greenwich time may be found by comparing that distance with those in the *Nautical Almanac*.

The distances there given, however, are the distances of the objects as seen from the centre of the earth; and therefore before a distance observed on the surface can be made available for finding the Greenwich time, it must be reduced to what it would have been if the observation had been made at the centre. Many formulæ have been devised, and numerous and extensive collections of tables have been formed, to assist in making this reduction; but perhaps the following is as convenient as any other that has been proposed.

Let m be the moon's app. zenith dist., s the sun's; M the moon's true zenith dist., S the sun's; d the app. dist. of the centres of the objects, and D the required or the true distance, and put

$$A\ \tfrac{1}{2}(M+S),\ B = \tfrac{1}{2}(m+s+d)-d,$$
$$\sin.X = \sqrt{(\text{cosec.}\,s\cdot\text{cosec.}\,m\cdot\sin.M\cdot\sin.S\cdot\sin.A\cdot\sin.B)}$$
$$\text{then } \sin.\tfrac{1}{2}D = \sqrt{[\sin.(A+X)\ \sin.(A-X)]}.$$

To compute the bearing of the sun, the altitude, polar distance, and latitude being known:—

Let a = the altitude, l = the latitude, p = the polar distance, $S = \frac{1}{2}(a+l+p)$, and B the required bearing, or azimuth — estimated from the south when the latitude is north, and from the north when the latitude is south; towards the east when the altitude is increasing, and towards the west when it is decreasing, then

$$\sin.\tfrac{1}{2}B = \sqrt{[\sec.a\cdot\sec.l\cdot\cos.S\cdot\cos.(S-p)]}.$$

If the compass bearing of the object be observed when the altitude is taken, the variation of the compass may hence be found; for let B′ = the compass bearing; then the variation is B + B′ or B—B′, the sign + being used when one bearing is eastward and the other westward, and — when both are on the same side of the meridian; and the variation is *west* when B is to the *left*, and eastward when it is to the right of B′.

For an account of the history of navigation, the reader is referred to the Introduction to *Robertson's Elements of Navigation*. Of modern works on this subject in general use among British seamen, we may notice those by Dr. Inman; and particularly those of Mr. Riddle and of Lieut. Raper, treating both of the theory and practice. The Epitomes of Moore, Mackay, and Norie are also very useful compilations, and have long had an extensive circulation.

NAVIGA'TION ACTS. Several statutes of our early kings were passed with a view to confine particular branches of the English carrying trade to English merchants; but as they were generally enacted merely for some temporary object, they produced little effect. In 1650 the first navigation act was framed under the republican government; partly with a view to punish the inhabitants of the sugar islands, who were chiefly loyalists, partly in hostility to the Dutch. It prohibited foreign vessels from trading to the English colonies (a prohibition extended, in 1651, to the mother country), without a licence from the council of state. In 1660 the government of Charles II. re-enacted these prohibitions on a more extended scale. The chief articles of the act 12 Car. 2. c. 18. are, that no goods be carried to or from any English colonies but in vessels built within the English dominions, or really the property of Englishmen, and whose masters, and at least three fourths of the crew, are English; that no goods of foreign growth or manufacture (with specified exceptions), be imported in English vessels, except from the country where they are grown and manufactured; that sugar, tobacco, and other colonial commodities (thence called in trade enumerated), be imported into no part of Europe but England and her dominions. The history of these acts, so much extolled by British politicians, and termed by some the charta maritima of England, and of the modifications which their provisions have since undergone, especially by Mr. Huskisson's act, 6 Geo. 4. c. 109., is succinctly traced in note xi. of M'Culloch's edition of the *Wealth of Nations*.

NAVI'RE. (Fr.) An order of knighthood instituted by St. Louis, king of France, in 1269, to encourage the lords of France to undertake the expedition to the Holy Land. After having fallen into desuetude, it was again revived, with renewed lustre, in 1448, under the name of the order of the crescent. This order derived its name either from the circumstance that the collars of the knights belonging to it had a ship pendent from them, or because the knights were allowed to bear in their arms a ship argent in chief.

NA'VY (Lat. navis, *a ship*), in its most extended signification is applied both to the mercantile and military marine of a nation; but it is more commonly restricted to vessels of *war* only, all others being said to belong to the merchant service. In treating of the navy, it is usual to consider it under two distinct heads, the *materiel* and *personnel*: the former comprising all that relates to the construction, armament, and equipment of ships; the latter including all who receive rank, pay, or emolument in the service of the navy, and whatever concerns the appointment, station, and duties of officers, sailors, and marines. Under the different heads the reader will find a notice of the chief subjects included in the *materiel* of the navy; and we shall in the present article restrict ourselves to some general remarks respecting its history, management, and present state, which may serve to give a coup d'œil of the whole subject, and which could not well be comprised under separate heads.

The naval history of England is usually divided into three eras; the first comprising all the period that preceded the reign of Henry VIII.; the second ending with the restoration of Charles II.; and the third from the Restoration down to the present time. Omitting all that period of English naval history that intervened between the Conquest and the reign of Henry VIII. as too unimportant to be dwelt upon in a sketch of this nature, we may state, before passing to the second period, that the first ship, properly so called, of the British navy, was built by Henry VII. in the third year of his reign. She was called "The Great Harry," had three masts *, carried 80 guns, measured 138 feet in length, and 36 feet in breadth from outside to outside, and cost upwards of 14,000*l*. This ship constituted the most noble monument of Henry VII.'s regard for the navy; but his designs were matured and perfected by his son Henry VIII., in whose reign England may be said to have first possessed a permanent navy. Previously to his reign our sovereigns had but few ships; when they wished to transport an army to France, or to undertake any considerable naval enterprise, it was usually effected by requisitions of ships and seamen from the different seaport towns of the kingdom, or by hiring them from the merchants of Hamburg, Lubeck, Genoa, &c.; which were dismissed as soon as the occasion for their service was over. But Henry, whose naval force, as in the preceding reigns, was chiefly dependent on foreign auxiliaries, caused several "shippes royall" to be constructed for the service of the state; one of which, the "Regent," measured 1000 tons burthen, and another, the "Marie Rose," measured 500 tons burthen, and carried 700 men. At the conclusion of his reign in Jan. 1547, the verified list of the navy amounted to seventy-one ships and vessels of all sorts, measuring 11,268 tons. During the succeeding reigns of Edward VI. and Mary, the naval force of England diminished considerably, and at the demise of the latter in 1558 amounted only to twenty-six vessels, measuring 7,110 tons burthen. During the long and prosperous reign of Elizabeth which ensued, the navy was greatly encouraged. The naval force collected to oppose the Armada, which consisted of 150 ships with nearly 30,000 men, amounted to 176 sail equipped with about 15,000 men; of these 34 ships with 6,225 men, a larger royal armament than had ever before assembled together, belonged to the crown, the remainder being made up from London, Bristol, Yarmouth, the Cinque Ports, &c. During the last twenty-five years of Elizabeth's reign the navy almost doubled its number; and at her death, in 1603, it amounted to forty-two ships, measuring 17,055 tons, and carrying 8,346 seamen. The reign of James I. was remarkable for the first able and scientific naval architect, Phineas Pett, to whom the art of shipbuilding was indebted for many improvements. "In my own time," says Raleigh, "the shape of our English ships hath been greatly bettered; in extremity we carry our ordnance better than we were wont; we have added crosse-pillars in our royall shippes to strengthen them; we have given longer floares to our shippes than in olden times, and better bearing under water." The striking of topmasts was also invented in this reign; and besides the improved shape of the vessels, Raleigh mentions various minor improvements, adding, "to the courses we have devised studdingsails, spritsails, and topsails; the weighing of the capstan is also new, and the chain-pump and bonnet; we have fallen into consideration of the length of cables, and by it we resist the malice of the greatest winds that can blow." At the death of James I. in 1625, the royal navy consisted of thirty-three ships, measuring 19,400 tons. The navy was first divided into rates and classes under Charles I., who built several new ships in the beginning of his reign, and among others the "Sovereign of the Seas," a larger ship than had ever been built in England, carrying 100 guns, and measuring 1683 tons. But in 1648 Prince Rupert carried off twenty-five ships, none of which ever returned to England; and so reduced was the navy at the commencement of Cromwell's government, that he could muster only fourteen men-of-war, some of them carrying only forty guns. But his vigorous administration speedily raised the navy to a magnitude and power formerly unknown; and under the command of Blake, it became not merely equal but superior to that of the Dutch, then the greatest maritime

* Down to the year 1545, the "Great Harry" was the only ship of that description in the British fleet. She was accidentally burnt at Woolwich in her sixty-fifth year.

power of Europe. It was during the Protectorate that the classes into which Charles I. had first divided the navy were clearly defined, and a regular system established, which has, with little alteration, remained in force down to the present time. At the death of Cromwell in 1658, the navy amounted to one hundred and fifty-seven ships, measuring 21,910 tons, and carrying 50,000 men.

At the restoration of Charles II. in 1660 (from which is dated the third period of English naval history), the whole fleet amounted to only sixty-five ships; but under the able administration of the Duke of York, the royal fleet soon augmented to a fine armament; and though the retirement of the latter, in consequence of his inability to take the Test Act, and the subsequent extravagance of the king, caused the navy to decay, yet such prompt and effective measures were afterwards taken by the Duke, on his recall to office, for its restoration, that at the demise of Charles II. the navy amounted to 179 vessels, measuring 103,558 tons. During the foregoing reign, a remarkable change had taken place in scientific and mechanical operations, and the art of shipbuilding, so long practised on vague and imperfect principles, began to be more highly and extensively developed; for not only were the proportions and qualities of vessels improved, but the mind of the designer was directed to theoretical investigation; and thus, coeval with the third period of naval history, may be justly reckoned the full development of the science of naval architecture. On his accession to the throne James II. continued to evince the same warm interest which, as lord high admiral, he had always manifested for the welfare of the navy. He suspended the navy board, and appointed a new commission, with which he joined Sir Anthony Deane, the best naval architect of the time: four hundred thousand pounds were annually set apart for naval purposes; and so diligent were the commissioners in the discharge of their duty, that on the abdication of James, in 1688, the navy amounted to 173 sail, measuring 101,892 tons, and carrying 6930 guns and 42,003 men. Under the administration of William and Mary, who made little alteration in the system adopted by their predecessor, 99 new ships were added to the fleet; and the celebrated engagement off Cape la Hogue, in 1692, gave the British navy an ascendency over that of France, which it has ever since preserved. Queen Anne at her accession found the navy to consist of 272 vessels, measuring 159,020 tons; but in the third year of her reign a most destructive storm visited this country and the adjacent coasts, by which the navy sustained great damage and loss. No fewer than ten men-of-war were totally lost, and many more were driven on shore and damaged. All measures adding to the strength and efficiency of the navy were exceedingly popular during this reign, and every plan compatible with financial economy was adopted for its benefit; so that though the number of ships was less at the end of Anne's reign, 1714, than at its commencement, the tonnage had increased 8199 tons. During the first four years of George I., large sums were voted for the extraordinary repairs which were required after the long war. A general survey was made of the dockyards and seastores; new dimensions for several classes of ships were established; and at the death of this monarch, in 1727, the navy consisted of 233 ships, measuring 170,862 tons. The navy remained stationary for the first twelve years of the reign of George II.; but on hostilities breaking out with Spain, in 1739, the navy was considerably augmented, and a scale of increased dimensions was established in 1742. In the wars of 1744 and 1755, our naval enterprises were crowned with the most signal success; and at the demise of George II., in 1760, the navy consisted of 412 ships, measuring 321,104 tons, the vote for the naval service of that year being 5,611,508*l.*, 51,645 seamen, and 18,355 marines. The unprecedented progress of the navy during the long reign of George III. is familiar to all. It may be sufficient, therefore, to observe, that though the combined fleets of France and Spain appeared to have an ascendency during the American war, the victories of Rodney restored our previous superiority. The nature of the struggle with revolutionary France, the bitterness with which it was carried on, and the fleets required not merely for the protection of our own shores, but for that of our mercantile shipping and of our numerous colonies in all parts of the world, led to an immense increase of our naval force; and while our navy was thus progressively augmented, the decisive victory of the 1st of June, 1794, followed by those of St. Vincent, Camperdown, the Nile, Copenhagen, and Trafalgar, almost destroyed every fleet that could be opposed to it, leaving us the undisputed masters of the ocean.

From the commencement of hostilities in 1793 to the peace of Amiens, the following table will show the losses sustained both by the English and their enemies, including the ships surrendered to be held in trust.

Loss sustained by the English.		Captured from the Enemy.	
Ships of the line	5	Ships of the line	86
Frigates	13	Frigates	209
Sloops and smaller vessels	41	Sloops and smaller vessels	275
Total	59	Total	570

From the declaration of war in May, 1803, to the general peace concluded in 1815, the number of ships and vessels of war captured and destroyed by the British, with the amount of loss sustained by our fleets during the same period, will be found in the following abstract:—

		Captured.	Destroyed.
French, Dutch, Spanish, Turkish, Danish, American	ships of the line	55	14
	frigates	79	23
	Total	134	37
British	ships of the line	0	0
	under	80	17
	Total	80	17

In the last seven years of the war the British naval force averaged one hundred and forty ships of the line in commission, and five hundred and eighty frigates, sloops, and smaller vessels; those in harbour, ordinary, and building, being estimated at three hundred during the same period. Since the peace of 1815 great improvements have taken place in every department of naval architecture; masts, rigging, sails, ordnance, implements, and instruments, have all undergone revision; alterations, not only in the form and magnitude of British ships, but even in the arrangement of the materials composing them, have been effected; and it is perhaps not going too far to assert, that never at any former period was our navy in a condition better calculated to maintain its long undisputed sovereignty of the ocean.

The following table will show the force of the British Navy at five distinct periods: viz. the year after the breaking out of the French revolutionary war; in 1820, five years subsequently to the peace; in 1830, on the accession of William IV.; on the accession of her present Majesty, in 1837; and in 1840, the date of the last official list:—

Ships, &c.	1793.					1820.					1830.					1837.					1840.				
	In Commission.	Ordinary.	Building.	Total.	Tons.	In Commission.	Ordinary.	Building.	Total.	Tons.	In Commission.	Ordinary.	Building.	Total.	Tons.	In Commission.	Ordinary.	Building.	Total.	Tons.	In Commission.	Ordinary.	Building.	Total.	Tons.
Of the Line	26	84	12	122		14	113	22	149		14	75	18	107		23	59	14	96		28	54	23	105	
Under small vessels	109	82	8	199		113	255	95	464		143	262	64	469		163	219	43	425		149	220	34	403	
Steamers											7	4	1	12		42	11	1	54		65	15	7	87	
Grand total	135	166	20	321	402,555	127	368	117	613	605,527	164	341	83	588	544,416	228	289	58	575	467,765	242	289	64	595	500,232

The parliamentary vote for the service of the navy 1841-42, is as follows:—

To be employed in the fleet	Seamen (including officers)	30,500
	Marines (ditto)	6,500
	Boys	2,000
In service on shore	Marines	4,000
Half pay and retired	Naval officers	4,845
	Marine officers	470
	Grand total	48,315

	£
For the effective service	4,931,905
For the non-effective service	1,415,002
For freight on account of the army and ordnance departments	267,249
Total	£6,614,156

Classes and Rates.—It is of great importance, in order to insure union in the movements of a fleet and to facilitate the fitting out and repair of ships, that those of the

same rate or class should not differ materially in size or build from each other. Until the Restoration vessels appear to have been "rated" from the complement assigned to each, without any reference to the ordnance they carried; but on the recommendation of a committee appointed in 1745 this method was superseded by classification according to *guns*. In 1793 our ships, which, in consequence of the previous wars, had outgrown their establishments of ordnance, were rated anew at so many guns and upwards; but the latitude of the term "and upwards" giving rise to great irregularities, an investigation took place in 1816, when by an order in council the rule which existed previously to 1793 was revived, and ships were ordered to be rated thenceforth from the number of guns and carronades actually carried, and not according to the erroneous denominations which had latterly grown into use. His late majesty William IV. made some alteration in this mode of rating ships, but not such as materially to interfere with the arrangement introduced by his predecessor. The royal navy, as at present constituted, comprises three principal classes: — 1. Rated ships and yachts, including razees, frigates, and corvettes. 2. Ships and bomb vessels, including vessels corvette-built or otherwise. 3. All smaller vessels, including brigs, ketches, brigantines, schooners, cutters, tenders, &c. Ships of the first class are commanded by captains; of the second class, by commanders; of the third class, by lieutenants and subordinate officers.

By the regulations of 1833, the following rates were established: — *First rate:* all three-decked ships. *Second rate:* one of her Majesty's yachts, and all two-decked ships whose war complements consist of 700 men and upwards. *Third rate:* the other royal yachts, and all yachts bearing the flag or pendant of an admiral or captain superintendent of a dock-yard; and all ships whose complements are under 700 and not less than 600. *Fourth rate:* ships whose complements are under 600 and not less than 400. *Fifth rate:* ships whose complements are under 400 and not less than 250. *Sixth rate;* ships whose complements are under 250.

Steam vessels are assigned a rate at the discretion of the lords of the admiralty. Ships or vessels fitted as troop ships, surveying ships, fire ships, store ships, or vessels used on any temporary service, are also given a rate not above the fourth. Ships of the 1st rate carry 100 guns and upwards; those of the 2d rate 80 and upwards; the 3d rate from 70 to 80; the 4th rate from 50 to 70; the 5th rate from 36 to 50; and the 6th rate from 24 to 36. (For the chief of these details we are indebted to an able and beautiful little work recently published, entitled an *Epitome of the Royal Naval Service of England*, by Mr. Miles.)

Government of the Navy. — The general direction and control of all affairs connected with the navy is intrusted, under her Majesty, to the lord high admiral, or to the commissioners for discharging the functions of that officer. The duties of the lord high admiral were formerly judicial as well as administrative; he having not merely to govern the navy, but to preside over a court for adjudging all nautical cases, and for taking cognizance of all offences committed on the high seas. But the judicial are now separated from the other duties of this high functionary, being devolved upon the judge of the Admiralty Court. *See* ADMIRALTY, COURT OF.

From the reign of Queen Anne down to the present time, with the exception of the short period during which William IV., when Duke of Clarence, held the office, the duties of the lord high admiral have been discharged by commissioners. These have consisted generally of a first lord, and of four or six junior lords. Civilians may be appointed to these offices; but at least two of the lords are always professional men. But, though assisted by junior lords practically, all the power and authority of the board is vested in the first lord. The powers exercised by the Board of Admiralty are very extensive and important. By their orders all ships are built, repaired, fitted for sea, or laid up in ordinary, broken up, or sold; put in commission, or out of commission; armed, stored, and provisioned; employed on the home or on foreign stations. All appointments or removals of commission and warrant officers are made by them, and all instructions issued for the guidance of their commanders; all promotions in the several ranks emanate from them; all honours bestowed for and without services, and all pensions, gratuities, and superannuations for wounds, infirmities, and long services, are granted on their recommendation. All returns from the fleet are sent to the Board of Admiralty, and every thing that relates to the discipline and good order of every ship. All orders for the payment of naval moneys are issued by the lords commissioners of the admiralty; and the annual estimate of the expenses of the navy, prepared by them, is laid before parliament for its sanction. All new inventions and experiments are submitted to them before being introduced into the service; all draughts of ships must have their approval; all repairs, alterations, and improvements in the dock-yards, and all new buildings, of every description, must be decided upon by them before they are undertaken. (*Sup. to Encyc. Britan.*, art. "Navy.")

Under the superintendence of the lords commissioners, the civil departments of the admiralty are directed by a surveyor of the navy, an accountant-general, a storekeeper-general, a comptroller of victualling, and a physician-general.

There are three gradations of admirals, viz. admirals, vice-admirals, and rear-admirals; and each of these dignities consists of three divisions, distinguished by the colour of their flags. Thus, there are admirals of the red, the white, and the blue squadrons, bearing their respective flags at the main-top-gallant-mast head; vice-admirals of the red, the white, and the blue squadrons, bearing their respective flags at the fore-top-gallant-mast head; and rear-admirals of the red, the white, and the blue squadrons, bearing their respective flags at the mizen-top-gallant-mast head. All admirals, whatever be their rank, take the common title of *flag officers*.

Admirals rank with generals in the army, vice-admirals with lieutenant-generals, and rear-admirals with major-generals. The command of each ship is entrusted to a captain, or to a commander, who has under him a certain number of lieutenants, according to the size of the ship, with a master, purser, midshipmen, gunners, &c. A captain of three years' standing ranks with a colonel in the army, and a captain of less than three years' standing with a lieutenant-colonel; a commander ranks with a major, and a lieutenant with a captain. The captain is responsible for the discipline and efficiency of the crew, and the good order of the ship. Notwithstanding he is furnished with minute instructions for his guidance in every particular, much must always necessarily depend on his conduct and character. He has power to order punishment to be inflicted; but it must be done in the presence of all the officers and ship's company. An account, stating all the circumstances, must also be entered in the ship's log, an abstract of which is forwarded each quarter to the admiralty. This regulation has tended to repress hasty and inconsiderate punishment; and has done much to improve the conduct of the officers, as well as to promote the proper discipline of the navy.

Composition of the Navy. — The navy is composed of two bodies of men — seamen and marines (*see* MARINES); and the officers under whose command it is placed are divided into three classes, viz. commissioned, warrant, and petty officers. Commissioned officers comprise flag officers (see *suprà*), commodores, captains, commanders, and lieutenants, appointed by commission from the lords commissioners of the admiralty, or by a commander-in-chief having authority in cases of vacancies by death or the decisions of courts martial abroad to make such appointments. Warrant officers are those who hold their appointment by warrant from the lords commissioners of the admiralty; to this class belong masters, secretaries, physicians, surgeons, &c. Petty officers are divided into two classes, *quarter-deck* and *working;* the former, comprising midshipmen, master's assistants, volunteers, &c., are entered by order of the lords commissioners, or by a commander-in-chief abroad; the latter, including captains of the maintop, foretop, &c. &c., are appointed by the captain or commander of the ship or vessel to which they belong.

Any person may enter the navy as a common seaman, on application to the commanding officer of any of her Majesty's ships in commission, provided he be approved by the examining surgeon, and have not previously been "discharged from the service with disgrace." Persons who have never been at sea are rated as landsmen, and seafaring men are rated as "ordinary" or "able" seamen, besides numerous gradations of petty officers, to which they are rated at the discretion of the commanding officer. Seamen are also obtained for the navy, at the breaking out of a war or any other emergency, by the practice of impressment. The antiquity and legality of this practice cannot be questioned; but very great and serious doubts have been and may be entertained as to its expediency. Foreigners are the only persons exempted at common law from impressment; but exemptions have been created by acts of parliament in favour of various classes, as landsmen, apprentices, seamen employed in the fisheries, watermen in the service of fire insurance companies, &c. *See* IMPRESSMENT.

Young gentlemen enter the service as volunteers of the first class; and every officer commissioning a ship is allowed to make one fresh entry. A volunteer must remain two complete years in that capacity, and attain the age of fourteen, before he can be rated a midshipman; when he has completed six years' service, and attained the age of nineteen, he may be examined in seamanship, and also in navigation, for the rank of lieutenant; and should he pass such examinations, he is eligible to hold a warrant as mate, if his conduct be satisfactory to his captain.

No person can receive a commission as lieutenant unless he have passed both the above examinations; but having done so, he is eligible for promotion to that rank. A lieutenant is not eligible for a commander's commis-

sion till he have served two years at sea in a ship of war as lieutenant; nor is a commander eligible for a captain's commission till he have served one complete year at sea in a ship of war as commander.

In 1830 a temporary restriction was placed on promotions by a minute of the Admiralty Board. This limited the promotion of officers to the rank of captain, and all below that rank to filling up one in three vacancies on the list, with the exception, viz., 1st, of death vacancies on foreign stations, which the commanders-in-chief have authority to fill up; 2d, the reservation to the admiralty of power to promote for special or brilliant services; 3d, of the occasion of a commander-in-chief striking his flag; and 4th, on the recommendation of the Board of Customs for services in the coast guard.

Captains and admirals are promoted by seniority, on what is termed a "flag promotion" taking place; but a captain must have served as under, in command of a rated ship, before he can obtain his flag; viz.

In war - - - -	4 years.
In war and peace combined -	5 —
In peace - - - -	6 —

All other classes of officers, as was remarked above, are promoted at the discretion of the Board of Admiralty. For the various important subjects connected with the pay, pension, discipline, &c. of the navy, see the *Navy List*. See, also, *Statistics of the British Empire;* and the valuable little work above referred to, *Epitome of the Royal Naval Service of England*, London, 1841. For other particulars relating to the navy, see NAVAL ARCHITECTURE, SHIP, and the other naval articles, which will be found under their respective heads in this work.

NA'ZARITE (Heb. nazar, *to separate*), signified, in the Jewish dispensation, one separated to the Lord by a vow. (Numbers, chap. 6.) The chief observances of the Nazarites were, to refrain from drinking wine, to suffer the hair to grow, and to avoid coming in contact with a corpse. This word must be distinguished from Nazarene, which signified a native of Nazareth, and was applied in contempt to the early Christians, inasmuch as they were followers of Jesus of Nazareth.

In some Eastern countries some Christian communities are still to be met with which have retained the appellation of Nazarenes. The sect of Nazarenes, which sprung up in Palestine in the second century, endeavoured to engraft the rites and observances of the Jews on the religion of Jesus Christ; in this respect they bore a considerable resemblance to the Ebionites, whose contemporaries they were, but with whom they must not be confounded. No traces of them existed in the 5th century.

NEAP, or NEEP TIDES, are the lowest tides, being those which are produced when the attractions of the sun and moon on the waters of the ocean are exerted in directions perpendicular to each other. When the two forces act in the same or exactly opposite directions, the *spring* or highest tides are produced. The neap tides take place about four or five days before the new and full moons. *See* TIDES.

NEAT. A term applied to cattle: *neat's foot oil* is the fat obtained by boiling calves' feet.

NE'BULÆ. (Lat. nebula, *a cloud*.) in Astronomy, the name given, on account of their general cloudy appearance, to a very numerous class of celestial objects, being, however, for by far the greater part, *telescopic*, and only visible in telescopes of considerable power.

It is to Sir William Herschel that astronomy is indebted for the first examination and analysis of these remarkable objects. A few of them have indeed been known since the discovery of the telescope, and one or two of them are visible to the naked eye; but his powerful telescopes first disclosed the fact of their existence in immense numbers, and in all quarters of the heavens, not indeed distributed uniformly, but, generally speaking, with a marked preference to a broad zone, crossing the milky-way nearly at right angles, and whose general direction is not very remote from that of the hour circle of 0^h and 12^h.

Nebulæ are divided by Sir W. Herschel into the following classes: — 1st, Clusters of stars, in which the stars are clearly distinguishable; 2d, Resolvable nebulæ, or such as excite a suspicion that they consist of stars, and which any increase of the optical power of the telescope might be expected to resolve into distinct stars; 3d, Nebulæ, properly so called, in which there is no appearance whatever of stars; 4th, Planetary nebulæ; 5th, Stellar nebulæ; and, 6th, Nebulous stars.

Clusters of Stars. — These are either globular or of an irregular figure, forming bright isolated patches, which attract attention, as if they were brought together by some general cause. The Pleiades is a cluster of this sort: the naked eye can distinctly perceive six or seven stars in it, and may catch occasional glimpses of a great many more; but the telescope shows fifty or sixty crowded together, in a very moderate space, and insulated from the rest of the heavens. A luminous spot, called *Præsepe*, or the Beehive, in the constellation Cancer, is resolved entirely into stars by an ordinary telescope. In the sword-handle of Perseus is another such spot, crowded with stars, but not so easily resolved. There are a great number of less distinct nebulous specks of the same kind, which in ordinary telescopes have much the appearance of comets without tails, and have frequently been mistaken for such; when, however, they are examined with instruments of great power, such as reflectors of 18 inches, 2 feet, or more in aperture, any such idea is completely destroyed. They are then, for the most part, perceived to consist entirely of stars, crowded together so as to occupy almost a definite outline, and to run up to a blaze of light in the centre, where their condensation is usually the greatest. Many of them are of an exactly round figure. Others, again, are of an irregular form, and less definite in their outline, so that it is not easy to say where they terminate. In some of them the stars are nearly all of a size, in others extremely different; and it is no uncommon thing to find a very red star, much brighter than the rest, occupying a conspicuous situation in the group. Sir W. Herschel regards these as globular clusters in a less advanced state of condensation; conceiving all such groups as approaching, by their mutual attraction, to the globular figure, and assembling themselves together from all the surrounding region.

Resolvable nebulæ are considered as objects of the same nature as the preceding; but as being either too remote, or consisting of stars too faint, to affect us by their individual light. They are universally round or oval; their irregularities of form being extinguished by the distance, and only the general figure of the condensed parts being discernible. In telescopes of insufficient optical power, all the great globular clusters exhibit themselves under this appearance.

Nebulæ, properly so called, present a great variety of appearances. One of the most remarkable is in the constellation Orion; and its appearance is very different from what might be supposed to arise from the aggregation of an immense collection of small stars. It is formed of little flocky masses, like wisps of cloud; and such wisps seem to adhere to many small stars at its outskirts, and especially to one considerable star, which it envelopes with a nebulous atmosphere of considerable extent and singular figure. This nebula was discovered by Huygens in 1656, who gave figures representing its appearance in his telescope. On comparing these with its present appearance, several astronomers have concluded that it has undergone a perceptible change; but the evidence of such change is by no means to be relied on. There is a nebula in the constellation of Andromeda visible to the naked eye, and often mistaken for a comet. Its appearance is described by Simon Marius as that of a candle shining through horn. Its form is a pretty long oval, increasing by insensible gradations of brightness, at first very gradually, but at last more rapidly, up to a central point, which, though very much brighter than the rest, is yet evidently not stellar, but only nebulous matter in a high state of condensation. It has in it a few small stars; but they are obviously casual; and the nebula itself offers not the slightest appearance to give ground for a suspicion of its consisting of stars. It is nearly half a degree long, and fifteen or twenty minutes broad. Like that last described, a very numerous class of nebulæ are of a round or oval figure, increasing more or less in density towards the central point. In this respect, however, they differ extremely; in some the condensation being slight and gradual, in others great and sudden. They also present great diversity of appearance, in respect of deviation from the spherical form. Some are only slightly elliptic, others much extended in length; and in some the extension is so great as to give the nebula the character of a long, narrow, spindle-shaped ray, tapering away at both ends to points. Some nebulæ are annular; but these are among the rarest objects in the heavens. The most conspicuous is situated half way between the stars β and γ Lyræ, and may be seen with a telescope of moderate power. It is small, and particularly well defined, so as to have, in fact, much more the appearance of a flat oval solid ring than of a nebula.

Planetary nebulæ have exactly the appearance of planets, — round or slightly oval disks, in some instances quite sharply terminated, in others a little hazy at the borders, and of a light exactly equable, or only a little mottled, which, in some of them, approaches in vividness to that of actual planets. Whatever the nature of these objects may be, they must be of enormous magnitude. One in Aquarius presents a diameter of 20″; another, in Andromeda, has a visible disk of 12″, perfectly defined and round. Granting them to be equally distant from us with the stars, their real dimensions must be such as would fill, on the lowest computation, the whole orbit of Uranus. Their intrinsic splendour must also be immeasurably inferior to that of the sun's; for a circular portion of the sun's disk, subtending an angle of 20″, would give a light equal to 100 *full moons*, whereas the nebulæ in question are hardly discernible with the naked eye.

Stellar nebulæ are those in which the condensation of the nebulous matter towards the centre is great and sudden; so sudden, indeed, as to present the appearance

of a dull and blotted star, or a star with a slight burr round it. The *nebulous stars* present the beautiful and striking phenomenon of a sharp and brilliant star, surrounded by a perfectly circular disk or atmosphere of faint light: in some cases dying away on all sides by insensible gradations, in others almost suddenly terminated. A very fine example of such a star is 55 Andromedæ, R. A. 1^h 43^m, N. P. D. 50° 7′.

"The nebulæ," says Sir J. Herschel, "furnish, in every point of view, an inexhaustible field of speculation and conjecture. That by far the largest of them consist of stars there can be little doubt; and in the interminable range of system upon system, and firmament upon firmament which we thus catch a glimpse of, the imagination is bewildered and lost. On the other hand, if it be true, as, to say the least, it seems extremely probable, that a phosphorescent or self-luminous matter also exists, disseminated through extensive regions of space, in the manner of a cloud or fog, now assuming capricious shapes, like actual clouds drifted by the wind, and now concentrating itself like a cometic atmosphere around particular stars, what, we naturally ask, is the nature and distinction of this nebulous matter? Is it absorbed by the stars in whose neighbourhood it is found, to furnish, by its condensation, their supply of light and heat? or is it progressively concentrating itself, by the effect of its own gravity, into masses, and so laying the foundations of new sidereal systems, or insulated stars? It is easier to propound such questions than to offer any probable reply to them." (See *Herschel's Treatise on Astronomy*, *Cabinet Cyclopædia*, from which the preceding description is abridged.)

NECE′SSITY, DOCTRINE OF. That scheme which represents all human actions and feelings as links in a chain of causation, determined by laws in every respect analogous to those by which the physical universe is governed. This doctrine has been attacked and defended with great zeal, in almost every period of speculative inquiry since the Reformation. The inductive method of research, applied by Bacon and his contemporaries to the phenomena of nature, led very soon to the adoption of a similar method in reference to the phenomena of mind. The discovery, or, rather, the distinct re-assertion of the law of association, by Hobbes, and the ready solution which it appeared to furnish of states of consciousness, which, without it, would have seemed capricious and unaccountable, encouraged many philosophers to attempt its application to every province of the human mind. It is only in connection with this fact that the prevalence of necessarian views in modern times can be adequately explained. Without venturing an opinion on the merits of the question at issue, between the advocates of free will and of necessity, we are sufficiently assured of the historical fact, that the distinction between man and nature, between the actions of a self-conscious agent and the workings of blind unintelligent powers, was considered by the great philosophers of antiquity as the groundwork of their systems of morality, and as involved in the very conception of moral science. It was natural that this distinction should be felt to be a barrier to the progress of the exclusively empirical psychology to which we have alluded. To the historians of man's nature the necessity of his actions appeared in the light of an hypothesis which lay at the very foundation of their inquiries, precisely as the natural philosopher is compelled to assume the regular recurrence of the same outward phenomena under the same circumstances. The psychologist considers the states of which he is conscious merely as they are related to each other in time; and, thus considered, it seems to him a mere identical proposition to assert that all that can be known of them is the order of their succession. If their succession were arbitrary or uncertain, nothing could be known of it, and the science which he professes could no longer have an existence. It is in this consideration, rather than in the dialectic subtleties by which the doctrine has been sometimes defended, that the real strength of the necessarian lies. So long as he can maintain the merely phenomenal character of human knowledge, he can reduce his opponents to the dilemma of either denying the possibility of mental science altogether, or of admitting the existence of those uniform laws which are its only object. In its relation to morality, the doctrine of necessity has been naturally considered to involve dangerous consequences. Attempts have been made by modern necessarians to rescue it from this imputation. Sir James Mackintosh, in particular, has devoted some portion of his Dissertation to the explanation of the principal ethical terms, on the necessarian hypothesis. (*General Remarks*, sec. vii. p. 393. of the reprint.) Notwithstanding the ingenuity of this effort, the student will probably find, on careful examination, that the great question at issue is left much in the same state as before.

NECK OF A CAPITAL. In Architecture, the space above the shaft of a column, between the annulet of the capital above and the astragal at the top of the shaft below.

NECRO′LOGY. (Gr. νέκρος, *dead*, and λόγος, *discourse*.) A collection of biographical notices of deceased persons, published shortly after their deaths, is commonly called a necrology. The list of deceased benefactors to a monastery, cathedral, &c., was also termed its necrology.

NE′CROMANCY. (Gr. νέκρος, and μάντεια, *prophecy*.) Divination by consulting the spirits of the dead. Necromancy is prohibited in Deuteronomy; and the passage in the first book of Samuel respecting the witch of Endor — whether it be understood of an actual evocation, or of a deception practised by a soothsayer — shows that necromancy, real or pretended, was among the usages of very distant times. In Homer, the portion of the *Odyssey* termed the Necyomanteia exhibits the superstition in a very peculiar form. Ulysses performs a sacrifice with peculiar solemnities, and pours the sacrificial blood into a ditch: the spectres of the dead rush wildly from the infernal regions to taste the blood; and, discovering that of Tiresias, of which he was in search, he compels it to answer his questions. The rest of the book, in which Ulysses appears actually to descend to the shades, and to see the punishments of celebrated criminals, is suspected by some commentators to have been an interpolation of later times. Similar customs in practising the art of necromancy seem to have been followed for a long period in Greece and Italy. Horace mentions the pouring of the blood of a sacrificed sheep into a ditch, in order to attract the manes from beneath. But in Thessaly, the most celebrated of classical regions for its proficiency in the art of magic, peculiar horrors seem to have attended the exercise of necromancy. Erichtho, Lucan's Thessalian witch, reanimates the corpse of a soldier slain in battle, and compels him to answer her questions respecting futurity. But the ψυχάγωγοι, or professed evokers of spirits, in Thessaly, seem to have performed their rites, whether as impostors or as fanatics, with the sacrifices of human beings and various other enormities. Modern necromancy, like most branches of divination in modern superstition, has been chiefly accomplished by the agency of devils, who either voluntarily or by compulsion act at the behest of the magician. *See* Magic, Witch.

NE′CROLITE. (Gr. νεκρος, and λιθος, *a stone*.) A mineral which is found in small nodules in the limestone of Baltimore, and which when struck exhales a fetid odour resembling that of putrid flesh.

NECRO′PHAGANS, *Necrophaga*. (Gr. νεκρος, and φαγω, *I eat*.) The name of a family of Clavicorn beetles, comprehending those which feed on dead and decomposing animal substances.

NECRO′SIS. (Gr. νεκρουν, *to destroy*.) This term is applied in surgery to the mortification of parts of bones.

Necrosis, or Spotting. In Botany, a disease of plants, chiefly found upon the leaves and soft parenchymatous parts of vegetables. It consists of small black spots, below which the substance of the plant decays.

NE′CTAR, in the Mythology of the Greeks and Romans, was the supposed drink of the immortal gods (ambrosia being their food), and was fabled to contribute largely to their immortality. If we believe the accounts of the poets, the qualities of this liquor must have been of a most delicious character. It imparted youth, bloom, and vigour to the body, and possessed the power of repairing all the defects and injuries of the mental constitution.

NECTA′RIUM. (Lat. nectar, *honey*.) Any part of a flower that secretes a honey-like substance. It is variously applied to modifications of the petals, stamens, and disk, and is now not much employed.

NEE′DLE, MAGNETICAL. A slender magnetized bar of steel, which, when suspended freely on a pivot or centre, arranges itself in the direction of the magnetic force of the earth. *See* Compass, Magnetism, Variation.

NEEDLE ORE. (From the acicular form of its crystals.) A native sulphuret of bismuth, copper, and lead: it occurs in the gold mine of Schlangenberg, in Siberia.

NEEDLE STONE. A species of acicular zeolite found in Iceland.

NE EXEAT REGNO. In Law, a writ to detain a person from going out of the kingdom without the king's licence, directed to the sheriff, or to the party himself. The use of the writ is to prevent a party from withdrawing his person and property from the jurisdiction of the courts in England; but this purpose was served at common law before the late Insolvent Act by arrest, and bail obtained. This writ lies, therefore, where there is a suit in equity for a demand for which the plaintiff could not arrest at law; and is always granted upon a bill just filed in equity.

NE′GATIVE, in Logic, denotes the quality of a proposition which denies the agreement between the subject and predicate.

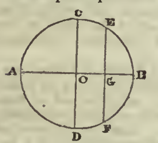
NE′GATIVE SIGN. In Algebra, the sign of subtraction, —. Any quantity to which this sign is prefixed is called a *negative* quantity.

The doctrine of negative quantities is attended with considerable difficulties, and has given rise to much discussion. When a negative quantity is preceded by a positive quantity greater than itself, nothing is simpler than the accurate notion of its signification. For instance, in the expression $a - b$, where a is greater than b, no difficulty can arise about the nature of the operation which is indicated. But in algebra quantities are constantly occurring of the form $a - b$, where b is greater than a; or of the form $-a$, where the negative quantity stands by itself; and it is often no easy matter, if indeed it be possible, to discover any exact principle by which such expressions are to be interpreted.

The definitions usually given by writers on algebra of isolated negative quantities are reducible to two:—1st, that negative quantities are less than nothing; and, 2d, that they are of the same nature as positive quantities, but taken in a contrary sense, or opposite direction. The first of these definitions, which, indeed, presents itself the most naturally, was adopted by Newton in the *Arithmetica Universalis*, and also by Euler, in his *Introductio in Analysin Infinitorum*. The second definition has been generally adopted by writers on the application of algebra to geometry and mechanics. But it has been shown by D'Alembert, and more particularly by Carnot, in his *Geométrie de Position*, that both definitions lead to inaccurate notions.

With regard to the first definition, D'Alembert reasons in this manner:—Let there be the proportion $1 : -1 :: -1 : 1$, which is true, because the product of the extremes is equal to the product of the means. Now, if -1 be less than nothing, much more will it be less than 1; therefore, the second term is less than the first; consequently the fourth must be less than the third: that is to say, 1 must be less than -1; therefore, -1 is both less than 1 and greater than 1, which is absurd. Carnot further remarks, that a multitude of paradoxes, or rather absurdities, arise from the notion that negative quantities are less than 0; for example, -3 must be less than 2, yet $(-3)^2$ would be greater than 2^2, because $(-3)^2$ is 9, and 2^2 is 4; that is to say, of two unequal quantities, 2 and -3, the square of the greater would be less than the square of the smaller, which is contrary to any clear and distinct notions that can be formed of the nature of quantity.

The principle that negative quantities are quantities taken in a different sense, or opposite direction to positive quantities, is shown by Carnot to lead to error by the following example:—Let A C B D be a circle, of which O is the centre, and A B a diameter; we have then A B = A O + O B. Through the centre O draw C D perpendicular to A B, and through any point in the circle E draw the chord E F parallel to C D, meeting A B in G.



Let A be the origin of the abscissa; and make A G $= x$, and G E $= y$; then, putting $a =$ the radius of the circle, we have the equation $y^2 = 2ax - x^2$. The solution of this quadratic gives $y = \pm\sqrt{2ax - x^2}$, which, according to the theory under consideration, shows that y has two values equal and directly opposite to each other; namely, G E represented by the positive root, and the other, G F, represented by the negative root; that is to say, we have G E $= +\sqrt{2ax - x^2}$, and G F $= -\sqrt{2ax - x^2}$, equations which ought to be true whatever be the value of A G or x. Let us, therefore, suppose A G = A O $= a$ · G E will then become O C, and G F will become O D; therefore, the two equations will become G E $= +a$, and G F $= -a$, and, consequently, G E + G F = 0; that is, A B = 0, which is absurd, although rigorously deduced from the theory. The theory, therefore, is false. It may be possible, Carnot remarks, to oppose metaphysical subtleties to this conclusion; but he thinks that no clear and satisfactory answer can be given to the argument.

Without entering into metaphysical subtleties, we may remark that there is an evident fallacy in the above conclusion, which arises from first assuming the signs + and − to be *symbols of interpretation*, and then considering them as *symbols of operation*; without regard to their directive signification. On making $x = a$, the two roots of the above quadratic are $+a$ and $-a$, and the signs are by the theory assumed to signify opposition or contrariety of direction. But in the equation $+x - a = o$ (from which G E + G F $= o$ is derived), the directive signification is entirely lost sight of; the signs are regarded as merely symbols of operation; and the equation being interpreted in the usual way simply affirms that the difference between the two roots, *in respect of absolute magnitude*, is nothing.

Having shown that the usually received notions respecting negative quantities are obscure and inaccurate, Carnot proceeds to establish the true principles of their theory. He concludes, 1st, That an isolated negative quantity is a mere creation of the mind, and that those which result from the operations of the calculus are nothing more than simple algebraic forms, incapable of representing any real and effective quantity whatever. 2d, That each of these forms, taken without reference to its sign, is nothing more than the difference of two other absolute quantities, of which the one that was the greater in the case on which the reasoning was founded, becomes the less in the case to which the results of the calculus producing that form is applicable.

According to this theory, the true meaning to be attached to the expression *negative quantity* is this:—An absolute quantity, which does not belong to the system on which the reasoning has been established, but to another system related to the former in such a manner that in order to render the formulæ for the first system applicable to it the sign which precedes it must be changed from + to −, or from − to +. For example, if y represent the difference between the two quantities a and z, it does not follow that, by substituting $-y$ for $+y$, the quantity represented by y becomes negative; but merely that, of the two quantities a and z, the one which was the greater in the case in which y has the sign + becomes the smaller when the sign of y is changed into −. The preceding remarks will suffice to give a notion of the nature of the difficulties which attend the rigorous interpretation of the negative sign in symbolical algebra. For full information on this abstruse subject, the reader is referred to the following works:—Carnot, *Geométrie de Position; Maseres on the Use of the Negative Sign; Warren on the Geometrical Representation of the Square Roots of Negative Quantities*, 1828; *Peacock's Algebra;* Id. *Report of the British Association for* 1834; *De Morgan's Trigonometry; Young's Mathematical Dissertations;* and the articles connected with the subject in the *Penny Cyclopædia*.

NE'GLIGENCE. (Lat. negligo, *to neglect.*) In the Fine Arts, a want of observance of admitted rules and principles in the several parts of a work; such as in costume, in the disposition of the light and shade, &c.

NE'GROES. The Ethiopian or fourth variety of the human race, according to the division of Blumenbach and his followers, widely spread over the surface of the earth; occupying almost the whole of Africa south of that great belt of desert which extends, in the latitude of the tropic of Cancer, from the Atlantic to the Red Sea. The distinctions of this race are marked aud peculiar; but they are not universal, or every where the same. Thus, the colour varies, although less so, perhaps, than that of any other of the great varieties of mankind; the Hottentots, and various southern tribes belonging to the Ethiopian race, are in this and other respects widely different from their brethren. The woolly hair, dark jet colour, and some external peculiarities of conformation, seem chiefly to belong to those numerous tribes which inhabit the west coast of Africa, between the equator and the tropic of Cancer. But, even within that region, some tribes are to be found whose physiognomy is very different from that which we are accustomed to regard as representing the Negro type. South of the equator many of the tribes are inferior in strength and stature, and very different in appearance: from this region many of the Brazilian negroes are imported. In New Guinea, off the south-eastern extremity of Asia, a native population is found with most of the characteristics of the African negro.

The Negro race appears to have been subjected to the tribute of furnishing slaves to its more powerful and intelligent neighbours from a very remote period of antiquity. Many ages before the first European slave ship had visited the coasts of Africa, the Arabs bore off slaves in their caravans, across the Sahara, to the northern coasts of the continent; and even in classical writers (Terence, for example), we find mention made of black or Ethiopian slaves. *See* SLAVE TRADE.

By the mixture of the Negro and white races the mulatto is produced; the Sambo is the offspring of a Negro and an American Indian. The numerous varieties of these mixed races, according to the proportion of Negro, European, or Indian blood in each, are classed and denominated accurately in the West Indies. It may, probably, be estimated that there are now on the continent and islands of America, including Negroes, Mulattos, but excluding those mixed races which have a larger proportion of European blood, about ten million individuals of African descent; viz.

In the United States - - -	3,500,000
British colonies - - - - -	900,000
Hayti - - - - -	700,000
Spanish, French, &c. West Indies -	1,200,000
Brazil - - - - - -	2,500,000
The free states of continental America, formerly Spanish colonies -	1,000,000
	9,800,000

Of whom five or six millions are now in a state of slavery;

the remainder, except in Hayti, forming an inferior and generally an oppressed class of free inhabitants. The ultimate destiny of this multitude of human beings is a matter of very anxious speculation. Hayti, peopled by the slaves of the French colony of St. Domingo, who threw off the yoke at the period of the French revolution, is the only region in which they have as yet established an independent community; and the progress of that community in civilization is not such as to encourage the sanguine hopes of the philanthropist.

It has long been a favourite theory of many philosophers that the negro races are naturally inferior in point of intellect, and do not possess the same capacity for improvement as the Europeans, or people of the Caucasian variety. This supposition has, however, been vehemently denied; and it has been contended over and over again that the peculiar circumstances under which they have been placed sufficiently account for the condition of the Africans — for their want of a literature and their low civilization. That great weight should be attached to the considerations now mentioned is true; but still we do not think that they are sufficient wholly to account for the existing state of things. Egypt was, at a very remote period, the principal seat of science and of art; and various nations of Africa were in contact with, and had a pretty extensive intercourse with, the Egyptians, and also with the Phœnicians, and afterwards the Romans. But they seem to have profited little or nothing by this association. And while the people of Greece, Asia Minor, and Magna Græcia raised themselves in a comparatively brief period to the highest pitch of civilization and refinement, the nations of Africa continue, without a solitary exception, down even to the present day, immersed in the grossest barbarism. Surely, however, during the space of 3000 or 4000 years, opportunities must have been afforded to some of them to make some advances. But if so, not one has had sagacity to profit by by them. Africa, in fact, does not seem to have produced a single great man. She has had no Hercules, no Minos, no Theseus, no Confucius, no Manco Capac. Among all the varieties of superstition that exist in it, we look in vain for hero-worship — for the divine honours paid in rude but improving nations in other parts of the world, by the public gratitude, to departed heroes, legislators, and authors of important discoveries in the arts.

With the exception of that of the ancient Egyptians and Ethiopians, whose descent is involved in the greatest uncertainty, almost all the civilization that exists in Africa seems to be of foreign origin. The introduction of Mohammedanism, though in a debased form, has gone far to banish cannibalism from many countries; and some of them have also adopted the letters and literature of Arabia. But the progress they have hitherto made is not such as to lead to any very sanguine anticipations as to their future advancement; and it would not, indeed, be very philosophical to suppose that those who have been wholly unable to produce any thing original should attain to much eminence in the practice of foreign arts and sciences.

It is unnecessary to enter into any examination of the *vexata questio* whether the varieties of the human race in Africa originally sprung from different sources, or whether they all belong to the same stock, but changed to the state in which we find them by the influence of circumstances in the lapse of ages. Whatever conclusion may be come to on this point cannot in anywise affect the question as to the comparative intelligence of the African people. The same circumstances that are supposed by those who contend for the original identity of the races to have so greatly affected their appearance and physical capacities, could hardly fail to have an equally powerful influence over their mental faculties. This in fact is substantially admitted by Dr. Pritchard, who has ably contended for their common origin, and the equality of their intellect with that of the other races. "The tribes," says he, "in whose prevalent conformation the negro type is discernible in an exaggerated degree, are uniformly in the lowest stage of human society; they are either ferocious savages, or stupid, sensual, and indolent. Such are the Papals, Bulloms, and other rude hordes on the coast of Western Guinea, and many tribes near the Slave coast, and in the Bight of Benin; countries where the slave trade has been carried on to the greatest extent, and has exercised its usually baneful influence. On the other hand, wherever we hear of a Negro state the inhabitants of which have attained any considerable degree of improvement in their social condition, we constantly find that their physical characters deviate considerably from the strongly marked or exaggerated type of the Negro. The Ashantee, the Sulema, the Dahomans, are exemplifications of this remark. The Negroes of Guber and Hausa, where a considerable degree of civilization has long existed, are, perhaps, the finest race of genuine Negroes in the whole continent, unless the Jolofs are to be excepted. The Jolofs have been a comparatively civilized people from the æra of their first discovery by the Portuguese." — (*Researches into the History of Man*, ii. 338. 3d ed.)

Here we have it distinctly laid down that the existence of the distinguishing features of the Negro race in a strongly marked degree is uniformly associated with the lowest state of barbarism; and that as they recede from this strongly marked type, we find a greater degree of civilization and improvement. The inevitable conclusion is, that every variety of the Negro type, which comprises the inhabitants of almost all central Africa, is indicative of mental inferiority; and that ferocity and stupidity are the characteristics of those tribes in which the peculiar Negro features are found most developed. We believe that this is a perfectly correct statement; and we do not know that any thing that can be said could show more conclusively the radical inferiority of the great bulk of the African people.

But we do not form our opinion as to their inferiority on their configuration and appearance, but on the fact that while numberless European and Asiatic nations have attained to a high state of civilization, they continue, with few exceptions, in nearly primeval barbarism. It is in vain to pretend that this is the result of the unfavourable circumstances under which they have been placed. An intelligent enterprising people contend against unfavourable circumstances, and make them become favourable; but the Africans, with the questionable exception of the ancient inhabitants of the valley of the Nile, have never discovered any considerable degree of enterprise or invention, or any wish to distinguish themselves either in arts or arms. From the remotest antiquity down to the present day they have been hewers of wood and drawers of water for others, and have made little or no progress; and the only legitimate inference from this lengthened induction seems to be, that they are incapable of making it; that civilization will not spring up spontaneously amongst them; and that if it ever grow up it must be introduced from abroad and fostered and matured under foreign auspices. (For full information on this subject, see the elaborate article on Africa in the *Geographical Dictionary*.)

NEHALLE'NIA. The name of an ancient Dutch and Flemish divinity who presided over commerce and navigation. Her origin and general character are unknown, and even her name suggests only forced and unsatisfactory associations; but the sixteen altars whereon her image and name were represented, which were found in the island Walcheren in 1647, leave no doubt of her former influence. (See *Grimm's Deutsche Mythologie*, and the authorities there cited.)

NEÏTH. One of the most ancient Egyptian deities, supposed to be identical with the Grecian Minerva or Rhea. Her name, according to Jablonski, indicates old or harmonious. She was regarded as an incarnation of nature, and as the patroness of all the arts. Her most celebrated temple was at Sais, where she was worshipped with peculiar veneration, and where stood the veiled image so famous in the mythology of Egypt, the rash inspection of which cost the adventurer either his life or his reason. (See Schiller's poem, "*Das verschleierte Bild zu Sais.*")

NEMATOI'DEANS, *Nematoidea*. (Gr. *νημα, a filament*, and *ειδος, form.*) The name of an order of *Cœlelmintha*, or cavitary intestinal worms, comprehending those which are diæcious, and have a round, filiform, elongated body.

NE'MATONEU'RA. (Gr. *νημα*, and *νευρον, nerve.*) A name proposed for that division of the *Radiata* of Cuvier, including animals in which nervous filaments are distinctly traceable, and the alimentary canal floats loosely in a distinct abdominal cavity.

NEM. CON. A contraction for *nemine contradicente*, signifying no one contradicting: *nem. diss.*, contracted for (Lat.) *nemine dissentiente*, signifies no one dissenting.

NE'MEAN GAMES. One of the four great national festivals of Greece, in which all the states participated. (*See* GAMES.) They were celebrated at Nemæa (whence their name), a village in the north-eastern part of Argolis. By some they are said to have been established by the Epigoni, children of the warriors who besieged Thebes, in memory of Ophaltes; but others relate that they were first instituted by Hercules, in honour of Jupiter, after his victory over the Nemean lion. They were held every third year, under the presidency of citizens chosen by lot from the states of Argos, Corinth, and Cleonæ. The games were the same as those of Olympia. The victorious combatants were crowned with parsley. See especially *Wachsmuth's Historical Antiquities of Greece*, Oxf. transl. vol. ii. 162.; and a memoir by Villoison, in the 38th volume of the *Mémoires de l'Ac. des Inscriptions*.

NE'MESIS. A Greek divinity, worshipped as the goddess of vengeance. According to Hesiod, she was the daughter of Night, and was represented as pursuing with inflexible hatred the proud and insolent. The reluctance of the Greeks to speak boastfully of their good fortune,

lest they should incur a reverse, is well known; and from various passages in the *Anthologia*, and other ancient writings, it is clear that this feeling originated in a desire to propitiate this divinity. The worship of this goddess was very extensive. Temples were erected to her honour, not only in Greece, but throughout the Roman empire. Nowhere, however, was her worship so pompously celebrated as at Rhamnus, a town of Attica, where she had a statue 10 cubits high of a single stone, and so exquisitely beautiful as to equal even the finest productions of Phidias. A fragment supposed to be the head of this statue was presented to the British Museum in 1820, where it may still be seen.

NEMO'CERA. (Gr. νημα, *a thread*, and κερας, *horn.*) The name of a family of Dipterous insects, including those which have long filiform antennæ.

NEMOGLOSSA'TA. (Gr. νημα, and γλωσσα, *a tongue.*) The name of a tribe of Hymenopterous insects, including those which have a long filiform tongue, as the bee tribe.

NEO'CORUS. (Gr. ναος, *temple*, and κορεω, *I take care of.*) In Grecian antiquities, the title of officers employed as guardians of temples and their treasures. (See *Mem. de l'Ac. des Inscr.* vol. xviii. 140.)

NE'OLOGISM, NE'OLOGY. (Gr. νεος, *new*, and λογος, *word.*) A new phrase or word introduced into a language, or any innovation on ordinary modes of expression. Most European tongues have their classical diction fixed by precedent and authority; and words introduced by bold or careless writers, since this standard was established, go by the name of neologisms until usage has added them at last to the received national vocabulary. *Neology*, in the last century, was the name given by orthodox divines in Germany to the novel system of interpretation which then began to be applied by many to the records of revealed religion. *See* RATIONALIST.

NEOME'NIA. (Gr. νεος, *new*, and μην, *a month.*) A festival observed by the Greeks at the beginning of every lunar month in honour of all the gods, but more especially of Apollo, thence called Νεομηνιος, as being the author of all light, and the grand luminary from which all time receives its distinctions and divisions. At these solemnities the Athenians offered up prayers and sacrifices, in the temple of Erechtheus, for the prosperity of their city during the month that had commenced. Games were also instituted during their celebration, and grand entertainments given by the richer to the poorer citizens.

NE'OPHYTE. (Gr. νεος, *young*; φυτος, *planted.*) In the primitive church newly converted Christians were so termed; and the same appellation is still given, in the Roman Catholic church, to converts made by missionaries among the heathen, to any person entering on the priestly office, and to those persons newly received into the communion of the church.

NE'OPLATONI'CIANS, or NEOPLATONISTS. In Ancient Literature, the mystical philosophers of the school of Ammonius Saccas and Plotinus are commonly so called, who mixed some tenets of ancient Platonism with others derived from a variety of sources, and particularly from the demonology of the East. They flourished in the 4th and 5th centuries of the Christian era. Some, however, have contended that this title is more properly applicable to the eclectic Platonists, or school of Antiochus and Philo. (*See* PLATONISTS, ECLECTICS.) For a singular view of the doctrines and tendency of the Neoplatonists, the reader may consult the *Quart. Rev.* July, 1840.

NEPE'NTHE. (Gr. νη, priv., and πενθος, *sorrow.*) A species of magic potion, mentioned by the Greeks and Romans, which was supposed to have the power of obliterating all pain and sorrow from the memory of those who partook of it. It is now used figuratively to express any efficient remedy in giving rest and consolation to an afflicted mind.

NEPHA'LIA. (Gr. νηφαλιος, *sober.*) Grecian festivals or sacrifices instituted in honour of various deities, as Aurora, Venus, &c. They were so called because no wine was offered during their celebration. It was chiefly at Athens that these festivals were observed.

NE'PHELINE. (Gr. νεφελη, *a cloud.*) A mineral from Somma, near Vesuvius, and Capo di Bova, near Rome; in nitric acid its transparent fragments become *cloudy*. It is a double silicate of alumina and soda. It is also known by the name of *sommite*.

NE'PHRITE. A hard tough mineral composed chiefly of silica, with lime, soda, and potash. It is difficult to break, cut, or polish; it is slightly translucent, and usually of a greenish colour. It is occasionally manufactured into sword and knife handles, and has even been cut into the form of a chain, which, from its extreme toughness, is not easily broken. Little plates of it were formerly suspended from the neck for the cure of *nephritic* complaints, whence its name. The Chinese are celebrated for articles composed of it. Its essential components are silica, alumina, and magnesia.

NEPHRI'TIS. (Gr. νεφρος, *a kidney.*) Inflammation of the kidney. This disease is attended by pain in the affected part, extending along the ureter, and increased on walking, or in the upright posture: nausea and vomiting are common attendants, and the appearance of the urine is generally far from healthy. Bleeding, warm baths, sudorifics, and aperients, with opiates and diluents, are the principal remedies resorted to.

NEPHRO'TOMY. (Gr. νεφρος, and τεμνω, *I cut.*) The operation of extracting a stone from the kidney.

NE'POTISM. A word invented to express a peculiar characteristic of many high ecclesiastics in Roman Catholic countries, and more particularly of popes: a propensity, namely, to aggrandize their family by exorbitant grants and favours conferred on members of it; literally, on nephews (nepotes). Many of the highest and wealthiest families of the Roman nobility owe their elevation entirely to this species of patronage.

NE'PTUNE. The Italian name of the deity called by the Greeks Poseidon (Ποσειδων). He was brother of Jupiter, and, in the partition of empire after the death of Saturn, the sea fell to his share, but in subservience to the former. His queen was Amphitrite, and his paramours nearly as numerous as those of his brother; but their progeny was not so celebrated, with the exception of the hero Pelops.

His most famous temples were at the Corinthian isthmus, Helicê, Træzen, and the promontories of Sunium and Tænarus; to which may be added the magnificent temple of Pæstum, in Italy, still in existence. Neptune was said to preside over horses and the manger. He is represented similar in appearance to Jupiter, but his symbols are a trident and the dolphin. *Neptunalia* were festivals celebrated by the Romans, during the months of July, in honour of Neptune. There were other festivals in honour of Neptune in his capacity of presiding over horses, called *consualia;* but the former were instituted to him in his character of god of the sea. During the solemnity it was customary to live in booths erected on the banks of the Tiber.

NEPTU'NIAN THEORY. The geological theory of Werner, which refers the formation of all rocks and strata to an aqueous origin.

NEREI'DEANS, *Nereideæ*. The name of the family of Dorsibranchiate Anellidans of which the genus *Nereis* is the type. The characters are, an even number of tentacula attached to the sides of the base of the head, and a little farther forwards two others which are biarticulate, between which are two simple ones. Their branchiæ consist of small laminæ, between which is spread a network of vessels; each foot is also furnished with two tubercles, two packets of bristles, one cirrus above and another beneath.

NE'REIDES. (Gr. Νηρειδες.) The daughters of Nereus and nymphs of the sea. They were originally conceived to be of a beautiful form, but later fictions degraded them to the idea of a mermaid. The nereids are said by most ancient writers to have been fifty in number, but Propertius makes them a hundred. Among the most famous of these goddesses were Amphitrite, Galatæa, Dido, Thetis, &c. Their worship was almost invariably connected with that of Neptune.

NE'REUS. (Gr. Νηρευς.) A marine Grecian deity, son of Ocean and Earth. He possessed the gift of prophecy, and was distinguished for his knowledge and love of truth and justice.

NERI'TA. (Lat. *Nerita*, the name of a shell-fish in Pliny.) This term was applied by Linnæus to a genus of his Vermes Testacea, characterized by having a shell with the columella in a straight line, which renders the aperture of a semicircular form: this aperture is always closed by an operculum. The genus is ranked by Cuvier amongst his Pectinibranchiate Gastropods, and is subdivided into the subgenera *Natica*, Lam., *Nerita*, *Voluta*, and *Neritina*, Lam. *Nerita* proper is a marine shell, while *Neritina* is an inhabitant of fresh waters. Examples of both genera are found fossil in the strata of the Paris basin.

NE'ROLI. The name given by perfumers to the essential oil of orange flowers. It is procured by distillation with water in the same way as the other volatile oils.

NE'RVINE. A medicine resorted to in nervous affections.

NE'RVOUS FEVER. A low fever in which nervous symptoms, or sensorial debility, are especially prevalent: the treatment consists in allaying nervous irritation and supporting the strength.

NERVOUS SYSTEM. In Physiology. The nerves are fibrous chords in direct or indirect connection with the brain, and extending their ramifications into every part of the body; their ultimate structure is filamentous, and they consist of a peculiar grey substance, their size depending upon the number of filaments enclosed in the common sheath. They are often so interwoven as to form a kind of network or *plexus;* and some of them have what are termed *ganglia*, or rounded masses of nervous matter, not fibrous, but apparently composed of globules disseminated through a vascular network.

There are two distinct systems of nerves; one of which is connected with the brain and with the spinal chord,

and are media of sensation and of voluntary motion: they are termed the nerves of *animal life*, or the *cerebro-spinal* nerves. The other system is only in communication with the brain and spinal chord, or with the cerebro-spinal nerves, by very small filaments, and they have numerous ganglions throughout their course; they preside over the nutritive functions, upon which the mind has no direct influence: these are the nerves of *organic life*, or *ganglionic* or great *sympathetic* nerves.

The cerebro-spinal nerves convey impressions from their extremities to the brain, and they also convey the influence of the will from the brain to the voluntary muscles; these passing and repassing, or receptive and emissive influences, are conveyed by distinct sets of nervous filaments, which, however, are generally enclosed in the same sheath, and therefore appear to form a single nerve: the terms *centripetal* and *centrifugal* filaments have been distinctively applied to them.

The history of the nervous system in all its details forms an extended and complicated, but a highly important part of anatomy and physiology, the investigations connected with which have led to many useful practical results, which, however, have thrown but little light upon the cause of the phenomena, or the ultimate nature of the nervous influence. The works of Sir Charles Bell, Dr. Marshall Hall, and Dr. Wilson Philip must be consulted in reference to the functions of the different classes of nerves; there is a good general account of the subject in Baly's translation of *Müller's Physiologie*.

NERVOUS SYSTEM. In Comp. Anat. In some of the lowest-organized animals the nervous system has been detected in the form of simple filaments; these are afterwards found connected with a nervous ring surrounding the œsophagus. As organization advances, nervous matter begins to be accumulated upon the ring, forming a brain; and upon different parts of the radiating filaments, forming ganglions.

When the principal gangliated filaments are not parallel, or not symmetrical in their course, they are associated with the type of organization which characterizes the molluscous or *heterogangliate* division of animals. When the gangliated filaments are two in number, symmetrical, and run parallel with each other along the ventral aspect of the body, they are associated with and bespeak the type of organization characteristic of the articulate or *homogangliate* division. When the brain ceases to present the form of a ring, and sends down the back a prolongation of its substance, called the spinal marrow, the rest of the organization is that which characterizes the vertebrate or *myelencephalous* subkingdom, or primary division of animals. In the vertebrate and articulate animals the superficial tract of the spinal or ventral chords is "sensitive," the deeper seated tract "motive."

NERVU'RES, in Entomology, are corneous tubes for expanding the wing and keeping it tense, and to afford protection to the air vessels: they are termed costal, post-costal, mediastinal, externo-median, interno-median, anal, axillary, &c., according to their relative positions. In Botany *nervures* are the veins of leaves.

NESS. The termination of several names of places in Great Britain where there is a headland or promontory, as Inverness, Sheerness. The word is probably derived from the Fr. nez, or the Germ. nase, *nose*.

NESTO'RIANS. The followers of Nestorius, patriarch of Constantinople, in the first half of the fifth century. This prelate agitated the Christian world, after the Arian controversy had been quietly settled, by the introduction of certain subtle disputations concerning the incarnation of our Lord, from whence debates and contentions arose which harassed the church for the space of more than two centuries. He affected to distinguish with peculiar precision between the divine and human natures united in Christ; and, in guarding over carefully against the propensity which he discovered in the Christians of his own day to confuse the two, and look upon them as absorbed into one compound substance, he forbade men to entertain any combined notion at all, and kept constantly before their eyes both the god and the man. He insisted, for instance, that the Virgin should not be entitled *Mother of God*, but *Mother of Christ*, or of *Man*, the human nature being essentially distinct from and only inhabited by the divine, as a temple by its divinity. The opinions of the Nestorians were, indeed, little more than subtle logical refinements upon mysteries which will not bear the application of such tests; and it was the habit of mind which they engendered that chiefly rendered them pernicious, and the fierce passions with which they were combined that gave them their celebrity and widely extended influence. Nestorius himself was condemned by the third general council held at Ephesus, in the year 431: his principal adversary being the president of the assembly, Cyril, the learned patriarch of Alexandria. The heretical prelate was deposed, and banished by the emperor to an oasis in Upper Egypt, where he died. His opinions, however, spread throughout Asia, and appear to have been carried along, with the advancing stream of Christianity, to the furthest parts of India and China. In more central regions, they were soon afterwards counteracted by the spread of the opposite heresy of Eutyches. For notices of the opinions which sprang out of these rival dogmatists, see INCARNATION, EUTYCHIANS, MONOPHYSITES, MONOTHELITES. Besides the well-known authorities, the reader may consult Doucin, *Hist. du Nestorianisme*, 1698; *Assemann's Biblioth. Orientalis*; and *Grant's Residence among the Nestorian Christians*, 8vo, 1841.

NESTS, ESCULENT. A species of nests built by swallows peculiar to the Indian islands, and very much esteemed in China and other parts of the world. These nests resemble in form those of other swallows; they are formed of a viscid substance, and in external appearance as well as consistence are not unlike fibrate ill-concocted isinglass. Esculent nests are principally found in Java, in caverns usually situated on the sea-coast. Nothing satisfactory is known as to the substance of which these nests are composed. (See the *Commercial Dict.*, art. "Birds' Nests.")

NET, or NEAT. In Commerce, something pure and unadulterated with any foreign mixture. Thus, wines are said to be *net* when not falsified; and coffee, rice, &c., to be so, when the filth and ordures are separated from them. The word *net* is also used for what remains after the tare has been taken out of any merchandize; *i. e.* when it is weighed clear of all package. (*See* TARE.) *Net Produce* (Ital. netto proceduto) is used in mercantile language to express what any commodity has yielded, after all tare and charges have been deducted.

NET (Germ. netz), is a textile fabric of knotted meshes for catching fish, and other purposes. Each mesh should be so secured as to be incapable of enlargement or diminution. The French government offered in 1802 a prize of 10,000 francs to the person who should invent a machine for making nets upon automatic principles, and adjudged it to M. Buron, who presented his mechanical invention to the *Conservatoire des Arts et Métiers*. It does not appear, however, that this machine has accomplished the object in view; for no establishment was ever mounted to carry it into execution. Nets are usually made by the fishermen and their families during periods of leisure. The formation of a mesh is too simple a matter to require description in this dictionary.

NE'THINIMS. Among the Jews, the servants of the priests and Levites, employed in the lowest and meanest offices about the temples. They were, as the Scripture expresses it, "the hewers of wood and drawers of water for the house of God." To this office the descendants of the Gibeonites were originally condemned by Joshua; but at a later period the same duties were assigned to the Canaanites who had surrendered themselves and were spared.

NE'TTINGS. Nets of small rope placed in a ship for various purposes, as stowage, or defence against accidents; also against boarding.

NE'TTLERASH. An eruption upon the skin much resembling the sting of a nettle. It usually lasts for a few hours, and then disappears or changes its place; it is relieved by bathing the affected part with a mixture of one part of vinegar and eight or ten of water, and by mild aperient medicines.

NEURA'LGIA. (Gr. νευρον, *a nerve*, and αλγος, *pain*.) An acute painful affection in the course of the nerves, generally subject to intermission. One of the most distressing forms of this disease is the *tic douleureux*.

NEURO'LOGY. (Gr. νευρον, and λογος, *a description*.) The doctrine of the nerves. *See* NERVOUS SYSTEM.

NEURO'MA. (Gr. νευρον.) A tumour formed in or upon a nervous trunk.

NEURO'PTERANS, *Neuroptera*. (Gr. νευρον, *a nerve*, πτερον, *a wing*.) The order of Tetrapterous Mandibulate insects, including those in which the nervures of the wings are so disposed as to form a more or less regular network. They are distinguished from the Coleopterous, Orthopterous, and Hemipterous orders of four-winged insects, by the first or anterior pair of wings being membranous, diaphanous, and resembling the second pair in texture and properties. The abdomen is unprovided with a sting. The antennæ are usually setaceous. Some neuropterans merely pass through a semi-metamorphosis, the rest a complete one; the larvæ have always six hooked feet. Many of these insects are carnivorous in their first state and their last. The dragon-fly may be regarded as the type of this order.

NEURO'TOMY. (Gr. νευρον, and τεμνω, *I cut*.) The cutting of a nerve.

NEU'TER (Lat. *neither*), in Grammar, signifies that gender which nouns possess that are neither masculine nor feminine. *Neuter* or *intransitive* verbs are those which represent the properties of a state or process, as *I rest*, *I fall*, *I grow*, &c. *See* GRAMMAR.

Neuter was the name given to the "labourers" of the hive-bee before it was discovered that they were essentially females, though infertile.

NEUTRA'LITY. In International Law, the condition of a state which does not take part in a war between other states. A neutral nation has the right of

furnishing to either of the contending parties all supplies which do not fall within the description of *contraband of war* (*see* CONTRABAND OF WAR), and to conclude treaties with either unconnected with the subject of the war. It appears to have been the old principle, with regard to the maritime trade of a neutral nation, that the property of an owner belonging to the hostile country might be seized by a belligerent on board a neutral power's vessel; but the general rule now asserted is that the flag covers the cargo: by which means right of search, except for specific purposes, is rendered unnecessary. But this rule is in effect set aside, according to the will or necessities of the most powerful belligerent, as it was during the last wars between England and the Continental powers.

NEUTRA'LIZATION. (Lat. neuter, *neither.*) In Chemistry, the combination of an acid and alkali in such proportions that the peculiar properties of each are rendered inert.

NEU'TRAL SALTS. Combinations of acids and bases which are neither acid nor alkaline, but in which the acid is exactly *neutralized* by the base.

NEUVAI'NES. (Fr. neuf, *nine.*) In the Roman Catholic Church, prayers offered up for nine successive days, in order to obtain the favour of Heaven. (See the *Dict. de la Conversation.*)

NEW CONNEXION METHODISTS, or KILHAMITES; so called from Mr. Alexander Kilham, who was the immediate means of their separation from the Wesleyans, and withdrew from this body on the ground of the almost irresponsible power exercised by the Conference. Having petitioned this convocation that the people might have a voice in the formation of the laws by which they were to be regulated, the choice of their own pastors and other officers, and the disposal of their own property, and those demands having been refused, the petitioners receded, and formed (1793) a distinct party, on a more liberal basis. The members of this body do not exceed 13,000. (*Life of Kilham*, by Thom and Grundel; *General Rules of the New Connexion Methodists.*)

NE'WEL. (Fr. noyau.) In Architecture, the space, either solid or open, round which the steps of a staircase are turned about.

NEW RED SANDSTONE. The sandstone immediately above the coal measures. *See* GEOLOGY.

NEWS. (Germ. neues, Lat. novus, Gr. νεος.) Literally, fresh information. This word has been fancifully derived from the initial letters of the four cardinal points of the compass, *n*orth, *e*ast, *w*est, and *s*outh.

NEW'SPAPERS. Publications in numbers, consisting commonly of single sheets, and published at short and stated intervals, conveying intelligence of passing events. In Rome, under the government of the emperors, periodical notices of passing events (diurna, acta diurna) were compiled and distributed for general reading; but our accounts of these ancient newspapers, derived from classical sources, are somewhat obscure and uncertain. In modern Europe, the earliest occasional sheets of daily intelligence seem to have appeared at Venice, during the war of 1563 against the Turks (*see* GAZETTE); and the earliest regular paper to have been a monthly one, published in the same city by the state: but these were distributed in manuscript, and, owing to the jealousy of the government, continued to be so down to very late times. Extraordinary gazettes are said to have been published in England by authority, during the time when the arrival of the Spanish Armada was apprehended; but the specimens preserved in the British Museum, and so long regarded as authentic, seem now to be demonstrated forgeries. The *Mercuries, Intelligencers*, &c. of the civil wars, seem to have been the first English papers which appeared regularly. The *Gazette de France* appeared regularly from 1631 to 1792, forming a collection of 163 volumes; it was continued, also, but with some interruptions, through the period of the Revolution; and the name still exists, the journal so called being at present one of the organs of the Carlist party. From their first imperfect beginning newspapers have gradually increased in number, matter, and consequence, until they form, in many European countries, one of the most important features in the social economy of the people; exercising a marked influence on domestic manners, literature, and usages, but more especially powerful as a great political instrument. In France newspapers are generally undertaken in shares. The editors and principal writers are more responsible and more generally known than in England: this is either a cause or an effect of the general prejudice in that country against anonymous writing, which is by no means so common as among ourselves; but, perhaps, one of its consequences is, that newspapers are more notoriously under the control of particular sections of the political world, or of powerful individuals. Political newspapers have their subsidiary articles on subjects of theatrical or literary criticism added in the shape technically termed *feuilleton*, a subdivision of the page. This custom was introduced about 1800 in the most influential paper of that period, and has since been generally followed. The periodical press of France was under strict control during the Empire: the censorship was continued until 1819, and re-established in 1820, but again abolished in 1821. At that period a law was passed compelling the proprietors to give security for the good conduct of their journals, under a penalty of 10,000 francs in Paris, and various lesser sums in the departments. The censorship was, however, again instituted, and again abolished in 1827. By the famous ordinances of 1830 the liberty of the periodical press was suspended. Since the revolution of that year there has been no attempt at re-establishing the censorship, although, in 1835, laws of a very severe character were passed, to subject the proprietors of journals to easier conviction, and heavier punishment, in case of trangressing the existing laws of libel against government or individuals, and extending and multiplying the provisions of that law. There were published in Paris, in 1839, 309 journals of all sorts, political, literary, scientific, &c.

In Great Britain newspapers are subjected to several statutory enactments. By 38 G. 3. c. 78. no person can print or publish any newspaper until an affidavit has been delivered at the stamp office, stating the name and places of abode of the printer, publisher, and proprietor; specifying the amount of shares in the undertaking, the title of the paper, and description of the building in which it is intended that the paper shall be printed. A copy of every newspaper is to be delivered, within six days after publication, to the commissioners of stamps, under a penalty of 100*l.* Persons publishing newspapers without the name and place of abode of the printer affixed may be apprehended and carried before a magistrate; and peace officers, by virtue of a warrant from a justice of the peace, may enter any place to make search, &c. By 60 G. 3. c. 9. every periodical pamphlet or paper, published at intervals not exceeding 26 days, containing public news or intelligence, or any remarks thereon, or on any matter in church or state, not containing more than two sheets, or published at a less price than sixpence, shall be deemed newspapers, and subject to the same regulations and stamp duties. By 1 W. 4. c. 73. securities may be demanded, to the amount of 400*l.* or 300*l.*, from both principal and sureties, when it is intended to publish a newspaper or pamphlet of the description mentioned in 60 G. 3. c. 9. These securities are intended to secure payment of damages or costs which may be incurred in an action for libel against the conductor of the paper. The laws respecting the stamp duties on newspapers have been recently placed on a new footing (in 1836). The effect of these restrictive provisions, and of the heavy rate of duty imposed on newspapers in England, is to create, especially in London, great monopolies, and to diminish the number of periodical papers, at the same time that their importance, and, according to the defenders of the system, their respectability and usefulness, is increased. There have rarely been more than five or six daily morning papers in London, and about as many evening. Of one of the former (*The Times*) the net profits have been estimated in some years at 24,000*l.* A morning paper in considerable circulation generally employs an editor, a sub-editor, from ten to fourteen regular reporters (*see* NEWSPAPER REPORTING), from thirty to thirty-five compositors, &c.; while the power and rapidity of the machinery which produces these huge sheets has been greatly increased of late years by the application of the steam engine. The evening newspapers, the apparatus of which is in other respects less costly, go to an enormous expense in procuring rapid intelligence from distant quarters. The irregular or occasional reporters are a numerous class: they multiply copies of the pieces of intelligence which they collect by means of polygraphs, and send them round to different newspapers to take the chance of their insertion.

The following calculation was formed, in 1827, of the number of periodical papers appearing in various countries, since which period it is probable that there has been a considerable increase:—Great Britain and Ireland, 483; France, 490; Russia, 288; Netherlands (Holland and Belgium), 160; German Confederation, excluding Austria and Prussia, 305; Sweden, 82; Denmark, 80; States of the Church, 6 only. It is obvious that without an approximation to the amount of copies of each newspaper, this calculation furnishes no grounds whatever for speculating on the proportion between the demand and supply of newspapers and the population in these respective countries; and wherever (as in England) newspapers are subjected to a heavy duty, each individual paper must necessarily sell a greater number of copies than elsewhere, in order to afford a profit; but the circulation of some French newspapers is said to exceed that of any among ourselves. The United States, at the same time, had 800 newspapers, and have at present upwards of 1000: about fifty of these appear daily. (See, among other antiquarian authorities as to early newspapers, *D'Israeli's Curiosities of Literature*, vol. i.; *Chalmers's Life of Ruddiman;* and the *Conv. Lexicon*, art. "Zeitung." See also the *Commercial Dictionary.*)

NEWSPAPER REPORTING. The name given to that system whereby the parliamentary debates and speeches delivered at public meetings, &c. are promulgated throughout the country. As it is contrary to the rules of both Houses that any stranger should be present, the publication of the debates is held to be a breach of privilege; but this regulation has always been defeated, either, as in former times, by the means adopted by Dr. Johnson and others of publishing the speeches of the different members under fictitious names, or, as at present, by the Houses themselves tacitly giving their sanction to the practice. The foundation of the present system of parliamentary reporting may be fairly ascribed to the late Mr. William Woodfall, whose retentive memory enabled him, after having listened to the debates, daily to communicate to the public, in what he called *A hasty Sketch of the Proceedings in Parliament last Night*, a full and most accurate account of the different speeches. Secret deliberations, however, have been so long renounced, that the right of the public to be present through their agents, the reporters, is as clearly established now as if no theoretical privacy had ever existed; but if any member were repeatedly to insist upon the exclusion of 'strangers,' as all are called who neither are members nor officers of the house, there can be no doubt that this abuse of the privilege must lead to such a modification of the standing order as would deprive individual members of any control over a matter so interesting to the nation. The process of parliamentary reporting, and the qualifications of those by whom the task is performed, cannot be adequately described within the narrow limits of this article; but it is hoped that the reader may be enabled to form some idea of both from the following brief outline. Every publication not copying from, or abridging any other, but giving original reports, keeps one of a series of reporters constantly in the gallery of the Lords, and another in the Commons. These, like sentinels, are at stated periods relieved by their colleagues, when they take advantage of the interval to transcribe their notes, in order to be ready again to resume the duty of note-taking, and afterwards that of transcription for the press. A succession of reporters for each establishment is thus maintained, and the process of writing from their notes never interrupted till an account of the whole debates of the evening has been committed to the hands of the printer. There are only seven publications for which a reporter is constantly in attendance; and these include the London morning newspapers, from which all others that give debates are under the necessity of copying or abridging them. The number of reporters maintained by each varies from ten or eleven to seventeen or eighteen. They are for the most part gentlemen of liberal education — many having graduated at the Universities of Oxford, Cambridge, Edinburgh, Glasgow, or Dublin; and they must all possess a competent knowledge of the multifarious subjects which come under the consideration of parliament. The expedition and ability with which their duties are performed must be admitted by every one who attends a debate and afterwards reads a newspaper, while the correctness and rapidity with which their manuscript is put in type and printed has long been a subject of surprise and admiration. (See the ***Parliamentary Companion***, a valuable brochure.)

NEW STYLE. In Chronology. *See* STYLE.

NEW TESTAMENT. The name given to that portion of the Bible which comprises the writings of the apostles and their immediate disciples. It consists of five historical books, viz. the respective Gospels of Matthew, Mark, Luke, and John, and the Acts of the Apostles (attributed to Luke); of twenty-one apostolical epistles, of which the early fathers have unanimously ascribed fourteen to St. Paul, three to St. John, two to St. Peter, one to St. James, and one to St. Jude; and of the book known by the name of the Apocalypse or the Revelation of St. John. *See* BIBLE, EPISTLE, EVANGELISTS.

NEWTO'NIAN PHILOSOPHY. This term is used in various senses. Sometimes it is used to denote the doctrine of the universe as delivered by Sir Isaac Newton in the *Principia;* sometimes the corpuscular, or modern, or experimental philosophy, as opposed to the the theories of Descartes and others; but most frequently, perhaps, the mathematical theory of universal gravitation. *See* GRAVITATION, PHYSICS.

NEW YEAR'S DAY. The celebration of the commencement of the new year dates from high antiquity. The Jews regarded it as the anniversary of Adam's birthday, and celebrated it with splendid entertainments, — a practice which they have continued down to the present time. The Romans also made this a holiday, and dedicated it to Janus with rich and numerous sacrifices; the newly elected magistracy entered upon their duties on this day; all undertakings then commenced were considered sure to terminate favourably; the people made each other presents of gilt dates, figs, and plums; and even the emperors received from their subjects new year's gifts, which at a later period it became compulsory to bestow. From the Romans the custom of making presents on New Year's Day was borrowed by the Christians, by whom it was long retained; but even in those countries where it lingered longest, in France and Scotland for instance, it is falling rapidly into desuetude, and congratulatory wishes are now almost universally substituted for the more substantial presents that were formerly conferred on this day as marks of affection and esteem.

NEX'I. (Lat. necto, *I bind.*) In Roman Antiquities, persons freeborn, who, for debt, were delivered bound to a creditor, and obliged to serve him until they could discharge it.

NIBELUNGEN, LAY OF THE. The name given to the most ancient existing monument of German epic poetry. The origin of this poem is veiled in great obscurity; it is supposed to have existed, in substance at least, two centuries before the reign of Charlemagne, and, like the early compositions of poets in all ages, to have consisted originally of detached ballads and poems, which were afterwards gradually collected, and at length moulded into the complete form in which they at present exist. The last of the modifications which it underwent took place towards the end of the 12th century, and is attributed to the Minnesaenger Henrich von Ofterdingen. The story turns upon the adventures of Chrimhold of Burgundy, who is first won by the valiant Siegfried, and after he is treacherously murdered gives her hand to Attila, king of the Huns, chiefly in the hope that through his power and influence she may be revenged on the murderers of her former lord. The assassins, accordingly, and all their kin, are induced to visit Attila, when, by the instigation of the queen, a deadly feud arises, in the course of which almost the whole army on both sides is cruelly slaughtered. By the powerful but reluctant aid of Diederich of Bern, however, the murderer of Siegfried is at last vanquished, and brought bound to the feet of the queen, who relentlessly raises the sword of the departed hero, and with her own hand strikes off the head of his enemy. The famous Hildebrand, whose exploits are depicted on the *Helden-Buch*, instantly avenged the atrocious and inhospitable act by stabbing the queen, who falls exulting on the body of her hated victim. The work is divided into thirty-eight books. The *Nibelungen Lied* formed for many centuries the chief traditionary record of the romantic deeds and sentiments of the German nation, but at the era of the Reformation it sank wholly into oblivion; from which, however, it has within the last thirty years been rescued, and permanently placed by the labours and commentaries of Hagen, Zeune, Simrock, and Schlegel, among the most conspicuous monuments of human genius. All the questions relating to its origin, nature, and characteristics are discussed with great interest by the German literati, to many of whom indeed it forms a distinct branch of study; and we cannot refrain from inserting in our pages Schlegel's notice of this poem which, whatever interest it has excited in Germany, is still comparatively unknown in England.

Among the heroic poems of those nations which, in contradistinction to those of the Greeks and Romans, whose skilful unfolding of incidents and dramatic vividness of representation were peculiar and unrivalled, have remained satisfied with a more simple mode of poetry, the *Nibelungen Lied* claims a very high place, — perhaps among all the heroic chivalrous poems of modern Europe, it is entitled to the first. It is peculiarly distinguished by its unity of plan; or rather it is a series of pictures, each naturally following the other, and all delineated with great boldness and simplicity and a total disregard of all superfluities. The German language appears in this work in a state of perfection to which in the subsequent periods of its early history it had no pretensions. In addition to all its natural liveliness and strength, it seems at that time to have possessed great flexibility, which soon afterwards gave place to a style of affectation, roughness, and indistinctness. The heroic legends of all nations have a great deal in common, so far as their essence and purpose are concerned; their variety is only produced by their being imbued with the peculiar feelings and composed in the peculiar measures of different nations. In the *Nibelungen Lied*, in the same manner as in the legends of Troy and of Iceland, the interest turns on the fate of a youthful hero, who is represented as invested with all the attributes of beauty, magnanimity, and triumph, but dearly purchasing all these perishable glories by the certainty of an early and predicted death. In his person, as is usual, we have a living type both of the splendour and the decline of the heroic world. The poem closes with the description of a great catastrophe borrowed from a half-historical incident in the early traditions of the north. In this respect also, as in many others, we cannot fail to perceive a resemblance to the *Iliad*. If the last catastrophe of the German poem be one more tragical, bloody, and titanic than any thing in Homer, the death of the German hero, on the other hand, has in it more solemnity and stillness, and is withal

depicted with more exquisite touches of tenderness, than any similar scene in any heroic poem with which we are acquainted. The *Nibelungen Lied* is, moreover, a poem abounding in variety; in it both sides of human life, the joyful as well as the sorrowful, are depicted in all their reality. The promise of the opening stanza is fulfilled:—

Von Freuden und Festes Zeiten, von Weinen und von Klagen,
Von kühner Helden Streiten, mögt Ihr nun Wunder hören sagen.

(*Schlegel's History of Literature*, Edin. 1818, vol. i. p. 270. 272.) See, for further information, the *Conversations-Lexicon*, and the works there referred to.

NICARA'GUA WOOD. The wood of the *Cæsalpina echinata*, a tree growing in Nicaragua; it is a species of Brazil wood. It is used with solution of tin as a mordant to dye a bright but fugitive red. Nicaragua woods differ greatly in their quality as well as price; one sort being so deficient in colouring matter that six pounds of it will only dye as much wool or cloth as one pound of Brazil wood, while another variety of it will produce nearly half the effect of an equal quantity of Brazil wood, and will sell proportionally dear. (*Bancroft on Colours*, vol. ii. p. 332.)

NICE, COUNCIL OF. The first, and, according to most writers, the most important, œcumenical council held in the Christian church. It was convened, A. D. 325, at Nicæa, by the emperor Constantine, in order to settle differences that had arisen in the Christian church in respect to the doctrines of Arius. This council was attended by upwards of 250 bishops, of whom a great majority came from the East, besides presbyters, deacons, and others from all parts of the Christian world. The chief question, as was remarked above, was the Arian heresy; and the council issued in the excommunication of Arius. (*See* ARIANS.) The decision of this council had not the effect of restoring tranquillity to the Eastern church, for the Arian controversy was still warmly carried on; but it has supplied that mode of stating the doctrine of the Divinity (as far as relates to the Father and Son) in which it has ever since been received by the orthodox. *See* NICENE CREED, COUNCIL.

NICE'NE CREED. The confession of faith in which the consubstantiality of the Father and Son is asserted against the Arians. (*See* art. ARIANS.) This creed was commenced by the council of Nice, A. D. 325, and completed by the second general council of Constantinople, A. D. 381. But the words "and the Son," after those "who proceedeth from the Father," were added by the Latin church (certainly before A. D. 411), expressing a point of doctrine in which it differs from the Greek. The Nicene creed was generally used by the Eastern churches in the administration of baptism; but was not inserted in their daily service till the fifth century. In the service of the church of Rome it was inscribed A. D. 1014.

NICHE. (Fr. niche.) In Architecture, a square or cylindrical recess in a wall, usually made for the reception of a statue.

NICKEL. A white metal, ductile, malleable, attracted by the magnet, and which, like iron, may be rendered magnetic. Its specific gravity when hammered is about 9. It is rather more fusible than pure iron; is not altered by exposure to air and moisture at common temperatures, but is slowly oxidized at a red heat. It is found in all meteoric iron; but its principal ore is a copper-coloured mineral found in Westphalia, and called *kupfernickel*, nickel being a term of detraction used by the German miners, who expected from the colour of the ore to find that it contained copper. The salifiable oxide of nickel consists of 30 nickel + 8 oxygen. Its salts are mostly of a grass-green colour, and the ammoniacal solution of its oxide is deep blue, like that of copper. Ferrocyanate of potassa precipitates it of a white or very pale green colour.

Since the manufacture of German silver, or *argentane*, became an object of commercial importance, the extraction of nickel has been undertaken upon a considerable scale. The cobalt ores are its most fruitful sources, and they are now treated by the method of Wöhler to effect the separation of the two metals. The arsenic is expelled by roasting the powdered *speise* first by itself, next with the addition of charcoal powder, till the garlic smell be no longer perceived. The residuum is to be mixed with three parts of sulphur and one of potash, melted in a crucible with a gentle heat, and the product being edulcorated with water leaves a powder of metallic lustre, which is a sulphuret of nickel free from arsenic; while the arsenic associated with the sulphur, and combined with the resulting sulphuret of potassium, remains dissolved. Should any arsenic still be found in the sulphuret, as may happen if the first roasting heat was too great, the above process must be repeated. The sulphuret must be finally washed, dissolved in concentrated sulphuric acid, with the addition of a little nitric; the metal must be precipitated by a carbonated alkali, and the carbonate reduced with charcoal.

In operating upon kupfernickel, or speise, in which nickel predominates, after the arsenic, iron, and copper have been separated, ammonia is to be digested upon the mixed oxides of cobalt and nickel, which will dissolve them into a blue liquor. This being diluted with distilled water deprived of its air by boiling, is to be decomposed by caustic potash till the blue colour disappears, when the whole is to be put into a bottle tightly stoppered, and set aside to settle. The green precipitate of oxide of nickel, which slowly forms, being freed by decantation from the supernatant red solution of oxide of cobalt, is to be edulcorated and reduced to the metallic state in a crucible containing crown glass. Pure nickel in the form of a metallic powder is readily obtained by exposing its oxalate to moderate ignition. (*Ure's Dict. of Arts, &c.*)

NICOLAI'TANS. One of the earliest Christian sects, mentioned in the Revelations of St. John, where the angel of God reproaches the church of Pergamos with harbouring persons of this denomination. They are there characterized as inclining to the licentious and pagan practices of the Gentiles; but the fathers have also accused them of partaking in a great measure of the Gnostic opinions. It is doubtful, however, whether on this point there be not some confusion between the Nicolaitans of the first and the followers of Nicolaus of the second century. (See *Mosheim* (transl. 1790.), i. 143. *Gieseler's Text Book* (transl.), i. 69.)

NICOTI'NA. A poisonous alkaline base, extracted from the leaves and seed of the *Nicotiana tabacum*, or common tobacco. It derives its name from Nicot, a Frenchman, who about 1560 first sent tobacco into France.

NICTITA'TION. (Lat. nicto, *I wink.*) Winking of the eyes. This is generally a nervous affection, and very frequently it becomes a trick or habit. Where it arises from any local irritating cause, bathing the eyes with warm water affords relief.

NIDDUI. A sort of minor excommunication among the Hebrews, which continued usually about a month. If not removed within that period, it was prolonged for sixty or even ninety days. If during this term satisfaction was not made, the excommunicated person fell into the *cherem*, which was the second species of excommunication; and afterwards into the *scammatha*, which was the most dreadful of all.

NIDIFICA'TION. (Lat. nidus, *a nest;* facio, *I make.*) The process by which birds construct their nests.

NIE'LLO. (Ital.) A method of engraving on plate. *See* art. ENGRAVING, where the process is described.

NIGHT. (Lat. nox, Ger. nacht.) The part of the natural day during which the sun is below the horizon.

NIGHT HERON. *See* ARDEA.

NIGHTINGALE. A migratory species of Passerines, and the sweetest of song-birds; the type of the subgenus *Luscinia*, which is more closely allied, according to Mr. Blythe, to the thrush family, than to the fauvettes (*Currucidæ*), among which it is placed by Cuvier. The males of the nightingale reach the southern counties of England sometimes in April, but more commonly not till the beginning of May; the females do not arrive till a week or ten days after the males. Migrating from the south, they visit this country for the purpose of breeding, and the famed song of the male is his "love chant," and ceases when his mate has hatched her brood. "Vigilance, anxiety, and caution now succeed to harmony; and his croak is the hush, the warning of danger and suspicion, to the infant charge and the mother bird." If by accident his mate be killed, the male resumes his song; and will continue to chant very late in summer unless he can attract, as he commonly soon does, another female. The nightingale feeds chiefly on the larvæ of insects, which abound at the season of its arrival in this country. The nest is built near the ground; the eggs are four or five in number, of a uniform dark brown colour: the young are excluded in the month of June, and are ready to accompany the parents in their southward migration in the month of August.

NIGHT-JAR. The name of a remarkable British bird, the type of the genus *Caprimulgus*, distinguished by the wide gape of its beak, whence perhaps has arisen the popular idea of its sucking the teats of cattle, and its other common name "goat-sucker," the equivalent of which it has received in most European languages, and which Linnæus has continued in its generic designation. It is scarcely necessary to observe that the structure of the bill renders the act of sucking impracticable in the night-jar or any other bird. The genus *Caprimulgus* is characterized by a wide and deeply-cleft beak, armed with strong bristles, and capable of engulphing the larger insects; the nostrils placed at its base are like small tubes; the wings are lengthened; the feet short, feathered to the toes, which are connected together by a membrane at their base; the claw of the middle toe is commonly pectinated at the base. The night-jars are most active and hunt their prey in the dusk; they have the same light and soft plumage as other nocturnal birds. Our common species (*Capr. Europæus*) is remarkable

for the loud sound it emits, like the burr or jarring of a spinning-wheel.

NIGHTMARE. An oppressive sensation and struggle during sleep, otherwise called *incubus* (which see); produced usually by indigestion.

NI'GHTSHADE. *See* DULCAMARA and BELLADONNA.

NIGHT WATCH. A period of the night as distinguished by a change of the watch. Among the Romans the night was divided into four watches, each of three hours' duration, and styled first, second, third, and fourth watches, according to the military usage, by which the guard was relieved four times during the night. The first watch began at six in the evening and lasted till nine, according to our mode of computing time; the second lasted from nine till twelve or midnight; the third from midnight till three in the morning (called *cock-crowing*); and the fourth commenced at three and ended at six, thus completing the twelve hours. The Jews originally divided the night into three watches; but at a later period, and previously to the appearance of our Saviour, they adopted the Roman division of the night, which is frequently alluded to in the New Testament. In the Roman mythology, Nox was the goddess who presided over the night. She is represented clothed with a tunic thickly set with stars; and in her honour the Romans sacrificed a cock during the night.

> Nocte deæ Nocti cristatus cæditur ales,
> Quod tepidum vigili provocet ore diem. OVID.

NI'GRINE. (Lat. niger, *black*.) Silico-calcareous oxide of titanium. It occurs in Ceylon and Transylvania.

NI'MBUS. (Lat.) In Painting and Sculpture, a circular disk round the heads of divinities, and sovereigns and saints.

NIMBUS CLOUD. In Meteorology. *See* CLOUD.

NI'NSIN ROOT. A bitter root, possessed of the medicinal qualities of ginseng. It is the root of the *Sium ninzi*.

NI'NTH. In Music, one of the dissonant intervals in music, being properly the second double.

NI'OBE. In Classical Mythology, daughter of Tantalus, and one of the Pleiades, married to Amphion, king of Thebes. Proud of her numerous and flourishing offspring, she provoked the anger of Apollo and Diana, who slew them all: she was herself changed by Jupiter, in Phrygia, into a rock, from which a rivulet, fed by her tears, continually pours. The subject of Niobe and her children was a great favourite with the poets of antiquity. Besides the beautiful story in Ovid (*Met.* vi. 146.), there are numerous epigrams in the Greek *Anthology*, which appear to be descriptive either of the group of figures to which we refer below, or to some similar group. See more especially that beginning,

> Ταντᾰλε και Νιοβα κλυ' εμαν φατιν αγγελον ατας.

This fable has also afforded a subject for art, and particularly for the sculptor of the beautiful group in the tribune at Florence, known by the name of Niobe and her Children. Some antiquaries attribute it to Scopas: Winkelman inclines to believe it the workmanship of Praxiteles. It is beautifully characterized by Hazlitt, in his "Treatise on Art," in the *Ency. Britannica*.

NI'PPERS. In Sea language, small ropes or selvages for attaching the messenger to the cable.

NI'SI PRIUS. In Law, a term originating in a legal fiction, when the pleadings in a cause in one of the superior courts of common law (*see* PLEADING) are concluded, and an issue of fact is raised between the parties. The issue is appointed, by the entry on the record or written proceedings, to be tried by a jury from the county, of which the proceedings are dated, at Westminster, *unless before* the day appointed (nisi prius) the judges shall have come to the county in question. The judges of assize, by virtue of their commission of nisi prius, try the causes thus appointed on their several circuits, unless they are dated of London or Middlesex; in which case they are tried in London or in Westminster, at the sittings during or after term. *See* COURTS, SUPERIOR; and TERM.

NITRA'TES. Salts of the nitric acid; thus *nitrate* of potassa is a compound of one atom of nitric acid and one atom of potassa. *See* NITRE.

NI'TRE, *Nitrate of Potassa, Saltpetre*. This salt consists of 54 nitric acid + 48 potassa; its equivalent, therefore, is 102. It is spontaneously generated in the soil, and crystallizes upon its surface in several parts of the world, especially in India, whence nearly the whole of the nitre used in Britain is derived. It has occasionally been produced artificially in *nitre beds*, formed of a mixture of calcareous soil with animal matter; in these nitrate of lime is slowly formed, which is extracted by lixiviation, and carbonate of potash added to the solution, which, by double decomposition, gives rise to the formation of nitrate of potash and carbonate of lime: the latter is precipitated; the former remains in solution, and is obtained in crystals by evaporation. Nitre crystallizes in six-sided prisms, soluble in seven parts of cold water and in less than its weight of boiling water. It has a cooling saline taste, and is anhydrous. At 616° it fuses, and at a red heat is decomposed. Its great use is in the manufacture of gunpowder, and in the production of nitric acid. It is also employed in the preservation of meat.

Nitrate of soda crystallizes in rhombic crystals; hence termed *cubic nitre*. It is found plentifully in Peru, and is imported into England from America. It is used as a manure and as a source of nitric acid, but, being slightly deliquescent, it cannot be employed in the manufacture of gunpowder.

Nitre has sometimes been mistaken for Glauber's salt, and, when taken in the quantity of half an ounce or an ounce, it acts as a powerful poison. In such cases the stomach should be evacuated as rapidly as possible, and the symptoms of spasm relieved by opiates. In doses of 5 to 15 grains it is diuretic and diaphoretic.

NITRIC ACID. This acid is a compound of 1 atom or equivalent of nitrogen = 14, and 5 of oxygen (8×5) = 40; hence its equivalent in the dry or anhydrous state, as it exists, for instance, in nitre, is $14 + 40 = 54$. As it usually occurs in the liquid state, it is a compound of 1 equivalent of dry acid, 54, and 2 of water (9×2), 18; hence the equivalent of the liquid acid is 72. It is commonly known in commerce under the name of *aqua fortis*, and is prepared by distilling a mixture of sulphuric acid and nitre. It is commonly yellow, or even deep orange coloured; but it may be deprived of nitric oxide, which occasions this colour, by heat, and is then colourless. It is intensely corrosive and sour, fumes when exposed to air, and has a specific gravity of 1·50 when in its utmost state of concentration. It boils at 248°, and freezes at −50°. It is a most powerfully oxidizing agent, and is decomposed with more or less rapidity by almost all the metals.

The salts which it forms are called *nitrates;* they are all soluble in water; they are decomposed by heat, and, when mixed and gently heated with sulphuric acid, they evolve nitric or nitrous acid.

NI'TRIC OXIDE, or NITROUS GAS. This gas was discovered by Hales, and more accurately studied by Priestley. It is obtained during the action of nitric acid diluted with about two parts of water upon metallic copper; it is copiously evolved, and may be collected over water. 100 cubical inches of this gas weigh between 32 and 33 grains; its density, therefore, compared with air, is 1037. It is at once easily recognized by forming orange-coloured fumes whenever it escapes into the air or comes into contact with oxygen, so that this gas and oxygen are excellent tests of each other's presence. It consists of equal volumes of nitrogen and oxygen, or of 1 equivalent of nitrogen and 2 of oxygen; hence it is termed a binoxide or deutoxide of nitrogen. The respective weight of its components, therefore, are 14 nitrogen + 16 oxygen, and the equivalent of the gas is 30.

NITRI'TES. Salts of the nitrous acid; thus *nitrite* of potassa is a compound of 1 atom of nitrous acid and 1 atom of potassa, &c.

NI'TROGEN. (Gr. νιτρον, and γεννασιν, *to produce*.) A simple gaseous body which forms a constituent part of nitric acid, and which, being unrespirable, has also been termed *azote:* from α, privative, and ζωη, *life*. It was identified as a peculiar gas by Dr. Rutherford in 1774, and shown to be one of the components of atmospheric air by Lavoisier in 1774. It is generally obtained by burning a piece of phosphorus in a jar full of air inverted over water. The phosphorus during its combustion combines with the oxygen of the air to form phosphoric acid, which is dissolved by the water, and the remaining element of the air, namely, the nitrogen, remains. Nitrogen is a colourless, inodorous, and tasteless gas, not absorbed by water, and having no action on vegetable colours. It extinguishes all burning bodies, and is itself uninflammable. It is a little lighter than atmospheric air, 100 cubic inches weighing 30·16 grains. Its equivalent is 14, and it combines with oxygen in 5 proportions, giving rise to the following compounds:—

	By volume. N. O.	By weight. N. O.	Equiv.	Symbols.
1. Nitrous oxide	$100 + 50$	$= 14 + 8$	$= 22$	$= n + o$.
2. Nitric oxide	$100 + 100$	$= 14 + 16$	$= 30$	$= n + 2\,o$.
3. Hyponitrous acid	$100 + 150$	$= 14 + 24$	$= 38$	$= n + 3\,o$.
4. Nitrous acid	$100 + 200$	$= 14 + 32$	$= 46$	$= n + 4\,o$.
5. Nitric acid	$100 + 250$	$= 14 + 40$	$= 54$	$= n + 5\,o$.

NI'TROMURIA'TIC ACID. Nitrohydrochloric acid of modern nomenclature. The mixture of nitric and of muriatic (or hydrochloric) acid; formerly called *aqua regia*, from its solvent power over gold, the *king* of the metals.

NITRONA'PTHALASE. A compound resulting from the action of nitric acid on napthalin: a modification of it has been termed *nitronapthalese*.

NITROSA'CCHARIC ACID. By the action of sulphuric acid on gelatine a peculiar saccharine matter is formed, which combines with nitric acid, and forms a crystallized acid designated as above.

NITROSULPHU'RIC ACID. An acid resulting from the mixture of one part of nitre with eight or ten parts of sulphuric acid. It was originally proposed by Mr. Keir as a useful agent for separating the silver from the copper of old plated goods. At the temperature of about 200° it dissolves silver, while it scarcely acts upon copper or lead, unless diluted, or at higher temperatures.

NI'TROUS ACID. When two volumes of nitric oxide and one of oxygen are mingled in an exhausted glass globe they form a dense orange-coloured vapour, which may be liquified by cold, and which is *nitrous acid*. Its elements are so condensed that 1 volume of nitrogen and 2 of oxygen form 1 volume of nitrous acid vapour, the specific gravity of which is 3·17. The presence of this vapour renders nitric acid red and fuming, in which state it is commonly termed *nitrous* acid.

NI'TROUS OXIDE. Protoxide of nitrogen; a gas obtained by heating nitrate of ammonia, which salt is thus resolved into nitrous oxide gas and water. When nitrous oxide is respired, it produces effects somewhat similar to those of intoxication; hence it has been called *laughing gas*.

NIZAM. The title of one of the native sovereigns of India, between whom and the East India Company many subsidiary treaties exist. This title is derived from Nizam-ul-Mulk, who in the beginning of last century obtained possession of the Mohammedan conquests in the Deccan; his successors in the sovereignty having assumed his name as their title of dignity, which they have retained to this day.

NOBILISSIMUS, was a title of dignity given to the princes of the imperial family of Rome. It is said by Doucine to have originated with Justin, but others hold it to be of much more ancient date.

NOBI'LITY. The general appellation for a distinguished order of society which exists in every civilized country, with the exception of the United States and Norway. (*See* PEERAGE.) In Roman antiquity persons were not noble by birth, but in consequence of the public offices held by their ancestors, who had the sole right to bequeath their images to their descendants (*jus imaginum*). (*See* HERALDRY.) Originally the patricians were the only nobles, they alone being eligible to the magistracy; but when the *equites*, and even the *plebs* were admissible, the great body of the nobles began to be formed. The first in any family who was raised to a curule dignity was styled *novus homo*. *See* NOVI HOMINES.

NO'BLE, an English coin of the middle ages, value 6*s*. 8*d*., current in the reign of Edward III. According to Knighton, the *rose noble* was a gold coin in use about the year 1344.

NOCTHORA. *See* SAGOUIN.

NOCTILU'CA. A term applied by Boyle and some of the older chemical philosophers to phosphorus.

NOCTU'RN. (Lat. nox, *night*.) An office consisting of psalms and prayers, celebrated in the Roman Catholic church at midnight, after the example of David (Ps. 118.). It was said to have been introduced into the West by St. Ambrose. It now forms part of the service of matins.

NOCTU'RNALS, *Nocturnæ*. (Lat. *nox*, night.) A tribe of Raptorial birds, including those which fly by night, and have the eyes directed forwards: also a family of Lepidopterous insects, which, in like manner, are active chiefly in the night season.

NODE, in Surgery, is a hard tumour upon a bone, which creates considerable pain, and often is attended by caries or necrosis. They are most common upon the tibia and bones of the head and fore-arm, where they are thinly covered by flesh.

NODES, in Astronomy, are the two points in which the orbit of a planet intersects the plane of the ecliptic. The point in which the centre of a planet passes from the south to the north side of the ecliptic is called the *ascending node*, and in astronomical computations is usually indicated by the symbol ☊; the opposite point, or that in which the planet passes to the south side of the ecliptic, is called the *descending node*, and is indicated by ☋. The straight line which joins these two points, formed by the intersection of the plane of the planet's orbit with the plane of the ecliptic, is called the *line of the nodes*. The nodes of the lunar orbit were anciently called the head and tail of the dragon.

The position of the nodes on the ecliptic is one of the elements by which the situation of the plane of an orbit in space is defined: in fact, it is easy to see that, if the position of the line of the nodes, and also the inclination of the orbit to the ecliptic, be known, the position of the plane of the orbit is entirely determined. The two nodes being distant 180°, it is only necessary to indicate the position of one of them: the longitude of the ascending node, or its distance from the first point of Aries, is the element used by astronomers. In all the planetary orbits the line of the nodes is variable, having a retrograde motion from east to west in respect of the fixed stars, but so slow that it amounts only to a few seconds in a year. The regression of the moon's nodes is very considerable, as it completes a revolution in about 19 years. (*See* MOON.) This retrograde motion of the nodes of all the planets is a necessary consequence of their mutual attractions. For the positions and variations of the nodes of the different planets, see PLANET.

NO'DULE. (Lat. nodus, *a knot*.) Rounded irregular lumps or masses.

NO'DUS. In Botany, a point situated upon the axis of a plant, whence a leaf or leaf-bud originates.

NOËL. The French name of Christmas Day, derived either from *dies natalis* (Lat. *birthday*), or from an abbreviation of the word Emmanuel.

NOE'TIANS. In Ecclesiastical History, a sect so called from Noetus, an Ephesian, the master of Sabellius. They acknowledged only one person in the divinity; and, consequently, were accused of maintaining that God the Father had suffered on the cross. *See* PATRIPASSIANS.

NOGGING. In Architecture, brickwork carried up between upright pieces or quarters.

NO'GGING PIECES. In Architecture, the horizontal pieces of timber fitting in between the quarters, to which they are nailed in a brick-nogged partition, which they serve to steady and strengthen.

NO'LI ME TA'NGERE, in Surgery, is a disease of the skin, commencing with small ulcerations which destroy the part. They sometimes affect the cartilage of the nose, which is destroyed by their progress; almost all applications rather increase the progress than allay it.

NO'LLE PRO'SEQUI. In Law, an acknowledgment or agreement by the plaintiff in a suit that he will not further prosecute it, either as to the whole or a part of the cause of action (as, for instance, where, on the defendant's demurring to one count in a declaration, the plaintiff enters a nolle prosequi as to that count, and proceeds to trial on the other counts); or as to one or more out of several defendants.

NO'MADES. (Gr. *νομαδες*; from *νομος*, *pasture*.) Tribes of men without fixed habitation. The nomades of classical times were generally tribes devoted to pastoral pursuits; for the ancients knew of no races of savages subsisting wholly by the chase. The principal nomadic tribes of antiquity were those of southern Russia and the interior of Asia, from whom sprung, in the decline of the Roman empire, many of the tribes which overran western Europe; and, at a later era, those which conquered empires in western and southern Asia.

NOME. (Gr. *νομος*; from *νεμω*, *I divide*.) The Greek name for the provinces into which Egypt was divided from the most remote antiquity. According to Diodorus Siculus, the division into nomes was performed by Sesostris, whom some modern writers consider as identical with the Remeses II. of the monuments; but it is supposed to have subsisted from the time of the earliest Pharaohs. There were 36 nomes, which, in the time of Strabo, were thus divided: — 10 in the Thebaïd, 16 in the Heptanomis, or intermediate district (which, according to its name, probably consisted in earlier times of 7 only), 10 in the Delta. This division was not materially altered until the latest age of the Roman government. (See D'Anville, *Mémoires sur l'Egypt*; *Wilkinson's Manners and Customs of the Ancient Egyptians*, vol. ii.)

NO'MENCLA'TOR. An officer employed by the candidates for the great state offices of Rome, to accompany them through the streets and whisper them the names of such citizens as they might meet, in order that they might then address them by name, and canvass their votes. It is derived from Lat. nomen, and the old word calo, *I call*.

NO'MENCLA'TURE, was originally applied to a catalogue of the most ordinary words in any language, with their significations, &c., drawn up for the purpose of facilitating their use and retention to those who are endeavouring to acquire a language. But, in a more general sense, this term is employed to denote the language peculiar to any science or art: thus we speak of the nomenclature of chemistry, botany, &c.

NO'MINALISTS. A term originally applied to a scholastic sect which arose in the 11th century. Its founder was John Roscelin, a churchman of Compiegne, who asserted that general terms have no corresponding reality either in or out of our minds, being, in truth, words, and nothing more (*flatus vocis*). This doctrine naturally excited great consternation among the schoolmen, with whom, hitherto, all that was real in nature was conceived to depend on these general notions or *essences*. Its promulgator underwent much persecution for his opinions, and was ultimately compelled to retract them, as inconsistent with the doctrine of the Trinity as it was then stated. He found, however, an able successor in the person of Peter Abelard, who attracted numerous disciples by his dialectical skill and eloquence, and, with his followers, whom he led in a body to Paris, was the occasion of founding the celebrated university of that city. After his death the ancient realism was restored to its supremacy; nor do we meet with a nominalist until the 13th century, when William of Occam revived his doctrines under some modifications. The last-mentioned philosopher may, in fact, with greater justice, be styled a conceptualist, as he distinctly stated

the formation of general terms to depend on the conditions of thought, and hence to possess a species of subjective reality, as the sign or indication of an actual process of thought, though not either distinct objects of consciousness or realities in nature. Those who hold either of the latter theories are realists. The controversy is one which has excited great attention among modern philosophers, among whom Hobbes and Dugald Stewart may be considered strict nominalists, while Locke and Dr. Thomas Brown style themselves conceptualists. There are, however, expressions in Locke's writings which would rather stamp him as a realist, under the former of the two modifications which we have given above. (See articles SCHOLASTIC PHILOSOPHY, THOMISTS, SCOTISTS.) There are very profound observations on the subject of this controversy in the first volume of *Hallam's Literature of the Middle Ages*. See also *Brucker's Historia Critica Philosophiæ*.

NO'MINATIVE CASE. In Grammar, that form of a noun which names or designates a substance *absolutely*, or without relation to any other substance.

NOMO'CANON. (Gr. νομος, *law*; κανων, *canon* or *rule*.) In Ecclesiastical Law, a work in which canons of the church, and imperial laws touching the same subjects, are collected and compared. The first was made by Joannes Scholasticus (A.D. 551). The most celebrated was that of Photius, patriarch of Constantinople.

NO'MOPHY'LACES. (Gr. νομος, *the law*, and φυλακες, *guardians*.) Among the Athenians, magistrates or legal officers, whose business it was to see that neither the privileged citizens nor the lower classes made any innovation upon the laws. They held seats in all the public assemblies, and during the public games and festivals had chairs erected for them opposite to those of the archons. This was also the appellation of those officers appointed to communicate to the combatants the laws of the Olympic games.

NOMO'THETÆ. (Gr. νομος, *law*, and τιθημι, *I lay down*.) A body of citizens at Athens, chosen by lot out of such as had been judges in the court Heliæa, to the number of a thousand. Their office seems to have been a sort of inspectorship of existing laws, with the duty of proposing amendments.

NO'NÆ ET DECIMÆ. In Ecclesiastical Law, the contributions of tenants of the church were anciently so called: the nonæ, or ninth part, standing for a species of rent, the decimæ for the tithe due to the church.

NONAGE. In Law. *See* INFANT, MINORITY.

NONAGE'SIMAL (Lat. nonagesimus, *the ninetieth*), in Astronomy, is the *ninetieth* degree of the ecliptic, reckoned from either of the points in which it is intersected by the horizon. It is therefore the highest point of the ecliptic at any instant, and its altitude is equal to the distance of the pole of the ecliptic from the zenith. The nonagesimal is used in calculating the parallaxes of the moon.

NO'NAGON. (Lat. novem, and γωνια, *angle*.) In Geometry, a plane figure having nine angles, and consequently nine sides. The area of a regular nonagon is $= \frac{9}{4}$ tan. $70^\circ = 6{\cdot}1818242$, the side being 1.

NON COMPOS MENTIS. (Lat.) In Law, a general term for those afflicted with mental incapacity. *See* LUNACY, IDIOT.

NO'NCONDU'CTOR. This term is generally limited to certain phenomena connected with the transfer of heat and electricity through bodies; those substances which resist the direct passage of those influences (and occasionally also of sound) are called *nonconductors*.

NONCONFOR'MISTS. A general term under which all the religious communities which do not conform to the liturgy of the church established in England may be comprehended. It belongs more properly to the large body of clergy who, at the Restoration, refused to subscribe to the Act of Uniformity, and were in consequence ejected from their benefices on St. Bartholomew's day, 1662. This act was first promulgated by Elizabeth, and required all the clergy to use the *Book of Common Prayer*, and inflicted severe penalties upon any one who should be convicted of speaking or preaching against it. The act of Charles II. contained still stricter provisions, enjoining every beneficed person not only to use the book, but to declare his assent and consent to every part of it; and enacting that unless this were done on a certain day he should be, *ipso facto*, ejected. Other declarations were also to be subscribed; as, "That it is unlawful to take arms against the king on any pretence whatsoever;" "That no obligation from the covenant lies upon himself or any other person." It is said that two thousand persons resigned their preferments in consequence; and even after this their party was subjected to the further infliction of the conventicle acts, which forbade more than five persons besides the family to assemble together in any house for religious worship; and the five mile act, which subjected to penalties and imprisonment any nonconformist clergyman who should take up his residence within five miles of any corporate town, or other place where he had been minister. *See* DISSENTERS.

NONES. (Lat. novem, *nine*.) In the Calendar, one of the three divisions of the Roman month, and so called because they fell on the *ninth* day, reckoned inclusively, before the ides. In the months of March, May, July, and October, the ides fell on the 15th day of the month, and the nones, consequently, on the 7th. In the other months, the ides were on the 13th day, and the nones on the 5th. *See* CALENDAR, CALENDS, IDES.

NON EST INVENTUS. (*He is not found.*) In Law, the formal Latin words anciently used in the sheriff's return to a writ of capias, that the defendant was not to be found within his bailiwick.

NO'NIUS. A name frequently given to that useful contrivance, the vernier, for subdividing the divisions of graduated arcs or scales into minute parts, from its invention having been erroneously ascribed to Pedro Nunez, or Nonius, a Portuguese, who lived in the early part of the 16th century. The contrivance employed by Nonius was widely different from the vernier now universally used. It consisted in describing within the same quadrant 45 concentric arcs, dividing the outermost into 90 equal parts, the next into 89, the next into 88, and so on, the innermost being consequently divided into 46 only. With this instrument the observed altitude of an object could be read off on the outermost arc only to degrees, but the fractions were obtained in the following manner: — The plumb-line, or moveable index, must intersect one of the concentric arcs at, or very near, a point of division. Now, it is evident that the number of parts read off at this point must be in the same proportion to the degrees and fractions of a degree intercepted on the outermost arc, as the number of parts into which the arc containing the point is divided, is to 90°. The division read off being therefore multiplied by 90, and divided by the number of parts in the arc, gives the observed altitude to fractions of a degree. Thus, if the plumb-line intercept 25 parts exactly on the arc in which the number of parts is 78, the angle measured will be $28{\cdot}846^\circ$: the fraction is easily converted into minutes and seconds. Nonius supposed that this artifice was known to Ptolemy. It was adopted by Tycho Brahe; but soon abandoned by him for the method of diagonal divisions, in consequence of the difficulty of dividing accurately the different arcs. (*Robins's Mathematical Tracts*, vol. ii.) *See* VERNIER.

NON-JU'RORS. In English History, that party among the clergy of the national church who refused to take the oath of allegiance to the new government after the Revolution. As many of these clergy, at the same time that they opposed a conscientious resistance to the usurpations of James II. had nevertheless continued to preach submission to his authority, on the principle of his divine right by hereditary succession to the obedience of his subjects, it became impossible for them with consistency to submit to a monarch crowned only by authority of parliament. It was therefore much desired by many friends of the new government to make some exception in their favour, and relieve them from the necessity of taking the oaths; not an amendment made by the House of Lords in the act requiring this oath, which purposed to excuse the clergy from taking it unless called on by the privy council, was rejected by the Commons. Eight bishops, including the primate Sancroft, with about four hundred clergy, were in consequence excluded from their sees and benefices. The original non-jurors were peaceable and honest men for the most part; but many of them soon became implicated in all the violence of the Jacobite faction. *See* JACOBITES, PRETENDER.

NON-NA'TURALS. A term applied by the old physicians to certain matters which are necessary to life, but do not form a part of the living body; such as air, food, excretions, sleep, &c.

NONPARE'IL. *See* PRINTING.

NON-RESISTANCE, THE DOCTRINE OF, in Politics, is that which inculcates the unlawfulness, on religious grounds, of resistance by force to the commands of a prince or magistrate. This is strongly laid down by the inspired writers, and especially by St. Paul, in the 13th chapter of his Epistle to the Romans. In the ordinary acceptation of the doctrine, it is taken to enforce the duty of obedience to the lawful commands of magistrates. But, in that peculiar sense which is attached to it in English constitutional history, it means unqualified obedience to every command, especially of the prince or supreme magistrate, whether lawful or not; and consequently condemns all forcible opposition even to tyranny or usurpation. But the advocates of non-resistance, in this extended sense, do not appear to have ever contended that it applied to commands of inferior magistrates in the same sense and degree as to those of the highest: they therefore supposed a peculiar sanctity in the person and office of the ruler which no other officer possessed; and thus combined the doctrine of divine right with that of passive obedience or non-resistance. These doctrines are plainly laid down in the homilies of the church of England; in which, in the phrase of Bolingbroke (*State of Parties*), they *skulked* until the reign of James I. (See especially that *On Wilful Disobedience and Rebellion.*)

But in that reign they were more generally avowed by the learned and loyal; and in 1622 the University of Oxford sanctioned them by a solemn decree. The events which led to and followed the great rebellion naturally led men's minds to pay greater attention to the speculative part of politics; and, while Hobbes was framing a theory of absolute monarchy on the principle of the social contract, a different class of reasoners arrived at the same result through a peculiar interpretation of scripture. Sir Robert Filmer (especially in his *Patriarcha*), Bishop Sanderson, and others, made the regal power originate in the patriarchal; and endeavoured to prove that all other forms of government, being unrecognized by scripture, were usurpations. Dean Sherlock, the ablest writer of the school of divine right (see his *Case of Resistance to Supreme Powers*, 1684), endeavoured to prove the absurdity of the theory of the social contract, and to show from scripture the unlawfulness of resisting any command, even of an usurping power. It is in answer to these reasoners that *Locke's Essay on Government* was written. In it he confutes the arguments for unqualified non-resistance, by showing that scripture and reason make no distinction between inferior and superior magistrates, and reducing his opponents to the absurdity of affirming that any command, however extravagant, of the lowest magistrate, must be obeyed. In 1683, the University of Oxford pronounced its second decree in favour of the tenets of divine right and non-resistance. But the current of court opinion changed at the Revolution. The doctrine of non-resistance was almost proscribed; but maintained by the non-jurors, who professed to *obey* the usurping government, while they refused to *recognize* it. In 1709 it was preached by Sacheverell, with the apparently inconsistent result of a riot. His sermon, together with the Oxford decree, were burntby order of the House of Lords. But the doctrine is at this day frequently asserted by the high church party. (See *Dr. Pusey's Sermon on the 5th of November*, 1838.)

NO'NSUIT, in Law, is the renunciation of a suit by the plaintiff. It is either adjudged, in consequence of certain neglects or delays in the prosecution of the suit, or it is voluntarily elected by the plaintiff. It is usual to call on the plaintiff, when he is unable to make out a case to support his pleadings for default of the necessary evidence, and the jury are about to give their verdict, to elect, if he pleases, to abandon his prosecution and submit to a nonsuit, upon payment of costs. The effect of which is, that as a nonsuit is not, except in certain cases, a peremptory bar, he is able to bring another action afterwards for the same cause.

Judgment as in case of a nonsuit, arises from the statute 14 G. 2. c. 17., which enacts that where any issue is joined in an action in the courts of record at Westminster, and the plaintiff has neglected to bring the issue to be tried, the court may, unless it sees reason for allowing the plaintiff farther time, give judgment for the defendant as in case of a nonsuit, which has the same force as a nonsuit, both as to costs and as to its effects on the action.

NOOTH'S APPARATUS. A series of three glass vessels, placed vertically, for the purpose of impregnating water with carbonic acid gas. The lower vessel contains the marble and muriatic acid for the evolution of the gas; the central vessel holds the water through which it is made to pass, under the pressure of the column of water in the third or upper vessel, which is closed by a conical stopper, which serves as a safety valve.

NO'PAL. The *Cactus opuntia*. The plant upon which the cochineal insect chiefly breeds.

NORFOLK CRAG. A tertiary formation which rests on London clay or chalk, and includes marine shells. A line drawn from Cromer on the northern coast of Norfolk to Wayburn, about six miles west, and thence extending southerly about eighteen miles towards Norwich, includes all the regular beds of this rock. *See* GEOLOGY.

NO'RMAL. (Lat. norma, *a rule*.) An adjective signifying that the ordinary structure peculiar to a family, a genus, or a species, is in nowise departed from.

NO'RMAL. A term sometimes used for perpendicular. In the geometry of curve lines, the normal to a curve at any point is a straight line perpendicular to the tangent at that point, and included between the curve and the axis of the abscissa.

NORMAN ARCHITECTURE. *See* ARCHITECTURE, and ENGLISH ARCHITECTURE.

NORNS. In Scandinavian Mythology, the three Fates, equivalent to the Moirai of the Greeks. Their names were Urd, Wörand, and Skuld; or *Past*, *Present*, and *Future*. They were represented as endowed with great beauty, but of a melancholy and sombre disposition; they were consulted even by the gods, and their decrees were sure and irrevocable.

NO'RROY. *See* KING AT ARMS, HERALD.

NORTH. (Germ. nord.) In Geography, one of the four cardinal points of the horizon; that which in European latitudes is opposite the sun at mid-day.

NORTHERN LIGHTS. The name popularly given to the *aurora borealis*.

NO'RTHING, in Navigation, is the difference of latitude made by a ship in sailing northwards.

NOSING OF A STEP. In Architecture, the projecting rounded edges of the tread of a step.

NOSO'LOGY. (Gr. *νοσος, a disease*, and *λογος, a discourse.*) The doctrine of diseases. The term is generally applied to the classification and nomenclature of diseases, and to their general methodical arrangement. *See* DISEASE.

NOSTA'LGIA. (Gr. *νοστεω, I return*, and *αλγος, grief.*) A species of melancholy, resulting from absence from home and country.

NOSTRUM. (Lat.) Literally, *our own;* applied to quack medicines retained for profit in the hands of the inventor or discoverer, or of his assignee.

NO'TABLES. In French history, the deputies of the states under the old régime, appointed and convoked on certain occasions by the king. In 1786 this assembly was summoned, 160 years after its last meeting, and proposed various reforms in different branches of the government: it again met, for the last time, in 1788.

NO'TACA'NTHA. (Gr. *νωτος, the back*, and *ακανθα, a spine.*) The name of a family of Dipterous insects, comprehending those in which the upper part of the thorax or scutellum is armed with teeth or spines.

NO'TARIES, APOSTOLICAL AND IMPERIAL. Public notaries appointed by the popes and emperors, in virtue of their supposed jurisdiction over other powers, to exercise their functions in foreign states. Edward II. forbade the imperial notaries to practise in England. Charles VIII. of France, in 1490, abolished both these classes of notaries, and forbade his lay subjects to employ them.

NO'TARY, or NOTARY PUBLIC. In English Law, one who publicly attests documents or writings, chiefly in mercantile matters, to make them authentic in a foreign country; protests foreign bills of exchange, and the like. The statutes 41 G. 3. c. 79. and 3 & 4 W. 4. c. 70. regulate the admission of notaries in England. In London, they must have been apprenticed seven years to a notary before such admission.

The name notary, among the Romans, appears to have signified a short-hand writer, and to have denoted originally the persons who acted in that capacity, especially at meetings of the senate. Afterwards, the notarii were secretaries to courts, officers, &c. In modern Europe, the notary is an officer whose attestation is necessary to the validity of certain instruments; and his duties are more or less important in different countries. In France, the notary is the necessary maker of all contracts, &c. where the subject matter exceeds 150 francs; and his instruments, which are preserved and registered by himself, are the originals, the parties retaining only copies. The presence and administration of a notary is also essential to the division of lands or goods of inheritance.

NOTA'TION (Lat. notatio), is defined by Dr. Johnson to be "the act or practice of recording any thing by marks, as by figures or letters."

Mathematical notation embraces two distinct subjects; namely, symbols of number and quantity, and symbols of operation. The system of numerical notation adopted in all European countries depends on the very refined idea of giving to each symbol a *local* as well as an absolute value. A refinement of this sort could only have been adopted by a people considerably advanced in the arts of civilization; but though the present system has been traced to the Hindus, among whom it appears to have been in use two thousand years ago, the epoch and country of its origin are entirely unknown. It is probable that the first numeral characters consisted simply of strokes or straight lines, which could be easily cut in wood or stone, and would be alike intelligible to all nations. Such characters are, in fact, preserved in the Roman notation with very little change. Thus, assuming a perpendicular line | to signify *one*, two lines | | would express *two*, the addition of a third | | | *three*, and so on till the reckoner had reached *ten*, which completed the first series of the numerical scale. He might then be supposed to throw a dash across the last stroke or unit to mark the completion of the series; and thus X would come to signify *ten*. The continued repetition of this mark would denote *twenty*, *thirty*, and so forth, till he arrived at a hundred, or *ten* tens, which completes the second series, and might be denoted by adding another dash to the mark for ten, or by merely connecting three strokes, thus ⊏. The repetition of this symbol would in like manner indicate the successive hundreds, the *tenth* of which would be marked by the addition of another stroke, so that four combined strokes ΛΛ would express a thousand. Such were the symbols originally employed in the Roman notation; in process of time it would be perceived that the inconvenience in writing, arising from so many repetitions of the same character, might be avoided, by adopting symbols for the intermediate numbers; and those were furnished by the division of the

symbols already in use. Thus, having parted in the middle the two strokes X, either the under half Λ, or the upper half V, was employed to signify *five*. Next, the mark ⊏ for a hundred was divided into Γ or L, either of which represented *fifty*. Again the four combined strokes having come, in the progress of the arts, to assume a round shape ↀ, was frequently expressed thus (|); and this last form, by partition, gave the two portions (| , or |), to represent *five hundred*. (*Leslie's Philosophy of Arithmetic*, Introd.)

The numeral notation of the Greeks, though far less convenient than that now in use, was formed on a perfectly regular and scientific plan, and could be used with tolerable effect as an instrument of calculation, to which the Roman system was totally inapplicable. They divided the twenty-four letters of their alphabet into three classes, and, by adding another symbol to each class, they had characters to represent the units, tens, and hundreds.

Thus, instead of the digits 1, 2, 3, 4, 5, 6, 7, 8, 9, they represented the units by the letters α, β, γ, δ, ε, ϛ, ζ, η, θ: the tens were denoted by ι, κ, λ, μ, ν, ξ, ο, π, ϟ; and the hundreds by ϱ, σ, τ, υ, φ, χ, ψ, ω, ϡ.

To represent the thousands they employed the first series with the iota subscribed, ͵α, ͵β, ͵γ, ͵δ, ͵ε, ͵ϛ, ͵ζ, ͵η, ͵θ. With these symbols they could express any number under 10,000; thus ͵θϡϟθ, denoted 9999; ͵ηλγ, denoted 8033; ͵δα, 4001, and so with the others. To denote the myriads they made use of the initial letter M, writing the number over it. Thus, $\overset{\alpha}{M}$, $\overset{\beta}{M}$, $\overset{\gamma}{M}$, &c., corresponded respectively to 10,000, 20,000, 30,000, &c. $\overset{\lambda\eta}{M}$ expressed thirty-eight myriads, or 380,000; $\overset{\delta\tau o\beta}{M}$ was equal to 43,720,000; so that the letter M placed under any number produced the same effect as is produced in our system by writing four ciphers to the right of the number. Diophantus and Pappus expressed the myriads more simply by a point after the number: thus, ͵δτοβ·ηκε denoted 43,728,025; and in this manner they proceeded to 9999·9999, or to any number under 100,000,000, which was the extent of their notation before the time of Archimedes, who showed how it might be extended indefinitely. By assuming 100,000,000, or the square of the myriad, as a new unit, and taking this any number of times capable of being expressed by the previous notation, he could represent any number which is expressed in the modern notation by sixteen digits. Assuming, again, the number which in our system is denoted by 1 with sixteen zeros as a second new unit, he was enabled to express any number consisting of twenty-four digits. This method can obviously be continued to any length. A great improvement was afterwards introduced by Apollonius, who proposed the simple myriad, instead of its square, for the root of the system; and thus any large number was constituted of periods of four characters, the first of which, on the right hand, represented units, the next, towards the left, the number of myriads, the third the square of the myriads, and so on to infinity. The different periods were distinguished by breaks or blanks. In this manner a *local* value was given to the symbols, and a single step only was wanting to assimilate this notation entirely to our own. It only required that to be done for the simple tens which had been done for the myriads or tens of thousands. (For an account of the Greek notation and arithmetic, see Delambre, *Astronomie Ancienne*, tome ii.)

From an inspection of the manuscripts preserved in public libraries, it appears that the Arabians had not generally adopted the denary numerals before the beginning of the 13th century of our era. For several ages after the formation of their empire, they hired Christian scribes to keep their accounts; and though, like most other oriental nations, they wrote from right to left, yet they implicitly followed the Greek mode of ranging the numerals and performing the calculations. It is probable that they derived their knowledge of the Indian digits through the medium of the Persians, but the subject is involved in much obscurity. The epoch at which the denary numerals were introduced into Europe is also uncertain; but it appears to have followed, at no great interval, the Saracen conquests in Spain. Vossius places this epoch about the year 1250; Du Cange thinks they were unknown before the 14th century; and they are very rarely to be found in the dates of any writings before the year 1400. They appear to have been first used by astronomers, and afterwards circulated over Europe in the almanacs.

Symbols of quantity are entirely arbitrary; but the letters of the alphabet may be said to be exclusively adopted by mathematicians. When the quantities belonging to any investigation are numerous, it may be necessary to have recourse to different alphabets; and it is always of very great importance to select such symbols as will most readily suggest the thing signified, as the initial letter of a word, or letters which have acquired a sort of conventional right to be applied to particular purposes. It is unfortunate that so little attention has been paid to this subject, and that some general principles have not been adopted by mathematicians to regulate the choice of symbols, inasmuch as the diversity of notation renders it often a troublesome task to compare with one another different investigations of the same problem, or the results of different methods of analysis. There are, however, a few rules, which, though altogether arbitrary, seem to be recognized by all modern writers of any authority. Thus, in algebra, the letters at the beginning of the alphabet are the symbols of quantities supposed to be known, and those at the end of the quantities sought. In analytical geometry and mechanics, x, y, and z are always used to denote the rectangular co-ordinates of a point in space. In trigonometry, the sides of a triangle are usually denoted by a, b, and c, and the angles opposite by A, B, and C respectively. In astronomy, the Greek letters are most frequently used to represent angles. Indices are usually employed when it is desirable to retain the same letters for the same class of quantities.

Symbols of operation are equally arbitrary with those of quantity, but there is much less diversity in the manner of employing them. The signs + and −, universally used to signify addition and subtraction, seem to have been introduced by Stifelius, a German, as the oldest work in which they are found is his *Arithmetica Integra*, published at Nuremberg in 1544. Stifelius also introduced the character $\surd$, originally r, the initial letter of *radix* (root), to denote the root of a quantity. The sign of equality = was introduced by Robert Recorde, and he gives as a reason that "noe 2 thynges can be moare equalle," namely, than the two parallel lines. In the modern calculus the letters of the alphabet are used as symbols of operation; thus, d for the differential and $\int$ for the integral of a quantity. Finite differences and sums are denoted by the corresponding Greek letters Δ and Σ. The fluxional notation introduced by Newton, and which continued to be used in this country till foreign books began to be more freely imported, after the last war, has at length been entirely abandoned for the differential notation of Leibnitz and the Bernoullis. The former is, in fact, utterly incapable of representing the extremely general processes of modern analysis. (See Notes to the English translation of *Lacroix's Elem. Treatise on the Diff. and Integral Calculus; Lubbock on Notation*, in the *Memoirs Roy. Astr. Soc.* vol. iv.; art. "Notation," *Edinburgh Encyclopædia*.)

NOTCHBOARD. (It. nocchia.) In Architecture, the board which receives the ends of the steps in a staircase so called; because it is notched out to receive the ends of the steps.

NOTE. (Lat. nota.) In Music, a character by which the elevations and depressions of sounds are marked, as well as the swiftness or slowness of their motions.

NOTES (Lat. notæ), in Literature, were originally marks affixed by the critics who reviewed the works of an author to those places which they considered to be spurious or faulty, or which on any other account were worthy of remark. In modern times the meaning of the term has been enlarged, being now used as synonymous with *annotation* or *commentary*. Among the Romans praiseworthy passages were usually marked with LL. (*i.e.* laudabiles loci); and faulty passages indicated by θ, a contraction, or, more properly, a symbol for αθετησιν. (*Per. Sat.* iv. 12.) Among the Greeks, good passages with the letter X, signifying χϱηστον, excellent, and against those which were condemned the word αχϱηστον was written, which Gellius calls *ad notamentum culpæ*.

Notes, in Printing, are — shoulder notes: these are at the top of the page in the outer margin, and contain the book, chapter, or date, or both of them; side notes or marginal notes, which give an abstract of the text, as in acts of parliament; or parallel passages, and different readings, as in the Bible; and bottom notes, or foot notes, which are placed at the bottom of the page, and generally contain commentaries and explanatory annotations.

NO'THING. (*No thing*, the negation of being.) In Mathematical language, the term *nothing* is of frequent occurrence, and denotes either the absence of magnitude in circumstances in which magnitude might have existed, as when equals are taken from equals; or it denotes the limit to which a variable magnitude approaches by continual diminution, as when it is said that a magnitude is susceptible of all values between nothing and infinity.

NOTICE, in Law, is that by which a party is supposed to communicate, or to receive, that presumed or real knowledge which is necessary to affect the receiver with legal liabilities. For instance, when a party proceeds to recover premises by ejectment, notice must be served by him, according to certain prescribed formalities, on the tenant in possession, in order to compel him to come in and defend the action. This is an instance of actual notice. Constructive notice is that which is presumed to arise from certain facts: as, for instance, in equity, a purchaser is presumed to have notice of a suit

pending which may affect the subject matter of the sale, except where, by a late enactment (2 Vict. c. 11.), express notice was rendered necessary.

NO'TODO'NTA. (Gr. νωτος, *back;* ὀδους, *tooth.*) The name of a genus of Lepidopterous insects.

NO'TONECTIDÆ. (Gr. νωτος; νεχτω, *I swim.*) The family of Hemipterous insects of which the water-boatman (*Notonecta*) is the type.

NOTTU'RNO. In Music, originally synonymous with serenade (which see); but applied at present to a piece of music in which the emotions chiefly of love and tenderness are developed. Of modern composers Chopin, Field, and Herg are the most distinguished in this department.

NOUN. (Lat. nomen, *a name.*) In Grammar, that part of speech which denotes a *conception;* in contradistinction to an affirmation or judgment, which is expressed by a *verb*. Nouns are divided into substantives and adjectives; the first denoting real or supposed *substances*, the second qualities or properties conceived as belonging to substances. *See* GRAMMAR.

NOVA'CULITE. (Lat. novacula, *a razor.*) The stone of which hones are made for sharpening razors. It is of a slaty structure, and owes its quality of giving an edge to the metal to the fine silicious particles which it contains.

NOVA'TIANS. The followers of Novatian, a presbyter of Rome, who was stigmatized as a schismatic and heretic, and founded a sect of this name in the 3d century, which continued to flourish to the end of the 5th. The aim of Novatian was to deny readmission into the church to all persons who, in time of persecution, or on other accounts, had once lapsed from the faith. In this extreme severity of sentiment he was opposed by the greater number of the clergy of Rome, and especially by one Cornelius, upon whose election to the see Novatian, who was a disappointed candidate, withdrew from the communion of the majority, and established a society of which he became himself the first bishop. This sect was also known by the title of Cathari, or Puritans, which they assumed to express the high sense they entertained of the excellence attainable by, and necessary to, all professors of Christianity.

NO'VEL. (From the Italian novella, derived from the Latin novus, *new.*) A species of prose fictitious composition.

The Italian novella, of which the best and earliest specimens are those contained in the *Decameron* of Boccaccio, was rather a short tale, turning on an event, or on a series of adventures of humour, pathos, or intrigue, than a novel in the modern acceptation of the term. In its present signification in the English language it seems to express a species of fictitious narrative somewhat different from a romance; yet it would be difficult to assign the exact distinction, and, in the French language, the same name (roman) is used for both; while it differs from a tale merely in the circumstance that a certain degree of length is necessary to constitute a novel.

Although, in fact, the terms novel and romance are often used indifferently, yet they have also often been treated as distinct classes of composition in English literature. Perhaps, if we seek to draw the distinction with as much of accuracy as the subject will admit, we may say that the proper object of a novel is the delineation of social manners, or the development of a story founded on the incidents of ordinary life, or both together. Thus will be excluded from the class of novels, on the one hand, tales of which the incidents are not merely improbable (for this may be the case in a novel), but occurring out of the common course of life, and such as are founded on imaginary times and imaginary manners, tales of supernatural incidents, chivalrous romances, pastoral romances, &c.; and, on the other hand, we must exclude from the same class fictitious narratives, in which the author's principal object is neither the story nor the costume, but which are obviously written with an ulterior view, although their incidents and character may perhaps, in other respects, fall under the definition suggested above. Thus, political, philosophical, and satirical fictions are clearly not to be ranked as novels. But it obvious that no definition can be drawn which shall, on this subject, entirely satisfy the caprices of popular language.

Of the novel, in this confined sense, the works of Richardson, and those of Fielding and Smollet, afforded, perhaps, the first examples in English literature. The first of these authors gave birth to the sentimental novel, the latter two to the comic or humorous. Marivaux, Prévost, &c. spread the former style of composition in France; where, as well as on the Continent generally, it attained a high degree of vogue. The novel of manners, whether comic or serious, has, perhaps, been always a more popular species of fiction in England. It may be doubted whether the historical fiction, to which Sir Walter Scott has given such universal popularity, belongs strictly to the class of novel or romance. By aiming at the delineation of real, although past manners, and by the general turn of the story, it seems to resemble the former; while the romantic character of many of its incidents seems to assimilate it to the latter.

For the general history of prose fictitious composition, see ROMANCE.

NO'VELS. (Lat. novellæ constitutiones, *new constitutions.*) In the Roman Law, supplementary constitutions of some emperors, so called because they appeared after the authentic publications of law made by them. Those of Justinian are the best known, and are commonly understood when the general term is used. The *Novels*, together with the *Code* and *Digest*, form the whole body of law which passes under the name of that emperor.

NOVE'MBER. (Lat. novem, *nine.*) The eleventh month of the Julian year; but the ninth month in the old Roman year, which began with March. *See* CALENDAR, YEAR.

NOVEMSILES. The name given by Romulus to the gods of the Sabines, whom he adopted after the conquest of that people. The term was afterwards applied to those heroes or demigods who, in consequence of their power or virtues, were deified after death.

NOVENNALIA (Lat. novem, *nine*, and annus, *a year*), among the Romans, signified, as the derivation of the term implies, festivals held in honour of the dead every *nine years*.

NO'VICE. (Lat. novitius.) A person admitted into a religious community as an inmate, for the purpose of preparation for becoming a member. The state of preparation is termed *novitiate*. The custom of giving novices the religious dress did not begin until the 12th century. The age of profession is fixed by the Council of Trent at sixteen years. During the period of the novitiate the novice is still at liberty to relinquish his intention. The term *novice* was applied to recruits in the ancient Roman soldiery; from which circumstance it appears to have been borrowed in ecclesiastical usage.

NOVI HOMINES, among the Romans, were such persons as, by their own personal merit, had raised themselves to curule dignities without the aid of family connections. This reproach, as is well known, was addressed by Catiline to Cicero.

NOX. (Lat.) In Mythology, the goddess of night. In the Grecian mythology, she was the daughter of Chaos, the sister of Elpen and Erebus, and the mother of Æther, Hemera, Manatas, Momus, the Fates, &c. &c.; which were all personifications of the natural phenomena life, sleep, death, &c.

NOYADES. (Fr. noyer.) The name given to a peculiar punishment resorted to in the first French revolution. The *noyades* were effected by drawing out a plug inserted in the bottom of a boat in which the wretched victims were launched. The genius of iniquity, says a writer in the *Edin. Review*, often displays itself in the same invention. It will be remembered that when Nero was desirous of despatching his mother, and found himself at a loss for an expedient, Anicatus proposed to him "the model of a ship upon a new construction, framed in such a manner that a part might be withdrawn, and the unsuspecting passenger committed to the waves." (*Tac. Ann.* lib. xiv. ar. 3.)

NOYAU. (Fr.) A delightful liqueur; it is flavoured with bitter almonds, or the kernels of peach stones, and contains prussic acid.

NU'CLEUS. (Lat.) Literally any thing round which matter has accumulated, or to which it is affixed. In Botany, it is used in various significations:—1. The central fleshy pulpy mass of an ovule. 2. That part of a seed contained within the testa, and consisting of either the embryo and albumen, or of the embryo only. 3. In lichens, the disk of the shield, which contains the sporules and their cases. 4. In the language of the older botanists what is now termed by gardeners a *clove;* that is, the secondary bulb of a bulbous plant.

NUCLEUS. In Astronomy, the solid part or body of a comet, as distinguished from its nebulosity. *See* COMET.

NU'CULA. (Lat. nux, *a nut.*) Either the fruit, called otherwise a gland or acorn, or any small, hard, one-seeded pericarp; or the female organ of the plant Chara.

NU'DIBRA'NCHIANS, *Nudibranchiata.* (Lat. nudus, *naked;* branchia, *gills.*) The name of an order of hermaphrodite Gastropodous Mollusks which have the branchiæ exposed on some part of the back.

NU'DIPEDA'LIA. (Lat. nudus, *naked*, and pes, *a foot.*) A religious ceremony among the Greeks, Romans, and other nations, observed on account of some public calamity, as famine, drought, pestilence; in the celebration of which (as the word imports) the votaries appeared with the feet uncovered. In various other religious observances this practice was adopted; thus, the Roman matrons, when they offered up supplications to the goddess Vesta, always walked to her temple barefooted: —

Huc pede matronam nudo descendere vidi. — OVID.

A similar ceremony existed among the Jews.

NU'DITIES. (Lat. nuditas, *nakedness.*) In the Fine Arts, figures entirely divested of drapery.

NUI'SANCES, in Law, are of two kinds: public or common, which annoy the king's subjects in general; and private, which are defined "any thing done to the hurt or annoyance of the lands, tenements, or hereditaments of another." The general remedy for public nuisances is by indictment or presentment; for private nuisances, by action on the case for damages.

NU'LLIPORES, *Nullipora.* (Lat. nullus, *no,* porus, *a pore.*) The name of a family of Lithophytous Polypes, the axis of which presents no visible pores on its surface.

NU'MBER (Lat. numerus), is defined by Euclid to be an assemblage or collection of units or things of the same species. This definition excludes the unit itself, or 1. Newton defines number as the abstract ratio of one quantity to another quantity of the same species; and hence there are three kinds of numbers, namely, integers, fractions, and surds. Number, abstractedly considered, conveys merely the notion of *times* or *repetitions.*

Mathematicians consider numbers under different points of view, or with relation to different properties; and hence arise the various distinctions which have been introduced, as even or odd, whole or fractional, rational or irrational, perfect or imperfect, prime or composite, abundant or defective, &c. Numbers also acquire various denominations from the manner in which they are composed; as triangular numbers, pyramidal numbers, polygonal numbers, &c. (See the respective adjectives.)

The theory of numbers forms one of the most subtle parts of the algebraic analysis. Judging from the fragments which have been preserved, the ancient mathematicians had pushed their researches into the properties of numbers to a considerable extent; but until the invention of algebra, and the introduction of a more convenient notation, the difficulties of the subject could only be partially overcome. The most ancient existing work on algebra is that of Diophantus, and it is devoted entirely to numbers. From the time of Diophantus, who lived in the 3d century, to that of Vieta, Bachet, and Fermat, who flourished in the 16th, no advancement was made in the theory; but the discoveries of these illustrious mathematicians carried it far beyond its ancient limits. Euler was the next from whom it received any considerable extension; he was followed by Lagrange, who added many important theories; and it has received its latest perfection from the hands of Gauss and Legendre. The theory of numbers may be studied in the following works: — the *Arithmetic* of Diophantus, with a Commentary by Bachet, and notes by Fermat, Toulouse, 1670; *Waring's Meditationes Algeb.*; Euler, *Introd. in Anal. Infinitorum, Opuscula Analytica,* and various papers in the *Petersburg Memoirs;* Lagrange, in the *Berlin Memoirs;* Gauss, *Disquisitiones Arithmeticæ,* or the French translation; Legendre, *Essai sur la Théorie des Nombres,* 2d edit. 1808. For the mystical properties of numbers the curious reader may consult *D. S. Boetii Arithmetica,* Parisiis, 1521; *P. Bungi Numerorum Mysteria,* 1591; *Taylor's Theoretic Arithmetic,* 1816.

NUMBERS, BOOK OF. *See* PENTATEUCH.

NUME'NIA. (Gr. νεος, *new,* and μην, *a month.*) Grecian festivals celebrated at the commencement of every lunar month, in honour of all the gods, demigods, and heroes of antiquity. They were observed with games and public entertainments, the expense of which was defrayed by the wealthy citizens. *See* NEOMENIA.

NUME'NIUS. The name under which Cuvier separated the curlews, as a distinct genus, from the other *Scolopaces* of Linnæus. They have a beak arcuated like that of the ibis, but it is more slender, and is cylindrical throughout; the tip of the upper mandible extends beyond the end of the lower one, and projects a little downwards in front of it. The toes are palmated at the base.

NUMERALS. The symbols or characters by which numbers are expressed. *See* NOTATION.

NUMERATION, is the art of classing and expressing numbers. Though the mode of reckoning numbers by *tens* or *decads* has prevailed among all civilized nations, and has become incorporated with the very structure of language, there is nothing in the nature of the subject which rendered its adoption a matter of necessity. Any other number might have been chosen for the root of the numerical scale; and, in fact, if a scale were now to be selected by mathematicians familiar with the properties of numbers, there are several considerations which would lead them to adopt *twelve,* in preference to ten. The selection of ten, therefore, which has been almost universal, implies the influence of some common determining principle; and it is easy to see that it arose from the practice, so familiar in the early stages of society, of counting by the fingers on both hands. In various languages, however, traces are found of an earlier and simpler mode of reckoning. We may suppose the earliest of all to be that of combining units in *pairs.* It is still familiar among sportsmen, who reckon by *braces* or *couples.* To count by *threes* was another step, and has been preserved by the same class of men under the term *leash,* meaning the strings by which *three* dogs, and no more, can be held at once in the hand. The numbering by *fours* has had a more extensive application: it was evidently suggested by the custom of taking, in the rapid tale of objects, a pair in each hand. Our fishermen, who generally count in this way, call every *double pair* (of herrings, for instance) a *throw* or *cast;* and the term *warp,* which has exactly the same import, is employed to denote *four,* in various articles of trade. It is alleged that the Guaranis and Lulos, two of the lowest races of savages inhabiting the forests of South America, count only by fours; at least they express the number *five* by four and one, *six* by four and two, and so forth. The quinary system, which reckons by *fives* or *pentads,* has its foundation in nature, being evidently derived from the practice of counting over the fingers of one hand. It appears, from the relations of travellers, to have been adopted by various savage nations of America; and we learn from Mungo Park that it is practised by the Yolofs and Foulahs of Africa, who designate 10 by two hands, 15 by three hands, and so progressively. It is even partially used in this country among wholesale traders. In reckoning articles delivered at the warehouse the person who takes charge of the *tale,* having traced a long horizontal line, continues to draw, alternately above and below it, a *warp,* or four vertical strokes, each set of which he crosses by an oblique score, and calls out *tally* as often as the number *five* is completed. (*Leslie's Philosophy of Arithmetic.*)

The mode of reckoning by *twelves* or *dozens* may be supposed to have had its origin in the observation of the celestial phenomena; there being twelve months or lunations commonly reckoned in a solar year. It appears in the subdivision of weights and measures, as twelve ounces to a pound, twelve inches to a foot; and is still very generally employed in wholesale business, extending to the second and even the third term of the progression. Thus *twelve* dozen, or 144, make the long hundred of the northern nations, or the *gross* of traders, and twelve times this again, or 1728, make the *double gross.* Traces of reckoning by *twenties* or *scores* remain in our own and other European idioms. The expression *three score and ten* is familiar. The French language has no terms for the numbers in the second series of the denary scale above *soixante,* or sixty. *Eighty* is expressed by *quatre-vingts,* and *ninety* by *quatre-vingts et dix, four twenties and ten.* The inhabitants of Biscay are said still to reckon by the powers of twenty, or the terms of progressive scores; and, according to Humboldt, the same mode of numeration was employed by the Mexicans. *See* ARITHMETIC, BINARY, DUODECIMALS, SEXAGESIMALS.

The primary object of numeration is to find names for the different numbers; and, as there are an infinity of numbers, while the number of words is limited, it became necessary to devise some systematic method of combining a few words, so as to express by means of them any number whatever. It is obvious that when large numbers are to be expressed, the lower scales, as the binary, ternary, &c., would be exceedingly inconvenient, on account of the multitude of words that would be required. On the other hand, as a name is required for at least every unit in the scale, a very high scale would be no less inconvenient. In the denary scale, the nomenclature is sufficiently convenient, and in our language almost perfectly regular. A name is given to the 9 units of the first order; the unit of the second order is *ten;* and, by the different combinations of this word, all numbers are named to 99: eleven and twelve are only *apparent* exceptions. A new appellation is wanted for the unit of the third order, or *hundred.* This suffices till we reach the fourth order, or *thousands;* and might even have sufficed to a hundred *hundreds,* or ten thousand. A thousand thousands is called a million, and a million millions a billion; further continuation is useless.

The second object of numeration is to express the nomenclature thus formed by the combinations of a small number of written symbols. This is most conveniently effected by the very refined artifice of giving to each symbol a *local* as well as an *absolute* value. So that the same symbol, 3 for example, is made to express not only 3 *units,* but 3 *tens,* 3 *hundreds,* 3 *thousands,* &c.; or 3 *tenth parts,* 3 *hundredth parts,* &c., according to its distance towards the left or right from the unit's place in any combination of symbols. *See* NOTATION.

NU'MERATOR, in Arithmetic, is that part of the numerical expression of a fraction which indicates how many of those parts into which the unit is supposed to be divided are expressed. Thus, in the fraction $\frac{7}{12}$, the lower number 12 is the denominator, and shows that the unit is divided into 12 parts; 7 is the numerator, and shows how many of those parts are to be taken.

NUMISMA'TICS. (From the Greek νόμισμα, Latin nummus, *a coin.*) The science of coins and medals. The distinction between these classes of objects is, in modern times, that the coin is struck for the purpose of circulation as money; the medal not as a piece of money,

but as a token commemorative of some person or event. But ancient coins are often termed, in common language, medals. The parts of a coin or medal are, the obverse or face, containing generally the head, bust, or figure of the sovereign or person in whose honour the medal was struck, or some emblematic figure in the coins of commonwealths; and the reverse, containing various figures or words. The words around the border of the coin form what is termed the *legend*, those in the middle the *inscription;* when occupying the lower extremity of the pieces, and separated from the rest by a horizontal line, they are termed the *exergue*.

The earliest Grecian coins which we possess appear to have been nearly of a spherical shape: they contain, on the obverse, some emblems of the particular cities which struck them; and on the reverse, deep indentations made by the puncheon in which the metal was held while the obverse was struck. These marks, or the dye, were soon brought into a more regular shape, sometimes forming a neat square, sometimes a circle. Types were afterwards introduced on both surfaces of the coin, by inserting some small object in one compartment of the dye. Ancient coins have been divided into various historical series, as exhibited in the following table:—

Grecian.	1. Civic.	Of Græcia Propria and the Islands. Of Greek colonies. Of Græco-Asiatic cities.
	2. Monarchic.	Kings of Macedon. Kings of states formed out of the Macedonian conquests: Syria, Egypt, &c. &c.; and the independent princes of Epirus and Syracuse.
Roman.	1. Consular.	Roman asses. Coins of the families.
	2. Imperial.	Roman. Grecian. — Provinces, Colonies, and Municipia.
	3. Medallions.	Grecian. Roman.
Barbarian.	1. European; of Thrace, &c. 2. Asiatic; of Persia, &c. 3. African.	

The objects on Grecian civic coins are either, 1. the emblems of the cities; 2. figures of deities, and their attributes; 3. miscellaneous or general symbols, usurped by many states and cities, usually consisting of warlike objects. The legends on Greek republican coins are either the name of the city or its initial letters; or monograms,—*i. e.* figures forming a portion of the name, in which the characters are so interlaced that a limb of one applies to many.

The earliest coins which bore the heads of princes were those of Macedon, commencing with Alexander the Great, and closing with the extinction of the dynasty of the Lagidæ in the Augustan age. Four principal series of Grecian monarchical coins (either of Greek states, or such as adopted the Greek language and customs) have been formed:—1. Of Macedon; 2. Of Sicily, Caria, Cyprus, Heraclea, Pontus; 3. Of Egypt, Syria, the Cimmerian Bosphorus, Thrace, &c. &c., from the era of Alexander the Great down to that of Christ; 4. Of dynasties which flourished subsequently to the latter era; including some kings of Thrace, Bosphorus, and Parthia, with those of Comagene, Edessa, Judæa; to which may be added some lines of Romanized monarchs, as those of Mauritania. The most beautiful monarchic series are those of the Seleucidæ in Syria, and Ptolemies in Egypt. The unit of the Grecian silver coinage, in point of value, may be considered as the drachma, which is of a size between our sixpence and shilling; the smallest silver coin is the dichalcos, only $\frac{1}{24}$th of the drachma; the largest, the tetradrachma, containing four drachmæ. The commonest gold coin is the didrachma, weighing two silver drachmæ, and in value 20, or 15*s.* sterling. Grecian copper coins are generally small.

The Roman coinage differs from the Grecian in many respects; the greater size of the copper coins in early times, and their superior workmanship in later, the prevailing simplicity of devices, &c., form characteristic marks of difference. In the first period of the republic they were cast. The consular copper coins have separate symbols for the pieces, according to their respective value; as the head of Janus for the *as*, Jupiter for the *semis*, &c. The *as* also bore the impress I, to denote its quality of unity as a measure of value. The name *family coins*, applied to many coins of the republic, arose from the custom of inserting the name of some distinguished family in the field of the coins. A silver coinage was first introduced into Rome 266 B. C. The oldest coin was the denarius, equivalent to ten asses: the earliest of these have the head of Janus, for which that of Rome was afterwards substituted on the obverse, with a variety of symbols on the reverse. The coinage of gold was introduced into Rome sixty years after that of silver: the pieces were, the scrupulum, one third of the denarius in weight; a coin weighing two thirds, and another weighing a whole denarius. Afterwards the chief gold coin was the *aureus* (twice the weight of the denarius), and its parts. The imperial Roman coins form by far the most complete and varied series which we possess of ancient or modern times. The symbols on the reverse have been arranged under four heads: as relating to religion, war, games, and the embellishments of the city, under the numerous subdivisions of these subjects. The obverses contain the portraits of emperors and empresses. The characters on the reverses of the coins are, generally speaking, explanatory of the type; expressing, in a few brief words, the history of some occurrence immediately after which the coin was struck, &c. The legends on the obverse mostly contain titles annexed to the imperial dignity, often expressed in abbreviations productive of not a little obscurity.

Not less than three hundred portraits are preserved in the series of Roman imperial coins. The term *medallion* is applied to those productions of the Roman or provincial mints which, in gold, exceed the size of the aureus; in silver, of the denarius; in copper, of the largest copper coin of ascertained value. It is doubtful whether they were intended for circulation as coins, or struck, like medals among ourselves, as commemorative tokens.

Modern coins present so wide a variety as to render it impossible to include any classification of them within the limits of the present notice. In England, Roman coins were current until the arrival of the Saxons: we have the coins of five out of the seven kingdoms of the heptarchy; among them some small copper coins, the only specimens of that metal coined before the reign of Elizabeth. Coins struck prior to the reign of Charles II. had their devices impressed by the blows of a hammer. The system of lettering on the edges, which was succeeded by graining, was invented in order to obviate the fraudulent practice of clipping and filing the current coin.

NUMMULI'TES. (Lat. nummus, *money*, and Gr. λιθος, *a stone*.) An extinct genus of the order of Molluscous animals called Cephalopoda, of a thin lenticular shape, divided internally into small chambers. These occur so abundantly in some parts of the chalk formation, that the name of nummulite limestone is given to the strata so characterized.

NU'NCIO. An envoy of the pope to the court of an emperor or king to negotiate ecclesiastical affairs. (*See* LEGATE.) Previously to the council of Trent the papal nuncios acted as judges in the first instance of matters which lay within ecclesiastical jurisdiction; but since that time they have formed a kind of court of appeal from the decisions of the respective bishops. This jurisdiction, however, holds good only in those countries which still hold themselves subject to the decretals and discipline of the council of Trent; for in other kingdoms and states, such as France, Austria, Tuscany, &c., which, though Roman Catholic, hold themselves independent of the Roman pontiff in matters of discipline, the papal nuncio has no jurisdiction whatever, and is invested merely with a diplomatic character, like the ambassadors of any secular power. The term *nuncio* is the Italian form of the Lat. *nuntius*.

NU'NCUPATIVE WILL. (Lat. nuncupo, *I name*.) In Law, a will orally delivered by the testator. *See* WILL.

NU'NDINÆ. (Lat. nonus, *ninth*, and dies, *a day*.) The market-days or fairs at Rome were so called, because they recurred every ninth day. On this day the people from the country and neighbouring towns flocked to Rome with the produce of their farms or industry. On that day, also, all public proclamations were made, causes heard, witnesses cited, and judgments given. The nundinæ were originally considered as *dies nefasti*, on which no other business could be done; but, for the convenience of the country people, this prohibition was removed by the *Lex Hortensia*.

NUNS. Female devotees among the Roman Catholics, who, like the monks of the other sex, seclude themselves in religious communities, and make profession of perpetual chastity. *See* MONACHISM.

The origin of this institution is commonly ascribed to St. Syncletica, the contemporary of St. Anthony. Among nuns, as among monks, there are various orders; some abandoning themselves entirely to contemplation and spiritual exercises, but many others to the more active duties of private and public charity.

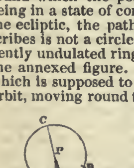
NU'RSERY. In Gardening, a plot of ground, or an entire garden, set apart for the propagation of plants, more particularly trees and shrubs. The situation ought to be open and airy, and the soil of an average quality, neither too heavy nor too light, so as to be adapted to the majority of plants; but in a complete nursery there ought also to be shady borders for plants requiring shade, and beds or compartments of peat-soil, or other peculiar soils, for such plants as are not readily propagated and grown in ordinary soils. Where tender plants are propagated, or where hardy plants are to be raised from seeds or struck from cuttings which are not easily ger-

minated or rooted in the open ground and in the ordinary manner, hot-beds, frames, and hand-glasses are also requisite. Every private garden of any extent requires a nursery to raise and bring forward young plants as a reserve for supplying failures by disease or accident in the general garden; and in every country where private gardens or plantations of trees are frequent, public or commercial nurseries are formed by persons who adopt nursery gardening as a business.

NUTA'TION. In Astronomy, the name given to a small gyratory movement of the earth's axis, in virtue of which, if it subsisted alone without the precession of the equinoxes, the pole of the equator would describe among the stars, in a period of about nineteen years, a small ellipse, having its longer axis equal to 18·5″, and its shorter to 13·74″; the longer being directed to the pole of the ecliptic, and the shorter, of course, at right angles to the longer.

In order to understand the nature of this phenomenon, it is necessary to consider it in connection with that of precession; both depending on the same physical cause, and forming, in fact, essential constituent parts of one and the same great phenomenon. The action of the sun and moon on the protuberant mass about the earth's equator tends constantly to draw the plane of the equator towards that of the ecliptic, or to diminish the angle between them. In consequence of the earth's rapid rotation about its axis, the inclination of the two planes is not permanently altered, but a motion is communicated to the plane of the equator, of such a kind that its axis revolves with a slow conical motion about the axis of the ecliptic; or, which is the same thing, the pole of the equator describes a circle in the heavens about the pole of the ecliptic as a centre, keeping constantly at the same mean distance of about 23° 28′ from it. The direction of this motion is from east to west, and its velocity amounts only to 50·1″ annually, so that the whole circle requires for its description a period of 25,868 years.

Let us now consider what would be the effect of the moon's action independently of that of the sun. The lunar orbit does not coincide with the ecliptic; it is inclined to it in an angle of about 5° 9′; and the position of the line in which the two planes intersect, that is, the line of the nodes, goes back on the ecliptic with a motion which carries it through a complete revolution in about eighteen years and seven months. The axis of the lunar orbit, therefore, also describes a conical motion about that of the ecliptic, or its pole describes a small circle in the heavens about the pole of the ecliptic, at the distance of 5° 9′, and in the same period of about eighteen years and seven months. Now, the effect of the moon's attraction on the parts of the terrestrial spheroid exterior to the inscribed sphere is to produce a slow conical motion of the earth's axis, not about the pole of the ecliptic, but about the pole of the lunar orbit, which is itself in a state of comparatively rapid motion about the pole of the ecliptic. The point, therefore, in the sphere of the heavens round which the pole of the earth's equator revolves, being in a state of continual circulation round the pole of the ecliptic, the path which the pole of the equator describes is not a circle, but a sort of epicycloidal curve, or gently undulated ring. This will be rendered evident by the annexed figure. Let P be the pole of the ecliptic, which is supposed to be fixed; A the pole of the moon's orbit, moving round the small circle A B C D in the space of nearly nineteen years; *a* the pole of the earth's equator, which at each moment moves in a direction perpendicular to the varying position of the line A *a*, and with a velocity varying with the intensity of the acting forces during the revolution of the moon's nodes, but, on the whole, so slow as to carry it round only in 25,868 years. When, therefore, A arrives successively at B, C, D, and E, the line A *a* will take the positions B *b*, C *c*, D *d*, E *e*: the earth's pole will thus, in one tropical revolution of A, have arrived at *e*; and its direction having been always perpendicular to B *b*, C *c*, &c., the path which it will have described will be of the form *a b c d e*. The same thing will be repeated at each succeeding revolution of the moon's node; and it is this alternate increase and diminution of the distances *P a*, *P c*, *P e*, which constitute the phenomenon of the nutation.



As the effect of the sun or moon in giving the earth a motion about its centre of gravity varies with the distance of the attracting body from the plane of the equator, it is evident that the effect of the sun is greatest at the solstices, and is reduced to nothing at the equinoxes. On this account, the obliquity of the ecliptic is subject to a small semi-annual variation, depending on the sun alone. This is called the *solar nutation*. Its existence is, however, only a deduction from the theory of attraction; for its amount, which is less than half a second, is too small to be sensible to observation. The result produced by the combined action of the sun and moon is called the *luni-solar nutation*; though the sensible part of it is produced only by the moon, and follows exactly the period of the moon's nodes.

The uranographical effect of the nutation is to produce a periodical fluctuation of the apparent obliquity of the ecliptic, and of the velocity of the regression of the equinoctial points. Hence arises the distinction between apparent and mean right ascension and declination; the former being given by direct observation, and the latter being the results obtained when the observed places of objects have been cleared of the periodical fluctuations arising from nutation. Formulæ and tables, for the reduction of observations to a common epoch, are given in all works on practical astronomy.

The discovery of the nutation of the terrestrial axis belongs to Bradley, and was a consequence of his other great discovery, the aberration of light. In prosecuting his observations with a zenith sector, with a view to establish his theory of the aberration, he found a greater apparent change in the declinations of stars near the equinoctial colure than could arise from a precession of 50″ in a year; and at the same time exactly the reverse effect in the case of stars near the solstitial colure. In the course of five years, the changes in question amounted, in some instances, to 9″ or 10″; and as it was evident that they could not be explained by any alteration of the quantity of precession, Bradley reverted to an idea which had previously occurred to him, in attempting to account for the phenomenon of aberration. "I suspected," says he, "that the moon's action upon the equatorial parts of the earth might produce these effects. For if the precession of the equinoxes be, according to Sir Isaac Newton's principles, caused by the action of the sun and moon upon those parts, the plane of the moon's orbit being at one time above ten degrees more inclined to the equator than at another, it was reasonable to conclude that the part of the whole annual precession which arises from her action would, in different years, be varied in its quantity; whereas the plane of the ecliptic wherein the sun appears keeping nearly always the same inclination to the equator, that part of the precession which is owing to the sun's action may be the same every year; and from hence it would follow that although the mean annual precession proceeding from the joint actions of the sun and moon were 50″, yet the apparent annual precession might sometimes exceed and sometimes fall short of that mean quantity, according to the various situations of the nodes of the moon's orbit."

A long series of observations on stars situated in different parts of the heavens proved the correctness of this theory; and it was found that all the phenomena were capable of being explained on the hypothesis that the pole of the equator describes a small circle about its mean place, contrary to the order of the signs, and in the same period as that of the revolution of the moon's nodes. Bradley himself afterwards remarked that they would be still more accurately represented by supposing the curve described by the pole about its mean place to be an ellipse instead of a circle. This is confirmed by accurately calculating, from theory, the amount of all the forces which tend to displace the terrestrial equator. The result shows the path of the pole to be an ellipse, and gives nearly the same values of its semi-transverse and conjugate axes as are given by observation. These values were found by Von Lindenau from a series of 810 observations, embracing three complete revolutions of the moon's nodes, to be 80·977″ and 6·682″ respectively. The value of the semiaxis major of the small ellipse imagined by Bradley is called the *constant of nutation*, and enters as an element into all reductions of astronomical observations. Von Lindenau's determination, above stated, is adopted by the German astronomers. The value generally used by British astronomers is 9·25″, which was deduced by Dr. Brinkley, Bishop of Cloyne, from his own observations with the Dublin circle. Very recently this important astronomical element has been investigated by Dr. Robinson of Armagh from the Greenwich observations with the mural circle from 1812 to 1835, and the result at which he arrives is 9·23913″. (*Memoirs Roy. Astr. Soc.* vol. xi. 1840; *Airy's Math. Tracts; Herschel's Astronomy*.) *See* PRECESSION.

NU'THATCH. The name of a shy and solitary bird of the genus *Sitta* (*S. Europæa*). It frequents woods, and feeds on insects chiefly; but also eats the kernel of the hazel nut, which it cracks by fixing it in a chink, and striking it from above with all its force. The nuthatch lays her eggs in holes of trees, and hisses like a snake when disturbed.

NUT OF A SCREW. In Architecture, a piece of wood, iron, or other metal, pierced cylindrically, wherein is cut a spiral groove, adapted to an external cylindrical spiral cut on a bolt. Its use is to screw two bodies together, a head being placed on one end of the bolt to counteract the action of the nut. Two bodies are thus held together by compression, the bolt between the head and the nut being a tie.

NUTRIA, or NEUTRIA. The commercial name for the skins of *Myopotamus Bonariensis* (Commerson), the *Coypou* of Molina, and the *Quoiya* of D'Azara. In France the skins were, and perhaps still are, sold under the name of *racoonda;* but in England they are imported as *nutria* skins — deriving their appellation, most probably, from some supposed similarity of the animal which produces them, in appearance and habits, to the otter, the Spanish name for which is nutria. Indeed, Molina speaks of the *coypou* as a species of water rat of the size and colour of the otter.

Nutria fur is largely used in the hat manufacture; and has become, within the last 15 or 20 years, an article of very considerable commercial importance. The imports fluctuate considerably. In 1823, they amounted to 1,570,103 skins; but they have not in any other year been much more than half that number. In 1826, they were only 60,871. In 1837 and 1838, the imports were, at an average, 358,280 skins a year. Those entered for home consumption pay a duty of 1½*d.* a skin. They are principally brought from the Rio de la Plata. Nutria skins are very extensively used on the Continent. Geoffrey mentions* that, in certain years, a single French furrier (M. Bechem) has received from 15,000 to 20,000 skins.

Like the beaver, the coypou is furnished with two kinds of fur; viz. the long ruddy hair which gives the tone of colour, and the brownish ash-coloured fur at its base, which, like the down of the beaver, is of much importance in hat-making, and the cause of the animal's commercial value.

The habits of the coypou are much like those of most of the other aquatic Rodent animals. Its principal food, in a state of nature, is vegetable. It affects the neighbourhood of water, swims perfectly well, and burrows in the ground. The female brings forth from 5 to 7 at a time; and the young always accompany her.

The coypou is easily domesticated, and its manners in captivity are very mild. (See *Martin*, in the *Proceedings of the Zoological Society*, 1835.)

NU'TRITION. *See* FOOD, DIGESTION.

NUTMEG. The fruit of the *Myristica moschata*, a beautiful tree of the family of the *Laurineæ* of Jussieu, which grows in the Molucca islands. All the parts of this tree are very aromatic; but only those portions of the fruit called mace and nutmeg are sent into the market. The entire fruit is a species of *drupa*, of an ovoid form, of the size of a peach, and furrowed longitudinally. The nutmeg is the innermost kernel or seed, contained in a thin shell, which is surrounded by the mace; and this again is enclosed in a tough fleshy skin, which opening at the tip separates into two valves. The nutmeg tree yields three crops annually; one in April, which is the best; one in August; and one in December.

Good nutmegs should be dense, and feel heavy in the hand. When they have been perforated by worms, they feel light; and though the holes have been fraudulently stopped, the unsound ones may be easily detected by this criterion.

Nutmegs afford two oily products. 1. Butter of nutmeg, vulgarly called oil of mace, is obtained in the Moluccas, by expression, from the fresh nutmegs, to the amount of 50 per cent. of their weight. It is a reddish-yellow butter-like substance, interspersed with light and dark streaks, and possesses the agreeable smell and taste of the nutmeg, from the presence of a volatile oil. It consists of two fats; one reddish and soft, soluble in cold alcohol; another white and solid, soluble in hot alcohol. 2. The volatile oil is solid, or a *stereoptène*, and has been styled *myristicine*. (*Ure's Dict. of Arts, &c.*)

NUTS. (Lat. nux.) The fruit of different species of *Coryli* or hazels. The kernels have a mild farinaceous oily taste, agreeable to most palates; a kind of chocolate has been prepared from them, and they have sometimes been made into bread. The expressed oil of hazel nuts is little inferior to that of almonds. Besides those raised at home, nuts are imported from different parts of France, Portugal, and Spain, but chiefly from the latter. The Spanish nuts in highest estimation, though sold by the name of Barcelona nuts, are not shipped from thence, but from Tarragona, whence the annual average export is estimated at from 25,000 to 30,000 bags, 4 to the ton. The annual entries of nuts for home consumption amount to from 100,000 to 125,000 bushels; the duty of 2*s.* a bushel yielding from 10,000 to 12,000*l.* nett. (*Commercial Dict.*)

NU'TTALITE. A mineral associated with calcspar, from Bolton, in Massachusetts: it occurs in prismatic crystals, and appears, from Dr. Thomson's analysis, to be an alumino-silicate of lime, potash, and iron.

NUX. A kind of fruit, hard, dry, not splitting, and containing only one seed; it is also extended by some writers to any similar fruit, whether it contains one cell or more than one. *See* NUTS.

NUX VOMICA. (Lat.) The fruit of a species of strychnos growing in the East Indies. It produces the alkaloid salts, strychnia, and bruchia, and is a very virulent poison.

NY'CTALOPS. (Gr. νυξ, *night*, and οπτομαι, *I see.*) One who only sees distinctly in twilight, or the dusk of evening.

NYMPH, *Nympha*. (Gr. νυμφη, *a nymph.*) The Metabolian insects are so called when in the second stage of their metamorphosis, especially when they possess the power of locomotion. *See* PUPA.

NYMPHÆ'A, was the name given to some public baths at Rome consecrated to the nymphs, with whose statues they were adorned.

NYMPHA'CEA. In Zoology, a name given by Lamarck to a family of Bivalves.

NYMPHÆA'CEÆ. (*Nymphæa*, one of the genera.) In Botany, a natural order of plants, containing the water lilies of various parts of the world; they are Polypetalous Polyandrous Exogens, with the sides of the cells of the fruit covered with numerous seeds. Their stems burrow among the mud of the places where they grow, and have slightly astringent narcotic properties. The species are most valued for the beauty of their flowers, which, in *Victoria regia*, are the largest in nature, measuring as much as four feet in circumference.

NYMPHA'LIS. A genus of diurnal Lepidopterous insects, now the type of a family.

NYMPHI'PARA. (Gr. νυμφη, *a nymph;* pario, *I produce.*) A hybrid name applied by Reaumur to a family of Dipterous insects, and changed by Latreille into *Pupipara*. See that word.

NYMPHS. (Gr. νυμφαι.) Female beings, in Grecian Mythology, partaking of the nature of gods and men. They peopled all the regions of earth and water, and were variously designated according to the places of their abode. Thus, the Naiades inhabited the streams, the Oreiades the mountains, the Dryades the woods, the Hamadryades trees, with which they were born and died. They are represented as very beautiful; they constituted the attendants of various of the higher female divinities, especially Diana, and were also considered as having been the nurses of many of the gods, as Jupiter and Pan. *See* NAIADS, NEREIDS.

NYSTA'GMUS. (Gr. νυσταγμος.) A winking of the eyes, as observed in a drowsy person.

O.

O. A letter of the vowel series, which, if arranged according to the nature of the sound, occupies a position between *a* and *u*. It is susceptible of numerous interchanges, for which the reader is referred to the *Penny Cyclopædia*. The Greeks had two forms of this letter, ο (ομικρον, or little *o*), and ω (ομεγα, or large *o*); the former of which was equivalent to the short, and the latter to the long pronunciation of this letter in other countries. Among the Irish, the letter O prefixed to a name was originally considered as a mark of family dignity; it is now, however, we believe, considered to be merely equivalent to *Fitz* in England and *Mac* in Scotland, indicating *son*.

O. In Music, the O, circle, or double C, or semicircle, is a note which we call a semibreve, and the Italians *circolo;* used by them to mark what they call *tempo perfetto*, and what we call triple time.

OAK. (Germ. eiche.) The general name of a well-known hard-wooded forest tree, much cultivated for the purposes of timber, particularly in ship-building, and in other cases when much exposure to the weather is required. There are several varieties of this valuable tree; but the common English oak (*Quercus robur*) claims precedence of every other. The oak timber imported from America is very inferior to that of this country: the oak from the central parts of Europe is also inferior, especially in compactness and resistance of cleavage. The knotty oak of England, the "unwedgeable and gnarled oak," as Shakspeare called it, when cut down at a proper age (from 50 to 70 years), is the best timber known. Some timber is harder, some more difficult to rend, and some less capable of being broken across; but none contains all the three qualities in so great and equal proportions; and thus, for at once supporting a weight, resisting a strain, and not splintering by a cannon shot, the timber of the oak is superior to every other.

A fine oak is one of the most picturesque of trees: it conveys to the mind associations of strength and duration which are very impressive. The oak stands up against the blast, and does not take, like other trees, a twisted form from the action of the winds. Except the cedar of Lebanon, no tree is so remarkable for the stoutness of its limbs: they do not exactly spring from the trunk, but divide from it; and thus it is sometimes difficult to know

* *Annales du Muséum*, vol. vi. p. 82. The figure given is, generally speaking, good; but the tail is too hairy, and contradicts the description.

which is stem and which is branch. The twisted branches of the oak, too, add greatly to its beauty; and the horizontal direction of its boughs, spreading over a large surface, completes the idea of its sovereignty over all the trees of the forest.

The oak is raised from acorns, sown either where the oak is to stand, or in a nursery whence the young trees are transplanted.

The colour of oak wood is a fine brown, and is familiar to every one: it is of different shades; that inclined to red is the most inferior kind of wood. The larger transverse septa are in general very distinct, producing beautiful flowers when cut obliquely. Where the septa are small, and not very distinct, the wood is much the strongest. The texture is alternately compact and porous; the compact part of the annual ring being of the darkest colour, and in irregular dots, surrounded by open pores, producing beautiful dark veins in some kinds, particularly pollard oaks. Oak timber has a particular smell, and the taste is slightly astringent. It contains gallic acid, and is blackened by contact with iron when it is damp. The young wood of English oak is very tough, often cross-grained, and difficult to work. Foreign wood, and that of old trees, is more brittle and workable. Oak warps and twists much in drying; and, in seasoning, shrinks about $\frac{1}{32}$d of its width.

Oak of a good quality is more durable than any other wood that attains a like size. Vitruvius says it is of eternal duration when driven into the earth: it is extremely durable in water; and in a dry state it has been known to last nearly 1000 years. The more compact it is, and the smaller the pores are, the longer it will last; but the open, porous, and foxy-coloured oak, which grows in Lincolnshire and some other places, is not near so durable.

Besides the common British oak (*Quercus robur*), the sessile-fruited bay oak (*Quercus sessiliflora*) is pretty abundant in several parts of England, particularly in the north. The wood of this species is said by Tredgold to be darker, heavier, harder, and more elastic than the common oak; tough, and difficult to work; and very subject to warp and split in seasoning. Mr. Tredgold seems disposed to regard this species as superior to the common oak for ship-building. But other, and also very high authorities, are opposed to him on this point; and, on the whole, we should think that it is sufficiently well established that for all the great practical purposes to which oak timber is applied, and especially for ship-building, the wood of the common oak deserves to be preferred to every other species. A well-informed writer in the *Quarterly Review* has the following remarks on the point in question: —

"We may here notice a fact long known to botanists, but of which our planters and purveyors of timber appear to have had no suspicion, that there are two distinct species of oak in England — the *Quercus robur*, and the *Quercus sessiliflora;* the former of which affords a close-grained, firm, solid timber, rarely subject to rot; the other more loose and sappy, very liable to rot, and not half so durable. This difference was noted so early as the time of Ray; and Martyn in his *Flora-Rustica*, and Sir James Smith in his *Flora Britannica*, have added their testimonies to the fact. The second species is supposed to have been introduced some two or three years ago from the Continent, where the oaks are chiefly of this latter species, especially in the German forests, the timber of which is known to be very worthless. But what is of more importance to us is, that *de facto* the imposture abounds, and is propagated vigorously in the New Forest and other parts of Hampshire, in Norfolk and the northern counties, and about London; and there is but too much reason to believe that the numerous complaints that were heard about our ships being infected with what was called, improperly enough, *dry rot*, were owing to the introduction of this species of oak into the naval dockyards, where, we understand, the distinction was not even suspected. It may thus be discriminated from the true old English oak: — The acorn stalks of the *robur* are *long*, and its leaves *short;* whereas the *sessiliflora* has the acorn stalks *short*, and the leaves *long:* the acorns of the former grow singly, or seldom two on the same footstalk; those of the latter in clusters of two or three close to the stem of the branch. We believe the Russian ships of the Baltic that are not of larch or fir are built of this species of oak; but if this were not the case, their exposure on the stocks, without cover, to the heat of summer, which, though short, is excessive, and the rifts and chinks which fill up with ice and snow in the long winter, are enough to destroy the stoutest oak, and quite sufficient to account for heir short-lived duration."

OA'KUM. The yarns of which rope is composed when twisted into fibre. When mingled with pitch it is used for stopping leaks.

OA'NNES. In ancient Mythology, the most celebrated divinity of the Babylonians. He was represented as a sea monster, with human feet and hands; and was said to dwell in the abysses of the Red Sea, whence he was in the habit of issuing daily, and proceeding to Babylon, where he communicated instruction on religion, the science of government, and the useful arts. It has been generally supposed that Oannes was identical with the god Dagon,

> —— Sea monster, upward man,
> And downward fish;

and it is certain that the worship of marine animals constituted a leading feature in the religious observances of the Syrians and the adjacent nations. *See* DAGON.

OAR. In Nautical Affairs, a long piece of timber, flat at one end, and round or square at the other, by which a boat, barge, or galley, &c. is propelled through the water. The flat part dipped into the water is called the *blade;* the other end is the *loom*, which terminates in the handle. The fulcrum of the oar is the hole in the gunwale called the *rowlock*, or between two pins called *thole pins*, or one thole pin with a loose strap for confining the oar. There are various nautical phrases contingent upon this term, a few of which may not, perhaps, be out of place here. *To boat the oars* signifies to lay them in from rowing; *to feather the oar*, to hold the blade horizontally, so as not to catch wind; *to lie on the oars*, to suspend rowing for any interval; this is also the salute given to persons of distinction in passing; to *ship* and *unship the oars*, respectively to fix them and throw them out of the rowlocks.

OA'SIS. (Derived from the Coptic ouah, Arab. wâh.) The name given to those fertile spots, watered by springs and covered with verdure, which are scattered about the great sandy deserts of Africa. The most noted are situated in the Lybian desert. The oases of Egypt are nothing more than valleys or *depressions* of the lofty plain which forms the extensive table-land of Eastern Africa. They bear, in many respects, a similarity to a portion of the valley of Egypt, being surrounded by steep cliffs of limestone at some distance from the cultivated land, which vary in height in the different oases, those rising from the southern oases being the highest; neither do they present a continuation of cultivable soil, all of them being intersected by patches of desert. They no doubt owe their origin to the springs with which they abound, the decay of the vegetation thence arising having produced the soil with which they are now covered. Their fertility has been deservedly celebrated; but the glowing eulogiums of travellers on their surpassing beauty are probably in a great measure to be ascribed to the striking contrast they present to the deserts of burning sand with which they are surrounded. It may appear contradictory, considering the high opinion the ancients entertained of the fertility and beauty of the oases, that they should have selected them for places of banishment; but that such was the case, at least under the Romans, is certain. A law of the *Digest*, lib. 48. tit. 22., refers to this practice; and it has been supposed that the poet Juvenal was one of those who suffered a temporary banishment (*relegatio*) to the oases, though the evidence of this is by no means clear. (*Biographie Universelle*, art. *Juvenal.*) But the fact of their being selected as places of banishment is not in anywise inconsistent with the received opinions as to their salubrity and fertility. They were selected, not because of their being naturally noxious or disagreeable, but because of their being, as it were, out of the world, and from the extreme difficulty of escaping from them. The larger oases have some fine remnants of antiquity; the most celebrated of which is the temple of Jupiter Ammon, at Siwah. (See the *Geo. Dict.* art. "Egypt," and the authorities there referred to.) *See* DESERT.

OAST. The term applied to a kiln for drying hops, and which differs from a kiln for drying corn chiefly in being heated by a stove with flues, instead of an open fire, the smoke and heat of which passes up through the corn.

OAT FIELD. *See* OPEN FIELD LAND.

OAT GALLS. *See* GALL NUTS.

OATH, is defined by Paley "the calling on God to witness, *i. e.* take notice of what we say; and invoking his vengeance, or renouncing his favour, if what we say be false, or if what we promise be not performed." By the jurisprudence of nearly all known nations it has been admitted, in one form or another, as the solemn test of truth in judicial proceedings. Thus, as a general rule, all evidence in such proceedings must be given on oath by English law; and the having taken such oath subjects the witness to the penalties of perjury if his testimony be false. The only exceptions are, 1. In favour of Quakers, Moravians, and Separatists, whose "affirmation" is now admissible in all judicial proceedings, whether civil or criminal. The 1 & 2 Vic. c. 77. extends this privilege to persons who have been Quakers or Moravians, but have left those communities, retaining their objections. 2. Persons entitled to privilege of peerage give in their answers, in chancery, "upon their honour," instead of on oath; and corporations put in answers under the great seal. Oaths are administered publicly in court,

where the witness is about to give his evidence viva voce; and by competent authority, where the evidence is reduced into writing, the attestation of the witness being termed his "affidavit."

Any believer in a definite form of religion can be a witness, and the oath may be administered "according to such forms and ceremonies as he may declare to be binding." (1 & 2 Vic. c. 108.) But persons who cannot take an oath are incapable of being witnesses; such, therefore, as will not declare their belief in God, in a future state of rewards and punishments, and that perjury will be punished by the Deity, are excluded; as well as those who, from their years or ignorance, are incapable of comprehending the nature of an oath.

Oaths are still required by law on many occasions besides the giving evidence in judicial proceedings, and were formerly in a still greater number, until the 5 & 6 W. 4. c. 62., which substituted declarations in a great variety of cases, especially relating to the customs, excises, and post-office. Besides the Quakers and Moravians, several small sects of Christians profess conscientious objections to oaths, grounded on the express language of the scriptures. The church of England, in common with the Catholic church in all ages, and with most varieties of Christians, considers judicial oaths lawful, and declares them so by her 39th article. They have also been held mischievous or unnecessary by some philosophical writers, especially Bentham, in his *Rationale of Evidence*. The only answer to his reasoning appears to be, that however unreasonable the belief that the duty of truth is rendered more imperative by the formality of an oath, still, while such belief is a prevalent one, or while the imagination of witnesses in general is impressed by its solemnity, the convenience of retaining the practice overbalances the disadvantages.

OATS. *See* AVENA.

OBE'DIENCE, PASSIVE, in Politics, signifies the unqualified obedience which, according to some political philosophers, is due from subjects to the supreme power in the state; insomuch that not only its lawful, but its unlawful commands, may not be forcibly resisted without sin. The doctrine of passive obedience or non-resistance was strongly professed by the church of England in the time of King James I.; much commented on by writers, both for and against it, under Charles and James II.; and condemned at the Revolution. *See* NON-RESISTANCE, and DIVINE RIGHT.

O'BELISK. (Gr. ὀβελίσκος, dim. from ὀβελος, Lat. obelus, *a needle, or dart.*) A lofty quadrangular monolithic column, "diminishing upwards, with the sides gently inclined, but not so as to terminate in an apex at the top; neither is it truncated or cut off at the summit, but the sides are sloped off so as to form a flattish pyramidal figure, by which the whole is suitably finished off and brought to a point, without the upper part being so contracted as to appear insignificant." Egypt was, properly speaking, the land of obelisks; and they are unquestionably to be reckoned among the most ancient monuments of that extraordinary people. Much learning and ingenuity has been expended in endeavouring to ascertain their origin, and the purposes for which they were erected; but it does not appear that any satisfactory solution of the problem has hitherto been given. It has been frequently asserted that obelisks were originally erected in honour of the sun, of which they were said to be symbolical, and that they served the purposes of a gnome or sun-dial; but this opinion is now almost totally rejected, and it is generally believed that obelisks were nothing more than monumental structures, serving as ornaments to the open squares in which they were generally built, or intended to celebrate some important event and to perpetuate its remembrance. They were usually adorned with hieroglyphics; and we learn from the testimony of Diodorus and Strabo that the inscriptions with which they were charged declared the amount of gold and silver, the number of troops, and the quantity of ivory, perfumes, and corn which all the countries subject to Egypt were required to furnish. The two largest obelisks were erected by Sesostris in Heliopolis. They were formed of a single block of granite, and measured 180 feet in height. When Egypt became a Roman province, Augustus removed these obelisks to his own capital; and this practice found numerous imitators both in some of his successors to the imperial throne, and, at a much later period, in many of the Roman pontiffs from the 16th century down to the present times. Of these obelisks that of the Lateran, which is the largest now known, being 105 feet in height exclusive of the pedestal, and weighing 440 tons, was brought by Constantine from Heliopolis to Alexandria, and thence by Constantius his son to Rome, where it was erected in the Circus Maximus. The obelisk next in size to that of the Lateran was placed originally in the Vatican circus by Caligula, but it now stands in the piazza of St. Peter's; its entire height is 132 feet, including the pedestal, &c. The obelisks most generally known, at least in name, are the Luxor, which was removed to Paris in 1833; and the two monoliths called Cleopatra's Needles, of which one is standing, and the other on the ground; but these are smaller than those we have adverted to, the Luxor being 76 feet in height, and the Needle of Cleopatra which still stands being about 63 feet in height, exclusive of the pedestal, &c. A full consideration of the Egyptian obelisks would involve us in the discussion of several most important questions, on which our limits preclude us from entering. Of these perhaps the most extraordinary is the wonderful knowledge of mechanical power which the Egyptians evinced in erecting and removing such gigantic structures,—a feat which it would require the greatest skill and ingenuity of modern engineers, even in the present comparatively perfect state of mechanical science, to accomplish. (See the learned treatise of Zoega on Obelisks; see also *Sir G. Wilkinson's Egyptians*, vol. iii., *passim*, which contains some excellent illustrations of the different methods adopted by that people for removing their huge structures from place to place.)

O'BELUS. In Diplomatics, a mark so called from its resemblance to a needle (Gr. ὀβελος); usually thus — or thus ÷ in ancient MSS. It was used by Origen, in his *Hexapla*, to mark the passages where something is found in the Septuagint which is not in the Hebrew. The common use of the line — in modern writing is to mark the place of a break in the sense, where it is suspended, or where there is an ungrammatical transition; but a paragraph introduced where the sense is suspended is more properly marked by the sign of a parenthesis.

O'BERON. In Mediæval Mythology, the King of the Fairies. Wieland's beautiful poem, and Weber's romantic opera of this name, the *Midsummer Night's Dream*, and innumerable other poems and tales of which he is the hero, have made the name of Oberon so familiar that it will be unnecessary to do more in this place than to state the origin of the fable. The name Oberon first appears in the old French *fabliaux* of Huon of Bordeaux; it is identical with Auberon, or Alberon, the first syllable of which is nothing more than the old German word Alb, *elf* or *fairy*, which, in the Helden-Buch and other old German poems, is expressed variously by Alberich or Alban. (See *Grimm's Deutsche Mythologie*, p. 256.) He was represented as endowed with magic powers, and with the qualities of a good and upright monarch, rewarding those who practised truth and honesty, and punishing those who acted otherwise. His wife's name was Titania, or Mab, whose powers have been so beautifully depicted in *Romeo and Juliet*.

OBE'SITY. (Lat. obesus, *fat.*) Unhealthy fatness. The tendency to the formation of fat is often so excessive as to constitute a disease, and it occasionally prevails in particular habits, so as to cause a most unsightly bulk of body, and to be independent of diet. The celebrated Lambert, who exhibited himself some years ago, was a remarkable specimen of this disease. He died in the fortieth year of his age, and weighed, a little before his death, 739 pounds. There is an account, in the *Philosophical Transactions* for 1813, of a girl, only four years old, who weighed 256 pounds from accumulation of fat.

When obesity is limited to the abdomen, arising from excessive deposition of fat in the omentum, and producing what is called a pot belly, or where it is the result of indolence and indulgence in luxurious diet, a slow and prudent change from a full to a spare diet, and the judicious use of purgatives and of appropriate modes of exercise, have occasionally effected remarkable cures.

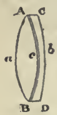
O'BIT. (Lat. obitus, *death.*) In the Roman Catholic liturgy, a service performed for the repose of a departed soul.

OBI'TUARY. (Lat. obitarium.) A register in which are enrolled the names of deceased persons for whom obits are to be performed, and the days of their funeral. It is also used for the book containing the foundation or institution of the several obits in a church or monastery. In the former sense it is synonymous with *necrology*, in the latter with *martyrology*.

OBJECT-GLASS (of a refracting telescope or microscope). The lens which first receives the rays of light coming directly from the object, and collects them into a focus, where they form an image which is viewed through the eye-glass.

The excellence of an object-glass depends on the distinctness of the image which it forms. On account of the unequal refrangibility of the rays of light, it is necessary, in order to procure a distinct image, to employ an achromatic combination of lenses, formed of substances having different dispersive powers, and of such figures that the aberration of the one may be corrected by that of the other. The substances chiefly used are crown-glass and flint-glass; the dispersive powers of which are respectively as 3 to 5. By combining a convex lens of crown-glass with a concave lens of flint-glass, having their focal distances in that proportion, an image would be formed free from colour, but it would not be free from aberration. The determination of the form of the compound lens which shall give the least possible aberration for parallel rays is a problem which admits of exact

calculation. The following are the dimensions found by Sir John Herschel for an object-glass of thirty inches focal length, of the form shown in the annexed figure, where A B is the convex lens of crown-glass on the outside towards the object, and C D the concave lens of flint-glass placed on the inside towards the eye: radius of the exterior surface *a* of the crown lens, 20·0364 inches; radius of the exterior surface *b* of the flint lens, 41·1687 inches; radii of the interior surfaces *c*, 10·1604 and 10·1613 inches. (*Encyc. Metr.*, art. "Light," § 471.) When the lenses have the forms here indicated, the focal lengths of each, separately, are in the direct ratio of their dispersive powers; and the two inside surfaces have so nearly the same curvature that they may be ground on the same tool, and united by a cement to prevent the loss of light at the two surfaces.



Such are the forms indicated by theory; but the practical difficulties of forming a good achromatic object-glass, for a telescope of large size, are so great that it often costs more than all the rest of the instrument. This, however, principally arises from the extreme difficulty of procuring disks of flint-glass, above a certain size, sufficiently free from veins and imperfections as to be fit for the purpose. No object-glasses of a larger size than seven inches diameter have been made of glass manufactured in this country; and, notwithstanding the success of Fraunhofer at Munich, and of Guinand in Switzerland, the procuring of flint-glass fit for object lenses of a larger size seems to be still, in a considerable degree, a matter of accident. Fraunhofer executed a telescope for the Russian observatory at Dorpat, having an object-glass of 9 inches diameter. Another was prepared by him for the king of Bavaria of 12 inches diameter. The object-glass of Sir James South's large telescope at the Campden Hill observatory is nearly 13 inches in diameter, and was executed in Paris of glass manufactured by Guinand.

In the fine telescopes formerly constructed by Dollond the object-glasses were composed of three lenses, the two exterior ones, A B and C D, being of crown-glass, and convex, and the interior, E F, of flint, and concave. This combination gives a more perfect correction of the spherical aberration; but the advantage is more than balanced by the greater complexity of their construction, the risk of imperfect centering, and the loss of light at the six surfaces. They have accordingly been disused.

Various attempts have been made to dispense with the concave flint lens, by the substitution of some other refractive substance. Dr. Blair found that the dispersion of crown-glass was corrected by a fluid lens, composed of a mixture of solutions of ammoniacal and mercurial salts. He succeeded in making object-glasses in his manner, which at first gave promise of answering well; but it soon appeared that they were not durable, the fluid undergoing some chemical change which entirely destroyed its virtue. Professor Barlow, of Woolwich, has also made numerous experiments on this subject. His correcting lens is formed of the liquid sulphuret of carbon, inclosed between two disks of glass, and a ring of the same material, the fluid being introduced at a high temperature. A telescope which he made on this principle had a single object lens of 7·8 inches, and the fluid lens was placed at the distance of 40 inches behind it. The performance of this telescope was, however, far inferior to an ordinary one of the same dimensions, with the common double achromatic object-glass. *See* Achromatism, Lens, Telescope.

O'BJECT, OBJECTIVE. In Philosophy, opposed to *subjective*. *See* Subject, Subjective.

O'BLATE. (Lat. oblatus, *offered*.) In Ecclesiastical Antiquities, 1. A person who, on embracing the monastic state, had made a donation of all his goods to the community. 2. One dedicated to a religious order by his parents from an early period of his life. 3. A layman residing as an inmate in a regular community, to which he had assigned his property either in perpetuity or for the period of his residence. 4. A layman who had made donation, not only of his property, but his person, as bondsman to a monastic community. In France the king possessed, in ancient times, a privilege of recommending a certain number of *oblati*, chiefly invalided soldiers, to monasteries, whom they were bound to maintain.

Oblate, in Geometry, signifies flattened at the poles. Thus, an *oblate* spheroid is a spheroid of the same form as that which is produced by the revolution of an ellipse about its shorter axis. Such is the figure of the earth. *See* Degree, Earth.

OBLA'TION (Lat. oblatio, *an offering*), means, properly, an offering presented to the church. This practice commenced at an early period in the history of the church, for originally the Christian priesthood had no other maintenance or allowance than the free gifts or oblations of the people. In the middle ages, oblations were of various kinds, and were known by different names, according to the purposes for which they were presented. (See Palmer, *Orig. Liturg.* ii. 67.)

OBLIGA'TION. (Lat. obligo, *I bind*.) In the most general sense, a duty imposed by law, to the fulfilment of which one party is bound towards another. Obligations, according to the civil law, are said to arise in four ways; out of contracts, quasi-contracts, delicts, or quasi-delicts. A principal obligation is that by which a debtor is bound to his creditor; an accessory obligation, that by which one is bound to another to satisfy the contract of a third party. The Roman jurisconsults divided obligations into natural, civil, and mixed, and also into civil and prætorian. An obligation, by the law of England, is a bond with penalty and condition; it may also be by statute or recognizance. He who enters into an obligation is styled obligor; he towards whom it is entered into, obligee.

OBLIGA'TO. (Ital.) In Music, a term applied to a movement or composition written for a particular instrument. It sometimes means that a movement is restrained by certain rules, to give particular expression to a passage, action, &c.

OBLI'QUE. (Lat. obliquus.) Not direct, deviating from the perpendicular. Thus, *oblique angle*, in Geometry, is an angle greater or less than a right angle. *Oblique circle*, in the Stereographic Projection, is any circle oblique to the line of projection. *Oblique planes*, in Dialling, are such as recline from the zenith. *Oblique projection*, in Mechanics, is where a body is projected in a line, making an oblique angle with the horizontal line. *Oblique sailing*, in Navigation, is that which includes the calculation of oblique-angled triangles. *Oblique sphere*, in Geography, is that in which the axis of the world is inclined to the horizon of the place.

OBLIQUE MOTION. In Music, that wherein one of the parts holds on a sound, whilst the other rises or falls on any note whatsoever.

OBLI'QUITY OF THE ECLIPTIC. In Astronomy, the inclination of the plane of the earth's equator to the plane of the eliptic, or the angle formed by those two planes, on which the phenomena of the seasons depend. *See* Ecliptic.

O'BLONG. In Elementary Geometry, a rectangle, or right-angled parallelogram, whose length is greater than its breadth. An *oblong spheroid* is generated by the revolution of an ellipse about its longer axis, and therefore elongated at the poles; hence the term is used in contradistinction to *oblate spheroid*, which denotes a spheroid flattened at the poles. The *oblong* spheroid is otherwise called the *prolate* spheroid.

O'BÖE. (Ital.) A musical wind instrument, sounded through a reed. It is shaped somewhat like a clarionet, being slender in the upper part, but spreading out conically at the bottom, and consists of three joints or pieces, besides the reed. Its compass is generally two octaves and a fifth, from C, below the treble clef, to G, the fourth line above the staff. The ancient name of oboe was *wayght*, which is still visible in the modern word *wait* (*see* Waits); and in this form the oboe was in use as far back as the reign of Edward III. It is only since the beginning of the present century that the Italian form of this word came into general use; previously to that period the French name, *hautbois*, was universally current.

O'BOLUS. (Gr. ὀβολος.) An Athenian silver coin of very small dimensions; being only equal in value to about $1\frac{1}{4}d.$ of our money, or less, according to some computations. Seven of them were equal to an Attic drachma.

OBRI'NE. The name of a military order, instituted in the 13th century by Conrad, duke of Mazovia in Poland; styled also the order of Jesus Christ. It was instituted to levy war against the Russians.

OBSCU'RANTS, OBSCURA'NTISM. A kind of philosophical nickname, commonly applied, in Germany, to those who endeavoured in their writings to oppose the progress of modern enlightenment (Aufklärung) and their doctrines. (See *Conv. Lex.*)

O'BSEQUIES (Lat. obsequium, *complaisance*), were solemnities performed at the burials of eminent persons. The term is now used for the funeral itself.

OBSE'RVANTS, otherwise RECOLLECTS. A branch of the Franciscan order. *See* Recollects.

OBSE'RVATORY. A place or building destined for the purpose of making astronomical or physical observations, and furnished with appropriate instruments.

Astronomical observatories appear to have been erected in very early times, the tower of Babel being supposed to have been an edifice of this kind; and the tomb of Osmandias is celebrated in the history of ancient Egypt as having had a similar destination. The Indians and Chinese have also traditions of observatories which existed in the remotest ages of their histories. In fact, as the observation of the relative positions of the celestial bodies requires instruments of some sort, and as instruments must have a locality, the existence of observatories must have been coeval with the first progress made in

practical astronomy. (See Bailly, *Histoire de l'Astronomie Ancienne.*)

According to Weidler, the first regular observatory in Europe was erected at Cassel, in 1561, by William, landgrave of Hesse. That of Tycho Brahe, in the island of Huen, was founded in 1576. From this time private observatories began to be multiplied; and some of them, as that of Hevelius at Dantzic, produced results which materially contributed to the progress of astronomy; but it was only in the following century that they came to be regarded, in the principal countries of Europe, as important and necessary public establishments. The royal observatory of Paris was built in 1667, that of Greenwich in 1675; the latter being professedly for the benefit of navigation.

The principal use of astronomical observatories is to contain the instruments by which the observations are made that are requisite for forming catalogues of the stars, and tables of the sun, moon, and planets. These observations requiring great precision can only be made with instruments of considerable size, firmly supported, and capable of being accurately placed and maintained in certain determinate positions. In the present state of astronomy, no observation can be regarded as useful for the purposes just named unless made with an instrument fixed in the meridian. The instruments, therefore, which must be considered as essentially necessary to an observatory are a transit instrument and sidereal clock, for the purpose of observing right ascensions; a circle, for observing polar distances; and a barometer and thermometer, for the purpose of ascertaining the state of the atmosphere, in order to determine the corrections to be applied for refraction. Furnished with this apparatus, the astronomer is in a condition to obtain all the data requisite for the formation of catalogues and tables, and for establishing or perfecting the theories of the celestial motions and physical astronomy. Another instrument, though of secondary importance, is also wanted for the observation of phenomena out of the meridian, as eclipses, occultations, comets, &c. The most convenient instrument for this purpose is the equatorial (see the term); and if the astronomer carries his views to the exploring of the sidereal spaces, to observe the forms of nebulæ, and watch the changes and motions of double and multiple stars, the equatorial must be furnished with a telescope of the largest kind; or a powerful reflecting telescope, suspended so as to have a free motion in azimuth, may be employed instead of it. In this department of astronomy all depends on the goodness of the telescope; the objects to be examined being, in fact, only limited by the power of seeing them. But as these researches have no immediate practical application, they are not considered as included among the purposes for which public observatories are established, and are therefore left to the zeal of individuals.

Public observatories are now established and maintained by the governments of almost every civilized country, and the means provided of publishing the observations, and rendering their results immediately available to the progress of astronomical science. The number of private observatories, particularly in this country, is very considerable; and several of them, in regard to the sumptuousness of their instruments, vie with, and even excel, the first and best appointed public institutions. The following is a list of the principal public observatories, with their latitudes and longitudes (in time) from that of Greenwich, as given in the *Nautical Almanac* for 1843: —

	Latitude.				Longitude.			
	°	′	″		*h.*	*m.*	*sec.*	
Abo (Finland)	60	26	57	N.	1	29	8·8	E.
Altona	53	32	45	N.	0	39	46·6	E.
Armagh	54	21	12·7	N.	0	26	35·5	W.
Berlin	52	31	13·5	N.	0	53	35·5	E.
Bremen	53	4	36	N.	0	35	15·9	E.
Cambridge	52	12	51·8	N.	0	0	23·5	E.
Cape of Good Hope	33	56	3	S.	1	13	55	E.
Copenhagen	55	40	53	N.	0	50	19·8	E.
Dorpat (Russia)	58	22	47	N.	1	46	55	E.
Dublin	53	23	13	N.	0	25	22	W.
Edinburgh	55	57	23·2	N.	0	12	43·6	W.
Geneva	46	11	59·4	N.	0	24	37·5	E.
Gottingen	51	31	48	N.	0	39	46·5	E.
Greenwich	51	28	39	N.	0	0	0	
Konigsberg (Prussia)	54	42	50	N.	1	22	0·5	E.
Madras	13	4	9·2	N.	5	21	3·8	E.
Marseilles	43	17	50·1	N.	0	21	29	E.
Munich	48	8	45	N.	0	46	26·5	E.
Oxford	51	45	40	N.	0	5	1·5	W.
Palermo	38	6	44	N.	0	53	25·6	E.
Paramatta (New South Wales)	33	48	49·8	S.	10	4	6·25	E.
Paris	48	50	13	N.	0	9	21·5	E.
Petersburg	59	56	31	N.	2	1	15·8	E.
Rome	41	53	52	N.	0	49	54·7	E.
St. Fernando (near Cadiz)	36	27	45	N.	0	24	49·1	W.
Turin	45	4	6	N.	0	30	48·4	E.
Vienna	48	12	35	N.	1	5	31·9	E.

OBSE'SSION. (Lat. obsideo, *I besiege.*) The state of a person vexed or besieged by an evil spirit. In the language of exorcists, demoniacal obsession differed from demoniacal possession: in the latter, the demon had possession of the patient internally; in the former, he attacks him from without. Thus, the state of Sara, the bride of Tobias, whose bridegrooms were killed by an evil spirit haunting her (Tob. iii. 8.), was one of obsession. Well-known marks of obsession were the being miraculously hoisted or elevated in the air, speaking languages of which the patient had no knowledge, aversion to the offices of religion, and so forth. *See* Possession, Demoniac; Exorcism.

OBSI'DIAN. So named, according to Pliny, from Obsidius, who first found it in Ethiopia. A glassy lava. Volcanic glass. It is of various colours, but usually black, and nearly opaque. In Mexico and Peru it is occasionally manufactured into cutting instruments, or cut into ringstones. It consists of silica and alumina, with a little potash and oxide of iron.

OBSI'DIONAL CROWN. (Lat. obsideo, *I besiege.*) In Roman Antiquities, a crown granted by the state to the general who raised the siege of a beleaguered place. It was formed of grass growing on the rampart. *Obsidional* coins, in Numismatics, are pieces struck in besieged places to supply the want of current money. They are of various base metals, and of different shapes. Some of the oldest known are those which were struck at the siege of Pavia, under Francis I.

O'BSOLETE. (Lat. obsoletus.) In Zoology, the term implies that a part, or a spot, or other character, is scarcely discoverable.

OBSTE'TRICS. (Lat. ars obstetricia, from obstare, *to stand so as to give assistance.*) The name frequently given to the science of midwifery.

OBTE'MPER. (Lat. obtempero, *I obey.*) In Scotch Law, to obey or comply with a judgment of a court.

OBTU'NDENTS. (Lat. obtundo.) Mucilaginous, oily and other bland medicines, supposed to sheathe parts from acrimony, and to blunt that of certain morbid secretions.

OBTURA'TOR MUSCLES. (Lat. obturare, *to close up.*) Certain muscles which fill up openings in bones.

O'BVERSE, or FACE. In Numismatics, the side of the coin which contains the principal symbol: usually, in the coins of monarchical states, ancient and modern, the face in profile of the sovereign: in some instances, the full or half-length figure. *See* Numismatics.

OCCA'SIONALISM, or the System of Occasional Causes. In Metaphysics, a name which has been given to certain theories of the Cartesian school of philosophers, especially Arnold Geulinx, of Antwerp, by which they accounted for the apparent action of the soul on the body; *e. g.* in the phenomena of voluntary motion. According to these theories (which were more or less clearly developed by different writers), the will was not the *cause* of the action of the body; but, whenever the will required a motion, God caused the body to move in the required direction. *See* Harmony, Pre-established.

OCCIDE'NTAL. (Lat. occidens, *setting.*) In Gem Sculpture, a term applied to those precious stones which possess an inferior degree of hardness and beauty.

OCCI'PITAL BONE. (Lat. occiput, *the hind head.*) The irregularly shaped bone which forms the posterior and inferior part of the skull.

OCCULTA'TIONS (Lat. occulto, *I conceal*), sometimes called Lunar Occultations, or Occultations of Stars by the Moon, are those phenomena in which a star or planet becomes hidden from our view by the intervening passage of the moon. By analogy, a total eclipse of the sun might be called an occultation of the sun by the moon.

As the motion of the moon in her orbit is from west to east, it is obvious that, when she is about to pass over a star, the first contact, or the immersion, must occur on her eastern limb; and the emersion, or re-appearance of the star, must take place on her western limb. It should, however, be observed, that some slight exceptions to this rule may be found where the moon has considerable motion in declination, and where the star is only grazed over by a small portion of the northern or southern limb. In these few exceptional cases, the disappearance and re-appearance of the star may both occur either on the eastern or the western side of the limb.

An occultation, like a solar eclipse, is presented only to a portion of the terrestrial globe. For suppose an observer to be stationed at the star, with the moon between him and the earth, and that he could perceive the moon's disc projected on that of the earth; then he would observe that the moon, in her passage over the earth, only covered a portion of the terrestrial disc, and it is evident that the phenomenon of the occultation of the star could only be presented to that portion of our globe.

The principles which enter into the calculation of occultations are just the same as for eclipses of the sun; the only difference consists in the star having neither motion, parallax, nor semidiameter, so that the moon's motion and parallax are to be employed in place of the relative motion and the relative parallax. For the mode

of conducting the calculation, it will therefore be sufficient to refer to the article ECLIPSES, page 381.; and to observe that the consideration may perhaps be simplified by giving to the star a motion contrary and equal to that of the moon, and then supposing the moon herself to be stationary.

In the case of a planet, it may be necessary to take into account its motion and parallax, and perhaps its semidiameter, if great nicety is to be observed.

For minute details, in reference to the calculation of eclipses and occultations in all their varieties, the reader will do well to consult the Appendix to the *Nautical Almanac* for the year 1836.

OCCU'LT SCIENCES. (Lat. occultus, *hid.*) A term applied to the imaginary sciences of the middle ages — magic, alchymy, astrology, especially the former.

O'CCUPANCY. In Law, the taking possession by any one of a thing of which there is no owner, and the right acquired by such taking possession. Anciently, when a man held land *pur auter vie* (for the life of another), and died before that other, as this estate could not descend to his heir, nor revert to the donor until the determination of the life upon it, it was considered to belong of right to the first who took possession of it for the remainder of the life, which was termed general occupancy. And, when the gift was to one *and his heirs* for the life of another, the heir was said to take as special occupant. By the Stat. of Frauds (29 C. 2. c. 3. sec. 12.) a man is enabled to devise lands held by him pur auter vie; and if no such devise be made, and there be no special occupant, it goes to his executors and administrators.

O'CEAN. (Gr. *ωκεανος.*) In Geography, the vast body of water which surrounds the continents, and is the receptacle of all their running waters. It is divided by geographers into five great basins; viz. the Pacific Ocean, (so called by reason of its comparative stillness), which separates Asia from America, and is the largest of all the basins; 2. the Atlantic Ocean, which has Europe and Africa on its eastern shore, and America on its western; 3. the Indian Ocean, which washes the south of Asia, and the south-eastern coast of Africa; 4. The Arctic Ocean, which surrounds the north pole; and 5. the Antarctic, which surrounds the south pole. Other smaller portions of the great connected body of water are called *seas*, of which the Mediterranean, the German, the Baltic, and Black seas, are the most considerable. The superficial extent of the several great basins is not known with any certainty, nor, indeed, can their limits be exactly defined. From the nearest estimation that can be made of the extent of the continents and principal islands, it is supposed that nearly three fourths of the whole surface of the globe are covered by water. The Pacific Ocean alone exceeds the whole surface of the dry land.

Depth of the Ocean. — If the superficial extent of the ocean cannot be easily ascertained, it will readily be supposed that its depth is a problem of much greater difficulty. The bottom appears, wherever it has been reached by the sounding line, to have similar inequalities to those of the surface of the land: hence the depth must be extremely various; and it might be supposed from analogy that the greatest depth of the ocean is at least equal to the height of the highest mountains above its surface. Lord Mulgrave found no bottom in the North Atlantic Ocean with a sounding line of 4680 feet; and Mr. Scoresby sounded to the depth of 7200 feet, without the lead touching the ground. These experiments are not altogether to be depended on for the determination of such great depths; for, the pressure becoming very great, the lead may be drawn out of the perpendicular direction by currents, of which it may encounter more than one, flowing in different directions. Over a great portion of the Atlantic and Pacific Oceans no bottom has been found. The depth of the ocean in general, and the form of the bed on which it rolls, cannot, therefore, be determined by experiment. The mathematical theory of the oscillations of fluids has, however, thrown some light on the subject. Laplace demonstrated that the difference which is indicated by observation between the height of two consecutive tides depends on the law of the depth of the sea, and that, but for the influence of accessory circumstances, it would disappear altogether if the depth were constant. It follows, therefore, that, since the difference between the consecutive tides is extremely small, the depth of the sea, taking in a large extent of ocean, must be nearly uniform; that is to say, there must be a certain mean depth from which the variations are not considerable. (*Méc. Céleste,* book xiii.)

Level of the Ocean.—Were it not for the disturbing actions of the sun and moon, and of the winds, the level of the ocean would be every where the same, and its surface would have the form determined by the attraction of the whole mass of the earth, combined with the centrifugal force belonging to its velocity of rotation; that is to say, the surface would be that of an oblate spheroid of revolution. This uniformity, however, can never be established. The tide at every instant is at different heights in different parts of the ocean; and therefore the form of the surface, within the limits of the rise and fall of the tides, is variable. But even if we neglect the alternate rise and fall of the water which constitutes the tides, and take the surface of the ocean at its mean height, it is found by accurate levelling that all its parts do not coincide with the surface of the same spheroid. Gulfs and inland seas, which communicate with the ocean by narrow openings, are affected according to their position with regard to the prevailing winds. The level of the Red Sea was found, by the French engineers in Egypt, to be 32½ feet higher than that of the Mediterranean, which is supposed to be a little lower than the ocean. Humboldt concluded, from observations made on the Isthmus of Panama, that the waters of the Gulf of Mexico are about 2 feet higher than those of the Pacific Ocean. The Baltic and Black seas rise in spring from the great quantity of river water poured into them, and are lowered in summer by the joint effects of a small supply and increased evaporation.

Colour of the Ocean. — The usual colour of the ocean is a bluish-green, of a darker tint at a distance from land, and clearer towards the shores. According to Mr. Scoresby, the hue of the Greenland sea varies from ultramarine blue to olive green, and from the purest transparency to great opacity. The surface of the Mediterranean, in its upper part, is said to have at times a purple tint. In the Gulf of Guinea the sea sometimes appears white; about the Maldive Islands black; and near California it has a reddish appearance. Various causes cooperate to produce this diversity of tint. The prevailing blue colour may be ascribed to the greater refrangibility of the blue rays of light, which, by reason of that property, pass in greatest abundance through the water. The other colours are ascribed to the existence of vast numbers of minute animalculæ; to marine vegetables at or near the surface; to the colour of the soil, the infusion of earthy substances; and very frequently the tint is modified by the aspect of the sky. The phosphorescent or shining appearance of the ocean, which is a common phenomenon, is also ascribed to animalculæ, and to semiputrescent matter diffused through the water.

Temperature of the Ocean. — Water being a slow conductor of heat, the temperature of the ocean is much more uniform than that of the atmosphere. At a certain distance from the equator, it follows, though not very closely, the mean temperature of the corresponding latitudes; the solar action being greatly modified by the existence of currents which convey the temperature of one region to another; so that at any place the temperature of the water depends in some measure on the direction of the currents. Within the tropics the mean temperature at the surface is about 80° of Fahrenheit, and generally ranges between 77° and 84°. At great depths the temperature is probably nearly the same under every latitude. In the torrid zone it is found to diminish with the depth; in the polar seas it increases with the depth; and about the latitude of 70° it is nearly constant at all depths. But the small number of observations which have yet been made on this subject do not indicate any uniform law, according to which the variation of temperature at different depths is regulated.

Saltness of the Ocean. — The ocean holds in solution a variety of saline matters, of which by far the most abundant is common salt, constituting in general about two thirds of the whole. The saltness of sea-water at particular places is influenced by temporary causes—storms, for example; as well as by the neighbourhood of large rivers, and permanent accumulations of ice. A series of experiments on this subject were made some years ago by the late Dr. Marcet; and the following are the general conclusions which he deduced from them: — 1. That the Southern Ocean contains more salt than the Northern Ocean, in the ratio of 1·02919 to 1·02757. 2. That the mean specific gravity of sea-water near the equator is 1·02777. 3. That there is no notable difference between sea-water under different meridians. 4. That there is no satisfactory evidence that the sea at great depths is more salt than at the surface. 5. That the sea in general contains more salt where it is deepest; and that its saltness is always diminished in the vicinity of large masses of ice. 6. That small inland seas, though communicating with the ocean, are much less salt than the ocean. 7. That the Mediterranean contains rather larger proportions of salt than the ocean. (*Phil. Trans.* 1819; *Prout's Bridgewater Treatise.*)

The peculiar bitter taste of sea-water does not appear to belong to it beyond a certain depth, and is ascribed to the vegetable and animal matter held in a state of decomposition near the surface. *See* TIDES.

OCE'ANUS. In Greek Mythology, the oldest of the Titans: according to some, the son of Ouranos and Gaia. His consort was Tethys, his daughters the Oceanides. In Homer, the word ocean merely designates the "river," or stream, which, according to his notion, encompassed the earth.

OCHLO'CRACY. (Gr. *οχλος, a crowd,* and *κρατειν, to govern.*) A word coined to express the condition of a state in which the populace have acquired an immediate illegal control over the government; and, by a figure

commonly used in the exaggeration of political speakers and writers, a government in which the power of the lower classes predominates, either for a time or permanently.

O'CHRE. (Gr. ὤχρα.) In Painting, a colour prepared from a species of earth. It is of various hues, as yellow, red, green, blue, and black. The colouring matter of ochre is almost always oxide of iron.

O'CHREA. (Lat. *a boot.*) A name applied to stipules that are membranous, and surround the stem like a vagina or sheath, cohering by their anterior margins, as in *Polygonum.*

OCHRE OF IRON. A hydrated oxide of iron.

O'CHROITE. A name given by Klaproth to an earth supposed to exist in the mineral since called cerite.

O'CREÆ. (Lat.), in Roman Antiquities, were a sort of military boots made of tin, and ornamented with gold and silver. They were equivalent to the κνημιδες of the Greeks, and the greaves of the English. *See* GREAVES.

OCTAE'DRITE. *See* OCTOEDRITE.

OCTAETE'RIS. (Gr. οκτω, *eight*, and ετος, *a year.*) A cycle or period of eight years, at the lapse of which three lunar months were added. This cycle was in use till Meton's invention of the golden number, or cycle of nineteen years.

O'CTAGON. (Gr. οκτω, and γωνια, *angle.*) In Geometry, a plane figure contained by eight sides, and consequently having eight angles. When the sides and angles are equal, it is a *regular* octagon. If a denote the side of a regular octagon, the area is $a^2 \times 2 \tan. 67\frac{1}{2}^{\circ} = a^2 \times 4{\cdot}828427$.

OCTAGON. In Fortification, a place which has eight sides or bastions.

OCTA'NDRIA. (Gr. οκτω, and ανηρ, *a male.*) In Botany, that class of plants which has eight stamens.

OCTANS. In Astronomy, *Octans Hadleianus* (Hadley's Octant) one of the constellations formed by Lacaille in the southern hemisphere. *See* CONSTELLATION.

O'CTANT. In Geometry, the eighth part of a circle. In astronomy, *octant* denotes a position or aspect; thus the moon is in her octants when she is in the positions intermediate between her syzygies and quarters, or at 45°, 135°, 225°, and 315° from her conjunction.

OCTA'NUS. A fever which returns every eighth day.

OCTASTY'LOS. (Gr. οκτω, *eight*, and στυλος, *a column.*) In Architecture, a temple or other building having eight columns in front.

O'CTAVE. (Lat. octavus.) In Music, an harmonical interval, containing five tones and two semitones, called, by the ancient authors, *diapason.*

OCTAVE, in Ecclesiastical Antiquities, signified the eighth day after a feast, the feast day itself included. Thus, the first Sunday after Easter is the octave of Easter, styled *octava infantium*, and by other names. The Circumcision (Jan. 1.) is the *octave natalis domini*, the octave of Christmas. The introduction of octaves is said to have been founded on and borrowed from the Jewish ritual. The *octave* of a feast is sometimes called the *Utas*, or "the Utas day:" thus, "Wrytyn at Norwich on the Utas day of Peter and Powll." (*Paston Letters*, vol. iii. p. 189.)

OCTA'VO. (Lat.) Usually contracted 8vo.; that which by a peculiar folding has eight leaves to a sheet.

OCTO'BER. (Lat. octo.) The eighth month of the old Roman year, which began with March. The commencement of the year was transferred by Numa Pompilius to the 1st of January, but the months retained their names. October is now the tenth month. *See* CALENDAR.

OCTOE'DRITE. A mineralogical name applied to the octoedral oxide of titanium.

OCTOHE'DRON. (Gr. οκτω, *eight*, and ἕδρον, *side.*) In Geometry, one of the five regular solids, or Platonic bodies, contained under eight equal and equilateral triangles. Let

A = the linear edge or side,
B = the whole surface,
C = the solid content,
R = radius of circumscribed sphere,
r = radius of inscribed sphere;

then,

$$A = r\sqrt{6} = R\sqrt{2} = \sqrt{(\tfrac{1}{6}B\sqrt{3})} = \sqrt[3]{(\tfrac{3}{2}C\sqrt{2})}$$
$$B = 12r^2\sqrt{3} = 4R^2\sqrt{3} = 2A^2\sqrt{3}$$
$$C = 4r^3\sqrt{3} = \tfrac{4}{3}R^3 = \tfrac{1}{3}A^3\sqrt{2}$$
$$R = r\sqrt{3} = \tfrac{1}{2}A\sqrt{2} = \tfrac{1}{2}\sqrt{B\sqrt{\tfrac{1}{3}}} = \sqrt[3]{\tfrac{3}{4}C}$$
$$r = \tfrac{1}{3}R\sqrt{3} = \tfrac{1}{6}A\sqrt{6} = \tfrac{1}{6}\sqrt{(B\sqrt{3})}.$$

O'CTOPODS, *Octopoda.* (Gr. οκτω, *eight*; πους, *a foot.*) The name of a tribe of Dibranchiate Cephalopods, including those which have only eight feet or cephalic tentacular appendages; also of a sub-order of Apterous insects, including those which have eight feet, as the Tracheary Arachnidans.

OCY'THOE. (Gr. ωκυς, *swift*, and θεω, *I run.*) The name applied by Rafinesque to a naked Cephalopod, supposed to be that which inhabits and constructs the argonaut shell.

O'DALISQUES, properly ODALIKS. (Turkish oda, *a chamber.*) Female slaves employed in domestic service about the persons of the wives, female relatives, &c. of the sultan.

ODD NUMBER. In Arithmetic, any number not divisible by 2 without remainder; the series of odd numbers is 1, 3, 5, 7, 9, &c.; and the algebraic form by which they are expressed is $2n + 1$. Every prime number, excepting 2, is an odd number. The differences of the successive terms of the series of square numbers produce the odd numbers.

ODE (Gr. ωδη, *a song*), among the Greeks and Romans, was a short lyric composition, usually intended to be sung, and accompanied by some musical instrument, generally the lyre; hence the expression lyric verse. In the modern sense of the word, the ode appears to be distinguished from the song by greater length and variety, and by not being necessarily adapted to music. It is distinguished also from the ballad, and other species of lyric poetry, by its being confined to the expression of sentiment, or of imaginative thought, on a given subject, not admitting of narrative, except incidentally. The odes of Pindar, Anacreon, and Horace, are, in fact, the models on which the modern notion of the ode is formed, and which have been imitated in similar compositions in modern times. Until the science of Greek metres was so accurately explored as it has recently been, the Pindaric ode was supposed to admit of an excessive irregularity in the length and measure of lines; and hence the Pindaric odes of the last and preceding century are constructed on a system of absolute licence in this respect. In point of fact, however, a scheme of perfect metrical regularity pervaded the Greek ode both in Pindar and in the dramatic choruses, in which a strophe, or succession of lines in varied metre, is exactly answered in the antistrophe or corresponding series. On the other hand, the Anacreontic ode consists of a number of lines of the same metrical length and arrangement. The Horatian ode, again, is generally constructed on a different system, of which we have only a few instances in Greek, in the Fragments of Alcæus and Sappho: it consists of an indefinite number of stanzas, precisely similar to each other, each forming a complete metrical whole. (*See* METRE.) The Dithyrambic ode (quod vide) was a bacchanalian song; and as, from the attributes of the divinity to which it was dedicated, it admitted great irregularity and licence, the name has been transferred in modern times to all odes partaking of a wild and impetuous character.

O'DERITE. A variety of black mica from Sweden is so called.

ODE'UM, or ODEON. (Gr. ωδη, *a song.*) In ancient Architecture, a building wherein the poets and musicians contended for the prizes, both in vocal and instrumental music. Pericles, who was the first person to erect one of these buildings at Athens, instituted it for the choragi of the different tribes to rehearse their performances; but these buildings in the end were used for far different purposes from those for which they were originally destined. An odeum was to be found in all the principal cities of antiquity. The word odeon has been preserved in most modern languages: thus, there is an odeon in Paris, appropriated to theatrical and other similar purposes; and in Munich there is a concert-room with this name.

O'DIN. A Scandinavian deity, who seems, like the Jupiter of the Greeks, to have formed the connecting link between the ancient and more recent systems of their mythology. The conqueror Odin appears to have been a chieftain who led the Asi (the Goths) from the confines of Asia to northern Europe. But, when deified by public adoration, the attributes of an earlier deity seem to have been transferred to him. Odin is the chief of the gods; by his wife Freya he has two chief sons, Thor and Balder: the death of the latter (for the Scandinavian gods are not all immortal) furnishes many legends to the northern mythology, and is known to English readers by Gray's translation, *The Descent of Odin.* (See this article in the *Conv. Lex.*, and in the *Encycl.* of Ersch and Gruber.) The more ancient Odin, among the Romans, was regarded as the representative of their god Mercury. *See* WUOTAN.

ODO'METER. (Gr. ὁδος, *a road*, and μετρον, *measure.*) An instrument attached to the wheel of a carriage by which the distance passed over is measured. *See* PERAMBULATOR.

ODONTA'LGIA. (Gr. οδους, *a tooth*, and αλγος, *pain.*) The toothache.

ODONTO'LOGY. (Gr. οδους, and λογος, *a discourse.*) The branch of anatomical science which treats of the teeth. *See* DENTES.

O'DORIN. One of the products of the redistillation of the volatile oil obtained by distilling bone; it has a very concentrated and diffusible empyreumatic odour, and is regarded by Unverdorben as a peculiar salifiable base.

O'DYSSEY. (Gr. Οδυσσεια.) An epic poem, attributed, in general, to Homer, but, according to some modern hypotheses, not by the hand of the author of the *Iliad.* The

subject of the poem is the return of Ulysses (Ὀδύσσευς) from Troy to his native island, Ithaca.

ŒCO'NOMY. (Gr. οἶκος, *a house*, and νέμω, *I distribute*.) In Architecture, the harmonious and skilful combination of the parts of a building, which renders them suitable to their several purposes, and tends to connect them conveniently with each other.

ŒCUME'NICAL. (Gr. οἰκουμένη, scil. γῆ, *the inhabited earth*: used in the New Testament.) In the Greek language applied to ecclesiastical matters in the sense of universal. Several patriarchs of Constantinople and Rome assumed the title of œcumenical (particularly John, A.D. 590, and Cyril, his successor), apparently in opposition to the pretensions of the bishop of Rome. Œcumenical councils are those to which prelates resorted from every part of Christendom under the jurisdiction of the Roman empire. (Palmer, *Church of Christ*, vol. ii. p. 150.) *See* COUNCIL.

Œ'CUS. (Lat.) In Ancient Architecture, an apartment adjoining a dining room.

ŒDE'MA. (Gr. οἰδάω, *I swell*.) A puffiness or swelling of parts, arising from water collecting in the cellular membranes.

Œ'DIPUS. A personage renowned in the early or mythological stage of Grecian history, the son of Laius and Jocasta. An oracle had warned Laius that he should be killed by his son: in consequence of which he caused the child to be exposed, with one of its feet pierced and fastened with a thong (his name was accordingly derived from the swelling of the foot). The slave entrusted with him carried the child to Polybus, king of Corinth, and deceived Laius with a false report. Œdipus, when grown up, slew, in ignorance, his father Laius; acquired the sovereignty of Thebes, after conquering the Sphynx, and married his mother Jocasta. On becoming acquainted with their fatal destiny, Jocasta killed herself, and Œdipus deprived himself of sight. Such is the outline of the story familiar to us by the noblest efforts of the Greek tragedians. The tale of Œdipus himself affords the subject of two tragedies of Sophocles: the first (*Œdipus Tyrannus*), the most perfect example of dramatic *skill* which antiquity has left us; the second (*Œdipus at Colonus*), perhaps the most beautiful of ancient dramatic *poems*. The fate of his offspring is portrayed in several of the remaining dramas of the three great tragedians. The miseries inflicted on Œdipus seem to us to be wholly undeserved, and of a kind that it is impossible to approve. He was a mere passive instrument in the hands of Fate or Destiny, and was not morally culpable for the death of his father or the marriage of his mother. The acts, in fact, were the acts of the gods, and not of Œdipus. In themselves they were bad; but as he was totally ignorant of and did not intend them, he is no more to be blamed than a dagger in the hand of an assassin is to be blamed for the murder. And hence there can be no real sympathy with the miseries inflicted on Œdipus, and still less with those entailed on his offspring, who are made to suffer without cause or reason of any kind.

ŒNA'NTHE CROCA'TA. In Botany, the name given to the hemlock dropwort, a poisonous plant, growing in Pembrokeshire. It is called by the inhabitants of the country *five-fingered root*, and has some reputation as a remedy in diseases of the skin.

Œ'NOMANCY. (Gr. οἶνος, *wine*, and μαντεία, *prophecy*.) A mode of divination among the Greeks, from the colour, sound, &c. of wine poured out in libations.

ŒNOTHIO'NIC ACID. (Gr. οἶνος, and θεῖον, *sulphur*.) The acid which is formed during the action of sulphuric acid upon alcohol. Sertuerner gave it the above name: it is the sulphovinic acid of Vogel and other chemical writers.

ŒSO'PHAGUS. (Obs. Gr. οἴειν, *to carry*, and φαγω, *I eat*.) The tube by which food is conveyed from the posterior part of the mouth, or *pharynx*, to the stomach. The gullet.

Œ'STRUS. (Gr. οἶστρος, *a gad-fly*.) The name of a genus of Dipterous insects, some of which lay their eggs in the skin of quadrupeds, which they pierce for that purpose; others near the nose, up which the larvæ creep to the frontal sinuses. The flies of an allied genus (*Gasterophilus*) attach their eggs to the hairs in situations where they can be licked off and swallowed; when, their vitality protecting them from the action of the gastric juice, they are hatched in the stomach, and the larvæ attach themselves to the inner membrane, forming what are called "bots" in the horse.

O'FFERINGS. Literally, gifts presented at the altar in token of acknowledgment of the divine goodness. Offerings constituted a large portion of the Jewish worship. They consisted chiefly of bread, salt, fruits, wine, and oil, and had different names according to the purposes for which they were employed. A distinction has often been made between offerings and sacrifices (*see* SACRIFICE); the former being said to refer only to the fruits of the earth, the latter to animals; but this can scarcely have been the case, for both the burnt and the sin offering required animals to be sacrificed. Among the Greeks, Romans, and other nations, the same practice prevailed of offering at their altars wheat, flour, and bread. In a modern sense, the term *offering* is applied to certain dues payable by custom to the church, as the Easter offerings, &c. This latter custom has obtained from the first period of Christianity, when those who officiated at the altar had no other maintenance or allowance than the free gifts or offerings (oblationes) of the people.

O'FFERTORY. The first part of the Mass, in which the priest prepares the elements for consecration. In the English communion service, it denotes the sentences which are delivered by the officiating priest while the people are making their oblations or offerings. (See Palmer, *Orig. Liturgicæ*.)

O'FFICE FOUND. In English Law, an inquiry executed by some officers of the crown, when certain events have occurred in consequence of which the crown becomes entitled to take possession of real or personal property. Such are the finding of treasure under certain circumstances, the intestacy of a bastard, &c. The verdict of a coroner's jury of "felo de se" is an instance of office found, on which the crown is entitled to take possession of the effects of the deceased.

O'FFICER, is used generally to signify any person in the enjoyment of a post or office, whether civil or military, under the crown. Under their different heads will be found a notice of the chief civil and military officers; to these the reader is referred.

OFFI'CIAL. In the Canon Law, the deputy or lieutenant of a bishop, abbot, &c., or an ecclesiastical judge appointed by them. The principal official of the bishop is his chancellor, whose jurisdiction is coextensive with the diocese. An *officialis foraneus* (styled in English law commissary) is appointed to part of a diocese when large. The court of the official is styled in the canon law his *officiality*.

O'FFICI'NAL. In Pharmacy, such medicines as are directed by the Pharmacopæia to be kept ready for use in the apothecaries' shops.

O'FFING. A Nautical term, denoting a part of the sea at a considerable distance from the shore where there is deep water.

O'FFSET. In Architecture, the superior surface left uncovered by the continuation upwards of a wall where the thickness diminishes, forming a ledge.

O'FFSETS, in Surveying, are short distances from the chain-line, usually measured with a rod, called an off-set staff, the most convenient length for which is 6 feet 7·2 inches, being equal to 10 links of the surveying chain. *See* SURVEYING.

OFFSETS. In Gardening, young radical bulbs when separated or taken off from the parent roots are so called. One of the chief methods of propagating plants is by offsets. *See* PROPAGATION OF PLANTS.

O'GEE. In Architecture, the same as *cyma reversa*: see that art., and MOULDING.

O'GHAMS. A peculiar kind of short-hand writing in use among the ancient Irish. It consisted of certain lines and marks which derived their power from their situation and position as they stood in relation to one horizontal principal line, over or under which they were placed, or through which they were drawn; the characters or marks, according to their position, standing in the place of vowels, consonants, diphthongs, &c. (See the elaborate article in *Rees's Cyclopædia*.)

O'GIVE. (Etym. uncertain.) In Architecture, the term used by the French for the pointed arch.

O'GRES. (Fr.) The well-known name of those imaginary monsters with which the nursery tales of England abound. They are usually represented as cannibals, of malignant dispositions, and as endowed with gigantic height and power. It is difficult to speak with certainty of the origin of these fabulous creations; but it is probable that the term ogre is derived from Oegir, one of the giants in the Scandinavian mythology (see *Grimm's Deutsche Mythologie*, p. 146.); though it has been alleged, with perhaps more probability, that it has been borrowed from the Ogurs, or Onogurs, a desperate and savage Asiatic horde, which overran part of Europe about the middle of the 5th century.

OGY'GIAN DELUGE. The name given to a great inundation mentioned in fabulous history, supposed to have taken place in the reign of Ogyges in Attica, whose death is fixed, in *Blair's Chronological Tables*, in the year 1764 before Christ. *See* DELUGE.

OIL GAS. The inflammable gases and vapours (chiefly *hydrocarbons*) which are obtained by passing fixed oils through red-hot tubes, and which may be used as *coal gas*, for the purposes of illumination; it yields a more brilliant light than the latter, but is too expensive to be generally adopted. The apparatus for the production of oil gas is described in the *Quarterly Journal*, vol. viii. A gallon of common whale oil yields from 90 to 100 cubical feet of gas; and an Argand burner, giving the light of six or seven wax candles, consumes from $1\frac{1}{2}$ to 2 cubical feet per hour; whereas, to produce the

same light, from 5 to 6 cubic feet of coal gas are required.

OIL OF BRICKS. A term applied by the old chemists to the empyreumatic oil obtained by subjecting a brick which has been soaked in oil to the process of distillation at a high temperature. This oil is used by lapidaries as a vehicle for the emery by which stones and gems are sawn or cut.

OIL OF VITRIOL. *See* SULPHURIC ACID.

OIL-PAINTING. Painting in which the medium for using the colours is oil. It is said to have been unknown to the ancients, and not used earlier than the 14th century; its invention being attributed to John Van Eyck, sometimes called John of Bruges. By him it was supposed to have been imparted to one Antonio da Messina, who first brought it to Venice. Giovanni Bellini, by a stratagem, got possession of the secret from him, and then made it publicly known. Oil-painting has the advantages, above all other modes, of affording great delicacy of execution, a union and insensible blending of the colours, and above all that of imparting great force to its effects. The various colours chiefly used in oil-painting are, white lead, Cremnitz white, chrome, king's yellow, Naples and patent yellow, the ochres, Dutch pink, terra da Sienna, yellow lake, vermilion, red lead, Indian and Venetian red, the several sorts of lake, brown pink, Vandyke brown, burnt and unburnt umber, ultramarine, Prussian and Antwerp blue, ivory black, blue black, asphaltum. The principal oils are those extracted from the poppy, nut, and linseed. With the latter driers are introduced.

OILS. (Germ. oehle.) The term oil is applied to two dissimilar and distinct organic products, which are usually called *fixed* oils and *volatile* oils. The fixed or fat oils are either of vegetable or animal origin; they are compounds of carbon, hydrogen, and oxygen; the relative proportions vary but little in the several species. The following analyses of olive and spermaceti oil may be assumed as types of the rest: —

	Olive Oil.	Spermaceti Oil.
Carbon - - -	772	780
Hydrogen - - -	133	118
Oxygen - - -	95	102
	1000	1000

The *fixed oils* abound in the fruit and seed of certain plants; they are lighter than water, unctuous, and insipid, or nearly so; some of these require a low temperature for their congelation, such as linseed oil; others, such as olive oil, concrete at a temperature higher than the freezing point of water; some are solid at common temperatures, such as cocoa-nut oil. Some of these oils when exposed to air absorb oxygen, and gradually harden, forming a kind of varnish; these are called *drying oils*, and are the basis of paints, such as linseed oil; others become rancid, as almond oil. All these oils, like the different kinds of fat, consist of two proximate principles, called *stearine* and *elaine:* the former is the fatty portion, which first concretes on cooling the oil, and from which the elaine, or oily portion, may be separated by pressure. These oils cannot be volatilized without decomposition. At a red heat they are resolved into volatile and gaseous products, among which carburetted hydrogen, in several of its forms, predominates; hence the use of these oils, when volatilized and burned by the aid of a wick, as sources of artificial light. The action of the alkali on the fat oils is highly important, as forming soap.

The *volatile oils* are generally obtained by distilling the vegetables which afford them with water; they fluctuate in density a little on either side of water: they are sparingly soluble in water, forming the perfumed or medicated waters, such as rose and peppermint water; they are mostly soluble in alcohol, forming essences. A few of them, such as oil of turpentine, of lemon peel, of copivi balsam, &c., are hydrocarbons, that is, consist of carbon and hydrogen only; the greater number, however, contain oxygen as one of their ultimate elements. They are chiefly used in medicine and in perfumery, and a few of them are extensively employed in the arts as vehicles for colours, and in the manufacture of varnishes; this is especially the case with oil of turpentine.

OI'SANITE. An ore of titanium, from the department of Oise.

OLD MAN OF THE MOUNTAIN. The chief of the band Assassins* who established themselves in the mountainous district of Kohistan in Persia, in the 11th century, was so called. *See* ASSASSINS.

OLD RED SANDSTONE. A series of rocks interposed between the mountain limestone and slates. (*See* GEOLOGY.) It is included in *Murchison's Devonian System of Rocks*.

OLD TE'STAMENT. The name given to that part of Scripture which contains the collected works of the inspired writers previously to the advent of our Saviour. The period of their being collected is unknown. Some of them were in existence before the Babylonish captivity (600 years B.C.); others were collected at a later period; and the collection as it at present stands was completed in the second century before Christ. The Jews divided the Old Testament into the Law, the Prophets, and other writings known by the name Hagiographa, of which the Psalms were at the head. The contents of the Old Testament may be conveniently divided into the Historical Books, of which there are 17; the Poetical, of which there are 5; and the Prophetical, of which there are 16, distinguished into the books of 4 greater and 12 minor prophets. The Historical Books include the Pentateuch, the Book of Joshua, Judges, Ruth, 2 Books of Samuel, 2 Books of Kings, 2 Books of Chronicles, the Book of Ezra, of Nehemiah, and of Esther; the Poetical Books include the Book of Job, the Psalms, the Proverbs, Ecclesiastes, and the Song of Solomon; and the Prophetical comprise (of the greater) Isaiah, Jeremiah, Ezekiel, and Daniel, and (of the minor) Hosea, Joel, Amos, Obadiah, Jonah, Micah, Nahum, Habakuk, Zephaniah, Haggai, Zachariah, and Malachi. *See* BIBLE, TESTAMENT, PROPHETS, PSALMS, &c.

OLEA'CEÆ. (Olea, one of the genera.) The natural order of plants which contains the olive tree and the ash; it consists of trees or shrubs inhabiting the temperate parts of the world, and distinguished from others by their flowers being monopetalous and diandrous, with a valvate æstivation. *See* OLIVE.

OLECRA'NON. (Gr. ωλενη, *the ulna*, and κρανον, *the head.*) The head of the ulna. The process of the ulna which forms the elbow.

OLE'FIANT GAS. This variety of carburetted hydrogen is obtained by heating a mixture of two measures of sulphuric acid and one of alcohol. It is of somewhat less specific gravity than atmospheric air, 100 cubic inches weighing 30·5 grains. It burns with a bright white flame, and produces during combustion such proportions of carbonic acid and water as show that 1 volume of the gas is constituted of 2 atoms or volumes of hydrogen and 2 atoms of carbon; hence the equivalent of olefiant gas is ($2\,h. + 12\,car.$) $= 14$. When 2 volumes of chlorine are mixed with 1 of olefiant gas, and inflamed, hydrochloric acid is formed, and the charcoal of the gas makes its appearance in the form of dense black soot. If the mixture, instead of being kindled, be left standing over water, it soon condenses into a liquid looking like oil (hence the term *olefiant gas*), which is a hydrochloride of carbon. It has an aromatic odour, not unlike that of oil of caraways.

O'LEIC ACID. The product resulting from the action of alkalies upon the *elaine*, or liquid part of oils and fats.

O'LEIN. *See* ELAIN.

O'LEON. A peculiar liquid obtained by the distillation of a mixture of oleic acid and lime.

O'LERON, LAWS OF. *See* MARITIME LAW.

OLFA'CTORY NERVES. (Lat. oleo, *I smell*, and facio, *I cause.*) The nerves of smell. The first pair of nerves. They arise from the part of the brain called the *corpora striata*, and, perforating the ethmoid bone, are distributed over the mucous membrane of the nose.

OLI'BANUM. A gum resin, imported from the Levant, in yellowish white and nearly opaque drops or tears; it has a bitterish flavour, and has been used in medicine. When burned it exhales rather an agreeable odour, and is sometimes called *frankincense*. It is either the produce of the *Juniperus lycia*, or of the *Boswellia serrata*.

O'LIGARCHY. (Gr. ὀλιγοι, *few*, and ἀρχειν, *to govern.*) A state in which the sovereign power is lodged in the hands of a small exclusive class is so called. It differs from aristocracy, in that the latter term appears to designate a government in which the whole of a particular class or interest, *e.g.* the noble, the wealthy, &c., share directly or indirectly in the management of public affairs; while, in an oligarchy, it is a party or section formed out of one of these classes which enjoys the advantages of government.

OLI'VA. (Lat. oliva, *an olive.*) A genus of Pectinibranchiate Gastropods, dismembered from the *Volutes* of Linnæus, and so called on account of the long and elliptical shape of the shell. The aperture is narrow, long, and notched opposite to the spire, which is short; the folds of the columella are numerous, and resemble striæ. The animal has a large foot, the anterior portion of which is marked off by an incision on each side. The horns or tentacula are slender, and the eyes are on the middle of their outer side. The proboscis and the breathing tube are tolerably long; there is no operculum. The species of *Oliva* rival the cowries in beauty.

* There are few words whose etymology has exercised, and at the same time baffled the ingenuity of the learned, more than this. Perhaps the following may not be very remote from the truth. Throughout all the East a preparation of hemp is universally used to exhilarate the spirits by a luxurious species of intoxication. This is known to the Orientals by the name of *haschish*, and those who are addicted to it are called *haschischin* and *haschaschin*; two expressions, as Dr. Sacy remarks, which explain why the Ismaelians have been called by the historians of the crusades at one time *Assissini*, and at another *Assassini*. So that, instead of "a secret murderer," *assassin* implies, in point of fact, "an habitual drunkard." (*Quart. Rev.* vol. 24.)

O'LIVE. (Lat. olea.) A genus of trees belonging to the Diandria Monagynia class of plants. The *Olea Europæa* has an upright stem, with numerous branches, grows to the height of twenty or thirty feet, and differs from most trees in yielding a fixed oil from the pericarp instead of from the seed. The olive tree has in all ages been held in peculiar estimation; and some authors have styled it a "mine upon earth." It was sacred to Minerva. Olive wreaths were used by the Greeks and Romans to crown the brows of victors; and it is still universally regarded as emblematic of peace. The olive flourishes only in warm and comparatively dry parts of the world, as the south of France and Spain; in Italy, Syria, and the north of Africa; and though it has been raised in the open air in this country, its fruit did not ripen. The fruit is a smooth oval plum, about three quarters of an inch in length, and half an inch in diameter; of a deep violet colour when ripe; whitish and fleshy within; bitter and nauseous, but replete with a bland oil. Olives intended for preservation are gathered before they are ripe. In pickling, the object is to remove and to preserve them green by impregnating them with a brine of aromatized sea salt; and for this purpose various methods are employed. But it is chiefly for the sake of its oil that the olive tree is cultivated. Olive oil is pale yellow; its density is ·910. When fresh, and of fine quality, it is almost tasteless, having only a very slight and agreeable nutty flavour. It is less apt than most other fixed oils to become viscid by exposure, and hence is preferred for greasing clock and watch-work. It is largely used as an article of food. It is the principal article of export from the kingdom of Naples. Of 2,791,057 gallons imported in 1830, 2,034,237 were from Italy, 639,468 from Spain, 52,004 from Malta, 21,467 from Turkey, 11,300 from the Ionian Islands, and about 30,000 (at second-hand) from Germany and the Netherlands. There is a duty of eight guineas a ton on olive oil. (See *Dict. of Commerce, &c.*)

O'LIVILE. A peculiar amylaceous or crystalline substance, obtained from the gum of the olive tree.

O'LIVINE. A variety of *chrysolite* containing oxide of iron, of an olive green colour. It is sometimes found associated with meteoric iron.

O'LLA PODRI'DA. (Span. *putrid mixture.*) The name given to a favourite dish of all classes in Spain; consisting of a mixture of all kinds of meat cut into small pieces, and stewed with various kinds of vegetables. The epithet *podrida* is applied to this dish, in consequence of the poorer classes being obliged to serve it up so often that the odour arising from long keeping is far from agreeable. The phrase *olla podrida* is often used metaphorically in England for any incongruous mélange.

OLY'MPIAD. (Gr. ὀλυμπιας.) In Chronology, a Grecian epoch of four years, being the interval between the celebration of the Olympic games.

The Olympic games, so famous in Grecian history, were said to have been instituted about 1354 years before the Christian era; but, having fallen into disuse, they were revived by Iphitus, king of Elis, 844 years B.C. About a hundred years later, the practice was introduced of designating the Olympic period by the name of the victor. The first who received the honour was Coræbus, and the commencement of the Olympiad of Coræbus forms the principal era of Grecian chronology. The games in which he was victor were celebrated about the time of the summer solstice, 776 years before the era of the incarnation, in the 3938th of the Julian period, and 23 years, according to the reckoning of Varro, before the foundation of Rome. Before the introduction of the Metonic cycle, the Olympic year began sometimes with the full moon which followed, sometimes with that which preceded the summer solstice. Subsequent to the introduction of that cycle, the year always commenced with the eleventh day of the moon which followed the solstice, and it is usually regarded as beginning on the first day of July. It is necessary to observe, in the comparison of dates, that as the Olympiads begin about the 1st of July, the first six months of a year of our era correspond to one Olympic year, and the second to another. The first year of the first Olympiad began 776 years and six months before our era; hence, in order to reduce the date by Olympiads to our era, the rule is this: — Multiply the number of the past Olympiad by four, and add the odd years; subtract the sum from 777, if before Christ, or subtract 776 from the sum, if after Christ: the remainder will be the year before Christ or after Christ, if the event happened in the first six months of the Olympic year, that is, between July and January; but if the event happened in the last six months of the Olympic year, or between January and July, the remainder in either case must be diminished by one. For example, — the foundation of Rome (according to Varro) was laid in the 3d year of the 6th Olympiad, and 10th month of that year; required the date? Here 5 complete periods are elapsed: therefore, $5 \times 4 + 3 = 23$; and $777 - 23 = 754$, which being diminished by one gives 753 B.C. for the date. The month corresponds to April.

The method of computing time by Olympiads did not come into use till after the death of Alexander; and first appears in the Parian Chronicle, which was engraved about sixty years after that event. The first historian who used it was Timæus Siculus, who wrote a few years later. About 200 years B.C. Eratosthenes of Alexandria digested a chronological table of the Olympiads.

OLY'MPIC GAMES. The greatest of the national festivals of Greece, celebrated once every four years at Olympia, or Pisa, in Elis, in honour of Olympian Jupiter. Their institution is variously attributed to Jupiter, Pelops, and Hercules; but it appears that they had fallen into disuse for some time, till they were revived by Iphitus, 776 B.C. From this period it is that the Olympiads are reckoned. Like the other public festivals, the Olympiau games might be attended by all who bore the Hellenic name; and such was their universal celebrity that spectators quaternially crowded to witness them, not only from all parts of Greece itself, but from every Grecian colony in Europe, Asia, and Africa. In these games, none were allowed to contend but those who could prove that they were freemen of genuine Hellenic origin, and unstained by crime or immorality. The superintendence of these games belonged sometimes to the Pisans, but for the most part to the Eleans, by whom the Pisans were destroyed. On one occasion, in the 104th Olympiad, the management was forcibly seized on by the Arcadians. The contests at these games consisted in the athletic exercises, and also in those of music and poetry. The orators were crowned with garlands of wild olive. (See *West's Pindar; Thirlwall's Greece*, vol. i. 384.; and the other authorities.) The place where these renowned games were celebrated is a plain, now called Anti-Lalla, opposite the little town of Lalla. They commenced a little after the summer solstice, on the 14th of the Attic month Hecatombæon.

O'MBRIA. (Gr. ὀμϐρος, *rain.*) A name formerly applied to certain fossil Echini, under the supposition of their having fallen from the clouds.

OMBRO'METER. (Gr. ὀμϐρος, *rain*, and μετρον, *measure.*) A name sometimes given to the rain-gauge. *See* RAIN-GAUGE.

O'MELET. A pancake or fritter made of eggs, common in Spain, France, and Germany.

O'MENS. Casual indications, from which men believe themselves enabled to conjecture or foretel future events. The essential characteristic of all omens is their happening by accident; and it is this which distinguishes them from all other modes of divination. This branch of superstition seems nearly as ancient as the world itself; and in none do we find such remarkable indications of sameness of origin. Many external circumstances appear to be received in almost all countries as ominous. One of the most remarkable instances of this coincidence is mentioned in a recent number of the *Edinburgh Review*. The omens in which the Thugs, or secret murderers of India, believe with peculiar devotion, are almost the very same which an ancient Roman would have observed with equal attention; especially the appearance of animals on the right or left hand. In classical antiquity, however, omens appear to have multiplied, and to have been the subjects of more curious superstition in later than in earlier ages. There are numberless omens in Homer; but they are generally of the simplest description: — thunder and lightning; the appearance of some sacred birds, especially, as some critics have observed, those which have the highest flight, and might be supposed to have arrived immediately from the throne of Jove himself. Omens, among the Greeks (and, we may add, among almost all nations in periods of ignorance, and among the vulgar of the present day), may be divided into three classes: those derived from natural occurrences, relating to inanimate objects, lightning, earthquakes, phosphoric appearances, &c.; those derived from animals, especially birds, the region of their appearance, their voices, &c.; and those which the individual drew from sudden sensations of his own. Sneezing, in most times and countries, has been a peculiarly ominous occurrence. The Romans, as is well known, carried the science of omens to a very profound depth: the flight of birds was the main element in *augury;* the omens afforded by the entrails of sacrificed animals, in the learning of *extispicium.* One remarkable variety between Greek and Roman divination has often been noticed: the right hand in the former generally denoted good luck, and the left the contrary. Among the Romans this rule was reversed, although their writers in later times often adopt the Greek mode of expression. *See* AUGURS.

OME'NTUM. (So called from Lat. omen, because the soothsayers prophesied from its inspection.) The membrane is formed of a duplicature of the peritoneum, and encloses more or less fat. It is attached to the stomach, and lies on the anterior surface of the intestines.

O'MNIBUS. (Lat. *for all.*) The name given to a peculiar kind of public carriage, too well known to require to be described, which takes a number of passengers at a cheap common rate. They were first introduced

into Paris in 1825, whence they were introduced into London in 1829; and they are now to be met with in almost every large town both of this country and the Continent.

O'MNIUM. In Finance, a term used at the Stock Exchange to express the aggregate value of the different stocks in which a loan is now usually funded. (See *Dictionary of Commerce.*)

O'MNIVORES. (Lat. omnis, *all*, and voro, *I eat.*) The name given by Temminck to an order of birds, including those Insessorial species which feed on both animal and vegetable substances; as the starling.

OMOHYOI'DEUS. A muscle which pulls the os hyoides obliquely downwards: it is sometimes called the coracohyoideus: it arises from the superior costa of the scapula, and is inserted into the base of the os hyoides.

OMPHALO'DIUM. (Gr. ομφαλος, *the navel.*) The centre of the hilum of a seed, through which the nourishing vessels pass from the placenta into the seminal integuments.

OMPHALO'TOMY. (Gr. ομφαλος, and τεμνω, *I cut.*) The division of the navel string.

ONAGRA'CEÆ. (*Onagra*, an old name for the genus *Ænothera.*) An extensive natural order of Polypetalous Exogenous plants, very common in gardens, where they are much valued for the beauty of their flowers. They are known by all the parts of their flowers being arranged in fours. The genera *Fuchsia*, *Œnothera*, and *Epilobium* are common illustrations of the order.

ONE'IROCRI'TICS, or ONEIROCRITICAL SCIENCE. (Gr. ονειρος, and κρινω, *I judge.*) The science of interpreting dreams: treated of by Artemidorus, Macrobius, and other classical writers; by Thomas Aquinas, and others of the schoolmen; and, among many other moderns, by Cardanus, and Maio, a Neapolitan philosopher. According to all these writers, the secret of oneirocritical science consists in the relation supposed to exist betwen the dream and the thing signified; but they are far from keeping to the relations of agreement and similitude, and they frequently have recourse to others of dissimilitude and contrariety.

ONEIRODY'NIA. (Gr. ὄνειρος, and οδυνη, *pain.*) Disturbed dreams, including the nightmare and somnambulism.

ONISCI'DÆ. The name of a family of Isopodous Crustaceans, of which the wood-louse (*Oniscus*) is the type.

O'NOMANCY, or ONO'MOMA'NCY. (Gr. ονομα, *a name*, and μαντεια, *prophecy.*) A species of divination from the letters of a person's name. Many fancies of this sort were current among the ancients; such as that names in which the numeral letters amounted to the highest sum were most lucky.

ONOMA'STICON. (Gr. ονομα.) A work containing words or names, with their explanation, arranged in alphabetical or other order; a dictionary, commonplace book, &c. The best known work under this title is the *Onom.* of Julius Pollux, in ten books, a valuable repertory of ancient philological learning.

ONOMATOPŒ'IA. (Gr. ὄνομα, *name;* ποιεω, *I make.*) Literally, the making or manufacture of names; a word expressing by its sound the thing represented. In most languages the cries of animals are thus expressed; and the line of Aristophanes,

Ὁ δ' ἠλίθιος ὥσπερ πρόβατον βῆ βῆ λέγων βαδίζει,

shows that the modern Greeks have not correctly retained the sound of the eta (which they pronounce like our *e*), as the sound imitated from nature would not be thus represented. Ennius imitated the sound of a trumpet by the word *taratantara;* and, to represent the croaking of frogs, Aristophanes used βρεκεκεκὲξ κοὰξ κοάξ. (*Frogs*, i. 209.) Greek and German are peculiarly rich in words of this description. M. Charles Nodier has published a dictionary of those in French. (*Dictionnaire des Onomatopées Françaises.*)

ONTO'LOGY. (Gr. τὸ ὄν, *being*, and λόγος, *discourse.*) The science of *being* in itself, or its ultimate grounds and conditions. *See* METAPHYSICS.

ONY'CHIA. (Gr. ονυξ, *the nail.*) A whitlow.

ONY'CHOTEUTHIS. (Gr. ονυξ, *a claw;* τευθος, *a calamary.*) The name of the genus of Calamaries, in which the suckers of the cephalic appendages are armed with a hook.

O'NYX. A regularly banded agate, much prized for cameos, especially where the colours are very distinct and opposed. Any stone exhibiting layers of two or more colours strongly contrasted is called an onyx.

O'NYX. In Surgery, an abscess of the cornea of the eye; so called from its resemblance to the stone termed an onyx.

O'OLITE. (Gr. ωον, *an egg*, and λιθος, *a stone.*) A granular variety of carbonate of lime, frequently called *roestone.* The frequency of the occurrence of this particular form of limestone in a great series of deposits, lying between the subcretaceous formations and the new red sandstone, has caused English geologists to give the whole series the name of oolitic. It is largely developed in England and France. *See* GEOLOGY.

OOZO'A. (Gr. ωον, *an egg*, ζωον, *animal.*) A name applied by Ficinus and Carus to a primary division of the animal kingdom, including those in which the nervous and sanguiferous systems are incompletely developed, and in which the organization resembles the simple condition of the ovum of the higher classes. This division corresponds to the *Acrita.*

OPA'CITY. (Lat. opacus, *dark.*) In Optics, that quality of bodies which renders them opaque, or incapable of transmitting light. According to the Newtonian theory of light, opacity in natural bodies arises from the multitude of reflections caused in their internal parts. Newton thought it probable that the molecules of opaque and coloured bodies are separated by minute pores, either entirely void, or filled with some subtle matter of a different density from the body. If light enters such a body, and experience proves that it does penetrate the surfaces of opaque bodies, it will be reflected on encountering a molecule; and, if the molecules are extremely minute (in comparison of those of transparent bodies), the number of reflections may become so great that no part of the light will again escape from the surface. On this hypothesis, Sir J. Herschel remarks, that unless we admit a cause of opacity in atoms different from that which causes it in their aggregates, the atoms cannot be otherwise than absolutely pellucid, since no reflections can take place where there are no intervals, and no change of medium. Of the sufficiency of this cause, either in natural bodies or atoms, there does appear, he adds, some room for doubt, as it seems difficult so to conceive their internal reflections that the rays subjected to them shall be *all* and *for ever* retained, entangled, as it were, and running their rounds from atom to atom, without a possibility of reaching the surface and escaping; which, were they to do, it is evident that every body so constituted receiving a beam of light would in fact only disperse it in all directions in the manner of a self-luminous one. (*Ency. Metr.*, art. "Light.")

O'PAL. A beautiful mineral characterized by its iridescent reflection of light: it is very brittle. It consists of silica, with about 10 *per cent.* of water. *Common opal* in some of its characters resembles the preceding; but it has no play of colours, and is abundant, the former being a very rare mineral. Opal is found in different parts of Europe, but particularly in Hungary; in the East Indies, &c. (For some curious details as to this stone, see *Plin. Hist. Nat.*, lib. 37. c. 6.)

OPALI'ZED WOOD. Wood petrified by silica, and acquiring a structure resembling common opal.

O'PEN FIELD LAND. Arable lands unenclosed by hedges or other fences, and in the occupation of different individuals, or under different crops. In former times, only those parts of a farm which lay around the farmyard were enclosed, while the more distant parts were open, and called open fields, or out fields.

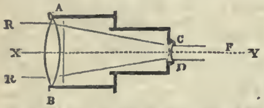
O'PENINGS. In Architecture, the piercings or unfilled parts in a wall, left for the purpose of admitting light, air, &c.

O'PERA. (Ital. *work.*) A musical drama, in which the music forms an essential part, and not merely an accompaniment. The whole dramatic art of the ancients possessed much of an operatic character. The choric parts were sung; and if the dialogue was not carried on in the musical tone termed *recitative* in modern times, it was certainly delivered in an artificially raised and sustained key, very different from the ordinary or oratorical speech. The first operas in modern times were performed in Italy, about the end of the 15th century. The *Orpheo* of Poliziano has been cited as the first complete piece of this sort. Jean Antoine Bäif introduced the opera into France, where the earliest representation of this kind is said to have taken place at the marriage of the Duc de Joyeuse, in 1582. In 1707, the opera of *Arsinöe*, consisting of English words adapted to Italian airs, was performed at Drury Lane, and a succession of entertainments of this kind terminated in the Italian opera. The first attempt at a wholly English opera was made by Sir William D'Avenant, in 1656. The opera is divided into *seria* and *buffa*, according to the subjects and the character of the music; and between the limits of both there is a third species, or *mezzo stilo*, not very accurately definable. The opera, properly speaking, admits only of singing and recitation, although, in some of the German operas, dialogue is also introduced. The romantic opera, which is considered as a German invention, is a compound between the two Italian species. Metastasio in Italy, and Goethe in Germany, have both written for the opera; but these are splendid exceptions, and the poetry has, in most instances, been held entirely subservient to the music. At the beginning of last century the opera, on its more general introduction into France and England, was attacked as an absurdity by almost all the wits and critics of the day. There were not, however, wanting defenders of this favourite child of the gay and fashionable world; and foremost among

them was Voltaire, to whose apology for the opera, in the preface to his tragedy of *Œdipe*, we take leave to refer the reader.

OPERA-GLASS. A small telescope used in theatres, whence it has its name.

The common opera-glass is nothing else than the Galilean telescope, invented by Galileo in 1609, which was the first ever employed for the purpose of exploring the heavens. A section of the instrument is represented in the annexed figure.



It consists of an object glass A B, the focal length of which is usually from 4 to 8 inches. The eye-glass, C D, is a double concave or plano-concave lens, from half an inch to 2 inches focus; the distance between the two lenses is equal to the difference of their focal lengths; and the magnifying power is in the ratio of those lengths. Rays of light, R R, falling on the object glass, are refracted towards the axis X Y, and proceed to meet in the focus of the lens at F. But before they reach that point they are intercepted by the concave lens C D, the focus of which is also at F, and by which they are restored to their parallelism. The rays, therefore, proceeding from the object enter the eye, which is applied to the lens C D, without crossing each other, or forming an image; and hence the distinctness of the Galilean exceeds that of all other telescopes; hence, also, there is no inversion of the image, and, as there are only two glasses, the loss of light is inconsiderable.

The lens A B may be either single or compound. If a single lens of plate-glass is used, it should be nearly convexo-plane; if a convex of plate and a concave of flint be combined to form the compound lens, the former should be nearly convexo-plane, and the latter concavo-plane. As to the eye-glass, it is always single; and the plano-concave form is perhaps better than the double concave, the eye being, in fact, never placed in actual contact with it. For any magnifying power above 3 or 4, it ought to be limited to an aperture rather less than that of the pupil of the eye; and where distinct vision is desired, the eye should be placed as accurately as possible on the axis of the instrument. (*Coddington's Optics*.)

The area or field of view of this instrument is very limited, and for this reason it cannot be used with any high magnifying power. *See* Telescope.

OPE'RCULUM. (Lat. operio, *I cover*.) The lid of any thing: applied by botanists to the cap of the pitcher of *Nepenthes*, to the loose apex of such fruits as that of *Lecythis*, to the conical limb of the calyx of *Eucalyptus*, and to the body which closes up the theca of a moss.

Operculum. In Zoology, this term is applied to the apparatus supported by four bones which protects the gills of fishes; also to the horny or calcareous plate which closes the aperture of univalve shells; and to the four calcareous pieces which defend the entrance to the tube of *Balanites* or bell-barnacles.

OPHICLEI'DE. (Gr. οφις, *a serpent*, and κλεις, *a key*.) The largest brass wind instrument used in the orchestra of the trumpet species, and forming the bass to that class of instruments: its compass is from double B *b* to A *b* above the line, in the bass clef, being three octaves.

OPHI'DIANS, *Ophidia*. (Gr. οφις, and ειδος, *form*.) The name of the order of reptiles which includes all the serpentiform species of that class, corresponding to the *Amphibia serpentes* of Linnæus.

O'PHIOMANCY. (Gr. οφις, and μαντεια, *prophecy*.) The art of divination from serpents. Thus the seven coils of the serpent seen on the tomb of Anchises were held to indicate the number of years of Æneas's future wanderings: —

Septem etenim gyros, septena volumina traxit.

O'PHITES. (Gr. οφις.) The name of an early sect of Christian heretics, who emanated from the Gnostics, so called from their worshipping the serpent that tempted Eve. They considered the serpent as the father of all the sciences, which, but for the temptation of our first parents, would never have been known. (Mosheim, *Eccl. Hist.*, vol. i.)

OPHIU'CHUS, or OPHIU'CUS; also called *Serpentarius*. One of the constellations of the northern hemisphere.

OPHTHA'LMIA, or OPHTHALMI'TIS. (Gr. οφθαλμος, *the eye*.) Inflammation of the eye. This term is applied to diseased action of various parts of the eye. In common cases its seat is the conjunctiva membrane, and it is relieved by fomentations of warm water or of decoction of poppy-heads, by leeches, cupping, purging; and, in violent cases, these depletive measures must sometimes be carried to a considerable extent, and aided by blisters to the temple or nape of the neck. Emetics have sometimes been of service. When all inflammatory symptoms have subsided, local astringents, and mild strengthening eye-waters, may be resorted to; but so long as any inflammation remains they should be most cautiously applied. Sometimes the iris is the seat of inflammation. This is attended with fever, great intolerance of light, and pain, and requires the same treatment. It sometimes terminates in a small abscess, which discharges its contents into the interior chamber of the eye, and the sight is destroyed by the permanent damage done to the part.

There is another form of ophthalmia in which the conjunctiva and inner membrane of the eyelids becomes inflamed and purulent, as in the *Egyptian ophthalmia*, which form of the disease is highly contagious. The swelling and purulent inflammation of the eyelids is so great as to close or distort them, and the ulceration sometimes extends over the cornea; the humours escape, the whole organ is frightfully disorganized, and the agony that attends the whole progress of the worst form of the malady is indescribable. The treatment originally resorted to consisted in bleeding and purging: the plan afterwards adopted was to give nauseating doses of tartar emetic, to remove the granulations by the scissors or knife, and afterwards to apply solutions of nitrate of silver or alum to prevent their reproduction.

There is a variety of ophthalmia called *metastatic*, caused by the translation of some other disease, such as gout, or by the application of some morbid poison to the part. Its treatment depends upon its origin.

The purulent opthalmia of new-born infants generally yields to the skilful application of mild astringent eye-waters, and to gentle aperients.

After the small-pox and measles, and some fevers, especially in scrofulous habits, the glands of the eyelids form a morbid secretion, which irritates and glues together the parts. This disease has been termed *psorophthalmia*; it frequently yields to fomentation with warm water, to a drop of vinous tincture of opium into the eye at bedtime, and to the application of the ointment of nitrate of mercury or red precipitate.

O'PIATE. (Gr. οπος, *juice*.) A medicine producing sleep. *See* Anodyne.

OPISTHO'GRAPHUM. (Gr. οπισθεν, *behind*, and γραφω, *I write*.) In Classical Antiquity, a set of tickets, or roll of parchment or paper, answering the purpose of a memorandum book or commonplace book, to enter notes and other extemporary matters to be revised afterwards; so called from being written over both on the front and back. Any ordinary MS. in which the transcriber had employed both the front and back of the papyrus was indeed an opisthograph, strictly so called; a practice to which allusion is made in the well-known verse of Juvenal: —

Scriptus et in tergo, nec dum finitus Orestes.

OPISTHO'TONOS. (Gr. οπισθεν, *backwards*, and τεινω, *I draw*.) A spasmodic action of the muscles, by which the body is bent backwards.

O'PIUM. (Gr. οπος, *juice*.) The inspissated juice of the poppy, obtained by wounding the unripe seed capsules of the *Papaver somniferum*, collecting the milky juice which exudes and dries in the sun, and kneading it into cakes. The cakes of the best opium are covered externally with pieces of dried leaves and the seed capsules of some species of *Rumex*. It should be of a rich brown colour, tough consistency, and smooth uniform texture; its peculiar narcotic smell should be strong and fresh; its taste bitter, warm, and somewhat acrid. The chemical analysis of opium has rendered it probable that its activity as a medicine depends upon the presence of a peculiar alkaline base called *morphia*, in combination with an acid which has been termed *meconic acid*. Opium also contains *narcotine*, *narceine*, *codein*, gum resin, extractive matter, and small portions of other proximate principles.

The chief countries in which opium is prepared are India, Egypt, Turkey, and other parts of Asia; it is even cultivated in Italy, France, and England, but the climate of Europe seems to be too uncertain to allow of its regular production. Opium is pretty extensively used, both as a masticatory and in smoking, in Turkey and India; but its great consumption is in China and the surrounding countries, where the habit of smoking it has become all but universal. The supplies for the Chinese market are derived from India and Turkey, but chiefly from the former. Indian opium is distinguished into three kinds: the Patna or that grown in the province of Bahar, the Benares, and the Malwa; of which the first is in the highest repute. The cultivation of opium in India is a strict government monopoly. Every one who chooses may, within the prescribed regulations, engage in the opium cultivation; but the drug, when prepared, must all be sold to the government at a fixed price, which is said to be so far from remunerating the growers that, were it not for the advances which government are obliged to make to enable them to carry on the business, the cultivation of opium would be discontinued,

in the greater portion of India. This monopoly has sometimes yielded a nett revenue of 1,000,000*l.* a year. This revenue has, however, of late years materially decreased, owing to the introduction into China of large supplies of opium from Turkey, into which it is found impossible to extend the monopoly. The East India opium is exported in chests of 159⅓ lbs. each. The introduction of opium into China was a legitimate branch of traffic down to the close of the last century. Ever since that period, however, the trade has been contraband; but though the Chinese government has issued edict upon edict prohibiting the importation of the drug, the consumption of Indian opium in China has, in little more than forty years, risen from 1000 to about 27,000 chests per annum. Such an extraordinary increase in a trade prohibited by law is attributable only to the corruption of the Chinese authorities. At first the trade was carried on at Whampoa, fifteen miles below Canton; and next at Macao, whence it was driven by the exactions of the Portuguese; and the principal entrepôt was, till the recent outbreak of hostilities between the British and Chinese, in the bay of Lintin. The opium is kept on board ships, commonly called receiving ships, of which there are often ten or twelve lying together at anchor. The sales are mostly effected by the English and American agents in Canton, who give orders for the delivery of the opium; which, on the order being produced, is handed over to the Chinese smuggler, who comes alongside at night to receive it. Frequently, however, the smuggler purchases the opium on his own account, paying for it on the spot in silver, it being a rule of the trade never violated that the money must be paid before the opium is delivered. When the drug is landed, the laws are equally set at defiance in its progress through the country, smoking houses being, it is said, every where established. During the first ten years of the present century, the exports from India to China were about 2,500 chests. In 1821-1822, after the introduction of Malwa opium into the markets of Bombay and Calcutta, the exports increased to 4,628 chests; and owing no doubt to the greatly increased supply and lower price of the article, the exports in 1831-1832 exceeded 20,000 chests, worth more than 13,000,000 dollars; and in 1837-1838 exceeded 30,000 chests, worth 20,000,000 dollars. In the beginning of 1839 the Chinese authorities resorted to decided measures to put a stop to opium smuggling; but the hostilities that consequently ensued between the two nations not having yet been composed, we shall not venture to enter upon so intricate a question, but shall merely observe, that whatever may be the result of the negotiations now pending, no system of restriction, how rigorous soever, will, in all probability, ever be able to check the smuggling of opium into China, where the popular tastes and habits are so decidedly in its favour. The opium consumed in England is derived chiefly from Turkey; but the supply is liable to great fluctuations. Thus, in 1830, the quantity imported from Turkey amounted to 192,136 lbs.; in the following year, to 8,184 lbs.; in 1833, to 72,020 lbs.; and in 1834, to 12,438 lbs. This remark is applicable to all the other places whence opium is imported into England, as well as to the quantity annually re-exported from England. Previously to 1828, the duty upon opium was 9*s.* per lb.; but in that year it was reduced to 4*s.*; and again in 1836 to 1*s.*, where it has since remained.

O'POBA'LSAM. (Gr. *οπος*, *juice*, and *βαλσαμον*, *balsam.*) Balsam or balm of Gilead. A compound of resin and essential oil of a peculiar fragrancy. It exudes from a species of *Amyris*.

OPODE'LDOC. A term invented and formerly applied by Paracelsus to a plaster for all external injuries; but in modern usage it signifies a liniment made by dissolving soap in alcohol, with the addition of camphor and volatile oils.

OPO'PONAX. A gum resin having a peculiar and rather disagreeable odour, formerly used in medicine. It is the produce of the *Pastinaca opoponax*.

OPO'SSUM. The common name of the Marsupial quadrupeds of the genus *Didelphis*, characterized by three kinds of teeth, viz. incisors, canines, and molars; by hinder hands, and a prehensile tail. With this organization the opossums, as might be expected, are arboreal in their habits; and feed on a mixed diet, in which animal food preponderates. The larger species have a well-developed abdominal pouch, in which the young are received at a singularly early stage of development. In some of the smaller opossums the characteristic pouch is nearly rudimentary, and the young are carried by the parent on the back, where they cling to the fur, and likewise hold on by entwining their little prehensile tails round that of the mother: the name *Didelphis dorsigera* is on this account given to one of the species. The true opossums are now limited to the American continent; but, during the Eocene period, there were species of *Didelphis* in both France and England.

OPPOSI'TION. (Lat. oppositio.) In a general sense, the fact of being in a state of contrary action or disagreement. In Politics, the name given in Great Britain to the party in parliament opposed to the administration for the time being, and which would most likely succeed to power were it displaced. A party in parliament which, though opposed to government, has no chance of succeeding to power were ministers dismissed, is not usually characterized by the term Opposition.

OPPOSITION, in Astronomy, denotes the aspect of two bodies when diametrically opposite to each other. Thus the moon, or a planet, is said to be in opposition with the sun when it passes the meridian at midnight.

OPPOSITION. In the Fine Arts, *contrast*; which see.

OPS. In Mythology, the Latin appellation of the Grecian goddess Rhea or Cybele; which see.

OPSIO'METER. (Gr. *ὄψις*, *sight*, and *μετρον*, *measure.*) An instrument for measuring the extent of the limits of distinct vision in different individuals, and consequently for determining the focal lengths of lenses necessary to correct imperfections of the eye. A contrivance for this purpose, by M. Lehot, is described in the *Annales des Sciences d'Observation* for June 1829, and in the Notes by M. Quetelet to the French translation of *Herschel's Treatise on Light*. Its principle depends on the appearance presented by a straight line placed very near the eye, in the direction of its axis; and the principle is carried into practice by placing a thread of white silk on a narrow rule covered with black velvet, and furnished with a suitable apparatus for marking the exact points at which the thread begins and ceases to be distinctly seen, when held in a certain position with respect to the eye. An instrument for the same purpose, on a different principle, had formerly been suggested by Dr. Young.

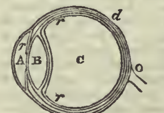
OPTATIVE MOOD. *See* GRAMMAR.

O'PTIC NERVES. The second pair of nerves. They arise from the *thalami nervorum opticorum*, and, perforating the bulb of the eye, form the *retina*.

O'PTICS. (Gr. *οπτομαι*, *I see.*) That branch of physical science which treats of light and vision.

The theory of light, and the different hypotheses respecting its propagation, having been explained under the term LIGHT, and its most remarkable properties being described under their respective heads (CHROMATICS, DIFFRACTION, INTERFERENCE, POLARIZATION, REFLEXION, REFRACTION, &c.), we shall here confine ourselves to the explanation of the phenomena and laws of vision, and the formation of images; and this, in fact, comprehends all that is meant by *Optics*, in the strict sense of the word.

Description of the Eye.—The human eye is of a spherical form, having a slight projection in front. The annexed figure represents a horizontal section of it through its axis. It consists of three principal chambers, filled with different *humours*, or transparent media of different refractive powers. The first of these media, occupying the anterior chamber A, is called the *aqueous* humour, and consists almost entirely of pure water. The cell in which the aqueous humour is contained is bounded on its anterior side by a strong horny transparent substance, called the *cornea*, the figure of which is an ellipsis of revolution about its major axis. The posterior side of the cell is formed by the *iris*, a kind of circular opaque screen, consisting of muscular fibres, by the contraction or expansion of which an aperture in its centre, called the *pupil*, is increased or diminished according to the illumination, in order to protect the eye and preserve its sensibility by equalizing the quantity of light admitted into it. The second humour, called the *crystalline lens*, B, enclosed in its capsule, lies immediately behind the pupil. Its figure is a solid of revolution, having its anterior surface much less curved than the posterior; and both surfaces are ellipsoids of revolution about their lesser axes. The crystalline is somewhat denser towards the centre than at the outside; the increase of density serving to correct the aberration, by shortening the focus of the rays near the centre. The third or *vitreous* humour, C, fills the posterior chamber of the eye. This fluid scarcely differs from the aqueous humour, either in specific gravity, or chemical composition, or refractive power.



The following are the refractive powers of the different humours of the eye, according to Sir David Brewster, the ray of light being incident on them from air: —

Aqueous Humour.	Crystalline Lens. Surface.	Centre.	Mean.	Vitreous Humour.
1·336	1·3767	1·3990	1·3879	1·3394

But as the rays refracted by the aqueous humour pass into the crystalline, and from the crystalline into the vitreous humour, the indices of refraction of the separating surfaces of these humours will be —

From aqueous humour to outer coat of crystalline 1·0466
From ditto to crystalline, using the mean index - 1·0353

From vitreous to crystalline outer coat - - 1·0445
From ditto to ditto, using the mean index - - 1·0332
(" Optics," *Cab. Cyclopædia.*)

The posterior surface of the cell of the vitreous humour is covered by the *retina*, *d*, a network of inconceivably delicate nerves, all branching from the *optic nerve*, O, which enters the eye obliquely at the inner side of the orbit, next the nose. The retina lines the whole of the cavity C from *r* to *r*, at which points the capsule of the crystalline commences. Its nerves are immersed in the *pigmentum nigrum*, a very black velvety matter which covers the choroid membrane, and the use of which is to absorb and stifle all the light which enters the eye as soon as it has done its office of exciting the retina ; thus preventing internal reflections, and consequent confusion of vision. The whole of these humours and membranes are contained in a thick tough coat, called the *sclerotica*, which unites with the cornea, and forms what is commonly called the *white of the eye*. The spot at which the optic nerve, O, enters the eye is totally insensible to the stimulus of light, and is therefore called the *punctum cæcum*. (Herschel on Light, *Ency. Metr.*)

From this description of the eye it is evident that light in passing through it must undergo a series of refractions, in the same manner as in passing through a system of lenses. When a pencil of luminous rays, proceeding from an exterior point, passes through the transparent cornea, and penetrates the aqueous humour, the divergence of the rays is diminished by this first refraction. The rays which pass through the pupil undergo a second refraction at the anterior surface of the crystalline, which renders them further convergent ; and, on leaving the crystalline and passing into the vitreous humour, they acquire their final degree of convergence, and proceed to form an image at a focus on the retina, or very near that membrane. Experience and calculation prove that when vision takes place with the least effort, the luminous point (or any very small object on which the eye is fixed) is at such a distance from the eye that the rays enter the eye with precisely that degree of divergence which is required, in order that after suffering the several refractions they may be brought to meet in a point on the retina itself. Hence it has been concluded that the sensation of sight is caused by the impression made by light on the retina, when it is concentrated on it in a single point or within a very small space.

The image of an object on the retina is evidently inverted with respect to the position of the object itself; for the ray proceeding from the upper extremity of an obobject, *a*, falls on the lower extremity *a'* of the image on the retina. Writers on optics have often puzzled themselves with attempts to explain the cause of erect vision from an inverted image ; the subject, however, is not worth the discussion which has been expended on it. " Erect," says Sir J. Herschel, " means nothing more than having the head farther from the ground, and the feet nearer than any other part. Now the earth, and the objects which stand on it, preserve the same relative situation in the picture on the retina that they do in nature. In that picture, it is true, men stand with their heads downwards, but then, at the same time, heavy bodies fall upwards ; and the mind, or its deputy the nerve, which is present in every part of the picture, judges only of the relations of its parts to one another. How these parts are related to external objects is known only by experience, and judged of at the instant only by habit."

Another circumstance, the cause of which has also been much discussed, is, that although an image of each object at which we look is formed on the retina of both eyes, the object appears single. Single vision with two eyes is attributed by Dr. Smith to the habit of referring the two impressions made on corresponding points of the two retinas to the same object ; and, in fact, if we press slightly on the cornea of one eye, so as to derange its optical axis, the two images, being no longer on parts of the retina which habitually correspond, will appear double. Those who have had one eye distorted by a blow see double, till habit has taught them anew to see single, though the distortion remains. (For a review of the various theories that have been proposed to account for this phenomenon, the reader may be referred to a paper on the Physiology of Vision, by Professor Wheatstone, in the *Phil. Trans.* for 1838.)

Straight lines drawn from the extremities of an object *a b* meet in a point *c*, nearly in the centre of the pupil, in the plane of the iris, which point is called the optical centre of the eye, and form the angle *a c b*, which is called the visual angle. On leaving the crystalline and entering the vitreous humour, the rays are slightly refracted, and form another angle, *a' c b'*, the base of which is the magnitude of the image on the retina. These two angles are not perfectly equal ; so that *a' b'*, the magnitude of the image on the retina, or the apparent magnitude, is not exactly proportional to the real magnitude, *a b*, for a given distance. But the difference is so small that it may in general be neglected, and then the visual angle becomes the measure of the apparent magnitude ; or the apparent magnitude of an object is proportional to its linear magnitude divided by its distance from the eye.

As the judgment which we form of the real magnitude of a distant object depends not only on the apparent magnitude, but also on our estimation of its distance, an erroneous estimate of the distance will necessarily produce an illusion with respect to the magnitude. Such illusions are frequent in the night time, when the darkness prevents us from distinguishing the real places of objects and their relative positions. An unusual increase or deficiency of the transparency of the atmosphere produces the same effect ; and at sea, where little assistance can be derived from the appearance of intervening objects, it requires a particular training of the eye to judge correctly of distances.

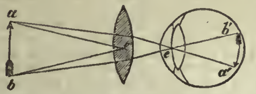
The effect of light on the eye has a sensible duration after the eye is shut, or the luminous object removed. During the twinkling of the eye, we never lose sight of the object on which we are looking ; and if a burning stick be attached to the extremity of a string, and whirled rapidly round, a complete circle of light appears. This *persistence* of light on the retina gives rise to a great number of illusions ; such as the apparent augmentation of volume of a musical chord when in rapid vibration, the train of light which appears to accompany falling meteors, &c. It was estimated by D'Arcy that the light of a live coal, whirled round at the distance of 165 feet, maintained its impression during the seventh part of a second. Experiments, however, of a more accurate kind, have shown that this time is not constant, but is influenced by several circumstances. Light must act on the eye for some continuance of time in order to produce a complete impression ; and it is found that the time during which the impression that has been produced can preserve an equal intensity after the action of light has ceased is greater in proportion as the impression is less intense. On the contrary, the whole duration of the impression is greater as the light is more intense. If the impression has been made by a strongly illuminated object, as the setting sun, it often passes through a series of different colours ; in other circumstances, it disappears, and is renewed after some seconds ; disappears again, and so on several times in succession.

The eye possesses considerable power of adjusting its parts so as to give distinct vision for all distances within certain limits. The first of these limits is the least distance from the eye at which small objects, as the print of a book, can be seen without effort ; and the second, the distance at which the image of the object becomes confused. The space between these limits is the field of vision ; but both its extent and distance from the eye vary considerably with respect to different individuals, and sometimes even with respect to the two eyes of the same individual. From the known dimensions of the eye, and the refractive powers of its different substances, it is found by calculation that the focal distances of two luminous points, situated at the two limits of the field of vision, differ by about one sixth part of the diameter of the eye.

All the refractions which take place in the interior of the eye are in the same direction ; consequently the eye, regarded as an optical instrument, is not achromatic. The absence of colour about the images formed on the retina, excepting in very particular cases, is to be ascribed in part to the small breadth of the pencil of luminous rays which passes through the pupil, but principally to the small focal distance of the eye ; in consequence of which the unequally refrangible rays can never be much separated from each other. It has also been surmised (*Coddington's Optics*) that a compensation takes place between the refractions at the cornea and the crystalline, a ray which is less refracted by the former being more refracted by the latter, in consequence of its passing through it at a greater distance from the axis.

Distinct vision depending on the convergence of the luminous rays which proceed from an object to a focus on the retina, it follows that if, from any defect in the original structure of the eye, or any deterioration of its form or powers, the rays which enter the pupil are not rendered sufficiently convergent to meet at the retina, or are rendered too much so, and thereby brought to a focus before they reach the retina, an imperfect and indistinct image will be produced. It happens with most persons, between the ages of thirty and fifty, that the crystalline lens begins to undergo a change, by which not only its form, but also its density and refractive power, are altered in such a manner as to leave it capable of affording distinct vision only of very remote objects. This defect is remedied by a convex lens, which makes up for the flatness of the crystalline, and renders parallel rays slightly convergent before entering the eye. Let *a b* be an object, *c* the lens, and *e* the centre of the eye, and suppose the object to be placed at the focal distance of the lens. Since the object is at the focus, the rays of a pencil diverging from any point *a* in it will emerge parallel to each other and

to $a\,c$; they will therefore, after refraction in the eye, be brought to converge on the retina at a point a', such that $e\,a'$ is parallel to $a\,c$. Similarly, rays from b, after refraction through the lens and the eye, will converge to the point b', such that $e\,b'$ is parallel to $b\,c$. Thus a distinct image $a'\,b'$ will be formed on the retina, and the apparent angular magnitude of the object seen through the lens will be the angle $a'\,e\,b'$, which is equal to $a\,c\,b$, the angle subtended by the object at the centre of the lens, and therefore greater than the angle subtended by the object at e, the centre of the eye. Hence the image appears enlarged; but, the nearer the lens is to the eye, the less will be the difference between the apparent magnitudes of the image as seen with and without the lens. When such lenses are employed in the form of spectacles, the enlargement of the image (which in this case is not intended) is hardly sensible, because the lens is commonly of low power, and because the person who must use it, to see distinctly, cannot easily make a comparison between the appearance of an object seen with or without the lens. The lenses of spectacles ought to be of the meniscus form (*see* LENS), in order to refract, without much indistinctness, pencils coming to the eye with any degree of obliquity. Such spectacles are called *periscopic*, and their advantage was first pointed out by Dr. Wollaston.



Sometimes the eye is so formed that its power of giving convergence is too great, and the rays are brought to a focus before they reach the retina. Persons having this defect are called *shortsighted*, from their inability to see distant objects distinctly. It arises from an increase of density in the central part of the crystalline; and its inconvenience is obviated by a concave lens, which increases the divergence of the rays before they enter the eye. For the same reason as mentioned above, the lens should be of the convexo-concave form, that is, convex on the outer side and concave on the inner side, the curvature of the latter being greater than that of the former. This lens diminishes the apparent magnitude of objects, but the effect is scarcely sensible. (*Smith's Optics;* Herschel's Treatise on Light, *Ency. Metropolitana;* Brewster's Optics, *Cabinet Cyclo.; Coddington's Optics;* Lamé, *Course de Physique.*) For optical instruments, see LENS, MICROSCOPE, TELESCOPE, &c.

OPTIMA'TES. (Lat.) A word sometimes used to denote the Roman nobility, in contradistinction to the plebeians, or populares.

O'PTIMISM. In Moral Philosophy and Theology, the system which regards physical and moral evil as elements of the universal order of things: so that every thing is good, viewed in relation to the whole; or, in the ordinary phrase, in which the doctrine is expressed, "all is for the best." This system was justified, with philosophical inductions, by Leibnitz, in his *Theodicæa* (which see), and is popularly illustrated by Pope, in his *Essay on Man;* but it is best known (as far as the name is concerned) by the irony of Voltaire, in his celebrated romance of *Candide.* The optimism of Leibnitz was based on the following trilemma: — If this world be not the best possible, God must either, 1. not have known how to make a better, 2. not have been able, 3. not have chosen. The first position contradicts his omniscience, the second his omnipotence, the third his benevolence. (See *Creuzer; Leibnitzii Doctrina de Mundo Optimo*, Lips. 1795.)

O'PTIMUS MAXIMUS. Epithets assigned to Jupiter by the ancient Romans to indicate his superlative greatness and goodness.

O'PTION. (Lat. opto, *I wish* or *choose.*) In Ecclesiastical Law, a prerogative of the archbishops of the church of England. Every bishop is bound, immediately after his confirmation, to make a legal conveyance to the archbishop of the next avoidance of any one benefice or dignity belonging to his see which the archbishop may choose (whence the name). If the archbishop die before the avoidance happens, the right of filling it up passes to his executors or administrators.

OPTION, at the Stock Exchange, signifies a per centage given for "the option" of putting or calling, *i. e.* selling or buying, stock in time bargains at a certain price.

OPU'NTIA. In Botany, the name given to those Cactaceous plants commonly called *Indian figs.* Their stems consist of flat joints, broader at the upper than at the lower end, becoming, however, eventually both continuous and cylindrical. Their native country is South America; but in some places the lava of Mount Etna is covered with them, and the large purple juicy fruits which they yield find considerable sale in the Sicilian markets. The cochineal insect (*Opuntia cochenillifera*) is fed on one of the varieties of *Opuntia.*

OR. (Fr. *gold.*) In Heraldry, one of the metals employed in blazonry. It is equivalent to topaz among precious stones, and Sol among planets. In engraving, it is represented by a surface sprinkled with equidistant dots.

ORA. An old Saxon coin, valued at sixteen pence, and sometimes, according to variation of the standard, at twenty pence. The word is of frequent occurrence in *Domesday Book*, and in the old records of the kingdom.

O'RACLE. (Lat. oraculum; from os, *a mouth.*) The name primarily given to the response delivered by the ancient heathen divinities to those who consulted them respecting the future, but afterwards applied both to the place where responses were given as well as to the divinities from whom the responses were supposed to proceed. To the desire so natural to man to obtain a glimpse into futurity, coupled with the ennobling belief that his destiny was predetermined in a higher sphere, is doubtless to be traced the origin of the art of divination, which has in all, but more especially in the earlier stages of society, exercised so powerful an influence over the human mind. But, of all the modes of divination, that by consulting the oracle was the most popular. In other cases, as the interpretation of events depended on man alone, there might be mistake or deception; but in the oracle, when the deity was believed to pronounce either in his own voice or in that of a consecrated agent, it was supposed there could be none. Hence oracles obtained such credit and celebrity in antiquity, but more especially among the Greeks, that they were resorted to on every occasion of doubt and emergency, both by princes and states, as well as by private individuals.

The general characteristics of oracles were ambiguity, obscurity, and convertibility; so that one answer would agree with several various and sometimes directly opposite events. Thus, when Crœsus was on the point of invading the Medes, he consulted the oracle of Delphi as to the success of the enterprise, and received for answer*, that by passing the river Halys he would ruin a great empire. But whether it was his own empire or that of his enemies that was destined to be ruined was not intimated; and, in either case, the oracle could not fail to be right. The answer of the oracle to Pyrrhus is another well-known instance of this sort of ambiguity, —

Aio, te, Æacida, Romanos vincere posse, —

as it might either be interpreted in favour of or against Pyrrhus. This ambiguity and equivocation was not, however, the worst feature that characterized the oracles of antiquity. They were at once ambiguous and venal. A rich or a powerful individual seldom found much difficulty in obtaining a response favourable to his projects, how unjust or objectionable soever. Such, for instance, were unquestionably the motives that dictated the favourable responses of the Pythia at Delphi to Philip of Macedon, which drew from Demosthenes the famous declaration, that the goddess *Philippised.* But such and so powerful is the influence of superstition, that this system of fraud and imposture maintained a lengthened ascendency, and the interested responses of the oracles frequently sufficed to excite bloody wars, and to spread desolation through extensive states.

The first oracles had their origin in the East, at a period to which the monuments of profane history do not ascend. The most ancient oracle is supposed to be that of Meroë; to which were afterwards added those of Thebes and Ammon, in all of which places the worship of Jupiter Ammon prevailed. From the Egyptians the use of oracles, along with a knowledge of many arts and sciences, passed to the Greeks, who soon surpassed every other nation both in the number and celebrity of their oracles. It has been affirmed that no fewer than three hundred oracles were established in different parts of Greece; but of those the oracles of Jupiter at Dodona, of Apollo at Delphi, and of Trophonius near Lebadeia (see these articles), may be mentioned as having enjoyed the highest reputation.† The oracles of antiquity had many leading features in common; but there were also several peculiarities about them, of which the variety of modes in which the oracular responses were delivered is one of the most striking. At Delphi responses were delivered by the Pythia, at Ammon by the priests, and at Dodona they issued from the hollow of an oak. Sometimes the response was communicated by letter; sometimes the desired information could only be obtained by casting lots; and sometimes the divinities chose to announce their will by dreams, visions, and preternatural voices.

Among the Jews there were several sorts of oracles: of these the Urim and Thummim (which see) bore a striking analogy to the heathen oracles; and the oracle of Bath-Kol, or *Daughter of the Voice* (mentioned in the *Talmud*, and other Jewish works), which originated after the time of Malachi, may be regarded as completely identical with them. The Old Testament teems with

* The Greek verse is,

Κροισος Αλυν διαβας μεγαλην αρχην καταλυσει.

Thus rendered in Latin,

Crœsus Halyn superans magnarum evertet opum vim

† It does not appear that the Romans ever had regularly established oracles among themselves; but on various important emergencies they had recourse to those of Greece, and especially to that of Delphi. (*Liv.* v. 15. &c.)

instances of the other species of oracles, in which supernatural revelations were made by means of dreams and visions; but every rational mind, even apart from scriptural authority, can at once perceive the wide distinction between the divine revelations vouchsafed in this manner to the Jews in ancient times, and the jugglery practised on the Gentile nations by the avarice and cunning of the priests. There are two points respecting oracles which have given rise to much controversy: viz. whether oracular responses ought to be ascribed to mere human ingenuity or to diabolical agency; and at what time responses ceased altogether to be given. With regard to the first point, most of the Christian fathers were of opinion that they ought to be attributed to diabolical machinations; but those who wish to see these arguments satisfactorily disposed of may consult, among others, the treatises of Ant. Van Dale, *De Oraculis Ethnicorum*, 1683, and of Fontenelle, *Histoire des Oracles*, 1689. With regard to the other question, at what time the oracles ceased to give responses, it has been frequently asserted that they became silent ever after the birth of Christ. Eusebius was the first who maintained this opinion; and many writers of great celebrity, anxious to do homage to the great Author of Christianity, have supported his views. In the *Hymn of the Nativity*, the most beautiful of his minor poems, Milton, in allusion to this theory, says—

> The oracles are dumb,
> No voice or hideous hum
> Rings through the arched roof in words deceiving.
> Apollo from his shrine
> Can no more divine,
> With hollow shriek the steep of Delphos leaving.
> No nightly trance or breathed spell
> Inspires the pale-eyed priest from the prophetic cell.

It appears, however, from the edicts of the emperors Theodosius, Gratian, and Valentinian, that oracles existed, and were occasionally at least consulted, down to A. D. 328. For several centuries previously they had been gradually sinking in public esteem, but at that period they entirely ceased; and there can be little doubt that this desirable consummation was mainly effected by the enlightening power of Christianity, and by the influence which even at so early a period it had acquired over a large portion of the then civilised world. (In addition to the works already quoted, see *M'Culloch's Geo. Dict.*, art. "Delphi;" Clavier, *Mem. sur les Oracles des Anciens*, 1819, &c.)

O'RAL, *Oralis*. (Lat. os, *a mouth*.) This term is applied to the various parts which form or relate to the mouth of animals.

ORA'NG, in the Malay language, signifies man; orang-utan is the man of the woods. It is by this term that we commonly designate the Indian or red orang. (*Simia satyrus*, Linn.) This species inhabits the great islands of Borneo and Sumatra, and attains the height of from four to five feet, measured in a straight line from the vertex to the heel. It has neither tail, cheek-pouches, nor ischial callosites; but has an appendix to the cœcum coli, as in man. It wants the ligament of the hip joint, and acquires an enormous laryngeal pouch when full-grown. *See* CHIMPANZEE.

O'RANGE. The well-known fruit of the orange tree, the *Citrus aurantium* of botanists. India and China are the native countries of the orange; and the Portuguese are entitled to the honour of having transferred the plant to other countries. The principal varieties of the orange tree are the orange, the lime, the lemon, and the citron, fruits which have now become so common as to give a tropical character to the dessert. The orange is not considered to have been grown in Europe till the 14th century; and in England they have been cultivated in conservatories since 1492. They are propagated either by seeds, by cuttings, by layers, by grafting, or by inoculation; but the plants grown from seeds require so long to come to perfection that they are seldom so propagated in England. Oranges are imported into this country in chests and boxes packed separately in paper. The best are brought from the Azores and Spain; but very good ones also come from Portugal, Italy, Malta, and other places. The orange trade carried on by this country is of considerable value and importance. Not only is the fruit held in high estimation, but, from the extreme productiveness of the tree, it is sold at a price little more and sometimes even less expensive than our ordinary domestic fruits. The entries for home consumption at an average of the three years ending 1838 amounted to about 260,000 boxes; each box containing about 700 lemons and oranges: the duty amounted to about 60,000*l*. a-year. The peel of the orange when preserved is a well-known article of confectionary; its flowers yield an essential oil scarcely less esteemed as a perfume than the celebrated ottar of roses; while, as if nature had intended every part of it for the use of man, the wood of the tree is susceptible of the highest polish, and is extensively employed in the arts.

O'RANGEMEN. The name given to the society instituted in Ireland in 1795 to uphold the Protestant religion and ascendency, and for the discouragement of Catholicism. It had office-bearers, a secret organization, distinctive or orange colours, and occasional processions. It was at length suppressed by act of parliament in 1836.

ORANGERY. A kind of gallery, in a garden or parterre, to preserve orange trees in during the winter season. For trees in large boxes a proportionably large and lofty house is requisite; it may be opaque on the north side, with a glass roof, front, and ends, of any convenient or desired length, width, and height. For one of moderate size, the height at the back wall may be fifteen feet, at front ten feet, and the width of the house fifteen feet. The floor may be either perfectly level, and the boxes placed on it, the largest behind, so as their tops may form a slope to the front glass, as in the conservatory of Prince Borghese at Rome; or if the trees are young, a stage may be erected for a few years, in order to raise the plants to the light: but if the trees are of a considerable size, the best way is to have square pits in the floor at regular distances, somewhat larger than each box, and in these to sink the boxes, covering them with mould, sand, or moss, nearly to the level of the pavement, so that each tree so placed and dressed will appear as if planted in a small compartment of earth. Such is the plan of the large conservatory in the royal gardens at Monza. The walk, unless where a stage is adopted, should be in the middle of the house, with corresponding doors in each end; but where the trees are young, and placed on a stage like greenhouse plants, the walk should be in front, as in no other situation could the eye of the spectator meet the foliage of the plants. Where the walk is in the middle, and a double row of trees on each side, as at Monza, the effect in winter is truly magnificent and gratifying.

Where the trees are to be planted as standards in the borders or floor of the house, it is essentially requisite to the health and beauty of the plants that the building be glazed on all sides. Showers might be supplied in Loddiges's manner; heat by steam, hot water, or flues; and in winter the beds might be covered with turf, strewed with daisies, violets, and primroses: these would come early into flower; and if the turf were kept very short about the roots of the flowering plants, and the trees in excellent condition, only those who have seen the first-rate regularly planted standard orange groves of Nervi could form an idea of the effect, which, by contrast with the external winter, would be felt as luxurious, and as anticipating real spring. An orangery is distinguished from a conservatory by its having an opaque roof, while that of the latter is glazed. The orangery at Versailles is the most magnificent that ever was built.

ORATO'RIO. (Ital., from Lat. oratorium, *a small chapel;* which again is derived from orare, *to pray*.) A sacred musical composition, consisting of airs, recitatives, duets, trios, choruses, &c., the subject of which is generally taken from scripture. The text is usually in a dramatic form, as in Handel's *Samson;* but it sometimes takes the form of a narrative, as in *Israel in Egypt;* occasionally it is of a mixed character, as in Haydn's *Creation;* and sometimes it consists merely of detached passages from scripture, as in the *Messiah*. The origin of oratorios has been variously ascribed; but the most prevalent opinion regards them as originally founded upon the spiritual songs and dialogues which were sung or recited by the priests of the oratory. (*See* ORATORY.) The more recent introduction of this species of musical drama is on all sides attributed to St. Philippo Neri, about the middle of the 16th century; but oratorios, properly so called, were not produced till about a century afterwards. At first the persons introduced were sometimes ideal, sometimes parabolical, and sometimes, as in the later oratorios, taken from sacred history; but this species of drama soon assumed a more regular form, and oratorios became great favourites in Italy, where they were constantly performed during the Carnival; and they have since given birth to some of the noblest and most elaborate compositions of the great masters both of that and other countries. Oratorios were first introduced into England by the great Handel in 1720, though they were not publicly performed till 1732; and such was their success that in 1737 they began to be performed twice a week during the season of Lent: a custom which, under the able management of T. C. Smith, Linley, and Arnold, &c., successively, was regularly continued down to a very recent period, when, in consequence of the introduction of profane music and other irregularities during the management of Mr. Ashley, they began to degenerate, and were at length discontinued.

Within the last two or three years similar performances, though not entitled *oratorios*, have been again revived at Exeter Hall by the *Sacred Harmonic Society*, on a scale of magnificence previously unknown.

O'RATORY, signifies, commonly, a room in a private house set apart for prayer. It differs from a chapel, inasmuch as it does not contain an altar, nor may mass be celebrated in it.

O'RATORY. *See* ELOQUENCE, RHETORIC.

O'RATORY, PRIESTS OF THE. Various congregations of ecclesiastical persons living in community, without being bound by any special vow, have assumed this title. The first congregation of the Oratory was founded by St. Philippo Neri, at Rome, in the beginning of the 16th century. Similar societies were soon formed in Italy and the Low Countries, but without any mutual connection. The congregation of the Oratory at Paris was founded by the cardinal Pierre de Bérulle in 1611, and had several houses in different parts of the country. It produced many men of celebrity; among others, Malebranche and Massillon. There can be no doubt that its chief object was to counterbalance the increasing influence of the Jesuits. (See *Mosheim's Eccl. Hist.* vol. iv.)

ORB (Lat. orbis), in the language of the old astronomers, usually signifies a hollow sphere; and they supposed the heavens to consist of such orbs or spheres, enclosing one another, and carrying with them in their revolutions the different planets. The *orbis maximus*, or great orb, was that in which the sun is placed. As the orbs were concentric, and their number equal to that of the known planets, with one for the moon and another for the fixed stars, it was neccessary to suppose them to be transparent or crystalline. Orb also denotes any round or circular body, and sometimes it is used synonymously with *orbit*.

ORBI'CULATES, *Orbiculata*. A tribe of Brachyurous Crustaceans, including those which have an oblong ovoid carapace.

ORBI'CULUS. In Botany, the whole mass of that part of a flower called the corona in the genus *Stapelia*; also, a round flat hymenium contained within the peridium of some genera of fungi.

ORBIT. (Lat. orbis, *a circle*.) In Astronomy, the path which any celestial body describes by its proper motion. The orbits of all the planets and satellites are ellipses; and recent discoveries seem to show that the orbits of double stars, which revolve about each other, are curves of the same kind. Some comets have been supposed to move in hyperbolic orbits. For the magnitudes and eccentricities of the planetary orbits, *see* PLANETS. *See* also MOON, SATELLITE, STAR.

ORBIT. In Ornithology, the term is applied to the skin which surrounds the eye: this is generally the base of feathers, for the facility of its movements, but especially so in the parrot tribe and the heron.

ORBIT. In Osteology, the bony cavity in which the eyeball is imbedded. Each orbit is formed by seven bones,— the frontal, maxillary, jugal, lachrymal, ethmoid, palatine, and sphenoid.

O'RCHARD. (Gr. ορχατος.) An enclosure devoted to the culture of fruit trees. The most productive orchards are generally such as are situated on declivities open to the south or south-east, and sheltered from the north, north-east, and west. The most suitable soil is a calcareous loam with a dry subsoil. The climate of orchards so situated is always warmer than any other kind of situation which this country affords, and the subsoil is more certain of being dry. The surface of the soil, in the case of orchards so situated, is generally kept under pasture; which, while it prevents the earth from being wasted away by rains, is favourable to the running of the roots immediately under the surface, by which they are sooner called into action by heat in spring, and sooner thrown into a torpid state by cold in autumn. The principal fruits grown in orchards of this description in Great Britain are the apple, the pear, the plum, and the cherry; and, wherever wheat can be ripened in the plains, these fruit will arrive at perfection on declivities such as we have mentioned.

O'RCHESTRA. (Gr. ὀρχήστρα, from ὀρχεῖσθαι, *to dance*.) In Architecture, that part in the interior of a theatre situate immediately between the stage and the place assigned to the audience. In the Greek and Roman theatres it was the part appropriated to the chorus and its evolutions, and was almost level with the stage. In the theatres of the moderns, it is the place appropriated to the musicians. The word is also applied to any erection for the performers in a concert.

ORCHIDA'CEÆ. (Orchis, one of the genera.) A natural order of Herbaceous Endogens, inhabiting all parts of the world excepting those climates situated upon the verge of the frozen zone, or remarkable for their exceeding dryness. They are well known for the singular form of their flowers. Some of them grow in the earth, others inhabit rocks and the branches of trees, and a few appear to be true parasites. They all belong to the class *Gynandria* of Linnæus; are often very agreeably scented; and sometimes produce an aromatic fleshy fruit, as in the case of vanilla, which contains a large quantity of benzoic acid. The nutritious substance called *salep* is prepared from the amylaceous roots of several terrestrial species.

ORCHIL. *See* ARCHIL.

O'RCIN. A crystallizable colouring matter or principle, obtained from a species of lichen (*Variolaria orcina*).

O'RDEAL. (In modern Latin ordalium; from the German urtheil, *judgment*.) The practice of referring litigated questions, and the guilt or innocence of parties under accusation to the judgment of God (testified, in popular belief, either by the event of lots, or by the success or failure of certain experiments), is of very ancient date; and was transferred, with other relics of their Pagan institutions, by the Teutonic nations, when settled in the provinces of ancient Rome, to their new bodies of jurisprudence. The ordeal was awarded in various cases; either arbitrarily by the court, or at the request of a party accused, who was anxious to clear himself; either as an alternative for trial by compurgation or by battle, or as the regular mode of deciding an issue. In the earlier ages of modern European history, the ordeal was under the peculiar protection of the clergy, who afterwards discountenanced it; and its gradual suppression must be mainly attributed to the decrees of popes and councils, of which several were pronounced against it in the course of the thirteenth century, beginning with the decree of the fourth Lateran council in 1215. Among the various forms of ordeal in use among different nations, the following are some of the most remarkable. The trial of the eucharist was used chiefly among the clergy; the accused party took the sacrament in attestation of his innocence, and it was believed that if he were guilty he would be immediately visited with punishment for the sacrilege. Of the same description was the corsnedd, or trial by the consecrated piece of bread or cheese, so much in use among the Anglo-Saxons. The trial of the cross was used, both in civil and criminal questions, in many European countries. See the supplementary formulæ to those of Marculfus, cited by Meyer, *Institutions Judiciaires*, liv. ii. c. 6. It appears that the litigants, or the accuser and accused, were to stand upright before a cross, and that he who fell or changed his position first was cast or condemned. This popular mode of ordeal was abolished by the capitulary of 816, in the reign of Louis le Debonnaire, as irreverent towards the mystery of the cross; but the abolition seems only to have been carried into effect in Italy and the provinces adjoining the seat of empire. The ordeal of hot water, in which the accused party plunged his hand into a vessel of boiling water, was used by the Salian Franks, when pagans, as early as the fifth century. It was afterwards extensively practised. In what was called the expurgatio simplex, the accused plunged his arm to the wrist; in the triple ordeal, to the elbow. Trials by burning iron were of various sorts: carrying a red-hot bar in the hand, and walking barefoot over heated ploughshares, mentioned in the imperial capitulary of 803, and adopted in England, as is well known from the celebrated example of Queen Emma. Among the Saxons, the iron was awarded to freemen, the water to those of inferior conditions. There can be no doubt that, in these severer forms of ordeal, some precaution was occasionally used by the clergy, under whose inspection and management the trial took place, to preserve parties whom it was wished to clear from suspicion from the ordinary consequences of such exposure. There were also ordeals by lot, as by the casual choice between a pair of dice, one marked with a cross and the other blank, mentioned in the laws of the Frisons. The famous trial of the bier, in which the supposed perpetrator was required to touch the body of a murdered person, and was pronounced guilty if the blood flowed, may be regarded as a species of ordeal, although founded more on usage than legal enactment; as this form of superstition did not become prevalent until later times, when ordeals were no longer a recognized part of the law. To the same head may be referred the various absurd and cruel methods which were adopted in different countries to try suspected witches. One of the most remarkable instances of the solemn application of the ordeal in later times took place in 1498, when the truth of the doctrines preached by Savonarola, a celebrated monk at Florence, was put to the test by a challenge between one of his disciples and a Franciscan friar to walk through a burning pile. This, however, may be rather regarded as the appeal of an enthusiast to the divine judgment than as an example of a recognized usage. Ordeals are of common use in the judicial practice of various heathen nations, especially of the Hindoos.

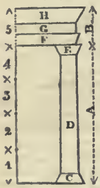
By the Anglo-Saxon laws, an option was given to the culprit in ordinary cases, when presented of a crime by the neighbourhood, or appealed against by the injured party, of defending himself by compurgation, or by the ordeal (of hot water or hot iron). If, being a villain, he could procure the testimony of his lord in favour of his character, the ordeal was simple; if otherwise, threefold. In the laws of William the Conqueror, we find that accusations between an Englishman and a Frenchman were decided, either by the Roman mode of trial by inquest, by battle, or by the ordeal. In general, it may be considered as Sir F. Palgrave remarks, rather as having afforded a last chance of escape to the accused party, than as an ordinary mode of deciding on guilt or innocence; since

it does not appear to have been resorted to in general, unless where the accused failed in clearing himself by the testimony of the neighbourhood to his character, or to the fact. Thus it stood in the same place as torture in the civil law, which, according to principle, was only applied where the evidence was sufficient to warrant a conviction, and the defendant refused to confess. When, however, the old form of trial by compurgation was abolished in England by the assizes of Hen. II., the trial by ordeal became more important than before. It appears that, in presentment by the inquest (whence originated the grand jury), the culprit was immediately adjudged, without option, to clear himself by ordeal; that, if he escaped this test, he was still condemned to abjure the country; so that the presentment became in some sort equivalent to a final trial. The *second* inquest or jury trial, at this period, is thought to have been only awarded as a matter of special favour. But when ordeal had been forbidden by the 18th canon of the fourth Lateran council, in 1215, as before mentioned, it was immediately disused in England; and hence, after a considerable interval, during which the practice of criminal law seems to have remained in a very uncertain state, the practice of trial by the second inquest, or petty jury, from being the exception gradually became the general rule. (See as to the early ordeals, *Mem. de l'Ac. des Inscr.* vol. xv.)

O'RDER. (Lat. ordo.) In the Fine Arts, the regular disposition of the parts of a work, so that neither confusion nor jarring effects may prevail.

Order. In Architecture, a system or assemblage of parts subject to certain uniform established proportions, regulated by the office each part has to perform. An order may be said to be the genus, whereof the species are Tuscan, Doric, Ionic, Corinthian, and Composite; and consists of two essential parts,— a column, A (see fig. 1.), and an entablature, B. These are subdivided: the first into three parts, namely, the base C, the shaft D, and the capital E; the second also into three parts,— namely, the architrave, or chief beam, F, which stands immediately on the column; the frieze G, which lies on the architrave; and the cornice H, which is the crowning or uppermost member of an order. In the subdivisions certain horizontal members are used, which, from the curved forms of their edges, are called mouldings. These are the ovolo, the talon, the cyma, the cavetto, the torus, the astragal, the scotia, and the fillet, which are defined under their several names in this work. The character of an order is displayed, not only in its column, but in its general forms and detail, whereof the column is, as it were, the regulator; the expression being of strength, grace, elegance, lightness, or richness. Though a building be without columns, it is, nevertheless, said to be of an order, if its details be regulated according to the method prescribed for such order.

(1.)

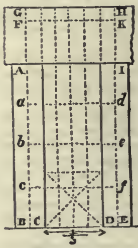


In setting up, or, as it is more technically expressed, in profiling an order, it is usual to make the entablature of the height of one fifth of the entire order. The height of the column is measured in terms of its lower diameter, which is divided into sixty parts, called minutes, used as a scale for the different subdivisions. In the Doric order the semidiameter of the column is called a module: it is, however, divided into thirty parts; so that there is, in fact, no essential difference between the scale of this and the other orders. The columns vary from seven to ten diameters in height in the different orders. The height of the entablature is usually divided into ten parts, whereof three are assigned to the architrave, three to the frieze, and four to the cornice; except in the Doric order, in which the height is divided into eight parts, whereof the architrave has only two, the frieze and cornice each three.

The rule above given for regulating the relative heights of the column and entablature is founded upon the practice of the ancients, who rarely exceeded or fell short of the proportion it establishes. Whether this practice of assigning one fifth of the height of the whole order to its entablature was arbitrary or empirical is worth an inquiry, which, we are inclined to think, has not been bestowed upon it in any architectural work, at least not in any one which has fallen under our notice: though the principles developed in a work by Le Brun, entitled, *Theorie de l'Architecture Grecque et Romaine, deduites de l'Analyse des Monumens Antiques* (fol. Paris, 1807), if carried through correctly, seems to point to the reason of the practice. One of the most obvious principles of proportion in respect of loads and supports, and one apparently founded on Nature herself, is, that a support should not be loaded with a greater mass than itself; or, in other words, that there should be an equality between the weights and supports; that is, in this case, between the entablature and column. In respect of the voids left between the columns or supports below the entablature, there seems to have been a great diversity of practice; for we find them varying from 1·03 to 2·18, unity being the measure of the supports. Le Brun makes the areas of the supports, weights, and voids equal to one another; and in the monumental specimens of the Doric order, such as the Parthenon, &c., he seems borne out in the law he endeavours to establish; but in lighter specimens, such as the temple of Bacchus, at Teos, where the supports are to the voids as 1 to 2·05, and in the temple of Minerva Polias, where the ratio is 1 : 2·18, he can hardly be considered correct. Indeed, there scarcely seems a necessity for such a limitation of the voids as he prescribes, seeing that, without relation separately to the weight and support, stability would be obtained so long as the centre of gravity of the load fell within the external face of the support. If, then, it be admitted that, as in the two examples above mentioned, the voids should be equal to the weights and supports jointly, we have the key to the rule; and, instead of being surprised at the apparently strange law of making the entablature one fourth of the height of the column, we shall find that none but the result assumed can flow from the investigation.

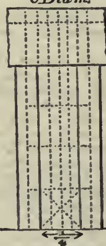
(2.)

6 *Diam.*



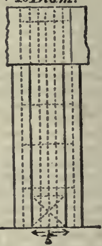
(3.)

8 *Diam.*



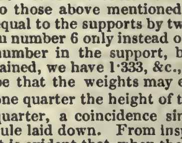
(4.)

10 *Diam.*



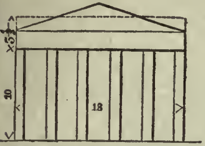
In the fig. 2., let AB be the height of the column, and let the distance between the columns be one third of the height of the column = C D. Now, if A B be subdivided into four equal parts, at *a*, *b*, and *c*, and the horizontal lines *a d*, *b e*, *c f*, be drawn; also, if C D be divided horizontally into four equal parts, and lines be drawn perpendicularly upwards intersecting the former ones; the void will be divided into 16 equal parallelograms, one half whereof are to be the measure of the two semi-supports. B C and D E being made equal then to one fourth of C D, it will be manifest, from inspection, that the two semi-supports will jointly be equal to 8 of the parallelograms above mentioned, or one half of the void. We have now to place the weight or entablature, A G H I, upon the supports or columns and equal to them in mass. Set up from A to F another row of parallelograms, each equal to those above mentioned, A F K I. These will not be equal to the supports by two whole parallelograms, being in number 6 only instead of 8: dividing, therefore, 8, the number in the support, by 6, the number already obtained, we have 1·333, &c., which is the height A G must be that the weights may equal the supports, exceeding one quarter the height of the column by only $\frac{33}{100}$ of such quarter, a coincidence singularly corroborative of the rule laid down. From inspection of figures 2., 3., and 4., it is evident that, when the void is $\frac{1}{3}$d of the height of the columns in width, the columns will be 6 diameters in height; when $\frac{1}{4}$th of their height, they will be 8 diameters high; and when $\frac{1}{5}$th of their height, they will be 10 diameters high; also, that the intercolumniation called systylos, or of two diameters, is constant by the arrangement. Let us now try the principle in another way: — Fig. 5. is the general form of a tetrastyle temple, wherein the columns are assumed at pleasure eight diameters high: then, $4 \times 8 = 32$, the area of the supports; and as, to fulfil the conditions, the three voids are to equal twice that area, or 64, they must in all be equal to 8 diameters, for $\frac{64}{8} = 8$; and the whole extent, therefore, will be 12 diameters of a column. To obtain the height of the entablature, so that its mass may equal that of the supports, as the measures are in diameters, we have only to divide 32, the columns, by 12, the whole extent of the façade, and we have two diameters and two thirds of a diameter for the height of the entablature; making it a little more than one quarter the height of the column, and again agreeing in terms of the diameter with many of the finest examples of antiquity, or very nearly so. If the pediment

(5.)



be employed, it is evident, the dotted lines A C, C B, being bisected in *a* and *b* respectively, that the triangles A E *a*, *b* B F, are equal to *a* D C and D C *b*, and the loading or weight will not be changed. Similar results are obtained in fig. 6., where the height is 10 diameters, the number of columns 6; the whole, therefore, 180, the supports being 60. Here $\frac{60}{18} = 3\frac{1}{3}$ diameters will be the height of the entablature.

(6.)



We cannot leave the subject without adverting to the rules given by Vitruvius (chap. ii. book iii.) — rules which were not his own only, but the result of the practice of the time in which he lived, and which, within small fractions, are most singularly corroborative of the assumed hypothesis of making the voids equal to twice the supports. Speaking of the five species of temples, after naming the different intercolumniations, and recommending the eustylos as the most beautiful, he thus directs the formation of temples with that interval between the columns. The rule for designing them is as follows:— "The extent of the front being given, it is, if tetrastylos, to be divided into eleven parts and a half, not including the projections of the base and plinth at each end; if hexastylos, into eighteen parts; if octastylos, into twenty-four parts and a half. One of either of these parts, according to the case, whether tetrastylos, hexastylos, or octastylos, will be a measure equal to the diameter of one of the columns. The heights of the columns will be eight parts and a half. Thus, the intercolumniations and the heights of the columns will have proper proportions." Further on in the same chapter he gives directions on aræostyle, diastyle, and systyle temples, on which it is unnecessary here further to enlarge. Let the above rules be examined. The tetrastylos is $11\frac{1}{2}$ parts wide, and $8\frac{1}{2}$ high: the area, therefore, of its whole front will be $11\frac{1}{2} \times 8\frac{1}{2} = 97\frac{3}{4}$. The four columns will be $4 \times 8\frac{1}{2} = 34$, or a very little more than one third of the whole area; the remaining two thirds, speaking in round numbers, being given to the intercolumns or voids. The hexastylos is eighteen parts long, and eight and a half high: the whole area, therefore, is $18 \times 8\frac{1}{2} = 153$. The six columns will be $6 \times 8\frac{1}{2} = 51$, or exactly one third of the whole area; the voids or intercolumns occupying the remaining two thirds. The octastylos is $24\frac{1}{2}$ parts in extent, and $8\frac{1}{2}$ in height: $24\frac{1}{2} \times 8\frac{1}{2} = 208\frac{1}{4}$. The eight columns will be $8 \times 8\frac{1}{2} = 68$, or very little less than one third of the area, and the voids or intercolumns about double, being the remaining two thirds.

The average of the intercolumniations in the first case will be $\frac{11\frac{1}{2} - 4}{3} = 2\frac{1}{2}$ diameters.

In the second case $\frac{18 - 6}{5} = 2\frac{2}{5}$.

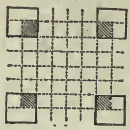
In the third case $\frac{24\frac{1}{2} - 8}{7} = 2\frac{357}{1000}$.

As, in our opinion, a discrepance between practice and theory will not shake the principle, we are not fearful of candidly submitting a synoptical view of some of the most celebrated examples of antiquity in which a comparison is exhibited between the voids and supports; certain it is that in every case the former exceed the latter, and that, in the early Dorics, the ratio between them nearly approached equality. In comparing, however, the supports with the weights, there is every appearance of that portion of the theory being strictly true; for, in taking a mean of the six examples of the Doric order, the supports are to the weights as 1 : 1·16; in the five of the Ionic order, as 1 : 1·05; and in the four of the Corinthian order, as 1 : 1·04; a coincidence so remarkable that it must be attributed to something more than accident, and deserving much more extended consideration than our limits here admit.

	Order.	No. of Columns.	Supports.	Weights.	Voids.
Temple of Jupiter Nemæus -	Doric	6	1·00	0·79	1·03
Parthenon - - - -	—	8	1·00	1·07	1·04
Temple at Bassæ - - -	—	6	1·00	1·14	1·16
of Minerva, at Sunium	—	6	1·00	1·40	1·17
of Theseus, at Athens -	—	6	1 00	1·13	1·21
of Jupiter Panhellennis	—	6	1·00	1·45	1·36
Temple of Erectheus - -	Ionic	6	1·00	0·89	1·24
of Fortuna Virilis - -	—	4	1·00	1·15	1·71
on the Ilyssus - -	—	4	1·00	0·96	1·72
of Bacchus, at Teos -	—	8	1·00	1·35	2·05
of Minerva Polias -	—	4	1·00	1·01	2·18
Portico of Septimius Severus -	Corinth.	6	1·00	0·93	1·37
Maison Carrée - - -	—	6	1·00	0·93	1·58
Temple at Jackly - - -	—	6	1·00	0·90	1·62
Pantheon - - -	—	8	1·00	1·43	1·84

We close this short inquiry by adverting to a curious fact connected with it; viz. the area of the points of support for the edifice which such an arrangement affords. In fig. 7. the hatched squares represent the quarter piers or columns in a series of intercolumniations every way, such intercolumniations being 2 diameters, or 4 semidiameters: these, added to the 2 quarter piers, will make 6, whose square, 36, therefore, is the area to be covered with the weight; the 4 quarter piers or columns = 4; hence the points of support are $\frac{4}{36}$ of the area = 0·111.

(7.)



Now, in twenty-five of the principal buildings in Europe (*see* POINTS OF SUPPORT), the ratio will be seen to be 0·168 on the mean, differing only 0·057 from the result here given; but if we take the subjoined buildings, the mean will be found to differ much less, viz.—

Temple of Peace - - -	0·127
S. Paolo fuori le Mura - - -	0·118
St. Sabino - - - -	0·100
S. Filippo Neri - - - -	0·129

ORDER OF SUPERPOSITION. A Geological term, implying the regular succession of arrangements which the strata forming the exterior crust of our globe invariably follow. (*See* GEOLOGY.) Although certain strata or formations are occasionally wanting, they never depart from a constant order of superposition.

ORDER OF THE DAY. In Parliamentary usage, one method of superseding a question already proposed to the House is by moving "for the order of the day to be read." This motion, to entitle it to precedence, must be for the order generally, and not for any particular order; and, if this is carried, the orders must be read and proceeded on in the course in which they stand. But it can be in its turn superseded by a motion "to adjourn." See *Hatsell's Prec. Parl.* vol. ii., who says that the first instance he has met with of this proceeding was on the 1st of April, 1747.

ORDERS, HOLY. A term, properly speaking, applied to the different ranks of ecclesiastical persons; but, in ordinary language, used to indicate the *character* of such persons. The Roman Catholic church admits of seven orders: four minor, secular, or petty, of doorkeeper, exorcist, reader, and acolyth; three major, of deacon, priest, and bishop. The first are mere formalities, and generally conferred on the same day; the admission to the latter constitutes the sixth sacrament of Romanism: the Reformed churches acknowledge only the three latter orders. (*See* EPISCOPACY.) The Greek church rejects the four minor, but has the additional one of sub-deacon. *See* ORDINATION.

OR'DERS, RELIGIOUS, are of three kinds; 1. Monastic, 2. Military, 3. Mendicant.

1. The Monastic orders were distinguished by the rules to which they were subjected by their respective founders. Of these the principal are the Basilian, the Benedictine, and the Augustinian.

i. The earliest comprehension of a number of conventual societies under one rule was effected by St. Basil, archbishop of Cæsarea, in Asia Minor, who united the hermits and cenobites already established in his diocese, and prescribed an uniform constitution for them, in which he strongly recommended the obligation of a vow upon admission. This recommendation was a novelty in the monastic system, which had existed up to that time (A. D. 370.) without any such imposition. This institution prevailed throughout the eastern districts of Christendom, and has subsisted in the Greek church up to the present time with little variation.

ii. In the West, the first order of monks was founded by Benedict of Nursia (A. D. 529). He conceived that the ends of monastic seclusion might be better attained by a milder discipline, uniformly imposed, than by the fanatical and arbitrary austerities of many of the European communities. While other reformers of the monkish system have aimed at repairing its laxity and degeneracy by the infusion of greater strictness and severity, he alone seems to have adopted a contrary course, and to have provided for the attainment of more real excellence by the imposition of milder obligations. He insisted, moreover, very strongly, upon the duties of manual labour and reading, as well as of prayer; and gave, as was the custom with other founders, minute directions for the employment of the day. This rule was revised three centuries later by another Benedict, a native of Ariane, in the south of France.

From this remodelled system, which was more severe than its predecessor, and was soon adopted throughout the Benedictine monasteries, already exceedingly numerous, arose various branches, all more or less famous in ecclesiastical history. The order of Cluni, the Cistercians, the Chartreux, the Camaldulenses, Præmonstratenses, &c. are distinct off-shoots from this main trunk,

and for many centuries have covered the face of Catholic Europe.

iii. The original inhabitants of the monasteries were laymen; the spiritual duties of the institution being performed by the pastor of a neighbouring village, or by one or two resident ecclesiastics. St. Augustin set the example of a clerical society, by living, in common with his inferior clergy, under certain instructions which he drew up for their direction. His authority was widely followed in later times; and the order of Augustinian canons, consisting expressly of persons ordained or destined to the sacred profession, claims a place among the three principal monastic institutions. These canons were afterwards divided into the regular and secular, according as they observed what tradition affirmed to be the rule prescribed by the founder himself, or those of certain bishops who, in later times, had reorganized the system.

2. i. The Military orders form also an important feature in ecclesiastical and political history. The necessity which the monks were under, in unsettled times, of assuming arms themselves to defend the possessions which they had accumulated, may have suggested the first idea of uniting the military with the religious profession.

The earliest order, however, of this kind — that of St. John of Jerusalem, or the Knights of the Hospital — arose, in the 11th century, out of a religious community, to which the care of an hospital in Jerusalem had been consigned. The Hospitallers were afterwards better known under the titles of Knights of Rhodes, and, still later, of Malta.

ii. The Knights Templars also received their appellation from Jerusalem, the place of their origin and early abode. They were founded in 1118; and to them certain military duties were from the first specially prescribed, as the defence of Palestine, and the protection of pilgrims in the Holy Land. After the expulsion of the Christian arms from that region, they spread over Europe, and became a very numerous and powerful body; until, having excited the fears or avarice of popes and princes, they were condemned by a council assembled at Vienna, and exterminated by a vigorous and cruel persecution.

iii. The third Military order is the Teutonic. This institution, again, was an offspring of the crusades, and a native of Palestine; originating in the officer of an hospital at the siege of Acre. On the termination of the holy wars, these knights became established in Germany, and distinguished themselves by the conquest and conversion of Prussia and Pomerania. Their order only ceased to exist when, at the Reformation, its members abandoned the cause of the papacy, and embraced the prevalent opinions of the north of Germany. To these may be added various inferior military orders, especially those of Spain and Portugal. *See* Calatrava and Alcantara, Orders of.

3. i. The Mendicant orders were the creation of the papacy, for the advancement of its own political purposes. It was in the 12th century that the apprehensions of the holy see were first excited by the rise and spread of heretical opinions; nor, at that period, were either the secular or the regular clergy disposed to rouse themselves from their indolence and vice to combat with these active assailants. The counteracting force, also, which the monks had supplied, in earlier ages, to the independent spirit of the secular priesthood, had lost much of its efficacy, and in some measure been turned against the central authority of Rome. A new ally was required, and was furnished in the order of St. Dominic, which, after completing its first mission in the extinction of the heresy of the Albigenses, was placed upon a permanent footing by a bull of Honorius III.

ii. The Franciscan friars were of cotemporary institution, and avowed the same principle of poverty and mendicity. Our limits allow us merely to mention — iii. The Carmelites (who derived their name from Mount Carmel, in Syria, where the order originated); iv. The Augustinians, who complete the number of the Mendicant orders; and, v. The Jesuits. *See* Jesuits.

O'RDINAL, or ORDER. The name given in England to an old work containing the ritual or religious ceremonies necessary to be performed before the ordination of a priest. It was composed in the reign of Edward VI., and revised by the English clergy in 1552.

O'RDINANCE. An obsolete word signifying a decree or enactment. After the time of Philip le Bel (1227), the laws made by French kings were generally termed ordinances (ordonnance); a term which, in its most comprehensive sense, included also their edicts, declarations, and letters patent. The right to issue ordinances for the execution of the laws (equivalent to proclamations and orders in council) is conferred on the monarch by the French charters; and it was on an ambiguity of language in the clause conferring this right in that of 1814, that a defence was attempted for the illegal proceedings of the ministers of Charles X. in 1830. The best collection of the *Ordonnances des Rois de France* is that begun by order of Louis XIV., of which the first volume appeared in 1723: it extends to 12 vols. folio.

The Self-denying Ordinance, in English History, was a resolution of the Long Parliament, in 1644, by which its members bound themselves not to take certain executive offices, particularly commands in the army; the effect of which, as is well known, was the transference of power, first in the the army, and then in the state, from the Presbyterian to the Independent party.

O'RDINAND. (Lat. ordinandus.) In Ecclesiastical Antiquities, one about to receive orders. — *Ordinant.* a prelate conferring orders.

O'RDINARY. A term of the Civil Law for any judge who has authority to take cognizance of causes in his own right, and not by delegation; used, in English law, with reference to ecclesiastical judges only. Thus, a bishop is ordinary in his own diocese; an archbishop, for the purpose of appeals, in his province.

Ordinary. In the Court of Session in Scotland, a single judge (by courtesy styled lord), who decides with or without a jury, as the case may be. There are five such judges: their decisions may be brought by appeal under review of the divisions of the court to which they respectively belong. *See* Session, Court of.

Ordinary. In the Navy, the establishment of the shipping not in actual service.

Ordinary, in Heraldry, is a portion of the escutcheon comprised between straight or other lines. It is the simplest species of charge; and many of the most ancient escutcheons known contain no other bearing, although in others, also of great antiquity, the ordinary itself is charged with other bearings. An ordinary should, it is said, comprise the fifth of the shield. The number of ordinaries in common use is considerable; among the chief are the pale, fess, bend, bar, saltier, chevron, cross (which see). Each of these is usually bounded by straight lines; but the lines may be also diversified in various manners. Thus, an ordinary bounded by serrated lines is said to be *indented*; bounded by undulating lines, *wavy*; and there are many other deviations from the straight line, as *ingrailed, invected, nebuly, raguly, rayonny, dancetty, embattled* or *crenelly, battled embattled, palissy, angled, levelled, escartely, nowy, dovetail, potency*. When an ordinary has two sides, and is only varied on the upper, it is said to be *superingrailed, superinvected,* &c.; if only on the lower, *subingrailed*, &c.

Ordinary, of Newgate. The clergyman who officiates in this prison is so called, whose duties consist in preaching and reading prayers to the prisoners, preparing condemned criminals to meet their fate, and in accompanying such to the place of execution.

O'RDINATE. (Lat. ordino, *I arrange*.) In Geometry, a straight line drawn from any point in a curve perpendicularly to another straight line, which is called the abscissa. (*See* Absciss.) The absciss and ordinate together are called the *co-ordinates* of the point. The situation of a point in a plane is determined when its distances from two straight lines in the same plane are known; and, when a series of points are so situated in respect of each other that the co-ordinates of each have the same mathematical relation, these points form a curve, the nature of which is expressed by the relation of the co-ordinates. *See* Co-ordinates.

ORDINA'TION. The ceremony of conferring orders in the church, which is derived, by all communities that admit a regular commission and succession in the ministry from the time of the apostles, from the authority of Jesus Christ; of whom it is said, in St. John's Gospel (xx. 21.), that, after his resurrection, he said, "As my father has sent me, even so send I you:" and then he breathed upon them, and said to them, "Receive ye the Holy Ghost: whose soever sins ye remit they are remitted unto them, and whatsoever sins ye retain they are retained." Prayer and the imposition of hands are also mentioned as forming part of the ceremony of ordination of deacons in the Acts; and ordination is even now conferred under similar forms in most Christian churches.

The Romish church holds ordination to be the sixth of its seven sacraments, as being an institution of Christ conferring a special grace. The Protestants show that it differs from a sacrament, according to the received definition of such, as containing no matter, like the water in baptism, or the elements in the eucharist. They deny that the vessels which are delivered to the newly ordained person according to the Romish rite can be taken as the matter of a sacrament, not being recommended by any Scripture authority, nor indeed known in the church till the tenth or eleventh century. (See *Hooker's Eccl. Pol.* books vii. and viii.)

In the Presbyterian church the term *ordination* has a meaning wholly distinct from that in which it is received by other Christian churches; being applied exclusively to that solemn act by which a *licensed* preacher or probationer is inducted into the charge of a particular parish or congregation, and not, as is sometimes erroneously asserted, to the act by which he is entitled to preach the Gospel, or, in other words, to the ceremony by which "orders" are conferred in the English church. In the English church a clergyman can be *ordained* but once: in the Scotch church he is said to be *ordained* as

often as he leaves one parish to be inducted into the charge of another.

O'RDNANCE. A Military term, applied generally to all sorts of great guns used in war, as cannons, mortars, howitzers, carronades, &c. See the respective terms.

O'RDNANCE, BOARD OF. The name given to the board which provides the troops of the line, the regiments of artillery and engineers, the militia, volunteers, and the navy, with guns, ammunition, and arms of every description. The Board of Ordnance also superintends the affairs of the regiments of artillery and engineers, the provision of forage for the whole of the troops at home, and the erection of fortifications and military works at home and abroad, &c. At the head of this board is placed an officer, called the Master-general of the ordnance, who has the military command of the artillery, and of the corps of royal engineers and sappers and miners. Besides the Master-general, the other chief officers connected with the ordnance are the Surveyor-general, the Clerk of the ordnance, and the Storekeeper of the ordnance, which are self-explanatory terms.

O'RDONNANCE. (Fr.) In Architecture, the right assignment, for convenience and propriety, of the measure of the several apartments, that they be neither too large nor too small for the purposes of the building, and that they be conveniently distributed and lighted.

O'READS. (Gr. ὄρος, *mountain*.) In Greek Mythology, nymphs of the mountains, companions of Diana, and usually invoked along with that goddess.

ORES. (Germ. erze.) The mineral bodies from which metals are extracted. Metals exist in the ores in one or the other of the four following states:—1. In a metallic state, and either solitary or combined with each other; in the latter case forming alloys. 2. Combined with sulphur, forming sulphurets. 3. Combined with oxygen, forming oxides. 4. Combined with acids, forming carbonates, phosphates, &c., which generally go by the name of metallic salts.

Certain ores which contain the metals most indispensable to human necessities have been treasured up by the Creator in very bountiful deposits; constituting either great masses in rocks of different kinds, or distributed in lodes, veins, nests, concretions, or beds with stony and earthy admixtures; the whole of which become the objects of mineral exploration. These precious stores occur in different stages of the geological formations; but their main portion, after having existed abundantly in the several orders of the primary strata, suddenly cease to be found towards the middle of the secondary. Iron ores are the only ones which continue among the more modern deposits, even so high as the beds immediately beneath the chalk, when they also disappear, or exist merely as colouring matters of the tertiary earthy beds.

The strata of gneiss and mica-slate constitute in Europe the grand metallic domain. There is hardly any kind of ore which does not occur there in sufficient abundance to become the object of mining operations, and many are found no where else. The transition rocks, and the lower part of the secondary ones, are not so rich, neither do they contain the same variety of ores. But this order of things, which is presented by Great Britain, Germany, France, Sweden, and Norway, is far from forming a general law; since in equinoxial America the gneiss is but little metalliferous; while the superior strata, such as the clay-schists, the sienitic porphyries, the limestones, which complete the transition series, as also several secondary deposits, include the greater portion of the immense mineral wealth of that region of the globe.

All the substances of which the ordinary metals form the basis, are not equally abundant in nature; a great proportion of the numerous mineral species which figure in our classifications are mere varieties scattered up and down in the cavities of the great masses or lodes. The workable ores are few in number, being mostly sulphurets, some oxides, and carbonates. These occasionally form of themselves very large masses, but more frequently they are blended with lumps of quartz, felspar, and carbonate of lime, which form the main body of the deposit; as happens always in proper lodes. The ores in that case are arranged in layers parallel to the strata of the formation, or in veins which traverse the rock in all directions, or in nests or concretions stationed irregularly, or finally disseminated in hardly visible particles. These deposits sometimes contain apparently only one species of ore, sometimes several, which must be mined together, as they seem to be of contemporaneous formation; whilst, in other cases, they are separable, having been probably formed at different epochs. Under the particular metals will be found an account of the localities of ores, &c.; but the following general observations may prove useful in presenting a condensed resumé of the whole subject.

1. *Tin* exists principally in primitive rocks, appearing either in interlaced masses in beds, or as a constituent part of the rock itself, and more rarely in distinct veins. Tin ore is found indeed sometimes in alluvial land, filling up low situations between lofty mountains.

2. *Gold* occurs either in beds or in veins, frequently in primitive rocks; though it is also found in other formations, and particularly in alluvial earth. When this metal exists in the bosom of primitive rocks, it is particularly in schists; it is not found in serpentine, but it is met with in greywacke in Transylvania. The gold of alluvial districts, called gold of washing or transport, occurs, as well as alluvial tin, among the debris of the more ancient rocks.

3. *Silver* is found, particularly in veins and beds, in primitive and transition formations; though some veins of this metal occur in secondary strata. The rocks richest in it are gneiss, mica-slate, clay-slate, greywacke, and old alpine limestone. Localities of silver-ore itself are not numerous, at least in Europe, among secondary formations; but it occurs in combination with the ores of copper or of lead.

4. *Copper* exists in the three mineral epochas:—1. In primitive rocks, principally in the state of pyritous copper, in beds, in masses, or in veins; 2. In transition districts, sometimes in masses, sometimes in veins of copper pyrites; 3. In secondary strata, especially in beds of cupreous schist.

5. *Lead* occurs also in each of the three mineral epochas; abounding particularly in primitive and transition grounds, where it usually constitutes veins, and occasionally beds of sulphuretted lead (galena). The same ore is found in strata or in veins among secondary rocks, associated now and then with ochreous iron-oxide and calamine (carbonate of zinc); and it is sometimes disseminated in grains through more recent strata.

6. *Iron* is met with in four different mineral eras, but in different ores. Among primitive rocks magnetic iron ore and specular iron ore occur chiefly in beds, sometimes of enormous size: the ores of red or brown oxide of iron (hæmatite) are found generally in veins, or occasionally in masses with sparry iron, both in primitive and transition rocks; as also sometimes in secondary strata; but more frequently in the coal-measure strata, as beds of clay-ironstone, of globular iron oxide, and carbonate of iron. In alluvial districts, we find ores of clay-ironstone, granular iron-ore, bog-ore, swamp-ore, and meadow-ore. The iron ores which belong to the primitive period have almost always the metallic aspect; with a richness amounting even to 80 per cent. of iron, while the ores in the posterior formations become in general more and more earthy, down to those in alluvial soils, some of which present the appearance of a common stone, and afford not more than 20 per cent. of metal, though its quality is often excellent.

7. *Mercury*, as a sulphuret, occurs principally among secondary strata in disseminated masses, along with combustible substances; though the metal is met with occasionally in primitive countries.

8. *Cobalt* belongs to the three mineral epochas; its most abundant deposits are veins in primitive rocks; small veins containing this metal are found, however, in secondary strata.

9. *Antimony* occurs in veins or beds among primitive and transition rocks.

10, 11. *Bismuth* and *nickel* do not appear to constitute the predominating substance of any mineral deposits; but they often accompany cobalt.

12. *Zinc* occurs in the three several formations; namely, as sulphuret, or blende, particularly in primitive and transition rocks; as calamine, in secondary strata, usually along with oxide of iron, and sometimes with sulphuret of lead.

In the analysis of ores, it is impossible to lay down any general rule, so numerous are the ores themselves, and so diversified the means necessary to be adopted in the various analytic processes. Under each particular metal will be found an account of its most important ores, and we shall here restrict ourselves to a few general remarks on the theory of smelting ores.

It is probable that the coaly matter employed in that process is not the *immediate* agent of their reduction; but the charcoal seems first of all to be transformed by the atmospherical oxygen into the oxide of carbon, which gaseous product then surrounds and penetrates the interior substance of the oxides, with the effect of decomposing them, and carrying off their oxygen. That this is the true mode of action, is evident from the well-known facts that bars of iron, stratified with pounded charcoal, in the steel-cementation chest, most readily absorb the carbonaceous principle to their innermost centre, while their surfaces get blistered by the expansion of carburetted gases formed within; and that an intermixture of ores and charcoal is not always necessary to reduction, but merely an interstratification of the two, without intimate contact of the particles. In this case, the carbonic acid which is generated at the lower surfaces of contact of the strata, rising up through the first bed of ignited charcoal, becomes converted into carbonic oxide; and this gaseous matter, passing up through the next layer of ore, seizes its oxygen, reduces it to metal, and is itself thereby transformed once more into carbonic acid; and

so on in continual alternation. It may be laid down, however, as a general rule, that the reduction is the more rapid and complete the more intimate the mixture of the charcoal and the metallic oxide has been, because the formation of both the carbonic acid and carbonic oxide becomes thereby more easy and direct. Indeed the cementation of iron bars into steel will not succeed, unless the charcoal be so porous as to contain, interspersed, enough of air to favour the commencement of its conversion into the gaseous oxide; thus acting like a ferment in brewing. Hence, also, finely pulverized charcoal does not answer well, unless a quantity of ground iron cinder or oxide of manganese be blended with it, to afford enough of oxygen to begin the generation of carbonic oxide gas; whereby the successive transformations into acid and oxide are put in train. (For these observations we are indebted chiefly to *Ure's Dict. of Arts, &c.*, arts. "Mine" and "Ores.") See also the art. GEOLOGY in this work.

ORE'XIS. (Gr. ὀρέγομαι, *I labour.*) A term applied in medicine to the appetite, or a sense of hunger.

O'RFRAIES. (Fr. orfrois, *broad welts of gold.*) A species of embroidered cloth of gold, worn anciently by the kings and nobles of England. This name was also given to the clothes worn by the king's guards, which were also embroidered with gold.

O'RGAN. (Gr. ὄργανον, *an instrument.*) In Music, a wind instrument; so called by way of eminence, being indeed perhaps less an instrument than a machine containing a collection of instruments, or, in other words, a mechanical orchestra, under the command of a single performer's fingers on the keyboard. This instrument was invented at an early period, though until the eighth century it was probably but little used. The Greeks appear to have been acquainted with it; and, in the tenth book of his *Architecture*, Vitruvius describes an hydraulic organ which was played, or rather blown, by the fall of water, but in what precise manner is not now known. The emperor Julian eulogises this instrument in an epigram; and St. Jerome speaks of one, with twelve pair of bellows, which might be heard at the distance of a thousand paces; and of another, at Jerusalem, which might be heard at the Mount of Olives. Its invention is attributed to Ctesibius, a barber of Alexandria.

The size of an organ is usually expressed by the length of its largest pipes; thus an organ of 32 feet, of 16 feet, &c., is one whose lowest bass pipes are of those respective lengths. Church organs consist of two parts; viz. the great organ, which comprises the main body; and the chair, or choir organ, a smaller one, commonly placed before the other. The organ is provided with at least one set of keys; and when it has a chair organ and a swell organ, with two, three, or even more. Besides these there are pedals for the lowest pipes, and composition pedals, which change the stops as required at one pressure; both of these are acted upon by the feet. There is another pedal to open the swell organ with the right foot. The key boards of organs vary in extent: the York has 6 octaves from C C C (16 feet) to C in alt; the Birmingham 5½ octaves; but the compass now in general use, here and on the Continent, is from C C (8 feet) to F in alt, 4½ octaves; the lower notes from C C to C C C (16 feet) being placed on the pedal organ. The G G compass is gradually falling into disuse, a compass which never prevailed on the Continent. Each key, being pressed down with the finger, opens a valve or plug, corresponding lengthwise with as many holes as there are rows of pipes on the sound board; and the holes of each row are opened and shut by a register or ruler pierced with holes equal in number to the keys. By drawing the register the holes of one row are opened, because they correspond with those of the sound board; so that, by opening a valve, the wind brought to the sound board by means of bellows finds its passage into the pipes which correspond to the open holes of the sound board. By pushing the register or stop, the holes therein not answering to any of those of the sound board, the row of pipes answering to the register so pushed is shut. It is obvious, therefore, by drawing several of these registers or stops, correspondent rows of pipes are opened: hence the rows of pipes become simple or compound; the former when only one row answers to one register, the latter when several do so. Organists call a row compound when several pipes play upon pressing one stop.

Organ pipes are of two sorts, mouth pipes and reed pipes, of each of which there are several species. The first, called pipes of mutation, consist, first, of a foot, which is a hollow cone, and receives the wind that sounds the pipe; second, the body of the pipe, which is fastened to the foot. Between the foot and the body of the pipe is a diaphragm or partition, having a little long narrow aperture to let out the wind; over this aperture is the mouth, whose upper lip, being horizontal, cuts the wind as it escapes through the aperture. The pipes are made either of pewter, of lead mixed with a certain portion of tin, or of wood. The tin pipes are always open at their extremities, are of very small diameter, and clear and shrill in their sound. Those of lead and tin mixed are larger, the shortest open, and the longest quite stopped; the medium ones are partly stopped, and have besides a little ear on each side of the mouth, drawn close or set farther apart, for the purpose of raising or lowering the sound. The wooden pipes are made square on the plane, and their extremities are stopped with a valve or tompion covered with leather, so as to be air-tight. The sound of these is very soft. The large pipes stopped are usually of wood, the small ones of lead. Of course the longest yield the gravest, the shortest the most acute sounds. Their lengths and widths are in the reciprocal ratio of their sounds; and the divisions regulated by their rule, which is called the diapason. The pipes, however, which are shut have the same length as those that are open, which give the same sound.

The reed pipes consist of a foot to carry the wind into the shallot or reed, a hollow half cylinder, whose extremity is fitted into a kind of mould by a wooden tompion. Its other extremity is at liberty; so that the wind, entering the shallot, causes it to vibrate or shake against the reed; and the longer that part of the tongue which is at liberty is made, the deeper the sound. The mould serving to fix the shallot or reed, the tongue, tompion, &c. serves also to stop the foot of the pipe, and to compel the wind to escape wholly at the reed. In the mould, the part called the tube is soldered, the inward opening whereof is a continuation of the reed. The form of the tube varies in different ranks of pipes. The acuteness and gravity of a reed pipe depends on the length of the tongue, and of that of the pipe, taken from the extremity of the shallot to the extremity of the tube. The quality of the sound depends on the width of the reed, the tongue, and the tube; and also on the thickness of the tongue, the figure of the tube, and the quantity of wind. To vary the character of the sound of the pipes a valve or portvent is added, which introduces the wind by fits and shakes.

At Ulm, there is an organ in the cathedral 93 feet high and 28 broad; its largest pipe is 13 inches in diameter, and it is supplied with sixteen pair of bellows. This organ, however, is surpassed by the famous one at Haarlem, which is 103 feet high and 50 feet broad, and was made in 1738 by Christian Muller. The great organ, or manual, contains sixteen stops or voices; the upper manual fifteen stops; the chair organ fourteen stops; and to the pedals, of which the deepest pipe is 38 feet long, and 15 inches in diameter, there are fifteen stops; being, in all, sixty voices or stops, two tremblans, two accouplemens, and nearly five thousand pipes. The bellows are each 9 feet long and 5 feet broad. The organ at Rotterdam is also on a very large scale, and not greatly inferior to that just described; its reed stops, indeed, are allowed to be superior.

At the period of the restoration of Charles II. the organs of this country had fallen much into decay, and the art of building them was then renewed here by the celebrated Bernard Schmidt, who, to distinguish him from his nephews, Gerard and Bernard, by whom he was accompanied, obtained the name of Father Smith; and by Harris, from France. The celebrated organ at the Temple church was built by the first-named person.

The science of organ-building has of late years again revived in this country, and indeed in other parts of Europe. The three largest organs in England are in York Minster, the Town Hall, Birmingham, and Christ Church, London. The first-named, by Messrs. Elliot and Hill, has a compass from C C C to C in alt, that is, 6 octaves. The great organ has 24 stops, 4 open diapasons 16 feet, four 16 feet reeds. The choir has 10 stops, from C C C to C in alt. The compass of the swell is from C C to C in alt, and it contains 12 stops. The pedal organ has 10 stops compass; 2 octaves 32 feet to 8 feet, 32 feet open diapason metal, do. wood, and do. trumpet; three 16 feet reed stops, four 16 feet diapason to 4 feet. There are in all 56 stops, 6 couples, and 7 composition pedals to shift the stops. There are 4089 pipes in 50 ranks.

The organ at the Town Hall in Birmingham, which was built by Mr. Hill, has a compass from C C C to F in alt. There are 4 rows of keys, and 2 octaves of keys, to play the double pedal-pipes with the fingers, on the bass side of the movements. The great organ contains the following stops: 3 open diapasons to 16 feet C, double diapason, and stopped diapason; 2 principals of metal, and 2 of wood; a twelfth and 2 fifteenths of metal, 1 of wood; a reed fifteenth 4 feet, posaune on a large scale (16 feet), trumpet 16 feet, clarion 8 feet, sesquialtra 4 ranks, mixture 3 ranks; two octaves of German pedals; thirty-two feet metal open diapason to 8 feet C; thirty-two feet wood open diapason to 8 feet C; two octaves of pedal trumpets 16 feet to 8 feet C. The 32 feet pipe with the remainder of the 2 octaves of double pedal pipes are in front. The choir organ from C C C (16 feet) to F in alt has open and stopped diapasons, principal, harmonia, flute, fifteenths, cremona, and bassoon, open diapason wood, and dulciana. Swell descends to C C, and has

open, double, and stopped diapason, principal, fifteenth, harmonica, horn, trumpet, hautboy, and clarion.

The ophicleide, or tuba mirabilis, on the swell manual from C C to F, the same compass as the swell, but separate from it, forms its prominent feature, having power equal to the whole of the great organ, with a full, fine, and smooth tone. This magnificent reed is unparalleled in Europe; and the Birmingham and Liverpool organs are the only instruments which can boast of its powers.

The first clavier is the choir, the second the great organ, the third the swell; the fourth clavier takes any single stop, or all of them, in either choir or swell, without affecting either, or, in other words, the performer may play the choir and swell in the usual manner, without at all affecting the fourth clavier. To accomplish the mechanical movement requires more draw stops than real stops of pipes, although the same object is gained by the fourth clavier as by a fourth separate organ. The collected lengths of the trackers, or wood rods, which communicate from the keys to the sound boards, would extend four miles and a half. The 32 feet C is 1 foot $8\frac{1}{2}$ inches in diameter: the same note, in wood, 3 feet by 2 feet 6 inches, and would hold 12 pipes and 13 gallons of wine. There are two octaves and a half of bells. The pedal pipes are played with the fingers, as easily as the great organ, by a newly invented valve * which resists the pressure of wind. There are at present 63 draw stops in this organ, including the tuba mirabilis recently inserted, and including coupler stops. The choir and swell have 2 draw stops to each row of pipes, as the fourth clavier may require.

The Christ Church organ, in Newgate-street, London, which is yet in progress, will be the largest manual organ in Europe, containing 71 stops; 24 in the great organ, 17 in the choir, 11 in the swell, 10 in the pedal organ, and 8 copulas. This was commenced by Mr. Hill in 1840. The two largest swell organs in Europe have been erected by Mr. Hill during the present year. The one is in St. Peter's Church, Cornhill, and contains 19 stops; the other is in the new Independent Chapel, Liverpool, and contains 20 stops. These swell organs are about double the size of those in the York and Birmingham organs, and contain many new stops; such as the wold flute, suabe flute, oboe flute, echo dulciana cornet, piccolo, and other qualities of tone hitherto unknown in this country.

ORGAN POINT. In Music, a succession of chords, in some of which the harmony of the fifth is taken unprepared on the bass as a holding note, whether preceded by the tonic or by the harmony of the fourth of the key.

ORGA'NICAL DESCRIPTON OF CURVES, in Geometry, signifies the description of curves on a plane by means of instruments; as the circle is described by a pair of compasses, the ellipse by means of a thread passing round two pins in the foci, the epicycloids by the revolution of circles on the circumferences of other circles, the conchoid by means of the *trammel*, the cissoid by the motion of a rectangular ruler, &c. See *Schooten's Exercitationes Mathematicæ; Newton's Arith. Universalis; Maclaurin's Geometria Organica*, &c.

ORGA'NIC DISEASE. A disease in which the structure of an organ is morbidly altered; opposed to *functional* disease, in which the secretions or functions only are deranged, without any apparent change of organization. Tuberculated induration of the liver is an *organic* or *structural* disease of that viscus: the secretion of viscid unhealthy bile is a *functional* derangement of it.

ORGA'NIC LAWS. In Modern Political Phraseology, the name given to laws directly concerning the fundamental parts of the constitution of a state. According to the distinction taken by some French writers, fundamental laws are merely declaratory, containing the principles or theory of government. Organic laws are those which apply those principles to the actual condition of society by positive enactment, and add the sanction of punishment.

ORGA'NIC REMAINS. The organized bodies, whether of animals or vegetables, found in a fossil state, are so called. *See* GEOLOGY.

O'RGANISTS. The old name given in the Roman Catholic Church to those priests who organized or sang in parts. The name *organists of the hallelujah* was applied in the 13th century to certain priests who assisted in the performance of the mass. They were generally four in number, and derived their name from singing in parts, or organizing the melody appropriated to the word hallelujah.

ORGANIZA'TION. (Lat.) The processes by which an organized body is formed: also the totality of the parts which constitute, and of the laws which regulate, an organized body.

ORGANO'GRAPHY. (Gr. οργανον, *a tool* or *instrument*, and γραφω, *I describe.*) A term usually applied to an account of the structure of plants. It comprises all that relates to the various forms of tissue of which plants are anatomically constructed; explains the exact organization of all those parts through which the vital functions are performed; and teaches the relation which one part bears to another, with the dependence of the whole upon the common system. *See* BOTANY.

O'RGANON. (Gr. οργανον.) In Philosophical language, nearly synonymous with *method*, and implying a body of rules and canons for the direction of the scientific faculty, either generally or in reference to some particular department. For an account of the *Organon* of Aristotle and that of Bacon, see articles ARISTOTELIAN and BACONIAN PHILOSOPHY respectively.

O'RGIES. (Gr. ὀργια.) In Mythology, the mysteries of Bacchus, as solemnized among the Greeks and Thracians. Writers derive the name from the word οργη, *anger*, from the fury and excitement of the Bacchanals, or from the wrath of Ceres against Jupiter. (*Clem. Alex.*) But these fanciful etymologies, after the manner of the Greeks, seem to show that the word was really of foreign origin, and adopted by them together with the thing itself. The author of the article "Mysteries" in the *Encyc. Brit.* would derive it from Hebr. argoz, *a chest*, from the casket containing the secret symbols of the god. According to his view, the orgies were the mysteries of Osiris, the Egyptian Bacchus, and from Egypt transplanted to Greece, where they became mingled with the gross corruptions peculiar to the worship of the Bacchus of Thebes. Others imagine their origin to have been in Thrace. The frantic solemnities of these rites are most poetically described in the *Bacchæ of Euripides*. The mysteries which they enveloped are extremely obscure.

ORGUES. In Fortification, long and thick pieces of wood shod with iron, and suspended each by a separate rope over a gate so as to be ready to be let fall and stop it up upon the approach of an enemy. The term also denotes a machine composed of arquebuses, or musket-barrels, linked together so that they may be discharged all at once, and used to defend breaches.

ORGY'IA. (Gr. οργυω, *I stretch out*, and γυιον, *a limb.*) A name applied by Ochsenheimer to a genus of Lepidopterans.

ORICHA'LCUM. (Gr. ορος, *a mountain*, and χαλκος, *brass.*) Literally, mountain brass. This was the name given to a peculiar kind of mixed metal in general use among the ancient Greeks and Romans. It is proved to have been made on much the same basis as brass; but various opinions have been entertained respecting the precise nature of the ingredients employed in its composition, and no definite conclusion has been arrived at on the subject.

O'RIEL. (Etym. uncertain.) In Gothic Architecture, a bay window. According to some passages in early writers, it seems also to signify a recess; but the former is the signification now usually attached to it.

O'RIENT. (Lat. orior, *I rise.*) The east, or eastern part of the horizon. In surveying, *to orient* a plan signifies to mark its situation or bearing with respect to the four cardinal points.

O'RIFLAMME. The ancient royal standard of France. It was the banner of the abbey of St. Denis, which was presented by the abbot to the lord-protector of the convent, whenever engaged in the field on its behalf. This protectorship was attached to the countship of Vexin; and when that county was added to the possessions of the crown by Philip I. this banner, which he bore in consequence, became in time the great standard of the monarchy. By some it is said to have been lost at Agincourt; but, according to others, its last display in the field was in the reign of Charles VII. Its derivation is uncertain: according to some, "quasi auri flamma." According to Count de Gebelin, the last syllable is the same with "fanon" (Germ. fahne). Felibien says it was still to be seen, in 1535, in an abbey, almost devoured by moths. (See *Mem. de l'Ac. des Inscr*. vol. xiii.)

ORI'GANUM, OIL OF. The distilled or volatile oil of the wild marjoram. It is imported from the south of Europe, and used in liniments and embrocations as a stimulant.

ORI'GENISTS. An early Christian sect, who pretended to draw their opinions from the writings of the celebrated Origen. They maintained that Christ was the Son of God only by adoption; and denied eternity of punishments. They existed in considerable numbers in the fourth, fifth, and sixth centuries; and their tenets spread among the monks of Egypt. This sect of Christians must by no means be confounded with the Origenarians, who sprang up at a somewhat later period than the former, and whose tenets surpassed in abomination even those of the Gnostics. (See *Mosheim* (transl.), ed. 1790, i. 392.)

ORI'GINAL. (Lat. originalis.) In Law, where the several parts of an indenture are interchangeably executed between the parties, that part which is executed by the grantor is commonly called the original, the others counterparts. (*See* INDENTURE, COUNTERPART.) But, when all

* For this valve Mr. Hill had the silver medal awarded to him by the Society for Promoting Arts and Commerce, May 31st, 1841.

the parties execute every part, all are originals. The *original* of any deed or document is the best evidence; and a copy not admitted until reasonable proof has been given that the former is destroyed, lost, &c., or that it is in the possession of the adverse party, who has been duly warned to produce it. (*See* Evidence.) The writ which a plaintiff sued out of chancery, in order to commence a suit, was formerly called an "original writ;" the use of it is abolished, in personal actions, by 2 W. 4. c. 39. *See* Pleading.

Original. In the Fine Arts, a work not copied from another, but the work of the artist himself. When an artist copies his own work, it is called a duplicate. A certain freedom and ease are always discernible in an original, which in a copy are looked for in vain; though copies have sometimes been executed which it is almost impossible to detect, and which have deceived even excellent judges.

ORI'GINAL SIN, in Theology, to use the language of the English church in her ninth article, "standeth not in the following of Adam. . . but is the fault and corruption of the nature of every man that naturally is engendered of the offspring of Adam; whereby man is very far gone from original righteousness, and is of his own nature inclined to evil," and it "deserveth God's wrath and damnation." By the following of Adam is here meant the imitation of Adam; the Pelagians, against whom this article is directed, having held that the words of Scripture, "in Adam have all sinned," related not to any inherent vice in the race of Adam, but to the propensity of mankind to imitate his transgression. (August., *De Nat. et Gratiâ.*) With this exception, the original depravity of man's nature, and the consequent necessity of "a new birth unto righteousness," have been commonly held by all sects of Christians. But a great and important difference has prevailed as to the character and cause of that depravity. The belief of St. Augustine is thus expressed by Bishop Burnet:—"That a covenant was made with all mankind in Adam as their first parent; that he was a person constituted by God to represent them all; and that the covenant was made by him so that if he had obeyed all his posterity would have been happy through his obedience; but by his disobedience they were all to be esteemed to have sinned in him, his acts being imputed and transferred to them all." This doctrine of *imputed guilt* has been held by many of the stricter sects and varieties of Christians, both in and out of the church of Rome; it is said by some to be the most consonant to the words of our article, as no doubt it is to the views of the framers of it, whose sentiments were deeply tinctured with Calvinism. But it may be questioned whether those words are not as easily applicable to what is, undoubtedly, the more common opinion among Protestant Christians,—that original sin is not the sin of Adam imputed to his descendants, but is that actual depravity and tendency to evil which philosophy, no less than religion, recognizes as existing in the human mind, and developed with its growth in each individual subject; the source of which, or its permission by the Divine Author of Good, is involved in the inevitable obscurity which surrounds the great question of the origin of evil.

ORI'LLON. In Fortification, a mass of earth lined with a wall, raised on the shoulder of a bastion for the purpose of covering the retired flank.

ORI'ON. One of the forty-eight ancient constellations formed by Ptolemy. It is situated in the southern hemisphere with respect to the ecliptic, but the equinoctial passes nearly across its middle. Orion is one of the most remarkable constellations in the heavens. It contains seven stars, which are very conspicuous to the naked eye; four of them form a square, and the three others are situated in the middle of it in a straight line. Two of the four are stars of the first magnitude; namely, Rigel in the left foot, and Betelguese in the right shoulder. The three stars in the middle of the square are of the second magnitude, and form what is called the *belt of Orion*. They are also popularly called *Jacob's staff*, and the *Yard-wand*. This constellation is represented by the figure of a man with a sword by his side. The name Orion is of great antiquity, and occurs in the books of Job, Amos, and Isaiah. Orion contains a remarkable nebula, and thousands of small stars which are only visible in powerful telescopes.

Orion. In Greek Mythology, the son of Hyrieus; according to Homer, a youth slain by Diana, on account of the love borne to him by Aurora; but according to others, a king and a mighty hunter. Antiquity is full of contradictions respecting the origin, character, and fate of this mythological personage, and the only point in which it agrees respecting him is his elevation to the stars after his death. Those who wish to see all the circumstances of his history philosophically investigated should consult the dissertation of the late Prof. Müller of Gottingen, *Über Orion*, which appeared in the *Rhein. Mus. Philol.* ii. 12.

ORISMO'LOGY. (Gr. *ορισμος*, *a term*, and *λογος*, *a discourse.*) That branch of natural history which relates to the explanation of the technical terms of the science. It is also called Glossology and Terminology.

O'RLO. (Ital. *a hem or edge.*) In Architecture, the plinth to the base of a column or a pedestal.

O'RLOP DECK. The lowest deck, or rather partial deck of a ship, below the water, on which the cables are coiled, the sails, &c. stowed.

ORMOLU. (Fr.) Bronze or copper gilt usually goes under this name. The French are celebrated in this branch of manufacture.

O'RNAMENT. (Lat. ornamentum.) In the Fine Arts. *See* Decoration.

ORNITHI'CNITES. (Gr. *ορνις*, *a bird*, *ιχνος*, *a trace.*) The footmarks of birds which occur in different strata. Some of these are very remarkable, as proving the existence of birds at very remote periods; for instance, at the early epoch of the new red sandstone formation. An account of these, as occurring in the red sandstone of Connecticut, is given by Professor Hitchcock in the *American Journal of Science and the Arts.*

ORNI'THOLITES. (Gr. *ορνις*, and *λιθος*, *a stone.*) The name given to fossil birds.

ORNITHO'LOGY. (Gr. *ορνις*, *a bird*, and *λογος*, *a description.*) The science which teaches the natural history and arrangement of birds. (*See* Aves for the general organical characters of the class, and the modifications of the feet by which the five orders of the Quinary arrangement are characterized.)

The subdivision of the class of birds is by no means so clearly indicated by either external or anatomical characters as that of Mammals, and the systems of Ornithology present, in consequence, greater discrepancy than the Mammalogical ones. It is not without interest to observe that if conditions of the procreative function be taken as guides to the primary division of the class, such division will present the binary character, as in the class of Mammals and of Reptiles; for example, birds may be divided into two great groups, in one of which the young are able to run about or swim and provide food for themselves the moment they quit the shell; while in the other the young are excluded feeble, naked, blind, and dependent on their parents for support. The species comprised in the first of these groups have been termed *Aves præcoces;* those of the second *Aves altrices*.

Professor Nitzsch divided the feathered tribes into three grand primary groups, corresponding with the three great divisions of the matter of our planet, as air, earth, and water, which constitute respectively the principal theatres of their vital actions.

This first order consists of the Raptorial and Passerine birds, the birds of flight *par excellence*, which he accordingly terms "Luft-vögeln," or *Aves aereæ*. The second order embraces the birds of the earth, "Erd-vogeln," *Aves terrestres*, represented by the ostrich and common fowl. The third great division includes the birds which frequent the waters, *Aves aquaticæ* (Wasser-vögeln), typified by the heron and the gull.

Sandewall's ornithological system has four primary groups or cohorts.

In the Quinary arrangement of birds proposed by Mr. Vigors, there may be traced a similar principle to that which guided Nitzsch in his ternary classification. Thus, the first order (*Raptores*, Virg.) includes the birds which soar in the upper regions of the air, which build their nests and rear their young on the highest rocks and loftiest trees. The second order (*Insessores*) includes the birds which affect the lower regions of the air, and which are peculiarly arboreal in their habits; whence the name of Perchers. The third order corresponds with Nitzsch's *Aves terrestres*, and is termed, as in the system of Illiger, *Rasores*. If the aquatic birds of Nitzsch be divided into those which frequent the fresh waters, and are restricted to wading into rivers, lakes, &c. in search of their food, and those which have the power of swimming or diving, and for the most part frequent the great ocean, we shall then have the two remaining orders of the Quinary arrangement, viz. *Grallatores* and *Natatores*. The chief merit of this arrangement is its aim to express the natural affinities, and their circular progression in the whole and in the several parts.

Linnæus and Cuvier have six orders of birds, which are characterized as follows by the latter naturalist:—

"Of all classes of animals, that of birds is the most strongly characterized,—that in which the species bear the greatest mutual resemblance, and which is separated from all others by the widest interval. Their systematic arrangement is based, as in the Mammalia, on the organs of manducation, or the beak, and in those of prehension, which are again the beak, and more particularly the feet.

"One is first struck by the character of *webbed feet*, or those wherein the toes are connected by membranes that distinguish all *swimming birds*. The backward position of their feet, the elongation of the sternum, the neck, often longer than the legs, to enable them to reach below them, the close glossy plumage impervious to water,

altogether concur with the feet to make good navigators of the *Palmipedes.*

"In other birds, which have also most frequently some small web to their feet, at least between the two external toes, we observe elevated tarsi; legs denuded of feathers above the heel-joint; a slender shape; in fine, all the requisites for wading in shallow waters in search of nourishment. Such, in fact, is the source of food of the greater number; and although some of them resort exclusively to dry places, they are nevertheless termed 'shore-birds' or 'waders' (*Grallæ*).

"Amongst the true land birds, the *Gallinaceæ* have, like our domestic cock, a heavy carriage, a short flight, the beak moderate, its upper mandible vaulted, the nostrils partly covered by a soft and tumid scale, and always the edges of the toes indented, with short membranes between the bases of those in front. They subsist chiefly on grain.

"Birds of prey (*Accipitres*) have a crooked beak, with its point sharp and curving downward, and the nostrils pierced in a membrane that invests its base: their feet are armed with strong talons. They live on flesh and pursue other birds; their flight accordingly is mostly powerful. The greater number still retain a slight web betwixt their external toes.

"The Passerine birds (*Passeres*) comprise many more species than all the other families; but their organization presents so many analogies that they cannot be separated, although they vary much in size and strength.

"Finally, the name of Climbers (*Scansores*) is applied to those birds in which the external toe is directed backwards like the thumb, because the greater number of them avail themselves of a conformation so favourable for a vertical position to climb the trunks of trees."

Anterior to Cuvier, but subsequently in the order of publication, is Pallas's modification of the ornithological system of Linnæus. It is contained in his great posthumous work, entitled *Zoographia Rosso-Asiatica.* He also divides the class of birds into six orders:—

1. *Præpetes*, having the characters of the *Accipitres*, with which it is synonymous.
2. *Oscines*, including the genus *Columba*, with the *Picæ* and certain *Passeres* of Linnæus.
3. *Fringillæ*, corresponding with the *Crassirostres*, *Granivoræ*, *Enucleatrices* of Ray.
4. *Pulveratrices*, having the characters of the *Gallinæ*.
5. *Grallæ*. This order commences with the genus *Otis*, and includes, as in the system of Cuvier, the Struthious birds with the true waders.
6. *Hydrophilæ*. The characters of this order corresponds with that of the *Palmipedes*, with which it is equivalent. As an example of the views entertained and expressed by Pallas of relations of analogy, the following passage may be taken from his exposition of the nature of his *Hydrophilæ*:—"*Rostra* in hoc ordine admodum variant, ut nullus ordinis character inde desumi possit, et quasi reliquos ordines æmulari videntur ut *Diomedeæ* et *Catarractæ*, Rapaces, *Lari*, *Sternæ*, *Alçæ*, *Cepphi*, et *Colymbi*, Oscines; *Uriæ*, *Pulveratrices*, *Lundæ*, Passeres, et tandem *Serratirostria genera* Phœnicopterum et Plataleam inter *Grallas* referant."

The primary division of the class of birds adopted by the author of the article "Aves," in the *Cyclopedia of Anatomy and Physiology*, includes seven orders; the Struthious birds, by virtue of their remarkable anatomical peculiarities, being separated from the *Grallæ* of Linnæus and Cuvier. The following are the orders:—

1. Raptores, *Accipitres*, Linn. Cuv. Birds of prey.
2. Insessores, *Passeres*, Cuv. Perchers.
3. Scansores, Cuv. Climbers.
4. Rasores, *Gallinæ*. Linn. Cuv. Scratchers.
5. Cursores, Illig. Coursers.
6. Grallatores, *Grallæ*, Linn. Waders.
7. Natatores, *Palmipedes*, Cuv.; *Anseres*, Linn. Swimmers.

Scopoli and Latham have divided birds into *nine* orders; Temminck has *sixteen* orders; Brisson has *twenty-eight*, and Lacepede has *thirty-eight* orders; but the principles and the characters on which a classification of birds is most philosophically founded, appear to be sufficiently illustrated in the systems that have been already explained.

ORNI'THOMANCY. (Gr. ορνις, μαντεια, *divination.*) Divination by the flight of birds. The Etruscans were the most celebrated practisers of it. *See* Augurs.

ORNI'THORHY'NCHUS. (Gr. ορνις, ρυγχος, *a beak.*) The name of the genus of Monotrematous Mammals, characterized by the form of the mouth, which resembles the bill of a duck. It is peculiar to the fresh-water rivers and lakes of Australia and Van Diemen's Land.

OROMA'SDES. In Persian Mythology, the principle of Good, created by the will of the great eternal spirit Zeruane Akherene, simultaneously with Ahriman, the principle of Evil, with whom he is in perpetual conflict. Oromasdes is the creator of the earth, sun, moon, and stars, to which he originally assigned each its proper place, and whose various movements he continues to regulate. According to the Persian myths, the world, which is to last 12,000 years, during which the war between the Good and Evil Principle is to go on increasing, is at length to be consumed, the Evil Principle exterminated, and a new world created in its room, over which Oromasdes is to reign as the sole and supreme monarch. The great apostle of the Persians, Zoroaster, was the prophet of Oromasdes; and there is an old prophecy extant that after the lapse of ages a descendant of Zoroaster shall be sent by Oromasdes to redeem the world. Here we cannot fail to perceive how striking a resemblance exists between the old Persian myth and that grand scheme of redemption communicated by the Almighty to the Jews, and which was consummated by the advent of Jesus Christ. *See* Ahriman, Polytheism.

O'RPHEAN MYSTERIES. The mysteries of which Orpheus was the founder were so called. These mysteries were at a remote period in the highest estimation, and exercised an important influence over the intellectual development of mankind. Orpheus is said to have been taught his mysteries by the Idæan Dactyli; and to have introduced them into Thrace, whence they were gradually propagated throughout all Greece by his initiated followers. The nature of these mysteries is involved in an impenetrable veil of obscurity; but there can be no doubt that they partook of the general character of all mysteries, inculcating a purer knowledge of religion than was compatible with the superstitious observances then prevalent. On the union of these mysteries with the Bacchanalian orgies they fell into merited contempt, and were at length gradually disused. (*See* Mysteries.) The initiated in these mysteries, as well as the persons employed to initiate candidates in them, were called, in some cases, *Orpheotelestæ.*)

O'RPHEUS. A mythological personage; according to the common story, a son of the Thracian river Æagrus and the muse Calliope. His power of moving inanimate things by music, the share he bore in the Argonautic expedition, his descent into the Shades to recover his wife Eurydice, and his death by the violence of the Thracian women, are well-known circumstances in ancient romantic fable. Moderns have imagined that his name is a general mythic designation for the earliest bards, who came with their art from Thrace to Greece. Whether any fragments of poetry, either of the real Orpheus or of this supposed school, existed in Grecian classical ages, has been doubted. What passed as the poetry of Orpheus in the time of Aristotle seems to have been decidedly supposititious, as much so as the poems which we possess under the same name, some of which are thought to be as recent as the 4th century after Christ. According to modern theories, the Orphic poetry of ancient times contained the whole body of Grecian esoterical religion and import of the Mysteries. (See *Lobeck's Aglaophamus*; *Bode's Orpheus*; Tiedemann, *Initia Philosophiæ Græcæ*; *the History of the Literature of Greece*, Lib. U. K. p. 231.; *Mém. de l'Acad. des Sciences*, vol. xii.)

O'RPIMENT. (Lat. auripigmentum.) Yellow *sulphuret of arsenic*; it forms the basis of the yellow paint, called *king's yellow*. The solution of orpiment in ammonia has been used as a yellow dye.

O'RPIN. (Fr.) In Painting, a yellow colour of various degrees of intensity, approaching also to red.

O'RPINE. The English name for the succulent herbaceous plant called by botanists *Sedum telephium*, which see.

O'RRERY. A machine for representing to children the motions and relative magnitudes and distances of the bodies composing the solar system. As these machines are often procured by well-meaning but ignorant people at considerable expense, it may be useful to quote an authority that will not be called in question. "As to getting correct notions on this subject" (the magnitudes and distances of the planets), says Sir John Herschel, "by drawing circles on paper, or, still worse, from those very childish toys called orreries, it is out of the question." (*Astronomy, Cab. Cyc.* p. 287. For the description of an orrery see *Ferguson's Astronomy*, by Brewster.)

O'RRIS ROOT. The root of the *Iris Florentina*. It has an agreeable odour, much like violets, and is sometimes used in perfumed powders; it is also turned into little balls for issues, called *orris peas*.

O'RTHITE. (Gr. ορθος, *straight.*) A mineral which occurs in straight rays or layers in Scandinavian granite. It contains cerium and yttria.

ORTHO'CERATES, *Orthocerata*. (Gr. ορθος, and κερας, *a horn.*) The name of a family of Cephalopods with chambered siphoniferous shells, which are straight, or are continued straight after commencing with a greater or less curvature, thus resembling a horn.

O'RTHODOX, or ORTHODOXY. (Gr. ορθος, and δοξα, *opinion.*) These terms are restricted in application to right judgments in matters of religious faith; and al-

though every sect maintains of course the exclusive correctness of its own views, yet the title of orthodoxy is appropriated by ecclesiastical historians to the standard maintained by the Catholic or universal church. The term orthodox is generally restricted also to those principal tenets which have been always held by the great mass of professing Christians: large bodies of dissenters in England are allowed by the church to be orthodox, inasmuch as they hold the three creeds, and therefore profess the principal articles of the Christian faith in common with those who differ from them in matters of church authority and discipline.

ORTHODRO'MICS (Gr. ορθος, and δρομος, *course*), in Navigation, is sailing on a right course, or on the arc of a great circle, which is the shortest distance between two points on the sphere.

O'RTHOEPY (Gr. ορθος, and επος, *a word*), in Grammar, signifies literally the right use of words; but it is applied, at least by modern writers, to signify that part of prosody which treats of the manner of uttering words, or of pronunciation in its limited sense. *See* PRONUNCIATION.

ORTHO'GONAL. (Gr. ορθος, and γωνια, *angle*.) In Geometry, the same as rectangular or right-angled.

ORTHOGRA'PHIC PROJECTION. The projection of points on a plane by straight lines at right angles to the plane. *See* PROJECTION.

ORTHO'GRAPHY. (Gr. ορθος, and γραφω, *I write*.) That part of grammar which relates to the method of denoting sounds by visible signs, to the different kinds of letters, and their combination into syllables and words.

ORTHOGRAPHY. In Architecture, a geometrical representation of an elevation or section of a building.

O'RTHOPNŒ'A. (Gr. ορθος, and πνοη, *breathing*.) A difficulty of breathing, which is increased by any deviation from the erect posture.

ORTHO'PTERANS, *Orthoptera*. (Gr. ορθος, and πτερον, *a wing*.) An order of insects, including all those species which have the wings disposed when at rest in straight longitudinal folds. Latreille characterizes the insects of this order as having the body generally less firm in texture than in the Coleoptera, and covered by soft semi-membranous elytra furnished with nervures, which, in the greater number, do not join at the suture in a straight line. Their wings are folded longitudinally, most frequently in the manner of a fan, and divided by membranous nervures running in the same direction. The maxillæ are always terminated by a dentated and horny piece covered with a *galea*, an appendage corresponding to the exterior division of the maxillæ of the Coleoptera. They have also a sort of tongue.

The *Orthoptera* undergo a semi-metamorphosis, of which all the mutations are reduced to the growth and development of the elytra and wings, that are always visible in a rudimental state in the nymph. As both this nymph, or semi-nymph, and the larva are otherwise similar to the perfect insect, they walk and feed in the same way.

The mouth of the *Orthoptera* consists of a labrum, two mandibles, as many maxillæ, and four palpi: those of the jaws always have five joints; whilst the labial palpi, as in the Coleoptera, present but three. The mandibles are always very strong and corneous, and the ligula is constantly divided into two or four thongs. The form of the antennæ varies less than in the Coleoptera, but they are usually composed of a greater number of joints. Several, besides their reticulated eyes, have two or three ocelli. The inferior surface of the first joints of the tarsi is frequently fleshy or membranous. Many females are furnished with a true perforater formed of two blades, frequently enclosed in a common envelop, by means of which they deposit their eggs. The posterior extremity of the body, in most of them, is provided with appendages.

All the known *Orthoptera*, without exception, are terrestrial, even in their two first states of existence. Some are carnivorous, or omnivorous, but the greater number feed on living plants.

O'RTIVE. (Lat. ortus, *a rising*.) In Astronomy, having reference to the rising of a star or planet; thus, *ortive amplitude*, or *eastern amplitude*, is the arc of the horizon intercepted between the point where a star rises and the east point.

O'RTOLAN. The name given in France and England to a species of *Frangillidæ* greatly esteemed for the delicacy of its flesh when in season. It is the *ortolano* of the Italians, and the *fettammer* of the Germans. The ortolan is a native of northern Africa; but in the summer and autumnal months it resorts to southern Europe, and frequently migrates to the central and even the northern parts. There are large establishments in Italy and in the south of France for feeding these birds, the flesh of which is styled by Prince Musignano *carne squisita*.

O'RUS, or HORUS. An Egyptian god, son of Isis and Osiris, according to Herodotus (ii. 144.); answering to the Greek Apollo. He frequently appears in Egyptian paintings sitting on the lap of Isis. (See *Egyptian Antiquities*, London, 1836, vol. ii.)

ORVI'ETAN. An antidote to poison, said to have been invented by a mountebank of Orvieta in Italy.

ORY'CTEROPE. (Gr. ορυσσω, *I dig*, and πους, *a foot*.) A genus of Edentate Mammals peculiar to the African continent, and provided with feet and claws well adapted for digging; from which circumstance, and the heavy shapeless form of the only known species of this genus, it is commonly called at the Cape of Good Hope the ground-hog. The principal food of the orycterope is the termite and other species of ants, which it dislodges by its strong and sharp claws, and entraps by means of a long extensible and glutinous tongue. It differs from the true ant-eaters principally in having molar teeth. The orycterope is about the size of a hog, stands low, has short hair, and is of greyish-brown colour. It has four toes before and five behind, and inhabits burrows. Its flesh is eaten.

ORYCTO'GNO'SY, or ORYCTO'LOGY. (Gr. ορυκτος, *fossil*, and λογος, *a discourse*.) The branch of zoological science which treats of fossil organic remains. These terms are sometimes used to denote those parts of mineralogy which have for their object the classification of minerals, their description, nomenclature, and arrangement.

ORY'ZA. (Arab. aruz.) The name by which rice was known to the ancient Greeks and Romans, and which has been adopted by modern botanists as the generic name of the plant yielding that invaluable grain. The genus *Oryza* belongs to the class *Hexandria*, order *Dygynia*; and has ten glumes to a single flower, and two halea nearly equal adhering to the seed. It affords many varieties, of which the most common is the *Oryza sativa*, or the English rice. This plant is raised in immense quantities in India, China, and most eastern countries; in the West Indies, Central America, and the United States; and in some of the southern countries of Europe. It, in fact, occupies the same place in most intertropical regions as wheat in the warmer parts of Europe, and oats and rye in those more to the north. Forming, as it does, the principal part of the food of the most civilized and populous eastern nations, it is more extensively consumed than any other species of grain. It is light and wholesome, but is said to contain less of the nutritive principle than wheat. When rough, or in its natural state in the husk, it is called *paddy*. There is an immense variety in the qualities of rice. That which is principally exported from Bengal has received the name of *cargo* rice. It is of a coarse reddish cast, but is sweet and large-grained, and is preferred by the natives to every other sort. It is not kiln-dried, but is parboiled in earthen pots or caldrons, partly to destroy the vegetative principle, so that it may keep better, and partly to facilitate the process of husking. Patna rice is more esteemed in Europe than any other sort of rice imported from the East. It is small-grained, rather long and wiry, and remarkably white. But the rice raised on the low marshy grounds of Carolina is unquestionably very superior to any brought from any part of India.

The produce of lands naturally or artificially irrigated is, as far as rice is concerned, from 5 to 10 times greater than that of dry land having no command of water; and hence the vast importance of irrigation in all countries where this grain is cultivated. But it is worthy of remark, that owing to the not unfrequent occurrence of severe droughts, there is a greater variation in the crops of rice than in those of any other species of grain. Those who, like the Hindoos, depend almost entirely on it for subsistence, are consequently placed in a very precarious situation. There can be no doubt that famines are at once more frequent and severe in Hindostan than in any other quarter.

A few years ago, England was principally supplied with cleaned rice from Carolina. Latterly, however, the imports of Carolina rice have been much reduced. An improved method of separating the husk, which throws out the grain clean and unbroken, has recently been practised in this country; and as the grain when in the husk is found to preserve its flavour and sweetness better during a long voyage than when shelled, large quantities are now imported rough from Bengal and the United States. Unquestionably, however, the oppressive discriminating duty of 14*s*. a cwt. on American and other foreign cleaned rice has done more than any thing else to increase the imports of rough grain; and the fact of the duty on paddy from Bengal being only 1*d*. per quarter, while that on paddy from Carolina is 2*s*. 6*d*. a bushel, sufficiently accounts for the increased imports from the former. (See *Com. Dict.*, art. "Rice.")

OSCHOPHO'RIA. A celebrated festival observed by the Athenians; for full information respecting which the reader is referred to *Plutarch's Life of Theseus*, by whom it was instituted. The name is derived from απο του φερειν τας οσχας, from carrying οσχαι, i. e. *boughs hung up with grapes*.

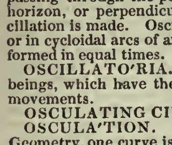
OSCILLA'TION. (Lat. oscillatio.) In Mechanics,

the vibration or alternate ascent and descent of a pendulous body. (*See* PENDULUM.) The centre of oscillation is a point in the oscillating body, such that if all the matter of the body were there collected the oscillations would be performed in the same time. (*See* CENTRE OF OSCILLATION.) The axis of oscillation is a straight line passing through the point of suspension parallel to the horizon, or perpendicular to the plane in which the oscillation is made. Oscillations in small arcs of a circle, or in cycloidal arcs of any length, are isochronal, or performed in equal times. *See* CYCLOID.

OSCILLATO'RIA. Minute filamentous organized beings, which have the faculty of exercising oscillatory movements.

OSCULATING CIRCLE. *See* OSCULATION.

OSCULA'TION. (Lat. osculare, *to embrace.*) In Geometry, one curve is said to osculate another when the two curves are in contact in such a manner that the number of points common to both is the greatest possible. Let A B be a curve, of which A C is the evolute; from P any part in A B draw P C, to touch A C in C. With C as a centre, and a radius C P, describe a circle $m\,n$; then the circle $m\,n$ osculates the curve A B at the point P. From the theory of the evolution of curve lines, the curvature of A B at the point P is equal to that of the circle; in fact, it is obvious from the development that the curvature of the involute at any point between A and P is greater than that of the circle, and at any point beyond P it is less than that of the circle, consequently at P it is exactly the same as that of the circle described with the radius C P. The circle $m\,n$ has, therefore, a more intimate contact with A B than any other circle which passes through P.



The theory of osculating curves in general is most easily explained by the methods of the differential calculus. Let $y = fx$ and $y = \mathrm{F}\,x$ be the equations of two curves; suppose x to become $x + h$, and let the functions $f(x + h)$, $\mathrm{F}\,(x + h)$, be developed by Taylor's theorem; then, if all the terms of the first development are respectively equal to the corresponding terms of the second, the curves are the same in every respect, or coincide. If the first terms only are equal, the two curves have only one common point; if the two first terms of the one development are respectively equal to the two first of the other, then two contiguous points coincide, or are common to both curves; if the three first terms in each are respectively equal, the curves have three common points, and so on. Now the number of terms of the first development which can be made equal to the corresponding terms of the second depends on the number of constants in the function fx (supposing $\mathrm{F}\,x$ to contain more constants than fx). The equations of a straight line being $y = a\,x + b$, contains two constants; the straight line can thus be made to coincide with two contiguous points of a curve: it then becomes a tangent, and the contact is said to be of the first order. The general equation of the circle is $(y - b)^2 + (x - a)^2 = r^2$, and contains three constants; a circle can therefore be determined which shall have three common points with a curve: it then *osculates* the curve, and the contact is said to be of the second order. In general, if the equation of the osculating curve is of the order n, it may have a contact of the same order with the curve which it osculates; and it is a consequence of this theory that no osculating curve of an inferior order can be made to pass between two curves having a contact of a higher order: for example, no straight line can be drawn through P between the curve A P and its osculating circle m P n. (Lagrange, *Théorie des Fonctions Analytiques;* Lacroix, *Traité du Calcul Différentiel et Intégral.*)

OSIA'NDRIANS. In Ecclesiastical History, a sect among the Lutherans; so called from their founder Osiander, a celebrated divine. They differed from the followers of Luther and Calvin as to the efficient cause of justification.

O'SIER. The name given to various species of willow or salix, chiefly employed in basket-making on account of their tough flexible shoots. (See *Loudon's Arboretum Britannicum*, p. 1490., which contains full information on all the points relative to osiers.)

OSI'RIS. In Mythology, one of the chief Egyptian divinities, the brother and husband of Isis, and together with her the greatest benefactor of Egypt; into which he introduced a knowledge of religion, laws, and the arts and sciences. After having accomplished great reformations at home, he visited the greater part of Europe and Asia, where he enlightened the minds of men by teaching them the worship of the gods and the arts of civilization; but on his return he found his own subjects excited to rebellion by his brother Typhon, by whose hand he was ultimately assassinated. Both ancient and modern writers have differed considerably respecting the powers and attributes of Osiris.* His principal office, as an Egyptian deity, was to judge the dead, and to rule over that kingdom into which the souls of the good were admitted to eternal felicity. The characters of Osiris, like those of Isis, who was thence called Myrionymus, or "with 10,000 names," were numerous. He was that attribute of the deity which signified the divine goodness; and in his most mysterious and sacred office, as an *avatar*, or manifestation of the divinity on earth, he was superior to any even of the Egyptian gods; for, as Herodotus observes, though all the Egyptians did not worship the same gods with equal reverence, the adoration paid to Osiris and Isis was universal. He was styled "the Manifester of Good;" and to this title he had an undisputed right, for he appeared on earth to benefit mankind; and after having performed the duties he had come to fulfil, and fallen a sacrifice to Typhon the evil principle (which was at length overcome by his influence after his leaving the world), he "rose again to a new life," and became the judge of mankind in a future state." Other titles of Osiris were, "President of the West," "Lord of the East," "Lord of Lords," "Eternal Ruler," "King of the Gods," &c. These, with many others, are commonly found in the hieroglyphic legends accompanying his figure; and the Papyri frequently present a list of 49 names of Osiris in the funeral rituals. Osiris has been identified with many of the Grecian divinities; but more especially with Jupiter, Pluto, and with Bacchus, on account of his reputed conquest of India. Osiris was particularly worshipped at Philae and Abydus: so sacred was the former that no one was permitted to visit it without express permission; and the latter was regarded with such veneration that persons living at a distance from it sought, and with difficulty obtained, permission to possess a sepulchre within its necropolis. The worship of Osiris was at a later period introduced into Rome; but the prurient imagination of the Romans soon converted the rites and mysteries of this deity into a means for practising the most unbounded licentiousness, which at length reached such a height that his worship was prohibited by law. Osiris was venerated under the form of the sacred bulls Apis and Mnevis; or as a human figure with a bull's head, distinguished by the name Apis-Osiris. He is usually represented as clad in pure white; and his usual attributes are the high cap of Upper Egypt, a crosier, a flagellum, and sometimes a spotted skin, an emblem supposed to connect him with the Grecian Bacchus. (For full particulars respecting the supposed history of Osiris, together with explanations thereof, we beg to refer to *Plutarch's Treatise on Isis and Osiris;* and for a resumé of the whole subject illustrated with ingenious observations, the reader may consult *Sir G. Wilkinson's Manners and Customs of the Ancient Egyptians.*) *See* ISIS.

O'SMAZOME. (Gr. *οσμη, odour*, and *ζωμος, broth.*) The extractive matter of muscular fibre, which gives the peculiar smell to boiled meat and flavour to broth and soup.

O'SMIUM. A metallic substance found associated with the ore of platinum; its peroxide is extremely volatile, and has a peculiar pungent odour, which suggested the name of the metal: from *οσμη, odour.* Neither osmium nor its compounds have been applied to any use, and it is a rare substance.

O'SSEANS, OSSEI, or PISCES OSSEI. In Ichthyology, a primary division of the class of fishes, including all those which have a true bony skeleton.

O'SSEOUS BRECCIA. The cemented mass of bone found in certain caverns and fissures of rocks.

O'SSIAN'S POEMS. The name given to a collection of poems, alleged to have been the production of Ossian, the son of Fingal, a Scottish bard, who lived in the third century. They were first given to the world in an English version by James M'Pherson, Esq., in 1760, with the assurance that they were translations made by himself from ancient Erse manuscripts which he had collected in the Highlands of Scotland; and such was the enthusiasm which their appearance excited, that they may be almost said to have given a new tone to poetry throughout all Europe. There were not, however, wanting many distinguished persons who from the first denied their authenticity: foremost among whom was Dr. Johnson, who boldly pronounced the whole of the poems ascribed to Ossian to be forgeries; and his opinion was corroborated by Hume, Gibbon, and many others, who defied M'Pherson to produce a manuscript of any Erse poem of earlier date than the sixteenth century. On the other hand, M'Pherson's assertions as to the genuineness of the poems found warm supporters in Dr. Blair (see his *Critical Dissertation on the Poems of Ossian*), Dr. Henry, Lord Kaimes, and many other distinguished names, and almost to a man in the whole body of the Highlanders. In this unsettled state the

* So cautious were those initiated into the worship of Osiris, that they made a scruple even of mentioning him; and Herodotus, wherever he relates any thing concerning this deity, excuses himself from uttering his name.

controversy remained till the year 1800, when Malcolm Laing, so well known for his historical labours, in a Dissertation appended to the second volume of his *History of Scotland*, endeavoured to establish, from historical and internal evidence, that the so called poems of Ossian are absolutely and totally spurious. The sensation created by this Dissertation was unprecedented. Many converts were made to the opinions therein set forth; but the general disbelief in the authenticity of the poems was not complete till 1805, when a committee of the Highland Society of Edinburgh, which had been appointed in 1797 to inquire into their nature and authenticity, reported to the effect "that they had not been able to obtain any one poem the same in title and tenor with the poems of Ossian." Since that period the controversy, so far as it regards their translation from Erse manuscripts, may be said to be terminated. But although these poems had never been committed to writing, or rather have not been handed down in writing, there can be, we believe, but little doubt that many of them still exist in the Highlands of Scotland in a dress not very different from that in which they were rendered by M'Pherson into English, having been committed to memory, and transmitted from one bard or storyteller to another in regular succession; and consequently their pretensions to be regarded as historical authority on many points can scarcely be denied. Their scene is sometimes laid in Scotland, but more frequently in Ireland; and they may be justly considered the *Iliad* and *Odyssey* of the Celtic race of the two islands, handed down by tradition only: — what the poems of Homer were, in all likelihood, to the Greeks themselves before they were acquainted with the art of writing. "The value of Ossian," says Mr. Skene, "as an historical poet, must stand in the highest rank; while, whether the chief part of these poems are of ancient or of modern composition, there can remain little doubt that in him we possess the oldest record of the history of a very remote age." (*The Highlanders of Scotland, their Origin, History, and Antiquities*, vol. i. p. 215.) Those who wish to see this subject exhibited in all its bearings, though, perhaps, with a slight prejudice against M'Pherson, may consult the elaborate article in the *Edin. Review*, vol. vi.

O'SSIFICATION. The formation of bone. The change of any soft solid of the body into bone.

OSTA'RA. An ancient German and Celtic divinity, worshipped with peculiar veneration by the Anglo-Saxons. Many writers regard her as identical with the Phœnician goddess Astarte; but, be this as it may, she was regarded as the queen of spring and of the morning; and from her name is derived the German *Ostern* (Anglice, *Easter*), which period of the year the ancient Germans were in the habit of celebrating with fires and festivals in gratitude for the advent of spring. (See *Grimm's Deutsche Mythologie*, p. 181.) The town Osterode on the Hartz is said to have been named from this goddess.

OS'TEOCO'LLA. (Gr. *οστεον, a bone*, and *κολλα, glue.*) An old mineralogical term for *encrusting* carbonate of lime, to which the property of uniting a fractured bone has been attributed.

OSTEO'GENY. (Gr. *οστεον, a bone*, and *γενναω, I generate.*) The formation or growth of bone.

OSTEO'LOGY. (Gr. *οστεον, a bone*, and *λογος, a discourse.*) The doctrine or history of the bones. *See* ANATOMY, BONE.

OSTEOLOGY. In Painting and Sculpture, a description of the bones of animals.

OSTRA'CEANS, *Ostracea*. The family of Bivalves of which the oyster (*Ostrea*) is the type; and which is characterized by the mantle being widely open, without special orifices.

OSTRA'CION. (Gr. *οστρακον, a shell.*) A genus of fishes of the order *Sclerodermi*, or rough-skinned, in the system of Cuvier. It is characterized by the armour of regular bony plates soldered together, with which the body is invested; the only moveable parts being the tail, fins, mouth, and a small gill-flap, which pass, as it were, through holes in the coat of mail. The body generally presents a quadrangular form, whence the name of trunk-fish, commonly given to the species of this genus.

O'STRACISM. (Gr. *οστρακισμος.*) A form of condemnation at Athens, by which persons who from their wealth or influence were considered dangerous to the state were banished for ten years, with leave to enjoy their estates and return after that period. It was not inflicted as a punishment, but merely as a precautionary measure to preserve the democracy. The process in this condemnation was as follows: — The people being assembled each man wrote the name of the person he wished to banish on a shell (*ὀστρακον*, whence the name *ὀστρακισμος*), and delivered it to the archons, who counted the numbers. Only one individual could be subjected to the ostracism at the same meeting, and 6000 hostile votes were necessary to the infliction of this condemnation. Hence if 6000 votes and upwards were recorded against one or more individuals, the one was banished against whom the greatest number of votes had been given. (See *Mem. de l'Acad. des Inscr.* vol. xvi.)

O'STRACODES, *Ostracoda*. (Gr. *οστρακον, a shell, ειδος, form.*) The name of a family of Entomostracans, comprehending those which have the shell folded in two, so as to resemble the shell of a bivalve mollusk.

O'STRICH. The largest known bird, and the type of the Cursorial or Struthious order. It is distinguished not only from its immediate congeners the *Cassowaries* and *Apteryx*, but from all other birds, by having only two toes, which correspond with the two outermost toes in the rest of the class. The wings are furnished with loose and flexible plumes, but are long enough to increase its speed in running. The elegance of these feathers, arising from their slender stems and the disunited barbs, has occasioned them to be prized in all ages, and they still constitute a valuable article of commerce. The beak of the ostrich is depressed, of a moderate length, and blunt at the end; the tongue is extremely short; the eye is large, and the lid fringed with short simple feathers like eyelashes. The legs are of prodigious strength, and the tarsi very long. The ostrich has a capacious crop; a strong gizzard; voluminous intestines, with two long cœca, complicated each with a spiral valve, and succeeded by a very long intestinum rectum with internal connivent valves, which latter structure is unique in the class of birds. It is likewise remarkable in this class for its large urinary receptacle. The ostrich abounds in the sandy deserts of Arabia and Africa. It attains the height of seven or eight feet; is gregarious in favourable localities; lays eggs of three pounds weight, which are incubated by the male principally, and defended courageously. The ostrich feeds on grain, grass, &c., to aid in digesting which many pebbles are taken into the gizzard; so obtuse is its taste that it will swallow pieces of metal, wood, &c. When pursued it dashes stones behind it with great violence, and exceeds in swiftness all other terrestrial animals; it is only the comparatively limited power of sustaining its course that enables the mounted Arab to run it down.

OTA'LGIA. (Gr. *ους, the ear*, and *αλγος, pain.*) The ear-ache.

OTA'RIA. (Gr. *ους.*) The name of the genus of seals characterized by having projecting external ears, and by the double cutting edge of the four middle upper incisors, a structure unknown in other animals: the molar teeth are simply conical, and with a single fang. These seals are principally confined to the southern hemisphere.

OTI'TIS. (Gr. *ους.*) Inflammation of any part of the organ of hearing.

O'TTAR, or OTTAR OF ROSES. The volatile or odorous oil of the rose; it is of a soft buttery consistence, and deposits when fluid a crystallizable portion, which is sparingly soluble in alcohol: it is much used as a perfume. The finest ottar of roses is prepared at Ghazedpore in India.

OTTA'VA RI'MA. (Eighth or octuple rhyme.) An Italian form of versification, consisting of stanzas of two alternate triplets and a couplet at the end; the verses being, in the proper Italian metre, the heroic of eleven syllables. It is the form peculiarly adopted and embellished by the poets termed Romanzieri, from Pulci to Fortiguerra. (*See* ROMANZIERI.) It is a happy metre, in the hands of an able versifier, for the expression of feelings varying from the sublime and pathetic to the humorous: although rather deficient in variety, and possessing too little repose and solemnity for the sustained majesty of epic poetry. It has been adopted by the Germans, who have given to it something of an elegiac turn; and, of late, by English poets, of whom the most distinguished is Lord Byron, who has employed it in his *Beppo* and *Don Juan*, works belonging to a mixed cast of poetry, between the serious and the burlesque.

O'TTER. A quadruped adapted to amphibious habits by its short, strong, flexible, palmated feet, which serve as oars to propel it through the water, and by its long and strong tail, which acts as a powerful rudder, and enables the animal to change its course with great ease and rapidity. The teeth, which consist, in each jaw, of six pointed incisors, two strong and sharp canines, and ten trenchant and cuspidated molars, determine the piscivorous diet and predatory habits of the species. The otter used to be met with in most of the British rivers and lakes; but the increase of population, and the unintermitting hostility which its destruction of the valuable fish of its native streams have called down upon it, have greatly thinned its numbers, and have exterminated it from many of the localities where it was formerly common; so that the otter, as a captive in our menageries, is now regarded with almost the same interest which an exotic species usually excites.

The otter selects for its retreat some convenient excavation concealed by the overhanging roots of the trees which grow from the banks of rivers, or other natural screen. The female goes with young nine weeks, and produces from three to five cubs in March or April. The usual weight of a full-grown male is from twenty to

twenty-four pounds. The fur of the otter is remarkably fine and close. It consists of two kinds of hair; the longer and stiffer shining hairs, which are greyish at the base and a rich brown at the point, concealing an extremely fine and soft fur of a whitish grey colour, brown at the tip. The hair and fur of the under part of the body, the cheeks, and the inner parts of the legs, is of a brownish grey throughout.

The otter is hunted in many parts of England, and especially in Wales, with dogs especially trained for this kind of sport, and with all the form and circumstance of the chase. "When the otter is found," says Mr. Bell, "the scene becomes exceedingly animated. He instantly takes the water and dives, remaining a long time underneath it, and rising at a considerable distance from the place at which he dived. Then the anxious watch that is kept of his rising to 'vent,' the steady purpose with which the dogs follow and bait him as he swims, the attempts of the cunning beast to drown his assailants by diving whilst they have fastened on him, the baying of the hounds, the cries of the hunters, and the fierce and dogged resolution with which the poor hopeless quarry holds his pursuers at bay, inflicting severe, sometimes fatal wounds, and holding on with unflinching pertinacity even to the last, must altogether form a scene as animated and exciting as the veriest epicure in hunting could desire." (*British Quadrupeds*, p. 133.)

The few species of otter which have been recognized in distant parts of the world do not greatly differ from the *Lutra vulgaris* of Europe. The sea-otter is an animal of larger size, and presents such modifications of its palmated feet, and of its teeth, as to form the type of a distinct subgenus (*Enhydras*), which connects the otter with the seal.

O'TTOMAN. An epithet given to the Turkish empire, from Othman I., who ascended the throne in the 14th century. It is also applied to a peculiar kind of sofa much in use in Turkey, and which has been imitated both here and on the Continent.

OUNCE. (Lat. uncia.) A denomination of weight. In troy weight the ounce is the 12th part of the pound, and weighs 480 grains. In avoirdupois weight the ounce is the 16th part of the pound, and equal to 437½ grains troy. *See* WEIGHT.

OURANO'GRAPHY. (Gr. ουρανος, *heaven*, and γραφω, *I describe*.) A term frequently used to signify a description of the heavens and the heavenly bodies.

OURO'LOGY, or OURO'SCOPY. (Gr. ουρον, λεγω, *I speak*, and σκοπεω, *I view*.) The judgment of diseases from an examination of the urine.

OU'TCROP. A Geological term, implying the exposure of a stratum at the earth's surface.

OU'TLAWRY, in Criminal Law, is a punishment inflicted for a contempt in refusing to be amenable to the jurisdiction of a competent court. The act 2 W. 4. c. 39. gives a provision for more expeditious and less expensive proceeding to outlawry in civil cases on mesne process than had previously prevailed. It is issued against a defendant after he has been five times proclaimed at a county court; but if the defendant has previously left the kingdom, he can set it aside by writ of error, or even on motion. The effect of outlawry in civil cases is a forfeiture of personal goods and chattels immediately upon the outlawry, and his chattels real and the profits of his lands when found on inquisition.

OU'TLIER. In Geology, a portion of a rock or stratum detached and at some distance from the principal mass.

OU'TLINE. In the Fine Arts. *See* CONTOUR.

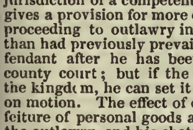
OU'TPOSTS. In a Military sense, a body of men posted beyond the main guard; so called as being the bounds or limits of the camp.

OUTRÈ. (Fr.) In the Fine Arts, anything exaggerated or overstrained.

OU'TRIGGER. The Sea term for any projecting spar or piece of timber for extending ropes, sails, or other temporary purposes.

OU'TWORKS. In Fortification, works raised on the outside of the ditch of a fortified place, for the purposes of covering the place, or keeping the besiegers at a distance. *See* FORTIFICATION.

O'VAL. (Lat. ovum, *an egg*.) A popular name for any curve figure resembling an ellipse, or the transverse section of an egg. The carpenter's oval is made up of four circular arcs, joined so as to leave no angular appearance, or present any rapid change of curvature. It may be described as follows: — Let A B and C D be the length and breadth of the proposed oval, and let these lines be placed at right angles, and bisecting each other at E. With C as a centre, and a radius equal to A E, describe an arc intersecting A B in F and G; with F and G as centres, and a radius equal to A F or B G, describe the small arcs m A m' and n B n' for the ends of the oval; and with C and D as centres (or centres near those points), and C D as a radius, describe the arcs m C n and m' D n'. It may be remarked, that the construction will fail when the breadth C D is not greater than half the length A B; but in this case C D may be produced, and points found in it by trial for the centres of the required arcs.



The *Ovals of Descartes* are a species of geometrical curves, proposed by that philosopher as the figures which give by their revolution about an axis the true surfaces which should separate two media of different densities, in order that all the rays which proceed from the same point, or converge towards one, may be refracted towards another point, or rendered parallel or divergent. They may be defined as the locus of the vertex of a triangle on a given base, one of whose sides has a given ratio to the sum or difference of a given line and the other side. Their generation has thus some resemblance to that of the ellipse and hyperbola, which are the loci of a triangle on a given base whose sides in the case of the ellipse have a given sum, and in the case of the hyperbola a given difference. (See the *Second Book of Descartes' Geometry*.)

Ovals are also produced by the construction of many equations of the higher orders, particularly those in which the dimensions are even, as the fourth, sixth, &c.

OVALBU'MEN. The albumen or white of egg; a term adopted in order to distinguish it from the albumen of the serum of the blood, which may be called *seralbumen*.

OVA'RIA. The two organs which contain the female ova.

OVA'RIUM. In Plants, a hollow case, enclosing ovules or young seeds, containing one or more cells, and ultimately becoming the fruit; it is always situated in the centre of the flower, and, together with the style and stigma, constitutes the female system of the vegetable kingdom. When it is united to the calyx, it is called inferior; when separate from it, it is termed superior.

OVA'TION. An inferior kind of triumph, which, according to the ancient Roman custom, was granted to distinguished military leaders. The name is said to be derived either from ovare (*to cry O!*), the cry of the soldiers; or from ovis, *a sheep*, the animal sacrificed on such occasions instead of bullocks. According to Dionysius of Halicarnassus, the first ovation was celebrated by P. Posthumius Tubertus (A.C. 503), some years after the expulsion of the kings. Some antiquaries imagine the distinction between the triumph and the ovation to have originally consisted, not in the greater or less degree of honour, but in the latter being strictly appropriated to successes by which peace was obtained, or to distinguish brilliant achievements in time of peace. Thus we find that ovations were permitted, though triumphs were not, in civil wars. An ovation was celebrated by Mark Antony and Octavius to solemnize their reconciliation.

OVERHANG. In Architecture. *See* BATTER.

O'VERSEERS OF THE POOR. Officers annually appointed in every parish, under the hand and seal of two justices, under the statute of 43 Eliz. Their number, by that statute, is four, three, or two, for each parish. By subsequent statutes any place maintaining its own poor, whether a parish or not, has overseers. Assistant overseers, with a salary, may be elected by the inhabitants of parishes, under 59 G. 3. *See* POOR LAWS.

O'VERSHOT WHEEL. In Mechanics, a water-wheel to which the water is conveyed over the top of the wheel and applied above the axle. In this case, the water acts merely by its weight, and not by the impulse of the stream.

O'VERT ACT. (Fr. ouvert, *open*.) In Law, an open or manifest act from whence criminality is implied. No indictment for high treason is good unless some *overt act* is alleged in it.

O'VERTURE. (Fr. ouverture.) The introductory piece of music prefixed to an opera or oratorio. Its movements in works of the modern school generally contain snatches of the more prominent and leading airs in the opera, and introduce the audience to a general notion of the emotions which it is the desire of the author to excite.

The word *overture* also signifies a *proposal*; in which sense it is always used in the Presbyterian church to indicate those resolutions proposed by presbyteries and synods, and afterwards laid before the General Assembly, either for its sanction or rejection.

O'VIDUCT, *Oviductus*. (Lat. ovum, *an egg*; duco, *I conduct*.) The tube which conducts the ovum from the ovary either to the uterus or to an external outlet. In Mammals this part is termed the Fallopian tube, from the circumstance of its having been first described by Fallopius about the year 1560 in the human subject, in which this tube or canal passes from each side of the fundus of the uterus to the ovarium. *See* FALLOPIAN TUBE.

OVI'FEROUS and OVI'GEROUS. (Lat. ovum, fero and gero, *I bear*.) In Zoology, certain receptacles, in which the eggs are received after having been excluded from the ordinary formative organs of the ovum, are so

called, as the long pouches appended to the hinder part of the body in many of the Entomostracous and Parasitic Crustaceans. Likewise the ciliated plates (beneath the tail of the higher Crustaceans, as the crab and lobster), to which the eggs are attached after having quitted the oviducts, are called ovigerous.

OVI'PAROUS. (Lat. ovum, and pario, *I produce.*) The mode of generation by the exclusion of the germ in the form and condition of an egg, the development of which takes place out of the body either with or without incubation. Fishes, reptiles, and birds are called Oviparous Vertebrata, although some of both the former classes hatch the egg within the body and bring forth their young alive, as the viper and dog-fish.

O'VIS. (Lat. *a sheep.*) The name by which Linnæus and Cuvier distinguish the sheep as a genus from the goats and antilopes. The character assigned by Cuvier to the genus *Ovis* is as follows:—"Horns directed backwards, and then inclining spirally more or less forwards; the profile or chaufrein more or less convex, and no beard:" to this may be added an interdigital sebaceous sac on the fore part of each foot. The *Mouflons* or *Musmons* of Africa and Sardinia, from which it is generally believed our domestic races of sheep are derived, form the species *Ovis ammon* of Linnæus, and *Ovis musimon* of Schreber. The coat of these wild sheep consists of coarse, stiff, long, and nearly straight hairs; but they possess the same character, that of an imbricated surface, which gives to the shorter and finer wool of the domestic races the felting property on which its peculiar utility depends. *See* HAIR.

Of the domestic animals belonging to Great Britain sheep are, with the exception perhaps of horses and cattle, by far the most important. They can be reared in situations and upon soils where other animals would not live. They afford a large supply of food, and one of the principal materials of clothing. Wool has long been a staple commodity of this country, and its manufacture employs an immense number of people. "The skin, dressed, forms different parts of our apparel; and is used for covers of books. The entrails, properly prepared and twisted, serve for strings for various musical instruments. The bones, calcined (like other bones in general), form materials for tests for the refiner. The milk is thicker than that of cows, and consequently yields a greater quantity of butter and cheese; and, in some places, is so rich that it will not produce the cheese without a mixture of water to make it part from the whey. The dung is a remarkably rich manure; insomuch that the folding of sheep is become too useful a branch of husbandry for the farmer to neglect. To conclude, whether we consider the advantages that result from this animal to individuals in particular, or to these kingdoms in general, we may, with Columella, consider this, in one sense, as the first of the domestic quadrupeds. '*Post majores quadrupedes ovilli pecoris secunda ratio est; quæ prima sit si ad utilitatis magnitudinem referas. Nam id præcipue contra frigoris violentiam protegit, corporibusque nostris liberaliora præbet velamina; et etiam elegantium mensas jucundis et numerosis dapibus exornat.*'—(*De Re Rustica*, lib. vii. cap. 2.) And, in addition to what Mr. Pennant has so forcibly stated, sheep are particularly deserving the attention of the agriculturist, both from the influence of improvements on the breed, and from their generally affording larger profits than can be obtained from the rearing and feeding of cattle. (*Statistics of the Brit. Empire*, vol. i. p. 492.)

The principal varieties of the English sheep are the large Lincolnshire, the Dorset breed, the South-down, and the Cheviot.

The Lincolnshire sheep are of a large size, big-boned, and afford a great quantity of wool, owing to the rich marshes on which they feed; but their flesh is coarser, leaner, and less finely flavoured than that of the smaller breeds.

The Dorset sheep are mostly white-faced; their horns are finely curved, their fleece clear and white; but many of them are without wool upon their bellies; their legs are long and small, and their general form handsome and well-proportioned. This breed is prolific, and is principally esteemed for producing lambs at an earlier period than other varieties. "Great numbers of these premature victims to luxury are yearly sent to the London markets, where they fetch the price of 10*s*. 6*d*. to 15*s*. per quarter. The manner of rearing the lambs is curious: they are imprisoned in little dark cabins; the ewes are fed on oil-cakes, hay, corn, turnips, or cabbages, which are given them in a field contiguous to the apartments where the lambs are kept; and at proper intervals the nurses are brought in to give suck to their young ones, while the attendants at the same time make their lodgings perfectly clean, and litter them with fresh straw. Great attention is paid to this, as much of the success of rearing these unseasonable productions depends upon warmth and cleanliness."

The South-down sheep have dun or black faces, and are of the same hardy nature as the Cheviot breed, being able to live and thrive on the barest chalk hills. Their wool is fine and their mutton well-flavoured. They have of late years, in consequence of these valuable qualities, extended to most parts of England, and have been introduced into Ireland. The Cheviot breed have no horns, and are mostly white-faced and white-legged; the body is long, with fine, clean, small-boned legs: the mutton is highly esteemed for its flavour. They are valuable as mountain sheep, on account of their hardiness and the superior value of their wool. There is a singular variety of sheep in the northern climates of Europe, in which the monstrosity of supernumerary horns has become hereditary: these are called many-horned sheep, and have from four to eight horns growing irregularly from the head.

It is not possible to form any accurate estimate either of the number of sheep or of the quantity of wool annually produced in this country. With the exception of Mr. Luccock's, most of the statements put forth with respect to both these points seem very much exaggerated. But Mr. L.'s estimate, which is considerably under any that had previously appeared, was drawn up with great care, and is supposed to approach nearer to accuracy.

According to Mr. Luccock, the

Number of long-woolled sheep in England and Wales, in 1800, was	4,153,308	
Of short-woolled, ditto -	14,854,299	
Total number shorn -		19,007,607
Slaughter of short-woolled sheep per annum - -	4,221,748	
Carrion of ditto - - -	211,087	
Slaughter of long-woolled ditto -	1,180,413	
Carrion of ditto - - -	59,020	
Slaughter of lambs - - -	1,400,560	
Carrion of ditto - - -	70,028	
		7,140,856
Total number of sheep and lambs -		26,148,463

In some parts of England there has been an increase in the numbers of sheep since 1800; but in others there has been a decrease. But we have been assured by competent judges that, on the whole, the number has not sensibly varied in the interval.

In the *General Report of Scotland* (vol. iii. Appendix, p. 6.) the number of sheep is estimated at 2,850,000; and, allowing for the increase that has taken place since 1814, they may now be estimated at about 3,500,000. Hence the total number of sheep in Great Britain will be 39,648,000. It is not supposed that there are 2,000,000 of sheep in Ireland. (*Statistics of the British Empire*, vol. i. p. 496.)

The foreign breeds of sheep are exceedingly numerous; but of these, perhaps, the Asiatic variety is the most singular. In India, the sheep is long-tailed; and in Persia, Tartary, and China, &c., the tail is not only elongated, but loaded with a mass of fat in some instances weighing ten pounds. The power which this animal possesses to accommodate itself to different climates seems almost unlimited: in the hot plains of Asia its covering becomes coarse and scanty; while in the frozen regions of Thibet its thick wool has an under lining of the finest kind, forming an important article in manufactures and commerce. (See the *Geo. Dict.*, art. "Asia," and the authorities there cited.)

O'VISAC, *Ovisaccus*. (Lat. ovum, *an egg*, and saccus, *a sack.*) The cavity in the ovary which immediately contains the ovum. In Mammals it forms, after the ovum is expelled, the *corpus luteum*.

OVIPO'SITOR (Lat. ovum, and pono, *I place*), in Entomology, is the instrument by which an insect conducts its eggs to their appropriate nidus, and often bores a way to it; the same instrument is, in some genera, used as a weapon of offence, when it is called the "aculeus."

O'VOLO. (Ital.) In Architecture, a moulding whose profile is the quadrant of a circle; though in Grecian architecture there is a deviation from that exact form, which is most apparent at the upper portion, where it resembles the form of an egg, whence this moulding derives its name.

OVOVIVI'PAROUS. (Lat. ovum, *an egg;* vivo, *I live;* and pario, *I produce.*) The mode of generation by the exclusion of a living fœtus more or less extricated from the egg-coverings, which has been developed within the body of the parent without any vascular or placental adhesions between the ovum and the womb. The marsupial animals among the Mammalia, the viper and salamander among Reptiles, the blenny and dog-fish among fishes, the *Paludina vivipara* and many bivalves among Mollusks, the scorpion and flesh-fly among insects, the earth-worm, and many of the intestinal worms, are examples of oviviparous animals.

O'VULUM. (Lat. ovum, *an egg.*) The name of a genus of Pectinibranchiate Gastropods, characterized by having a shell of an oval form, and with a long and narrow aperture, without furrows or teeth, on the side of the columella; the spire is concealed, and the two extremities of the aperture are equally prolonged into a canal.

This diminutive is also applied to the ovum of the Mammalia on account of its relatively minute size: it is, however, a true ovum, having all the essential parts, as the germinal spot, germinal membrane, vitellus, vitelline membrane, and chorion. *See* OVUM.

OVULUM. In Botany, a small pellucid pulpy body, borne by the placenta of a plant, and gradually changing into a seed; it consists of a central nucleus, enclosed within a definite number of coats, varying from one to two, and furnished with an aperture or foramen, through which impregnation takes place.

OVUM. (Lat. *an egg.*) In Anatomy, the body formed by the female in which, after impregnation, the development of the fœtus takes place. It is generally formed in a special organ, called the ovarium; but in some of the simplest animals, as the Polypes, the common cellular parenchyme of the body seems to have the unlimited faculty of producing the ova. The essential and apparently first-formed part of an ovum is a minute pellucid cell, called the "germinal vesicle," which is characterized by an opaque speck or nucleus, called the "germinal spot." The vesicle is immediately surrounded by a stratum of granules or nucleated cells, which form the "germinal disk." These parts float in a greater or less quantity of fluid and granules, called the yolk, which is generally of some well-marked colour, as yellow, green, violet, red, through the presence of a minutely diffused oil. The yolk is inclosed in a thin, delicate, structureless coat, called the "vitelline membrane," and this is finally surrounded by an outer tunic called the "chorion." Between the chorion and vitelline membrane there is commonly a greater or less quantity of albumen. In the birds this fluid, which is called the "white," and the "yolk," is in great quantity; the chorion is laminated, and the outer layer is combined with earthy salts to give due firmness, and preserve the shape of the egg while subject to the weight of the parent during incubation. Two twisted strings of firm albumen, called "chalazæ," are continued from each end of the yolk, a little below the poles, and serve to keep uppermost the "cicatricula" or "tread," formed by the impregnated germinal vesicle and disk. A space intercepted between two of the layers of the chorion, or "membrana putaminis," at the great end of the egg, contains a small quantity of gas, containing more oxygen than atmospheric air: this space is called the "vesica aerea." (For the chemical properties of *ovum*, see EGG.)

OVUM. In Architecture, the same as Ovolo; which see.

OWL. *See* NOCTURNALS and STRIX.

OW'LING. In Law, so called from its being generally committed during the night. An offence consisting in conveying sheep or wool to the sea side in order to export them. This offence was formerly capital, particularly if the offenders neglected to surrender after proclamation made for that purpose; — it is now punishable with seven years' banishment.

OWL, THE. Among the ancients, generally was considered as an omen of misfortune or death. As, however, according to Philostratus, the Egyptians represented Minerva under the form of an owl, the Athenians, so peculiarly under the care of this goddess, looked upon the appearance of this bird as a favourable omen. From this circumstance it formed, upon ancient coins, the symbol of Athens and her foreign possessions.

OX. Synonymous with the generic name *Bos*, which see; in a more restricted sense it signifies the castrated male of the domestic variety.

OXALAMIDE. *See* OXAMIDE.

O'XALATES. Salts of the oxalic acid.

OXA'LIC ACID. A vegetable acid, first discovered in the juice of the *Oxalis acetosella;* it was afterwards ascertained that the same acid might be produced artificially by the action of nitric acid upon sugar: this process yields it in slender prismatic crystals, intensely sour, and soluble in about 10 parts of cold water. These crystals consist of 1 atom of real acid and 3 of water: the equivalent of the acid is 36; and in its anhydrous state, as it exists in the dry oxalates, it is constituted of 2 atoms of carbon $(6 \times 2) = 12$, and 3 of oxygen $(8 \times 3) = 24$: so that it may be represented by an atom of carbonic acid and one of carbonic oxide. Solutions of oxalic acid, or of soluble oxalates, yield an insoluble precipitate in solutions containing lime and its salts: hence its use in the laboratory as a test of the presence of that earth. The solution of oxalate of ammonia is generally used for the purpose. Oxalic acid is a powerful poison, and, from its resemblance to Epsom salt, it has sometimes been sold and mistaken for that harmless aperient. In such cases, the best antidote is a mixture of chalk and water, and where it is immediately administered it generally prevents the accession of fatal symptoms; it forms an insoluble oxalate of lime, which is inert.

OXALIDA'CEÆ. (Oxalis, one of the genera.) A natural order of herbaceous or shrubby Exogens, inhabiting the hotter and temperate parts of the world. Their foliage is generally acid, and fit to supply the place of sorrel. *Oxalis acetosella* contains pure oxalic acid, and many are used in Brazil against malignant fevers.

O'XAMIDE. A white substance produced during the destructive distillation of oxalate of ammonia: hence its name, compounded of *oxalis* and *ammonia*. It is a compound of nitrogen, hydrogen, oxygen, and carbon, in such proportions as to form oxalate of ammonia by the addition of one atom of water. (See Dumas, *Theorie des Amides, Chim. App. aux Arts*, v. 84.)

OXGANG (Germ. ochs, *an ox*, and gang, *a walk*), in English Antiquities, was used to signify as much land as a single ox could *ear* or plough in a season. The *oxgang* was contracted or expanded according to the quality of the land; forty acres constituting the *maximum* and six the *minimum* of the measure.

OXIDATION, or OXIDIZEMENT. The act of combination with oxygen.

O'XIDE. (Gr. *οξυς*, *acid*, and *ειδος*, *form.*) Compounds containing oxygen, but which are not *acid*, have been termed *oxides*. The metallic oxides are a most important class of bodies. To designate the different oxides of one base we generally use the first syllable of the Greek ordinal numerals, designating the first, second, third, &c. oxides by the terms *protoxide, deutoxide, tritoxide,* &c.; and when the base is saturated with oxygen (still not acid), it is termed a *peroxide*. Compounds of bases with one atom and a half oxygen, or of two base and three oxygen, are now generally distinguished by the term *sesquioxides*.

O'XYGEN. (Gr. *οξυς*, and *γενναειν*, *to generate.*) This important element was discovered, in 1774, by Dr. Priestley. It has been termed *dephlogisticated air, vital air*, and *empyreal air*. As it forms a component part of many of the acids, it was termed, at the framing of the new nomenclature, *oxygen gas*. There are several compounds of oxygen which, when exposed to heat, are decomposed, and yield the gas in a state of purity: of these the best is chlorate of potash; but as that salt is expensive, we generally resort to black oxide of manganese, which, at a dull red heat, gives out a considerable quantity of tolerably pure oxygen gas.

Oxygen gas is colourless, tasteless, and inodorous; it is electro-negative, and therefore when compounds containing it are electrically decomposed, it always appears at the positive surface. It is a little heavier than atmospheric air, in the proportion, that is, of 11 to 10; 100 cubical inches weighing 34·6 grains. It is not absorbed by water, and is neither acid nor alkaline. It has a powerful attraction for most of the simple substances, especially for the electro-positive bodies: the act of combining with it is called *oxidation*. The compounds thus formed are divided into *acids* and *oxides:* among the latter are the alkalis, and almost all salifiable bases. Oxidation is often attended with the evolution of heat and light, as in all processes of combustion in atmospheric air: sometimes it is slow, and unattended with such phenomena, as in the gradual rusting of metals. Oxygen is a most powerful supporter of combustion; it constitutes one fifth of the bulk of the atmosphere, and is the principle which enables combustible bodies to burn in it. The product of combustion, that is, the oxide or acid, is sometimes itself gaseous, as when charcoal, by burning, is converted into carbonic acid; or it is liquid, as hydrogen, by combustion, produces water; or it is solid, as when iron, by burning, produces oxide of iron. Oxygen gas is also essential to respiration; that is, to the evolution of carbonic acid from the blood.

OXY'GONE. (Gr. *οξυς*, and *γωνια*, *angle.*) In Geometry, a term applied to figures in which all the angles are acute.

OXYHY'DROGEN BLOWPIPE. When a mixture of one volume of oxygen and two of hydrogen are burned whilst issuing from a small aperture, they produce intense heat; and instruments under the above name have been contrived for their safe combustion, so as to avoid the risk of explosion.

O'XYMEL. (Gr. *οξυς*, and *μελι*, *honey.*) A mixture of honey and vinegar. It is sometimes made the vehicle of medicines, as oxymel of squills, &c.

OXYMU'RIATE OF LIME. The valuable bleaching compound obtained by exposing slaked quicklime to the action of chlorine is commonly so termed; it is, however, a chloride of lime.

O'XYMURIA'TIC ACID. This name was originally applied to chlorine, under the idea that it consisted of muriatic acid and oxygen. The fallacy of that opinion was first demonstrated by Davy, who showed that, in all the apparent cases of the evolution of oxygen from chlorine, its source was referable to the presence of water or of an oxide. Chlorine possesses a stronger attraction for bases than oxygen; so that, when metallic oxides are exposed to its action, the chlorine combines with the metal to form a chloride (formerly called a *muriate*), and the oxygen is evolved.

OXYO'PIA. (Gr. *οξυς*, and *ωψ*, *the eye.*) Preternaturally acute vision.

OXYU'RES, *Oxyuri.* (Gr. *οξυς*, and *ουρα*, *a tail.*) The

name of a family of Pupivorous Hymenopterans, comprehending those which have a sort of tail, or terminal appendage, produced by an external ovipositor or borer. A genus of intestinal worms (Cæleiminthans) is also called *Oxyurus*.

OYER. (From the Norman French oyer, *to hear.*) In Law, when an action is brought on a bond or other specialty the defendant, previously to pleading in bar, may crave oyer of the instrument on which the action is brought; that is, to have it read to him; which prayer includes that of a copy also. Whenever offer of a deed is necessarily made by the party relying on it (by what is termed a *profert in curia*), the other party may crave oyer. Oyer is not, in strictness, demandable of a record, or of an act of parliament.

OYER AND TERMINER. (Fr. *to hear and determine.*) In Law, a commission directed to the judges, and other gentlemen of the courts to which it is issued, by virtue of which they have power, as the terms imply, *to hear and determine* certain specified offences.

OYEZ. (Plur. imperative of the same verb.) "Hear ye." The cry of ushers in Norman courts of justice, metamorphosed into the English "O yes."

OYSANITE. *See* OISANITE.

OYSTER. (Lat. ostrea, *an oyster.*) This name is generally understood to signify the species of Ostracean bivalve called *Ostrea edulis*, which is one of a numerous genus, characterized by an inequivalve shell, composed of two irregular lamellated valves, of which the convex or under one adheres to rocks, piles, or to the shell of another individual. The animal is unprovided with either a byssus or a foot; it is the best flavoured of its class, and has, consequently, been always much esteemed. Vast beds of oysters are artificially formed, and attended too with great care, at the estuary of the Thames and many other localities, where the temperature of the water is somewhat raised by a mixture of salt and fresh water, in which they best thrive. Certain restrictions and regulations are enforced in reference to the sale of oysters in the metropolis, in order to favour the multiplication and rearing of this valuable bivalve. They are permitted to be sold from August to May, the close months being May, June, and July. They cast their spat or spawn in May, when they are said to be sick; but begin to recover in June and July, and in August they are perfectly well. Oysters differ in quality, according to the different nature of the soil or bed. The best British oysters are found at Purfleet; the worst near Liverpool. The nursing and feeding of oysters is almost exclusively carried on at Colchester, and other places in Essex. The oysters are brought from the coast of Hampshire, Dorset, and other maritime counties, even as far as Scotland, and laid on beds or layings in creeks along the shore, where they grow, in two or three years, to a considerable size, and have their flavour improved. There are said to be about 200 vessels, from 12 to 40 or 50 tons burden, immediately employed in dredging for oysters, having from 400 to 500 men and boys attached to them. The quantity of oysters bred and taken in Essex, and consumed mostly in London, is supposed to amount to 14,000 or 15,000 bushels a year. (*Supp. to Ency. Brit.*, art. "Fisheries.") Oysters formed a great luxury among the Romans, and, as in France, were served at the commencement of a repast. The largest and best of Italy were caught on the shores of the Lucrine; but the Romans used to send vessels even to the coast of Britain in quest of this luxury, the British oysters being then as now in the highest estimation.

OZÆ'NA. (Gr. οζω, *I smell.*) An ulcer in the nose which discharges a fœtid purulent matter, and is sometimes symptomatic of caries of the bones.

P.

P. A consonant of the labial series. As was to be expected from the approximation of this letter in sound to *b*, it is susceptible of interchange with the latter in nearly all the languages of which we have any knowledge, but more especially in the German. Both in this country and on the Continent there are whole districts in which not only is the ear of the natives insensible to the difference between the sound of these letters, but, with a tendency to error of which it would be vain to investigate the cause, they are almost invariably confounded in pronunciation. Of this peculiarity several counties of Wales among ourselves, and the whole of Lower Saxony in Germany, present noted examples. For the most usual abbreviations of this letter, see ABBREVIATION.

P. In Music, an abbreviation of the Italian word *piano*, soft, denoting that the force of the voice or instrument is to be diminished. P.P. means *piu piano*, or more soft; and P.P.P. *pianissimo*, as soft as possible.

PACE. (Fr. pas.) A denomination of linear measure, of uncertain extent; assumed by some to be 5 feet, by others 4·4. It is the quantity supposed to be measured by the foot from the place where it is taken up to that where it is set down. The ancient Roman pace, considered as the thousandth part of a mile, was five Roman feet, and each foot contained between 11·60 and 11·64 modern English inches; hence the pace was about 58·1 English inches, and the Roman mile, the *mille passus*, equal to 1614 yards. *See* MILE.

PA'CHA. (Pronounced *pasha;* contracted from the Persian padi shah, *foot of the shah.*) A title of honour, given in the origin of the Turkish empire to the ministers and chief assistants of the sultan, whether military or learned. (See *Von Hammer's History of the Turkish Empire*, vol. i. p. 137.) In process of time attributed particularly to the governors of provinces, styled *pachaliks.* The well-known distinction of rank between the two classes of pachas consists in the number of horse-tails which are carried before them as standards, the higher having three and the lower two. There were until recently 25 pachaliks, subdivided into sangiacates, besides various independent jurisdictions scattered over the empire.

PA'CHACA'MAC. The name given by the idolaters of Peru to the being whom they worshipped as the creator of the universe; this divinity was held in the highest veneration. In the fruitful valley of Pachacama (whence the name) the incas dedicated to his honour a temple of such splendour and wealth, that notwithstanding the rapacity of the Spanish soldiers, by whom it was plundered previously to the arrival of Pizarro, that general is said to have drawn from it treasures to the amount of 900,000 ducats. The ruins of this temple which still remain furnish a high notion of its former magnificence.

PA'CHYDE'RMATA. (Gr. παχυς, *thick*, and δερμα, *skin.*) An order of quadrupeds, including the elephant, horse, pig, &c., distinguished by the thickness of their hides.

PACHYGLOSSATES, *Pachyglossi.* (Gr. παχυς, and γλωσσα, *a tongue.*) The name of a family of parrots (*Psittacini*), comprehending those which have a thick protractile tongue.

PACHYO'TES, *Pachyoti.* (Gr. παχυς, and ους, *an ear.*) The name of a family of bats (*Cheiroptera*), including those which have thick external ears.

PACI'FIC. The name given by Magalhaens, the first European who traversed it, to the ocean which extends between America on the east and Asia and Australia on the west, in consequence of his enjoying fair weather on entering it, after having previously experienced a track of bad weather and tempestuous gales in the straits which bear his name. The Pacific is the greatest expanse of water on the globe.

PACIFICA'TION, EDICTS OF. The term usually applied to the edicts issued by the French monarchs in favour of their Protestant subjects, in the view of allaying the commotions occasioned by their previous persecutions. The first edict of this nature was promulgated by Charles IX. in 1562; but the most celebrated was the edict of Nantes (which see), issued by Henry IV. in 1598, and revoked by Louis XIV. in 1685.

PA'CKET, in Navigation, meant originally a vessel appointed by government to carry the mails between the mother country and foreign countries or her own dependencies. It is now used as nearly synonymous with an ordinary vessel, chiefly of small burden, that freights goods or passengers.

PA'CKFONG. The Chinese name of the alloy of nickel and copper commonly called *German silver.* It is an alloy of 7 parts of zinc, 2·5 copper, and 6·5 nickel.

PACK-HORSE. A horse employed to carry goods on its back in bundles, called packages or packs. In countries not yet intersected by regular roads this is the only mode of transporting goods from one part to another. In Britain horses were formerly employed for this purpose, but for these carts and waggons are now substituted. In Spain mules and asses are still so employed, and in Asia and Africa camels and dromedaries.

PA'COS. The Peruvian name of an earthy-looking ore, which consists of brown oxide of iron, with imperceptible particles of native silver disseminated through it. (See *Ure's Dictionary of Arts, &c.*)

PA'DDING, in Calico-printing, is the impregnation of the cloth with a mordant.

PA'DDLE. A kind of oar used by savage nations in navigating their canoes. The paddle is broader at the end than the common oar; and being employed at the stern of the canoe, not only impels her forwards, but regulates her course exactly like a rudder. *See* SCULLING.

PADDLES. *See* STEAM NAVIGATION.

PA'DDOCK. This term was formerly applied to a strip of ground in a park, pailed round, for hounds to run matches in; but at present it is chiefly used to denote a small enclosure under pasture, immediately adjoining the stables of a domain, for turning in a sick horse, a mare and foal, or any similar purpose.

PADI'SHA. (From pad, *protector* or *throne*, and

shah, *prince.*) A title of the Turkish sultan and Persian shah. Formerly the Turkish emperor conferred this title upon the kings of France alone among the European sovereigns, but we believe that the honour is now likewise shared by the emperors of Austria and Russia. *See* PACHA.

PA'DUAN COINS. In the Fine Arts, coins forged by the celebrated Paduans, Cavino and Bassiano; who were also the artists employed on the pope's medals, from Julius III. to Gregory XIII. (1571). These coins hold the first rank in imitations of ancient medals for their masterly execution. M. Beauvais says of them, "that they are seldom thinner than the ancient coins themselves; that they seldom appear as worn or damaged, whilst others very frequently do, especially in the reverse, which sometimes, as in many Othos, appears half consumed by time; and while (he observes) counterfeit medals are very commonly of as irregular a form as the real, those of the Paduan masters are generally circular." Still more modern forgers, who were without the talents which these Paduans possessed to engrave dies, have been content to mould them from their productions; but these are cast coins, which it requires no very extraordinary knowledge to detect. The marks of the file upon their edges are mostly a sure sign of the imposition; those, however, who collect these objects of art should be constantly on their guard.

PÆ'AN. (Gr. Παιάν.) Among the Greeks, properly a hymn in honour of Apollo, who was also called Pæan. Also a war song before or after battle: in the first case in honour of Mars, in the second as a thanksgiving to Apollo.

PÆAN. In Ancient Poetry, a foot consisting of four syllables, of which there are four kinds; the Pæan primus, secundus, &c. *See* FOOT.

PÆ'DOBA'PTISTS. (Gr. παις, *a child*, and βαπτιζω, *I baptize.*) Those who hold that baptism should be administered during infancy. The great majority of Christian churches which allow the baptism of infants are thus denominated from that circumstance, and are thereby distinguished from the Antipædobaptists, *i. e.* those who deny the validity of infant baptism. *See* BAPTISTS.

PA'GAN (Lat. paganus; from pagus, *a village*), among the Romans, was, as the term imports, applied to all who lived in villages, in contradistinction to the inhabitants of cities. In its present signification it is the opposite of *Christian*, being synonymous with heathen, gentile, and idolater; and was originally so applied because the inhabitants of villages continued to adhere to their idolatrous practices after Christianity had been introduced into towns and cities. The precise period when the term pagan was first used in its present acceptation has not been ascertained. *See* HEATHEN.

PAGANA'LIA. (Lat.) Festivals held in each Roman village in honour of the local tutelary divinities. They were instituted by Servius Tullius, who commanded every inhabitant of each *pagus*, or village, to assemble annually on a certain day, and offer public sacrifices. In instituting these festivals Servius had both a political and religious object in view; for, as every inhabitant was compelled to bring a small coin, varying with the age and sex of the bearer, he was annually acquainted with the strength of each district, and consequently with that of the kingdom.

PA'GANISM. A general appellation for the religious worship of the whole human race, except of that portion which has embraced Christianity, Judaeism, or Mohammedanism. Under the head POLYTHEISM, we have given a brief outline of the different kinds of pagan worship, and we shall in this place confine our remarks to the origin of the system.

That in the most ancient times one God, sole, eternal, indivisible, the creator of the universe, was acknowledged and worshipped, has been proved by the most profound investigators of antiquity. The existence of this belief may not only be traced in the tradition of all people, but is expressly affirmed by some of the greatest philosophers of the heathen world. Nothing, indeed, could exceed the contempt with which some of them regarded the gods of the vulgar, though fear of danger or some other cause often taught them to conceal the sentiment.

The causes of idolatry were manifold, and were mostly of oriental growth. A great king regarded it as below his dignity to enter into the minute details of administration: he placed vicars or ministers over provinces and cities, over the great departments of national polity. If the onerous charge was inapplicable to an earthly, it was still more so to the celestial Sovereign: hence the subordinate deities which we perceive in the religious systems of all nations, — the presiding genii of the Chaldæans, the numerous gods of Greece and Rome. The worship due to the Supreme alone was soon transferred to those imaginary entities, which, from functionaries, were transferred into so many independent chiefs, until the simple primeval notion of the divine unity was lost. The other causes of idolatry are foreign to our purpose: the one already assigned, which is indisputably the most ancient and the most obvious, is of itself sufficient to account for the fact.

In its origin paganism, as a system, was simpel. A few great divinities were placed in heaven to guide the affairs of the visible and invisible worlds. By degrees each great planet, each law of nature, each region and city, nay each river, fountain, wood, tree, mineral, had its tutelary divinity. The laws of nature were often inexplicable; what more obvious than to infer that each was subject to a superior power? As the ideas of men became more precise and refined, gods were placed over human faculties and passions: thus the understanding and the will, love and revenge, were the offspring of certain deities. Mere abstractions were similarly personified; until the empire of reason, of sentiment, and of morals, was as much pervaded as earth, air, and ocean with these visionary beings. But might not men themselves attain to that mysterious dignity? might they not become at least a sort of demigods,—a distinction earned by some uncommon merit? In all countries we find instances of deification. Nor need this surprise. The human mind is naturally prone to exaggeration, — the human heart to be led astray by the intensity of its own feelings. Thus he who, during life, proved himself a benefactor to his countrymen, who taught them useful arts, or freed them from some impending evil, would be regarded with affectionate admiration by his contemporaries; and time, which so constantly increases every object, would convert a great exploit, a shining virtue, into a divine effort. But it not unfrequently happened that men were often deified for brute strength, unaccompanied by those elevated mental qualities which form the noblest distinction of the hero. It may, however, be observed, that in such cases men were always reverenced for the quality most wanted in a state. If a district were infested by wild beasts, or by predatory savages, a Hercules arose to free it. If a country required laws, a Minos established them. If the culture of the grape was unknown, a Bacchus appeared to teach it. Such benefactors, it was believed, deserved, as they certainly obtained, the peculiar favour of heaven, — rewards which far transcended those bestowed on other men. In most cases, however, each was held to be a divinity, or at least the offspring of one. As the generation of the gods was a received tenet, and their union with mortals of constant occurrence, imagination had little difficulty in the filiation of a benefactor. Most nations were eager to proclaim a god as their founder; and when one laid claim to the honour, the example was speedily followed by others with equal appearance of justice. Hence the prodigious number of divinities; heaven and hell, the earth and the planets, air and ocean, the whole frame of nature, every part of the universe, visible and invisible, even the realms of imagination, being pervaded by them; and hence idolatry became a complicated system, endless in its forms of worship as in its objects.

It has indeed been contended that even in the most unenlightened times, men — except, perhaps, the grossest in comprehension — were never so absurd as to receive this almost infinite plurality of deities; that each derived its name from its being a distinct manifestation of the divine energy; that the Neptune of the sea, the Apollo of the sun, the Minerva of the understanding, the Jove of the thunder, were mere denominations, founded on the distinct modes in which the Supreme manifests himself to the world: in short, that those denominations were but so many imaginative terms for the emanations of the all-pervading Deity; and that under each distinct emanation this deity might be worshipped without the charge of idolatry. But this hypothesis is too refined to be just, and is contrary to experience. The known progress of the human mind is from sensual to ideal, not from the ideal to the sensual; philosophy is the end, not the beginning of knowledge. If that great patriarchal truth, the unity of the Godhead, was obscured by successive ages of ignorance, it could be regained only by an opposite and equally laborious process of the intellect; and even when thus recovered, it could not be communicated without danger to the multitude. (*Cab. Cyc.; Arts, &c. of the Greeks and Romans*, vol. ii.) *See* MONOTHEISM.

PAGE. (Modern Latin pagius, of uncertain derivation; according to some, from pagus, *village.*) In high life, a youth attached to the service of a royal or noble personage. In the ancient Persian court (which has been not ill termed the archetype of all courts), we find the usage of employing a number of youths of the noblest families of the empire in personal attendance on the sovereign. Among the Greeks and Romans (to whom monarchical institutions, strictly so called, were unknown), no analogous custom appears to have prevailed. Among the northern nations, on the other hand, personal service of this sort was common. The name pages, however, appears confined to slaves and attendants of an inferior description, in modern Europe, until the reigns of Charles VI. and VII. of France. (*Fauchet's Origine des Chevaliers.*) As chivalric institutions prevailed, the office, by whatever

name called, became of importance; courts and castles were the schools in which the young noble passed through the degree of page, in order to reach the farther steps of esquire and knight, when he became "hors de page." In the 16th century the chivalrous character had become much adulterated; but the custom of bringing up sons as pages at courts continued until the disorder and licence of the age rendered the service so dangerous that it was no longer sought by the better classes as a mode of education for their children. Pages then became, as they are now, mere relics of feudal custom: from some courts (the Prussian, for instance) they have entirely disappeared; and the young noblemen of the cadet school perform the office of pages on solemn occasions. (See Sainte-Palaye, *Memoires sur la Chevalrie; Mem. de l'Ac. des Inscr.* vol. xx.)

PAGE. In Printing, one side of the leaf of a book. A folio volume contains 4 pages in every sheet; a quarto 8, an octavo 16, a duodecimo 24, and an octodecimo (18mo.) 36 pages.

PA'GEANT, in its general sense, a public representation or exhibition of a showy and splendid character. It was a very early custom in the middle ages, both in England and on the Continent, to celebrate festive occasions of a public nature, as royal visits, marriages, &c., by some ornamental show in the public streets of cities. During the period of chivalry these shows began to be exhibited with the addition of masked figures, representing allegorical personages, with appropriate scenery; and as, in process of time, speeches in verse or prose were put into the mouths of these figures, and sometimes a kind of dramatic entertainment performed between them, the pageant consequently holds a place in our early literature. The earliest speaking pageant of which we have any account was presented on the triumphal entry of Henry VI. into London, in 1432; and the poetical part of it is conjectured to have been supplied by Lydgate. The reign of Henry VIII. was fertile in pageants of an extraordinary magnificence and splendour; but in that of queen Elizabeth they assumed a different form, and were both devised and enacted with much more elegance: partly from the tincture of romantic gallantry which distinguished the court of the maiden queen, and was perceptible in all the homage rendered to her by her subjects, and partly from the sudden development of the poetical genius of the nation. The pageants gradually became more dramatic, and thus approximated more nearly to the more elegant character of the masque (*see* MASQUE), which, under her successor, became the fashionable court entertainment. Pageants, however, were still presented by the city of London, which retained a poet laureat of its own for the purpose of inditing the spoken part of them, down to the year 1700, or thereabouts; and the lord mayor's procession still retains some characteristics of these ancient entertainments. The derivation of this word is wholly unknown, and has afforded much scope to the fancy of etymologists.

PA'GINA. (Lat.) In Botany, the surface of a leaf.

PAGO'DA. (Pers. poutghad, *a house of an idol.*) In Architecture, the East Indian name for a temple containing an idol. Sometimes it signifies the idol itself. The pagoda is generally of three subdivisions. First, an apartment whose ceiling is a dome resting on columns of stone or marble: this part is open to all persons. Second, an apartment forbidden to all but brahmins. Third and last, the cell which contains the statue of the deity, enclosed with a massy gate.

PAGODA, is also the name of a gold coin, value from 8*s.* to 9*s.*, current in several parts of India. It is also the name of a silver coin of the same value, on which are stamped images of the Hindoo gods.

PA'GODITE. A species of steatite or serpentine, which the Chinese carve into figures.

PAGU'RIANS, *Paguridæ.* (Lat. pagurus, *hermit-crabs.*) The name of a tribe of Macrurous Decapod Crustaceans, of which the genus *Pagurus* is the type. Most of the species of this family inhabit, parasitically, the deserted shells of univalves.

PAI'NIM. A poetical expression used by English writers for *pagan.*

PAINS AND PENALTIES, BILL OF. A species of process employed to inflict punishment on state offenders out of the ordinary course of justice. Every bill brought into parliament for the purpose of inflicting such punishment is a bill of pains and penalties, of which bills of attainder (*see* ATTAINDER) are, properly speaking, a species; but the term is more commonly confined to bills introduced to inflict specified penalties for particular acts. The latest instance of this extraordinary proceeding was the bill of pains and penalties against Queen Caroline (1820), introduced into the House of Lords, and passed by them, but which was not carried into the Commons.

PAI'NTER. In Naval language, a rope used to fasten a boat either alongside of the ship to which it belongs, or to some wharf, quay, &c., as occasion requires.

PAI'NTERS' COLIC. The peculiar disease, which usually terminates in palsy and mental imbecility, to which painters and others subject to lead poisons are subject. It is also called colic of Poitou and Devonshire colic; the miners employed in lead-works being also liable to its attacks. *See* COLIC.

PAI'NTING (Fr. peinture, Lat. pictura), strictly defined, is an art which, by means of lines and colours, represents on a plane surface all objects presented to the eye or to the imagination. The etymology of the word (γραφειν) used to express painting among the Greeks, being the same as that employed for writing, seems to identify the tools with which it was performed among that people: viz. a style or pen of wood, used on a levigated plane of wood, metal, or some other prepared ground; the mode, letters or lines. Until its operations become founded on the faithful representations of visible objects of nature, undisfigured by mannerism and modification from the fashion and habits of a country, such, for instance, as we meet with in the Indian, Egyptian, and Chinese representations of the human form, it is scarcely entitled to the appellation of art; hence we shall, in this article, dismiss, with very few remarks, its appearance in those countries where traces of it in that condition are to be found, reserving the principal part of this article for that development, simplicity of end, and uniformity of pursuit, which enabled the Greeks, the great arbiters of form, to carry it to a degree of excellence which no subsequent age or nation has been able to reach, or even rival.

It seems probable that drawing and recorded language were coeval in invention. In Greek we have mentioned that the same word (γραφειν) expressed the act of performing one as well as the other. Goguet, in his *Origine des Loix*, says that the first essay of the art of writing, using the expression in its most general sense, was by means of the representation of corporeal objects. Its invention would thus be carried back to a period almost as remote as that of the existence itself of the human race. The earliest people, he says, naturally used this method for exhibiting their thoughts, and commenced by representing to the eye the objects they wished to impress on the mind. The origin, however, of painting, properly so called, involved as it is in the greatest obscurity, presents one of the most difficult questions in the history of the arts; and opinions are very much divided as to the country that gave birth to it. Some authors have assigned its invention to a period antecedent to the siege of Troy. (*Plin.* l. vii.) Others, to one long after. (*Plin.* l. xxxv.) Pliny says, that the Egyptians boasted of being acquainted with the art six thousand years before the Grecians; but his words are, "Affirmant, vana prædicatione, ut palum est." Profane no less than sacred history rejects such a chimæra. But, though such a period of antiquity be fabulous, it is quite certain that painting was much used by them at a very early period. It is argued by Goguet that, as much as it was in his power, Cambyses destroyed the monuments of art he found in Egypt. Hence may be considered as posterior to his invasion such of the monuments as display specimens of the art. The epoch whereof we are speaking is 525 B. C. This, however, is an argument far from satisfactory, where all is conjecture. The specimens of Egyptian paintings now extant exhibit a collection of representations of human and other figures which indicate extremely slender advances in the art. They are all rudely and falsely drawn: no notion of grouping, as we understand it, nor sentiment, appears in any of their productions. As the Phœnicians were an early cultivated people, and have the credit of the invention of letters, they may, perhaps, have a claim to the invention equal to that of any other nation. In the time of Solomon, 992 B. C., they were so well skilled in the arts that that king employed them in building the temple. The Scriptures record the magnificence and splendour of their buildings, abounding with decorated apartments and sculptured ornaments; and we know, from the coins of the Phœnicians that have reached us, that in the design and execution of their coinage they were not far behind the Greeks.

"Thou, also, son of man, take thee a tile, and lay it before thee, and pourtray upon it the city, even Jerusalem," are the words with which the fourth chapter of Ezekiel commences; the words in the Septuagint being διαγράψεις ἐπ' αὐτὴν πόλιν τὴν Ἱερουσαλήμ. This is about 590 B. C., and would tend to show that the art was practised by the Jews so early as that period. The commandment, "Thou shalt not make to thyself any graven image," which some sects, even in the present day, construe into a prohibition against all art, was merely a prohibition of the worship of idols; for we find Moses himself, by the command of God, employing sculpture for the sanctuary. The employment of art of this nature is found, also, in many other passages of Scripture, which will doubtless occur to the reader.

The Persians, the Arabians, and the Parthians, from the peculiar opinions they entertained, could have no claims either to the origin or improvement of the art of painting. With them the representation of the human

figure in a state of nudity was considered almost as indecorous as the appearance before them of a naked man himself. Their figures are clothed almost invariably with drapery, falling in clumsy folds profusely plaited. Worshippers of fire, they used no representations of the Deity; and it is curious that, in their successful invasion of Egypt, they imbibed no taste for the arts and religion of that polytheistic country — not that they had, perhaps, in the former, much to acquire.

The art of painting in China, if we may judge of it from the time it first became known in this country, has remained the same time immemorial. It has never exceeded the bounds of imitation, and even in that respect it is devoid of taste and truth. The human figure with the Chinese is a distorted misrepresentation, and their perspective is attained by piling one object on the top of another till the picture is all earth and no sky. Invention and imagination were never known among them; and though in many respects ingenious in manipulation, their dexterity is exhausted in painting the fins of a fish, or the petals of a plant. In such a country it would be vain to look for the origin or progress of the art.

Etruscan art is known to almost every person by the vases that bear that name. In the article ARCHITECTURE we have touched upon the perfection, at a remote period of time, of the arts of Etruria; a country which, in its ancient state, was the most powerful and civilized in Italy. Diodorus speaks of the rich and powerful cities in their territories, and of the uncontrolled sway which their fleets exercised on the seas encircling the peninsula. Though the history of this nation is involved in obscurity, though the Romans strove to remove all the memorials of their ancient fame, sufficient information has reached us to demonstrate the height of perfection to which they carried the fine arts. About twelve miles from the town of Civita Vecchia stood the ancient Etruscan city of Tarquinia, near which are found a considerable number of sepulchral grottos, whereof some are decorated with paintings and figures much in the style of those on the Etruscan vases. These antiquities have been published, with a detailed description and plates, by the late Mr. Byres. Some of the pictures represent combats, and in others the subjects are dances of females, all executed with considerable spirit. The pottery, however, which we have above noticed, appears to afford the greatest number of their specimens of the arts of design: the forms displayed in the contours of the vases, no less than the paintings with which they are decorated, evince a wonderful attainment of elegance in design, purity of form, and ingenuity in its delineation. The power over line, and the facility of execution they reached, may be easily conceived from the absorbent nature of the material upon which they wrought. No retouching was possible; but the whole must have been completely arranged in the mind before it could be struck off by the artist. Pliny states that, in his day, the town of Ardea, an ancient city of Etruria, contained some paintings which he ascribes to a period anterior to the foundation of Rome, and mentions with surprise their then perfect state of preservation. At Lacuvium, also, he describes some pictures of Atalanta and Helen, which were simply painted on the wall, and exhibited great merit in execution. These Caligula, after a fruitless attempt, failed in removing. Cere, another Etruscan city, boasted some paintings of an early date. All these specimens are doubtless of a remote epoch; but attempts to fix it with precision would not be likely to bring us to the exact or even proximate period of their execution. The history of painting, however, can only be told under the head of Grecian art, to which we shall now proceed, premising that in our account we shall use most freely the *Lectures on Painting* of the late Henry Fuseli, professor of painting of the Royal Academy, who, whatever may be thought of his pictures, was an enthusiastic lover of his art, a scholar, and a critic of the highest order.

The vocabulary of the technical expressions, *nature*, *beauty*, *grace*, *taste*, *copy*, *imitation*, *genius*, and *talent*, is explained as follows: — By *nature* is meant the general and permanent principles of visible objects, neither disfigured by accident nor distempered by disease, neither modified by fashion nor local habits. *Beauty* is that harmonious whole of the human frame, that unison of parts to one end, which enchants us. It is the result of the standard set by the great masters of the art, the ancients, and confirmed by modern imitation. *Grace* is an artless balance of motion and repose, springing from character, founded on propriety, and neither falling short of the demands nor overleaping the modesty of nature. Applied to execution, it is that dexterous power which hides the means by which it is attained. By *taste* is meant not crudely the knowledge of what is right in art, but an estimation of the degrees of excellence by comparison, proceeding from justness to refinement. *Copy*, though generally confounded with *imitation*, is essentially different in operation and meaning. Precision of eye and obedience of hand are the requisites of the former, without pretence to choice or selection; whereas choice, directed by judgment or taste, is the essence of imitation. "Of *genius* I shall speak with reserve," says the professor; "for no word has been more indiscriminately confounded:" by genius is meant the power which enlarges the circle of human knowledge, which discovers new materials of nature, or combines the known with novelty; whilst *talent* arranges, cultivates, and polishes the discoveries of genius.

Religion was the motive of Greek art; it was therefore natural that they should endeavour to invest their own authors, for they considered themselves of divine origin, with the most perfect form; and as man possessed that exclusively, they completely and intellectually studied his elements and constitution. The climate that was favourable to the development of that form, the establishment of exercises by their civil and political institutions, created models in nature which raised Greek art to the highest excellence.

Skiagrams, or simple shaded outlines, similar to those known under the name of *silhouettes*, were the first essays of the art. They had no addition of character or feature but what the profile of the object thus delineated could afford. "Greek art had her infancy; but the Graces rocked the cradle, and Love taught her to speak. If ever legend deserved our belief, the amorous tale of the Corinthian maid, who traced the shade of her departing lover by the secret lamp, appeals to our sympathy to grant it."

The next step of the art was the *monogram*, which is the outline of figures without light or shade, with the addition, however, of parts within the outline. From this to the *monochrom*, or painting of a single colour on a tablet primed with white, then covered with what was called punic wax, first amalgamated with a resinous pigment, generally of a red, sometimes of a dark brown or black colour, was the next advance. Through this inky ground the outlines were traced with a firm though pliant *style*, called a *cestrum*: the line could be altered with the finger or a sponge, and easily replaced by a fresh one. When the whole was settled it was suffered to dry, and covered with a brown encaustic varnish; the lights were worked over again, and rendered more brilliant with a more delicate point, according to the gradual advance from mere outlines to some indication, and at last to masses of light and shade: thence to the superinduction of different colours, or the invention of the *polychrom*, which, by the addition of the pencil to the style, raised the stained drawing to a legitimate picture, and at length produced that vaunted harmony, the magic scale of Grecian colour. If these conjectures be founded in fact, the supposed momentaneous productions on the Etruscan vases, which we have above noticed, would be no longer matter of astonishment; and indeed it appears much more likely that such should have been the case, than that the figures so drawn should have been "the magic produce of a winged pencil," rather than "the result of gradual improvement exquisitely finished *monochroms*."

The period at which the pencil supplanted the cestrum cannot be ascertained. Apollodorus, in the 93d Olympiad, and Zeuxis, in the 94th, are said to have used it with freedom and power; Parrhasius painted the battle of the Lapithæ and Centaurs on the shield of the Minerva of Phidias, to enable Mys to chase it; but this was most probably a monochrom, designed with the cestrum for greater accuracy. It was nearly a century after this that Apelles and Protogenes had a competition in drawing lines with the pencil, in which delicacy and evanescent subtlety being the characteristic, some notion of their mechanical skill may be formed. Of the *encaustic* method used by the ancients no account can be given on which reliance may be placed. "The most probable account," says Fuseli, "is, that it bore some resemblance to our oil painting; and that the name was adopted to denote the use of the materials inflammable or prepared by fire, the supposed durability of which, whether applied hot or cold, authorized the terms *ἐνεκαυσε* and *inussit*."

Polygnotus is the first great name that appears on record at a period when some satisfactory history of the art might be commenced. He flourished about 400 years B.C. So great was his success in the Pœcile at Athens, and the Lesche or public hall at Delphi, that, in a general council of the Amphictyons, it was solemnly decreed that his expenses, whenever he travelled in Greece, should be borne at the public charge. From the description of his pictures by Pausanias, it would seem that composition in painting, as we now understand that term, was not at all understood, inasmuch as that author begins his description at one end of the picture and finishes at the opposite extremity, which indicates pretty plainly that there could be no central group or figure to which the rest were subordinate. Aristotle says that Polygnotus improved his model; and it would be unjust to pronounce, considering the variety of powers by which the parts of his pictures were distinguished, that the primitive arrangement we have just mentioned arose from want of comprehension in the artist.

After Aglaophon, Phidias Panænus, Colotes, and Eve-

nor, the father of Parrhasius, came Apollodorus, the Athenian. "This painter applied the essential principles of Polygnotus to the delineation of the species, by investigating the leading forms that discriminate the various classes of human qualities and passions. The acuteness of his taste led him to discover that as all men were connected by one general form, so they were separated each by some predominant power which fixed character and bound them to a class." Pliny and Plutarch considered Apollodorus as the first colourist of his age. It is probable from their descriptions that he was the inventor of local colour and tone, which received from the former the term splendour. Zeuxis succeeded to Apollodorus, and, by uniting in one figure the most perfect parts of many models, produced an ideal form, which, in his opinion, constituted the supreme degree of human beauty. Lucian describes a picture he exhibited at the Olympic games as remarkable for its invention. It was the representation of a female Centaur suckling her young, and the account is to be found in the memoir inscribed with the name of Zeuxis. This artist used but few colours; but he seems to have understood the extension of light to masses, from the circumstance of his painting monochroms on a black ground, adding the lights in white. "Pinxit et monochromata ex albo," says Pliny.

Parrhasius, a native of Ephesus, but a citizen of Athens, was the son and disciple of Evenor, and cotemporary of Zeuxis. By his subtle examination of outline, he "established that standard of divine and heroic form which raised him to the authority of a legislator from whose decisions there was no appeal. That he was a thorough master of allegory is evident from his embodying by signs, universally understood, the Athenian people (ΔΗΜΟΣ), in which he expressed at once its contradictory qualities. "Perhaps," observes Fuseli, "he traced the jarring branches to their source, the aboriginal moral principle of the Athenian character, which he made intuitive. This supposition alone can shed a dawn of possibility on what else appears impossible." In his competition with Timanthes the Cythnian, or, as some say, of Sicyon, he had the mortification to have been declared by a majority of votes inferior to him. The subject of the competition in which he was thus defeated was the contest of Ajax and Ulysses for the arms of Achilles.

No picture of antiquity has acquired so much celebrity as the sacrifice of Iphigenia in Aulis by Timanthes. Quintilian informs us that it was painted in contest with Colotes of Teos, an artist from the school of Phidias, and crowned with victory at its rival exhibition. This picture, which has been the subject of the unlimited praise of critics of antiquity, has, in modern times, been the subject of criticism, from the circumstance of Timanthes hiding the face of the father (Agamemnon) of the victim to be immolated in his mantle, unable by his art to express the intensity and agony of his grief. Upon this Sir Joshua Reynolds observes, in his Eighth Discourse, "If difficulties overcome make a great part of the merit of art, difficulties evaded can deserve but little commendation." The French critic, Falconet, has not been less unsparing than the president in his condemnation of the artifice. The answer of Fuseli to these critics appears to us satisfactory. He says, "The subject of Timanthes was the immolation of Iphigenia. Iphigenia was the principal figure; and her form, her resignation, or her anguish, was the painter's principal task: the figure of Agamemnon, however important, is merely accessory, and no more necessary to make the subject a completely tragic one than that of Clytemnestra, the mother; no more than that of Priam, to impress us with sympathy at the death of Polyxena." Again, "They ascribe to impotence what was the forbearance of judgment. Timanthes felt like a father; he did not hide the face of Agamemnon because it was beyond the power of his art,—not because it was beyond the possibility, but because it was beyond the dignity of expression; because the inspiring feature of paternal affection at that moment, and the action which of necessity must have accompanied it, would either have destroyed the grandeur of the character and the solemnity of the scene, or subject the painter with the majority of his judges to the imputation of insensibility." The same expedient to express grief was adopted by Michael Angelo in the figure of Abijam, and by Raphael in the Expulsion from Paradise, borrowed from Masaccio. These were the artists who formed the second school of art, and established its end and limits. On it was founded the third period of style, in which refinement induced a grace and beauty to forms not to be surpassed. The masters of this period were Apelles, Protogenes, Aristides, Euphranor, Pausias, and the pupils of Pamphilus and his master Eupompus. This last-named artist was of Sicyon; and his authority was so great that out of the Asiatic and Grecian schools of painting he formed a third, by dividing the last into the Attic and the Sicyonian. When consulted by Lysippus (*Pliny*, l. xxxv.) on a standard of imitation in art, he pointed to the crowd passing by; observing that nature, not an artist, should be the object of imitation. Pamphilus, a Macedonian, the master of Apelles, and the most scientific artist of his day, adopted the doctrines of Eupompus. To the art of painting he joined the study of mathematics, and held the opinion that without the aid of geometry no painter could ever arrive at perfection. In Apelles of Cos, or, according to Lucian, of Ephesus, we are told by Pliny unrivalled excellence was found. Grace was his powerful and peculiar faculty, in which, and in knowing where to stop, he surpassed all that preceded him, and left not his equal in the world. The story of the lines which were drawn by himself and Protogenes in competition with each other is not a legendary tale, but a well-attested fact: into the nature of them, however, it would be now useless and unavailing to inquire. Aristides of Thebes, and cotemporary of Apelles, was the first who, by the rules of art, attained a perfect knowledge of expressing the passions and affections of the mind. The history we have of the picture which Alexander, at the sacking of Thebes, sent to Pella, proves his power of infusing the passions into his works. In it were expressed the anguish of maternal affection and the pangs of death. Euphranor, the Isthmian and pupil of Aristides, is said to have carried still farther the refinements of that expression so powerful in the hands of his master. Skilled in sculpture as well as painting, his conceptions were noble and elevated, his style masculine and bold; and he was the first who distinguished himself by imparting majesty to his heroes.

Asclepiodorus, the Athenian sculptor as well as painter, was, as the latter, celebrated for the beauties of a correct style and the truth of his proportions. Apelles allowed himself to be, in these respects, as much inferior to this artist, as he was to Amphion in the good ordering and disposition of his figures. About this period appeared Nichomachus, Nicophanes, Pyreicus, and others. Nicias, an Athenian, 322 B. C., was in great repute for the great variety and noble choice of his subjects, for the mode of distributing his lights and shadows, and for consummate skill in the representation of quadrupeds. In Rome, about 301 B. C., Fabius, a noble Roman, painted the Temple of Health, and gloried so much in the art that he assumed the surname of Pictor. Without a further enumeration of masters we may add, that for a long period after the reigns of Vespasian and his son Titus, painting as well as sculpture continued to flourish in Italy. Even under their successors, Domitian, Nerva, and Trajan, they met with as much encouragement as in the most palmy state of the arts in Greece. Under Adrian, Antonine, Alexander Severus, Constantine, and Valentinian, the art of painting continued to be an object of interest; but at length, in the reign of Phocas, with the fall of the empire, with the rest of the noble arts and sciences, it was involved in the common heap of ruins.

Painting in Italy owes the dawn of its restoration to the feeble rays that emanated from the pencil of Giovanni Cimabue, who was nobly descended, and born at Florence in the middle of the thirteenth century. He was the disciple of some indifferent painters, who had been brought from Greece by the government of Florence: these he soon surpassed both in drawing and colouring. Without the art of managing his lights and shadows, and but slenderly acquainted with the rules of perspective, he nevertheless laid so firm a foundation for the future improvement of the art, as to entitle him to the name of the father of the first age of modern painting. His death took place in the year 1300 at Florence, where, and at Pisa, some of his productions are still to be seen. Giotto, his pupil, also a Florentine, was a more able painter than his master. He divested himself of the shackels in which the system of the Greek art of that age had bound his master, adding somewhat of grace to his figures and nature to his colouring. Of a picture which he painted in the church D'Ogni Santi at Florence, representing the death of the Virgin with the Apostles about her, Vasari related that M. Angelo da Buonaroti used to say that the truth could not be nearer approached than in it—"Non potere essere più simile al vero di quello, ch' èra." He was the friend of Dante and Petrarch, and painted the portrait of the former. On his decease, in 1336, the city of Florence erected his statue in marble over his tomb.

In the year 1410, thirty years before the invention of printing by Gutemburg, John Van Eyck, born in the Low Countries in 1370, is understood to have invented the art of painting in oil, which he taught to Antonello of Messina, who visited Flanders to become acquainted with the secret: he it was who first practised and taught it in Italy. The principal masters who flourished in this first period of the resuscitation of the arts were Andrea Orgagna, so celebrated for his Loggia in the great square at Florence, Pietro Cavallino, Stefano, Bonamico, Buffalmacco, Pietro Laurati, Lippo, Spinello, Casentino, Pisano, &c. The art did advance, though but slowly, gathering little strength till the appearance of Masaccio. "Sculpture had already produced respectable specimens of its reviving powers in the bassi-relievi of Lorenzo

Ghiberti, some works of Donato, and the Christ of Philippo Brunelleschi, when the first symptoms of imitation appeared in the frescos of Tommaso da San Giovanni, commonly called Masaccio, from the total neglect of his appearance and person. Masaccio first conceived that parts are to constitute a whole; that composition ought to have a centre, expression truth, and execution unity: his line deserves attention, though his subjects led him not to investigation of form; and the shortness of his life forbade his extending those elements which Raphael, nearly a century afterwards, carried to perfection." Masaccio, who was born in Tuscany in 1417, is considered the father of the second or middle age of painting. His death, caused, it is supposed, by poison, occurred in 1443. Andrea Montegna, born at Padua in 1431, was a disciple of Jacopo Squarcione. Though correct in his drawing, well versed in perspective, and apparently acquainted with the antique, albeit the best antique statues had not then come to light, his neglect of nature induced a crudeness of taste and grotesqueness of fancy. He died in 1517, having been the first who practised the art of engraving in Italy. In this place we must not forget the master of so great a man as Leonardo da Vinci, Andrea Verocchio, a Florentine, born in 1432. He was well skilled in geometry, optics, music, architecture, sculpture, and painting; the last whereof he is said to have abandoned, because, in a picture whereon he was engaged of the baptism of our Saviour, his pupil, Leonardo, had, under his order, painted in an angel holding up some part of our Saviour's garment so far excelling Andrea's own figures that, enraged at being outdone by a youth, he resolved never again to wield the pencil. It is said he was the first who preserved individual likeness by moulding the face in plaster of Paris. Leonardo da Vinci, of noble descent, and born about 1445 in a castle so named near Florence, surpassed all his predecessors. His powers seem to have been unlimited: he was an admirable sculptor and architect, a skilful musician, an excellent poet, expert in anatomy and chemistry, and well versed in all parts of the mathematics. Rubens had a very high opinion of his works, and especially of his Cenacolo, in the refectory of the Dominicans at Milan, which "he abandoned without finishing the head of Christ, exhausted by a wild chase after models for the heads and hands of the apostles: had he been able to conceive the centre, the radii would have followed of course." He was many years director of the academy of painting at Milan, which city he much benefitted by his contrivance of the canal that supplies it with water from the river Adda. He had the honour of expiring in the arms of Francis I.—an honour by which destiny atoned to that monarch for his future disaster at Pavia, when he became a captive. His death took place in 1520. The last master of this period was Bartolomeo della Porta. Though not endowed with the comprehension of Leonardo, he first gave gradation to colour, form and masses to drapery, and dignity to execution. Fra Bartolomeo, as he was called, being a member of a religious order, was a native of Savignano, a village about ten miles from Florence, and was born in 1469. Nudities were scarcely ever represented by him, though he was a perfect master of drawing the human figure. He was the first who used the lay figure. Fuseli says of him, "He was the true master of Raphael, whom his tuition weaned from the meanness of Pietro Perugino, and prepared for the mighty style of Michael Angelo Buonaroti." Of this master, the greatest beyond comparison that ever appeared, we cannot refrain from again quoting the same author at considerable length, to which, if necessary, might be added the testimony of Sir Joshua Reynolds, whose parting wish, when he took leave of the Royal Academy, was that the last words he might pronounce within its walls might be the name of this wonder of mankind. "Sublimity of conception, grandeur of form, and breadth of manner, are the elements of Michael Angelo's style. By these principles, he selected or rejected the objects of imitation. As painter, as sculptor, as architect, he attempted, and, above any other man, succeeded, to unite magnificence of plan, and endless variety of subordinate parts, with the utmost simplicity and breadth. His line is uniformly grand; character and beauty were admitted only as far as they could be made subservient to grandeur. The child, the female, meanness, deformity, were by him indiscriminately stamped with grandeur. A beggar rose from his hand the patriarch of poverty; the hump of his dwarf is impressed with dignity; his women are moulds of generation; his infants teem with the man; his men are a race of giants." Again, "He is the inventor of epic painting, in that sublime circle of the Sistine Chapel, which exhibits the origin, the progress, and the final dispensations of theocracy." Michael Angelo was of noble family, and born at Castel Caprese, near Florence, in 1474. His master was Domenico Ghirlandaio. He died in great wealth, at Rome, in 1564; from thence his remains were removed to Florence, and there honourably interred. His principal disciples were Marcello Venusti, Il Rosso, Giorgio Vasari, and Fra Bastiano. Raphael Sanzio d'Urbino was born on Good Friday in the year 1483, and died on Good Friday in the year 1520. The grace and mild genius of Raphael were, perhaps, much more capable of exciting our sympathies than the burst of inspiration which the works of the last-named master universally exhibited. As Michael Angelo was the father of epic painting, so was Raphael that of dramatic painting. "If, separately taken, the line of Raphael has been excelled in correctness, elegance, and energy, his colour far surpassed in tone, and truth, and harmony; his masses in roundness, and his chiaro-oscuro in effect: considered as instruments of pathos, his pictures have never been equalled; and in composition, invention, expression, and the power of telling a story, he has never been approached." Giulio Romano was his greatest pupil. His conceptions were more extraordinary, more profound, and more elevated than even those of the master himself. His style was drier and harder than any of Raphael's school, and he was frequently harsh and ungraceful. He died at the age of fifty-four, in the year 1546.

Giorgio del Castel Franco, called, because of his size and beauty, Giorgione, and Tiziano Vecelli, combined to form the alluring and fascinating charm of colour. Born in the Venetian States, and in the same year, 1477, they laid the foundation of the Venetian school. Of the latter, our professor says, "he penetrated the essence and the general principle of the substances before him, and on these established his theory of colour. He invented that breadth of local tint which no imitation has attained; and first expressed the negative nature of shade: his are the charms of glazing, and the mystery of reflexes, by which he detached, rounded, connected, or enriched his objects. His harmony is less indebted to the force of light and shade, or the artifices of contrast, than to a due balance of colour, equally remote from monotony and spots. His backgrounds seem to be dictated by nature. Landscape, whether it be considered as the transcript of a spot, or the rich combination of congenial objects, or as the scene of a phenomenon, dates its origin from him: he is the father of portrait painting, of resemblance with form, character with dignity, and costume with subordination." Antonio Læti, or Allegri, called Correggio, from the place of his birth, in the duchy of Modena, completed the charms of colouring and chiaro-oscuro. Giulio Romano, when he saw the Leda and Venus he had painted for Frederic duke of Modena, declared he thought it impossible for colouring to be carried farther. His chief works are at Modena and Parma; at which last place he passed the greater portion of his life, and died at the age of forty, in the year 1534. Though the power of Correggio's colouring was great, still greater was that of his chiaro-oscuro. "The bland central light of a globe, imperceptibly gliding through lucid demi-tints into rich reflected shades, composes the spell of Correggio, and affects us with the soft emotions of a delicious dream." The merits of Raphael are pathos and character; the power of Titian was his colour, and of Correggio his harmony. We have not space to dwell on the lively genius of Pordinone, who disputed the superiority of Titian, the meagre style of Andrea Vannuchi, surnamed del Sarto, nor the extraordinary vigour and puerile imbecility of conception of Pellegrino Tibaldi; but we must not pass without notice the name of Sebastiano del Piombo, a Venetian, who died at the age of 62, in 1547. His name, Del Piombo, is derived from an office he held in the management of the lead mines, given him by pope Clement VII. For some time he practised the science of music, to which he was bred; but the fascinations of painting drew him aside from his original pursuit, and he became a disciple of old Gio-Ballino, continued his studies under Giorgione, and, having attained considerable perfection in colouring, went to Rome. Here he so ingratiated himself with Michael Angelo, by joining the party against Raphael, that he was assisted in his designs by that great master, and especially in that wonderful picture, now in the National Gallery here, of the Raising of Lazarus, which gained the universal applause of Rome, and was even put on a par with the celebrated picture of the Transfiguration by Raphael. Equally favoured by Michael Angelo was Daniel Ricciarelli of Volterra, in whose picture of Christ and the Women, in the Descent from the Cross, as well as in that of Sebastian's just mentioned, the master hand that directed them is manifest. The depravation of the style of Michael Angelo is sufficiently visible in the works of Giorgio Vasari, born at Arezzo in 1514, to whom the world is more indebted for the labours of his pen, in the History of the Lives of the most celebrated Painters, Sculptors, and Architects, first published at Florence, in 1550, than those of his pencil: him Fuseli describes as the most superficial artist, and the most abandoned mannerist of his time. "He overwhelmed the palaces of the Medici and of the popes, the convents and churches of Italy, with a deluge of mediocrity, commended by rapidity and shameless bravura of hand: he alone did more work than all the artists of Tuscany together; and to

him may be truly applied, what he had the insolence to say of Tintoretto, that he turned the art into a boy's toy." Felibien has taxed him with the flattery of the masters of his time, and partiality to those of his own country; but his work is nevertheless a valuable record of the lives of men to whom the world is much beholden; and contains many interesting anecdotes, which, but for him, would have been lost for ever. His death happened in 1578. Primaticcio, the scholar of Giulio Romano, made abbé of St. Martin de Troyes by Francis the First, studied and spread the style of his master in France, where he decorated the palaces of that king with mythology and allegory, in which he was assisted by his pupil, Nicolo del l'Abbate, an excellent artist. Primaticcio continued in France from the period of his first establishment there; lived in great pomp and state, more like a nobleman than a painter, through four several reigns, and died at the age of 80, in the year 1570. After Polidoro da Caravaggio, whose abilities were wasted on the representations of Roman military basso-relievos, the Roman school scarcely deserves notice till the appearance of Nicolas Poussin of Andilly, a town in Normandy, who was born in 1594. He was descended of a noble family of Picardy; but that his productions have shed a ray of lustre on the family which no nobility of blood could have effected, his designation by the name of the French Raphael sufficiently testifies. Nicolas was the disciple of Simon Varin, a French painter of mediocrity, and afterwards studied in the academy of Domenichino, and also in company with the famous sculptor Francesco Fiammingo, who was born in the same year, and bred in the same house with him. After a stay of more than 16 years in Rome, he was invited, by a letter under the hand of Louis XIII. himself, to return to his native country, where he was received with every honour, declared first painter to the king, and had a considerable pension conferred upon him. Upon the death of this king, and that of the cardinal Richelieu, he returned to Italy, to settle his affairs and return with his family; but, on his arrival in Rome, he entirely laid aside his intention of returning, and ended his days in Rome, at the age of 71 years. "Such was his attachment to the ancients, that it may be said he less imitated their spirit than copied their relics and painted sculpture. The costume, the mythology, the rites of antiquity, were his element; his scenery, his landscape, are pure classic ground. His eye, though impressed with the tint, and breadth, and imitation of Tiziano, seldom inspired him to charm with colour; crudity and patches frequently deform his effects." The mantle of Correggio seemed to have fallen on Parmegiano, though he possessed not the mode of expressing that expanse of harmony which no other eye than that of Correggio has conceived. Francesco Mazzuoli, called from Parma, the place of his birth, Parmegiano, was born in 1501, and died at the early age of thirty-six. "That disengaged play of delicate forms, the 'Sveltezza' of the Italians, is the prerogative of Parmegiano, though nearly always obtained at the expense of proportion. His grandeur, as conscious as his grace, sacrifices the motive to the mode, simplicity to contrast. His St. John loses the fervour of the apostle in the orator; his Moses the dignity of the lawgiver in the savage. With incredible force of chiaro-oscuro, he united bland effects and fascinating hues; but their frequent ruins teach the important lesson, that the mixtures which anticipate the beauties of time are big with the seeds of premature decay."

Towards the end of the sixteenth century, Lodovico Caracci, with his cousins Annibale and Agostino, founded a school at Bologna, in which it was proposed to select the beauties, correct the faults, supply the defects, and avoid the extremes of the different styles, and so attempt to form a perfect system. The recipe of ingredients for the formation of a perfect painter are contained in a sonnet by Agostino, well known to artists; they are as follows — Roman design, Venetian motion and shade, Lombardy's dignified tone of colour, the fierce style of Michael Angelo, Raphael's symmetry, Titian's truth to nature, and Correggio's sovereign purity: add to these the decorum and solidity of Tibaldi, the learned invention of Primaticcio, and a little of Parmegiano's grace; or, to save all this trouble, imitate the works of our dear Nicolo. This was empiricism unworthy of such men as the Caracci, whose talents were splendid, and of a very high order. Lodivoco was "the sworn pupil of nature." "Agostino, with a singular modesty, which prompted him rather to propagate the fame of others by his graver, than by steady exertion to rely on his own power for perpetuity of name, combined with some learning a cultivated taste, correctness though not elegance of form, and a Correggiesque colour." Annibal, whose taste was unequal to both of these, though his power of execution was far superior, was born at Bologna, in 1560, and was the disciple of his cousin Lodovico. His great work was the Farnese Palace, in which, whilst we admire the vigour of the execution, we cannot help lamenting the choice of subject, which is "a chaotic series of trite fable and bacchanalian revelry, without allegory, void of illusion, merely to gratify the puerile ostentation of dauntless execution and academic vigour." Such was the veneration of Annibal Caracci for the genius of Raphael, that his deathbed request was to be buried in the same tomb with him, which request was complied with, in the Pantheon at Rome, 1609. This eclectic Bolognese school did not last long; its scholars soon followed each his own peculiar taste. Its principal elèves were Schidone, Guido, Lanfranco, Albani, Zampieri, called Domenichino, and Francesco Barbieri, called Guercino. The merits of these are summed up as follows, by the admirable critic we have so often quoted in this article: — "Schidone, whose mind was in his eye, embraced and often applied the harmony and colour of Correggio; whilst Lanfranco strove without success to follow him through the expanse of his creation and masses. Grace attracted Guido, but it was the studied grace of theatres; his female forms are abstracts of antique beauty, attended by languishing attitudes, and arrayed by voluptuous fashions. His male forms, transcripts of models found in a genial climate, are sometimes characteristic of dignified manhood or apostolic fervour, sometimes stately, courteous, insipid." "His Aurora deserved to precede a more majestic Sun, and Hours less clumsy." His colour is occasionally bland and harmonious, sometimes vigorous, and sometimes insipid. Albani formed Nereids on plump Venetian models, and contrasted their pearly hues with the rosy tints of Loves, the juicy brown of fauns and satyrs of rich marine or sylvan scenery. Domenichino aimed at the beauty of the antique, the expression of Raphael, the vigour of Annibal Caracci, the colour of Lodovico; and, mixing something of each, fell short of all: whilst Guercino broke through all academic rules, sacrificing mind, form, and costume to effects of colour, fierceness of chiaro-oscuro, and intrepidity of hand. From this period the art declined rapidly in Italy: it was, indeed, held up for a short period by the exertions of Nicolas Poussin, of whom we have already spoken. Pietro da Cortona and Luca Giordano possessed very considerable talents; but they were much abused in their exercise by implicit obedience to the tasteless commissions of their employers.

Germany, though without much apparent intercourse at the time with Italy, had profited by the progress of the arts; therefore, towards the end of the fifteenth century, we find the works of Albert Durer had succeeded the rude and uncouth productions of Schön, Wolgemuth, and Altorfer. Albert Durer was born at Nuremberg on Good Friday, 1471. Notwithstanding his style was crude and ungraceful, his prints were esteemed throughout Italy, copied at Venice by the celebrated Marc Antonio, and so much admired by even Raphael himself that he decorated his own chamber with them, and often lamented that such a man had been educated in a country where the want of models and works of art must have so retarded his progress. His principal works were painted at Prague, for the Emperor Maximilian I. He died in 1528. Fuseli says of him, "Albert Durer was, in my opinion, a man of great ingenuity, without being a genius. He studied, and, as far as his penetration reached, established certain proportions of the human frame, but he did not invent a style: every work of his is a proof that he wanted the power of invention, of concluding from what he saw to what he did not see; that he copied rather than selected the forms that surrounded him, and, sans remorse, tacked deformity and meagreness to fulness, and sometimes to beauty." Lucas of Leyden was but a clumsy imitator of Albert. Aldegraver, Beheim, and George Pentz, from the study of Raphael, known to them through the medium of Marc Antonio's prints, and from the style of Michael Angelo, distilled through prints from Tibaldi's pictures, seem to have made some advances in the art. The knowledge, however, of its state in Italy attracted hosts of German, Dutch, and Flemish students, who, "though content to feed on the husks of Tuscan design, imbibed the colour of Venice, and spread the elements of that excellence which distinguished the succeeding schools of Flanders and of Holland."

Peter Paul Rubens, born in Cologne in 1578, and Rembrandt Van Rhyn, born near Leyden in 1606, by their extraordinary powers showed that Italy was not the only spot in which art could take root, but that Flanders and Holland afforded a soil in which it could flourish. The former of these, bred at Antwerp under the instruction of Otho Van Veen, had, previous to his journey to Italy, acquired an unbounded power over the instruments of his art, and on his arrival was the successful competitor for fame with those masters whom he selected as objects of emulation. Venice was the centre of attraction for him; and there, from the splendour of Paulo Veronese, and the glow of Tintoretto, he compounded "that florid system of mannered magnificence which is the element of his art, and the principle of his school." His scholars saw through the eye of their master instead of seeing through that of nature; but from this censure must be excluded the illustrious name of Van-

dyck, and that of Abraham Diepenbeck. Of the portraits of Vandyck no mention is here necessary to enhance the esteem in which they are held. "The fancy of Diepenbeck, though not so exuberant, excelled in sublimity the imagination of Rubens; his Bellerophon, Hippolitus, Ixion, Sisyphus, fear no competitor among the productions of his master." Rembrandt, except in what relates to form, was a genius of the highest order. "In spite of the most portentous deformity, and without considering the spell of his chiaro-oscuro, such were his powers of nature, such the grandeur, pathos, or simplicity of his composition, from the most elevated or extensive arrangement to the meanest and most homely, that the best cultivated eye, the purest sensibility, and the most refined taste dwell on them equally enthralled." His followers, if such they deserve to be called, were a race of "colourists, content to tip the cottage, the hamlet, the boor, the ale-pot, the shambles, and the haze of winter with orient hues or the glow of setting summer suns."

Switzerland rests its title to distinction on the names of Hans Holbein and Francesco Mola; the former of Basil, born in 1498, died in London at the age of 46; the latter, the scholar of Giuseppe d'Artino and Francesco Albani, was born at the village of Coldré in 1621, and died in Rome in 1666. The Swiss school exhibited a style poised between the emaciated dryness of Albert Durer and the bloated corpulence of Goltzius.

The school of the Caracci seems to have taken its deepest root in France, which, with few exceptions, has not produced artists greatly above mediocrity. The exceptions, however, which are to be named are, Nicolas Poussin, who has already been mentioned: to this must be added those of Eustache Le Sueur, Charles Le Brun, Sebastian Bourdon, and Pierre Mignard. "The Seven Works of Charity, by S. Bourdon, teem with surprisingly pathetic and always novel images; and in the Plague of David, by Pierre Mignard, our sympathy is roused by energies of terror and combinations of woe which escaped Poussin and Raphael himself."

From what cause may be difficult to say, but the labours of the Spanish school were confined almost within the narrow limits of individual imitation. The degree of perfection in this respect was indeed great, though the means pursued were very different; and the works of Diego Velasquez, Joseph Ribera, and Murillo, though never approaching the great style of art, impress us with respect for their powers, and deservedly received the homage of the Spanish nation.

In this country, Henry VIII. was the first monarch who seems to have taken any interest in the art. He invited Titian to England, and patronised Holbein and Torregiano. But this patronage, very unlike that bestowed by Francis I. on Andrea del Sarto, Primaticcio, Nicola, Cellini, and others, was so restricted in the choice of subjects, that neither Henry nor his daughter Elizabeth deserve our veneration for the assistance they rendered to the arts of the country. In the court of Henry's father a profligate Flemish painter, of the name of Mabuse, had indeed been employed; but it is not known whether he came here at that king's solicitation or driven by his own distresses. The pencil of Holbein, among its other employments, was of course employed to portray the beauties of Henry's wives, or of those he intended to make so: sometimes, indeed, to obtain a just report of the latter he was despatched to the Continent; and in the case of Anne of Cleves, through his faithless pencil Cromwell, the minister, lost his head. If painting was at this period likely to have taken root and flourished here, the Reformation, and the worse than absurd edicts passed by Edward VI. and Elizabeth, forbidding statues and pictures in churches, were nipping frosts that destroyed its growth. Charles was the first real patron of the arts that governed this country. By him was Rubens invited to the country; but the unfortunate fate of the monarch intercepted the progress that art then seemed likely to make. "His son, in possession of the cartoons of Raphael, and with the magnificence of Whitehall before his eyes, suffered Verrio to contaminate the walls of his palaces, or degraded Lely to paint the Cymons and Iphigenias of his court; whilst the manner of Kneller swept away completely what yet might be left of taste under his successors." The state of art continued extremely low in this country till the appearance of Reynolds. Walpole says that in the commencement of the reign of George I. the arts of England were sunk almost to the lowest ebb. The names of Reynolds, Hogarth, Gainsborough, and Wilson, in their time, entitled this nation to some rank in the art; though we have as yet had no indication of that great style of art whose history has occupied a considerable portion of the preceding pages. The names we have mentioned have been succeeded by others, and some now living, which have, perhaps, not only prevented the accusation of a retrograde movement, but have raised the art generally in the country higher than it was ever known in a preceding period—yet much remains to be done. The genius of the nation seems bound up in commerce and politics; total ignorance of the first principles of art seems still to pervade those who only are capable of affording patronage; and many a collector, on whose walls hang the most splendid specimens of the Roman and Florentine schools, must, if he will speak the truth, admit that his admiration of the tobacco pipes, pewter pots, and vulgar boors of the Dutch school, a school of low ideas and good painting, is more profound than of the sublime conceptions of Raphael and Michael Angelo.

Practice of Painting.— The nature of this work precludes a very enlarged notice of the theory and practice of painting: we shall, however, subjoin a few leading observations on the subject. One of the principal requisites for its successful practice is *anatomy*. It is obvious that to represent successfully the human form its construction in the skeleton, and the tendons and muscles by which the bones of the skeleton are connected and move, is knowledge that must be acquired, inasmuch as they appear more or less through the integuments with which they are covered. Without this knowledge the living model becomes useless to him; for that, after a very short period of standing, sinks into languor, which an acquaintance with the origin and insertion of muscles enables the painter to correct, and thus animate the work. It was the constant observation of the youth in their gymnastic games that enabled the Grecians so successfully to display and develop the muscular system in their sculpture: these afforded models of the most perfect nature. *Comparative anatomy* is another of the requisites to be acquired by the artist; since the painting of animals must necessarily involve a want of the same information as is requisite for the human figure. *Symmetry*, which results from the relative proportion of the parts to each other, follows from the knowledge of anatomy. It is by the knowledge of this that the length of a finger may be made to measure the height of a figure. Without the most thorough acquaintance of the rules of *perspective*, no objects can be placed properly in a picture. Some have said that though it is a science of the first importance to a painter, yet he is not to be too strictly confined to its rules, but to endeavour to render them subservient to his own purposes. We confess that such is not our opinion; nor can we conceive how any violation of truth, which any infraction of the rules of perspective would be, can be made agreeable in a picture. The rules, too, of perspective are so simple, and their practice so easily acquired, that no excuse can be admitted for the neglect of so indispensable an accomplishment. The science of *optics* is so far necessary as to enable the artist to determine how the reflexes against the sides of surfaces in shade would affect the intensity of them. This is called chiaro-oscuro. The determination of shadows, and the direction in which they would fall, depends upon the science of optics combined with that of perspective. As perfect form is produced by leaving out peculiarities, and retaining only general ideas, so this principle, extended in the other branches of the art, gives what is called the grand style to invention, to composition, to expression, and even to colouring and drapery. *Invention* in painting is not the same as in poetry, inasmuch as that the subject is supplied by the poet or historian. The subject should be general, and kept free from all that might tend to embarrass or divide the attention of the spectator. "Whenever," observes Sir Joshua Reynolds, in his Fourth Discourse, "a story is related, every man forms a picture in his mind of the action and expression of the persons employed. The power of representing this mental picture on canvass is what we call invention in a painter; and as in the conception of this ideal picture the mind does not enter into the minute particularities of the dress, furniture, or scene of action, so, when the painter comes to represent it, he contrives those little necessary concomitant circumstances in such a manner that they shall strike the spectator no more than they did himself in his first conception of the story." The painter may deviate from strict historical truth in pursuing the grandeur of his design, such being but poetical licence. "A painter of portraits retains the individual likeness; a painter of history shows the man by showing his actions. He has but one sentence to utter, but one moment to exhibit." *Expression*, which in painting signifies the representation of the emotions and passions of the mind, must, like invention, not descend to peculiarities. Thus Bernini, in representing David casting the stone from his sling, mistook accident for generality when he made him bite his under lip. *Colouring*, also, has its laws, and in this the same general principle must be attended to. "All trifling or artful play of little lights, or an attention to a variety of tints, is to be avoided; a quietness and simplicity must reign over the whole work, to which a breadth of uniform and simple colour will very much contribute. Grandeur of effect is produced by two different ways, which seem entirely opposed to each other. One is by reducing the colours to little more than chiaro-oscuro, which was often the practice of the Bolognese schools; and the other by making the colours very distinct and forcible, such as we

see in those of Rome and Florence; but still the presiding principle of both those manners is simplicity." *Drapery*, again, is managed by the same general laws: minute attention to the minor details of drapery injure the general effect; the folds should communicate easily, and be so cast as to have the appearance of accident; they must also be so contrived as to give the greatest effect to the figure. Artifice is as much as possible to be avoided.

Annibal Caracci considered twelve figures sufficient for any story; more than that, he thought, could only be employed to fill up space, or, as he expressed himself, they would be figures to be let.

Painting is divided into twelve branches, which their names sufficiently explain; viz. history, which comprises mystery and allegory; grotesque, such as the celebrated Loggia at the Vatican; portrait, fancy, animals, fruits and flowers, battle pieces, landscape, sea views; still life, which comprises all inanimate objects, but is chiefly applied to household furniture, and instruments and architecture.

PAI'RING. In Parliamentary language, that practice by which two members of the House of Commons, of opposite political opinions, agree to absent themselves from divisions of the house during a stated period. *See* PARLIAMENT.

PA'LACE. (Lat. palatium, whose etymology is not precisely ascertained.) In Architecture, a word generally used to denote the residence of kings and princes. On the Continent, however, the term is used with a much more extended signification; and even in this country the residences of bishops, and of some noblemen, are so called.

PA'LACE COURT. A court of justice erected by Charles I., and made a court of record, with power to try personal actions between party and party within a liberty extending to the distance of twelve miles round Whitehall. The judges are the steward of the king's household and knight-marshal for the time being, and the steward of the court or his deputy.

PA'LADIN. In the Romances of the Middle Ages, a term derived from the Roman Palatinus (from palatium, *a palace*), having its origin in the customs of the Byzantine court, by which the officers of the palace (palatini, comites palatii) were regarded as the highest dignitaries of the country; hence palasin, or paladin, in the early French romances, for a lord or chieftain; and the name was thence appropriated by the Italian romantic poets to the heroes of their legends, the warriors of Charlemagne.

PALÆO'GRAPHY. (Gr. πάλαιος, *ancient*, and γεάφω, *I write*.) The science or art of deciphering ancient inscriptions, including the knowledge of the various characters used at different periods by the writers and sculptors of different nations and languages, their usual abbreviations, initials, &c. The science termed diplomatics is, in effect, a branch of palæography. (*See* DIPLOMATICS.) Among many other modern authorities on this subject, the reader may be referred to Mr. Ottley's remarkable paper in the *Archæologia*, vol. xxvi., on an ancient MS. of Aratus; Champollion, *Traité d'Archéologie;* the publications of the Ecole des Chartes, under the directions of M. Champollion, at the Royal Library at Paris; Kopp, *Bilder und Schriften der Vorzeit*, 1819; *Palæo-Critica*, 1817. The most valuable compilation of palæographical knowledge is to be found in the *Traité de Diplomatique* of the Benedictines of St. Maur, 6 vols. 4to. 1748. See also *Maffei*, *Istoria Diplomatica*, 1727; Trombelli, *Arte di Conoscere l'Età de' Codici*, 1778. But, as Mr. Ottley truly observes, "nothing is more fallacious than the idea of being able to determine the ages of ancient inscriptions from the particular forms of their characters; and it is mere folly upon such grounds to attempt to build any solid argument."

PALÆONTO'LOGY. (Gr. παλαιος; ον, *being;* λογος, *a discourse*.) The branch of zoological science which treats of fossil organic remains.

PALÆOTHE'RIUM. (Gr. παλαιὸς, and θηριον, *beast*.) The name of a genus of extinct Pachyderms. It was characterized by having twenty-eight complex molar teeth, four canines, and twelve incisors, four in each jaw. Cuvier concludes that the palæotheres, like the tapirs, had also a short fleshy proboscis. Their remains characterize the gypsum quarries belonging to the eocene tertiary formations near Paris. They have also been found in the corresponding strata of the Isle of Wight. About twelve species of this extinct genus are already known.

PALÆ'STRA. (Gr. παλαιστρα.) Properly, a wrestling place or school (παλη, *wrestling*); and hence the place where public games of strength were performed, and, by metaphor, such games themselves (*studium palæstræ*, Horace). In Architecture, the palæstra was a part of the gymnasium (see *Pausan.* vi. 21. 2., and 23. 4.), especially appropriated to the athletes. The art of wrestling was termed palæstricè (παλαιστριχη).

PALANQUI'N. A sort of chair or chaise used by the Chinese, and in most parts of the East, as a vehicle of conveyance from one place to another. They are furnished with cushions and curtains; many of them are fitted up in the most costly style, and are usually borne by eight men, who relieve each other at intervals.

PA'LATALS. (Lat. palatum, *the palate*.) The letters *d*, *g*, soft and hard, *j*, *k*, *l*, *n*, and *q*, are so called, from the organ chiefly employed in their pronunciation.

PA'LATE. (Lat. palatum.) In Anatomy, the roof of the mouth. That part which is formed by the lower portions of the superior maxillary and palatine bones is called the "hard palate;" that which is due to the extension of membranous and muscular substance unsupported by bone is termed the "soft palate." In Zoology, the modifications of the bony palate, and the "palatal ridges," and other inequalties of the soft parts, are of use in the discrimination of the species of Mammalia.

PALATE, in a flower, is the convex base of the lower lip of a personate corolla.

PALA'TINATE. The name formerly given to two states of Germany, which were designated, by way of distinction, the Upper and Lower Palatinate, and, though not contiguous, were under the control of the same sovereign till 1620. At that period they underwent great changes, which it would be out of place here to indicate; but since the wars of the first French revolution, which contributed more than any event on record to unsettle the ancient landmarks, they have been divided among different German sovereigns, and their very name has disappeared from the maps of Germany. The word Palatinate is of feudal origin, and signifies, in a more restricted sense, the province or seigniory of a palatine; *i. e.* of a high dignitary during the middle ages, who originally held office in the court of the sovereign, and was designated the *comes palatii*, but who afterwards obtained the privilege of exercising the same power, rank, and jurisdiction, within his own province or district, as the comes palatii exercised in the palace.

PALATINE, COUNTY. *See* COUNTY.

PALATO-PHARYNGEUS. A muscle which arises at the root of the uvula and soft palate, and is inserted into the upper and back part of the thyroid cartilage; it draws the uvula and soft palate downwards and backwards, and pulls the thyroid cartilage and pharynx upwards.

PALE. (Lat. palus, *a stake*.) In Heraldry, the first and simplest kind of ordinary. It is bounded by two vertical lines, at equal distances from the sides of the escutcheon, of which it encloses one third. It seldom contains more than three charges. The *pallet*, when borne by itself, is one half of the pale; but sometimes as many as three pallets are borne together. A coat bisected by a vertical line, with a different field on each side of it, is said to be *party* (or divided) *per pale*. The pale is a very ancient and honourable bearing.

PALE, WITHIN THE. An expression well known in Irish history, applied to that portion of Ireland to which for some centuries after its invasion by the English, under Henry II. in 1172, the dominion of the latter was confined. The limits of the *pale* seldom extended beyond the modern province of Leinster, and were frequently much less considerable. (*Statistics of the British Empire*, vol. i. p. 429.)

PA'LEÆ. (Lat. palea, *chaff*.) A name given to the bracts that are stationed upon the receptacle of Compositæ between the florets, and having generally a membranous texture and no colour; also the interior bracts of the flowers of grasses.

PA'LES. The Italian goddess presiding over cattle, who was worshipped with great solemnity. Her festivals, called *Palilia*, were celebrated on the 21st of April, the day upon which, according to tradition, the foundations of Rome were laid by Romulus — the dies natalis urbis Romæ — as a great rustic holiday. On this day the shepherds purified their flocks by making them pass round a great fire made of laurel, pine, and olive branches, sprinkled with sulphur. An offering of wine, milk, and millet was then placed on the altar of the goddess, who was entreated to bless the earth and the flocks with fecundity, and to avert injury from them both. The term *palilia* is frequently written *parilia* in the ancient MSS.; but no doubt can be entertained as to the correctness of the former.

PALE'TTE. (Fr.) In Painting, the light board held by a painter while at work, on which the colours are arranged in their various tints.

PA'LFREY. A word seldom used, except in novels and romances to signify a small or gentle horse, such as is fit for a lady's use. It is also used by the old poetical writers for a horse used by kings or noblemen, or on state occasions.

PALI'CI. In Grecian Mythology, twin divinities, worshipped in Sicily, and especially in the neighbourhood of Etna; sons, according to some, of Jupiter and Thalia, the daughter of Vulcan; according to others, of Vulcan and Ætna, daughter of Ocean. Their heads appear on coins of Catania. Their name is said to be derived from returning (παλιν ἱκεσθαι) out of the earth, under which

their mother had borne them. (*Æschyl. Ætna*, apud *Macrob. Saturn*, v. 19.) Their celebrated Sicilian temple is mentioned by Virgil: —

> Pinguis ubi et placabilis ara Palici. *Æn.* ix. 585.

PALI'LLOGY, or PALILOGY. (Gr. παλιν, *again*, and λεγω, *I speak.*) In Rhetoric, the repetition of a word, or fragment of a sentence, for the sake of greater energy: also, epanalepsis and epizeuxis. Thus, Cicero (*pro Cæc.* ix. 24.), "Ferro, inquit, ferro, te rejeci;" "The living, the living, shall praise thee" (Psalms). A peculiar species of palilogy, also called *deuterologia*, or *anadiplosis*, is where the last word of a verse, or of a paragraph in prose, is repeated at the beginning of the next: —

> ——supervenit Ægle—
> Ægle naiadum pulcherrima. *Virg. Eclog.* vi. 20.
>
> ——the innocent sleep —
> Sleep that knits up the ravell'd brow of care. *Macbeth.*

PA'LIMPSEST. (Gr. παλιν, *again*, and ψαω, *I rub or efface.*) The name given to a sort of parchment, from which whatever was written thereon might be erased, so as to admit of its being written on anew. The term means literally *twice-rubbed* (*membrana iterum abrasa, charta deletilis*), not as the glossary of Ducange would seem to denote, because the parchment had twice undergone erasure, or the writing been twice obliterated; but because it had been twice prepared for writing, which was principally effected by rubbing it with pumice, first in the course of manufacture after the skin had been cured, and again by the same process after the original writing had been taken away by washing or in any other manner. The strict and precise sense of *palimpsest* is, therefore, "twice prepared for writing;" the repetition of such preparation being the prevailing idea in the etymology, and not erasure, as some have erroneously supposed. The great antiquity of the practice of making palimpsests may be gathered from an extract from a letter from Cicero to Trebatius: — "Ut ad epistolas tuas redeam, cætera belle, &c.; nam quod in palimpsesto, laudo equidem parsimoniam; sed miror quid in illa chartula fuerit, quod delere malueris quam hæc non scribere; nisi forte tuas formulas. Non enim puto te meas epistolas delere, ut reponas tuas. An hoc significas, nihil fieri? Frigere te? Ne chartam quidem tibi suppeditare?" (*Cic. ad Fam.*, l. 7. c. 18.) But while there can be no doubt as to the antiquity of this practice, the attention of the learned was first directed to the subject in modern times by Montfaucon, in a curious essay entitled *Dissertation sur la Plante appellée Papyrus, &c.*, which appeared in the *Mem. de l'Acad. Fran.*, vol. vi.; and in which the origin of the Palimpsest MSS. is briefly and plainly described in the following words: —

"Cela (le papier bombycin) vint fort â propos dans un temps, où il paroit qu'il y avoit grande disette de parchemin; ce qui nous a fait perdre plusieurs anciens auteurs: voicy comment. Depuis le 12e siècle, les Grecs, plongez dans l'ignorance, s'avisèrent de racler les écritures des anciens MSS. en parchemin, et d'en ôter, autant qu'ils pouvoient, toutes les traces, pour y écrire des livres d'Eglise: ce fut ainsi qu'au grand préjudice de la république des lettres, les Polybes, les Dions, les Diodores de Sicile, et d'autres auteurs que nous n'avons plus, furent métamorphosez en Triodions, en Pentecostaires, en Homélies, et en d'autres livres d'Eglise. Après une exacte recherche, je puis assurer que des livres écrits sur du parchemin depuis le 12e siècle, j'en ay plus trouvé dont on avoit raclé l'ancienne écriture, que d'autres. Mais comme tous les copistes n'estoient pas également habiles â effacer ainsi ces premiers auteurs, il s'en trouve quelques-uns où l'on peut lire au moins une partie de ce qu'on avoit voulu raturer."

We have already seen that the practice of which Montfaucon speaks had a much more ancient date than that which he assigned to it; although it was in all probability most frequent during the middle ages, when, in consequence of the scarcity and expense of parchment, and the growing demand for the writings of the fathers and of books of devotion, the monks were induced to efface the writings of the ancient authors to make room for their own. Our limits preclude us from entering at length into the means adopted by the monks of effacing the original writing, or of that still more interesting process by which in recent times the original writing has been again brought to light, and which has thus put us in possession of some most valuable works and fragments of the classic authors which had been given up as lost. On these points we beg to refer the reader to an able article in the *Edin. Rev.* vol. xlviii., in which all that has been done in the restoration of ancient MSS. is set forth with great clearness and brevity; and shall content ourselves with observing, that the most important of these discoveries are the treatise of Cicero, *De Republica*, which was found in the Vatican library at Rome, in a MS. which had been rewritten, with a Commentary of St. Augustin on the Psalms; and the *Institutions of Gaius*, found also in the same place. For the restitution of the former the learned world is indebted to Angelo Maio, the principal librarian of the Vatican library at Rome, who may indeed be regarded as the hero of palimpsests; and for the latter to the labours of Bluhm and Goeschen, who were sent to Rome for the purpose of examining MSS. by the Royal Academy of Sciences at Berlin.

PALI'NDROMUS. (Gr. παλιν, and δρομος, *a course.*) A verse or line which was the same when read backwards or forwards. The well-known verse which has been put into the mouth of the devil may serve for an example: —

> Signa te, signa, temere me tangis et angis.

PALINGENE'SIA. (Gr. παλιν, and γενεσις, *birth.*) In Philosophy, a new or second birth—regeneration. The doctrine of the destruction and reproduction of worlds and living beings is oriental; but the word in question appears to be of Stoical origin. (*Diog. Laert.* vii. 72.) The Stoics are said to have held that the demiurgus, or creator, had absorbed all being in himself, and reproduced it out of himself. In the language of the New Testament, it is used for moral regeneration. (Titus, iii. 5.)

PA'LINODE. (Gr. παλιν, *again*, and ῳδη, *song.*) In Poetry, a recantation: properly, a piece in which the poet retracts the invectives contained in a former satire. (See *Mem. de l'Acad. des Inscr.* vol. xii.)

PALINU'RUS. The steersman of the vessel of Æneas, drowned, according to Virgil, off the coast of Italy (*Æn.* v.), and afterwards met with by the Trojan hero in the shades. A promontory on the coast received his name.

PA'LISADES, or PALISADOS. In Fortification, stakes driven into the ground, and sharpened at the top, for the purpose of defence against the surprise of an enemy. They are usually 9 or 10 feet long, and planted so as to make an angle inclining outwards from the work.

PA'LLA. In Latin, the long outer garment appropriate to Roman females of respectable rank. A part of it was thrown over the left shoulder, and hung down from the arm. It is particularly described by Apuleius. (*Met.* xi.) The palla was not worn by men, except some effeminate persons; although the long robes of barbarians are sometimes called by its name by Latin writers. There seems to have been a shorter palla. (*Martial*, i. 93.)

PALLA'DIUM. (Gr. Παλλάδιον.) A wooden statue of Minerva or Pallas, which was said to have fallen from the skies, as a sign to Ilus, the founder of Troy, to convince him he was under the guidance of Jupiter. On its preservation depended the safety of Troy; and, accordingly, Ulysses and Diomed were commissioned to steal it, and performed the enterprise. According to other accounts, the palladium was conveyed from Troy to Italy by Æneas, and was afterwards preserved with great care in the temple of Vesta at Rome. The word palladium passed into European languages, in which it signifies that particular law or privilege which is regarded as the safeguard of the people's liberties. The trial by jury, and the freedom of the press, are each called the *palladium* of the British constitution.

Palladium. A metal discovered in 1803 by Wollaston, associated with the ore of *platinum*. It resembles platinum in colour and lustre, and it is ductile and malleable, but very hard. Its specific gravity is 11·8. Its fusibility is intermediate between gold and platinum; it is oxidized and dissolved by nitric acid: its oxide forms red salts.

PA'LLAS, or more properly PALLAS ATHE'NE. In Mythology, the Grecian goddess of wisdom, identified at a later period with the Roman Minerva, to whom were assigned all the attributes of her Grecian sister. The term is probably derived from the Gr. παλλειν, *to brandish a spear.* *See* Minerva.

Pallas. One of the four small planets which revolve between the orbits of Mars and Jupiter, discovered by Dr. Olbers, of Bremen, on the 28th of March, 1802. Its symbol is a lance ⚴. On account of the minuteness of this planet, and the nebulous appearance by which it is surrounded, it is extremely difficult to arrive at any certain conclusion respecting its real magnitude. Sir W. Herschel estimated its diameter at eighty miles, and Schroeter at 2099 miles, or nearly the size of Mercury; but astronomers prefer the former measure. The light of the planet undergoes considerable variations, the cause of which is unknown. The following are the elements of the orbit given by Encke, in the Berlin *Astronomisches Jahrbuch* for 1831: —

Semi-axis major $= 2{\cdot}77263$
Eccentricity $= 0{\cdot}24199$
Period of revolution $= 1686{\cdot}25$ days
Inclination $= 34^\circ\ 35'\ 49''{\cdot}1$
Longitude of ascending node $= 172^\circ\ 38'\ 29''{\cdot}8$
Longitude of perihelion $= 121^\circ\ 5'\ 0''{\cdot}5$.

The motion of the planet in its obit is greatly disturbed by the powerful attraction of Jupiter. *See* Planet.

PA'LLETS, in Clock and Watch-work, are the pieces connected with the pendulum or balance which receive

the immediate impulse of the swing-wheel, or balance-wheel. They are of various forms and constructions, according to the kind of escapement employed.

PALLIOBRA'NCHIATES, *Palliobranchiata.* (Lat. pallium, *a mantle*, and branchia, *gills.*) The name of an order of Acephalous Mollusks, including those in which the gills are situated on the internal surface of the lobes of the mantle.

PA'LLIUM. (Lat. *a cloak.*) A vestment which, by ancient usage, is sent from Rome to all archbishops of the Roman Catholic church, and to the four Latin patriarchs of the East, on their accession. The history of this usage, and the gradual submission of the Western patriarchs to it, thereby acknowledging in the end the complete authority of the see of Rome, is carefully traced by M. Rheinwald, in the new *Encyclopædia* of Ersch and Gruber, art. "Pallium." It is now a short white cloak, with a red cross, encircling the neck and shoulders, and falling on the back. It was the custom, at the period of the greatest power of the Roman see (introduced by Gregory VII. himself), for the archbishops to come to Rome for the purpose of receiving it: it is now delivered as a mandatory, or merely by a delegate from Rome. Some simple bishops receive the pallium as a mark of honour. The cloth of which the pallium is made is woven from the wool of ten white lambs, blessed at Rome on the festival of St. Agnes, and deposited on the tomb of St. Peter during the eve of his festival.

PALM. (Lat. palma, *the hand.*) An ancient measure of length taken from the extent of the hand. There were two different palms; one corresponding to the length of the hand, and the other to the breadth. The Roman palm was about 8¼ English inches. The English palm is understood to be 3 inches.

PALMA'RES. (Lat. palma, *the hand.*) Muscles belonging to the hand. The *palmaris brevis* is situate between the wrist and little finger, and assists in contracting the palm of the hand; the *palmaris longus* is situate on the forearm, and bends the hand.

PA'LMER. In Ecclesiastical History, a name popularly given to crusaders returned from the holy war, or pilgrims from Palestine, from the branch of palm-tree which they were wont to carry with them as a staff in commemoration of their journey.

PA'LMIPEDS, *Palmipedes.* (Lat. palma, *a palm,* and pes, *a foot.*) The name given by Cuvier and Temminck to an order of birds corresponding to the *Anseres* of Linnæus, and the *Natatores*, or swimming-birds, of Illiger.

PA'LMISTRY. (Lat. palma, *the hand.*) A species of divination, which foretold future events from the inspection of the lines and marks on the hands and fingers. *See* CHIROMANCY.

PALM OIL. An article imported from the west coast of Africa: it is solid, and of a reddish-yellow colour. It is used in the manufacture of soap: candles have been made of its stearine, and it is sometimes burned in lamps, and made into ointments. It is chiefly the produce of the *Elæius Guinænsis.*

PALM, ORDER OF THE FRUITFUL. A society formed in 1617 in Germany, and connected by a species of chivalrous institution, for the preservation and culture of the German language. Lewis, prince of Anhalt, was the first head of the order. This body is said to have done much for the German language, but to have ended by attempting too much in the way of refinement and innovation. It was dissolved in 1680. (*Ersch and Gruber's Encyclopædia.*)

PALMS, called by Linnæus, from their noble and stately appearance, the princes of the vegetable kingdom, are a natural order of Arborescent Endogens, chiefly inhabiting the tropics, distinguished by their fleshy, colourless, six-parted flowers, enclosed within spathes; their minute embryo, lying in the midst of albumen, and remote from the hilum; and rigid plaited or pinnated inarticulated leaves, sometimes called fronds. Wine, oil, flax, flour, sugar, and salt, says Humboldt, are the produce of this tribe; to which Von Martius adds thread, utensils, weapons, food, and habitations. The most common species is the cocoa-nut. Their wounded stems, or spathes, yield in abundance a saccharine fluid, known in India by the name of toddy. The succulent rind of the date is a most nutritious as well as agreeable fruit. Sago is yielded by the interior of the trunks of nearly all, except *Areca catechu*, the well-known *pisang*, or betel-nut: the fruit of the latter species is remarkable for its narcotic or intoxicating power. The common canes or rattans of the shops are the flexible stems of species of the genus *Calamus.*

PALM-SUNDAY (Dominica Palmarum, Pascha Floridum), the Sunday before Easter, is the day of celebration of the triumphal entry of Christ into Jerusalem. But the custom of carrying palm branches on particular days of festivity (βαιοφορια) was an older Jewish observance. The feast of Palm Sunday appears to have been observed all along in the Eastern church, but is said to have been revived in the West by Gregory the Great. The earliest known Latin homily for the day is by the Venerable Bede.

PALP. (Lat. palpus, *a feeler.*) A jointed sensiferous organ, attached in pairs to the *labium* and *maxilla* of insects, and termed respectively "labial" and "maxillary" palpi, or feelers.

PALPA'TORS, *Palpatores.* The name of a family of Clavicorn beetles, including those which have very long maxillary feelers, or palps.

PALSY. *See* PARALYSIS.

PALU'DAME'NTUM. The peculiar military dress of a Roman general (imperator), in the times of the republic (*Apul. Apologia*), afterwards adopted by the emperors. It was worn only in the campaign, and exchanged for the toga in Rome. Vitellius, according to Tacitus, was advised not to enter the city in it, as it would be making it look like a city taken by storm. (*Hist.* ii. 89. See *Mem. de l'Acad. des Inscr.* vol. xxi.)

PALUDI'NA. (Lat. palus, *a marsh.*) A genus of fresh-water or marsh snails; so called from their location in marshes, ditches, and slow streams. Many species are common in Great Britain; a beautiful example, called the agate marsh-shell (*Paludina achatina*, Lam.), may be found in the smaller tributaries of the Thames.

PA'MPAS. The name given to one of the great systems of South American plains, which can scarcely with propriety be called *deserts*, inasmuch as they are covered with luxuriant herbage, and inhabited by vast herds of wild cattle and droves of horses. The region of the Pampas forms the basins of the Paraguay and La Plata, and includes the vast plains of Buenos Ayres, extending from the foot of the eastern ridge of the Andes to the "sea-like Plata," and stretching southward into the deserts of Patagonia. (*Traill's Physical Geography.*)

PA'MPHLET. A word for which various etymologies have been suggested; as, for instance, pagina filata, *a threaded page*, i.e. leaves stitched together with a thread; while others consider it to be derived simply from pampier, or papier, *paper.* It signifies a short treatise or essay, generally speaking on some subjects of temporary interest, which excites public attention at the time of its appearance. We commonly understand by the word pamphlet a production of the above character when it comes from the publishers merely stitched together in sheets, and not bound. The word is of considerable antiquity, being used by Chaucer. Pamphlets became of common use in political and religious controversy about the middle of the 16th century; in England, under the reign of Elizabeth; in France, during the wars of religion.

PA'MPRE. (Fr.; from Lat. pampinus, *a cluster.*) In Sculpture, ornaments consisting of vine leaves and grapes.

PAN. (Gr. Πάν.) The chief rural divinity of the Greeks, who presided over flocks and herds. He was said by some to be the son of Mercury; and his birthplace was Arcadia, to which province his worship seems to have been confined in early times. The introduction of his worship into the other Grecian states is thus accounted for. When Philippides, an Athenian courtier, was traversing Mount Parthenius, above Tegea, a short time before the battle of Marathon, he was encountered by Pan, who commanded him to ask the Athenians why they paid no respect to a divinity who had ever been friendly to them, and was still ready to promote their welfare; and in consequence of this remonstrance the Athenians, after the defeat of the Persians, dedicated a temple to this divinity beneath the Acropolis, and propitiated his favour by annual sacrifices and torch races. He was represented with the head and breast of an elderly man, while his lower parts were like the hind quarters of a goat, whose horns he likewise bore on his forehead. His emblems were the shepherd's crook and pipe of seven reeds, his own invention. The name Pan is derived probably from the Gr. παειν, *to tend flocks*, which, as being the most general mode of life in primitive times, has led to the belief that this god was a symbol of Universal Nature; an idea to which Milton alludes in the beautiful lines, —

> ——— while Universal Pan,
> Knit with the Graces and the Hours in dance,
> Led on the eternal spring.

PANACE'A (Gr. παν, *all*, and ακεομαι, *I cure*), signifies a remedy which professes the power of curing all sorts of diseases. The word is said to be derived from Panacea, a daughter of Esculapius, the goddess of health, to whom, in conjunction with her better known sister, Hygeia, the power of healing all diseases was ascribed.

PA'NATHENÆ'A. (Gr. Παναθηναια; from παν, *all*, and Αθηναῖος, *Athenian.*) The great national festival of the inhabitants of Attica, celebrated in honour of Minerva. There were two solemnities of this name, the great and little. The former were celebrated once in every five years; the latter in every third year, or, as some think, every year. The exhibitions at these festivals were torch races, gymnastic, and musical, and poetical contests, with sacrifices and feasts; and, at the great

Panathenæa, the sacred stole (πέπλος), decorated by the hands of chosen virgins with embroidery representing the deeds of heroes and patriots, was hung like a sail on a machine in the form of a ship, and thus conveyed up to the Acropolis in a procession, and placed on the statue of Minerva.

PANCA'RTES, or PANCHARTÆ. In Diplomatics, royal charters, in which the enjoyment of all his possessions (enumerated in the instrument) is confirmed to a subject. The word, however, is used in other and looser significations.

PANCRA'TIUM. (Gr. παγκρατιον; from παν, *all*, and κρατειν, *to subdue*.) A kind of athletic contest practised by the Greeks, which combined wrestling and boxing together.

PA'NCREAS. (Gr. παν, and κρεας, *flesh*, from its fleshy consistence.) A glandular viscus of the abdomen, situated under and behind the stomach; its duct enters the duodenum, into which it conveys a fluid very like the saliva. Its use appears to dilute the bile, and render it more miscible with the food. It is commonly called the *sweetbread* in animals.

PANDÆMO'NIUM. (Gr. παν, and δαιμων, *a demon*.) The general appeliation bestowed by Milton on

—— the high capital
Of Satan and his peers. *Par. Lost*, i. 81.

PANDANA'CEÆ. (Pandanus, one of the genera.) A natural order of Arborescent Endogens inhabiting the Indian Archipelago, and most of the tropical islands of the old world. They have the aspect of gigantic pine-apples, bearing the flowers of a sparganium; and are remarkable among arborescent Monocotyledons for their constant tendency to branch, which is always effected in a dichotomous manner; and also for their leaves being arranged so distinctly in a spiral manner that they have acquired the common name of *screw pines*. The seeds of *Pandanus* are eatable.

PA'NDECTS, or DIGEST. (Gr. πανδεκτα; from παν, *every thing*, and δεχομαι, *I receive*.) The great compilation of the Roman law published by the Emperor Justinian. *See* DIGEST.

PANDO'RA. (Gr. παν, and δωρον, *a gift*.) Literally *the all-gifted*. In Grecian Mythology, the name given to the first mortal female, according to Hesiod, that ever lived. She was formed of clay by Vulcan, at the request of Jupiter, and was created for the purpose of punishing Prometheus (*see* PROMETHEUS) for his numerous impieties. All the gods vied in making her presents: thus, from Venus she received beauty, from the Graces the power of captivating; Mercury taught her eloquence, and Minerva wisdom; but Jupiter gave her a box filled with innumerable evils, which she was desired to give to the man who married her. She was then conducted to Prometheus, who, sensible of the deceit, would not accept of the present; but his brother Epimetheus, not gifted with the same prudence, fell a victim to Pandora's charms, accepted the box, from which on its being opened there issued all the ills and diseases which have since continued to afflict the human race. Hope alone remained at the bottom of the box, as the only consolation of the troubles of mankind.

PANDOU'RS. A kind of light infantry, formerly organized as separate corps in the Austrian service; raised from the Servian and Rascian inhabitants of the Turkish frontier, and originally under leaders of their own, styled Harumbachas. Since 1755, they have been included in the regular army.

PANDURIFORM. Literally, *fiddle-shaped;* applied by botanists to the leaves of some plants.

PANEGY'RIC. (Gr. λόγος πανηγυρικος, *a speech addressed to a general assembly*, and πανήγυρις, *panegyric*.) In Oratory, an eulogy or harangue, written or spoken, in praise of an individual or body of men. Among the ancients, orations were recited in praise of the departed on various occasions, before solemn assemblies: hence the name. Among the later Romans, the baser practice prevailed of reciting panegyrical orations on distinguished living persons in their presence. Among the moderns, panegyrical oratory has been chiefly confined to funeral discourses from the pulpit. In France, however, the eloges or orations, pronounced in some literary and scientific societies on the decease of a member, bear something of the character of classical panegyrics.

PA'NEL. In Law, said by Sir H. Spelman to mean "schedula," or "pagina," as a *panel* of parchment, &c. It commonly designates the roll containing the names of jurors whom the sheriff returns to pass on a trial. In Scottish law, the accused person in a criminal action from the time of his appearance is styled the "pannel."

PA'NIC (Lat. Pan), is usually applied to a sudden and groundless alarm. The word originated in the stratagem which Pan had recourse to, during the Indian expedition of Bacchus, on being surrounded by a numerous army; viz. ordering his men suddenly to raise a simultaneous shout, which, favoured by the echoes of a rocky valley, had the appearance of so augmenting their numbers that the enemy were inspired by terror, and instantly took to flight.

PA'NICLE. A form of inflorescence in which the primary axis develops secondary axes, which themselves produce tertiary; or, in other words, a raceme bearing branches of flowers in place of simple ones.

PA'NNEL, or PANEL. (Fr. panneau.) In Architecture, an area sunk from the general face of the surrounding work. In Joinery, it is a tympanum, or thin piece of wood, framed or received in a groove by two mounters or upright pieces, and two traverses or cross pieces.

PA'NOPLY. (Gr. παν, and ὅπλον, *armour*.) Literally all the armour that can be worn for defence; complete armour.

PANO'PTICON. (Gr. παν, and οπτομαι, *I see*.) A term coined by Jeremy Bentham to denote the plan of the prison which he designed and recommended for adoption in his *Theory of Punishments*. This building was distinguished by three leading properties, for an account of which the reader is referred to vol. xxii. of the *Edin. Review*, pp. 19, 20.; but its greatest peculiarity consisted in its form, and in the disposition of its cells, which were so constructed that the inspector could see each prisoner at all times without himself being seen; and hence the origin of the term.

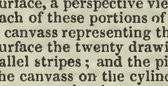
PANORA'MA. (Gr. παν, *all*, and ὁραω, *I see*.) A picture in which all the objects of nature that are visible from a single point are represented on the interior surface of a round or cylindrical wall, the point of view being in the axis of the cylinder. The rules according to which the different objects are represented in perspective are easily deduced from the consideration that the lines on the panorama are the intersections of the cylindrical surface of the picture with one or more conical surfaces having their summits at the point of view, and of which the bases are the lines of nature which the artist proposes to represent. In executing this kind of perspective the artist divides the horizon into a considerable number of parts, twenty, for example, and draws, in the ordinary way, on a plane surface, a perspective view of all the objects comprised in each of these portions of the horizon. He then paints on a canvass representing the development of the cylindrical surface the twenty drawings, in as many vertical and parallel stripes; and the picture is completed by stretching the canvass on the cylindrical wall of the rotunda which is to contain the panorama. When a painting of this kind is well executed, its truth is such as to produce a complete illusion. No other method of representing objects is so well calculated to give an exact idea of the general aspect and appearance of a country as seen all round from a given point.

The first panorama exhibited in London was painted by Barker in 1793; it represented the objects about Portsmouth and the Isle of Wight. A panorama of London was the first that was introduced into Germany, in 1800. Since that time they have become common in all the principal cities of Europe.

PANSTE'REORA'MA. (Gr. παν; στερεὸς, *solid*, and ὁράω, *I see*.) In Rilievo, a model of a town or country in cork, wood, pasteboard, or other substances.

PA'NSY. (Fr. pensée, *a thought*.) A term applied chiefly to the garden varieties of *Viola tricolor*, and others which are usually cultivated under the name of *heart's ease*. *See* VIOLA.

PA'NTAGRAPH. (Gr. παν, and γραφω, *I write*.) Frequently but improperly written *Pentagraph*. An instrufor copying, reducing, or enlarging plans. It consists of a jointed rhombus, A B C D, made of wood or brass, and having the two sides B A and B C extended to double their length. The side A D and branch A E are graduated from A, in such a manner that if O and T be corresponding divisions, A O is to B O in the same ratio as A T to B E or B F. Small sliding boxes for holding a pencil or tracing point are brought to the corresponding graduations, and fixed in their positions by screws, and a third is fixed at the point F. Now, since in every position of the instrument the two sides A D and B F are parallel, and the points O and T are so taken that OA : A T : : O B : B F, the three points O, T, and F must necessarily range in a straight line; consequently, if any one of these three points be taken as the centre of motion, and another of them be carried along the boundaries of any figure, the third will trace out a similar figure, reduced or enlarged according as it is nearer to or farther from the centre of motion than the point which is carried along the figure to be copied. Suppose the point O to be made the centre of motion, the tracer to be fixed at F, and the crayon or drawing point at T, the division of A D corresponding to O; then, while F is carried along



any figure, T will describe a similar figure reduced in the proportion of O T to O F, or of O A to O B. But if the tracer be fixed at T, and the drawing point at F, the copy will be enlarged in the proportion of O B to O A; or, if the fulcrum be placed at T, the tracer at O, and the crayon at F, the figure delineated will be enlarged in the proportion of O T to T F. If the points O and T be brought to coincide with E and D, and the fulcrum be placed at D; then, the distance E D and D F being equal, the original figure will be transferred into a copy of exactly the same dimensions. The pantagraph was invented by the Jesuit Christopher Scheiner in 1603, and is described by him in a tract entitled *Pantographice sive Ars Delineandi, &c.*, published at Rome in 1623. A more perfect instrument for accomplishing the same objects has recently been invented by Professor Wallace of Edinburgh, who has given it the name of *Eidograph:* for a description of which see the *Transactions of the Royal Society of Edinburgh*, vol. xiii.; or *Wallace's Geometrical Theorems and Analytical Formulæ*, 1839. Both instruments may be so modified as to produce a reversed representation of the figure to be copied; an application which is extremely useful for the purposes of copper-plate engraving and lithography.

PA'NTALOON. One of the chief characters in all pantomimic representations. He was originally dressed in a manner similar to that from which a well-known article of modern dress has derived its name. His name is said by antiquarians to be derived from the Italian words "Pianta-leone," as it were the "lion-planter," in allusion to the boastful language of the Venetians. (See *Lord Byron's Childe Harold*, canto iv.) The pantaloon of the original Italian pantomime was a Venetian burgher.

PANTE'CHNICON (Gr. παν, and τεχνη, *art*), signifies a place in which, as the term imports, every species of workmanship is collected and exposed for sale. The large building near Belgrave Square is an excellent specimen of this modern invention.

PA'NTHEISM. (Gr. Παν, and Θεος, *God.*) In Metaphysical Theology, the theory which identifies nature, or the τὸ πᾶν, the universe in its totality, with God. This doctrine differs from atheism in the greater distinctness with which it asserts the unity and essential vitality of nature; parts of which all animated beings are. The most ancient Greek philosophers were pantheists in this sense; Anaxagoras being the first who distinctly stated the coexistence with nature of a reasonable creator — "a mind, the principle of all things." In this sense, too, Spinoza may be called a pantheist. The pantheism of Schelling, and many modern German philosophers, is of a different stamp. According to these thinkers, God is conceived as the absolute and original Being, revealing himself variously in outward nature, and in human intelligence and freedom. It is not easy to see how pantheism in this sense differs from the Christian view of God, as expressed in the sublime language of St. Paul, "In whom we live, and move, and have our being." The world is, indeed, conceived to be animated by the presence and agency of the Deity; but his distinctness and independent subsistence are definitely laid down as the condition and ground of all phenomenal existence, and of reason itself. God may exist without the world, but the world is inconceivable without God. (See this article in *Ersch and Gruber's Encyclopædia.*) It must, however, be remarked, that many pseudo-philosophers of modern times assume the name of Pantheists as a convenient medium for the dissemination of *atheistical* opinions which they have not the courage boldly to avow.

PANTHEI'STIC. (Gr. Παν, and Θεος, *God.*) In Sculpture, a term applied to statues and figures which bear the symbols of several deities together, the meaning of which has been a subject of much dispute among antiquaries.

PANTHE'ON. (Gr. πάνθειον; from παν, *all*, and θεος, *a god.*) A temple dedicated to all the gods. Two magnificent structures of this kind existed in antiquity; one at Athens, the other at Rome. The latter, which still exists, though comparatively in ruins, is one of the most splendid remains of the ancients. The foundation of this building is generally ascribed to Agrippa, the son-in-law of Augustus. It now forms a Christian church, dedicated to the Virgin Mary and All Saints, and generally called the Rotunda. The form is circular, and its roof a hemispherical dome 144 feet diameter, its height being the same from the pavement to the top of the dome. It has a noble Corinthian portico, consisting of sixteen granite columns of the Corinthian order, of which eight stand in front. Pliny ranked this edifice as one of the wonders of the world. Since its erection it has been grievously spoiled of its ornaments. The term pantheon has been applied to places of public exhibition in which every variety of amusement is found. It is also used for a work containing a view of the mythology or all the gods of the ancients (as the term imports); as in *Tooke's Pantheon.*

PANTOCHRONO'METER. (Gr. παν, χρονος, *time*, and μετρον, *a measure.*) A term recently invented and applied to an instrument which is a combination of the compass, the sun-dial, and the universal time-dial, and performing the offices of all three.

PANTOLO'GIA. (Gr. παν, and λογος.) A work of universal instruction or science; equivalent to *dictionary* or *encyclopædia*, which see.

PA'NTOMIME. (Gr. παν, and μιμεω, *I imitate.*) A species of theatrical entertainment, in which, according to the derivation of the word, the whole action of the piece should be represented by gesticulation, without the use of words: also, a theatrical performer skilled in mimicry. The English pantomime is an amusement peculiar to our theatre. A class of actors in vogue at Rome, who performed pieces in dumb show, expressing every thing by their dancing and gestures, were also called pantomimes, and were in all probability the archetypes of this species of amusement among ourselves. (See the *Conversations-Lexicon;* and as to ancient pantomimes, *Mem. de l'Ac. des Inscr.* vol. xxiii.) *See* MIMES.

PA'PACY. The office of pope, or, historically, the succession of popes in the see of Rome. The origin of the term is oriental. The word papas was used in lower Greek with the signification of father, and is still applied by the Greek church to the priests of that communion. In the Western church, the title was not uncommonly given to bishops in general, and was not confined to the Roman pontiff for several centuries. In this article it will be our endeavour to trace, with the conciseness which our limits demand, the steps by which the bishops of Rome attained to the vast religious and political importance which they once possessed, and of which they still retain the shadow.

1. It is generally agreed that a certain degree of deference was paid to the church of Rome by the Christian societies dispersed throughout the empire in the primitive age. As St. Peter appears to have held a certain prominency among the apostles, so was his see looked up to, and its advice occasionally resorted to, by the other metropolitan churches, which, though its equal in rank, might allow to it some moral superiority. But, as the other apostles did not hesitate to rebuke St. Peter when his conduct appeared to their judgment to deserve it, nor to take the lead and initiative when he paused in the career which the Holy Spirit pointed out, so we find Irenæus of Lyons interfering to check the dogmatism of Victor of Rome, and Cyprian maintaining the validity of heretical baptism, in concert with the Asiatic church, and in opposition to the Roman.

2. It is in the fourth century that the first dawn of substantial power appears in the Roman see. Upon the recognition of Christianity by the civil government, the bishop of Rome is found in the enjoyment of precedence among the prelates of the empire. The patriarch of Constantinople is expressly exalted by Theodosius (A. D. 381) to the *second* rank. The canons of the council of Sardis, 347 (the genuineness, however, of which is suspected), allow bishops in certain cases an *appeal* to the Roman pontiff. Even the removal of the seat of government to Constantinople, although the very fact of its residence at Rome had undoubtedly contributed to the pre-eminence of its bishop in earlier times, seems to have favoured the pretensions which the popes began now openly to maintain. Rome was no longer under the immediate eye of the emperor. The patriarch of Constantinople, although he enjoyed the imperial favour up to a certain point, was not allowed to outstep it, and was subject to be deposed if he forgot for a moment the relative position in which he stood. The emperors of the West, on the other hand, took up their abode at Milan, or Ravenna; and when they had been overturned, and the barbarians began to found new dynasties upon the ruins of the Italian provinces, the popes were among their most useful instruments in civilizing and consolidating the fragments of their power.

Again, the nearer contact which thus took place between the Italian clergy and the children of the pagans of the north afforded the popes an opportunity of diffusing the idea of their own supremacy, at the same time that they extended the limits of Christianity; and while Antioch and Alexandria were trembling before the birth of Mahometanism, and Constantinople was losing one by one its fairest provinces and strongest partizans, the dominion of the Western primacy was acquiring daily a wider basis and a more devoted people.

3. With Gregory I., at the end of the sixth century, commenced one of the most important epochs in the papal history. The system of aggrandizement, of which he laid the foundations, consisted in the conversion of the heathen, upon the principle above mentioned, and the connection of the monastic orders with the Roman see, by releasing them from the immediate jurisdiction of their own diocesans.

4. The next important step in our history is the famous donation of Pepin, by which the Italian provinces which the French king had conquered from the Lombards were transferred by him, not to his own dominions, nor

to the Greek emperor, who had the ancient hereditary claim, but in temporal sovereignty to the pope. But even this political power, thus acquired, was not in itself pregnant with such important consequences as the principle which was sanctioned by the immediate occasion of the donation; for Pepin had taken counsel with Pope Zachary whether he should be justified in overturning the throne of the imbecile prince whose servant he was, and had been formally authorized so to do. However, the possessions which thus came into the hands of the Roman bishops, confirmed and enlarged by the addition of the territory of Rome itself by Charlemagne, at the close of the eighth century, have continued up to this day, with little extension or diminution, to form the temporal patrimony of St. Peter. It is to be observed, that the nature and extent of the power accorded to the popes by Charlemagne has given rise to much dispute; and the partizans of the Roman see have been charged with giving to it a false and exaggerated colouring. "The most probable account of the matter," says Mosheim, "seems to be this, that the Roman pontiff possessed the city of Rome and its territory by the same right that he held the exarchate of Ravenna, and the other lands which he received from Charlemagne; that is to say, that he possessed Rome as a feudal tenure, though charged with less marks of dependence than other fiefs generally are, on account of the lustre and dignity of the city which had so long been the capital of the empire." (*Cent. VIII.* pt. 2. cap. 2. note.)

5. The dissensions which took place among the successors of Charlemagne in the 9th century afforded a tempting opportunity for political encroachment on the part of the Roman bishops. In 879, Charles the Bald was proclaimed emperor by Pope John VIII., and his immediate successors received their nomination also from the same source. It was in the same century that the forgery of the decretal epistles gave a colour and authority to many temporal claims of the Roman see.

6. It was not, however, till the pontificate of Gregory VII. (1073—1086), that the principle of temporal aggrandizement which we have been tracing received a systematic development. The grand project which that prelate entertained was to reduce the whole territory of Christendom to a feudal subjection to the holy see. He assumed the right of appointment to all the crowns of Europe; and with such success that when his principal opponent, Henry IV. of Germany, had succeeded in dispossessing him of his pontifical chair, and placing therein the antipope, Clement III., the victorious monarch continued to recognize, in the creature whom he had thus installed in the papal prerogatives, the very same authority which Gregory had claimed over him, and received from his hands his own imperial crown. A main feature in this political scheme was the reduction of the whole body of the clergy into immediate dependants upon the papal throne. In order to effect this, the law of celibacy was strictly enforced; the elections of bishops by their diocesan clergy discouraged and almost abolished; and their investiture by their national sovereigns, in itself a monarchical usurpation, became the great subject of contention between the pope and the emperor; in which, though the former was finally unsuccessful, yet principles were advanced during its progress, and claims bequeathed to posterity, which smoothed the way for the more fortunate aggressions of later pontiffs, and exalted the power of the papacy to its greatest height under Innocent III. at the beginning of the 13th century.

7. The power of excommunication had long been exercised and wantonly abused before the time of Gregory; the interdict, by which a whole state was laid under a spiritual ban, was not adopted till about that period. This weapon was unsparingly wielded by Innocent III.; and the degradation to which John of England was subjected by him through these means is one of the strongest instances of the extent to which the papal power was advanced. But Innocent, although his clergy were better disciplined subjects, and his pretensions invested with the superior efficacy of prescription, had new and greater difficulties to contend with than his famous predecessors. At this time the tide of human opinion was already on the turn. Numerous reforming sects arose and threatened to undermine the fidelity of the lower classes; the princes were more conscious of the yoke which had been imposed upon them, and more anxious to avail themselves of an opportunity to cast it off: the clergy also, the main stay of the papal cause, were beginning to excite general murmurs by their corruption of manners. It is between Gregory and Innocent, therefore, that the period of the substantial greatness of the Roman see must be placed by the historian who contemplates both eras from a distance, and observes the seeds of decay which began to manifest themselves in the latter. The violence, however, and assumption of power, which had increased up to this time, continued to grow under the successors of Innocent, who appear not to have felt, even up to the Reformation itself, that the foundations of their authority were slipping rapidly from under them. But the same causes which we have enumerated as counteracting the apparent glory of Innocent's pontificate continued to work steadily against his successors; and at length when Luther arose to combine the force resulting from the three, the papacy, though relaxing nothing from its extravagant pretensions, found itself suddenly shorn of one third of its subjects entirely, and deprived of a great proportion of its authority over the rest. From that time to the present the power of the papacy has continued to retrograde, even in spiritual matters. It has been forced to concede a certain degree of independence to the clergy of France, and to enter into disadvantageous concordats with Napoleon and some of the German princes. It has even encouraged its writers in disclaiming the schemes of its earlier pontiffs, and allows them to assert the interference of the church between the prince and the subject to be tyrannical and unchristian. Its spiritual influence, however, although harassed on all sides by the free and discursive opinions of the day, continues still, from its combined pressure and elasticity, to be the most remarkable feature of modern history; its share in the recent political events of Europe has been very great, while the number of its subjects is probably at this moment much greater than at the times of Gregory or Innocent.

PAPA'VERA'CEÆ. (Papaver, one of the genera.) A natural order of narcotic plants, belonging to the Polypetalous division of the Exogenous class, and nearly related to *Ranunculaceæ*, with which it corresponds in habit and the structure of the seeds, but differs in having parietal placentæ and a calyx of only two pieces. The common poppy, the horned poppy, argemône, and some other genera, are well-known species, either cultivated for the sake of their flowers, or destroyed as showy but troublesome weeds. Opium is the inspissated juice of *Papaver somniferum*.

PA'PER. (Gr. *πάπυρος*; Fr. *papier*.) A thin and flexible substance of various colours, but most commonly white, used for writing and printing on, and for various other purposes. It is manufactured of vegetable matter, reduced to a pulp by means of water and grinding; and is made up into *sheets*, quires, and reams, each quire consisting of twenty-four sheets, and each ream of twenty quires.

For the chief purposes to which paper is applied in modern times the ancients had recourse to a variety of materials; stone, tablets of wood, plates of lead, skins, parchment, linen, layers of wax, tablets of ivory, and, above all, the papyrus. The ability to write created a necessity for some material on which to inscribe; and all these various materials were resorted to in succession, as the ineligibility of each induced a fresh endeavour to discover some more desirable substitute.

As our present object is to trace the progress of paper, rather than to enter into a minute account of those materials which were employed antecedent to its manufacture, it will not be necessary to dwell upon the other substances, which are as diversified as human ingenuity could devise; but pass on to the papyrus, the immediate precursor of paper, and the article from which it was first manufactured. Egypt has the honour of the invention; and Isidore even fixes the locality at Memphis: the date remains in some obscurity, although it has been warmly disputed. Varro, the Roman, ascribes it to the time of Alexander the Great, after the founding of Alexandria; but we find in Pliny the recital of a passage, extracted from the writings of Cassius Hemina, an ancient annalist, in which he speaks of some books found in the tomb of Numa when it was opened, 535 years after his decease, and asserts that these books were of *paper*, and had been interred with him. As Numa preceded Alexander 300 years, this circumstance, if admitted, would carry back the date of the invention anterior to that time. However, the antiquity of such a date is much doubted; but as Pliny gives an account of the manner of making the papyrus paper, and it seems to have been in high reputation in the time of Alexander the Great, it is probable that such improvements were made during his reign as to enhance the value and increase the manufacture.

It is true that papyrus continued in use long after the invention of paper; and this is the argument by which it is contended that the manufacture was of more modern date, although the only fair inference seems to be that it was only rare or expensive. It appears, however, that after this time papyrus paper was chiefly manufactured at Alexandria, and continued a source of profit to that city up to the fifth century, to the close of which it remained in general use throughout Europe; Italy retained it to the eleventh, and France even so late as the twelfth century.

We have thought it right thus briefly to narrate the differences of opinion which have prevailed respecting the origin of paper. Our own belief is, that the transition of the use of the papyrus in its natural state to that in its manufactured was so gradual, that it does not leave room to fix on any precise point at which to

say that the papyrus became paper. Probably the first step arose from the perception that the leaf was not strong enough for its purposes; and then how simply came the remedy of placing the leaves together, the waters of the Nile, amid which the plants grew, serving to cement them; afterwards came a pressure to flatten the transverse leaves; and this simple process seems to give the origin of paper. We believe that many an invention for which the learned have contended, has advanced by steps as simple and as gradual, leaving it impossible to decide at what point invention began, since it was only improvement that was taking place.

The next improvement in paper was its manufacture from cotton. It is supposed that the Chinese and Persians were acquainted with this material for its production, and that the Arabians learnt it from their conquest in Tartary. The ancient paper bears no marks of the wire through which the water is drained in modern paper-making; and it is therefore inferred that a different process was employed. Paper made from cotton was in use earlier with the Greeks than with the Romans. The manufacture of paper from cotton cannot be traced further back than to the tenth century; and the oldest manuscript document written on this cotton paper is dated 1050.

When or by whom linen paper was invented seems uncertain: some give the credit to Germany, some to Italy, some to Greece; but the Chinese appear to have the best pretensions. The Rev. Dr. Dibdin, in his *Typographical Antiquities*, says that "the art of paper-making with linen rags is supposed to have been discovered in the eleventh century, though Father Mabillon thinks it was in the twelfth. Montfaucon acknowledges that he has not been able to meet with a single leaf of paper with a date anterior to the death of St. Louis in 1270." Its introduction into England took place about the year 1342, in the reign of Edward III., although some have supposed it as early as 1320. France had it in 1314, and Italy in 1367. The Germans possess a specimen bearing the date of 1308, although it has been surmised that this single instance may have been a mixture of linen with cotton.

In the Preface to the *Kalendars of the Exchequer*, published by the Record Commission, it is stated that "some of the letters addressed to Hugh le Despencer, from Gascony (at various periods in the reign of Edward II.), are written on very stout and beautiful vellum; others on paper, of a sound and strong fabric, well sized, and such as may altogether be called a good article. And although, in the Tower, there are a few letters upon cotton paper, yet parchment or vellum was generally used; and these are amongst the earliest examples of any continued correspondence upon the more commodious material, which in England was very rarely employed. It is highly probable that, in the south of France, the supply was received from the Moorish merchants or manufacturers of Spain." "The original register of the privy seal of Edward the Black Prince from July, 20 Edw. III., to January, 21 Edw. III., forming one volume, is on paper."

It is a commonly received opinion that the first paper mill was erected in England during the reign of Elizabeth; though it has been asserted that the first mill was set up in Charles the First's reign, by a German of the name of John Spilman, or Spielman; that the king granted him a patent, and a salary of 200*l.* a year. Both these opinions are proved to be erroneous by an entry in the privy purse expenses of Henry VII., dated May 25th, 1498, published in the *Excerpta Historica*. "For a rewarde yeven at the paper mylne, 16*s.* 8*d.*," which establishes with certainty an anterior date of full fifty years. Dr. Dibdin gives this account of Spilman, on the authority of Dr. Harris; but the statement is invalidated by Mr. Nicholls, in his *Progresses of Queen Elizabeth*, who has reprinted in that work a poem of the date 1588, of which the following is the title: — *A Description and playne Discourse of Paper, and the whole Benefitts that Paper brings, with Rehearsall, and setting foorth in Verse a Paper-myll built near Darthford, by an high Germaine, called Master Spilman, Jeweller to the Queene's Majestie*, 1588. Perhaps no other manufacture ever remained so long nearly stationary; though within the last fifty years such great and rapid improvements have been made in it, as to equal, if not to surpass, any other branch of manufacturing industry.

The application of paper to the purposes of writing and printing, and the fact of its being indispensable to the prosecution of the latter, render its manufacture of the highest utility and importance. But, even in a commercial point of view, its value is very considerable. France, Holland, and Genoa had, for a lengthened period, a decided superiority in this department. The finest and best paper being made of linen rags, its quality may be supposed to depend, in a considerable degree, on the sort of linen usually worn in the country where it is manufactured; and this circumstance is said to account for the greater whiteness of the Dutch and Belgian papers as compared with those of the French and Italians, and still more of the Germans. The rags used in the manufacture of writing-paper in Great Britain are collected at home; but those used in the manufacture of the best printing-paper are imported principally from Italy, Hamburgh, and the Austrian states, by way of Trieste.

We believe, however, that it was owing rather to the want of skill than, as has sometimes been supposed, to the inferior quality of the linen of this country, that the manufacture of paper was not carried on with much success in England till a comparatively recent period. During the 17th century most part of our supply was imported from the Continent, especially from France. The manufacture is said to have been considerably improved by the French refugees who fled to this country in 1685. But it is distinctly stated in the *British Merchant* (vol. ii. p. 266.), that hardly any sort of paper, except brown, was made here previously to the Revolution. In 1690, however, the manufacture of white paper was attempted; and, within a few years, most branches were much improved. In 1721 it is supposed that there were about 300,000 reams of paper annually produced in Great Britain, which was equal to about two thirds of the whole consumption. In 1783 the value of the paper annually manufactured was estimated at 780,000*l.* At present, besides making a sufficient quantity of most sorts of paper for our own use, we annually export about 100,000*l.* worth of books. We still, however, continue to import certain descriptions of paper for engravings from France, and a small supply of paper-hangings. The duty on both amounts to about 2800*l.* a year.

In 1813, Dr. Colquhoun estimated the value of paper annually produced in Great Britain at 2,000,000*l.*; but Mr. Stevenson, an incomparably better authority upon such subjects, estimated it at only half this sum. From information obtained from those engaged in the trade, we incline to think that the total annual value of the paper manufacture in the United Kingdom, exclusive of the duty, may at present amount to about 1,200,000*l.* or 1,300,000*l.* There are about 700 paper-mills in England, and from 70 to 80 in Scotland. The number in Ireland is but inconsiderable. About 27,000 individuals are supposed to be directly engaged in the trade; and, besides the workmen employed in the mills, the paper manufacture creates a considerable demand for the labour of mill-wrights, machinists, smiths, carpenters, iron and brass-founders, wire-workers, woollen manufacturers, and others in the machinery and apparatus of the mills. Some parts of these are very powerful, and subject to severe strain; and other parts are complicated and delicate, and require continual renovation. Owing to this, the manufacture is of much greater importance, as a source of employment, than might at first be supposed, or than it would seem to be considered by government, who have loaded it with an excise duty amounting to more than three times as much as the total wages of the work-people employed!

We pass on from this brief account of the history and statistics of paper to the mechanical process of its production; only remarking, that many articles have been resorted to in its manufacture, — the tendrils of the vine, the stalks of the nettle, the thistle, and mallow *; the bark of the willow, the hawthorn, the beech, the aspin, and the lime. Some patents have been obtained for making it of straw; and the bine of the hop, it is presumed, might furnish material for the supply of paper to all England; but, leaving these inferior substitutes, we shall confine ourselves to the description of paper made from linen rags, that being the staple of the manufacture.

The rags in the London market are sold to the manufacturers according to their respective quality, under the terms fine, 2d, 3d English rags; and SPFF, SPF, FF, &c. foreign rags: fine being wholly linen, and of the best quality, is used for the finest writing paper, and so in their gradation down to the commonest, which is coarse, often canvass, and can only be made into an inferior printing paper when it has been thoroughly bleached. In these inferior papers some cotton is mixed. There are also the strong coarse bags in which the rags are packed, and the coloured rags, only fit for the most common papers; though out of these the blue are usually sorted for the purpose of making blue paper. It is necessary that these rags should be dusted; and, to accomplish this, they are either placed in a cylinder formed of wire net, turning on pivots at each end, and enclosed in a box which receives the dust as it falls through the net-work, or else their

* The works of the Marquis de Villette, published in London, 1786, in 24mo., are printed on paper made of marshmallow; and at the end are specimens, in single leaves, of paper made of the nettle, hops, moss, reed, three of three species of conferva, couch grass, spindle trees, wayfaring tree, elm, lime tree, yellow willow, sallow willow, poplar, oak, two of burdock, coltsfoot, and thistle.

The Chinese make their paper in large sheets of the raw vegetable material; it has all the appearance of the pulp having been laid on a smooth flat surface with a brush, similar to painting, having one side smooth, and the other with the marks of the brush on it. It is unequalled in its quality of receiving a fine and delicate impression of engravings, either from copper or wood.

sorting takes place over a table frame covered with wire net, through which the dust falls into a box beneath as the workwoman proceeds in her labours. The first of these modes, however, is a great preservation of the health of those employed in the work. The rags are then cut into pieces not exceeding three or four inches square, the parts that have seams being thrown into a separate heap, or the sewing thread might make filaments in the paper. In this process the rags are scrupulously sorted according to their texture and degree of strength, not according to their colour; for, were they not carefully arranged by this rule, the fine in texture would be reduced to a pulp long before the coarse, and be lost in the preparation; or, if preserved, when reduced to pulp, would not be found of the same consistency as the coarser sorts, and the paper when manufactured would necessarily be clouded and inferior. It is for these reasons that this part of the process is important. When carefully sorted, and the different degrees of texture having, by a longer or shorter process, been reduced to a pulp of similar consistency, they may then be mixed together; but this cannot be previously done. While in this state the rags often appear so dirty and discoloured as to preclude all hope, to an inexperienced eye, that they can ever assume the purity of that beautiful fabric so valuable to the artist and the scribe. This purification used formerly to be effected by water running through a receptacle filled with the rags, which in its passage eventually carried off their soil; but the present more expeditious process is that of boiling them, mixed up with lime, in a species of chest, so perforated as to allow the admission of steam; and by this means they are partially bleached. It is but due to the superior cleanliness of our own country to state, that the rags collected in England require little bleaching; but, as these form a small proportion of the quantity used in our extensive manufactories, bleaching takes an important place in the process. The superfluous moisture is squeezed from the rags, and they are placed in a sort of chamber or receiver, which is air-tight, and pipes are conducted into it from a retort, which convey chlorine, formed, by the application of heat, from manganese, common salt, and sulphuric acid. This part requires much care; for if carried beyond its due point, it proves most injurious to the durability of the fabric. The rags when taken from this chamber are strongly imbued with a most nauseous smell, and require profuse and frequent washings. After this process they are put into the beating engines, and pass through a sort of trituration, which reduces them to a coarse and imperfect pulp, which is called half stuff or first stuff, and this is again levigated until it assumes the appearance of cream.

The state and quality of this pulp is of the utmost importance to the final perfection of the paper. If, in the levigation, the fibre should have been so entirely destroyed as to reduce it to a jelly, the paper will inevitably prove liable to break, moulder away, and be rotten; and this must result whatever the previous excellence of the material. A fibre is absolutely necessary to the production of a serviceable paper. Mr. Murray, in a little work on the subject full of practical science, recommends that a small proportion of unbleached flax should be added to the half stuff, — an expedient that would doubtless much increase the strength and durability of our manufacture. But, unfortunately, so far from means being taken to improve its consistency, others are resorted to, for the sake of an increased profit, which deteriorate almost to destruction: we mean the introduction of plaster of Paris, or other earthy substances, into the pulp; and this can never be done without ensuring brittleness and want of cohesion as the result. While the pulp is in this state, the size, made from sheep-skins and other animal substances, together with a solution of alum, is introduced; excepting only in the manufacture of writing paper, and then the sheets are most generally sized after their formation.

Having described the preparation of the material, we shall pass on to its formation into paper.

The fine pulp, or stuff, as it is technically called, is transferred into a chest or large tub with a revolving agitator; from thence into a vat, usually about 5 feet in diameter, and 2½ feet in depth, and sustained at a proper temperature by means of a fire; and it is generally arranged for this vat to be placed against a wall of the room, that the fuel to the fire may be supplied at an aperture externally, to prevent any injury from smoke. During the whole of the subsequent process it is requisite that the pulp in the vat should be stirred up at short intervals, to keep it of an equal consistency. There are three workmen employed in this stage of the operation, called the *dipper*, the *coucher*, and the *lifter*. The dipper is provided with a mould, formed of well-seasoned mahogany, across which parallel wires are stretched close together, a few other stronger ones being also placed at right angles with them, and at some distance from each other. The lines formed in the paper by these wires are called water-marks; but, in the modern improvement of wove paper, these are avoided by using wire cloth woven in a loom, which, being tightly stretched over the frame, produces no water-mark. This mould is provided with another frame, called a *deckle*, which fits it exactly, and forms a boundary line to the sheet of paper, which would otherwise have a rough and jagged edge. This contrivance, by supplying an edge to the mould, gives it the character of a sieve, which enables the dipper, after he has dipped the mould into the vat, and taken in a sufficient quantity of the pulp, and given it a gentle motion to equalize its thickness, to drain the water away; he then removes the deckle, replaces it on another mould, and proceeds as before; whilst the second workman, the coucher, removes the sheet of paper thus made on to a felt, being a piece of woollen cloth, and then returns the mould to the dipper, who, in the meantime, has been operating with another mould, and forming another sheet: they thus exchange the moulds, the one dipping, and the other couching, until they have completed six quires of paper, which is called a *post*. When this quantity is completed, the heap is conveyed to the vat press, and subjected to heavy pressure. These six quires remain in the vat press until the dipper and the coucher have perfected another post, when they are removed to give place to it; and then the office of the third workman, the lifter, commences. He separates the sheets of paper from the felts, and forms them into a pile, which is again subjected to a second press, which detaches from them a great quantity of moisture. Here it remains until the workmen are prepared to replace it with a similar quantity, when it is taken to the drying rooms, and hung up on lines to dry. These lines are carefully covered with wax, both to prevent adhesion and contraction; and the opening of the windows should be strictly attended to, that the drying may not proceed too rapidly. This being accomplished, it is taken down, shaken, to make the dust fall out, and to separate the sheets from each other, and laid up in heaps, ready to be sized. The size is prepared of a due consistence, twice filtered, and a portion of alum added. The workman dips a handful of the sheets, holding them open at the edges, that they may more equally imbibe the moisture, and after this process they are again subjected to the press. They are afterwards dried, sorted, brought under repeated and excessive pressure, and, finally, made up into quires and reams.

But as the process of paper-making must necessarily be comparatively slow when practised by hand, machinery has been resorted to, which has nearly supplanted the old method. We believe France has the honour of the invention, although it has been greatly improved in England by Messrs. Donkin and Co. That in most general use here is after Fourdrinier, who invented the endless web of wire. One of these machines can produce 25 superficial feet of paper per minute; and it is this which enables us to enter into competition with the foreign market, which we could not otherwise do, on account of the difference in the value of manual labour. In the old method, it took three months after receiving the rags into the mill to complete the paper: by the machine, they can receive the rags on one day, and deliver the paper made from them on the next.

The stuff, having been prepared and bleached in an expeditious manner by machinery, is emptied into the chest or tub, as before, and from thence is delivered gradually into the vat, where it is kept in continued motion by means of revolving fans, called *hogs*. Nearly at the top of the vat there is a gate, which can be raised or lowered at pleasure, by means of which the flow of stuff is regulated on to the lip or trough, from which it falls upon the endless web of fine wire, which is kept continually moving in a horizontal direction over a series of revolving rollers, and is placed immediately under the hanging lip of the trough, so that the pulp may have the shortest distance possible to fall. These revolving rollers prevent the wire web from falling in or bagging, and keep it level; and as it is preserved at a due tension from side to side, it has all the appearance of a table. A leather strap, or ledge of wood, on each side, forms the boundary line of the paper, answering the purpose of the deckle in the hand-making process; these are moveable according to the intended width of the paper. The long cascade or continuous stream of pulp, regulated with reference to the proposed thickness of the paper to be made, thus gently descends on this moving wire plane, which is perpetually travelling onward and onward; and, for its more perfect equalization, a second movement is resorted to, by means of a sort of crank, which gives the web a jerking motion at short intervals, and diffuses the liquid pulp unvaryingly over the surface. At the end nearest to the trough the pulp is, of course, perfectly fluid; but, as the web travels on, the moisture partially sinks through the fine apertures of the webbing, and the material coagulates. There has been a fashion prevalent of late years of having paper barred or ribbed: this appearance is given at this juncture. While yet moist, just before passing from the wire webbing, it is subjected to the pressure of a wire roller, which gives the indentations of the stripes or lines;

this cylinder is called a *dandy:* from this it travels to a web of cloth or felt, during which advance it is subjected to heavy pressures, from passing between rollers covered with felt, and called the *pressing rollers*. This process answers to the wet press in the hand-made paper; and formerly this was the termination of the labours of the machines, the remaining work of drying, &c. being accomplished by hand. But an incalculable improvement took place in the addition of the drying rollers. These are three cylinders of polished metal, which effect in a few moments the perfect drying of the paper: while yet moist it passes over the first moderately warm; again over the second, of larger diameter, of greater warmth; and again over the third with an augmented heat. The paper is now perfectly dry, and any casual inequalities are removed from its surface. The final action of this wonderful machine is to wind the paper round a last roller or reel, which when full is exchanged for another, and so on successively.

Here the work of the machine is finished; and the paper, being in long webs of many yards, requires to be cut into sheets. After different methods had been tried, a supplementary machine has been invented, which receives the web from off the reel on to a drum, cuts it into sheets of proper lengths with a circular knife, continually revolving, while the divided web proceeds; and these sheets are received and placed in regular heaps by children.

Mr. Dickinson has recently made great improvements in the machine, which has consequently been followed by a corresponding improvement in the paper manufactured by the house of Messrs. John Dickinson & Co., which has long been celebrated for producing paper of a superior quality.

The manufacture of the paper being thus completed, the sheets are separately examined, and every knot or blemish carefully removed, the torn or damaged ones being laid apart. In this state they are subjected to the action of a powerful press, in the full and open size of the sheet: they are afterwards cut round the edge, and then counted into quires of twenty-four sheets, which are folded in the middle, and put into reams, each ream containing twenty quires, of which the two on the outside are made up of twenty sheets each from the damaged sheets that were thrown out. In this state they are again pressed, and finally tied up in wrappers. These wrappers are stamped by the exciseman; and, by the act 6 & 7 Will. 4. c. 52., the paper is charged with an excise duty of three halfpence a pound.

When the duty on paper was charged according to the size, the makers were obliged to be particular in the dimensions. The following table shows the exact size of the different writing, drawing, and printing papers, as enforced by the excise under the powers vested in them by act of parliament.

	First Table. Writing.	Second Table. Drawing.	Third Table. Printing.
	Inches.	Inches.	Inches.
Double Atlas -	- -	55 by 31½	
Grand Eagle, or Double Elephant - -	- -	40 26¾	
Double Demy -	- -	- -	38½ by 26
Columbier -	- -	34½ 23½	
Atlas - -	- -	34 26¼	
Atlas, small -	- -	31 25	
Imperial - -	30½ by 22	30¼ 22	
Double Crown -	- -	- -	30 20
Elephant - -	- -	28 23	
Super Royal -	27½ 19¼	27½ 19¼	
Long Royal -	- -	27½ 18	
Royal - -	24 19¼	24 19¼	26 20
Ditto - -	- -	- -	24¼ 19½
Double Pott -	- -	- -	25½ 17
Large Fan -	- -	23½ 20½	
Small Fan -	- -	22¼ 13¼	
Medium - -	22½ 17½		23 18
Extra large Post - -	21 16½		
Thick and thin Post - -	19½ 15¼		
Small Post -	16½ 13½		
Demy, single -	- -	- -	22 17½
Ditto -	- -	- -	21½ 19¼
Demy - -	20 15½	22 17	
Short Demy -	- -	20¼ 14	
Copy, or Bastard - -	- -	20¼ 16	
Crown - -	- -	20 15	
Single Crown -	- -	- -	20 15
Foolscap - -	16¾ 13½	16¾ 13½	
Littriss Foolscap - -	- -	17½ 13½	
Pott - -	15½ 12½	15 12½	

It will be seen, by the preceding table, that the largest sheet of hand-made paper is 4 feet 7 inches in length by 2 feet 7 inches and a half in breadth; while machine-made paper is of the width of 5 feet, and appears to be unlimited as to its length.

PAPER HANGINGS. This important and elegant substitute for the ancient "hangings" of tapestry or cloth came into use about 200 years ago: the manufacture has undergone a gradual succession of improvements, and has now reached a high state of beauty and perfection. The patterns on these papers are sometimes produced by stencil plates, but more commonly by blocks, each colour being laid on by a separate block cut in wood or metal upon a plain or tinted ground. The patterns are sometimes printed in varnish or size, and gilt or copper leaf applied; or bisulphurate of tin (*aurum musinum*) is dusted over so as to adhere to the pattern; and in what are called *flock papers*, dyed wools minced into powder are similarly applied. Powdered steatite, or French chalk, is used to produce the peculiar gloss known under the name of *satin*. Striped papers are sometimes made by passing the paper rapidly under a trough, which has parallel slits in its bottom through which the colour is delivered; and a number of other very ingenious and beautiful contrivances have lately been applied in this important branch of art. The invention of the paper machine, by which any length of paper may be obtained, effected a great change in paper hangings, which could formerly only be printed upon separate sheets, and were much more inconvenient to print as well as to apply to the walls. A plausible suggestion upon the subject of "intellectual paper hangings" will be found in No. 504. of the *Penny Magazine*. The reduction of the duty on paper, and the repeal of that on paper hangings, not only create a greater demand for, but are likely to lead to further improvements in, this manufacture.

PAPER MONEY. *See* Banks.

PAPER SAILOR, or PAPER NAUTILUS. *See* Argonaut.

PAPIER-MACHÉ. A name given to articles manufactured of the pulp of paper, or of old paper ground up into a pulp, bleached, if necessary, and moulded into various forms. This article has lately been used upon an extensive scale for the manufacture of mouldings, rosettes, and other architectural ornaments; pilasters, capitals, and even figures as large as life, have also been made of it. It is lighter, more durable, and less brittle and liable to damage than plaster, and admits of being coloured, gilt, or otherwise ornamented. Another article sometimes goes under the same name which is more like pasteboard, consisting of sheets of paper pasted or glued and powerfully pressed together, so as to acquire when dry the hardness of board, and yet to admit while moist of curvature and flexure: tea-trays, waiters, snuffboxes, and similar articles are thus prepared, and afterwards carefully covered by japan or other varnishes, and often beautifully ornamented by figures or landscapes and other devices, &c., occasionally inlaid with mother of pearl. A mixture of sulphate of iron, quicklime, and glue, or white of egg, with the pulp for papier-maché, renders it to a greater extent water-proof; and the further addition of borax and phosphate of soda contributes to make it almost fire-proof. The chief papier-maché manufactory in England is that of Bielefeld, in Wellington Street, Strand, who has recently published a concise history of the manufacture, embellished with numerous illustrations.

PAPILIONACEÆ. *See* Leguminaceæ.

PAPILIONA'CEOUS. A name given to the corolla of leguminous plants, from its fancied resemblance to the figure of a butterfly: it is that of the garden pea and bean, and consists of a large upper petal or vexillum, two lateral petals called alæ, and two intermediate petals forming a carina.

PAPILIO'NIDÆ. (Lat. papilio, *a butterfly*.) The name of a family of Lepidopterous insects, of which the genus *Papilio* is the type. *See* Diurnals.

PA'PIST. (Lat. papa, *the pope*.) A word in common use to designate a member of the Roman Catholic church. It has a shade of meaning somewhat different from *Romanist*, being employed generally with a certain degree of prejudice and obloquy attached to it.

PA'PPUS. A name given to the calyx of Compositæ, which exists in the rudimentary condition of a cap or membranous coronet, or of slender hairs, or in some other similar condition.

PAPY'RI. The name given to the written scrolls, made of the *papyrus*, which have been found in various places, but more especially in Egypt and Herculaneum. The process of making papyri was as follows: — The interior of the stalks of the plant, after the rind had been removed, was cut into thin slices in the direction of their length; these being laid on a flat board in succession, similar slices were placed over them at right angles; and their surfaces being cemented together by a sort of glue, and subjected to a proper degree of pressure, and well dried, the papyrus was completed. The length of the slices depended of course on the breadth of the intended sheet, as that of the sheet on the number of slices placed in succession beside each other; so that though the breadth was limited, the papyrus might be extended to an indefinite length. Many of the papyri which have been preserved vary greatly in their texture and appearance: they are generally fragile and difficult to unrol until ren-

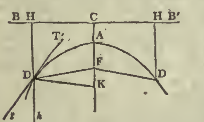
dered pliable by gradual exposure to steam or the damp of an English climate; and some are so brittle that they appear to have been dried by artificial means. (*Sir G. Wilkinson's Manners and Customs of the Ancient Egyptians*, vol. iii. p. 147–8.) Much interest was excited by the discovery of the papyri rolls at Herculaneum, and great expectations were entertained by archæologists that many of the valuable remains of antiquity would be restored to the world; but "after all the trouble that has been taken, and all the ingenuity that has been displayed in unrolling and deciphering many of them, little or nothing has been found worthy of the pains. They consist chiefly of Greek sophists and rhetoricians; works on music, medicine, and the arts; and some on natural and moral philosophy, &c. All the deciphered papyri are contained in the work *Herculaniensium Voluminum quæ supersunt*, published at Naples, 1827.

PAPY'RUS. In Botany, a Cyperaceous plant found in the districts of many tropical countries, but especially in the valley of the Nile, and whose soft cellular flower-stem afforded the most ancient material from which paper was made. Among the ancients the term *papyrus* formed the general appellation for all the different plants of the genus *Cyperus*, which was extensively used for making mats, baskets, boats, and many other purposes; the species confined to the manufacture of paper being usually designated *Cyperus papyrus*, or *Byblos*. The latter was particularly cultivated in the Sebennytic nome; though other parts of the Delta also produced it, and probably even some districts in Upper Egypt. The paper made from it differed in quality, being dependent upon the growth of the plant and the part of the stalk whence it was taken. The process of the manufacture is minutely described by Pliny in his *Hist. Nat.* xiii. 11, 12. The period at which paper began to be manufactured from the papyrus is involved in great obscurity; but there can be little doubt that Pliny was greatly in error when he assigned it a date posterior to the reign of Alexander the Great; for we meet with papyri (see above) of the most remote Pharaonic periods, the same mode of writing on which is shown from the sculptures to have been common in the age of Suphis or Cheops, the builder of the great pyramid, more than 2000 years before the Christian era. The manufacture of paper from the papyrus continued in general use down to the end of the 7th century, when it was superseded by parchment (which see).

PAR OF EXCHANGE. *See* EXCHANGE.

PA'RABLE. (Gr. παραβολη; from παραβαλλω, *I compare.*) In Rhetoric, in the original sense, a comparison; but the word has become, in modern language, appropriate in a particular meaning. The parables of the New Testament are illustrations, in the form of short tales, after the oriental manner, in each of which not only a moral or religious truth is conveyed, but the objects contained in the hidden sense are distinctly represented by parallel objects or types in the external narrative.

PARA'BOLA. In Geometry, one of the conic sections; formed by the intersection of the cone with a plane parallel to one of its sides. Considered as a plane curve, the parabola may be defined as follows:— A point F, and a straight line B B′, being given by position in a plane, let another point D be supposed to move in such a manner that its distance D F from the given point is always equal to its distance D H from the given straight line: the point D will trace out the parabola.



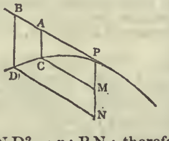
The given line B B′ is called the *directrix* of the parabola; the given point F is the *focus;* the straight line F C, drawn through F perpendicular to the directrix, is the *axis;* any straight line parallel to C F is a *diameter;* the point in which the diameter meets the curve is the *vertex* of the diameter; and a straight line, quadruple the distance between the vertex of any diameter and the directrix, is called the *latus rectum* or *parameter* of that diameter.

From the preceding definition of the curve its algebraic equation is easily found. Let A be the origin of the rectangular co-ordinates, $AK = x$, $KD = y$, and $AF = AC = a$: we have DK^2 or $y^2 = DF^2 - FK^2$; but $DF = DH = CK = x + a$, and $FK = AK - AF = x - a$; therefore $y^2 = (x+a)^2 - (x-a)^2$, whence $y^2 = 4ax$; or, if we assume $p = 4a$ (= the parameter of the axis), the equation becomes $y^2 = px$; that is, the square of the ordinate is equal to the rectangle under the absciss and the parameter. This property holds true of every other diameter as well as of the axis, the ordinate being taken parallel to the tangent at the vertex of the diameter. It was on account of this property that the curve received its name.

Let $FD = r$, and the angle $AFD = \phi$; then $FK = -r\cos.\phi$, and consequently $CK = 2a - r\cos.\phi$. But by the definition of the curve, $CK = FD = r$; therefore $r = 2a - r\cos.\phi$, whence $r = \dfrac{2a}{1+\cos.\phi}$. This is the polar equation of the parabola.

Let T *t* be a tangent to the parabola through D; it is a property of the curve that the angle H D T, and consequently the vertical angle *h* D *t*, is equal to F D T. A ray of light, therefore, falling on the curve in the direction *h* D, and being reflected by it, would pass through the point F; and as this takes place with regard to every ray parallel to the axis, it follows that the concave surface formed by the revolution of a parabola about its axis is that by which all the parallel rays of light are collected into a single point. Hence the point F is called the *focus*, or burning point.

Another remarkable property of the parabola is the following:— Let P A be a tangent to the curve at P, and from A and B, points in the tangent, let A C and B D be drawn parallel to the diameter P M N; then $AC : BD :: PA^2 : PB^2$.



For, making C M and D N parallel to P B, and assuming p = the parameter of the diameter P N, we have, from a property already mentioned, $MC^2 = p \cdot PM$, and $ND^2 = p \cdot PN$; therefore $MC^2 : ND^2 :: PM : PN$, or $PA^2 : PB^2 :: AC : BD$. Hence the parabola is the curve described by a projectile in a vacuum; for a body projected from P in the direction P A, and not resisted, would pass over spaces in that direction proportional to the times; and, in consequence of the accelerating force of gravity, it falls through spaces A C and B D in the perpendicular direction proportional to the squares of the times, or proportional to the squares of P A and P B. *See* GUNNERY, PROJECTILE.

The parabola is remarkable, as being the first curve of which the indefinite quadrature was found. Let P N be a diameter, and P B a tangent at its vertex, and B D and D N respectively parallel to P N and P B; it was demonstrated by Archimedes that the area contained by P N, N D, and the parabolic arc P C D, is equal to two thirds of the parallelogram P B D N.

The curve which has now been described is called the *conical* or *Apollonian* parabola; but the term parabola is also applied to all algebraic curves of a higher order determined by an equation of the form $y^{m+n} = a^m x^n$. The curve whose equation is $y^3 = a^2 x$ is called the cubical parabola; and that which has for its equation $y^3 = ax^2$, the semicubical parabola. This latter curve is celebrated in the history of the algebraic analysis as being the first curve that was rectified, or found equal in length to an assignable straight line; and the honour of the discovery belongs to an Englishman, William Neil, who died in 1670 at the early age of thirty-three. The same discovery was made nearly at the same time by Van Heuraet in Holland: till then it had been supposed by geometers impossible to assign a straight line equal to the arc of any algebraic curve (the rectification of the cycloid had been found by Sir Christopher Wren); but the discovery of the method of fluxions soon showed that there are innumerable classes of curves susceptible of indefinite rectification. In fact, all parabolas of this form $y^{2n+1} = ax^{2n}$, where n is any number whatever, may be rectified. (Montucla, *Histoire des Mathematiques*, tom. ii. p. 151.) *See* CONIC SECTIONS.

PARABO'LIC CONOID. The solid generated by the rotation of a parabola about its axis. It is equal in content to $\frac{1}{2}$ the circumscribed cylinder, and to $\frac{3}{2}$ of the cone having the same base and altitude.

PARABO'LIC CURVE. A curve of which the equation is of the form $y = a + bx + cx^2 + dx^3 +$ &c. Curves of this kind are frequently employed for the purpose of representing a number of observations, or for approximating to the areas of other curves; for it is always possible to cause a parabolic curve to pass through any number of points in a given curve, by making as many of the coefficients, *a*, *b*, *c*, &c., indeterminate as there are points given; and the curve thus described will differ less from the given curve according as the number of points is greater. But the area of the parabolic curve can always be determined; therefore that of the other curve may be found to any required degree of approximation.

PARABO'LIC SPINDLE. The solid conceived to be formed by the rotation of a parabola about its base, or double ordinate.

PARABO'LOID, is sometimes used to denote the parabolas of the higher orders; and sometimes the solid formed by the rotation of a parabola about its axis, or the parabolic conoid.

PARACE'LSISTS. Followers of the school of Paracelsus in medicine, physics, and mystical science. The founder of this school may perhaps be called with justice the most distinguished quack who ever made a figure in the world. He practised medicine "with the boldness of a wandering empiric," and established a

successful opposition to the traditionary doctrines of the so-called schools of Hippocrates and Aristotle. He mingled his medical and chemical knowledge with the speculations of the Cabbala, and with a theosophy of his own. He died in 1541. His followers continued to influence the schools of Germany for more than a century. (See *Hallam's Introduction to the Literature of the Middle Ages*, i. 541. 639. ii. 70. &c.; and *Mosheim*, vol. iv.)

PARACENTE'SIS. (Gr. παρακεντεω, *I perforate*.) The operation of *tapping* any of the cavities of the body for the purpose of withdrawing a contained fluid.

PARACE'NTRIC. (Gr. παρα, and κεντρον, *centre*.) In the higher Geometry, the name given to a curve line having this property, that a heavy body descending along it by the force of gravity will approach to, or recede from a *centre* or fixed point, by equal distances in equal times.

PARACENTRIC MOTION, in Astronomy, denotes the rate at which a planet approaches nearer to, or recedes farther from the sun or centre of attraction, in a given interval.

PARACE'PHALOPHO'RES. (Gr. παρα, *beside*, κεφαλη, *head*, and φερω, *I carry*.) A name given by M. De Blainville to a class of Mollusks, comprehending those in which the head is but little distinct from the body, but always provided with some of the organs of sense.

PARACHU'TE. (Fr. parer, *to ward off*, and chute, *fall; a guard against falling*.) An apparatus resembling the common umbrella, but of far greater extent, intended to enable an aëronaut, in case of alarm, to drop from his balloon to the ground without sustaining injury. This is effected by means of the resistance of the atmosphere. When the parachute is detached from the balloon, and abandoned with its load in the air, it must proceed at first, from the continued action of gravity, with an accelerated motion, until the increased velocity produces a resistance equal to the force of attraction, or the weight of the apparatus with its load. After this equilibrium has been attained, the parachute will descend with a nearly uniform velocity. According to theory, this terminal velocity, supposing the surface of the parachute to be flat, is equal to that which a heavy body would acquire in falling through the altitude of a column of air incumbent on that surface, and having the same weight as the whole apparatus. A circular parachute having a diameter of 30 feet, and weighing with its load 225 pounds, would acquire a terminal velocity of about 13 feet per second; and a person descending with it at this rate would receive the same shock on reaching the ground as if he dropped freely from a height of $2\frac{3}{8}$ feet. (For the method of solving this problem, see *Hutton's Mathematical Tracts*, vol. iii. p. 316.) The actual resistance of the air is, however, greater than is given by theory, and is besides augmented by the concavity of the parachute, which occasions an accumulation of the fluid; but, on account of the action of the wind, the axis of the parachute will probably become inclined to the vertical, in which case the resistance will suffer a diminution.

One of the most remarkable instances of descent from a great height with a parachute is that of Garnerin, a Frenchman, who ascended in a balloon from an enclosure, near North Audley Street, in London, on the 2d of September, 1802. After hovering seven or eight minutes in the atmosphere, he cut the cord by which his parachute was attached to the balloon. It instantly expanded, and for some seconds descended with an accelerating velocity, till it became tossed extremely, and took such wide oscillations that the basket or car was at times thrown almost into a horizontal position. The intrepid aëronaut narrowly escaped destruction by being precipitated on the houses in St. Pancras, and at last fortunately came to the ground in a neighbouring field. He seemed to be much agitated, and trembled exceedingly at the moment he was released from the car. (*Ency. Brit.*, "Aeronautics.")

A recent experiment of this kind, made by Mr. Cocking, was attended with fatal consequences. Having conceived a notion that the vibrations might be avoided by giving the machine a different form, this projector constructed one in the form of an inverted umbrella, that is, having the concave side uppermost, and bound to a strong wooden hoop to prevent its collapse in the descent. The diameter of the hoop was 34 feet; and there was also a hole of 6 feet in diameter in the middle of the parachute, which, it was supposed, would also contribute to give greater steadiness. Having attached himself to this machine, he ascended from Vauxhall Gardens on the 24th of July, 1837. On being cut away from the balloon the parachute descended rapidly, and with violent oscillations: the hoop broke, and the unfortunate projector fell, dreadfully mangled, at Lee, near Blackheath. The persons in the car of the balloon were also placed in great danger, having narrowly escaped suffocation from the quantity of gas expelled in consequence of the great velocity with which the balloon darted upwards immediately on being liberated from the parachute. They suffered extreme pain, and for a time were deprived of sight; but fortunately they had carried up with them a large bag filled with atmospheric air, by means of which they were enabled to breathe. Without this, they would probably have perished.

PA'RACLETE. (Gr. παρακλητος, *advocate*.) A name attached to the Holy Spirit, as an advocate, intercessor, or comforter of mankind; such as he is represented, John, xiv. 16. 26.; Rom. viii. 26. It was not an uncommon opinion of the early heretics, that the Paraclete, whose mission was promised by Christ, was to appear corporeally upon the earth, and complete the dispensation announced by our Lord and the apostles; and they drew a distinction between the person of the Comforter and the effusion of his grace upon the disciples on the day of Pentecost. Accordingly, several of them, Simon Magus, Manes, and others, gave themselves out as this expected Paraclete; and Tertullian himself was at one period infatuated by the claims advanced by Montanus to this personification.

PARACRO'STIC. A poetical composition in which the first verse contains, in order, all the letters which commence the remaining verses of the poem or division. According to Cicero (*De Divinatione*, ii. 54.), the original Sibylline verses were paracrostics. *See* ACROSTIC.

PARACYA'NOGEN. When cyanuret of mercury is decomposed by heat, a brown solid matter remains having the same composition as gaseous cyanogen, hence designated as above.

PARA'DE. (Fr.) The place where troops draw up to do duty, mount guard, &c. The original meaning of the word is *show* or *ostentation;* and it is used as above, because on these occasions officers and men are expected to be in full uniform, or completely equipped.

PA'RADIGM. (Gr. παραδειγμα, *an example*.) In Rhetoric, a general term, used by Greek writers in the sense of "example," or "illustration," of which "parable" and "fable" are species. (*Quintilian*, v. 2.) Hence, in early theology, those writers who narrated the lives of religious persons, by way of examples of Christian holiness, were styled Paradigmatics.

PA'RADISE. (Gr. παραδεισος: said to be derived from a Persian or Chaldaic word, or from the Arabic firdauz, *a fruitful valley*.) This name, of oriental origin, was used by the Greek historians to denote the extensive parks or pleasure grounds of the Persian monarchs. (Xenophon, *Cyrop.* and *Œconom.; Diod. Sic.* xvi. 41., xviii. 36.; described by *Quintus Curtius*, viii. 1., who does not use the word. See also *Aulus Gellius*, ii. 20.) The Septuaginta have employed the word in their translation of Genesis, ii. 8., to signify the abode in which Adam and Eve were placed by their Creator. It also occurs in other parts of their translation. (Numbers, xxiv. 6.; Genesis, xiii. 10.; Ez. xxviii. 13., xxxi. 8.) It is used in the N. T., in the memorable passage, Luke, xxiii. 43. The speculations into which this mysterious passage has led learned and pious men, in all ages of the church, form too extensive a subject to be entered upon here. The mythologies of many nations contain similar ideas, whether derived from the ancient tradition of a paradise, or formed out of the inherent sense of man of his own imperfection and longing after a better state, from which he imagines himself to have fallen. (See, especially, the first part of *Buttmann's Mythologus*, and *Bryant's Mythology*.) The rabbis have formed, as usual, a strange collection of legendary tales out of the simple narrative of Scripture. According to them, there is an upper or heavenly, and a lower or earthly paradise. The lower is situated somewhere under the terrestrial equator. Each is divided into seven dwellings, and each of these is twelve times 10,000 miles in length and breadth. A column ascends from the lower to the upper heaven, by which the souls of the blessed mount after a temporary sojourn in the former. A wall of partition divides paradise from hell; and this will fall when the Redeemer comes, and all Israel be gathered together in blessedness.

The celestial paradise is generally referred to as identical with heaven, or the place of bliss hereafter. Some critics, who weigh very nicely our Lord's expression in addressing the penitent thief, "To-day shalt thou be with me in paradise," have imagined the existence of a distinct abode for the souls of the just before the final judgment. When we consider, however, that, upon the authority of another passage in Scripture, we affirm that our Saviour went down into hell between his death and resurrection, it will be better, perhaps, not to affix too definite a meaning either to the one expression or the other.

The local situation of the terrestrial paradise has been a favourite subject of speculation, both with the fathers of the church and with later inquirers. The reader may consult, if he will, the first volume of the compilation called the *Ancient Universal History*, where the matter is seriously discussed at great length; he will also find it treated in an entertaining article of the *Enc. Metropolitana*. (See also Schulthess, *Das Paradies*, Zurich, 1816.) The most ordinary opinion has placed it on the Euphrates and Tigris. Josephus regards the Pison

mentioned in Genesis as the Ganges, the Gihon as the Nile. Hardouin places his in Palestine. Huet (*De la Situation du Paradis Terrestre*, 1691) enumerates a variety of these theories. The paradise of the Moslems is termed in the *Koran* Gannath, or the Happy Gardens; and its description is evidently borrowed from the notions of the rabbis and oriental Christians. See, chiefly, chapters lv. lvi.; but these passages, although flowery enough, contain a very small part of the extravagances, chiefly drawn from tradition, which make up the vulgar Mohammedan notion of paradise. (See, in addition to the authorities already cited, a learned article in the unfinished *Encyclopædia* of Ersch and Gruber.)

PA'RADOX. (Gr. παραδοξος, *contrary to received opinion.*) A term applied to any proposition which seems to be absurd, or at variance with common sense, or to contradict some previously ascertained truth; though, when properly investigated, it may be found to be perfectly well founded. The reader will find in Bishop Horsley's 19th Sermon the nature of a paradox, and the points wherein it differs from a contradiction, clearly illustrated.

PARADO'XUS. (Gr. παραδοξος, *wonderful.*) A name devised to express the obscure nature of a genus of Trilobites (fossil Crustaceans), to which it is attached, and which is characterized by the absence or indistinct nature of the prominent even-formed eyes which are borne on the shield of all other Trilobites. The segments extend beyond the sides of the body, and are free at their lateral extremity. It serves also as a specific name for obscure and anomalous animals; as the *Ornithorhynchus paradoxus*, *Lepidosiren paradoxa*, &c.

PA'RAFFINE. A substance contained in the products of the distillation of the tar of beech wood. It is a tasteless inodorous fatty matter, fusible at 112°, and resists the action of acids and alkalis. It appears to be a hydro-carbon. Its name is compounded of parum, *little*, and affinis, *akin*, to denote the remarkable chemical indifference which is its characteristic feature. A similar substance has been obtained by Dr. Christison from the petroleum of Rangoon.

PARA'GIUM. (Lat. par, *equal.*) In Feudal Jurisprudence, the body of nobles (peerage) was so termed; the word likewise expressed equality of condition in various legal relations, as, for example, between the lords in partnership of a fief. Parage was also a custom by which the elder of several coheirs of a fief rendered homage for the whole, and thereby guaranteed the enjoyment of it to his coheirs as well as himself; in the same manner, one of several copurchasers might be admitted to a similar privilege.

PARAGO'GE. (Gr. παρα, *by the side of*, and αγω, *I bring.*) In Grammar, a figure by which one or more letters are added at the end of a word; *e.g.* in the ordinary formation of diminutives in most languages. *See* METAPLASM.

PARAGO'GIC LETTERS. (Gr. παραγωγη, *an addition.*) In the Semitic languages, letters which, by their addition to the ordinary form of the word, import additional emphasis, or some peculiar inflexion into the sense. Their real meaning and authority have been much debated among Hebrew scholars.

PA'RAGRAPH (Gr. παραγραφος), ordinarily signifies a small subdivision of a connected discourse, and is indicated by the sign ¶ in modern orthography.

Parágraphe, as used by Greek rhetorical writers, is a poetical figure employed when the writer sums up in a few words the substance of a previous passage, by way of transition to a new one. It was probably so called by analogy. (*Eustathius on Hom. Il.* i. 304.)

PARALEI'PSIS. (Gr. παραλειπω, *I omit.*) In Rhetoric, the artificially exhibited omission or slight mention of some important point, in order to impress the hearers with indignation, pity, &c., called by the Latins præteritio, omissio, &c.; as in the famous lines —

> Occidat illa dies ævo, nec postera credant
> Sæcula: nos certe, taceamus, et obruta multa
> Nocte tegi nostræ patiamur crimina gentis.

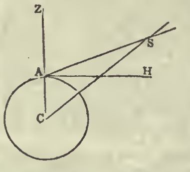
The passage, Hebr. xii. 32., may be given as another instance; or the following from Cicero: — "Præterco illum nefarium conatum tuum," &c. (*Conc. c. Antonium.*)

PARALIPO'MENA. (Gr. παραλειπόμενα, *things left out or aside.*) A term applied, in Bibliography, to works of a supplementary character. The two books of the Old Testament called by us, after Saint Jerome, the Chronicles, are also termed Paralipomena.

PARALLA'CTIC INSTRUMENT. An astronomical instrument for determining the moon's parallax, described by Ptolemy in his *Almagest*, and usually called *Ptolemy's Rules*. The term *parallactic* is sometimes applied to the equatorial; but in this sense the proper word would seem to be *parallatic*, as derived not from *parallax*, but from *parallel*, the instrument being constructed for the purpose of following the stars in their diurnal parallels. (Lalande, *Astronomie*, § 2278.)

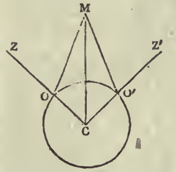
PA'RALLAX. (Gr. παραλλαξις, *change.*) A change of place or of aspect. The term is used in astronomy to denote the difference between the *apparent* place of a celestial object and its *true* place, or that in which it would be seen if the observer were placed at the centre to which the motion is referred. When the point of reference is the centre of the earth, the change of aspect is called the *diurnal parallax*; when it is the centre of the earth's orbit, the change is called the *annual parallax.*

Diurnal Parallax. — Let C be the centre of the earth, A the place of the observer, Z his zenith, and S a celestial body. On observing the body from A, it will be seen in the direction A S, making the angle Z A S with the zenith. But if the observer could be placed at C, he would see the body in the direction C S, making the angle Z C S with the zenith. The difference between these two angles Z A S and Z C S is the parallax of S, which, therefore, is equal to the angle A S C. Hence it appears that the parallax of a celestial body is the angle comprised between two lines drawn from the body, the one to the centre of the earth, and the other to a point on its surface. On account of the immense distance of the fixed stars, the diurnal parallax is altogether insensible with regard to them. It may amount to a degree in respect of the moon; but the greatest parallax of the nearest planet does not exceed 30″.



It is evident, from the inspection of the figure, that although the distance of the object S remain the same, the angle A S C is not a constant quantity, but is greatest when S is seen in the direction of the horizon A H, and diminishes as the altitude of S increases, until it vanishes altogether at the zenith, where the two lines A S and C S merge into the line C Z. In order to discover the law of this variation, let $a =$ C A, the semidiameter of the earth; $d =$ C S, the distance of the observed object from the centre; Z = Z A S, the apparent zenith distance; and P = A S C, the parallax. Now, the sides of a triangle being in the same proportion as the sines of their opposite angles, we have $d : a :: \sin. Z : \sin. P$, whence $\sin. P = \frac{a}{d} \sin. Z$. But as P is always a very small angle, the arc may be substituted for the sine without sensible error, and the formula becomes $P = \frac{a}{d} \sin. Z$; that is to say, the parallax is proportional to the sine of the zenith distance. At the horizon Z is a right angle, and sin. Z = 1: in this case, therefore, the expression for the parallax becomes $P = \frac{a}{d}$. This is called the horizontal parallax; and when its amount has been determined by any means with respect to a celestial body, the parallax of the body at any altitude is found by multiplying the horizontal parallax by the cosine of the altitude, or sine of the zenith distance.

Since the parallax of a body is given in terms of its distance and the earth's semidiameter, it follows, reciprocally, that the distance of the body is given in terms of its parallax. The determination of the parallaxes of the different bodies of the solar system is therefore a problem of great importance in astronomy; but it is attended with considerable difficulty in practice, although the principle on which it depends is extremely simple. It may be described as follows: — Let two observers be stationed at the points O and O′, of which the latitudes are supposed to be known, and which are both situated on the same meridian, and let them simultaneously observe the zenith distances of the body M (suppose the moon). These observations will give the angles Z O M and Z′ O′ M, and, consequently, M O C and M O′ C. The angle O C O′ is also known, being the difference or the sum of their latitudes, according as they are on the same or opposite sides of the equator. But the two sides C O and C O′ of the quadrilateral M O C O′, being radii of the earth, are also supposed to be known; hence the quadrilateral is determined, and its diagonal C M may easily be computed by the rules of plane trigonometry. But when C M is found, the horizontal parallax is also determined, being equal, by what has been already shown, to the quotient obtained by dividing the radius C O by the distance C M. In this manner the horizontal parallax of the moon was determined by Lacaille and Lalande; the former observing at the Cape of Good Hope, and the latter simultaneously at Berlin. There are methods, however,



by which the lunar parallax may be determined by observations made at a single place.

The moon's mean horizontal parallax amounts to 57′ 4″·17, or ·95116 of a degree. In respect of all the other bodies of the solar system the parallax is an extremely small quantity, and, excepting perhaps in the case of Mars, cannot be determined by the method now described with sufficient precision and certainty. That of the sun, the most important of all, is most accurately found by observations of the transits of Venus over his disk, as was first suggested by James Gregory, in his *Optica Promota*. It amounts only to 8·6″; whence we infer that the mean distance of the sun from the earth is 23·984 times the length of the earth's radius, or about 95,000,000 miles. (*See* SUN.) This determination suffices for finding the parallaxes and distances of all the planets in the system; for in consequence of the relation established by Kepler's third law between the distances and periodic times, when the distance of any one planet from the sun is known that of every other can be deduced from the times of revolution. (See *Kepler's Laws*.)

When the parallax of a celestial body has been determined, we can find not only the distance of the body, but also its diameter and real magnitude. For the apparent diameter being found by observation, the true magnitude is given by this proportion: — The horizontal parallax is to the apparent radius, as the radius of the earth to the true radius of the body.

The effect of parallax is to depress the observed body in the vertical circle, or to increase its zenith distance. If the body at the time of the observation is on the meridian, the parallax only affects its declination; but if it is not on the meridian, the observed right ascension and declination are both altered, and the effect on each of these co-ordinates must be computed from the previously known horizontal parallax by the rules of spherical trigonometry. The computation, in the case of the moon, is considerably complicated by the earth's ellipticity.

Annual Parallax. — In what has yet been said the centre of the earth has been taken as the point of reference, and therefore regard has only been had to the difference of apparent situation occasioned by the eccentric position of the observer at the surface of the earth. But the sun, and not the earth, may be regarded as the centre to which the motion is referred; and the position of any celestial body of which the distance from the sun is not so great as to be incomparable with the semidiameter of the earth's orbit, would be different if viewed from the sun from what it is when viewed from the earth. This difference is called the *annual parallax*, or *parallax of the great orb*. It is the angle under which the semidiameter of the earth's orbit would be seen from a superior planet, or from a fixed star. Such, however, is the enormous distance even of the nearest fixed stars, that excepting two or three instances, which perhaps may be still regarded as doubtful, not one of them has yet been discovered to be sensibly affected by annual parallax; though observations have been carried to such nicety that did the quantity in question amount to a single second, it could not possibly have escaped detection.

From observations of right ascension and declination, Piazzi deduced a parallax of 4″ for Sirius, and of 5·7″ for Procyon, and Calandrelli one of 4″ for α Lyræ; but these determinations have been proved to be erroneous. Dr. Brinkley conceived that his observations with the Dublin circle indicated a sensible parallax in the three stars, α Lyræ, α Cygni, and α Aquilæ; but Mr. Pond showed that no sensible parallax in any of these stars could be deduced from the Greenwich observations, and Mr. Airy has confirmed this conclusion in respect of α Lyræ. Mr. Henderson, however, has found a probable parallax in the star α Centauri from his observations made at the Cape of Good Hope. Sir William Herschel first pointed out the micrometrical measurements of the distances of two stars very close to each other, or nearly in the same line of vision, as a likely method of detecting parallax; for the apparent distance between two such stars, if either has a sensible parallax, must vary at different times of the year; and this method has very recently been applied by Struve, at Dorpat, to α Lyræ, and by Bessel, at Konigsberg, to the double star 61 Cygni. The results obtained by the latter are the most unequivocal. By a series of observations with the heliometer, continued from August, 1838, to March, 1840, Bessel obtained the value of the parallax = 0·348″, a little more than the third of a second of space. Assuming this determination, and astronomers seem to regard it as established within certain small limits, the distance of the star from the earth must be 519,200 times the sun's distance, — a distance so enormous that light, which travels at the rate of 192,000 miles in a second, would require 9¼ years to pass through it. (*Monthly Notices of the R. Astr. Soc.* for May, 1840. For the history of researches on the subject of the annual parallax, see *Mem. R. Astr. Soc.* vol. xii.) *See* STAR.

PARALLE′LEPIPED (Gr. παραλληλ-επιπεδον), frequently, but incorrectly, written *Parallelopiped*. A solid contained by six planes, three of which are parallel to the other three. The content of this solid is found by multiplying the area of one of its faces by its distance from the opposite face. Consequently, parallelepipeds on equal bases, and of the same height, are equal.

PA′RALLEL LINES, in Geometry, are defined by Euclid to be "straight lines which are in the same plane, and, being produced ever so far both ways, do not meet."

The subject of parallel lines is one of the most difficult in the elements of geometry, and has accordingly given rise to much learned discussion. The difficulty consists in demonstrating that two parallel lines, when they meet a third line, are equally inclined to it, or make the alternate angles with it equal. In order to demonstrate this proposition, Euclid assumes as an axiom that "If a straight line meet two straight lines, so as to make the interior angles on the same side of it less than two right angles, these straight lines, being continually produced, will at length meet on the side on which the angles are which are less than two right angles." But this is not a self-evident truth: it is, in fact, a proposition which requires to be demonstrated; and the converse of it, namely, that two straight lines which meet one another make with any third line the interior angles less than two right angles, forms the 17th proposition of Euclid's first book. Geometers have attempted in many different ways, but without complete success, to remove this blemish from the Elements. The methods which they have employed for this purpose are of three kinds: 1. By adopting a new definition of parallel lines; 2. By introducing a new axiom; 3. By reasoning merely from the definition of parallel lines and the properties of lines already demonstrated.

Some geometers, among whom are Wolfius, Boscovich, and Thomas Simpson, have adopted the following as the definition of parallel lines; namely, that "straight lines are parallel which preserve always the same distance from each other;" but this, like Euclid's definition, as remarked by D'Alembert, is begging the question. The correct definition would be, that "two straight lines are parallel when there are two points in the one from which the perpendiculars drawn to the other, and on the same side of it, are equal." The difficulty then consists in demonstrating that *all* the perpendiculars drawn from the one of these lines to the other are equal. Another definition, which has been adopted by Varignon, Bezout, and others, is, that "parallel lines are those which make equal angles with a third line towards the same parts, or make the exterior angle equal to the interior and opposite." When this definition is adopted, the difficulty consists in proving that straight lines which are equally inclined to one *given* straight line must be equally inclined to *all* the other straight lines which fall upon them.

Of the new axioms which have been substituted in place of Euclid's, we shall merely notice that given by Thomas Simpson, in the second edition of *Elements;* namely, that "If two points in a straight line are posited at unequal distances from another straight line in the same plane, those two lines, being indefinitely produced on the side of the least distance, will meet one another." By help of this axiom he proves that if two straight lines are parallel, the perpendiculars to the one terminated by the other are equal, and also perpendicular to the other parallel; and thence the proposition from which all the rest follows, namely, that if a straight line fall on two parallel lines, it makes the alternate angles equal. Playfair remarks on this method, that it is extremely plain and concise, and perhaps as good as any that can be followed when a new axiom is assumed.

Legendre, in his *Elements of Geometry*, has attempted to overcome the difficulty of parallel lines by previously demonstrating that all the angles of a triangle are equal to two right angles, from which proposition it is easy to prove every thing with respect to parallels. His demonstration, however, is of too refined and subtle a kind to be admissible into the Elements. (See the Notes to *Playfair's Euclid*, *Legendre's Geometry*, and *Leslie's Geometry*. But the reader who wishes to have a complete view of what has been written on this subject should consult a learned *excursus* to the first book of *Camerer's Euclid*, Berlin, 1825; and also *Colonel P. Thomson's Geometry without Axioms*.)

It may be remarked, that the whole of the difficulty which exists with respect to the doctrine of parallel lines is of a metaphysical rather than of a mathematical kind; and the learner need not perplex himself about subtleties which can hardly be considered as affecting the rigour of geometrical truth.

PARALLE′LOGRAM. (Gr. παραλληλογραμμα.) A plane four-sided figure, of which the opposite sides are parallel. The area of a parallelogram is found by multiplying the length of one of its sides by that of the perpendicular let fall upon it from the opposite side. Hence parallelograms on equal bases, and of the same altitudes, are equal.

PARALLEL PLANES, are such as never meet, though indefinitely produced.

PARALLEL RULER. A mathematical instrument,

formed of two equal rulers connected by two cross bars or blades moveable about joints, so that, while the distance between the two rulers is increased or diminished, their edges always remain parallel; and consequently if the edge of one of the rulers be applied to a straight line, a parallel straight line may be drawn along the edge of the other ruler.

PARALLEL SAILING, in Navigation, is sailing on a parallel of latitude, or circle parallel to the equator. *See* NAVIGATION.

PARALLELS OF ALTITUDE, in Geography, are small circles of the sphere parallel to the horizon; also called *almacantars*.

PARALLELS OF DECLINATION. In Astronomy, small circles of the sphere parallel to the equator.

PARALLELS OF LATITUDE, on the Terrestrial Sphere, are small circles parallel to the equator; but, in the Celestial Sphere, they are parallel to the ecliptic.

PARALLEL SPHERE, in Geography, is that position of the sphere in which the equator coincides with the horizon, and the poles are in the zenith and nadir. This is the appearance which the sphere would have to a spectator placed at the pole. The stars neither rise nor set, but move constantly in circles parallel to the horizon; and the sun rises and sets only once a year.

PARA'LOGISM. (Gr. παρὰ, *beside*, and λόγος, *reason.*) In Logic and Rhetoric, a reasoning which is false in point of form; *i.e.* in which a conclusion is drawn from premises which do not logically warrant it. It is the opposite to a syllogism or correct logical deduction. *See* SYLLOGISM.

PARA'LYSIS. (Gr. παραλυω, *I weaken.*) Palsy. A diminution or loss of power of any part of the body. In general one side only is affected, or the upper or lower extremities. Whatever debilitates the system may produce palsy; it is also produced by pressure upon certain parts of the brain and spinal marrow, and occasionally by poisons, by local injuries, and by the sudden suppression of certain evacuations. It frequently produces a distortion of the mouth or eye, the speech becoming indistinct, and the judgment often impaired. The treatment of palsy depends upon a careful consideration of its cause; more or less depletion is generally required, together with purges and nervine stimulants, such as ammonia, &c., and blisters to the head and neck.

PARA'METER. In Geometry, a constant straight line belonging to each of the three conic sections; otherwise called the *latus rectum*. In the parabola, the parameter is a third proportional to the absciss and its corresponding ordinate; in the ellipse and hyperbola, the parameter of a diameter is a third proportional to that diameter and its conjugate. The term is also used in a general sense, to denote the constant quantity which enters into the equation of a curve.

PARA'MO. (Sometimes rendered, though incorrectly, by *desert* or *heath.*) The name given in South America to a mountainous district covered with stunted trees, exposed to the winds, and in which a damp cold perpetually prevails. Under the torrid zone, the Paramos are generally from 10,000 to 12,000 feet in height. Snow often falls on them, but remains only a few hours; in which respect they are distinguished from the *Nevados*, which enter the limits of perpetual snow. The Paramos are almost constantly enveloped in a cold thick fog; so that when a thick small rain falls, accompanied with a depression of the temperature, they say at Bogota, or at Mexico, *cae un paramito*. Hence has been formed the provincial word *emparamarse*, — to be as cold as if one were on a *paramo*. (*Humb. Pers. Nat.* ii. p. 252.)

PA'RANA'PHTHALINE. A substance so termed from Gr. παρα, *near to*, because it closely resembles *naphthaline*. It appears to be a mixture of paraffine and naphthaline.

PARA'NTHINE. A rare mineral, so named by Haüy; the same as *Scapolite*.

PA'RANYMPH. (Gr. παρανυμφος.) A bridesman. It is translated in our version of the Scriptures by "master of the feast."

PA'RAPET, or BREAST-WORK. (Ital. parapetto, *breast-work.*) In Fortification, a wall or screen raised on the extreme edge of a rampart or other work, through which embrasures or openings are cut for the cannon to fire through. The solid parts of the parapet, between the embrasures, are called the *merlons*. In common language, a parapet is a breast-wall, raised on the edges of bridges, quays, &c. to prevent people from falling over.

PA'RAPH. (Gr. παρα, and ἁπτω, *I touch.*) In Diplomatics, the figure formed by a flourish of the pen at the conclusion of a signature. This formed, in the middle ages, a sort of rude provision against forgery, like the flourishes in the plates of bank notes. In some countries (as in Spain) the paraph is still a usual addition to a signature.

PA'RAPHERNA'LIA. (Gr. φερνη, *a dowry.*) In the Civil Law, the apparel, jewels, &c. of a wife, which are held to belong to her as a species of separate property. The husband may dispose of them in her lifetime, but cannot bequeath them away from her; and if he have not parted with them before his death, she may retain them against his executors and all other persons, except his creditors, where his other funds are not sufficient to satisfy their claims.

PARAPHO'NIA. (Gr. παρα, and φωνη, *voice.*) Alteration of voice.

PA'RAPHRASE. (Gr. παρα, *beside*, and φράζω, *I speak.*) In Rhetoric, the rendering of a passage or portion of writing in other phraseology, more distinct and easier of explanation, and therefore usually at greater length. A loose translation, or one in which a new series of ideas and illustrations conveying the same general meaning with those of the original is substituted for them, is also termed a paraphrase, although not with strict propriety.

PARAPHY'SES. (Gr. παρα, and φυσις, *nature.*) A term used in describing mosses, to denote the sessile ovate abortive bodies placed below the theca.

PARAPLE'GIA. (Gr. παραπλησσω, *I strike inharmoniously.*) Palsy of the upper or of the lower half of the body.

PA'RASANG. (Gr.) A Persian measure of length; according to Herodotus, equal to 30 stadia, and (reckoning 8 stadia to the English mile) equal to 3¾ English miles. The length of the parasang was reckoned differently by different authors; and such are the discrepant estimates of the ancients that some have assigned it the length of 60 stadia. The word is supposed to be derived from the Persian seng, signifying *a stone*.

PARASCE'NIUM. (Gr. παρα, and σκηνη, *a scene.*) In Antiquities, called also *postscenium*, the back part of a theatre beyond the stage, or the room to which actors withdrew on quitting the stage. It was equivalent to the modern *green room*.

PA'RASITE. (Gr. παρα, *at hand*, and σιτος, *food.*) Originally, according to Crates in Athenæus, a term of honour, being the appellation of certain ministers at sacrifices, whose office is not distinctly ascertained. (See *Mem. de l'Acad. des Inscr.* vol. xxxi.) The habits of a luxurious age produced the race of poor companions, ready guests at the table of a patron, who formed a standing character in the later Greek comedy. Some attribute the first conception of the dramatic personage to Araros, the son of Aristophanes. Diphilus, according to Athenæus, gave the most complete portrait of it in his comedy *Telesias*. Our notions of the ancient parasite are now derived chiefly from the Latin comic poets. Ingenious writers have divided parasites into four classes: — 1. The poor confidential friend, whose services to his patron are sometimes rendered with a mixture of real attachment, as in the character of Ergasilus in the *Captives* of Plautus. 2. The guest who is invited with a view to make him pay for his reception by the exertion of his powers of entertainment (Anglicè diner-out), the "ridiculi" and "derisores" of Plautus, and who alone are described under the name of parasites by Julius Pollux: Vibidius and Balatro, the two umbræ of Mæcenas at the supper of Nasidienus, seem to have partaken of this quality. These degenerated, thirdly, into the class of mere buffoons, who were invited to play tricks and undergo practical jokes, under pain, as Ergasilus complains, in the play already cited, if they refused to lend themselves to the manual pleasantries of their guests, of "taking up their beggar's wallet and marching." The fourth and worst class, κολακες, were the attendant flatterers of their patron. Such is Artotrogus, or Loaf-eater, the humble companion of Pyrgo-Polinices in the *Miles Gloriosus* of Plautus; and the best known of all parasites, Gnatho, in the *Eunuch* of Terence.

PA'RASITES. In Zoology, this term, as designative of a group of animals, is variously applied by different naturalists. Lamarck includes under it a family of antennated Arachnidans; Cuvier, Latreille, and Kirby apply the term to an order of Apterous insects; Straus to a tribe of Crustaceans: but all the sections include animals of parasitic habits.

PARASITI'CAL PLANTS, are those which grow into the tissue of other species, and feed upon their juices. Of this kind are the misletoe, the broom rape (*Orobanche*), the *Lathræa;* and, among exotics, the monstrous *Rafflesia*. Such species have no proper roots. The term *parasitical* is, however, often applied to mosses, Orchidaceous plants, Tillandsias, and the like, which are mostly Epiphytes, growing upon the bark of trees, but deriving their food from the air by means of their own roots.

PARA'STATÆ. (Gr. παρα, *from*, and ἱστημι, *I stand.*) In Architecture, pilasters, or rather square pillars, which stand insulated. *See* ANTA.

PA'RATA'XIS. (Gr. παρατασσω, *I arrange side by side.*) In Grammar, opposed to Syntax. The mere ranging of propositions one after another, as the corresponding judgments present themselves to our mind, without marking their dependance on each other by way of consequence or the like.

PA'RBUCKLE. In Naval language, to roll a cask

or any cylindrical body by pulling upon ropes fastened towards the place where the cask is to go, and laid along the ground or an inclined plane, and then over the ends or quarters.

PA'RCÆ. The Latin name of the Fates. According to Klausen (art. "Parcæ," in the *Encyclopædia* of Ersch and Gruber), the original Roman Parca (the harsh or avaricious goddess) was equivalent to Mors, the goddess of death, the third of the Fates. It was not until the Augustan age, when the Greek and Roman mythology became mingled, that the Parcæ became plural (*Virg. Ec.* iv. 47.), and acquired their similarity to the Greek Moirai, Clotho, Lachesis, and Atropos.

PARCEL A ROPE. In Naval language, to cover it smoothly with tarred canvass, which is then bound over with spun-yarn.

PARCENERS. In Law. *See* COPARCENERS.

PA'RCHMENT. (Fr. parchemin.) A material formed of the prepared skins chiefly of sheep and goats, when intended to be written upon. A similar preparation of calves', kids', and lambs' skins is called *vellum*. The skins are first prepared as for tanning; then shaved down and pumiced; and lastly, stretched and carefully dried. The parchment of drums is made of the skins of asses, calves, and wolves; ass skin is used for battledores; and goat skin is preferred for sieves. For some kinds of bookbinding parchment is dyed green by verdigrease. (See *Ure's Dictionary of Arts*.)

Parchment was known at a very early period. It was used for writing as early as the year 250 before the Christian era by Eumenes, king of Pergamus; who, desirous of collecting a library which should vie with that of Alexandria, but prevented by the jealousy of the Ptolemies from obtaining a sufficient quantity of papyrus, had recourse to this substitute; and its invention at Pergamus claimed and secured to it the lasting name of Pergamena: whence *parchment*. (*Sir G. Wilkinson's Manners and Customs of the Ancient Egyptians*, iii. 151.) In the beginning of the eighth century, the use of the papyrus was almost entirely superseded by parchment, on which we find that all the public documents under Charlemagne and his dynasty were written. When the different kinds of parchment came into use for the purposes of writing, they were rolled up before they could be sealed: hence the word *volumen*, from Lat. volvere, *to roll*. And as parties wrote to the very bottom of the parchment, *i.e.* to the place where the cord used for the folding was fastened, we may account for the well-known expression, *opus ad umbilicum perductum*.

PA'RDON. In Law, it is part of the prerogative of the crown to pardon all offences merely against the crown or the public, excepting the offence of committing any person to prison out of the realm, which, by the Habeas Corpus Act, is made a præmunire, unpardonable even by the king: and excepting those offences in the prosecution of which private justice is in some measure concerned, as nuisances and offences against a popular or penal statute after information; for thereupon the informer has a private property in his part of the penalty. Pardon is granted under the great seal, or by warrant under the sign manual, countersigned by one of the principal secretaries of state; or by act of parliament. Its effect is, in almost all cases, to make the offender a new man, and to discharge him from all the penal consequences attaching to his offence.

PARE'CBASIS. (Gr. παρα, and εκβαινω, *I go out of*.) The word used by Greek authors to signify what by the Latins is called digression; by *Quintilian* (iv. 14.) termed "alienæ rei, sed ad utilitatem causæ pertinentis, extrâ ordinem occurrens tractatio."

PAREGO'RIC. (Gr. παρηγορεω, *I assuage*.) That which allays pain. *Paregoric elixir* is a camphorated tincture of opium flavoured by oil of aniseed.

PAREI'RA BRA'VA. The root of the *Cissampelos pareira*, brought from South America. It has a sweetish and a bitter flavour, and has been used in nephritic complaints and some affections of the bladder.

PARE'LLA. In Botany, a kind of lichen; the *Lecanora parella*, found on rocks in mountainous countries, especially in the north of Europe. It is the *Perelle* of Auvergne, where it is extensively used by the dyer, and is found equal to orchil (*Rocaila tinctoria*).

PARE'MBOLE. (Gr. παρα, and εμβαλλω, *I throw in*.) In Rhetoric, a figure by which a paragraph is inserted in the middle of a sentence with which it does not grammatically cohere, by way of explaining something. It is also called *paremptosis*, and is a species of parenthesis.

PARENCHY'MA. (Gr. παρεγχυειν, *to strain through*.) The spongy and cellular tissue of animals and vegetables. The old physiologists supposed that the crude juices underwent a kind of filtration in the cellular substance.

PARENCHY'MATOUS ENTOZOONS, *Parenchymatosa*. (Gr. παρεγχυμα.) An order of Entozoa, including those which have their nutrient canals simply excavated in the parenchymatous tissue of which their entire body is composed. *See* STERELMINTHA.

PARE'NTHESIS. (Gr. παρα and εν, and the verb τίθημι, *I place*.) In Rhetoric, a figure by which a series of words is inserted in a sentence, having no grammatical connection with those which precede or follow, with the object of explaining some detached portion of the sentence. In ancient authors, a parenthetical form of writing is even more common than among moderns; because much which a Greek or Roman author would have conveyed by way of parenthesis is now inserted in separate explanatory notes.

PA'RGASITE. A variety of actinolite, from Pargas in Finland.

PA'RGET. (Etymology uncertain.) In Architecture, the plaster formed of lime, hair, and cow-dung, used for coating the flue of a chimney.

PARHE'LION, or MOCK SUN. (Gr. παρα, and ἥλιος, *the sun*.) A meteor which consists in the simultaneous appearance of several suns, "fantastic images of the true one." These images appear at the same height above the horizon as the true sun, and they are always connected with one another by a white horizontal circle or halo, of which the pole is at the zenith, and the apparent semidiameter equal to the sun's distance from the zenith. The images or mock suns, which appear on the same side of this circle with the true sun, are tinted with the prismatic colours, and sometimes a part of the circle itself contiguous to them appears coloured. But those which appear on the circumference opposite to the sun are always without colour; whence it may be conjectured that these (as well as the luminous ring itself) are produced by reflection, and the others by refraction. In general, when these phenomena are produced, the sun is surrounded by one or more concentric circular coronæ which exhibit the colours of the rainbow; and sometimes arcs of circles, or even entire circles, appear touching the coronæ. These also are coloured, and contain other parhelia. The phenomenon has been described by Aristotle, Pliny, Scheiner, Descartes, and many others; but the most perfect apparition yet recorded is that which was observed by Hevelius at Dantzic, on the 20th of February, 1661. It is represented in the annexed figure.

Parhelia have continued visible for two, three, or four hours. In general two, but sometimes four, and even six or seven, are visible together.

No very satisfactory explanation of the cause of these curious but rare phenomena has yet been given. Huygens supposed them to be produced partly by the reflection and partly by the refraction of the sun's rays, falling on an infinite number of small cylinders of ice suspended vertically in the atmosphere, and having certain determinate positions relative to the sun and the observer. This theory is explained at length in the second volume of his *Opera Posthuma*. (See also *Smith's Optics; Priestly on Light;* Biot, *Traité de Physique*, tom. iii.)

Fraunhofer, in a memoir on halos and parhelia, published in *Schumacher's Astronomische Abhandlungen*, p. iii., has attempted to explain these phenomena on a different principle. On looking at the sun through a horizontal grating of very fine wires, two images of the sun appear, one above and the other below the true sun; and, if there is some inequality in the distances between the wires, the images appear slightly coloured, and a vertical streak of light is seen. Fraunhofer thinks that this affords a clue to the theory of the parhelia; for if the small spherules of moisture floating in the atmosphere are disposed in horizontal parallel lines with tolerable regularity, two vertical parhelia (but this is a very rare phenomenon) will be seen; and if they are disposed in vertical lines, the more common phenomena of horizontal parhelia with the luminous circles may be produced. It must be confessed, however, that even when this arrangement of the particles of vapour in parallel lines is admitted, several circumstances attending the phenomena will still remain unexplained.

Parasclenæ, or images of the moon, are also seen under similar circumstances as parhelia: the same theory will of course apply to both.

PA'RIAN CHRONICLE. (So called from the island of Paros, where it was originally found.) The name given to one of the celebrated marbles imported into England with the rest of the collection known by the name of the Arundelian. In its perfect state it contained a chronological register of the principal events in the history of ancient Greece during a series of 1318 years, beginning with the reign of Cecrops, the first king of Athens, B. C. 1582, and ending with the archonship of Diognetus; but the last ninety years are nearly obliterated by the injuries of time, so that the part which now remains ends at the archonship of Diotimus, B. C. 354.

The marble on which the chronicle is engraved is 5 inches in thickness, and measured, when Selden viewed it, 3 feet 7 inches by 2 feet 7; but one corner had been broken off. It contained originally about 100 lines, each consisting on an average of 16 words, or 130 letters;

so that the whole might have been comprised in six octavo pages.

This venerable monument was purchased at Smyrna, with many others, by Mr. W. Petty, who was employed by the Earl of Arundel, in the year 1624, for the purpose of collecting marbles, books, statues, and other curiosities in Italy, Greece, and Asia Minor. When brought to England, in 1627, it was placed in the gardens belonging to Arundel House, the site of which is now occupied by Arundel, Norfolk, Surrey, and Howard Streets, in the Strand; and early on the following day it was examined, with eager curiosity, by some of the most distinguished literati of that time; among whom were Sir R. Cotton, Selden, Patrick Young, and Richard James. After much labour it was deciphered, and a copy of it published by Selden in the year 1628, accompanied with a Latin translation and commentary.

During the civil wars, and the subsequent usurpation of Cromwell, the Parian Chronicle was unfortunately broken into smaller fragments, and almost entirely defaced. The upper part, containing nearly half the original tablet, is said to have been used in repairing a chimneypiece or hearth in Arundel House; but luckily the inscription, or at least as much of it as could be made out, was preserved in the copy which Selden had previously taken and published. In the year 1667 the remaining fragments were presented by the Hon. Henry Howard, grandson of the first collector, to the University of Oxford, where they are now deposited.

The genuineness of this valuable relic of antiquity was universally acknowledged throughout Europe as soon as its contents were made known. Its authority was considered as equal, if not superior, to any other; writers of the first eminence derived the greatest advantage from it in their historical and chronological researches; and it was not till the year 1788, when the Rev. John Robertson, a gentleman of considerable learning and industry, published an elaborate volume called *A Dissertation on the Authenticity of the Parian Chronicle*, in which he maintained it to be a fabrication of modern times, that its authenticity was impeached. The doubts and objections of Mr. R. were founded on the following considerations: — 1. The characters have no certain or unequivocal marks of antiquity. 2. It is not probable that the chronicle was engraved for private use. 3. It does not appear to have been engraved by public authority. 4. The Greek and Roman writers, for a long time after the date of this work, complain that they had no chronological account of the affairs of ancient Greece. 5. This chronicle is not once mentioned by any writer of antiquity. 6. Some of the facts seem to have been taken from authors of a later date. 7. Parachronisms appear in some of the epochas, which we can scarcely suppose a Greek chronologer, in the 129th Olympiad, would be liable to commit. 8. The history of the discovery of the marbles is obscure and unsatisfactory; and 9. The literary world has been frequently imposed upon by spurious books and inscriptions, and therefore we should be extremely cautious with regard to what we receive under the venerable name of antiquity.

These observations were made the subject of separate chapters and disquisitions, and were illustrated with such candour and extensive erudition that for a short time the credit of the Parian Chronicle was shaken in the public opinion. Early, however, in the following year, the objections of Mr. Robertson were replied to by Mr. Hewlett, in a pamphlet entitled *A Vindication of the Authenticity of the Parian Chronicle*, Lond. 1789; by Mr. Gough, in the ninth vol. of the *Archæologia;* and by Porson, in the *Monthly Review;* and the result of their inquiries, coupled with the defence of Wagner (Gött. 1790), and the more recent investigations of Hales in his *Chronology*, and of Boeckh in the second volume of his *Corpus Inscriptionum*, leave no doubt respecting the authenticity and antiquity of the Parian Chronicle. It is impossible within our limits to give a detailed account of the manner in which these different writers have disposed of the arguments of Mr. Robertson; suffice it to say, that they have established satisfactorily that the Parian Chronicle is written in pure and classical Greek; that the characters bear several marks of antiquity; that the events it recounts are infinitely too minute and detailed to have been forged; and lastly, that the silence of classical writers respecting it (which is perhaps the strongest argument against its antiquity) may be easily accounted for from the retired and insular situation of Paros. (The reader will find in vol. i. of *Hales's Analysis of Chronology* an examination of the dates assigned to the different events recorded in the Parian Chronicle. See also the *Penny Cyclop.*)

PARIAN MARBLE. *See* MARBLE.

PA'RIAS. The lowest class of the inhabitants of some parts of Hindostan, who have, properly speaking, no caste, and are supposed to be descended from original races of occupiers long since conquered by foreign invaders. In the widest sense, the term appears to comprehend *all* the different classes of distinct non-Hindoo tribes, and degraded or foreign races, not comprised in the four Hindoo castes; forming, probably, nine tenths of the whole population, exclusively of the Mussulmans.

PARI'ETAL. (Lat. paries, *a wall.*) In Botany, any organ which grows from the sides of another. Those ovaries are parietal which grow from the sides of a calyx; and placentæ or ovules have this name when they proceed from the sides of the ovary.

PARIETAL BONES. Two arched and irregularly square bones, one on each side of the superior part of the skull. So called from paries, *a wall*, because they protect the brain like walls.

PAR-IMPAR. Among the Romans, the game of *even or odd*. The game was played exactly as it is at present among the children of our own country.

PA'RING AND BURNING. The operation of paring off the surface of worn-out grass land, or lands covered with coarse herbage, and burning it for the sake of the ashes, and for the destruction of weeds, seeds, insects, &c. Agriculturists differ as to the value of this mode of improving land; the greater number preferring a naked fallow even for one or two years, alleging that more injury is done by the vegetable matter lost in burning, than benefit obtained by the ashes produced. Where the object is to bring land abounding in coarse herbage immediately into a state of good culture, paring and burning is evidently the most rapid mode that can be employed; and if the soil contains calcareous matter, burning will have nearly the same effect on it as if a dressing of quicklime had been applied. Much, however, depends on the mode in which the land is treated afterwards.

PA'RISH. (Gr. παροικια, *a neighbourhood.*) Properly, an ecclesiastical division of a town or district subject to the ministry of one pastor. In the earliest ages of the church, the parochia was the district placed under the superintendence of the bishop, and was equivalent to the diocese. It denoted, says Bingham, not only what we now call a parish church, but a city with its adjacent towns or country regions. It was not until the Christians became sufficiently numerous to present distinct congregations in the smaller towns and villages that the bishop appointed his presbyters to reside among them, and thus subdivided his diocese into several parishes. This constitution is recognized in several councils and other monuments of the fifth century. It is, indeed, probable that in many cities there existed more than one church and congregation even in the time of the apostles; but it does not appear whether these deserved the name of parishes, as being each under the distinct superintendence of its respective pastor. But although parishes were originally ecclesiastical divisions, they may now be more properly considered as coming under the class of civil divisions; and consequently claim our attention under this head. It is not easy to determine the era of the division of England into parishes; they are mentioned in the laws of King Edgar so early as 970, when the whole kingdom seems to have been divided into parishes; but it is probable that the division was not made at once, but by degrees. It is, according to Blackstone, pretty clear and certain that the boundaries of parishes were originally ascertained by those of manors; for it very seldom happens that a manor extends itself over more parishes than one, though there are often many manors in one parish. The parochial division of England was nearly the same in the reign of Edward I. (1272—1307) as at present.

Parishes are frequently intermixed with one another. This seems to have arisen from the lord of the manor having had a parcel of land detached from the main part of his estate, but not sufficient to form a parish of itself. It was natural for him to endow the church which he had erected upon his principal estate with the tithes of these disjointed lands; especially if it happened that there was no church in any lordship adjoining to them.

The boundaries of parishes depend on immemorial custom; but it is probable that they were not settled with very minute precision till the introduction of the poor laws, when, in consequence of the claim for relief upon their particular parishes given to the poor, it became a matter of consequence to define exactly the limits of each parish. They cannot now be altered but by legislative enactment.

In the northern counties, where the parishes sometimes embrace thirty or forty square miles, the poor laws, the due administration of which must always depend on an intimate knowledge of the situation and character of every one applying for relief, could not be properly carried into effect. To remedy this inconvenience, an act was passed in the 13th of Charles II. permitting townships and villages, though not entire parishes, severally and distinctly to maintain their own poor. Hence townships in the north of England may be regarded as divisions subordinate to parishes, and are, in practice, as distinctly limited as if they were separate parishes.

Towns originally contained but one parish; but, from

the increase of inhabitants, many of them are now divided into several parishes.

Besides parishes, or townships, there are places which are deemed extra-parochial, or not within the limits of any parish. These were formerly the site of religious houses, or of castles, the owners of which would not permit any interference with their rights. At present they enjoy some most valuable privileges; among others, a virtual exemption from the poor's rate, because there is no overseer on whom the order of a magistrate may be served — from the militia laws, because there is no constable to make the return — and from repairing the highways, because there is no surveyor. Their tithes are, by immemorial custom, payable to the king instead of the bishop. The number of such places is not inconsiderable, amounting to more than 200. It seems highly inexpedient that any part of the country should enjoy such an exemption from burdens imposed for the benefit of the community. Extra-parochial wastes and marsh lands, when improved and drained, are assessed to all parochial rates in the parish next adjoining. In some counties, *liberties* interrupt the general course of law as affecting hundreds, in the same manner as extra-parochial places do with regard to parishes. This inconvenience is particularly felt in Dorsetshire. The number of parishes and parochial chapelries in England and Wales is not exactly ascertained; but there are not many doubtful cases, and for any general purpose they may safely be taken at 10,700. About 550 parishes extend into two counties, or into more than one hundred or other divisions. (*Blackstone's Commentaries*, Introd. § 4.; and *Preliminary Remarks to Census of* 1831, pp. 14—18.)

The parishes of Scotland are purely ecclesiastical: for an account of the system on which they are divided, we must refer the reader to the article PRESBYTERY.

PARISH CLERK. The name of one of the lowest functionaries of the English church. Parish clerks are regarded by the common law as persons having freeholds in their office; and consequently though they may be punished, they cannot be deprived, by ecclesiastical censures. In former times parish clerks were frequently in orders, and even at present this is sometimes the case. They are generally appointed by the incumbent, but by custom may be chosen by the inhabitants.

PARK. A considerable extent of pasture and wood land surrounding or adjoining the country residence of a man of wealth, devoted to purposes of recreation or enjoyment, but chiefly to the support of a herd of deer, though sometimes to cattle and sheep. Parks were originally nothing more than portions of forest scenery appropriated by the lord of the soil for the exclusive use of animals of the chase; but this is now become in many cases a secondary consideration, and the chief uses of a park are as indications of wealth and extent of territory, and as grazing ground for domesticated animals.

PARK OF ARTILLERY. An assemblage of the heavy ordnance belonging to an army, with its carriages, ammunition waggons, and stores, on ground contiguous to that occupied by the troops when encamped. *See* ARTILLERY PARK.

PA'RLIAMENT. (In modern Latin *parliamentum*, in French *parlement;* from the Fr. parler, *to speak.*) The supreme legislative assembly of Great Britain and Ireland.

Origin of Parliament. — By the principles of the feudal system, every sovereign and every great feudatory had his council, composed of his greater and lesser vassals, which occasionally assembled to assist him both in judicial and legislative matters; and which was held in theory to be permanent, so that its assent was necessary to the validity of his acts. And it was also an ancient custom, in several of the western kingdoms of Europe, for such potentates to hold assemblies of their barons at the great festivals of the year, termed *cours plenières* and *parlemens;* principally, however, if not entirely, for the mere purpose of show and magnificence. But occasionally such special assemblies were summoned for more important purposes; and the meeting in 1146, at which the crusade of Saint Louis was undertaken, is said to furnish the first occasion in which the word parliament is used for a deliberative assembly. In France, however, the word was afterwards transferred to signify the principal judicial courts of that country. (*See* PARLIAMENT.) The only realms in which it appears to have become appropriated to the great legislative assemblies are England, Scotland, and the Norman kingdom of Sicily. The parliament of the latter country consisted, in the 13th century, of spiritual and temporal barons summoned by the king's writ; and occasionally, but not uniformly, of deputies from the towns similarly summoned.

All the extensive and laborious researches which have been made, of late years, towards dispelling the obscurity which rests over the commencement and early constitution of our parliaments, have only shown that little new information is attainable on the subject. We can, indeed, conjecture pretty accurately the process by which meetings of delegates for the purpose of apportioning taxation became gradually assemblies, granting or refusing supplies with absolute authority; and that by which a convention summoned for the object of representing grievances to the sovereign, and giving their approbation to his acts, became a sovereign legislative body. But to investigate the internal changes in the assembly itself, the mode by which it became divided into distinct chambers, the manner in which the peerage was formed as a distinct body out of the free baronage of the country, and that in which the lower house acquired the features of a regular representative body, may be safely pronounced, with our present knowledge, impossible.

The Norman and Plantagenet kings had two councils, — the great council of the kingdom, and the lesser or privy council; and it may be freely stated, after making all deductions from the principle on the score of arbitrary powers occasionally exercised by the sovereign, that, ever since the Norman conquest, the supreme legislative power in England has been placed in the king and great council conjointly. It was, moreover, in early times, a court of criminal judicature also, and aided the sovereign in all the more important transactions of his government. It interfered even in matters of ecclesiastical discipline; in questions of peace and war, of grace and justice; and, by way of advice, in the appointment to vacant offices, civil or ecclesiastical. The meetings of the great council were at stated festivals under the Norman kings; but after the civil wars in the reign of Stephen they were summoned at irregular periods. The inferior or privy council, which, as well as the great council, is indifferently termed *curia regis* in early writers, was composed of members named by the king, and constantly attended on his person; and this inferior body usurped, during the decadence of the great council, and before the full establishment of parliament, many of the legislative functions of the former: but by Magna Charta all aids and scutages were to be assessed by the great council; which thus, in principle at least, possessed a control over the extraordinary revenues of the crown. Any meeting of the great council, or of a portion of it, went by the ordinary name of a "parliament," or colloquy.

But of the constituent parts of this assembly, and the changes which took place in it, no writers give a satisfactory account. All we know is, that it was supposed to consist of all the tenants in chief of the crown; but, by the charter of King John, the archbishops, bishops, abbots, earls, and greater barons, were to be summoned personally; the other tenants in chief by the sheriffs and bailiffs. From this distinction is supposed to have arisen the institution of the peerage as a separate body from the lesser nobility, which so peculiarly distinguishes the constitution of England from those of all other feudal monarchies.

From these mixed assemblies to a representative body the change proceeded by steps, which it is impossible wholly to trace. The first vestiges, perhaps, of representation, appear in the 15th year of King John, when, for a particular purpose, writs were issued to the sheriffs, commanding them to return four knights for each county, "ad loquendum cum rege de negotio regni," at Oxford. But the better known and more distinct evidence of the beginning of the system is found in the Earl of Leicester's parliament after the battle of Lewes, in 48 Hen. 3., when four knights for every county (except nine) were summoned to attend with the barons, probably as representatives of the inferior nobility or lesser barons; and in the following years were issued the earliest writs of summons to parliament. These were to archbishops, bishops, and abbots; to certain earls and barons of the party of the Earl of Leicester; and to the sheriffs of counties and boroughs, to return two knights and burgesses, besides four from each of the Cinque Ports. And although no subsequent writs directed to the sheriffs for the purpose of county elections are in existence earlier than 18 Edw. I., nor of borough elections earlier than the 23d of the same reign, yet it is at least highly probable that the example set by the rebellious Earl of Leicester was ever after substantially followed, and that the representatives of counties and towns were occasionally summoned to parliament; as well for the purpose of assessing tallage and other aids demanded, as for that of giving their counsel respecting other affairs of the government. Edw. I. usually held four parliaments in a year; nor does it appear that these were legislative assemblies: they were rather supreme courts of justice, chiefly attended by the ordinary or privy councillors of the king; while the legislative assembly, certainly composed, after the 23d of this reign, of lords spiritual and temporal and representatives of the commons, was summoned to meet the king occasionally during one of these parliaments.

The constitutional law of the country, whatever it may have been in practice, was first declared by the statute 15 Edw. 2., which annulled the award against the king's favourites, the Despencers. In this act the legislative authority was declared to reside in the king, with the assent of the prelates, earls, barons, and commons, as-

sembled in parliament; and from that time the real existence of that body, and of the form of government which has ever since subsisted, has been uninterrupted, except only during the period of the Commonwealth.

The division of parliament into two houses took place at a period which it is not possible to ascertain; but it is probable that the three orders met in separate conventions for the purpose of assessing taxation, and that the representatives of the commons were at no period admitted to sit in the same chamber with the earls and barons after these were expressly summoned by the king. Although the numbers of both houses have varied materially, no fundamental alteration in their constitution took place from this time until the union with Scotland. (See the Report of the Lords' Committee on the Dignity of a Peer; *Hallam's Constitutional History of England.*)

House of Lords.—1. *Temporal Peers.*—The origin of the English peerage is involved in the same obscurity which rests on other parts of our early constitutional history. The greater barons, as before stated, appear under the first Plantagenet kings to have been those who were personally summoned to the council, while inferior tenants in capite were summoned together by a general compellation; but at what period their dignity became strictly hereditary is unknown.

Baronies are either by tenure, by writ, or by patent. The first were the original feudal titles, in which dignity was invariably attached to the possession of land. The greater barons, who sat of right in the great council, are supposed up to the reign of Henry III. to have been those who were in the possession of entire baronies. But from the date of 22 Edw. 1. it appears that the possessors of entire baronies ceased, of right, to be summoned to parliament; and it is therefore generally held that no barony by tenure subsists at the present day, although some recent efforts have been made to establish a title to this peculiar dignity; the latest claim having been made on the barony of Berkeley, by virtue of possession of the castle of that name.

Baronies by writ were created by writ of summons to parliament, which constituted an individual so addressed by name baron of the realm, and, it is supposed, also made that dignity hereditary. The earliest writ of this description was issued 49 Hen. 3.; and two now existing baronies (Despencer and Roos) are considered to have been created by it. In the case of a barony by writ, the dignity is not conferred until the person so summoned has actually sat in parliament. Baronies by writ descend in fee to all the heirs of the body of the person first created. If there be no son, and more daughters than one, the title falls into abeyance until only one daughter, or the sole heir of only one daughter, survives.

Baronies by patent are created by letters patent, under the great seal, conferring the dignity on the donee; in which are inserted words of limitation. These are usually to the heirs male of the body of the donee; and where there are no words of limitation in letters patent, it is held that the dignity will pass in the same course. Otherwise, the limitation is to other classes of heirs, or to specified persons, and their heirs by way of remainder. *See* Remainder.

Viscountcies are always created by letters patent. This is the most modern of English titles of peerage; and was first conferred on John Viscount Beaumont, 18 Hen. 6. The title vice-comes, or vice-earl, had been long employed to denote the sheriff of a county.

Earldoms were introduced into England by the Normans at the Conquest. The dignity of an earl seems to have been originally attached to the possession of a particular tract of land; but in the reign of Edward III. it began to be conferred by charters or letters patent, with an express limitation either to heirs general or heirs male of the body of the grantee. The word earl is of Saxon origin; but answers in dignity to the count (comes), in languages of Latin descent.

Of *Marquisates*, the first was that of Dublin, conferred on Robert de Vere, Earl of Oxford, for life, by Richard II. The term marquis is derived from the Latin marchio, signifying a military officer, governor of the mark or frontier. This dignity has been always conferred by letters patent.

Dukedoms are the highest titles of the English peerage. The first was created 2 Edw. 3., when Edward the Black Prince was made Duke of Cornwall. It has been a question whether the duchies of Cornwall and Lancaster were not duchies by tenure; but every other dukedom is a mere personal honour, and conferred by charter or letters patent. The term duke is derived from the Latin dux, *leader of an army;* answering to the German herzog, which has the same signification.

All peerages are forfeited by attainder for high treason; and attainder is consequent either on judgment or on outlawry, upon an indictment for that offence. Nothing but a reversal of such act of attainder by parliament can restore an attainted person, or his posterity, to the lost dignity. But where a peerage is vested in a person in tail male, with remainder over to another in tail male, if the first be attainted the peerage is forfeited as to him and his issue male; but, failing such issue male, the dignity becomes vested in the remainder-man, or his descendant.

Peerages by writ are also forfeited by attainder for felony; but not peerages by charter or letters patent.

By the twenty-second and twenty-third articles of the Union between England and Scotland, sixteen representatives are elected by the Scots peers to serve in every parliament of the United Kingdom. The eldest sons of Scottish peers were rendered, by a decision of the House of Commons shortly after the union, incapable of sitting in parliament. It was held for a long time that a Scottish peer could not sit in the House of Lords if he became a peer of Great Britain; but the point was decided the other way in 1780.

By the Act of Union between Great Britain and Ireland (39 & 40 G. 3. c. 67.), twenty-eight lords temporal are elected for life by the peers of Ireland. Peers of Ireland, who are members of the House of Commons, are not eligible to serve as peers while they continue members of the former house.

2. *Lords Spiritual.*—The right of the two archbishops and twenty-four bishops of England and Wales to sit and vote in parliament as members of the House of Lords, is generally said to belong to them as barons of the realm. It is undoubtedly probable that at the period of the Conquest a change took place in the tenure of the lands which were held by bishops and the high regular clergy; and that the Norman tenure by barony, then introduced for the first time, was made to comprehend both spiritual and temporal possessions, which under the Saxon kings had been regarded in a different light. But it is most probable that the dignitaries of the church were constituent members of the great council of the realm, by the English as well as all other feudal constitutions, independent of their quality as barons (see *Hallam, Middle Ages*, c. viii. part 3.); but that the place which was assigned them in the House of Lords, when the two houses became separate, was in virtue of their baronial character. Under the Plantagenet kings the clergy were summoned to meet by their representatives, as well as the laity, when subsidies were required; and under Edward I. (see *Luders on Parliaments*, chap. iii.) attempts were made to unite them and the laity together in parliament; but they were always resisted by the clergy, and at last they ceased altogether to attend in any capacity, retaintaining their own assemblies. (*See* Convocation.) At the period of the dissolution of monasteries by Henry VIII., the spiritual lords consisted of the then archbishops and bishops, and of twenty-six mitred abbots, and two priors, all of whom were then removed on the dissolution of their houses. The present spiritual lords have the same rights and privileges in every respect as the temporal, except that it is still a disputed point in constitutional law whether they have a right, on charge of treason and felony, to a trial by the peers; and it is also doubted whether they have judicial power, as peers, in capital cases.

By the Act of Union between Great Britain and Ireland, four lords spiritual from among the archbishops and bishops of that country sit in the House of Lords by rotation of session.

House of Commons.—1. *Persons qualified to serve in it.*—Persons incompetent to sit as members of parliament are, first, those labouring under the incapacities of alienship, attaint, outlawry in criminal proceedings, minority, lunacy, &c.; next, those who are disqualified by the possession of certain offices, or by certain other temporary causes. Clergymen, peers, Scotch peers, Irish peers for places in Ireland, the eldest sons of Scotch peers for places in Scotland, the fifteen judges of England, the Scotch judges and barons of the Scotch exchequer, are ineligible. Where the influence of government is supposed to have a direct control over the party, a disqualification has been created by various statutes. Persons concerned in the management of the revenues, with some few exceptions, are ineligible. So are persons holding new offices under the crown created since 1705, together with other persons mentioned in 6 Anne, c. 7. So pensioners during pleasure or for a term of years, police magistrates, government contractors, and placemen in public offices, specified in 15 G. 2. c. 22. There are also offices connected with the excise and customs which only disqualify the holder from sitting and voting, but not from being elected. Persons returned on a double return are not competent to sit until the return is decided by a committee.

The acceptance of any office of profit from the crown by a member vacates his seat, by 6 Anne, c. 7. And there are two places of no profit, the acceptance of which is considered to vacate a seat; viz. the stewardship of the Chiltern Hundreds, and the stewardship of the manor of East Hendred. Officers of the army and navy receiving new commissions are excepted from this statute: so are those who accept a foreign employment, as ambassadors.

A member becoming a bankrupt is incapable of sitting and voting for a year, unless within that time the commission is superseded, or the creditors paid; if this be not done within the year, the seat of the member is vacated.

Whether a resolution of the house can render a person ineligible, may still be considered an undecided question.

II. *Electoral Franchise.* — Since the Acts of Union with Scotland and Ireland, and the changes introduced by the Reform Act, the House of Commons consists of 658 members — 500 English and Welsh; 53 Scotch; 105 Irish — divided as follows:

		English and Welsh.	Scotch.		Irish.
Counties		159	30		64
Boroughs		337	23		39
Universities —	Oxford	2		Dublin	2
	Cambridge	2			
		500	53		105

All persons are competent to vote in the election of members of parliament, except infants, women, aliens (unless made denizens by letters patent or naturalized by act of parliament), persons convicted of felony and certain other infamous crimes, peers; Irish peers, unless themselves members of the House of Commons; and persons holding various employments under government not freehold offices. There are also some temporary disqualifications, arising out of employment in particular characters at elections, and the receipt of public alms. They must, however, possess a certain qualification, which (except in the universities, in which the right of voting belongs to all such as have attained certain academical degrees) is one of property.

1. In English and Welsh counties, the right of voting belongs to all such as possess a freehold estate in lands, tenements, or hereditaments, of the value of 40*s.* per annum above reprises; or who are seised of lands or tenements in copyhold, or any other non-freehold tenure for life, or for a larger estate of the value of 10*l.* per annum; or entitled as lessee or assignee to lands or tenements for the unexpired residue of a term of not less than sixty years of the same value, or of a term of not less than twenty years of the value of 50*l.* per annum; and occupiers of lands and tenements at a *bonâ fide* rent of 50*l.* or more per annum. But freehold tenements for life, if under the value of 10*l.* per annum, do not confer a vote, unless the party is in the actual occupation of them, or unless they have come to him by devise, marriage, &c., and not by gift or sale. And in the case of freeholds and copyholds, possession for six months before the last day of July in the year in which the voter is registered is a necessary condition; in that of leaseholds, &c., twelve months.

2. The qualifications of voters in cities and boroughs, in England, were, under the law as it stood before the Reform Act, extremely various, and depending more on the local law of every place than on the general custom of the country. The principal franchises were,—1. In respect of property; thus freeholders to the amount of 40*s.* voted in many towns and cities which were counties of themselves; leaseholders, copyholders, &c., in other places; and burgage tenants. The franchise of burgage tenure, which existed in some towns, depended on the possession of certain ancient tenements, which conferred a right to vote. 2. In respect of corporate privileges. Freemen or burgesses, and in London liverymen (*see* CORPORATION), enjoyed by virtue of their privilege a right of voting in corporate towns. 3. In respect of inhabitancy. Voters in this respect were of four sorts: inhabitants paying scot and lot; inhabitants householders, housekeepers, pot-wallers (*i. e.* pot-boilers), legally settled; inhabitants householders resiant; inhabitants generally. In many towns, several of these qualifications were recognized at the same time as conferring a right to vote.

The alterations introduced into the system of borough qualifications by the English Reform Act were twofold. In the first place, a new franchise is created which is everywhere the same. Every capable person who occupies within the limits of a borough any house or building falling within the specifications of the act, which is either separately or jointly with land held within the same borough as owner, or of the same landlord, of the clear yearly value of 10*l.*, is entitled to vote; provided he has occupied such premises for twelve months previous to the last day of July in the year in which he is registered; and provided he has been rated, and paid all rates for the relief of the poor due up to the 6th of April next preceding, and also all assessed taxes. In the next place, former franchises are modified as follows: — Freemen, and in cities being counties of themselves freeholders and burgage tenants, are to retain their qualification. But no one can claim to be registered as a burgess or freeman who was admitted since the 1st of March, 1831, except he derive his title through birth or servitude; or for a freehold or burgage tenement for an estate acquired since that day. All other borough franchises are abolished, saving their rights to individuals possessed of them at the passing of the Reform Act.

Finally, the act requires that every person, in order to be registered as a voter for a city or borough, must have resided for six calendar months next previously to the last day of July in that year within such city or borough, or within seven miles of it. And it is also provided, that no tenement situate within a borough, and capable of conferring a qualification on its occupier to vote within the borough, shall give a vote for the county.

Several boroughs in Wales, as well as in Scotland, are *contributary;* several towns being joined in one for the purpose of returning members to parliament.

The system of registration of voters, in England and Wales, was framed by the Reform Act. *In counties,* the register is formed by the overseers of the poor in every parish or township making the list by inserting all persons who have delivered to them, before the 20th of July in each year, a claim to vote in respect of property situate within their district. The lists thus drawn up by the overseers, according to a form specified in the act, are delivered to the high constable, and by him to the clerk of the peace for the county. The overseers are empowered to object to any person on their list whom they conceive not entitled to vote. They are also to receive written notices of objection by third parties, who are themselves voters or claimants, duly delivered to them, and to mark the names of all parties so objected to on the list. The lists thus formed are revised by the barrister or barristers appointed for that purpose. These officers are nominated by the senior judge of assize travelling the summer circuit within his district; and by the chief justice of the King's Bench in the metropolitan county and boroughs. Their courts, for the purpose of revising the lists and deciding on claims and objections, must be held between the 15th September and 25th October in every year. The lists revised by them form the register for the county, which is the authentic list of voters until the next registration. Any person having his name and qualification once inserted in the register is not bound to make a claim another year.

In cities and boroughs the course is somewhat different. On or before the last day of July in every year the overseers are to make out an alphabetical list of persons entitled to vote under this act; and another of persons entitled to vote in respect of ancient rights (except freemen, the list of whom is to be made by the town clerk, and in London by the clerks of the several companies). Any person whose name has been omitted in either of these lists is to give notice of a claim, in writing, to the overseer or town clerk. Objections are to be made, in boroughs, only by parties whose names are inserted in the list. The lists are revised by the barristers in the same manner as those for the counties, and delivered to the returning officer.

3. In Scotland, the right of voting in counties is declared by the Scotch Reform Act, 2 & 3 W. 4. c. 65., to be in the owners of ancient rights (termed superiorities) not acquired since 1831: in such persons as have been owners for six months previous to the last day of July of "any lands, feu duties, or other heritable subjects," of the annual value of 10*l.* after deductions. Where two or more parties are interested in any subject to which a right of voting is for the first time attached by the act, as life-renter and as fiar, the right shall be in the former. The right is also extended to tenants for life, or on lease of fifty-seven years or more, at 10*l.* per annum; tenants on lease of nineteen years or more, or occupants at 50*l.* per annum; and tenants who have paid for their interest a price of 300*l.*

4. In Scottish boroughs, the right of voting is in occupiers of houses, &c. (as in the English Reform Act) of the yearly value of 10*l.* Claims by qualified persons to vote for counties are to be lodged with the schoolmaster, and he is to make out the lists of claimants and objections. Claims for votes in boroughs are given in to the town clerk, and the lists made out by him. The sheriff holds courts to decide on questions relative to the registration: his powers and duties are analogous to those of the revising barrister in England.

5. In Ireland, the right of voting in counties is in freeholders at 10*l.* per annum (by the act 10 G. 4. c. 8., which abolished the old 40*s.* qualification); and by 2 & 3 W. 4. c. 88., in leaseholders for sixty years at 10*l.* per annum, for fourteen years at 20*l.*; and in copyholders at 10*l.* per annum.

6. In counties of cities and counties of towns in Ireland, the franchise is in 10*l.* freeholders, 20*l.* leaseholders, 10*l.* householders, and in the 40*s.* freeholders entitled under 4 G. 4. c. 55.; but not in any persons acquiring such freeholds since 1831, except by descent, marriage, &c.; and in 10*l.* occupiers who have occupied for six months: in all other boroughs, in 10*l.* occupiers (the franchise being the same as in England, with the exception that the words "or other building" are omitted) who have occupied for six months. The existing rights of freemen, &c. are saved. Registration in Ireland takes

place at a special session before the assistant barrister or chairman of each county; parties desirous to be put on the register, whether for counties or boroughs, having previously given notice to the clerk of the peace, his deputy, or the high constable. Persons declared by the assistant barrister to be entitled verify their title by affidavit, which is filed of record. An appeal is given to the judges of assize. A certificate of registry is given to each registered voter. Freeholders at 50*l.* per annum may be registered at assizes, or before a judge in Dublin.

III. *Mode of Election.* — 1. In England and Wales, when the sheriff receives the writ commanding him to return a knight or knight of the shire, or division of the shire, he makes proclamation, within two days after receiving the writ, at the place where the election is to be holden; that is, the principal polling place. Counties and divisions are subdivided into convenient districts, with a polling place in each. On the day fixed, after the Bribery Act has been read, the candidates are proposed; and the election proceeds. In boroughs, the sheriff (or other officer to whom the writ is directed) sends his precept to the returning officer, who acts in the same manner as the sheriff in the county; and boroughs are similarly divided into polling districts.

When a candidate is proposed, he may be called on by any other candidate, or any two of the electors, to swear to his qualification. The qualification required by 9 Anne, c. 5., is, for a knight of the shire 600*l.* per annum in lands and tenements, freehold or copyhold, for his own life, or a greater estate; for burgesses, 300*l.* per annum of similar property. Eldest sons of peers, or of persons qualified to sit as knights of the shire, are themselves qualified. Members for the universities are not required to possess any qualification.

It is still questionable whether the returning officer can refuse to return a candidate who refuses to take the qualification oath before the poll. After the election, and before he takes his seat, each member must deliver to the clerk of the house a paper signed by himself containing a description of his estate of qualification, and is sworn to its value at the same time at which he takes the other oaths. His qualification may then be questioned in a petition against his election.

When more candidates are proposed than the number to be returned, the election is decided by the sheriff's declaring the majority on view (by calling on them to hold up their hands). But a poll may be demanded by a candidate or elector, either before or after such declaration by the sheriff.

The poll must commence on the day on which it is demanded, or on the day after. By the Reform Act (s. 58.) three questions only can be asked of any person offering to vote as to his right, — whether he is the same person whose name appears on the register, whether he has already voted, whether he has the same qualification for which his name was inserted on the register; and he may be required to take the oath specified in the act as to his person and qualification. Besides this, the oaths of allegiance, and supremacy, and abjuration, may be put to an elector at the request of any candidate, unless the elector be a Roman Catholic, in which case he may be required to take the oath specified in 10 G. 4. c. 7.: all the foregoing oaths are to be taken before commissioners. The bribery oath may also be administered at the poll by the returning officer. There are also certain local oaths, required by act of parliament to be taken at the election for particular boroughs.

By the Reform Act the poll was limited, in England and Wales, to two days' duration, both in counties and boroughs. And now, by a recent enactment, the poll is declared, in counties, the day next but one after its close; in boroughs, the day after its close. By 5 & 6 W. 4. c. 1. the duration of the poll in boroughs was further limited to a single day. The return is made, in counties, by tacking the names of the persons chosen to the writ; in boroughs, by tacking them to the precepts and returning them to the sheriff, who then tacks them to the writ, and forwards the whole together to the clerk of the crown in chancery. Where the votes are equal, it is the practice to make double returns.

2. In Scotland, the sheriff fixes the day for a county election at not less than ten or more than sixteen days after the writ is received: the counties are divided into polling districts, not exceeding fifteen in number; and the poll lasts two days. In boroughs similar regulations are adopted to those in England; but the sheriff, or his substitute, superintends the poll, which may last three days. The sheriff is the returning officer.

3. In Ireland, the sheriff proclaims the time and place of a county election five days after receiving the writ; and from ten to sixteen days after such proclamation the election is held. In boroughs, the sheriff of a county of a city or town, the mayor, sovereign, or other returning officer, holds the election, not later than eight days after receipt of the precept from the sheriff. The poll shall commence on the day on which it is demanded, and continue five days, but may be closed on any day on which not more than twenty persons have polled.

IV. *Election Committees.* — In the first parliament of James I. a committee of privileges and returns was appointed, to which the trial of every petition against an election was referred which was not heard before the House of Commons. A similar committee was appointed at the commencement of every session, until the present practice of trying such petitions before select committees began. This practice is founded on a variety of statutes, beginning with 10 G. 3. c. 16., commonly called the Grenville Act, consolidated by 9 G. 4. c. 22.

There are six sorts of petitions referred to a select committee: — 1. Complaining of undue election. 2. Of undue return. 3. That no return has been made to the writ in due time, &c. 4. That the return is not according to the requisition of the writ; or complaining of special matters contained in it (as double returns or special returns). 5. To oppose the right of election, or of appointing returning officers, determined by a select committee, and repeated to the house. 6. To defend such right. The four first may be subscribed by any candidate or person claiming a right to vote; the two last by all persons. A petition to be admitted as a party to defend such return, or oppose the prayer of such petition, is addressed to the house, and not referred to a committee. An election petition is presented to the house by a member within a certain time limited by the house. No proceedings will be had on petitions complaining of an undue election or return, &c., unless the subscriber, within fourteen days after its presentation, or farther time limited by the house, enter into certain recognizances for the payment of costs and compliance with other conditions.

When such a petition is presented, a day and hour are appointed by the house for taking it into consideration. At that time, under the Grenville Act, if 100 members were present, the parties and agents attending, thirty-three were selected by ballot; which number, on each party striking off one alternately, was reduced to eleven. If more than one petition is to be taken into consideration on the same day, successive lists of thirty-three were formed, two, three, or more, according to the number of members present in the house. Voters, petitioners, members against whom petitions are presented, and those whose return has not been brought in, were disqualified from serving, and their names, if drawn, were set aside. If no party appeared to oppose the petition, the clerk of the house and the petitioner reduced the list to eleven. This system was considerably altered by the provisions of 2 & 3 Vict. c. 38., an act introduced by Sir Robert Peel. Under it a general committee of elections is appointed by the speaker at the beginning of every session. This general committee chooses six members and a chairman to form a select committee to try an election petition, out of the whole list of members, divided and corrected in the manner therein specified..

The same nicety, it is said, is not required in election petitions, as to their form, as in pleadings at law; but it is now decided, by a series of precedents, that it is necessary that the matter intended to be proved should be sufficiently set forth in the allegations of the petition; and that, on the hearing of the petition, it will not be competent to the party to go into evidence in proof of facts not distinctly alleged therein. But there is considerable variety in the decisions as to what is sufficiency of allegation. An election petition, when once presented, can only be withdrawn by permission of the house: to which jurisdiction in this respect is still left by the Grenville Act. The house will therefore require to be satisfied that there is no fraud or concert in the withdrawal. Supplemental election petitions may be presented, on the discovery of new matter after the presentation of the first petition.

In petitions of the first four classes, parties (if the election is defended) are required to send in to the clerk of the House of Commons lists of the votes to which they intend to object.

Select committees sit every day; but with power to adjourn for twenty-four hours on their own authority, and for a longer period on leave obtained from the house on motion. Members may only absent themselves by leave, or on excuse to be allowed by the house: if any are absent otherwise, the committee cannot sit. Committees are not dissolved by prorogation of parliament, but adjourned to the next time of meeting.

In the first four classes of petitions, the committee have to try the merits of the election; and to determine, by their votes, whether the petitioners, or the sitting members, or either of them, were duly returned; or whether the election is void, and a new writ ought to issue. The fifth class raises the question as to the right of election, or of nominating returning officers, &c. The determination of the committee is in each case final and conclusive; and is embodied in its report to the house at the conclusion of its sittings. A committee has also the power, if it pleases, of making a special report, instead of

deciding generally on the merits; in which case the house makes such order on the report as may seem proper. An examination into the bad votes given on each side is termed a scrutiny; and the effect of it is, that if on balancing the number of good votes retained after such examination the petitioner has the majority, it is reported that he ought to have been returned. Where an incapacitated person has been elected, the principle of parliamentary law is, that if his disqualification was sufficiently known to the electors at the time they returned him, their votes are considered as lost; and it is reported that the next on the poll ought to have been returned. If the fact of his disqualification was not known, the election is simply void. It appears, however, not to be absolutely decided whether the incapacity which renders the votes thrown away must be an inherent or contingent incapacity; as, for example, where it was *publicly known* that a candidate was disqualified by reason of having been guilty of acts of bribery with reference to the election. In this case it has been argued that the election is not void, but that the votes given for the person so disqualified are thrown away. In other cases, bribery, treating, undue interference, &c., have the effect of avoiding elections; and the report is, that a new writ ought to issue.

Finally, an election committee has the power of declaring either the petition, or the opposition to it, "frivolous and vexatious" in its report; the effect of which is to fix the party against whom such declaration is made with the payment of costs. These costs are ascertained by application to the speaker, who directs two persons to tax them, and then grants a certificate; on production of which in a superior court judgment may be entered up for the amount.

V. *Mode of Assembling Parliament.* — Parliament can only be convened by the authority of the king; and, by 6 W. & M. c. 2., must be held at least once every three years; but, in point of fact, as the Mutiny Act, Land Tax, and Malt Act are only passed for a single year, the sittings of parliament are of necessity annual. The same order by the king in council which commands the lord chancellor to cause the great seal to be affixed to a proclamation for dissolving parliament, is accompanied with a warrant to issue writs for a new one. Writs for the return of members of the House of Commons are directed to the sheriffs of counties, with certain exceptions: viz. the returning officers of places counties in themselves, the Bishop of Durham, the Chancellor of the Duchy of Lancaster, the Chamberlain of the County Palatine of Chester, the Constable of Dover, and the Warden of the Cinque Ports. On a vacancy during the sitting of parliament, the writ issues under warrant of the speaker by the authority of the house itself.

VI. *Meeting of Parliament. Preliminary Proceedings.*— The new parliament meets on the return day of the writ, unless prorogued by writ of prorogation; but when it is intended that it should meet for the actual despatch of business on the day to which it is prorogued, notice to that effect is given by proclamation forty days before; and the parliament begins only on the day to which it is prorogued. The acts of meeting and passing a statute constitute together a session. Upon the assembling of parliament the king meets it in person, or by representation, and explains in his speech the reasons of convening it. In modern times, the speech is not delivered until the commons have chosen a speaker, which they receive a command from the king to do.

The first occasion on which this important officer is expressly named occurs in the parliament 51 Edw. 3. His duties are, — to act entirely as the servant of the house which appoints him. He takes the chair, which he cannot do unless forty members are present; maintains order, by naming (if necessary) members who are disorderly; explains and informs on questions of order or practice, if he is referred to. He can neither speak nor vote unless in case of equality of votes; or in committees of the whole house, where, as soon as the chair is taken, he is reduced to the footing of an ordinary member.

On the first day of the meeting of every new parliament certain oaths are administered to the members by the Lord Steward of the King's Household: these are the oaths of allegiance, supremacy, and abjuration; but, by the Roman Catholic Relief Act, members professing that religion take, instead of these oaths, a declaration substituted for them. By 33 G. 2. c. 20. they are also required to make oath that they are qualified, and deliver in their qualification at the table. But, previous to being sworn, every person returned is to all intents and purposes a member of the house, except as to the right of voting only. Before the king's speech is taken into consideration, it is usual to read a bill as a matter of form. The king's speech being then reported to the house, an address of thanks, as moved or as amended, is returned. The usual committees are then appointed: of these the committee of privilege is the only one of which the duties are at present of a practical kind.

The method of proceeding in making laws is, for the most part, similar in the two houses; but different in public and private bills.

VII. *Method of Proceeding on Bills in general.*—Statutes are divided into public and private; and the distinction, in a parliamentary sense, is merely derived from the payment of fees, which are due on private and not on public acts. Constitutionally, public acts are, in general, such as relate to the kingdom at large; private acts, to individuals and classes. Many acts, however, which immediately concern classes only are within the category of public acts; as, for instance, acts concerning all spiritual persons, or all lords of manors. Judicially the distinction between the classes is, that the courts of justice are officially bound to notice public acts; but private acts must be formally shown or pleaded. This rule, however, admits of certain technical exceptions.

All private bills affecting the peerage must begin with the lords; all bills which, directly or indirectly, impose a charge on the people must begin with the commons. This class, therefore, includes all bills under which tolls may be levied for private benefit; such as bills for making roads, canals, railways, bridges, inclosure bills, and bills containing clauses inflicting pecuniary penalties for offences against private property, &c.

All other private bills may begin with either house indifferently; but, in practice, one large class of private enactments, — viz. estate bills, which enlarge or alter the power of individuals in disposing of their property; divorce bills; bills to enable parties, under statutable restrictions, to alienate, &c., — begin in the lords; that house, from its judicial character, being best fitted for the discussion of similar subjects. On the other hand, bills concerning the parliamentary rights, &c. of particular places, usually commence, by custom, in the commons. There is one instance of a bill which begins with neither house, but with the crown; viz. a bill for a general pardon. Bills are always read in each house, after leave has been given to bring them in, three times before they are passed (with the exception of bills of grace, such as for a general pardon, which are passed on the first reading). General petitions against a bill are usually ordered to lie on the table until the second reading; on which occasion counsel are heard against a bill, whenever leave is given for their introduction. The second reading affords the legitimate period for discussion on the principle of the bill; and the bill is then (as indeed it is, on principle, in every stage) open to the proposal of amendments. If a bill be rejected, either on the first or second reading, it cannot be again proposed that session. After the second reading, the bill is committed; *i. e.* referred either to a select committee, or, if the bill be of importance, to a committee of the whole house. Such a committee requires, in the commons, the presence only of forty members; in the lords, of all members in attendance. In committee the bill is debated clause by clause, with the advantage that members are not restricted, as in a debate of the house, to speaking once. The proper province of the committee is to consider the bill in its details. When the bill has gone through the committee, the chairman reports it to the house, with such amendments as the committee may have made. The house can then agree or disagree with the amendments of the committee. (*See* Amendment.) The bill is then engrossed, and afterwards read a third time. In the commons, it is usual to read a bill which originates with the lords the third time on the same day on which it is reported. A new clause added to a bill on the third reading is termed a rider. A bill thrice read, and passed, admits of no farther alteration, except for clerical errors. A bill sent from the commons to the lords is usually read the first time in the latter house on the day on which it is brought; and, when it has passed through the different stages, is sent back to the commons, with the amendments, if any have been made, with which the commons then agree or disagree; the same process, substantially, being followed, vice versâ, where the bill originates with the lords. The amendments returned with a bill from one house to another are taken into separate consideration; and the amendments, if agreed to, are always considered as proceeding from that house in which the bill first originated. If one house cannot agree to the amendments proposed by the other, a conference is usually held between members deputed by each house, who can only make use of the instructions delivered by the house in their arguments, the conference being desired by that house which disagrees with the amendments in question. If the house which amends is not satisfied at the first conference with the reasons alleged for its disagreement by the other, it desires another conference; if this too is unsuccessful, what is termed a free conference may be demanded, in which the managers of the conference are not under the same restrictions as to instructions, but may urge their own arguments. If one or more free conferences fail of producing unanimity, the bill is dropped. It is necessary to observe, that in bills of supply (which originate in the commons) the lords cannot make any except verbal amendments; they must either admit

or reject altogether. When a bill has passed both houses, it is deposited in the House of Lords, to wait for the royal assent (except in the case of a bill of supply, which is presented by the speaker to the throne). The royal assent is given either in person, or by letter patent under the great seal, notified by commission. The bill then becomes a statute, is transcribed into a roll by the clerk of the parliament, delivered into chancery, and by usage, although not necessarily, printed at the king's press.

VIII. *Method of Proceeding on Private Bills.*—Petitions for private bills must be presented in the commons within fourteen days after the first Friday in the session ; and, on being presented by a member, are referred to a committee, which is then named, consisting of five members selected by the committee clerk. The committee on the petition ascertains whether or not the standing orders applicable to the case have been complied with ; in which case they make their report accordingly to the house: leave is then given to bring in a bill ; unless, as in some cases, it is expedient first to re-commit the report. The bill having been read a first time, after an interval which is varied in practice according to the nature of its subject, the house proceeds to the second reading ; on which occasion objections to the *principle* of the bill are usually made, specific objections to its provisions being more properly reserved to a later stage. A member may, individually, oppose a private bill in any stage, or he may present a petition against it. On the bill being read a second time, it is referred to a committee, which is formed in the same manner as the first committee on the petition. In the committee on the bill all the blanks left on its first introduction are filled up, and amendments introduced ; and, if unopposed, the bill is reported. Opposition to a private bill, in a committee of the House of Commons, is conducted as follows : — The petition against the bill, having been referred to the committee, is read there ; if the parties supporting it appear, the promoters of the bill first state their case, and produce and sum up their evidence in support of its preamble ; the opponents next state their case, produce and sum up their evidence against it ; the promoters then reply, and the committee vote. If the committee resolve that the preamble is proved, the clauses are read, and the opponents are at liberty to make objections to each successively ; the promoters not being called upon otherwise to offer evidence in support of them. The presence of five members of the committee is necessary to any proceeding. A committee cannot dissolve itself, and consequently its existence continues until it has reported to the house ; although by adjourning indefinitely, or by voting the chairman out of the chair, they might in effect entirely release themselves from the duty imposed on them ; but the house, in similar cases, has exercised the power of ordering the committee to proceed forthwith.

When the report is brought up and read, as in the case of other bills, it is ordered to lie on the table. After seven days, the amendments having been read and agreed to, it is ordered to be engrossed ; after which it is competent to any member to move the third reading of it. Additional clauses added at this time are termed riders. When passed, the member who presented the petition, with seven others, takes it to the House of Lords, and delivers it to the lord chancellor. If the lords make amendments, the concurrence of the commons to these amendments is moved by the same member. Should the lords' amendments not be agreed to (a rare occurrence in private bills), a conference is held by a deputation from both houses; and, should the disagreement continue, the bill is finally withdrawn, or rather dropped.

IX. *Standing Orders of the House of Commons.*—These are a series of regulations, adopted by way of resolutions of the house at various periods, from 1685 to the present time, relating partly to the internal order, &c. of the house, partly to certain preliminaries and forms required on the introduction of particular bills, both public and private, and to the promulgation of statutes. The most numerous of these relate to private bills, and specify the mode of signing and presenting, the time for delivering notices and their necessary contents, the formalities to be required respecting instruments, and a variety of other particulars. When a resolution is made which is intended to be permanent, it is usual to add the form, " Ordered that the said resolutions be standing orders of the house." Standing orders on private bills are sometimes (but only on special application) dispensed with by the house, or farther time, &c. given for complying with them.

X. *Rules of Business in the two Houses.*—In the Commons, a house for the transaction of business consists of forty members, by an order of the year 1640 ; and, if a less number be present, the speaker will not take the chair. This rule extends to committees of the whole house. The speaker of the House of Commons cannot speak in the house ; the speaker of the House of Lords may. A call of the House of Commons is an expedient to secure attendance for an important occasion : when it is made, members absent without leave may be ordered to be taken into custody. No member can be present on the debate of a bill or other business concerning himself. The order " for the sergeant-at-arms to take into custody strangers that are in the gallery of the house " is repeated every year, the first instance having been in 1705 ; so that the House of Commons is supposed to sit with closed doors, although the order is partly permitted to be infringed. When the speaker's mace lies upon the table of the House of Commons, it is a house ; when under, a committee ; when out of the house, no business can be done ; when in the hands of the sergeant at the bar, no motion can be made.

With regard to the manner of speaking and voting in the commons, motions are made, and petitions presented, by a member *in his place;* the readings of bills, &c. are moved *at the table.* The member who moves a motion puts it in writing, and delivers it to the speaker, who, when it has been seconded, puts it to the house ; it cannot then be withdrawn except by leave of the house. The *motion to adjourn* is put in order to supersede a motion of which the house is already in possession. The motion *for reading the order of the day* has equally the effect of superseding the existing question. The motion *for the previous question* has been commonly but mistakenly attributed to Sir Harry Vane, as its inventor. It can take place only in a house, and not in a committee ; in which latter the equivalent motion is, *that the chairman do now leave the chair.* The speaker names the member whom he first perceives to rise in order to speak ; but the house is not bound by the speaker's decision. It is understood to be the rule, that a member may speak even after the question put, if the affirmative voice only has been given, and the negative not yet given. The effect of the speaker's " naming a member," on the occasion of disorder in the house, is that such member, after being heard, if he pleases, is directed to withdraw, and the house then considers what penalty to inflict. In the commons, votes are given by *ay* and *no ;* if a division is demanded, the speaker (by a resolution of 1603) appoints two tellers on each side to count. Strangers are directed to withdraw, and the doors closed before the question is put. On a division one party leaves the body of the house, the other remains ; and the general rule is, that the side which is for the *innovation* goes out ; thus, on the question on a bill, the *affirmative* voices go out : but this rule is governed in its application by various special usages. On a division in a committee of the whole house, the ayes go on one side, and the noes on the other. The speaker has the casting vote in a house, the chairman in a committee.

In the House of Lords.—The general rules of proceeding in the House of Lords vary little in material points from those adopted by the commons. The speaker can debate as well as vote. Votes are given seriatim, the youngest baron voting first. The privilege of the lords to vote by proxy is only by licence from the king. Proxies from spiritual lords are only to spiritual ; proxies from temporal only to temporal. No lord can hold more than two proxies. The lord chancellor is ex officio speaker of the House of Lords ; and as he is able to speak and vote, he has no casting vote : the rule, therefore, in case of equality of voices always is, that the presumption is in favour of the negative side.

With regard to messages between the two houses, those from the commons to the lords are sent by one member, but will not be received unless eight at least attend in all. Messages from lords to commons are sent by two masters in chancery ; or, on special occasions, by two judges. Messages from the king are of various sorts : those to the commons, to desire any proceeding on their part, are usually written in the king's own hand ; those which are sent when a member of the house is put under arrest on account of the public service are verbal, and delivered by a minister of the department of service concerned. (See *Hatsell's Precedents in Parliament.*)

XI. *Jurisdiction of Parliament as a Court of Justice.*—i. For the trial of a peer, indicted for treason or felony, or for misprision of either, the lords spiritual and temporal sit as the court of the lord high steward of England, an office which is in general created *pro hâc vice* by a commission under the great seal. But, if the trial should occur during the sitting of parliament, it is said to be before the same court " of our lord the king in parliament ;" in which case the high steward is only, as it were, pro tempore speaker of the house, and has a vote with the other peers ; whereas, in his own courts, held in the recess of parliament, he is judge of the court, and, like any other judge, sole arbiter on the question of law.

ii. The House of Lords has also a twofold jurisdiction ; 1. in criminal cases, 2. in civil cases. — 1. The first is for the trial of high crimes and misdemeanors by the method of parliamentary impeachment by the House of Commons. (*See* Impeachment.) The proceeding on a bill of attainder, or of pains and penalties, is, in fact, a legislative act, and not a judicial one. (*See* Attainder, Pains and Penalties, Bill of.) 2. The jurisdiction of the House of Lords, in civil cases, is divided by Lord Hale

into their jurisdiction in the first instance, and in the second instance as a court of appeal; but the former, which consisted in special powers of interference, occasionally exercised for particular purposes, is now obsolete. In the last instance, the House of Lords is the supreme court of judicature in the kingdom. Appeal lies to it, by writ of error, from the court of King's Bench, and from the subordinate court of appeal of the Exchequer Chamber; and appeal from the High Court of Chancery also, not only in order to obtain the reversal of a decree, but also on any interlocutory matter. On writs of error, the House of Lords pronounces the judgment; on appeals, it gives directions to the court below to rectify its own decree.

XII. *Privilege of Parliament*, in the ordinary sense of the words, denotes the privileges of individual members of either house, enjoyed by virtue of their seats. These privileges are partly limited by known precedent, or by statute; but they are to a great extent customary, and the houses themselves constitute the only tribunals before which the inquiry whether their privileges have been violated or not can be instituted.

The first privilege is freedom of speech in debates: this claim is sanctioned by the statute 2 W. & M. 2., which declares the liberties of the people. This privilege does not extend to the publication of what is spoken: if a member publish his speech without the authority of the house, he is liable to the common legal tribunals for its contents. An exception to the privilege also is to be found in the jurisdiction of the house itself; which has the power of committing, expelling, or fining (the latter not exercised since the reign of Elizabeth) a member for a libel or contempt against the dignity of the house.

The next privilege, of freedom from arrest in civil suits, is probably as old as parliament itself. Privilege of parliament was formerly supposed to exempt peers and members of the House of Commons from civil actions as well as arrests; but this was finally abolished by 10 G. 3. This is the privilege of peerage, not of parliament; consequently it extends to Scotch and Irish peers. The exemption does not extend to criminal cases, or breaches of the peace; or to attachments in case of contempt by the superior court. And, by a peculiar process enacted by 10 G. 3., a member of parliament may be made a bankrupt. Unless the commission is superseded within twelve months from its being issued, he vacates his seat. The liberation of parties improperly arrested is effected either by the authority of the houses themselves, or, when parliament is not sitting, or (in the case of peers) when it is dissolved, by writ of privilege, or on motion in the superior courts. The duration of the privilege, in the case of members of the lower house, is not exactly defined. It is the general opinion that it extends forty days after every prorogation, and forty days before the next appointed meeting. Members of parliament are not liable to be called on to serve as jurors during sitting or adjournment.

The old privilege of franking was fixed, by 4 G. 3. c. 24., to continue during the same period which is mentioned as that of freedom from arrest. By 35 G. 3. c. 53. it was restrained to letters within an ounce in weight, and the number to ten sent and fifteen received. It is now altogether abolished.

The general or "ancient and just" privileges of the houses are, as has been said, undefined. "The law of parliament," says Hallam, "as determined by regular custom, is incorporated into our constitution; but not so as to warrant an indefinite uncontrollable assumption of power in any case, least of all in judicial proceedings, where the form and essence of justice are inseparable from each other."

Besides the general privilege of parliament, we may here briefly notice the privileges claimed by the two houses, or by members of them, with respect to the conduct of their legislative proceedings.

Two privileges peculiar to the House of Lords are, 1. That possessed by every peer of giving his vote by proxy. (See antè, *Rules of Business in the two Houses*.) 2. That which he possesses of entering on the journals of the house his dissent from a vote of the house, together with his reasons for it, which is styled his protest. The first protests, with reasons annexed, are said by Lord Clarendon to have been made in 1641.

Of the peculiar privileges of the House of Commons, the most important is that of originating all money bills; and this, in principle, is a very ancient part of the constitution. But it was not before 1690 that it was fully established that the lords could not alter, any more than originate, any rate or tax granted by the commons. This privilege is now understood under the following limitations: — In bills of aid and supply, the lords can neither originate them nor make any alterations beyond verbal amendments. In bills which impose pecuniary burdens as a collateral object, — such, for example, as bills for turnpike roads and canals, or for the management of the poor, — the lords may make amendments, but not such as affect the quantity, disposition, or collection of the rate. No amendments may be made by the lords which appear likely, in their consequences, to bring a charge on the people; nor can they insert or alter pecuniary penalties and forfeitures in a bill.

By a resolution bearing date 1667, and now strictly adhered to, any proposition for taxing the subject must be first examined by a committee of the whole house, and their opinion reported. The effect of this rule is, that subjects on which frequent speaking by the same member, and other departures from regular proceedings are desirable, are discussed in a meeting unfettered by some of the special rules of the house.

When a bill of supply has received the concurrence of the lords, it is returned to the commons, and by them presented to the throne.

XIII. *Adjournment.*—An adjournment is a continuance of the session from one day to another. This is done by each house for itself, either from day to day, or over a recess, as at Christmas and Easter. In neither house can the speaker adjourn unless upon motion of the house. The king can signify his desire of an adjournment; but has no further power.

XIV. *Prorogation of Parliament.* — A prorogation is the continuance of parliament from one session to another: and is made by the royal authority, either expressed by the lord chancellor in the king's presence, or by writ under the great seal, or by commission. In the proclamation for prorogation, if it is intended that parliament, when next it meets, shall proceed to the despatch of business, notice is given of that purpose; and such notice bears date usually forty days at least before the day appointed for meeting; but, in time of rebellion or danger of invasion, the king is empowered to call together parliament with fourteen days' notice only.

XV. *Dissolution of Parliament* is effected either, 1. By the king's will, which is the exercise of one of his highest prerogatives: this is usually done by proclamation after parliament has been prorogued. 2. By the demise of the crown; but, by 7 & 8 W. 3., the existing parliament continues six months after that event; assembles immediately, if under prorogation or adjournment; and if there be no parliament at the time, the members of the last parliament are empowered to reassemble themselves. 3. By efflux of time; viz. at the end of every seventh year, if not sooner dissolved by the Septennial Act, 1 G. 1. s. 2. c. 38. The seven years are counted from the day on which parliament was appointed to meet in the writ of summons.

Pa'rliament, or Parlement. (Fr. parlement.) The title of certain high courts of justice under the old French monarchy. The French parliament, like those of England and Naples, was in its origin a convocation of the great vassals of the crown, who treated of judicial as well as political matters in their assemblies. Saint Louis was the king who first introduced into this body counsellors of inferior rank, chiefly ecclesiastics, as legal assistants; and the earliest registers of the proceedings of the parliament, which afterwards became fixed at Paris, are of the date of 1254. The important step of rendering that court permanent, and fixing its seat in the capital city, is generally attributed to Philip the Fair (1304): from that time the great barons gradually discontinued their attendance, and the lawyers occupied the higher places and more important functions of the court. The twelve peers of France, however, remained constant members of the parliament, after the other great vassals had, by disuse, ceased to be considered as members of it (although they, likewise, in process of time, ceased to take part in its judicial business). The parliament of Paris thenceforward remained the chief tribunal of the country until the revolution, with the exception of the short period of its suppression by Louis XV. in 1771; but as the great fiefs of the French monarchy were successively united to the crown, the supreme feudal court of each was invested with the title and attributes of a parliament. These were fixed at Toulouse, Grenoble, Bordeaux, Dijon, Besançon, Rouen, Aix, Pau, Rennes, Metz, Douay, Nancy. The most remarkable prerogative exercised by the parliaments is one of which the origin has not been satisfactorily accounted for; that of registering the edicts of the sovereign, and thereby giving them the force of law. M. Meyer (*Institutions Judiciaires*, liv. iv. ch. 9.) supposes that it arose from the character of the parliament, as the court of the feudal lord of each province: thus, the edict of the king of France was referred to the parliament of Bordeaux, to examine whether it interfered with the special rights and duties of the same sovereign as duke of Guienne, &c. It appears, however, to have been the received doctrine, by the end of the 14th century, that this formality of registration was essential to the validity of an edict in every province. Hence the important part which the parliaments, and especially that of Paris, so often enacted in French history, in modifying the otherwise absolute power of the monarchs. (*See* Bed of Justice.) It was usual for the parliament of Paris, and undoubtedly legal, although not customary, for the other parliaments, to convey remonstrances to the king on the

subject of his edicts. But Louis XIV. ordained that these remonstrances should always be presented after they had testified their obedience by registering them. The parliaments had also a power of a legislative character, that of pronouncing *arrêts de reglement*, by which they gave authoritative decisions on legal questions, not only binding on present but in future cases. The counsellors of parliament were, by a law of Louis XI., immoveable except in case of legal forfeiture; but the place of counsellors and presidents early became purchaseable, and afterwards transmissible by hereditary descent. Hence, in part, the powerful esprit de corps which distinguished those bodies. As a high court of appeal, the parliament of Paris was divided into five chambers; one termed the great chamber, three *des enquêtes*, one *des requêtes*. Besides these, the *chambre de la tournelle*, in which criminal cases were tried, was a fluctuating court, in which members of all the regular chambers sat in turn.

PA'RLOUR (Fr. parler, *to speak*), signified originally the little room in which in former times the nuns and monks used to give interviews to their visitors; or in which the novices used to converse together at the hours of recreation.

PARME'NIANISTS. In Ecclesiastical History, a name given to the Donatists (see that article), from Parmenianus, Bishop of Carthage, one of their chief leaders, and an antagonist of Augustine.

PARNA'SSUS. In Mythology, a celebrated mountain in ancient Greece, sacred to Apollo and the Muses, and, from the numerous objects of classical interest of which it formed the theatre, considered "holy" by the Greeks. On its side stood the city of Delphi, near which flowed the Castalian spring, the grand source of ancient inspiration; and from this circumstance, in metaphorical language, the word Parnassus has come to signify poetry itself. A good collection of the Italian poets, printed at Milan, bears the title *Il Parnasso Italiano*.

PA'RODY. (Gr. παρα, and ῳδη, *a song*.) A species of composition in which the form and expressions of portions or passages of grave or serious writings are closely imitated in similar passages of a ridiculous character. Parody is a species of burlesque (*see* BURLESQUE); but the imitation is more close and exact than in ordinary burlesque composition. Antiquity has left us no complete works of this species, although some fragments are preserved by Athenæus and other writers. The *Batrachomyomachia*, the authorship of which is attributed to Homer, though a very ingenious specimen of the burlesque, is not, in the modern sense of the word, a parody. The French critics do not seem to draw an adequate distinction between the nature of a parody and a *travestie*.

PAR'O'L. (Fr. parole.) In Law, word of mouth. Thus, a parol agreement is contrasted with one in writing, parol with written evidence, &c. For the legal principles bearing on this distinction in different cases, see AGREEMENT, CONTRACT, EVIDENCE.

PARO'LE. In Military matters, the allowing of prisoners to enjoy certain indulgences, on their giving their word of honour (*parole d'honneur*) that they will not serve during the continuance of the war against the country by which they are liberated, or upon their pledging their word to abide by such other conditions as may be stipulated.

PA'RONOMA'SIA. (Gr. παρα, and ὀνομα, *a name*.) In Rhetoric, a figure by which the same word is used in different senses, or words similar in sound are set in opposition to each other; so as to give a kind of antithetical force to the expression.

PARONY'CHIA. (Gr. παρα, and ονυξ, *the nail*.) A whitlow.

PARO'NYMOUS. (Gr. ονομα, *name*.) In Grammar, words of similar derivation, or principal words with their derivation: e. g. *equus*, *eques*, *equito*; *man*, *manhood*, *mankind*.

PARO'TID GLAND. (Gr. παρα, and ους, *the ear*.) A large gland situated under the ear, between the maxillary process of the temple bone and the angle of the lower jaw. It secretes saliva, which is carried into the mouth by the *Stenonian duct*.

PAROTI'TIS. Inflammation of the parotid gland. The *mumps*.

PA'ROXYSM. (Gr. παρα, and οξυς, *sharp*.) In Medicine, the periodical exacerbation of a disease.

PARR. This name is applied in most parts of England and Scotland to the young of the salmon (*Salmo salar*, Linn.) up to near the end of their second year, when they lose their dark lateral bars by the superaddition of a silvery pigment, and congregate together for their seaward migration. From the circumstance of the milt and roe being developed at this immature period, a precocious condition by no means uncommon in the cold-blooded tribes, the parr has been regarded by some ichthyologists as a distinct species, and was described as such by Willughby and Ray, under the name of *Salmo salmulus*. *See* SALMON.

PA'RREL. In Naval language, the collar of greased rope, or trucks, by which the yard is confined to the mast while it slides up and down it.

PA'RRICIDE (Lat. pater, *a father*, and cædo, *I kill*), implies, properly, the murder or murderer of a father. But the term is also extended to the murder of any near relative, as a husband, wife, mother, &c.; and even to that of distinguished or sacred persons, as a king, archbishop, &c. The Athenians had no law against parricides, from an opinion that human atrocity could never reach to the guilt of parricide. This was also originally the case at Rome; but at a later period parricide was punished by the Roman law with greater severity than any other kind of homicide. The delinquent, after being scourged, was sewed up in a leathern sack, with a live dog, a cock, a viper, and an ape, and so cast into the Tiber. The English laws treat this crime only as simple murder; but in some of the German states the criminal convicted of parricide is put to death with exquisite torture, the penalty being that such persons shall be beaten to death with iron clubs, beginning with the feet, and gradually ascending to the head.

PA'RSEE. (Pers. parsi.) The name given by English writers to the Persian refugees, driven from their country by the persecutions of the Mussulmans, who now inhabit various parts of India. Their principal emigration to Baroach, Surat, and the neighbouring coast, is supposed to have taken place about the end of the 8th century. The sacred fire, the emblem of their religion (*see* GUEBRES), called *behrem*, is believed by them to have been brought by the first emigrants from Persia, and, after many changes of place, is now preserved at Odisari and Nausari, near Surat, and at Bombay. In this latter city, under the protection of the British government, they have grown into a colony of considerable numbers and of great opulence. They have become particularly distinguished in the art of shipbuilding, and the dockyard of Bombay is now almost exclusively in their hands. Their character is variously estimated by different observers; but all agree in attributing to them industry and economy, and attachment to their religion, and to those of the higher class strong sentiments of honour and honesty. Their number is said to equal 700,000; and at Bombay, according to late calculations, at least 20,000.

PA'RSING. The art of resolving a sentence into its grammatical elements or parts.

PA'RSON. (Lat. persona ecclesiæ.) In Law, one that has full possession of all the rights of a parochial church. His title is derived from the Latin persona, because in his person the church itself which he occupies is represented; and he is a corporation sole. A parson, or rector, has the freehold of the parsonage house, the glebe, the tithes, and other dues, during his life. Four requisites are necessary to constitute a parson: holy orders, presentation, institution, and induction. See these terms. In common language, parson is a vulgar term for a clergyman of any kind.

PART. (Lat. pars.) In Music, a single piece of the score or partition, being one set of the successions of sounds which constitute the harmony.

PARTE'RRE. (Fr.) A system of beds of different shapes and sizes in which flowers are cultivated, connected together, with intervening spaces of gravel or turf for walking on. The form of the beds may vary according to the taste of the designer; but their breadth should never be greater than will admit of the spectator who wishes to gather flowers, or the gardener who is to cultivate them, reaching the middle. Where the object is chiefly to produce a display of flowers, the beds should be of simple shapes, with few acute angles, as these can never be completely covered with plants; but where the object is to display a curious figure, to be seen from a point considerably above the level of the parterre, the beds may be formed of arabesque shapes, or like the figures used in embroidery and lace-work. Figures of this description are generally planted with dwarf box, kept low by clipping, with only here and there a flowering plant, or a small shrub, placed in the broadest parts of the beds or scroll-work. Parterres of this description were in use during the time of the Romans, as appears by the description of Pliny's own garden by himself, in which the letters composing his name were planted of box, kept regularly clipt, a practice not uncommon in Rome and its neighbourhood at the present day. Embroidered parterres, however, were brought to the highest degree of perfection in the time of Louis XIV., when the arabesque style of ornament was introduced into every thing. The flowers and flowering shrubs in culture in those days were comparatively few; and hence the leading features of the parterre were beds of turf, always an object of luxury, and requiring to be kept up at considerable expense of watering in the climate of France, and scroll-work of box. This description of parterre was imitated in England; but smooth green turf not being here an object of luxury, beds of flowers became more frequently substituted in its stead; and as the number of foreign flowers introduced increased, the number of turf

beds and scroll-work diminished, till, at the present time, the latter is rarely to be met with. In this manner has gradually arisen the modern English flower garden, which consists of small beds, more or less orbiculate, and scattered over a surface of smooth turf, so as to combine into groups, which are planted with flowers, or low flowering shrubs; sometimes in masses of only one kind in a bed, and at other times of several kinds mixed together.

Parterre. In French, the pit of a theatre.

PA'RTHENON. (Παρθενών.) The magnificent temple of Minerva in the Acropolis of Athens, so called in honour of the virginity of that goddess (from παρθένος, *a virgin*). It was a peripteral octostyle of the Doric order, with 17 columns on the sides, each 6 ft. 2 in. in diameter at the base, and 34 ft. in height, elevated on three steps. Its height, from the base of the pediments, was 65 ft., and the dimensions of the area 233 ft. by 102. The eastern pediment was adorned with two groups of statues, one of which represented the birth of Minerva, the other the contest of Minerva with Neptune for the government of Athens. On the metopes was sculptured the battle of the Centaurs with the Lapithæ; and the frieze contained a representation of the Panathenaic festivals. Ictinus, Callicrates, and Carpion were the architects of this temple; Phidias was the artist; and its entire cost has been estimated at 1½ million sterling. Of this building 8 columns of the eastern front and several of the lateral colonnades are still standing. Of the frontispiece, which represented the contest of Neptune and Minerva, nothing remains but the head of a sea horse and the figures of two women without heads. The combat of the Centaurs and the Lapithæ is in better preservation; but of the numerous statues with which this temple was enriched, that of Adrian alone remains. The Parthenon, however, dilapidated as it is, still retains an air of inexpressible grandeur and sublimity; and it forms at once the highest point in Athens, and the centre of the Acropolis. It is hardly necessary to inform the reader that the chief portion of the sculpture of the Parthenon is now placed in the British Museum, where it forms, with some additions, the collection of the Elgin Marbles. *See* Elgin Marbles.

PARTI'CIPANTS. A semi-religious order of knighthood, founded by Pope Sextus V., in 1586, in honour of Our Lady of Loretto. The members of this order were allowed to marry. The order was soon extinguished; and the title of Knights of Loretto is now conferred on some civil servants of the pope.

PA'RTICIPLES. (Lat. participium.) A part of speech which *partakes of* the properties both of a verb and an adjective. It may be described either as a verb without affirmation, or as an adjective with the addition of the notion of time. *See* Grammar.

PA'RTICLE. (Lat. particula, *little part.*) In Grammar, a general term to express the subordinate or secondary parts of speech, — the adverb, the preposition, and the conjunction. But it is more in accordance with grammatical precision to apply this term to those minor words to be met with in all languages, which serve apparently to give clearness and precision to a sentence, but respecting whose exact use Grammarians are not agreed. To this class belong the Gr. γε, αρα, τοι, δη, &c.; the Germ. ia, wohl, &c.; and the English *now*, *then*, *truly*, &c. The term *particle* is also applied by grammarians to those words or enclitics (as they are called, from Gr. εν and κλινω, *I lean*) which cannot be used separately, but must form part of the preceding word, as in *virumque*.

Particle, in Physics, denotes the minutest parts into which a body can be mechanically divided. It is in general used synonymously with molecule, corpuscle, atom; but sometimes these terms are distinguished.

PARTI'CULARISTS. In Theology, those among the Reformed who have held the doctrine of God's particular decrees of salvation and reprobation. As a party name, it seems to date from the Synod of Dort. That branch of the Baptists attached to high Calvinistic opinions is still called the church of the *Particular* Baptists.

PARTI'DAS, LAS SIETE. (Span. *the seven parts.*) A celebrated ancient Spanish code of laws, drawn up in the reign of Alphonso X. of Castile (about 1260), so called from the number of principal parts into which it is divided. This famous collection did not acquire the obligatory virtue of a code until 1338, when sanctioned by Alphonso XI.

PARTI'TION. (Lat. partitio.) In Music, the arrangement of the several parts of a composition on the same page or pages, ranged methodically above and under each other, so that they may be all under the eye of the performer or conductor, and sung or played jointly or separately as the composer intended. It is commonly called a *score*.

Partition. In Architecture, the vertical assemblage of materials which divides one apartment from another. It is usually, however, employed to denote such division when constructed of vertical pieces of timber called *quarters*.

Partition. In Politics, the division of the states of a sovereign or prince after his decease among his heirs, as was the custom in some of the princely families in the ancient German empire; or among other powers, such as that of the states of the king of Spain, which was in contemplation (against all justice) between William III., Louis XIV., and the Dutch, by the treaties of 1698 and 1699, when Charles II., the reigning monarch, was without near heirs. But the most celebrated partitions in history, to which the name has become almost exclusively attached, were those of Poland, by Russia, Prussia, and Austria. The first of these took place in 1772, when various provinces were wrested from the republic in pretended satisfaction of ancient claims, and the old and vicious constitution guaranteed by the three powers. The second was submitted to by Stanislas in 1793, when Russia obtained the remainder of Lithuania, and Prussia Dantzic, Thorn, and an extensive district. This partition was followed by the insurrection under Kosciusko, which brought about the third and last partition in 1795, when the remnant of the country was dismembered. It was organized in 1807, altered in 1815; but the conditions under which Poland was then annexed to Russia, as a separate kingdom, were entirely set aside after the Polish insurrection of 1830, and it is now substantially and in fact a province of Russia. These partitions overturned the ancient balance of power in Europe, and prepared the way for the violent changes which followed the French revolution. (See Koch, *Revolutions de l'Europe;* Rulhieres, *Histoire de l'Anarchie de Pologne;* Ferrand, *Histoire des Trois Démembremens de Pologne*, 3 vols. Paris, 1820; *Ed. Rev.* vol. xxxvii. p. 462.)

PA'RTNERSHIP. A relation established between two or more persons, by an agreement to combine property or labour in furtherance of a common undertaking, and for the acquisition of a common profit. A community of profit between the parties is the true criterion of a partnership; for one partner may stipulate to be free from loss, and this stipulation would be effectual as between himself and his partners, though he would be liable equally with them to the world at large. A dormant partner, that is, one who in point of fact participates in the profits of a firm, but is not held out as a member of it, will nevertheless be liable for its engagements, because he takes part of that fund which is a security to creditors for payment of their debts. There is no particular form necessary to the constitution of a partnership, nor is it necessary that the contract should be in writing. It may be dissolved at the individual pleasure of any one partner, if no stated period has been fixed for its continuance; and, even if such a period has been fixed, it will be dissolved, in the absence of any proviso to the contrary, by his bankruptcy, attainder, or death, or by marriage, in the case of a female. Courts of equity, also, will put an end to it by decree, on proof of lunacy or gross misconduct. A partnership is by any of the above matters terminated as between the partners themselves; but, to prevent a continuing liability to strangers, public notice of the dissolution is necessary. One partner cannot sue another at law in respect of the partnership account, unless a balance has been struck, the remedy being in equity, which affords a machinery better adapted to the investigation of accounts. As regards the rights of third persons against the partnership, it is a general rule that it will be bound by the engagements of any one partner acting with reference to the joint business, either by his simple contracts on the purchase and sale of goods, or by negotiable instruments circulated on its behalf.

PA'RTNERS OF THE MASTS. The woodwork round the mast at the deck, to strengthen and support the deck against the pressure of the mast. The term is also applied to the similar supports round the capstan and pumps.

PA'RTRIDGE WOOD. A variegated wood imported from Martinique: it is said to be the produce of the *Heisteria coccinea.*

PA'RTY. In Politics, a body of men united under different leaders for promoting by their joint endeavours the national interest, upon some particular principle in which they are all agreed. The origin of party may be traced to that law of the human mind which is founded in our natural desire of sympathy and our disposition to afford it. From the earliest ages down to the present time, the principle of mutual co-operation has been adopted with success in executing favourite designs, and in aiming at the accomplishment of certain ends. Among the ancient Romans, for example, "*idem sentire de republica*" formed a principal ground of friendship and attachment; and the same feeling, modified by different forms of government and other circumstances, is at present in full operation in all the civilized states of Europe and America. The benefits of party may be briefly stated to be, increased energy in pursuit of a common object, regular co-operation, mutual control and regulation, and an advantageous division of labour. But though party or combination may in this manner be productive of good results, like every other principle and feeling in our nature, it is liable to be abused and there can be no

doubt that it is frequently attended with such evil consequences as greatly to countervail its admitted benefits. It involves a frequent sacrifice of individual notions of what is just and proper, and tempts bodies of men to act in a way that would often be deemed discreditable in individuals. Perhaps the worst effect of party is its tendency to generate narrow, false, and illiberal prejudices, by teaching the adherents of one party to regard those that belong to an opposing party as unworthy of confidence; and in making them oppose good measures because they happen to be proposed by a different party, and support bad measures because they are proposed or supported by their own party. A thorough-going party adherent is in fact a political slave; a person who allows others on all occasions to think for him; who, as far as politics is concerned, has no principle or rule of action, save that of slavish adherence and blind obedience to the dictation of the leader of his party. (The uses and abuses of Party are discussed with great ability in vol. xxx. of the *Edin. Review*). The different parties, both of England and other countries, will be found under their respective heads.

PARTY. In Heraldry — as party per pale, fess, &c.; terms used to signify the division of a shield by a line running in the direction of either of these ordinaries.

PARTY WALL. In Architecture, the wall separating two buildings belonging to different owners or occupiers. The regulations relative to the thickness of party walls in the metropolis have been the subject of several statutes, beginning with one passed 19 Car. 2. and ending with the 14 Geo. 3., better known by the name of the Building Act. This last governs the thickness of all party and external walls to be built after 24th day of June, 1774.

PARULIS. (Gr. παρα, and ουλον, *the gum*.) A gum-boil.

PA'RUS. (Lat. parus, *a titmouse*.) A genus of Conirostral Passerine birds allied to the crows, characterized by having the conical beak straight and rather slender, with few hairs at its base; nostrils round, and covered by reflected bristly feathers; the hind toe is strong, and armed with a long hooked claw. To this genus belong the native birds commonly called tits or titmice, of which the tomtit (*Parus cæruleus*, Ray) is the best known species. The great tit (*Parus major*), the marsh tit (*Parus palustris*), the cole tit (*Parus ater*), and the crested tit (*Parus cristatus*), have the bill longer and more pointed; the last-named species is rare in this country. They are active little birds, continually flitting from spray to spray, and suspending themselves in all kinds of attitudes, rending apart the seeds on which they feed, devouring insects, and not even sparing small birds when they happen to find them sick and are able to destroy them. They store up provisions of grain, build their nests in the holes of trees, and produce more eggs than is usual among the Passerine birds.

PA'SCHAL CYCLE. The name given to the cycle which serves to ascertain when Easter occurs. It is formed by multiplying by each other the cycle of the sun, which consists of 28, and the cycle of the moon, which consists of 19 years. *See* PASSOVER.

PA'SCHAL FLOWER. The *Anemone pulsatilla*; so called from its flowering about Easter.

PASI'GRAPHY. In Literature. (Gr. πας, *universal*, and γραφω, *I write*.) The imaginary universal language, to be spoken and written by all nations, the invention of which has exercised the ingenuity of so many learned men, has been denoted by this word. Leibnitz seems to have been one of the first who conceived this to be possible. Many writers in Germany (where the name was invented) have followed him in the endeavour to devise schemes for this fanciful object. In England, Bishop Wilkins, in the reign of Charles II., invented a scheme for a universal language, grammar, and character.

PASQUINA'DE. (Ital. pasquinata.) A satirical writing directed against one or more individuals. A mutilated ancient statue of a gladiator dug up at Rome about 300 years ago, which now lies in the court of the Capitol, was popularly termed, by the Romans, "Pasquino," from the name, it is said, of a barber of eccentric and well-known character, opposite to whose house it was originally set up. This statue, and another, called by the populace Marforio, which was situated near it, were used for the purpose of bearing satirical placards, often reflecting on the court and church of Rome, which were affixed to them at night, not unfrequently in the form of a dialogue between the two statues. So annoying did Pasquin often become to the government, that on one occasion a serious design was entertained of throwing him into the river; but the ministers of the reigning pontiff are said to have dissuaded him from it, representing that if this were done "the frogs in the Tiber would croak louder than ever Pasquin had spoken." He has, however, lost his public spirit, and rarely or never ventures to attack the powers that be. But his statue is still the occasional receptacle of jocose comments on private matters. M. Matthews (*Diary of an Invalid*) mentions an instance which occurred during his stay at Rome. A man of the name of Cæsar (common among the townsfolk there) had married a girl of the name of Roma. Pasquin was placarded with "Cave, Cæsar, ne tua Roma respublica fiat." The man replied by Marforio, "Cæsar imperat." To which the retort was "Ergo coronabitur." Hence Pasquinata and Pasquilles became, in Italy, conventional words to signify writings of that description, and have been naturalized in other languages. In French and German they have been used in the legal vocabulary for libel.

PASS, in a military sense, signifies a strait or narrow defile which shuts up the entrance into a country.

PASSAGE. (Lat. passus, *a step*.) In Architecture, the part of a building allotted for giving access to the different apartments.

PASSAGE. In Music, a portion of an air or tune consisting of one, two, or three measures.

PASSAGE, BIRDS OF. *See* MIGRATION.

PASSANT. In Heraldry, a term used to describe a beast when represented in a walking position. Passant guardant, walking with the full face turned towards the spectator.

PASSEPARTOU'T. In Engraving, a plate or wood block, whose centre part is entirely cut out round the outer part, whereof a border or ornamental design is engraved, serving as a frame to what may be placed in the centre.

PA'SSERINES, *Passeres*, or *Passerinæ*. (Lat. passer, *a sparrow*.) The name given by Linnæus and Cuvier to the typical order of birds including those which neither manifest the violence of the birds of prey, nor have the fixed regimen of the terrestrial birds, but which feed on insects, fruit, or grain, according to the slenderness or strength of their beak; some with sharp and toothed mandibles pursue and feed on small birds. All the Passerines have short and slender legs, with three toes before and one behind; the two external toes being united by a very short membrane. They form the most extensive and varied order of birds, and are the least readily recognizable by distinctive characters common to the whole group. Their feet, being more especially adapted to the delicate labours of nidification, have neither the webbed structure of those of the *swimmers*, nor the robust strength and destructive talons which characterize the feet of the *bird of rapine*, nor yet the extended toes which enable the *wader* to walk safely over marshy soils, and tread lightly on the floating leaves of aquatic plants; but the toes are slender, flexible, and moderately elongated, with long, pointed, and slightly curved claws.

The Passerines in general have the females smaller and less brilliant in their plumage than the males; they always live in pairs, build in trees, and display the greatest art in the construction of their nests. The young are excluded in a blind and naked state, and wholly depend for subsistence, during a certain period, on parental care. The brain arrives in this order at its greatest proportional size; the organ of voice here attains its utmost complexity; and all the characteristics of the bird, as power of flight, melody of voice, and beauty of plumage, are enjoyed in the highest perfection by one or other of the groups of this extensive and varied order.

The beak of the Passerines varies in form according to the nature of their food, which may be small or young birds, carrion, insects, fruit, seeds, vegetable, juices, or of a mixed kind. The modifications of the rostrum have therefore afforded convenient characters for the tribes or subdivisions of the order: these are termed, 1. *Dentirostres*; 2. *Conirostres*; 3. *Tenuirostres*; 4. *Fissirostres*. See those words.

PASSIFLORA'CEÆ. (Passiflora, or Flos passionis, one of the genera.) A natural order of twining plants with very showy flowers, furnished with numerous rays of brilliant colours between the corolla and the stamens. They chiefly inhabit the hotter parts of the world, and bear a fruit not unlike that of the gourd, to which natural order they are related. Independently of the beauty of their flowers, some yield fruits, eaten under the name of granadilla and water lemon; and others have a hard black wood, not unlike ebony.

PASSING NOTES. In Music, graces wherein two notes are connected by smaller intervening notes.

PA'SSION. (Lat. patior, *I suffer*.) The sufferings of our Lord, which he is described as having endured between the Last Supper and the moment of his death. Passion-week is that in the course of which these sufferings took place; namely, that immediately preceding Easter. (See as to its solemn ceremonial in the Romish church, this article in the *Encyclopædia* of Ersch and Gruber.) It was variously called *Hebdomada luctuosa*, *inofficiosa*, *pœnosa*, *indulgentiæ*, *nigra*, *sancta*, *ultima*.

PA'SSIONS. The name popularly given to the different emotions of the mind, as love, anger, &c. Various ingenious speculations have been instituted to ascertain whether the precise situation of the impetus of the pas-

sions be in the spiritual or material part of man. Some philosophers, and among these Des Cartes, consider them wholly seated in the corporeal system. Mallebranche regards them as those agitations of the soul which proceed from uncommon influence and motion in the blood and animal spirits. "Though the passions," says Burton, in his *Anatomy of Melancholy*, "dwell between the confines of sense and reason, yet they rather follow sense than reason, because they are drowned in corporeal organs of sense. They are commonly reduced into two inclinations, *irascible* and *concupiscible*. The Thomists subdivide them into eleven, six in the *coveting* and five in the *invading*. Aristotle reduceth all to pleasure and pain, Plato to love and hatred, Vives to good and bad. If good, it is present, and then we absolutely joy and love; or to come, and then we desire and hope for it: if evil, we absolutely hate it; if present, it is sorrow; if to come, fear. . . . All other passions are subordinate unto these four, or six, as some will, — love, joy, desire, hatred, sorrow, fear. The rest, as anger, envy, emulation, pride, jealousie, anxiety, miserie, shame, discontent, despair, ambition, avarice, &c., are reducible unto the first" (*i.e.* the *irascible*). With several writers it has been a question whether the passions be each a distinct innate disposition, or merely modifications of those dispositions which are common to all mankind. The theories and conjectures of philosophers upon this subject are almost boundless; but to pursue them would be of little advantage, even if our limits permitted, and we shall merely refer the reader for ample particulars to the works of Hume, Reid, Hartley, Locke, Lord Kames, &c. (See also *Maass's Versuch Uber die Leidenschaften*, 2 thle. Halle, 1805.)

Passions. In Painting and Sculpture, the representation in the countenance and other parts of the violent emotions of the mind, produced by anger, fear, grief, &c. The expression of the passions is a language without which the painter can never hope for success: it is in this that he has the means of appealing to the sympathy of the spectator. The close observation of nature under similar circumstances is the only mode by which his aim can be accomplished.

PA'SSOVER, or PASCHA. A festival among the Jews, which derives its English name from God's *passing over* the houses of the Israelites, and sparing their first born, when those of the Egyptians were put to death. The name of passover or paschal lamb was likewise given to the *lamb* slain in memory of that deliverance. The festival lasted seven days, beginning on the evening of the 14th of the month Nisan, and commenced with killing the lamb. The regulations appointed for this festival are detailed in Exod. xii.

That the passover had a typical reference to our Saviour has been the universal belief of the Christian world in all ages, and is mainly grounded on passages in St. John and St. Paul. (John, xix. 36.; 1 Cor. v. 7.) Christ is said to be our passover; his blood being shed to protect mankind from the divine justice, as the blood of the paschal lamb, which was sprinkled upon the door-posts of the Israelites' houses, preserved them from the visitation of the angel of the Lord.

PA'SSPORT. A warrant of protection and authority to travel, granted to persons moving from place to place by the competent officer. The word appears to be derived from the maritime usage of some continental countries, of giving similar authorities from the admiral of a naval station to vessels leaving harbours within his jurisdiction. As passports are not required in our own country, the only species known to British travellers is that of foreign passports, which, for an Englishman travelling on the continent of Europe, are usually made out by the resident minister or consul of the country he intends first to visit, in London, or at one of the ports. They are also granted by the Foreign Office on payment of fees, which now (1841) amount in all to 2*l.* 7*s.* They are subject to visa or inspection by the proper authorities at the place where the traveller disembarks, and also at other places which he may reach, according to the police regulations of each particular country, and on passing the frontiers of states. Austria is, we believe, the only European state which at this time requires absolutely the visa of an ambassador or minister of her own for travellers entering her domains by land. In France, and in many continental countries, home passports are necessary for the native traveller. According to the letter of the French law (since 1796), a Frenchman cannot pass the limits of the canton in which he is domiciled without a passport; but in practice it is not required within the extent of the department. Legally speaking, the strict formalities of an internal passport, in France, require the direction of a journey to be specified, and its exact execution attested by the visas and signatures of the police authorities at every place mentioned in it; and these laws are, from their severity, so incapable of complete execution, that it is a common saying, that no man but a rogue is ever entirely en règle with respect to his passport, suspicious characters being usually the most particular in their attention to formalities, for fear of detention. A Frenchman travelling without properly authenticated passport is liable to arrest, and detention for a period not exceeding a month. The fees fixed in France are two francs for a passport to travel at home, and ten to go abroad.

PASTE. (Fr. pâte.) In Gem Sculpture, a preparation of glass, calcined crystal, lead, and other ingredients, for imitating gems. This art was well known to the ancients, and, after being long lost, was restored, at the end of the fifteenth century, by a Milanese painter.

Some modern artists have succeeded in obtaining a composition possessing a hard, fine, and brilliant lustre or appearance; but *pastes*, or mock diamonds, as they are called, depend most for brilliancy on the art displayed in setting the foil or tinsel behind them. Several recipes have been given by M. Fontanien; but the most useful, and that generally employed for the production of artificial diamonds, is the following: — Take of litharge 20 parts, of silex 12, of nitre 4, of borax 4, and of white arsenic 2 parts. These ingredients are to be well mixed together in a crucible and melted; the fused metal is thrown into water; and should any of the lead employed be reduced to the metallic state, it becomes separated by this process, and the glass is remelted for use. For the finer kinds rock crystal is used instead of flint or sand, as it occurs in a much purer state; *i.e.* more free from the admixture of metallic oxides, which give to vitreous compounds their different colours. In place of the above, Loysel recommends the following ingredients to form a compound having the same specific gravity as the oriental diamond, and on this account considered superior, as it more nearly approaches the gem with regard to its refractive and dispersive powers; but, like the former, it requires to be kept for some two or three days in a fused state, in order to expel the superabundant alkali and to perfect the refining. A moderate degree of heat fuses it. The following is its composition: — Take of white sand purified by being washed, first in muriatic acid and afterwards in pure water, until all traces of acid are removed, 100 parts; red oxide of lead (minium) 150 parts; calcined potash 30 to 35 parts; calcined borax 10; and oxide of arsenic 1 part. (See the *Polytechnic Journal* for July, 1841.)

The term paste is also applied to the earthy mixture for pottery and porcelain; also to dough, and to the solution of starch or wheat flour, made by first mixing it with a proper portion of cold water, and then adding boiling water under constant stirring, so as to form an even solution. Alum is often added to paste to strengthen it.

PA'STEL. (Lat. pastillus.) In Painting, a crayon formed with any colour and gum water, for painting on paper or parchment. The great defect of this mode of painting is its want of durability. *See* Crayon.

PA'STERN. The part of the horse's foot under the fetlock to the heel.

PASTI'CCIO. (It.) In Painting, a picture painted by a master in a style dissimilar to that in which he generally painted. David Teniers could, for instance, imitate, with surprising exactness, the styles of many of the first masters of Italy and Flanders. The same may be affirmed of Luca Giordano, a Neapolitan artist.

PASTI'L. In Pharmacy, a kind of lozenge. A compound of charcoal with odoriferous substances, which diffuses an agreeable perfume during its slow combustion.

PA'STORAL. *See* Eclogue, Bucolic, Idyl.

PA'STOUREAUX. (Old Fr. *shepherds*.) Insurgent peasants, who took up arms in France during the absence of King Louis IX. on his crusade. They were led by an apostate Cistercian monk, who took the name of "Jacob, Master of Hungary," who seduced them to follow him in various fanatical extravagances. They committed various excesses, from the frontier of Flanders, on which they at first assembled, to Bourges, where their leader was killed in a tumult, and his horde dispersed.

PASTURE. Land under a particular decription of grasses and herbage, which is eaten on the spot by horses, cattle, &c. Hill pasture is a term applied to hilly and mountainous lands, which are kept perpetually under the natural grasses and herbage which spring up on them; while artificial pastures are such as are sown by art on lands which are occasionally subjected to the plough. In all artificial pastures the principal grass is rye grass, and the principal herbage plant the white clover. Perpetual pastures are such as are never subjected to the plough, and never receive any other manure than what is left on them by the pasturing animals; but artificial pastures are occasionally mown, and sometimes receive a top-dressing of dung, or some mixture of dung and earth, lime, &c.

PATAVI'NITY. A term in use among critics to denote a provincial idiom in speech; so named after that of Livy the historian, from his being born at Padavium, a provincial town of the Roman empire. Wherein the alleged defect of Livy's writings consists has never been distinctly pointed out by any critic, ancient or modern.

PATE. In Fortification, a kind of platform encompassed with a parapet, and having nothing to flank it.

PATEE, or PATTEE. (Fr.) In Heraldry, a sort of cross, small at the centre and widening towards the ends, which are very broad.

PATE'LLA. The small, flat, and somewhat heart-shaped bone, which is placed at the fore part of the knee joint, and commonly called the *kneepan*.

PATELLOI'DS, *Patelloidea*. The name of a family of Cyclobranchiate Gastropods, having the limpet (*Patella*) as the type.

PA'TEN. (Lat. patina.) In Ecclesiastical usage, the stand or saucer on which the chalice rests. It was frequently highly ornamented by artists in the 15th and 16th centuries. In the administration of the Eucharist in England, the paten is the vessel on which the bread is placed.

PA'TENT, in Commercal Law, is defined a privilege from the crown granted by letters patent, conveying to the persons specified therein the sole right to make, use, or dispose of some new invention or discovery, for a limited period. This power is said to be inherent in the crown; but was first defined by stat. 21 J. 1. c. 3., which gives the term of fourteen years or under, "so they be not contrary to the law, nor mischievous to the state, by raising prices of commodities at home, or hurt of trade, or generally inconvenient." Ever since the reign of Anne it has been a condition in patents, that the inventor should, by an instrument technically called a "specification," particularly describe and ascertain the nature of his invention; on failure of which the patent becomes void. These letters are obtained on petition to the crown, and are granted on the recommendation of the attorney or solicitor general. An injunction may be obtained, or an action brought, for the infringement of a patent; but it is necessary to show the novelty and utility of the invention, and that it is of something capable of being turned immediately to account in commerce; no patent will be good for a mere philosophical principle neither organized nor capable of being so. It is now held that a new process or method, as well as an article, may be the subject of a patent. A party who believes himself to have discovered an invention, but has not yet been able to reduce it to practice, may enter a *caveat*; that is, an instrument by which notice is desired to be given by any one who may seek a patent for a similar invention. The law of patents has been recently amended by 5 & 6 W. 4. c. 77., and some difficulties under which inventors were placed, particularly as to the strictness of the specification, removed; but the policy of some of the clauses is questioned.

The phrase *letters patent* is also frequently applied to the state documents or ordinances of the German sovereigns: in which sense it is equivalent to the *bulls* of the pope, or the *ukases* of the czar.

PATENT YELLOW. A pigment obtained by fusing a mixture of oxide and chloride of lead.

PA'TERA. (Lat. patere, *to be open.*) In Roman Antiquities, a large open goblet or cup of gold, silver, marble, or earth, &c., used in offering libations to the gods.

PATERA. In Architecture, the representation of a cup, usually in bas relief, and employed to decorate friezes, fasciæ, imposts, &c.

PATERI'NI. One of the names by which the Paulicians, a sect which appeared in Italy in the 11th century, were very commonly known. The origin of the term is obscure, as is also the connection of the sect with the Manicheans of the East. (See *Faber on the Church of the Waldenses and Albigenses.*)

PA'TERNO'STER. The Latin expression for *Our Father*, signifying the Lord's Prayer. *See* ROSARY.

PATER PATRA'TUS. In Roman Classical Antiquities, the chief of the fecials or heralds; specially named for the performance of certain solemn acts, such as declarations of war.

PATHE'TIC. (Gr. παθητικος; from πάσχω, *I suffer.*) In Painting and Sculpture, the expression of the softer or more sorrowful passions. Its tendency is to depress and compose the feelings of the spectator.

PATHETIC NERVES. A pair of small nerves, which influence the expression of the face. They rise in the brain, and supply the trochear muscle of the eye.

PATHOGNOMO'NIC. (Gr. παθος, *a disease*, and γνωμη, *opinion.*) Symptoms which are peculiar to particular diseases, and by which they are recognized, are termed pathognomonic symptoms.

PATHO'LOGY. (Gr. παθος, and λογος, *a discourse.*) Literally, the doctrine of disease. As physiology teaches the nature of the functions of the body in a state of health, so pathology relates to the various derangements of these functions which constitute disease. Its objects, therefore, are to ascertain the various symptoms which characterize the disorders of each organ of the body, and especially the diagnostic and pathognomic symptoms, which afford the means of discrimination between diseases that resemble one another; to determine the causes, both predisposing and exciting, by which diseases are induced; to point out the tendency and probable issue of each disease from the varying appearance of the symptoms; and finally to explain the symptoms of recovery, and the nature and operation of the remedies adapted to the various circumstances and periods of diseases. (*Conversations Lexicon.*)

PA'THOS (Gr. παθος, *suffering*), is applied in literary language to any composition calculated to excite all, but chiefly the tender, emotions of the mind. In France, this term is generally used in a somewhat disparaging sense, being applied to that species of composition which indulges in strained and unnatural declamation.

PA'TINA. (Gr. πατανη, *a dish.*) In Numismatics, the fine rust with which coins become covered by lying in peculiar soils, which, like varnish, is at once preservative and ornamental. It is, says Mr. Pinkerton, a natural varnish, not imitable by any effort of human art; sometimes of delicate blue, like that of a turquoise; sometimes of a bronze brown, equal to that observable in ancient statues of bronze; sometimes of an exquisite green, a little on the azure hue, which last is the most beautiful of all. It is also found of a fine purple, of olive, and of a cream colour, or pale yellow, which last is exquisite. The Neapolitan patina is of a light green; and, when free from excrescence or blemish, is very beautiful. Sometimes the purple patina gleams through an upper coat of another colour, with as fine effect as a variegated silk or gem. In a few instances a rust of deeper green is found, and it is sometimes spotted with the red or bronze shade, which gives it the appearance of the East Indian stone called bloodstone. These rusts are all, when the real product of time, as hard as the metal itself, and preserve it much better than any artificial varnish could have done; concealing, at the same time, not the most minute particle of the impression of the coin. Gold admits no rust but iron-mould, when lying in a soil impregnated with iron. Silver takes many kinds, but chiefly green and red, which yield to vinegar; for in this metal the rust is prejudicial.

PA'TOIS. (Supposed to be derived from Lat. pater, *a father.*) A word in general use in most European countries, signifying the dialect peculiar to the lower classes.

PATRES CONSCRIPTI. *See* CONSCRIPT FATHERS.

PA'TRIARCH. (A compound of πατηρ, *father*, and αρχω, *I govern.*) The title given by the sacred writers to the earliest heads of families recorded in Scripture, from Adam to Jacob and his sons. This title was assumed also in the early ages of the church by the bishops of the principal cities of the empire, as Rome, Constantinople, Antioch, &c. The name was adopted from the practice of the Jews; who, after the dispersion, subjected themselves to the spiritual superintendence of the patriarchs resident at Tiberias and Babylon. The first mention of a Christian patriarch occurs about 440. They were, for the most part, superior to archbishops or metropolitans, being set over several provinces. This, however, was not always the case. The patriarchs of Ephesus and Cæsarea, for instance, were subject to the bishop of Constantinople, and were only on a par with diocesan prelates. (See *Hooker*, *Eccles. Polity*, 6, 7.; *Mosheim*, vol. i. pp. 179. 349., trans. 1790.)

PATRI'CIANS. (Lat. patres, *fathers.*) The first order or nobility of the Roman people. When the constitution of Rome was monarchical, they elected the king; and after the expulsion of the Tarquins all the great officers of state, as consuls, prætors, &c., were chosen from their body for many generations. Of the patricians, also, the senate was composed; but, in after times, both this and the great magistracies were thrown open to the plebeians. The subdivisions of this order were as follow:—First, they were classed into three tribes, called Ramnenses, Titienses, and Luceres; of which the first contained the original patricians of Romulus, the two latter being probably admitted to their privilege at different subsequent times. Each of these tribes again was divided into ten curies, and each curia again contained ten clans, or gentes. The general assembly of the patrician houses, who constituted the populus, in contradistinction to the plebs, or plebeian citizens, was called *comitia curiata*, because they voted therein by curies; and this, in the earliest times, was the Roman popular assembly, to which plebeians were not admitted.

PA'TRICK, SAINT, ORDER OF. An Irish order of knighthood, instituted by George III. in 1783, composed of the sovereign, a prince of the blood royal, a grand master, and fifteen knights; the lord-lieutenant of Ireland for the time being is grand master.

PATRIPA'SSIANS (Lat. pater, *father*, and passio, *suffering*), are persons who, by overlooking the distinction between the persons of the Trinity, are reduced to allow that the Father himself suffered on the cross. This argument has been advanced against heretics of various denominations, and the title has, in consequence, been applied to many such. It is the Sabellians, however, who considered the Father, Son, and Spirit as three modes or representations of the one God, that are generally opprobriously designated by this term. *See* SABELLIANS. (See also *Mosheim*, vol. i. cent. 4.)

PATRI'STIC. (Lat. pater, *father*.) In Theology, of or belonging to the fathers of the church; as patristic theology, literature, study.

PATRO'LE. (Fr. patrouille.) In Military language, a detachment, ordinarily of from four to eight men, under a corporal, charged to march in a given circuit through the streets of a garrison town, in order to repress disorder. The patroles are drawn from the posts of the city, and set out at an hour fixed by the commandant. They are usually accompanied, in Continental towns, by an officer of police.

PA'TRON. (Lat. patronus; from pater, *father*.) The relation of patron and client, in ancient Rome, has been explained under the head CLIENT. After the extinction of republican sentiments and usages, the term patron was still applied to advocates who defended causes for hire. But the right of patronage, analogous to that which had subsisted under the commonwealth, may be said only to have existed in the relation between masters and freedmen, the latter of whom were placed under various obligations to their former owners. In the usage of the Roman Catholic Church, a *patron* saint is the peculiar protector of each country, community, profession, &c., or of individuals. The prime minister of the pope is termed the cardinal-patron. (As to the Roman patrons, see *Mem. de l'Acad. des Inscr.* vol. xii.)

PA'TRONAGE. In the Church of Scotland, the right of presentation to livings in lay patrons was recognized by the old practice of the church, with the exception of the period from 1690 to 1712; during which lay patronage was abolished, and the right of presentation lodged in the heritors (land owners) and members of the kirk session. In 1712, lay patronage was restored; but still under the control of the parishioners, whose *call* (as it was termed) was necessary to ratify the presentation. But the call gradually became a mere nominal ceremony; and disregard to the expressed wishes of the parishioners in one or two instances was the cause of the great secession from the Scottish kirk. (*See* BURGHERS.) In 1834, by an act of Assembly (*see* VETO ACT), the right of the parishioners was fully revived; it being expressly enacted that the disapproval of a majority should invalidate the presentation. This act of the General Assembly, however, is found by the courts of law not to be efficient. The abolition of patronage is desired by a large portion of the Scottish public; and it is highly probable, unless some legislative arrangement be come to on the subject, that the present disputes in the Scotch church will terminate in a new secession.

PATRONY'MIC. (Gr. πατηρ, and ονομα, *a name*.) A name which designates a person by alluding to some of his ancestors, either immediate or remote; as Pelides, *i.e.* Achilles, the son of Peleus; Æacides, *i.e.* Achilles, the grandson of Æacus. Patronymics were chiefly employed by the classical poets of antiquity.

PA'ULIANISTS. A sect of heretics who embraced the Sabellian doctrines of Paulus of Samosata, a bishop of Antioch in the third century, from whom they derived their name. *See* SABELLIANS, PATRIPASSIANS.

PAULI'CIANS. A sect of heretics, whose history is interwoven with that of the Greek church in the 9th and 10th centuries, who appear to have arisen in considerable numbers in Armenia, and to have adopted the name by which they are distinguished, from Paulus, one of their leaders, in order to avoid the imputation of connection with the Manicheans, with which they were generally charged. Their opinions are to be collected only from the allegations of their enemies, who accused them of holding the doctrine of the two principles, and denying the inspiration of the Old Testament to have proceeded from the Supreme God. At the same time, the charges which were brought against them, alleging their contempt for the worship of the Virgin and of the cross, seem to point them out as in some respects genuine reformers in doctrinal points, and to have led their bigotted enemies to invent other and more scandalous imputations against them, for the sake of more effectually blackening their character. In the East, they underwent a series of persecutions for two centuries: a remnant, however, survived in the country of their birth. A colony of Paulicians was transplanted to Bulgaria and Thrace, from whence, in the 11th century, they spread themselves over the West, where they were known under the names of Cathari, Paterini, &c., and have been supposed to have been connected with the Albigenses of the south of France. (See *Mosheim*, vol. ii.; *Faber on the Churches of the Waldenses and Albigenses*, 1838.)

PAUPER. *See* POOR LAWS.

PAUSE. (Gr. παυω, *I stop*.) In Music, a character denoting silence in a part for a certain time, according to the sort of pause marked.

PAVAN. (Lat. pavo, *a peacock*.) A slow and stately dance formerly practised in England, but now confined to the Spaniards. It derived its name from the peculiarity of the dresses of those who engaged in it, the motion of which produced a fancied resemblance to the peacock's tail.

PA'VEMENT. (Lat. pavimentum.) In Architecture, a causeway or floor paved with stone, brick, or other hard material, for greater convenience of walking. *See* ROADS.

PA'VESE, or PAVOIS. A large shield, used in the warfare of the middle ages to cover assailants advancing to the walls of a fortress.

PAVI'LION. (Fr. pavillon.) In Architecture, a projecting apartment on the flank of a building, usually higher than the rest of it. Summer houses in gardens are sometimes called by this name, but improperly. The term pavilion is also used to signify a military tent.

PA'VO. (Lat. *a pea-fowl*.) The name given by Linnæus to the genus of Gallinaceous birds, of which the splendid Indian peacock (*Pavo indicus*, Linn.) is the type. They are characterized by a crest of peculiar form, and by the tail coverts of the male extending far beyond the quills, and being capable of erection into a broad and gorgeous disk. The shining lax and silky barbs of these feathers, and the eye-like spots which decorate their extremities, are known to every one. The Indian pea-fowl exist wild in the north of India, whence they were introduced into Europe by Alexander the Great. A distinct species of pea-fowl exists in the Isle of Java.

PAW'NBROKER. A species of banker, who advances money at a certain rate of interest upon the security of goods deposited in his hands; having power to sell the goods if the principal sum, and the interest thereon, be not paid within a specified time. The practice of advancing money to the poor, either with or without interest, seems to have been occasionally adopted in ancient times; but the first public establishments of this kind were founded in Italy, under the name of Monti di Pietà, in the 14th and 15th centuries, and were intended to countervail the exorbitant usurious practices of the Jews, who formed at that period the great money-lenders of Europe. From Italy these establishments gradually spread over the Continent, in many parts of which they still exist. (*See* MONT DE PIETE.) For a view of the advantages and disadvantages of pawnbroking, and the law as to pawnbrokers, &c., see the *Commercial Dict.*

PAX. An allegorical divinity among the ancients, worshipped as the goddess of peace. She had a celebrated temple at Rome, which was built by Vespasian, and was consumed by fire in the reign of Commodus. This term is sometimes applied to a small image of Christ, because, in former times, the kiss which the people gave it before leaving church was called the kiss of peace. But the common pax, or osculatorium, was a metallic plate with a crucifix engraved on it. It is now disused. (See Ducange, *Osculatorium*; Milner, in the *Archæologia*, vol. xx. p. 534.)

PA'YMASTER-GENERAL OF THE FORCES. This office was formerly extremely lucrative, from the interest on the large sum of money which remained for a long time in the possession of the paymaster. In 1782 it was deprived of these extraordinary emoluments, and the salary fixed at 4000*l.* a year. The paymaster is constituted by letters patent under the great seal; he is, ex officio, of the privy council, sometimes of the cabinet. In the Pay Office there are under him a deputy paymaster, accountant-general, cashier, and various assistants.

PAYMASTER OF THE HOUSEHOLD. An officer in the lord steward's department. This office has superseded that of the ancient cofferers. It has a salary of 450*l.* per annum.

PEACE, JUSTICES OF. *See* JUSTICES.

PEAK. In Naval language, the name given to the upper corner of those sails which are extended by a gaff, or by a yard crossing the mast obliquely; as the mizzen yard of a ship, &c.

PEARLASH. Impure carbonate of potash. *See* POTASH.

PEARLS. These are substances formed by certain bivalve Mollusks, consisting of concentric layers of a fine compact nacre, or substance identical with that which lines the inside of the shell; they are sometimes found free and detached within the lobes of the mantle, but most commonly adherent to the nacrous coat of the shell, which on that account is termed "mother of pearl." The species of bivalve which produces the most valuable pearls is the pearl oyster of Ceylon, *Meleagrina margaritifera*, Lam. A pure pearl is generally spherical, and has a white, or bluish, or yellowish white colour, with a peculiar lustre and iridescence, and consists of alternating concentric layers of membrane and carbonate of lime. When steeped in dilute muriatic acid, the carbonate is decomposed with effervescence, and films of membrane remain undissolved.

Pearls were in the highest possible estimation in ancient Rome, and bore an enormous price. *Principium culmenque omnium rerum pretii, margaritæ tenent.* (*Plin. Hist. Nat.* lib. ix. c. 35.) Their price in modern times has very much declined; partly, no doubt, from changes of manners and fashions, but more, probably, from the admirable imitations of pearls that may be obtained at a very low price. According to Mr. Milburn, a handsome necklace of Ceylon pearls, smaller than a

large pea, cost from 170*l.* to 300*l.*; but one of pearls about the size of peppercorns may be had for 15*l.*: the pearls in the former sell at a guinea each, and those in the latter at about 1*s.* 6*d.* When the pearls dwindle to the size of small shot, they are denominated *seed* pearls, and are of little value. They are mostly sent to China. One of the most remarkable pearls of which we have any authentic account was bought by Tavernier, at Catifa, in Arabia, a fishery famous in the days of Pliny, for the enormous sum of 10,000*l.*! It is pear-shaped, regular, and without blemish. The diameter is ·63 inch at the largest part, and the length from 2 to 3 inches. It is in the possession of the shah of Persia.

The pearl oyster is fished in various parts of the world, particularly on the west coast of Ceylon; at Tuticoreen, in the province of Tinnevelley, on the coast of Coromandel; at the Bahrein Islands, in the Gulf of Persia; at the Sooloo Islands; off the coast of Algiers; off St. Margarita, or Pearl Islands, in the West Indies, and other places on the coast of Colombia; and in the Bay of Panama, in the South Sea. Pearls have sometimes been found on the Scotch coast, and in various other places.

The pearl fishery of Tuticoreen is monopolized by the East India Company, and that of Ceylon by government. But these monopolies are of no value; as in neither case does the sum for which the fishery is let equal the expenses incurred in guarding, surveying, and managing the banks. It is therefore sufficiently obvious that this system ought to be abolished, and every one allowed to fish on paying a moderate licence duty. The fear of exhausting the banks is quite ludicrous. The fishery would be abandoned as unprofitable long before the breed of oysters had been injuriously diminished, and in a few years it would be as productive as ever. Besides giving fresh life to the fishery, the abolition of the monopoly would put an end to some very oppressive regulations enacted by the Dutch more than a century ago. (For full details respecting the pearl fishery, see the *Commercial Dict.*)

PEARLSINTER. In Mineralogy, a siliceous mineral found in volcanic tufa: it is also called *fiorite*.

PEARLSTONE. A variety of obsidian, a volcanic product of a pearly lustre: it is a silicate of alumina.

PEASTONE, or PISOLITE. A variety of limestone composed of globular concretions of the size of a pea.

PEAT. The natural accumulation of vegetable matter on the surface of lands not in a state of cultivation; always more or less saturated with water, and generally abounding in modifications of extractive matter, varying with the nature of the plants of which the peat is composed.

Peat is generally of a black or dark brown colour, or, when recently formed, of a yellowish brown: it is soft, and of a viscid consistence; but it becomes hard and darker by exposure to the air. It is generally more or less mixed with earthy substances. When steeped in water it gives out a brown liquor, more or less dark. When thoroughly dried it may be set fire to, and burns slowly, giving out a gentle heat without much smoke. This smoke communicates a peculiar flavour to all the articles with which it comes in contact; and this flavour is considered a characteristic of spirits which have been distilled in vessels heated by this kind of fuel, and also of malt, corn, and fish which have been dried by it. Peat abounds in every part of the world, but more especially in the cold moist climates of temperate regions. It covers many thousand acres in Ireland, and in the Highlands and western counties of the Lowlands of Scotland, and in the western counties of England; but all these bogs are rapidly disappearing, in consequence of being drained, and having their surfaces slightly covered with earth, and stirred and sown with grass seeds.

When peaty matter accumulates on the sides of declivities it is generally comparatively dry, and is then called hill-peat; but when peat accumulates on hollow places, or on flat surfaces, it is generally thoroughly saturated with water, and is then called peat-bog. In most cases the principal plant which forms the peaty matter is the *Sphagnum palustre* of Linnæus; a moss which is common on all moist peaty surfaces throughout Europe, and is frequent in many parts of North America. This moss continues growing upwards from the points of the shoots, while decay is advancing in a similar manner from their lower extremities; thus forming a thick close mass of vegetable matter, which rots below as it increases in height. The rotten part is frequently dug out and dried, to be used as fuel, or to be mixed with dung or lime and rotted into manure.

When peaty matter accumulates on a surface which abounds in springs, the water sometimes oozes out beneath the peat, and between it and the natural soil, in such quantities as to raise up the layer of peat, and float it off to a distance; sometimes carrying every thing before it, and ending by burying under it lands in a state of culture. About the middle of the 18th century, a remarkable irruption of this kind took place near Annan in Dumfries-shire; and such irruptions are frequent in Ireland. The circumstances favourable to the growth of peat are a soil abounding in springs, a flat surface or hollow surrounded by hills, and a moist climate. Hence peat-bogs are more abundant in Ireland, and in the western counties of Scotland, than in any other part of the British empire.

When an accumulation of peat has taken place in a level situation, or on a declivity not abounding in springs, the matter accumulated is comparatively dry, and is then called peat moss. One of the most remarkable peat mosses in Britain is the Flanders Moss, in Stirlingshire. It rests on a flat surface of excellent alluvial soil, of which it covers about 4000 acres. Great part of this peat moss, being quite light, has been cut into small pieces, and floated off by means of a stream of water to the sea; thus exposing the natural soil, and rendering it fit for culture. This operation was commenced at Blair Drummond, towards the end of the last century, by the celebrated Lord Kames, and is still continued by his son, Mr. Drummond.

PEATS. Peat bog cut out in small square or rectangular pieces, and dried for being used as fuel. These pieces are cut out with light spades in the summer season, spread abroad to dry, and afterwards carted home and put up in stacks, or heaps, which are thatched to exclude the rain. These peats are afterwards used as fuel, not only for domestic purposes, but for burning lime, and for heating kilns for drying corn, &c. To facilitate the drying of peat, the water is sometimes pressed out of the square pieces after they are cut, and thrown out of the bog, by a compressing machine, which also renders the material more compact and durable in the fire. Peats are also sometimes charred by a smothered combustion, so as to be rendered better adapted to serve as a substitute for pit-coal, coke, or charcoal, in smelting iron or other metals, in generating steam, &c. Attempts have been made to separate astringent matter from peat, and to use it in tanning leather.

PEAT SOIL. Peat in a state of decomposition, on which corn or other agricultural crops may be grown. The process of turning living peat into peat soil is greatly facilitated by draining, and by laying earth or lime on its surface, and afterwards mixing the earthy matter with the peat by ploughing or digging. In this manner every kind of peaty surface may be rendered available for agricultural purposes; and accordingly, in Ireland, in Lancashire, and in Ayrshire, good crops of corn, potatoes, and artificial grasses are produced on the surface of peat lands, which consist of a layer of peat from five to twenty feet in depth. The plants which thrive best on the surface of beds of peat of this description are those which extend their roots immediately under the surface. Hence few trees will thrive in such soils, with the exception of the spruce fir, the silver fir, the birch, and two or three kinds of willows. Peaty soil is extensively used in gardening, in the culture of plants which are found growing on this soil in a wild state.

Peat from wood, or *woody peat*, is a composition of the branches, trunks, and roots of trees, with their leaves, and the shrubs and plants which have grown up among them, which have lain so long in water as to have decayed into a mass soft enough to be cut with a spade. The colour is a blackish brown, like that of mossy peat; and it may be used as manure, for fuel, and for the growth of plants. Peat of this description is found in some parts of Holland, and also in the Vale of Kennett, in Berkshire; but is most abundant in North America, where it forms the soil in which many of the plants and trees of that country thrive with the greatest vigour. Wherever it can be found, it is the most suitable of all kinds of peat for garden purposes. This kind of peat is frequently burned for its ashes, both in Britain and Holland; and these, from the alkali they contain, are found an excellent manure.

Peat, sandy, or *sandy peat*, is mossy peat in a state of decay or mould, naturally mixed with sand brought over it, from soil lying above its level, or by the overflowings of rivers. It is used in gardening for the same purposes as heath soil.

PE'BBLES. A term applied to rounded nodules, especially of siliceous minerals, such as rock-crystal, agates, &c. Among opticians the term pebble generally means the transparent and colourless rock-crystal or quartz (pure silica), which is used as a substitute for glass in spectacles: its extreme hardness renders it more durable, and little apt to be scratched.

PE'CCARI. A Pachydermatous quadruped allied to the hog; but generically distinguished by the absence of the outer toe of the hind foot, and the presence of a peculiar gland, which exudes its secretion by an orifice situated on the back; whence Cuvier devised the name *Dicotyles* (two navels) for the genus. The incisor and molar teeth resemble those of the hog, but the canines do not project from the mouth. The metacarpal and metatarsal bones of their two middle and largest toes are confluent, as in the Ruminants; with which their stomach

also, divided into three compartments with cæcal appendages, presents a marked analogy. Two species of peccari are known, both natives of South America; viz. the collared peccari (*Dicotyles torquatus*), and the white-lipped peccari (*Dic. labiatus*, Cuv.).

PECHBLEND, or PITCHBLEND. An ore of uranium.

PECK. A measure of capacity containing two gallons, or the fourth part of a bushel. The imperial peck contains 554·55 cubic inches. *See* MEASURE.

PE'CORA. (Lat. pecus, *a sheep.*) The name given by Linnæus to an order of Mammals corresponding with the Ruminantia of Cuvier.

P'ECTEN (Lat. *a comb*), in Comparative Anatomy, is the vascular membrane, in structure resembling the choroid, plicated with parallel folds like the teeth of a comb, and extending, in the eyes of birds, from the back of the retina through the vitreous humour to, or near to, the crystalline lens, where it mostly terminates in a point. This organ resembles a flattened conical bag, whence it is also termed "marsupium."

In Zoology, the name is applied to the genus of bivalve shells commonly called "clams." They have a hinge like that of the oyster; but have been removed on account of their shell being inequivalve, semicircular, always regularly marked with ribs, which radiate from the summit of each valve to the circumference, and furnished with two angular productions, called "ears," which widen the sides of the hinge.

The animal is chiefly remarkable for the little dark green metallic globule which terminates most of the tentacles of the exterior row of those at the circumference of the mantle. These specks are conjectured to be rudimental ogans of vision, whence Poli was induced to call the soft parts of the pecten "argus."

PE'CTIN. (Gr. πηκτος, *coagulated.*) Also termed *Pectic Acid.* The gelatinizing principle of certain vegetables, such as currants, apples, &c. It may be abundantly obtained from some of the esculent roots, especially carrots, whence their excellence as an ingredient in soup. To obtain it from this source the carrots are rasped, and the pulp strongly pressed, so as to render it as dry as possible; in this state it is washed in repeated portions of cold soft water, till all soluble matters are removed from it. The pulp thus prepared is then boiled with 5 parts of bicarbonate of potash to every 100 of the washed pulp; the decoction is filtered, and chloride of calcium added to it, which forms a bulky precipitate of *pectate of lime;* this is well washed, and the lime removed by very weak muriatic acid. Pectin, or pectic acid, thus obtained, is in the form of a jelly, which forms insoluble compounds with the earths and several of the other metallic oxides. It seems doubtful whether this jelly is not a *product*, resulting from the action of the alkaline carbonate of the lignin of the carrot. It must, however, be easily formed; for when carrots are stewed or boiled for a length of time, they become very gelatinous. When pectic acid is boiled in a strong solution of potassa, oxalate of potassa is produced.

PECTINA'TUM TECTUM. (Lat. pecten, *a comb.*) In Architecture, a roof which has obtained this name from its shape resembling that of a comb, and contrived to throw off the rain water in two ways.

PECTINIBRANCHIATES, *Pectinibranchiata.* (Lat. pecten, and branchia, *gills.*) The name given by Cuvier to his sixth order of Gastropods. It is the most extensive division of that class, since it includes almost all the spiral univalve shells, as well as several which are merely conical. The order is thus characterized by Cuvier:— "The branchiæ, composed of numerous leaflets or fringes, ranged parallel like the teeth of a comb, are affixed in two or three lines (according to the genera) to the floor of the respiratory cavity, which occupies the last whorl of the shell, and which communicates outwards by a wide aperture between the margin of the cloak and the body. Two genera only — *Cyclostoma* and *Helicina* — have, instead of branchiæ, a vascular network clothing the ceiling of the cavity, in all respects the same as that of the order; and they are the only ones which respire the atmosphere, water being the medium of respiration to all the rest."

All the Pectinibranchiates have two tentacula and two eyes, raised sometimes on pedicles; a mouth in the form of a proboscis, more or less lengthened; and separate sexes. The penis of the male, attached to the right side of the neck, cannot in general be drawn within the body, but is reflected into the branchial cavity; it is sometimes very large. The *Paludina* alone has the organ concealed, and it comes out through a hole pierced in the right tentaculum; the rectum and the oviduct of the female also creep along the right side of the branchial cavity; and there is between them and the branchiæ a peculiar organ, composed of cells filled with a very viscous fluid, the use of which is to form a common envelop for the inclosure of the eggs, and which the animal deposits within them. The form of that envelop is often very complicated and very remarkable.

The tongue is armed with little hooks (or curved spinules), and wears down the hardest bodies by slow and oft-repeated frictions.

The grand difference between these animals lies in the presence or absence of the canal formed by the prolongation of the margin of the branchial cavity on the left side, and which passes along a similar canal or sinus in the shell, to enable the animal to breathe without leaving its shell. There is also this distinction between the genera, that some want the operculum; and the species vary in the filaments, fringes, and other ornaments that deck the head, the foot, or the cloak.

PE'CTORALS, or PECTORAL FINS. (Lat. pectus, *the breast.*) The anterior and lateral pair of fins, which represent, in fishes, the fore legs or anterior members of other vertebrate animals.

PECULA'TION. (Lat. *peculium.*) A term of the Roman law, rendered in that of France by *concussion.* The embezzlement by a public officer of public money. Peculation, in the Roman law, also comprehended offences relating to the coin.

PECU'LIAR. In Ecclesiastical Law, an exempt jurisdiction, which is not under the ordinary of the diocese, but has one of its own. They are,—royal, of which the king is ordinary; peculiars of archbishops, bishops, deans, chapters, prebendaries, and the like; to which were formerly added peculiars of monasteries, the jurisdiction over which, by 31 H. 8. c. 13., was granted to the ordinary within whose diocese they were situate, or to such persons as the king should appoint.

PE'CULIUM. (Lat.) In the Roman Law, the property which a slave might acquire independent of the control of his master. This property was frequently permitted to accumulate, so as to enable the slave to purchase his freedom. The son being, on the principles of the Roman law, unemancipated during the lifetime of his father, whatever property he might acquire appertained in strictness to the latter; but, by degrees, certain species of property acquired by the child obtained the title and character of *peculia.* Of these, however, the only one which was absolutely the child's was that which the son acquired in military service (peculium castrense), or in public service of any kind, which by a legal fiction was regarded as equivalent to military.

PE'DAGOGUE. (Gr. παιδαγωγος; from παις, *boy*, and αγωγος, *leader.*) Among the ancient Greeks, a slave charged with the personal care of a boy from the earliest age after infancy (from the milk, in the loose phrase of Plutarch; from about the age of seven, as it is more accurately stated by Æschines) until he became a youth (μειρακιον), *i. e.* until the seventeenth or twentieth year. The pedagogue's duty was to attend his charge on all occasions when he left his father's house; to the lecture rooms of masters, the theatre, &c. (See especially Plato, *Sympos.*) He was also intrusted with the duty of instructing and disciplining the child in inferior branches of education and ordinary manners. He was, consequently, of a very superior order of common slaves, and must be understood as excepted when Aristotle recommends that a child should be left to converse as little as possible with persons of the servile class. (*Politic.* vii. 156.) The custom of entrusting children to slaves in this manner was common in other Grecian states; the Romans also employed a slave for similar purposes, with the title of *custos* or *magister.*

In modern times, and especially in Germany, the word *pedagogic* is used to signify the science or art of education.

PEDAL HARMONIES. In Music, the same as *Organ Point*, which see.

PEDALMA'SCHI. A Turkish officer, whose duty consists in looking after the interests of the Sultan in cases of legacies. The Ottoman treasury receives through this officer a tithe of all bequests made to heirs male.

PE'DALS (Lat. pes, *a foot*), in such musical instruments as the organ, harp, and pianoforte, are either keys acted on by the feet of the performer (whence the name), to modify the tone of these respective instruments, or levers acting on the swell of the organ, and on the stops. The invention of the pedals or foot-keys of the organ is attributed to a German named Bernhard, who lived in the 15th century. It was long, however, before their utility and importance were acknowledged by other nations; and it is a singular fact that though England was the first to introduce the organ generally into the church, she was the last to adopt this invention. Within the last twenty years many improvements have been made in the construction of pedals, and few organs, except those of small dimensions, are now built without them. *See* ORGAN.

PE'DATE. In Botany, a palmate leaf, with the two lateral lobes themselves divided into smaller segments, the midribs of which do not run directly into the common central point; as in the leaf of *Arum dracunculus.*

PE'DESTAL. (Lat. pes, *a foot.*) In Architecture, the substruction to a column or wall. The component parts of a pedestal are three; the base, the die, and the cornice.

The whole height of a pedestal is from one quarter to one third of the height of the column, with its entablature.

PE'DICEL. (Lat. pes.) One of the ramifications of that part of a flower called the peduncle.

PEDICE'LLATES, *Pedicellata*. (Lat. pes.) The name of an order of Echinoderms, comprehending those which have the vesicular pedicellate organs, which are termed feet in this class, but which project from various parts of the surface of the body.

PE'DIMANES, *Pedimani*. (Lat. pes, and manus, *a hand.*) The name of a family of Marsupial animals, of which the opossum (*Didelphis*) is the type; they are distinguished by the opposable property of the hinder thumb or hallux, the fore feet being organized like those of ordinary Unguiculate quadrupeds.

PE'DIMENT. (Lat. pes.) In Architecture, the low triangular mass representing the gable of a roof over the front of a building, portico, door, window, &c.; though sometimes these ornaments are terminated upwards by segments of circles. A pediment is frequently ornamented with sculpture. The heights of pediments are seldom more than two ninths of their width.

PE'DIPALPS, *Pedipalpi*. (Lat. pes; and palpo, *I feel.*) A name given to a tribe of pulmonary Arachnidans, comprehending those which have the feelers in the form of pincers, or armed with a didactyle claw; as the scorpions.

PEDLAR. *See* HAWKER.

PEDO'METER, or PODOMETER. (Gr. πους, *the foot*, and μετρον, *measure.*) An instrument for the purpose of registering the number of paces taken by a man in travelling or walking, whence the distance is ascertained. It is usually in the form of a watch, and receives its movement from the motion of the body, so that it advances one division at each step. The number of divisions may be noted by an index or hand, in the same manner as the number of vibrations of a watch-balance. The best construction, or rather the only one now used in this country, is that of Mr. Payne, watchmaker, of Bond Street. *See* PERAMBULATOR.

PEDU'NCULATES, *Pedunculata*. The name of an order of Cirripeds, comprehending those which have the body supported by a flexible tubular stem.

PEDU'NCULUS. (Lat. pes, *a foot.*) That part of a branch or stem that immediately bears the flowers.

PEEP-O'-DAY BOYS. The well-known appellation of certain insurgents who appeared in Ireland in 1784. They obtained this name from visiting the houses of their antagonists, called *defenders*, at break of day in search of arms.

PEER. (From the Latin *par*, French *pair.*) Equal, which meaning it still retains in the language of the common law, as trial by jury is said to be by the peers, or equals, of the defendant. In this sense, the name remains as a relic of feudal institutions, according to which every rank of society formed an association for the purpose of mutual defence and the decision of disputes; as the tenants of a lord paramount or inferior, who met as equals (pares curiæ) in the court over which he presided. Hence, in the French monarchy, the highest vassals of the crown formed a rank apart, and were called pares or peers with reference to each other; and the designation became a title of honour. The peers of France differed in number at different periods of the early French monarchy, as their domains became united to the crown; but, according to heraldic theory, there are six temporal, —the Dukes of Burgundy, Aquitaine, and Normandy, and Counts of Flanders, Toulouse, and Champagne; and six spiritual,—the Archbishop of Rheims, and the Bishops of Laon, Beauvais, Noyon, Chalons, and Langres. In later times new peerages were created, as the duchy of Brittany and counties of Artois and Anjou. At last the title remained as a simple dignity; and Louis XIV. increased the number of dukes and peers (ducs et pairs) until at last they amounted to thirty-seven. They had no privileges except precedence, and a seat in the parliaments. On the restoration of Louis XVIII. hereditary peerage was established in France on the model of that of England, but was abolished in 1831; and the members of the present chamber of peers are nominated for life by the people. For the history and privileges of the English peerage, see PARLIAMENT. There is a curious analysis of the English peerage in the *Quart. Review*, vol. 41.

PE'GASUS. In Greek mythology, a winged horse, produced by Neptune; or, according to some authors, which sprung from the blood of Medusa when Perseus cut off her head. *See* BELLEROPHON.

PEGASUS. This name is applied, in Zoology, to a genus of Lophobranchiate fishes with large pectoral fins, by means of which they are enabled to take short saltatory flights through the air.

PEGASUS. One of the 48 ancient constellations of Ptolemy, situated in the northern hemisphere.

PELA'GIANISM. The religious system promulgated by Pelagius, a British monk of the fifth century, who after attaining to considerable notoriety in his own day, by first eliciting the discussion of the great questions respecting grace and predestination, has succeeded in bequeathing his name as a designation in all after ages for those who have held the extreme opinions by which he was distinguished. His tenets are thus clearly stated by a modern writer:—"1. That the sins of our first parents are imputed to themselves alone, and not to their posterity; that we derive no corruption from their fate; that we inherit no depravity from our origin, but enter into the world as pure and unspotted as Adam at his creation. It was a necessary inference from this doctrine that infant baptism is not a *sign* or *seal* of the remission of sins, but only a mark of admission into the kingdom of Christ. 2. That our own powers are sufficient for our own justification; that as by our own free will we run into sin, so by the same voluntary exercise of our faculties we are able to repent and reform, and raise ourselves to the highest degree of virtue and piety; that we are indeed assisted by that external grace of God which has taught us the truths of revelation, which opens to us our prospects, and enlightens our understanding, and animates our exertions after holiness; that the internal or immediate operation of the Holy Spirit is not necessary either to awaken us to religious feeling, or to further us in our progress towards holiness; in short, that man, by the unassisted agency of his natural perfections, under the guidance of his own *free will*, is enabled to work out his own salvation." (*Waddington's Hist. of the Church.*) These opinions were formally condemned by a decree of Pope Zosimus, about 418, and again by the council of Ephesus, in 431. Their principal opponent was the famous Augustin, who, in the course of his arguments against them, advanced an explanation of the questions involved in the discussion, which has been stigmatized as leading directly to the opposite extreme of fatalism. (See *Mosheim*, vol. ii. cent. 5.) The Pelagian opinions respecting original sin are condemned in the 9th article of the English church.

PELECA'NIDÆ. The name of a family of swimming birds, of which the pelican (*Pelicanus*) is the type.

PELLA'GRA. (Lat. pellis, *the skin*, and æger, *sick.*) A disease of the skin somewhat resembling *elephantiasis*, and occasionally producing great constitutional derangement. It is endemic in certain districts of Italy, especially in the Milanese.

PE'LLICLE. (Lat. pellis, *skin.*) A thin membrane. In Chemistry, the term is applied to the film of salt or other substances which forms upon the surface of solutions during evaporation.

PE'LLITORY OF SPAIN. The root of the *Anthemis pyrethrum*. It has a pungent flavour, and when chewed promotes the flow of saliva, and is often useful in toothach.

PE'LTA. (Lat. *a shield.*) In Botany, a term used in describing lichens to denote a flat shield without any elevated rim, as in the genus *Peltidea*.

PELTA'STÆ. Light-armed infantry were so named among the Greeks, from carrying the pelta or target. (See *Mem. de l'Ac. des Inscr.*, vol. xxxii.)

PE'LTATE. (Lat. pelta, *a shield.*) A leaf or any other organ which is fixed to the stalk by the centre, or by some point distinctly within the margin, as in the *Tropæolum*.

PE'LTRY. (Germ. peltz, from Lat. pellis, *a skin.*) The name given to the skins of different kinds of wild animals found in high northern latitudes, particularly in America; such as the beaver, sable, wolf, bear, &c. When the skins of such animals have received no preparation, they are termed *peltry*; but when the inner side has been tanned by an aluminous process, they are denominated *furs*.

PE'LVIS. (Gr. πελυς, *a basin.*) The inferior part of the abdomen, the bony circumference of which is formed by the two *ossa innominata*, the *sacrum*, and the *os coccygis*. It contains the rectum, the urinary bladder, and internal organs of generation.

PE'MPHIGUS. (Gr. πεμφιξ, *a vesicle.*) A fever attended by almond-shaped vesicular eruptions.

PE'NALTY (Lat. pœna, *punishment*), is of three kinds, says Lord Coke; *pœna pecuniaria*, *pœna corporalis*, and *pœna exilii*. Where any thing is prohibited by statute under a penalty, if the penalty, or part of it, be not appointed by the statute to the informer, it goes to the crown. Penal statutes are to be construed strictly. *See* STATUTE.

PE'NANCE. *See* PENITENCE.

PENA'TES. The household gods of the ancient Italians, who presided over families, and were worshipped in the interior of each dwelling. The term is derived from penitus, *within*. Penates is in fact a generic term, comprising in its strict sense all the gods worshipped in the interior of the house, and consequently including the Lares, with whom they are continually mentioned in conjunction. The number and names of the Penates were indeterminate. As there were public as well as domestic Lares, so there were public Penates, who exercised a general influence over the destinies of the whole Roman people. Thus Tacitus relates, that "delubrum Vestæ cum

Penatibus populi Romani" was consumed, along with other very ancient temples, in the great fire during the reign of Nero. But the term may, perhaps, be considered as belonging to the rhetorical style of that author, and to signify merely the tutelary god of the republic.

The subject of the domestic deities of the Romans, the Lares and Penates, is involved in great obscurity, from the conflicting statements of the classic authors respecting them. Those who wish to see the question investigated in all its bearings may consult *Müller's Etruscans*, vol. ii. p. 90. &c.; Jaekel, *De Diis Domesticis;* Hartung, *Religion der Römer*, &c. (See also the notes by Prof. Ramsay of Glasgow, appended to his valuable little work entitled *Elegiac Extracts from Tibullus and Ovid, with English Introductions and Notes*, 12mo. 1840.)

PE'NCIL. (Lat. penicillum.) In Painting, Drawing, &c., the instrument wherewith the colours are applied. Pencils are of various sorts, sizes, and materials, suited to the nature of the work. The *black lead pencil* is made of long slips of black lead (plumbago or graphite), inclosed in cylindrical pieces of cedar, and is too well known to need further description.

PENCIL OF LIGHT, in Optics, is a collection of the rays or evanescent streams of light converging to a point, as the focus of a lens or mirror.

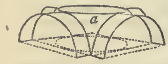
PE'NDANT. (Lat. pendo, *I hang.*) In Gothic Architecture, an ornamented polygonal piece of stone or timber hanging down from the vault or roof of a building. Of stone pendants some exquisite examples may be seen in Henry VII.'s Chapel at Westminster. In ancient writers the springers of arches, which rest on shafts or corbels, are called *pendants.*

Pendants of a Ship, are those streamers or long colours which are split or divided into two parts ending in points, and hang at the mast head or at the yard-arm ends.

PE'NDANT. In Painting, &c., a picture or print which, from uniformity of size and subject, seems to hang up as a companion to another. The term may also be applied to bassi rilievi of similar sizes.

Pendant is also the general term for all kinds of ornaments worn in the ears by both sexes in savage, and by females chiefly in civilized countries; usually termed ear-rings, which see.

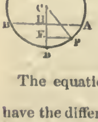
PENDE'NTIVE. (Lat. pendo, *I hang.*) In Architecture, the portion of a vault between the arches under a dome, called by the French *fourche*, or *panache*, lettered *a* in the diagram, by which it will be seen that it falls at its superior part into a circle inscribed in the square formed on the plan of the four arches. Hence it is obvious that a dome may be formed by means of pendentives over any regular polygon.



PE'NDULUM. (Lat. pendulus; from pendo, *I hang.*) If any heavy body, suspended by an inflexible rod from a fixed point, be drawn aside from the vertical position, and then let fall, it will descend in the arc of a circle of which the point of suspension is the centre. On reaching the vertical position it will have acquired a velocity equal to that which it would have acquired by falling vertically through the versed sine of the arc it has described, in consequence of which it will continue to move in the same arc until the whole velocity is destroyed; and, if no other force than gravity acted, this would take place when the body reached a height on the opposite side of the vertical equal to the height from which it fell. Having reached this height it would again descend, and so continue to vibrate for ever; but in consequence of the friction of the axis, and the resistance of the air, each successive excursion will be diminished, and the body soon be brought to rest in the vertical position. A body thus suspended, and caused to vibrate, is called a *pendulum;* and the passage from the greatest distance from the vertical on the one side, to the greatest distance on the other, is called an oscillation.

In order to investigate the circumstances of the motion, the body must be regarded as a gravitating point, and the inflexible rod as devoid of weight. This is denominated the *simple pendulum;* and the problem to be resolved is to determine the motion of a point constrained to move in a circular arc in virtue of the accelerating force of terrestrial gravity.

Let C be the fixed point, A D B the arc described by the pendulum, C D the vertical, and P the place of the pendulum at a given instant. Draw P E perpendicular to C D, and put D E $= x$, E P $= y$, the arc D P $= s$, D H (the versed sine of the arc D A) $= h$, and the radius C D $= l$; also let $v =$ the velocity at P, and $t =$ the time of descent through A P.



The equation of the circle being $y^2 = 2\,l\,x - x^2$, we have the differential equation $d\,s = \dfrac{l\,d\,x}{\sqrt{(2\,l\,x - x^2)}}$; and, by the doctrine of falling bodies, the velocity at P is that which a body would acquire in falling through H E, or equal to $\sqrt{2\,g\,\text{H E}}$ (g being the accelerating force of gravity): therefore $v = \sqrt{2g\,(h - x)}$. But $d\,t = \dfrac{d\,s}{v}$: therefore, on substituting the values of $d\,s$ and v above given, we get the equation

$$d\,t = \frac{l}{\sqrt{2\,g}} \cdot \frac{d\,x}{\sqrt{\{(h - x)\,(2\,l\,x - x^2)\}}}$$

This equation, being developed and integrated, gives the time of descent from A to D, or the time of a semi-oscillation, as follows (π being the ratio of the circumference to the diameter, or $= 3{\cdot}14159$):—

$$\frac{\pi}{2}\sqrt{\frac{l}{g}}\left[1 + \left(\frac{1}{2}\right)^2 \frac{h}{2\,l} + \left(\frac{1{\cdot}3}{2{\cdot}4}\right)^2 \left(\frac{h}{2\,l}\right)^2 + \&c.\right]$$

When the arc of vibration is small, it is only necessary to take account of the first two terms of the series; whence the time of a whole oscillation from A to B, which we shall denote by T, is given by the formula—

$$\text{T} = \pi\sqrt{\frac{l}{g}} \times \left(1 + \frac{h}{8\,l}\right);$$

and if the arc is so small that h (its versed sine) becomes evanescent in comparison of $8\,l$, we have simply $\text{T} = \pi\sqrt{\dfrac{l}{g}}$. Whence it appears that the time of an oscillation in an infinitely small arc is directly as the square root of the length of the pendulum, and inversely as the square root of the accelerating force of gravity.

Suppose gravity to be a constant force (as it is at any given place on the earth's surface), the time of oscillation is proportional to the square root of the length of the pendulum; consequently, if T′ denote the time of oscillation of a seconds' pendulum, and l' its length, we have $\text{T} : \text{T}' :: \sqrt{l} : \sqrt{l'}$. Now, let N be the number of oscillations the first pendulum makes in a given time, and N′ the number the second makes in the same time; then the number of oscillations being evidently in the inverse ratio of the times, we have $\text{N} : \text{N}' :: \text{T}' : \text{T}$; or $\text{N} : \text{N}' :: \sqrt{l'} : \sqrt{l}$, whence $l = \dfrac{\text{N}'^2}{\text{N}^2}\,l'$; so that if the length of one pendulum be known, we can compute the length of another pendulum by observing the number of oscillations that each makes in any given time; for example, an hour.

In like manner, if we suppose the same pendulum to be transported to different parts of the earth (in which case l is constant and g variable), and assume that the values of N and g at the first station become respectively N′ and g' at the second, we shall have $\text{T} : \text{T}' :: \dfrac{1}{\sqrt{g}} : \dfrac{1}{\sqrt{g'}}$; whence $g' = \dfrac{\text{T}^2}{\text{T}'^2}g$; or $g' = \dfrac{\text{N}'^2}{\text{N}^2}g$. So that the force of gravity at different places may be compared by observing the number of oscillations which a pendulum makes at each place in a given time. Or, if we suppose the times of oscillation constant (that is, if we suppose two pendulums so adjusted as to beat seconds at two different stations), and l and g variable; then, since $\text{T} = \pi\sqrt{\dfrac{l}{g}}$, and $\text{T}' = \pi\sqrt{\dfrac{l'}{g'}}$, we shall have $\dfrac{l}{g} = \dfrac{l'}{g'}$; or $l' = l\dfrac{g'}{g}$; whence the length of the seconds' pendulum at any place is directly proportional to the intensity of gravity at that place.

According to the theory of falling bodies (*see* GRAVITY), the time t in which a body falls through the space s, by the accelerating force of gravity, is given by the equation $t = \sqrt{\dfrac{2\,s}{g}}$. Let $2\,s = l$; then $t = \sqrt{\dfrac{l}{g}}$. But the time T, of the oscillation of a pendulum whose length is l, is $\text{T} = \pi\sqrt{\dfrac{l}{g}}$. therefore $\text{T} : t :: \pi : 1$; consequently the time of the oscillation of a pendulum is to the time that a heavy body would fall freely by the force of gravity through half its length, as the circumference of a circle to its diameter.

If we suppose the time to be expressed in seconds, and make $\text{T} = 1$, we shall have $g = \pi^2\,l$. Now Captain Kater found the length of the simple pendulum at London to be 39·13929 inches, and we know that $\pi^2 = 9{\cdot}8696$; therefore $g = 9{\cdot}8696 \times 39{\cdot}139 = 386{\cdot}29$ inches, or $g = 32{\cdot}2$ feet. It follows, therefore, that the space through which a body falls freely at London in a second of time is 16·1 feet.

Compound Pendulum.—The simple pendulum, as above defined, is only a theoretical abstraction; for the oscillating body can neither be so small that it may be regarded as a mathematical point, nor can the rod be entirely devoid of weight. When the body has a sensible magnitude, and the suspending rod a sensible magnitude and weight, as they must have in all actual constructions, the apparatus is called a *compound pendulum;*

and instead of being supported by a single point it is supported by an axis, or by a series of points situated in the same straight line. According to this definition, any heavy body oscillating about an axis of suspension is a compound pendulum.

In every compound pendulum there is necessarily a certain point at which if all the matter of the pendulum were collected the oscillations would be performed in exactly the same time. This point is the centre of oscillation. (*See* Centre of Oscillation.) It is situated in the vertical plane passing through the centre of gravity of the pendulum, and at a distance from the axis of suspension (the axis being always supposed horizontal), which is determined by the following formula: — Let dm be the element of the mass of the compound pendulum, r its distance from the axis of rotation, and x the distance of the centre of oscillation from the same axis; then

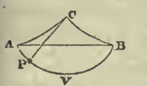
$$x = \int r^2\, dm \div \int r\, dm;$$

that is, the distance of the centre of oscillation from the axis of suspension is equal to the moment of inertia of the oscillating body divided by its moment of rotation. This value of x is the length of the isochronous simple pendulum, and is what is always to be understood by the term *length of a pendulum*.

The centre of oscillation possesses a very remarkable property, which was discovered by Huygens; namely, that if the body be suspended from this point, or a horizontal axis passing through it parallel to the former axis of suspension, its oscillations will be performed in the same time as before; in other words, the axes of suspension and oscillation are interchangeable. This property furnishes an easy practical method of determining the centre of oscillation, and thence the length of a compound pendulum.

Applications of the Pendulum. — The most important application that has been made of the pendulum is to the measurement of time. It is said that Galileo, while a young man, having had his attention drawn to the oscillations of a lamp suspended from the roof of a church in Pisa, perceived that, although their extent was gradually diminished, they continued to be made in equal times, and thence conceived the idea of employing a pendulum as a means of measuring small intervals of time in astronomical observations. But though a pendulous body, by the isochronism of its oscillations, furnishes a means of dividing time into equal portions, it could obviously be of no great use until a method was devised of continuing the motion, and registering the number of oscillations. The application of clock-work to this purpose has been claimed for various individuals, but is generally and deservedly ascribed to Huygens; and the invention, one of the most important that ever was made in reference to practical astronomy, dates from the year 1656.

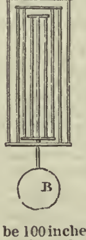
Huygens' researches on the subject of the oscillations of the pendulum are contained in his admirable work entitled *Horologium Oscillatorium*. He soon found that the oscillations in circular arcs of different amplitudes are not equal, the wider requiring rather a longer time than the narrower; and, with a view to remedy this defect, he undertook to investigate the nature of the curve in which the oscillations would be performed in equal times, whatever might be the extent of the arc described. The curve possessing this remarkable property was found to be the cycloid. (*See* Cycloid.) The next object was to devise a means of causing a pendulum to vibrate in such a manner that its centre of oscillation shall describe the arc of a cycloid. This was also effected by Huygens by the following construction, which depends on another property of the cycloid, namely, that its evolute is a similar curve: — If A C and B C be two semicycloids, or semicycloidal cheeks, each equal to the half of A V B, touching A B in A and B, and meeting one another in C; and if there be fixed at C a pendulum P, hanging by a thread P C, equal in length to the semicycloid; then P, in its oscillations, will describe the cycloidal arc A V B. Nothing more simple or beautiful in point of theory could be conceived than this construction; but, on attempting to reduce it to practice, it was soon found to possess no advantage, in consequence of the mechanical difficulty of making the cycloidal cheeks with the requisite accuracy, and the impossibility of obtaining a flexible string of invariable length. Huygens himself showed that the error of a hundredth of an inch in the form of the curve would cause a greater irregularity than a circular vibration of 10 or 12 degrees. Accordingly, the use of cycloidal cheeks was abandoned, and the attention of artists directed to the means whereby the oscillations might be confined within very small circular arcs, in which case any inequality in the lengths of the arcs becomes insensible. In clocks of the best construction the arc of vibration is very small; and the pendulum is made very heavy, in order that, by possessing a great momentum, it may be less affected by the imperfections of the machinery.



Compensation Pendulum. — The value of the pendulum as a regulator of timepieces depends on the isochronism of its oscillations; which, in its turn, depends on the invariability of the distance between the points of suspension and oscillation. But, as every known substance expands with heat and contracts with cold, the length of the pendulum will vary with every alteration of temperature, and the rate of the clock consequently undergo a corresponding change. To counteract this variation, numerous contrivances have been employed. The principle is, however, the same in all; and consists in combining two substances, whose rates of expansion are unequal, in such a manner that the expansion of the one counteracts that of the other, and keeps the centre of oscillation of the compound body always at the same distance from the axis of suspension. A brief description of the two compensation pendulums in most common use — the *Mercurial Pendulum* and the *Gridiron Pendulum* — will sufficiently explain the means by which compensation is obtained.

Mercurial Pendulum. — This was the invention of Mr. George Graham, a celebrated watchmaker, who subjected it to the test of experiment in the year 1721. The rod of the pendulum is made of steel, and may be either a flat bar or a cylinder. The bob or weight is formed by a cylindrical glass vessel, about 8 inches in length and 2 inches in diameter, which is filled with mercury to the depth of about $6\frac{1}{2}$ inches. The cylinder is supported and embraced by a stirrup, formed also of steel, through the top of which the lower extremity of the rod passes, and to which it is firmly fixed by a nut and screw on the end of the rod. Now the effect of an increase of temperature on this apparatus is evidently as follows: — In the first place, the rod expands, and the distance between the axis of suspension and the bottom of the stirrup is increased. In the second place, by the expansion of the mercury in the cylinder, its column is lengthened, and the distance of its centre of gravity from the bottom of the stirrup consequently increased. But, as the expansion of mercury is about sixteen times greater than that of steel, the height of the mercurial column may be so adjusted by trial that the expansion of the rod and stirrup shall be exactly compensated by that of the mercury, and the centre of oscillation of the whole suffer no change. This pendulum is, perhaps, the most perfect of all compensators; but, as its adjustments are attended with considerable difficulty, it is seldom used excepting in astronomical observatories.

Gridiron Pendulum. — This was contrived by Mr. Harrison, the inventor of the chronometer. It consists of a frame of nine parallel bars of steel and brass, arranged and connected as in the annexed figure. The bars marked *s* are of steel; the four marked *b* are of brass; the centre rod, of steel, is fixed at top to the cross bar connecting the two middle brass rods, but slides freely through the two lower bars, and bears the bob B. The remaining rods are fastened to the cross pieces at both ends, and the uppermost cross piece is attached to the axis of suspension. It is easy to see, from the mere inspection of the figure, that the expansion of the steel rods tends to lengthen the pendulum, while that of the brass rods tends to shorten it; consequently, if the two expansions exactly counteract each other, the length of the pendulum will remain unchanged. The relative lengths of the brass and steel bars are determined by the expansions of the two metals, which are found by experiment to be, in general, nearly as 100 to 61. If, then, the lengths of all the five steel bars added together be 100 inches, the sum of the lengths of the four brass bars ought to be 61 inches. When the compensation is found on trial not to be perfect, an adjustment is made by shifting one or more of the cross pieces higher on the bars.



Harrison's pendulum has been greatly improved by Troughton, who substituted for the two pair of brass rods two cylinders of brass, sliding the one within the other, to which the steel rods are attached. For a description of this, and various other modes of compensation, we refer the reader to an excellent chapter on the subject by the late Captain Kater, in the volume of *Mechanics* in the *Cabinet Cyclopædia*.

Application of the Pendulum to the Determination of the relative Force of Gravity at different Places. — There are two methods of determining the relative intensity of gravity by means of the pendulum. According to the first, the absolute length of the simple pendulum which makes a certain number of oscillations in a given time is accurately ascertained at each of the places, and the comparative force of gravity is then given by the formula $g' = \frac{l'}{l}g$. According to the other method, an invariable pendulum is swung at the different places, and

the number of its oscillations noted at each, when the relative gravity is given by the formula $g' = \frac{N'^2}{N^2} g$. Each of these methods has been followed in the delicate experiments which have been made for the purpose of determining the figure of the earth; but though the results of both appear to be nearly equal in point of accuracy, the latter method, on account of its affording greater facilities in practice, is now generally adopted.

It will readily be conceived that a pendulum would be altogether unfit for the purpose of determining the minute variations of gravity if it were attached to a clock, or any machinery by which its motions could be influenced. It must be suspended from a very firm support, to which it can communicate no vibratory motion; and the most delicate precautions are necessary to avoid the effects of friction, and other disturbing causes, by which the experiment may be influenced. The method followed by the French astronomers, in their operations connected with the measurement of the meridian, was this: — The pendulum was composed of a sphere of platinum, suspended by a slender iron wire from a knife edge of hardened steel resting on plane surfaces of polished agate. It was placed in front of a well-regulated astronomical clock, with which its oscillations were compared, and the distance between its centres of suspension and oscillation determined by calculation from the length of the wire and the diameter of the sphere, ascertained by actual measurement. A different, and in many respects preferable mode of measuring the lengths of the seconds' pendulum, was adopted by Captain Kater, grounded on the property of oscillating bodies discovered by Huygens; namely, that the centres of suspension and oscillation are convertible. From this property it follows that if two knife edges, turned in opposite directions, are inserted in the same pendulum, and the mass be so adjusted, by means of a moveable weight sliding on the rod, that the oscillations are performed in exactly equal times when the pendulum is suspended from either knife edge, then the distance between the knife edges is the true length of the isochronous simple pendulum. In this manner the measurement is effected more directly, and no calculation is required for finding the centre of oscillation. A third method, lately put in practice by the celebrated astronomer Bessel, consists in suspending a ball and wire first from the upper end and then from the lower end of a rod of a given length, the ball being in both cases at the same distance below the rod. From the difference of the times of oscillation of the two pendulums thus formed, the length of the simple pendulum can be computed in terms of the rod, which is the difference of their lengths. The French method is described, with all the requisite details, in the third volume of *Base Métrique*, in *Delambre's Astronomie*, tome iii.; and in the *Recueil d'Observations Géodésiques, &c.*, by Biot and Arago, Paris, 1821. Captain Kater's pendulum is described in the *Phil. Trans.* for 1818; and Bessel's in his *Untersuchungen über die Länge des einfachen Secundenpendels*, Berlin, 1828.

Captain Kater's pendulum was formed of a very thin bar of plate brass, with a heavy bob and moveable weight, by means of which the isochronism was obtained when the suspension was made from the opposite knife edges. But a much simpler modification has been adopted in the recent experiments. The experimental pendulums of the Royal Astronomical Society consist merely of a plain straight bar of iron or copper, 2 inches wide, half an inch thick, and about 62¼ inches long. At the distance of 5 inches from one end of the bar is placed the apex of one of the knife edges, A; and at the distance of 39·4 inches therefrom the apex of the other knife edge, B; and the required adjustment to synchronism is produced by filing away one of the ends of the pendulum until the vibrations are found by trial to be equal in both positions of the pendulum. It is obvious that, for the purpose of merely ascertaining the variations of gravity, a bar of this form with a single knife edge would equally answer the purpose; but the advantage of the double suspension is this, that besides having two distinct and independent pendulums, each of which is a check upon the other, it furnishes the means of ascertaining whether the pendulum has sustained any accidental injury, which would be immediately discoverable from the inequality of the number of vibrations between the two knife edges.

Corrections. — In order that the results of different sets of experiments may be exactly comparable with each other, several corrections must be applied. The first of these is on account of the length of the arc of vibration, which, being of a finite and variable extent, the duration of the oscillations is consequently unequal, but always greater than in the case of an infinitely small arc. The number of oscillations is reduced to the case of an infinitely small arc by the formula

$$N \times \frac{M \sin. (A + a) \sin. (A - a)}{32 (\log. \sin. A - \log. \sin. a)}$$

where N is the number observed, M the logarithmic modulus = ·4342945, A the initial, and a the final arc of vibration; and as the arcs are always small, the computation may be shortened by using the arcs instead of the sines.

In the second place, all the experiments must be reduced to a common standard of temperature, which, in this country, is assumed at 62° of Fahrenheit. Let e denote the rate of expansion of the metal, t the mean height of the thermometer at the time of the experiment; then the correction of the number of vibrations on account of the temperature is $N \times \frac{1}{2} e (t - 62°)$.

A third correction is required on account of the atmospheric pressure. The effect of the pressure of the atmosphere on the pendulum is to diminish the force of gravity in the ratio of the specific gravity of the pendulum to that of the air; and on this principle the correction was formerly applied, regard being had to the height of the barometer. But it was recently remarked by Bessel that the pendulum drags with it a certain portion of air, the amount of which depends on the form of the pendulum; and, consequently, the specific gravity of the actually moving mass cannot be previously computed, but must be ascertained for each pendulum by actual experiments in air and in a vacuum. See a paper on this subject by Mr. Baily, in the *Phil. Trans.* for 1832. Also *Memoirs of the Royal Astr. Soc.* vol. vii.

Application of the Pendulum to the Determination of the Figure of the Earth. — The ellipticity of the earth is deduced from the observed number of oscillations made by an invariable pendulum at different latitudes, by means of the following theorem: — Let N = the number of oscillations made by a pendulum at the equator in a mean solar day, N′ = the number of oscillations made by the same pendulum at the latitude l, G = the force of gravity at the equator, and g = the same force at the latitude l; then, supposing the figure of the earth to be that of an oblate spheroid of revolution, we have $g = G (1 + n \sin.^2 l)$. But, by the property of the pendulum, $g : G :: N'^2 : N^2$; therefore, $N'^2 = N^2 (1 + n \sin.^2 l)$. In this equation the quantity n depends upon the centrifugal force of rotation at the equator, and the ellipticity; and, according to a theorem discovered by Clairaut, its value is $\frac{5}{2} m - e$, m being the ratio of the centrifugal force to gravity, and e the ellipticity. Newton showed that $m = \frac{1}{289}$, whence $n = \frac{5}{2 \times 289} - e$; therefore, as N'^2 is given by observation, the only unknown quantities in the equation $N'^2 = N^2 (1 + n \sin.^2 l)$ are N^2 and n: so that, by combining the results at two different latitudes, we can determine these quantities, and, consequently, e. The length of the seconds' pendulum being also proportional to the intensity of gravity, it is obvious that the lengths might be substituted in the above equation for N'^2 and N^2.

The seventh volume of the *Memoirs of the Royal Astr. Society* contains the results of experiments made with the invariable pendulum at 79 different latitudes. The values of N^2 and n, deduced from the whole of these results, are respectively

$$N^2 = 7441625711, \quad n = ·00514491;$$

whence the ellipticity deduced from the whole is $\frac{1}{285·26}$. It is remarkable that all the pendulum experiments agree in giving a greater ellipticity to the earth than is found by the comparison of measured arcs of meridian.

As the force of gravity varies inversely as the square of the distance from the centre of the earth, a correction is obviously required for the differences of altitude of the stations where the observations are made. Accordingly, the results at every station are reduced to what they would have been if the observations had been made at the level of the sea. Let h = the height of the station above that level, and R = the radius of the earth; g = the force of gravity at the station, and g' the same force at the level of the sea; then $g : g' :: R^2 : (R + h)^2$; whence, expanding the quantity $(R + h)^2$, and leaving out $\frac{h^2}{R^2}$ as insensible, we have $g' = g \left(1 + \frac{2h}{R}\right)$, in which we may substitute for g' and g either the lengths of the seconds' pendulum, or the square of the number of its oscillations at the station and the level of the sea. The result, however, is modified by the local attraction of the mass of ground surrounding the station, and Dr. Young assumes that the formula should be multiplied by the fraction ·6.

The following table, from Mr. Airy's treatise on the Figure of the Earth (*Ency. Metrop.*), shows the length of the seconds' pendulum in English inches at a few of the stations, where it has been actually determined. It is to be remarked, however, that some degree of uncertainty

attends all the results, on account of the error in the correction for the density of the air, which may amount to about ·0018 for each.

Station.	Latitude.	Length of Pendulum.	Observers.
	° ′	*Inches.*	
Spitzbergen -	79 50 N.	39·21469	Sabine.
Unst - - -	60 45	39·17162	Biot and Kater.
Leith Fort - -	55 59	39·15546	Biot and Kater.
London - -	51 31	39·13929	Kater.
Paris - -	48 50	39·12851	Borda, Biot, and Sabine (mean).
Bordeaux - -	44 50	39·11296	Biot.
New York - -	40 43	39·10120	Sabine.
Formentera -	38 40	39·09510	Biot (twice).
Sandwich Isles -	20 52	39·04690	Freycinet.
Trinidad - -	10 39	39·01888	Sabine.
St. Thomas -	0 25	39·02074	Sabine.
Bahia - -	12 59 S.	39·02433	Sabine.
Isle of France -	20 10	39·04684	Freycinet & Duperry
Cape of Good Hope	35 55	39·07800	Freycinet & Fallows

PENICI'LLATE, (Lat. penicillum, *a pencil.*) In Zoology, when a part supports one or more small bundles of diverging hairs.

PENI'NSULA. (Lat. pene, *almost*, and insula, *an island.*) A portion of land, as the term implies, nearly surrounded by water; as Africa, the Morea, California. In common parlance, the term Peninsula is usually applied to Spain and Portugal; and the struggle so long maintained between these countries, aided by the British, and the French, at the commencement of the present century, is called the Peninsular war.

PE'NITENCE, or PENANCE, in the Roman Catholic Church, is one of the seven sacraments. Priestly orders give the power to confer this sacrament; but, as a matter of discipline, their power is not exercised without authority from the Ordinary, either general or special, except in cases of necessity. The terms penitence and penance are likewise used for the good works commanded by a priest to a penitent, to be performed in satisfaction of the sins of which he absolves him. Public penance, in the earlier times of the church, was imposed for great offences committed after baptism. It consisted in exclusion from the church, solitude, prayer, and fasting, and the readmission was only gradual: the penitent being first allowed to approach the doors of the church; then to attend at sermons and readings, but not at prayers; then to pray, kneeling, &c. The time of penance varied according to different usages: St. Basil mentions two years for theft, seven for sensuality, fifteen for adultery, twenty for homicide, and the whole life for apostacy. Public penance for secret sins was generally remitted about the 7th century; and its commutation for the repetition of prayers and bestowing of alms began in the next. These alms were frequently applied by the penitent to the purchase of masses for himself or others. Afterwards the usage of pilgrimage as a mode of penance became general; and, finally, indulgences began to be sold in the 12th century.

PENITE'NTIARY. A prison in which convicted offenders are placed and subjected to a course of instruction and discipline, with a view to their reformation. Imprisonment after conviction is of two kinds: the simply repressive and penal, and that which is at the same time reformatory. But it is obvious that there is no advantage in attempting to produce the latter effect in those short imprisonments of a year or a few months, which form the ordinary punishments of our law for smaller offences. Crimes of a higher order are with us usually punished by transportation; and hence there is less room for the development of the penitentiary system among ourselves than in other European countries, and in the United States of America. At Genoa, the convict is only subjected to the penitentiary system at the end of the first year of his imprisonment: some writers on the subject recommend two years as a more appropriate limit for the commencement of this species of discipline. In England, the first act for the establishment of penitentiaries was passed in 1776, at the suggestion of the philanthropist Howard and judge Blackstone; and attempts were made in consequence, at Gloucester and other places, with little success. In 1812 the act was passed under which the Milbank prison was erected as a general penitentiary for England and Wales. It is now adapted to contain 800 male and 400 female prisoners. The chief object in penitentiaries, besides conferring moral and religious instruction on the prisoners, is to employ them in some useful labour; but there is always considerable difficulty in carrying into effect this part of the system, especially so as to reconcile it with the necessity of keeping prisoners separate as far as possible. At Milbank, tailoring forms the principal occupation of a large proportion of the inmates. *See* PRISONS.

PENITE'NTIARY, GRAND. An officer of the Roman Catholic church, usually a cardinal, appointed by the pope to grant absolution in cases reserved for the papal authority, dispensations for marriage, &c. In like manner, bishops appoint penitentiaries to perform the like office in such cases as are reserved for episcopal absolution. Briefs granted by the grand penitentiary are at the present time entirely gratuitous, and headed with the words "pro Deo."

PE'NITENTS. A name given in Roman Catholic countries to certain religious fraternities, distinguished by their particoloured garments. Of these there were a great variety in France, Spain, and Portugal, &c.; but the most extraordinary were the White Penitents, a body of fanatics, who appeared in the north of Italy in 1399, clothed in white, and bearing crucifixes, under the guidance of a priest, whose real history seems unknown, but concerning whom many strange stories were told; among others, that he professed to be the prophet Elias, and that his mission was to announce the immediate destruction of the world. The contagion of this outburst of religious feeling extended to Tuscany, and thence over the whole of Italy; and was accompanied by a general cessation of violence and private war. But it lasted only a few months. (Waddington, *Hist. of the Church*, p. 546., and the authors there referred to.)

PENNATULA'RIÆ. (Lat. penna, *a feather.*) The name of a family of Polypes, of which the sea-pen (*Pennatula*) is the type.

PE'NNON. A term sometimes poetically used for a streamer or banner; but restricted in the middle ages to the banner of a knight, baronet, or esquire.

PE'NNY. The twelfth part of a shilling. The penny was formerly a silver coin, first struck in England by the Saxons. It contained the 240th part of their pound, and its weight was about 22½ grains. Till the time of Edward the First the English penny was struck with a cross so deeply sunk in it that it might, on occasion, be easily broken and parted into halves, thence called halfpenny; or in four parts, thence called *fourthings*, or farthings. Edward the First also reduced the weight of the penny to a standard; ordering that it should weigh the 20th part of an ounce. It afterwards suffered successive diminutions, till, in the reign of Elizabeth, its value was reduced to the 62d part of an ounce of silver. This proportion is still observed.

PE'NNYWEIGHT. A weight equal to twenty-four grains, or the 20th part of an ounce troy. This was the weight of the silver penny in the time of Edward the First. *See* PENNY.

PENS. (Lat. penna, *a feather.*) Well-known instruments for writing, usually formed of the quills of the goose, swan, or some other bird. Metallic pens have been occasionally employed for a lengthened period; but it is only within these few years that they have been extensively introduced. They first began to be largely manufactured by Mr. John Perry, of London. Mr. P. having succeeded in giving to his pens a greater degree of softness and elasticity than was possessed by any metallic pens previously in use, they speedily obtained a very extensive sale. This success brought crowds of rivals into the field; so that metallic pens are now manufactured in vast quantities, and of an immense variety of forms. But though they have superseded to a very considerable extent the use of quills, and have some peculiar advantages, it does not appear possible to give them the elasticity of the quill, nor fit them so well for quick and easy writing. In the manufacture of steel pens the best metal, made from Dannemora or hoop (L) iron, is employed. It is laminated into slips about 3 feet long and 4 inches broad, of a thickness corresponding to the desired stiffness and flexibility of the pens. These slips are subjected to the action of a stamping-press, somewhat similar to that for making buttons. The point destined for the nib is next introduced into an appropriate gauged hole of a little machine, and pressed into the semicylindrical shape; where it is also pierced with the middle slit, and the lateral ones, provided the latter are to be given. The pens are now cleaned, by being tossed about among each other, in a tin cylinder about 3 feet long, and 9 inches in diameter; which is suspended at each end upon joints to two cranks, formed one on each of two shafts. The cylinder, by the rotation of a fly-wheel acting upon the crank-shafts, is made to describe such revolutions as agitate the pens in all directions, and polish them by mutual attrition. In the course of four hours several thousand pens may be finished upon this machine. (See *Commercial Dict.*, and *Ure's Dict. of Arts, &c.*)

PE'NSIONARY, THE GRAND, of Holland, was the prime minister of the states of the province of Holland. He proposed the measures to be discussed in the assembly of the states. He also transacted business with foreign ministers, and fulfilled other important functions. His term of service was five years, and he was capable of re-election.

PENSIONER. Literally, one who receives a pension or allowance. At the universities of Cambridge, however, and Dublin, this term has a peculiar meaning, being applied to those students who live at their own expense, *i. e.* without any support from the beneficent foundations of

the respective colleges. In this sense it is synonymous with commoner at Oxford.

PENTA'CRINITES. (Gr. πεντε, *five*, and κρινον, *lily.*) The name of a tribe of Echinoderms, comprehending those in which the animal consists of an angular, jointed, flexible column, fixed at the base, and supporting on its free extremity a concave disc or body, terminating in five dichotomizing, jointed, semicylindrical arms. Most of the species and genera of this tribe are extinct.

PENTADO'RON. (Gr. πεντε, and δωρον, *a palm.*) In Ancient Architecture, a brick of five palms in length, used by the Greeks in the construction of their public edifices.

PE'NTAGON. (Gr. πεντε, and γωνια, *angle.*) In Geometry, a plane figure, having five angles, or contained by five sides. It is a *regular* pentagon when the sides and angles are equal, and is consequently inscribable in a circle. The length of the side of a regular pentagon is equal to twice the sine of 36°, radius being unit; and its area $= 5$ sin. $36^{\circ} \times$ cos. 36°; or, making the side $= s$, the area $= \frac{5}{4} s^2 \times$ tan. 54°. It is a remarkable property of the regular pentagon, that the square of its side is equal to the sum of the squares of the sides of the hexagon and decagon inscribed in the same circle.

PENTAGRAPH. *See* PANTAGRAPH.

PENTAME'RANS, *Pentamera.* (Gr. πεντε, and μηρος, *a joint.*) The name of a section of Coleopterous insects, including those which have five joints on the tarsus of each leg.

PENTA'METER. (Gr. πεντε, and μετρον, *measure.*) A species of verse consisting of five feet or measures (whence the name), and which when subjoined to a hexameter verse constituted what is denominated *elegiac.* The scheme of the pentameter is as follows: —

– ⏖ | – ⏖ | – | – ⏑⏑ | – ⏑⏑ | – |

Or more properly thus,

– ⏖ | – ⏖ | – – | ⏑⏑ – | ⏑⏑ – |.

It must be observed, that the cæsural pause at the third foot must always terminate a word; and, as a general rule, the last word of the verse must consist of two syllables, although a quadrisyllable, especially in proper names, is sometimes admitted.

The first Greek elegiac writers were Callinus and Tyrtæus, who were followed by Mimnermus, Theognis, and Solon, in their own country; and by Catullus, Propertius, Tibullus, and Ovid, in Rome. The variety of themes sung by these different writers proves the capacity of this measure for adaptation to every subject, whether mournful, as the term *elegiac* would imply; or political and warlike, like the strains of Tyrtæus and Callinus; or erotic, like those of Propertius, Tibullus, and Ovid; or historical and mythological, like the *Fasti* of the last. The pentameter has not been generally introduced into any modern language with which we are acquainted; though Goethe and Schiller have left us some excellent specimens of the facility with which it might be engrafted on the German language. The hexameter and pentameter distich is beautifully described in the following lines of Schiller: —

Im Hexameter steigt des Springquells flüssige Säule:
Im Pentameter drauf fällt sie melodisch herab.

Thus admirably rendered by Coleridge, who was long considered as the original author: —

In the hexameter rises the fountain's silvery column:
In the pentameter aye falling in melody back.

Every page of Ovid's *Heroides*, or *Tristia*, illustrates the manner in which the hexameter breaks, as it were, and falls back in the pentameter, thereby adding a most exquisite grace to the rhythm: indeed the secret genius of the metre appears to consist in this play. The following instances, taken from Penelope's letter to Ulysses, will illustrate the truth of this observation: —

Troja jacet certe, Danais invisa puellis:
Vix Priamus tanti totaque *Troja* fuit.

Again,

Sive quis *Antilochum* narrabat ab Hectore victum;
Antilochus nostri causa timoris erat.

Besides this peculiarity in the pentameter, grammarians have pointed out several others, an observance of which is necessary to constitute a perfect pentameter. Of these perhaps the most important is the axiom, that although either a spondee or a dactyl may be used at pleasure in the first two feet of the verse, a dactyl should be preferred to a spondee whenever practicable; and a comparison of the ancient authors will show that on the frequent use of the former much of the beauty of this elegant measure depends. *See* HEXAMETER.

PENTA'POLIS. (Gr. πεντε, and πολις, *a city.*) A name given by the ancient Greeks to certain countries which were remarkable for having five distinguished cities; thus there was the Pentapolis of Lybia, Italy, and Asia Minor: but the most celebrated was the Pentapolis Cyrenaica (or of Egypt), whose five cities were Berenice, Arsinoe, Ptolemais, Cyrene, and Apollonia.

PE'NTASTYLE. (Gr. πεντε, and στυλος, *a column.*) In Architecture, a building having five columns in front.

PE'NTATEUCH (Gr. πεντατευχον; from πεντε, and τευχον, *an instrument*), signifies the five volumes of the books of Moses; viz. Genesis, Exodus, Leviticus, Numbers, and Deuteronomy.

1. The book of *Genesis* (as the term implies) gives an account of the creation of the world and of man; the fall of man; the flood; and the history of the Jewish patriarchs, Abraham, Isaac, and Jacob, down to Joseph (1750 B. C.). This book was looked upon with great veneration by the Jews, as comprising the history of their venerable founder Abraham, and his nearest descendants, — around whom many of their peculiar customs and laws were intertwined; but it is no less valuable to the Christian world, both from its venerable antiquity, and from its furnishing rich materials for historical, geographical, and antiquarian investigations. It contains, besides, numerous subjects for moral and religious reflections, which are referred to in many other later portions of the Old and New Testament. 2. The book of *Exodus* (Gr. εξ, and οδος, *a way*), narrates the fortunes of the descendants of Abraham after their migration to Egypt; the birth of Moses, and his endeavours to emancipate the Jewish nation from Egyptian bondage; their escape from Egypt; their journey through the wilderness; and the delivery of the law to Moses. This book, besides being peculiarly valuable in a religious point of view, possesses also great interest from marking the transition of the Jewish people from the pastoral or *nomadic* to the agricultural or *fixed* mode of life. 3. The book of *Leviticus* (so called from Levi, a priest), consists chiefly of the law and ordinances of the Jewish priesthood, or regulations as to the different kinds of sacrifices to be offered up; the duties of masters towards their slaves; regulations as to marriage, &c. It is replete with interesting antiquarian matter. 4. The book of *Numbers* (so called from its giving an account of the numbering of the people), contains besides an enumeration of many civil and ceremonial ordinances; and embraces an historical period of 38 years, chiefly relating to the captivity and the wilderness. 5. The book of *Deuteronomy* (Gr. δευτερος, *second*, and νομος, *law*), contains chiefly (as the origin of the term implies) a condensed summary of the laws and ordinances delivered in the three preceding books.

There are two ancient and authentic copies of the Pentateuch: the one written in Samaritan or Phœnician characters; the other in Chaldean, which was adopted by the Jews, in preference to the former, after their return from Babylon. The differences between the two are represented as not material; but it is imagined that some alterations and additions have been made in the Samaritan text, in order to favour the peculiar prejudices and claims of that people.

The Pentateuch was, down to a recent period, universally attributed to Moses; but some German theologians have attempted to prove, in our opinion with but little success, that Moses was not the author. There are no doubt several passages, especially in Deuteronomy, which could not possibly have been written by Moses; but these can easily be accounted for as interpolations of a copyist, and do not affect the authenticity of the whole Pentateuch. The chief arguments for the genuineness of the Pentateuch are ably given in the *Penny Cyclopædia*, to which we beg to refer the reader.

PENTA'THLIUM. (Gr. πεντε, and αθλος, *a contest.*) A general appellation given by the Greeks to their five chief bodily exercises; viz. running, leaping, throwing the quoit or discus, hurling the javelin, and wrestling. These five exercises were termed *Quinquectium* by the Romans.

PE'NTECOST. (Gr. πεντηκοστος, *fiftieth.*) A Jewish festival; so called because it was observed on the *fiftieth* day after the feast of unleavened bread; *i. e.* the fifteenth of the month Nisan, and next day after the Feast of the Passover. Being celebrated seven weeks after this latter, it also obtained the name of the Feast of Weeks. It occurred about the beginning of the harvest, and seems to have been instituted as an acknowledgment of the goodness of God in giving the fruits of the earth. It also commemorated the giving of the law on Mount Sinai upon that day. The diffusion of the Holy Spirit upon the apostles upon the same day, as recorded in Acts ii., has occasioned its observance to be continued among Christians. In England it is known by the name of Whit Sunday; and in Germany by that of *Pfingsten.*

PENTELA'SMIDÆ. (Gr. πεντε, and ελασμα, *a layer.*) The family of Pedunculate Cirripeds, of which the common barnacle (*Pentelasmis crocea*) is the type. The principal organs of the body are protected by five shelly plates.

PENTE'LICAN MARBLE. *See* MARBLE.

PE'NULT, or PENU'LTIMA. (Lat. penè ultima, *almost last.*) In Grammar and Prosody, the last syllable of a word but one.

PENU'MBRA. (Lat. *pene*, almost, and *umbra*, shadow.) An imperfect shadow. The penumbra of the earth is occasioned by the apparent magnitude of the sun's disk, and is that portion of space behind the earth within which a body will be illuminated by a part only, and not by the whole of the disk. It is thus distinguished from the *umbra*, or perfect shadow, which is the conical

space within which no part of the disk is visible. Let S be the sun, E the earth, A D the orbit of the moon; and let *a* A, *a* C, *d* B, *d* D, be tangents to S and E. As soon as the moon passes the point A, a portion of the sun's disk at *a* will be intercepted, and the visible portion will become less and less until the moon reaches B, where total darkness begins. From A to B, therefore, the moon is in the penumbra. The umbra extends from B to C. When the moon passes C, it will again receive the light from the border of the solar disk at *a*, and will be in the penumbra from C to D. The whole penumbra thus forms a cone, of which the apex is at O, and the angle at the apex equal to A O D. As the obscurity evidently becomes greater in proportion as more of the solar disk is concealed, and insensibly merges into total shade, it is extremely difficult in eclipses of the moon to determine by observation the exact time at which the moon's limb passes the point B or C, and the eclipse begins or ends.

In solar eclipses those parts of the earth which are covered by the penumbra of the moon are only partially deprived of the sun's light. Let E be the moon, and A D part of the earth's orbit. To a spectator on the earth, placed between A and B, a part of the sun's disk is concealed, and the sun is partially eclipsed. The limits are calculated from the known magnitudes and positions of the sun and moon, and their respective distances from the earth. *See* ECLIPSE.

PENUMBRA. In Painting, &c., the boundary of shade and light where the one blends with the other, the gradation being almost imperceptible.

PEPERI'NO. An Italian name for a particular kind of volcanic rock, formed by the cementing together of sand, cinders, &c.

PE'PLUM. An upper garment anciently worn by the Grecian, and especially by the Athenian females: it was without sleeves, and fastened by a clasp on the arm or shoulder. The celebrated peplum of Minerva was carried every year, in the Panathenaic processions of Minerva, from the Ceramicus to the temple of Ceres, and thence to the Parthenon, where it was offered to the goddess. The antiquity of this kind of ceremony is evinced by the passage in the *Iliad* (book v.) where the Trojan women offer a similar robe.

PEPPER. *See* PIPERACEÆ, PIMENTO.

PE'PTIC, relating to digestion. *See* DYSPEPSIA.

PERAMBULATOR. (Lat. ambulo, *I walk.*) A machine for measuring distances on roads; also called *odometer* and *surveying wheel*. Various sorts of machines have been constructed for this purpose, both in ancient and modern times. One is described by Vitruvius in his work *De Architectura*, lib. x. c. 14. The machine commonly employed consists of a wheel, to which a sort of double pole is attached, carrying an apparatus of clockwork, which is set in motion by the revolution of the wheel, and shows the number of miles, furlongs, &c., passed over by an index and dial. The apparatus may be drawn along by a person on foot, or by a carriage, to which it is more usually attached. For the sake of facility in reckoning, the circumference of the measuring wheel is made equal to an aliquot part of a mile; usually half a pole, or 99 inches. (See the *Repository of Arts*, vi. 249.)

PERCE'PTION. (Lat.) In Mental Philosophy, that power, act, or state of the mind, which has a conscious reference to external objects. Various theories of perception have arisen among philosophers, differing as this reference is supposed to be more or less immediate, or as the objects to which it refers are conceived to possess an independent reality or not. These theories are designated by the terms *idealism* and *realism*; which latter is subdivided into natural or positive, and relative or negative realism. The best known system of idealism is that of Bishop Berkeley. *See* IDEALISM.

According to the scheme of negative or relative realism, all that we can know of an object is the feeling which it excites in our minds. The cause of this feeling we necessarily judge to be something external to ourselves; but what it is in itself we have no means of knowing. This is the view adopted by the great majority of philosophers, from Plato and Aristotle down to Kant and Brown.

The theory of natural realism is the one supported by Dr. Reid under the name of the *common-sense* system. This philosopher conceives the object in perception to be in some way *immediately* present to our consciousness; its qualities are not merely felt by us, but discovered *in it*. We derive a certain sensation from the whiteness or roundness of an object; but it is the object itself and not our minds that are white or round. This doctrine, which was also that of the ancient Stoics, and expressed by them in nearly the same words as those used by Reid (see Cicero, *Acad. Quæst.*), is in fact rather a statement than an explanation of the problem. It has been recently supported with great acuteness by a learned writer in the *Edin. Review*, No. 113.; to which we refer our readers for a full account of all possible theories of perception.

PERCH, in Land Measure, is the fortieth part of a rood, or equal to $30\frac{1}{4}$ square yards. Perch is also sometimes used as a denomination of long measure, when it signifies the same thing as a rod or pole, being $5\frac{1}{2}$ yards, or $16\frac{1}{2}$ feet.

PERCHERS. The name of an order of birds including the *Scansores* and *Passeres* of Cuvier. *See* INSESSORES.

PERCHLO'RIC ACID. When sulphuric acid is poured upon chlorate of potash, gaseous oxide of chlorine is evolved, and the saline matter which remains is a mixture of bisulphate of potash and perchlorate of potash; by washing it with cold water the former salt is dissolved, but the latter remains in the form of a white powder. When this is mixed with half its weight of sulphuric acid, diluted with one third of water, and heat applied, white vapours rise, which condense as a colourless liquid in the receiver. This is a solution of perchloric acid, which consists of 1 equivalent of chlorine = 36, and 7 equivalents of oxygen $(8 \times 7) = 56$; the equivalent of the perchloric acid, therefore, is $(36+56)$ 92. Perchlorate of potash requires 65 parts of water at 60° for solution.

PE'RCOIDS, *Percoidæ*. (Lat. perca, *a perch.*) The name of the tribe of Acanthopterygian fishes of which the genus *Perca* is the type.

PERCU'SSION. (Lat.) In Mechanics, the striking of one body against another, or the shock arising from the collision of two bodies. *See* COLLISION.

PERCUSSION CAPS. *See* GUN.

PERCUSSION, CENTRE OF. That point in a solid body revolving on an axis at which, if an obstacle were there applied sufficient to resist the rotation of the system, no motion would be communicated to the axis; or, which is the same thing, if the axis were not fixed the system would acquire no tendency to revolve through the shock applied at that point. The centre of percussion is in the straight line passing through the centre of gravity perpendicular to the axis; and its distance from the axis is expressed by the formula $\int r^2\, d\, m \div \int r\, d\, m$, where $d\, m$ is the element of the mass, and r the distance of $d\, m$ from the axis. *See* CENTRE.

PERCUSSION OF FLUIDS. *See* HYDRODYNAMICS.

PEREDI'OLA. (Gr. περιδέω, *I bind round.*) The membrane by which the sporules of Algaceous plants are immediately covered.

PER'ENNIALS. (Lat. perennis, *lasting throughout the year.*) In Botany, those plants whose roots remain alive more years than two, but whose stems flower and perish annually. Gardeners generally call them Herbaceous plants. They differ from annuals and biennials not only in the time of their duration; but also in this, that the two former perish as soon as they have flowered, the act of reproduction exhausting their vital energies. Notwithstanding this distinction, it is not at all times easy to say whether a plant is a perennial or not; as for instance in the *Agave Americana*, commonly called the American aloe. This plant is herbaceous, and lives for many years; but when it flowers it dies: so that in one respect it is annual, its whole life being regarded as only one season of growth; in another respect it is truly perennial. Such perennials are called by De Candolle *monocarpic*.

PERE'NNIBRANCHIATES, *Perennibranchiata*. (Lat. perennis; branchia, *gills.*) The name of that division of Batrachian reptiles including the species which preserve the external branchiæ, or branchial apertures, throughout life; as the Siren, Proteus, and Menopome.

PE'RFECT CADENCE. In Music. *See* CADENCE.

PERFECTIBI'LITY. The capability of arriving at perfection. This word, which is entirely modern, and scarcely as yet admitted in our language on classical English authority, is commonly used in reasoning on the social condition of mankind. The theory of the indefinite perfectibility of the human faculties, which constitutes the basis of many modern systems, is perhaps nowhere so plainly developed as in the Preface to the *Tableau Historique de l'Entendement Humain* of Condorcet.

PE'RFECT NUMBER. In Arithmetic, a number equal to the sum of all its divisors. Thus 6 is a perfect number, for its divisors are 1, 2, and 3; and $1 + 2 + 3 = 6$. In like manner, 28 is a perfect number, for its divisors are 1, 2, 4, 7, 14; the sum of which = 28.

In general, every number of the form $2^{n-1}(2^n - 1)$, the latter factor being a prime, is a perfect number, the sum of its divisors being equal to the number itself. The difficulty, therefore, of finding perfect numbers arises from that of finding primes of the form $2^n - 1$, which is very laborious. The only values of n yet discovered which make $2^n - 1$ a prime number are 2, 3, 5, 7, 13, 17, 19, and 31. Substituting these values of n successively in the formula of the perfect number, we shall obtain the following results: —

If $n = 2$, then $2\ (2^2 - 1) = 6$
$n = 3$, $2^2\ (2^3 - 1) = 28$
$n = 5$, $2^4\ (2^5 - 1) = 496$
$n = 7$, $2^6\ (2^7 - 1) = 8128$
$n = 13$, $2^{12}\ (2^{13} - 1) = 33550336$
$n = 17$, $2^{16}\ (2^{17} - 1) = 8589869056$
$n = 19$, $2^{18}\ (2^{19} - 1) = 137438691328$
$n = 31$, $2^{30}\ (2^{31} - 1) = 2305843008139952128$
all which are perfect numbers.

PE'RFECT TENSE. That form of the verb denoted in English by the auxiliary *have*, which designates an action finished at the time when we speak of it. Also termed the preterite tense, from Lat. præteritum, *past*.

PERFU'ME. (Fr. parfum.) A term used to denote the volatile effluvia from any body affecting the organ of smelling, or the substance emitting those effluvia. Perfumes were in general use among the ancients (see the *Quart. Rev.* vol. xxiii.); and in France, Germany, Spain, and Portugal, and even, though not to so considerable an extent, in England, they are regarded almost as necessaries. In general they are made of musk, ambergris, civet, rose and cedar woods, orange flowers, jessamines, jonquils, tuberoses, and other odoriferous flowers. Aromatic drugs, such as storax, frankincense, benzoin, cloves, &c. &c., enter into the composition of a perfume; and many perfumes are composed of aromatic herbs or leaves, as lavender, marjoram, sage, thyme, &c. &c. (See the article " Perfumery " in *Ure's Dict. of Arts, &c.*)

PERGAME'NEOUS. (Lat. pergamena, *parchment.*) In Entomology, when a part consists of a thin, tough, semitransparent substance, somewhat resembling parchment.

PE'RGULA. (Lat.) In Ancient Architecture, a sort of gallery in a house. It is used by Plautus to signify a balcony, in which the courtezans placed themselves to catch the attention of passengers. By Winckelman it is thought to be an arbour in a garden, or a terrace overhanging one.

PERIA'NTHIUM. (Gr. περι, *around*, and ανθος, *a flower.*) A calyx and corolla, the limits of which are undefined, so that they cannot be satisfactorily distinguished from each other; as in many Monocotyledonous plants.

PERI'BOLOS. (Gr. περι, and βαλλω, *I cast.*) In Architecture, a court or enclosure entirely round a temple, surrounded by a wall. One of the most extraordinary examples of a peribolos is at Palmyra, where the great temple is surrounded by a wall with two rows of interior columns, each side whereof is from 700 to 800 feet long.

PERICARDI'TIS. Inflammation of the pericardium. It is of the same origin as

PERICA'RDIUM. (Gr. περι, *about;* καρδια, *the heart.*) The membranous sac which surrounds the heart.

PERICA'RPIUM. (Gr. περι, and καρπος, *fruit.*) Every part of a ripe fruit on the outer side of the placenta.

PERICHŒ'TIAL. (Gr. περι, and χαιτη, *a bristle.*) The leaves situated at the base of the setæ of mosses.

PERI'COPE. (Gr. περι, and κοπτω, *I cut; something cut out, an extract.*) A word used by theologians to signify a passage of the Bible extracted for the purpose of reading in the communion service and other portions of the ritual; or as a text for a sermon or homily.

PERICRA'NIUM. (Gr. περι, and κρανιον, *the skull.*) The membrane of the bones of the skull.

PE'RIDOT. In Mineralogy, the prismatic chrysolite.

PE'RIDROME. (Gr. περι, and δρομος, *a course.*) In Ancient Architecture, the space in a peripteral temple between the walls of the cell and the columns. It is a term that may be applied to any gallery of communication round an edifice.

PE'RIGEE. (Gr. περι, and γη, *the earth.*) In Astronomy, that point of the moon's orbit which is nearest to the earth. Anciently the term *perigee* was applied to the orbits of the sun and planets, as well as the moon, because they were supposed to circulate round the earth. Since the true centre of motion has been discovered, the term *perihelion* is used to denote the corresponding points.

PERIGO'NIUM. (Gr. περι, and γινομαι, *I grow.*) A synonym of the word perianth.

PERIGY'NIUM. (Gr. περι, and γυνη, *a female.*) The urceolate body formed in the genus *Carex* by two bracteæ, which become confluent at their edges, and enclose the pistillum, leaving a passage for the stigmata at their apex. Also used occasionally to denote that organ commonly called the disk.

PERI'GYNOUS. A term applied to stamens which originate from the sides of a calyx.

PERIHE'LION. (Gr. περι, and ἡλιος, *the sun.*) In Astronomy, the point in the orbit of a planet or comet which is nearest the sun. It is the extremity of the major axis of the orbit nearest to that focus in which the sun is placed; and its position, or longitude, is one of the elements by which the orbit is determined. *See* PLANET.

PERI'METER. (Gr. περι, and μετρον, *measure.*) In Geometry, the circuit or boundary of any plane figure. In round figures it is equivalent to circumference, or periphery; but the term is more frequently applied to figures bounded by straight lines.

PE'RIOD (Gr. περιοδος), in Astronomy and Chronology, denotes an interval of time at the end of which the same phenomenon again takes place. The period of a planet is the time in which it performs a revolution in its orbit. For chronological periods, see CYCLE. The term is also used in arithmetic, to denote the recurrence of a series of digits or numbers in the same order, as in circulating decimal fractions.

PERIOD, or SENTENCE, in Rhetoric, has been defined "a passage, *i.e.* series of words, developed in properly connected parts." In a stricter sense, a period is a sentence so framed that the grammatical construction will not admit a close, and the meaning remains suspended until the end of it. A sentence in which the sense would permit of a stop before its completion is, in this sense, not a period. The Greek and Latin languages were much more periodic than most modern tongues; that is, they admitted of the construction of sentences so that a single grammatical connection should run through a great series of words, while a similar series, in a modern language, would be so arranged as to form several distinct grammatical wholes.

PERIOD, THE JULIAN. In Chronology. *See* JULIAN PERIOD.

PERIO'DIC ACID. An acid analogous in composition to the *perchloric*, consisting of 1 equivalent of iodine + 7 equivalents of oxygen.

PERIO'DICALS. In Literature, strictly publications continued in numbers, appearing at regular intervals. But papers of the same description appearing at uncertain intervals (especially in Germany), are often comprehended under this general name. The first periodical in the character of a review was the *Journal des Savans*, begun in 1663.

PERIŒ'CI, or PERIŒCIANS (Gr. περι, *about*, and οικεω, *I dwell*), in Geography, is used to denote those inhabitants of the globe who live under the same parallel of latitude, but on opposite meridians; that is, in places which have the same latitude, but differ in longitude by 180°. They have their spring, summer, winter, and autumn in the same months of the year; but when it is noon with the one it is midnight with the other.

PERIO'STEUM. (Gr. περι, and οστεον, *a bone.*) The membrane which invests the bones. It is of a fibrous texture, and vascular.

PERIO'STRACUM. (Gr. περι, and οστρακον, *a shell.*) The layer of animal substance, or cuticle, which covers the outer surface of shells, and which the French conchologists term *drap marin*.

PERIPATE'TICS. That school of ancient philosophers which derived its origin from Aristotle. The name was given them from the Gr. περιπατοι or *walks* in the Lyceum, the scene of Aristotle's instruction. (For the doctrines of the Peripatetics, see ARISTOTELIAN PHILOSOPHY.) The immediate successors of Aristotle in the peripatetic doctrine were Theophrastus, Eudemus the Rhodian (from whom is derived the title of the Eudemian Ethics), Dicæarchus of Messana, Aristoxenus of Tarentum, and Strato of Lampsacus; among the later Peripatetics are preserved the names of Glycon of Troas, Hieronymus of Rhodes, &c. It would be unreasonable to expect that so elaborate a system as that of Aristotle should have received any important addition to its leading doctrines at the hands of his followers. They contented themselves either with defending and interpreting their master's doctrines, or with applying his method to the explanation of natural philosophy. Under their hands his system seems to have degenerated into a species of empirical materialism, a scheme as widely at variance with his genuine doctrines, as was the dry scholastic formalism which in the dark ages passed for the philosophy of Aristotle. (For notices of the later Peripatetics, see Cicero, *Acad. Quæst.*, and *De Finibus*, c. 5.; Lactant. *De Irâ Dei*, c. 10.; Plutarch, *De Solertiâ*, &c.) The Peripatetic school produced no men of note after its great founder, which is attributable to the current of free speculation being shackled by the authority of Aristotle, whose dogmas it was content to illustrate without daring ever to impugn; and in this respect its spirit was remarkably contrasted with the scepticism of the new Academy. (See *Ritter's Hist. of Anc. Philosophy*, book ix. ch. i.)

PERIPETEI'A, or REVOLUTION. (Gr. περιπετεια.) According to Aristotle, in his *Art of Poetry*, a necessary condition or circumstance of the drama; being a change of fortune, from happiness to misery, or the reverse, which takes place in the situation of the principal personage. *See* CATASTROPHE, DRAMA.

PERI'PHERY. (Gr. περι, and φερω, *I carry.*) In Geometry, the circumference of a circle or ellipse, or of any other curvilinear figure.

PERI'PHRASIS, or CIRCUMLOCUTION. (Gr. περι, and φραζω, *I speak.*) In Rhetoric, the use of several words to express the sense of one, or of a more involved and prolix form of expression to convey a meaning which might be adequately denoted by a shorter phrase.

PE'RIPLUS. (Gr. περὶ, and πλοῦς, *sailing.*) A circumnavigation. The word is only used as the title of some fragments which remain to us of narratives of voyages of the classical ancients. The *Periplus* of Hanno is a Greek translation (real or supposititious) of an inscription said to have been erected at Carthage in memory of a voyage along the western coast of Africa, respecting which much discussion has arisen among modern geographers. The date of this voyage is uncertain, but generally fixed by conjecture at 400 or 500 years before Christ. The *Periplus* of Scylax, which is supposed to belong to the age of Augustus, contains a succinct account of some journeys along the coasts of Europe and Asia. Two works bearing the same title pass under the name of Arrian, who wrote in the second century after Christ; the first contains a description of the Euxine, the second of the Erythræan Sea (Persian Gulf).

PERIPNEU'MONY. (Gr. περι, and πνεω, *I breathe.*) Inflammation of the lungs. *See* PNEUMONIA.

PERI'PTERY, *Peripteral.* (Gr. περι, and πτερον, *a wing.*) In Architecture, a building surrounded with a wing, aisle, or passage. The word *peripteral* characterizes one of the species of Greek temples, in which the cell is surrounded by a single row of columns, to distinguish it from the word *dipteral*, which designates a temple with two ranks of columns.

PE'RIS, in the Persian Mythology, are a class of imaginary beings closely allied to the elves or fairies of more northern latitudes, supposed to be the descendants of the fallen angels, and excluded from Paradise till they have made atonement for their sins. (See Moore's beautiful poem, "Paradise and the Peri," in *Lalla Rookh.*)

PERI'SCII. (Gr. περι, and σκια, *shadow.*) A name applied by the ancient geographers to the inhabitants within the arctic and antarctic circles, because, as the sun at certain times of the year does not set to them in the course of his diurnal revolution, their shadows describe an entire circumference.

PE'RISPERM. (Gr. περι, and σπερμα, *a seed.*) A term used by some to denote the testa, and by others the albumen of a seed.

PERISTA'LTIC. (Gr. περιστελλω, *I contract.*) A term applied to the peculiar motion of the intestines, by which their contents are gradually propelled from one end of the canal to the other.

PE'RISTOMES, *Peristomidæ.* (Gr. περι, and στομα, *a mouth.*) The name of a family of Pectinibranchiate Gastropods, including those species in which the shells have the margin of the aperture or mouth unbroken and continuous.

PE'RISTYLIUM. (Gr. περι, and στυλος, *a column.*) In Architecture, a court, square, or cloister, with columns on three sides: hence improperly so called. In peristylia with columns on each of the four sides, that towards the south was frequently higher than the rest. This species was called a Rhodian peristylium.

PERITHE'RIDES. (Gr.) In Architecture. *See* ANCONES.

PERITONÆ'UM. (Gr. περιτεινω, *I extend round.*) The membrane which envelops the abdominal viscera, and lines the cavity of the abdomen. Hence also *peritonitis*, or inflammation of the peritoneal membrane.

PERITRO'CHIUM. (Gr. περιτροχεω, *I run about.*) In Mechanics, a wheel or circular frame of wood, fixed upon a cylinder or axle, round which a rope is wound; and the wheel and cylinder being moveable about a common axis, a power applied to the wheel will raise a weight attached to the rope with so much the greater advantage as the circumference of the wheel is greater than that of the cylinder. This mechanical power is called the *axis in peritrochio*; the windlass and capstan are constructed on the same principle.

PE'RJURY (Lat. pejero), in Law, is a wilful false oath taken in a court of justice, by a witness lawfully required to depose the truth in a matter of some consequence to the point in question. A false oath, therefore, taken before no court, or before a court incompetent to try the issue in question, does not constitute the offence of perjury. Perjury is a misdemeanor at common law, and by several statutes punishable by fine and imprisonment, and by transportation for a term not exceeding seven years.

PERKUNOS. One of the chief divinities of ancient Prussia, who, together with Rikollos and Potrimpos, formed the sacred Trinity of the Slavonic and the adjoining nations. He was regarded as the god of the elements; and his worship extended even to Russia, Poland, Bohemia, where there were numerous temples erected to his honour. (See *Grimm's Deutsche Mythologie.*)

PE'RMIT. An order or written permission from an officer of the customs, authorizing the removal of goods subject to excise duties from one place to another.

PERMUTA'TION, in Algebra, denotes the arrangement of any determinate number of things or letters in all possible orders one after the other. For example, two letters, *a b*, give the two permutations *a b* and *b a*; and three letters, *a b c*, give the six permutations *a b c*, *a c b*, *b a c*, *b c a*, *c a b*, *c b a*. *Permutation* is effected by placing the letters in all possible orders, so that all the letters enter into each result, and each enters into it only once; and is therefore distinguished from *combination*, which implies that the arrangements are so made that any two of them differ in respect of one at least of the letters which enter into the results, without regard to the order of the arrangement.

To find the number of permutations that can be made upon any number of letters n, taken together, we may reason in this way: — Suppose the total number of permutations that can be made of $n-1$ letters to be known, and let it be designated by Q. Let us consider one of the given letters, f, by itself, and suppose it to be placed on the right of each of the Q permutations given by the other $n-1$ letters; there will result Q permutations of n letters, each ending with f. But as each of the n letters may be considered separately in the same manner as f, it follows that the total number of permutations of the n letters is equal to $Q \times n$. Let $n = 2$; Q then denotes the number of permutations of one letter; whence $Q = 1$, and $Q \times n = 1 \times 2$. Let $n = 3$; Q then denotes the number of permutations of two letters, which is just found equal to 1×2. Therefore $Q \times n = 1 \times 2 \times 3$. Let $n = 4$; Q then denotes the number of permutations that can be made on three letters, or $1 \times 2 \times 3$. Therefore $Q \times n = 1 \times 2 \times 3 \times 4$.

In general, the number of permutations that can be made upon n letters, taken together, is expressed by the continued product

$$1 \times 2 \times 3 \times \ldots . (n-1) \times n.$$

For example, the number of changes that can be rung upon twelve bells is $1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 \times 8 \times 9 \times 10 \times 11 \times 12 = 479001600$.

PERNIO. *See* CHILBLAIN.

PERORA'TION. (Lat. per, and os, *mouth.*) The concluding part of an oration, in which either the arguments and representations of the speech are briefly recapitulated, or a short and comprehensive conclusion deduced from them, or a brief appeal made to the sentiments or passions of the audience.

PERO'XIDE. The highest degree of oxidizement of which a metal or other substance is susceptible without becoming an acid.

PERPENDI'CULAR. In Geometry, a straight line is said to be perpendicular to another straight line when the adjacent angles formed by their intersection are equal, and, consequently, each is a right angle. A straight line is perpendicular to a curve at a given point when it is perpendicular to the tangent to the curve at that point. In this case the perpendicular is usually called a *normal* to the curve. (*See* NORMAL.) A straight line is perpendicular to a plane when it is at right angles with every straight line in the plane passing through the point of intersection. A plane is perpendicular to a plane when any straight line in the first which is perpendicular to the common intersection of the two planes is also perpendicular to the second plane.

PERPETUAL MOTION. In Mechanics, a machine which, when set in motion, would continue to move for ever, or at least until destroyed by the friction of its parts, without the aid of any exterior cause. The discovery of the perpetual motion has always been a celebrated problem in mechanics, on which many ingenious, though in general ill-instructed, persons have consumed their time; but all the labour bestowed on it has proved abortive. In fact the impossibility of its existence has been so fully demonstrated from the known laws of matter, that it is rather an insult than a praise to say of any one that he has occupied himself with the research. Nevertheless, the pursuit of the chimera has been the cause of many useful inventions.

In speaking of the perpetual motion, it is to be understood that from among the forces by which motion may be produced we are to exclude not only air and water, but other natural agents, as heat, atmospheric changes, &c. The only admissible agents are the inertia of matter, and its attractive forces, which may all be considered of the same kind as gravitation.

It is an admitted principle in philosophy that action and reaction are equal; and that when motion is communicated from one body to another, the first loses just as much as is gained by the second. But every moving body is continually retarded by two passive forces, the resistance of the air and friction. In order, therefore, that motion may be continued without diminution, one of two things is necessary, — either that it be maintained by an exterior force (in which case it would cease to be what we understand by a perpetual motion); or that the resistance of the air and friction be annihilated, which is physically impossible. The motion cannot be perpetuated till these retarding forces are compensated, and they can only be compensated by an exterior force; for the force communicated to any body cannot be greater than the generating force, and this is only sufficient to continue the same quantity of motion when there is no

resistance. To find the perpetual motion is therefore a proposition equivalent to this,—to find a force (either an attractive force like that of gravitation or magnetism, or an elastic force, that of a spring for example) greater than itself.

But it may be argued that by some arrangement or combination of mechanical powers a force may be gained equal to that which is lost in overcoming friction and atmospheric resistance. This notion at first mention appears plausible, and is in fact that by which most speculators have been led astray. It is, however, entirely erroneous; for by no multiplication of forces or powers by mechanical agents can the quantity of motion be increased. Whatever is gained in power is lost in time; the quantity of motion transmitted by the machine remains unaltered.

Although the perpetual motion has been demonstrated again and again to be impossible on any known principle of mechanics, projectors have not thereby been deterred from the pursuit. In 1775 the Academy of Sciences at Paris resolved not to consider or admit into their Memoirs any future proposal for the discovery of the perpetual motion; yet such appears to be the seductive nature of the subject that innumerable schemes, designs, and projects for accomplishing it have since been, and even to the present time continue to be, put forward; and there are very recent instances of men of no common attainments and reputation, and well versed moreover in the principles of mechanical science, who have been deceived by the ingenious frauds of charlatans and impostors into a belief of its actual discovery. (Montucla, *Hist. des Math.* tome iii. p. 813.; *Repertory of Arts*, vols. vii. and xiv.; *London Journal of Arts*, May, 1827; Airy, *Trans. of the Cambridge Phil. Soc.* vol. iii. part. 2.; Poppe, *Wunder der Mechanik*, 1832; and various papers in the earlier volumes of the *Memoires de l'Academie des Sciences*, and the *Philosophical Transactions*.)

PERPETUI'TY, in the doctrine of Annuities, is the sum of money which will purchase a certain annuity to continue for ever. This is equal to the product of the annuity into the number of years in which the simple interest of any sum will equal the principal. For example, if the rate of interest be 4 per cent., the simple interest of any sum will amount to a sum equal to the principal in twenty-five years. The value, therefore, of the perpetuity of 100*l.* per annum is 2500*l.* The number of years is equal to unit divided by the rate of interest, or 100 divided by the rate per cent.

PE'RRY. (Lat. pirum, *a pear.*) A fermented liquor made from pears, in the same manner as cider from apples. The pears best fitted for producing perry are exceedingly harsh and tart; but it is itself pleasant and wholesome.

PERSECU'TIONS. The name by which several periods in the history of the Christian church are historically distinguished. Of these by far the most sanguinary occurred in the first centuries of the Christian era, and originated in the desire of the Gentile nations to extirpate the followers of the Christian faith. On the accession of Constantine to the throne of the Western world, these Gentile persecutions ceased; and the subsequent history of the church is disfigured by persecutions raised by the more powerful against the weaker of the Christian sects.

PERSEUS. Son of Jupiter and Danae, one of the most distinguished heroes of the Grecian mythology. His history is too well known to be recapitulated here. His chief exploit was the conquest of *Medusa* (which see).

PERSEUS. One of the forty-eight ancient constellations, situated in the northern hemisphere.

PERSEVE'RANCE, or FINAL PERSEVERANCE. In Theology, the continuance of the elect in a state of grace to the end of their lives, which, according to some theologians, must always be the case with him who has once been truly called into such a state. Since God is represented as the image of perfection and immutability in himself, so, it is argued, having once begun the preparation of a human being for a blessed eternity, he will not leave his work unfinished; but the person concerned must necessarily persevere to the end in a state of acceptance, under the absolute decree of which he was originally elected unto life.

PE'RSIAN WHEEL. In Mechanics, a contrivance for raising water to some height above the level of a stream. In the rim of a wheel turned by the stream a number of strong pins are fixed, from which buckets are suspended. As the wheel turns, the buckets on one side go down into the stream, where they are filled, and return up full on the other side till they reach the top. Here an obstacle is placed in such a position that the buckets successively strike against it and are overset, and the water emptied into a trough. As the water can never be raised by this means higher than the diameter of the wheel, it is obvious that this rude machine is capable of only a very limited application. Sometimes the wheel is made to raise the water only to the height of the axis. In this case, instead of buckets, the spokes are made hollow, and bent into such a form that when they dip into the water it runs into them, and is thus conveyed to a box on the axle, whence it is emptied into a cistern. Such wheels are in common use on the banks of the Nile, and elsewhere.

PERSISTENCE (Lat. per, *through;* sisto, *I remain*), in Optics, signifies the duration of the impression of light on the retina after the luminous object has disappeared. Thus, if a lighted torch is whirled round rapidly, a continuous circle of light is seen. A great number of illusions of the same kind, as the augmentation of the apparent volume of a musical chord when in vibration, the luminous train accompanying a falling meteor, &c., are explained by this property of vision; and it has been ingeniously applied by Professor Wheatstone to measure the velocity of electric light.

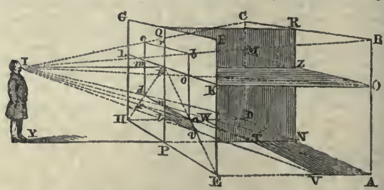
PERSON. *See* GRAMMAR.

PE'RSONAL PROPERTY, according to the division recognized by our law, is best defined negatively, as including every thing which may be made the subject of property, and which is not legally considered as appertaining to land. The original distinction was undoubtedly between things moveable and immoveable. But, on the one hand, a personal interest may be acquired in things immoveable, *i. e.* in land by lease for years (chattels real); while, on the other hand, some things not affixed to the soil and some bare rights and privileges are considered as freehold. The distinction, therefore, is scarcely maintained with philosophical accuracy, although we may still consider that every thing which is of a freehold nature is either obviously or constructively connected with the enjoyment of land, or, in technical language, *savours of the realty;* while every thing wholly unconnected with land falls under the denomination of chattels personal. The term *chattel* is derived from the barbarous Latin word *catallum*.

Besides chattels real, already adverted to, personal property is said to be either *in possession* or *in action*. The first class of objects includes every thing comprehended under goods and chattels, ready money and stock, or such animals as are the subjects of property: the second class are legally termed *choses* or things in *action*, and are defined to be things to which a man has a bare right without any occupation, the possession whereof may be recovered by a suit or action at law. Of this class, therefore, are all debts, and the securities for them, unless these securities attach on land. Sums of money due on bond, on bills of exchange, and promissory notes, property in the funds, all fall within this comprehensive class, which, originally so trifling as to be hardly noticed in early jurisprudence, now comprehends by far the greater part in value of the moveable property of our commercial community.

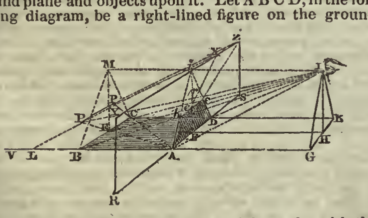
PERSONIFICA'TION, or PROSOPOPŒIA. In Rhetoric and Composition, a figure of speech, being a species of metaphor (*see* METAPHOR), by which inanimate objects, or abstract notions, are represented as endued with life and action: sometimes by being addressed as living agents (*see* APOSTROPHE); at other times, by being coupled with attributes which belong only to living agents.

PERSPECTIVE. (Lat. perspicio, *I look through.*) In the Fine Arts, the art of delineating on a given transparent plane or superficies objects as they appear to an eye placed at a given height and distance. From the definition, it is evident that to delineate the true appearance of an object on a plane surface, it becomes necessary to know the laws according to which the apparent linear dimensions of an object increase or decrease; and they are these generally:—1. The visual angle, or the apparent magnitude of a line, will be less the greater the distance, and the converse; 2. It will be less the more obliquely a line is viewed; 3. The law of diminution will be nearly in proportion to the obliquity and distance conjointly. In the following diagram, let the eye



of the spectator be at I, and let E F G H be the plane on which the appearance of objects is observed. This is called the *perspective plane*, or *plane of the picture*. Now the appearance of every object to be delineated will vary according to the plane in which it stands, considered with respect to the perspective plane; hence the particular situations of object planes are the main points for consideration. It is manifest that any plane passing through the eye can only be seen on the perspective

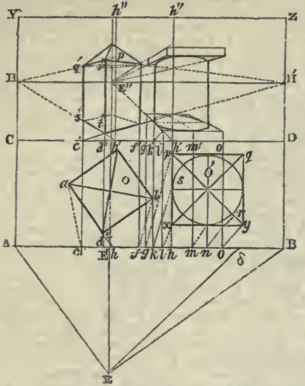
plane as a line; for the eye, having neither elevation above nor depression below such plane, can see no part of its surface, its edge being all that is visible to the eye. Of such planes two are of primary importance in perspective; viz. the *horizontal plane*, O K L M, parallel to the horizon; and the *vertical plane*, Q P R N, perpendicular to the last. The first intersects the perspective plane in the line L K, called the *horizontal line;* and the last in the line Q P, called the *vertical line.* Planes not passing through the eye must have a *direct* or an *oblique* situation relative thereto. If the former, it must be parallel to the perspective plane, which is supposed to be placed *directly* before the eye; thus, the plane A B C D is a direct one, and parallel to the perspective plane G E. Of the planes situated obliquely to the eye, the most considerable is A E H D, which is called the *ground plane*, and is parallel to that of the horizon. From the foregoing observations, then, it appears that objects in the surfaces of the horizontal and vertical planes cannot be seen by the eye at I; and therefore cannot be represented on the perspective plane. If O B be an object in the direct plane, and from the extreme points O and B the visual rays O I, B I be drawn to the eye at I, they will pass through the perspective plane in the points *o* and *b*, and by joining them the right line *o b* will be the representation of the line or object O B on the perspective plane. In like manner the representation of O A is *o a*, and *b r* and *a n* will be the representation of B R and A N, and consequently *r b a n* of R B A N, &c. &c. So all lines parallel to A B or C D in the object plane will have their perspective lines parallel to *a b* and *c d* in the picture on the perspective plane; and however the object plane A C may be divided, their representations on the perspective plane or planes of the picture will divide that in a similar manner. Any point B in a direct plane has the same ratio of distance from the horizontal and vertical planes, as its perspective has from the horizontal and vertical planes, viz. that of the distances of the planes from the eye, from the nature of similar triangles: hence the forms of objects on the perspective plane, when they are presented in a direct view, may be drawn with facility. The last species of plane whereon it is supposed we may view the natural object is that of the ground itself, as A D H E, above which the eye has more or less an elevation; as *i* P, equal to I Y. This is hence called the *ground plane*, and its intersection, H E, with the perspective plane is called the *ground line.* It is more important than all others, as being the common table, as it were, on which every thing is placed. In respect to this horizontal plane, we have seen that the two remote angles thereof, A and D, are represented by *a* and *d* in the perspective plane; the other two angles, E and H, are in the same plane also, as being common to both; therefore, by drawing the lines *a* E and *d* H, there will be formed the figure E and H on the perspective plane, which will be the correct perspective appearance of the ground plane A D H E. Thus, *a* E is the perspective of A E, *n* P of N P, and *d* H of D H; and lines that are parallel in the ground plane and perpendicular to the perspective plane are not so in their perspective picture, but converge to a point *i*, called the *point of sight*, in the perspective plane, because exactly opposite to the eye, or the point in which a perpendicular from the eye falls on the plane. In the ground plane draw V W parallel to A D; its perspective *v w* will be parallel to *a d* in the picture, and *a d w v* will be the perspective of the part A D W V in the original plane. We shall now proceed to a demonstration of what relates to forming the perspective appearance or picture of the ground plane and objects upon it. Let A B C D, in the following diagram, be a right-lined figure on the ground



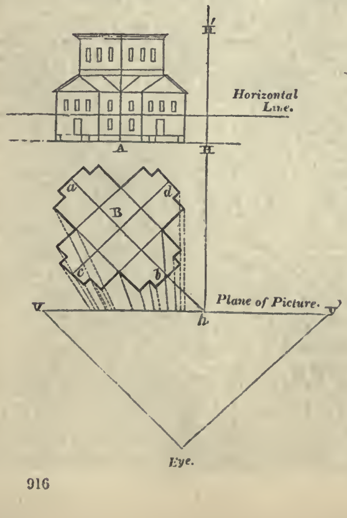
plane V G K C, contiguous to and at right angles with the perspective plane Y Z S R. F H is the distance of the plane, and H I the height of the eye at I. H E is parallel to G B or C K, and bisects A D and B C in the points F and E. On the point E raise the perpendicular E M, equal to H I, and draw the lines B M, C M, G I, and K I. Draw the visual lines I A, I B, and I M, which is called the *principal ray*, and is perpendicular to the perspective plane in the point *i*. Now it is evident that the plane I G B M intersects the perspective plane in the line A *i*, and the ray B I, being in the said plane G M, must intersect the line A *i* in some point *b*, which is therefore the perspective of the point B: hence A *b* is the perspective of the line A B. Also, as the plane I K C M intersects the perspective plane R Z in the line D *i*, and the ray I C is in that plane, and intersects the line *i* D in the point *c*, that point will be the perspective of the point C, and D *c* that of the line D C. Joining the points *b c*, the line *b c* will be the perspective of the line B C in the ground plane. Let A B equal D C, then B C will be parallel to A D; and as in this case A *b* is equal to D *c*, *b c* will be parallel to A D also. From this it is manifest *that all right lines, as* B C *in the ground plane, which are parallel to the ground line* A D, *will also be parallel to the same in their representations on the perspective plane.* It is moreover evident *that the representations* A *b*, F *e*, D *c*, *of all lines* A B, F E, D C, *perpendicular to the ground line* A D, *converge or tend to the point of sight i in the perspective plane.* If the line A B be carried out infinitely in the direction of V, then, supposing the point B to move along that line continually, the visual ray B I will keep rising on the plane I G B M towards I M, making the angle B I M less and less, till the point B being at an infinite distance the ray I B will coincide with I M, and consequently the line A *i* will be the perspective of A B continued infinitely. So D *i* will be the representation of the line D C continued infinitely. Hence *the triangle* A *i* D *will, on the perspective plane, be the true representation of the plane* A B C D *carried out infinitely on the plane of the horizon.* Hence, also, the line Y *i* Z is the perspective of the horizon or boundary of the sight at an infinite distance; and therefore all objects on the plane of the horizon will, in their representations, be seen to rise from the ground line towards the point of sight, and lessen in appearance as they grow more distant, till at last they vanish in the horizontal line Y Z. We now come to lines which lie oblique to or make an angle with the ground line A D, or any other parallel to it. Make A L equal to A G or I *i*, and draw A *p* to make any angle *p* A R or *p* A D with the base A D, acute or obtuse. Then in the horizontal line Y Z take *i* X, equal to L *p*, and draw *p* X and *i* X; the plane I X *p* A will intersect the perspective plane in the line A X. Draw the visual ray I *p*, which, being in the plane I X *p* A, must go through the perspective plane somewhere in the line A X, which suppose at *r*. Then is the point *r* the perspective of *p;* and since the point *p* is supposed to pass from A to *p*, in describing the line A *p* its perspective *r* will move in the plane A Z from A to *r*, and describe the line A *r*, which therefore will be the representation of the line A *p*. If A *p* be carried out infinitely, and the point *p* supposed to move constantly therein, its representation *r* will appear to move towards X, till at length the point *p* being at an infinite distance, *r* arrives at and coincides with X in the horizontal line. A X is therefore the representation of the line A *p* infinitely continued; and X is called the *accidental point*, to which the representations of all lines parallel to A *p* tend. Let L P be taken equal to A L, and *i* Z equal to *i* I; then, joining A P and *i* Z, the triangles A P L and *i* Z I are equal. Then will the plane *i* A P Z intersect the perspective plane in the line A Z, which will be the representation of the line A P carried to an infinite distance. But since A L is equal to L P, and L P is parallel to A D, therefore A P is the diagonal of a square, and contains an angle D A P of forty-five degrees with the ground line A D; hence the point of distance Z is that to which all rays parallel to A P tend in the perspective plane. Let A B equal A D; then is A B C D a geometrical square, and its diagonal A C, whereof the representation is A *c;* and the point *c* is therefore that in which the perspective diagonal A Z intersects the ray or radial line *i* D. Make *i* Y equal *i* Z, or *i* I, and join D Y, and it will be the perspective diagonal of D B (the other diagonal of the square A C) infinitely continued, and D *b* the representation of the diagonal D B, determined by the intersection of the lines D Y and A *i*, as before. Thus it is demonstrated that A *b c* D on the perspective plane A S Z Y is the true picture or perspective representation of the original square A B C D on the ground plane, as required.

From the above principles are deduced the common rules of perspective, of which we shall give two or three examples. A B C D is a ground plane, whereon are seated the objects O and O′. The line A B is the plan of the plane of the picture, or its intersection with the ground plane; and C D Y Z is the plane of the picture, or the perspective plane, as we have before called it. It will be observed that one of the objects, O, lies obliquely towards the perspective plane, and the other is parallel to it or direct. We will first deal with the former. From the station of the eye, E, parallel to *a e* and *e b*, two of the sides of the object, draw the lines E A and E B, cutting the plane of the picture in A and B. Then will A be the vanishing point of all lines parallel to *a e*, as will be B of all lines parallel to *e b*. E′ is the place of the eye at the intersection of the ground plane with the picture, being a perpendicular from A B to E′. If H H′ be the horizontal line, then H E″, equal to A E′, is the place of the eye on the perspective plane. From the different points of the object *a e b* draw towards E as a centre the visual rays *a c*, *e d*, *b f*, intersecting A B in

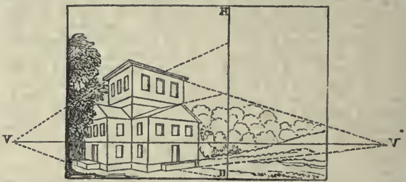
c, d, and f; and from them continue upwards indefinitely the verticals $c\,c'$, $d\,d'$, $f\,f'$, which will be the boundaries of



the sides $a\,e$ and $e\,b$ respectively. On the plan continue one of the sides $a\,e$ till it intersects the picture in h, and make C h' on the perspective plane equal to A h on the plan; and draw the vertical $h'\,h''$, which will be the *line of heights* on which they are to be set out. Then, if $h'\,p$ be the height of the object O, lines drawn from h' and p to the vanishing point H will intersect the verticals in q and r and s' and t'. In like manner, lines drawn from t' and r' towards the vanishing point H will give the representation of the other side. Lines drawn in opposite directions at the top of the figure (dotted in the diagram) will enable the draftsman to draw diagonals from whose intersection a vertical may be raised for crowning the object with a pyramid or other figure. In respect of the object O′, which on the plan is a square circumscribing a circle, the object being direct or parallel to the picture, all those lines parallel to it will be horizontal, and the vanishing point of the returning sides $p\,x$, $q\,y$ will be found in E′ (or E″ in the picture), which, as in the former case, is found by a line from E parallel to those sides intersecting the picture. Similarly, a line from E parallel to $x\,q$, intersecting the picture in δ, will be the vanishing point of all diagonals of a square in that direction. The visual rays tending to E, shown at $g\,k\,l$, &c., are to be transferred to the picture by verticals as before. In this object $h\,h'\,h''$ will be seen to be the line of heights, on which all heights are to be set out. The perspective extent of a circle is easily obtained by lines bounding its convexity, transferred by the visual rays $s\,k\,r\,n$ to the picture, which, aided by the diameters, will give the form required. To give the reader a general notion of the common mode of proceeding in perspective representations of buildings, we present the following diagrams. B is the plan of a building to be thrown into



perspective, inclined to the plane of the picture at any angle $v\,h\,a$. The vanishing points of all lines parallel to $a\,b$ are found by a line from the eye parallel to $a\,b$, cutting the picture in V. Similarly, V′ is found to be the vanishing point of all lines parallel to $c\,d$. If $a\,b$ be continued to h, it gives the place of the line H H′, whereon the heights of the different parts of the elevation A may be set according to their several altitudes. The place of the horizontal line is chosen so as to afford the most agreeable representation of the object; its height depending, of course, on that at which the eye would most probably be placed, or might be supposed to be. The visual rays to the eyes are shown by the dotted lines. Having thus prepared the geometrical plan and elevation of the object, the plane of the picture is set out as under; and the reader must observe that the whole extent of it hori-



zontally must not take in an angle of more than sixty degrees, that being as great as the eye can take in without turning the head, though in internal views a greater extent is generally tolerated. It is to be observed that in this diagram the representation, for the sake of greater distinctness, is doubled in dimensions from the plan. The place of H H′ is transferred to the picture, and the height carried down from it to the vertical lines, whose places have been found by the visual rays above mentioned. The vanishing points V and V′ are transferred to the horizontal line V V′, and the horizontal lines in the sides tend thereto. It is obvious that a similar process enables the draftsman to make internal representations, the principles whereon they are conducted being precisely the same. It is needless to expatiate on the importance of perspective to the painter; and though Fresnoy has advised that "the compasses should be rather in his eyes than in his hands," it is clear that without a knowledge of its laws he can never hope to succeed.

That perspective was unknown to the ancients, as some have supposed, is a mistake. What has led to such an error has been, perhaps, the violation of its rules in basso relievo, and particularly in those on the Trajan column, where attention to them would have been impossible, if not improper. Another ground for the supposition is the ignorance of perspective displayed in the paintings of Herculaneum and Pompeii. But such examples are no proof. How many painters of our own days, some of them even possessing a certain sort of reputation, are sadly ignorant upon the subject. The truth is, that the ancients were not only eminent for their success in painting walls with architectural subjects, but they were also known to have required the practice of this branch of the arts in the decorations of their theatres. To such a point of perfection was it carried, if we may rely on Pliny, that in the decorations of the theatre of Claudius Pulcher the imitations were so striking that the birds attempted to alight on the tiles of the roofs. This probably, however, is but a figurative description of the work, and that it was so intended; for otherwise it would be drawing rather too largely on our credulity. Vitruvius tells us, in the Preface to his 7th Book, that perspective was well understood at a very early period. His words are, "Agathasius, at the time when Æschylus taught at Athens the rules of tragic poetry, was the first who contrived scenery, upon which subject he left a treatise. This led Democritus and Anaxagoras, who wrote thereon, to explain how the points of sight and distance ought to guide the lines, as in nature, to a centre; so that, by means of pictorial deception, the real appearances of buildings appear on the scene, which, painted on a flat vertical surface, seem nevertheless to advance and recede." Neither was the practice of perspective confined to the representations just mentioned. Its knowledge was considered equally necessary in pictures. The painter Pamphilus, whose celebrated school of design was at Sicyon, taught perspective publicly, and carried his opinions on this head to such an extent that he considered no perfect painting could be executed without a knowledge of geometry. "Omnibus letteris eruditus præcipuè arithmeticæ et geometriæ, sine quibus negabat artem perfici posse."

The earliest authors on the subject whose works have reached us are Bartolomeo Bramantino of Milan, whose work, *Regole di Prospettiva e Misure delle Antichità di Lombardia*, appeared in 1440; and Pietro del Borgo, who, as he died in 1443, probably wrote earlier. Baltazzare

Peruzzi, improving on the methods of Pietro, whom he had carefully studied, very considerably advanced the science. Guido Ubaldi followed him; and, publishing his work at Pesaro, in 1600, established its principles on a basis which left little to be done by our countryman Dr. Brook Taylor, the first Englishman who wrote scientifically on the subject. The works on the subject are in every language very abundant; but, in our own, the work of Thomas Malton, published in folio, London, 1776, entitled *A complete Treatise on Perspective, in Theory and Practice, on the Principles of Dr. Brook Taylor*, is the most valuable to the student, and should be in the hands of every one who has a desire to be thoroughly acquainted with the subject.

PERSPECTIVE, AERIAL. *See* AERIAL.

PERSPIRA'TION. (Lat. perspiratio.) The vapour secreted by the ramification of the cuticular arteries over the surface of the body. In the healthy state it is slightly acid and saline. According to Lavoisier and Seguin, the greatest amount of perspiration exceeds six pounds in the twenty-four hours, and the smallest two pounds; it is at its maximum immediately after taking food, and decreases during digestion. Whatever quantity of food is taken, or whatever are the variations of the atmosphere, the same person, after having increased in weight by all the food he has taken, returns in twenty-four hours nearly to the same weight he was the day before, provided he is not growing and has not indulged in any excess.

The substances perspired are water, carbonic acid, saline substances, lactic acid, and some organic matter. In certain cases of disease, the perspiration is not only greatly modified as to quantity, but often as to quality.

PERTURBA'TION. In Astronomy, the deviation of a celestial body from the elliptic orbit which it would describe if acted upon by no other attractive force than that of the sun, or central body about which it revolves. If the planets exercised no attraction on each other, the orbit described by each of them would be accurately an ellipse, having the sun in one of its foci; and the law of the motion such that the area described by a straight line joining the centre of the sun and the planet would describe equal areas in equal times. But in consequence of the universal gravitation of matter, every body in the system is more or less affected by the attractive influence of all the others, and is consequently forced to deviate from the path it would describe in virtue of the central force acting alone. The forces which cause these deviations are called the *perturbing* forces; and the determination of their effect on each orbit is the great problem of physical astronomy.

The simplest case of the problem is a system in which there are only three bodies, — a central body and two revolving bodies, disturbing the motions of each other. Such, for example, would be the case of the sun, the earth, and the moon, if all the other planets were conceived to be annihilated, or at so great a distance that their disturbing force was rendered insensible. For the sake of perspicuity, let one of the revolving bodies be called the *disturbed* and the other the *disturbing* body. Now it is by no means difficult to obtain a general idea of the effects that must be produced by the disturbing force. It is easy to see, for example, that in certain positions of its orbit the motion of the disturbed body must be accelerated, and in others retarded; that in one case it may be drawn above, and in another depressed below the plane of the orbit it would describe about the central body. But a far more difficult problem remains — namely, that of determining the ultimate effect of the reciprocal action of the revolving bodies after an infinite number of revolutions. When the masses and distances of the bodies are supposed to be given, this is a problem of pure mathematics; but such is its difficulty that even when restricted to three bodies, its general solution transcends the power of analysis; and it is only in a particular case (that, however, which is presented by nature), namely, when the mass of the disturbing body is very small in comparison of the central one, that mathematicians have succeeded in integrating the equations of motion, and determining the final results.

It is easy to conceive that if the problem presents great difficulties when only three bodies are taken into consideration, these difficulties must be infinitely increased when it is attempted to investigate the reciprocal actions of all the individuals composing the solar system. To determine the circumstances of the motions of about thirty bodies projected in space and abandoned to their mutual attractions, is a problem indeed which far transcends the power of any known calculus. Nevertheless there are circumstances in the peculiar constitution of the solar system which enable us not only to foresee the general effect, but to determine the form and dimensions and position of an orbit, and the place of the body it, at any given time, past or future, with all the precision which astronomical observations admit of. These circumstances are the following: — In the first place, by reason of the immensely preponderating attraction of the sun, the force by which any planet is attracted by another is extremely feeble in comparison of that by which it is retained in the orbit it would describe if there was no other body than itself and the sun. Hence the deviations from that orbit are small, and the disturbing action of each planet admits of being computed independently of the others. In the second place, all the large planets are confined to a zone of a few degrees in breadth, and therefore can exert only a comparatively feeble influence in drawing one another from the planes of their orbits. In the third place, the system is broken up into subordinate and partial systems, which are almost independent of one another. Thus, for example, the Sun, Jupiter, and Saturn form a system, in which the two planets exert a very sensible action on each other, but are very little affected by the influence of any other body; and the same is the case, though in a less degree, with Venus and the Earth. By reason of these circumstances, mathematicians have been enabled to accomplish what would otherwise have been impossible, and to express the disturbing forces of the several bodies of the system by algebraic equations, from which the positions of all the planets and the principal satellites are computed for several years to come, and reduced into tables for the purposes of navigation.

The inequalities produced in the motions of the planets by their reciprocal actions are divided into two kinds. The first depend on the *configurations* of the planets, that is, the relative positions they have with regard to each other; and, as the inequalities depending on this cause increase, diminish, and disappear after certain intervals of time, they are called *periodic inequalities*. Those of the second kind are independent of the relative positions of the planets: they are also periodic, but their periods are incomparably longer than those of the first kind; hence they are called *secular inequalities*, as if their periods were not to be reckoned by years, but by centuries. It is by the discovery of the periodic nature and ultimate compensation of all the inequalities of both kinds, occasioned by the perturbing forces, that the permanent stability of the system is demonstrated.

In order to assure the stability of the planetary orbits, three elements must remain constant, or be subject only to small periodic fluctuations. These are, 1. The major axis of the orbit, or the planet's mean distance from the sun; 2. The inclination of its orbit to a fixed plane; and 3. The eccentricity of the orbit. Now, with respect to the major axes, it has been demonstrated by Lagrange that they are exempted altogether from secular inequalities, and are subject only to periodical changes depending on the configurations of the planets. They are therefore restored to their former values when the planets resume the same relative positions; and their mean values, and consequently the mean motions which depend upon them, remain unalterably the same. With regard to the inclinations and eccentricities, they are affected both by periodic and secular inequalities; but their secular changes are confined within very small limits, and ultimately work out a compensation. Besides, the inclinations and eccentricities of the different orbits are connected with each other in such a manner, that whatever any one orbit gains in either of these respects is lost among the others. These relations are defined by the two following theorems discovered by Lagrange, than which analysis has furnished no more remarkable or beautiful results: —

1. If the mass of every planet be multiplied by the square root of the major axis of its orbit, and the product by the square of the tangent of its inclination to a fixed plane, the sum of all these products will be constantly the same under the influence of their mutual attraction.

2. If the mass of each planet be multiplied by the square root of the axis of its orbit, and the product by the square of the eccentricity, the sum of all such products throughout the system is invariable.

From the periodic nature of the changes produced in the three elements mentioned above, it follows that the whole effect of the perturbing forces is to cause the system to oscillate about a mean state, and that the inequalities of the planetary motions are all compensated in the long run; and that consequently the system contains within itself no element of destruction, but is calculated to endure for ever, unless an external force be introduced. These results of theory are, in a speculative point of view, by far the most interesting in the whole range of astronomical discovery. They are not deduced, however, from the solution of the general problem of the motion of bodies mutually attracting each other, but are founded on certain conditions which belong to the individual system; viz. 1. That the eccentricities of the orbits are inconsiderable; 2. That the inclinations to the plane of the ecliptic are small; and, 3. That all the planets, primary and secondary, move in the same direction. Now these conditions are not necessary consequences of gravitation. For any thing that has been proved to the contrary, a system might exist under the Newtonian law of gravitation in which not one of them would be satisfied. Of their final causes, however, we are, and may ever remain, entirely ignorant; but the fact of their existence (for the chances are almost as infinity to one

that they are not accidental) proves clearly enough that the primitive impulse which determined the directions of the different motions must have been communicated to all the planets and satellites by the same mechanical cause.

The history of the problem of the perturbations dates from the discovery of universal gravitation. Newton himself pointed out the general effects which the mutual attractions of the planets must have in disturbing the motions of each other, and applied his theory to the investigation of the precession of the equinoxes, and the inequalities of the moon. The problem of three bodies was solved by Clairaut, D'Alembert, and Euler, about the middle of the last century. Euler first pointed out the periodic nature of the variations of the orbits of Jupiter and Saturn occasioned by their mutual perturbations. Laplace remarked that on taking account of some of the first terms of the analytical development of the expressions of the perturbed orbits, those on which the secular inequalities depend are capable of increase only within certain limits; and Lagrange demonstrated generally that no secular inequality, or term proportional to the time, can possibly enter into the expression of the greater axis of the orbit, or the mean motion which depends on it. It may be said that the discoveries of these two great mathematicians completed the theory of gravitation, inasmuch as every inequality in the system not previously accounted for was by them referred to its proximate cause, and its analytical expression assigned. The labours of all succeeding mathematicians in the department of physical astronomy have been confined to the extension and simplification of their theories.

For a popular account of this subject, the reader may consult *Laplace's Système du Monde, Sir J. Herschel's Treatise on Astronomy*, and *Airy's Gravitation*. The mathematical theory is contained in the *Mécanique Céleste*, and other works on physical astronomy. (See, also, *Playfair's Outlines of Nat. Phil.; Woodhouse's Astronomy*, vol. ii.; Pontécoulant, *Théorie Analytique du Système du Monde;* Gautier, *Essai Historique sur le Problème des Trois Corps*.)

PERTU'SSIS. The whooping cough.

PERU'VIAN BALSAM. The produce of the *Myroxylon Peruvianum;* a tree which grows in the warmest parts of South America. It is obtained by boiling the twigs in water. It is a thick brown liquid, of a fragrant odour, and a pungent and bitterish flavour.

PERUVIAN BARK. *See* CINCHONA.

PERVIGI'LIUM. (Lat. from vigil, *watchful;* a watch lasting through the night.) The nocturnal festivals to some deities were so styled by the Romans. The *Pervigilium Veneris*, a beautiful relic of Latin poetry, is attributed by some critics to Catullus.

PESTILENCE. (Lat. pestis.) Any contagious or infectious disease which is endemic or epidemic, and mortal. The term is also used in a moral sense. *See* PLAGUE.

PE'TALISM. (Gr. πεταλον, *a leaf.*) In Antiquity, a form of condemnation practised at Syracuse, by which persons who from their wealth or influence were considered dangerous to the state were banished for five years, with leave to enjoy their estates and to return after that period. It was in fact only another form of the Athenian ostracism (*see* OSTRACISM); with this difference, that in the latter the condemnation was written on shells and lasted for ten years, whereas in petalism leaves were made use of, and the condemnation lasted only five years.

PE'TALITE. A Swedish mineral of a grey or reddish colour and a foliated texture. It is a silicate of alumina and lithia, and contains between five and six per cent. of the latter alkali.

PETALO'CERANS, *Petalocera*. (Gr. πεταλον, *a leaf;* κερας, *a horn.*) A tribe of Coleopterous insects, including those which have antennæ terminated by a foliated mass.

PETALOI'DEUS. (Gr. πεταλον, and ειδος, *like.*) A term applied by botanists to any organ the texture and colour of which resemble a petal.

PETALS. (Gr. πεταλον.) In Botany, the divisions of the corolla of a plant.

PETA'RD. (Fr.) In Artillery, an engine formerly much used for breaking down gates, barricades, &c. The petard had some resemblance to a high-crowned hat. It was formed of gun metal, was about seven inches deep, and five inches in diameter at the mouth, and held from nine to twenty pounds of gunpowder. When about to be used it was screwed to a thick plank, and suspended before the gate to be burst open. Petards were first used by the French Hugonots at the siege of Cahors in 1579. Their use is now discontinued; and it has been discovered that gunpowder in loose bags is equally efficacious.

PE'TASUS. (Gr.) A broad-brimmed hat used on journeys by the classical ancients; hence a petasus with wings attached to it is the emblem of the celestial traveller Mercury.

PETAURIST, *Petaurus*. (Gr. πεταω, *I expand*, and ουρα, *a tail.*) The name of a genus of Marsupial animals, which have the power of taking extensive leaps through the air, like the flying squirrel, by means of outstretched tegumentary folds between the fore and hind extremities, aided by an expanded tail.

PETE'CHIÆ. (Ital. petichia.) Small red spots produced by the effusion of drops of blood in the skin, immediately under the cuticle. They resemble flea-bites, and usually indicate an altered and impure state of the blood.

PE'TER-PENCE. The popular name of an impost, otherwise termed "the fee of Rome," or, in the Anglo-Saxon, "Romescot:" originally a voluntary offering by the faithful to the see of Rome; afterwards a due levied in various amounts from every house or family in a country. Peter-pence were paid in France, Poland, and other realms. In England this tax is recognized by the Norman laws of William the Conqueror. Edward III. discontinued the payment when the popes resided at Avignon; but it was afterwards revived, and finally ceased in the reign of Henry VIII.

PE'TIOLE. That portion of a leaf that connects the lamina with the stem of a plant; the footstalk.

PETI'TION (Lat. peto, *I ask*), signifies generally a supplication preferred by one person to another, who is supposed to be capable of granting the request. The right of the British subject to petition either house of parliament, or the king, is founded on the Bill of Rights. But this act is not considered as having repealed 13 C. 2. stat. 1. c. 5., by which it is criminal to solicit or procure the putting the hands of more than twenty persons to a petition for alterations in church or state, unless by consent of three or more justices, or a majority of the grand jury at assizes or sessions, &c.; and repairing to the king or parliament to deliver such petition with above the number of ten persons is also rendered criminal.

PETITION. In Law, an application in writing, addressed to the Lord Chancellor, the Master of the Rolls, or to the equity side of the Court of Exchequer, in which certain facts are set forth as the ground on which the petitioner rests his prayer for the order and direction of these respective courts. Petitions are of two kinds, — *cause petitions*, or *exparte petitions*. The former are those in regard to matters of which the court is already in possession, by virtue of there being a suit concerning their substance (the petitioner in this case being either generally a party to such suit, or in some way or other possessing an interest therein); the latter (*exparte petitions*) are so called when there is no suit existing about the matter of the petition. Both these kinds of petitions are susceptible of numerous subdivisions.

PETI'TIO PRINCI'PII. (Lat. *a demand of the principle.*) In Logic, a popular designation for a species of vicious reasoning, which consists in tacitly assuming the proposition to be proved as a premise of the syllogism by which it is to be proved; vulgo, *begging the question*.

PETONG. The Chinese white copper; it is an alloy of copper and nickel. *See* PAKFONG.

PETRELS. In Ornithology. *See* PROCELLARIÆ.

PETRIFA'CTIONS. (Lat. petra, *a stone*, and facio, *I make.*) A general term by which naturalists designate the conversion of vegetable or animal materials into a stony substance. The word is equivalent with such expressions as "organized fossils, organic remains," &c.; which however, are all liable to exception on the ground of not distinctly explaining what they are meant to define; and though the term *petrifaction* is itself open to censure on the same score, it does not seem that any other word more acceptable to the naturalist has hitherto been found to supersede it. The branch of science which treats more peculiarly of substances in a petrified state is usually denominated *Oryctology*, which see.

PETROBRU'SIANS. The followers of Peter de Bruys, a heretic or reformer of the 12th century, who declaimed with great success against the vices of the clergy, and gathered around him considerable numbers of adherents in the south of France. The exact opinions which he advanced are only to be collected from the assertions of his adversaries, who, at a time when the lower classes throughout Europe were listening eagerly to violent and perhaps fanatical oppugners of the dominant church, did not fail to exaggerate and discolour their doctrines to suit their own purposes. Besides the vague charge of Manicheism which was made against most of these sectarians, the imputations cast upon them chiefly refer to their contempt for the ordinances of the church; in which it is very probable that, along with the real abuses of the day, the crucifixes, images, and relics, the ignorant multitude may have included the sacraments and other purer ceremonies in one indiscriminate abhorrence. A treatise was composed against them by St. Bernard. (See *Faber's Albigenses and Waldenses; Waddington's History of the Church*, ch. xviii.)

PETRO'LEUM. A brown liquid bitumen, found in several parts of Europe, in Persia, and in the West Indies. It is often termed *Barbadoes tar*.

PE'TROLINE. A substance obtained by distilling the petroleum of Rangoon; analogous to *paraffine*.

PE'TROSI'LEX. A variety of flint or hornstone. The term is sometimes applied to compact felspar.

PETU'NTZE. (Chinese.) A decomposing variety of felspar, used in China in the manufacture of porcelain.

PETWORTH MARBLE, called also *Sussex Marble:* It is a variously coloured limestone, occurring in the weald-clay, and composed of the remains of fresh-water shells. *See* GEOLOGY.

PEUTINGE'RIAN MAP or TABLE. (Germ. Peutinger Tafel; so called from Conrad Peutinger, a native of Augsburg, who was the first to make it generally known.) The name given to a map of the roads of the ancient Roman world, written on parchment, and supposed to have been constructed about the time of Alexander Severus, A. D. 226. The original, which is 21 feet in length, and only about 1 foot in width, is deposited in the imperial library at Vienna; but copies of it are to be found in the *Ptolemy* of Bertius; in Horne, *Orbis Delineato;* in Bergier, *Historique des Grands Chemins de Empire Romain;* and part of it in *Murray's Encyclopædia of Geography*. Combined with the celebrated *Antonine Itinerary*, which it serves admirably to illustrate, though it differs from the latter in several essential particulars, the Peutingerian Table may be justly regarded as one of the most valuable bequests of ancient geography to modern times. In this table the high road which traversed the Roman empire in the general direction of east and west is made the first meridian, and to this every part is subjected. The objects along this line are minutely and faithfully exhibited; but of those lying to the north and south of it only some general notion can be conveyed. From the novel and peculiar construction of the table, every object is of course enormously extended in length and reduced in breadth. (See *Mannert's Introduction* to his new edition of the *Peutingerian Table*, Leipsic, 1824.)

PEW'TER. An alloy of tin with lead and antimony frequently bears this name; but the best pewter was formerly made of 12 parts of tin with 1 of antimony, and a very small addition of copper. A fine pewter is made, according to Aiken, by fusing together 100 parts of tin, 8 of antimony, 1 of bismuth, and 4 of copper. The use of these additions to tin is to harden it and preserve its colour; and a good pewter, when clean and polished, has a silvery lustre, and does not readily tarnish. Common pewter, of which measures and pewter pots are made, is an alloy of lead and tin.

PHAËTON. (Gr. φαέθων, *shining*.) In Mythology, the son of Apollo and Clymenes; one of the Oceanides, according to most writers. The fable of his adventures is well known. Taunted with his doubtful origin, he asked his father to lend him the chariot of the sun for a day, as a proof of his filial rights. Unable to guide the fiery steeds, he was dashed to the ground by Jupiter with a thunderbolt, to prevent his consuming the heavens and earth. The best known narrative is that in *Ovid's Metamorphoses*.

PHAGEDÆ'NIC. (Gr. φαγειν, *to eat*.) A term applied to ulcers which rapidly corrode and destroy the parts which they attack.

PHALA'NGER, *Phalangista*. (Gr. φαλαγξ, *a phalanx*.) The name of a genus of Marsupial animals, including those in which the second and third toes of each hind foot are united together as far as the last phalanx in a common cutaneous sheath, and which have a hinder thumb, but no lateral cutaneous parachute.

PHALA'NGES. In Anatomy, the small bones of the fingers and toes.

PHALA'NGIUM, or SHEPHERD-SPIDER. The name of a genus of Arachnidans, including those in which all the legs are very long and slender; the tarsi sometimes consisting of more than fifty joints.

PHA'LANX. (Gr. φάλαγξ.) The close order of battle, in which the heavy-armed troops of a Grecian army were usually drawn up. There were several different arrangements of the phalanx peculiar to different states; but the most celebrated was that invented by Philip of Macedon. The men stood close together, sometimes with their shields locked, in ranks of several men in depth, displaying in front a row of long-extended spears. The phalanx, whose charge was irresistible in a smooth plain by a lighter body, was found to be overmatched by the combined strength and activity of the Roman legion, which was able to take advantage of any inequality of ground, and charge in flank and rear; and when once an accident offered an opening in the unwieldy mass of the enemy, their confusion was inevitable, and rally hopeless. The phalanx is described in most works on Grecian antiquities; but see especially the *Mem. de l'Ac. des Inscr*. vol. xxiv. xxv., and the Essay in vol. xli. by M. de Maignal.

PHA'LERA. In Roman Military Antiquities, various kinds of ornaments were so called, chiefly but not exclusively appropriated to the equipment of horse soldiers; it was also applied to the frontlets of the horses themselves. It is evidently, however, as the ornament of the man, and not the horse, that Virgil uses the word in the lines —

Euryalus phaleras Ramnetis et aurea bullis
Cingula . . . . humeris nequicquam fortibus aptat.

(See the 3d and 22d Memoires of M. le Beau on the Roman Legion, in *Mem. de l'Acad. des Inscr*. vols. xxviii. and xxxix.)

PHA'LEROPE, *Phaleropus*. (Gr. φαλερος, *scolloped*, and πους, *a foot*.) The name of a wading bird, with the toes provided with scolloped membranes.

PHA'NERONEURANS, *Phaneroneura*. (Gr. φανερος, and νευρον, *a nerve*.) A name applied by Rudolphi to all those animals in which the nerves are distinctly eliminated.

PHANTA'SMAGO'RIA. (Gr. φαντασμα, *appearance, spectre*, and αγορευομαι, *I collect*.) An optical apparatus, by means of which the images of objects can be magnified or diminished at pleasure, and motion given to them whereby a strong illusion is produced. The apparatus is in fact nothing more than a magic lantern, in which the images are received on a transparent screen, and the sliders on which the figures are drawn rendered perfectly opake, excepting in the figures themselves; so that all light is excluded, excepting that which is transmitted through the image. The lantern, mounted on wheels, is made to recede from or approach to the screen, by which the enlargement or diminution of the image is effected; and in order to preserve distinctness in the picture, the tube in the side of the lantern which carries the lens is, by a particular mechanism, drawn out or pushed in, so as to increase or diminish the distance between the lens and the slider, according as the lantern approaches to or recedes from the screen. The phantasmagoria affords a very popular exhibition in lecture rooms. (See *Hutton's Dictionary; Young's Natural Philosophy; Halle's Natürl. Magie*.)

PHA'RISEES. A sect among the Jews, whose name is derived from *Pharas*, a Hebrew word signifying *separated* or *set apart;* because theyseparated themselves from the rest of the nation, and pretended to the distinction of peculiar holiness. The time of their origin is not accurately determined; but they are referred to by Josephus as a considerable sect, B. C. 110. In the time of our Saviour they constituted the most influential party among the Jews. Though their rivals the Sadducees numbered amongst themselves some individuals of the highest rank, and those who affected to be conversant with the manners and philosophy of the Greeks and Romans, the Pharisees embraced a greater proportion of the upper classes, and were supported by the admiration of the people, and the national feeling in favour of the opinions and habits of their ancestors. Besides being strict interpreters of the written law, their sect superinduced upon it what they called the traditions of the elders, and asserted that Moses delivered an oral law as a supplement to that of the scriptures. They are frequently reproached by our Saviour with explaining the latter by the former, so as in effect frequently to destroy the validity of the written law. They also attached a mistaken importance to many outward ceremonies of human invention, which they observed with a studied ostentation which gained for them the esteem and veneration of the multitude. They maintained, in opposition to the Sadducees, the popular doctrine of the resurrection; which, however, they appear to have corrupted with some vague notions touching the transmigration of souls.

PHARMACO'LOGY. (Gr. φαρμακον, *a medicine*, and λογος.) The history of the properties and uses of drugs.

PHA'RMACOPŒIA. (Gr. φαρμακον, and ποιειν, *to make*.) A book containing directions for the preparation of medicines.

PHA'RMACY. (Gr. φαρμακον.) The branch of knowledge which relates to the medical and chemical history of the different articles of the *Materia Medica;* to the mode of prescribing them, their effects, and composition.

PHARMA'KOLITE. In Mineralogy, a term applied to the native arseniate of lime.

PHA'ROS. Properly the name of an island at the mouth of the harbour of Alexandria, on which a lighthouse was erected; whence it came to be applied as a common name for all lighthouses. *See* LIGHTHOUSE.

PHARYNGO'TOMY. (Gr. φαρυγξ, and τεμνω, *I cut*.) The operation of making an external opening into the windpipe, necessary in certain cases of suffocation.

PHA'RYNX. (Gr. φερειν, *to convey;* because the food is conveyed by it into the œsophagus and stomach.) The back part of the mouth: it is somewhat funnel-shaped, attached to the fauces behind the larynx, and terminating in the œsophagus.

PHASCOLA'RCTOS. (Gr. φασκωλος, *a pouch*, and αρκτος, *a bear*.) The name of a genus of Marsupial animals, of which the koala is the type: its dentition is like that of the kangaroo rats; but it has no tail, and has short hind legs.

PHA'SCOLOME, *Phascolomys*. (Gr. φασκωλος, and μυς, *a mouse*.) The name of a Marsupial quadruped, commonly called the wombat, which has the teeth of a

Rodent animal, with the exception of an additional true molar on each side of both jaws.

PHASE (Gr. φασις, *appearance*), in Astronomy, denotes the different appearances of the moon or inferior planets, according as a greater or smaller portion of the hemisphere illuminated by the sun is visible to the observer. The phases of the moon sometimes denote in particular the new moons, the full moons, and the quarters, these being the principal phases.

PHASE, in Natural Philosophy, denotes the particular state, at any given instant, of a phenomenon which undergoes a periodic change, or increases to a given point, and then diminishes in a regular gradation. Thus we speak of the *phase of a tide*, the *phase of an eclipse*, &c.

PHASIA'NIDÆ. (Gr. φασιανος, *a pheasant*.) The name of the family of Gallinaceous birds of which the genus *Phasianus* is the type. The pheasant is a native of warmer and drier climates than England, as the Linnæan specific name (*Phasianus colchicus*) implies. Cuvier states that it was brought from the banks of the Phasis by the Argonauts, and subsequently became diffused over all temperate Europe. It is consequently a matter of difficulty to preserve the species in this country; and were it not for the assistance which the common fowl affords in hatching the eggs of the pheasant, the breed would probably soon become extinct; for although the female produces a great many eggs in the artificial preserves of the wealthy sportsman, yet she soon forsakes the task of incubation, when disturbed, as is too often the case, by the male.

When roused the pheasant will not unfrequently perch upon the first tree; and seems more intent upon the dogs than the approach of the sportsman: they betray themselves likewise by the habit which they have of crowing or making a chuckling noise at the time when they perch. Foxes destroy many pheasants; and as these are commonly females engaged in incubation, the tendency to diminution of the race from this cause is increased. But the chief loss of the pheasant-breeder is caused by the mortality of the young birds, about the time of changing their nestling feathers, produced by the development of great numbers of a peculiar species of Entozoon (*Syngamus trachealis*) in the windpipe. This accumulation occasions a difficulty of breathing; and the convulsive attempt to gasp the air, or expel the worms, has occasioned the name of "the gapes" to be given to this disease.

The best remedy is a preventive treatment, by due attention on the part of the keepers to the young pheasants in keeping them clean, and administering plenty and variety of food. When the disease is far advanced, obliging the birds to breathe air strongly impregnated with fumes of tobacco, carefully watching its effect, is the best remedy.

The male pheasant is distinguished, like most *Gallinacea*, by its superiority in size and brilliancy of plumage from the female; and the dependency of this difference on the generative function is proved by the remarkable instances of assumption on the part of the female of more or less of the male livery, consequent upon the abrogation of that function in her either by age or by injury or disease of the female organs. The food of the pheasant varies according to the season: in winter it consists chiefly of grain and seeds; in spring and summer of insects and nutritive bulbous roots, as that of the "crow-foot" (*Ranunculus bulbosus*).

The pure breed of *Phasianus colchicus* is distinguished by the absence of the white ring round the neck, and the reddish copper tint of the croup. Another species, from China, with a white ring round the neck, and a greener cast of colour, especially upon the croup, has also been imported and turned wild. It seems to have produced a prolific race of hybrids with the common pheasant.

China produces several other species, which are remarkable for their superb and brilliant plumage; as the golden pheasant (*Ph. pictus*), Amherst's pheasant (*Ph. Amherstii*); both of which have a gorgeous ruff round the neck, and the latter is remarkable for its exceedingly long tail. A like appendage characterizes the magnificent Reeves's pheasant (*Ph. Reevesii*). The silver pheasant (*Ph. nycthemerus*) from China, and the *Phasianus lineatus* from the mountains of Thibet, approach nearer in their carriage to the common fowl.

PHE'NECIN. (Gr. φοινιξ, *purple*.) The purple powder which is precipitated when sulphuric solution of indigo is diluted with water. It appears to be a hydrate of indigo.

PHENGI'TES MARBLE. *See* MARBLE.

PHENO'MENON; plural, *Phenomena*. (Gr. φαινω, *I shine*.) In Natural Philosophy, this term is usually applied to those appearances of nature of which the cause is not immediately obvious: such as the phenomena of light, of the magnet, of electricity, &c., produced by physical experiments; or unusual natural appearances, as meteors, comets, earthquakes, &c., which occur without the intervention of human agency.

PHIGA'LIAN MARBLES (so called from having been discovered near the site of Phigalia, a town of Arcadia), the name given to a series of sculptures in alto relievo, now deposited in the British Museum, where they form part of the collection known by the name of the *Elgin Marbles*. They originally formed the fringe round the interior of the cella of the temple dedicated to Apollo the Deliverer; a title conferred on him by the Phigalians in gratitude for his having delivered them from a pestilence. They represent the combat of the Centaurs and the Lapithæ, and that of the Greeks and Amazons. The similarity, both in design and execution, which they bear to the decorations on the Parthenon leaves no doubt that they are the workmanship of the same master minds which designed, constructed, and adorned that splendid monument of the golden age of art. *See* PARTHENON, ELGIN MARBLES.

PHILADE'LPHES. (Gr. φιλεω, *I love*, αδελφος, *brother*.) A secret society said to have existed in France during the government of Napoleon, and to have produced the conspiracy of Colonel Malet in 1812. An account of it is given, but we do not know how far it is to be understood as narrating matters of fact, in the *Histoire des Sociétés Sécretes de l'Armée*, published in 1814.

PHILANTHRO'PINISM. A name given in Germany to the system of education on natural principles, as it is termed, which was promoted by Basedow and his friends in the last century, and mainly founded on the notions of Locke and Rousseau. An institution for the purposes of education, founded under the protection of the Duke of Dessau in 1774, was the first so called "Philanthropin." It was dissolved in 1793; and of the similar institutions afterwards founded, only one, it is said, has continued to maintain itself. But the influence of the labours of the Philanthropinists has undoubtedly entered largely into the modern system of education. (*Conv. Lex.*)

PHILANTHROPY. (Gr. φιλεω, *I love*, and ανθρωπος, *a man*.) A general term for a benevolent feeling towards the whole human race. It is opposed to misanthropy.

PHILIBEG, or FILIBEG. *See* KILT.

PHILI'PPIC. The title of several orations of Demosthenes against Philip king of Macedon, the spirit and animosity of which has caused the name to be transferred to similar compositions. Thus Cicero gave this name to the orations which drove Mark Antony from Rome, and impelled the senate to prosecute the war against him after the murder of Julius Cæsar.

PHILOCTE'TES. In Mythology, the son of Pæan; according to some authors, one of the Argonauts. The friend and companion of Hercules, and one of the most celebrated heroes of the siege of Troy, though but little referred to in the *Iliad*. His adventures, too long to be here recounted, form the subject of one of the tragedies of Sophocles.

PHILO'LOGY. (Gr. φιλεω, *I love*, and λογος, *speech, discourse*.) This word appears to have been used by the classical ancients to designate the whole circle of belles-lettres, and even of the sciences: cultivated as they then were very imperfectly, and more in a theoretical than an inductive shape; considered, not with respect to their respective subject matters, but to the language in which they were conveyed. A philologist was one who studied or taught the elegance of diction, as applicable to every branch of human learning; nor can the meaning of the designation be very accurately distinguished from that of the γραμματικος, or grammarian: while sometimes the term philology was usurped in a wider sense, so as to comprehend learning in general. After the revival of letters, the word was introduced into modern European languages, but in a much more restricted signification. It then comprehended grammatical criticism and etymology, and some branches of archæology; and as these studies were almost confined to the ancient languages, and other relics of classical antiquity, which alone were then studied in a scientific manner, the only philologists were the learned investigators of the Greek and Latin idioms and literature. Commentaries on ancient authors, etymological works, and glossaries of their language, grammars, &c. were then the class of writings usually denominated philological; and although the field of philology, considered in this sense, is now more extensive, as the modern European and non-European languages have also become the subjects of accurate investigation, it is with the same general meaning that the word is chiefly used, at least among English writers, at the present day. It is defined by Johnson "criticism, grammatical learning." In this popular sense philology may be said to embrace, 1. Etymology, or the science of the origin of words; 2. Grammar, or the science of the construction of language in general and of individual languages; 3. Literary criticism, or the investigation of merits and demerits in style and diction.

Of late years, however, a new and very extensive province has been added to the dominion of philology; namely, the science of language in a more general sense, considered philosophically with respect to the light it throws on the nature of the human intellect and progress of human knowledge; and historically, with refer-

ence to the connection between different tongues, and the connection thus indicated between different nations and races. Some attempts have recently been made to confine the use of the word philology to this particular branch of learning. It comprehends, 1. *Phonology*, or the knowledge of the sounds of the human voice; which appears to include orthography, or the system to be adopted when we endeavour to render, by our own alphabet, the sounds of a foreign language; 2. *Etymology*; 3. *Ideology*, or the science of the modification of language by grammatical forms, according to the various points of view from which men contemplate the ideas which words are meant to express.

Classical Philology.—By German writers the use of the word philology is still not uncommonly restricted to this branch of study. The earliest commentators, lexicographers, and grammarians, whose works we possess, flourished in Greece and Rome at various periods between the Christian era and the fall of the Roman empire. During the middle ages the knowledge of the classical languages, or of the works written in them, ceased to be cultivated as a science. Philology was revived about the end of the 14th and beginning of the 15th century, and chiefly by the labours of various learned Greeks expelled from their own country by the encroachments of the Romans. In the 15th century, Italy was peculiarly animated with a zeal for classical literature, which, in fact, essentially injured, during the whole of that period, the cultivation of the native language of the country. In the following age, the cultivation of this study passed chiefly into the hands of the French, Dutch, and Germans; nor was it long retained in any perfection among the students of the first of these nations. In the hands of the industrious writers of Holland and Germany classical philology assumed a new form. Less elegant, and pursued in a less poetical mind than it had been among the Italians, it became a vast and laborious science, exacting the severest industry, and no common ingenuity. During the 16th and 17th century, philologists may be said to have been chiefly occupied in collecting the materials of knowledge: the task of criticism, and of separating the true from the false in classical idiom and diction, began with the 17th; and the earliest name in this department of study is perhaps still the most illustrious; that, namely, of Richard Bentley. Since his time, we have had many distinguished classical scholars in our own country, especially in the present day, which has produced Parr, Porson, and Elmsley; but Germany still remains the true nursery of classical research; and the school of Wolf, Heyne, and Hermann, in that country, has laid down canons of inquiry, as to the genuineness and authority of some of the earliest works in the ancient language, which have imparted a new character to classical criticism in general. *See* LANGUAGE, CLASSICS.

PHILOLOGY, SACRED. The art of criticising the languages and dialects of the Hebrew and Hebræo-Greek writers in order to elucidate the meaning of the sacred Scriptures. The Hebrew language, consisting principally of the old Phœnician, with admixtures of the Aramæan from Mesopotamia, introduced by Abraham and his horde, received also a few modifications, owing to the long servitude of the Israelites in Egypt. How old the book of Job may be, is still a *vexata questio* among critics, some of whom suppose that it was originally written in *Arabic* and afterwards translated, while others trace it to a remote period of *Hebrew* literature; but whether it be older or not than the works of Moses, the Pentateuch must ever be considered the basis of the Hebrew as a fixed written language. The institution of the schools of the prophets under the Judges no doubt tended to give that polish and poetic character seen in the writings of David and Solomon; but the Hebrew language remained essentially the same down to the conquest of Palestine, first by Shalmaneser (who introduced an Aramæan population in lieu of the expelled ten tribes); and secondly by Nebuchadnezzar, who (B. C. 588) took the holy city, and captured the two remaining tribes, transporting them also, according to a still prevalent eastern custom, into his own territories. The Jews, however, during their captivity at Babylon, not only acquired new habits, but received many additions to their language, both of words and idioms; and henceforward they spoke a dialect usually known as the *Hebræo-Aramaic*, bearing nearly the same analogy to the Hebrew that the modern Italian bears to the Latin. In the later historical writers traces may be discovered of this corruption. The prophecies of Haggai, Zechariah, and Malachi, also, though very pure, present a few instances of Chaldeism; but the new dialect is most of all perceptible in the Targums and other uninspired commentaries by which alone the Scriptures could be made intelligible to the common people. Schultens, Rosenmüller, the elder Michaelis, Bishops Louth and Horsley, Gesenius, Ewald, and Prof. Lee have successfully laboured in elucidating the history of the Hebrew language; and the best editions of the Hebrew Scriptures are by Kennicott and De Rossi. After the cessation of Hebrew prophecy on the death of Malachi, about 400 years B.C., the Aramæan dialect prevailed more or less, owing to the adherence of the Jews to their national language, down to the capture of Jerusalem by Titus. The conquests of Alexander, however, had an undoubted influence over the learned castes, who gradually became acquainted with the Greek language; and accordingly (B. C. 280), Ptolemy Philadelphus invited *five* Jewish scribes to Alexandria for the purpose of translating into Greek the Pentateuch, that part of the Jewish history relating to the Egyptians. Some years afterwards the other books of the Old Testament were translated by different hands; but the name *Septuagint* (*see* SEPTUAGINT) is a misnomer; and the story connected with it (resting wholly on the very questionable authority of Plutarch and Diodorus Siculus) is quite unworthy of credit. The work, however, is written in good Macedonian Greek (*κοινὴ διάλεκτος*), with a few Hebrew admixtures; and hence the Septuagint should be studied in connection with the New Testament, which presents similar features. In the time of Christ the Aramaic (as the Gospels furnish abundant proof) was the vulgar language of Palestine; and even Galilee had a separate though cognate dialect. (Luke, xxii. 59.; Acts, ii. 7.) After the descent of the Holy Spirit, the followers of Christ became gifted with that power of expression necessary to carry the tidings of the Gospel into distant countries; and the Greek language, so far as the regions west of Palestine were concerned, was the great medium of communication. Hence the Evangelists and Apostles wrote in this language. But though their ideas were inspired, their words were of their own creation; and hence arose those peculiarities of diction, Hebrew expressions, &c., the understanding of which is absolutely necessary to an intimate acquaintance with the inspired writers of Christianity. This, indeed, constitutes the science of sacred philology; and in this work the labours of Wetstein, Mill, Griesbach, and Scholz have been employed in producing a pure Greek text from the examination of the best MSS.; while the most celebrated critics of the New Testament, Bengel, the younger Michaelis, Küinoel, De Wette, Bp. Marsh, Stuart, Ernesti, Winer, and Robinson have spent their best days in elucidating the meaning of the Evangelists and Apostles—the great pillars of the church, of which Christ is the head corner-stone.

PHILO'SOPHER'S STONE. *See* ALCHEMY.

PHILO'SOPHY (Gr. φιλεω, *I love*, and σοφία, *wisdom*), in common acceptation, is a general term, signifying the sum total of systematic human knowledge. It is commonly divided into three grand departments; metaphysics, physics, and ethics. If we include in the first logic, this may be regarded as a complete distribution of science, properly so called. The first has for its object those truths which go beyond mere experience; as the nature of being, of God, of the soul, &c., as they are in themselves, or as they are apprehended by us. (*See* METAPHYSICS.) The second relates to objects as they are in nature, as subject to the relation of cause and effect. The third contemplates human actions as they *ought* to be, not merely as they are; and takes account of the ideas of duty, freedom, responsibility, and the like—of all, in short, which constitutes the distinction between *an action* and *an event*.

This word was first used by the Pythagoreans, and adopted from them by Socrates, who considered himself a lover or seeker of wisdom only; in distinction from a *sophist*, or one who conceives himself to be in the possession or exercise of wisdom.

Many valuable histories of philosophy have appeared of late years, especially in Germany. The most celebrated are those of Brucker, Tennemann, and Ritter. A sketch of the history of philosophy written by the late Mr. Dugald Stewart, originally prefixed to the *Encyclopædia Britannica*, is now printed in a separate volume.

PHI'LTER. (Gr. φιλεω, *I love*.) A drug or preparation supposed by the ancients to have the power of exciting love. Nothing certain is known respecting the composition of these celebrated potions; but there can be no doubt that recourse was frequently had to them by the ancients, and that their operation was so violent that many persons lost their lives and their reason by their means. The Thessalian philters were in the highest celebrity. (See *Juv.* vi. 610.)

PHI'LYRA. In Mythology, one of the Oceanides, and mother of the centaur Chiron by Saturn, who visited her in the shape of a horse. Alarmed at the monstrosity of her offspring, she implored Saturn to change her nature; when the god granted her request, and changed her into a linden tree, which is still called in Greek by her name. Her son received the gift of immortality.

PHLEBO'TOMY. (Gr. φλεψ, *a vein*, and τεμνω, *I cut.*) The operation of opening a vein for the purpose of taking away blood.

PHLEGE'THON. (Gr. φλεγέθων, *burning*.) The mass of fire which, according to the poets of Rome and Greece, washed the shores of the infernal regions. It is

also the name of one of the rivers of the infernal regions. *See* Cocytus.

PHLOGI'STON. (Gr. φλογιζω, *I burn.*) An imaginary principle, by which Stahl and the chemists of his school accounted for the phenomena of combustion; the matter of fire fixed in combustible bodies.

PHLYCTÆ'NA. (Gr. φλυκταινα.) A small vesicle which contains a serous fluid.

PHLYZA'CIUM. (Gr. φλυζειν, *to be hot.*) A pustule upon the skin.

PHOCA'CEANS, *Phocacea*, or Seal Tribe. The name of the family of carnivorous and amphibious Mammals of which the seal (*Phoca*) is the type. *See* Seals.

PHOCÆ'NA. (Gr. φωκαινα, *a porpoise.*) A subgenus of dolphins, distinguished by the absence of the beak-like prolongation of the jaws.

PHOCE'NIN. A peculiar fatty matter contained in the oil of the porpoise (*Delphinum*). When saponified it yields a volatile odorous acid, called *phocenic acid.*

PHŒ'BUS. (Gr. φοιβος, *brilliant.*) A name of Apollo, often used in the same sense as Sol.

PHŒNICO'PTERUS. (Gr. φοινιξ, *red*, and πτερον, *a wing.*) The generic name of the flamingo: also a term applied to other animals which have red wings, as the *Bombycilla phœnicoptera.*

PHŒ'NIX. In Mythology, a bird of great celebrity among the ancients; and, from the peculiar circumstances connected with its origin, longevity, and death, regarded as the emblem of immortality. She was described as of the size of an eagle, her head finely crested, her body covered with a beautiful plumage, and her eyes sparkling like stars. She was said to live 500 or 600 years in the wilderness, when she built for herself a funeral pile of wood and aromatic gums, which she lighted with the fanning of her wings, and thus *apparently* consumed herself, but not *really;* this being merely the process by which she endowed herself with new vitality: she then

> Mounts from her funeral pyre on wings of flame;
> And soars and shines, another and the same!

Four periods of history are mentioned by ancient writers as having been graced by the appearance of the phœnix. The first was in the reign of Sesostris; the second in that of Amasis; the third in that of Ptolemy III., king of Egypt; and the fourth in that of Tiberius. There is, however, a great discrepancy of opinion on this point, as well as on every other relating to the phœnix. The history and imaginary attributes of the phœnix have formed a theme to poets in every age; and in most languages its name has passed into a proverb. By the fathers of the church it was frequently brought forward as an illustration of the doctrine of the resurrection (see Spanheim, *De Usu et Præstantia Numismatum*, diss. v. c. 13., and the authorities cited in that learned work); and it appears on the coins of several Roman emperors, sometimes as a symbol of their own apotheosis, sometimes as an emblem of the renovation of the world and the revival of the golden age under their beneficent rule. The chief ancient authorities with regard to the phœnix are Herodotus, b. ii. c. 73.; Ovid, *Met.* xv. 391.; Pliny, *Hist. Nat.* x. 2.; and Tacitus, *Annal.* vi. 18. Besides these, the reader may consult, in the third volume of Wernsdorf, *Poetæ Minores* (to which the editor has prefixed a learned introduction), the poem *De Phœnice*, which is usually attributed to Lactantius, and in which every circumstance on record with regard to the phœnix has been chronicled with the most laborious precision. The reader will also find in Metral's work, *Le Phœnix, ou l'Oiseau du Soleil* (Paris, 1824), a resumé of all that has been written, both in ancient and modern times, respecting the history and peculiarities of the phœnix.

Phœnix. One of the modern constellations in the southern hemisphere.

PHOLA'DEANS, *Pholadeæ*. (Gr. φωλεος, *a lurking place.*) The family of Lamellibranchiate Bivalves of which the genus *Pholas* is the type: they are remarkable for the *hiding places* which they excavate for themselves in rocks and clay.

PHONE'TIC WRITING. (Gr. φωνη, *sound.*) That writing in which the signs used represent sounds; in opposition to *ideographic*, in which they represent objects, or symbolically denote abstract ideas, as in the figurative part of the Egyptian hieroglyphics. The signs representing sounds are usually arbitrary, or at least have become so in process of time; as in the ancient Roman alphabet, of which the letters are for the most part derived from the Hebrew or Phœnician, in which languages they may have originally partaken of a symbolical character. But, in a species of phonetic writing which is intermixed with the figurative hieroglyphics in Egyptian inscriptions, every letter is denoted by a figure representing some object, the name of which begins with that letter. *See* Hieroglyphics.

PHO'NICS. (Gr. φωνη.) The doctrine of sound: the same as *acoustics*. (*See* Sound.) As sound, like light, is subject to certain laws of reflection and refraction, the science, like that of light, may be treated under three heads; namely, direct, reflected, and refracted sound. In allusion to the corresponding branches of optics, these have been denominated *phonics, cataphonics*, and *diaphonics.*

PHO'NOLITE. (Gr. φωνη, and λιθος, *a stone.*) A species of compact basalt; sonorous when struck.

PHO'RCUS. In Mythology, a marine deity, son of Pontus and Terra; father of the Gorgons, the dragon that guarded the apples of the Hesperides, and other fabulous monsters.

PHORONO'MIA, or PHORONO'MICS. (Gr. φερω, *I bear or carry.*) A term sometimes used to denote the science of motion. In this sense, it was employed by Hermann, a mathematician who flourished in the beginning of the 18th century, in a work entitled *Phoronomia, seu de Viribus et Motibus Corporum Solidorum et Liquidorum* (Amstel. 1716), and of great merit for the time in which it appeared. The term mechanics being now employed generally to signify the doctrine of moving bodies, *phoronomia*, or *phoronomics*, seldom occurs in works of modern science.

PHO'SGENE GAS. (Gr. φως, *light*, and γιγνομαι, *I produce.*) A compound of chlorine and carbonic oxide, made by exposing equal measures of those gases to the sunshine, or to bright daylight. They will not unite in the dark.

PHO'SPHATES. Salts containing *phosphoric acid.*

PHOSPHITES. Salts containing *phosphorous acid.*

PHOSPHORE'SCENCE. The emission of light by substances at common temperatures, or below a red heat.

PHOSPHORESCENT ANIMALS. Those species are so called which have the faculty of emitting a luminous fluid. They are much more numerous than the electric animals; belonging to most of the Invertebrate classes, and frequently rendering vast tracts of the ocean luminous by their prodigious numbers. The glow-worm (*Lampyris*), the phosphorescent sea-pen (*Pennatula phosphorea*), and the brilliant pyrosome (*Pyrosoma Atlanticum*), are amongst the most remarkable of these animals.

PHO'SPHORITE. Native phosphate of lime.

PHO'SPHORUS. (Gr. φως, *light*, and φερω, *I carry.*) So called from its property of shining in the dark. It was discovered in 1668 by Brandt, an alchemist of Hamburgh, and was originally obtained by distilling urine; but it is now always extracted from *bone earth*, by a process contrived by Scheele. The bones are calcined, so as to destroy the animal matter, and, being powdered, are mixed with water, to which half their weight of sulphuric acid is added. The bone earth, consisting chiefly of phosphate of lime, is thus decomposed, sulphate of lime is formed, and phosphoric acid is evolved; or, rather, superphosphate of lime, which, being much more soluble than the sulphate, remains in the liquid, and may be obtained by its evaporation: it is mixed with about half its weight of charcoal, and put into a well-luted earthen retort, the beak of which dips into water. At a bright red heat, the phosphorus distils over into the water. It is purified by carefully melting it under water, and straining it through a piece of chamois leather.

Pure phosphorus is almost colourless, and semitransparent; it may be cut with a knife, and its surface has a waxy lustre. It fuses at 108°, boils at 550°, and is converted into vapour, having, according to Dumas, a density $= 4 \cdot 35$. It is sparingly soluble in fixed and volatile oils, and in ether and alcohol; but insoluble in water. It shines in the dark, and emits a luminous vapour, undergoing a slow combustion, and exhaling a peculiar smell like garlic. When rubbed, or heated to a temperature of about 110°, it takes fire and burns with great rapidity, with a white flame, emitting abundance of acid fumes; in oxygen gas its combustion is so intensely brilliant that the eye can scarcely bear the light.

The product of the perfect combustion of phosphorus is *phosphoric acid*, a fusible substance, very soluble in water, and intensely sour. It appears to consist of 1 equivalent of phosphorus $= 16$, and $2\frac{1}{2}$ of oxygen $= 20$; its equivalent being 36.

There are two other acids of phosphorus; namely, the *phosphorous acid*, consisting of 16 phosphorus + 12 oxygen; and the *hypophosphorous acid*, which appears to be a compound of 2 equivalents of phosphorus $(16 \times 2) = 32$, and 1 of oxygen $= 8$. When phosphorus is boiled in a solution of caustic potash a gas is evolved, which is remarkably distinguished by its spontaneous inflammability; each bubble, as it rises through the water, taking fire upon the surface, and producing a beautiful ring of smoke: this gas is commonly called *phosphuretted hydrogen.* Phosphorus may be made to combine with the greater number of the metals, forming compounds called *phosphurets.*

PHOTOGE'NIC DRAWING. (Gr. φως, and γιγνομαι, *I generate.*) When the article Daguerrotype was written, under which we have adverted to the extraordinary results obtained by Daguerre, the mode by which they were produced had not been made public; since that time, however, all the details of the manipulation have been fully

disclosed, and they are extremely interesting and curious, though the explanation or theory of the process is still somewhat obscure. The whole subject has lately acquired much additional importance from its extended applications; namely, from architectural objects, sculpture, and interiors of rooms, to portraits, and more lately to groups, and even whole-lengths; and it is undergoing almost daily extension and improvement.

The outline of the process is as follows: — A piece of copper is plated in the usual way with silver by passing the metals together through a rolling mill, and is then cut into pieces of a proper size. The silver surface is carefully polished, and cleansed by wiping it over with a piece of cotton dipped in dilute nitric acid, washing, and drying. When thus duly prepared, — and much depends upon the manner in which these preliminary operations are performed and the materials used, — the plate is subjected to the diffused vapour of iodine, which forms a slightly brown or yellow film upon the silver; it is then ready to be subjected to the action of the image to be represented, which is thrown upon it, care being taken to exclude all other light, by an instrument upon the principle of the camera obscura. In the course of a few seconds or minutes, the requisite time depending upon the intensity of the light, the plate is removed; and though nothing is as yet visible upon it, it has received the image, which is brought out and rendered evident by subjecting it, inclined at an angle of about 45°, to the vapour of mercury. This operation is performed in a box with a glass side, at the bottom of which is a basin of mercury heated to about 170°, so that the operator may see the progress of the appearance of the image, and remove the plate when it is perfect; but light must be as far as possible excluded, and more especially daylight. The plate is then washed by cautious immersion in a solution of hyposulphite of soda, and lastly with boiling distilled water, and allowed to dry: it is now perfect, may be exposed to light without injury; but must be carefully protected from all friction by covering it with a glass. The action of the various shades of light upon the film of iodine, and the subsequent influence of the mercurial vapour, upon which the visibility of the picture depends, have not been satisfactorily explained, and require further experimental elucidation. The perfection of the drawing, and the extraordinary manner in which the minutest details are represented, we have noticed in our former article; they must, however, be seen to be accurately judged of and duly appreciated.

The term "Photogenic Drawing" has usually been applied to a process very different from the preceding; namely, to representations of various objects upon paper imbued with some of the salts of silver. If a piece of paper be dipped into a weak solution of nitrate of silver, carefully dried, and preserved out of the contact of light, it remains white; but if exposed to light it gradually becomes discoloured, acquiring a brownish or grey tint, and ultimately blackens, the depth of colour depending upon the intensity of the light and duration of exposure. If any opaque or translucent object be laid upon a sheet of paper so prepared, so as wholly or partially to intercept the incident light, a representation of the object is obtained upon the paper. Where the light has been wholly intercepted, it remains white; where partially so, various shades are produced; and wherever the light has fallen without interruption, the utmost blackness is obtained. If, for instance, a portrait painted in transparent colours upon a plate of glass be laid upon a piece of the prepared paper, and exposed to the solar light, a copy is obtained in which the lights of the original are shades, and the shades lights in proportion to their intensity; but if such a picture be taken upon a very thin piece of paper, this may be again copied by a repetition of the process, and then the lights and shades will be as in the original. It is, however, obvious that such a photograph will only be durable whilst kept in the dark, and that exposure to light will gradually obliterate the whole; to fix it, the paper must be washed in a solution of hyposulphite of lime or of soda, which removes all remaining and unaltered salt of silver, but leaves the image untouched. In this process the paper, after having been impregnated with nitrate of silver, or with ammonia-nitrate of silver, is generally dipped in a solution of common salt, by which chloride of silver is formed, and this is more susceptible of the influence of light than the mere nitrate.

In this article we have merely given an outline of the theory of the process of photogenic drawing; the use of nitrate of silver for this purpose, and the mode of copying paintings on glass, was originally suggested about forty years ago by Mr. Wedgwood and Sir H. Davy. The interest excited by Daguerre's discoveries induced various experimentalists to resume the inquiry; and many new and important facts connected with it have accordingly been brought to light, especially by Mr. Fox Talbot and Sir J. F. W. Herschel, whose communications are published in the *Philosophical Transactions;* and by Mr. A. Taylor, who has written a small tract upon the subject.

PHOTOGRAPHY. *See* PHOTOGENIC DRAWING.

PHOTO'METER. (Gr. φως, *light*, and μετρον, *measure.*) An instrument for measuring the intensity of light, or of illumination.

The most elegant instrument which goes under this name is the photometer invented by the late Sir John Leslie. It is merely the differential thermometer of the same ingenious philosopher, having one of its balls diaphanous, and the other coated with China ink, or blown of deep black enamel; and the whole covered by a case of thin transparent glass, to defend the balls from the disturbing influence of currents of air. The photometer has two general forms; the one *portable* (fig. 1.), in which the black ball is about an inch higher than the other, and bent forward to the same vertical line, or the axis of the translucent cylindrical case; and the other *stationary* (fig. 2.), having both its balls of the same height, and reclining in opposite ways; the case being composed of a wide cylinder surmounted by the larger segment of a hollow glass sphere. The latter form of the instrument, though less commodious, is better adapted for nice observations; since, besides receiving the light more regularly, its balls, from being on the same level, are not liable to be any how disturbed in their indications by different strata of unequally heated air.

(1.) (2.)

The theory of this photometer depends on the assumed principle that the intensity of light is proportional to the heat excited by its incidence on the black ball. When the instrument is exposed to light, the rays which fall on the clear ball pass through it, without suffering obstruction; but those which strike the dark ball are stopt and absorbed at its surface, where, assuming a latent form, they act as heat, which, by expanding the air within the ball, causes the liquid in the stem to descend. This heat will continue to accumulate till its farther increase comes to be counteracted by an opposite dispersion, caused by the rise of temperature which the ball has acquired. But, in still air, the rate of cooling is, within moderate limits, proportional to the excess of the temperature of a given surface above that of the surrounding medium. Hence the space through which the coloured liquid sinks in the stem will measure the momentary impressions of light, or its actual intensity. (*Leslie on the Relations of Air to Heat and Moisture.*)

The graduation is entirely arbitrary, and may be regulated according to fancy or convenience. Leslie adopted the same scale of divisions as in the differential thermometer, ten degrees of which correspond to one of the centigrade thermometer. When the temperature of both balls is exactly the same, that is, when the instrument is excluded from light, the liquid in the stem next the coloured ball stands at zero. In this country the direct impression of the sun at noon, about the summer solstice, forces the liquid down to 90° or 100°. The greatest force of the solar beams, in the depth of winter, measures only about 25°. At the altitude of 3° above the horizon, the whole effect of the sun's rays does not exceed one degree. The indirect light from the sky at noon in summer is from 30° to 40°; in winter from 10° to 15°. Comparing the illuminating power of the solar rays with that of artificial lights, Leslie found the light emitted by the sun 12,000 times more powerful than that of a wax candle; that is to say, if a portion of the luminous solar matter, rather less than half an inch in diameter, were transmitted to our planet, it would throw forth a light equal to the effect of 12,000 candles.

It has been objected that the instrument now described is only a species of thermometer, and not strictly a photometer; since it measures heat, and not light. To this objection Sir J. Leslie replies by asking, "What does the thermometer itself indicate except *expansion?* As heat is measured by the expansion it occasions, so light is determined by the intensity of the heat which in every supposition invariably accompanies it. What other mode, after all, could be imagined for detecting the presence of light? How can an unknown quantity be expounded but in terms of one already known?" (*Ency. Brit.*, art. "Climate.")

It must be admitted, however, that the same quantity of light emitted by terrestrial bodies of different kinds is not always accompanied with the same degree of heat. Thus, phosphorus burns in oxygen gas with intense splendour, and yet gives out far less heat than the comparatively dull combustion of hydrogen in the same gas; and the photometer is more affected by a fire so dull that not a single letter could be discerned in a well-printed page, than by the degree of daylight by which the same page could be read with pleasure and facility. For a particular description of the photometer, and an account of its numerous applications, see *Leslie's Experimental Inquiry into the Nature and Propagation of Heat*, 1804.

PHOTO'METRY. (Gr. φως, and μετρον, *measure.*) The science which treats of the measurement of light. Attempts to determine the relative intensities of different

lights were made at an early period in the history of experimental science. For the purpose of comparing the light of Sirius with that of the sun, the celebrated Huygens employed a tube having a very small aperture at one end, into which was inserted a minute globular lens, which allowed only the 27664th part of the solar disk to be seen, and this small portion afforded a light which appeared equally bright with Sirius; whence he concluded the distance of Sirius to be 27664 times greater than that of the sun. (*Huygenii Cosmotheoros.*) Celsius appears to have been the first who proposed to measure light directly by means of what he called a *lucimeter*. His method, however, which was an extremely imperfect one, consisted simply in observing the greatest distance from the eye at which small circles painted on paper were distinctly visible in different lights. It was reserved for Bouguer to establish photometry on true principles. Having been induced by Mairan's remarks on the relative proportion of the sun's light at the summer and winter solstice to investigate the subject, he undertook a series of experiments, of which the results were first published in his *Essai d'Optique*, 1729; and afterwards in his *Traité d'Optique sur la Gradation de la Lumière*, which appeared in 1760, two years after his death. In the same year appeared the *Photometria* of Lambert; in which the subject was treated more generally, and with great mathematical elegance. The principle adopted by Bouguer and Lambert is extremely simple. Though the eye cannot judge of the proportional force of different lights, it can distinguish in many cases with great precision when two similar surfaces presented together are equally illuminated, or when the shadows of an opaque object thrown upon them by different lights are equally dark. But, as the particles of light proceed in straight lines, they must spread uniformly, and hence their density will diminish in the duplicate ratio of their distances. From the respective situations, therefore, of the centres of divergency when the contrasted surfaces become equally bright, we may easily compute their relative degrees of illumination. The objection to this method is that the apparatus admits of no certain standard of comparison. Even the light of the sun itself, at the same altitude, and in the same climate, is subject to considerable variation; much more so any artificial light, the force of which must always be influenced by a number of undefinable circumstances. In this respect, therefore, the photometer described in the preceding article has a great and decided advantage.

A simple and elegant application of the principle of Bouguer was made by the late Dr. Ritchie. His apparatus consists of a rectangular box, about an inch and a half or two inches square, open at both ends and blackened within, to absorb extraneous light. Within, inclined at angles of 45° to its axis, are placed two rectangular plates of plane looking-glass, cut from one and the same strip, to ensure equality of their reflecting powers, and fastened so as to meet at the top, in the middle of a narrow slit about an inch long and an eighth of an inch broad, which is covered with a slip of fine tissue or oiled paper. In comparing, by means of this instrument, the illuminating powers of two different sources of light, they must be placed at such a distance from each other, and from the instrument between them, that the light from every part of each shall fall on the reflector next it, and be reflected to the corresponding portion of the oiled paper. The instrument is then moved nearer the one or the other, till the two portions of the paper corresponding to the respective mirrors are equally illuminated, of which the eye can judge with considerable certainty.

The modification of this method, which consists in contrasting the shadows of an opaque object formed by different lights, is usually ascribed to Count Rumford, by whom it was proposed in the *Phil. Trans.*, vol. lxxxiv., but was long before used by Lambert. It is generally supposed that the equality of two shadows can be appreciated with more certainty than that of two lights; but, when the lights are of different colours, their estimation by either method admits of little precision.

M. Arago has proposed a method of determining the relative intensities of different lights entirely different in principle from any of the preceding, and probably susceptible of much greater accuracy. It is founded on the properties of polarized light. When two lights are to be compared, the rays from each are polarized by causing them to pass through a plate of tourmaline cut parallel to the axis, or by reflecting them from a plate of glass, on which they fall at the polarizing angle. They are then received on a plate of rock crystal, cut perpendicularly to the axis, and observed through a doubly refracting prism. Each light will thus give two images tinged with the complementary colours. The images are then brought into such a position that the red of the one falls over the green of the other. If the two lights are equal in intensity, this superposition will produce a white image; if unequal, the image will be slightly coloured with red or green, according as the one or the other predominates. The apparatus which this method requires is somewhat complicated, and its manipulation must be attended with considerable trouble. (See the Notes to the French translation of *Sir J. Herschel's Treatise on Light*, Paris, 1833.)

PHOTOPHO'BIA. (Gr. φως, *light*, and φοβεω, *I terrify*.) An intolerance or dread of light; it is a symptom of internal ophthalmia.

PHRASE. (Gr. φρασις, *speech or expression.*) In Music, a short melody in which a perfect musical idea is not entirely developed.

PHRASEO'LOGY (Gr. φρασις, and λογος, *science*), properly the science or knowledge of style; but used in common language to signify the peculiarities of diction of a writer, school, &c.

PHRA'TRY. (Gr. φρατρία.) A subdivision of Athenian citizens, analogous to the Spartan *obe* and Roman *curia*, distinguished by particular rites and ceremonies that bound its members together. Each of the four ancient tribes was divided into three phratries, and each phratry into thirty sections or clans, which bore a name exactly answering to the Roman *gens* (γένος); and this division remained subsequently to and independent of the ten tribes of Cleisthenes. The free Athenians registered their own or their adopted children in the phratries to which they themselves belonged, at the festival of the Apaturia; but what the age of registry was is uncertain.

PHRE'NIC. (Gr. φρενες (plural of φρην, *the mind*), *the diaphragm.*) Relating to the diaphragm.

PHRENI'TIS. (Gr. φρην, *the mind.*) Inflammation of the brain or its membranes.

PHRENO'LOGY (Gr. φρην, *the mind*, and λογος, *discourse*), ought, according to its etymology, to signify mental philosophy. The word has, however, been appropriated by craniologists, on account of the light which their observations of the convolutions of the brain, and corresponding elevations on the skull, are supposed to throw on the nature and province of our different faculties. Those who wish to judge how far this pretension is justifiable may consult the works of Dr. Spurzheim and of Mr. Combe on the subject. These gentlemen divide our faculties into three classes: the intellectual or perceptive, the sentiments or emotions, and the animal propensities. To the first of these is assigned the anterior portion of the head; the second occupies the middle and upper; while the posterior region and the cerebellum are allowed to the third and most inglorious division. That this distribution, in its general outline, is borne out by facts, observation is sufficient to convince us; but whether the subdivision of those regions into minute special organs corresponding to distinct faculties is equally well supported, and whether the mental analysis implied in it can be considered sound and accurate, are questions which our limits forbid us to discuss. We subjoin, however, for the reader's convenience in consultation, the following outline of the different faculties, with their uses and abuses, which we have borrowed from the Introduction to Mr. G. Combe's *Notes on the United States of America, during a Phrenological Visit in* 1838-9-40, as probably containing the most recent as well as the most authentic account of the present state of this much canvassed science. The subjoined figure will be of use in illustrating the observations.

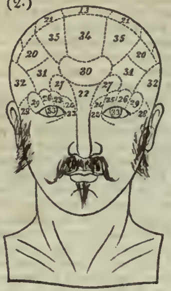
This figure shows the three great phrenological divisions of the brain. The line B runs through the centre of ossification of the parietal bone (the organ of Cautiousness, No. 12.), and terminates in the centre of ossification of the frontal bone situated at the point where it touches the line A A (the organ of Causality, No. 35.) The portion above the line B is named the coronal region, and serves to manifest chiefly the moral sentiments. The line A corresponds to the posterior lateral edge of the superorbitar plate, on which

the anterior lobe of the brain rests. The space before the line A A indicates the size of the anterior lobe, the region devoted to the manifestation of the intellectual faculties. If the space before the lower A be long, the organs of the observing faculties are large; and if the space forward from the point where the line B meets the line A A be long, the reflecting organs are large. The space below B and behind A A manifests the propensities common to man with the lower animals. We may remark that in the above figure the coronal region would be said to be large, indicating powerful moral sentiments; the intellectual region about an average, and that of the so called animal propensities moderate.

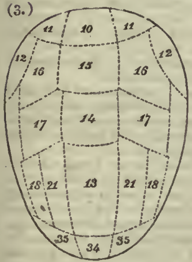
The faculties generally recognized by phrenologists are the following.*

(1.)

(2.)



(3.)



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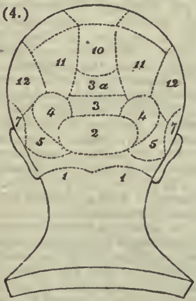


Order I. Feelings.

Genus I. Propensities — *Common to Man with the Lower Animals.*

† The Love of Life.
Appetite for Food. — *Uses:* Nutrition. — *Abuses:* Gluttony and drunkenness.

1. Amativeness — Produces sexual love.

2. Philoprogenitiveness. — *Uses:* Affection for young and tender beings. — *Abuses:* Pampering and spoiling children.

3. Concentrativeness. — *Uses:* It renders permanent emotions and ideas in the mind. — *Abuses:* Morbid dwelling on the internal emotions and ideas, to the neglect of external impressions.

3. *a.* Inhabitiveness. — *Uses:* It produces the desire of permanence in place. — *Abuses:* Aversion to move abroad.

4. Adhesiveness. — *Uses:* Attachment, friendship, and society result from it. — *Abuses:* Clanship for improper objects, attachment to worthless individuals.

5. Combativeness. — *Uses:* Courage to meet danger and overcome difficulties, tendency to oppose and attack whatever requires opposition and to resist unjust encroachments. — *Abuses:* Love of contention, and tendency to provoke and assault. This feeling obviously adapts man to a world in which danger and difficulty abound.

6. Destructiveness. — *Uses:* Desire to destroy noxious objects, and to kill for food. It is very discernible in carnivorous animals. — *Abuses:* Cruelty, murder, desire to torment; tendency to passion, rage, and harshness and severity in speech and writing. This feeling places man in harmony with death and destruction, which are woven into the system of sublunary creation.

7. Secretiveness. — *Uses:* Tendency to restrain within the mind the various emotions and ideas that involuntarily present themselves until the judgment has approved of giving them utterance; it is simply the propensity to conceal, and is an ingredient in prudence. — *Abuses:* Cunning, deceit, duplicity, and lying.

8. Acquisitiveness. — *Uses:* Desire to possess, and tendency to accumulate articles of utility to provide against want. — *Abuses:* Inordinate desire of property, selfishness, avarice, theft.

9. Constructiveness. — *Uses:* Desire to build and construct works of art. — *Abuses:* Construction of engines to injure or destroy, and fabrication of objects to deceive mankind.

Genus II. Sentiments.

I. *Sentiments common to Man with the Lower Animals.*

10. Self-esteem. — *Uses:* Self-respect, self-interest, love of independence, personal dignity. — *Abuses:* Pride, disdain, overweening conceit, excessive selfishness, love of dominion.

11. Love of Approbation. — *Uses:* Desire of the esteem of others, love of praise, desire of fame or glory. — *Abuses:* Vanity, ambition, thirst for praise independently of praiseworthiness.

12. Cautiousness. — *Uses:* It gives origin to the sentiment of fear, the desire to shun danger, and circumspection; and it is an ingredient in prudence. — *Abuses:* Excessive timidity, poltroonery, unfounded apprehensions, despondency, melancholy.

13. Benevolence. — *Uses:* Desire of the happiness of others, universal charity, mildness of disposition, and a lively sympathy with the enjoyment of all animated beings. — *Abuses:* Profusion, injurious indulgence of the appetites and fancies of others, prodigality, facility of temper.

II. *Sentiments proper to Man.*

14. Veneration. — *Uses:* Tendency to venerate or respect whatever is great and good; gives origin to religious adoration. — *Abuses:* Senseless respect for unworthy objects consecrated by time or situation, love of antiquated customs, abject subserviency to persons in authority, superstitious awe.

15. Firmness. — *Uses:* Determination, perseverance, steadiness of purpose. — *Abuses:* Stubbornness, infatuation, tenacity in evil.

16. Conscientiousness. — *Uses:* It gives origin to the sentiment of justice, or respect for the rights of others, openness to conviction, the love of truth. — *Abuses:* Scrupulous adherence to noxious principles when ignorantly embraced, excessive refinement in the views of duty and obligation, excess in remorse or self-condemnation.

17. Hope. — *Uses:* Tendency to expect future good; it cherishes faith. — *Abuses:* Credulity with respect to the attainment of what is desired, absurd expectations of felicity not founded on reason.

18. Wonder. — *Uses:* The desire of novelty; admiration of the new, the unexpected, the grand, the wonderful, and extraordinary. — *Abuses:* Love of the marvellous and occult; senseless astonishment; belief in prodigies, magic, ghosts, and other supernatural absurdities.

19. Ideality. — *Uses:* Love of the beautiful and splendid, desire of excellence, poetic feeling. — *Abuses:* Extravagance and absurd enthusiasm, preference of the showy and glaring to the solid and useful, a tendency to dwell in the regions of fancy and to neglect the duties of life.

19. *a.* The organ of Sublimity; but not sufficiently ascertained.

20. Wit — Gives the feeling of the ludicrous, and disposes to mirth.

21. Imitation — Copies the manners, gestures, and actions of others, and appearances in nature generally.

Order II. Intellectual Faculties.

Genus I. External Senses.

Feeling or Touch. Taste. Smell. Hearing. Sight.	*Uses:* To bring man into communication with external objects, and to enable him to enjoy them. — *Abuses:* Excessive indulgence in the pleasures arising from the senses, to the extent of impairing bodily health and debilitating or deteriorating the mind.

Genus II. Knowing Faculties, which perceive the Existence and Qualities of External Objects.

22. Individuality — Takes cognizance of existence and simple facts.

23. Form — Renders man observant of form.

24. Size — Gives the idea of space, and enables him to appreciate dimension and distance.

25. Weight — Communicates the perception of momentum, weight, and resistance, and aids equilibrium.

26. Colouring — Gives perception of colours and their harmonies.

Genus III. Knowing Faculties, which perceive the Relations of External Objects.

27. Locality — Gives the idea of relative position.

28. Number — Gives the talent for calculation.

29. Order — Communicates the love of physical arrangement.

30. Eventuality — Takes cognizance of occurrences or events.

* The organs are double, each faculty having two lying in corresponding situations of the hemispheres of the brain; except in those organs, such as *individuality, eventuality, benevolence,* &c., represented in the fig. by 22, 30, 13, &c., which occupy the central part of the skull.

† These organs are not fully ascertained, but some facts indicate that they lie in the base of the brain. The first is not marked on the bust, but the second is indicated by 6 *a.* on Fig. 1.

31. TIME — Gives rise to the perception of duration.
32. TUNE — The sense of Melody and Harmony arises from it.
33. LANGUAGE — Gives facility in acquiring a knowledge of arbitrary signs to express thoughts, readiness in the use of them, and the power of inventing and recollecting them.

Genus IV. REFLECTING FACULTIES, WHICH COMPARE, JUDGE, AND DISCRIMINATE.

34. COMPARISON — Gives the power of discovering analogies, resemblances, and differences.
35. CAUSALITY — Traces the dependences of phenomena, and the relation of cause and effect.

The most accredited works in favour of phrenology are Mr. Combe's writings, and the *Phrenological Journal*, which is ably conducted. The most hostile inquiry into the pretensions of phrenology to be regarded as a science appeared in 1826, in the *Edinburgh Review*. In that article, which was well known to have emanated from the pen of Mr. (now Lord) Jeffrey, the views of the phrenologists are treated with ridicule, and their weak side subjected to one of the most vigorous attacks ever made in literary criticism.

PHRYGA'NIDÆ. *Case-worm flies.* The family of Trichopterous insects of which the genus *Phrygania* is the type. *See* TRICHOPTERANS.

PHRYGIAN MARBLE. *See* MARBLE.

PHRY'GIANS. An early sect of heretics; so called from Phrygia, the country where they abounded. They regarded Montanus, the founder of the Montanists (which see), as their prophet; and their distinguishing characteristic was the spirit of prophecy to which they laid claim.

PHTHIRI'ASIS. (Gr. φθειρ, *a louse.*) A disease in which the body is overrun with lice.

PHTHISIS. (Gr. φθινω, *I consume.*) Consumption, which see.

PHYCOMA'TER. (Gr. φυκος, *sea-weed*, and μητηρ, *mother.*) The gelatine in which the sporules of Algaceous plants first vegetate.

PHYLA'CTERY. (Gr. φυλακτήριον, *a protection or preservation.*) An amulet or preservative against infection. The phylacteries of the Jews were derived from the injunction contained in Exodus, xiii. 9.; and consisted of slips of parchment inscribed with verses of the law, enclosed in cases, and worn during prayer on the arm and between the eyes.

PHY'LÆ. (Gr. φυλη, *a tribe.*) The tribes into which the whole of Attica was divided in antiquity. Originally there were but four phylæ, which were frequently remodelled, but remained the same in number till soon after the expulsion of the Pisistratidæ, when Cleisthenes caused their number to be increased to ten. What the precise nature of the change effected on this occasion was is not known, but it is probable that the new tribes embraced a large number of citizens that had been excluded from the former. The phylæ were afterwards increased to twelve, by the addition of two in honour of Antigonus and his son Demetrius. The Athenian senate was composed of fifty delegates from each of these tribes.

PHY'LARCH. (Gr. φυλαρχος, *ruler of a phyle.*) An Athenian officer appointed for each phyle or tribe, to superintend the registering of its members and other common duties. The title answers to that of the Roman tribune, but its functions never reached the same importance.

PHYLLO'DIA. (Gr. φυλλον, *a leaf.*) A term applied to the petioles of certain leafless plants which become so much developed as to assume the appearance of leaves, all the functions of which they perform.

PHYLLONY'CTERANS. (Gr. φυλλον, and νυκτερις, *a bat.*) The name of a primary division of the order *Cheiroptera*, including the "foliated bats," or those species which have the ears and nose complicated by grotesque and variously-figured membranous foliations, serving the purpose of antennæ, and augmenting the sense of touch in these night-flying and short-sighted species. The tribe is also characterized by having a single finger, the innermost, armed with a hook-shaped claw, and the molar teeth beset with sharp-pointed tubercles adapted for crushing insects.

PHYLLO'PHAGANS, *Phyllophaga.* (Gr. φυλλον, and φαγω, *I eat.*) The name of a tribe of Marsupials, including the Phalangers, Petaurists, and Koala; also of a tribe of beetles, including those which live by suction of the tender parts of vegetables, as the leaves and succulent sprouts.

PHY'LLOPODS, *Phyllopoda.* (Gr. φυλλον, and πους, *a foot.*) The name of a tribe of Crustaceans, comprehending those in which the feet are of a flattened leaf-like form.

PHY'LLOSTOMES, *Phyllostomata.* (Gr. φυλλον, and στομα, *a mouth.*) A family of bats, including those in which the nose supports a simple leaf-shaped appendage.

PHYSA. (Gr. φυσα, *a bubble.*) A genus of fresh-water snails; so called from the thinness and inflated appearance of the shell. Several species of bubble-shell are found in England; as *Physa fontinalis*, in the Thames; *Physa alba*, in North Wales; *Physa hypnorum*, common in ponds and slow streams.

PHY'SALIS, or PHYSA'LIA. (Gr. φυσα.) The name of a hydrostatic Acalephan, commonly called the Portuguese man-of-war, remarkable for its size, the brilliancy of its hues, and the severe burning pain produced by its contact.

PHY'SALITE. In Mineralogy, a species of topaz.

PHYSCO'NIA. (Gr. φυσκων, *a big-bellied fellow.*) This term is applied to various enlargements of the abdomen unconnected with dropsy or with accumulations of air, such as morbid states of the liver or of the spleen.

PHY'SICS. (Gr. φυσις, *nature.*) The science of nature. In modern language, however, the term has a less general signification than its derivation implies. Nature signifying the assemblage of all the bodies of the universe, the *science* of *nature* comprehends every species of knowledge which regards the external world. But bodies may be studied under three different points of view; they may be examined with relation to their different properties, with relation to their constituent parts, and with relation to their appearances and exterior qualities. These three distinct views give rise to the three great divisions of natural science; namely, *Physics*, *Chemistry*, and *Natural History*. Physics has for its object the properties of bodies, chemistry studies their elementary principles, and natural history observes their physiognomy or external appearance.

PHYSIO'GNOMY. (Gr. φύσις, *nature*, and γνώμων, *a rule or measure.*) The art of interpreting the indications of the inward disposition supposed to be afforded by the outward appearance, especially the features of the face. (See *Lavater's Physiognomy.*)

PHYSIO'LOGY. (Gr. φυσις, and λογος, *a discourse.*) The science of things generated or alive; but usually regarded as the doctrine of vital phenomena. This science is divided, according to the two great classes of generated beings, into *animal* and *vegetable physiology*. Some philosophers have proposed to change the term for "biology;" but the restricted application of *bios* to the life of an individual in other English compound words, as "biography," would be an objection to this change, even if the word physiology were less appropriate than it is, or if its use in the sense above defined had not been sanctioned by philosophers of other nations.

The chief object of the physiologist is to ascertain the precise mode in which each part or organ of a living being reacts when stimulated. When the precise conditions and mode of the reaction of the circulating fluid upon the solids, and reciprocally, are understood, a true and intelligible definition of life may, perhaps, be given.

In animal physiology, the simplest condition under which life can be contemplated is that which it presents in the torpid hybernater.

During this state a dark nutrient fluid, the venous blood (*see* BLOOD), is propelled, by the contractions of a hollow muscle (*see* HEART), along the arteries to every part of the body, whence it is again returned to the heart by the veins. With respect to this chief manifestation of life in the torpid animal it may be asked, What is the cause or condition of the reaction of the fibres of the hollow muscle upon the stimulating fluid? How does each tissue of the body select from the currents flowing through the terminal capillaries the appropriate particles for its growth or reparation, and, in return, add to the blood, either directly or through the medium of lymphatic vessels, its effete particles? These are questions which physiology has yet to resolve: the electric conditions of the parts concerned have not been ascertained. The blood is maintained in a fit state for the preservation of the tissues of the torpid animal by slowly parting with some noxious or useless principles, through the excretion of the kidneys, and of the different mucous and serous surfaces. The reaction of the circulating fluids upon the solids supersedes the ordinary chemical reaction, by which they would be decomposed and destroyed, and thus the torpid animal is kept alive; but it is the life of the plant or of the ovum. The functions of circulation, nutrition, execretion, are manifested when life is thus reduced, as in the plant, to its simplest condition; and these must, therefore, be its most essential actions. In the torpid animal, the phenomena of irritability and contractility of muscular fibre are superadded, as in the action of the heart; and this is dependent on the connection of the muscular fibre with a nerve. The power of the external decomposing forces is increased by elevation of temperature; and the stimulus of heat produces in the torpid animal, in a manner not understood, a reaction of the mucous surface of the lungs: this reaction influences, through the nerves, the muscles of respiration, and atmospheric air is inspired and brought into contact with the thin membrane over which the pulmonary capillaries are richly spread. The result of this contact is the immediate elimination of the carbon

from the blood, which changes its dark for a florid red colour; or converts it from venous to arterial blood.

The blood so changed stimulates in a different and more potent manner the parts over which it is distributed; the heart contracts more vigorously and frequently; the brain and nervous system now receiving more blood, and that of a different kind, begin to react on the application of stimuli to which they were before insensible.

First, self-consciousness; then sensation of external impressions; lastly, the propagation of a stimulus to the muscular system generally, which produces the reaction of vibratile contraction of its fibre, and by which the animal moves its parts upon each other, or its entire body upon external matter, are successively manifested; and to circulation, nutrition, excretion, and respiration, are now added the functions of sensation and voluntary motion. But with this greatly increased activity of the whole organic machinery, there is a proportional increase of vital decomposition; *i. e.* of abstraction by the tissues of assimilating particles from the capillary blood, and of addition to the same of effete particles; and those actions demand not only increased activity in the organs which eliminate the waste and noxious particles from the blood, and expel them from the body, but also a means of supplying new blood. This is effected by digestion, chylification, and lacteal absorption.

It is the consciousness of this want that impels the newly roused hybernating animal to seek for its appropriate food: the first use to which the machine is put is to supply itself with the means for its continued activity; and this completes the circle of the functions by which animal life is maintained, as respects the individual being.

It is a law, that the renovation of the parts of a living body should not be uniform: at first the power is in excess, and the body grows; afterwards it is unequal to the waste, and the body shrinks; it is at no period, perhaps, quite perfect; the machinery of renovation thus in time becomes unequal to its office, and the ordinary chemical decompositions and recompositions take the place of those in which life had before essentially consisted.

A given term of life characterizes each species of animal; but that the species should continue, it is necessary that the death of the individual be compensated for. This is effected by the power which living beings possess of detaching a portion of themselves; which portion contains in itself potentially all the faculties or functions of life; develops their organs progressively, and according to the pattern of the parent from which it was derived; and when arrived at maturity, in like manner generates or separates another portion of itself, with similar powers of development and growth; then decays and dies. Thus the species of living beings are maintained by the function of generation through a long, but apparently not an indefinite period of time; for the history of the changes of the earth's surface teaches us that the duration of the existence of species, as well as of the individual, is limited, and that many species have become extinct. So far, however, as observation has been able to reach, the death of a species seems to have been rather a violent than a natural one. We have, as yet, had no experience of the extinction of a species by a gradual abrogation of the procreative powers in the individuals of successive generations. Of the introduction of new species we know of no natural cause, nor can hardly form a conception of such.

The science of physiology is that of the different functions of which life is the manifestation; that is to say, of circulation, nutrition, excretion, respiration, sensation, muscular contraction, digestion, absorption, generation; with other subordinate faculties, as the maintenance of equable temperature, the production of vocal sounds, the mental phenomena. To explain these functions, we must first know the instruments by which they are performed; secondly, the matters which they attract, those which they reject, and the nature of that which remains; thirdly, by what forces these matters are transported, attracted, retained, and rejected; and finally, the nature of the stimuli appropriate to each part, and the mode in which such part reacts when stimulated. Physiology has thus many departments, and each department has its anatomical, chemical, dynamical, and what may be termed its purely physiological line of research.

PHYSIOLOGY, VEGETABLE. *See* BOTANY.

PHY'SOGRADES, *Physograda.* (Gr. φυσις, *air*, and gradior, *I proceed.* The name of a tribe of Acalephæ, comprehending those which swim by means of air-bladders.

PHYTI'PHAGANS, *Phytiphaga.* (Gr. φυτον, *a plant*, and φαγω, *I eat.*) The name of a tribe of Cetaceous Mammals, synonymous with *Herbivora.* Also applied by Lamarck to a section of his order of Trachelipod Mollusks.

PHYTO'GRAPHY. (Gr. φυτον, *a plant*, and γραφω, *I describe.*) That branch of science which concerns itself with the rules to be observed in describing and naming plants. *See* BOTANY.

PHYTO'LOGY. (Gr. φυτον, and λογος, *a discourse.*) A book containing herbs and plants.

PHYTO'PHAGOUS. (Gr. φυτον, *a plant*, and φαγω, *I eat.*) Plant-eating.

PHYTO'ZOONS, *Phytozoa.* (Gr. φυτον, *a plant*, and ζωον, *an animal.*) This term is applied by various naturalists to different sections of the sub-kingdom *Zoophyta* of Cuvier.

PIA MATER. A thin vascular membrane covering the convolutions of the brain and the spinal marrow.

PIA'NO. In Music. *See* P. &c.

PIA'NO-FORTE. (It.) A musical stringed instrument of the keyed species. Its name, compounded of two Italian words, signifying *soft* and *loud*, was probably given to it to distinguish it from the harpsichord and spinet, in which no lightness of touch could lessen the strength of the sound produced from the quills always striking the strings with equal force; whereas in the piano-forte, the strings are put in vibration by means of small hammers connected by levers with the key or finger board, which hammers quit the string the moment it is struck, a damper falling down upon it the moment the finger quits the key. The invention of the piano-forte is ascribed to a German named Schroeder, who lived at the beginning of last century; but it was first introduced into England in 1766 by Zumpe, by whom it was greatly improved. Within the present century this instrument has received many useful and valuable improvements from the hands both of Englishmen and foreigners; so that it may be now fairly regarded as, next to the organ, the noblest and most elegant instrument in the whole compass of musical practice. Many distinguished musicians have devoted themselves to the composition of pieces for this instrument; and several of the most distinguished composers in modern times, among whom we may mention Hummel, Czerny, Herz, Kalkbrenner, Cramer, Moscheles, Chopin, Thalberg, Liszt, &c., have made the instrument itself almost their exclusive study. There is an excellent article on the piano-forte in the *British and Foreign Review for* 1839.

PI'ARISTS. (Patres Scholarum Piarum.) Members of a religious order founded at Rome by Casalanza, a Spanish nobleman, early in the 17th century. They were bound by a special vow to devote themselves to the purpose of education. They still continue to superintend a great number of schools in Hungary, Poland, Bohemia, &c.

PIA'STRE. A silver coin used in Spain, Italy, Turkey, South America, the East Indies, &c., varying in value in every country. *See* MONEY.

PIA'ZZA. (Ital.) In Architecture, a square open space surrounded by buildings. Improperly used in England to denote a walk under an arcade.

PI'BROCH. Martial music produced by the bagpipe of the Highlanders. It is said to signify also the instrument itself; but the former meaning, if indeed there are *any* instances of the latter to be found in any classical writer, has received the sanction of the two most celebrated poets of their time, Lord Byron and Sir Walter Scott. The connoisseurs, says the latter writer, in pipe-music, affect to discover, in a well-composed pibroch, the imitative sounds of march, conflict, flight, pursuit, and all the "current of a heady fight." (See a note in *Beattie's Essay on Laughter and Ludicrous Composition*, chap. iii., for a description of the nature of the pibroch.) The 17th stanza of the 2d canto of the *Lady of the Lake*, in which the effects of this martial music are so admirably depicted, must be familiar to every reader.

PI'CA. In Printing, a type of a moderate size; so called because it was used in printing the *Pic*, the service book of old Catholic times, which again is supposed to derive its appellation from the *piecolour* of the text and rubric.

PI'CAMAR. The bitter principle of tar; whence it derives its name (*in pice amarum*).

PICA'RDS. The name of a fanatical and immoral sect of Christians who sprang up in Bohemia in the 15th century. They derived their name from Picard, a native of Flanders, who styled himself the New Adam, and attempted to revive the absurdities of the Adamites of the 2d century, in imitating the state of primeval innocence. They were completely annihilated by Zisca, the great general of the Hussites, who, struck with their abominable practices, had marched against them.

PI'CHURIM BEAN. An oblong heavy seed brought from Brazil, and used medicinally in the cure of colic. It has a musky odour, and is supposed to be the produce of a species of *Laurus.*

PICI. (Lat. picus, *a woodpecker.*) The name given by Linnæus to a group of birds corresponding to the *Scansores* and part of the *Passeres* of Cuvier.

PICIDÆ. *Woodpeckers.* The family of birds of which the genus *Picus* is the type.

PI'CKET. In Fortification, a stake used in laying out ground, to mark the bounds and angles. Pickets are of various lengths, according to the purpose they are to serve. One end is sharp and shod with iron, and the other sometimes carries a small flag, for the purpose of rendering it visible at a distance.

PI'CROMEL. (Gr. πικρος, *bitter*, and μελι, *honey.*)

A peculiar substance, of a sweetish bitter taste, which exists in bile.

PICROTO'XIA. (Gr. πικρος, *bitter*, and τοξικον, *a poison.*) A poisonous bitter principle which exists in the *Cocculus indicus*.

PICTS WALL. One of the barriers erected by the Romans across the northern part of our island to restrain the incursions of the Scots.

PICTURE'SQUE. (Equivalent to the Ital. pittoresco, and the Germ. malerisch.) In the strict sense of the word, all objects which afford fit combinations of form and colour for the imitation of the painter. In literary composition, a style which represents objects and events in such a manner as to call up vivid impressions, as it were, of visible reality, is termed picturesque.

A great diversity of opinion prevails as to the precise nature of that quality which peculiarly recommends objects for pictorial representation; but it would be impossible in this place to lay down any general rules on the subject that would be of any use for the guidance ofthe student. Meanwhile, however, it may be necessary to notice the fact, that the term picturesque is used in a totally different sense from that above adverted to, being applied by many writers to such natural objects as have a somewhat rugged appearance, in contradistinction to those objects which have a *sublime* or *beautiful* character. Thus, in water, that of which the surface is broken, and the motion abrupt and irregular; and, among trees, "not the smooth young beech, nor the fresh and tender ash, but the rugged oak or knotty wich elm, is picturesque. Nor is it necessary they should be of great bulk; it is sufficient if they are rough and mossy, with a character of age, and with sudden variations of their forms. Among animals, the ass is generally thought to be more picturesque than the horse; and among horses, it is the wild and rough forester, or the worn-out cart horse, to which that title is applied. In our own species, objects merely picturesque are to be found among the wandering tribes of gipsies and beggars, who, in all the qualities that give them that character, bear a close analogy to the wild forester and the worn-out cart horse; and again to old mills, hovels, and other inanimate objects of that kind." Such objects, it is argued, are neither beautiful nor sublime; and though far less universally pleasing and alluring than those which possess the qualities of beauty or sublimity, are nevertheless endowed with qualities of their own, which are not only highly suited to the painter and his art, but attractive also to the rest of mankind whose minds have been at all cultivated or improved; and to such objects the term picturesque ought to be exclusively applied. It is impossible, we believe, to invalidate this argument, for the circumstances are sufficiently striking and general to admit of a satisfactory solution; though it must be conceded that great caution is necessary before joining a third and distinct character to the two graces which it is universally admitted embellish natural forms — the sublime and beautiful. But on this question our limits preclude us from entering; and we must refer the reader to Price's elaborate work on the *Picturesque* for full information. (See also the *Quart. Rev.* vol. iv.)

PIEDROIT. (Fr.) In Architecture, a pier or square pillar partly hid within a wall. It is without base or capital, therein differing from a pilaster.

PIE'NO. (It.) In Music, a term denoting that the composition where the word is appended is *full*, that is, for all the performers.

PIE POUDRE COURT. In English Law, a court established to decide on the spot disputes arising at fairs or markets. It was styled in Lat. *curia pedis pulverizati*, and derived its name from the itinerant "dusty-footed" dealers (in old Fr. *pied pouldreux*), for whose convenience it was principally instituted.

PIER. In Architecture, the solid between the openings of a building, or that from which an arch springs. An abutment pier, in a bridge, is that next the shore. For the mode of building the piers of a bridge, see BRIDGE.

PIER. In Engineering, identical with mote, and is used to designate the masses of building erected to form harbours, landing places, &c.

PIERCED. In Heraldry, a term used when a charge is represented as perforated, so as to show the field under it.

PIE'RIDES. A name of the Muses, who were so called from Pieria, a district of Thrace. This was also the name of the nine daughters of Pierus, the king of Emathia, whose profound acquaintance with the fine arts tempted them to challenge the Muses to a contest of musical skill; but, being worsted, were changed by the latter into magpies. In memory of their victory over the Pierides, the Muses are considered, by some authors, to have adopted the name.

PI'ETISTS. The name given to certain reformers of the doctrines and practice of the Lutheran church that arose in Germany towards the end of the 17th century, and caused great dissensions in that body. The Pietists may be divided into two classes, of which the one proposed to effect merely an amendment of life and manners, and to promote a more evangelical spirit and conception of gospel truth than was cherished by the reformed churches, which, at the period in question, had degenerated into great coldness and formality. Out of the discussions which this agitation excited there arose, however, a more violent and fanatical sect, who accompanied the assaults they made on the doctrine and discipline of the church by the assertion of various mystical extravagances. Arnold, Dippelius, and Petersen were their most distinguished leaders. The same school of theologians gave birth to the celebrated enthusiast Jacob Behmen. (See *Mosheim*, vol. v. p. 312., trans. 1790.) The term *Pietist* is at present applied, in Germany, much in the same sense of disparagement as the word Methodist is vulgarly used among ourselves, to those persons who make a display of strong religious feelings.

PIEZO'METER. (Gr. πιεζω, *I press*, and μετρον, *measure.*) An instrument for ascertaining the compressibility of liquids.

PI'GMENT. (Lat. pigmentum.) A term applied by anatomists to the mucous secretion which covers the iris of the eye, and gives it its various colours; and to the dark matter which covers the anterior surface of the choroid membrane, and the interior surface of the ciliary processes.

PIGMENT. In Painting, a general term denoting any colour used by artists.

PI'GMY, or PYGMY. (Gr. πυγμαιος, sc. ανηρ, from πυγμη, *a cubit; a diminutive man.*) By ancient authors on natural history this name was applied to a fabulous race of dwarfish and deformed human beings; it is now restricted to a species of ape, the *Simia troglodytes* of Blumenbach, or the Chimpanzee. (See *Tyson's Anatomy of a Pygmie*, with an Essay concerning the Pygmies of the Ancients, fol. 1699.) Ancient fable (as ancient as Homer, *Il.* b. 3.) described a nation of pygmies dwelling somewhere near the shores of the ocean, and maintaining perpetual wars with the cranes; of which Athenæus gives the mythological origin. Ctesias the Greek historian, as quoted by Photius, represented a nation of them as inhabiting India, and attending its king on his military expeditions. Other ancients believed them to inhabit the Indian islands; and Aristotle places them in Ethiopia, Pliny in Transgangetic India. Some modern lovers of the marvellous have constructed these stories from legends of pigmy nations inhabiting the northernmost part of the earth. These numerous fables appear to originate partly, as Strabo long ago observed, in the stunted growth of particular races, under the sufferings of a severe climate or great privations; thus the Esquimaux or Laplanders furnished the ancient Northmen with their legendary "Dwergar," or nations of malicious dwarfs. Some of the low-caste races which inhabit the forests of interior Hindostan are feeble and puny enough to have given origin to the account of Ctesias; while the pygmies of the Malay Archipelago and the interior of Africa were probably apes. (See the *Encyc. Metropolitana.*)

PIG NUT. The bulbous root of the *Bunium bulbocastanum;* so called because pigs are fond of and dig for them.

PIKE. In Ichthyology, the English term for a fish belonging to the order *Malacopterygii*, section *Abdominales*, family *Esocidae*, and genus *Esox*. *See* MALACOPTERYGIANS.

PIKE. In Military affairs, an offensive weapon used in antiquity and modern times down to the invention of the bayonet, by which it has been universally superseded, consisting of a shaft of wood of 12 or 14 feet in length, surmounted with a flat pointed steel, commonly called the spear. It was chiefly used by the infantry.

PILA'STER. (Ital. pilastro.) In Architecture, a square pillar engaged in a wall, usually projecting not more than one fifth or one sixth of its width. Pilasters are subject to the same rules of proportion as columns.

PI'LCHARD. In Ichthyology, the common name for a fish closely resembling the common herring; but smaller, and at the same thicker and rounder. They are found chiefly on the coasts of Devon and Cornwall, particularly the latter, where they are taken in great numbers from July to September. It is a saying of the Cornwall fishermen, that the pilchard is the least fish in size, but greatest in number and for gain, taken from the sea. For some curious details on the pilchard fishery, see the *Com. Dict.*

PILE. In Heraldry, an ordinary which is represented of a wedge-shape, tapering from the chief downwards towards the point; said to represent the piles on which bridges and other erections are founded.

PILE. In Artillery, a heap of shot or shells, piled up by horizontal courses in a pyramidal or wedge-like form. The form of the pile is determined by that of the base, which may be a triangle, a square, or a rectangle. In a triangular pile the base is an equilateral triangle, and there is one shot at the vertex. The number in the successive horizontal courses, reckoned from the top downwards, are represented by the triangular numbers 1, 3, 6, 10 . . . . $\frac{1}{2}n\ (n+1)$, the sum of which is $\frac{1}{6}n\ (n+1)\ (n+2)$; which, therefore, is the number of shot in a pile of n courses. *See* FIGURATE NUMBERS.

If the base is a square, the number in the successive courses is represented by the series of squares 1, 4, 9, 16, &c.; and the number in the pile of n courses is $\frac{1}{6} n (n + 1)(2n + 1)$.

If the base is a rectangle, n the number of shot in the shortest side (or the number of courses), and $n + d$ the number in the longest side, then the number in the pile continued until there is a single row of $d + 1$ shot at the top is $\frac{1}{6} n (n + 1)(2n + 1 + 3d)$.

PILE DRIVER. An engine for driving down piles. It consists of a large ram or block of iron, which slides between two guide posts. Being drawn up to the top, and then let fall from a considerable height, it comes down on the head of the pile with a violent blow. It may be worked by men or horses, or a steam engine.

PILES, in Building, are timbers driven into the ground or bed of a river, for supporting the foundations of an edifice, or the piers of a bridge. They may be round or square, and formed of any wood which does not rot under water: oak, elm, and chiefly fir, are employed. The end of the pile which penetrates the ground is pointed and shod with iron, and the top is bound with a strong iron band or hoop, to prevent the piles from being split by the violent strokes of the ram by which they are driven down.

PILES. A disease originating in the morbid dilatation of the veins of the lower part of the rectum, and upon the verge of the anus, and frequently caused by costiveness and irregularity of alvine evacuation; the contents of the rectum pressing upon the veins, and preventing the return of their blood, so that they become turgid and varicose, often forming bleeding or ulcerated enlargements and tumours. Mild aperients, especially sulphur and castor oil, are necessary in the relief of the early stage of piles: when there is much inflammation, cold and astringent lotions may be used, and the pain is often relieved by fomentation with decoction of poppies. When the tumours are large and flaccid, an ointment of powdered galls, with a little opium and acetate of lead, often affords relief; and, in old relaxed piles, the internal use and local application of copaiba balsam, and even *Ward's paste*, which contains black pepper, do good. In many cases of protrusions of the tumours, they require removal by ligature or by the knife.

PI'LGRIMAGE. A journey undertaken for devotional purposes to some spot hallowed by religious associations. The custom of making these pilgrimages has long been recommended and enjoined by the Roman church, and they are frequently imposed by way of penance; the remission of sins, and various spiritual advantages, being promised as the reward of the faithful and pious pilgrim. There exist traces in the history of the early church of such journeys being occasionally undertaken from the natural motives, we may suppose, of curiosity, or of a deeper interest; in process of time, the custom of celebrating festivals in honour of martyrs at the place of their sepulture drew larger numbers together from a distance, who, doubtless, soon began to look with some complacency upon their own merits in doing honour to the saints at the expense of fatigue or danger to themselves. But the systematic establishment of pilgrimage as a meritorious work seems to be of much later date. That which was undertaken to the tomb of St. Martin of Tours is among the earliest canonically enjoined. Such places of devotion became gradually very numerous; of which, however, Jerusalem was held naturally in the highest estimation. The difficulties which presented themselves to the pilgrims who attempted to accomplish this journey, when Palestine had fallen into the hands of the Saracens, were the proximate cause of the excitement which armed Europe to the rescue of the Holy Land. The cupidity of the persons in whose custody these shrines were, and the immorality which ensued from the desultory habits which the pilgrims acquired, called forth the earliest animadversion of the church, at the council of Chalons in the 9th century; but the evil seems to have continued steadily on the increase, until, at the time of the Reformation, we find what was originally a harmless, and even a pious practice, degenerated into one of the most crying abuses of the ecclesiastical system. The earliest pilgrimage on record is perhaps that of Helena, the wife of Constantine, to the Holy Land. (See *Schrocck's Kirchen Geschichte*, part 5. 8. 19. 23. 25.)

But pilgrimages are not confined to Christian nations. According to a command in the *Koran*, every good Mussulman is enjoined once in his lifetime to repair to Mecca; and there are many other places, especially in Persia, endowed with sufficient sanctity to attract multitudes of pilgrims. The Hindoos have also their pilgrimages, the most celebrated of which is to the city of Juggernaut, where stands the temple erected in honour of the deity of the same name; a full account of which will be found in the *Geo. Dict.*, art. "Juggernaut." Among existing Christian pilgrimages, the most celebrated is that of Marianzell, in Austria.

PILI'DIUM. The orbicular hemispherical shield or apothecium of a lichen, the outside of which changes to powder, as in *Calycium*.

PILLAR. In Architecture. *See* COLUMN.

PI'LLORY. (Fr. pilori; supposed from pilier, *a pillar.*) A wooden engine on which offenders were formerly exposed to public view, and generally to public insult. It was a common punishment in England, and, by the "statute of the pillory," 51 Hen. 3. c. 6., appointed for forestallers, users of deceitful weights, perjury, forgery, &c. By 56 G. 3. c. 138. it was abolished in all cases except perjury; and as it was discretionary in that instance, it had been long wholly disused. It was finally abolished in 1837 by the statute 1 Vict. c. 23. The French punishment of the same description is now termed the "carcan," from the iron collar by which the neck of the criminal is fixed to a post; anciently, "pilori." It is not now specifically appropriated to particular crimes, but in heavy cases accompanies the sentence of imprisonment or forced labour.

PILOSE. (Lat. pilus, *a hair.*) In Zoology, when an animal or part is covered with hair.

PI'LOT. A person qualified and appointed by proper authority to conduct ships in and out of particular harbours, or along certain coasts, at a certain fixed rate, depending on the draught of water. The pilot has the charge of the vessel while in *pilot water*, and the captain or master neglects or opposes the pilot's advice on his own responsibility. (See *M'Culloch's Commercial Dict.*)

PI'MELITE. (Gr. πιμελη, *fatness.*) A green hydrated silico-aluminous mineral, containing oxide of nickel, of a *greasy* feel.

PIME'NTO. The berry of the *Myrtus pimenta*; allspice, or Jamaica pepper. *See* PIPERACEÆ.

PIN. A small bit of wire, usually brass, with a point at one end and a spherical head at the other. No fewer than fourteen distinct operations are necessary in making this little article; for an account of which see *Ure's Dict. of Arts, &c.* There is a good account of this manufacture in *Babbage's Economy of Manufactures*. See also *Wealth of Nations*, p. 3.; where the pin is cited as an admirable instance of the good effects of a division of labour.

PIN. A term of Chinese diplomacy, signifying a petition or address from foreigners to the emperor of China or any of his viceroys or deputies.

PINACOTHE'CA. (Gr. πιναξ, *a picture*, and τιθημι, *I place.*) In Ancient Architecture, the apartment in a house for the reception of paintings.

PI'NCHBECK. An alloy of copper of zinc; a species of brass much resembling what is now termed *Mosaic gold*. It was brought into notice by a person of the above name.

PI'NEAL GLAND. A small heart-shaped protuberance of the brain, hanging by two peduncles from the beds of the optic nerves immediately over the *corpora quadrigemina*. Some fanciful physiologists have asserted that it is the seat of the soul.

PINE. *See* ABIES.

PI'NION. In Mechanics, a small wheel which plays in the teeth of a larger, or sometimes only an arbor or spindle, having notches or leaves, which are caught successively by the teeth of the wheel, and the motion thereby communicated.

PI'NITE. (From the mine *Pini*, at Schneeberg in Saxony.) A soft crystallized mineral, composed of alumine, silex, and oxide of iron.

PINK, DUTCH. In Painting, a colour of a reddish hue.

PI'NNA. (Lat. pinna, *a fin.*) The name of a genus of Ostracean Acephalous Mollusks, commonly called "wing-shells," remarkable for the size of the byssus, by which they adhere to rocks, and which the natives of Sicily manufacture into gloves, socks, and other articles of sale.

PI'NNACE. A small light vessel with sails and oars: it is at present generally understood as one of the boats belonging to a ship of war.

PIN'NACLE. (Lat. pinna.) In Architecture, a small square or polygonal pillar, generally, though not necessarily, applied at the angles of a building, terminating upward pyramidally, and embellished with foliage at the angles of the pyramidal part.

PI'NNATES. A term applied by Linnæus to the feet of those birds which have the toes bordered by a scalloped membrane, as the coots.

PINNA'TIPEDS, *Pinnatipedia*. (Lat. pinna, *a fin*, and pes, *a foot.*) A term applied by Temminck to an order of birds comprehending those which have the digits bordered by membranes.

PI'NNIPEDS, *Pinnipedes*. The name of a section of crabs (Brachyurous Decapod Crustaceans), in which are comprehended those that have the last pair of feet, if not more, terminated by a flattened joint fitted for swimming.

PI'NNOTHERES. (Gr. πιννοθηρης, from Lat. pinna, and Gr. θηραω, *I pursue.*) A small parasitic species of crab, which takes up its abode in the shell of the *pinna* and other bivalves.

PINT. A measure of capacity, being the eighth part of a gallon. *See* MEASURES.

PIO'NEERS, in the Military Art, are certain soldiers, in all infantry and cavalry regiments, whose business it is to clear the road before an army, to sink mines, and throw up works and fortifications. Pioneers are provided on a march with hatchets, axes, spades, pickaxes, and all other necessary implements.

PIPE. A wine measure, usually containing 105 (very nearly) imperial, or 126 wine gallons. Two pipes, or 210 imperial gallons, make a tun. But, in practice, the size of the pipe varies according to the description of wine it contains. Thus, a pipe of port contains 138 wine gallons, of sherry 130, of Lisbon and Bucellas 140, of Madeira 110, and of Vidonia 120. The pipe of port, it is to be observed, is seldom accurately 138 gallons, and it is usual to charge what the vessel actually contains.

PIPE CLAY. A species of clay, abounding in Devonshire and other parts of England, employed in the manufacture of various sorts of earthenware.

PIPERA'CEÆ. (Piper, one of the genera.) A natural order of shrubby or herbaceous Exogens, inhabiting the hotter parts of the world. According to Blume and Richard they are monocotyledonous; but that they are really dicotyledonous is proved by their medullary rays, articulated leaves, and two-lobed embryo. They are closely related to *Polygonaceæ*, *Saururaceæ*, and *Urticaceæ*, from all of which they are distinguished by obvious characters. Common pepper represents the ordinary property of this order. The cubebs of the shops is the produce of the *Piper cubeba* and *caninum;* betel, an acrid stimulating substance, much used for chewing by the Malays, is obtained from *Piper betel* and *siriboa*. Black pepper is the unprepared fruit of *Piper nigrum*, and white pepper is the same deprived of its pulpy covering. Long pepper consists of the half-ripe flower-heads of *Piper longum* and *chaba*.

PI'PERIN. A white crystallizable substance extracted from black pepper. It is tasteless, and free from pungency, the acrimony of pepper residing in a peculiar fixed oil.

PI'RACY. (Gr. πειρατης; from πειρα, *an attempt.*) In Law, an offence which consists in the commission of those acts of robbery and depredation upon the high seas which, if committed on land, would have amounted to felony there. By the statutes 11 & 12 W. 3. c. 7. and 6 G. 1. c. 19., piracies committed on the sea or in haven, &c., where the admiral has jurisdiction, may be tried at sea or on land, in his majesty's islands, &c., by commissioners under the great seal appointed for that purpose, who may commit the offenders, and call a court of admiralty for the purpose of the trial. By the same statutes various acts are enumerated as amounting to piracy, and aiders and abettors of pirates are declared accessaries, punishable as principals. By subsequent enactments, acts of trading with pirates, and acts of hostility committed by natural-born subjects against his majesty's subjects under colour of a foreign commission, are declared piracy. In the realm of England, felonies, robberies, and murders, committed by pirates, are triable under 28 H. 8. c. 15. by the king's commission of oyer and terminer, as if the offences had been committed on land. (See as to the pirates of antiquity, the *Mem. de l'Ac. des Inscr.* vol. xii.)

Piracy is also frequently used to signify any infringement on the law of copyright. It is extremely difficult to lay down any general principle on which to decide as to what is and what is not piracy. Generally it is held, that one writer may borrow the ideas or theories of another; but that he must dress them up and explain them in a different way, and in his own language. This, however, is often done so as merely to evade the law; and it were well, in order to make greater attention be paid to originality, were the law as to piracy less lax than it is at present. (See as to the existing law of piracy, the art. "Copyright—Books," in *Com. Dict.*)

PISALPHA'LTUM. Mineral pitch; an indurated bitumen.

PI'SCES. (Lat. pisces, *a fish.*) The name of the fourth great subdivision of Vertebrate animals, or the class of fishes characterized by a branchial respiration, a bilocular heart, and a covering of scales. The nasal cavities do not communicate with the mouth, but have only external apertures. *See* Ichthyology.

Pi'sces. (The Fishes.) One of the twelve zodiacal constellations, the twelfth in order from Aries. *See* Constellation, Zodiac.

PISCIS AUSTRALIS. (The Southern Fish.) One of Ptolemy's 48 constellations, in the southern hemisphere. The brilliant star Fomalhaut, of the first magnitude, belongs to this constellation.

PISCIS VOLANS. A small modern constellation of the southern hemisphere, formed by Bayer. It is situated on the antarctic circle.

PISÉ. (Fr.) In Architecture, a species of wall constructed of stiff earth or clay, carried up in moulds, and rammed down as the work is carried up.

PISI'DIUM. (Lat. pisum, *a pea.*) A genus of fresh water Gastropods; so named on account of the resemblance of the shell to a small pea. Many of the species are British; as *Pisidium obtusale*, which may be found in the New River; *P. pusillum*, *P. nitidum*, *P. pulchellum*, &c.

PI'SOLITE. (Gr. πισον, and λιθος, *peastone.*) A concretional carbonate of lime. The concretions generally contain a central grain of sand.

PISTA'CHIA or PISTA'CHIO NUTS. (Ger. pistachen; Du. pistasjes; Fr. pistaches; It. pistacchi, fastucchi; Sp. alfocigos; Lat. pistaciæ.) The fruit of the *Pistachia vera*, a kind of turpentine tree. It grows naturally in Arabia, Persia, and Syria; also in Sicily, whence the nuts are annually brought to us. They are oblong and pointed, about the size and shape of a filbert, including a kernel of a pale greenish colour, covered with a yellowish or reddish skin. They have a pleasant, sweetish, or unctuous taste, resembling that of sweet almonds; their principal difference from which consists in their having a greater degree of sweetness, accompanied with a light grateful flavour, and in being more oily. Pistachias imported from the East are superior to those raised in Europe.

PISTI'LLUM. The organ which occupies the centre of a flower, within the stamens and disk (if the latter be present). It is distinguished into three parts: an upper or stigma, a lower or ovarium, and a central part or style. It is the female organ of the flower, and contains the ovules or young seeds within the ovary.

PISTOLE. A gold coin common in many parts of Germany, equivalent to about 8*s*. 6*d*. sterling.

PI'STON. In Machinery, a short cylinder of wood or metal, which fits exactly the cavity of a pump or barrel, and works up and down in it alternately. Two sorts of pistons are used in pumps: one hollow, with a valve, used in the sucking pump; and the other solid, which is employed in the forcing pump. *See* Pump.

PIT. *See* Shaft.

PITCH. (Fr. picts.) In Music, the degree of acuteness or graveness of a note.

Pitch. (Germ. pech.) The same as Asphalt and Bitumen, which see.

Pitch. The residuum which remains after boiling tar in an open iron pot, or in a still, till the volatile matter be driven off. It is most extensively used in shipbuilding.

PITCHBLENDE. A mineral found in Saxony; it is a compound of the oxides of uranium and iron.

PITCH OF A ROOF. In Architecture, the inclination of the sloping sides to the horizon. It is usually designated by the ratio of its height to its space.

PI'TCHSTONE. A silicious mineral, the fracture of which resembles that of pitch or resin. It is of various colours.

PITCOAL. *See* Coal, and Geology.

PITH. A cylindrical or angular column of cellular tissue, arising at the neck of the stem of a Dicotyledonous plant, and terminating at the leaf-buds, with all of which, whether they are lateral or terminal, it is in direct communication. It forms the centre of a stem, and is covered over by the wood. Its use is to act as a reservoir of nutritious matter for the young leaves when first developing.

PITHE'CUS. (Gr. πιθηκος, *an ape.*) The subgeneric name of the orang-utan; *Pithicus satyrus*, Geoff.

PITOT'S TUBE. In Hydraulics, an apparatus, so called from the name of its inventor, for measuring the velocity of a stream, or of a body moved through stagnant water. A tube open at both ends is bent into two unequal branches at right angles to each other. It is then placed in the stream, the longer branch in a vertical position, and the shorter turned round so that the water enters directly into the orifice, which should be somewhat contracted. When thus placed, the water enters the tube with the velocity of the stream, and the pressure causes it to rise in the upright branch of the tube to the height from which it must have fallen in order to acquire this velocity. The height to which the water rises in the tube is measured by placing a graduated rod in the tube of such specific gravity as to float on the water; or if the tube is of glass, the height may be measured externally. The corresponding velocity is obtained from the formula $v = \sqrt{(2\,g\,h)}$; where v denotes the velocity, g the accelerating force of gravity, and h the height to which the water rises in the tube, all expressed in units of the same denomination. The result is tolerably accurate, except when the velocity is small; but the effect is somewhat diminished by the friction on the tube.

PI'TTACAL. (Gr. πιττα, *pitch*, and καλλος, *ornament.*) A fine blue substance, obtained by the action of a solution of baryta upon the heavy oil of tar.

PITUI'TARY GLAND. A gland situated within the cranium, between a fold of the *dura mater*, in the *sella turcica* of the sphenoid bone.

PITUI'TARY MEMBRANE. The mucous membrane of the nose.

PITYRI'ASIS. (Gr. πιτυρον, *bran.*) A cutaneous disease consisting of irregular scaly patches, unattended by

inflammation. When it affects infants, it is called *dandriff.* A similar exfoliation of the cuticle in reddish patches is not uncommon in adults. Soap and water, and mild cooling lotions, or very weak nitro-muriatic lotion, are the best applications.

PIU. (Ital.) In Music, a word frequently prefixed to another to increase the strength of its meaning; as *più allegro*, a little quicker.

PI'VOT. (Fr.) In Military language, that officer or soldier upon whom the different wheelings are made in the various evolutions of the drill, &c.

Pivot. In Mechanics, the extremity of the axle about which a body revolves.

PLACA'RD. (Said to be from the Greek πλαξ, *a tablet.*) A writing affixed to a wall, post, &c. in a public place, is commonly so called; and as this was in ancient times the common mode of publishing proclamations and edicts, and also of giving notoriety to libels and seditious advertisements, the word is not uncommonly used in early modern writers in both these senses.

PLACE'NTA. (Gr. πλακους, *a cake.*) The afterbirth. In the human subject it is a single subcircular, flattened, and lobulated organ, composed of the capillary extremities of the fœtal hypogastric arteries and umbilical vein, and of a fine cellular structure, which receives the maternal blood from the tortuous uterine or decidual arteries.

The placenta forms a single lobe in the New World monkeys, the bats, the Insectivora, and the Rodentia. It surrounds the fœtus like a broad hoop in the Carnivora. It is bilobed in the Old World monkeys; and subdivided into many separate lobes, called cotyledons, in the true Ruminantia. The placenta is replaced by a diffused vascular villosity of the chorion in the *Camellidæ*, the ordinary Pachyderms, and the Cetacea. The placenta is absent and the chorion ceases to be vascular in the Marsupialia.

Place'nta. In Botany, a copious development of cellular tissue, formed at some point of the inside of a carpellum, and out of which the ovules or young seeds arise.

PLACENTA'LIA. The name of that primary division of the class Mammalia which includes the orders that have either a placenta or a vascular chorion, by which the fœtus is attached to the parietes of the uterus.

PLA'CITA (Lat.), in the Middle Ages, were public courts or assemblies, in which the sovereign presided when a consultation was held upon the affairs of the state. They were termed "Generalia Placita," because "generalitas universorum majorum tam clericorum quam laicorum ibidem conveniebat." The same custom appears to have existed in France, with a slight modification. According to the *Black Book* in the Exchequer, lib. ii. let. 13., this term was also applied to penalties or fines.

PLA'GAL MELODIES. (Gr. πλαγιος, *oblique.*) In Music, such as have their principal notes lying between the fifth of the key and its octave or twelfth.

PLA'GIARISM. (From the Latin legal term plagium, which signified the offence of stealing a slave, or kidnapping a free person into slavery.) A plagiary, in the modern sense of the word, is one who borrows without acknowledgment, in literary composition, the thoughts or words of another; and the theft itself is styled plagiarism.

PLA'GIOSTOMES, *Plagiostoma.* (Gr. πλαγιος, *transverse*, and στομα, *a mouth.*) A tribe of Cartilaginous fishes, comprehending all those which have the mouth situated transversely beneath the snout. Also the name of a genus of Univalve Mollusks.

PLAGUE. "A typhus fever eminently contagious, and attended by excessive debility: at an uncertain period of the disease carbuncles or buboes ensue." This is Cullen's brief but correct definition of this horrible disease. The best account of the plague, and of its ravages, is to be found in Heberden's work on the *Rise and Decline of Disease.* See also the article Cholera in this work.

PLAID. A striped or variegated cloth much worn by the Highlanders of Scotland, forming a prominent part of the national costume, and indicating, by the variety of its patterns, the different Scottish clans.

PLAIN CHANT. In Music, a term in ancient ecclesiastical music to signify the chief melody, which was confined within the natural sounds of the scale.

PLAINS. In Geography, the general term for all those parts of the dry land which cannot properly be called mountainous, and which compose by far the greater part of the earth's surface. Plains have different physical appearances according to their geographical position, and the peculiar characteristics of each have procured for them different names; thus we have the steppes of Asia, the deserts of Africa, the pampas of South America, and the prairies or savannahs of North America. See these different terms.

PLAN. (Lat. planus.) A drawing of something on a plane.

Plan. In Architecture, an horizontal section of the walls, partitions, staircases, &c. of a building, showing the distribution of the ground plot.

PLANA'RIA. (Lat. planus, *flat.*) The name of a genus of *Sterelmintha*, or Parenchymatous Intestinalia of Cuvier, which do not inhabit the interior of animal bodies, but closely resemble, in their organization, the parasitic species of Trematode Entozoa. They lead from this order to the Suctorious Anellides, or leeches.

PLANE, in Geometry, is a surface without curvature; or it is a surface such that if any two points whatever in it be joined by a straight line, the whole of the straight line will be in the surface.

PLANE PROBLEM, in Geometry, is a problem which can be solved by the intersections of straight lines and circles, without the aid of the conic sections or any of the higher curves. Such problems as require the construction of the conic sections were called, by the ancient geometers, *solid problems.*

PLANE SAILING, in Navigation, is the art of determining the ship's place, on the supposition that she is moving on a plane, or that the surface of the ocean is plane instead of being spherical. On account of the magnitude of the terrestrial radius, this supposition may be adopted for short distances without leading to great errors; and it affords great facilities in calculation, for the place of the ship is found by the solution of a right-angled plane triangle. The part of the meridian between the ship and the parallel of latitude of the place whence she departed forms the perpendicular of the triangle; the distance on the parallel between the place of departure and the foot of the perpendicular is the base of the triangle (technically called the departure); and the distance sailed is the hypothenuse. The angle at the ship is called the course, and the other acute angle the complement of the course. Now, of these four things, the perpendicular, the departure, the distance sailed, and the course, any two being given, the triangle can be laid down on the chart, and all the other parts of it found. See Navigation.

PLA'NET. (Gr. ἀστηρ πλανητης, *wandering star.*) The name given by the ancient Greeks to a few bright and conspicuous stars which are constantly changing their apparent situations in the celestial sphere, and thus appear to *wander* among the constellations. The modern discovery of satellites and periodic comets has rendered it necessary to adopt a more precise definition, in order to individualize the class of objects to which the term is applied; and accordingly modern astronomers understand by the term planet a body which, in a telescope of sufficient power, exhibits a round and well-defined disk, and which revolves about the sun in an elliptic orbit, not differing very greatly from a circle.

The number of planets, including the earth, at present known to belong to the solar system, is eleven. Five of them — namely, Mercury, Venus, Mars, Jupiter, and Saturn — have been known from the earliest ages of astronomy; Uranus was discovered by Sir William Herschel in 1781; Ceres by Piazzi, at Palermo, on the first day of the present century; and the discovery was soon followed by that of Juno, Pallas, and Vesta. The last four are never visible to the naked eye; under favourable circumstances Uranus may be discerned without a telescope; and Mercury, though it appears as a large star, is seldom to be seen (in our climates at least), in consequence of its proximity to the sun.

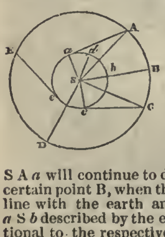
Of the apparent Motions of the Planets. — On watching the motions of any of the conspicuous planets for a few days or weeks, their change of position among the fixed stars becomes sufficiently apparent, even without the aid of an instrument to measure their relative distances. Their paths deviate little from that followed by the sun in his apparent annual revolution through the heavens; but their motions are exceedingly irregular. Sometimes they advance rapidly, then relax in their speed, come to a stop, and then move for a while in an opposite direction. Through the most considerable part of their orbits they move like the sun from west to east, in opposition to the apparent diurnal motion; their course is then said to be *direct.* When it lies in the opposite direction, their motion is *retrograde;* and between each change from the one direction to the other, they remain for a few days *stationary.* On the whole, however, the direct motion prevails, and the planets make the entire circuit of the heavens. These phenomena, which are called the *stations* and *retrogradations* of the planets, may be exhibited in the following manner:—

Let E C represent the ecliptic developed on a plane surface: the path of a planet, found by laying down its observed positions with reference to the ecliptic from day to day, will present the appearance of the zigzag line P Q R S. From P to Q the motion is direct, but becomes slower as the planet approaches to Q. At Q it is stationary; from Q to R retrograde; at R again stationary; from R to S direct, and so on. Such is the general character of the apparent motion; but the arcs and times of retrogradation differ greatly in respect of the different planets.

Mercury and Venus exhibit phenomena peculiar to themselves, inasmuch as they never appear in the opposite quarter of the heavens to the sun, but oscillate about the sun from side to side; the oscillations of the former being much quicker, and performed in a much smaller arc than those of the latter. The distance of Venus from the sun never exceeds an arc of about 47°; and at its greatest distance the planet does not continue above the horizon more than about 3 hours after sunset. Its brilliancy, however, is such, that it may frequently be seen in the morning several hours after the sun has risen. Mercury never recedes farther from the sun than 28° 20′, and does not appear above the horizon more than 1 h. 40 m. after sunset, or before sunrise. For these reasons, Mercury and Venus were regarded by some of the ancient astronomers as satellites of the sun, and supposed to describe orbits round that luminary. The other planets, Mars, Jupiter, and Saturn, being frequently seen in opposition to the sun, and at all different distances from it, were supposed to have independent motions.

In order to explain and represent the apparent motions of the planets, the ancient astronomers had imagined various hypotheses, of which the most celebrated is that of epicyles and deferents, invented by the geometer Apollonius; and adopted by Ptolemy, after whom it was called the Ptolemaic system of the universe, and implicitly believed in during many centuries. According to this hypothesis, each planet moves uniformly in a small circle, called the *epicyle*, the centre of which is carried along, with a uniform motion, in the circumference of another large circle, called the *deferent*, which has the earth at its centre. (*See* EPICYCLE.) By supposing the velocity of the planet in its epicycle to be greater than that with which the centre of the epicycle is carried along the deferent, and by assigning proper relations between the lengths of the radii of the epicycles and deferent circles (their absolute lengths are immaterial), the apparent geocentric motions may be represented with all the exactness of which the ancient observations admitted. Ptolemy placed the earth at the centre of the universe, and nearest to it the moon. Next to the moon was Mercury, then Venus, then the sun; after which followed in order Mars, Jupiter, and Saturn; the distances of the three last being arranged according to their respective periods of revolution; it being natural to suppose that those which required the longest time to complete their periods must revolve in the widest circles. At the present day, and familiar as we now are with the true nature of the celestial motions, this complicated system appears abundantly absurd; but it should be recollected that Ptolemy possessed no means of forming any accurate notions of the distances of the planets: he was unacquainted with the alternate increase and diminution of their apparent diameters, with the phases of Venus, and all the other information afforded by the telescope; in short, he knew of no phenomenon which could not be reconciled to his theory; and he does not appear to have ever regarded his system of epicycles and deferents in any other light than a mere hypothesis, by means of which the celestial motions could be reduced to calculation.

All the apparent irregularities of the planetary movements are got rid of at once by referring them to the sun as a centre, instead of the earth. This great step in theoretical astronomy was made by Copernicus, who first demonstrated that all the phenomena were explicable in the simplest manner by supposing the sun to be placed at the common centre of the planetary motions, and ascribing to the earth a double motion; namely, a diurnal rotation about its axis, and an annual revolution about the sun. On this hypothesis, the truth of which has been established by a multitude of different considerations, the stations and retrogradations of the planets, and all the geocentric appearances which so much perplexed the ancient astronomers, become simple consequences of relative motion. In order to illustrate this, let us consider the appearances which must result from the combined motions of the earth and an *inferior* planet; that is, a planet nearer to the sun than the earth is. Let S be the sun, A B C D the orbit of the earth, and *a b c d* that of Mercury, both moving in the same direction, or in the order of the letters. Suppose A to be the position of the earth, and *a* that of Mercury at its greatest eastern elongation: the line A *a* will be a tangent to the orbit at *a*. As the earth advances from A towards B, and the planet from *a* toward *b*, the angle of elongation S A *a* will continue to diminish, till the earth arrives at a certain point B, when the planet is at *b* in the same straight line with the earth and the sun, the angles A S B and *a* S *b* described by the earth and the planet being proportional to the respective mean angular motions. In this situation the planet is said to be at its *inferior conjunction*.



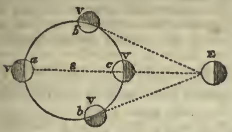
When the earth has passed B, the planet, advancing with a more rapid angular motion, will begin to appear on the western side of the sun, and the angle of elongation continue to increase, till the planet arrives at *c*, and the earth at C, where the visual line is again a tangent to the orbit. The angle of elongation has now attained a second time its maximum value, and from this point will continue to decrease, till it vanishes altogether when the earth arrives at D and the planet at *d*, the three points D S and *d* being in the same straight line. The planet is now at its *superior conjunction*, and *beyond* the sun. Soon after this the planet reappears on the eastern side of the sun; and the angle of elongation continues to increase till the planet comes round to *e*, and the earth arrives at E, where the line E *e* is again a tangent to the orbit. The earth, the planet, and the sun have now precisely the same relative situations in respect of each other as they had when the earth was at A and the planet at *a*, so that the series of changes will here recommence and proceed in the same order as before. The intervals after which these phenomena occur may be easily computed from a knowledge of the periods of revolution of the earth and planet, and of the proportion of the radii of their respective orbits, which is, moreover, known immediately from the observed angle of greatest elongation, S A *a*; for, since S *a* A is a right angle, we have S A to S *a* as radius to the cosine of S A *a*: that is, the radius of the planet's orbit is equal to the the radius of earth's orbit multiplied by the cosine angle of greatest elongation.

From the preceding figure, it is easy to see how the phenomena of the stations and retrogradations must arise. At the point *b*, where the planet is at its inferior conjunction, the earth and planet are both moving in the same direction; but, as the planet is moving faster, it will leave the earth behind it; and the apparent motion, as seen from the earth, will be the same as if the planet stood still, and the earth moved in a contrary direction, with a velocity equal to the difference of their relative motions. The apparent motion of the planet is therefore contrary to the apparent motion of the sun, and consequently retrograde. At the superior conjunction *d*, the planet and earth are moving in opposite directions in respect of the line D *d*; the relative motion is therefore the same as if the planet stood still, and the earth was moving in its proper direction with a velocity equal to their united motions: the apparent motion of the planet in this situation is therefore direct. At the points of greatest elongation, *a* and *c*, the planet is moving in the direction of the line of vision, A *a* or C *c*, and the earth perpendicular (nearly) to that line; the apparent motion of the planet at those points is therefore direct. But since it is direct at *a* and *c*, and retrograde at *b*, there must be a point between *a* and *b*, and another between *b* and *c*, where the apparent motion is neither direct nor retrograde, that is, where the planet appears stationary. The problem of determining the stationary points is one of pure geometry, and very easily resolved when the orbits are supposed to be circular, and the motion uniform; but, in the case of elliptic orbits and unequable motion, it is considerably more complicated. The stationary points of Mercury are variable from 15° to 20° of elongation from the sun; those of Venus are about 29°. Mercury continues to retrograde about twenty-two days, Venus about forty-two.

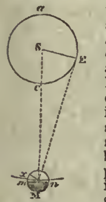
The apparent motions of the *superior* planets, or those which are at a greater distance from the sun than the earth is, are explained with equal facility. As their orbits embrace that of the earth, they are not confined to certain limits of elongation from the sun, but appear at all distances from it, even in the directly opposite quarter of the heavens. When they are in *conjunction*, they are situated beyond the sun, in the same straight line with the sun and earth; and when the earth comes between them and the sun, they are said to be in *opposition*. All the superior planets, when in opposition, and for some time before and after, appear to have a retrograde motion; but the extent of the arc of retrogradation, the time during which the motion is retrograde, and the velocity, are very different in respect of the different planets. Mars continues to retrograde about 73 days, Jupiter 121, and Saturn 138.

Phases of the Planets. — It is a necessary consequence of the Copernican theory, that the planets, supposing them to be, like the earth, round opake bodies illuminated by the sun, must exhibit phases like the moon, according to the angles under which the illuminated half of their surfaces is seen from the earth. When viewed through the telescope, this is found to be the case with Mercury and Venus, and to a certain extent also with Mars; and the appearance of the phase is in every case exactly such as is determined *a priori*, on the supposition that the planet is seen by the reflected light of the sun. Let S be the sun, E the earth, and V Venus, in different positions of her orbit. When the planet is at its superior conjunction *a*, the whole of its illuminated surface is seen from the earth, and it consequently exhibits a round disk. At the points of greatest elongation, *b* and *b*, one half only of the illuminated hemisphere is visible, and it therefore

appears half-mooned at these points. At c, the inferior conjunction, the dark side is turned directly to the earth, and it is consequently invisible. Between a and b, the planet will therefore appear gibbous (*i. e.* more than the half full); and between b and c it will appear in the form of a crescent, like the moon in its first or last quarter. The phases of Mercury are precisely similar.



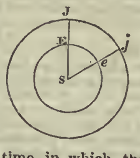
With respect to the superior planets, the absence of phases is a necessary consequence of their great distances from the sun in comparison of the earth's distance. Let S be the sun, E the earth, and M Mars. It is evident that, as the earth goes round its orbit, the smallest portion of the enlightened hemisphere, $m\ x\ n$, will be visible when the earth is at E, or in such a position that the angle S E M is a right angle. Suppose a line, therefore, to be drawn from the centre of the planet perpendicular to E M, and intersecting the surface in x, the visible surface will be contained between x and n, so that the disk will appear to be gibbous, but can never appear as a crescent. These phenomena prove in the most convincing manner that the planets are opake spherical bodies, deriving their light from the sun.



Distances and Periodic Times of the Planets. — Practical astronomy furnishes various methods of determining the distances of the planets from the sun in terms of the earth's distance, and the times in which they complete their revolutions. It has already been stated, that the distances of Mercury and Venus may be compared with that of the earth by observing the angle of greatest elongation. In the case of a superior planet, an approximation to the relative length of the *radius vector* (the line which joins the planet with the sun) may be obtained by observing the angular velocity of its apparent retrogradation about the time when it is in opposition. Thus, conceive E e to be a small portion of the earth's orbit described in a given interval of time, a day, for example, and M m to be the corresponding portion of the orbit of Mars described in the same interval, the planet being near the opposition. Join $e\,m$, and draw $e\,n$ parallel to SM. As seen from e, Mars will appear to have retrograded from n to m; therefore the angle $n\ e\ m$ is given by observation, and consequently its complement $m\ e$ E becomes known (for the arc E e, being very small, may be regarded as a straight line). Now, in the triangle e S E, right-angled at E, the angle at S is given, being the angle described by the radius vector of the earth in the given interval; consequently the angle S e E becomes known, and hence also S $e\ m$. Supposing, therefore, the periodic time of Mars to be known, the arc M m, or the angle M S m, will be given; and therefore m S e, which is its difference from E S e, becomes known. In the triangle S $e\ m$, we have therefore given the two angles S $e\ m$, and e S m, and consequently also the third angle $e\ m$ S, whence the triangle is given in species, and the ratio of S e to S m is determined. But S m is the distance of Mars from the sun, which, therefore, is determined in terms of the radius vector of the earth.

The method of finding the planet's distance, which has just been described, requires that the periodic time be previously known. There are various methods of determining the periodic time, independently of a knowledge of the distance of the planet from the earth. One is to observe the times at which the planet is in either of its nodes, *i. e.* when it passes through the plane of the ecliptic. As the orbits are all inclined to the ecliptic, and have the sun nearly at their centres, they are intersected by the plane of the ecliptic in two opposite points, which are called the *nodes*. Now it is easy to ascertain by observation when a planet is in its node; for, as it then passes from the one side of the ecliptic to the other, from the north to the south side, for example, we have only to convert the observed right ascensions and declinations into longitudes and latitudes, and the change from north to south latitude between two successive observations will indicate that the planet has passed its node in the interval; while a simple proportion, grounded on the quantity of its motion in latitude, will fix the precise hour and minute at which it was in the ecliptic. The interval between two successive passages of the planet through the same node differs from the *sidereal* period, or the interval which the planet occupies in returning to the same point of the heavens, or the same *star*, as seen from the centre of the sun, by a very small quantity, depending on a minute motion of the node, and which in a general view of the subject may be disregarded.

Another and more convenient method of finding the period of a superior planet consists in determining, from the observations of a few consecutive days, the exact time at which it is in opposition to the sun. At this instant the longitude of the planet is 180°, and on the day of the opposition it passes the meridian twelve hours after the sun. The interval between two successive returns to the opposition is the *synodic* period of the planet; this differs very considerably from the sidereal period, but the latter is easily deduced from it. Let E and J be the positions of the earth and Jupiter, when Jupiter is in opposition. The next opposition will take place after the earth has made a complete revolution, together with a certain arc E e, which we shall call x, corresponding to Jupiter's angular motion in the interval. Now the number of days between the two oppositions, or the synodic period, is known: call this $365 + t$; then the time in which the arc E e or x has been described becomes t days. We have therefore $365 : t :: 360° : x$; whence x, or the angle J S j, is known. But, if p denote the sidereal period, we shall have $x : 360° :: t : p$, and therefore $p = \frac{360\,t}{x}$. On account of the orbits not being exactly circular, these intervals are not quite equal; but by taking the average of a considerable number of observed oppositions, the inequalities disappear, and the mean synodic periods (and consequently the sidereal periods) are obtained with the utmost accuracy.



The following table exhibits the mean sidereal periods of the planets, and their mean distances from the sun, in terms of the mean distance of the earth from the sun being supposed equal to unity. (*Baily's Astronomical Tables.*)

Planet.	Mean Sidereal Period.	Mean Distance from the Sun.
	Days.	
Mercury	87·969258	0·387098
Venus	224·700787	0·723332
The Earth	365·256361	1·000000
Mars	686·979646	1·523692
Vesta	1325·743100	2·367870
Juno	1592·660800	2·669009
Ceres	1681·393100	2·767245
Pallas	1686·538800	2·772886
Jupiter	4332·584821	5·202776
Saturn	10759·219817	9·538786
Uranus	30686·820830	19·182390

Relations between the Periods and Distances. — On comparing the columns of the above table, the idea of a certain relation between the periods and distances cannot fail to suggest itself, as they both increase in a tolerably regular progression (the four small planets between Mars and Jupiter being accounted as one), though the periods increase in a much more rapid proportion than the distances. Jupiter, for example, is five times more distant from the sun than the earth is, but his period is nearly twelve times that of the earth. Kepler, the great founder of physical astronomy, undertook to investigate the analogy; and, after a most laborious comparison of the numbers (and their various powers) representing the periodic times and the mean distances of the six planets known in his age, discovered this most remarkable law: — "That the squares of the periodic times of any two planets are to each other in the same proportion as the cubes of their mean distances from the sun." (*See* KEPLER'S LAWS.) Taking, for example, the earth and Mars, whose periods are respectively 365·256 and 686·979 days, and distances in the proportion of 1 and 1·5237, it will be found that $(365·256)^2 : (686·979)^2 :: 1 : (1·5237)^3$, very nearly. Nor is this merely an empirical relation, deduced from observed facts, but not referable to any known cause; on the contrary, it is a necessary result of the law of gravitation, and pregnant with important consequences. From its being observed in the planetary system, it follows that all the planets are bodies of the same kind as the earth, and that they are all acted upon in the same manner by the solar attraction (modified only by the distance), which alone determines their periods, and retains them in their orbits.

A curious relation of the numbers which express the relative distances of the planets from the sun was discovered by M. Bode, an astronomer of Berlin. Let the number 10 be assumed to represent the distance of the earth from the sun; then the distances of the other planets may be expressed in round numbers as follows: —

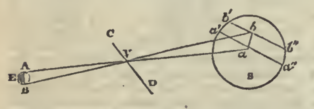
Mercury	$4 = 4$
Venus	$7 = 4 + 3·2^0$
The Earth	$10 = 4 + 3·2^1$
Mars	$16 = 4 + 3·2^2$
The four New Planets	$28 = 4 + 3·2^3$

Jupiter	- - - -	$52 = 4 + 3 \cdot 2^4$
Saturn	- - - -	$100 = 4 + 3 \cdot 2^5$
Uranus	- - -	$196 = 4 + 3 \cdot 2^6$

It had been conjectured by Kepler that an unknown planet must exist circulating between the orbits of Mars and Jupiter, a conjecture which was strangely verified by the discovery of four planets circulating in that region, nearly in equal periods, and at equal distances from the sun, and exactly in the place where a planet was wanting to fill up the above progression. The progression is, however, purely empirical, and not even very accurate; yet it agrees so well, on the whole, with the actual distances of the planets, that one can scarcely help thinking it must be connected in some manner with the essential constitution of the planetary system.

Real Dimensions of the Planetary Orbits.— Hitherto we have spoken of the distances of the planets from the sun only in relation to the sun's distance from the earth; but it is interesting to determine what these distances actually are in terms of some measure with which we are familiarly acquainted. In consequence of Kepler's law of the relation between the periods and distances, if the real dimensions of any one orbit have been ascertained, those of all the other orbits will be found immediately when the periodic times of the planets are respectively known. In fact, the dimensions of the orbits having been already stated in terms of that of the earth, it is only necessary to find the earth's distance from the sun, in order to find the respective distances of all of them. Now, to find the earth's distance from the sun is the same thing as to find the sun's horizontal parallax, that is, the angle which the radius of the earth would subtend if seen from the sun; for the determination of that angle gives the relation between the earth's distance and its semidiameter, which is known from the actual measurement of degrees of the terrestrial meridian. Of the various methods which astronomers possess of determining the sun's horizontal parallax, the most accurate is that which depends on observations of the transits of Venus over the sun's disk; a phenomenon, however, of very rare occurrence, so that the method can very seldom be practised.

When Venus is at her inferior conjunction, and at the same time very near one of her nodes, the planet will be projected on the disk of the sun; and through the effect of her proper motion, combined with that of the earth, will be seen as a black spot to pass over, or *transit*, the solar disk, describing a chord which will be referred to different positions on the disk by observers stationed at different points on the earth's surface. Let E be the earth, V Venus, S the sun, and C D a portion of Venus's orbit, described while she is transiting the sun's disk.



Suppose A and B to be the two opposite extremities of the earth's diameter which is perpendicular to the ecliptic: a spectator at A would see the centre of Venus projected on the sun's disk at *a*, and describing in her successive positions the chord *a′ a a″*; while a spectator placed at B would, at the same instant, see her projected on the disk at *b*, and describing the chord *b′ b b″*. Now it is evident that if there be any means of measuring the distance between the two chords *a′ a″* and *b′ b″*, or the line *a b*, that distance will give the sun's horizontal parallax; for the two triangles A V B and *a* V *b* being similar, *a b* is to A B as *a* V to A V, or as the distance of Venus from the sun is to the distance of Venus from the earth. But the relative distances of the earth and Venus from the sun are known; therefore the ratio of *a* V to A V is known, and consequently that of *a b* to A B. This ratio is that of 68 to 27, or 2½ to 1 (very nearly); therefore the distance *a b* as seen from the earth is 2½ times greater than A B as seen from the sun, or, which is the same thing, equal to 5 times the sun's horizontal parallax. The whole difficulty of the problem, therefore, consists in determining the distance of the two chords *a′ a″* and *b′ b″*, or their relative positions on the sun's disk, from which their distance can be deduced. One of the best ways of accomplishing this is to note, with great accuracy, the instants at which Venus enters and emerges from the solar disk, so as to obtain the exact time occupied in the transit; for, the relative motion of Venus being accurately known, the time occupied in the transit gives the length of the chord described; and the sun's apparent diameter being also known, the arcs cut off by *a′ a″* and *b′ b″* are thus found, and the difference between the versed sines of those arcs is evidently the distance between the chords, or the line *a b*. The problem, however, is rendered much more complicated by the earth's rotation, and other circumstances here neglected, of which it is unnecessary to take account in a general explanation.

The last transit of Venus took place in 1769, and was the occasion of the first of the celebrated voyages of Captain Cook to Otaheite. It was observed at Otaheite, at Wardhus in Norway, at Cajaneburg, and Kola in Lapland; at Petersburg, Paris, California, Hudson's Bay, &c. The general result of all the observations gave the sun's horizontal parallax equal to 8·5776″. Hence, the sun's distance is given in terms of the earth's radius by the proportion

sin. 8·5776″ : radius : : radius of earth : sun's distance;

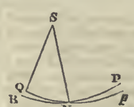
whence, on reducing the radius of a circle to seconds, we have the sun's distance $= \dfrac{360 \times 60 \times 60}{8 \cdot 5776 \times 2 \times 3 \cdot 14159} = 24047$ terrestrial radii. Assuming the earth's semidiameter (*see* EARTH) to be 4000 miles in round numbers, the sun's distance from the earth will therefore be 24047 × 4000 = 96,188,000, or about 96 millions of English miles.

This application of the transits of the inferior planets to the important purpose of determining the sun's distance from the earth was first pointed out by James Gregory, in his *Optica Promota*, published in 1663. Those of Venus recur after intervals of 113 years; but as Venus returns to her conjunction at nearly the same point of her orbit in about eight years, and the difference of her latitude at two successive conjunctions amounts only to 20′ or 24′, which is less than the sun's diameter, it will generally happen that two transits take place within eight years; the first before the planet has passed the node, and the second after the passage of the node. But three transits cannot take place within 16 years; hence, after two transits have occurred within 8 years, another cannot be expected before 105, that is, 113 — 8 years, and may not happen until after 121 years. The two last transits took place in 1761 and 1769; the two next will take place in 1874 and 1882; after which there will not be another till 2004. By reason of the small distance of Mercury from the sun, the difference between his horizontal parallax and that of the sun cannot be so accurately ascertained: and hence the transits of that planet, though of more frequent occurrence than those of Venus, cannot be employed with such certainty in determining the sun's parallax.

Having found the mean distance of the earth from the sun in terms of a known unit, the mean distances of all the other planets from the sun, the ratios of which to that of the earth were given above, may be expressed in the same terms. They are, in round numbers, as follows:—

		Miles.
Mercury	- - -	37,000,000
Venus	- - - -	68,000,000
The Earth	- - - -	96,000,000
Mars	- - - -	142,000,000
Ceres	- - - -	262,000,000
Jupiter	- - - -	485,000,000
Saturn	- - - -	890,000,000
Uranus	- - -	1,800,000,000.

Inclination and Nodes of the Planetary Orbits.— The planes of the planetary orbits are inclined to each other under different angles, and, in determining the circumstances of a planet's motion, one of the first steps to be taken is to fix the situation in space of the plane in which it moves. For this purpose, it is necessary to refer it to some other plane whose situation is assumed to be known. The plane of the ecliptic is that to which we naturally refer the bodies of the solar system, and the line of the equinoxes is taken as the origin of angular reckoning in that plane. Hence, to determine the position in space of the plane of a planet's orbit, we must determine its inclination to the ecliptic, and the position of the line in which it intersects the ecliptic with respect to the line of the equinoxes. Let S be the sun, P N R the orbit of of a planet, and *p* N Q the projection of that orbit on the plane of the ecliptic, intersecting the line of the equinoxes S Q in Q; then Q is the point from which the longitudes are reckoned, N is the node, S N the line of the nodes, or line in which the plane of the orbit intersects the ecliptic, the angle Q S N the longitude of the node as seen from the sun, and P N *p* the inclination of the orbit.



If R be supposed to be on the south side of the ecliptic, and P on the north side, and the planet's motion to be in the direction R P, then N is the *ascending* node. The place of the node is determined by observing the planet when its latitude is very nearly equal to nothing; and the equinoctial point Q being known, the *geocentric* longitude of the node (the angle formed by drawing straight lines from Q and N to the earth) is determined by observation; whence there are sufficient data for computing, by a trigonometrical process, the *heliocentric* longitude Q S N, and also the inclination P N *p*. The places of the nodes are not absolutely fixed. In consequence of the mutual attractions of the planets to each other, they have a slow retrograde motion in respect of the fixed stars. The inclinations are also subject to a slight variation, but so small as to amount at most to a few seconds in a century. Hence, in mentioning the longitudes of the nodes, and the inclin-

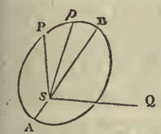
ations of the orbits, it is necessary to state the epoch to which the values refer. In the following table the values correspond to the 1st January, 1801; excepting those for Vesta, Juno, Ceres, and Pallas, which are referred to January 1. 1820:—

Planet.	Inclination.			Longitude of ascending node.		
	°	′	″	°	′	″
Mercury	7	0	9·1	45	57	30·9
Venus	3	23	28·5	74	54	12·9
Mars	1	51	6·2	48	0	3·5
Vesta	7	8	9·0	103	13	18·2
Juno	13	4	9·7	171	7	40·4
Ceres	10	37	26·2	80	41	24·0
Pallas	34	34	55·0	172	39	26·8
Jupiter	1	18	51·3	98	26	18·9
Saturn	2	29	35·7	111	56	37·4
Uranus	0	46	28·4	72	59	35·3

The ancients gave the name of *zodiac* to that zone of the heavens within which the planets were observed to move, and which, consequently, had a breadth of 14°, or twice the inclination of the orbit of Mercury. The inclinations of the four recently discovered planets being greater than that of Mercury, they go beyond the zodiac, and hence have been named the *extra-zodiacal* planets.

Figures of the Planetary Orbits.— When the inclination of a planet's orbit and the situation of the line of the nodes have been determined, the radius vector of the planet, at any instant, may be computed in terms of the sun's distance from the earth, from the planet's latitude and longitude found by a single observation. By computing, therefore, the values of its radius vector at a great many different points of the orbit, and laying down each on paper at the proper angle of elongation round the sun, the form of the orbit which the planet describes will be ascertained. A few observations of this sort will show that the radius vector varies in length, and, consequently, that the orbit is eccentric. This fact was known from the time of Hipparchus; but the true form of the planetary orbits was not discovered till Kepler found, by a laborious computation of the distances of Mars at its oppositions, from the observations of Tycho Brahe, that the orbit of that planet is an ellipse. He subsequently found the same thing to be true of the orbit of the earth, and of the other planets then known; and hence established the first of those important laws respecting the planetary motions which still go by his name, viz. that the orbits of al. the planets are ellipses, of which the sun occupies one of the foci. See Kepler's Laws.

The same observations which show the orbit to be an ellipse will also serve for the determination of its eccentricity, which is half the difference between its greatest and least distances. The only element which then requires to be known, in order to fix the path described by the planet in space, is the position of the orbit on its plane, or the situation of its transverse axis with respect to the line of the equinoxes. Let A P B be the projection of an orbit on the plane of the ecliptic, A B its transverse axis, and S Q the line of the equinoxes, S being the focus occupied by the sun. The point A is the *perihelion* of the orbit, and B the *aphelion;* the line A B is the line of the *apsides;* and the position of A B with respect to S Q will be known by means of one of the angles Q S A or Q S B, which are respectively the longitudes of these points. In modern tables, the angle Q S A, or *longitude of the perihelion*, is that whose value is given. The eccentricities of all the planets are subject to a very small secular variation; the line of the apsides is also in a state of continual but slow revolution, so that the perihelia are gradually shifting their places on the planes of the orbits. In the case of all the planets excepting Venus, the motion of the line of the apsides is direct; that is to say, it is in the same direction as the motion of the planet in its orbit. The perihelion of Venus, referred to the fixed stars, moves in a contrary direction. The following table shows the eccentricities and longitudes of the perihelia of the different planets; the epoch, as before, being January 1. 1801, for the old planets, and 1820 for the four new ones:—



Planet.	Eccentricity.	Longitude of Perihelion.		
		°	′	″
Mercury	0·205515	74	21	47
Venus	0·006861	128	43	53
The Earth	0·016784	99	30	5
Mars	0·093307	332	23	57
Vesta	0·089130	249	33	24
Juno	0·257848	53	33	46
Ceres	0·078439	147	7	31
Pallas	0·241648	121	7	4
Jupiter	0·048162	11	8	35
Saturn	0·056151	89	9	30
Uranus	0·046679	167	31	16

Motion of the Planets in their Orbits.— When the six elements of which numerical values have now been given, viz. the mean distance and periodic time, the inclination of the orbit and longitude of the node, the eccentricity and longitude of the perihelion, have been determined for each planet, it will be possible to compute the position of a planet in its orbit, provided we know the law according to which the planet moves at every point of the orbit, and also the instant of time at which it occupied any given point. The motion in the orbit is given by the second of Kepler's laws; viz. "The areas described by the radius vector are proportional to the times employed in describing them." Thus, if the planet has moved from A to P (see the preceding figure), or the radius vector S P has described the area A S P in the time t, and the area A S p in the time t'; then $t : t' :: $ sector P S A : sector p S A. The problem which proposes to find the point P, or the angle A S P (which is called the *true anomaly*), from the condition that the area A S P shall be to the whole ellipse as the given time in which A P is described is to the time of a whole revolution, is important in practical astronomy, and known by the name of Kepler's problem. See Kepler's Problem.

Magnitude and Rotation of the Planets.—When the planets are examined through powerful telescopes, they are seen to be round bodies, having measureable, and even considerable, apparent diameters. The distance of a planet being known, if the visual angle subtended by its diameter be measured by the micrometer, the real magnitude of its diameter will be discovered. In this manner it is found that all the planets are incomparably smaller than the sun, though some of them are vastly larger than the earth. The diameter of Jupiter is eleven times times greater than that of the earth, whence his volume is about 1280 times greater than the earth. That of Saturn is little less considerable. The surfaces of the larger planets are also seen to be diversified by dark patches or spots, from the attentive observation of which it is found that they resemble the earth in having a rotation about their own axes. Mercury, Venus, and Mars revolve about their axes in nearly the same time as the earth; Jupiter and Saturn in less than half that time. The four *new planets*, Vesta, Juno, Ceres, and Pallas, are so small and indistinctly seen that their diameters cannot be accurately measured, and their periods of rotation are unknown. Pallas, considered to be the largest of them, was supposed by Sir William Herschel to have a diameter of only 80 English miles. In the following table the true diameters and the volumes are given in terms of the diameter and volume of the earth, supposed to be unit:—

Planet.	Diameter.	Volume.	Sidereal Rotation.		
			hrs.	m.	sec.
Mercury	0·398	0·063	24	5	28
Venus	0·975	0·927	23	21	7
The Earth	1·000	1·000	24	0	0
Mars	0·517	0·139	24	39	21
Jupiter	10·860	1280·900	9	55	50
Saturn	9·982	995·000	10	29	17
Uranus	4·332	80·490	unknown.		

(For other particulars respecting the appearances and physical condition of the several planets, their masses, densities, &c., see the respective terms.)

The force which retains the planets in their orbits is the attraction of the sun; and, if they were acted upon by no other force, the laws of Kepler would be accurately observed, and the elements of their orbits would remain invariable. But each planet exercises an attracting force on every other, in consequence of which their motions, though principally obedient to the predominating influence of the sun, are affected by a number of forces of which the intensities and directions are perpetually changing. Hence all the elements of the orbits, their magnitudes and forms, their inclinations to the ecliptic, and their positions on their planes, are in a state of constant oscillation; fluctuating, however, between certain mean values from which they never greatly depart. See Gravitation, Perturbation.

Hypothesis of Laplace, respecting the Formation of the Planetary System.—The motion of the planets in elliptic orbits, and the relation between their periods and distances, are necessary consequences of the law of gravitation which prevails throughout the universe; but the solar system presents several remarkable phenomena of which gravitation fails to give any account, which cannot be supposed to be the effect of accident, and which lead almost irresistibly to the conclusion that all the bodies which belong to it have had a common origin, and been formed under the agency of the same mechanical laws. All the planets, as well as satellites, move in the same direction, from west to east. The orbits of all the large planets are situated very nearly in the plane of the ecliptic; and, so far as has been discovered, they all revolve about their axes in the same direction, also from west to east. To account for these phenomena, Laplace

has hazarded the speculation that all the planets and satellites have had their origin in the solar atmosphere, which he supposes to have extended beyond the orbits of the most distant planets, and to have undergone a progressive contraction by the radiation of heat into the stellar spaces. Now, as the solar atmosphere partakes of the sun's rotation about his axis, and in fact may be regarded as part of his mass, in proportion as its limits are contracted by cooling the rotatory motion must increase, according to a well-known principle of mechanics; and the centrifugal force thus becoming greater, the point or limit at which it is balanced by gravity approaches nearer the centre. Supposing, therefore, the atmosphere to have extended to this limit at any epoch, it must, in cooling, have abandoned the molecules situated there and at the different limits successively produced by the increased velocity of the sun's rotation. This effect, however, would only take place at the equator; for on the parallels of latitude the centrifugal would not equal the attractive force. Thus, zones of vapours would continue to be abandoned at the equator; and if the condensation of the molecules of these zones continued without any disunion taking place, the matter would, in the long run, form a solid or liquid ring, circulating about the sun in the plane of his equator. But the uniformity which would be necessary for the production of this effect, both in all the parts of the zone and in the cooling, must render such a phenomenon extremely rare. In fact, the ring of Saturn is the only instance of it in the planetary system. In almost every case each zone of vapours must have been broken up into numerous masses, which, moving with nearly the same velocities, would continue to circulate about the sun, nearly at the same distances. These separate masses would assume the spheroidal form, with a motion of rotation in the same direction as their revolving motion; in short, they would become so many planets in the state of vapour. But if any one of them was considerably larger than the rest, it would finally by its attraction unite all the others about its centre; and thus the zone originally abandoned would be transformed into a single spheroidal mass of vapours, circulating about the sun. This latter case must have been the most common. An instance, however, of permanent separation occurs in the four small planets between Mars and Jupiter.

Conceiving the planet to have been detached from the solar atmosphere in the manner now described, the further cooling would occasion a nucleus to be formed at its centre, which would progressively increase by the condensation of the vapours surrounding it. The condition of the planet would now perfectly resemble that of the sun, and consequently similar results would follow from the continuance of the condensation. Hence the formation of the satellites from the atmospheres of the planets, as the planets are formed from that of the sun.

This hypothesis of Laplace does not explain the origin of the comets, which may be regarded as small nebulosities wandering from one solar system to another, and formed by the condensation of nebulous matter, which appears to be scattered through the universe in great profusion. Whatever may be the fate of the hypothesis, it must be allowed the merit of assigning a mechanical cause for some of the most remarkable phenomena of the universe, without invoking the aid of any other force than that of gravity, — a property which belongs to matter in every form. *See* Astronomy, Satellite, Star, Sun.

PLANE TABLE. An instrument employed in land-surveying, by means of which a plan is made on the spot, without any protraction or measurement of angles. It consists of a plane rectangular board, about sixteen inches square, to the under side of which a centre is attached with a ball and socket, or parallel plate screws, by which it can be fixed upon a staff head or three-legged stand, and set horizontal by means of a circular spirit level. A boxwood frame is accurately fitted round the edges of the board, for the purpose of stretching and retaining the drawing paper. It is usual to divide one face of the frame into 360° from a centre in the middle of the board; but this graduation is scarcely of any use, and may be dispensed with. The reverse face of the frame is divided into equal parts, as inches and tenths, for the convenience of ruling parallel lines and squares, and for shifting the paper. A compass-box with a magnetic needle is screwed into one side of the table, to indicate the bearings, and to enable the surveyor to set up the instrument at a new station parallel to the position it had at a former one. A brass rule or index, with a sloping edge, and having perpendicular sight-vanes erected at each extremity, completes the apparatus.

The plane-table is used as follows: — Two stations are selected as the extremities of a base line, the distance between which is accurately measured, and a line drawn on the paper, representing that distance according to the assumed scale. The instrument is then set up at one of the stations, and a fine needle or pin being stuck into the table, at one extremity of the line drawn on the paper, the edge of the index is brought to press gently on the pin and coincide with the line, and the table turned round till the object at the second station is bisected through the sight-vanes; the table is then clamped, and the direction of the magnetic meridian marked. The fiducial edge of the index, still in contact with the upright pin, which serves as a centre, is then directed successively to all the different objects which have been selected as stations, and lines drawn on the paper in the direction of each. This being done, the table is removed to the second station, and the pin placed at the corresponding point on the paper, which forms a second centre. The edge of the ruler is then directed, as before, to each of the objects which were observed from the first station, and lines drawn in those different directions. The intersections of the lines drawn from the second centre with those drawn from the first marks on the paper the position of each of the observed objects.

The plane table is not susceptible of great accuracy, but it is extremely useful in forming a sketch-map, or filling up the details of a survey, where the principal points have been fixed by the theodolite, or some equivalent instrument. *See* Surveying.

PLANETA'RIUM. A machine for exhibiting the relative motions of the planets, and their positions in respect of the sun. *See* Orrery.

PLA'NIPENNATES, *Planipennes.* (Lat. planus, *flat;* penna, *a feather.*) The name of a tribe of Neuropterous insects, comprehending those which have flat wings, of which the inferior pair almost equal the superior ones, and are simply folded underneath at their anterior margin. The antennæ are multiarticulate, much longer than the head, without being subulate or styliform. The maxillary palps are usually filiform or somewhat thicker at the extremity, shorter than the head, and composed of from four to five joints. The ant-lions (*Myrmeleon*) and termites are examples of this tribe.

PLA'NISPHERE. A projection of the sphere and its various circles on a plane. *See* Projection.

PLANK. (Fr. planche.) In Architecture, a board that exceeds nine inches in width.

PLANO-CONCAVE. In Optics, a lens which is plane on one side and concave on the other. *Plano-convex* is a lens plane on one side and convex on the other. *See* Lens.

PLANO'RBIS. (Lat. planus, and orbis, *an orb.*) A genus of marsh snails, so called from the form of the shell, which is that of a flattened orb, arising from the volutions being coiled on the same plane. Many species of this genus are common in Britain.

PLANT. In Natural History. *See* Botany.

PLANTA'GENET. The surname of the royal family of England from Henry II. to Richard III. inclusive. The origin of the name is involved in deep obscurity. The best antiquaries derive it from the well-known story of the Earl of Anjou, the ancestor of the royal race, who having made a pilgrimage to Rome, where he was scourged with broom twigs, assumed the name of *Plantagenista* (literally, a *broom twig*), which his descendants retained. The name Plantagenet belongs to the noble house of Buckingham.

PLANTA'TION. A piece of ground planted with trees, for the purpose of producing timber or coppice wood. In new countries not generally cultivated, and more especially in warm climates, the term plantation is applied to land employed in the culture of the more important crops; such as the sugar-cane, coffee, pepper, cotton, &c. In Britain it is exclusively applied to lands planted with trees or shrubs.

PLA'NTIGRADES, *Plantigrada.* (Lat. planta, *the sole of the foot;* gradior, *I march.*) The name of a tribe of Carnivorous Mammals, comprehending those which apply the whole or a great part of the sole to the ground in progressive motion.

PLA'NTING. The art of forming plantations of trees. Also the art of inserting plants in the soil by the spade, dibble, trowel, or by other means in use in agriculture and gardening. *See* Arboriculture.

PLA'SHING. A mode of repairing or modifying a hedge by bending down a portion of the shoots, cutting them half through near the ground, to render them more pliable, and twisting them among the upright stems, so as to render the whole effective as a fence, and at the same time preserve all the branches alive. For this purpose the branches to be plashed, or bent down, must not be cut more than half through, in order that a sufficient portion of sap may rise up from the root to keep alive the upper part of the branches. Where hedges are properly formed and kept, they can very seldom require to be plashed; but this mode of treating a hedge is most valuable in the case of hedges abounding with hedgerow trees, when from neglect, or from any other cause, the hedge has become of irregular growth.

PLA'STER. In Architecture, the material of which ornaments are cast, and also that with which the fine stuff or gauge for mouldings and other parts is mixed, when quick setting is required.

Plaster. In Pharmacy, a compound, generally of oxide of lead and olive oil, for external applications.

PLASTER OF PARIS. *Gypsum*, or sulphate of

lime, commonly termed *plaster stone*, and found abundantly near Paris.

PLA'STIC. (Gr. πλασσω, *1 form.*) In Sculpture, that which can be modelled, as clay, &c. In the arts it has a more extended signification, and signifies those materials and circumstances which are susceptible of being formed and fashioned to the purpose wanted.

PLASTIC CLAY. A clay used in the manufacture of pottery. See also GEOLOGY.

PLA'TANIST, *Platanista.* A name applied by Pliny to a fish in the river Ganges, having a snout and a tail like a dolphin, but much larger. In modern Zoology, it is the generic appellation of the Gangetic dolphin (*Delphinus gangeticus*, Cuv.).

PLA'TBAND. (Fr. plate and bande.) In Architecture, a square moulding projecting less than its height or breadth. The fillets between the flutes of columns are sometimes called, but improperly, by this name. It is also sometimes used to denote the lintel of a door.

PLATE. (Fr. platte.) In Architecture, a piece of timber lying horizontally on a wall for the reception of the ends of girders, joints, rafters, &c.

PLATE. The name usually given to gold and silver wrought into articles of household furniture. For the regulations under which the manufacture of plate is carried on, see the *Com. Dict.*

PLA'TFORM. (Fr. plateforme.) In Architecture, a plane surface, lying level, of any materials used in a foundation or elsewhere, for the reception of the foundations of a building, or for the piers of a bridge: also a level scaffold, raised above the ground for a temporary purpose.

PLATFORM. In Artillery, an elevated floor on which guns are placed.

PLATING. The art of covering copper and other metals with silver or gold: it is effected in various ways. Sometimes the silver is attached to and rolled out with the copper by pressure; sometimes the one metal is precipitated from its solutions upon the other; and of late manufacturers have availed themselves of electro-chemical decomposition for the purpose. *See* VOLTATYPE.

PLA'TINUM. (So called from the Spanish word plata, *silver*, on account of its colour.) A metal of a white colour, exceedingly ductile, malleable, and difficult of fusion. It is the heaviest substance known, its specific gravity being 21·5. It undergoes no change from air or moisture, and is not attacked by any of the pure acids; it is dissolved by chlorine and nitromuriatic acid, and is oxidized at high temperatures by pure potassa and lithia. It is only found in South America and in the Uralian Mountains: it is usually in small grains of a metallic lustre, associated or combined with palladium, rhodium, iridium, and osmium; and with copper, iron, lead, titanium, chromium, gold and silver; it is also usually mixed with alluvial sand. The particles are seldom so large as a small pea, but sometimes lumps have been found of the size of a hazel nut to that of a pigeon's egg. In 1826, it was first discovered in a *vein* associated with gold by Boussingault, in the province of Antioquia, in South America. When a perfectly clean surface of platinum is presented to a mixture of hydrogen and oxygen gas, it has the extraordinary property of causing them to combine so as to form water, and often with such rapidity as to render the metal red hot: *spongy platinum*, as it is usually called, obtained by heating the ammonio-muriate of platinum, is most effective in producing this extraordinary result; and a jet of hydrogen directed upon it may be inflamed by the metal thus ignited, a property which has been applied to the construction of convenient instruments for procuring a light. The equivalent of platinum is about 98. It is precipitated from its nitromuriatic solution by sal ammoniac, which throws it down in the form of a yellow powder, composed of bichloride of platinum and sal ammoniac.

PLATO'NIC BODIES. The five regular geometrical solids, so called because they were treated of or described by Plato. They are the tetraedron, the hexaedron, the octaedron, the dodecaedron, and the icosaedron. Besides these five, there can be no other solids bounded by like, equal, and regular plane figures, and whose solid angles are all equal.

PLA'TONISM. The philosophy of Plato. To give a satisfactory account of the system of this great thinker, within the limits which the nature of the present work necessarily impose upon us, would be an undertaking of no common difficulty. Those of our readers who are adequately conversant with the original writings of Plato must be well aware that the views entertained in our own country of his philosophical character and merits are, to say the least, partial and incomplete; while those who add to this knowledge an acquaintance with the researches of our German contemporaries on this subject will admit the possibility, at the same time that they appreciate the difficulty, of attaining a fuller and more adequate comprehension. The leading characteristic of the mind of Plato is its comprehensiveness. This quality discovers itself equally in the form in which his philosophy is communicated, and in that philosophy itself. The form to which we allude is, it is well known, that of the dialogue. The Dialogues of Plato are at once vivid representations of Athenian life and character, and constituent parts of a system of universal philosophy; the harmonious productions of a genius which combined the dramatic imagination with the scientific intellect in a degree which has never before nor since been equalled. It is in this circumstance that we must seek alike for the influence which Plato's writings have exerted, and for the difficulty of rightly apprehending their meaning. What has been said of history in general may with equal truth be applied to the Platonic dialogues — that they are "philosophy teaching by examples." In place of a formal refutation of sophistry, we are introduced to living sophists; in the room of an elaborate system of philosophy, we meet the greatest philosophers of his day, reasoning and conversing with disciples eager in the pursuit of knowledge, — with Athenians full of natural prejudices, with men abounding with individual peculiarities.

Under no other or less complex form of composition could Plato have accomplished the manifold purposes which he had in view; purposes not of the philosopher only, but of the reformer and educator of the moral and intellectual nature of his countrymen. In most of his dialogues one or other of these intentions is the prominent one; in some the refutation of false philosophy, in others the establishment of his own; while others again seem chiefly designed as exemplifications of scientific method generally; though we agree with Schleiermacher in thinking that there are none which do not contribute to the gradual development of his own system.

But it is not merely in the form in which his doctrines are clothed that we discern the comprehensiveness of Plato's genius. The same quality is, as we have said, equally apparent in the philosophy of which his dialogues are the vehicle. By referring to the articles ELEATIC, IONIC, and PYTHAGOREAN PHILOSOPHY, the reader will be able to form some conception of the systems which preceded that of Plato. In each of these some leading idea is taken up, and traced, generally to the exclusion of all others, through all its possible consequences. These three schools may, indeed, be severally taken as the representatives of the three constituent portions of universal philosophy: the Eleatics of the logical or dialectic; the Ionians of the physical; and the Pythagoreans, though in a less exclusive degree, of the ethical element. It was in Plato that these different tendencies first converged. Each viewed by itself was essentially partial and one-sided, and, with whatever of truth it might contain, must necessarily, by its very exclusiveness, combine much of error. Of this circumstance the sophists had taken advantage, and, by setting the doctrines of one system in contradiction to those of another, had succeeded in the introduction of a universal scepticism. Plato was thus led clearly to discern the necessity of laying the foundations of science deeper than they had been laid by his predecessors. The ultimate unity of all knowledge, properly so called, and the mutual dependence of all its parts on each other, is the fundamental intention of his philosophy. How this first principle was to be attained, whether, indeed, it were attainable or not, could only be ascertained by a previous inquiry into the nature, not of *being*, but of *knowledge*. This is one mark which distinguishes Plato from earlier speculators; and it is important to bear it in mind, if we would form a correct estimate of the services rendered by him to the progress of philosophy. The hint was unquestionably given by Socrates, but Plato was the only one among his immediate disciples who appears to have followed it up. He may, in truth, be styled the founder of the ancient psychology; and the dialogue entitled *Theætetus* may be considered one of the most important contributions to the most important branch of that science, the theory of perception and judgment, which antiquity affords. It is in this dialogue that the negative side of the inquiry into knowledge, which we have alluded to, is contained. Knowledge, it is there shown, is not to be confounded either with the impressions on the senses, or with the judgments (δόξας) founded upon them. Sensation, by its very nature, is relative only: it is the joint effect of the conditions of our internal constitution and a motion, or change, communicated from without. Judgment, in so far as it is founded on a prior impression, can have no validity save in reference to that impression. Pure knowledge, therefore, if it exist at all, must be sought in some other direction. It is here that the celebrated doctrine of ideas finds its place. Without entering into the question more deeply than our limits allow, it is sufficiently clear that no other word, such as conception, notion, or the like, is adequate to convey all that Plato meant by an *idea*. Having failed in finding alike knowledge in the senses and permanent being, its object in nature, he was driven, in order to avoid the sophistic doctrine of the relative nature of all knowledge, to seek for the true objects of reason in something distinct from the material universe. In place of the doctrine of Protagoras, "Man is the measure of all things," he substituted, "God is the measure of

all things;" meaning by this, as he elsewhere explains himself, that in the divine nature reason and being are one. From this original unity, which is denominated by Plato the good, or the supreme good, proceed, on the one hand, human reason; on the other, those ideas which constitute all in nature that is real; all, that is, which the reason can apprehend. We might hence be led to suppose that the modern term "law" may be correctly used in place of the Platonic "idea." But, when we examine the matter more narrowly, we shall find an essential difference between the two words, not merely in the ontological or theological considerations just alluded to, but also in the habit, which Plato inherited from his master Socrates, of referring the laws of the universe to a moral or *teleological* standard. The three great ideas of truth, beauty, and order or fitness, are the ultimate unities to which he conceives it to be the business of the reason to refer all its conceptions. These ideas are themselves included in the highest unity, or God, from whom it is that they derive their reality. But the supreme nature is to us incomprehensible; it is in the consciousness of our separation from the great source of being that philosophy takes its rise. The senses it is which first suggest to us this want: we strive to bring their phenomena under general conceptions; and every attempt to understand the sensible is a self-recognition of the reason, and a step towards divinity. Theology is therefore the ultimate science in which all the other sciences converge: dialectics, as the science of the true, ethics as the science of the morally beautiful, and physics as that which discerns the order and fitness of outward things. Such is a very imperfect sketch of the Platonic idea of science in its three constituent parts. The threefold division above given we nowhere find expressly laid down in the written works of Plato; but, besides that it is throughout implied, the fact that it is taken for granted by his immediate successors, Xenocrates and Aristotle, justifies us in supposing that it formed part of Plato's oral communications. But, besides this comprehensive view of universal science, we are indebted to Plato for many valuable discoveries, and many more most pregnant hints, in subordinate branches of inquiry. Among these may be enumerated the discussion of the theory of pleasure and pain, and their relation to desire and emotion, in the *Philebus;* of the first principles of the science of grammar in the *Cratylus* and *Sophist;* of the nature of mathematical science, and its place in general philosophy, *Rep.* vi., &c. The ethics of Plato, though, in many important respects, they must be allowed to be greatly defective, as, in particular, in the omission of the notions of duty and responsibility, are yet far from deserving the contemptuous treatment they have met with from certain writers among ourselves. In the *Republic*, which contains the substance of his moral doctrines, the intention of Plato manifestly was to develop the idea of perfect humanity, alike in the individual, and in what he regarded as an enlarged transcript of the individual, the state. (*See* ETHICS.) The most important contribution to the study and right understanding of the Platonic philosophy, with which modern times have furnished us, is to be found in the arrangement of his *Dialogues*, and the introduction prefixed to each, by the celebrated Schleiermacher, a work which has recently been translated into English. See also *Ritter*, *Gesch. der Philosophie*, b. viii.; and, for some abstruse portions of Plato's doctrine, *Trendelenburg's Ideæ Plat. ex Aristot. illust.*

The best editions of Plato's works are those of Bekker and Hallbaum. For an account of his life, see *Ast's Leben und Schriften Platon.*

PLATOO'N. In the art Military, a small square body of musketeers, drawn out from the main body to strengthen the angle of a larger square, or to do duty in ambuscades or defiles, &c., when there is not room for whole regiments or battalions to act.

PLA'TYRHINES, *Platyrhinæ.* (Gr. πλατυς, *wide*, and ῥιν, *a nose*.) The name of a section of the Linnæan genus *Simia*, including those species which have the nostrils separated by a wide interspace. These monkeys are peculiar to the New World.

PLA'TYSOMES, *Platysoma.* (Gr. πλατυς, and σωμα, *body*.) The name of a family of Coleopterous insects comprehending species with a wide and much depressed body. These insects are found under the bark of trees, and form the genus *Cucujus* of Fabricius, now subdivided.

PLEA'DING. (Lat. placitum, Norman French plaid, together with the verb placitare, *to plead;* derived from placitum, the decree or sentence of a judicial or legislative authority.) Pleadings, in English law, are the preparatory allegations in writing which intervene between the commencement of a cause and its trial.

The first object in deciding a dispute between two litigant parties is always to ascertain the subject for decision. This must be accomplished by disengaging the point in debate from all the extraneous matter in which the complaints and answers of the respective parties have involved it. This is the principle from which all the subtleties of the system of pleading, commonly called *special pleading*, are derived; and, in so far as it has departed from this object, it has wandered from its original purpose.

Pleadings were conducted orally in the first times of our jurisprudence; the parties, or their advocates, exposing the state of facts on which they relied successively before the judge, who moderated between them, and answering each other until the judge was able to fix upon the point at issue, as it was called; that is, the question, whether of fact or law, on which the judge, or the jury, was eventually to decide. Hence issues are said to be *in fact* or *in law*. The same principle governs the course of *written pleadings* now adopted.

The plaintiff, or complaining party, having summoned the defendant into court, by a writ stating the nature of his complaint, makes his first statement, which is termed a *declaration*. The defendant may now answer him, either by denying that there is any ground in law for the action, either because there is defect *in substance* in the plaintiff's alleged right, or defect *in form* in his proceedings; or by controverting the facts which he alleges, or alleging new facts in answer to them. In the former case the defendant *demurs* to the declaration; in the latter case he answers by one or more *pleas*.

A demurrer may take place either at this or at any subsequent stage of the proceedings; and may be made either by plaintiff or defendant. And it is either *general* to substance, or *special* to form. (But, by the increased liberality of the courts, many errors in form may now be amended on application which formerly were fatal.) If the demurrer comes to be argued (which is done in term time, or in bench, before all the judges of the court in which the action is brought), the court will examine the whole pleadings on both sides; and their decision on the point of law is final as to the action.

The defendant may answer or *traverse* the facts, 1. By pleading what is termed *the general issue;* a form which, in its original signification, implied an absolute denial of the facts on which the plaintiff founded his complaint; and concludes with the words, "and of this the said defendant puts himself on the country," that is, offers to have the issue tried by a jury. But, by the refinements introduced into pleading, the general issue was gradually admitted, in each of the several *forms of action* to which we shall presently refer, not only to deny the plaintiff's facts, but to allow the defendant to bring forward other facts in answer; although these more properly form the subject, 2. of *special pleas*. When the defendant admits all or a part of the plaintiff's facts, but relies on certain other facts as exonerating him from the liability asserted by the plaintiff, he ought to state these facts in answer; for instance, in order to answer the claim of a debt, that it is barred by length of time, or that the defendant has a set-off to allege against it: this is termed a plea by way of confession and avoidance. The plea stating such new facts concludes with the assertion, "and this the said defendant is ready to verify." To this the plaintiff may reply in his second statement, called a *replication*, either by denying the defendant's facts, that is, a replication *by way of traverse*, or by alleging fresh ones; the defendant may deny these, or again allege fresh ones, in his *rejoinder;* sometimes a *surrejoinder*, a *rebutter*, and a *surrebutter* may be added; and the edifice of pleading is raised by stories gradually narrowing, by the exclusion of superfluous facts, until it reaches its summit in the production of one or more issues, either in law or fact, the decision of which finally arranges the dispute; and, by what are called the new rules of pleading, framed in 1834, many defences which might formerly have been given under the general issue must be pleaded specially.

Thus, in an action of debt, the defendant pleads *specially* the statute of limitations, that is, that more than six years have passed since the cause of action accrued; the plaintiff replies, admitting the length of time, but alleging that the defendant has since promised to pay the debt; this the defendant denies in his rejoinder; and hereupon, *i.e.* on the fact of the promise, issue is joined.

A plaintiff complains of breach of covenant by his lessee, in not repairing premises. The defendant pleads, admitting the lease and the want of repair; but alleges that he had received from the plaintiff a release from all his liability. The plaintiff replies, admitting the release, but asserting that it was obtained from him by force or duress. The defendant may perhaps deny the legal sufficiency of this ground, or *demur to the replication;* or he may traverse it in his rejoinder, denying the force or duress. In the former case, an issue of law is raised for the court; in the latter, an issue of fact for the jury.

The attorneys for the parties deliver in their respective pleadings on paper to the officers of the court. When issue is joined, these pleadings are entered on a parchment roll, and the issue is likewise entered; in the form of appointing a day for the trial of the demurrer, if the issue be in law; or in the form of a precept to the sheriff of the county named in the pleadings, to summon twelve good and lawful men for the trial of the issue in fact. This roll is called the record, and is preserved as an au-

thentic memorial of the proceedings in the case; the verdict, and the judgment, being entered on it.

Such is a brief outline of the forms of pleading as applicable to every injury of which complaint can be made in the courts of common law. But, according to the nature of the injury complained of, his action will assume a particular form, allotted by law to enable him to recover the particular remedy he seeks. *See* ACTION, and the FORMS OF ACTION, under their several heads.

PLEASURE-GROUND. That portion of ground adjoining a dwelling in the country which is exclusively devoted to ornamental and recreative purposes. In the ancient style of gardening, the pleasure-ground was laid out in straight walks, and regular or symmetrical forms, commonly borrowed from architecture; but, in the modern style, it is laid out in winding walks, and in forms borrowed direct from nature. A portion of lawn or smooth grassy surface may be considered as essential to the pleasure-ground under both styles.

PLEBE'IANS. The free citizens of Rome who did not come under the class of the patricians or clients. Though always personally independent, they had in early times no political power, the government being entirely in the hands of the patricians, who, with their clients and the king, formed the original people. The class of plebeians was of after growth, and probably drew its numbers from various sources, as from clients whose obligations were dissolved by the decay of the houses of their patrons, and the inhabitants of conquered states who were admitted to rights of citizenship. The plebeian families with patrician names are supposed to have arisen from marriages of disparagement contracted between the higher and lower classes.

As this body, from its constitution, naturally grew in vigour while the patricians became weaker, it soon formed the main strength of the Roman armies, and became desirous of sharing in the advantages of the conquests made by its prowess; while the patricians, on their part, tenaciously clung to all their privileges, and, far from yielding to the demands of the other party, exercised the severe rights which as creditors they possessed over the liberties of many of its members. This state of things produced a continued series of collisions between the two orders, in which the latter gradually gained ground, till, in the last ages of the republic, it was admitted to a full share of all the powers and privileges before confined to one order.

PLEBISCI'TUM. (Lat. *a decree of the people.*) In Roman History, a law enacted by the common people, under the superintendence of the tribune or some subordinate plebeian magistrate, without the intervention of the senate. The term, however, is used in a more peculiar sense, being applied chiefly to the law made when, upon a misunderstanding with the senate, they retired to Mount Aventine.

PLE'CTOGNATHES, *Plectognathi.* (Gr. πλέκω, *I connect*, and γναθος, *a jaw.*) The name of an order of fishes, including those which have the maxillary bones anchylosed to the sides of the intermaxillaries, which alone form the jaws.

PLE'CTROPO'MA. (Gr. πλῆκτρον, *a spur*, and πωμα, *a lid.*) A name applied by Cuvier to a genus of Percoid fishes, characterized by having the angle of the preoperculum produced, or divided into a series of spines, like those which arm the rowel of a spur. All the species are exotic, and belong to warm climates.

PLE'CTRUM. (Gr. πληκτρον; from πλησσω, *I strike.*) The small ivory instrument with which the ancients struck the lyre.

PLEI'ADES. In Mythology, the seven daughters of Atlas and Pleione were so called, whose names were Alcyone, Maia, Electra, Merope, Calano, Sterope, and Taygeta. They were loved for seven years by Orion, from whose solicitations they were at length released by the interposition of Jupiter, who transformed them to the stars, where they now form a cluster in the neck of the constellation Taurus. Only six of these stars are visible to the naked eye; and the ancients supposed that the seventh concealed herself, out of shame for having bestowed her love on a mere mortal, Sisyphus, while her sisters were the favourites of divine personages.

PLE'NARTY. (Lat. plenus, *full.*) In Law, the state of a benefice, office, &c., when full: in opposition to vacancy.

PLENE ADMINISTRA'VIT. (Lat.) In Law, a plea pleaded by an executor or administrator to an action on a liability of the deceased, that he has *fully administered* his goods.

PLE'NICORNS, *Plenicornia.* (Lat. plenus, *full*, and cornu, *a horn.*) The name of a tribe of Ruminants, including those which have horns composed of an uniform solid osseous substance as the antlers of deer. *See* CORNUA.

PLENIPOTENTIARY. *See* AMBASSADOR.

PLE'ONASM. (Gr. πλεον, *more.*) In Rhetoric, a redundant phrase or expression, sometimes introduced to give additional energy, at other times needless and ungraceful.

PLE'SIOMO'RPHISM. (Gr. πλησιος, *near*, and μορφη, *form.*) A term applied to crystallized substances the forms of which closely resemble each other, but are not absolutely identical. The primary form of sulphate of strontia is a rhombic prism very similar to that of sulphate of baryta; but, on measuring the inclination of corresponding sides on each prism, the difference exceeds 2°. Similar differences are observable in the rhomboedrons of carbonate of lime and carbonate of iron. Such substances, therefore, are *plesiomorphous.*

PLE'SIOSAUR, *Plesiosaurus.* (Gr. πλησιος, and σαυρος, *a lizard.*) The name of a genus of extinct marine saurians, chiefly remarkable for their length of neck. The head is small, but like that of a crocodile; the vertebræ are articulated generally by nearly plane surfaces; the cervical vertebræ have an articular surface, divided by a longitudinal impression, for a rudimental rib on each side, and two vascular foramina beneath the digital bones of both the hind and fore extremities are flattened, and are enveloped in a sheath of skin like the paddles of the *Cetacea.* The remains of the *Plesiosauri* occur in the formations from the muschel-chalk to the chalk inclusive; but are most common in the lias and kimmeridge clay beds.

PLE'THORA. (Gr. πληθω, *I fill.*) A redundant fulness of the blood-vessels. It results from various causes, generally referred to *sanguine plethora*, to which the robust and athletic are most subject; and to *serous plethora*, which attacks debilitated constitutions.

PLEU'RA. (Lat.) The membrane which covers the inner surface of the thorax and its viscera. It forms two distinct portions, or bags, which, being applied laterally to each other, form the partition called the *mediastinum.*

PLEURI'TIS, *Pleurisy.* Inflammation of the pleura. This disease begins with fever, cough, pain in the side, a peculiar hard and strong pulse: the symptoms often run on with great rapidity, attended by very painful respiration and other alarming symptoms. (*See* PNEUMONIA.) The treatment must be prompt and decided: it consists in bleeding, blisters, and purging; and in the after treatment, great care must be taken against an insidious and local form of the disease, which often extends to the lungs.

PLEU'RONECTIDÆ. (Gr. πλευρα, *a side*, and νεκτης, *a swimmer.*) The name of a family of Jugular fishes which swim on their side, and of which the genus *Pleuronectes*, or sole, is the type; they are commonly called flat-fishes.

PLI'CA. (Lat. plico, *I entangle.*) A disease said to be peculiar to Poland, Lithuania, and Tartary, in which the hair becomes matted and inextricably entangled. It is often called *Plica Polonica.*

PLI'CIPENNATES, *Plicipennes.* (Lat. plico, *I fold*, and penna, *a feather.*) The name of a tribe of Neuropterous insects, comprehending those which have the inferior wings wider than the others, and folded longitudinally. The mandibles are wanting in this tribe, which is represented by the genus *Phryganea*, or caddis-flies.

PLINTH. (Gr. πλινθος, *a brick.*) In Architecture, the lowest member of the base of a column, bearing, as its name indicates, the form of a square brick or tile. (*See* BASE.) Sometimes the abacus of the Tuscan capital is called the plinth of the capital.

PLI'OCENE. (Gr. πλειων, *greater*, and καινος, *recent.*) A geological term applied to the most modern of the divisions of the tertiary epoch, because the major part of its fossil testacea are referable to recent species. *See* GEOLOGY.

PLO'TTING, in Surveying, signifies describing or laying down on paper the several angles and lines of a tract of land which has been surveyed and measured. It is usually performed by means of a *protractor* (see the term); sometimes by the *plotting scale.*

PLO'TTING SCALE. A mathematical instrument used in *plotting*, or setting off the lengths of lines in surveying. It consists of two graduated ivory scales, one of which is perforated nearly its whole length by a dovetail shaped groove, for the reception of a sliding piece to which the second scale is attached, and with which it moves, the edge of the second being always at right angles to the edge of the first. By this means the rectangular co-ordinates of a point are measured at once on the scales; or the position of the point laid down on the plan.

PLO'TUS. A genus of web-footed birds of the family *Pelicanidæ*, and nearly allied to the cormorants. They are generally known by the name of *Anhinga*, or "darters," from the rapidity with which they shoot down into the water in the capture of fish. The white-billed anhinga (*Plotus melanogaster*) is the most common and best known species: it is a native of the tropical regions of both North and South America.

PLOUGH. (Germ. pflug.) An implement drawn by horses and guided by a driver, by which the surface of the soil is cut into longitudinal slices, and successively raised up and turned over. The object of the operation is to expose a new surface to the action of the air, and to render it fit for receiving the seed, or for harrowing, or for

other operations of agriculture. Ploughs are of two kinds: those without wheels, commonly called swing-ploughs; and those with one or more wheels, called wheel ploughs. The essential parts which compose both kinds of plough are, the beam by which it is drawn; the stilts or handles by which the ploughman guides it, being two levers connected with the beam; the coulter fixed into the beam, by which the furrow-slice is cut; the share, also attached to the beam, by which the slice is raised up; and, finally, the mould-board, by which the slice is turned over. The most improved form of the swing plough is that in general use in Scotland and the North of England, which is known as a modification of what is called Small's improved swing plough. The most improved wheel plough is the same implement, with a wheel attached to the beam, for the purpose of keeping the share at a uniform distance beneath the surface. The subsoil plough, the invention of Mr. Smith, of Deanston, in Stirlingshire, is the swing plough, of a somewhat stronger construction than that in common use, but without the coulter and the mould-board. The use of this implement is to follow the common plough, and lessen the subsoil at the bottom of the furrow without raising it to the surface. The most improved form of this implement contains a muzzle (the instrument by which it is drawn), so contrived as that the horses may walk on the firm soil. The use of the subsoil plough is one of the greatest modern improvements that has been introduced into the culture of arable land. Draining ploughs are of different kinds. The mole plough, instead of a share and mould-board, has a small iron cylinder attached to the lower extremity of the coulter, and which, being drawn through grass land, leaves in its track a small opening, which has been compared to the underground track of a mole, and into which the water percolates from the surface through the narrow slit formed by the upper part of the coulter, and is thus carried off to an open drain. The other kinds of draining ploughs cut out the soil, raise it to the surface, and turn it over in the manner of the common plough, thus leaving a deep furrow, which is commonly further deepened and modified by the spade, and afterwards partially filled with stones, draining tiles, or other materials through which water may find its way, and finally covered with the surface soil. Draining ploughs, though in theory promising a saving of manual labour, yet in practice are found inconvenient, from the number of horses required to work them. Their use is, therefore, generally confined to free, deep, loamy soils, with an even surface.

PLOUGHING. The act of turning over the soil by means of the plough. Trench ploughing is effected by the plough passing twice along the same furrow; the first time for the purpose of throwing the surface soil into the bottom of the furrow; and the second time for raising a furrow slice from under that which had been already turned over, and raising it up, &c., turning it upon the first furrow slice, by means of which the surface soil is entirely buried, and a stratum of subsoil laid over it: thus effecting in the field what trenching with the spade does in the garden. Trench ploughing can only be employed with advantage where the subsoil is naturally dry and of good quality, or where it has been rendered so by draining and subsoil ploughing; for bad subsoil brought to the surface would be unfit for receiving seeds or plants. *See* PLOUGH.

PLUG. In Architecture, a piece of wood driven horizontally into a wall, its end being then sawn away flush with the wall, to afford a hold for the nailing up dressings, &c.

PLUMBA'GIN. A crystallizable substance, extracted from the root of the *Plumbago Europæa*.

PLUMBA'GO, *Graphite, Black Lead*. This useful substance is a compound of carbon, generally with a minute quantity of iron; there is, however, some doubt as to the nature of the combination. The finest plumbago is from Borrodale in Cumberland.

PLUMB-LINE, PLUMMET. (Lat. plumbum, *lead.*) A heavy body (usually a piece of lead, whence the name) suspended by a flexible thread for the purpose of indicating the perpendicular to the horizon, or the direction of terrestrial gravity. In former times, the plumb-line constituted an essential part of the apparatus employed for adjusting astronomical instruments; but it is seldom used in modern observations, excepting those made with the zenith sector, its place being either more conveniently supplied by the spirit level, or the method of determining the zenith point by combining direct and reflected observations rendering it unnecessary. For the common artificer's plummet, see LEVEL.

PLU'MULA. (Lat. pluma, *a feather.*) The growing point of the embryo, situated at the apex of the radicle and at the base of the cotyledons, by which it is protected when young. It is the rudiment of the future stem of a plant.

PLUPE'RFECT TENSE. (Lat. plus quam perfectum, *more than perfect.*) In Grammar, the tense which denotes that an action was finished at a certain period to which the speaker refers.

PLURAL. *See* GRAMMAR.

PLURA'LITY. In Ecclesiastical Law, the holding of more than one benefice. It was ordained in the council of Lateran, A.D. 1215, that whosoever should take any benefice with cure of souls, if he should before have attained a like benefice should, *ipso facto*, be deprived of the latter. Exceptions were made to this rule in certain cases of *in commendam*, by a constitution published in the council of Lyons; but it could always be evaded by dispensation from the pope. Since the Reformation, dispensations in England are granted by archbishops. The first English enactment on the subject was that of 21 H. 8. c 13., and rendered the former benefice void if of the value of 8*l*. or above. A benefice, therefore, with which another may be held, must be below that value in "the king's books." By the 4th Canon, 41., no licence or dispensation for the holding of more benefices than one can be granted to any one, unless a graduate as A.M. in one of the universities; and he must reside a reasonable time on each benefice, and licensed as a preacher; nor may they be more than thirty miles asunder; and he must have under him a preacher properly licensed in that where he resides least. Formerly, dispensations even from the injunctions of this canon were obtained from the crown; but none, it is said, since the Revolution. The practice was very common in this country in Roman Catholic times; and though, as we have already observed, restrained by various statutes, still subsist to a considerable extent. Until every benefice is made capable of supporting an incumbent, it is manifestly impossible to abolish it entirely; and, in the case of an individual holding one rich and one poor living together, the arrangement may frequently be practically advantageous. Under the existing laws (1836), dispensations for holding two benefices may be obtained on various pleas; but measures of further restraint are understood to be in contemplation.

PLUS. In Algebra, the additive or positive sign +, which, being placed between two quantities, signifies that they are to be taken collectively, or added together. According to Dr. Hutton, this character was first used by Stifelius, as a contraction of the letter *p*, the initial of *plus*.

PLUTO. (Gr. Πλούτων.) Called also Hades (Αΐδης), Aïdoneus (Αϊδωνεύς) by the Greeks, or Orcus by the Romans, was the brother of Jupiter and Neptune, and lord of the infernal regions. He is not, like his brothers, celebrated for amours, but remained faithful to Proserpine, whom he carried away from the plains of Sicily, and made his queen.

Pluto is represented as an old man with a dignified but severe countenance, holding in his hand a two-pronged fork.

PLUTO'NIC ROCKS. Unstratified crystalline rocks, probably formed at great depths beneath the surface by igneous fusion. The term is opposed to *volcanic rocks*, also formed by fire, but having cooled near the surface. *See* GEOLOGY.

PLUTUS. (Gr. πλοῦτος, *wealth.*) The god of riches, said to have been the son of Jasius and Demeter or Ceres. There are no particulars known as to his worship; but he is introduced as an actor in the play of Aristophanes which bears his name, and he bears a part also in the *Timon* of Lucian.

PLUVIAMETER. (Lat. pluvius, *rain.*) *See* RAIN-GAUGE.

PNEUMA'TICS. (Gr. πνευμα, *air or breath.*) The science which treats of the mechanical properties of elastic fluids, and particularly of atmospheric air.

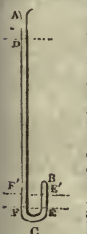
Elastic fluids are divided into two classes,— permanent gases, and vapours. The gases cannot be converted into the liquid state by any known process of art; whereas the vapours are readily reduced to the liquid form by pressure, or diminution of temperature. In respect of their mechanical properties there is, however, no essential difference between the two classes.

Elastic fluids, in a state of equilibrium, are subject to the action of two forces; namely, gravity, and a molecular force acting from particle to particle. Gravity acts on the gases, in the same manner as on all other material substances; but the action of the molecular forces is altogether different from that which takes place among the elementary particles of solids and liquids; for, in the case of solid bodies, the molecules strongly attract each other (whence results their cohesion), and, in the case of liquids, exert a feeble or evanescent attraction, so as to be indifferent to internal motion; but, in the case of the gases, the molecular forces are repulsive, and the molecules, yielding to the action of these forces, tend incessantly to recede from each other, and, in fact, do recede, until their further separation is prevented by an exterior obstacle. Thus, air confined within a close vessel exerts a constant pressure against the interior surface, which is not sensible, only because it is balanced by the equal pressure of the atmosphere on the exterior surface. This pressure exerted by the air against the sides of a vessel within which it is confined is called its *elasticity*, or *elastic force*, or *tension*.

Conditions of equilibrium. — In order that all the parts of an elastic fluid may be in equilibrium, one condition only is necessary; namely, that the elastic force be the same at every point situated in the same horizontal plane. This condition is likewise necessary to the equilibrium of liquids, and the same circumstances give rise to it in both cases; namely, the mobility of the particles, and the action of gravity upon them. Conceive a close vessel to be filled with air, or a gas; and let a and b be two molecules situated in the same horizontal plane. It is evident that if the two molecules are in a state of equilibrium, the force with which a repels b must be exactly counteracted by that with which b repels a, for otherwise motion would take place. The same thing takes place in respect of every horizontal section of the gas; but the pressure on each section varies with its altitude. Suppose c and d to be two molecules situated in a horizontal section, *lower* than that in which are a and b. It is evident that the molecules c and d sustain a greater pressure than a and b; for, in the first place, the whole of the pressure on a and b is transmitted to them by the principle of the equality of pressure in all directions; and, in the second place, they sustain a new pressure, arising from the weight or gravity of all the molecules situated between the two horizontal planes $a\,b$ and $c\,d$.

The principle which has just been explained is proved experimentally by the diminution of the pressure of the atmosphere at greater altitudes. A column of air reaching from the ground to the top of the atmosphere exerts a pressure equal to the weight of a column of mercury of the same diameter, and whose height is equal to that in the barometric tube. Now, on carrying the barometer to the top of a mountain, for example, the mercurial column is observed gradually to become shorter as we ascend; and the diminution of the column, and consequently of atmospheric pressure, is connected with the increase of altitude by a certain constant law, which enables us to deduce the one from the other, and to apply the barometer to the very important purpose of determining the relative altitudes of places on the surface of the earth. *See* HEIGHTS, MEASUREMENT OF.

Law of Mariotte. — In order to determine the relation between the density and pressure of the elastic fluids in the state of equilibrium, let A C B be a graduated bent tube (like a siphon barometer), having two unequal branches, of which the shorter is hermetically sealed at B, and the longer open at A. Let a small quantity of mercury be poured into the tube, just enough to fill the bend, and intercept the communication between the air in C B and the external atmosphere, and let the level E F be marked at which it stands in the two branches of the tube. It is evident that in this state the pressure of the air imprisoned between E and B is exactly equal to that of the atmosphere. Now, let mercury be poured into the tube at A; it will rise slowly in the branch E B, and much more rapidly in the open branch F A. Let mercury then be continued to be poured in until it stands at two points, D and E′, so situated that the altitude of D above E′, or D F′, is just equal to the height of the column in the barometer, or about 30 inches. In this state, the elasticity of the air in the space E′ B is in equilibrium with the pressure arising from the weight of the mercurial column F′ D, and the pressure of the atmosphere exerted on D. But the weight of the mercurial column F′ D is just equal to the atmospheric pressure, consequently the air in E′ B is compressed by a force equal to twice the atmospheric pressure. Now, on observing the length of the column E′ B, it will be found exactly one half of E B, or the air has been reduced to half its former volume. On increasing the length of the open branch of the siphon, and pouring in a proper quantity of mercury, it is found that a pressure of three atmospheres reduces the volume of air at B to one third, and of four atmospheres to a fourth of its first volume; whence it is inferred, generally, that *the volumes of gases are inversely as the pressures which they support.* This fundamental property of elastic fluids is called the *Law of Mariotte*, from its having been discovered by that philosopher in France. It has been verified in several ways, on all the known gases; and, in the case of dry air, its verification has been pushed, by MM. Dulong and Arago, to pressures equivalent to twenty-seven atmospheres. (Lamé, *Cours de Physique.*) It also holds true in respect of vapours or steam subjected to a smaller degree of pressure than that which is necessary to reduce them to the liquid state; and even for mixtures of different gases. It is important, however, to observe, that it is supposed no variation of temperature has taken place during the experiment. The apparatus above described is called a *manometer*.



The density of bodies being inversely as their volumes, the law of Mariotte may be otherwise expressed, by saying *the density of an elastic fluid is directly proportional to the pressure it sustains.* Under the pressure of a single atmosphere, the density of air is about the 770th part of that of water; whence it follows that, under the pressure of 770 atmospheres, air is as dense as water. Thus, the average atmospheric pressure being equal to that of a column of water of about 32 feet in altitude, at the bottom of the sea, at a depth of 24640 ($= 770 \times 32$) feet, or $4\frac{2}{3}$ miles, air would be heavier than water; and though it should still remain in a gaseous state, it would be incapable of rising to the surface.

Effects of Heat on the Elasticity of the Gases. — The repulsive energy of the molecules of the elastic fluids is greatly augmented by an increase of temperature; and it is of the utmost importance in many physical inquiries to ascertain the relation between the temperature and the elastic force. If air and several other gases, sustaining the same constant pressure, are exposed to an increase of temperature which affects all of them equally, it is proved by observation that they all undergo an equal expansion; that is to say, the increase of volume of all the gases is the same for equal augmentations of temperature, and proportional to these augmentations. Experience also shows that, within a considerable range of temperature, the indications of the air thermometer differ very little from those of the mercurial thermometer; so that, within this range, the expansion of any gas whatever is proportional to the increase of temperature indicated by the degrees of the ordinary thermometer. From the temperature of melting ice to that of boiling water, or from zero to 100° of the centigrade thermometer, Gay-Lussac found the expansion of air subjected to a constant pressure to be in the ratio of unity to 1·375; which gives an expansion of 0·00375 for each centigrade degree. This being assumed, let V be the volume of any gas at the zero temperature, P its elastic force, or the pressure it sustains, and D its density. Let $a = \cdot 00375$, and suppose the values of V and D to become V′ and D′ when the temperature is increased t degrees; then the pressure P being supposed constant, we have evidently

$$V' = V\,(1 + at);$$

and the density being inversely as the volume, we have also

$$D' = \frac{D}{1 + at}.$$

Now suppose the pressure to be varied without any change of the temperature, and let p denote the new pressure, and d the corresponding density; the law of Mariotte gives

$$P : D' :: p : d, \text{ whence } p = \frac{P\,d}{D'};$$

and on substituting for D′ its value given by the preceding formula, and making $\frac{P}{D} = k$, we obtain

$$p = kd\,(1 + at)$$

for the expression of the elastic force of any gas in a function of its density and temperature.

The coefficient k is constant for the same gas, but has a different value for different gases, depending on their densities or specific gravities. With respect to atmospheric air, its value may be found thus:—The density of air, compared with water, is 0·0013, and that of mercury 13·59; therefore, supposing the height of the barometer to be 30 inches, the value of k, or the height of a column of air of uniform density, exerting on its base a pressure equal to that of the atmosphere, is 30 in. $\times \frac{13 \cdot 59}{\cdot 0013} = 313860$ inches, or 26155 feet (about five miles), the temperature being that of freezing water.

Of the Motion of the Gases. — Elastic fluids, in escaping from a vessel by a small orifice or tube into a vacuum, observe, like liquids, a law first discovered by Torricelli; namely, that the velocity of the molecules, when they escape from the orifice, is equal to that which they would have acquired by falling through a height equal to the height of a vertical column of uniform density, producing the same pressure as is exerted by the gas at the level of the orifice. Thus, it has just been shown that the pressure of the atmosphere when the barometer stands at 30 inches, and the temperature is that of freezing, is equal to that which would be produced by a column of air of uniform density extending to an altitude of 26155 feet. Now, putting $g =$ the accelerating force of gravity $= 32$ feet per second, the velocity which a heavy body would acquire by falling in a vacuum from a height of 26155 feet is $\sqrt{(2\,g \times 26155)} = 8\sqrt{26155} = 1294$ feet in a second; which, therefore, is the velocity with which air rushes into a vacuum. If the temperature varies, the velocity will vary also, and will become $1294\sqrt{(1 + a\,t)}$. For example, if the temperature were 16° centigrade (about 61° of Fahrenheit), the velocity would be 1332 feet per second.

Since the densities of the gases are proportional to the pressures they support, air will always rush into a vacuum with the same velocity, whatever its density may

be in the vessel from which it escapes; for the homogeneous column of the same density, and exercising the same pressure as the air in the vessel, must in all cases have the same altitude.

The velocities with which the different gases enter a vacuum are inversely as the square roots of their densities; for they are proportional to the square roots of the altitudes from which the molecules are supposed to fall, and these altitudes are inversely as the densities. Thus, hydrogen gas, the lightest of all the gases, and whose density is only 0·0688 of that of air, would enter a vacuum with a velocity of 4933 (= 1294 divided by the square root of 0·0688) feet in a second. It is to be remarked, however, that all those laws relative to the flow of gases are rather inferences from theory than truths demonstrated by direct experiment.

In the case of air or any gas flowing into a space containing a gas of an inferior density, the velocity will be the same as that of an incompressible liquid of similar density with the effluent gas, and capable of exercising a pressure equal to the difference between the pressures of the two gases. Taking, for example, the case of a gas flowing from a gasometer into the atmosphere: let h denote the height of the barometer, and $h + \mathrm{H}$ that of the column of mercury exercising a pressure equal to the elasticity of the effluent gas, so that H is the difference of the two pressures. Also let Δ denote the density of mercury, d that of the gas in the gasometer corresponding to the pressure $h + \mathrm{H}$, and v the velocity per second; then

$$v = \sqrt{\left(2g\,\mathrm{H}\,\frac{\Delta}{d}\right)} = 8\sqrt{\left(\mathrm{H}\,\frac{\Delta}{d}\right)}.$$

Now if, in the formula $p = k\,d\,(1 + a\,t)$ we substitute the pressure in the gasometer $(h + \mathrm{H})\,\Delta$ for p, and also for k its value as above determined in feet, this expression will become

$$v = 1294\sqrt{\left\{\frac{\mathrm{H}}{h + \mathrm{H}}\,(1 + a\,t)\right\}},$$

where v is expressed in feet. If, therefore, A denote the area of the orifice in feet, the volume or number of cubic feet discharged in a second will be v A. It is to be observed, that the volume thus determined is the volume of a gas of the same density as in the gasometer; if it were required to find the number of cubic feet at a different density corresponding to the pressure of a mercurial column whose height $= h'$, it would be necessary to multiply the above expression by the ratio $(h + \mathrm{H}) \div h'$.

From the experiments of D'Aubuisson, it has been ascertained that air, in passing through an orifice pierced in a thin plate, forms a *vena contracta*, whose area, as in the case of a liquid, is 0·65 of the area of the orifice. The application of cylindric adjutages increases the quantity issuing through the orifice to 0·93, and a conical tube to 0·95. The length of the adjutage may be 20 or 30 times the diameter of the orifice before the discharge begins to be diminished by friction. If, therefore, we suppose the gas to flow through a cylindric tube, and assume the multiplier 0·93; and also express the area of the orifice in terms of the diameter of the tube, which we shall suppose $= m$ feet; then, observing that $4\,\mathrm{A} = 3{\cdot}14159\,m^2$, the formula for the number of cubic feet discharged in a second, the density being measured by $h + \mathrm{H}$, will become

$$945\,m^2\sqrt{\left\{\frac{\mathrm{H}}{h + \mathrm{H}}\,(1 + a\,t)\right\}}.$$

The principle of the lateral communication of motion holds good with respect to the gases as well as the liquids. On this principle we may explain a curious fact, observed in the efflux of air from a blowing machine, and in the escape of steam from the valves of boilers. If a circular disk of four or five times the diameter of the orifice be placed close to it, not only will it not be forced away by the current of the elastic fluid, but it will be retained by a considerable force; insomuch that if the orifice be directed downwards, the disk, though formed of a dense metallic substance, will be supported in opposition to its gravity. Let air issuing with considerable force through the aperture A B have its course interrupted by the metallic plate C D; the current will assume the form of a conoid E A B F, containing the cavity E G F. At first the space C G D will be filled with the effluent air; but if a lateral communication of motion takes place, the air in this conoid will join itself to that which escapes by the edges of the plate, and a vacuum be formed in the space C G D, and the plate C D be forced towards the aperture by the pressure of the atmosphere on the opposite side. But as it approaches the orifice the action of the effluent air will become more intense, and the dimensions of the void space be diminished, so that the plate will assume a position in which the forces tending to move it in opposite directions will be balanced.

It has been demonstrated by Newton, in the second book of the *Principia*, that the velocity with which sound is propagated through the air is the same as that which a heavy body would acquire by falling through *half* the height of the homogeneous atmosphere, and consequently equal to $8\sqrt{13078}$, or about 915 feet per second. But this theoretical determination is found to differ considerably from experiment, which gives a velocity of 1125 feet per second when the temperature of the air is at 62° of Fahrenheit's thermometer. Laplace suggested a very probable explanation of this discrepancy; namely, that the condensation caused by the vibrations produced a degree of sensible heat by which the elasticity of the air is increased, or, rather, the density diminished, while the elastic force remains the same. In consequence of this extrication of heat, the number given by the formula of Newton must be multiplied by the square root of the number which expresses the ratio of the specific heat of the air under a constant pressure to its specific heat under a constant volume. This number is found by experiment to be 1·375, the square root of which is 1·173; and on applying this correction, with the proper corrections for temperature, the theoretical determination does not differ very widely from the experimental result. *See* Sound.

Pneumatics forms a branch of physical science which has been entirely created by modern discoveries. Galileo first demonstrated that air possesses weight. His pupil Torricelli invented the barometer; and Pascal, by observing the difference of the altitudes of the mercurial column at the top and the foot of the *Puy de Dome*, proved that the suspension of the mercury is caused by the pressure of the atmosphere. Otto Guericke, a citizen of Magdeburg, invented the air-pump about the year 1654; and Boyle and Mariotte, soon afterwards, detected by its means the principal mechanical properties of atmospheric air. Analogous properties have been proved to belong to all the other aeriform fluids. The problem of determining the velocity of their vibrations was solved by Newton and Euler, but more completely by Lagrange. The theoretical principles relative to the pressure and motion of elastic fluids, from which the practical formulæ are deduced, were established by Daniel Bernoulli, in his *Hydrodynamica* (1738); but have been rendered more general by Navier (*Mem. de l'Acad.* 1830). The experiments of D'Aubuisson, above referred to, are given in different volumes of the *Annales de Chimie* (1826, 1828, 1829). *See* Gas, Resistance, Vapour.

PNEUMATIC RAILWAY. *See* Railroad.

PNEUMATO'MACHI. (Gr. πνευμα, *spirit*, and μαχη, *contest.*) In Ecclesiastical History, a name of reproach, given by the orthodox to those various classes of heretics who, in the fourth and fifth centuries, impugned the divinity of the Holy Ghost. *See* Macedonians.

PNEUMATO'SIS. (Gr. πνευματοω, *I inflate.*) Emphysema. A collection of air in the cellular membrane, rendering the part tumid, elastic, and crepitating when pressed. It rarely arises spontaneously, but generally from some wound which affects the lungs, and by which the air spreads through the cellular membrane. In some rare cases it is an effect of certain poisons.

PNEUMOBRAN'CHIATES, *Pneumobranchiata.* (Gr. πνευμα, *air*, βραγχια, *gills.*) A name applied by Hunter to the Perennibranchiate reptiles of recent zoologists; and by Lamarck to an order of Gastropodous mollusks.

PNEUMO'NIA, or PNEUMONITIS. An inflammation of the lungs. This disease generally attacks those of robust habit after exposure to the cold or wet, and suppressed perspiration; it is sometimes produced by any inordinate exertion of the lungs. Fever, cough, difficult breathing, a strong, hard, and quick pulse, usher in the disease, which, if neglected, sometimes proceeds so rapidly as to end in suffocation; it may also prove fatal by terminating in suppuration and gangrene. A free and abundant expectoration, perspiration, or diarrhœa, are favourable symptoms of its termination in resolution. Large bleeding at the outset, repeated, however, with much circumspection, local bleeding, purges, and diaphoretics of calomel and antimony, and afterwards small doses of opium, hemlock, and such remedies as quiet the cough and procure sleep, constitute the leading principles of treatment.

PNEU'MOTHO'RAX. (Gr. πνευμα, and θωραξ, *chest.*) An accumulation of air in the sac of the pleura.

POA. (Gr. ποη, *grass.*) A name given by botanists to a genus of grasses of considerable extent, and very abundant in the pasturages of Europe. One of the commonest of all weeds is the *Poa annua*. *Poa trivialis* and *pratensis* are other species, sown extensively as a part of the artificial pastures and lawns, which are now commonly made with picked grasses instead of "hay seeds." In general, they appear to be nutritious and agreeable to cattle.

POACHERS. *See* Game Laws.

POCO. (Ital.) In Music, a word frequently prefixed to another to lessen the strength of its signification; as *poco largo*, a little slow.

PO'DAGRA. (Gr. πους, *the foot*, and αγρα, *a seizure.*) *See* Gout.

PODESTA. One of the chief magistrates of Genoa and Venice is so called.

PODE'TIA. (Gr. πους, *a foot.*) The stalk-like elongations of the thallus, which, in certain lichens, support the fructification, as in *Cenomyce.*

PO'DICEPS. (Gr. *divided foot.*) A genus of birds, commonly called *Grebes*, placed in the order of Palmipeds by Cuvier, but forming the transition from the waders to the swimmers by having the webs of the toes incomplete, and formed by a scalloped membrane, as in the coot. The legs are, however, placed far back, so as to render them efficient organs of swimming, while their use in walking on dry land is proportionally deteriorated; the feet are admirably organized for propelling the body through the water; and the grebe, which dives more than it swims, assists the feet with a simultaneous action of its wings; but these, like the pectoral fins of fishes, serve mainly to direct and vary the course of the bird.

PO'DIUM. (Lat.) In Architecture, the part in an amphitheatre projecting over the arena, above which it was raised about 12 or 15 feet: in this part sat the personages of distinction. The word is also used to signify a balcony.

PŒ'CILE. (Gr.) A celebrated portico or gallery at Athens, where Zeno inculcated his doctrines. The Pœcile was adorned with the statues of gods and benefactors; and the picture of Polygnotus, so well known to the classical reader, which represented Miltiades at the head of the 1000 Greeks at the battle of Marathon, was here suspended for ages.

PŒ'CILOPODS, *Pœcilopoda.* (Gr. ποικιλος, *varied*, and πους, *a foot.*) The name of an order of Entomostracous Crustaceans, including those which have feet of different forms and uses, the anterior ones being ambulatory or prehensile, the posterior branchial and natatory.

POETRY. (Gr. ποιησις, *a poem*, and ποιητικη τεχνη, *the art of poetry;* from ποιεω, *I make*, according to Aristotle, because the writers of each different class of poems, epic, elegiac, &c., were said, in common language, to "make" them; and called εποποιοι, ελεγειοποιοι, *epic-makers*, and *elegy-makers. De Poet.* sec. iii.) To produce a complete and satisfactory definition of poetry has been, hitherto, unsuccessfully attempted by writers on taste, and by poets themselves. A popular one, sufficiently adapted to general notions, is furnished by the *doyen* of living critics, Lord Jeffrey: — "The end of poetry is to please; and the name, we think, is strictly applicable to every metrical composition from which we derive pleasure without any laborious exercise of the understanding." (*Ed. Rev.* xi. p. 216.) But, in the first place, it has been truly observed, that "verse is the limit by which poetry is bounded: it is the adjunct of poetry, but not its living principle."—"Poetry," says Coleridge, "is not the proper antithesis to prose, but to science. Poetry is opposed to science, and prose to metre."—"The proper and immediate object of science is the acquirement or communication of truth; the proper and immediate object of poetry is the communication of immediate pleasure." In the next place, Lord Jeffrey's definition would clearly include burlesque composition. Is this strictly *poetry?* It was included, certainly, in their rather artificial analysis of poetry by ancient critics: in the *Poetics* of Aristotle the rules of comic composition are as elaborately laid down as those of any other species. Yet the excitement of the ridiculous is altogether of a different nature from that produced by poetry in the modern sense of the word: which is necessarily either elevating, imaginative, or tender. And this it does, as Coleridge, with a true poetical feeling, has described it, by communicating to the reader "that pleasurable emotion, that peculiar state and degree of excitement, which arises in the poet himself in the act of composition." (*Literary Remains.*) The end of poetry, then, appears to be to produce intellectual pleasure by exciting emotions either of the elevated or pathetic order. But in what mode does poetry effect this? The sight of a distressed object raises tender feelings; a tale of distress does the same: to be witness of some stupendous event, or great natural phenomenon, elevates them; and so does the description of such. Yet this tale or description is not poetry. Some dramas, almost utterly destitute of poetical merit, retain a hold on theatrical audiences merely because they are transcripts of painful scenes actually occurring in domestic life. But these are not poetry, although constantly mistaken for it. So again, the mere narration of a grand and surprising circumstance is not poetry, however akin to poetical the emotion it inspires. Few passages in poetry retain a greater hold on the imagination than the well-known accounts of Napoleon amidst the fires of Moscow, or the sack of Rome by Bourbon, or the execution of Charles the First, or mere descriptions of the Alps or Niagara: the most prosaic writer who treats these subjects, if he only adhere to truth and bring out its striking particulars, cannot fail of producing an effect which may be termed, as regards the reader, poetical; but not by the employment of poetry. This consideration leads us to its great characteristic. It is essentially a creative art: its operation is "making," not transcribing. "Imitation" it is, as Aristotle defines it; not because it copies, but because it has its model in nature, and can never depart far from it without losing its character. Lord Bacon explains this by saying, that poetry "doth raise and erect the mind, by *submitting the shows of things to the desire of the mind.*" The imagination alters these "shows of things" by adding or subtracting qualities; and poetry produces to view the forms which result from the operation.

But Lord Jeffrey goes on, in the passage which has been already quoted, to give an analysis of the elements of poetical pleasure, which appears to us singularly clear and accurate. "This pleasure may, in general, be analysed into three parts: that which we receive from the excitement of passion or emotion; that which is derived from the play of imagination, or the easy exercise of reason; and that which depends on the character and qualities of the diction." The two first are the vital and primary species of poetical delight. And this analysis may lead us to consider the faculties by the exercise of which these several pleasures are produced, — faculties widely different, yet all poetical; some of them more and some less essential to the production of poetical pleasure; some less and some more conspicuous in different poets; all united in hardly any.

1. Imagination is, emphatically, the great poetical faculty. It is "the first moving or creative principle of the mind, which fashions out of materials previously existing new materials and original truths." It is "a complex power, including those faculties which are called by metaphysicians conception, abstraction, and judgment:" the first enabling us to form a notion of objects of perception and knowledge; the second "separating the selected materials from the qualities and circumstances which are connected with them in nature;" the third selecting the materials. (*Stewart:* see the article "Poetry" in the *Encycl. Britannica.*) Its operations are most various, and it exhibits itself in poetry in very different degrees and forms. It may shine here and there, chiefly in comparison, or in bold and pleasing metaphor, breaking the chain of a narrative, as in Homer and the earlier poetry of most nations; it may hurry image on image, connected only by those exquisite links of thought which are present in the mind of the poet, in daring, compressed, rapid language, as if language were inadequate to its expression, as in the inspired prophets, in Æschylus, and often in Shakspeare; it may predominate in entire sustained conceptions, grasping at general features, as in Milton; it may cling more closely to the "shows of things," dwelling in particulars, reproducing with startling vividness images little altered, graphic, and minute, as in Dante; and here it often approaches to fancy. Imagination, combined in a greater or less degree with thought or reflection, but with little of the other poetical qualities, produces a kind of poetry which suits the taste of a refined and thoughtful class, but has little hold on the general mind; departing too widely from Milton's rule in being, if simple, neither "sensuous nor passionate," of which striking examples may be found in Wordsworth, and sometimes in Goethe, a writer of a very different cast.

2. No distinction has given critics more trouble, in the way of definition, than that between imagination and fancy. "Fancy," it has been said, "is given to beguile and quicken the temporal part of our nature; imagination to incite and support the eternal." — "The distinction between fancy and imagination," says another, "is simply that the former altogether changes and remodels the original idea, impregnating it with something extraneous; the latter leaves it undisturbed, but associates it with things to which in some view or other it bears a resemblance." Now the latter is an operation of thought, wit, or judgment; and this perhaps will lead us to a right conclusion. The poetry of true fancy is merely that of imagination "at a lower point of excitement," or employed on less elevated subject matter. The poetry of the *Midsummer Night's Dream*, for instance, may be termed either imaginative or fanciful with equal correctness. But there is also a spurious fancy, the offspring of a quick wit, adopting poetical diction: are we wrong in calling this the real quality of one of the most charming of modern poets, whose wit is very nearly allied to imagination, yet not the same, — Thomas Moore?

3. Lord Jeffrey, as we have seen, associates with the pleasure of imagination that derived from "the easy exercise of reason." This is produced chiefly by the faculties of thought, wit, and reflection. It may indeed be doubted whether the expression of thought, however energetic and acute, clad in current poetical diction, is really poetry. Certainly it is so, if at all, in a very inferior degree to that of the imagination. And yet when we reflect how much of the pleasure which we derive from verse is of this kind, how many of the greatest names in the history of poetry are distinguished for this alone, and that one great literary nation (the French) seems to have placed its idea of poetry entirely in the expression of thought and feeling, and chiefly the former, we can scarcely refuse it an important place. It also takes many

shapes. It appears in the form of witty or acute conceits, as in Donne and Cowley, and many French and Italian poets; nearly allied to that spurious fancy of which we have spoken. It lightens in flashes of high-minded indignation or keen sarcasm in Juvenal; assumes a still loftier moral tone in Persius, and often in Dryden, mixed with grave, energetic, powerful reflection. It takes the easier tone of acute knowledge of the ways of man, and light satire, in the pages of Horace, and enlivens the charming narrative of Ariosto. It often assumes a rhetorical character, as in Corneille and Lucan. There is a trivial experiment by which the difference between this and imaginative poetry may be tested. Turn both into prose; the latter retains its poetical character; the former seems to lose it.

4. The expression of passion, sentiment, or pathos, is the most common and universal of all sources of poetical pleasure. It is the very soul of all early and simple poetry; it pervades no less that of the most civilized communities. Yet this class of poetry is less truly and emphatically poetical than the imaginative; although more popular. The pleasure occasioned by it is of a mixed nature: it arises from the excitement of peculiar sympathies, not produced, but heightened only, by the form in which that excitement is conveyed. This is the reason why mere popularity is not a test of the excellence of poetry. The uncritical reader calls that the best poetry by which he is best pleased. Devotional poetry, for instance, appeals to an elevated and universal class of sympathies; and on this account often passes for worth more than, as poetry, it really is. The highest attribute of a poet, in this branch of the poetical faculty, is a sensibility to all the springs of our passions, joined with the art of expressing it; these, when united with that power of personification which is more peculiarly the dramatic faculty, produce the drama in its highest and noblest shape, such as it is exhibited by Shakspeare, and by him alone. But the power of giving language to the sentiments of any common and elevated passion is by itself a great poetical merit. The passion of love is the staple of numberless bards. The passion for war or conflict, unhappily natural to man; is a source of poetry: it is impossible not to perceive in Homer and Scott, independently of their art of narration and energy of description, an exultation in the animal excitement of the imaginary battle, the *certaminis gaudia* of the savage Attila, peculiarly and intensely poetical. The sentiment of self-love, the natural propensity to exhibit self to self in a romantic or elevated point of view, forms a great part of the charm of such a muse as that of Byron. Again, independently of the direct expression of feeling, there is in some poets a general colouring derived from it, thrown as a light veil over all the objects presented, which is a singularly attractive attribute. Such is the tinge of grave and serious tenderness which shades the poetry of Sophocles and Virgil; and assumes, perhaps, a more feminine character in that of Tasso.

These are the more strictly subjective qualities of true poetry. There are others, of a more objective character, which can scarcely be said to belong to it strictly *as* poetry, and yet can scarcely be excluded from a general review.

5. The dramatic faculty, of which we have already spoken, seems to consist in acute powers of observation of the varieties of human character, together with the rarer power of delineating it with such force as to bring the imaginary person distinctly before the reader. It is the wonderful and unique characteristic of Shakspeare, in whom all individuality, as has been often observed, seems absolutely lost. If we are to look for a second to Shakspeare in this high faculty, we shall find him, among poets, only in Scott. But it is a power often much developed in writers who are not poets in any sense, such as Le Sage and De Foe.

6. The descriptive faculty is of the same kind; that of bringing the objects of external nature, or passing scenes of whatever sort, vividly before the reader's fancy. When the objects or scenes so represented are such as the painter might choose with advantage for the exercise of his art, the faculty is properly termed picturesque; though that word is often of a looser acceptation. It is obvious that this also is a faculty common to poets, with many others who are not so; but sustained energy of description, as in Homer, forms a magnificent ground work for strictly poetical ornament. In the poetry of modern times, especially in this country, and in Germany, the description of external nature has been made subservient to the purposes of imagination and reflection by writers of high genius; and this combination peculiarly characterizes the taste of the age.

7. Lord Jeffrey ranks last the pleasure derived from diction, as of a secondary order; which it undoubtedly is, and yet almost essential. The highest poetry, without beauty of style, is rarely or never popular. We have no space to characterize minutely this poetical quality; but, by way of example, it may suffice to observe, that Virgil is, perhaps, of all poets, he of whose charm the greatest proportion is derived from simple beauty and felicity of diction; through a whole range of ill-chosen subjects, always graceful, always equable, and as nearly approaching to faultlessness as human skill can construct.

8. Lastly, we must not omit the pleasure of *melody:* not essential to poetry, since there may be poetry without verse; not always a merit of the poet's own, since much depends on the language, — and a Greek or Italian poet, cæteris paribus, will ever be preferable to an English or German one, on this account alone; but a grace which heightens the charm of the noblest poetry, and sometimes captivates the sense even in the most indifferent.

POIKILI'TIC FORMATION. (Gr. ποικιλος, *variegated.*) In Geology, a term applied to the new red sandstone formation, in consequence of the varieties of colours which it exhibits.

POI'NDING. In Scottish Law a species of diligence (*i. e.* process), whereby the property of the debtor's moveables is transferred to the creditor. Poindings are either real or personal; the former affecting the debtor's moveables on the lands to which the debt attaches, the other his moveables generally. The effect of real poinding is to give the user of it right to the rents.

POINT. A steel instrument used by engravers for tracing the work on a copper-plate.

POINT. In Heraldry, an ordinary somewhat resembling the pile (*see* PILE), but issuing from the base of the escutcheon instead of the chief: seldom used in English, but frequently in foreign armories.

POINT. In Music, a character used by many instead of the dash, its chief use being to distinguish those notes from which an intermediate effect is required dissimilar to the dash.

POINT BLANK, in Gunnery, denotes the position of the gun when pointed so that its axis is parallel to the horizon. *Point-blank range* is the distance to which a shot fired in the *point-blank* or horizontal direction is carried.

POI'NTING, in Artillery, denotes placing the gun so as to give the shot a particular direction. This is usually done by help of the gunner's quadrant or level. *See* LEVEL.

POINTS. Small flat pieces of cordage put through the sails in horizontal rows, for the purpose of reefing them.

POINTS OF SUPPORT, in Architecture, are the collected areas *on the plan* of the piers, walls, columns, &c., upon which an edifice rests, or by which it is supported. It is evident that the smaller their total area, compared with the superficies of the whole building, the greater is the skill exhibited by the architect; and this for many reasons, not the least whereof is the greater resultant economy. We subjoin a table of some few buildings in Europe, examined in this respect. They are arranged in the order of the ratio of their points of support, whose area, as well as their total superficies, are added in separate columns.

Ratio of Area to Points of Support.	Edifice.	Total Area in English Feet.	Area of Points of Support.
0·056	Temple of Claudius in Rome, now church of St. Stefano	36,726	2,051
0·100	Church of St. Sabino in Rome (destroyed) - -	15,139	1,543
0·118	Church of St. Paul in Rome, without the walls of the city	106,513	12,655
0·127	Temple of Peace in Rome -	67,123	8,571
0·129	Church of St. Filippo Neri, Naples - - -	22,826	2,944
0·139	Church of St. Giuseppe, Palermo - - -	26,046	3,611
0·140	Church of Notre Dame, Paris	67,343	8,784
0·146	Church of St. Dominico, Palermo - - -	34,144	4,988
0·151	Church of St. Sulpice, Paris	60,760	9,127
0·154	Pantheon, or Church of St. Geneviéve, Paris - -	60,287	9,269
0·155	Church of St. Peter, ad Vincula, Rome - -	21,520	3,353
0·157	Church of St. Vital, Ravenna	7,276	1,142
0·163	Temple of Juno Lucina, Sicily - - -	6,821	1,110
0·167	Central building of baths of Diocleslan, Rome - -	351,636	58,797
0·169	Cathedral, Milan - -	125,853	21,365
0·170	St. Paul's, London - -	84,025	14,311
0·172	Great Temple at Pæstum -		2,649
0 176	Central building of baths of Caracalla, Rome - -	15,353 275,503	48,911
0·194	Temple of Concord, Girgenti, Sicily - - -	6,849	1,330
0·201	Cathedral Sta. M. del Fiore, Florence - - -	84,802	17,030
0·217	Mosque of Sta. Sophia, Constantinople - -	103,200	22,567
0·232	Pantheon at Rome - -	34,238	7,954
0·235	Ancient Temple Galuzzo, Rome - - -	9,206	2,167
0·261	St. Peter's, Rome - -	227,069	59,308
0·268	Hotel des Invalides, Paris -	29,003	7,790

POINTS OF THE COMPASS. In Geography and Navigation, the points of division of the circle representing the horizon, or of the compass card over which the

magnetic needle is suspended. A diameter of the circle being drawn to represent the meridian, or north and south directions, and another at right angles to it to represent the directions east and west, the circle is thus divided into four quarters, each of which is subdivided into eight equal parts, so that the whole circle is divided into thirty-two equal parts; and the points of division are termed the points of the compass. Each has a particular name, indicating its place with reference to the four principal or *cardinal points;* namely, the north, south, east, and west points. *See* COMPASS.

POINTS OF THE ESCUTCHEON, in Heraldry, are nine. These are marked by letters in the cut attached to the article HERALDRY, which is copied from those in the ordinary English works on the elements of the science. They are — A, dexter chief; B, middle chief; C, sinister chief (Fr. chef, *head*); D, honour point; E, fess point, which is the centre of the shield (fascia, *belt*, or *sash*, from the belt encircling the middle of a man); F, nombril point (navel); G, dexter base; H, middle base; and I, sinister base. It will be observed, that the greater part of these names are taken from those parts of the human body which the shield was taken figuratively to represent.

POI'SON. (Fr. *poison.*) A substance which disturbs, suspends, or destroys one or more of the vital functions. Poisons are classified by Orfila under the four heads of Irritants, Narcotics, Narcotico-acrids, and Putrefiants or Septics. See TOXICOLOGY.

POISON-FANG. The superior maxillary teeth of certain species of serpents are so called; which, besides the cavity for the pulp, appear to be perforated by a second longitudinal canal, which is open at both ends, and receives at that next the base of the fang the termination of the duct of the poison-gland. The tooth essentially consists of a narrow and thin plate, bent upon itself lengthwise, and with the approximated margins adherent together. In some poison-fangs the line of adhesion is visible along the convex side of the tooth.

There is generally but one poison-fang on each maxillary bone, as in the viper and naia; but sometimes there are a few additional teeth behind the principal fang. The fang ordinarily lies recumbent; but when the serpent designs to strike with this weapon, it is erected by a rotatory movement of the jaw, and the poison-gland is at the same time compressed and emptied of its secretion, which is injected through the hollow fang into the wound.

POISON-GLAND. Those glands which secrete an acrid or venomous liquor, which is conveyed along an instrument capable of inflicting a wound, are so termed. The glands at the sides of the head of poisonous serpents, those at the base of the hollow jaws of the centipede, at the aculeated tail of the scorpion, communicating with the sting of the bee or the spur of the ornithorhynchus, are examples.

POLA'CCA. A peculiar vessel with three masts, navigated chiefly in the Levant and other parts of the Mediterranean.

POLAI'RE. A peculiar rig of a vessel, having pole masts, no tops, and sometimes no crosstrees, whereby the yard and sail are lowered almost close down to the yard next below.

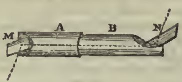
POLAR. Having reference to poles; as *polar circles, polar regions, polar projection*, &c.

POLA'RITY. In Physics, that property of bodies in consequence of which, when at liberty to move freely, they arrange themselves in certain determinate directions, or point, as it were, to given poles. Thus, an iron bar acquires polarity by magnetism, and, when suspended from a single point, arranges itself in the direction of the magnetic meridian, or points to the magnetic poles of the earth. When light is supposed to consist of material particles emitted from the sun, it is necessary, in order to explain certain phenomena of optics, to assume that the particles are endowed with *polarity*, which merely signifies that the opposite sides of a particle have different physical properties. *See* POLARIZATION.

PO'LARIZA'TION OF LIGHT. Light which has undergone certain reflexions or refractions, or been subjected to the action of material bodies in any one of a great number of ways, acquires a certain modification, in consequence of which it no longer presents the same phenomena of reflexion and transmission as light which has not been subjected to such action. This modification is termed the *polarization of light;* its rays being supposed, according to particular theoretical views, to have acquired *poles* (like the magnet), or sides with opposite properties.

The polarization of light may be effected in various ways, but chiefly in the following: — 1. By reflexion at a proper angle from the surfaces of transparent media, as glass, water, &c. 2. By transmission through crystals possessing the property of double refraction. 3. By transmission through a sufficient number of transparent uncrystallized plates placed at proper angles. 4. By transmission through a number of other bodies imperfectly crystallized, as agate, mother of pearl, &c. The following experiment will serve to illustrate the first of these modes, and also give a clear idea of the difference between common and polarized light.

Let A and B be two metallic or pasteboard tubes, open at both ends, and fitting into each so as to turn stiffly. Into each of these let a piece of polished glass, M, N, having one of its sides roughened, and blackened with melted pitch or black varnish so as to destroy its internal reflexion, be fixed in such a position that its surface makes an angle of 33 degrees with the axis of the tubes.



Let the tubes now be placed so that the light from the sun, or any luminary, falling on the plate M, shall be reflected along the axis; and let the tube A be fixed in that position. The light which traverses the axis of the tube will fall on the plate N, from which it will be again reflected, and may be received by the eye, or on a screen. The apparatus being thus arranged, let the tube B be turned round within A, carrying with it the reflector N, which in its revolution will always preserve the same inclination to the axis of the tube; and the ray of light reflected from N will describe a conical surface. Now, on attending to the ray reflected from N, it will be observed in the course of the revolution constantly to vary in intensity: at two opposite points it will acquire a maximum of intensity; and at other two opposite points, intermediate between these, it will entirely disappear. On comparing the positions of the reflecting planes at the occurrence of these phases, it will be found that the intensity of the light is greatest when the plane N is *parallel* to M, and that there is no reflexion from N when the two planes are *at right angles.* It thus appears that a ray of light reflected from the surface of glass at this particular angle of 33° is incapable of being reflected a second time from a similar surface, perpendicular to the former, at an equal angle of incidence. This property is expressed by saying that the light reflected from M is *polarized in the plane of reflexion.* It has, in fact, acquired some property or modification, in virtue of which, while it preserves the power of being again reflected in the same plane, it ceases to be subject to the ordinary law of reflexion in a perpendicular plane.

If the ray reflected from M, instead of being received on a second reflecting surface N, be thrown upon a crystal of Iceland spar, or any doubly refracting crystal, so placed that its principal plane (*i. e.* the plane passing through the direction of the ray and the shorter diagonal of the rhombus) is parallel to the plane of reflexion M, then there will only be a single refraction; the extraordinary ray will disappear, and the ordinary ray alone be produced. But if the face of the crystal be turned round 90°, the phenomena are reversed; the extraordinary ray alone is produced, and the ordinary one disappears. The light, therefore, in consequence of its reflexion from the surface M, ceases to obey the same laws of double refraction as ordinary light.

When the ray reflected from M is received perpendicularly on a tourmaline plate, it will present different phenomena of transmission according to the position of the axis of the plate, that is, the axis of the crystal from which the plate was cut. If the axis is parallel to the reflecting plane, the whole of the light will be transmitted through the plate; but if the plate be turned round in its own plane until the axis becomes perpendicular to the reflecting plane, no portion of the light will be transmitted.

From these experiments it appears that light polarized by reflexion possesses the following characters, which are invariably found to belong to all polarized light, in whatever way the polarization may have been produced: — 1. It is incapable of being reflected by polished transparent bodies at certain angles of incidence, and in certain positions of the plane of incidence. 2. It is incapable of undergoing division into two equal pencils by double refraction, in positions of the doubly refracting bodies in which a ray of ordinary light would be so divided. 3. It is incapable of being transmitted by a plate of tourmaline when incident perpendicularly upon it, in certain positions of the plate; and is readily transmitted by it in certain other positions, at right angles to the former.

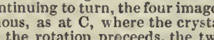
The polarization of light by reflexion is only effected completely when the light falls on the reflecting surface at a particular angle; and it has been mentioned that, in the case of glass, the angle which the direction of the ray must make with the surface is about 33°, or the *angle of incidence* (the complement of the former) must be 57°, in round numbers. This angle is called the *polarizing angle*. It is different for different substances; but from an extensive series of experiments with a great number of different bodies, Sir David Brewster found the following remarkably simple and beautiful relation to subsist in all cases between the polarizing angle and the refractive power of the medium, viz. — *The tangent of the polarizing angle for any medium is the index of refraction belonging to that medium.*

All reflecting substances are capable of polarizing light if incident at proper angles; but metallic bodies, and

bodies of very high refractive power, like the diamond, appear to do so only imperfectly, the reflected ray not *entirely* disappearing in circumstances when a perfectly polarized ray would be completely extinguished.

When light is reflected at an angle greater or less than the polarizing angle, it is partially polarized. A second reflexion in the same plane renders the polarization more complete; and, by repeating the reflexions a sufficient number of times, it may be polarized at any angle of incidence.

The second method of effecting the polarization of light, above mentioned, is by transmission through doubly refracting crystals. When a ray of common light is separated into two by double refraction, both the pencils, at their emergence from the crystal, are found to be completely polarized; but in different planes, at right angles to each other. This may be proved by receiving them on a reflecting surface at the polarizing angle, or by examining them through a plate of tourmaline, or by interposing a second crystal also having the power of double refraction; and in all cases each pencil will exhibit the same phenomena as light polarized by reflexion. Let a ray of light fall on a rhomboid of Iceland spar, it will be separated into two, of which call O the ordinary ray and E the extraordinary ray. Let both pencils be received on a second rhomboid, and the following phenomena will be observed. When the rhomboids are in similar positions, or have their homologous faces parallel, neither of the pencils will be separated by the second crystal; but O will produce only an ordinary ray, and E only an extraordinary ray. On turning the second crystal round through an angle of 90°, O produces only an extraordinary ray, and E only an ordinary ray. In intermediate positions, each pencil is separated by the second crystal into two, in the same manner as ordinary light. This experiment, which was first made by Huygens, and accurately described by him, may be made as follows:— Take two pretty thick rhomboids of Iceland spar, and lay them down (the one over the other) on a sheet of white paper, having a small and well-defined black spot on it. When the rhomboids are so placed that their homologous sides are parallel, the spot will be seen double through the combined crystals, as if they formed one piece; both images will be equally bright, and the line which joins them will be parallel to the principal sections of the crystals. This is shown at A in the figure below. If we now turn round the upper crystal in the horizontal plane from left to right, two new faint images will make their appearance, as at B. Continuing to turn, the four images will be all equally luminous, as at C, where the crystal has been turned 45°. As the rotation proceeds, the two original images become extremely faint, as at D. When the crystal has been turned 90°, there will again be only two images, as at E: two new faint images will again appear at F. At G, where the angle of rotation is three quadrants, the four will be again equally bright; farther on at H they will become unequal; and at I, when the revolution is precisely 180°, they will all coalesce into one bright spot.


A B C D E F G H I

From all these appearances it follows that the ordinary ray is polarized in the principal plane of the crystal, and the extraordinary ray in a plane perpendicular to the principal plane.

The phenomena produced by the polarization of light are among the most splendid and singular in the whole range of physical science. They lay open many new views of the constitution of natural bodies, and their explanation constitutes the principal part of the theory of light. The general explanation, according to the Newtonian theory of emission, is this:—The molecular forces of the crystal, acting on the particles of light, give them a rotatory motion round their centres of gravity, till their axes assume certain determinate positions, after which they remain at rest. There are, however, cases in which the luminous particles, in traversing the crystal, assume no fixed position, but oscillate about their centres of gravity in regular periods, termed by Newton *fits;* and there are even cases in which it is necessary to suppose that they are endowed with a continuous rotation. In giving a rational account of these complicated phenomena, and reducing them to calculation, the followers of the undulatory theory have been more successful, and the whole are connected and explained by a simple hypothesis, which may be enunciated as follows:—

"Common light consists of undulations in which the vibrations of each particle are in the plane perpendicular to the wave's motion. The polarization of light is the resolution of each vibration into two, one parallel to a given plane passing through the direction of the wave's motion, and the other perpendicular to that plane, which become in certain cases the origin of waves that travel in different directions. When we are able to separate one of these from the other, we say that the light of each is polarized. When the resolved vibration parallel to the plane is preserved unaltered, and that perpendicular to the plane is diminished in a given ratio (or vice versâ), and not separated from it, we say that the light is partially polarized." (*Airy's Mathematical Tracts*, p. 339.)

The polarization of light by reflexion was accidentally discovered by Malus, a French engineer officer, in the year 1810; and the phenomena, which appeared the most remarkable of any that had yet been observed, both on account of their splendour and their intimate relations with the more interesting parts of physical optics and the theory of light, soon began to be studied with great care, and to be varied in every possible way, by Malus himself, by Biot, Arago, Dr. Young, Seebeck, Sir David Brewster, Sir John Herschel, and many others. But the individual who beyond all doubt contributed most to connect them with theory, and to show their mutual relations and dependencies, was Fresnel, whose success in deriving them, by à priori reasoning, from the principles of the undulatory hypothesis of light, was so complete as to place the evidence of the truth of that theory on almost the same footing of credibility as that of gravitation itself. Analogous phenomena to those of the polarization of light have been found to belong also to radiant heat. Professor Forbes of Edinburgh, who has been the most successful investigator in this interesting department of physics, has shown that heat is polarized both by reflexion and refraction. He has also succeeded in depolarizing heat, and thereby proved that heat possesses the property of double refraction.

See Malus, *Théorie de la Double Refraction;* Fresnel, *Mémoires de l'Institut*, 1824, 1826, 1827; Herschel's Treatise on Light, *Ency. Metr.;* Brewster's "Optics," *Cabinet Cyclopedia;* various papers in the *Phil. Trans.* from 1813 to 1819; *Airy's Math. Tracts*, 2d ed. 1831; and the various scientific journals.

POLE. In Surveying, a measure of length, containing $16\frac{1}{2}$ feet or $5\frac{1}{2}$ yards; it is the same as *rod.* Sometimes the term is used as a superficial measure; a *square pole* denoting $5\frac{1}{2}\times 5\frac{1}{2}$ yards, or $30\frac{1}{4}$ square yards.

POLE'MICS, or POLEMICAL THEOLOGY. (Gr. *πολεμος, war.*) The same as controversial. The term is not necessarily applicable to theology only, but it is generally so applied; and it reflects little credit on human nature that such a subject should have been treated in such a manner as the appellation indicates.

PO'LEMOSCOPE. (Gr. *πολεμος, war*, and *σκοπεω, I view.*) An instrument imagined by Hevelius, for seeing objects which cannot be seen by direct vision. It consists of a mirror placed obliquely in a tube or box, having an opening in the side opposite the mirror, so that rays from any object falling on the mirror are reflected to the eye of the spectator. Hevelius chose the name of *polemoscope* because he thought the instrument might be applied, in time of war, to discover what was going on in the camp of the enemy, while the spectator remained concealed behind a wall or other defence, and therefore could not employ a telescope. Opera glasses are sometimes constructed on this principle, for the purpose of enabling a person to see others on the right or left, while he appears to look straight forward.

POLES. (Gr. *πόλος.*) In Geometry and Astronomy, the extremities of an axis of rotation of a sphere or spheroid. In spherics, the poles of a great circle are the extremities of the straight line perpendicular to the plane of the circle, and passing through its centre. The *poles of the ecliptic* are the points about which the stars are carried by the slow motion of the precession of the equinoxes; the *poles of the equator*, or *poles of the world*, are the two points about which the stars perform their diurnal rotation; the *poles of the horizon* are the zenith and nadir; the *poles of the meridian* are the points of the horizon due east and west.

POLES, in Physics, are the points of a body in which its attractive or repulsive energy appears to be concentrated. Thus, the *poles of a magnet* are the opposite points in which the magnetic force is collected.

POLICE, is a term employed to designate those regulations which have for their object to secure the maintenance of good order, cleanliness, health, &c. in cities and country districts; and it is also used to designate the description of force by which these objects are effected. This force differs from military in its being commanded by civil officers, and not being under military law; but it is generally drilled and armed in a half military manner, and has a distinctive uniform. The police force is employed alike to prevent and detect offences; and may be either open or secret. By an open police is meant officers dressed in their accustomed uniform, and known to every body; while, by a secret police is meant officers whom it may be difficult or impossible to distinguish from certain classes of citizens, whose dress and manners they may think it expedient to assume. The latter are employed that they may, without exciting the suspicion of guilty parties, or of those who are projecting some outrage, acquire their confidence, and, by making themselves masters of their secrets, secure their apprehension or prevent the outrage. It is needless to say that the employment of a

police force of this description is attended with many inconveniences; and sometimes it is believed the officers have stimulated to the commission of the very offences they were employed to detect and prevent. Still, however, it does not seem that it should be altogether dispensed with; and, under proper regulations, it affords not only the best means of detecting crimes, but also of preventing the commission of such as require any previous combination or arrangement.

The organisation and efficiency of the police differ in different places. Its expenses are usually defrayed by a rate laid on the inhabitants of the town or place where it is established. The metropolitan police was newly organised a few years ago, and is now a most effective force. The city of London is not under the charge of the metropolitan police, but is protected by a body of men, organised on the plan and in imitation of that body, but placed under the city authorities. The metropolitan police amounts in all to nearly 4,000 men.

The police or constabulary force of Ireland is armed, and has more of a military than of a civil character. According to recent arrangements, a lord-lieutenant is appointed to each Irish county, through whom all communications to the Irish government are made. The lords-lieutenant are assisted in the discharge of their duties by an indefinite number of deputy lieutenants. All these officers act gratuitously, and are removeable at pleasure.

The constabulary force of Ireland amounted, in 1840, to about 7,650 men, exclusive of a temporary police force of about 650 men.

POLICY. *See* Assurance.

POLISH, *Polishing*. (Lat. polio, *to make smooth*.) In Sculpture, the operation of giving a smoothness and gloss to any surface. The polishing of marble is effected by first rubbing the surface with freestone; after which it is wrought upon with pumicestone; and lastly with the finest emery powder, from which the glossy surface is obtained.

POLITICAL ARITHMETIC. See Statistics.

POLITICAL ECONOMY.* Political science is commonly divided into two great departments. One of these has for its object to ascertain and establish the principles according to which the governments of states may be best organized; to discriminate between the legislative, judicial, and executive departments, and to assign to each its proper functions, limits, and duties; to determine to what hands, and under what conditions and limitations, the supreme power may be most advantageously committed, and how its various subordinate officers should be selected and controlled; to decide, in fine, how the government, under any given set of circumstances, should be framed, so that it may be most likely to promote the well-being of those subjected to its authority. This is what is commonly called pure politics. The other department of political science has a different, more practical, and not less important object in view. Those engaged in its study do not inquire into the best methods of distributing political power, or of constituting the governing body; but, taking them as they exist, they endeavour to ascertain the rules and principles — the *leges legum*, as they were termed by Bacon — according to which all governments, however formed, should act, so as to procure for their subjects the greatest amount of wealth, civilisation, and happiness. This department of the science has received the name of political economy; and we shall endeavour, in this article, to give a brief exposition of its objects and principles. To enlarge on its importance would be superfluous. The history of the human race proves that national prosperity, or the well-being of the bulk of the people, is not the exclusive attribute of any particular species or form of government. It has been and may be enjoyed by all countries, how different soever their political organization, provided they adopt a sound system of political economy; and it can be enjoyed by none who do not. Without, therefore, undervaluing the other great branch of the political sciences, or that which treats of the constitution of governments, this seems to possess at least equal claims on the public attention. Its leading principles and rules are applicable at all times and under all circumstances; they are equally suitable to despotic monarchies and to republics, and cannot be neglected or contemned by either without the most injurious consequences.

It is in general said of political economy that its object is to ascertain the circumstances most favourable for the production of wealth, and the laws which determine its distribution among the different ranks and orders into which society is divided; and this definition seems quite unexceptionable, provided it be clearly understood that by wealth in this science is meant only those articles or products which require some portion of human industry for their production, acquisition, or preservation, and which, consequently, possess exchangeable value. A commodity or product is not valuable merely because it is useful or desirable; but it is valuable when, in addition to these qualities, it can only be procured or enjoyed through the intervention of labour. It cannot justly be said that food or clothes are more useful than atmospheric air; and yet they are possessed of that value in exchange of which the latter is wholly destitute. The reason is, that food and clothes are not, like air, gratuitous products; they cannot be had at all times, in any quantity, and enjoyed without any voluntary exertion. On the contrary, labour is always required for their production or appropriation, or both; and as no one will voluntarily sacrifice the fruits of his industry without receiving an equivalent, they are truly said to possess exchangeable value.

The production and distribution of such articles as exist, and may be obtained in unlimited quantities, independently of voluntary human agency, form no part of the investigations of the political economist. The results of the industry of man comprise the only subjects that come within the scope of his inquiries. This may, indeed, be said to be the science of values, or of the circumstances which determine the production and distribution of products possessed of exchangeable value, or which will be received as an equivalent for something else which it has taken some labour to produce or obtain.

The word *value* is very frequently employed to express, not only the exchangeable worth of a commodity, or its capacity of exchanging for other commodities, but also its *utility*, or capacity of satisfying our wants, or of contributing to our comforts and enjoyments. But it is obvious that the utility of commodities, — that the capacity of bread, for example, to appease hunger, and of water to quench thirst, is a totally different and distinct quality from the capacity of exchanging for other commodities. Dr. Smith perceived this difference, and showed the importance of carefully distinguishing between utility, or, as he expressed it, "value in use," and value in exchange. But he did not always keep this distinction in view, and it has been very often lost sight of by subsequent writers. There can be no doubt, indeed, that the confounding of these opposite qualities has been one of the principal causes of the confusion and obscurity in which many branches of the science, not in themselves difficult, have been involved. When, for example, it is said that water is highly valuable, a very different meaning is attached to the phrase from what is attached to it when it is said that gold is valuable. Water is indispensable to existence, and has therefore a high degree of utility, or of "value in use;" but as it can generally be obtained in large quantities, without much labour or exertion, it has, in most places, but a very low value in exchange. Gold, on the contrary, is of comparatively little utility; but as it exists only in limited quantities, and requires a great deal of labour on its production, it has a comparatively high exchangeable value, and may be exchanged or bartered for a proportionally large quantity of most other things. Those who confound qualities so different must obviously arrive at the most erroneous conclusions. And therefore to obviate all chance of error from mistaking the sense of so important a word as value, it is better not to use it except to signify exchangeable worth, or value in exchange, and to employ the word *utility* to express the power or capacity of an article to satisfy our wants or gratify our desires.

Capacity of appropriation is indispensably necessary to make any thing wealth. A man is not said to be wealthy because he has an indefinite command over atmospheric air, the rays of the sun, or the articles with which, in common with others, he is gratuitously furnished by nature; for this being a privilege which he enjoys in common with every one else, can form no ground of distinction: but he is said to be wealthy according to the degree in which he can afford to command those necessaries, conveniencies, and luxuries that are not the gifts of nature, but the products of human industry.

The proper meaning to be attached to the term wealth being thus ascertained, we shall now proceed to show that labour is the only source of wealth; and having done this, we shall next inquire into the means by which labour may be rendered most efficient, that is, into the means by which the greatest amount of wealth may be obtained with the least expenditure of labour: when this inquiry is completed, we shall have exhausted that great department of the science which treats of the production of wealth.

I. Production of Wealth.

1. *Labour the only Source of Wealth.* — It may be necessary, perhaps, to observe at the outset, that by production, in this science, is not meant the production of matter, that being the exclusive attribute of Omnipotence; but the production of *utility*, and consequently of value, by appropriating and modifying matter already in existence, so as to fit it to satisfy our wants and contribute to our enjoyments. Nature spontaneously furnishes the matter of which all commodities are made; but until labour has been applied to appropriate that matter, or to

* Economy, from οικος, *a house or family*, and νομος, *a law*. Hence, political economy may be said to be to the state what private economy is to a single family.

adapt it to our use, it is wholly destitute of value, and is not, nor ever has been, considered as forming wealth. Were we placed on the banks of a river, or in an orchard, we should infallibly perish of thirst or hunger, unless by an effort of industry we raised the water to our lips, or plucked the fruit from its parent tree. It is seldom, however, that the mere appropriation of matter is sufficient. In the vast majority of cases, labour is required not only to appropriate it, but to convey it from place to place, and to give it that peculiar shape without which it may be totally useless, and incapable of administering either to our necessities or our comforts. The coal used in our fires is buried deep in the bowels of the earth, and is absolutely worthless until, by the labour of the miner, it has been extracted from the mine, and brought into a situation where it may be made use of. The stones and mortar used in building our houses, and the rugged and shapeless materials that have been fashioned into the various articles of convenience and ornament with which they are furnished, were, in their original state, destitute alike of value and utility. And of the innumerable variety of animal, vegetable, and mineral products which form the materials of our food and clothes, none were originally serviceable, while many were extremely noxious to man. The labour that has subdued their bad qualities, that has given them utility, and fitted them to satisfy our wants, and to minister to our comforts and enjoyments, is plainly, therefore, the only source of wealth. "Labour," to use the words of Adam Smith, "was the first price, the original purchase-money, that was paid for all things. It was not by gold or by silver, but by labour, that all the wealth of the world was originally purchased."—(*Wealth of Nations*, p. 14.)

Those who observe the progress and trace the history of the human race in different countries and states of society, will find that their comfort and happiness have in all cases been principally dependent on their ability to appropriate the raw products of nature, and to adapt them to their use. The savage whose labour is confined, like that of the Australian, to the gathering of wild fruits, or of shell-fish on the sea-coast, is placed at the very bottom of the scale of civilization, and is, in point of comfort, decidedly inferior to many of the lower animals. The *first* step in the progress of society is made when man learns to hunt wild animals, to feed himself with their flesh, and clothe himself with their skins. But labour, when confined to the chase, is extremely barren and unproductive. Tribes of hunters, like beasts of prey, whom they closely resemble in their habits and modes of subsistence, are but thinly scattered over the countries which they occupy; and notwithstanding the fewness of their numbers, any unusual deficiency in the supply of game never fails to reduce them to the extremity of want. The *second* step in the progress of society is made when the tribes of hunters and fishers devote themselves, like the ancient Scythians and modern Tartars, to the domestication of wild animals and the rearing of flocks. The subsistence of herdsmen and shepherds is much less precarious than that of hunters; but they are almost entirely destitute of the various comforts and elegancies that give to civilized life its chief value. The *third* and most decisive step in the progress of civilization, in the great art of producing the necessaries and conveniences of life, is made when the wandering tribes of hunters and shepherds renounce their migratory habits, and become agriculturists and manufacturers. It is then that man begins fully to avail himself of his productive powers. He then becomes laborious, and by a necessary consequence his wants are then, for the first time, fully supplied, and he acquires an extensive command over the articles necessary for his comfort as well as his subsistence.

The importance of labour in the production of wealth was very clearly perceived by Locke. In his *Essay on Civil Government*, published in 1689, he has entered into a lengthened, discriminating, and able analysis, to show that it is from labour that the products of the earth derive almost all their value. "Let any one consider," says he, "what the difference is between an acre of land planted with tobacco or sugar, sown with wheat or barley, and an acre of the same land lying in common, without any husbandry upon it, and he will find that the improvement of labour makes the far greater part of the value. I think it will be but a very modest computation to say, that of the products of the earth useful to the life of man, *nine tenths* are the effects of labour; nay, if we will rightly estimate things as they come to our use, and cast up the several expenses about them, what in them is purely owing to nature, and what to labour, we shall find that in most of them *ninety-nine hundredths* are wholly to be put on the account of labour.

"There cannot be a clearer demonstration of any thing than several nations of the Americans are of this, who are rich in land, and poor in all the comforts of life; whom nature having furnished as liberally as any other people with the materials of plenty, *i.e.* a fruitful soil apt to produce in abundance what might serve for food, raiment, and delight; yet, for want of improving it by labour, have not one hundredth part of the conveniences we enjoy; and the king of a large and fruitful territory there feeds, lodges, and is clad worse than a day labourer in England.

"To make this a little clearer, let us but trace some of the ordinary provisions of life through their several progresses before they come to our use, and see how much they receive of their value from human industry. Bread, wine, and cloth are things of daily use and great plenty; yet, notwithstanding, acorns, water, and leaves or skins must be our bread, drink, and clothing, did not labour furnish us with these more useful commodities; for whatever bread is more worth than acorns, wine than water, and cloth or silk than leaves, skins, or moss, that is solely owing to labour and industry: the one of these being the food and raiment which unassisted nature furnishes us with; the other provisions which our industry and pains prepare for us; which how much they exceed the other in value when any one hath computed, he will then see how much labour makes the far greatest part of the value of things we enjoy in this world. And the ground which produces the materials is scarce to be reckoned in as any, or at most but a very small part of it; so little, that even amongst us, land that is wholly left to nature, that hath no improvement of pasturage, tillage, or planting, is called, as indeed it is, *waste;* and we shall find the benefit of it amount to little more than nothing.

"An acre of land that bears here twenty bushels of wheat, and another in America which, with the same husbandry, would do the like, are, without doubt, of the same natural intrinsic value (utility). But yet the benefit mankind receives from the one in a year is worth five pounds, and from the other possibly not worth a penny, if all the profit an Indian received from it were to be valued and sold here; at least, I may truly say, not one thousandth. It is labour, then, which puts the greatest part of value upon land, without which it would scarcely be worth anything. It is to that we owe the greatest part of all its useful products; for all that the straw, bran, bread, of that acre of wheat, is more worth than the product of an acre of as good land which lies waste, is all the effect of labour. For it is not barely the ploughman's pains, the reaper's and thrasher's toil, and the baker's sweat is to be accounted into the bread we eat; the labour of those who broke the oxen, who digged and wrought the iron and stones, who felled and framed the timber employed about the plough, mill, oven, or any other utensils, which are a vast number, requisite to this corn; from its being seed to be sown to its being made bread must all be charged on the account of *labour*, and received as an effect of that, nature and the earth furnished only the almost worthless materials as in themselves. It would be a strange catalogue of things that industry provided and made use of about every loaf of bread before it came to our use, if we could trace them; iron, wood, leather, bark, timber, stone, bricks, coals, lime, cloth, dyeing drugs, pitch, tar, masts, ropes, and all the materials made use of in the ships that brought away the commodities made use of by any of the workmen to any part of the work; all which it would be almost impossible, at least too long, to reckon up."

Mr. Locke has here all but established the fundamental principle upon which this science rests. Had he carried his analysis a little further, he could not have failed to perceive that neither water, leaves, skins, nor any one of the spontaneous products of nature, has any *value*, except what it owes to the labour required for its appropriation. The utility of such products makes them be demanded, but it does not give them value; this is a quality which can be communicated only through the agency of voluntary labour of some sort or other. An object which it does not require any portion of labour to appropriate, or to adapt to our use, may, like atmospherical air, be of the very highest utility; but as it is the free gift of nature, it is quite impossible it should have the smallest value.

That commodities could not be produced without the co-operation of the powers of nature, is most certain. We are very far, indeed, from wishing to depreciate the obligations we are under to our common mother, or to exalt the benefits man owes to his own exertions by concealing or underrating those which he enjoys through the bounty of nature. But it is the distinguishing characteristic of the services rendered by the latter, that they are *gratuitous*. They are infinitely useful, and they are, at the same time, infinitely cheap. They are not, like human services, sold for a price; they are merely appropriated. When a fish is caught, or a tree is felled, do the Nereids, or wood nymphs, make their appearance, and stipulate that the labour of nature in producing it should be paid for, before it be carried off and made use of by man? When the miner has dug his way down to the ore, does Plutus interpose to prevent its appropriation? Nature is not, as so many would have us to suppose, frugal and grudging. Her rude products, and her ca-

pacities and powers, are all offered freely to man. She neither demands nor receives a return for her favours. Her services are of inestimable *utility;* but being granted freely and unconditionally, they are wholly destitute of value, and are consequently without the power of communicating that quality to any thing.

The utility of water, or its capacity to slake thirst, is equal at all times and places; but as this quality is communicated to it by nature, it adds nothing to its value, which is, in all cases, measured by the labour required for its appropriation. A very small expenditure of labour being required to raise water from a river to the lips of an individual on its banks, its value, under such circumstances, is very trifling indeed. But when, instead of being upon its banks, the consumers of the water are five, ten, or twenty miles distant, its value, being increased proportionally to the greater expenditure of labour upon its conveyance, may become very considerable. This principle holds universally. The utility of coal, or its capacity of furnishing heat and light, makes it an object of demand; but this utility, being a free gift of nature, has no influence over its value or price: this depends entirely on the labour required to extract the coal from the mine, and to convey it to the consumers.

"Si je retranche," to use a striking illustration of this doctrine given by M. Canard, "de ma montre, par la pensée, tous les travaux qui lui ont été successivement appliqués, il ne restera que quelques grains de minéral placés dans l'intérieur de la terre, d'où on les a tirés, et où ils n'ont aucune valeur. De même, si je décompose le pain que je mange, et que j'en retranche successivement tous les travaux successifs qu'il a reçus, il ne restera que quelques tiges d'herbes graminées, éparsés dans des déserts incultes, et sans aucune valeur."

It is true, that natural powers and products may sometimes be appropriated or engrossed by one or more individuals to the exclusion of others, and those by whom they are so engrossed may exact a price for them; but does that show that they cost the engrossers any thing? If A. have a waterfall on his estate, he may, probably, get a rent for it. It is plain, however, that the work performed by the waterfall is as completely gratuitous as that which is performed by the wind that acts on a windmill. The only difference between them originates in this, — that all individuals having it in their power to avail themselves of the services of the wind, no one can intercept the bounty of nature, and exact a price for that which she freely bestows; whereas A., by appropriating the waterfall, and consequently acquiring a command over it, has it in his power to prevent its being used at all, or to sell its services. He can oblige B., C., and D. to pay for liberty to use it; but as they pay for that which costs him nothing, he gains the *whole* that they lose; so that the services rendered by the waterfall are still so much clear gain — so much work performed gratuitously for society.

Had Mr. Senior attended to this principle, he would not have made the strange supposition, that if aerolithes consisted wholly of gold, they would, according to the principles now explained, be destitute of value.* If, indeed, they were so very abundant as to supply every one with as much gold as he desired, they would have no value whatever, other than what they might derive from the trouble of gathering them, but, if they existed only in limited quantities, and were quite incapable of supplying the demand for gold, the fortunate finder of one of them would be able to sell it, or exchange it, for the same quantity of produce it would have commanded had it been produced, like other gold, by the labour of the miner, smelter, &c. But it is obvious that its value is in this case derived from circumstances which, though extrinsic to itself, depend wholly on the expenditure of labour; and that, in fact, it is measured or determined by the labour required to produce gold under ordinary circumstances, precisely in the same way that the value of the waterfall is determined by the quantity of labour it will save to the party by whom it is bought or rented.

Labour, therefore, is the sole source of exchangeable value, and, consequently, of wealth. It is the talisman that has raised man from the condition of the savage — that has changed the desert and the forest into cultivated fields; that has covered the earth with cities, and the ocean with ships; that has given us abundance, comfort, and elegance, instead of want, misery, and barbarism: —

> "All is the gift of Industry; whate'er
> Exalts, embellishes, and renders life
> Delightful.

The fundamental principle, that it is only through the agency of labour that the various articles and conveniences required for the use and accommodation of man can be obtained, being thus established, it necessarily follows, that the great practical problem involved in that part of the science which treats of the *production* of wealth must resolve itself into a discussion of the means by which labour may be rendered most efficient. Every measure that has any tendency to add to the power of labour, or, which is the same thing, to reduce the cost of commodities, must add proportionally to the means of obtaining wealth and riches; while every measure or regulation that has any tendency to waste labour, or to raise the cost of commodities, must equally lessen these means. This, then, is the simple and decisive test by which to judge of the expediency of all measures affecting the wealth of a country, and of the value of all inventions. If they render labour more productive, — if, by reducing the value of commodities, they render them more easily obtainable, and bring them within the command of a greater portion of society, they must be advantageous; and conversely. Considered in this point of view, that great branch of the science which treats of the *production* of wealth will be found to be abundantly simple, and easily understood.

Labour, according as it is applied to the raising of raw produce, to the fashioning of that raw produce when raised into articles of utility, convenience, or ornament, or to the conveyance of raw and wrought produce from one country or place to another, is said to be agricultural, manufacturing, or commercial. An acquaintance with the particular processes, and most advantageous methods of applying labour in each of these grand departments of industry, forms the peculiar and appropriate study of agriculturists, manufacturers, and merchants. It is not consistent with the objects of the political economist to enter into the details of particular businesses and professions. He confines himself to an investigation of the means by which labour in general may be rendered most productive, and how its powers may be increased in *all* the departments of industry.

In thus endeavouring to exhibit the importance of labour, and the advantages which its successful prosecution confers on man, it must not be supposed that reference is made to the labour of the hand only. This species, indeed, comes most under our observation: it is that, too, without which we could not exist, and which principally determines the value of commodities. It is questionable, however, whether it be really more productive than the labour of the mind. The hand is not more necessary to execute than the head to contrive. Some very valuable discoveries have no doubt been the result of accident; while others have naturally grown out of the progress of society, without being materially advanced by the efforts of any single individual. These, however, have not been their only, nor, perhaps, their most copious sources; and every one, how little soever he may be acquainted with the history of his species, is aware that we are indebted to the labour of the mind, to patient study and long-continued research, for numberless inventions, some of which have made almost incalculable additions to our powers, and changed, indeed, the whole aspect and condition of society.

2. *Means by which Labour may be facilitated.* — Having thus endeavoured to show that man is indebted to labour or industry for all those articles or products which constitute wealth, or which are not freely bestowed by nature, we have next to inquire into the means by which labour may be rendered most productive, or by which the greatest amount of wealth may be obtained with the least labour, or at the least expense.

It may seem on a cursory view as if an inquiry of this sort would necessarily branch out into an infinity of details. But, in so far as this science, which deals only with the general principles applicable to all departments of industry, is concerned, such is not the case. On the contrary, it will be found, supposing the security of property, without which there can be neither industry nor accumulation, to be established, that all the means by which labour may be facilitated and wealth increased resolve themselves, 1st, into the better division and combination of employments among individuals and nations; and, 2d, into the more extensive or more judicious application of capital or stock in industrious undertakings. All the improvements that ever have been or ever will be made in the great art of producing the various necessaries, conveniences, and enjoyments of human life may be classed under one or other of these heads; that is, they will be found to consist either in the better distribution of employments, or in the greater command and better application of capital. Without availing themselves of these means no people can make any advance in civilization. And, supposing property to be equally well protected, it will, generally speaking, be found that those nations have been the wealthiest, most cultivated, and refined, in which the division of labour has been carried to the farthest extent, and capital been most abundant and most judiciously applied.

Division of Employments. — The division of employments can only be imperfectly established in rude societies and thinly-peopled countries; but in every state of society — in the rudest as well as the most improved — we may trace its operation and effects. The various physical powers, talents, and propensities, with which men are endowed, fit them for different occupations; and a

* Art. "Political Economy," *Encyclopædia Metropolitana.*

regard to mutual interest and convenience naturally leads them, at a very early period, to establish a system of barter and a division of employments. It was speedily seen that by separating and combining their efforts so as to bring about some desirable end, they might, with ease, accomplish tasks that could not otherwise be attempted. Even in the simplest businesses this co-operation is required: neither hunting nor fishing, any more than agriculture or manufactures, can be advantageously carried on by solitary individuals. Man is the creature of society; and is compelled, in every stage of his progress, to, depend for help on his fellows: — *Quò alio fortes sumus quàm quòd mutuis juvamur officiis?* Instead of trusting to his own unaided efforts for a provision of the various articles required for his subsistence, comfort, and security, he instinctively associates himself with others, and finds in this association the principal source of his superior power. Perceiving that he can obtain an incomparably greater command of all that he deems useful or desirable by applying himself in preference to some one department of industry, he limits his attention to it only. As society advances, this division extends itself on all sides: one man becomes a tanner or dresser of skins; another a shoemaker; a third a weaver; a fourth a house-carpenter; a fifth a smith, and so on; one undertakes the defence of the society, and one the distribution of justice; and each endeavours to cultivate and bring to perfection whatever talent or genius he may possess for the particular calling in which he is engaged. The wealth and comforts of all classes are, in consequence, prodigiously augmented. In countries where the division of labour is carried to a considerable extent, agriculturists are not obliged to spend their time in clumsy attempts to manufacture their own produce, and manufacturers cease to interest themselves about the raising of corn, and the fattening of cattle. The facility of exchanging is the vivifying principle of industry; it stimulates agriculturists to adopt the best system of cultivation, and to raise the largest crops, because it enables them to exchange whatever portion of the produce of their lands exceeds their own wants for other commodities contributing to their comforts and enjoyments; and it stimulates manufacturers and merchants to increase and improve the quantity, variety, and quality of their goods, that they may thereby obtain greater supplies of raw produce. A spirit of industry is thus universally diffused; and that apathy and languor which characterize a rude state of society entirely disappear.

But the facility of exchanging, or the circumstance of being able readily to barter the surplus produce of our own labour for such parts of the surplus produce of other people's labour as we may desire to obtain and they may choose to part with, is not the only advantage of the separation of employments. Besides enabling each individual to addict himself in preference to those departments which suit his taste and disposition, it adds very largely to the efficacy of his powers, and enables him to produce a much greater quantity of useful and desirable articles than he could do were he to engage indiscriminately in different businesses. Dr. Smith, who has treated this subject in the most masterly manner, has classed the circumstances which conspire to increase the productive powers of industry, when labour is divided, under the following heads: — *First*, the increased skill and dexterity of the workmen; *second*, the saving of time which is commonly lost in passing from one employment to another; and, *third*, the circumstance of the division of employments having a tendency to facilitate the invention of machines and processes for abridging and saving labour. A few observations on each of these heads are subjoined.

1st. *With respect to the improvement of the skill and dexterity of the labourer.* — It is sufficiently plain that when a person's whole attention is devoted to one branch of business, when all the energies of his mind and powers of his body are made to converge, as it were, to a single point, he must attain to a degree of proficiency in that particular branch, to which no individual engaged in a variety of occupations can be expected to reach. A peculiar play of the muscles, or *sleight of hand*, is necessary to perform the simplest operation in the best and most expeditious manner, and this can only be acquired by habitual and constant practice. Smith has given a striking example, in the case of the nail-manufacturer, of the extreme difference between training a workman to the precise occupation in which he is to be employed, and training him to a similar and closely allied occupation. " A common smith," says he, " who, though accustomed to handle the hammer, has never been used to make nails, if, upon some particular occasion, he is obliged to attempt it, will scarce, I am assured, be able to make above two or three hundred nails in a day, and those, too, very bad ones. A smith who has been accustomed to make nails, but whose sole or principal business has not been that of a nailer, can seldom, with his utmost diligence, make more than eight hundred or a thousand nails in a day. But I have seen several boys, under twenty years of age, who had never exercised any other trade but that of making nails, and who, when they exerted themselves, could make, each of them, upwards of *two thousand three hundred nails in a day*, or nearly three times the number of the smith who had been accustomed to make them, but who was not entirely devoted to that particular business." (*Wealth of Nations*, p. 4.)

2d. The influence of the division of labour in preventing that *waste of time in moving from one employment to another*, which must always take place when an individual engages in different occupations, is even more obvious than its influence in improving his skill and dexterity. When the same person carries on different employments, in different and perhaps distant places, and with different sets of tools, he must plainly lose a considerable portion of time in passing between them. If the different employments in which he is to be engaged could be carried on in the same workshop, the loss of time would be less; but even in that case it would be considerable. " A man," as Dr. Smith has justly observed, " commonly saunters a little in turning his hand from one sort of employment to another. When he first begins the new work, he is seldom very keen and hearty; his mind, as they say, does not go along with it, and for some time he rather trifles than applies to good purpose. The habit of sauntering and of indolent careless application, which is naturally, or rather necessarily, acquired by every country workman, who is obliged to change his work and his tools every half hour, and to apply his hand in twenty different ways almost every day of his life, renders him almost always slothful and lazy, and incapable of any vigorous application, even on the most pressing occasions. Independent, therefore, of his deficiency in point of dexterity, this cause alone must always reduce considerably the quantity of work which he is capable of performing." (*Wealth of Nations*, p. 5.)

3d. *With regard to the influence of the division of employments in facilitating the invention of machines, and processes for abridging and saving labour.* — It is obvious that those engaged in any branch of industry will be more likely to discover easier and readier methods of carrying it on when the whole attention of their minds is devoted exclusively to it, than if it were dissipated among a variety of objects. But it is a mistake to suppose, as has been sometimes done, that the inventive genius of workmen and artificers is alone whetted and improved by the division of labour. As society advances, the study of particular branches of science and philosophy becomes the principal or sole occupation of the most ingenious men. Chemistry becomes a distinct science from natural philosophy; the physical astronomer separates himself from the astronomical observer; the political economist from the politician; and each, meditating exclusively or principally on his peculiar department of science, attains to a degree of proficiency and expertness in it which the general scholar seldom or never reaches. And hence, in labouring to promote our own ends, we all necessarily adopt that precise course which is most advantageous for all. Like the different parts of a well-constructed engine, the inhabitants of a civilized country are all mutually dependent on and connected with each other. Without any previous consent, and obeying only the powerful and steady impulse of self-interest, they universally conspire to the same great end; and contribute, each in his respective sphere, to furnish the greatest supply of necessaries, luxuries, conveniences, and enjoyments.

Probably, however, the most advantageous result of the division of labour may be found in the circumstance of its enabling manufacturers or others engaged in any complicated business, or department of industry, to employ work-people of very various degrees of skill and force. In the cotton manufacture, for example, some processes that are indispensable may be quite as well performed by children and women as by the most expert and powerful workmen. It is clear, however, that but for the distribution of the labour required to bring about any result among different individuals possessing the degree of skill and strength necessary in each particular part of the process, none could be employed but those who possessed the skill and strength required in the most difficult and laborious; and, consequently, workmen at 30*s*. or 40*s*. a week would have to engage in tasks that might be as well or better performed by girls at 5*s*. or 6*s*. a week. In all the great departments of industry it is of the utmost importance to separate the processes requiring peculiar skill, dexterity, and force from the others, and to appropriate them exclusively to certain classes of individuals; and to perform the operations requiring less skill, or less strength, by sets of inferior labourers. The success of most industrious undertakings depends, in fact, principally on the sagacity with which this distribution of employments is made, or with which the skill and power of the work-people are proportioned to the results to be produced. (For further illustrations of this principle see *Babbage's Economy of Manufactures*, p. 172. &c.)

It is necessary to bear in mind that the advantages derived from the division of labour, though they may be, and in fact are, partially enjoyed in every country and state of society, can only be carried to their full extent where there is a great power of exchanging, or an *extensive market*. There are an infinite variety of employments which cannot be separately carried on without the precincts of a large city; and in all cases the division becomes more perfect, according as the demand for the produce is extended. It is stated by Dr. Smith that ten labourers, employed in different departments in a pin manufactory, can produce 48,000 pins a day, and since his time the quantity has been more than doubled; but it is evident that if the demand were not sufficient to take off this quantity, ten persons could not be constantly employed in the business; and the division of employments in it not being carried so far, the labour would be less economically and efficiently applied, and the cost of the pins proportionally increased. The same principle holds universally. A cotton mill could not be constructed in a small country having no intercourse with its neighbours. The demand and competition of Europe, Asia, and America have been necessary to carry the manufactures of Glasgow, Manchester, and Birmingham to their present state of improvement.

Territorial Division of Labour, or Commerce. — Besides that sort of division of labour which enables each individual in a limited society to confine himself to a particular employment, there is another and most important branch of the division of labour, which not only enables particular individuals, but the inhabitants of entire districts, and even nations, to addict themselves in preference to certain branches of industry. It is on this *territorial division of labour*, as it has been appropriately termed, that the commerce carried on between different districts of the same country, and between different countries, is founded. The variations in the situation, soil, climate, mineral products, &c. of the different districts of an extensive country, render them more suitable for some than for other species of industry. A district where coal is abundant, which has an easy access to the ocean, and a considerable command of internal navigation, is the natural seat of manufactures. Wheat and other species of grain are the proper products of rich arable soils; and cattle, after being reared in mountainous districts, are most advantageously fattened in meadows and low grounds. Nothing can be more obvious than that the inhabitants of these different districts will be able, by confining themselves to those employments for the prosecution of which they have some peculiar capability, to produce a much greater quantity of useful and desirable articles than they could do were they to engage indiscriminately in every possible employment. Can it be doubted that a vastly greater supply of manufactured goods, corn, and cattle is produced by the inhabitants of Glasgow, the Carse of Gowrie, and Argyleshire respectively confining themselves to manufactures, agriculture, and the rearing of cattle, than if each endeavoured directly to raise these various products?

But it is easy to see that foreign trade, or the territorial division of labour between different and independent countries, contributes to increase the wealth of each in precisely the same manner that the trade between different provinces of the same kingdom contributes to increase their wealth. There is a still greater difference between the productive powers with which Providence has endowed different and distant countries, than there is between the productive powers of the provinces of the same country; and consequently the establishment of a free intercourse between them must be proportionally more advantageous. Indeed, there are a great many products, and some of them of the very greatest utility, that cannot be raised, except in particular situations. Were it not for commercial intercourse, we should not be able to obtain the smallest supply of tea, spices, raw cotton, raw silk, gold and silver, and a thousand other equally useful and desirable commodities. Providence, by giving different soils, climates, and natural productions to different countries, has evidently provided for their mutual intercourse and civilization. By permitting the people of each to employ their capital and labour in those departments in which their geographical situation, the physical capacities of their soil, their national character and habits fit them to excel, foreign commerce, or the territorial division of labour, has a wonderful influence in multiplying the products of arts and industry. Where the freedom of commerce is not interfered with, each country necessarily devotes itself to such employments as are most beneficial for itself. And this pursuit of individual advantage is in the highest degree conducive to the good of the whole. By stimulating industry, by rewarding ingenuity, and by using most efficaciously the particular powers bestowed by nature, commerce distributes labour most effectively and economically; while by increasing the mass of necessary and useful products it diffuses opulence, and binds together the universal society of nations by the common and powerful ties of mutual interest and reciprocal obligation. Commerce enables each particular state to profit by the inventions and discoveries of every other state. It creates new tastes and new appetites, and it also gives the means and the desire of gratifying them. The progress of domestic industry is accelerated by the competition of foreigners. Commerce has either entirely removed or greatly weakened a host of unworthy prejudices. It has shown that nothing can be more illiberal and absurd than that once prevalent dread of the progress of others in wealth and civilization; and that the true glory and real interest of each particular people will be more certainly advanced by endeavouring to emulate and outstrip its neighbours in the career of science and civilization, than by labouring to attain a barren pre-eminence in the bloody and destructive though necessary art of war.

The influence of commerce in giving increased efficacy to labour, and augmenting national wealth, may be easily illustrated. Thus in the case of the intercourse or territorial division of labour carried on between England and Portugal, our superior wool, and our command of coal, of skilful workmen, of improved machinery, in short, of all the instruments of manufacturing industry, enable us to produce cloth at a much cheaper rate than the Portuguese; but, on the other hand, the soil and climate of Portugal being peculiarly favourable for the cultivation and growth of the grape, she is able to produce wine at an infinitely less cost than it can be produced here. And hence it is obvious that England, by confining herself to the manufacture of cloth, in which she has a natural advantage, and exchanging it with the Portuguese for wine, will obtain a vastly larger supply of that commodity than if she attempted to cultivate the grape at home; and Portugal, by exchanging her wine for the cloth of England, will obtain a much greater quantity of cloth than if she attempted to counteract the intention of nature by converting a portion of her capital and industry from the raising of wine, in which she has an advantage, to the manufacture of cloth, in which the advantage is on the side of another.

What has been already stated is sufficient to expose the sophism of the French economists, who contended, that as an equivalent must be always given for commodities brought from abroad, it is impossible foreign commerce should be a means of increasing wealth. "How," they asked, "can the wealth of a country be increased by giving equal values for equal values?" They admitted that commerce might be the means of making a better distribution of the wealth of the world; but as it did nothing more than exchange one sort of wealth for another, they denied that it could make any addition to its amount. At first sight, this sophistical and delusive statement appears sufficiently conclusive; but a very few words will be sufficient to demonstrate its fallacy. The advantage of commerce does not consist in its enabling either of the parties who carry it on to obtain articles of greater value than those they give in exchange. It may have cost as much to produce the cloth with which the English merchant purchases the wine of Portugal as it did to produce the latter, or it may have cost more. But then it must be observed that in making the exchange the value of the wine is estimated by what it takes to produce it in Portugal, which has peculiar capabilities for that species of industry, and not by what it would take to produce it in England were the trade put an end to; and, in like manner, the value of the cloth is estimated by what it takes to produce it in England, and not by what it would take to produce it in Portugal. The advantage of the intercourse consists in this, that it enables each country to obtain commodities for the production of which it has no natural capability, and which it would therefore cost vastly more to produce directly at home, at the price required to produce them under the most favourable circumstances, and with the least possible expense. The gain of the one party is not the loss of the other. Both benefit by the intercourse, for it enables both to save labour and expense in the production of commodities; so that the wealth of the two countries is not only better distributed, but is also greatly increased, by the territorial division of labour established between them.

"The commerce of one country with another is merely an extension of that division of labour by which so many benefits are conferred on the human race. As the same country is rendered richer by the trade of one province with another; as its labour becomes thus infinitely more divided and more productive than it could otherwise have been; and as the mutual interchange of all those commodities which one province has, and another wants, multiplies the accommodations and comforts of the whole, and the country becomes thus in a wonderful degree more opulent and happy: so the same beautiful train of consequences is observable in the world at large, — that vast empire, of which the different kingdoms may be regarded as the provinces. In this magnificent empire, one province is favourable to the production of one species of produce, and another province to another. By their

mutual intercourse, mankind are enabled to distribute their labour as best fits the genius of each particular country and people. The industry of the whole is thus rendered incomparably more productive; and every species of necessary, useful, and agreeable accommodation is obtained in much greater abundance, and with infinitely less expense." (*Mill's Commerce Defended*, p. 38.)

The supply of a great city with its various articles of provision and consumption affords, as has been justly observed, one of the most striking instances of the benefits resulting from the division and combination of employments on the most extensive scale. In illustration of this, it may be stated, that at this moment (1841), there are not less than two millions of inhabitants congregated within ten miles round St. Paul's, comprising a large proportion of the wealthiest individuals in the kingdom. The production of the provisions and other accommodations required by this vast population employs not only a very large proportion of the people of the United Kingdom, but also an immense number of labourers in the most distant countries. The Chinese furnish the tea; the planters of Jamaica and Demerara the sugar and coffee; Ceylon and the Eastern Archipelago the spices; the Portuguese and French the wines; the people of Cashmere in Central Asia the shawls; the Australians and Germans the wool; the Americans the cotton; the Italians and Chinese the silk; the Norwegians the lobsters; the Spaniards and the people of the Azores the oranges, and so forth, required for the supply of London. And yet, notwithstanding the extreme diversity of the sources whence they are brought, and of the conditions under which they are produced, every article is supplied to the exact extent to which it is wanted; and every individual in this immense city may get, on the shortest notice, any quantity of any article, how great or how small soever, that he requires. There is no excess at one time, or scarcity at another. The supply of every article is adjusted to the demand with a precision that any one not acquainted with the circumstances would, *à priori*, have pronounced impossible.

And how, it may be inquired, are these astonishing results, this constant and equable supply of infinitely varied wants, brought about? Had government undertaken such a task, it certainly would have exhibited, even with the assistance of a whole army of officers and purveyors, a signal and total failure; but it is now effected with the utmost facility by the efforts of individuals, who, in the prosecution of their own interests, confer inestimable advantages on this great city, and, indeed, enable it to subsist. Every retail dealer is aware of the ordinary or average demand of his customers for the article or articles in which he deals; and in like manner the wholesale dealers, who commission articles of the producers, are each and all aware of the quantity that will be taken off by the retailers, whose agents they are, and of the periods when they will have to be supplied. In this way the aggregate and individual wants of any population, how great soever, come to be accurately known; and the quantity of labour required to supply the different articles of which they stand in need, and no more, is put in motion.

It would be unnecessary, in a work of this kind, to dwell on the advantages resulting to society from the formation of improved roads, canals, and other easy means of communication. At bottom, however, the principal advantage of these consists in the facility which they afford for enabling products to be conveyed from one place to another; that is, for enabling the division of labour between different parts of the country to be carried to the greatest extent. And the same principle that teaches us that it is for the public advantage to construct new and improved roads, and to promote to the utmost the facilities of intercourse between the different parts of the United Kingdom, should teach us to abolish, in as far as practicable, all restrictions on the intercourse with foreign countries, and to give full scope to the territorial division of labour between our people and those of other nations. All the arguments that can be used for the opening of new roads, the throwing of bridges over ravines and rivers, and otherwise improving the means of internal intercourse, apply with but little variation, and with equal force, to the abolition of restrictions on the exportation of native and the importation of foreign produce; the object of the one class of measures as of the other is to facilitate the interchange of the various products of art and industry, and consequently to enable capital and labour to be employed in the channels in which they are sure to be most productive. (*See* the art. COMMERCE in this Dict., and the authorities therein referred to.)

The various provisions made by society for its protection, and for securing and preserving the rights and privileges of individuals, owe their origin to this principle. Government itself is wholly founded on a sense of the advantages resulting from the division of employments. "In the rudest state of society each man relies principally on himself for the protection both of his person and of his property. For these purposes he must be always armed, and always watchful; what little property he has must be moveable, so as never to be far distant from its owner. Defence or escape occupy almost all his thoughts, and almost all his time; and, after all these sacrifices, they are very imperfectly effected. 'If ever you see an old man here,' said an inhabitant of the confines of Abyssinia to Bruce, 'he is a stranger; the natives all die young by the lance.'

"But the labour which every individual who relies on himself for protection must himself undergo is more than sufficient to enable a few individuals to protect themselves, and also the whole of a numerous community. To this may be traced the origin of governments. The nucleus of every government must have been some person who offered protection in exchange for submission. On the governor and those with whom he is associated, or whom he appoints, is devolved the care of defending the community from violence and fraud; and so far as internal violence is concerned, and that is the evil most dreaded in civilized society, it is wonderful how small a number of persons can provide for the security of multitudes. About fifteen thousand soldiers, and not fifteen thousand policemen, watchmen, and officers of justice, protect the persons and property of the seventeen millions of inhabitants of Great Britain. There is scarcely a trade that does not engross the labour of a greater number of persons than are employed to perform this the most important of all services." (*Senior on Political Economy.*)

Definition and Employment of Capital.—The capital of a country consists of those portions of the produce of industry existing in it that may be made directly available, either for the support of human beings, or the facilitating of production. It consequently comprises all those articles that may be employed for the subsistence, clothing, and lodging of the labourers engaged in industrious undertakings; and the various animals, tools, and machines of which they may avail themselves in performing their tasks. It is usual to call the former, or the food, clothes, &c., required for the subsistence of the labourer, the corn used as seed and in the feeding of horses, coal, &c., *circulating* capital; while those articles that are more slowly consumed, as the lower animals, the houses, and the various instruments and machines that either are or may be employed in industrious undertakings, are called *fixed* capital. But though this distinction be convenient for some purposes, no distinct line of demarcation can be drawn between the different varieties of capital, and they are alike indispensable to the successful prosecution of most branches of industry. Without a supply of the first, or circulating capital, that is, without a supply of food, clothes, &c., it would plainly be impossible to engage in any sort of undertaking where the return was at all distant; and without the second, or fixed capital, that is, without the aid of tools and machines (which are merely a more complex species of tools), there are but few sorts of labour that could be carried on at all, or with any advantage. But the progressive nature of man, his foresight and inventive faculty, lead him, even in the earliest ages, and in the rudest states of society, to provide a reserve of food, and to contrive tools and instruments to assist him in his operations. The American hunters make use of clubs and slings to abridge their labour and facilitate the acquisition of game; and the same principle which prompts them to construct and avail themselves of those rude instruments never ceases to operate: it is always producing some new improvement, and in an advanced and refined period substitutes ships for canoes, muskets for slings, steam-engines for clubs, and cotton-mills for distaffs.

Hence it is only by the employment and co-operation of both descriptions of capital that wealth can be largely produced, and universally diffused. An agriculturist might have an ample supply of carts and ploughs, of oxen and horses, and, generally, of all the instruments and animals used in his department of industry; but were he destitute of circulating capital, or food and clothes, he would be unable to avail himself of their assistance; and instead of tilling the ground, would have to resort to some species of appropriative industry: and, on the other hand, supposing he were abundantly supplied with provisions, what could he do without the assistance of a fixed capital, or tools? What could the most skilful husbandman perform without his spade and plough? a weaver without his loom? a carpenter without his saw, his hatchet, and his planes.

The division of labour cannot be carried to any considerable extent without the previous accumulation of capital. Before labour can be divided, "a stock of goods of different kinds must be stored up somewhere, sufficient to maintain the labourer, and to supply him with materials and tools. A weaver cannot apply himself entirely to his peculiar business, unless there is beforehand stored up somewhere, either in his own possession or in that of some other person, a stock sufficient to maintain him, and to supply him with the materials and tools of his works, till he has not only completed but sold his web. This accumulation must, evidently, be previous to his

applying himself for so long a time to such a peculiar business." (*Wealth of Nations*, 119.)

As the accumulation of capital must have preceded the extensive division of labour, so its subsequent division can only be perfected as capital is more and more accumulated. Accumulation and division act and react on each other. The quantity of work which the same number of people can perform increases in a great proportion with every fresh subdivision of labour; and according as the operations of each workman are reduced to a greater degree of identity and simplicity, he has, as already explained, a greater chance of discovering machines and processes for facilitating his separate task. The quantity of industry, therefore, not only increases in every country with the increase of the stock or capital which sets it in motion; but, in consequence of this increase, the division of labour is extended, new and more powerful implements and machines are invented, and the same quantity of labour is made to produce an infinitely greater quantity of commodities.

Besides enabling labour to be divided, capital contributes to facilitate labour and produce wealth in the three following ways:—

First. — It enables work to be executed that could not be executed, or commodities to be produced that could not be produced, without it.

Second. — It saves labour in the production of almost every species of commodities.

Third. — It enables work to be executed better, as well as more expeditiously.

With regard to the first advantage derived from the employment of capital, or the circumstance of its enabling commodities to be produced that could not be produced without it, it is plain, as already observed, that the production of such commodities as require a considerable period for their completion could not be attempted unless a stock of circulating capital, or of food and clothes sufficient for the maintenance of the labourer while employed on them, was previously provided. But the possession of fixed capital, or of tools and machines, is frequently as necessary to the production of commodities as the possession of circulating capital. It would, for example, be quite impossible to produce a pair of stockings without the aid of wires; and although the ground might be cultivated without the aid of a plough, it could not be cultivated without the aid of a spade or a hoe. If we run over the vast catalogue of the arts practised in a civilized country, it will be found that extremely few can be carried on by the mere employment of the fingers, or rude tools with which man is furnished by nature. It is almost always necessary to provide ourselves with the result of previous industry and invention, and to strengthen our feeble hands by arming them, if we may so speak, "with the force of all the elements."

In the second place, besides supplying many species of commodities that could not be produced without its co-operation, the employment of capital occasions a saving of labour in the production of many others; and, by lowering their cost, brings them within the reach of a far greater number of consumers. We have been so long accustomed to profit by the services of the most commodious and powerful machines, that it requires a considerable effort of abstraction to become fully aware of the advantages we owe to them. But if we compare the arts practised alike by highly civilized societies and those in a less advanced state, we can hardly fail of being convinced that we are indebted to the employment of machinery for a very large proportion of our superior comforts and enjoyments. Suppose, that, like the Peruvians, and many other people of the New as well as the Old World, we were destitute of iron, and unacquainted with the method of domesticating and employing oxen and horses, how prodigious a change for the worse would be made in our condition! It was customary, in some countries, to make cloth by taking up thread after thread of the warp, and passing the woof between them by the unassisted agency of the hand; so that years were consumed in the manufacture of a piece which, with the aid of the loom, may be produced in as many days. Nothing, perhaps, has contributed so much to accelerate the progress and diffuse the blessings of civilization, as the establishment of a commercial intercourse between different and distant nations. But how could this be effected without the construction of vessels, and the discovery of the art of navigation? And if we compare the early navigators, creeping timidly along the shore in canoes formed out of trees partly hollowed by fire, and partly by the aid of a stone hatchet or the bone of some animal, with those who now boldly traverse the trackless ocean in noble ships, laden with the produce of every climate, we shall have a faint idea of the advance of the arts, and what we owe to machinery and science. Those who have distinguished themselves in this career, though they have rarely met with that gratitude and applause from their fellow-citizens to which they had so just a claim, have been the great benefactors of the human race. By pressing the powers of nature into our service, and subjecting them to our control, they have given man almost omnipotent power, and rendered him equal to the most gigantic undertakings. Without their assistance we should be poor indeed! Such as the naked and half-famished savage of New Holland is at this day, such would the Athenian, the Roman, and the Englishman have been, but for the invention of tools and machines, and the employment of natural agents in the great work of production.

The *third* advantage derived from the employment of capital consists in its enabling work to be done *better*, as well as more expeditiously. Cotton, for example, might be spun by the hand; but the admirable machines invented by Hargreaves, Arkwright, and others, enable a hundred or a thousand times as much yarn to be spun as could be effected by means of a common spindle, at the same time that they have improved its quality and given it a degree of fineness and of evenness, or equality in its parts, which was never previously attained. A painter would occupy months, or it might be years, in painting with a brush the cottons, or printed cloths, used in the hanging of a single room; and it would be very difficult, if not impossible, for the best artist to give that perfect identity to his figures which is given to them by the machinery now made use of for that purpose. Not to mention the other and more important advantages resulting from the invention of moveable types and printing, it is certain that the most perfect manuscript, one on which years of patient and irksome labour have been expended, is unable, in point of delicacy and correctness, to match a well-printed work, executed in the hundredth part of the time, and at a hundredth part of the expense. The great foreign demand for English manufactured goods results no less from the superiority of their manufacture than from their greater cheapness; and for both these advantages we are principally indebted to the excellence of our machinery.

There are other considerations which equally illustrate the extreme importance of the accumulation and employment of capital. The food and other accommodations enjoyed by a nation cannot be increased except by an increase in the number of its labourers, or in their productive powers; but, without an increase of capital, it is in most cases impossible to employ more workmen with advantage If the articles applicable to the support of the labourers, and the tools and machines with which they are to operate, be required for the maintenance and efficient employment of those already in existence, there can be no additional demand for others. Under such circumstances the rate of wages cannot rise; and if the number of inhabitants be increased, they must be worse provided for. Neither is it at all probable that the powers of the labourer should be augmented, except capital be previously increased. Without the better education and training of workmen, the greater subdivision of their employments, or the improvement of machinery, their productive energies can never be materially increased; and in almost all these cases additional capital is required. It is seldom, unless by its means, that workmen can be better trained, or that the undertaker of any work can either provide them with better machinery, or make a proper distribution of labour among them. Should the work to be done consist of a number of parts, to keep a workman constantly employed in one only requires a much larger stock than when he is occasionally employed in every different part. "When," says Dr. Smith, "we compare the state of a nation at two different periods, and find that the annual produce of its land and labour is evidently greater at the latter than at the former, that its lands are better cultivated, its manufactures more numerous and more flourishing, and its trade more extensive, we may be assured that its capital must have increased during the interval between these two periods, and that more must have been added to it, by the good conduct of some, than had been taken from it, either by the private misconduct of others, or by the public extravagance of government." (*Wealth of Nations*, 152.) It is therefore apparent that no country can ever reach the stationary state, so long as she continues to accumulate additional capital. While she does this she will have an increased demand for labour, and will be uniformly augmenting the mass of necessaries, luxuries, and conveniences, and consequently, also, the numbers of her people. But with every diminution of the rate at which capital has been accumulating, the demand for labour will decline. When no additions are made to capital, no more labour will be, or, at least, can be advantageously employed. And should the national capital diminish, the condition of the great body of the people will deteriorate; the wages of labour will be reduced; and pauperism, with its attendant train of vice, misery, and crime, will spread its ravages throughout society.

Objections to Machinery unfounded. — But, admitting what has been stated, still it may be, and indeed has been contended, that how advantageous soever to the country, machines, on their first introduction, frequently injure the labouring class, by lessening the demand for labour and

the rate of wages. In point of fact, however, it admits of demonstration that every introduction of improved machinery is sure to increase the aggregate demand for labour; at the same time that, by reducing the cost of commodities, it enables the labouring class, in common with the rest of society, to obtain a greater command over necessaries and conveniences. It sometimes, indeed, happens that the introduction of machinery is injurious to the labourers employed in a particular department; but if it displace them, it cannot fail to occasion a more than equivalent demand for their services in other departments. The introduction of moveable types and printing threw out of employment all those who had been previously engaged in the copying of manuscripts; but, at the same time, it is certain that this invention, by cheapening and multiplying books, has made at least from a hundred to five hundred persons be employed in the book trade for one that was employed in it when it began to be introduced, or that would have been employed in it at this moment had it not been discovered.

Precisely similar results follow in all cases in which any peculiar description of hand labour is superseded by machinery. At this moment we have an example of the principle before us in the business of hand-loom weaving, which is in the course of being superseded by the introduction of power-looms, the hand-loom weavers being, like the copying clerks in the 15th and 16th centuries, involved in the greatest difficulties. But these, how severe soever in the meantime, will be but of temporary duration, and society will be perpetual gainers by the change. Power-looms are introduced only because they do their work cheaper than it can be done by the hand. But the wealth of those who buy the products of the power-looms is not affected by the change; and whatever they may save through the reduction of their price will be laid out on other things, the production of which will, in the end, fully absorb the unemployed hand-loom weavers, at the same time that the cheapened products will be brought within the command of new classes of purchasers, and that the demand for them will be proportionally increased; and this, it is plain, will open a new field for the employment of many additional hands in the construction of machinery, and in the various subordinate departments connected with the manufacture. To suppose, indeed, that the introduction of improved machinery should, under any circumstances, entail a real injury on society, is to suppose what is contradictory and absurd; it is equivalent to supposing that society might be injured by an increased productiveness of soil, and an increased salubrity of climate; it is to suppose that wealth may be too much increased, and that the necessaries and conveniences of life may be too widely diffused.

Circumstances most favourable for the Accumulation of Capital.—Having thus endeavoured to point out the vast importance of the employment of capital, and the manner in which it co-operates in facilitating production, we proceed to explain the circumstances most favourable for its accumulation. Now, as capital is nothing but the accumulated produce of previous industry, it is evident that its increase will be most likely to be most rapid where industry is most productive; or, in other words, where the profits of stock are highest. The man who can produce a bushel of wheat in three days may accumulate twice as fast as the man who, either from a deficiency of skill, or from having to cultivate a bad soil, is forced to labour six days to produce the same quantity; and the capitalist who can invest stock so as to yield him a profit of ten per cent., has it equally in his power to accumulate twice as fast as he who can only obtain five per cent. for his capital. Experience, too, shows, that while high profits afford greater means of saving, they act as incentives to accumulation. Hence it is found that in those countries most rapidly increasing in wealth and population, the rate of profit is always comparatively high. Thus in the United States, the rate of profit is usually twice as high as in Great Britain or France; and it is to this that the more rapid advancement of the former in wealth and population is entirely to be ascribed. We do not mean to say that high profits are necessarily, and in every instance, accompanied by a great degree of prosperity. Countries with every other advantage for the profitable employment of industry and stock may be subjected to a despotical government, which does not respect the right of property; and the want of adequate security thence resulting may be sufficient to paralyse all the exertions of those who are otherwise placed in the most favourable situation for the accumulation of capital. But we have no hesitation in laying it down as a principle which holds in every case, and from which there is really no exception, that if the governments of any two or more countries be about equally liberal, and property in each be about equally well secured, their comparative prosperity will depend on the rate of profit: wherever profits are high, there is a great demand for labour, and the society rapidly augments both in population and riches. On the other hand, wherever they are low, the demand for labour is proportionally reduced, and the progress of society rendered so much the slower. But however high the rate of profit, had men always lived up to their incomes, that is, had they always consumed the whole produce of their industry in the gratification of their immediate wants and desires, it is obvious there could have been no such thing as capital in the world. High profits are advantageous, because they afford the means of amassing capital; but something more is necessary to make us use these means, and this is the accumulating principle. The desire implanted in the breast of every individual of rising in the world, and improving his condition, has prompted mankind to save a portion of their income, or of the produce of their industry, from immediate consumption, and to set it apart as a fund, or capital, to assist them in their future undertakings. It is to this principle, therefore, or rather to its effect, parsimony, that we owe our capital; and it is to capital that we owe almost all our comforts and enjoyments. Without its assistance and co-operation, labour could not have been divided; arts could not have made any progress; and mankind must have continued to shelter themselves, as in the earliest ages, in caves and forests, and to clothe themselves with the skins of wild animals. All the accumulated riches of the world, the cities which cover its surface, the ships which traverse its seas, and the innumerable variety of improvements, owe their origin to this principle, — to the desire to rise in the world, and consequently to save and amass.

It has been wisely ordered that this principle should be as powerful as it is advantageous. "With regard to profusion," says Smith, "the principle which prompts to expense is the passion for present enjoyment; which, though sometimes violent, and very difficult to be restrained, is, in general, only momentary and occasional. But the principle which prompts to save is the desire of bettering our condition; a desire which, though generally calm and dispassionate, comes with us from the womb, and never leaves us till we go into the grave. In the whole interval which separates the two moments, there is scarce, perhaps, a single instance in which any man is so perfectly and completely satisfied with his situation as to be without any wish of alteration or improvement of any kind. An augmentation of fortune is the means by which the greater part of men propose and wish to better their condition. It is the means the most vulgar and the most obvious; and the most likely way of augmenting their fortune is to save and accumulate some part of what they acquire, either regularly and annually, or upon some extraordinary occasion. Though the principle of expense, therefore, prevails in almost all men upon some occasions, and in some men upon almost all occasions, yet in the greater part of men, taking the whole course of their life at an average, the principle of frugality seems not only to predominate, but to predominate very greatly." (*Wealth of Nations*, 151.)

It is this principle which carries society forward. The spirit of parsimony, and the efforts which the frugal and industrious classes make to improve their condition, in most instances balance not only the profusion of individuals, but also the more wasteful profusion and extravagance of government. The spirit of economy has been happily compared by Smith to the unknown principle of animal life, the *vis medicatrix naturæ*, which frequently restores health and vigour to the constitution, in spite both of disease, and of the absurd prescriptions of the physician.

But however great the capacity of the principle of accumulation to repair the waste of capital, we must take care not to fall into the error of supposing, as very many have done, that its operations are in all cases promoted by a large public expenditure. To a certain extent this is indeed true. A moderate increase of taxation has the same effects on the habits and industry of a nation that an increase of his family, or of his necessary and unavoidable expenses, has upon a private individual. Man is not influenced solely by hope, — he is also powerfully operated upon by fear; taxation brings the latter principle into the field. To the desire of rising in the world inherent in the breast of every individual, an increase of taxation superadds the fear of being cast down to a lower station, — of being deprived of conveniences and gratifications which habit has rendered almost indispensable; and the combined influence of the two principles produces efforts that could not be produced by the unassisted agency of either. They stimulate individuals to endeavour, by increased efforts of industry and economy, to repair the breach taxation has made in their fortunes; and it not unfrequently happens that their efforts do more than this, and that, consequently, the national wealth is increased through the increase of taxation. But we must be on our guard against the abuse of this doctrine. To render an increase of taxation a cause of greater exertion, economy, and invention, its increase should be slow and gradual; and it should never be carried to such a height as to incapacitate individuals from meeting the sacrifices it imposes on them by such a moderate degree of increased exertion and economy as it may be in their

power to make, without requiring any very violent change in their habits. The increase of taxation must not be such as to render it impracticable to overcome its influence, or to induce the belief that it is impracticable. Difficulties that seem to be surmountable sharpen the inventive powers, and are readily grappled with; but an apparently insurmountable difficulty, or such an excessive weight of taxation as it was deemed impossible to meet, would not stimulate, but destroy exertion. Instead of producing new efforts of ingenuity and economy, it would produce only despair. Whenever taxation becomes so heavy that the produce it takes from individuals can no longer be replaced by fresh efforts, these efforts uniformly cease to be made; the population becomes dispirited, industry is paralysed, and the country rapidly declines.

Ambition to rise is the animating principle of society. Instead of remaining satisfied with the condition of their fathers, the great object of mankind in every age has been to rise above it,— to elevate themselves in the scale of wealth; to continue stationary, or to retrograde, is not natural to society. Man from youth grows to manhood, then decays and dies; but such is not the destiny of nations. The arts, sciences, and capital of one generation become the patrimony of that which succeeds them, and in their hands are augmented and rendered more efficient; so that, if not counteracted by the want of security, or by other adventitious causes, the principle of improvement would always operate, and would secure the constant advancement of nations in wealth and population.

Such is a short outline of the circumstances on which the production of wealth depends. It is difficult in separately considering the influence of the combination and division of employments, and of the introduction and improvement of machinery, to avoid ascribing an undue degree of importance to the one immediately under consideration. But neither is intitled to any pre-eminence over the other. They are alike important; or rather, we should say, they are alike indispensable to the production of wealth. It would, indeed, be quite as profitable to inquire whether the heart or the lungs be most essential to animal existence, as it is to inquire whether the division and combination of employments, or the command of capital, including tools and machines, be most essential to the growth of opulence and civilization. Without their combined and powerful aid, man must have continued sunk in primeval barbarism and ignorance. Take away the division and combination of employments, and the isolated efforts of individuals will be wholly unable to produce any considerable result; and take away capital, or the aid derived from previous savings, and from tools and machinery, and we shall immediately sink to the level of the Australian savages.

It would be inconsistent with the objects and limits of this work to enter further into details. The sketch now given comprises, we believe, an accurate statement of the great principles that lie at the bottom of the science, and by the application of which a correct judgment may be formed of most practical measures affecting the production of wealth. But those who wish for more detailed statements, and expositions of difficulties, must resort to works especially appropriated to such investigations.

The second great division of Political Economy has for its object to inquire into the laws which regulate the distribution of wealth among the various ranks and orders of the community.

II. Distribution of Wealth.

The inhabitants of such countries as have made any considerable progress in civilization may be divided into the three great classes of labourers, landlords, and capitalists; that is, into those who employ themselves for hire in any undertaking, those to whom the lands belong, and those who are the owners of capital. An individual may combine in his own person each of these separate characters; but they are, notwithstanding, sufficiently well marked to admit of their classification and separate consideration in the case of all individuals. And whatever be the condition of any country or society, whether it be rude or refined, rich or poor, every person belonging to it, who is not a pauper, or who does not subsist on the bounty of others, may be reckoned in one or other of these classes. They divide amongst them all the wealth of the community. Public functionaries of all sorts, and the various individuals engaged in what are called liberal or learned professions, exchange their services for valuable considerations. The whole subsistence of such persons, in so far as they depend upon their employments, is derived from wages; and they are as evidently labourers as if they handled a spade or a plough. "Every man," says Dr. Paley, "has his work. The kind of work varies, and that is all the difference there is. A great deal of labour exists besides that of the hands: many species of industry beside bodily operation; equally necessary, requiring equal assiduity, more attention, more anxiety. It is not true, therefore, that men of elevated stations are exempted from work; it is only true that there is assigned to them work of a different kind: whether more easy or more pleasant may be questioned; but certainly not less wanted, nor less essential to the common good." (*Assize Sermon*, 29th July, 1795.) Hence it is that the inquiry into the distribution of wealth among the different orders of the society, resolves itself into an investigation of the laws which regulate wages, rent, and profit, and of the best methods of providing for the exigencies of the poor, or of those who are unable to provide for themselves. We believe, however, that it will be the preferable plan to refer the consideration of these topics to the heads now mentioned, which will, consequently, comprise all that is essential to a general view of this department of the science.

Among the many works that have been written on this science, the first place is due to the *Wealth of Nations*, by Adam Smith: an edition of this work was published in 1838 in one volume, 8vo., with notes and illustrations by the author of this article. See also Ricardo's *Principles of Political Economy and Taxation; Torrens on the Production of Wealth;* Senior's art. on Political Economy in the *Encyclopædia Metropolitana;* M'Culloch's *Principles of Political Economy;* Say, *Traité d'Economie Politique*, &c.

POʹLITICS (Gr. πολις, *a city*), may be considered either as a science or an art, according to the manner in which it is treated. Political science is that which treats of the theory and practice of government, and the subjects which it comprises have been arranged under the following heads: — 1. Natural law; 2. Abstract politics, *i.e.* the object of a state, and the relations between it and individual citizens; 3. Political economy; 4. The science of police, or municipal regulation; 5. Practical politics, or the conduct of the immediate public affairs of a state; 6. History of politics; 7. History of the European system of states, being the only system in which the modern art of politics has received a practical development; 8. Statistics; 9. Positive law relating to state affairs, commonly called constitutional law; 10. Practical law of nations; 11. Diplomacy; 12. The technical science of politics, an acquaintance with the forms and style of public business in different countries. The ancient Greek writers treated the science of politics uniformly with reference to an imaginary perfect state; the constitution of which each propounded according to his own speculative views, and then proceeded to show in what respects existing governments differed from this ideal standard, the cause of these variations, &c.

POLL. In Politics. *See* Parliament.

POLLARD. A tree with the head cut off at the height of 10 or 12 feet from the ground, for the purpose of inducing it to throw out branches all round the section where amputation has taken place; which branches are cut off periodically, when they attain the length of 8 or 10 feet, to be used as fuel, fence wood, or for other rustic purposes. Pollard trees are for the most part found in hedgerows, which they greatly injure by the dense shade produced by their branches on the plants below; and excepting when the round formal heads of the pollards enter into combination with overgrown hedge plants, or with large trees which have not been pollarded, they disfigure the landscape, from the sameness of their appearance, and their expression of meanness, as compared with that of trees undecapitated and left in all their native luxuriance. In the time of Evelyn the term pollard appears to have been chiefly applied to trees which were lopped or deprived of their side branches, excepting a few at top, leaving the tree standing like a naked pole. Examples of this kind of pollard are frequent among the hedgerow elms in the neighbourhood of London. The decapitated tree, now called a pollard, was in Evelyn's time called a dottard.

POLLEN. In Botany, the pulverulent substance which fills the cells of the anthers of a plant, consisting of a multitude of little hollow cases filled with a fluid holding very minute molecular matter in suspension. The latter is eventually discharged by the grains of pollen through their hollow tubes, and is supposed to be the spermatic fluid of a plant.

POLLEN TUBES, are the tubular processes emitted by the pollen when it comes in contact with the stigma of a plant, and which are supposed to conduct the impregnating matter down the style into the ovules through the foramen.

POLL TAX. A tax still levied in many of the Continental states, and formerly also in England, in proportion to the rank or fortune of the individual. In England this species of tax was first levied in 1378; and, as is well known, it was from the brutality with which the levying of it was accompanied that the rebellion of Wat Tyler took its rise in 1381. Various poll taxes were levied at different periods in the subsequent history of England; but they were finally abolished in the reign of William III. *See* Taxation.

POʹLLUX. In Astronomy, one of the twins forming the constellation *Gemini*. (*See* Castor.) Pollux is also

the name of a star of the second magnitude in the same constellation.

PO'LYARCHY. (Gr. πολυς, *many*, and ἀρχειν, *to govern.*) A word sometimes used by political writers in a sense opposed to monarchy: the government of many, whether a privileged class (aristocracy), or the people at large (democracy).

POLYCHRO'ITE. (Gr. πολυς, and χροα, *colour.*) A term applied to the colouring matter of saffron, in consequence of the variety of colours which it exhibits when acted upon by various re-agents.

PO'LYCHREST. (Gr. πολυς, and χρηστος, *useful.*) A term applied by the old chemists to certain preparations which they regarded as possessed of multifarious virtues. *Polychrest salt* was the sulphate of potash.

POLYGALA'CEÆ. (Polygala, one of the genera.) A natural order of irregular Polypetalous Exogens, possessing tonic, astringent, and nephritic properties. The species are also sometimes cultivated for the sake of their beautiful flowers; they usually inhabit temperate climates, and are particularly common at the Cape of Good Hope. Rhatany root, a powerful astringent, belongs to *Krameria*, a genus of this order.

POLY'GAMOUS (Gr. πολυς, and γαμος, *marriage*), in Grasses, signifies when one of the two flowerets of which a spikelet consists is unisexual, the other hermaphrodite, as in *Spodiopogon*, &c.; in other plants it expresses the presence in the same individual of male, female, and hermaphrodite flowers.

POLY'GAMY. (Gr. πολυς, and γαμος, *marriage.*) The custom of having several wives; a custom apparently common to all nations in remote antiquity, and common now to most of those in which the tie of marriage is recognized, and to which Christianity has not extended. It was admitted among the Patriarchs, and under the Mosaic dispensation (Exod. xxi. 10., Deut. xxi. 15.); and Selden (*Uxor Hebraica*) has shown its prevalence among the Jews, without mentioning the extraordinary instances of sovereigns, such as David and Solomon, recounted in Scripture. It may be questioned, however, whether it continued at the period of our Saviour's preaching. Certainly his injunctions in regard to marriage seem rather to be founded on the supposition of monogamy; and the absence of positive injunctions against polygamy has been relied on by some modern disputants, with very little reason, as an authority that the licence assumed by the holy men of the Old Testament is not revoked. The severer manners of Western nations seem to have repudiated it. It was no part of Grecian manners: the notion that the Athenian laws allowed of two wives (founded in part on a passage in *Athenæus*, l. xiii. ch. 1.) seems a mistake; but it appears to have been allowed to a citizen, in addition to his lawful wife, herself a citizen, to live in a kind of legitimate concubinage with a female not belonging to that class. Thus (if there is any truth in the story of Socrates' two wives) his plague, Xantippe, was the wife by night, while the softer Myrto was only a wife by courtesy. In republican Rome no such licence was known; but under the emperors the practice of polygamy seems to have crept in, though repudiated both by the moral sense and civil usages of the people. Valentinian I. legalized it by an edict. But the Christian ecclesiastics of the empire strenuously opposed it; and it disappeared altogether, we believe, from Christendom with the fall of the Roman empire. In the East it has continued to prevail.

A few bold writers in modern times have raised the defence of polygamy, grounded on the supposed absence of its express prohibition. Bernardus Achinus, a well-known and able but unsteady theologian of the 16th century, who belonged by turns to the Roman Catholic and Protestant communions, is among the most remarkable. Lyserus (*Polygamia Triumphatrix*) adopted a still more decided view. The Rev. Mr. Madon, in his *Thelyphthora* (a work which excited an extraordinary and very unfavourable sensation on its appearance), limited the privilege of polygamy to men; and asserted that the injunction of St. Paul, that a bishop "should be the husband of one wife," plainly demonstrated its lawfulness in others; meaning one wife at a time: a supposition which is not improbable, although it will scarcely support his conclusions. But a greater number of philosophical writers have sought for a justification of the practice in the East. Voltaire, Montesquieu, and others, defend it on the ground of the rapid decay of female beauty in those regions. Montesquieu also relies on the strange notion, that the number of females in eastern countries is much greater than that of males; which the traveller Bruce asserts on the authority of his own observations. But the supposed fact on which these reasonings rest seems to be altogether imaginary. At all events, the *practice* of polygamy in the East is confined to so few that it can have little direct effect on manners, and none on population. Mr. Urquhart, who endeavours to place Turkish usages in a favourable contrast with those of the West, after to a certain extent defending polygamy, says rather inconsistently, "While the law of nature renders this practice an impossibility as regards the community, it is here still farther restrained, among the few who have the means of indulging in it, both by the domestic unquiet that results from it, and by the public censure and reprobation of which it is the object." (*Spirit of the East.*) He adds, that in his time "a case of polygamy was unknown in Candia, among a population of 40,000 Mussulmen." And Niebuhr says, that in Arabia the conduct of those who take more than one wife "is blamed by all other men." But it seems scarcely to have occurred to most reasoners that while polygamy itself is rare, its recognition is almost always accompanied with the toleration of concubinage by public morality. The man who is not rich enough to take two wives, or who does not choose to encounter the household disturbances which follow such an arrangement, falls entirely in with the public opinion of his class, in taking into his family a recognized concubine to dwell with his lawful spouse. Our Western manners divide the female part of the community into two classes: a greater number, treated with the highest respect, and in whom perfect purity is presumed; a smaller number, abandoned to utter degradation. Where polygamy and concubinage are recognized, there is probably much less gross prostitution; but the general character of the sex stands on a lower basis.

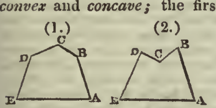
POLYGA'STRIA. (Gr. πολυς, and γαστηρ, *a stomach.*) The name of the most minute and simple class of Infusories, and of the whole animal kingdom. The Polygastrians are characterized by Ehrenberg as animalcules devoid of spinal marrow, and of vascular and respiratory organs, with many stomachs, of an indefinite form, and androgynous, with spurious locomotive organs of various nature. They are all endowed with an organization characteristic of the animal kingdom; and manifest such modifications of internal structure and external form that they can be divided into twenty-two families, of which eleven are naked and eleven clothed in a siliceous case. Forty-eight species, referable to twenty-one distinct genera, are provided with eyes or coloured eye-specks; and, among these, nervous ganglia have been detected beneath the eye in *Amblyophis* and *Euglena*. They occur in all parts of the world, and differ according to diversity of climate, region, kind of water, &c. They are invisible to the naked eye; but, by their immense numbers, can impart a distinct colour to the water in which they swarm: they are one of the causes of the phosphorescence of the sea. They enjoy the most extensive powers of reproduction; and through their faculty of spontaneous *fission*, the individual becomes constant, and, as it were, perpetually renews its youth. By virtue of the imperishability of their external cases the *Polygastria* have formed vast masses of rock, as at Bilin in Bohemia, where a single stratum, extending over a wide area, is no less than 14 feet thick; and this consists exclusively of the cases of *Bacillaria*, *Gaillonella*, &c., united together without any visible cement. They sometimes so choke up water by their vast numbers as to cause the death of fishes contained therein. They appear never to sleep: they are very tenacious of life, and fall into a kind of torpidity by excess of dryness, heat, or cold. The more minute species are probably often suspended in the air. They act according to external circumstances, as the higher organized animals do. They are injuriously affected or killed by strong poisons; but can sometimes support great degrees of warmth and cold, and can live with or without light: their motions are slow. Ehrenberg calculates that the *Monas punctum*, if it were to continue its ordinary rate of motion in a straight line, would traverse one mile of space in five years; while the *Navicula grandis* would require forty years to travel over the same distance. But their movements manifest the phenomena of consciousness and choice, and their muscular power is indicated by the strong maxillary apparatus with which many are provided.

PO'LYGLOT. (Gr. πολυς, and γλωττα, *language.*) A word generally applied to such Bibles as have been printed with the text represented in various languages. The most ancient instance of this parallel representation of various texts is the work of Origen, known by the name of the *Hexapla*, in imitation of which several similar editions of the Scriptures have been published since the invention of printing; of which the most important are, — 1. *The Complutensian*, or edition of Cardinal Ximenes, printed at Alcala in Spain, 1515, in four languages, comprehended in six vols. folio. 2. *The Plantin*, Antwerp, 1572. 3. *The Polyglot* of De Sacy, Paris, 1645. 4. *The English*, or *Walton's Polyglot*, London, 1657. These contain among them the Hebrew, Chaldee, Syriac, and Samaritan texts, with Latin versions of each; the Septuagint, the Greek of the New Testament, the Italic and the Vulgate; with some of the Hebrew and Chaldee paraphrases, and copious indexes and grammatical illustrations. 5. *Hutter's Polyglot*, Nuremberg, 1599, contains twelve languages; the Hebrew, Syriac, Greek, Latin, German, Bohemian, Italian, Spanish, French, English, Danish, and Polish.

PO'LYGON (Gr. πολυς, and γωνια, *angle*), according to Euclid, is any plane rectilinear figure having more than four sides or four angles; but, in treating of polygons generally, geometers also include the triangle and the quadrangle. If the sides of the polygon are all equal, it is said to be a regular polygon; otherwise it is irregular. Every regular polygon can be circumscribed by a circle, or have a circle inscribed in it; but of irregular polygons, excepting triangles, there is only one case in which a circle will pass through all their angular points; namely, when the polygon has an equal number of sides, one half of which are equal to one another, and the other half also equal to one another, but different from the former, and the equal and unequal sides are placed alternately. It is obvious that all the angles of such a figure are equal.

Euclid has shown in the *Elements* how to inscribe a triangle, a square, and a pentagon in a given circle; and as any arc of a circle may be bisected geometrically, and the halves again bisected continually, it follows that any regular polygon, of which the number of sides is 2^n (n being any number whatever), or 3×2^n, or 5×2^n, may be inscribed in a circle by elementary geometry. Until a recent discovery respecting the division of angles was made by Gauss, it was supposed that if the number of sides of a polygon was any other prime number than 3 or 5, the figure could not be inscribed in a circle; but this geometer, in his *Disquisitiones Arithmeticæ*, has demonstrated that every polygon, the number of whose sides is a prime number of the form $2^n + 1$, may be geometrically inscribed in a circle. When $n = 1$, this form gives 3, or the triangle; when $n = 2$, it gives 5, or the pentagon; when $n = 3$, it gives 9, which is not a prime; when $n = 4$, it gives 17, whence a seventeen-sided figure may be inscribed in a circle geometrically. The next prime is found by making $n = 8$, when the form gives 257.

In order to investigate the general properties of polygons, it is necessary to divide them into two classes, *convex* and *concave;* the first comprehending those of which all the interior angles are less than two right angles (fig. 1.), and the second those which have one or more *re-entering* angles, as C (fig. 2.). If we call those the *interior* angles of the polygon which belong to the interior of the figure (whether less or greater than two right angles), and those *exterior* angles which are obtained by substracting each interior angle from four right angles, the two following theorems will be true of the polygons of both classes: —



1. The sum of the interior angles of a polygon is equal to as many times two right angles as there are sides *minus* two. Thus, let S denote the sum of the interior angles, R a right angle, and n the number of sides of the polygon; then $S = 2(n - 2) R$.

2. The sum of the exterior angles of a polygon is equal to as many times two right angles as there are sides *plus* two. Let S′ be the sum of the exterior angles, as above defined; then $S' = 2(n + 2) R$.

Any polygon may be decomposed into triangles by drawing straight lines from one of its angular points to each of the opposite angles, and the area of the polygon is the sum of the areas of all the component triangles. But a beautiful theorem was found by L'Huilier of Geneva, by means of which, when the sides and angles of a polygon are known, the area is found without decomposing it into triangles, which, when the number of sides is considerable, leads to laborious calculations. The theorem is this:—The double of the surface of any rectilinear figure is equal to the sum of the rectangles of its sides, taken two and two, *excepting one*, multiplied by the sine of the sum of the supplements of the interior angles contained between each pair of sides. Thus, in the preceding figure (fig. 1.), let A, B, C, D, E be the supplements of the interior angles at those points; then

$$\begin{aligned}2\text{ area} = {} & AB \times BC \sin. B \\ & + AB \times CD \sin. (B + C) \\ & + AB \times DE \sin. (B + C + D) \\ & + BC \times CD \sin. C \\ & + BC \times DE \sin. (C + D) \\ & + CD \times DE \sin. D.\end{aligned}$$

This formula also gives the area of the polygons of the second class (fig. 2.); only the supplement of the re-entering angle C must be taken with the negative sign. (See *L'Huilier's Polygonométrie*, Genève, 1789.)

Polygon, in Fortification, is either *exterior* or *interior*. The exterior polygon is the figure formed by lines connecting the angles of the bastions with one another all round the work; the interior polygon by lines connecting the centres of the bastions all round.

POLYGONA'CEÆ. (Polygonum, one of the genera.) A natural order of herbaceous, rarely shrubby, apetalous Exogens, inhabiting the whole world; distinguished from most other plants by the cohesion of the scarious stipules into a sheath, technically called an *ochrea* or *boot*, and by their triangular fruit. Sorrel on the one hand, and rhubarb on the other, represent the general qualities of this order. While the leaves and young shoots are acid and agreeable, the roots are universally nauseous and purgative. *Rumex acetosa* contains pure oxalic acid, and many species of Polygonum are used in dyeing. The *Rheum* or rhubarb, and *Rumex* or dock, are well-known plants of this order; which is also sometimes remarkably astringent, as in the case of the *Coccoloba uvifera*, or sea-side grape of the West Indies, an extract of whose bark forms a kind of kino.

POLYGONAL NUMBERS, in Arithmetic, are the successive sums of a series of numbers in arithmetical progression. When the common difference of the series in arithmetical progression is 1, then the sums of the terms give the *triangular* numbers; when the common difference of the terms of the arithmetical series is 2, the sums of the terms are the *square* numbers; when the difference is 3, the sums are the *pentagonal* numbers; and so on. Thus: —

Common difference = 1;	1, 2, 3, 4, 5, 6, &c.
Triangular numbers	1, 3, 6, 10, 15, 21, &c.
Common difference = 2;	1, 3, 5, 7, 9, 11, &c.
Square numbers	1, 4, 9, 16, 25, 36, &c.
Common difference = 3;	1, 4, 7, 10, 13, 16, &c.
Pentagonal numbers	1, 5, 12, 22, 35, 51, &c.

and so on. These numbers are called, in general, *polygonal*, from possessing this property, that the same number of points may be arranged in the form of that polygonal figure to which it belongs. For example, the pentagonal numbers 5, 12, 22, 35, 51, &c. may be severally arranged in a pentagonal form. Thus, in the annexed figure, 5 points form the pentagon *a b c d e;* 12 the pentagon *a f g h i*, with the former enclosed; 22 the pentagon *a k l m n*, with the two former enclosed.

A very general and remarkable property of polygonal numbers was discovered by Fermat, though it has yet been demonstrated only in respect of the triangular and square numbers. It is this:—Every number whatever is the sum of one, two, or three triangular numbers; the sum of one, two, three, or four squares; the sum of one, two, three, four, or five pentagonal numbers; and so on. *See* Figurate Numbers.

POLYGON OF FORCES. In Mechanics, the name given to a theorem, the discovery of which is attributed to Leibnitz. The theorem is this: — If any number of forces act upon a point, and a polygon be taken, one of the sides of which is formed by the line representing one of the forces, and the following sides in succession by lines representing the other forces in magnitude, and parallel to their directions, then the line which completes the polygon will represent the resultant of all the forces.

PO'LYGONO'METRY. The doctrine of polygons, as trigonometry is the doctrine of triangles. The properties of polygons are usually investigated by resolving them into triangles; their areas, however, may be found, when so many of their sides and angles as suffice to determine them are known. *See* Polygon.

PO'LYGRAM. (Gr. πολυς, *many*, and γϱαμμα, *a line*.) A figure consisting of many lines.

PO'LYGRAPH. (Gr. πολυς, and γϱάφω, *I write*.) In Bibliography, a name invented to designate a collection of different works either by one or several authors.

POLY'HALITE. (Gr. πολυς, and ἁλς, *salt*.) A mineral found at Ischel, in Upper Austria, composed of muriate of soda, and of the sulphates of magnesia, lime, and potash.

POLYHE'DRON. (Gr. πολυς, and ἑδϱα, *seat*.) In Geometry, a solid body bounded by many faces or planes. When all the faces are regular polygons, similar and equal to each other, the solid becomes a regular body. It may be demonstrated that only five regular solids can exist; namely, the tetraedron, the hexaedron, the octaedron, the dodecaedron, and the icosaedron. See the terms; see also Platonic Bodies.

Polyhedron. In Optics. *See* Polyscope.

POLYHY'MNIA, the muse who presided over lyric poetry: —

> Nec Polyhymnia
> Lesboam refugit tendere barbiton. *Hom. Od.* i. 1.

PO'LYMI'GNITE. (Gr. πολυς, and μιγνυμι, *I mix*.) A mineral which occurs in small prismatic crystals of a metallic lustre; its constituents are titanic acid, zirconia, lime, yttria, oxides of iron, cerium and manganese, magnesia, potassa, silica, and oxide of tin. It is found in Norway.

POLYNO'MIAL, or MULTINOMIAL, in Algebra, denotes a quantity having many terms. Such, for example, is the expression $a + 2b + 3c + nd$, &c.

POLYO'PTRON. (Gr. πολυς, and οπτϱον, *a looking-glass*.) In Optics, a glass through which objects appear multiplied, but diminished. It consists of a lens one side of which is plane, but in the other are ground several spherical concavities. Each of these concavities

becomes a plano-concave lens, through which an object appears diminished; and when there are a number of them together, the object will be seen through each, and thus multiplied.

PO'LYPES, *Polypi.* (Gr. πολυς, and πους, *a foot.*) The name of an extensive group of radiated animals in the system of Cuvier, associated together by the common character of a fleshy body, of a conical or cylindrical form, commonly fixed by one extremity, and with the mouth situated at the opposite end and surrounded by more or less numerous arms or tentacles. Under this external form is masked various grades of organization, of which three at least have been well defined by recent and minute anatomical researches.

The lowest grade of organization is manifested by the fresh-water polype (*Hydra*), and the compound marine corallines (*Sertulariæ, Tubulariæ*, &c.). The body here consists of a granular parenchyma, having a contractile power in every part, not requiring a distinct allocation and arrangement of muscular fibres. When it is defended, as in the Corallines, by a polypary, it can be retracted into its cell without being folded upon itself. The oral tentacles are not provided with vibratile cilia; the stomach is not distinct from the parietes of the body. The polypes thus organized have been termed *Dimorpheæ* by Ehrenberg; and *Nudibrachiata*, or Hydriform Polypes, by Dr. Farre. In the second group of Polypes the body is distinctly membranous and fibrous, and the stomach forms a separate pouch suspended in its centre. The stomach has but one external orifice, which serves for mouth and vent; but posteriorly it communicates with the main cavity of the body. This is divided into several compartments by vertical partitions passing from the walls of the cavity to those of the stomach; and with the chambers thus formed the tubular arms surrounding the mouth communicate: these arms are not ciliated externally. This group of Polypes has been termed *Anthozoa* by Ehrenberg: it includes the Sea-anemonies, Madrepores, Coral-polypes, &c. In the third and highest group of Polypes the parietes of the stomach are not only distinct from those of the body, but are continued into an intestinal tube, which is reflected forward, and terminates in a distinct anal aperture near the mouth: the tentacula are provided with vibratile cilia. The Polypes of this division are aggregated or compound, and provided with flexible or calcareous cells: they have been termed *Bryozoa* by Ehrenberg, and *Ciliobrachiata* by Dr. Farre. All the groups of Polypes propagate by gemmation, and likewise by ova, which are first developed into ciliated and locomotive gemmules. In the *Ciliobrachiata* the sexes are distinct.

POLYPHEMUS. *See* CYCLOPS.

PO'LYPUS. In Surgery, a fleshy tumour, which is occasionally formed in the nostrils: the same term is also applied to a fleshy tumour of the uterus.

POLYSA'RCIA. (Gr. πολυς, and σαρξ, *flesh.*) Corpulency.

PO'LYSCOPE. (Gr. πολυς, and σκοπεω, *I view.*) In Optics, a lens plane on one side and convex on the other; but of which the convex side is formed of several plane surfaces, or *facettes*, so that an object seen through it appears multiplied. The reason of the multiplication of the image is this: — When the opposite sides of a thick piece of glass are not parallel, an object seen through it appears out of its true place on account of the refraction; consequently, if a lens is ground so that portions of its convex surface are differently inclined to its plane side, the object will appear in different places at the same time. The polyscope may be used to collect the images of several dispersed objects into a single point, or to collect parts of the same object represented in different places, so as to form a single image. The instrument is a mere toy, and only used for the purpose of amusement.

POLYSPA'STON. A term used by some of the old writers on mechanics to denote an assemblage of pulleys for raising heavy weights.

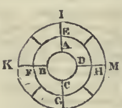
PO'LYSTYLE. (Gr. πολυς, and στυλος, *a column.*) In Architecture, an edifice in which there are a great number of columns.

POLYTE'CHNIC SCHOOL. (Gr. πολυς, and τεχνη, *art.*) This establishment was founded in 1794, at Paris, by a decree of the National Convention. Its object is to instruct youth in the mathematical, physical, and chemical sciences. Napoleon, who introduced various modifications into its constitution, gave a military turn to its discipline. It prepares pupils for the artillery service and civil and military engineering. The number is limited to 300. Youths are admitted between the age of sixteen and twenty, and the course of study lasts two years. In the lists of its professors have been included the illustrious names of Lagrange, La Place, Monge, Berthollet, &c.; and from the ranks of its pupils have proceeded, almost without exception, all the mathematicians and philosophers of France who have attained to eminence during the last half century.

POLYTHALAMA'CEANS, *Polythalamacea.* (Gr. πολυς, *many*, and θαλαμος, *a chamber.*) A name applied by De Blainville to an order of Cephalopods, including those which have many-chambered shells. Like all divisions founded merely on external or dermal characters, it contains animals of different degrees of organization, and which cannot be grouped together in the same order in a natural system. *See* TETRABRANCHIATES.

POLY'THEISM. (Gr. πολυς, and Θεος, *God.*) The doctrine of a plurality of gods. Sabianism (or planet-worship), Zendism, dæmon worship, hero-worship, and animal worship, together with the *fetichism* of some Negro tribes, may all be considered as varieties of Polytheism. That the first deviation from pure Theism, such as we believe to have been at the outset revealed to man, was into the worship of the sun, moon, and stars (the host of heaven; Hebr. Tsaba, *an host;* whence Tsabianism or Sabianism, which see), is sufficiently probable. The origin of the worship of the good and evil principle as distinct deities, which characterized the religion of some oriental nations, is not so easily explicable. Some have attributed it to the recognition of the opposites to those phenomena which had been deified in the Sabian notions, — *e. g.* darkness as contrary to light, night to day, &c.; some to traditionary belief in the existence of evil or reprobate spirits; some to a mere philosophical theory adapted by priests to popular comprehension. Dæmon worship, or the worship of intermediate intelligences, appropriated to external objects, and subordinate to the highest God, was a natural effect of Sabianism. The worship of heroes, or deified mortals, arose again from it in a later stage of society; and the most probable theory of the greatest systems of Polytheism which have been recognized by divisions of the human race, viz. the Egyptian, Greek, Indian, and Scandinavian, seems to be this, that hero worship, the most congenial of all to the vulgar imagination, superseded former modes of belief; that the gods were actually heroes, who had gradually absorbed to themselves the honours formerly paid to dæmons or intelligences, and to the host of heaven, so that their attributes, in later mythology, present a vague mixture of the characters of all. If, however, this be the case, it remains to be explained how, *after* the gods of Olympus had acquired their station and attributes in the Grecian religion, a secondary race of heroes, the ηρωες, properly so called (whose worship is quite of recent origin, and certainly posterior to Homer), should have found a place in the same mythology. The strange system of animal worship seems peculiar to ancient Egypt, and has been derived by some from the natural circumstances of the country; the scarcity of domesticated animals having given them an importance which the priests made use of, and connected with superstition. As to the theory and general history of polytheism, the following among many other books may be mentioned: — *Stillingfleet's Origines Sacræ; Kames's Sketches of the History of Man; Court de Gebelin Monde Primitif; Bryant's Mythology;* the Works of Herder; *Warburton's Divine Legation; Cudworth's Intellectual System; Vossius, De Origine Idololatriæ; Mem. de l'Acad. des Inscr.* vol. xxxviii.

POLYZO'NAL LENS. (Gr. πολυς, and ζωνη, *zone.*) The name given by Sir David Brewster to a burning lens constructed of several zones or rings, each of which may be again composed of separate segments. In the annexed figure, A B C D is a central lens formed of one piece of glass; E F G H is a middle ring, or zone, composed of four separate pieces; I K L M is another ring composed of eight segments, and surrounding the former. The number of zones, and of parts in each, may be as great or as small as we please.



This method of forming lenses is attended with several important advantages. The difficulty of procuring flint glass of sufficient purity to render it fit for the construction of a solid lens of large dimensions is removed, and the expense greatly diminished. If impurity exist in any of the spherical segments, or if an accident happen to any of them, it can easily be replaced. Another advantage attending the construction is, that it enables us to correct, very nearly, the spherical aberration, by making the foci of each zone coincide. Lenses of this kind have been made in France of crown glass, and have been introduced into the principal French light-houses. One was constructed, under the directions of Sir David Brewster, for the commissioners of the northern light-houses. It was made of pure flint glass, was three feet in diameter, and consisted of numerous zones and segments. (See *Brewster's Treatise on New Philosophical Instruments;* and "Optics" in *Lardner's Cyclopædia.*)

POLY'ZOONS. *Polyzoa.* (Gr. πολυς, and ζωον, *animal.*) A class of compound animals resembling in their organs of support the Sertularians, but in their internal organization approaching nearly to the compound Ascidians.

POMA'CEÆ. (Lat. pomum, *an apple.*) That division of the natural order *Rosaceæ* to which the apple, pear,

quince, and medlar belong. It differs from *Rosaceæ* proper in having an inferior ovary.

POMEGRA'NATE. The fruit of the *Punica granatum*. The pulp is acid, and the rind highly astringent. The dried flowers, which are also astringent, were formerly used in medicine, under the name of Balaustine flowers.

POMŒ'RIUM. (Lat. post, *behind*, and murus, *a wall*.) In Roman Antiquities, a space of ground, both within and without the walls of a city, kept free from buildings (*Livy*, xiii.), and consecrated by a reliigous ceremony derived from the Etruscans. (See a memoir of D'Anville on the extent of ancient Rome, *Mem. de l'Acad. des Inscr*. vol. xxi. p. 206.) When it was found necessary to extend the limits of any city, a new *pomœcium* was formed, and the former one desecrated.

POMO'NA. The Italian goddess of fruit trees. Her worship was assiduously cultivated at Rome, where there was a *flamen pomonalis*, who sacrificed to her every year for the preservation of the fruit. The story of Pomona and Vertumnus is well known. (See *Ovid. Met*. 14. 623.) The name is derived from poma, *fruit*.

PO'MPHOLIX. (Gr. πομφος, *a bubble*.) An alchemical term for oxide of zinc.

Po'mpholix. In Medicine, a vesicular eruption upon the skin.

PO'MUM ADA'MI. *Adam's apple*. The protuberance in front of the neck formed by the thyroid gland. It has been fancifully supposed to represent the forbidden apple eaten by Adam.

POND. An artificial excavation in the soil, or a natural hollow dammed up for the purpose of detaining water, generally made in fields in order to supply drink to pasturing animals. The essential difference between a pond and a lake is, that the former is formed by art, the water being often ponded, or impounded, by a bank of earth thrown across a natural gutter, hollow, or bourne containing a stream. In Gloucestershire, Kent, and other counties where the soil does not abound in springs, the formation of ponds in the fields is as essential to the business of farming as the building of farm offices. A pond in a garden, when of a round form, is termed a basin; and when of some length, with parallel sides, a canal.

PO'NE. (Lat.) In Law, a writ which lies to remove actions of debt, detinue, writs of right, nuisances, &c., out of the county or other inferior court into the Common Pleas, and sometimes into the Queen's Bench.

PONS VARO'LII. The bridge of Varolius. An arched eminence of the *medulla oblongata*, formed by the two exterior crura of the cerebellum becoming flattened, and passing over the crura of the cerebrum.

PO'NTEE. In Glass Manufacture, an iron instrument by which the hot glass is taken out of the glass-pot.

PO'NTIA. (Gr. Ποντια, one of the names of the goddess of love.) A genus of butterflies, of which the common white or cabbage butterfly (*Pontia brassicæ*) is a well-known native species.

PO'NTIFEX. (Lat.) The highest Roman sacerdotal title. Numa instituted four pontifices, chosen from the patricians; to which were added, long subsequently, four plebeians. Sylla increased their number to fifteen. The college was divided into two classes, distinguished by the epithets *majores* and *minores*; but it is not certain whether this difference of title marked out the patricians from the plebeians, or the more ancient members from the seven added by Sylla. The pontifices judged in all causes relating to sacred things, and inspected the conduct of the inferior priests. They were a self-elected body down to the latter ages of the republic, when the power of election was sometimes held by the people. It was finally vested in the emperors, who added as many to their numbers as they thought fit. The chief of the pontifices was called the *pontifex maximus*, and was always created by the people, being generally chosen from those who had borne the first offices in the state. His station was one of great dignity and power, as he not only had supreme authority in religious matters, but, in consequence of the close connection between the civil government and religion of Rome, he had also considerable political influence. The title of pontifex maximus being for life, Augustus never assumed it till the death of Lepidus, after which it was always held by himself and his successors to the time of Theodosius. The insignia consisted of the *toga prætexta*, and a conical woollen cap with a tassel (*galerus*). (See the *Mem. de l'Ac. des Inscr*., vols. xii. xv. xxiv. xxxvii.) From this word the well-known title of Pontiff in modern Europe is derived. "Supreme Pontiff" is a common style of the pope.

PONTOO'N. A Military term, denoting a kind of flat-bottomed boat, generally lined within and without with tin. Our pontoons are about 21 feet long, 5 feet broad, and 2 feet deep. They are carried along with an army for the purpose of making temporary bridges, called *pontoon bridges*, by which an army is pursued over rivers.

POOP. A partial deck extending close aft, above the complete deck of the vessel. A sea coming over the stern is said to *poop* the vessel.

POOR, THE. (Lat. pauperes.) In Political Economy, the term employed to designate those persons, or that portion of the population of any county, who, being destitute of wealth, are, through age, bodily or mental infirmity, want of employment, or other cause, unable to support themselves, and have to depend for support on the contributions of others.

The first notice of the poor by the legislature of England appears to have occurred in 1376; and there does not seem to be any good grounds for thinking that any portion of the people were known by this designation previously to the 14th century. The truth is, how paradoxical soever the statement may at first appear, that the poor, as a class, owe their existence to the abolition of villenage and the progress of civilization. Previously to this abolition, the great bulk of the people were in a state of predial slavery, or in a condition closely resembling that of the Spartan helots. But in such a state of society the class of persons now known as the destitute poor could not exist. It is essential to the idea of slavery, whether predial or absolute, that the masters should provide their bondsmen or slaves with at least the necessaries of life; and, in the event of their neglecting to do so, the law, if it interfere, merely directs that they shall fulfil this natural obligation, or that otherwise they shall sell or assign their slaves to those by whom it will be fulfilled. But after the establishment of corporate bodies in the towns and cities and the growth of manufactures and commerce had given birth to a class of free labourers, the poor began to make their appearance, and to attract the notice of the legislature. Free labourers owe no compulsory service to any one. They are their own masters; and may employ themselves in any way not injurious to others they think fit. But it is plain that such persons cannot, in the event of their becoming infirm or destitute, claim to be supported by any particular individual or class of individuals. They are not bound to serve any one when in health, and, consequently, no one can be bound to provide for them when in want. Under such circumstances, they have nothing to look to but the compassionate charity of individuals or the public. But as the conduct of individuals must, in such matters, be left to be determined by their own sense of what is right and proper, we shall now, without alluding farther to them, briefly inquire what, in this respect, is the duty of the public, or whether and to what extent it should interfere to relieve the destitute.

The poor and destitute may be divided into two great classes: the first consisting of maimed and impotent persons, or of those whom natural or accidental infirmities disable from working; and the second of those who, though able and willing to work, are unable to find employment, or do not receive wages adequate for their support and that of their families. There is a very wide difference in the situation of these classes; and the same means of relief that may be advantageously afforded to the one may not, in various respects, be suitable for the other.

1. With respect, however, to the first class, or the impotent poor, there does not seem to be much room for doubt as to the policy, as well as humanity, of giving them a legal claim to relief. It has sometimes, indeed, been contended, that, by affording relief to those who are unable, from age or the gradual decay of their bodily powers, to provide for themselves, the motives that induce individuals, while in health, to make a provision against future contingencies are weakened; so that, in attempting to protect a few from the effects of their own improvidence, an injury is done to the whole community. This statement is, probably, true to a certain extent; though it be difficult to imagine that any considerable portion of a moderately intelligent population will ever be tempted to relax in their efforts to save and accumulate, when they have the means of doing so, from a knowledge that the workhouse will receive them in old age! But whatever may have been the faults of individuals, it would be abhorrent to all the feelings of humanity to allow them to suffer the extremity of want. An individual is unfortunate, perhaps, or he may not have been as thrifty or as prudent as he ought; but is he, therefore, to be allowed to die in the streets? It is proper certainly to do nothing that can really weaken the spirit of industry; but if, in order to strengthen it, all relief were refused to the maimed and impotent poor, the habits and feelings of the people would be degraded and brutalized by familiarity with the most abject wretchedness; at the same time, that, by driving the victims of poverty to despair, a foundation would be laid for the most dreadful crimes, and such a shock given to the security of property as would very much overbalance whatever additional spur the refusal of support might give to industry and economy. It does, therefore, appear sufficiently clear that this class of poor should be supported in one way or other; and that, when the parties are either without relations or friends, or when these do not come voluntarily forward to discharge this indispensable duty, the necessary funds should be provided

by a tax or rate, made equally to affect all classes; for, if they be not so raised, the poor will either not be provided for at all, or the burden of providing for them will fall wholly on the benevolent, who should not, in such a case, be called upon to contribute more than their fair share.

II. The only question, then, about which there seems to be any real ground for doubt or difference of opinion is, whether any legal claim for relief should be given to the able-bodied poor, or to those who are able and ready to work, but who cannot find employment, or cannot earn wages adequate for their support? Now this, it must be confessed, is rather a difficult question, and one which does not, perhaps, admit of any very satisfactory solution. On the whole, however, it appears, for the reasons we shall now shortly state, that it should, under certain restrictions, be decided in the affirmative.

In the first place, it may be observed, that owing to changes of fashion, to the miscalculation of producers and merchants, and to political events, those engaged in manufacturing employments are necessarily exposed to many vicissitudes; and when their number is so very great as in this country, it is quite essential that a resource should be provided for their support in periods of adversity. In the event of no such provision being made, and of the distress being at the same time extensive and severe, the public tranquillity would most likely be seriously endangered. Lord Bacon has observed, that "of all rebellions, those of the belly are the worst." It would be visionary, indeed, to imagine that those who have nothing should quietly submit to suffer the extremity of want without attacking the property of others; and hence, if we would preserve unimpaired the peace, and consequently the prosperity, of the country, we must beware of allowing any considerable portion of the population to fall into a state of destitution. But without the establishment of a compulsory provision for the support of the unemployed poor, it is difficult to see how they could avoid occasionally falling into this state. Through its instrumentality, however, they are sustained in periods of adversity, without being driven by necessity to commit crimes. It must, indeed, be admitted that a provision of this sort is very liable to abuse. Means have, however, been devised for checking this tendency; and whatever imperfections may, after all, attach to it, it has not yet been shown how security and good order could be maintained in periods when either employment or food was deficient, were it abolished.

In the second place, supposing it were possible to maintain tranquillity without making a legal provision for the support of the unemployed poor, the privations to which, under such circumstances, they would be forced to submit, would, in all probability, lower their notions as to what was necessary for their comfortable subsistence, and exert a most pernicious influence over their conduct and character. It is, perhaps, unnecessary to enter into any statements to show the importance of endeavouring to guard against any such obviously mischievous results. But Mr. Barton has made some observations on this point, which are so striking and conclusive, that we cannot forbear laying them before the reader. "It is to be remembered," says he, "that even those who most strongly assert the impolicy and injurious tendency of our poor laws, admit that causes wholly unconnected with these laws do, at times, depress the condition of the labourer. Poor families are often thrown into a state of severe necessity by long-continued illness or unavoidable misfortunes, from which it would be impossible for them to return to the enjoyment of decent competence if not supported by extraneous means. It is well known, too, that a general rise in the price of commodities is seldom immediately followed by a rise in the wages of country labour. In the meantime, great suffering must be endured by the whole class of peasantry, if no legislative provision existed for their relief; and when such a rise of prices goes on gradually increasing for a series of years, as sometimes happens, the sufferings resulting from it must be proportionally prolonged. The question at issue is simply this, whether that suffering be calculated to cherish habits of sober and self-denying prudence, or to generate a spirit of careless desperation?

"During these periods of extraordinary privation the labourer, if not effectually relieved, would imperceptibly lose that taste for order, decency, and cleanliness, which had been gradually formed and accumulated, in better times, by the insensible operation of habit and example; and no strength of argument, no force of authority, could again instil into the minds of a new generation, growing up under more prosperous circumstances, the sentiments and tastes thus blighted and destroyed by the cold breath of penury. Every return of temporary distress would, therefore, vitiate the feelings and lower the sensibilities of the labouring classes. The little progress of improvement made in happier times would be lost and forgotten. If we ward off a few of the bitterest blasts of calamity, the sacred flame may be kept alive till the tempest be past; but if once extinguished, how hard is the task of rekindling it in minds long inured to degradation and wretchedness!" (*Inquiry into the Depreciation of Agricultural Labour*, p. 32.)

In the third place, it will, we suppose, be admitted, that when a considerable number of destitute poor persons are thrown out of employment, a provision of some sort or other should be made for their support. Suppose now that it is made, not by a compulsory rate, but by the charitable contributions of the benevolent: it is contended that such a mode of relieving their distress tends to nourish the better feelings of the poor, and that many would rather choose to undergo the greatest privations than submit to solicit a share of this charitable contribution, who yet would make no scruple of claiming it had the state given them a legal right to look to it for support. But, admitting the truth of this statement, it has been already seen that it is not for the advantage of society that the poor should be forced to submit to such extraordinary privations. It is, besides, abundantly certain that many would not be influenced by the motives alluded to; and in the event of the distress being either very severe, or long-continued, even those most disinclined to become a burden on others might be forced to beg a pittance. And it is pretty obvious, notwithstanding all that has been said to the contrary, that the necessary result of such a state of things would be far more prejudicial to the character of the poor, — that it would do more to prostrate their pride and independence, and to sink them in their own estimation, than the acceptance of relief from a poor's rate. It is idle, indeed, to talk about the independence of a man who is receiving charity; but an individual supported by a poor's rate cannot fairly be regarded in such a point of view. He is merely sharing in a public provision made by the state; and as all property has been acquired with the knowledge that it was responsible to this claim on the part of the poor, it cannot justly be considered as entailing any burden on any particular individual. It may, therefore, one should think, be fairly presumed that the pride and independence of the poor will be more likely to be supported under a system of this sort, than if they were obliged to depend, in periods of distress, on the bounty of others. Wherever the poor have not either *de jure* or *de facto* a claim for support, they must unavoidably, in such periods, be allowed to beg. But of all the scourges that afflict and disgrace humanity, there is, perhaps, none more destructive than the prevalence of mendicity. A common beggar is the most degraded of beings; and the experience of Ireland, down to a very late date, as well as of France, Italy, Spain, and, in short, of every country where there is no established provision for the support of the poor, shows that wherever they are compelled to depend on so precarious a resource as charity, we look in vain for that manliness and independence of character among the labouring classes which distinguish those of England, and find in their stead all those degrading vices which a sense of insecurity, and the prevalence of beggary, are sure to produce.

The people and legislature of England have acquiesced in the justice and expediency of the principles now laid down. A compulsory provision for the support of the poor has, in fact, existed in England for a lengthened period. It grew out of the impotent attempts made in the reigns of Henry VIII., Edward VI., and the earlier part of that of Elizabeth, to suppress mendicancy, and at the same time to provide for the poor by voluntary contributions. At length the earlier statutes on the subject were consolidated, and the principle of compulsory provision carried to the fullest extent by the famous statute of the 43 Eliz. c. 2., which enacted, that all maimed and impotent persons should be provided for at the expense of their respective parishes, and that employment should be found for the unemployed able-bodied poor. From this remote period, the law of England has regarded every parish in the light of a family, the richer members of which were bound to provide for those who, through inability, misfortune, or want of work, could not provide for themselves. This, also, is the principle embodied in the law of Scotland with respect to the poor; and provided the means for carrying it into effect be so contrived that indigence and suffering may be relieved, without at the same time encouraging indolence and vice, the system would seem to be quite unexceptionable. Practically, however, this has been found to be a problem of exceedingly difficult solution, and this difficulty has made not a few conclude that, however administered, all systematic attempts to relieve the poor are necessarily, in the end, productive of increased want and misery.

The poor, no doubt, are naturally anxious that the compulsory provision for their support should be raised to the highest limit; and that their necessities should not only be relieved, but that they should be able, without molestation, to eat the bread of idleness. But wherever the assessment and administration of the provision for their support is left to the care of those on whom the burden of its payment really falls, this tendency to abuse is not long in being effectually provided against; and the sustaining and beneficial influence of the system alone

remains. The complicated code of laws respecting settlements, and the establishment of workhouses, owes its origin to this principle — to the wish of the legislature to relieve the poor, and, at the same time, to prevent the abuse of the rates; and there is unquestionable evidence to show, that, from the establishment of the system in 1603 down to about 1780, the devices in question were effectual for their object; and that while poverty was relieved, no encouragement was given to sloth, or to early and improvident unions. But soon after this period various innovations were made on the old law, which broke down most of the securities against the abuse of the rates; and, in 1795, the pernicious principle was adopted of mixing together wages and poor rates, and of eking out what was supposed to be a deficiency in the former by payments from the latter! In consequence of this subversion of the principle on which the poor rates had been previously administered, they began rapidly to increase, and threatened to swallow up the whole, or, at least, a very large part of the surplus produce of the land. Various devices were resorted to, in the view of checking the evil; but, unaccountable as it may appear, not one of them had for its object to revert to those practices and mode of administering the law which the experience of more than 250 years had shown were fully effectual for the prevention of abuse. At length the Poor Law Amendment Act was passed in 1834, which introduced a totally new system for the administration of the poor laws. Under this act the country has been divided into unions of more or fewer parishes, according to circumstances, the administration of all matters relating to the poor in these unions being intrusted to a board of guardians elected by the rate-payers. But these guardians are themselves controlled by, and in fact are merely the executive officers of, a central board of three commissioners established in London, who have power to issue rules and regulations as to the management of the poor, which all guardians, and other inferior officers, are bound to obey. The central board is assisted by deputy commissioners, who attend at meetings of guardians, explain the law, and adjudicate or report upon extraordinary cases, and see that the rules laid down by the central board are complied with. The whole that can be said in favour of this law is, that the poor rates have been materially reduced since its introduction; but we incline to think that the reduction would have been about as great had the system for the regulation of the compulsory provision that prevailed in the reign of George II. been revived, with a few alterations; while many pernicious consequences, inseparable from the existing system, would have been avoided. (See *Wealth of Nations*, M'Culloch's ed. note xxii.)

We subjoin a table of the sums expended for the relief and maintenance of the poor of England and Wales at different periods since 1748, with an estimate of the pop. at these periods: —

Years.	Sums expended on Poor.	Population.
Average.	*L.*	
1748, 1749, 1750	689,971	6,000,000
1775, 1776	1,530,800	7,000,000
1783, 1784, 1785	2,004,239	8,000,000
1801	4,017,871	8,872,000
1813	6,656,100	10,160,000
1821	6,959,249	11,978,000
1831	6,798,888	13,897,000
1835	5,526,418	14,750,000
1839	4,406,907	15,577,000

POPE. A title derived from an oriental word signifying father, and in earlier times applied indiscriminately to all bishops, and in the East even to ministers; but for many centuries the term has been confined to the bishop of Rome, who is also designated by Roman Catholics as the Holy Father. *See* PAPACY.

POPERY. *See* PAPACY.

POPLITEAL. (Lat. poples, *the ham.*) Relating to the posterior part of the knee-joint or *ham*.

POPULATION. (Lat. populus, *people.*) The inhabitants or people of any particular territory or district.

POPULATION, LAW OR PRINCIPLE OF, in Political Economy, means the law according to which the population of any country would increase, independently of immigration or emigration, under any assumed set of circumstances.

The law of population, or of the increase of the human species, has not, till a comparatively recent period, attracted that attention to which it is eminently entitled. It was formerly taken for granted that every increase of population was an advantage, and it was usual for legislators to encourage early marriages, and to bestow rewards on those who brought up the greatest number of children. But the researches of Mr. Malthus* have shown the mischievous nature of such interferences: they have shown that every increase in the numbers of a people, occasioned by artificial expedients, and which is not either accompanied or preceded by a corresponding increase of the means of subsistence, can be productive only of misery or of increased mortality; that the difficulty never is to bring human beings into the world, but to feed, clothe, and educate them when there; that mankind do everywhere increase their numbers, till their farther multiplication is restrained by the difficulty of providing subsistence, and the poverty of some part of the society; and that, consequently, instead of attempting to strengthen the principle of increase, we should rather endeavour to strengthen the principles by which it is controlled and regulated.

In order briefly to show the principle on which the increase of population depends, we may state that the sexual passion or instinct has appeared in all ages and countries so nearly the same, that it may, in the language of geometers, be called a constant quantity. Now, it has been shown by the experience of America, and of other countries under nearly similar circumstances, or where there has been a nearly equal command over the means of subsistence, that population has gone on, for a lengthened period, doubling in every twenty or five and twenty years. But the same principle or instinct that doubles the population of any particular country in this short period is every where in existence, and is every where about equally powerful. And, such being the case, it may be asked, Why does not population every where increase with the same rapidity as in Kentucky or Illinois? The reason is, that the increase of population must always depend upon, and can never for any considerable period exceed, the increase of the food and other accommodations required for the subsistence of human beings; and this increase being very different in different countries, the progress of population must vary accordingly: in some it may be rapid, in others slowly progressive, and in others stationary, or even retrograde.

It is certain, however, that the principle of increase in the species is sufficiently powerful to keep the population of the most favoured countries, or of those where wealth is most easily obtained and rapidly increased, quite up to the level of the means of subsistence. This is evinced by the poverty of a considerable portion of the people of such countries, by their usually having more claimants for employ than employers, or by the demand for labour being rather greater than that for labourers; in short, by the constant pressure, as it were, of a part of the population against the limits of subsistence. But, when such is the case, even in the most favourably situated countries, it is quite obvious that if the principle of increase were allowed to exert its full force in countries placed under less favourable circumstances, — if the same habit of early and universal marriage were indulged in the latter as in the former, it could not fail to occasion the most deplorable results. Man cannot increase beyond the means of subsistence; and where these are either stationary, or but slowly advancing, any such development of the principle of increase as is exhibited in countries where these means are increasing most rapidly would be productive only of increased misery and mortality. And hence, in the vast majority of cases, the principle of increase is restrained and controlled by prudential considerations. Man is not, like the lower animals, actuated only by instinct. To occasion a marriage, it is not always enough that the parties should be attached to each other. The obligation of providing for the children that may be expected to spring from it, is one that cannot fail to awaken the forethought and to influence the conduct of all but the most improvident and thoughtless. If the situation of those who might be disposed to enter into a matrimonial alliance be such as to preclude all reasonable expectation of their being able to bring up and educate their children, without exposing themselves to privations, or to the risk of being cast down to a lower place in society, they may not improbably either relinquish all thoughts of forming a union, or postpone it till a more convenient opportunity. No doubt there are very many individuals in all countries who are not affected by such considerations, and who, seeing the future through the deceitful medium of their passions, are not deterred from gratifying their inclinations by any fear of the consequences. But the great majority of every society act on sounder principles. They are anxious not to preserve merely, but to improve their condition in society, and cannot bear the idea that their family should be in a worse situation than themselves. Hence the reason that in all old settled or densely peopled countries, marriages are deferred to a much later period than in colonies and newly settled countries, where there are comparatively great facilities for gaining a livelihood, and that a much larger proportion of the population find it expedient to pass their lives in celibacy. And it is fortunate that such is the case, — that the forethought and good sense of the people, and their laudable wish to maintain and better their condition, make them control

* Essay on the Principle of Population, *passim*. The first edition of this work was published in 1798.

the violence of their passions, and disregard the dicta of spurious advisers. It is quite obvious that if the capacity of multiplication, or the principle of increase, in densely peopled countries, where there is a comparatively great difficulty in obtaining supplies of food, were not checked by the prevalence of moral restraint, arising from the consideration of the circumstances under which society is placed, it would occasion the constant pressure of misery and famine. There is no alternative. The population of every country has the power, supposing food and other necessary accommodations to be adequately supplied, to go on doubling every twenty or five and twenty years; but as the limited extent and limited fertility of the soil render it impossible to go on permanently producing food in this ratio, it unavoidably follows that unless the passions be moderated, and a proportional diminution be effected in the number of marriages and births, the standard of subsistence will be reduced to the lowest assignable limit, and famine and pestilence will be perpetually at work to relieve the population of wretches born only to be starved.

Although, therefore, the principle or instinct which prompts to the increase of the species be alike powerful in the most opposite conditions and states of society, its development depends on a variety of circumstances. Generally, however, there can be no question that it is sufficiently powerful, even where the means of subsistence are acquired with the greatest ease, to keep population on a level with these means; and in all but the most favoured situations, it could hardly fail, if not controlled by other circumstances, to make the increase of population outrun that of the means of subsistence, and, consequently, to occasion an increase of misery and mortality. But this tendency is seldom or never allowed to exert its full influence. The principle of increase, though one of the strongest implanted in our nature, is, after all, governed less by instinct than by reason. At all events, it is invariably found, when we look at nations or great masses of individuals, that the period and frequency of marriages and the rate of increase are determined by the state of the population with respect to food, and that the latter is never outrun by the former.

The principle of increase is not, therefore, the bugbear, the invincible obstacle to all real improvement it has been represented by those who have overlooked the influence of moral causes in modifying and controlling its action. That the tendency to increase is not inconsistent with the improvement of society is a fact, as to which, indeed, there can be no dispute. Without going back to antiquity, let any one compare the state of this or any other European country 500 or 100 years ago with its present state, and he will be satisfied that prodigious advances have been made, that the means of subsistence have increased much more rapidly than the population, and that the labouring classes are now generally in the possession of conveniences and luxuries that were formerly not enjoyed even by the richest lords. The principle of increase is not, however, merely consistent with the continued improvement of the bulk of society—it is, in fact, the great cause of this improvement, and of the wonderful progress made in the arts. Had the principle been less powerful, or had it not existed at all, every new discovery, by diminishing the necessity for others, would have occasioned a decline in the spirit of invention; and society would long since have been either in a languishing or a stationary state. But the increase of population, though generally subordinate to the increase of food, is always sufficiently powerful to keep invention on the stretch. All that numerous class who live by their labour, and who are either striving to raise themselves to a higher station, or to maintain their present position, are at this moment impelled by the same powerful motives to invent and contrive new and more powerful methods of production that impelled their ancestors 5,000 years ago; and so it will be in all time to come. The *curis acuens mortalia corda* will never cease to operate, and will secure the continued advancement of society. To suppose, as some have done, that the extraordinary progress already made in science and the arts would have been equal or greater had the tendency to increase been less powerful, is in truth equivalent to supposing that industry and invention would be promoted by lessening the motives to their exercise, and the advantages derivable from them. There might, perhaps, have been less squalid poverty among the very dregs of the population, had there been no principle of increase; but it is a contradiction to pretend, had such really been the case, that the powers and resources of industry would have been so astonishingly developed, that scientific investigations would have been prosecuted with equal perseverance and zeal, that so much wealth would have been accumulated by the upper and middle classes, or that the same circumstances which urged society forward in its infancy would have continued in every subsequent age to preserve their energy unimpaired; and it may well be doubted whether an exemption from the evils incident to poverty would not have been dearly purchased, even by the very lowest classes, by the sacrifice of the hopes and fears attached to their present condition, and the extraordinary gratification they now reap from successful industry.

If these conclusions be well founded, it follows that the schemes proposed for directly repressing population in the ancient and modern world, besides being for the most part atrocious and disgusting, have really been opposed to the ultimate objects their projectors had in view. Could the rate of increase be subjected to any easily applied physical control, few comparatively among the poorer classes would be inclined to burden themselves with the task of providing for a family; and the most effective stimulus to exertion being destroyed, society would gradually sink into apathy and languor. It is, therefore, to the principle of moral restraint, or to the exercise of the prudential virtues, that we should exclusively trust for the regulation of the increase of population. In an instructed society, where there are no institutions favourable to improvidence, this check is sufficiently powerful to confine the progress of population within due limits, at the same time that it is not so powerful as to hinder it from operating, in all cases, as the strongest incentive to industry and economy.

Mr. Malthus's *Essay on Population* made a great sensation at the time when it appeared, and is valuable from its showing conclusively that the principle of increase is strong enough, without any adventitious encouragement, to keep population always on a level with the means of subsistence. In other respects, however, it is altogether defective. Mr. Malthus has not shown that the mischievous consequences that might otherwise result from the operation of the principle of increase are sure to be countervailed by the operation of those prudential considerations to which it necessarily gives rise; nor has he shown the important and powerful influence of the principle in securing the continued improvement of society. One of the best expositions of the theory of population is that given by Bishop Sumner in his *Records of the Creation*. See also the note on Population in M'Culloch's edition of the *Wealth of Nations*.

PO'PULIN. A crystallizable substance separated from the bark of the *Populus tremula*.

PO'RCATE. (Lat. porca, *a ridge*.) In Entomology, when a surface has several parallel elevated longitudinal ridges.

PORCELAIN. *See* POTTERY.

PORCELLANITE. An opake brittle variety of jasper.

PORCH. (Fr. porche.) In Architecture, an arched or flat or ceiled vestibule at the entrance of a church or other building.

PORES. In Natural Philosophy, the small interstices between the particles or molecules of matter which compose bodies. There are many considerations which prove that all bodies, even the densest, are composed of molecules, not in absolute contact, but separated from each other by intervals, which, though so small as to be inappreciable to the senses, have, nevertheless, a magnitude considerable in respect of the molecules themselves. The porosity of bodies may be demonstrated in many cases by very simple experiments. If a piece of wood, or marble, granite, or other compact stone, be plunged under water and placed under the receiver of an air-pump, on withdrawing the external pressure the air which had been dispersed through the interior cavities, or pores, will issue from every point of their surface, and rise in a torrent of bubbles. In like manner, mercury is forced through a piece of dry wood or leather, and made to fall in a finely divided shower. A body plunged deep under a liquid sustains a pressure, in consequence of which it is contracted in all its dimensions, and the liquid penetrates the body without producing any apparent disruption of its parts. Iron, by being hammered, is reduced in volume; and the dimensions of all bodies are affected by heat and cold. The facility with which translucent substances are penetrated by the rays of light evinces extreme porosity. And this penetration is not confined to bodies which are usually termed diaphanous; for gold itself, one of the most opake of the metals, when beaten into extreme thinness, transmits a soft green light. All these facts prove the existence of pores; and it has been inferred that gold has more pores than solid parts; whence water, or any substance of the same specific gravity, must have many times more pores than solid parts.

PORI'FERA. (Lat. porus, *a pore*, and fero, *I carry*.) A name invented and applied by Mr. Hogg to a group of Polyps, including the genera *Cellepora*, *Millepora*, and *Tubulipora*: also used by Dr. Grant to designate the class of organized beings including the marine and fresh-water sponges.

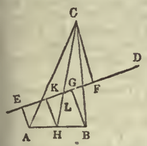
PO'RISM. (Gr. *πορισμα*; from *ποριζω*, *I investigate*), in Geometry, is defined by professor Playfair to be "a proposition affirming the possibility of finding such conditions as will render a certain problem indeterminate, or capable of innumerable solutions."

According to Pappus, the porisms constituted one of

the eight subjects which formed the ancient geometrical analysis. Euclid composed a treatise on porisms in three books, of which no trace now remains, except some obscure hints preserved in the mathematical collections of Pappus. From the manner in which the porisms are mentioned by Pappus, it is evident that the ancients set a high value on this class of propositions; but the description which he has given of them is so vague that geometers were long unable to divine his meaning, or to discover the peculiar circumstances in respect of which a porism differs from an ordinary problem. The subject, indeed, baffled the ingenuity of the most eminent mathematicians, until it was taken up by Dr. Simson, of Glasgow, who at length succeeded in restoring a great number of Euclid's porisms, together with their analysis. The propositions thus restored form a part of his posthumous works, published in 1776, at the expense of Earl Stanhope. It still remained, however, to inquire into the probable origin of the porisms, or the steps by which the ancient geometers had been led to their discovery; and also to point out the relations in which they stand to other classes of geometrical truths. This was accomplished by the late Professor Playfair, in an admirable paper, "On the Origin and Investigation of Porisms," published in vol. iii. of the *Transactions of the Royal Society of Edinburgh*, and afterwards in the 3d volume of his collected Works, Edin. 1822.

The nature of a porism, and the manner in which it is derived from an ordinary proposition, will be best illustrated by an example. The following proposition is one of those selected by Mr. Playfair for the purpose: —

A triangle A B C being given, and also a point D; to draw through D a straight line D E, such that perpendiculars being drawn to it from the three angles of the triangle, namely, A E, B G, C F, the sum of the two perpendiculars on the same side of D E shall be equal to the remaining perpendicular, or that A E and B G together shall be equal to C F.



Suppose it done; bisect A B in H, join C H (intersecting D E in L), and draw H K perpendicular to D E.

Because A B is bisected in H, the two perpendiculars A E and B G are together double of H K; and, as they are equal to C F, by hypothesis, C F must also be double of H K, and C L of L H. Now C H is given in position and magnitude, therefore the point L is given; and the point D being also given, the line D L is given in position, which was to be found.

The construction is obvious. Bisect A B in H, join C H, and take H L equal to one third of C H; the straight line which joins the points D and L is the line required.

Now, it is plain that while the triangle A B C remains the same, the point L also remains the same, wherever the point D may be. The point D may therefore coincide with L; and, when this happens, the position of the line to be drawn remains undetermined; that is to say, any line whatever drawn through L will satisfy the conditions of the problem. Here, then, we have an indeterminate case of a problem, and, of consequence, a porism, which may be thus enunciated: —

A triangle being given in position, a point in it may be found such that any straight line whatever being drawn through that point, the perpendiculars drawn to this straight line from the two angles of the triangle which are on one side of it, will be together equal to the perpendicular that is drawn to the same line from the angle on the other side of it.

For examples of porisms, see *Simson's Opera Reliqua;* Playfair's paper above mentioned; a paper by Prof. Wallace, entitled "Some Geometrical Porisms, &c." in the *Edinburgh Transactions*, vol. iv.; *Stewart's General Theorems*, 1746; *Leslie's Geometrical Analysis;* and *Leybourn's Mathematical Repository*. See also *Traill's Account of the Life and Writings of Robert Simson, M.D.;* and Chasles, *Aperçu Historique sur l'Origine et le Développement des Méthodes en Géometrie*, Brux. 1837.

The term porism is also used by the Greek geometricians to signify merely the corollary to a proposition.

PORO'SITY. A property of matter, in consequence of which its molecules are not in absolute contact, but separated by intervals or *pores*. The quantity of matter in a body is inversely as its porosity; whence the ratio of the porosity of one body to another may be determined from their weight. *See* PORES.

PO'RPHYRY. (Gr. πορφυρα, *purple*.) In Statuary, an extremely hard stone of a red, or rather purple and white colour, more or less variegated, its purple being of all gradations, from violet to a claret colour. It is susceptible of a very high polish. Egypt and the East furnish very plentiful strata of this material. It is also found in Minorca. The extreme ease with which the ancients seem to have cut this substance and worked it in sculptural subjects has been a matter of much discussion among the moderns. Dr. Lister, in a paper of the *Philosophical Transactions*, seems to think that the ancients possessed the secret of tempering steel better than the moderns. The French cut it with an iron saw without teeth, using a kind of freestone pulverized and mixed with water. And Cosmo di Medici is said to have distilled a water by the help whereof Francesco Taddi, his sculptor, gave his tools a hardness and temper capable of working the hardest and most compact substances.

PORPHYRY. In Geology, an unstratified or igneous rock containing embedded crystals of felspar. The term was originally applied to a *red* rock of this kind found in Egypt, alluded to in the preceding article. *See* GEOLOGY.

PO'RPITA. (Gr. πορπη, *Annulus clypei.*) The name of a genus of sea-nettles (*Acalephæ*), characterized by an internal circular flattened disk of a calcareous and horny texture.

PORRECT. (Lat. porrigo, *I extend.*) In Zoology, when a part extends forth horizontally, as if to meet something.

PORRI'GO. (Lat. porrigo.) The ringworm, or scald-head.

PORT. *See* HARBOUR.

PORT is, usually, the adverb of larboard; as, the ship heels *to port*, for to the larboard side. Put the helm *a-port*, &c.

PORT. The opening or embrasure in the ship's side for a gun. The ports of the lower deck are defended, when at sea, by strong covers hanging from hinges; the ropes by which these are held up or open are called *port lanyards*, and consist of a pendant passing through a leaded hole in the side with a tackle.

PORTAL. (Fr. portail.) In Architecture, the lesser of two gates, when they are of two dimensions, at the entrance of a building.

PORTCU'LLIS. (Fr. portecoulisse.) In Fortification, a sort of machine composed of several large pieces of wood laid across one another, like a harrow, and pointed with iron, used formerly to be hung over gateways of fortified places, to be let down in case of a surprise, and when there was not time to shut the gate.

PORTE, THE SUBLIME. The official title of the government of the Ottoman Empire: said to be derived from a gate of the palace at Broussa, the original metropolis of that empire, called Bâb Humayoor, the sublime gate.

PO'RTER. A liquor brewed from malt, part of which has been more highly dried than that used for ale. It is hopped in the same way as ale; and its deep colour is finally given to it either by burned sugar, which usually goes under the name of *colouring*, or more legitimately by roasted or parched malt. Porter was first brewed in 1722. The malt liquor previously drunk consisted of three kinds — ale, beer, and "twopenny;" and a mixture of either of these kinds was a favourite beverage under the name of "half-and-half;" or a mixture was drunk called "three threads," consisting of equal portions of each of the above kinds of liquor, for a draught of which the publican had to go to three different casks. About 1722, Harwood, a London brewer, commenced brewing a malt liquor, which was intended to unite the flavours of ale and beer, or ale, beer, and "twopenny;" and having succeeded, he called his liquor "entire," or "entire butt;" a name intended to intimate that it was drawn from one cask or butt only. A mixture of ale or porter, drawn from different casks, is very commonly drunk in London at the present time. Harwood's liquor obtained the name of porter from its consumption by porters and labourers. From 1722 to 1761, the retail price of porter was 3*d.* per pot, when it was raised to 3½*d.*, at which it continued till 1799; it has never been higher than 6*d.*, nor during the present century lower than at the present time (September, 1841), when the price is 4*d.* The following account of the fluctuations of the price per barrel since 1816 is from a private source: — In July, 1816, the price was reduced from 45*s.* to 40*s.*, but in October was again advanced to 45*s.*; in January, 1817, a further advance was made to 50*s.*; and in December of the same year it reached 55*s.* In 1819, 1820, and 1822, the price was successively reduced from 55*s.* to 50*s.*, 45*s.*, and 40*s.* In January, 1824, it was advanced to 45*s.*; in November, 1825, to 50*s.*; but a few months afterwards it again fell to 45*s.* Since the abolition of the beer duties in 1830, the price has been 33*s.* per barrel.

PORT-FIRE. In Gunnery, a paper tube about 10 inches long, filled with a composition of meal-powder, sulphur, and nitre, rammed moderately hard; used to fire guns and mortars instead of a match. (*Hutton's Dict.*)

PO'RTICO. (Ital.; from porticus, Lat.) In Architecture, a place for walking in under shelter, occasionally raised after the manner of a gallery with arches. Sometimes the portico is vaulted, and sometimes it is with a flat ceiling. The most usual application of the word is to the projection supported by columns placed before a building.

PO'RTIO, or PORTION, is a term anatomically ap-

plied to two branches of the seventh pair of nerves; the *portio dura*, or hard portion, and the *portio mollis*, or soft portion: the former is the facial nerve, the latter the auditory or acoustic nerve.

PO'RTLAND POWDER. A mixture of several indigenous bitter herbs which was once a celebrated remedy in the gout.

PO'RTLAND STONE. A granular limestone belonging to the upper part of the oolite formation, and abounding in the island of Portland, upon the coast of Dorsetshire. *See* GEOLOGY.

PORTLAND VASE. A celebrated cinerary urn or vase, long in possession of the noble family of the Barberini at Rome (whence it was called the Barberini vase); from whom it came into the possession of the Portland family, who deposited it in 1810 in the British Museum, of which it is one of the most valuable reliques. This beautiful specimen of ancient art was found in the tomb of the Emperor Alexander Severus and his mother Mammæa. It is described by Montfauçon (*Antiq. Expliqué*, tom. v.), who was evidently mistaken in representing it as formed of a precious stone. The substance is said to be of glass, or composition; it is of a deep blue or violet colour, and the figures in the scene depicted on it are white. The subjects are mythological, but have been very imperfectly explained. (See two memoirs upon it, by Dr. King and W. Marsh, in the 8th volume of the *Archæologia*, and one by Dr. Darwin in the Notes to his *Botanic Garden*.) The late Mr. Wedgwood made a mould of this vase, and took from it a number of casts made with the greatest skill, and perfectly resembling the original.

PO'RTRAIT. (Fr. pourtrait.) In Painting, the representation of an individual, or, more strictly speaking, of a face, painted from real life. Portraits are of full length, half length, &c.; and are executed in oil or water colours, crayons, &c.

PORTREE'VE, or PORT GREVE. (Ang. Sax. gerefa.) Anciently the principal magistrate in ports and maritime towns. According to Camden, this was the ancient title of the officer who was afterwards called mayor in London.

PORT ROYALISTS. The name popularly given to the members of the celebrated convent of the Port Royal des Champs. It was founded about 1204 by Matthieu de Marli, on the eve of his departure for the Holy Land; and though originally limited in its means and objects, it gradually acquired such importance as to have secured for it a prominent place in the history of Europe. It would be out of place here to give any details of its varied fortunes, and the religious controversies which it carried on in the 17th century — the period of its greatest importance; and we refer the reader to the learned work of Reuchlin (*Geschichte von Port Royal*), for full information. (See also the eloquent article in vol. lxxiv. of the *Edin. Review*.) It was abolished by Louis XIV., as a nest of Jansenists and heretics. Among the distinguished names connected with the Port Royal are those of Lancelot, Paschal, Arnauld, Nicole de Sacy, and Tillemont. The school books which were published for the use of that institution were translated into all the languages of Europe, and maintained their reputation long after its abolition; and though they are now fallen into disuse, the following deserve especial mention: — 1. *Nouvelle Méthode pour apprendre la Langue Latine*; 2. *Nouvelle Méthode pour apprendre la Langue Grecque*; 3. *Grammaire Générale, &c.*

POSI'TION. (Lat. pono, *I place*.) A rule in Arithmetic, called also the rule of supposition, or *rule of false*. It consists in assuming a number, and performing upon it the operation described in the question, and then comparing the result with that given in the question, in order to discover the error of the assumption. Writers on arithmetic divide the rule into two parts, *single position* and *double position*; the former comprehending those questions in which the results are proportional to the suppositions, and where, consequently, only one assumption is required; the latter those in which the results are not proportional to the suppositions, and where two suppositions are necessary in order to deduce the true answer. To simple position belong such questions as the following: — What number is that from which, if a third and a fourth of itself be subtracted, the remainder is 60? Double position comprehends questions of this sort: — What number is that which, being multiplied by 6, the product increased by 18, and the sum divided by 9, the quotient shall be 20? It will be observed that both these questions are immediately solved by a simple algebraic equation; and, in fact, the same process is performed in the arithmetical operation in the assured number, which, in the algebraic, is performed on the unknown quantity. The rules given for the solution of questions in double position are founded on certain principles of algebra, which may be applied with much greater facility to the immediate solution of the questions themselves. Such questions, therefore, cannot be considered as properly belonging to arithmetic, but to what may be denominated numerical analysis. Position is also called the *rule of trial and error*, and is sometimes employed with good effect in approximating to the roots of numerical equations.

POSITION. In Painting, the placing of the model in the manner best calculated for the end in view by the artist. Such positions as are most natural and easy, and which exhibit the peculiar habit of the individual, in portrait painting, are preferable.

POSITIVE ELECTRICITY. *See* ELECTRICITY.

POSITIVE QUANTITY, in Algebra, denotes an affirmative or additive quantity; which character is indicated by the sign +, called, in consequence, the *positive sign*. The term is used in contradistinction to *negative*; negative quantities being such as are subtractive, and marked by the sign —, which is called the *negative sign*. *See* SIGN.

PO'SSE COMITA'TUS. (Lat.) In Law, the power of the county, which the sheriff is empowered to raise in case of riot, possession kept on forcible entry, rescue, or other force made in opposition to the king's writ or execution of justice. It is said to include all knights and other men, above the age of fifteen, able to travel within the county. Justices of the peace may also raise the posse in order to remove a force in making entry into or detaining lands.

POST. (Fr. poste.) In Architecture, any vertical piece of timber; as a truss post, door post, a quarter in a partition.

POST. In Public Economy, a messenger, courier, or conveyance that travels at stated periods, and generally with more than ordinary speed, employed to convey letters or other despatches, whether of government or individuals.

POST-ABDOMEN. (Lat.) The name applied by Latreille to the five posterior segments of the abdomen of Hexapod insects; and to the tail of Crustaceans, which consists of analogous but more numerous segments.

POSTAGE. The duty or rate of charge levied on letters or other articles conveyed by post.

PO'STEA. (Lat.) In Law, the return of the judge before whom a cause is tried, after verdict, of what was done in the cause, which is endorsed on the back of the nisi prius record.

PO'STERN. (Fr. posterne.) In Architecture, a small gate or door at the back of a building.

POSTERN. In Fortification, a small gate, usually made in the angle of the flank of a bastion, or in that of the curtain.

POSTI'LUM. (Lat.) In Architecture, the portico at the back of a temple. *See* NAOS.

POSTLIMI'NIUM, or JUS POSTLIMINII. (Lat. limen, *a threshold*.) In National and Civil Law, the right by virtue of which persons taken by an enemy return to their former state of freedom, with their former rights and property, on its termination; and property so taken reverts to its former owners.

POST OBIT. (Lat. post obitum, *after death*.) A bond given for the purpose of securing a sum of money on the death of some specified individual.

POST OFFICE. A place for the reception and distribution of the letters and despatches that are to be or that have been carried by the post; where the duties on them are paid, and where the various departments connected with the business of the post are conducted, or superintended.

The conveyance of letters by post is one of the few industrious undertakings which are certainly better managed by government than they could be by individuals. It is indispensable to the satisfactory working of the post office that it should be conducted with the greatest regularity and precision; and that all the departments should be made subservient to each other, and conducted on the same plan. It is plain that such results could not be obtained in any extensive country otherwise than by the agency of government; and the interference of the latter is also required to make arrangements for the safe and speedy conveyance of letters to, from, and through foreign countries.

The organization of the post office supplies one of the most striking examples of the advantages resulting from the division and combination of employments. "Nearly the same exertions that are necessary to send a single letter from Falmouth to New York will suffice to send 50,000. If every man were to effect the transmission of his own correspondence, the whole life of an eminent merchant might be passed in travelling, without his being able to deliver all the letters which the post office forwards for him in a single evening. The labour of a few individuals, devoted exclusively to the forwarding of letters, produces results which all the exertions of all the inhabitants of Europe could not effect, each person acting independently." (*Senior on Political Economy*.)

Posts appear to have been established for the first time in modern Europe in 1479, by Louis XI. of France. They were originally intended to serve merely for the conveyance of public despatches, and of persons travelling by authority of government. Subsequently, however, private individuals were allowed to avail themselves of

this institution for forwarding letters and despatches; and governments, by imposing higher duties or rates of postage on the letters and parcels conveyed by post than are sufficient to defray the expense of the establishment, have rendered it productive of a considerable revenue. Nor, while the rates of postage are confined within reasonable limits, and do not materially affect the facility of correspondence, is there, perhaps, a less objectionable tax.

The post office was not established in England till the 17th century. Post-masters, indeed, existed in more ancient times; but their business was confined to the furnishing of post horses to persons who were desirous of travelling expeditiously, and to the despatching of extraordinary packets upon special occasions. In 1635, Charles I. erected a letter office for England and Scotland; but this extended only to a few of the principal roads; the times of carriage were uncertain; and the post-masters on each road were required to furnish horses for the conveyance of the letters at the rate of $2\frac{1}{2}d.$ a mile. This establishment did not succeed; and, at the breaking out of the civil war, great difficulty was experienced in the forwarding of letters. At length a post office, or establishment for the weekly conveyance of letters to all parts of the kingdom, was instituted in 1649, by Mr. Edward Prideaux, attorney-general for the Commonwealth; the immediate consequence of which was a saving to the public of 7,000*l.* a-year on account of post-masters. In 1657, the post office was established nearly on its present footing, and the rates of postage that were then fixed were continued till the reign of Queen Anne. (*Black. Com.*, book i. c. 8.)

From the establishment of the post office by Cromwell, down to 1784, mails were conveyed either on horseback, or in carts made for the purpose; and instead of being the most expeditious and safest conveyance, the post had become, at the latter period, one of the slowest and most easily robbed of any in the country. In 1784, it was usual for the diligences between London and Bath to accomplish the journey in *seventeen* hours, while the post took *forty* hours; and on other roads the comparative rate of travelling of the post and stage coaches was in about the same proportion. The natural consequence of such a difference in point of despatch was, that a very great number of letters were sent by other conveyances than the mail: the law to the contrary being easily defeated, by giving them the form of small parcels.

Under these circumstances, it occurred to Mr. John Palmer of Bath, comptroller-general of the post office, that a very great improvement might be made in the conveyance of letters, in respect of economy, as well as of speed and safety, by contracting with the proprietors of stage coaches for the carriage of the mail; the latter being bound to perform the journey in a specified time, and to take a guard with the mail for its protection. Mr. Palmer's plan encountered much opposition, but was at length carried into effect with the most advantageous results. The use of mail-coaches speedily extended to most parts of the empire; and, while letters and parcels were conveyed in less than half the time that had been required under the old system, the coaches by which they were conveyed afforded, by their regularity and speed, a most desirable mode of conveyance for travellers. Mr. Palmer was the author of several other improvements in the economy of the post-office; nor is there any individual to whom the department owes more. (*Macpherson's Annals of Com.* anno 1784.)

Within the last few years, however, the construction of railways between most of the great towns of the empire has gone far to supersede the use of mail coaches on the principal lines of road, and has added prodigiously to the facilities of correspondence and travelling. The journey from London to Liverpool, which had been accomplished by the mail in about twenty or twenty-two hours, is now accomplished, by railway, in nine or ten hours! and on other roads in the same proportion. The great expense of the post office consists, in fact, not so much in the conveyance of letters from place to place, as in their previous collection and their distribution after they have been conveyed to their destination. This necessitates the establishment of a vast number of subordinate offices in the remoter parts of the kingdom, many of which do not defray their expenses. This is particularly the case in Ireland, where, in 1838, the expense of collecting the gross post office revenue amounted to 39*l.* 16*s.* $4\frac{1}{2}d.$ per cent.

Revenue and Rates of Postage. — During 1838 the post office of the United Kingdom produced a gross revenue of 2,346,278*l.*, and a nett revenue, after deducting the expense of collection, of 1,676,522*l.* This large revenue was derived from rates of postage, varying with the distance according to which letters were conveyed, but so that at an average they amounted to about 7*d.* or $7\frac{1}{2}d.$ for a single letter. But the fact that the post office revenue had continued nearly stationary during the twenty years ending with 1838, notwithstanding the vast increase in that period of population and of the intercourse between the different parts of the empire, was a conclusive proof that the rates of postage had been carried to a vicious excess; and that in the arithmetic of the post office, as well as of the customs, two and two, instead of always making four, sometimes make only one. The effectual reduction of these rates was therefore urgently required, not only because of the importance to a commercial and manufacturing community of having the charge for the conveyance of correspondence fixed at a moderate amount, but because it was all but certain that moderate rates of postage would be more productive of revenue. It did not, however, follow, that because an average charge of 7*d.* or $7\frac{1}{2}d$ each on all letters conveyed by post was very decidedly too much, that the plan for making an invariable charge of 1*d.*, whether the letter were conveyed one mile or 1000 miles, should have been adopted. This was to rush from one extreme to another, and to endanger a considerable amount of revenue without any equivalent advantage. It must, no doubt, be admitted that the proposal for a uniform penny rate of postage, had many recommendations in its favour. Being calculated at once to obviate trouble and save expense, it could not fail to be acceptable (what reduction of taxation is not?) to a large portion of the public, particularly to persons engaged in business. We believe, however, that the scheme was more indebted for its popularity to the oppressiveness of the old rates of postage than to any intrinsic merits of its own. Had these been reduced four or five years previously to a reasonable amount, that is, had letters of 1 oz. weight coming from Scotland or Ireland to London been reduced to 6*d.*, and other letters in proportion, and mercantile circulars been allowed to pass under covers open at the ends at 1*d.* or 2*d.* each, we venture to say that the clamour for a uniform rate of penny postage would not have made any way. But in this, as usually happens on similar occasions, those who delay to make reasonable and necessary concessions at the outset, are in the end compelled to concede a great deal more than would at first have been satisfactory. This, at all events, has been eminently true in the present instance. The clamour for a uniform penny rate became too powerful to be resisted; and parliament, whether it were so inclined or not, was obliged to lend its sanction to the measure And under the provision of the act 2 & 3 Vict. cap. 52., it has been enacted that all inland letters, without regard to the number of enclosures, or the distance conveyed, provided they be paid when posted or despatched, shall, if not exceeding $\frac{1}{2}$ oz. weight, be charged 1*d.*; 1 oz. 2*d.*; 2 oz. 4*d.*; 3 oz. 6*d.*; and so on; 2*d.* being added for every additional ounce up to 16 oz., beyond which, with the following exceptions, no packet, whether subject to postage or not, is received: —

1. Parliamentary petitions and addresses to her Majesty.
2. Parliamentary proceedings.
3. Letters and packets addressed to or received from places beyond sea.
4. Letters and packets to and from public departments, and to and from public officers that formerly franked by virtue of their offices.
5. Deeds, if sent open, or in covers open at the sides. They may be tied with string and sealed, in order to prevent inspection of the contents; but they must be open at the sides, that it may be seen that they are entitled to the privilege.

With these exceptions, all packets above the weight of 16 oz. will be immediately forwarded to the Dead Letter Office.

But all letters not paid when they are posted or despatched are charged *double the above rates*.

All parliamentary and official franking has been put an end to; but members of either house of parliament are entitled to receive petitions to parliament free of charge, provided such petitions be sent in covers open at the ends, and do not exceed 6 oz. weight.

To facilitate the working of the plan, envelopes and stamps for single, double, &c. letters, are furnished by the post office, and have been widely distributed.

Such are the more prominent features of the new system; and none can deny that it has the recommendations of simplicity and cheapness in its favour, and that it has greatly facilitated correspondence. But it may nevertheless be doubted whether its adoption was expedient. It is certainly very convenient for merchants, bankers, middlemen, and retail dealers, to get letters for 1*d.*, that previously cost them 7*d.* or $7d\frac{1}{2}$.; but their satisfaction is not the only thing to be attended to in forming a fair estimate of the measure. The public exigencies require that a sum of above fifty millions a year should be raised, one way or other; and so long as we are pressed by an unreasoning necessity of this sort, it is not much to say in favour of the repeal or diminution of any tax, that those on whom it fell with the greatest severity are delighted with the reduction. Sugar has in England become a necessary of life; and its consumption, to say the least of it, is quite as indispensable to the bulk of the people, and especially to the labouring classes, as the

writing of letters. But would it, therefore, be a wise measure to repeal the duty on sugar, or to reduce it to 1s. a cwt.? It has been alleged, indeed, that taxes on the transmission of letters are objectionable on principle, and should therefore be repealed, independently altogether of financial considerations. But it is easier to make an allegation of this sort than to prove it. All taxes, however imposed, if they be carried (as was the case with the old rates of postage) beyond their proper limits, are objectionable; but provided these be not exceeded, we have yet to learn why a tax on a letter should be more objectionable than a tax on the paper on which it is written, on the food of the writer, or on fifty other things.

During the first year (1840) of the new system, the nett revenue of the Post Office fell off about 1,200,000*l*.! No doubt, however, the revenue will increase in subsequent years, with the increasing population and wealth of the country. But it would have done this under any system of moderate duties; and its future increase, whatever it may be, is consequently no proof of the superiority of the present system.

POST POSITION. In Music, retardations of the harmony, effected by placing discords upon the accented parts of a bar not prepared and resolved according to the rules for discords.

POSTSCE'NIUM. (Lat. post, *behind*, and scena, *a scene*.) In Architecture, the back part of the theatre behind the scenes, furnished with conveniences for robing the actors and depositing the machinery.

PO'STULATE. (Lat. postulare, *to demand*.) In Geometry, something to be assumed, or taken for granted. Euclid has constructed his *Elements* on the three following postulates: — 1. That a straight line may be drawn from any one point to any other point. 2. That a terminated straight line may be produced to any length in a straight line. 3. That a circle may be described from any centre at any distance from that centre. (*Playfair's Euclid*.)

Postulate. In Logic and Philosophy, a proposition of which the truth is *demanded* or assumed for the purpose of future reasoning.

POTA'SH. The saline matter obtained by lixiviating the ashes of wood. When purified by calcination it is termed *pearlash*, and is in that state an impure *carbonate of potassa*. The production of potash is carried on upon a large scale in Russia and America; it can only be thus obtained in countries where there are vast natural forests, and where the value of timber is little more than that of the labour of felling it. *See* Potassium.

POTASSA. *See* Potassium.

POTA'SSIUM. This extraordinary metal was discovered by Davy in the year 1807, and was one of the first fruits of his masterly researches into the chemical powers of electricity. Its properties are so remarkable, that it was for a time doubted whether it could with propriety be placed among the metals; but the progress of discovery has removed all difficulty upon that point, by making us acquainted with other metallic substances, the properties of which are, as it were, intermediate between those of potassium on the one hand, and the common metals on the other. One of the striking peculiarities of potassium is mechanical rather than chemical, namely, its low specific gravity, it being the lightest known solid; another is its intense affinity for oxygen, and its consequent energetic action when placed upon water, where it immediately takes fire. The specific gravity of potassium is ·865 at the temperature of 60°.; it is solid at the ordinary temperature of the atmosphere; at 80° it becomes soft, and at 150° is perfectly liquid; at 32° it is brittle, and has a crystalline texture. In colour and lustre it resembles mercury. Its attraction for oxygen is such that it immediately loses its brilliancy on exposure to air, and becomes converted into potassa; heated in the air it burns with a purple flame. The equivalent of potassium is 40, and that of *potassa* or *protoxide of potassium* is 48. When potassium is heated in oxygen it absorbs a larger quantity of that element and becomes a *peroxide*, which, however, is immediately converted into protoxide by the action of water. Protoxide of potassium exists in the state of *hydrate* in what is called *caustic potash*, which is a compound of 48 potassa + 9 water. This substance fuses at a dull red heat: it is very soluble and deliquescent, and powerfully corrodes almost all animal textures. It is the *lapis causticus* of old pharmacy. Dissolved in water it forms *soap ley*, or the *liquor potassæ* of the Pharmacopœia. This solution is obtained by pouring water upon a mixture of equal parts of quicklime and carbonate of potassa; the lime abstracts carbonic acid from the carbonate, and becomes converted into an insoluble carbonate of lime, whilst the evolved potassa is taken up by the water. The solution thus obtained is powerfully alkaline and caustic; and, as it soon absorbs carbonic acid when exposed to air, it should be carefully preserved in well-stopped phials. Free potassa is easily detected and recognized, when in solution, by its alkaline reaction upon proper vegetable colours, rendering, for instance, the yellow of turmeric brown, and the blue of violet green: when excess of tartaric acid is added to it, it yields a white granular precipitate of bitartrate of potassa, and an alcoholic solution of carbazotic acid yields with it yellow and difficultly soluble crystals of carbazotate of potassa. When potassa is in combination, as, for instance, when any of its salts are dissolved in water, they are best detected by a strong solution of chloride of platinum, which causes a yellow precipitate of the potassio-chloride of platinum.

When potassium and sulphur are heated together, they combine and form a sulphuret of potassium. With the acids, potassa forms a variety of useful salts; such as nitre, or nitrate of potassa, with nitric acid; sulphate of potassa, with the sulphuric acid; and carbonate of potassa, with the carbonic acid. The latter is a very important salt: it forms great part of the residuum or ash of burnt wood, from which it is obtained by lixiviation, and brought to this country from Russia and America, under the name of *pearlash* and *potash*. It consists of 48 potassa + 22 carbonic acid; it is deliquescent, uncrystallizable, and has an alkaline reaction. When carbonic acid is passed through a solution of this salt, it becomes converted into bicarbonate of potassa, composed of 48 potassa + 44 carbonic acid. Potassium burns with great splendour in chlorine, and forms chloride of potassium; it also combines with iodine, bromine, and fluorine.

POTA'TOES. The common name for the roots of the *Solanum tuberosum*, which see.

POTE'NTIAL MOOD. (Lat. possum, *I am able*.) In Grammar, that mood of the verb which expresses an action conceived as *possible*; denoted in English by the auxiliary verb *may* or *might*.

POTE'NTIAL QUALITIES. In Scholastic Philosophy, such as are supposed to exist in a body *in potentia* only. In Grammar, a mood of the verb, also called the optative; by some considered as the same with the subjunctive.

POTI'TII. The Roman priests of Hercules, who were said to have been instituted by Evander. Of an inferior grade to them, but in the service of the same god, were the Pinari; but these became extinct through the means of Appius Claudius.

PO'TSTONE. A tough variety of steatite, sometimes manufactured into culinary vessels. It is the *lapis ollaris* of Pliny.

PO'TTERY AND PORCELAIN. The better kind of pottery, called in this country *Staffordshire ware*, is made of an artificial mixture of alumina and silica; the former obtained in the form of a fine clay, from Devonshire chiefly; and the latter consisting of chert or flint, which is heated red-hot, quenched in water, and then reduced to powder. Each material, carefully powdered and sifted, is diffused through water, mixed by measure, and brought to a due consistency by evaporation: it is then highly plastic, and formed upon the potter's wheel and lathe into various circular vessels, or moulded into other forms, which, after having been dried in a warm room, are enclosed in baked clay cases resembling bandboxes, and called *seggars*; these are ranged in the kiln so as nearly to fill it, leaving only space enough for the fuel; here the ware is kept red-hot for a considerable time, and thus brought to the state of *biscuit*. This is afterwards glazed, which is done by dipping the biscuit-ware into a tub containing a mixture of about 60 parts of litharge, 10 of clay, and 20 of ground flint, diffused in water to a creamy consistence; and when taken out enough adheres to the piece to give an uniform glazing when again heated. The pieces are then again packed up in the seggars, with small bits of pottery interposed between each, and fired in a kiln as before. The glazing mixture fuses at a very moderate heat, and gives an uniform glossy coating, which finishes the process when it is intended for common white ware.

The patterns upon ordinary porcelain, which are chiefly in blue, in consequence of the facility of applying cobalt, are generally first printed off upon paper, which is attached to the plate or other article while in the state of biscuit; the colour adheres permanently to the surface when heat is properly applied: other mineral colours, such as the oxides of chrome and manganese, are also occasionally employed in the same way.

The manufacture of Porcelain is a more refined branch of art; the materials are selected with the greatest caution, it being necessary that the compound should remain perfectly white after exposure to heat: it is also required that it should endure a very high temperature without fusing, and at the same time acquire a semivitreous texture, and a peculiar degree of translucency and toughness. These qualities are united in some of the oriental porcelain, or *China*, and in some of the old Dresden; but they are rarely found coexistent in that of modern European manufacture. Some of the French and English porcelain, especially that made at Sèvres and Worcester, is extremely white, and duly translucent; but it is more apt to crack by sudden changes of temperature; more brittle, and consequently requires to be formed into thicker and heavier vessels; and more fusible than the finest porcelains of Japan and China.

The colours employed in painting porcelain are the same metallic oxides used for colouring glass, and in all the more delicate patterns they are laid on with a camel-hair pencil, and generally previously mixed with a little oil of turpentine. Where several colours are used, they often require various temperatures for their perfection; in which case those that bear the highest heat are first applied, and subsequently those which are brought out at lower temperatures. This art of painting on porcelain, or *in enamel*, is of the most delicate description: much experience and skill are required in it, and with every care there are frequent failures; hence it is attended with considerable expense. The gilding of porcelain is generally performed by applying finely divided gold mixed with gum-water and borax; upon the application of heat the gum burns off, and the borax vitrifying upon the surface causes the gold firmly to adhere: it is afterwards burnished.

In the manufacture of various kinds of pottery employed in the chemical laboratory, and especially in regard to *crucibles*, many difficulties occur; and many requisites are necessary, which cannot be united in the same vessel. To the late Mr. Wedgwood we are indebted for vast improvements in this as well as in other branches of the art. Crucibles composed of one part of pure clay mixed with about three parts of coarse and pure sand, slowly dried and annealed, resist a very high temperature without fusion, and generally retain metallic substances; but where the metals are suffered to oxidize, there are few which do not act upon any earthen vessel, and some cause its rapid fusion, as the oxides of lead, bismuth, &c. Where saline fluxes are used, the best crucibles will always suffer; but platinum may often be employed in these cases, and the chemist is thus enabled to combat many difficulties which were nearly insurmountable before this metal was thus applied. Whenever silica and alumina are blended, as in the mixture of clay and sand, the compound softens, and the vessel loses its shape when exposed to a long-continued white heat, and this is the case with the *Hessian* crucibles: consequently, the most refractory of all vessels are those made entirely of clay, coarsely powdered burned clay being used as a substitute for the sand. Such a compound resists the action of saline fluxes longer than any other, and is therefore used for the pots in glass furnaces. A Hessian crucible lined with purer clay is rendered much more retentive; and a thin china cup, or other dense porcelain, resists the action of saline matters in fusion for a considerable time. Plumbago is a very good material for crucibles, and applicable to many purposes; when mixed with clay it forms a very difficultly fusible compound, and is protected from the action of the air at high temperatures: it is well calculated for small table furnaces.

POULP. The English generic name of the eight-footed Dibranchiate Cephalopods (*Octopi*), which have a double alternate row of suckers on each foot.

PO'ULTRY. Different kinds of birds reared for the production of eggs, feathers, and for the use of their bodies as animal food. The domestic poultry in common use in Britain are the common domestic fowls, or cock and hen, the turkey, the duck, and the goose; to which may be added, as occasionally reared, the guinea fowl and the peacock. The most generally useful kind of poultry is the common domestic fowl, which, though a native of India, accompanies man through all climates, but which is only productive of abundance of eggs when well fed and warmly lodged. Hence, all poultry houses, when not built adjoining an apartment in which fire is kept, or over a stable or cowhouse, where they might benefit by the heat generated by the larger animals, ought to be furnished with flues, or some other means of generating heat artificially during winter and spring. Without some mode of effecting this, poultry will seldom produce abundance of eggs in cold weather, particularly in the colder parts of Britain. Hence, in Scotland, the common hen roosts in the same room that the cottager lives in; and the poultry-house of the small farmer is a loft either over his kitchen, or over his cowhouse. In the management of poultry it is not sufficient to supply abundance of food and warmth, but it is equally necessary that they have ample space for exercise. This space should always contain living plants of various kinds, and some gravelly or sandy soil; because worms, snails, and insects, as well as occasionally grass and herbage, form a part of the food of poultry; and sand or gravel is swallowed by them for the purpose of promoting digestion. Hence, no healthy poultry can ever be reared in towns, however much the natural food may be imitated by the supply of animal matters, herbage, and sand: the want of exercise in poultry so circumstanced will soon become evident from the appearance of the fowls, and from the soft shell of their eggs, in consequence of the animal functions not being efficiently performed.

POULTRY-HOUSES. Structures in which poultry are kept in the night time; the principal features of which ought to be, that each kind of bird shall be separately lodged, and that all shall have access to an ample field, containing a pond and a heap of gravel. *See* POULTRY.

POUNCE. A powder to prevent ink from spreading upon paper after erasures: it is either sandarach (resin of the juniper) in powder, or the powdered bone of the cuttle-fish. The term pounce is also applied to coloured powders used by pattern drawers for sprinkling over pricked papers.

POUND. (Lat. pondus, *weight*.) A measure of weight. In England two different pounds are used; the *pound avoirdupois*, and the *pound troy*. The pound avoirdupois weighs 7000 grains troy, and the pound troy 5760 grains. The former is divided into 16 ounces, and the latter into 12. (*See* WEIGHT.) Pound is also a denomination of money; the pound sterling being equal in value to 20 shillings, or 240 pence. Anciently 240 pence were equivalent to a pound of silver; hence the origin of the term.

POUPART'S LIGAMENT. The tendinous attachment of the external oblique muscle of the abdomen to the superior and anterior spinous process of the os ileum and os pubis.

POU'RPRESTURE, or PU'RPRESTURE, in Law, is said to be when any man takes unto himself or appropriates any thing that he ought not, whether it be in any jurisdiction, land, or franchise; and generally when any thing is done to the nuisance of the king's tenants, by way of nuisance or hurt to the king's highways or demesnes, by inclosing, &c. Pourpresture may also be by tenant against lord of the fee, or by one neighbour against another.

POURSUIVANT. *See* PURSUIVANT.

POWER, in Algebra and Arithmetic, denotes the product arising from the continued multiplication of a quantity or number into itself. The successive powers of a number are formed and indicated as follows: — Thus, taking the number 3,

$$\begin{aligned} 3^1 &= 3, \text{ the 1st power of 3;} \\ 3 \times 3 \text{ or } 3^2 &= 9, \text{ the 2d power, or square of 3;} \\ 3^2 \times 3 \text{ or } 3^3 &= 27, \text{ the 3d power, or cube of 3;} \\ 3^3 \times 3 \text{ or } 3^4 &= 81, \text{ the 4th power of 3, \&c.} \end{aligned}$$

In like manner, the successive powers of the quantity a are a^1, a^2, a^3, a^4, &c. The numbers indicating the powers are called the *exponents*; and it is obvious from their formation that powers of the same quantity are multiplied by adding their exponents, and divided by subtracting their exponents. Powers are considered as negative or fractional which have negative or fractional exponents.

POWER, in Mechanics, denotes a force which being applied to a machine tends to produce motion. A *mechanical power* denotes one of the six simple machines; viz. the *lever*, the *inclined plane*, the *screw*, the *wheel and axle*, the *wedge*, and the *pulley*.

POWER. In Law, a term commonly employed to designate a reservation made in a conveyance, either for the party conveying or for some other party, to enable him to do certain acts regarding the property conveyed. Powers are either common law authorities, or have their validity from the Statute of Uses. To the former class belong powers granted by will or by act of parliament to certain persons to sell estates, &c. The latter are of several sorts — 1. Powers appendant, or appurtenant, are powers granted to one who has an estate given him by the deed creating the power, and strictly depending on he estate so limited; as where an estate for life is limited to a man, with power to grant leases in possession. 2. A power collateral, or in gross, given also to one having an interest, either granted by the same deed, or subsisting previously to its execution; but it enables him to create such interests only as will not attach on the interest limited to him, as a power to tenant for life to appoint the estate after his decease among his children. 3. A power simply collateral is one given to a party who has not any interest in the land, either after, or subsisting immediately up to, the period of the execution of the deed.

POWER OF ATTORNEY. In Law, an instrument by which a party empowers another to perform certain acts for him, either generally, or for a particular purpose; such as to accept and negotiate letters of exchange, to receive dividends, &c. An instrument by which a party authorizes his attorney to appear and plead for him is termed a warrant of attorney (see that article).

POWERS, GREAT, OF EUROPE. In the language of modern diplomacy, England, France, Austria, Russia, and Prussia, are so called.

POZZUOLA'NA. Volcanic ashes used in the manufacture of a mortar which hardens under water. They are exported from Pozzuoli, a town in the Bay of Naples.

PRAAM. A sort of lighter used in Holland and the Baltic.

PRA'CTICE. A rule in arithmetic for expeditiously solving questions in proportion; or, rather, for abridging the operation of multiplying quantities expressed in different denominations: as pounds, shillings, and pence; yards, feet, and inches, &c.

PRÆ-A'DAMITES. A term given to those inhabitants of the earth who are presumed, by some writers, to have lived before Adam. In support of this theory, a work was published in 1655, by Isaac de la Pyreri, which proved the means of converting many to its author's opinions.

PRÆCORDIA. (Lat. præ, *before*, and cor, *the heart.*) The fore part of the chest.

PRÆFECT. (Lat. præfectus.) A common name of various Roman functionaries; among others a military officer, who had the command of the cavalry of a legion. The prætorian præfect was the commanding officer of the prætorian cohorts, who were the imperial guard, and always stationed at Rome. This office, after the time of Severus, engrossed the highest powers to which a subject could attain. (*See* PRÆTORIAN COHORTS.) Præfect was likewise the title given to the imperial governor of Egypt, which was on a different footing from the other provinces, which were superintended by senatorial men with the titles of proconsul and proprætor. The præfect of Egypt, on the contrary, was always of the equestrian order, and was a military governor. This anomaly is said to have arisen from a prophecy which foretold that Egypt should recover its liberty when the Roman fasces and prætexta should come to it; and which Augustus took advantage of, to bring that province more immediately under his own superintendence.

PRÆMUNI'RE. In Law, a name given to a species of offence, in the nature of a contempt, against the king and his government. The name is derived from the words "præmoneri," or "præmuniri facias," which are used in the beginning of the writ preparatory to the prosecution of the offence: "Cause A. B. to be forewarned that he appear before us," &c. The first statute of præmunire was passed in the reign of Edward I. to restrain the encroachments of the Romish clergy; and several subsequent statutes before the Reformation have extended the number of penal acts under this title. The principal were those proceeding from an assumption of authority in England by virtue of papal and other foreign provisions. But, by still later statutes, acts of a very miscellaneous character have been rendered liable to the penalties of præmunire, as refusing to take the oaths of allegiance and supremacy, &c.

PRÆNO'MEN. *See* COGNOMEN, NAME.

PRÆTE'XTA. (Lat.) A long white robe with a purple border, originally appropriated by Tullus Hostilius to the Roman magistrates and some of the priests; but afterwards worn by the children of the higher classes; by boys till the age of seventeen (when they assumed the toga virilis), and by girls till they were married.

PRÆ'TOR. A Roman magistrate ranking in dignity next to the consuls. Anciently the name of prætor was common to all the chief magistrates; but, on account of the continual absence of the consuls in foreign wars, and their consequent inability to discharge many of their civil duties, a new civil magistrate was created to supply their place (A.U. 389), to whom the title of prætor was specially assigned. He was at first elected from the patricians, but the office was afterwards (A.U. 418) thrown open also to the plebeians. When it was found that a single prætor was inadequate to the due discharge of his duties, in consequence of the great influx of strangers, another was added (A.U. 519) to administer justice in cases in which they were involved, with the epithet *peregrinus* attached to his title, to distinguish him from the more ancient and honourable magistrate, the *prætor urbanus*, as he was called. This latter dignitary corresponded in many respects to the lord mayors, mayors, or provosts of our country, combining with their functions the judicial power of lord chancellor. Besides this he performed the duties of the consuls on many occasions in their absence, presiding in the assemblies of the people, and convening the senate. So long as the Roman empire was confined to Italy, the number of prætors did not exceed two; but on the reduction of Sicily and Sardinia to the form of provinces, two more were added to govern them, and again two more were created on the subjection of hither and farther Spain to the Roman yoke. The prætors on being elected determined their province, like the consuls, by casting lots. Under the emperors the powers of the prætors were reduced, their principal functions being transferred to the prætorian præfect; but the name of the magistrate continued to the time of Justinian. (See *Niebuhr's Roman History.*)

PRÆTO'RIAN COHORTS. A body of troops among the Romans, distinguished from the rest of the army by double pay and superior privileges, first instituted by Augustus, and called by that name, in imitation of the select band which attended a Roman general in battle. At their first institution they were nine in number, three being stationed at Rome, and the rest in the adjacent towns of Italy, and consisted of Italian soldiers only. Tiberius assembled them all at Rome, and placed them in a permanent camp; a measure which, while it answered the purpose of keeping the citizens in awe, proved dangerous and sometimes destructive to his successors. The emperor Severus disarmed the old guards, and established the prætorian cohorts on a new footing, increasing their number, and filling them entirely with troops draughted from the armies of the northern frontier. The command of these troops was vested in an officer called the Prætorian præfect, who, as the government gradually degenerated into a military despotism, rose from the station of simple captain of the guards not only to be the head of the army, but of the provinces, and even of the law. In every department of administration he represented the person and exercised the authority of the emperor. The prætorian bands were deprived of all their privileges by Diocletian, who replaced them by other troops, and were finally abolished by Constantine.

PRÆTO'RIUM. That part of a Roman camp in which the general's tent stood, and where he took the auspices. It was raised a few feet above the level of the rest of the camp. Of the four gates of the Roman camp, that which lay next the enemy was called the *prætorian* gate.

PRAGMA'TIC SANCTION, more correctly *Pragmatic Rescript*. A term of which the use seems to have originated in the Byzantine empire, signifying a public and solemn constitution or decree pronounced by a prince; distinguished from the simple rescript, which was a declaration of law in answer to a question propounded on behalf of an individual. In European history several important treaties are called by the name *Pragmatic Sanction*; among which the principal are, — 1. The ordinance of Charles VII. of France in 1438, which constituted the foundation of the liberties of the Gallican church. 2. Charles VI., emperor of Germany, being without male descendants, endeavoured by an instrument termed the Pragmatic Sanction to secure the succession to his female heirs; which caused the Bavarian war of succession, 1740. 3. The law of succession to the kingdom of Naples, when ceded by Charles II. of Spain, in 1759, to his third son and his posterity.

PRAIRIE. (Fr.) A term in common use for the vast plains or savannahs of the Mississippi and Missouri. *See* SAVANNAHS.

PRASE. Green quartz. The colouring matter of this mineral appears to be actinolite.

PRA'XEANS. A sect of heretics that sprung up in Asia in the second century; so called from their founder, Praxeas, an Asiatic hæresiarch. The distinguishing characteristics of this sect were their denial of plurality of persons in the godhead, and their belief that it was the Father himself who suffered on the cross. The Monarchici, Sabellians, and Patripassians adopted these sentiments.

PREA'MBLE. The commencement of a statute, which recites the intention of parliament in framing it, and is often admissible in argument to prove its meaning.

PRE'BEND. (Lat. præbenda.) The share of the estate of a cathedral or collegiate church received by a prebendary. To all such churches there are several prebendaries attached, who reside and officiate in rotation.

PRECE'DENCY. (Lat. precedo, *I go first.*) The relative rank of men and women in the etiquette of society; strictly it means the order in which they follow one another in a state procession, which it is part of the office of herald's duty to ascertain and preserve. The following are the degrees of precedency commonly recognized in England among men: — 1. The Sovereign. 2. The Prince of Wales. 3. The Queen's consort. 4. The Queen Dowager. 5. The princes of the blood according to seniority. 6. The Sovereign's uncles 7. Cousins of the Sovereign. 8. Husbands of princesses. 9. The archbishop of Canterbury. 10. The lord high chancellor. 11. The archbishop of York. 12. Lord high treasurer. 13. Lord president of the privy council. 14. Lord privy seal. 15. Lord high constable. 16. Earl marshal. 17. Lord high admiral. 18. Lord steward of the household. 19. Lord chamberlain of the household. (The last five, however, take precedence only of all their degree: *i. e.* if dukes, they precede all dukes; if marquises, all marquises, &c.) 20. Dukes. 21. Marquises. 22. Dukes' eldest sons. 23. Earls. 24. Marquises' eldest sons. 25. Dukes' younger sons. 26. Viscounts. 27. Earls' eldest sons. 28. Marquises' younger sons. 29, 30, 31. The bishops of London, Durham, and Winchester. 32. Other bishops, according to priority of consecration. 33. Barons. 34. Speaker of the House of Commons. 35. Viscounts' eldest sons. 36. Earls' younger sons. 37. Barons' eldest sons. 38. Knights of the Garter. 39. Privy councillors. 40. Chancellor of the Exchequer. 41. Chancellor of the duchy of Lancaster. 42. Lord chief justice of K. B. 43. Vice-chancellor. 44. Master of the Rolls. 45. Lord chief justice of C. P. 46. Lord chief baron of the Exchequer. 47. Judges and barons of the Exchequer of the degree of the coif, by seniority. 48. Knights bannerets made by the king in person. 49. Viscounts' younger sons. 50. Barons' younger sons. 51. Baronets. 52. Bannerets not made by the king in person. 53. Knights grand crosses of the Bath. 54. Knights commanders of the Bath.

55. Knights bachelors. 56. Companions of the Bath. 57. Eldest sons of the younger sons of peers. 58. Baronets' eldest sons. 59. Knights of the Garter's eldest sons. 60. Bannerets' eldest sons. 61. Knights of the Bath's eldest sons. 62. Knights' eldest sons. 63. Baronets' younger sons. 64. Esquires of the King's body. 65. Gentlemen of the privy chamber. 66. Esquires of the knights of the Bath. 67. Esquires by creation. 68. Esquires by office. 69. Younger sons of knights of the Garter. 70. Younger sons of bannerets. 71. Younger sons of knights of the Bath. 72. Younger sons of knights bachelors. 73. Gentlemen entitled to bear arms.

PRE'CEDENTS, in Law, are defined authorities to be followed in courts of justice. Precedents, strictly speaking, are only binding on tribunals when they are in the shape of actual judicial decisions of the point in question. What English lawyers term an extrajudicial opinion, — *i. e.* the opinion of a judge pronounced where it was not called for to decide the issue, — can only have authority from the character of the individual judge, and not as a precedent. When the principles of equity were as yet unsettled, it was held by many that precedents were inapplicable in that branch of law; as its very name seemed to imply that each case should be governed by the judge's opinion of its individual merits. But Lord Keeper Bridgman, among others, seriously refuted this supposition; and precedents have long been of as much authority in courts of equity as in those of common law. A form of an instrument or a pleading, from which others corresponding in circumstances may be copied, is also termed a precedent.

PRECE'PTORIES. In the Middle Ages, a kind of benefices possessed by the more eminent Knights Templar, whom the grand master created and styled *Præceptores Templi;* whence the name. Of these preceptories, 16 are recorded as belonging to the Templars in England (see *Mon. Ang.*); but it is averred by some writers that these places were merely cells, subordinate to their head-quarters, the Temple in London. *See* COMMANDERY.

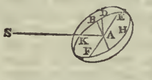
PRECE'SSION OF THE EQUINOXES. A term used in astronomy to denote a small annual variation in the position of the line in which the planes of the ecliptic and equator intersect each other, in consequence of which the sun returns to the same equinoctial point before completing his apparent revolution with respect to the fixed stars.

The longitude of a star is counted on the ecliptic eastward from the first point of Aries, or the vernal equinox. If the line of the equinoxes, therefore, maintained always the same position with respect to the celestial sphere, the longitudes of the stars would be invariable. But on comparing the actual state of the heavens with the observations recorded by ancient astronomers, it is found that the longitudes of all the stars have considerably increased, and all to the same degree; so that the celestial sphere appears to turn round the axis of the ecliptic with a slow motion from west to east, or in the same direction as the sun in his annual revolution. The phenomena, however, will be in all respects the same, if, instead of supposing the whole firmament to advance in the order of the signs, we suppose the axis of the earth's equator to have a slow motion about the axis of the ecliptic in the opposite direction. This will give to the line of intersection of the two planes (which is the line of the equinoxes) a retrograde motion from east to west, in consequence of which the sun, whose motion is from west to east, arrives at the equinoctial points sooner than if they remained at rest; and therefore the equinoxes, and the seasons which depend on them, come round before the sun has completed an entire circuit of the sphere. On this account the motion has been called the *precession of the equinoxes*.

Although the existence of the precessional motion of the equinoctial points was known at an early period in the history of astronomy, the imperfection of instruments prior to the sixteenth century did not permit of observations being made with sufficient accuracy to determine its precise rate, which must therefore be deduced from comparisons of the longitude of the same star calculated from modern observations; although, on account of the extreme slowness of the motion, the determination must be liable to some uncertainty, unless a considerable interval of time has elapsed between the epochs of observation. According to Bradley's observations, the longitude of the star *Spica Virginis*, at the beginning of the year 1760, was 200·4944°. At the beginning of 1802 Maskelyne found the longitude of the same star to be 201·0781°. The difference is 0·5837° in 42 years, which gives 50·03″ in a year. The comparison of a great number of observations on different stars gives 50·1″ for the annual precession. According to this estimate, the equinoctial points retrograde on the ecliptic at the rate of one degree in 71·6 years, and therefore will require a period of about 25,800 years to make a complete revolution.

The physical cause of the precession of the equinoxes is the combined action of the sun and moon on the mass of matter accumulated about the earth's equator, and forming the excess of the terrestrial spheroid above its inscribed sphere. The matter of this spheroidal shell, in reference to the effect of the solar attraction on it, may be regarded as forming a ring about the earth in the plane of the equator. Now the solar force, acting on the part of the ring which is above the ecliptic, may at every point be resolved into two parts, one parallel to the plane of the equator, and the other perpendicular to it; and the resultant of all the latter forces must be a force tending to impress on the ring a motion round the intersection of its plane with the ecliptic. The same thing holds true of the other half of the ring which is under the ecliptic. If the earth, therefore, had no motion of rotation, the plane of the equator would turn round the line of its intersection with the ecliptic until it coincided with the latter plane. But while the equator has this tendency to revolve about an axis in its plane, it has also a rotatory motion about an axis perpendicular to its plane; it will therefore, according to a well-known theorem in mechanics, not revolve on either of these axes, but on one which divides the angle between them, so that the sine of its angular distance from each axis is in the inverse ratio of the angular velocity round that axis. *See* ROTATION.

In order to illustrate this, let E K F H be the earth's equator, A the centre, A B the axis of rotation, S the sun, and E F the diameter of the equator perpendicular to A S; and suppose the earth to be in the position it occupies at the summer solstice. We may also



suppose the centre of gravity A to be at rest, as the effect in question is not altered by the orbital motion. It is plain that if the earth were a sphere, the sun's attraction would have no tendency to give it an angular motion about the centre A; for all the matter being symmetrically arranged about the line S A, the effect of the attraction on any point on one side of that line would be exactly compensated by the attraction on the corresponding point on the opposite side. But the earth being an oblate spheroid, we must consider the effect of the sun's attraction on the mass of matter exterior to the sphere which touches the spheroid at its poles. Now let K be an element of the protuberant matter, which we may suppose to be all accumulated in the plane of the equator; the sun's attraction on K, acting in the line which joins S and K, may be resolved into two parts, — one of them acting in the plane of the equator, and the other in a line perpendicular to that plane. The part of the solar force acting on K perpendicularly to the equator tends to give that plane a rotatory motion about the axis E F, by drawing K towards the plane of the ecliptic; but the earth at the same time revolves about the axis A B, which is perpendicular to E F. In consequence of this compound motion the axis of rotation will change its position from A B to A D, the pole B moving in a direction opposite to that of the rotation; and as the solar force continues to act at every instant, the pole B will have a continuous slow motion about the pole of the ecliptic, and the plane of the equator, which is perpendicular to A B, will at every instant intersect the ecliptic in a new line; which will slowly recede or go backward on the ecliptic in the direction opposite to that of the earth's rotation.

The motion now described may be assimilated to that of a top put into rapid motion, with its axis inclined to the horizon. In this position the axis of the top slowly revolves about the vertical drawn from the point on which it rests, describing the surface of a cone; and any section of the top perpendicular to the axis, if produced to meet the horizon, will at every instant intersect that plane in a new line; and the line of intersection will revolve with a motion corresponding to that of the axis in the direction opposite to that of the rotation.

The attraction of the moon on the spheroidal shell produces a similar effect to that of the sun, and in a still greater degree, in the ratio of about 5 to 2. It is easy to see that the effect of both those bodies in displacing the equator of the terrestrial spheroid must vary with their position in reference to it; for if they moved in the plane of the equator, there would evidently be no displacement, and their power to produce it is greatest when the earth is in such a position that the inclination of the equator to the ecliptic, or to the plane of the lunar orbit, is a maximum. This inequality of action gives rise to another highly important astronomical phenomenon; namely, an apparent vibratory motion of the equator, which Bradley (who first discovered its cause and period) significantly denominated the *nutation of the earth's axis*. *See* NUTATION.

In consequence of the precession of the equinoxes the sun's place among the zodiacal constellations, at any given season of the year, is now greatly different from what it was in remote ages. Some time before the age of Hipparchus the first points of Aries and Libra corresponded to the vernal and autumnal equinoxes, and those of Cancer and Capricorn to the summer and winter solstices,

These points have now receded 30° from the constellations to which they then corresponded. The vernal equinox now happens when the sun is in Pisces, the summer solstice when he is in Gemini, the autumnal equinox when he is in Virgo, and the winter solstice when he is in Sagittarius. Astronomers, however, still employ the term *the first point of Aries* to denote the position of the vernal equinox. On this account the *signs of the zodiac*, or ecliptic, which are fixed in respect of the equinoctial points, must be carefully distinguished from the *constellations*, which are moveable with respect to those points. (See *Airy's Mathematical Tracts; Encyc. Brit.*, art. "Precession;" *Woodhouse's Physical Astronomy;* La Place, *Mécanique Céleste;* Poisson, *Sur le Mouvement de la Terre autour de son Centre de Gravité*, in the *Mém. de l'Acad. des Sciences de Paris*, tom. vii. 1829.)

PRECI'PITATE. (Lat. præceps, *headlong.*) A result of chemical decomposition, in which a substance is *thrown down* in a solid, and generally in a finely divided state, from a liquid.

PREDA'CEANS. (Lat. præda, *booty.*) The English name used by Kirby as synonymous with the *Carnassiers* of Cuvier. *See* FERINES.

PREDESTINA'TION. (In Gr. προορισμος, Rom. viii. 29.; Eph. 1. 5. 11.) The belief that God has from all eternity decreed whatever comes to pass. In a theological sense, it is thus defined in the 17th Article of our church: — "Predestination to life is the everlasting purpose of God, whereby, before the foundations of the world were laid, he hath constantly decreed by his counsel, secret to us, to deliver from curse and damnation those whom he hath chosen in Christ out of mankind, and to bring them by Christ to everlasting salvation." The Lambeth Articles, agreed to in 1595 by a portion of the clergy, assert that "God from eternity hath predestinated certain men unto life, certain he hath reprobated." Theological writers have generally forborne to use the word predestination with respect to the rejected: "Nefas est dicere Deum aliquid nisi bonum prædestinare." (August., *De Dono Perseverantiæ.*) *See* ELECTION, CALVINISM.

PREDETERMINA'TION. In Scholastic Philosophy, that concurrence of God which determines men in the performance of their actions, good or evil; called physical predetermination, or premotion.

PRE'DIAL. (Lat. prædium, *farm.*) Of or belonging to a farm. Thus we often read of *predial* slaves and slavery, in opposition to *domestic; predial* disturbances in Ireland, &c.

PRE'DICABLE. In Logic, a term which can be affirmatively predicated of several others. The notions expressed by such terms are formed by the faculty termed abstraction, after the particular circumstances characterizing each individual have been withdrawn from it. The predicables are commonly said to be five; genus, species, difference, property (which has been subdivided into four heads by no very intelligible system of classification), and accident (which is either separable or inseparable). See these terms, and LOGIC.

PREDI'CAMENTS, or CA'TEGORIES, in Logic, are a certain number of general heads, or, in logical phraseology, *summa genera*, under one or other of which every term may be arranged. Aristotle enumerated ten predicaments; others, by subdividing some of these, have increased their number. Those of Aristotle are — substance, quantity, quality, relation, place, time, situation, possession, action, suffering. It is evident that all these may be arranged under two grand heads, — substance and attribute. *See* CATEGORY, ATTRIBUTE.

PRE'DICATE, in Logic, is, of the two terms of a proposition, that which is affirmed or denied of the other. *See* TERM, PROPOSITION, LOGIC.

PREDISPO'SING CAUSE, in Medicine, is any circumstance which renders the body susceptible of disease.

PRE-EXISTENCE. In Philosophy, the existence of any thing before another; commonly used for the existence of the human soul, in some former condition, before it became connected with its present body. It was the doctrine of the Pythagorean school, and connected with their peculiar tenet of the Metempsychosis. It was also the doctrine of Plato; and he uses in support of it arguments which have exercised a strong influence on many minds, and to this day are constantly recurring to those who study the subject on independent principles; particularly the rapidity of learning in early childhood, which he explains as an effort of reminiscence, not acquisition. Others have enlisted into the service those peculiar sensations which are sometimes raised by scenes, persons, sounds, words, though seen or heard, as our reason would persuade us, for the first time, as if we were conscious of some prior familiarity with them. This poetical, rather than philosophical view of the subject, is beautifully illustrated in a well-known ode of Wordsworth.

PRE'FACE. (Lat. præ, and fari, *to speak.*) The observations prefixed to a work or treatise, intended to inform the reader of its plan and peculiarities. There are few subjects which afford so wide a field for the display of skill and address as preface writing; and those who wish to witness an unrivalled exhibition of these qualities may consult some of Dr. Johnson's prefaces, either to his own writings, or to the numerous works which he edited.

PRE'FECT. An important political functionary in modern France. Under the old régime, the officers who were sent round to the provinces to superintend the details of administration on behalf of the king were at first styled maitres des requêtes. These were made permanent local officers in the reign of Henry II., and afterwards attained many additional powers, with the title of intendants. These were abolished at the Revolution, when various attempts were made to establish elective local governments. By a law of the year 1800 prefects were first appointed for the departments, with powers similar in many respects to those of the old intendants, with a council of the prefecture, and a general council of the department; which, however, fell into disuse. With slight variations, the prefects retain the same jurisdiction. They are, in some respects, analogous to our sheriffs; but with far greater powers. They possess not the nominal only, but the actual direction of the police establishment, within their respective departments, together with extensive powers of municipal regulation: the arrondissements or districts into which the departments are subdivided are under sous-préfets appointed by them. Their power, however, is considerably controlled by that of the council of the prefecture, which acts in some measure as a court of appeal from the prefect, taking cognizance of various cases within the sphere of his administrative interference, if legal disputes arise upon it.

PRE'HNITE. A mineral of a greenish colour, allied to the zeolites; originally discovered at the Cape of Good Hope by Colonel Prehn.

PRE'LACY. *See* EPISCOPACY.

PRE'LATE. (Lat. prelatus.) A term commonly applied to bishops, archbishops, and patriarchs, in Christian churches. Anciently, mitred abbots seem also to have been called prelates.

PRE'LUDE. (Lat. præ, *before*, and ludo, *I play.*) In Music, the preface or introduction to a movement, and usually consisting of a few bars of harmony in the same key as the movement which it precedes; being, in fact, a preparation to the ear for what is to follow.

PRE'MIER. (Fr.) The name generally given to the prime minister of England.

PRE'MISES. In Logic, the two first propositions of a syllogism are so called. *See* SYLLOGISM.

PREMO'NSTRANTS. A religious order of regular canons instituted in 1120 by St. Norbert (whence they are also called Norbertines), at Premonstratum, in Picardy, which is said to have derived its name from being *pointed out* by the Virgin. The canons of this order followed the rule of St. Austin, and were sometimes called White Canons, from the colour of their habits. They were brought into England about 1140, where they are said to have established thirty-five houses of their order.

PRENSICULA'NTIA. (Lat. prehendo, *I seize.*) A name applied by Illiger to an order of Mammalia, corresponding with the *Glires* of Linnæus and the *Rodentia* of Cuvier, and indicative of the prehensile faculty with which the fore paw is endowed in most of the species of this order.

PREPARA'TION. In Music, the previous adjustment of two notes by whose introduction a note which is to become a discord is heard in the preceding harmony. *See* MUSIC.

PREPOSI'TION. (Lat. præpono, *I place before.*) In Grammar, that part of speech which denotes the relations between objects; as *in, to, upon. See* GRAMMAR.

PRERO'GATIVE. (Lat. *prærogativa*, applied in ancient Rome to that tribe, or century, which had the privilege of giving its votes (rogare suffragia) first at the comitia.) A word in English law, signifying the king's special rights, both as chief of the kingdom in point of honour, and as supreme magistrate intrusted with the execution of the laws. Prerogatives are said to be of two kinds, direct and incidental: the first, such as belong to the king essentially by virtue of his high political character; such as the inviolability of his person, the appointment to offices and places of trust, the command of the army, the power of making war and peace, the supremacy of the national church, his legislative authority, &c.; and the latter, such exceptions as are made in his favour from the ordinary rules of law in private matters. Such are, with respect to debts, the power to levy first execution before other creditors, and of levying by the prerogative writ of extent; the power of taking goods and chattels in succession, which no other corporation can do; exemption from all customs general and special as to descent of lands, in a case where any such custom would have the effect of preventing lands held jure coronæ from passing to the successor; the abstract dominion of all lands and hereditaments by the fiction of

universal occupancy; the right to derelict lands by the sudden retiring of the sea; the dominion of seas, navigable rivers, &c.

PRERO'GATIVE COURT. The court in which wills are proved, and administrations taken, which belong to the archbishop, by his prerogative. *See* Law, Ecclesiastical.

PRESBYO'PIA. (Gr. πρεσβυς, *old*, and ωψ, *the eye*.) An imperfection of vision commonly attendant upon the more advanced periods of life, in which near objects are seen less distinctly than those at a distance. It is usually caused by flattening of the cornea; hence convex spectacles are required. It often happens that one eye is more affected than the other, in which case glasses of different foci should be used.

PRE'SBYTER. (Gr. πρεσβυτερος, *elder*; by which word it is translated in our New Testament.) One of an order of ministers in the Christian church, frequently alluded to in the Scriptures as having, in its several members, the spiritual care of distinct congregations, and exercising as a class a general superintendence over the concerns of the church. It is allowed that, up to the time of Calvin, there never existed a church in which there was not an order of presbytery, or priests, subordinate to that of bishops; and, although the words themselves are sometimes confounded in the New Testament, the assertors of episcopacy point out the distinction between the offices as accurately preserved throughout. *See* Episcopacy and Presbytery.

PRESBYTE'RIANS. The name given to that sect of Christians who have embraced the Presbyterian form of government. *See* Presbytery.

PRE'SBYTERY (Gr. πρεσβυτεριον, *a council or assembly of elders*), is that form of ecclesiastical polity according to which there is no gradation of order in the church, but which vests church government in a society of clerical and lay presbyters, or, in common phraseology, ministers and lay elders, all possessed officially of equal rank and power. The Presbyterians maintain that the words presbyter (πρεσβυτερος) and bishop (επισκοπος) are synonymous and interchangeable terms; that we nowhere read in the New Testament of bishops and presbyters or of pastors of different rank, in the same church; that all ministers of the gospel, being ambassadors of Christ, are inherently equal; and that deacons are laymen, whose sole duty it is to take charge of the poor. Among other proofs they quote the following:—"The elders (πρεσβυτεροι) who are among you I exhort, *who am also an elder* (συμπρεσβυτερος). Feed the flock which is among you, taking the oversight thereof (επισκοπουντες, *acting as bishops over them*), not by restraint, but willingly; not for filthy lucre, but of a ready mind; neither as being lords over God's heritage." (1 Peter, v. 1, 2, 3.) It is contended that, in this passage, the identity of presbyter and bishop is apparent; and that the apostle himself, as an officer of the church, was simply a presbyter or elder. (See also Hebrews, xiii. 7. 17.; 1 Thess. v. 12. 6.) On these grounds the Presbyterians assume that "the very chiefest apostles" were presbyters, or labouring ministers; and that every faithful pastor of a flock ordained by the imposition of hands, as sanctioned and taught in Scripture, is a successor of the apostles in every respect in which divinely inspired men can be regarded as having any successors. It is farther argued, in support of the polity under review, that Timothy himself, though said to be a bishop, was ordained "with the laying on of the hands of the *presbytery*." (1 Tim. iv. 14.)

It is, however, admitted by the Presbyterians that episcopacy was introduced at an early period into the Christian church, and has hitherto been the prevailing polity; but they insist that as St. Paul presided at the ordination of Timothy, not as supreme over his brethren, but as moderator or chairman for the occasion, *primus in paribus*, so the moderator of a presbytery, instead of being changed or re-elected, had in course of time been declared permanent; and hence the origin of the episcopal order. (*Mosheim*, i. 90.; *Hill's Theol. Institutes*.)

But while the Presbyterians trace the origin of their church to the practice of the apostles, and affirm that there are no intimations of episcopacy in Scripture, or in the writings of the apostolical fathers, they admit that presbytery, as it now obtains, did not exist between the 2d century and the reformation of religion. "The first reformers, who believed that the distinction between bishops and presbyters had no foundation in Scripture, and who wished to apply an effectual remedy to the abuses which appeared to them to have arisen in the progress of human inventions of investing bishops with powers superior to presbyters, did not consider the antiquity or universality of that practice as any reason for its being continued. Recurring to what they considered the primitive Scripture model, they laid the foundation of presbyterian church government on this principle, that all members are equal in rank and power; and they did not admit any official preference, but that which is constituted by voluntary agreement for the sake of order." (*Hill's Theol. Inst.* p. 167.)

The first presbyterian church, in modern times, was founded in Geneva by John Calvin, about 1541; and the system was thence introduced into Scotland, with some modifications, by John Knox, about 1560, but was not legally established there till 1592. For about a century from this date there was a continual struggle in Scotland between presbytery and episcopacy for superiority. The latter (which was patronized by the court) predominated in 1606; but was superseded by the former (to which the great body of the people were attached) in 1638. Presbytery kept its ground from this period till the revolution in 1660, when episcopacy again obtained the ascendancy, which it maintained till 1688; soon after which it was abolished, and the national church of Scotland declared presbyterian,—a form which it has since retained. The most numerous bodies of dissenters from the Scottish established church, such as the Associate and Relief Synods, are also Presbyterians; their cause of secession being that the church had relaxed the strictness of presbyterian principles.

Presbytery has never flourished greatly in England. Here the first presbyterian church was formed at Wandsworth, Surrey, in 1572, about 20 years before presbytery was established by law in Scotland; but though the system was never palatable to the English nation generally, an attempt was made to make the established church presbyterian in the reign of Charles I. This object was signally promoted by the famous Assembly of Divines at Westminster. In 1649, presbytery was sanctioned by the English parliament, and the established church was nominally presbyterian from this date till the restoration in 1660; yet it was never generally adopted, or regularly organized, except in London and in Lancashire. (*Murray's Life of Samuel Rutherford*, Edin. 1828, chap. viii.) Upwards of 2000 presbyterian clergy were ejected from their cures in England, in consequence of the Act of Uniformity in 1662. There are still many congregations (about 150) in England, particularly in the northern counties, called presbyterian; some of them in full connection with the Scottish church, others differing materially from that polity, while not a few of them have adopted nearly the same church government with the Independents. In Ireland, chiefly in the province of Ulster, there are about 450 presbyterian congregations. There are upwards of 100 such congregations in our North American possessions; and presbytery has also been introduced to a greater or less extent in the other British colonies.

In the United States of America presbytery embraces upwards of 2800 congregations, with 2000 ministers. (*American Almanac* for 1840.) The same system, though somewhat modified from that which obtains in Scotland, is the established church in Holland. (*Steven's Brief View of the Dutch Eccles. Establishment*, ed. 1839.) It still exists, though to a very limited extent, in Geneva; it prevails also less or more in several of the other Swiss cantons.

The constitution of the church of Scotland, which has long been the most perfect and efficient model of presbytery, is as follows:—The kirk session is the lowest court, and is composed of the parochial minister and of lay elders, the number of whom varies in different parishes, but is generally about 12. The minister is moderator *ex officio*. This kirk session exercises the religious discipline of the parish; but an appeal may be made from its decisions to the presbytery, the court next in dignity. The presbytery, from which there is a power of appeal to the synod, is composed of the ministers of a number of contiguous parishes (varying in number in different cases), with a lay elder from each. A moderator, who must be a clergyman, is chosen every half year. A presbytery generally meets once a month, but it must meet at least twice a year; and it may hold *pro re nata* meetings. This court takes young men on trials as candidates for licence; ordains presentees to vacant livings; has the power of sitting in judgment on the conduct of any of its members, and can depose them; and has the general superintendence of religion and education within its bounds. The number of presbyteries is at present 82. The synod, which meets twice yearly, is formed of the members, both lay and clerical, of two or more presbyteries. At every meeting a moderator is chosen, who must be a clergyman; and a sermon is preached before the court proceeds to business. The number of synods is sixteen. The general assembly is the highest ecclesiastical court, its decisions being supreme. It meets annually in the month of May, and sits for ten successive days. Unlike the inferior courts, it consist of representatives chosen by the various presbyteries, royal burghs, and universities of Scotland. The number of representatives from presbyteries depends on the number of members of which each is composed. No presbytery sends less than two ministers and one lay elder; and none more than six ministers and three elders. The total number of members of the general assembly is 386, of whom 218 are ministers. This supreme court has of late consisted of more than this number, as the church

has admitted the ministers of *quoad sacra* parishes as constituent members of ecclesiastical courts; but the civil law has not given its sanction to this measure: indeed the question is at present *sub judice*. The assembly chooses a new moderator yearly, who, in recent times, is always a clergyman. A sermon is preached before the opening of the court. The assembly is honoured with the presence of a nobleman as representative of the sovereign, under the title of lord high commissioner; but this high functionary takes no part in the proceedings of the court, except in opening and closing or dissolving its sittings, and has no voice in its deliberations. The assembly before its close appoints a commission, which is equivalent to a committee of the whole house, being composed of all the members of assembly, and one minister additional, named by the moderator. The commission meets quarterly; but may hold *pro re nata* meetings.

The income of the clergy, which may average about 250*l*. yearly, including manse and glebe, is regulated by the state; and they are nominated to livings by patronage. They have no liturgy, no altar, no instrumental music. The Scottish presbyterians do not kneel, but stand in time of prayer; and in singing the praises of God they sit. The sacrament of the Supper is not administered in private houses to any person under any circumstances whatever. (*The Directory for the Public Worship of God, by the Westminster Assembly of Divines*.) Pluralities have been prohibited; and the residence of clergymen within their repective parishes has always been imperative. Their creed is rigid Calvinism, and may be found embodied in the *Westminster Confession of Faith* and the *Larger* and *Shorter Catechisms*. But though the faith of the Scottish Presbyterians, whether churchmen or dissenters, is Calvinistic, not a few of the Presbyterians in other countries have adopted an Arminian, and not unfrequently a Unitarian creed. (*Adam's Relig. World Displayed*, ii. 289—305.; *Lord King's Inquiry into the Constitution of the Primitive Church; Forbes's Presbyterian Letters*.)

Presbytery. In the Scottish Kirk, a district composed of a number of adjacent parishes. See the preceding article.

Presbytery. In Architecture, a portion of the choir or chancel of a church arranged with seats for the dignitaries of the establishment.

PRESCRI'PTION. A title acquired by use and time to incorporeal hereditaments, such as a right of way or of common, and the like. All prescription is either personal, as when it is in a man and his ancestors, or it is in right of a particular estate; which last being in a man, and those whose estate he hath, is called prescription in a *que* estate. It presupposes a grant, and can therefore give a title to those things only which can pass by grant. After uninterrupted enjoyment for thirty, and in many cases for twenty years, a primâ facie title arises by prescription to the thing enjoyed; and unless such enjoyment have continued under some consent or agreement, the title becomes, in sixty years, absolute and indefeasible. The time of prescription in most of the ordinary instances to which it applies is now regulated by 2 & 3 W. 4. c. 71.

PRESENTATION. In Law, the appointment of a clergyman to a benefice by the patron, which takes place by presenting him to the bishop for institution.

PRESENTATION, FEAST OF. In Ecclesiastical Usage, the same with the Purification of the Blessed Virgin. *See* Purification.

PRESE'NTMENT, in Criminal Law, is defined to be an information made by the jury in a court before a judge who has authority to punish an offence. Properly speaking, it is the notice taken by a grand jury of their own knowledge, without any bill or indictment found before them, at the suit of the king, of any offence, nuisance, libel, &c. of which they are competent to take notice. An indictment, correctly speaking, is that which is drawn up and engrossed to be found by the grand jury, founded on their presentment or note of instruction. Presentment is also comprehensively taken to include inquisitions of office and indictments, as well as presentments strictly so called.

PRE'SIDENT. (Lat. præsideo, *I sit foremost*.) A title applied to many officers in various capacities, but generally denoting a pre-eminency, either temporary or fixed, among a number of individuals assembled for a definite purpose. Thus the superior of a board or council, &c. is generally entitled president, as is the individual called to preside over an occasional meeting, or to fill the chair at a club, dinner, &c.; although the old English title of chairman is frequently used on such occasions.

The supreme executive officer of the United States of America is styled president. The qualifications required of a person raised to this dignity are, to be a natural-born citizen of the age of thirty-five years, and to have resided fourteen years within the States. The election is by electoral colleges in every state. These colleges contain, in each state, a number of electors equal to all the senators and representatives of that state in congress; but their appointment varies in different states, and at different times; sometimes it is made by their respective legislatures, sometimes by general election throughout the state, sometimes part of the electors are chosen by district and part by general election. The colleges in each state vote by ballot for a president (and at the same time for a vice-president); and the votes of all the electors, taken in this manner, are counted by the president of the senate: when, if any person have an absolute majority of votes, he is duly elected; if not, the election is made by the house of representatives between the three persons having the highest number; in which case the votes are taken by states, and a majority of all the states is necessary to constitute a choice. On two occasions, of which the last was in 1824, no candidate having had a majority of the whole number of voters, the house of representatives has proceeded to make the election; and, on the last of these occasions, a majority of states chose a candidate (Adams) who had a smaller number of electoral votes than one of his opponents (Jackson). On one occasion, in 1800, the states balloted thirty-six times before any candidate could obtain an absolute majority. Should the president die during his term of office, he is succeeded by the vice-president, an event which has recently occurred.

In his legislative capacity, the president has the power of approving bills sent to him after passing both houses of congress, or of returning them to the house in which they have originated with his objections annexed. In the latter case, the bill must be reconsidered by that house; and if, on reconsideration, it obtain a majority of two thirds in both houses, it passes into a law. In his executive capacity, he is commander-in-chief of the army and navy of the Union, and of the state militias when called into the service of the Union; he has the power of reprieving and pardoning, except in cases of impeachment; he has power to make treaties, with the consent of the senate (by a majority of two thirds); he nominates ambassadors, consuls, judges of the supreme court, and all other officers of the United States whose appointments are not vested elsewhere by the constitution.

PRESIDENT, LORD, OF THE COUNCIL. The fourth great officer of state in England; appointed by letters patent under the great seal, durante bene placito.

PRESS. (Fr. presse.) The machine by which books, &c. are printed. Very little improvement in the construction of this instrument took place from the first introduction of the art into Europe till the late Earl Stanhope applied the powers of his mind to the subject, and introduced a new press of a decidedly superior construction. The old press was made of wood, with an iron screw that had a bar fitted in it; to the lower end of this screw was attached, horizontally, a flat piece of wood, called the platen, which was brought down by means of the screw, and pressed the paper upon the face of the types; and thus the impression was obtained. This press has, however, entirely given place to presses made of iron. Lord Stanhope's press is constructed of iron, with a screw; but the bar is fixed to an upright spindle, to which a lever is attached connected with a second lever fixed to the top of the screw by a connecting bar. These two levers are placed at different angles to each other; and when the platen is brought down to the face of the types, and power is wanted, the two levers take such a position with each other so as to act with the greatest advantage, and thus an almost incredible accession of power is gained, which enables the pressman to print larger sheets of paper in a superior manner, with less labour, and with greater ease to himself. This press maintains its superiority over all others.

This great improvement in the printing press that Lord Stanhope had accomplished excited other ingenious men to exert their abilities in attempts at further improvements; among whom was a Mr. George Clymer, an American, who brought forward an iron press, called the Columbian press, in which he discarded the screw, and obtained his power entirely by levers. This press has great power, and consequently great strength, and is made of a size to print larger sheets of paper than any other; but for the common run of printing it does not work so easy as the Stanhope press. These two are looked upon as the best presses.

There are a variety of others which are great improvements upon the old construction, and which are held in estimation by printers, but the limits of this work will not admit of the details of their respective merits.

The *book press*, in the warehouse department, used for pressing books previous to their delivery, is the common screw press, with a perpendicular screw, and screwed down by means of an iron bar: it is also used for pressing paper, when wetted, previous to being printed on, for the purpose of making it in better condition for the process; and also in cylindrical or machine printing to cause it to lie flat, otherwise it is apt to wrinkle, particularly large sheets, in being carried round the cylinders upon a flat surface. In large establishments Brahmah's hydraulic

press is generally used for these purposes, as being much more powerful, and also more expeditious, not only in its use, but also in its effect.

PRESS. A machine for the purpose of compressing or squeezing bodies. Any of the mechanical powers may be used for this purpose. When constructed on a large scale, the hydrostatic pressure of water is the power generally employed. *See* HYDROSTATICS.

PRESS is metaphorically applied either to the whole literature of a country, or to that part of it more immediately connected with newspapers or other periodical publications.

PRESSIRO'STERS, *Pressirostres.* (Lat. pressus, *flattened;* rostrum, *a beak.*) A tribe of wading birds, including those which have a flattened or compressed beak.

PRE'SSURE. Dr. Young defines pressure to be "a force counteracted by another force, so that no motion is produced." (*Lectures on Nat. Phil.*) Thus, when a heavy body is supported on a table, or the ground, the force of terrestrial gravity, which, if the support were removed, would cause the body to descend towards the centre of the earth, being destroyed at every instant by the resistance of the support, produces a pressure. A pressure and a moving force differ from one another only in this respect, that the infinitely small velocities which the pressure tends to produce are incessantly destroyed by the resistance of the obstacle; whereas those that are actually produced at every instant by the moving forces are accumulated in the moving body, and produce a finite velocity after a finite time. The pressures of two different bodies are, therefore, to each other as the masses multiplied by the infinitely small velocities which they tend to produce in the same instant of time, and which they would produce if the bodies were free to move.

The pressure of a solid body is exerted in the direction of the resultant of all the forces by which the body is acted upon. In the interior of liquid and aëriform bodies, the pressure is equal in all directions. (*See* HYDROSTATICS, PNEUMATICS.) *Centre of Pressure*, in Hydrostatics, is that point of a plane or side of a vessel containing a liquid to which, if a force were applied equal to the total pressure, and with the opposite direction, it would exactly balance the effort of the total pressure.

PRESSWORK, in Printing, is the operation of taking impressions from types, &c. by means of the press; distinct from *composing*, which is arranging the types to prepare them for press.

PRESTO. (It.) In Music. *See* ALLEGRO.

PRESU'MPTION OF LAW, is the assuming the truth of a certain state of facts by the ordinary custom of the law. It is either "juris et de jure," which is a presumption which no evidence to the contrary can be admitted to traverse, as the presumption of incapacity in a minor with guardians to act without their consent; or it is "juris" only, which may be traversed by evidence, as where the property of goods is presumed to be in the possessor until the contrary is shown.

PRESUMPTIVE HEIR. *See* HEIR.

PRETE'NDER. The name by which the Chevalier Charles Stuart is usually known, from his having pretended a right to the British crown, from which he had been excluded.

PRE'VOTALES, COURS. (Fr. *courts of prevots, or provosts.*) Certain tribunals of summary jurisdiction, which existed in France before the Revolution, were called by this name. They were the courts of the prevots of France and of Paris, of the prevots des maréchaux (*see* PROVOST, PROVOST-MARSHAL, &c.), and exercised a summary jurisdiction over vagrants, highway robbers, disturbers of the peace, &c. These ancient institutions furnished Napoleon with the model of certain extraordinary courts, with mixed civil and military judges, which were formed in 1808 for the purpose of preserving public order in a summary manner. All these unconstitutional tribunals were abolished by the first charter of 1814; but with provision for the restoration of the Cours Prevotales, should it be thought necessary. They were accordingly established in 1815, to last for two years; but expired in 1818.

PRIA'PUS. (Gr. Πρίαπος.) A divinity introduced into Grecian mythology after the time of Alexander. He was the god of fruitfulness, and by the Romans was looked on particularly as the guardian of gardens, in which indecent and rudely sculptured wooden statues of him were usually set up.

PRICE (Fr. prix), in Commerce, means the value or exchangeable worth of any commodity or product estimated or rated in money, or simply the quantity of money for which it will exchange. The price of a commodity rises when it fetches more, and falls when it fetches less money.

Price of freely produced Commodities. — The exchangeable value of commodities — that is, their power of exchanging for or buying other commodities — depends, at any given period, partly on the comparative facility of their production, and partly on the relation of the supply and demand. If any two or more commodities respectively required the same outlay of capital and labour to bring them to market, and if the supply of each were adjusted exactly according to the effectual demand — that is, were they all in sufficient abundance, and no more, to supply the wants of those able and willing to pay the outlay upon them, and the ordinary rate of profit at the time, they would each fetch the same price, or exchange for the same quantity of money or any thing else. But if any single commodity should happen to require less or more capital and labour for its production, while the quantity required to produce the others continued stationary, its value, as compared with these, would, in the first case, fall, and in the second rise; and supposing the cost of its production not to vary, its value might be increased by a falling off in the supply, or by an increase of demand, and conversely.

But it is of importance to bear in mind, that all variations of price arising from any disproportion in the supply and demand of such commodities as may be *freely produced in indefinite quantities* are *temporary* only; while those that are occasioned by changes in the cost of their production are *permanent*, at least as much so as the cause in which they originate. A general mourning occasions a transient rise in the price of black cloth; but supposing that the fashion of wearing black were to continue, its price would not permanently vary; for those who previously manufactured blue and brown cloths, &c., would henceforth manufacture only black cloth; and the supply being in this way increased to the same extent as the demand, the price would settle at its old level. Hence the importance of distinguishing between a variation of price originating in a change of fashion, or other accidental circumstance — such, for example, as a deficient harvest, — and a variation occasioned by some change in the cost of production. In the former case, prices will at no distant period revert to their old level; in the latter, the variation will be lasting.

When the *price* of a freely produced commodity rises or falls, such variation may evidently be occasioned either by something affecting its value, or by something affecting the value of money; but when the generality of commodities rise or fall, the fair presumption is, that the change is not in them, but in the money with which they are compared. This conclusion does not, however, apply in all cases; and we believe that most part of that fall in the price of commodities which has taken place since the peace, and which has been so generally ascribed to a rise in the value of money occasioned by a decline in the productiveness of the mines, has been caused by the increased productiveness of industry, arising from the abolition of oppressive restraints on commerce, the opening of new and more abundant sources of supply, and the discovery of new means and improved methods of production.

Price of monopolised Commodities. — Exclusive, however, of the commodities now alluded to, there is a considerable class whose producers or holders enjoy either an *absolute* or a *partial* monopoly of the supply. When such is the case, prices depend entirely or principally on the proportion between the supply and demand, and are not liable to be influenced, or only in a secondary degree, by changes in the cost of production. Antique statues and gems, the pictures of the great masters, wines of a peculiar flavour produced in small quantities in particular situations, and a few other articles, exist under what may be called absolute monopolies; — their supply cannot be increased; and their price must therefore depend entirely on the competition of those who may wish to buy them, without being in the slightest degree influenced by the cost of their production.

Monopolies are sometimes established by law; as when the power to supply the market with a particular article is made over to one individual or society of individuals, without any limitation of the price at which it may be sold; which of course enables those possessed of the monopoly to exact the highest price for it that the competition of the buyers will afford, though such price may exceed the cost of production in any conceivable degree. Monopolies of this sort used to be common in England, particularly in the reign of Elizabeth; but they were finally abolished by the famous act of the 21 Jac. 1. c. 3., an act which, by establishing the freedom of competition in all businesses carried on at home, has been productive of the greatest advantages.

The rights conveyed by patents sometimes establish a valuable monopoly; for they enable the inventors of improved methods of production to maintain, during the continuance of the patent, the price of the article at a level which may be much higher than is required to afford them the ordinary rate of profit. This advantage, however, by stimulating invention, and exciting to new discoveries, of which it is the natural and appropriate reward, instead of being injurious, is beneficial to the public.

There are also partial monopolies, depending upon situation, connection, fashion, &c.; these and other inappreciable circumstances sometimes occasion a dif-

ference of 30 per cent., or more, in the price of the same article in shops not very distant from each other.

Generally speaking, the supply of monopolised commodities is less liable to vary than those that are freely produced; and their prices are commonly steady. But there are various exceptions to this rule; and of these the partial monopoly of the supply of corn, which the existing corn laws secure to the British agriculturists, may be taken as an example. The variations in the harvests of particular countries, and their average equality throughout the world, expose a nation which shuts foreign corn out of its ports to vicissitudes of price, from which it would enjoy a comparative exemption were its ports always open. Sometimes the expiration of a monopoly, a patent for example, has occasioned a sudden and extraordinary increase of supply, and consequent fall of price; entailing, of course, a serious loss on the holders of large stocks of goods produced under the monopoly.

New Sources of Supply. — The effects on prices produced by the opening of new markets, or new sources of supply, are familiar to every one. The fall that has taken place in the price of pepper, and of most sorts of commodities brought from the East, since the opening of the trade in 1814, is a conspicuous proof of what is now stated.

Influence of Taxes on Prices. — It is unnecessary to dilate on a topic so familiar to every one. When a tax is laid on a commodity, its price necessarily rises in a corresponding proportion; for otherwise the producers would not obtain the ordinary rate of profit, and would, of course, withdraw from the business. A considerable part of the price of many articles in this and other countries really consists of the tax or duty laid upon them.

These statements will probably suffice to give our readers a general idea of the principles which determine the value of commodities. To go deeper into the subject would involve us in discussions that belong to political economy, and which are nowise suited for such a work as this.

Such however of our readers as wish for full and satisfactory information as to these topics, and the practical operation of the different circumstances to which we have now adverted, would do well to consult Mr. Tooke's *History of Prices*. This work is especially valuable for the rare union which it exhibits of a perfect knowledge of principles with the most extensive acquaintance with practical details.

PRICKING-UP. In Architecture, the first coating of plaster in work of three coats upon laths. It is executed with *coarse stuff* in London, usually compounded with road stuff, or Thames sand. The surface is scratched over, to form a better key for the next coat.

PRICK-POST. In Architecture, a post in wooden buildings framed intermediately between two principal posts.

PRIEST. (Gr. πρεσβύτερος, *elder.*) Etymologically, the Christian priest is merely a minister who presides over the spiritual affairs of a congregation. The word, however, is commonly used also to represent the Greek ἱερεύς, who, like the Jewish priest, had both a sacrificial and mediatorial character; and the Roman Catholic looks upon the Christian priest in the same light.

PRIMÆ VIÆ. (Lat. *the first passages.*) Medical men apply this term to the stomach and bowels.

PRI'MAGE. A certain allowance paid by the shipper or consigner of goods to the master and sailors of a vessel for loading the same. It varies in different places according to their respective customs.

PRI'MARY COLOURS. The colours into which a ray of white solar light may be decomposed or separated. Newton supposed them to be seven; red, orange, yellow, green, blue, indigo, and violet. Mayer considered some of these to be secondary colours, and that there are only three primary colours in the solar spectrum; namely, red, yellow, and blue, certain portions of which constitute white light and all the other colours. (*Opera inedita*, 1775.) Dr. Young assumes red, green, and violet as the fundamental colours. (*Lectures on Nat. Phil.* p. 439.) In fact, any three prismatic rays may be assumed as the primary colours, and all the rest compounded from them, provided we attend only to the predominant tint resulting, and disregard its dilution with white. (*Herschel on Light*, § 518.) *See* CHROMATICS, LIGHT.

PRIMARY ROCKS, or PRIMITIVE ROCKS. *See* GEOLOGY.

PRI'MATE. (Lat. primus, *first.*) A prelate of superior dignity and authority. In England, the archbishop of York is entitled Primate of England; the archbishop of Canterbury, Primate of all England.

PRIMA'TES. The name given by Linnæus to the first order of animals in his *Systema Naturæ*, which associated man with the monkeys and bats, and corresponded to the Bimana, Quadrumana, and Cheiroptera of Cuvier.

PRIME NUMBERS, in Arithmetic, are numbers which have no divisors, or which cannot be divided into any less number of equal integral parts than the number of units of which they are composed; such are 2, 3, 5, 7, 11, 13, &c.

A general method of finding prime numbers, beyond a certain limit, by a direct process, is one of the most difficult problems in the theory of numbers; and, though often sought after, has not yet been discovered. Many remarkable properties of numbers have, however, been detected, by means of which it is in most cases not difficult to determine whether an assigned number is prime or not. Some of these properties are the following: —

1. Every prime number above 3 is comprehended in one of these forms, $6n+1$, or $6n-1$ (n being any whole number); that is to say, if a prime number be increased or diminished by unity, the result is a multiple of 6. In order to prove this, it will be sufficient to remark that every whole number is necessarily comprised in one or other of these six forms (where n is successively 0, 1, 2, 3, &c.),

$$6n+1,\ 6n+2,\ 6n+3,\ 6n+4,\ 6n+5,\ 6n+6.$$

Now the second, fourth, and sixth of these forms, being divisible by 2, cannot give prime numbers. The third gives only numbers divisible by 3; therefore the primes can only be of the form $6n+1$, or $6n+5$. But $6n+5 = 6n+6-1 = 6(n+1)-1 = 6n'-1$, n' being any whole number; it follows therefore that all prime numbers are comprehended in one of the forms $6n+1$, or $6n-1$.

2. In like manner, every prime number above 2 is of one of the forms $4n+1$, or $4n-1$; and every prime number, excepting 2, of one of the forms $8n+1$, $8n+3$, $8n+5$, $8n+7$. In fact, prime numbers may be divided in this manner into classes, according to any modulus, at pleasure; the last four forms, however, are those which possess the most distinctive properties.

Although every prime number is comprehended in one of these forms, the converse proposition is not true; namely, that every number in one of these forms is a prime number. No direct rule has yet been given by which it can be determined *à priori* whether a given number be prime or not.

3. If a number cannot be divided by another number less than the square root of itself, that number is a prime.

4. If n denote any prime number, the product, $1\cdot2\cdot3\cdot4\cdots(n-1)$, increased by unity, is divisible by n.

It is frequently of use in arithmetical investigations to know whether a number is prime or not; tables of them have accordingly been formed to a certain extent, and are given in various works. Vega's tables contain the prime numbers under 400,000. The largest prime number which has yet been verified is $2^{31}-1=2147483647$. This was found by Euler.

For properties of prime numbers, see Fermat's edition of *Diophantus; Euler's Algebra*, and *Analysis Infinitorum;* Legendre, *Essai sur la Théorie des Nombres; Barlow's Elementary Investigations, &c.;* and especially the *Disquisitiones Arithmeticæ* of Gauss, of which there is a French translation by Delisle.

Prime and Ultimate Ratios.—A method of calculation invented by Newton, and employed in the *Principia*, being an extension and simplification of the ancient method of exhaustions. It may be thus explained: — Let there be two variable quantities constantly approaching each other in value, so that their ratio or quotient continually approaches to unity, and at last differs from unity by less than any assignable quantity; the *ultimate ratio* of these two quantities, is said to be a ratio of equality. In general, when different variable quantities respectively and simultaneously approach other quantities considered as invariable, so that the differences between the variable and invariable quantities become at the same time less than any assignable quantity, the ultimate ratios of the variables are the ratios of the invariable quantities or *limits*, to which they continually and simultaneously approach. They are called *prime ratios*, or *ultimate ratios*, according as the ratios of the variables are considered as receding from, or approaching to, the ratios of the limits. (See *Principia*, book i.)

PRI'MER, signified anciently a religious work employed in the Roman Catholic service; but it is now generally used to denote the first book for children.

PRIMER SEISIN. (Norm. Fr.) An ancient branch of the royal prerogative in England, whereby it had possession for a year of the lands and tenements of which a tenant in capite died seised, if the heir was of full age; or, if not, until he was of age.

PRIME VERTICAL. In Astronomy, the vertical circle of the sphere which intersects the meridian at right angles, and passes through the east and west points of the horizon. In dialling, prime vertical dials are those which are projected on the plane of the prime vertical, or a plane parallel to it.

PRI'MINE. In Botany, the outermost sac or covering of an ovule; either composed of cellular tissue only, or traversed by numerous veins or bundles of tubes.

PRIMING. (Lat. primus, *first.*) In Architecture, the first coat of painting.

PRIMIPI'LUS. In Ancient History, the name of the centurion of the first cohort of a legion, who had charge of the Roman eagle. This office was one of considerable dignity, and entitled its holder to various privileges, which conferred both rank and emolument. On quitting his charge, the primipilus assumed his place among the members of the equestrian order, with the title primipilarius. (See *Adam's Rom. Antiquities; Mém. de l'Acad. des Inscr.* vol. xxxii.)

PRIMI'TIÆ. The first fruits of any production of the earth, which were uniformly consecrated to the Deity by all the nations of antiquity. *See* FIRST FRUITS.

PRI'MITIVE. In Grammar, a word neither derived from any other language, nor compounded from any other words of the same; as *horse*, *man*.

PRI'MITIVE COLOURS, in Painting, are red, yellow, and blue, from the mixtures whereof all other colours may be obtained.

PRIMOGE'NITURE. The right of the eldest son, and those who derive through the eldest son, to succeed to the property of the ancestor. Among ancient nations, the Jews alone appear, as far as is known, to have recognized this usage among their institutions. For some notice of the policy of the system of primogeniture, see SUCCESSION, LAW OF.

PRIMULA'CEÆ. (Primula, one of the genera.) A natural order of herbaceous Exogens, inhabiting the northern and colder parts of the globe. It is nearly allied to all the regular Monopetalous orders, with a capsular superior fruit, especially to *Solanaceæ* and *Ericaceæ*, from both of which it is readily known by the stamens being placed opposite to the segments of the corolla. In this respect it agrees with *Myrsinaceæ*, which differ chiefly in their fleshy fruit and arborescent habit. The cowslip, from which a sedative wine is made; the primrose, auricula, and the acrid cyclamen; together with anagallis, or the herb pimpernel, which regularly closes its flowers at the approach of rain, — are species of this order.

PRI'MUM MO'BILE, in the Ptolemaic Astronomy, is the outermost sphere of the universe, which gives motion to all the others (*i. e.* those of the moon, planets, &c.), and carries them round with it in its diurnal revolution. Its centre is the centre of the earth.

PRI'MURIES, or PRIMARY QUILLS. (*Primores*, Linn.) The largest feathers of the wings; they rise from the pinion-bones, or those corresponding to the metacarpus and digits.

PRINCE. (From the Latin princeps, *first*, *leader*, *or foremost.*) This title is probably of Teutonic origin: the German equivalent, fürst, has the same etymological signification, and the Latin nation appears to have translated it. In England, the title is applied only to members of the royal family; and in no case, except that of the eldest son of the reigning king (Prince of Wales), is it connected with a territorial distinction. On the Continent, the rank of princes is various: in France, under the old regime, the title belonged only to certain families of high distinction, connected with the royal blood; it ranks in Germany below that of duke.

PRINCE OF WALES. The title bestowed by patent on the heir apparent to the crown of England. He is born Duke of Cornwall, &c.; but the title of Duke of Cornwall does not necessarily belong to the heir apparent, as it can only be held by the *first-begotten* (not *eldest*) son of a king: thus Henry VIII. was not, in the life of his father, Duke of Cornwall. The origin of the title of Prince of Wales is as follows: — When Edward I. subdued Wales, he promised the people of that country, upon condition of their submission, to give them a prince who was born amongst them, and who could speak no other language. Upon their acquiescence with this deceitful offer he conferred the principality of Wales upon his second son Edward, then an infant, born within the principality, and unable to speak any language. Edward, by the death of his elder brother Alfonso, became heir to the crown, and from that time this honour has been appropriated to the eldest sons of the Kings of England. The Earldom of Chester, which is likewise usually conferred upon the heir-apparent, was once a principality, and erected into that title by parliament in the 21st of Richard II.; it was then appointed to be given to the king's eldest son. But the whole acts of that parliament were repealed in the reign of Henry IV., although the earldom has usually been since given with the principality of Wales. The revenue of the last Prince of Wales was 125,000*l.*; 60.000*l.* being paid from the civil list, and 65,000*l.* from the consolidated fund. His income was last regulated by 35 G. 3. c. 125. To compass the death of the Prince of Wales, or violate the chastity of his consort, is high treason within the statute of 25 Ed. 3. The Prince of Wales has a household of his own, of which the chief officers are a comptroller and auditor-general, treasurer, vice-chamberlain, Gloucester king-at-arms, and herald; besides another class of officers belonging to the duchy of Cornwall, and another as great steward of Scotland. As Duke of Cornwall and Earl of Chester, the prince appoints sheriffs, &c. for those counties. By a statute of the order of the Garter, issued in 1805, the Prince of Wales was declared a constituent part of the original institution. Hence every prince becomes a Knight of the Garter the moment he is created Prince of Wales. For the constitutional question raised in 1788, respecting the right of the Prince of Wales to the regency, see REGENT.

PRINCEPS SENA'TUS. Prince or first of the senate. In Ancient Rome, the citizen whose name was inscribed first on the list of the senate by the censors was so called. This high dignity was not connected with any office, and was conferred, in later times, only on those who were recognized as the most considerable citizens of the state. Before the second Punic war, it seems to have belonged to the oldest of those who had held the office of censor; but the first deviation from this practice was in favour of Fabius Maximus. This title was the first germ of the imperial authority of Augustus. (*See* SENATE.) There is a memoir on the subject in vol. xxiv. of the *Mémoires de l'Academie des Inscriptions.*

PRI'NCIPAL. (Lat. princeps, *chief.*) In Architecture, a main timber in an assemblage of carpentry. Thus, in a roof, the strong rafters used for trussing the beams are called principal rafters.

PRINCIPAL. The name by which the heads of the Scottish universities are distinguished.

PRINCIPAL. In the Fine Arts, the chief circumstance in a work of art, to which the rest are to be subordinate.

PRI'NCIPES. The name given to one of the four grand divisions of the Roman infantry. It was their duty to assume the initiative in an engagement, for which they were admirably qualified, being the choice men of the Roman army, and from this circumstance their name is said to be derived. The other three bodies were the velites, hastati, and triarii, which see. (See *Mém. de l'Acad. des Inscr.* vol. xxix.)

PRI'NCIPLE. (Lat. principium.) In Chemistry, a term sometimes applied to certain proximate components of organic bodies, such as *bitter principle*, *febrifuge principle*, *narcotic principle*, &c. This term, however, is now almost disused, it having been found that each bitter, febrifuge, narcotic, or other substance, generally contains a principle peculiar to itself upon which its powers depend, and that there is no such common or universal principle as was formerly supposed. For the same reason the term "principle of inflammability," or *phlogiston*, is rejected, as applied in common with "nervous principle," &c., to an imaginary existence.

PRI'NCIPLES. In the Fine Arts, those general and fundamental truths from which the rules and maxims of art are deduced. To each art particular principles are attached on which its theory is founded. These principles, before they can be said to have stability, must be found to depend on certain truths, which, recognized by every one, and indisputable, oblige the mind to concur in the deductions that result from them. Before a law in any art is laid down, it is necessary to trace it to the principles from which it springs, though there may be causes which prevent those principles being universally admitted: such as ignorance, prejudice, love of novelty, and the like. Indeed, there is an everlasting contest between truth and error in all human institutions. The former, like light, is acknowledged by all, though our passions and interests too often tempt us to obscure it; but, as darkness itself proves that light exists, so falsehood only enables truth to shine with greater lustre.

PR'INTING. (Fr. imprimerie.) Letterpress printing, to which this article is confined, is the art of taking impressions from engravings in relief.

The process is generally limited to printing from types, and from engravings on wood.

The history of its origin is enveloped in mystery; and this art, which commemorates all other inventions, which hands down to posterity every important event, which immortalizes the actions of the great, and which, above all, extends and diffuses the word of God to all mankind; this very art has left its own origin in obscurity, and has given employment to the studies and researches of the most learned men in Europe, to determine to whom the honour of the invention is due.

Some writers maintain that the art was practised as far back at least as the building of Babylon; and hold that the characters impressed on the bricks found on the supposed site of that city are literally printed: we are in possession of metal stamps, with words engraved in relief, which the Romans made use of to mark their various articles. On this subject Mr. Landseer, in his *Lectures on the Art of Engraving*, 8vo. 1807, observes, "Had the modern art of making paper been known to the ancients, we had probably never heard the names of Faust and Finiguerra; for, with the same kind of stamps which the Roman tradesmen used for their pottery and packages, books might also have been printed; and the same engraving which adorned the

shields and pateras of the more remote ages, with the addition of paper, might have spread the rays of Greek and Etrurian intelligence over the world of antiquity. Of the truth of this assertion I have the satisfaction to lay before you the most decided proofs, by exhibiting engraved Latin inscriptions, both in cameo and intaglio, from the collection of Mr. Douce, with impressions taken from them at Mr. Savage's letterpress but yesterday (in 1805). One of these is an intaglio stamp, engraved on stone, with which a Roman oculist was used to mark his medicines; the other, which is of metal, and in cameo, is simply the proper name of the (Roman) tradesman by whom it has probably been used, 'Titus Valagini Mauri.'" Of the latter stamp, the following impression is a facsimile:—

Papillon's relation of the two Cunio, who engraved on wood the heroic actions of Alexander the Great, and printed impressions from them in the year 1285, the truth of which has been defended by Zani, Ottley, and Singer; the print of St. Christopher carrying the infant Jesus across the sea, with an inscription and the date 1423 at the bottom on the same block, in the library of Earl Spencer; and the decree of the government of Venice, of the date 11th October, 1441, respecting "playing cards, and coloured figures printed," the art and mystery of making which had fallen to total decay at Venice, in consequence of the great quantity which were made out of Venice, and prohibiting the introduction of them under pain and forfeiture and fine,—a decree which carries the art of printing back into the 14th century: these circumstances, taken together, prove that the knowledge and the practice of the art of printing existed in Europe long before the time which is usually attributed to it, although it had not been applied to the multiplication of books.

According to Du Halde and the missionaries, the art of printing from engraved blocks of wood was practised in China nearly fifty years before the Christian era; and from the early commercial intercourse of the Venetians with that country, there is reason to believe that the knowledge of the art and of its application to the multiplying of books was derived from thence; for Venice is the first place in Europe of which we have any account in which it was practised, as appears by the decree above mentioned, which is the most ancient document in existence respecting printing; but the date of this application of the art, or the place where it was first practised, it is impossible to determine. From that decree and the existence of the print of St. Christopher, it would seem that it had been long applied to the production of playing cards, and of religious subjects; and when it was extended to books they were printed by the Chinese method, still in use, each page being engraved on a block of wood: and if this plan was followed, as most probably it was, from its being the most expeditious and the most correct,—of fastening a page of manuscript on the face of the block and engraving from that, instead of drawing the characters on the wood,—it would at once account for the diversity of characters found in the block books, which varied with the different handwritings of the scribes, and has completely puzzled the learned, who endeavour to ascertain the printer by comparing the characters with some other work; as well as for their great similarity to manuscripts, for which they were sold. This appearance too was aided by their being printed on one side of the paper only, the indention being removed by burnishing the back, and two leaves were pasted together, thus making them such perfect facsimiles of manuscripts as to require even at the present day great discrimination and even chemical skill to distinguish them from each other; and as these books had neither names, dates, nor places affixed to them, it is now impossible to ascertain by whom, when, or where they were executed; and thus the fabrication of these pseudo-manuscripts involved the first introduction of the art of printing books in Europe in complete obscurity.

About the year 1450, the great and accumulating expense of engraving blocks for each separate work of the increasing number of books produced by means of printing, led to the important improvement of the art of casting separate metal types, and substituting them for the wooden blocks previously used. This formed a new epoch in the art, and is now termed, erroneously, the origin of printing. After a lapse of many years, several cities claimed the honour of this invention, but time has reduced these claims to two,—Haarlem and Mentz; and this rivalry has employed the studies and the pens of many learned men, who have laboured to prove the respective claims of these cities to the imaginary honour of the invention of printing; for what can be more imaginary than such an honour? seeing the art had been practised in Europe, privately and publicly, in a modified form, for sixty or seventy years previously to the period which forms the subject in dispute. The claims of Haarlem rest upon the statement of Hadrian Junius, who gives it upon the testimony of one Cornelius, who had been a servant of Laurence Coster, for whom the invention is claimed; but this testimony, is our opinion, utterly worthless. Modern research gives the credit of the introduction of moveable metal types (unquestionably a grand *improvement*), to Peter Schoeffer, the assistant and son-in-law of John Fust or Faust of Mentz, so well known in Europe as Dr. Faustus. Of two writers who have supported the respective claims of these two places, it has been observed, that it now seems to be allowed that Heinecken has paid too little attention to the antiquity of the claims of Haarlem, and Meerman infinitely too much.

The first edition of the *Speculum Humanæ Salvationis* was printed by Coster at Haarlem, about the year 1440 as is supposed, and is one of the earliest productions of the press of which the printer is known, and of which we shall have occasion to speak hereafter. But the celebrated Bible, known as the "Mentz Bible without date," is the first important specimen of printing with metal types: this was executed by Gutemberg and Fust, between the years 1450 and 1455, and was the occasion of the secret being divulged, of producing books by mechanical means, as is mentioned in the article Black Letter. Then followed "the *Psalter*, of 1457," by Fust and Schoeffer. These works are executed in such a manner that, with all our boasted skill, and our improvements in the art, we are decidedly of opinion, perfect facsimiles, taking the ink and workmanship into account, could not have been executed in England so lately as twenty-five years ago. When the secret was made known, books avowedly printed issued from the press in all parts of Europe, far beyond what could have been calculated upon from a new discovery; for before the year 1500, there were printing offices in upwards of 220 places,—in Austria, Bavaria, Bohemia, Calabria, the Cremonese, Denmark, England, Flanders, France, Franconia, the Frioul, Geneva, Genoa, Germany, Holland, Hungary, Italy, Lombardy, Mecklenburg, Moravia, Naples, the Palatinate, Piedmont, Poland, Portugal, Rome, Sardinia, Upper and Lower Saxony, Sicily, Silesia, Spain, Swabia, Switzerland, Thessalonica, Turkey, Tuscany, the Tyrol, Venice, the Veronese, Westphalia, Wirtemberg, &c. The number of places in which the art was practised, the wide extent to which it had spread in so short a space of time, combined with the skill which the early printers displayed in their works, appear to us to be totally incompatible with the date generally assigned to the invention; and we are of opinion that, after having been long practised in private, it emerged into publicity in a state nearly approaching to perfection.

It is impossible in this short and rapid sketch of the history of the art to enter into detail, or to trace its progress in the different cities and towns, or even in the different countries where it was first publicly practised after the secret was divulged: in fact it would be impossible to arrive at any satisfactory conclusion; for as the first printers neither affixed their names, dates, nor places where their productions were executed, the greatest research could only result in vagueness and uncertainty. There has been great difference of opinion among bibliographers who have written on the subject, even respecting the first edition of the Latin translation of the Bible; and Meerman has enumerated ten ancient editions without date, in favour of the priority of each of which pretensions have been advanced and supported.

William Caxton is generally regarded as first who introduced the art of printing into England, and practised it at Westminster; but a prior claim is advanced in favour of Oxford, which has occasioned much controversy. Dr. Dibdin, in his *Typographical Antiquities*, says, "Although Caxton is called by me the first English printer, yet I fully believe in the authenticity of the Oxford edition of the *Exposicio sancti Jeronimi in simbolo apostolorum*, &c.. of the date of 1468, which was printed by a foreigner at Oxford, who was interrupted in the prosecution of his typographical labours." Several copies of this work are in existence: one is in the Bodleian library, another in the public library at Cambridge, and a third in the British Museum: Herbert mentions a fourth in the Earl of Pembroke's library; a fifth in All Souls library, of which a doubt may be entertained; and Hearne speaks of a sixth copy in the school tower at Oxford. Those who deny the priority for Oxford argue that the date is incorrect, either from accident or design; that being in Roman numerals an X is omitted, and that the real date of the book should be MCCCCLXXVIII.

Caxton, during a long residence on the Continent on

commercial affairs and political missions, in the reign of Henry VII., acquired a practical knowledge of the art, and on his return to England established a printing-office in a chapel adjoining to Westminster Abbey, where for many years he was indefatigable in translating and preparing works for the press, and in printing them; and to him may be fairly ascribed the merit of being the first to introduce the practice of printing generally into England. He printed many books on a variety of subjects; and all the productions of his press are objects of great interest to book collectors. He commenced printing in England about the year 1474, and was followed by Wynkyn de Worde, Richard Pynson, &c.

In the Privy Purse Expenses of Henry the Seventh are the following entries:—

"June 6, 1499. To the Printers at Westmr, £1."

"Nov. 1, 1504. To Richard Pynson the Prynter, in rewarde, £1."

"24. For pryntyng of new Colletts, £1 13s. 4d."

"July 12, 1505. To Ric. Pynson opon a prest for massebokes to be printed, £10."—*Excerpta Historica*, 8vo. 1833.

Dr. Dibdin relates, that, in 1524, Dr. Robert Wakefield, chaplain to Henry VIII., published his *Oratio de Laudibus et Utilitate trium Linguarum, Arabicæ, Chaldaicæ, et Hebraicæ*, &c. 4to. The printer was Wynkyn de Worde; and the author complains that he was obliged to omit his whole third part, because the printer had no Hebrew types. We have now in the British founderies, in addition to the Roman and Italic characters, Arabic, Armenian, Coptic, Domesday, Engrossing, Ethiopic, Etruscan, German, Greek, Alexandrian Greek, Gothic, Hebrew, Hibernian or Irish, Malabaric, Malayan, Nagari or Brahmin, Persian, Philosophical, Runic, Russian, Samaritan, Sanscrit, Saxon, Sclavonian or ancient Russian, Script in imitation of writing, Swedish, Syriac, Tamoul, Télegú, Turkish; also black letter, and music; and, in addition, a great variety of fancy types.

The first book in which Greek types occur is Cicero's *Offices*, printed in the year 1465, in which the characters are so imperfect that the words are with difficulty deciphered; and the first book printed in Roman characters was Cicero's *Epistolæ Familiares*, by Sweynheim and Pannartz, at Rome, in 1467. The Italic type was the invention of Aldus Manutius, the celebrated printer at Venice, about 1500, and dedicated by him to the States of Italy, from which it took its name.

The art appeared to start into publicity in a state of perfection. As it extended, the workmanship became much inferior; so that while the productions of the first printers were executed in a very superior style, and the embellishments showed a great proficiency both in design and engraving, the productions of their competitors had all the crudeness and imperfection of a new invention; and in the 17th century it had retrograded to a very low state. At the commencement of the 18th century, Caslon made great improvement in types; and about 1750 Baskerville of Birmingham also made great improvements, both in types and printing, which were subsequently carried on by Bensley, Bulmer, Corrall, Davison, M'Creery, Whittingham, and a few others, in London; the Foulis at Glasgow; the Ballantynes in Edinburgh; Bodoni at Parma, and Didot at Paris.

Many of the manuscripts of the 14th and 15th centuries were written in a beautiful manner, and embellished by borders round the pages, and by the large letters at the commencement of chapters being drawn and coloured with brilliant colours, heightened with burnished gold, and finished with taste, delicacy, and great ability, so as to produce a most splendid effect. These were called illuminated manuscripts. On the first production of books by the process of printing these ornamental letters were left blank, and both these letters and the borders were finished by hand in the usual manner, which gave to the book a perfect resemblance to a manuscript, of which it became by these means a complete facsimile. This is the case with the Mentz Bible by Fust and Gutenberg. The first printers soon began to print these large ornamented letters, the letter itself being in some instances red and the ornamental part blue, in others the letter is blue and the ornamental part red; and these were afterwards finished by hand, as is apparent in the Psalter of 1457, printed by Fust and Schoeffer, who also showed great ingenuity and skill in the large letter B in the same book, which is printed with red ink, and the ornamental part, consisting of a flourished line, as if it had been drawn with a pen, extending from the top to the bottom of the folio page, with blue ink. Of two copies which we have examined, one was in the library of Geo. III., at Buckingham Palace, and the other is in the possession of Earl Spencer.

The first edition of the *Speculum Humanæ Salvationis*, which was printed at Haarlem, about the year 1440, by Laurence Coster, has engravings on wood printed in a different coloured ink from the body of the work. A copy of this rare and curious work, which we examined some years ago in the valuable collection of Messrs. Longman, impressed us momentarily with the idea that the engravings were pen and ink drawings, and that the ink had turned brown with age, so precisely was this effect produced by the tone of the ink.

We mention these early specimens of printing with coloured inks, and in the case of the Psalter having two blocks of wood with two different colours, as being produced by means of the press, coeval with the generally received opinion of the invention of printing, to show the impossibility of the case. For, looking at the freedom of the engraving in the letter B, and the skill of the workman in printing it, it must be evident to every person conversant with the art that this perfection could only be obtained by long practice; and the contrast between these productions of the first practitioners and their competitors, when the art became public, puts the question beyond a doubt, as an examination of the facsimiles given by Heinecken from Fables printed at Bamberg about 1461, from the *Legendes* printed at the same place about 1470, and also the Fables of Æsop by Caxton, will, we think, satisfy the most scrupulous and sceptical.

Towards the end of the 15th century the art was extended to the imitation of pen and ink sketches with a coloured ground, by the great masters of painting; and in a few years it was further extended to the imitation of drawings in clare-obscure, and that with such success as to induce some of the first artists to encourage it by drawing the subjects on the blocks. The first practisers of this extension of the art were, Michael Wolgemuth of Nuremberg, who furnished the designs for the *Nuremberg Chronicle*, and also engraved them on wood, and Mair, a native of Landshut, the disciple of Martin Schön; between whom the priority rests of printing in clare-obscure. After them were Girolomo Mocetto, Lucas Cranach, Baldassar Peruzzi, Hans Burghmair, and Ugo da Carpi (who has been generally regarded as the inventor of this style of printing, but dates prove this opinion to be erroneous), Domenico Beccafumii, John Ulric, Albert Altdorfer, Hans Baldung, Lucas Jacobs Leyden (called Lucas Van); all these were born in the 15th century. In the 16th century, there were Antonio da Trenta, Giovanni Nicolo Vicentino (called Rossigliani), Herbert Goltz or Goltzius, Andrew Andreani, Henry Goltz or Goltzius, Abraham Bloemaert, Paul Moreelze, Bartolomeo Coriolano, Giovanni Batista Coriolano, Christopher Jegher, George L'Allemand, and Frederick Bloemaert. In the 17th century, there were Louis Businck, Vincent le Sueur, Antonio Maria Zanetti, Nicholas le Sueur, Comte de Caylus, Edward Kirkhall, and John Baptist Michael Papillon. This last-mentioned engraver, in his treatise on *Engraving on Wood*, expressly states that Albert Durer engraved some subjects in clare-obscure, and that he had examined them in the collection of the king of France; Parmigiano also superintended the printing in this manner of a number of his own designs; Titian, Raffaelle, and other eminent masters made designs on the blocks for printing; and the author of *An Enquiry into the Origin of Printing in Europe* states, that "one of the greatest princes and connoisseurs of our age used to say, he saw nothing in prints that could give him the pleasure he received from looking at the wood prints, done in chiaro-oscuro by Hugo di Carpi." This prince was the Duke of Orleans, regent of France.

After these were John Baptist Jackson, who executed a number of subjects, of a large size, in clare-obscure, copied from celebrated paintings in churches in Italy, and from private collections; he afterwards established a manufactory at Chelsea for printing paper-hangings in oil colours, a speculation, however, which was unsuccessful. Some of his productions printed in colours were complete failures, the oil having spread in the paper; and the subjects being in the first instance engraved with strong lines, they have the appearance of coarse engravings coloured by children. Jackson flourished from 1720 to 1754. Mr. John Skippe, an amateur, executed many subjects in clare-obscure very adroitly.

Gubitz, an engraver at Berlin, has produced a great number of subjects printed in colours, of a very superior character, but none of them can be called imitations of drawings. The writer of this article was the first who attempted to imitate drawings in water colours by means of the common printing press, and accomplished the applying of all the colours used by artists to the composition of printing ink, thus serving as a pioneer to more skilful persons who might devote themselves to this branch of art; and he succeeded in producing facsimiles of the drawings of different artists so as to deceive every one who examined them. Messrs. Whiting and Branston, of Beaufort House, applied printing in coloured inks to the prevention of forgery, and to embossing on paper; and Messrs. Vizetelly and Branston have produced some very tasteful things in colours; but neither of these establishments has, to our knowledge, turned their attention to the imitation of drawings. Mr. Baxter is now pursuing the subject, and has executed many very superior specimens in a manner that would have been deemed totally im-

practicable twenty-five years ago. The result is confirming the most sanguine expectations we ever entertained on the subject; and we are decidedly of opinion that the powers of the printing press in producing works of art are far from being fully developed.

The art of taking impressions in gold from types, and from engravings on wood and metals in relief, generally called printing in gold, is executed most successfully by the common printing press. It is also accomplished with bronze of different colours in the most delicate engravings; but however beautiful the effect of bronze may be at first, it unfortunately is not permanent.

After this brief sketch of the history and progress of the art of printing in Europe, an art more important in the effects it has produced on the human mind, and consequently on the state of society, than any other that has ever been practised, we shall lay before the reader a short outline of the practical part, for the better understanding of which, we shall subjoin a glossary of the chief technical terms in common use.

The first operation, called composing, is to arrange the separate letters called types (*see* Types) into words, lines, and pages. These pages, being placed upon a large flat surface, called an imposing stone, in such an order that when they are printed, and the sheet of paper is folded, the pages will follow each other consecutively, are then wedged up in an iron frame, termed a chase. This operation is styled imposing.

A printing press is a machine on which the matter to be printed is laid on an even surface horizontally placed, either of stone or iron; and the pressure upon the types is produced by a parallel surface of wood or iron, technically a platen, by means of a screw, or lever, or both combined. *See* Press.

Perhaps the most satisfactory way of explaining the process generally will be to take a printing-office just commencing, and describe the whole arrangement, and follow, in the order of its proceeding, the execution of a work from its being put in hand to its completion.

The office having been supplied with all the necessary materials; viz. frames, cases, case racks, bulks, boards, board racks, imposing stone, furniture, quoins, mallet, shooting-sticks, brass rule, chases, and types, in the quantity and variety that may be judged necessary; and also presses with their accompaniments, banks and horses, with a sink, lye trough, wetting trough, and paper boards; and in the warehouse, with a gathering table, poles, a peel, and a press to press the books before they are delivered, — it may be said that the office is in a state to commence business.

The compositor now proceeds to lay the letter into as many cases as may be judged expedient in the first instance (*see* Case), laying the Italic in cases distinct from the Roman, each letter or sort in the box appropriated to it: having done this with one fount, he will put the cases into the case rack, and proceed with another fount, till the whole of the letter is laid; he will put the superfluous sorts either into a fount case or into coffins; and he will then be ready to take copy.

The pressman has to adjust his press, place the footstep so as to give him the greatest advantage in the pull, fix the rounce, place the girths so that the carriage shall run in and out properly, fix the back stay, justify the platen so that it shall bear equally on all parts of the form, and cover his tympans and frisket; and he is also ready to proceed in his work.

The compositor having taken copy, and received directions respecting the measure, the length of the page, any peculiarity in the spelling of particular words, the use of capital letters, the punctuation, the words that are to be in Italic or small capitals, and any other directions that may be deemed necessary, proceeds to make his measure, and cut a composing rule; he then begins to compose, letter by letter, till he has formed a word; he separates this from the following word by a space, and so continues till he has composed a line; he then justifies this line, by increasing the space between the words or lessening it according to circumstances, so that the line shall be tolerably tight in the composing stick; and thus proceeds till he has completed a page: after having set the head line and direction line with the signature, he ties a page-cord round it, to preserve it from falling asunder, puts it on a page-paper, and places it on the bottom of his frame; and thus continues, page after page, till he has composed a sheet.

It may be necessary to state that every line is of the same length, whether the types fill it out or not; the last line of a paragraph, lines of poetry, and short lines of any other description, are filled up with quadrats to the proper length, in order that they be secured from derangement by being wedged up in the chase; which is termed locking-up.

The pages are then taken to the imposing stone, and arranged in the proper order; the page-papers removed; a chase is then placed over them (*see* Chase), furniture put about them (*see* Furniture), and the page cords taken away; proper quoins are then selected, and the form is locked up. It is then taken to a press, and one impression is printed; this is styled the first proof, which is folded and taken to the reader with the copy; a boy reads the copy to him, while he examines the proof and marks the errors of the compositor, and puts a query to any doubtful matter for the author's consideration; the proof is then returned to the compositor, who corrects the errors and mistakes, and a second impression is printed with more care, and generally on better paper; this is styled a clean proof; it is examined by the first proof to see that the errors of workmanship are corrected, which is termed revising, and then sent out with the copy to the author; he makes what alterations and corrections he may think necessary (*see* Correcting); these are corrected by the compositor; another impression is printed, revised, and read finally and with care for press; the margin is then adjusted (*see* Margin); and the corrections being carefully made, it is taken to the press to be printed off.

In the mean time, after the author has returned the sheet for press, the warehouseman delivers out the proper quantity of paper, which the pressman wets, by drawing the paper, to the extent of three, four, five, or six dips for each quire, through clean water, according as the paper may be hard-sized or porous, and also as the form may be solid or open; the paper as it is wetted is laid upon a board, opened out, and another board is laid upon it with weights; on the following day it is turned, which causes fresh surfaces to come into contact with each other, and diffuses the moisture equally throughout every part of the heap; it will be in good condition to print on the next day. This wetting the paper causes it to receive the impression of the ink in a much more perfect manner than it could possibly be made to do if dry.

The pressman having received the forms lays the inner form on the press, and prints one copy, which is called a revise; this he takes to the person appointed to revise it, and while that is doing proceeds to secure the form on the table of the press by means of quoins; to place his tympan sheet; to fix the points which make small holes in the paper that enable him to cause the pages to fall precisely on the back of each other when the second side of the paper is printed, and to produce an even and uniform impression in all the pages; he then cuts his frisket, which preserves the margin of the paper clean, and, when the revise is corrected, proceeds to ink the surface of the types by means of balls or rollers. When the whole impression of one side of the paper is printed, he lifts the form off the press, washes the ink off the face of the type with lye, and rinses it with water. He then proceeds in a similar manner with the outer form, which completes the sheet; and thus sheet after sheet.

If it be intended to have large paper copies of a work, the alteration of margin is made when the number of small paper copies is printed off from each form.

When the sheet is printed the compositor lays it up, distributes the letter, and proceeds, sheet after sheet, till the body of the work is finished; then the title, dedication, preface, introduction, contents, and any other prefatory matter is proceeded with, these being always printed the last.

The warehouseman then takes the printed sheets away, and hangs them up on poles to dry, varying the number of sheets hung up together from five or six to ten or eleven, according to the state of the weather, the heat of the room, or the pressure of business; when these sheets are dry they are taken down from the poles, carefully knocked up, and put away in the warehouse in piles: when the book is nearly finished from ten to fourteen consecutive sheets are laid upon the gathering table in order, and collected sheet by sheet by boys, who deposit each gathering in a heap at the end of the table, which is generally what is styled a horse-shoe table, so that when a boy has deposited his gathering he has only to turn himself and begin again. These gatherings are then carefully collated, to ascertain that the different sheets are correct and in order, and folded up the middle. When the work is finished the gatherings are put together, one of each, which forms a copy of the work, and pressed; the work is now completed, and awaits the order of the bookseller, &c. to deliver the copies either to himself, the bookbinder, or to others, according to circumstances.

A new method of obtaining impressions from types by means of cylinders has been introduced, and the power generally employed is steam. Mr. König, a Saxon, had considered that steam might be employed with advantage to expedite the process; but not receiving encouragement on the Continent to enable him to prosecute his plans, he came to England in 1804, and, after explaining his views to some of the principal printers in London, Mr. Thomas Bensley, Mr. George Woodfall, and Mr. Richard Taylor embarked in the undertaking, but Mr. Woodfall soon withdrew. After innumerable experiments, and a great outlay of capital, the result was not satisfactory; but the experience gained by prosecuting these experiments resulted in the production of a machine to print with cylinders instead of a flat surface, as was the case with the printing press, which was limited in the size of

the paper by the size of the press and the power of the pressman. In cylindrical printing, by which the pressure is communicated in lines, the size may be very considerably increased.

The first machine that was constructed was capable of printing 1000 copies per hour of double demy paper on both sides, while a press is estimated to print 250 copies of a single sheet on one side only in the same time.

When this machine was completed, the proprietors of the *Times* newspaper, ever ready to adopt any improvement that would expedite its publication, without regarding expense, agreed with the patentees for two machines; and on the 28th of November, 1814, the *Times* was published, executed by cylindrical printing, the moving power being steam: these were the only machines constructed under the first patent.

Various improvements and simplifications of this complex machine were soon effected by different ingenious men, and were adopted by many printers. They have become invaluable for the publication of periodicals where the number of copies is great, and also for newspapers; for their power of printing sheets of paper of a size far beyond the capability of any press, and their rapidity of throwing off copies, enable the editors to increase the size, and to delay commencing the printing off for a considerable time later than before their introduction, and thus avail themselves of any intelligence that might arrive in the interval.

Perhaps the most complete machine for printing one side of the paper is that used at the office of the *Times*; the carriage on which the pages to be printed are laid travels under the printing cylinders, of which there are four, and back again nineteen times in a minute, producing two impressions in going, and two in returning, or seventy-six in a minute, being 4,560 copies of four pages of that newspaper in the hour, at its ordinary rate of working. The paper is laid on at both ends of the machine, two persons laying on at each end; and the printed sheets are delivered two at each end.

The types are inked by means of rollers, and the apparatus for this purpose was the invention of Mr. Edward Cowper; the paper is secured in travelling round the cylinders by means of tapes, as first practised by Mr. König: the chief improvements in this machine are known as those of Messrs. Applegath and Cowper, by the former of whom it was constructed and fitted up.

This machine has the appearance of four single machines formed into one, and working at less speed than separate machines are in the habit of doing, many of which are capable of printing 1500 per hour; and we have no hesitation in saying, that if it were requisite for the sake of despatch, the principle might be extended, and a machine constructed to print 6000 or 8000 an hour without difficulty.

The idea of cylindrical printing in England originated some years anterior to Mr. König submitting his plan, for the late Mr. William Nicholson took out a patent for the purpose, dated 29th April, 1790, but it was never acted on; and, as to the use of steam as the motive power, the late Mr. Alexander Tilloch is known to have stated previously to the introduction of these machines, that he had long had it in contemplation to apply steam as the power to print off the *Star* newspaper.

The late Sir William Congreve took out a patent for a machine to print two colours at once, which was made by Messrs. Donkin and Company, and completely answered the purpose. This machine was intended to print stamps and bank bills, which Sir William stated would be inimitable, except by the machine of which he was the patentee; but he was too sanguine, and the opinion was fallacious, for nothing in the process of printing is more easy to execute at the common press by a common workman than this inimitable plan for preventing forgeries.

Glossary to the Article Printing.

Alteration of Margin, is increasing the space between the pages, so as to enlarge the margin of a book, and make it proportional in large paper copies.

Back Stay, is a girth or strap of strong leather attached to the back of the carriage, and fastened to the hind part of the press: its use is to check the carriage in running out beyond the point which will allow the tympan to rise clear of the front of the platen.

Balls are used for coating the face of the type or engraving with ink for the purpose of obtaining impressions. They consist of the ball-stock, stuffed with carded wool, and not many years ago were covered with an undressed sheep-skin, the hair taken off, termed a pelt. The noisome smell which these balls occasioned in a printing-office by the means used to keep them in good working order, induced many persons to turn their attention to the providing of a substitute for them; but long without success: at length Mr. B. Foster introduced composition balls, made of glue and treacle melted together and cast in a dished mould, so that the edges are thinner than the middle, and attached to a piece of canvass as a substitute for the pelt; these balls were found to answer so well, and be so free from any noxious smell, that they have generally superseded the pelt balls.

Bank. A table placed at the side of a press, on one end of which the horse containing the paper to be printed is laid, and at the other the sheets printed during the operation.

Board Rack. Grooves formed in some recess, or under the imposing stone or a bulk, or in a closet, to receive letter boards on which types are placed that are not in immediate use.

Carriage. That part of a press on which the types are placed to be printed, which is run in till they are immediately under the platen, and, when the impression is taken, run out, in order to change the sheet of paper, and to ink the types again.

Case Rack. A frame of wood of the width and depth of a case, with ledges attached to the inside of the upright parts to receive those cases which are not in use.

Coffin. A piece of strong paper twisted into a conical shape like a sugar paper, into which any superfluous types are temporarily deposited. Also that part of the carriage of a wooden press in which the stone is bedded.

Composing Rule. A piece of brass rule, the width of which is equal to the height of the types, cut to the length of the line, and laid in the composing stick, upon which the compositor arranges the types; it facilitates the process, and by means of it he empties his stick when it is full.

Composing Stick. An instrument of simple construction, in which the compositor arranges the words and lines. It has a slide, which is secured by a screw, by means of which he is enabled to make the lines of any length that may be required.

Direction Line. A line of quadrats at the bottom of each page, in which is inserted the first word of the next page, which is called the catch-word; in the first page of each sheet there is also inserted in it the number of the volume, if more than one, and the signature.

To Distribute. To replace the letters in their respective situations in the cases after a sheet has been printed off, to enable the compositor to proceed with the work.

Footstep. An inclined plane fixed under the front side of the press, for the pressman to place his foot upon when at work, to enable him to exert his strength to advantage.

Form. A chase with one or more pages wedged up in it.

Fount Case. A case of large dimension in which the superfluous sorts of a fount are placed, as a depôt, till they be wanted.

Frame. It is made of wood, of a height to suit a man standing to work at it, on which the cases are placed. It is much higher at the back than the front, which brings the most distant boxes nearer to the compositor's hand.

Frisket. A light iron frame, attached to the tympan by joints or pivots, which turns down upon the tympan over the sheet of paper to be printed, to preserve the margin clean, and to retain the paper in its position; to effect this, the frisket is covered with paper, and openings cut in it the size of the pages to be printed.

Girths. Two pieces of girthweb or strong leather, fastened at one of the ends to the wheel, and wound different ways round it, and the other ends attached to the extreme ends of the carriage; by this means turning the rounce one way causes the carriage to run in under the platen, and turning it the reverse way causes it to run out again.

Head Line. The line at the top of the page, which contains the folio or number of the page, and frequently the title of the book, or the subject of the chapter or of the page.

Horse. An apparatus of a desk-like shape, placed on the bank close to the tympan of the press, on which the paper to be printed is laid.

Inner Form. The chase and pages in proper order, wedged up, which contains the 2d, 3d, 6th, 7th, 10th, 11th, 14th, and 15th pages of a sheet in octavo; it invariably contains the second page of a sheet, whatever may be the size of the book.

Justifying. Putting equal space between the words in each line; making the lines of precisely the same length; placing the marginal notes opposite the references; making the pages uniformly of one length; and adjusting any peculiar matter, so that the whole shall be tight and proper when wedged up.

To Knock-up. At press, it is for the pressmen to make a pair of balls. In the warehouse, it is to make the printed sheets even at the edges, which is performed by taking hold of a parcel of sheets by the two edges, holding them slack in the hands, and letting them fall on their bottom edge by their own weight, then by a sleight of hand throwing them flat on the board, repeating the operation till all the sheets are even at the edges, when they are placed in piles until they are gathered.

To Lay-up. This is the operation of washing the ink off the types after the impression is printed, by laying

the form on a letter board, loosening the quoins, and working the letter with the hand, pouring on it plenty of water to clean the types for distribution.

Letter Board. A board on which pages of types are placed for distribution, and also when they are not immediately wanted. There are two ledges of wood grooved in on the under side, which project a little more than an inch, on which it rests, which allows it to be set over other types on boards without putting them in confusion.

Lye Trough. A shallow trough, lined with lead, sufficiently capacious to admit a board on which a form is laid; this trough has some lye in it, with which the surface of the letter, the chase, and the furniture is brushed over, to remove the ink which has accumulated during the process of printing; the form is then taken out, set upon its edge, and rinsed with water. The lye is composed of water and pearlash.

Mallet. (Fr. maillet.) A wooden hammer, with which the quoins are tightened, and also loosened; and which is also used for general purposes.

Measure. (Fr. mesure.) The space in the composing stick between the end and the slide, which is the length of a line, however large or small the page may be, is styled the measure.

Outer Form. The chase and pages in proper order, wedged up, which contains the 1st, 4th, 5th, 8th, 9th, 12th, 13th, and 16th pages of a sheet in octavo; it invariably contains the first and last pages of a sheet, whatever may be the size of the book.

Page Cord. Small twine, even and strong, which is used to tie round the pages of types, to secure them from accidents till they are imposed, when the cords are taken off.

Page Papers. Pieces of stout and smooth paper, on which the pages of types in the progress of a work are placed in a safe place till a sheet is ready to be imposed.

Paper Boards. Boards on which paper is laid when wetted; also those boards used in pressing books; they are of various dimensions, according to the size of the paper. They differ from letter boards in being smooth and even on both sides.

Peel. A thin piece of wood with a long handle affixed to it, in the shape of the letter T; it is used for hanging the sheets of a book upon the poles to dry, and for taking them down again.

Platen. A thick piece of wood, or more generally now made of iron, perfectly level on its under side, attached immediately under the moving power of a printing press, which produces the impression.

Point. There are always two points used in presswork, when a sheet of paper is printed on both sides; they are made of thin iron, with a notch at one end, and a projecting spur or point at the other end; they are attached to the tympan by screws, and lie flat upon it; the spurs being under the sheet of paper to be printed make small holes in it, so that when the reiteration or second side is printed the spurs are placed in these holes, which cause the pages to fall exactly on the back of each other.

Poles. Long pieces of fir wood, about an inch and a half thick, and three or four inches broad, placed across the warehouse and other rooms in a printing-office, at about eight or nine inches apart, and about fourteen inches from the ceiling; their ends rest in notches cut in stretchers fastened to the wall. Their use is to hang the damp printed paper upon to dry, which is done with facility by means of the peel.

Quadrats. (Fr. quadrat.) Pieces of metal of the same body as the type, but cast lower in height; used to fill up short lines, and to form a blank line or lines where necessary; being cast lower than the type, they do not produce any impression on the paper.

Quoin. A wedge about half an inch thick and of various widths, to wedge up the pages of type in a chase.

Roller. (Fr. rouleau.) The roller has nearly superseded the use of balls for inking the surface of the types. It is formed of a composition of glue and treacle cast on a wooden cylinder, turning on its axis in a light frame.

Rounce. The rounce is the handle by which the carriage of the press, on which the form to be printed is laid, is run in under the platen and out again; it is fixed on the spit, which is the axis, that passes through the drum, a cylinder of wood on which one end of the girths are fastened. The whole apparatus is generally termed the rounce.

Run-in. The act of placing the carriage with the form of types under the platen, to obtain an impression. This is effected by turning the rounce.

Run-out. The act of withdrawing the carriage with the form of types from under the platen, by turning the rounce the reverse way from the preceding, after the impression is taken.

Shooting Stick. An implement for tightening and loosening the quoins that wedge up the pages in a chase. It is in the shape of a wedge, about two inches broad and nine inches long, and is usually made of box wood. In use the small end is placed against the quoin, and the other struck by the mallet.

Signature. A letter of the alphabet placed at the bottom of the first page of a sheet, and so on to each sheet consecutively through the alphabet, with the exception of the letters J, V, and W; their use is to facilitate collating a book, as a guide to the bookbinder in folding the sheets, and as a ready means of referring to any part of a work before it is bound.

Sink. A corner of the pressroom, generally inclosed and lined with lead, with loose boards upon the lead; in this sink are placed the lye trough and a wetting trough; it is here where the forms are washed, rinsed, and laid up. There is always a pipe to carry off the waste water.

Sorts. It is generally used in the plural; it means any letter, point, mark, space, or quadrat, that is either deficient or redundant in quantity. A work runs upon sorts; that is, a greater number of some particular letters are required than the regular proportion, an index for instance.

Space. A piece of metal cast lower than a type, so as not to print, used to separate words; they are of different thicknesses, so as to enable the compositor to arrange the words at equal distances from each other in the same line.

Tympan. A wooden frame attached to the carriage of the press by joints, and covered with parchment, on which the sheet of paper to be printed is laid; there is another frame called the inner tympan, which fits into this, also covered with parchment; between these are placed pieces of woollen cloth, termed blankets, which form a soft medium between the types and the platen that tends to produce an equal impression.

Tympan Sheet. A sheet of paper, the same that a work is printed on, laid upon the tympan, and fastened to it at the corners with paste; it is the guide on which the sheets to be printed are laid, by which means the margin is kept regular and uniform.

Wetting Trough. Two troughs joined together and lined with lead; one deep, containing the water; the other shallow, of sufficient size to contain a paper board. The paper is wetted for printing by drawing it through the water, and opening it out on the board.

PRINTING INK. A composition with which the face of types and engravings in relief are coated previous to obtaining an impression from them: it is made of different colours; but books, and the generality of printing, are executed with black ink. Its composition, generally speaking, is linseed oil boiled to a varnish, with colouring matter added to it. The preparation of this article was long kept a profound secret by the few manufacturers of it in England, who completely monopolized the trade, till Mr. W. Savage published a treatise on the subject, in which he gave the process in detail for making printing ink of every quality and colour, which may be consulted with advantage by those who are interested in the subject.

PRIOR, PRIORESS. (Lat.) The heads of certain convents of monks or nuns, which are thence denominated *priories:* the prior is inferior in dignity to the abbot.

PRISCI'LLIANISTS. In Ecclesiastical History, heretics of the 4th century; so named from Priscillian, bishop of Atila in Spain, who was put to death in A. D. 382 by Maximus, tyrant of Gaul, for heresy, on the accusation of another bishop, Ithacius: one of the earliest instances of persecution to death for that offence. The opinions of Priscillian and his followers are said to have been Manichæan; but it is remarkable that Sulp. Severus, himself sufficiently zealous against their doctrines, admits that their persecutor Ithacius was a man of disreputable character, and that purity and austerity of manners were often sufficient with him to ground an accusation of Priscillianism. This affords a curious parallel with the history of the 12th and 13th centuries, when accusations of Manichelsm were liberally brought against sectaries whose avowed tenets extended only to the reformation of ecclesiastical matters and denial of the church's authority. (See *Mosheim*, cent. iv. part 2.)

PRISM. In Geometry, a solid contained by planes of which two that are opposite are equal, similar, and parallel, and all the rest parallelograms. Prisms take particular names from the figures of their ends, or opposite equal and parallel sides. When the ends are triangles, they are called triangular prisms; when the ends are square, square prisms; when the ends are pentagonal, pentagonal prisms; and so on. A *right* prism has its sides perpendicular to its ends; an *oblique* prism is that of which the sides are oblique to the ends. The solid content of a prism is found by multiplying the area of the base into the perpendicular altitude; hence all prisms are to one another in the ratio compounded of their bases and altitudes.

PRISM. In Dioptrics, a piece of glass or other diaphanous substance, in form of a triangular prism, employed to separate a ray of light into its constituent parts or colours by refraction. The prism is the instrument by means of which most of the remarkable phenomena of

light and colours are exhibited. *See* CHROMATICS, OPTICS, REFRACTION.

PRISMATIC COLOURS. The colours produced by decomposing light by a prism. *See* PRIMARY COLOURS.

PRISMATIC COMPASS. A surveying instrument, much used on account of its convenient size and form in military sketching, and for filling up the details of a map where great accuracy is not required. The construction is as follows: — The compass-card, divided into degrees and minutes, is attached to the needle and turns with it. On one side of the compass-box stands a perpendicular slip, called the sight-vane, having a long narrow perpendicular slit in it, along the middle of which a fine thread is stretched. On one side of the box, opposite to the sight-vane, there is a prism, through which and through the sight-vane an object is observed, and bisected by the thread. The use of the prism is this — the rays of light passing from the thread to the eye are refracted in passing through the prism, so that the thread appears to be prolonged and to intersect the circle on the card on which the divisions are; consequently, the magnetic azimuth of any object which the thread bisects is indicated immediately by the division with which the thread coincides. The angle between two stations is thus obtained, being equal when the stations are on opposite sides of the meridian to the sum of their azimuths, and to the difference of the azimuths when they are on the same side of the meridian. The card is divided to 15′ of a degree, which is, perhaps, a smaller angle than can be measured by this instrument. (See *Simms's Treatise on Mathematical Instruments.*)

PRISMOID. An imperfect prism; a figure resembling a prism, but not answering exactly to the definition.

PRI′SON. (Fr. prendre, *to take.*) Imprisonment is used in most civilized states for three purposes: for safe custody of persons charged with offences, for the detention of debtors, and for punishment; under which latter head the reformation of prisoners must be comprehended, as being properly only an adjunct to punishment. The first principles of order seem to require that these three classes of prisoners should be kept entirely distinct, and, if possible, in separate places of confinement; but even the former rule has been generally very imperfectly observed, while the latter is in most places impracticable by reason of expense. The alleviation of the horrors of imprisonment, by physical improvement of the condition of prisoners and the imparting of religious instruction, has been from very early times an object with philanthropists; but the adaptation of imprisonment to serve the end of punishment has been, comparatively speaking, only very recently attempted. The Society of the Brothers of Mercy, in Italy, paid much attention to the former subject in the 15th and 16th centuries; and the names of S. Carlo Bórromeo and St. Vincent de Paule have derived from it much of their lustre. But the earliest instance of a prison managed on any principles of policy and humanity seems to be that of the Penitentiary at Amsterdam, erected in 1595; an example which was soon followed by some of the German towns, especially Hamburg and Bremen. In England it is well known that the impulse of prison improvement was first communicated by the celebrated Howard, whose sufferings, when taken by a privateer and imprisoned at Brest, during the seven years' war, are said to have first directed his attention to the subject. The fruits of his observations, in his repeated visits to most of the prisons of Europe, were given to the world partly in his publications, and partly on examination before a committee of the House of Commons in 1774. To his suggestions, and those of Jonas Hanway, are principally owing the provisions of the 19 G. 3. c. 74. (passed in 1778), truly called the basis of succeeding legislation on the subject. Solitary imprisonment was then first instituted. The works of Neeld and others, and the labours of the Prison Discipline Society, (founded, we believe, chiefly by Mr. Fowell Buxton,) kept the attention of the public fixed on the subject. In 1813, the construction of the Milbank Penitentiary was begun, intended as a species of model prison; but that establishment, from many errors committed in its foundation and first management, was long before it answered in any degree the views of its projectors. Meanwhile practical improvement had proceeded much further in the United States of America, where the experiments of solitary confinement and of association in silence were both first instituted on any extensive scale, and have formed the basis of two different systems, which now divide the suffrages of observers. Europe has in this matter taken lessons from America; and the reports of French visiters (Messrs. Beaumont and De Tocqueville, 1834; Messrs. De Metz and Blouet, sent by government, 1837), of Dr. Juliers, sent from Prussia, and Mr. Crawford from England, have contributed largely to the present state of public opinion on the subject. In 1834, inspectors were appointed to report annually on the state of English and Scottish prisons, — a measure which had been earlier adopted with reference to Ireland; and their reports may be consulted with great advantage, both with a view to the actual state of prisons, and their prospective reform. The "Third Report of the English Inspector for the Home District" (1838) is particularly valuable, from the historical sketch it contains, and from the comparison there instituted between the separate and the silent systems. The chief heads of improvement in prison discipline which have been recommended or introduced since public attention was called to the subject are, 1. Inspection and control; 2. Classification; 3. Separate or solitary punishment; 4. The "silent" or non-intercourse system; 5. The introduction of labour; 6. Religious and intellectual instruction.—1. The first of these is matter rather of practical than theoretical development. The history of the plan originally suggested by General Bentham and his brother, the philosopher, which has formed, to a certain extent, the basis of later experiments, is mentioned under the head PENITENTIARY. 2. Classification, under the English gaol acts of 1823 and 1824, has been extensively introduced into prisons. It is of course a great improvement on the indiscriminate mixture of prisoners of all classes and characters which formerly prevailed; but as a means of reformation, or of punishment, it has not answered the views once entertained of it. And the reason is obvious: the only object of classification is the exclusion of the moral influence of more or less corrupted minds; but by no system of classification (and as many as fifteen classes have been introduced in some prisons) can this be excluded. In every class, whether arranged according to age, or degree of offence, or in any other practicable mode, there will probably be some unusually depraved characters; and then the experiment must fail. The only perfect classification is that which constitutes the basis of, 3. The *separate* system; namely, the entire separation of prisoners from each other in solitary cells. When this has been carried to excess as a means of punishment, namely, seclusion by day and by night, without labour, without employment, with only the occasional silent visits of the turnkey or the medical attendant, it has generally proved more than human nature can bear, at least for any time; but separate confinement *with* labour as an alleviation, and with occasional visits for religious consolation and instruction, is a very different mode of treatment. The separate system is that established in the great eastern penitentiary of Philadelphia, now in operation for ten or eleven years; and in that of Glasgow, — which may be mentioned as models in their kind. 4. The difficulty of enforcing solitary confinement, in some American prisons, seems to have led to the adoption of the *silent* system: of which the prison at Auburn, in Pennsylvania, affords the most celebrated instance. The prisoners work together in the day, but are prevented from all communication: at night they are separate. It was, we believe, introduced several years ago in the Maison de Force at Ghent. In England, it is in operation at Coldbath Fields, Wakefield, and elsewhere. With respect to the comparative advantages of the two systems, the work of Messrs. Beaumont and De Tocqueville may be consulted for an impartial summary of evidence, without the expression of decided opinion. (Part I. chap. ii. s. 3.) The "separate" was recommended in 1832 by the committee on secondary punishments; and is advocated by Mr. Crauford, in his *Report on the Penitentiaries of the U. S.* 1837, and in the 4th Report above alluded to; by Dr. Juliers; by Messrs. De Metz and Blouet; and by M. Moreau-Christophe in various works. The silent system seems to be supported by M. Lucas, *De la Reforme des Prisons*, 1836; while, in his *Théorie de l'Emprisonnement*, he attempts to reconcile the two; by Messrs. Berenger and Gasparin; and by Mr. Inspector Williams (4th Report, England; Northern and Eastern Division). The chief objections to the separate system are, — 1. As a punishment, its inequality, being felt far more severely by some than others; but to this it may be answered, that those who do feel it are precisely those whom it is most desirable to affect — the more depraved. 2. Its effects on the mind and passions in some respects; a very difficult and delicate subject, and by far the most serious charge against it. 3. That even as a system of reform, for which, in subjects presenting any prospect of amendment, it is best calculated, it is utterly useless in short terms of imprisonment. "Those best acquainted with the subject in the U. S.," says Mr. Williams, "conceive that two years' imprisonment are required before any impression can be made, and from four to six years to achieve the work of reformation." To the silent system, its enemies object,—1. The extreme difficulty of carrying it into successful operation. 2. Its supposed effect in irritating, degrading, and even brutalizing the minds of prisoners, by its vexatious discipline. They appeal in support of this position to the quantity of punishment (corporal, or by solitary confinement) which is required to carry it into effect. In Wakefield and Coldbath Fields, upon this system, 26,257 punishments were inflicted on 13,188 prisoners, or two on each on the average; while in all England the proportion was found to be 54,825 punishments to 109,495 prisoners, or one to two only. But this is explained in some degree, in the

latter prison at least, by the number of short imprisonments. 5. With respect to the introduction of *labour* into prisons of punishment, the chief question seems to be, whether it ought to form part of the punishment, and be of a vexatious and severe nature; or whether it should be used as an alleviation to the rigour of separate confinement, as a preparation of the criminal for re-entrance into society. The former is the principle commonly adopted in England; the ordinary sentence, for many offences, being imprisonment with *hard* labour, and with occasional intervals of solitary confinement; the treadwheel being the most common species of labour. On this subject the reader may consult the *original* article "Prisons" in the *Enc. Britannica;* but the views of the author are somewhat too dogmatically expressed. The policy and practicability of making prison labour pay or contribute largely towards the maintenance of the prison has not been much discussed in England; where, from our less economical habits, the experiment has hardly been tried. In America several are said to afford a revenue to the state. (See Messrs. De Beaumont and Tocqueville.) In Belgium they have long been rendered very productive; the works of the present very able inspector-general, M. Ducpétiaux, contain ample information on the subject. The 16th and 17th Reports of the Irish Inspectors refer largely to it: from the latter it appears that the cost of work has been more than repaid by the return in every prison; but it does not appear clearly what is comprehended under the former head, and the numbers seem not altogether accurate. There are, however, serious moral objections to plans combining economical advantage with punishment and reformation. It is impossible to conclude an article on this subject without noticing that terrible defect in our institutions, the want of any control over or provision for offenders discharged from prisons; a defect which the abolition of transportation, without any substitute, will render even more conspicuously injurious than it has hitherto been. Most of the best modern authorities on this subject are referred to in the course of this article: see also the article "Gefängniss" in the *Conversations Lexicon*, and the German works mentioned at the end of it; and the *Ed. Rev.* vols. xxii. xxx. xxxv. xxxvi.

The last prisons act is the 2 & 3 Vict. c. 56. (1839). By this act, *separate* confinement is for the first time distinguished from the severer punishment of *solitary* confinement. The justices are empowered to make rules for classification, &c., subject to the approval of the secretary of state. According to the reports of 1838, 133,312 persons were confined in the prisons of England and Wales during that year; of whom 23,808 were committed for trial at assizes and sessions, 56,736 on summary conviction.

PRISONS, MAMERTINE. Certain fearful places of confinement in ancient Rome, chiefly intended for state prisoners. They were constructed by Ancus Martius of large uncemented stones; and, from the specimens of them which remain, it is difficult to imagine a more horrible place for the confinement of a human being. There were two apartments, one above the other, to which there was no entrance except by a small aperture in the upper roof; and a similar hole in the upper floor led to the cell below, there being no staircase to either. The upper prison was 27 feet long by 20 wide, and the lower, which was elliptical, was 20 by 10; the height of the former was 14 feet, of the latter 7. None but persons of distinction had the privilege of occupying these prisons.

PRIVATEE'R. A vessel belonging to one or more private individuals, sailing with a licence from government, in time of war, to seize and plunder the ships of the enemy. The practice of granting commissions to privateers first became general in the war between Spain and the revolted Netherlands, at the end of the sixteenth century; when it was extensively made use of by the Prince of Orange as a means of annoying the Spanish trade.

PRI'VILEGE. (Lat. privilegium: defined by Cicero, lex privato homini irrogata.) In the ordinary acceptation of the word, a law, or an exception from the common provisions of law, in favour of an individual or a body. Privilege is said to be personal or real; that is, attached to the person only, or to the person in respect of a particular place; as to a member of one of the universities, an officer of one of the courts at Westminster. The privileges chiefly recognized by the English law are privilege of parliament (*see* PARLIAMENT), and the privilege to sue and be sued, according to particular provisions, allowed to officers and attendants in the courts of justice.

PRI'VITY, in Law, is a peculiar mutual relation which subsists between individuals connected in various ways; so that, besides those who are actually parties to a transaction, others connected with these parties are said to be privy to the transaction, and are bound by its consequences. Several sorts of privity are enumerated by writers on law; but those of most ordinary occurrence are three; privity of blood, of estate, and of contract. The former subsists between an ancestor and his heir; the second between lessor and lessee, tenant for life and reversioner created by the same instrument; and privity of contract between those who are parties to a contract, which species of privity is personal only.

PRIVY CHAMBER, GENTLEMEN OF THE. Officers of the king's household, instituted by Henry VII. Their proper duties are to attend the king and queen at court, in their diversions, progresses, &c. There are also four gentlemen ushers of the privy chamber, whose office is to wait in the presence chamber, attend on the king's person, and note affairs under the lord chamberlain and vice-chamberlain.

PRIVY COUNCIL. *See* COUNCIL, PRIVY.

PRIVY SEAL, LORD. The fifth great officer of state in England, who has the custody of the privy seal of the king, used to all grants, charters, pardons, &c. before they come to the great seal.

PRIZE. Any thing captured by a belligerent using the right of war: in common language, only ships thus captured, with the property taken in them, are so called. Prizes taken in war are condemned by the proper judicature in the courts of the captors: such condemnation is held to divest the title of the proprietor and confer a new ownership. In order to give jurisdiction to a court of prize, it is deemed necessary, by the law of nations, that the property captured should be in possession of the captors in their own ports, those of an ally, or of a neutral; but no belligerent power has a right to capture in the ports of a neutral country, or within a marine league of her shores; nor does a capture made then render the adjudication valid. Subject to capture are hostile property, *i.e.* the property of persons domiciled in a hostile country, and neutral property contraband of war. *See* CONTRABAND.

PRO'A, FLYING. A narrow canoe about 30 feet long by 3 feet wide, used in the Ladrone Islands. The lee side is flat, being the mere longitudinal section of the common form, and the head and stem exactly alike. A slight frame-work projects several feet to windward, bearing a small block of wood like a canoe: this float supports the vessel from oversetting to that side, as she would otherwise do, and the frame-work affords support for a weight acting against the pressure of the sail. The vessel is steered by a paddle at either end, and moves with great velocity, either backwards or forwards, being adapted to a side wind in running between two places. The sail is mat, with a boom, upon one mast. *Proa* is also the name for large boats used by the Malays, propelled both by oars and sails.

PROAU'LION. (Gr. πρό, and αὐλή, *a hall.*) In Architecture, the same as vestibule; which see.

PRO'BABILISM. In Theology and Ethics, a theory professed by some casuistical divines, chiefly of the Jesuit order, according to which it is lawful to follow a *probable* opinion in doubtful points, although other opinions may seem to the mind of the inquirer more probable. Those who teach this doctrine are styled *Probabilists.* This and the other tenets of the once celebrated science of casuistry are ably touched on by Mr. Hallam, in vol. iii. of his *Literature of Europe.*

PROBABI'LITY, THEORY OF. A very extensive and important application of analysis, having for its object the determination of the number of ways in which a future or uncertain event may happen or fail, in order that we may be enabled to judge whether the *chances* of its happening or failing are the greater, and in what proportion.

In this theory the word *chance* is used to signify the occurrence of an event in a particular way, when there exist two or more ways by which it may take place, and no reason can be assigned for its happening in one way rather than another. For example, if a die be thrown up into the air, it will necessarily fall on one or other of its six faces; but as we know of no reason why it should fall on the face marked one, rather than on that which is marked two, or on any other face, and as the circumstances are precisely the same in all the cases, we say the chance of its falling on any one face is equal to the chance of its falling on any other. Suppose, again, a die, having four of its faces white, and the other two black, to be tossed up. There are four ways in which the die may fall so as to turn up a white face, and two in which it may turn up a black face; we therefore say the chances of its turning up a white face are to the chances of its turning up a black face as four to two. In ordinary language, when an event is said to happen by chance, it is merely implied that the cause is unknown, or cannot be certainly appreciated.

The term *probable*, in its common acceptation, is applied to any contingent or future event, to denote that in our judgment the event is more likely to happen than not to happen. In mathematical language *probability* has a definite signification. Suppose 5 balls to be placed in an urn, 3 of them white, and 2 black; and, one of them being drawn out at random, let it be proposed to assign a measure of the probability of its being a white or a black ball. In th

case there are 5 chances in all, 3 of which are in favour of a white ball, and 2 in favour of a black. The probability of drawing at the first trial any particular ball will evidently be represented by the fraction $\frac{1}{5}$; hence the probability of drawing a white ball is $\frac{3}{5}$, and the probability of drawing a black ball $\frac{2}{5}$. Now it is obvious that the absolute number of balls in the urn will not affect the relative probabilities, so long as the proportion of white to black balls remains unaltered. Suppose, for example, the number of balls increased to 50, of which 30 are white and 20 black; the probability of drawing a white ball at the first trial must still remain the same, there being always 3 chances in favour of a white ball for every 2 in favour of a black. Whatever, therefore, the number of balls in the urn may be, the probability of drawing one of a particular colour must remain the same, so long as the ratio of the number of balls of that colour to the whole number in the urn remains unaltered. Hence, we derive the following definition, which is, in fact, the basis of the whole doctrine of probabilities: —

The probability of the occurrence of any event is measured by a fraction, the numerator of which expresses the number of chances favourable to the occurrence of the event, and the denominator the whole number of chances favourable and unfavourable.

This fraction is called the mathematical probability. It is important to remark, that all the chances are considered as equal; for example, that, in drawing a ball from the urn, any one ball has the same chance of being drawn as any other.

Every contingent event gives rise to two opposite probabilities,—one, that the event will happen; the other, that it will not; and the sum of these probabilities is always equal to unity. Thus, in the preceding example, the probability that a white ball will be drawn from the urn is $\frac{3}{5}$, and the probability that a black ball will be drawn (*i. e.* that a white ball will *not* be drawn) is $\frac{2}{5}$; and $\frac{3}{5} + \frac{2}{5} = \frac{5}{5} = 1$. In general, let m denote the number of chances favourable to an event, and n the number of unfavourable chances; then, the whole number of chances, or ways in which the event can happen or fail, being $m + n$, the probability that the event will happen is $\frac{m}{m+n}$, the probability that it will not happen $\frac{n}{m+n}$, and the sum of these probabilities is 1. Hence, if p denote the probability of the occurrence of any event, the probability that it will not occur is $1 - p$. For instance, let p = the probability that an individual of a given age will live over one year; then $1 - p$ is the probability that he will *not* live over the year, or that he will be dead within the year. As the individual must either be alive or dead, the sum of the probabilities must necessarily amount to *certainty*, which is represented by *unity*, and hence the probability of any contingent event is always a fraction less than unity.

Probability of simultaneous Events.—The probability of the simultaneous occurrence of several independent events is calculated as follows: — Let it be required, for example, to determine the probability of throwing aces with two dice. Let the dice be called respectively A and B. The probability that A will turn up ace is $\frac{1}{6}$; and if a person were to purchase the chance of receiving a sum of 36*l.* on the occurrence of this event alone, the proper sum he ought to pay for the chance is 6*l.* But, if the sum is to be received only on condition of A and B both turning up ace, the above probability will only be beneficial to him provided B also turns up ace. Now, the probability of this event is likewise $\frac{1}{6}$; therefore, the probability of receiving the sum is $\frac{1}{6}$ of $\frac{1}{6}$, that is $\frac{1}{36}$, and the price to be paid for the chance is $\frac{1}{6}$ of 6*l.*, that is, 1*l.*

The same reasoning may be applied to any number of independent events; and the conclusion, which is perfectly general, may be expressed by the following rule: — "The probability of the occurrence of several independent events is obtained by multiplying together their separate probabilities." Thus, let p denote the probability of an event A, q that of an event B, r that of an event C, &c.; then the probability of the joint occurrence of those events is expressed by the continued product $p\,q\,r$, &c.

Probability of successive Events.— The probability of the successive recurrence of the same or different events is determined precisely in the same manner. For example, let the probability be required of throwing ace twice successively with the same die. The probability of ace turning up at the first throw is $\frac{1}{6}$, and at the second $\frac{1}{6}$; the probability of ace turning up at both throws is therefore $\frac{1}{6}$ of $\frac{1}{6} = \frac{1}{36}$. Hence the probability that ace will not turn up *both* at the first and second throw is $1 - \frac{1}{36} = \frac{35}{36}$. This last probability, it is necessary to remark, is quite distinct from the probability that ace will not turn up in either throw, and which is found thus — The probability that ace will *not* be thrown at the first throw is $\frac{5}{6}$; and the probability that it will not be thrown at the second also $\frac{5}{6}$: hence, by the former rule, the probability that it will not be thrown at either throw is $\frac{5}{6} \times \frac{5}{6} = \frac{25}{36}$. This added to $\frac{1}{36}$, the probability that ace will be thrown both times, does not give the sum equal to unity, for there are still two cases to be taken account of. Ace may be thrown at the first throw, and not at the second; or ace may not be thrown at the first throw, but thrown at the second. The probability that ace will turn up at the first throw is $\frac{1}{6}$, and that it will not turn up at the second throw $\frac{5}{6}$; hence the probability that it will turn up at the first, and not at the second, is $\frac{1}{6} \times \frac{5}{6} = \frac{5}{36}$. The probability that it will not turn at the first, but turn up at the second, is $\frac{5}{6} \times \frac{1}{6} = \frac{5}{36}$; and the sum of these, added to the sum of the probabilities of the two former cases, gives a result equal to unity. A distinct enumeration of the different suppositions that may be made relative to the ace point, in two successive throws of the same die, will render this reasoning more obvious. The event can happen only in one of four ways, which, with their respective probabilities, are as follows: —

1. Ace at both throws, probability $= \frac{1}{36}$
2. Ace at neither throw, probability $= \frac{25}{36}$
3. Ace at first, not at second, probability $= \frac{5}{36}$
4. Ace at second, not at first, probability $= \frac{5}{36}$

And the sum of these fractions is $\frac{36}{36} = 1$.

This reasoning may be rendered general. Suppose m = the number of white balls in an urn, and n = the number of black balls in the same urn, and that when a ball has been drawn it is immediately replaced in the urn, so that at each trial the whole number of chances is $m + n$. Let p = the probability of drawing a white ball on any trial, and q = the probability of drawing a black ball; we have then $p = \frac{m}{m+n}$, and $q = \frac{n}{m+n}$. And first let us consider the probabilities of the different possible events that may happen on two trials.

The only possible ways in which the balls can be drawn in two successive trials are these four: —

1. First white, second white; probability $= p \times p = p^2$;
2. First white, second black; probability $= p \times q = p\,q$;
3. First black, second white; probability $= q \times p = p\,q$;
4. First black, second black; probability $= q \times q = q^2$.

Adding together these probabilities, we get

$$p^2 + 2\,p\,q + q^2 = (p + q)^2,$$

and the sum is equal to unity, as will be evident by substituting for p and q their values in terms of m and n.

It thus appears that the probabilities of all the different combinations that can be formed in two trials are respectively given by the development of the binomial $(p + q)^2$. It will be observed that the term $2\,p\,q$ gives the probability of drawing a ball of each colour in the two trials without distinction of order; that is, the white ball may be drawn either at the first or second trial.

Now, let the number of trials, instead of being two, be increased to any number u; the probabilities of the different combinations will be given by the development of the binomial $(p + q)^u$. This development is

$$p^u + \frac{u}{1} p^{u-1} q + \frac{u\,(u-1)}{1 \cdot 2} p^{u-2} q^2 \ldots.$$
$$+ \frac{u\,(u-1\,(u-2)\ \ldots\ (u-v+1)}{1\ .\ 2\ .\ 3\ \ \ldots.\ \ v} p^{u-v} q^v + \&c.$$

The first term p^u indicates the probability of drawing a white ball in each of the u trials, or that all the balls drawn will be white. The second term $u\,p^{u-1}\,q$ denotes the probability of drawing $u - 1$ white balls and one black ball in u trials, without regard to the order; that is to say, the black ball may be drawn at the first, second, third, or any other trial. The general term

$$\frac{u\,(u-1)\,(u-2)\ \ldots.\ (u-v+1)}{1\ .\ 2\ .\ 3\ \ \ldots..\ \ v} p^{u-v} q^v$$

gives the probability that in u trials $u - v$ white balls will be drawn, and v black balls, without distinction of order. If the probability of drawing the ball in a determinate order of succession were required; for instance, if it were required to determine the probability of drawing $u - v$ white balls successively, and then v black balls; the coefficient of the term must be suppressed, and the probability becomes $p^{u-v}\,q^v$.

The practical question that most frequently arises is, not to determine the probability of the repetitions of an event in any precise order, but the probability that the number of repetitions will exceed or not exceed a certain limit. Thus, in the preceding example, suppose it were required to assign the probability that not fewer than $u - v$ white balls will be drawn in u trials; it is evident that as the first term gives the probability of drawing u white balls, the second term that of drawing

$u - 1$ white balls, and so on, and as each of these combinations satisfies the condition, the required probability will be found by taking the sum of all the terms of the development of $(p + q)^u$ from the first to that in which the factor $p^{u-v} q^v$ appears, both inclusive. As an example, let it be required to determine the probability of throwing ace at least *twice* in four throws of the same die. Here we have $p = \frac{1}{6}$, $q = \frac{5}{6}$, $u = 4$, and $u - v = 2$, whence $v = 2$. Now the development of $(p + q)^4$ to the term in which $p^2 q^2$ occurs is $p^4 + 4 p^3 q + 6 p^2 q^2$, which, on substituting for p and q their values, becomes $(\frac{1}{6})^4 + 4 (\frac{1}{6})^3 \times \frac{5}{6} + 6 (\frac{1}{6})^2 \times (\frac{5}{6})^2 = \frac{171}{1296} =$ between $\frac{1}{7}$ and $\frac{1}{8}$. Again, suppose the question were to assign the probability of throwing ace at least *once* in four trials, we should have $u - v = 1$, and therefore $v = 3$. Now the term of the development of $(p + q)^4$ in which $p q^3$ occurs is the fourth, or last but one; the sum of the first four terms, therefore, gives the required probability. But the calculation of this sum is easy; for, since the sum of all the terms is $(p + q)^4 = 1$, and the last term is q^4, the sum of the first four is $1 - q^4 = 1 - (\frac{5}{6})^4 = 1 - \frac{525}{1296} = \frac{671}{1296}$.

Probability derived from Experience. — In what precedes it has been supposed that the number of ways in which an event can arrive are known *à priori*; but it may happen, and indeed does happen, in the greater number of the most important questions to which the calculus of probabilities is applied, that the number of chances favourable and unfavourable to the occurrence of any particular event is unknown, and that the ratio of the one to the other can only be inferred from considering the ways in which the event has been observed already to happen. Recurring to the case of the urn, — let us suppose the urn to contain a certain number of balls of different colours; but that the number of each colour is unknown, and that, from having observed the result of several trials, we have to determine the probability of drawing a ball of a particular colour at the next trial. The method of proceeding is as follows: — Taking a simple case; suppose the urn to contain only four balls, of two colours, white and black, and that on four successive trials (the ball drawn being in each case replaced in the urn) three white balls and one black have been drawn. Three hypotheses may be formed respecting the number of balls of each colour in the urn; and if $p =$ the probability of drawing a white ball, and $q =$ that of drawing a black ball, on any hypothesis, the three hypotheses, with the corresponding values of p and q, will be as under, viz.: —

1. 3 white, 1 black, $p = \frac{3}{4}$, $q = \frac{1}{4}$;
2. 2 white, 2 black, $p = \frac{2}{4}$, $q = \frac{2}{4}$;
3. 1 white, 3 black, $p = \frac{1}{4}$, $q = \frac{3}{4}$.

Now, on calculating from each of these hypotheses the probability of the event observed, namely, of drawing three white balls and one black in four trials, which probability, by what was shown above, is expressed by $4 p^3 q$, we have,

by 1st hypothesis, $4 p^3 q = \frac{27}{64}$,
by 2d hypothesis, $4 p^3 q = \frac{16}{64}$,
by 3d hypothesis, $4 p^3 q = \frac{3}{64}$.

The numerators of these fractions, which represent the relative probabilities of the event which has happened on each of the hypotheses, may be considered as giving the relative probabilities of the hypotheses as to the causes of the event, or to the state of the urn by which the event was determined; and, as one or other of these hypotheses must necessarily be true, the sum of their probabilities must be unity; whence the probability of each hypothesis is respectively

$$\frac{27}{46}, \frac{16}{46}, \frac{3}{46}.$$

This result may be expressed generally as follows: — The probabilities of the different hypotheses are found by dividing the probability of the event which has been observed calculated according to each hypothesis by the sum of its probabilities calculated on all the hypotheses.

Now, in order to find the probability of drawing a white ball at the next trial, we may reason in this manner: — If the first hypothesis be true, the chance of drawing a white ball is $\frac{3}{4}$, and the probability of the hypothesis being true is $\frac{27}{46}$; therefore the compound probability of both hypothesis and event is $\frac{3}{4} \times \frac{27}{46} = \frac{81}{184}$. If the second hypothesis be true, the probability of drawing a white ball is $\frac{2}{4}$, and the probability of the hypothesis is $\frac{16}{46}$; therefore the compound probability is $\frac{2}{4} \times \frac{16}{46} = \frac{32}{148}$. If the third hypothesis be true, the chance of drawing a white ball is $\frac{1}{4}$, and the probability of the hypothesis is $\frac{3}{46}$; therefore the joint probability of the hypothesis being

true and of the event arising is $\frac{1}{4} \times \frac{3}{46} = \frac{3}{184}$. Adding together these partial probabilities, the whole probability of drawing a white ball at a future trial is $\frac{81}{184} + \frac{32}{184} + \frac{3}{184} = \frac{116}{184}$.

In like manner, the probability of drawing a black ball at a future trial is

$$\frac{1}{4} \times \frac{27}{46} + \frac{2}{4} \times \frac{16}{46} + \frac{3}{4} \times \frac{3}{46} = \frac{68}{184}.$$

And the sum of the two probabilities is 1, as it ought to be, since the ball must necessarily be white or black.

The method of proceeding which has been followed in this particular case is quite general, and applicable to all cases where it is required to compute the probabilities of events depending on causes not known *à priori*, but only inferred from experience. It may be stated generally as follows: — Let c, c', c'', c''', &c. be so many independent causes (or hypotheses), each of which may give rise to an event E; and let the probabilities of the existence of these causes be respectively h, h', h'', h''', &c., and those of the events calculated according to each hypothesis p, p', p'', p''', &c.; then the probability of the event E is $h p + h' p' + h'' p'' + h''' p''' +$ &c.

The preceding examples will suffice to give some idea of the manner in which the probability of the occurrence or failure of events depending on chance is submitted to numerical estimation; but for the methods of applying the calculus in particular cases, and especially when the formulæ involve high numbers, and the ordinary processes of arithmetic become unavailable, reference must be made to works specially devoted to the subject, a list of which is given at the end of this article.

The calculus of probabilities had its origin in the speculations of Pascal, Fermat, Huygens, and other eminent mathematicians of the 17th century. It was first applied to the solution of questions connected with games of chance; but it has since, by the researches of James Bernoulli, Montmort, Demoivre, D'Alembert, Simpson, Condorcet, Lagrange, La Place, Poisson, and others, become one of the most interesting branches of mathematics, and been applied with equal success and advantage to numerous important questions belonging to natural and political philosophy. One of its most familiar and useful applications is to the subject of annuities, assurances, reversions, and other interests depending on the average duration of human life, and the expectation of the continuance or survivorship of lives of given ages. (*See* Annuity, Expectation of Life.) Another important application is to determine the most probable *mean*, or average, of a great number of observations; and hence its utility in many cases of practical astronomy and general physics. (*See* Probable Error.) Condorcet has applied it to determine the value of testimony, the verdicts of juries, and the best mode of constituting tribunals, and of collecting votes in elections. In such applications, it is true, assumptions more or less arbitrary must be admitted, and great uncertainty will always attach to results which are influenced by human will or caprice; nevertheless, the knowledge derived from an accurate and systematic analysis of the circumstances concerned, and of the consequences of their various combinations, affords important aid in guiding our judgments, and may be of great use in the practical affairs of life.

The following are the principal works on the subject: — Montmort, *Analyse des Jeux de Hasard* (1st edit. 1708; 2d, 1713); Bernoulli, *Ars Conjectandi*, 1713; De Moivre, *Doctrine of Chances* (1st edit. 1718; 3d, greatly enlarged, 1785); Simpson, *Laws of Chance*, 1740; Condorcet, *Essai sur l'Application de l'Analyse à la Probabilité des Décisions rendues à la Pluralité des Voix*, 1785; La Place, *Théorie Analytique des Probabilités*, 3d edit. 1820; Poisson, *Recherches sur la Probabilité des Jugemens*, 1837; the article in the *Encyc. Metropol.* by Professor De Morgan, and that in the *Encyc. Brit.* by Mr. Galloway (which is published separately). For elementary works the reader may be referred to *Simpson's Laws of Chance*, and *Lacroix's Traité Elémentaire*, &c.; and for an explanation of the objects and results of the science, without mathematical investigation, to Professor De Morgan's *Essay on Probabilities, and on their Application to Life Contingencies and Insurance Offices*, in the *Cabinet Cyclopædia*.

PRO'BABLE ERROR. In Astronomy and Physics, when the value of any quantity or element, as the declination of a star, the latitude of a place, the specific gravity of a body, &c., has been determined by means of a number of independent observations, each liable to a small amount of error, the determination (in whatever way it may have been deduced from the observations) will also be liable to some uncertainty; and the *probable error* is the quantity, which is such that there is the same probability of the difference between the determination and the true absolute value of the thing to be determined exceeding or falling short of it. Thus, if twenty measurements of an angle have been made with the theodolite, and the arithmetical mean or average of the whole gives 50° 27′ 13″; and if it be an equal wager that the

error of this result (either in excess or defect) is less than 2 seconds, or greater than 2 seconds, then the probable error of the determination is 2 seconds. The method of computing the probable error, which is deduced from the theory of probability, is as follows:— Let l, l', l'', &c. be the *observed* values, h the number of observations, m the average value (*i.e.* the sum of the observed values divided by number of observations); then if we call $l-m$ the error of the observation l, and $\Sigma(l-m)^2$ the sum of the squares of the errors of all the observations, the probable error is $\cdot 674489 \times \frac{\sqrt{\Sigma(l-m)^2}}{h}$; that is, the square root of the sum of the squares of the errors, divided by the number of observations, and multiplied by the decimal ·674489.

It is frequently convenient to compute the probable error of a result from another function, which is called the *weight*. The weight is the square of the number of observations divided by *twice* the sum of the squares of the errors; and the probable error is ·476936 divided by the square root of the weight. This definition agrees with the former, for $\cdot 674489 = \cdot 476936 \times \sqrt{2}$.

PROBANG. A flexible piece of whalebone with a ball of sponge attached to its extremity, for the purpose of removing obstructions in the œsophagus.

PRO'BATE OF TESTAMENTS. In Law, the exhibiting and proving wills and testaments before the ecclesiastical judge delegated by the ordinary of the place where the party dies. It is done by granting letters testamentary to the executor under seal of the court; and such probate is evidence in questions relating to the personal estates.

PROBE. (Lat. probo, *I try.*) A surgical instrument, generally made of silver wire, rounded at one end, and pointed at the other, for the purpose of examining wounds.

PRO'BLEM. In Geometry, a proposition requiring some operation to be performed or construction to be executed; such as to bisect a line, to describe a circle passing through three given points. In algebra, a *problem* requires some unknown truth to be investigated, or discovered and demonstrated.

PROBOSCI'DIANS, *Proboscidia.* (Lat. proboscis, *a trunk.*) The name of a family of Pachydermatous Mammals, including those which have the nose prolonged into a prehensile trunk or proboscis; as the elephant and mastodon.

PROBO'SCIS, in Mammalogy, signifies the prehensile organ formed by a prolongation of the nose, of which the trunk of the elephant is an example. In Entomology, the oral instrument of the Diptera is so called, in which the ordinary trophi are replaced by an ex-articulate sheath, terminated by a pair of tumid lobes (labella), and containing one or more lancet-shaped instruments (scapella), covered by a valve. In Malacology, the same term is applied to the tongue of certain Gastropods, when it is so long as to be capable of being protruded for some distance from the mouth; in which case it is generally organized at the extremity for the purpose of boring the shells of other testacea, and of destroying by suction the soft parts of the inhabitant.

PROCEDE'NDO (or *Procedendo in Loquelâ*). A writ which lies where an action has been removed from an inferior to a superior jurisdiction, and it does not appear to the court that the suggestion on which the removal took place was sufficiently proved to send the cause back to the inferior court for further proceeding.

Procedendo ad Judicium. A writ which issues out of the court of chancery, commanding inferior courts to proceed to judgment where it has been unjustly delayed.

PROCELLA'RIA. (Lat. procella, *a storm.*) A Linnæan genus of web-footed birds, now the type of a family of the *Longipennate Palmipedes* in the system of Cuvier, characterized by the beak being hooked at the tip, with its extremity appearing as though a piece had been articulated to the rest; the nostrils are united to form a tube, which lies along the back of the upper mandible; and their feet, instead of a back toe, have merely a claw implanted in the heel. Those species in which the lower mandible is truncated belong to the true *Procellariæ.* Some smaller species, with a shorter bill, rather longer legs, and black plumage, commonly called *Storm-birds*, or *Mother Carey's chickens*, are associated under the generic name *Thalassidroma.* The *Procellariæ* range over the high seas at the greatest distance from land. Their name of *Petrel*, which is a diminutive of *Peter*, has been applied to them from their habit of walking on the waves, which they do with the assistance of their wings.

PRO'CESS, in the language of English Common Law, is used in two senses: to signify the whole proceedings in an action or prosecution; and to signify the means whereby the defendant in an action is compelled to appear in court. When actions were commenced by original writ (*see* PLEADING), original *process* was that which was founded on that writ, commencing with notice, writ of attachment, &c. *Mesne*, or intermediate process, was, properly speaking, such process as issued pending the writ on some collateral or interlocutory matter; as to summon juries or witnesses. But in popular language it was taken to signify the whole process, from the commencement of the suit, before the final process which ended it. Thus a defendant was said to be arrested on *mesne* process, *i.e.* on a writ of capias issued *pending* the suit. This was done originally when the defendant, being summoned or attached, neglected to appear or made default. In course of time, by a legal fiction, the summons and neglect were *supposed;* and the writ of capias became the commencement of the proceedings, to which the term mesne process was still, inaccurately, applied. The term mesne process is now commonly applied to the writ of summons, which is the instrument now in use for commencing personal actions. Thus the popular inaccuracy of language is retained. Final process is the writ of execution used to carry the judgment into effect. In ordinary language, the regular proceedings of every court of judicature in a suit are called its process.

PROCE'S VERBAL. In the language of French jurisprudence, an authentic written minute or report of an official act or proceeding, or statement of facts. The term is also used to signify minutes drawn up by a secretary or other officer of the proceedings of an assembly.

PROCLAMA'TION. Public notice given by the king to his subjects. (*See* KING, PRIVY COUNCIL.) The power of issuing proclamations is a branch of the king's prerogative, and vested in him alone. They have a binding force on the subject, in so far as they are grounded on and enforce the laws of the realm. They may be said to be of two sorts: the one, enforcing an actually existing law by giving it a particular application of time, place, and circumstance; the other, exercising an extraordinary power vested in the king, which until so exercised is dormant; as a proclamation to prohibit any subject from leaving the realm during a certain time. Proclamations must be under the great seal. By 31 H. 8. c. 8. it was enacted that the king's proclamations should have the force of law; an enactment which, while it subsisted, did, in effect, make a complete revolution in the government of this country. It was, however, repealed five years afterwards by 1 E. 6. c. 12. Nevertheless, in later times, it was held by crown lawyers, that the king might suspend or dispense with an existing law in favour of particular circumstances. But by 1 W. & M. stat. 2. c. 2. it is declared that no such power exists.

PROCO'NSUL. Originally an officer invested with consular command without the office. Thus, a consul sometimes had his command prolonged to him after his year of magistracy had ceased, with the title of proconsul. The provinces which at first were governed by prætors were, for the most part, subsequently put under *proconsuls* and *proprætors*, who were at first especially appointed at the Comitia Tributa; but afterwards, by the Sempronean law, entered on their provincial jurisdictions forthwith, on the expiration of their year of consulship or prætorship. The office was properly annual; but it might be prolonged, as was done in the case of Cæsar. In the time of the republic the proconsul held the military command as well as the civil jurisdiction of his province, and accordingly had about him a large staff of officers, as the lieutenants or legati, præfects, &c. But Augustus, on assuming the chief power in the state, remodelled the system by a new partition of the provinces, and by separating the civil jurisdiction, which was left the proconsul, from the military command. Under the emperors, the proconsuls and proprætors were thus distinguished; the former being appointed to the provinces under the especial superintendence of the senate, the latter to those which the emperor held.

PROCRU'STES. In Mythology, a famous robber of ancient Greece, who tortured his victims by placing them on an iron bed, which their stature was made to fit by stretching or mutilating them so as to suit its dimensions; whence the well-known metaphorical expression, the *bed of Procrustes.* He was killed by Theseus near Hermione, in Argolis. According to a recent critic (Böttiger), Procrustes, Sinis, Philyocamptes, &c. were all different names for one real or fabulous robber, derived from the different kinds of violence applied by him to travellers.

PRO'CTOR. (Lat. procurator.) In Ecclesiastical Law, he who undertakes for his fee to manage a cause in the ecclesiastical or civil court, being duly admitted under 53 G. 3. c. 127., exercising the same office which is performed by attorneys and solicitors in courts of common law and equity.

PROCTORS. In the English Universities, both at Oxford and Cambridge, two masters of arts are appointed annually to this office. Each college, in both, nominates a proctor in rotation, according to a cycle of years drawn up, on mathematical principles, to suit the number of fellows on the foundation of each. The proctors are officers of considerable importance; being, in the first place, the chief police magistrates for the time being of each

university. They, with their deputies the pro-proctors, have power not only to enforce the rules of academical discipline on the students, but also an extensive summary authority over the townspeople, according to the special privileges of the universities. They also have, in both universities, peculiar legislative authority as assistants to the heads of houses, and official votes in the election of many professors and other officers. The proctors must be masters of arts, and their standing as such, at Oxford, from four to ten years.

PRO'CURATOR. (Lat. pro, *for*, and cura, *care*.) A Roman provincial magistrate, whose office it was to manage the affairs of the revenue, and exercise a judicial authority in matters pertaining to it. Sometimes the procurator discharged the office of governor, especially in a small province, as did Pontius Pilate in Judæa; in which case, but not otherwise, he had the power of inflicting capital punishment. This magistracy did not exist under the republic, its duties being comprised under those of the prætor or proconsul, but was instituted by Augustus. They were called *Procuratores Cæsaris*, to distinguish them from the common procurator, who was merely an agent employed by private persons to manage their affairs in their absence when an action was brought against them.

PROCURATOR, *Procureur*, &c. In the Civil Jurisprudence, one who undertakes the care of any legal proceeding for another, and stands in his place by virtue of a power or *procuration* from him. A *mandatory* is said to differ from a *procurator* in that the latter acts only by virtue of an express written instrument. In France, before the revolution, the procureurs (procuratores ad lites) were officers legally empowered to carry on suits on behalf of clients. This body was abolished in 1791, and that of *avoucs* substituted in its place. The *procureurs du roi*, in France, are officers of whom one is appointed to every tribunal of arrondissement, together with a sufficient number of "substitutes."

PROCUREUR-GENERAL. The public advocate of the crown in France. Every *parlement* or *cour souveraine* had, before the Revolution, a *procureur-general* attached to it. Under the present system of judicature, one of these officers is established in every *cour royale*, for the criminal part of its proceedings; and under him an *avocat-general*, for the civil department of the court. The public accusers in the inferior courts of assize, and *premiere instance*, are termed respectively *procureurs criminels* and *procureurs du roi*. These officers are charged with the conduct of all criminal proceedings on behalf of the prosecution; and are placed under the immediate control of the minister of justice.

PRO'DIGY (of very doubtful etymology), in ordinary modern language, signifies a surprising though natural event; in contradistinction to *miracle*, which is something out of the course of nature. Among the Romans, however, any extraordinary event or appearance, to which, from insufficient acquaintance with natural history, they could not assign a cause, was termed a *prodigy*, and regarded as a supernatural event, indicative of favourable or (more generally) of unfavourable dispositions of their gods. Hence the number of recorded prodigies, many evidently false, some real but misunderstood, which Livy has inserted in his annals.

PRO'DOMUS. (Gr. προ, and δομος, *house*.) In Ancient Architecture, the portico before the entrance of the cella of a temple; the same as *pronaos*. *See* NAOS.

PRO'DUCT, in Arithmetic and Algebra, is the result of, or quantity produced by, the multiplication of one number by another, or a quantity of any kind by a number. *See* MULTIPLICATION.

PRODU'CTA. An extinct genus of fossil bivalve shells, closely allied to the living genus *Terebratula*. They only occur in the older secondary rocks.

PRO'EM. (Gr. προ ειμι, *I go before*.) A term formerly used for *preface*, which see.

PROEMPTO'SIS. (Gr. προ, *before*, and εμπιπτω, *I fall upon*.) The term applied to the lunar equation or addition of a day to prevent the new moon happening too soon; which must be effected by the addition of a day every 330 years and another every 2400. The opposite term is *metemptosis*, which is used to signify the solar equation necessary to prevent the new moon from falling a day too late, or the suppression of the bissextile every 134 years.

PROFE'SSOR. The recognized title, in all universities, of the public and authorized teachers in the various faculties. In the origin of those institutions the degrees conferred on students were, in fact, licences to commence as public teachers; and the terms master, doctor, and professor seem to have been used indifferently. But as in process of time the great body of graduates ceased, in most of them, to have any concern in public instruction, a separate body of recognized teachers gradually arose; endowed in some instances with salaries, in others paid by fees. These were the professors. But in those universities in which collegiate foundations prevailed, as in Oxford and Cambridge, these officers fell into a secondary situation. The necessary business of instruction was transacted, and still continues to be so, by the functionaries of the several colleges. The professors therefore, and the instruction which they convey by lectures, have become only auxiliaries, instead of principals, and attendance on their lectures is in few cases compulsory. On the other hand, in universities destitute or nearly so of collegiate endowments (as those of Scotland, Germany, and others founded on the German model), the professors have become at once the governing body of the university, and the sole recognized functionaries for the purpose of education.

PROFI'LE. (Fr. profil.) In Architecture, the contour of the different parts of an order.

PROFILE. In the Fine Arts, an outline of the principal parts of an object, free from all fore-shortening, showing their real projections, indentations, &c.

PRO'FIT (Fr. profit), in Political Economy, means the advantage or gain resulting to the owner of capital from its employment in industrious undertakings. It is the premium, as it were, on accumulation. Were there no profit, there would be little or no motive to save and amass; and all the vast advantages that society derives from the formation and employment of capital would be unknown. But without taking into account the security and consequence conferred on the possessors of capital or wealth, and looking only at its tangible results, profit consists of that part of the produce raised by the agency of capital employed in industrious undertakings that remains in the hands of those by whom it is employed after replacing the capital itself, or such portions of it as may have been wasted in the businesses, and every expense necessarily incurred in superintending its employment.

The *rate* of profit is the proportion which the amount of profit derived from an undertaking bears to the capital employed in it.

Thus, suppose an agriculturist employs a capital equivalent to 1000 quarters of corn, or 1000*l*., in the cultivation of a farm, and that the net surplus produce remaining to him at the end of the year, after his capital has been replaced, and he has been indemnified for the trouble of superintendence, and for every necessary expense incurred in the management of the farm, is 100 quarters, or 100*l*.; this net surplus would form the profits of the agriculturist, being to the capital by whose agency they are obtained in the ratio of 100 to 1000, or at the rate of ten per cent.

It has been shown by Dr. Smith and others, that the capital vested in different businesses yields, provided they be not subjected to any species of monopoly, about the same rate of net profit; and we shall now endeavour shortly to state the circumstances which seem to determine this rate.

In this investigation it is not necessary to inquire whether the capital engaged in certain businesses yield rent as well as profits, or profits only. The competition of the producers will always reduce profits in different businesses to what is, taking all things into account, nearly the same common level; and, as rent is in every case a surplus over and above profits, it may in this investigation be left wholly out of view. The laws by which profits are regulated in countries where the best lands only are cultivated, and no rents are paid, are in no respect different from those which regulate them in countries where cultivation has been widely extended, and where lands of superior fertility yield a high rent.

Suppose, therefore, that rent is deducted, or set aside, it follows that the whole of the remaining produce of industry must, in the first instance, be divided between capitalists and labourers; that is, between those who furnish the capital and those who furnish the manual labour made use of in the production of commodities. And hence, were taxation either unknown or constant, the proportion of the produce of industry under deduction of rent falling to the share of the capitalists could not be increased without the proportion falling to the share of the labourers being at the same time diminished, and conversely. But the share of the produce of industry falling to the capitalists includes, besides profit, the portion required to replace the capital wasted in production, and to defray the wages of superintendence. So that the rate of profit is not, as has been already stated, determined by the ratio which the share of the produce of industry that goes in the first instance to the capitalists, after every sort of outlay has been deducted, bears to the total capital employed.

Suppose, for example, that an agriculturist employs a quantity of capital of the value of 1000 quarters of corn, or 1000*l*., in cultivating a farm; that half this capital consists of seed, horses, and other instruments used in agriculture, the other half being employed in the payment of wages; and suppose that after his rent has been deducted or set aside, he has produce equivalent to 1200 quarters, or 1200*l*.; of this sum 1000 quarters, or 1000*l*., must go to replace his capital; and supposing that his taxes amount to 100 quarters, or 100*l*., it follows that 100 quarters, or 100*l*., will remain for his profits, which are consequently at the rate of ten per cent. Now, in this case — and this case is, *mutatis, mutandis*, the case of every man engaged

in business, — it is obvious that the rate of profit may be raised in three, but only in three ways; viz. 1. By industry becoming more productive; or 2. By a reduction in the rate of wages; or 3. By a reduction in the amount of taxation. And it may be reduced by the opposite circumstances; or 1. By industry becoming less productive; or 2. By a rise in the rate of wages; or 3. By a rise in the amount of taxation. Profits cannot be affected in any way not referable to one or other of these heads.

To revert to the previous example, let it be supposed, other things remaining the same, that the quantity of produce is increased, by means of the better application of the capital and labour employed, from 1200 quarters, or 1200*l.*, to 1300 quarters, or 1300*l.*; the gross amount of profits would in this case be increased from 100 quarters, or 100*l.*, to 200 quarters, or 200*l.*, and the rate of profit would be raised from 10 to 20 per cent. A similar result would be produced, other things being the same, were wages reduced from 500 quarters, or 500*l.*, to 400 quarters, or 400*l.*; and were taxation reduced from 100 quarters, or 100*l.*, to 50 quarters, or 50*l.*, the rate of profit would be raised from 10 to 15 per cent. On the other hand, if we suppose that the quantity of produce, instead of being increased, is diminished, or that wages or taxes are augmented, the gross amount of profit, and the rate of profit, will be proportionally lessened.

Had it not been for the gradually decreasing productiveness of the capital laid out on the lands, the productiveness of industry would have increased with every discovery and invention for saving labour; so that, without a corresponding increase of wages and taxes, the rate of profit would have been continually increasing. But, though improvements may materially increase the productiveness of agricultural industry for a lengthened period, the increase cannot be permanent; inasmuch as the growth of population never fails, in the end, to force recourse to inferior lands, which, of course, yield less produce in return for the same outlay. This decreasing productiveness of the capital applied to the soil has a double influence over profits; for, in the first place, it lessens the quantity of produce obtained by the outlay of capital and labour; and, in the second place, it increases the portion of that produce going to the labourer as wages. The latter must always get enough to enable him to subsist and continue his race; and though, in the event of his resorting to a lower species of food or an inferior standard of comfort, a rise in the price of raw produce may not be followed by a rise of wages, yet, speaking generally, the one is always consequent to the other. The cost of food is the main regulator of wages; and it is quite impossible to go on, for any lengthened period, by taking bad land into cultivation, or forcing the good land, making constant additions to its cost, without ultimately raising wages. Manufacturing industry, or the adaptation of matter to our use, necessarily becomes, from the influence of discoveries and inventions, more and more productive as society advances; so that the decreasing fertility of the soil is at bottom the only cause of whatever reduction in the rate of profit is to be ascribed to a decline in the productiveness of industry; and it is pretty frequently also the cause of those reductions that are occasioned by a rise in the rate of wages. The latter, it is true, is also brought about by an increased demand for labour, and by a greater prevalence of moral restraint. But a rise of wages caused by the increased cost of necessaries does not depend on contingent circumstances, or on the forethought of the labourers. It must be experienced in every country and state of society, according as it becomes more and more difficult to obtain supplies of food for an increasing population. The absolute wages of the labourer, or the quantity of necessaries and conveniences given him for his labour, may be, and indeed frequently are, diminished in the progress of society; but when cultivation is far extended, he is uniformly almost in the receipt of a larger share of the produce of his labour; so that, as has just been observed, profits are reduced in an advanced stage of society, because the quantity of produce is diminished, and because the labourers get a larger share of this diminished quantity.

The theory of Smith, as to the circumstances which determine the rate of profit, differs widely from the above. He seems to have had no idea of the important principle which shows that, despite the countervailing influence of improvements, the capitals successively applied to the land are sure, in the long run, to decrease in productiveness. And not imagining that there was any natural cause why the produce obtained by the outlay of equal amounts of capital and labour should ever be diminished, he supposed that profits were lowered through the competition of capitalists; that when capital increased, the undertakers of different businesses became anxious to encroach on each other; and that, in order to attain their object, they offered their produce at a lower price, and gave higher wages to their workmen.

But though, at first view, this theory appear sufficiently plausible, it will not bear the least examination. It is easy to see that competition cannot occasion a general fall of profits. All that competition can do, and all that it ever does, is to reduce the profits obtained in different businesses and employments to the same common level, to prevent particular individuals realizing greater or lesser profits than their neighbours. Farther than this competition cannot go. The common and average rate of profit depends not on it, but on the excess of the produce obtained by employing capital after it is replaced, along with every contingent expense. Competition cannot affect the productiveness of industry, neither can it, speaking generally, affect the rate of wages; for, such as the ordinary demand for labour is, such will be its supply, and it has no influence over taxation. It is plain, therefore, that it has nothing to do with the determination of the common and average rate of profit. It hinders individuals from getting more or less than this common rate; but it has no further effect.

Hence it appears, that that fall in the rate of profit that is usually observed to take place as society advances is not owing to an increase of capital, or to the competition consequent upon that increase, but to an inability to employ capital with the same advantage as before; resulting (1.) from a decrease in the fertility of the soils to which recourse must be had, or (2.) from a rise of wages, or (3.) from an increase of taxation. Of these causes, one may be the more powerful at one period, and another at a different period. The first not only lessens the quantity of produce raised by the outlay of capital and labour, but it also, as already seen, generally raises in the end the rate of proportional wages. It is, of course, impossible to lay down any fixed principles with respect to the influence of taxation. In the progress of society, it may increase or diminish. It has been shown that the heavy taxation of Holland, during the last century, was the principal cause of the low rate of profit in that country (*Principles of Political Economy*, 2d ed. p. 494.); and, no doubt, profits in England are sensibly affected by our taxation.

The principles already established show, 1. That so long as the productiveness of industry is undiminished, profits cannot be reduced otherwise than by a rise of wages or of taxes; 2. That so long as the rate of wages is constant, profits cannot be reduced, unless industry become less productive, or taxation be augmented; and 3. That so long as taxation remains constant, profits cannot be reduced, unless industry become less productive, or wages be raised. It is supposed, in these cases, for the sake of simplicity, that when one of the regulating principles of profit remains constant, the other two vary in the same way. But they might vary in different ways; and if so, their influence on profits would obviously depend on the extent to which the variation in the one exceeded the variation in the other. Suppose, for instance, that while the productiveness of industry remains constant, a rise of wages and a reduction of taxation are experienced; the effect of this variation will plainly depend on the rise of wages exceeding, falling short, or being identical with the reduction in the amount of taxation: if it exceed the reduction of taxation, profits will be lowered proportionally to the excess; if it be less than the reduction of taxation, profits will be proportionally raised; and if the rise of wages and the reduction of taxation be exactly equivalent, profits will, of course, undergo no change.

PROGNO'SIS. (Gr. πρό, and γινώσκω, *I know*.) An opinion respecting the progress and termination of a disease.

PRO'GRAMME. An old university term, signifying an outline of the speeches or orations to be delivered on a particular occasion; but now applied in a more extended sense to the outline of any entertainment or public ceremony.

PRO'GRESS. The state journeys of royal personages were called by this name in old English etiquette. In the reigns of Elizabeth and James they were frequent, and somewhat costly to the wealthier subjects, inasmuch as they were usually honoured with the onerous privilege of affording hospitality to royalty. The "progresses" of Queen Elizabeth form the subject of a work by Mr. Nicholl. (See also *Quart. Rev.* vol. xli.) Perhaps the most celebrated progress in English history is that of James I. from Scotland to London on his accession.

PROGRE'SSION. (Lat. progressio.) In Arithmetic, a series of numbers proceeding according to a certain order. It is arithmetical, geometrical, or harmonical.

An Arithmetical Progression is a series of numbers, increasing or decreasing by equal differences. Thus,

increasing, 1, 3, 5, 7, 9, &c.
decreasing, 18, 15, 12, 9, 6, &c.

Or, generally, $a \pm d, a \pm 2d, a \pm 3d, a \pm 4d, \pm$, &c.

Let a denote the least term,
z the greatest term,
d the common difference,
n the number of terms,
s the sum of all the terms;

then the principal properties of an arithmetical progression are expressed by the following formulæ: —

$$a = z - (n-1)\,d,\ z = a + (n-1)\,d,$$
$$d = \frac{z-a}{n-1},\ n = \frac{z-a}{d} + 1,\ s = \frac{a+z}{2}\,n;$$

and these expressions become still simpler when the first term, a, is nothing.

A Geometrical Progression is a series of numbers increasing or decreasing in a certain constant ratio; or such that the quotient of any one of them by that which immediately precedes is constantly the same. Thus,

increasing, 1, 2, 4, 8, 16, &c.
decreasing, 81, 27, 9, 3, 1, &c.

Or, generally, $a,\ r\,a,\ r^2\,a,\ r^3\,a$, &c.

$$\text{Or } a,\ \frac{a}{r},\ \frac{a}{r^2},\ \frac{a}{r^3},\ \text{\&c.};$$

where a is the first term, and r the common ratio in the one case, and $1 \div r$ the common ratio in the other.

Let a denote the least term,
z the greatest term,
r the common ratio,
n the number of terms,
s the sum of the terms;

then the principal properties of a geometrical progression are expressed as follows: —

$$a = \frac{z}{r^{n-1}},\ z = a\,r^{n-1},\quad r = \left(\frac{z}{a}\right)^{\frac{1}{n-1}},$$
$$n = \log.\frac{r\,z}{a} \div \log.\,r,\ s = \frac{r\,z - a}{r-1} = \frac{r^n - 1}{r-1}a.$$

Some of these formulæ may be more conveniently expressed in terms of s which does not enter into any one of the first four. Thus,

$$a = \frac{r-1}{r^n - 1}s;\ \text{or } a = z\,r - (r-1)\,s;\ r = \frac{s-a}{s-z}.$$

An Harmonical Progression is a series of numbers in harmonical proportion, or such that, of any three consecutive terms, the first is to the third as the difference between the first and second is to the difference between the second and third. (*See* Harmonical Proportion.) The reciprocals of an arithmetical progression form an harmonical progression. Thus, the reciprocals of the arithmetical series 1, 2, 3, 4, 5, &c. are

$$\frac{1}{1},\ \frac{1}{2},\ \frac{1}{3},\ \frac{1}{4},\ \frac{1}{5},\ \text{\&c}$$

which form an harmonical progression.

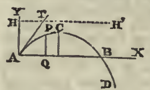
PRO'HEDRI. (Gr. προέδροι.) Certain Athenian officers chosen to superintend the proceedings in the two legislative assemblies; so called because they had the privilege of sitting in the front seats (προεδρία). The prohedri of the senate were ten in number. (*See* Prytanes.) The prohedri of the ecclesia were more in number, one being appointed from each tribe, which did not contain the prytanes for the time being. Their duties only extended to the one assembly of the people, a new set being elected each time; and one of their number was appointed epistates or president. Their employment was to propose the subject of debate to the people, and to count the votes.

PROHIBI'TION. In Law, a writ to forbid any court from proceeding in a cause then depending, on suggestion that the cause of it does not properly belong to that court. In modern times, the writ of prohibition is chiefly used where parties have been impleaded before the ecclesiastical courts. It issues properly out of the court of King's Bench; but may also be had in some cases out of the Chancery, Common Pleas, or Exchequer. It is the proper remedy where the court against which it is sued has exceeded its jurisdiction in taking cognizance of matters not properly belonging to it. It is granted on motion; but if the question of jurisdiction be doubtful, the courts direct the party suing the writ to *declare in prohibition.* This proceeding rested originally on a fiction of law. The plaintiff assumed that the writ had been granted, and brought his action against the defendant, on the supposition that he was proceeding in the case, notwithstanding the prohibition; and the merits were then tried on demurrer. But now, by 1 W. 4. c. 21., the declaration concludes with a prayer for a writ.

PRO'JECTILE (Lat. projicio, *I throw forward*), in Mechanics, is a body which, having had a motion in space impressed on it by the action of an external force, is abandoned by this force, and left to pursue its course. Thus, a stone thrown from the hand or a sling, an arrow shot from a bow, and a bullet discharged from a cannon are projectiles while they continue in motion.

Motion of Projectiles. — When a heavy body is projected from the earth, it is subject to the action of three separate and independent forces: — 1. The projectile force, or that by which it was put in motion, and in virtue of which, if no other force interfered, the body would continue for ever to move forward in a straight line with the same constant velocity. 2. The force of gravity, by which it is at every instant pulled towards the earth in a vertical line. 3. The resistance of the atmosphere, which, acting in the direction opposite to that in which the body is moving, tends at every instant to destroy its motion, or to bring it to rest.

When the projectile is a body possessing considerable density, and the motion is slow, the resistance of the air is inconsiderable, and the body describes almost the same path as if it had been projected in a vacuum; but when the velocity is great, as in the case of a cannon ball (and it is only in such cases that the theory of the motion of projectiles has any practical application), the resistance of the air becomes enormous, and causes the projectile to deviate widely from the path it would have pursued if this force had not been in action. The direct investigation of the path of a projectile in a resisting medium being a problem of the higher mathematics, and attended with very considerable difficulty, the way in which the subject can be rendered most intelligible is to proceed, in the first place, on the supposition that there is no resistance, and determine the circumstances of the motion of a body supposed to obey only the impulse by which it was projected and the force of gravity, and then to consider the resistance as a disturbing force, and find the correction that must be applied in consequence to the path determined on the previous supposition.



Motion of Projectiles in vacuo. — In order to determine the path of a projectile on the supposition that it is not resisted by the atmosphere, suppose it to be projected from the point A with a velocity a, in the direction A T; since gravity acts only in the vertical direction, it is evident that the body will move in the vertical plane passing through A T. Let A C D, therefore, be its path or trajectory in this plane; and let A X and A Y be the rectangular co-ordinates of the curve, A X being horizontal, and A Y in the direction of gravity. At the end of any given time t, let P be the place of the projectile; $x =$ A Q, its absciss; and $y =$ P Q, its ordinate: also let g be the accelerating force of gravity (= 32 feet per second), and A the angle T A X.

The body being projected in the direction of the line A T with a velocity $= a$, its velocity in the horizontal direction will continue uniform, and $= a \cos. A$. In like manner, its velocity in the vertical direction A Y, due to the projectile force, is $= a \sin. A$; and at the end of any time t the spaces passed over in those directions, if gravity did not act, would be respectively, $t\,a \cos. z$, and $t\,a \sin. A$. But the space through which a heavy body falls by the action of gravity in the time t is $\frac{1}{2} g\,t^2$; and as this is in the vertical direction, and opposite to A Y, it must be joined to the resolved part of the projectile motion in that direction, with a contrary sign. We have, therefore,

$$x = t\,a \cos. A,\ y = t\,a \sin. A - \tfrac{1}{2} g\,t^2 \ \ldots\ldots (1.)$$

On eliminating t from these two equations, and supposing the velocity a to be that which a body would acquire in falling from a height $= h$, so that $a = \sqrt{2\,g\,h}$, we obtain the following for the equation of the curve described by the projectile: —

$$y = x \tan. A - \frac{x^2}{4\,h \cos.^2 A} \ \ldots\ldots (2.)$$

This equation belongs to a parabola whose axis is vertical, or parallel to A Y. The summit of the parabola is found by differentiating the equation, and making $\frac{d\,y}{d\,x} = 0$, which gives $x = 2\,h \cos. A \sin. A$, and consequently $y = h \sin.^2 A$, for the values of x and y at that point.

In order to find the *amplitude* or *range* of the projectile, that is, the point B in which it again passes through the horizontal plane from which it was projected, we have only to suppose, in the above equation, $y = 0$. This gives

$$x = 4\,h \cos. A \sin. A = 2\,h \sin. 2\,A$$

for the value of A B; and, as the sine of an angle continues to increase to 90°, the value of A B will be greatest when A, the angle of projection, is 45°. The amplitude is then $= 2\,h$, or twice the altitude due to the initial velocity. At every other inclination there are two angles which give the same range, the one as much less than 45° as the other is greater.

The velocity v, at any point in the curve, is found by means of the differential formula $v^2 = \frac{d\,x^2 + d\,y^2}{d\,t^2}$. On differentiating the values of x and y in the equations (1.), and adding the results, we find

$$v^2 = a^2 - 2\,a\,g\,t \sin. A + g^2\,t^2.$$

Let k = the height from which a body must have fallen to acquire the velocity v, then $v^2 = 2gk$. But we have also $a^2 = 2gh$, and $t = \frac{x}{a \cos. A}$; substituting, therefore, these values in the above equation, we obtain

$$k = h - x \tan. A + \frac{x^2}{4h \cos.^2 A};$$

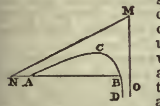
and comparing this with the value of y in equation (2.), we have ultimately $k + y = h$.

From this equation it appears that if in A Y a point H be taken, such that A H $= h$, the height from which a heavy body must fall to acquire the initial velocity, and a straight line H H′ be drawn though H parallel to the horizon, or to A X, the velocity of the projectile in the curve at any point P is equal to that which a heavy body would acquire by falling freely from the line H H′ to P. The line H H′, as is easily proved, is the directrix of the parabola; and hence all the parabolas described by bodies projected from the same point, and with the same velocities, though with different elevations, have the same directrix, and consequently their foci in the circumference of the same circle.

Thus it appears that the theory of the motion of projectiles in a vacuum is extremely simple; but, as has been already mentioned, the resistance which the air opposes to their motion, particularly when the velocity is great, is by far too considerable to be neglected; in fact, it changes entirely the form of the trajectory, and the law of motion by which it is described.

Motion of Projectiles in a resisting Medium. — When the resistance of the air is taken into account, the determination of the path described by a projectile is a problem of far greater difficulty, though still capable of rigid solution, on assuming an algebraic relation between the velocity and the resistance; but when it is considered that, in order to compute the trajectory of a resisted body, it is necessary not only to assume a law of resistance which we never can be quite sure is the true one, but also to know accurately the initial velocity of the body, together with its density, form, and dimensions, it is easy to see that no great practical advantage is likely to be obtained in any case from the theory, and that recourse must be had to experiment. The problem, however, regarded merely as a mathematical speculation, possesses considerable interest, and has been discussed by Newton in the *Principia* (Scholium, prop. 10. lib. ii.), by John Bernoulli, Dr. Brook Taylor, Hermann, Euler, and others. For the solution, see Legendre, *Exercises de Calcul Integral*, tom. i.; Poisson, *Traité de Mécanique*.

The hypothesis usually made with respect to the resistance is, that it is proportional to the square of the velocity. On this hypothesis it was shown by Newton that the trajectory has more resemblance to a hyperbola than a parabola. The two branches A C and C D are dissimilar; and the motion in the descending branch C D becomes constantly more nearly vertical and uniform, so that ultimately the body would describe a vertical line with a uniform velocity. This branch of the curve has therefore a vertical asymptote M O, to which it continually approaches. The other branch A C has likewise an asymptote, which makes an angle with the axis A B, and intersects it at a distance A N from A, depending on the initial direction and velocity of the projectile.



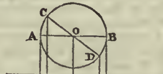
Some anomalous circumstances are observed in experiments with artillery, which are quite beyond the reach of theoretical calculation. Bullets are frequently driven to the right or left of the plane in which they were projected, as if a force acted upon them sideways as well as vertically, and in this case their path becomes a curve of double curvature. Dr. Hutton ascribes this chiefly to a whirling motion acquired by the bullet about an axis, in consequence of its friction against the sides of the piece; for this rotatory motion, combined with the progressive motion, causes each part of the ball's surface to strike the air in a direction different from what it would do if there were no such whirl. Euler, on the other hand, attributes the lateral deflection chiefly to the irregularity of the figure of the ball, and in a small degree to its rotation. Mr. Robins found the range of shot extremely uncertain, falling sometimes 200 yards short of what it did at other times, though there was no visible cause of difference in making the experiment; and Dr. Hutton states that he often experienced a difference of one fifth or one sixth of the whole range, both in the deflection to the right or left, and also in the extent of the range of cannon shot. *See* Gunnery, Resistance.

PROJECTION. In Perspective, the representation of any object on the perspective plane. *See* Perspective.

PROJECTION OF THE SPHERE. In Geography, the representation of the several parts of the surface of the sphere on a plane, according to some geometrical law by which the different points in the representation can be accurately referred to their relative positions on the sphere. It is a problem of much importance, in consequence of its application to the construction of maps, charts, planispheres, &c.

Projections are of various kinds, according to the situations in which the eye is supposed to be placed in respect of the sphere and the plane on which it is to be projected; but there are three which, by reason of the frequency of their use, are particularly deserving of attention; namely, the *orthographic*, the *stereographic*, and the *central* or *gnomonic*.

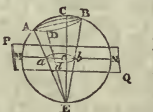
1. *Orthographic Projection.* — In this projection the eye is supposed to be at an infinite distance, and the *plane of projection*, i. e. the plane on which the representation is made, perpendicular to the direction of the rays of light, which are all parallel to each other. The laws of this projection are easily deduced. 1. Any point in space is projected by drawing a straight line from it perpendicular to the plane of projection. 2. A straight line perpendicular to the plane of projection is projected into a point. A straight line A B, parallel to the plane of projection P Q, is projected into an equal straight line $a\,b$; and a straight line CD, inclined to the plane of projection, is projected into a straight line $c\,d$, which is shorter than C D, in the proportion of the cosine of the angle of inclination to radius. 3. A plane surface perpendicular to the plane of projection is projected into a straight line. 4. A circle parallel to the plane of projection is projected into an equal circle; but a circle oblique to the plane of projection is projected into an ellipse, of which the greater axis is equal to the diameter of the circle, and the lesser axis is equal to that diameter multiplied by the cosine of the obliquity.



Orthographic projections of the sphere are usually made either on the plane of the equator, or on the plane of a meridian. When on the plane of the equator, the meridians are all represented by straight lines intersecting in the centre of the projection, and the parallels of latitude by circles whose radii are respectively equal to the cosines of the latitude. When the representation is on the plane of a meridian, the other meridians are represented by ellipses, and the parallels of latitude by straight lines parallel to the diameter of the projection. Orthographic projections of a hemisphere have this defect, that they are much crowded and distorted near the circumference of the representation, as may be inferred from the above figure; all the points in the arc A C being compressed within the line $a\,c$ (which is equal to the versed sine of the arc), while an arc at the vertex of the hemisphere is projected into a line nearly equal to itself.

The orthographic projection has a multitude of other applications. The plans and sections by which artificers execute their different constructions are orthographic projections of the things to be constructed; and a solid body may be represented in all its dimensions by orthographic projections on two planes at right angles to each other. *See* Descriptive Geometry.

2. *Stereographic Projection.* — In this projection the eye is supposed to be situated at the surface of the sphere, and the plane of projection is that of the great circle, which is every where 90 degrees from the position of the eye. Thus, let AC B E represent a sphere cut by a plane P Q passing through the centre, and perpendicular to the plane of the great circle A B E; and let E be the position of the eye in this circle. If straight lines be drawn from E to any points A D B in the opposite hemisphere, the points $a\,d\,b$ in which those lines cut the plane P Q will be the stereographic projections of A D B.



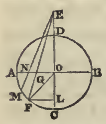
Some of the principal properties of this projection are the following: — 1. The projection of any circle on the sphere which does not pass through the eye is a circle; and circles whose planes pass through the eye are projected into straight lines. 2. The angle made on the surface of the sphere by two circles which cut each other, and the angle made by their projections, is equal. 3. Let C be the pole opposite to E, and c its projection; then any point A is projected into a point a, such that $c\,a$ is equal to half the tangent of the arc A C.

3. *Gnomonic or Central Projection.* — In this projection the eye is situated at the centre of the sphere, and the plane of projection is a plane which touches the sphere at any point assumed at pleasure. The point of contact is called the *principal point*; and the projections of all other points on the sphere are at the extremities of the tangents of the arcs intercepted between them and the principal point. As the tangents increase very rapidly when the arcs exceed 45°, and at 90° become infinite, the central projection cannot be adopted for a whole hemisphere.

The orthographic and stereographic projections were both employed by the ancient Greek astronomers for the purpose of representing the celestial sphere with all its circles on a plane. The first was called by them the *analemma*. Ptolemy wrote a treatise on this projection; and the Arabs derived from it the fundamental theorems of trigonometry. The stereographic projection appears to have been invented by Hipparchus, and was denominated by the Greek astronomers *planisphere*. The name stereographic (derived from *στερεος*, *a solid*) was given to it by the Jesuit Aguilon, because it results from the intersection of two solids, the cone and the sphere. Hipparchus and Ptolemy appear (though they do not expressly mention it) to have been acquainted with its principal property, namely, that circles on the sphere are projected into circles, which affords great facilities for the construction of maps. The second property, not less remarkable, that all circles in the projection intersect each other in angles equal to those made by the corresponding circles on the sphere, is of modern discovery, and appears to have been first demonstrated by Dr. Halley, in 1696, in No. 219. of the *Phil. Trans.*, where the discovery is attributed to Demoivre or Hooke. From the equality of the angles, it follows that any very small portion of the spherical surface and its projection are similar figures, — a property of great importance in the construction of maps, but which is not peculiar to this projection, as it belongs also to Mercator's; and numerous other relations may be assigned between the original and projected figures in which it will hold good. The gnomonic projection is also described by Ptolemy; but as the Greeks had no idea of the trigonometrical tangents, the polar distances were expressed by the ratios of the sines to the cosines of the arcs.

In constructing maps of countries, the object sought to be attained is to lay down the places in their true relative positions, and at the same time to preserve as much as possible the same scale of distances throughout. In the three projections which have been explained, equal portions of the spherical surface are represented by unequal portions of a plane surface, and the deviation from equality becomes greater from the centre to the circumference of the projection. The degrees of latitude are greatly contracted towards the circumference in the orthographic projection, and enlarged in the gnomonic, so as in both cases to produce a great distortion. Geographers have, accordingly, attempted to correct this deviation by placing the point of view at some finite distance without the sphere. This gives rise to the following, which was proposed by Lahire.

Globular Projection.—Let A C B be the hemisphere to be represented on the plane passing through the diameter A B, and let E be the position of the eye in a straight line passing through the centre O perpendicular to A B; the representation will be perfect, if the several arcs A M, M F, F C, have each the same ratio to their projections A N, N G, G O. This cannot be accomplished accurately, but the nearest approximate will be obtained by placing the point E in such a position that if F be the middle point of the arc A C, its corresponding point G is also the middle of A O. The problem, therefore, is to find a point E in C D, such that on drawing the line E F to bisect A C it shall also bisect the radius A O.



Draw F L perpendicular to O C, and join F O. It is evident that F L is half the side of the inscribed square, and G O is half the radius; therefore F L is to G O as O F or O C to O L. But $FL : GO :: LE : OE$; therefore, $LE : OE :: OC : OL$, and consequently $LO : OE :: CL : OL$; whence $OE \cdot CL = OL^2$. But $DL \cdot CL = FL^2 = OL^2$; therefore $OE = DL$, or $DE = OL$, the cosine or sine of 45°; consequently, by the trigonometrical tables, $DE = \cdot 71$, the radius being unity.

The projections which have now been explained are seldom used in delineating the features of a single country, or a small portion of the earth's surface. For this purpose it is found more convenient to employ some of the methods of development of the spherical surface explained under the term MAP.

The projection of the circles of the sphere on a plane is a problem of which the solution is easily found, either by the methods of the descriptive geometry, or by common algebra, or spherical trigonometry. Whatever be the situation of the eye, every circle on the sphere, not passing through the eye, forms the base of a cone, of which the eye is the apex; and the intersection of this cone with the plane of projection gives the curve into which the circle is projected. This curve, therefore, can be no other than a conic section, and its equation can never exceed the second degree. On forming the general equation, and assigning a particular position to the eye and the plane of projection, all the properties of the different kinds of projection are readily deduced. The subject is explained in a popular manner in *Murray's Encyclopædia of Geography* (*Introduction*), Malte Brun's *Geography*, and most other works on that science; and treated mathematically by Lambert in his *Beitrage*, &c. Berlin, 1772; by Euler in the *Petersburg Commentaries* for 1777; by Lagrange in the *Berlin Memoirs* for 1779; and by Gauss in a Memoir which is translated in the *Philosophical Magazine* for August and September, 1828.

PROJE'CTURE. In Architecture, the jutting or leaning outwards of the mouldings and other members of architecture beyond the face of a wall, column, &c.

PROLA'PSUS. (Lat.) A protrusion or falling down of a part of a viscus that is uncovered.

PROLATE SPHEROID. In Geometry, a spheroid produced by the revolution of an ellipse about its transverse diameter; so called in opposition to the *oblate* spheroid, which is produced by the revolution of the ellipse about its shorter axis.

PROLEGO'MENA. (Gr. προλεγόμενα.) In Literature, preliminary or introductory observations or dissertations prefixed to any work. The famous dissertation prefixed by D'Alembert to the *Encyclopêdie*, and the dissertations prefixed by Dugald Stewart, Playfair, Leslie, and Mackintosh to the last edition of the *Encyclopædia Britannica*, are among the best specimens of prolegomena.

PRO'LEGS, in Entomology, are the fleshy, exarticulate, pediform, often retractile organs, which assist various larvæ in walking and other motions, but which disappear in the perfect insect.

PROLE'PSIS. (Gr. προλαμβάνω, *I anticipate.*) In Rhetoric, a figure by which the speaker anticipates and answers imaginary objections, such as might be raised against the sentiments which he is urging.

PRO'LOGUE. (Gr. πρόλογος.) A piece in verse, recited before the representation of a play, and serving as an introduction to it. *See* EPILOGUE.

PROLU'SION. (Lat.) A classical word which has been adopted in a rather general sense by authors unwilling to entitle their own productions by a more ambitious designation; an essay or preparatory exercise, in which the writer tries his own strength, or throws out some preliminary remarks on a subject which he intends to treat more profoundly. The early and fugitive pieces of some poets (as the Culex and others attributed to Virgil) have been termed, by critics, their prolusions.

PROME'THEANS. A term applied to small glass tubes containing concentrated sulphuric acid, and surrounded with an inflammable mixture, which they ignite on being pressed, and thereby give instantaneous light. The term is derived from

PROME'THEUS. (From Gr. μητις, *counsel.*) According to the most ordinary form of his legend in Greek mythology, one of the Titans, who was exposed to the wrath of Jupiter on account of his having taught mortals the arts, and especially the use of fire; which he was said to have stolen from heaven, concealed in a pipe. According to another story, Prometheus was actually the creator of men; and in the *Protagoras* of Plato he is made not to have created, but to have inspired them with thought and sense. His punishment was to be chained to a rock on Caucasus, where a vulture perpetually gnawed his liver; from which he was finally rescued by Hercules. This legend has formed the subject of the grandest of all the poetical illustrations of Greek supernatural belief, the *Prometheus Bound* of Æschylus. Many have recognized in the indomitable resolution of this suffering Titan, and his stern endurance of the evils inflicted on him by a power with which he had vainly warred for supremacy, the prototype of the arch-fiend of Milton. Others have sought for a recondite analogy, and discovered in the tortures endured by Prometheus as a sacrifice for mankind, whom he had benefited, a foreshadowing of the great mystery of Christianity.

PRO'MISSORY NOTE. A note or writing by which an individual, or number of individuals, promise or engage to undertake or perform some specified act. In ordinary language, however, it is applied to engagements to pay certain specified sums of money at certain dates. Such documents, if drawn on proper stamps, are legal negotiable instruments that enjoy the same privileges as bills.

PRO'MONTORY. (Lat. pro, and mons, *a mountain.*) In Geography, a point of land, whether high or low is indifferent, projecting into the sea. *See* CAPE.

PROMU'SCIS. The name of the suctorious organ of the Hemipterous insects, formed by the union of the two jaws (*maxillæ*) to the lower lip, which they embrace; thus forming a jointed organ, containing four long capillary lancets and a short tongue.

PRONA'OS. (Gr. προ, and ναος, *a temple.*) In Architecture, the front porch of a temple. *See* NAOS.

PRONA'TOR MUSCLES. Those which are used in turning the palm of the hand downwards.

PRO'NOUNS. In Grammar, parts of speech which are used in the stead of nouns, to avoid needless or inconvenient specification. Pronouns are divided into *substantive* or *personal*, and *adjective*; the latter including

possessive, *demonstrative*, *relative*, *indefinite*, and *interrogative* pronouns.

PROOF. (From the verb *to prove.*) In Engraving, an impression taken from an engraving to prove the state of it during the progress of executing it; also one taken before the insertion of the letters are engraved on the plate.

PROOF. In Printing, an impression on which the errors and mistakes are marked for the purpose of being corrected. Proofs are,— first proof, which is the impression taken with all the errors of workmanship. After, it is read by the copy, and the errors corrected, which if not many, and carefully done, another impression is printed with more care, to send to the author; this is termed a clean proof. On it he makes his corrections and alterations: when those are altered in the types, another proof is printed, and read over carefully, previously to the whole number being printed off; this is called the press proof.

PROOF. *See* EVIDENCE.

PROOF SPIRIT. A mixture of equal weights of absolute alcohol and water; the specific gravity of such a mixture is 0·917; but the density of the proof spirit of commerce is 0·930.

PROPÆDEU'TICS. (Gr. προ, and παιδευω, *I instruct.*) A term used by German writers to signify the preliminary learning connected with any art or science: that in which it is necessary to be instructed, in order to study with advantage the art or science itself.

PROPAGA'NDA. The name given to an association, or, as it is termed, the congregation *De propagandâ Fide*, established at Rome by Gregory XV. in 1622, for diffusing a knowledge of Christianity throughout the world. It is a committee of cardinals and special agents of the pope, under whose presidency it meets every week. Its duties are, the superintendence and assistance of missionaries in all parts of the globe, the maintenance of recent converts, the publication of religious works in foreign languages, &c. Derived from this celebrated society, the name *propaganda* is applied in modern political language as a term of reproach to secret associations for the spread of opinions and principles which are viewed by most governments with horror and aversion.

PROPAGA'TION OF PLANTS. The greater number of plants are propagated naturally by means of seeds; but, in addition to these, many plants are extended over the surface on which they take root by the production of runners or lateral shoots, which spread along the surface, and root at the joints or buds, from which they send up new plants; by suckers or side shoots from the roots; and by various other natural means. Artificially, plants are propagated by seed, by runners, suckers, offsets, dividing the tubers, layers, cuttings, grafting, budding, inarching, &c. Seeds are gathered when mature, and sown on recently stirred soil, and covered to different depths, according to the size of the seed, the nature of the soil and situation, and other circumstances. The plants formed by runners are separated from the parent plant by cutting through the runner, and removing the young plant, in order to plant it elsewhere. Suckers, slips, or side shoots from the roots, are separated from the parent plant by being slipped down, or cut off, so as to carry with them a portion of fibrous roots; and they are afterwards planted in suitable soil, &c. Offsets are small bulbs which are produced round the base of larger ones, and, being taken off and planted, become plants. Tubers are underground stems, containing leaf-buds; and these may be separated and planted entire, or cut into as many pieces as there are buds, in either of which cases new plants will be formed. Layers are branches or shoots of either woody or herbaceous plants, which are bent down, and a portion of their length buried a few inches in the soil; that portion having been previously wounded by cutting, bruising, or twisting, which, by checking the descent of the sap, gives rise, after a certain period, to the production of roots. After these roots are formed, the portion of the layer which has produced them is separated from the main stock or parent plant, and planted by itself. Cuttings are portions of shoots, either of ligneous or herbaceous plants; and they are made of the young shoots with the leaves on, or of the ripened wood either with or without its leaves; and after they have, either in a herbaceous state with the leaves on, or with the wood mature and with or without the leaves, been properly prepared and planted, they form roots at their lower extremity, each cutting becoming a perfect plant. In general, cuttings should be taken from those shoots of a plant which are nearest the soil; because, from the moisture and shade there, such shoots are more predisposed to emit roots than those on the upper part of the plant. The young or last-formed shoots are to be taken in preference to such as are older, as containing more perfect buds in an undeveloped state, and a bark more easily permeable by roots; and the cutting is to be prepared by cutting its lower extremity across at a joint, the lenticells or root-buds being there most abundant. When the cutting is planted, the principal part of the art consists in making it quite firm at the lower extremity, so as completely to exclude the air from the wounded section. Cuttings emit roots at this section, either in consequence of the action of the accumulated sap in the cutting, as in the case of the ripened wood in deciduous trees and shrubs; or in consequence of the joint action of the accumulated sap and of the leaves, as in the case of cuttings of soft wood with the leaves on, and in a living state. A few plants are propagated by cuttings of the leaves, the petiole of the leaf being slipped off from the parent plant, and probably containing the latent embryos of buds. Grafting and budding are processes which have been already explained. (See these words.) Inarching may be described as a species of grafting, in which the scion is not separated from the parent plant till it has become united with the stock.

PRO'PEDS, *Prcpedes.* The name given by Kirby to the soft, fleshy, inarticulate, pediform appendages of certain larvæ, placed behind the true feet, and disappearing in the mature insects.

PRO'PER. In Heraldry, any object represented of its natural colour is so termed.

PRO'PERTY. In Logic, a predicable which denotes something essentially conjoined to the essence of the species. There are enumerated in books on logic four kinds of property, which are termed "universal, but not peculiar;" "peculiar, but not universal;" "universal and peculiar;" "universal and peculiar, but not at every time." The last kind is evidently more properly designated as Accident. *See* LOGIC, PREDICABLE.

PROPERTY, RIGHT OF. *See* RIGHT OF PROPERTY.

PRO'PHETS. (Gr. προ, *before*, and φημι, *I speak.*) A title given in the Scriptures to persons inspired, or endowed with the capacity to predict future events. The first to whom it is applied is Abraham; and we hear, in the same extended sense, of companies of prophets, persons who were employed in the study or exposition of the divine law, in which case it does not necessarily imply the power of predicting future events. In its more strict signification, the term prophet is given to Elijah, Elisha, and others, who did not commit their prophecies to writing, but whose inspiration is attested in the historical books of the Old Testament, and to the sixteen whose books are collected under the subdivisions of the greater and the lesser. Jonah, the earliest, lived about 800 B. C.; and Malachi, the latest, about 400 B. C.

PROPHYLA'CTIC. (Gr. προφυλασσω, *I defend.*) Means used to prevent disease.

PROPO'RTION (Lat. proportio), in Arithmetic and Geometry, is the equality or similitude of ratios; four numbers or magnitudes being said to be proportional, or in proportion, when the ratio of the first to the second is the same as the ratio of the third to the fourth, or when the first divided by the second gives the same quotient as the third divided by the fourth.

The definition of proportion has given rise to much controversy among writers on the elements of geometry. Euclid's celebrated definition in the fifth book, whatever may be said in favour of its ingenuity and exactness, is found by experience to be much too complicated and refined to be understood by beginners; and accordingly many attempts have been made to substitute for it one more intelligible; but, on account of the difficulty of defining the term *ratio* in such a manner as to include incommensurable quantities, none of these attempts can be said to have been perfectly successful. This imperfection, however, must be understood as belonging merely to the metaphysical accuracy of the definition, for many of the treatises which have been composed with the view of superseding Euclid's have all the simplicity and elegance which can be desired. On this subject the reader may consult *Barrow's Mathematical Lectures;* the notes to *Playfair's Euclid; Camerer's Euclid*, Berlin, 1825; De Morgan, *On the Connexion of Number and Magnitude*, 1836; and the art. "Proportion" in the *Penny Cyc.*

Proportion is *continual* or *discrete*, *direct* or *inverse*. It is continual when every two adjacent terms have the same ratio, or when the consequent of one ratio is the antecedent of the next following: thus, 2, 4, 8, 16, &c., are numbers in continual proportion, for the ratio of 2 to 4 is the same as that of 4 to 8, of 8 to 16, &c. *Discrete* proportion is when the antecedent of one ratio is different from the consequent of the former; thus, 2, 3, 4, 6. The terms *direct* and *inverse* have reference to arithmetical questions in what is denominated the Rule of Three, and which in their enunciation include four numbers, two of which are of one kind and two of another, and moreover each number of the second kind intimately connected with one of the numbers of the first kind by the nature of the question. Now, when the four numbers are written in the form of a proportion, if the antecedents of the two ratios are the related numbers, the proportion is said to be direct; but if the antecedent of the first ratio is the number connected with the consequent of the second, the proportion is inverse. For example, let the question be this; If 8 yards cost 12 shillings,

what is the price of 20 yards? The answer is 30 shillings. Now, in this question, the numbers 8 and 20 are of one kind, namely, yards; and the two others, 12 and 30, are of the same kind, shillings. The numbers form the proportion 8 : 20 : : 12 : 30; and the numbers 8 and 12 (the antecedents of the ratios) are related to each other, and also 20 and 30; 12 shillings being the price of 8 yards, and 30 the price of 20. The proportion is therefore *direct*. But if the question were to find in how many days 4 men will do a piece of work, supposing 6 men can do it in 10 days, the related numbers would be differently placed; for the answer being 15 days, the four numbers written as proportionals must stand thus, 4 : 6 : : 10 : 15; and as the numbers 4 and 15 are here the related numbers, or the antecedent of the first ratio is related to the consequent of the second, the proportion is *inverse*. This is also called *reciprocal* proportion; for if one of the ratios be formed of the reciprocals of the given numbers instead of the numbers themselves, the related numbers would stand as in direct proportion; thus, $\frac{1}{4} : \frac{1}{6} : : 10 : 15$; or $6 : 4 : : \frac{1}{10} : \frac{1}{15}$.

It is a property of proportional numbers, derived immediately from the definition, that the product of the first and fourth terms is equal to the product of the second and third. Hence, when three terms of a proportion are given, the fourth can be found. This is the object of all questions in the Rule of Three.

The preceding remarks apply exclusively to *geometrical* proportion; that is to say, when the proportion consists in the equality of ratios. Writers on arithmetic also mention *arithmetical* proportion, and *harmonical* proportion, for which see the respective terms.

Proportion. In the Fine Arts, the most proper relation of the measure of parts to each other and to the whole. The Greeks used the word συμμετρια (symmetry), to express this idea. In many instances, proportion may be considered almost synonymous with fitness, though there is a distinction between them; since every form susceptible of proportion may be considered either with respect to its whole as connected with the end designed, or with respect to the relation of the several parts to the end. In the first case, fitness is the thing considered; in the second, proportion. Fitness, therefore, expresses the general relation of means to an end, and proportion the proper relation of parts to an end. It is hence needless to dwell on the intimate connection that exists between beauty and proportion, in all complex forms. Payne Knight, *in his Inquiry into the Principles of Taste*, has asserted that in many productions of art "symmetry is the result of arbitrary connection." It would be very easy to show the absurdity of this assertion, if we considered it worth the space.

PROPORTIONAL COMPASSES. Compasses with two pairs of opposite legs, by which distances are enlarged or diminished in any proportion.

PROPORTIONAL SCALES. *See* Scales.

PROPORTIONALS. The terms of a proportion; of these the first and last are the *extremes*, and the intermediate the *means*, or the *mean* when the proportion consists of only three terms. *See* Proportion.

PROPORTIONS, DEFINITE. In Chemistry. *See* Affinity.

PROPOSI'TION, in Logic, is defined "a sentence indicative;" *i. e.* a sentence which affirms or denies. Thus, sentences in the form of command or question are excluded from the character of propositions. Logical propositions are said to be divided, first, according to substance, into categorical and hypothetical; secondly, according to quality, into affirmative and negative; thirdly, according to quantity, into universal and particular. 1. A categorical proposition is where the sentence affirms or denies absolutely, as "man is mortal." A hypothetical proposition is defined to be two or more categoricals united by a conjunction, as "if Caius is man, he is mortal." There are several sorts of hypothetical propositions; conditional, disjunctive, causal, &c. 2. An affirmative proposition is one whose copula (or conjunction) is affirmative, as "man is mortal;" a negative proposition has a negative copula, as "man is not immortal." 3. An universal proposition is when the predicate is said of the whole of the subject, as "all men are mortal," "Caius is mortal;" a particular, when it is said of part of the subject only, as "some men are rich." To these two species may be added the indefinite proposition, when the subject has no sign of universality or particularity, or is a singular noun, which is either universal or particular according to the matter. The matter of a proposition is said to be either necessary, impossible, or contingent; and if the matter of an indefinite proposition be either of the former, it is equivalent to an universal; if the last, to a particular: *e.g.* "birds fly," *i. e.* all birds — universal. "No birds are quadrupeds;" here the matter is impossible, and the proposition universal. "Birds sing," *i. e.* some birds — particular.

The fourfold division of propositions according to quality and quantity is denoted by arbitrary signs; *e.g.* A stands for an universal affirmative, in the logic used at Oxford; E for an universal negative; I for a particular affirmative; O for a particular negative.

A categorical proposition is composed of two terms united by a copula. (*See* Term, Copula.) The first term, *i. e.* that of which the other is affirmed or denied, is the subject; the other (that which is affirmed or denied respecting the first) the predicate. In the collocation of our language, the subject usually, but not invariably, precedes the predicate. Thus, "Diana of the Ephesians (subject) is great" (predicate), is transposed into "Great is Diana of the Ephesians." In some languages, as Greek and Latin, the latter form of collocation is not less natural or usual than the former. When the subject of a proposition is a common term (*see* Term) it is said to be "distributed," when the universal sign (all, no, every, &c.) is prefixed, and the proposition consequently universal. The predicate is said to be "distributed" in all negative and no affirmative propositions, inasmuch as a negative proposition denies that any part of the predicate agrees with the subject, whereas an affirmative can *never* assert that every part of the predicate agrees with the subject; *i. e.* can never do so necessarily, by the logical force of the proposition, although it may undoubtedly happen that the predicate agrees with the subject and with nothing else: *e. g.* "Cæsar was the first Roman emperor." Two propositions are said to be opposed, when, having the same subject or predicate, they differ in quantity, in quality, or in both. The two universals (A and E) are termed *contraries* to each other; the two particulars (I and O) *sub-contraries;* the universals and particulars (A and E, I and O) *subalterns;* A and O, or E and I (those which differ both in quantity and quality), *contradictories*. A proposition is said to be converted when its terms are transposed; *i. e.* when the subject is made the predicate, and the predicate the subject. *See* Conversion of Propositions.

Proposition. In Mathematics, a theorem proposed to be demonstrated, or a problem in which something is proposed to be done.

PROPRÆ'TOR. A Roman magistrate, bearing the same relation to the prætor that the proconsul did to the consul. (*See* Proconsul.) Under the emperors, proprætors, as distinguished from proconsuls, were appointed as governors to the imperial provinces, the latter being the servants of the senate.

PROPYLÆ'UM. (Gr. προπυλαιον.) In Ancient Architecture, the vestibule of a house. The vestibules or porticos at Athens, leading to the Acropolis, were thus denominated.

PRO RE NATA. (Lat. *according as occasion may require.*) A term commonly used in medical prescriptions.

PROROGA'TION. *See* Parliament.

PROSCE'NIUM. (Gr. προ, *before*, and σκηνη, *a scene.*) In Architecture, the frontispiece or part in a theatre where the drop scene separates the stage from the audience, and beyond the orchestra. In the ancient theatres it comprised the whole of the stage.

PROSCRI'PTION. (Lat. proscribere, *to proscribe, outlaw, or doom to death; to confiscate one's property.*) The most vindictive species of proscription was that introduced by Sylla when he wrested Rome from the hands of the Marian faction. It consisted in making out a list of persons supposed to be obnoxious to the state, and getting a sentence of condemnation passed against them, which made it unlawful to harbour a proscribed person. By these measures thousands of citizens perished in the civil wars of Rome. The most celebrated proscription was that of the triumvirs, Octavius, Antony, and Lepidus, in which Cicero was slain.

PROSE. (Lat. prorsa oratio; from prorsus, adv., *direct* or *straightforward.*) In Literature, all language not in verse. Prose diction, to be good, or even admissible, in ordinary criticism, must be conformable to the rules of composition as to style, cadence, &c.

PRO'SELYTE. (Gr. προσηλυτος, *one who arrives as a stranger.*) A term in use among the Jews after their connection with the Greeks, and applied to such foreigners as embraced their religion. These they divided, according to the common opinion, into two classes; distinguished by the terms proselytes of the gate, and proselytes of righteousness. Of these the former were such as merely renounced idolatry, and believed in and worshipped the true God, observing the precepts of the natural law, and, from being admitted within the first gate of the temple, received this appellation. The latter class were those who submitted to circumcision, and in every other respect conformed entirely to the customs of the Jewish people. Dr. Burton, however, it must be admitted, thinks this distinction unfounded. (*Lectures on the Eccl. History of the First Three Centuries*, l. iii.)

PRO'SENCHYMA. (Gr. προσεγχεω, *I pour still more upon.*) Cellular tissue, the cellules of which taper to each end, and consequently overlap each other at their extremities. It is the first approach on the part of cellular tissue to the condition of woody tissue.

PRO'SERPINE. The Latin form of Persephone, the

name of a Grecian goddess, sprung from Jupiter and Ceres. She was stolen from her mother by Pluto, who, enamoured of her beauty, carried her off from the plains of Enna in Sicily, while sporting with her companions, to the infernal regions, where she became his queen. The wanderings of Ceres in search of her daughter were much celebrated by the ancient poets. When she at last discovered the place of her concealment, a compromise was entered into, by which Proserpine was allowed to spend two thirds of the year with her parents and the rest with Pluto in his empire.

PRO'SODY. (Gr. προς, *to*, and ωδη, *song;* signifying, literally, a guide or assistance to versification.) The science which treats of quantity, accent, and the laws of harmony, both in metrical and prose composition. In the Greek and Latin languages every syllable had its determinate value or quantity, and verses were constructed by systems of recurring feet, each foot containing a definite number of syllables possessing a certain quantity and arrangement. (*See* FOOT.) The versification of modern European languages, in general, is constructed simply by accent and number of syllables. They have, therefore, no prosody strictly so called. The Germans, however, have laboured to subject their language to the ancient metrical system, but with indifferent success.

PROSOPO'GRAPHY. (Gr. προσωπον, *figure* or *person*, and γραφω, *I describe.*) In Rhetoric, a word used by some critical writers to signify the description of animated objects. Of this figure the portraits of the horse and the leviathan in the book of Job are well known and beautiful examples.

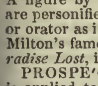
PROSOPOPŒ'IA. (Gr. προσωπον, and ποιεω, *I make.*) A figure by which inanimate objects, or abstract ideas, are personified, and addressed or represented by the poet or orator as if endowed with human shape or sentiments. Milton's famous digression of Sin and Death, in the *Paradise Lost*, is at once a prosopopœia, and an allegory.

PROSPE'CTUS (Lat.), in its most extended sense, is applied to the outline of any plan or proposal submitted for public approbation; but it is most usually confined to literary undertakings, in which it signifies an outline or sketch of the plan or design of a work, together with such other circumstances connected with the publication, &c., as it may be thought desirable to enlarge upon or make known.

PRO'STATE GLAND. In Comparative Anatomy, the prostate gland retains its single compact form in most of the Quadrumana; but is bifid in the Ruminantia; in the Rodentia and Insectivora it is resolved into numerous slender elongated cæcal tubes; in the mole it is remarkable for its periodical increase of size.

PRO'STATES. (Gr.) The name given to the guardians of the foreign settlers at Athens, whose business it was to represent them in courts of law, and protect them from injury.

PRO'STHAPHE'RESIS. (Gr. προσθεν, and αφαιρεσις, *subtraction.*) A term used by the older writers on astronomy to signify the difference between the true and mean motion, or the true and mean place of a planet, or the quantity which must be taken from or added to the mean anomaly, in order to get the true anomaly.



Let P (or P') be the place of a planet in its orbit, S the sun, C the centre, and A the perihelion of the orbit; the angle A S P is the true anomaly, A C P is the mean anomaly; and the difference between A S P and A C P is S P C, which is the prosthapheresis. If A C P be less than a right angle, S P C must be added to A C P in order to get the true anomaly; but if it be greater than a right angle, the angle S P C must be deducted. The angle S P C is called by modern writers the equation of the *centre*, or equation of the orbit.

PRO'STHESIS. (Gr. προς, and τιθημι, *I place.*) A figure of grammar by which one or more letters are added to the commencement of a word; as in the common English participles, *be*loved, *be*reft, &c. *See* METAPLASM.

PRO'STYLE, or PROSTYLOS. (Gr. προ, *before*, and στυλος, *a column.*) In Architecture, a temple or other building with columns in its front face.

PRO'TASIS. (Gr. προτασις, from προτεινω, *I stretch or put forth.*) In Grammar and Rhetoric, every properly constructed period (*see* PERIOD) is said to be naturally divisible into two parts; of which the first is termed protasis, the second apodosis. In the ancient drama, the protasis was the exposition, usually contained in the first part of the piece, either by way of soliloquy or dialogue, serving to make known the characters and the plot to the audience.

PROTEA'CEÆ. (Protea, one of the genera.) A natural order of arborescent, rigid, useless Exogens, inhabiting the hotter parts of the world, and found in dry, sterile, stony, exposed places, especially near to the sea coast. They are known from *Elæagnaceæ* by the woody texture of their leaves; by the irregular calyxes having a valvate æstivation, with the stamens placed upon the lobes; and by the dehiscent fruit. The genera *Banksia*, *Dryandra*, *Protea*, and *Grevillea*, are cultivated for the sake of their beautiful foliage and flowers. The seeds of *Gucvina* are sold in Chili for the same use as hazel nuts with us. One of the larger timber trees of New Zealand is the *Knightia excelsa*, a plant of this order.

PROTE'CTOR. In English History, a title which has been three times assumed by daring statesmen: — 1. Richard, duke of York, in 1453, was appointed by parliament protector during pleasure. 2. The duke of Somerset, being constituted one of Henry VIII.'s sixteen executors, obtained a patent from the young king, Edward VI., in 1548, constituting him protector, with the assistance of the other fifteen as councillors; but he only enjoyed this dignity a few months, and his loss of it was soon followed by his death. 3. Cromwell took the title of lord protector of the commonwealth of England, Scotland, and Ireland, on the 12th Dec. 1653, when the "Barebones Parliament" resigned its authority into his hand. His son Richard succeeded him in his title and authority, but was never formally installed protector.

PRO'TEST. In Parliamentary Law, is a privilege peculiar to the members of the upper house of parliament of entering (by leave of the house always presumed) their dissent from a motion or resolution agreed to by a majority of the house, together with their reasons for dissenting. The paper embodying these reasons of dissent is called a protest, and is entered on the journals. Protests, with the reasons, were first set down, according to Lord Clarendon, in 1641. *See* PARLIAMENT.

PRO'TESTANTS. A general name applied to the various denominations of Christians which have sprung from the adoption of the principles of the Reformation in the 16th century. The term was assumed, in the first instance, by the reformers of North Germany, who, in the year 1529, formally protested against a decree of the imperial diet held at Spires, which ordained that the question between the parties should remain unsettled, some restrictions being laid upon the progress of the new opinions, until the calling of a general council, the time of which was left uncertain. The Protestants accordingly asserted that the decree was unfavourable and unjust to their party, and claimed the immediate summons of a lawful council, which they knew it was the interest of the papacy, under the circumstances, to delay. In the early period of the Reformation, the principal reformed churches were two, those of the followers of Luther and of Calvin, the partisans of Zuingli having become nearly identified with the latter. Since that time the number of subdivisions upon every point of doctrine and discipline has been infinite. The general bond of union, however, among all, continues to this day to be the assertion of private judgment, and rejection of any infallible head of the church, or ultimate authority in pope or council. We believe, also, that no Protestant church has ever relapsed into any one of the prominent results of the Romish system — such as the doctrine of the seven sacraments, of transubstantiation, or of purgatory, the celibacy of the clergy, or veneration of images or relics.

There are, however, two lines of argument upon which these principles are maintained, the respective assumption of which seems to constitute the strongest line of distinction among Protestants. The first is that to which the German and Swiss reformers most generally leaned, which considers the Bible to contain within itself so complete a repository of divine truths as to be its own interpreter, as well as the evidence of its own authenticity and inspiration. The English reformers, on the other hand, endeavoured to base their doctrines upon the practice of the first three centuries, and appealed therein to similar principles with the Roman church, which they maintained to be corrupt, not in its origin, but in its growth.

PRO'TEUS. A marine deity of the Greeks, celebrated for his gift of divination, and the power of changing his form, by which means he eluded those who resorted to him for information.

PRO'TEUS. In Zoology, this name was originally and very aptly applied to a genus of Infusories, which, during life, never for a single minute maintain the same form; this peculiarity is strikingly manifested, as in the common species called *Proteus diffluens*. The term was subsequently used by Laurenti to designate a singular amphibious reptile, peculiar to certain subterranean waters in Carniola, and which, like the American siren, retains the external gills, together with internal lungs or air-bags throughout life.

PROTHO'NOTARY. (Lat. proto-notarius, or *first notary.*) A title originally of the Byzantine empire. The Apostolical prothonotaries of the Papal court are officers having precedence of the other notaries or secretaries of the Roman chancery; the papal "notaries participant" rank after bishops, but before abbots. In England, officers in the courts of King's Bench and Common Pleas had this title, until the recent changes in those courts.

PROTHO'RAX. (Gr. προ, *before*, and θωραξ, *a shield.*)

In Entomology, signifies the first segment of the thorax in insects; by Kirby the term is restricted to the upper part only, or shield of that segment.

PROTHY'RIDES. (Gr. προ, and θυρα, *a door.*) *See* ANCONES.

PRO'THYRUM. (Gr. προ, and θυρα.) In Architecture, a porch before the outer door of a house.

PRO'TOCOL. (From the Latin protocollum: a word derived from the Greek πρωτος, *first*, and κολλα, *glue;* but the etymological signification attached to this derivation seems unknown.) The word protocol, in the French language, signifies the formulæ or technical words of legal instruments; in Germany, it has been used to denote the minutes or rough draught of an instrument or transaction. It is in the latter sense that the word has been borrowed by diplomacy, in which it signifies the original copy of any dispatch, treaty, or other document.

PRO'TOTYPE. (Gr. πρωτος, *first*, and τυπος, *a mark.*) In the Fine Arts, the original pattern or model of a thing whereon are founded principles of imitation.

PROTOZO'A. (Gr. πρωτος, and ζωον, *animal.*) A name synonymous with acrita and oozoa, and applied to the simplest animals, or those which stand, as it were, on the first step of organization.

PROTRA'CTOR. A mathematical instrument for laying down angles on paper, used in surveying, plotting, &c.

In its simplest form, the protractor consists merely of a semicircular limb of metal, divided into 180°, and subtended by a diameter, in the middle of which is a notch to mark the position of the centre. On placing this notch over the angular point, and laying the diameter along a given straight line, an angle of any number of degrees may be made by marking the point on the paper which coincides with the given degree on the limb, and joining this point with the centre, when the instrument is removed. The protractor is rendered more commodious by transferring the divisions to the edge of a parallel ruler.

When a survey is to be plotted on a large scale, and it becomes necessary, in consequence, to lay down the angles with considerable precision, a more complex apparatus is required. The most approved form of the protractor may be described as follows: — It consists of an entire circle, connected with its centre by four radial bars. The centre of the metal is removed, and a circular disk of glass fixed in its place, on which are drawn two lines crossing each other at right angles, the point of intersection denoting the centre of the protractor. Round the centre, and concentric with the circle, is fitted a collar carrying two arms, one of which has a vernier at its extremity adapted to the divided circle; and the other a milled head, which turns a pinion working in a toothed rack round the exterior edge of the instrument. The rack and pinion give motion to the arms, which can thus be turned quite round the circle, and set the vernier to any angle that may be required. Each of the two arms is prolonged beyond the edge of the protractor, and carries a fine steel pricker, which is pressed down when the instrument is placed in its required position, and makes a small puncture in the paper. It is essential that the points of the two prickers, and the centre of the instrument, be accurately in the same straight line. (*Simms on Mathematical Instruments.*)

In Anatomy, the muscles which draw forwards a part are termed *protractors.*

PRO'VERB. (Lat. proverbium.) A familiar saying, which has been variously defined. In point of form, there are two species of proverbs; one containing a maxim directly expressed in a concise and familiar style; the other, in which a maxim is expressed metaphorically, *e.g.* "honesty is the best policy," or, rather, allegorically, *e.g.* "strike, while the iron is hot." In point of substance, proverbs are for the most part rules of moral, or, still more properly, of prudential, conduct.

In dramatic literature, chiefly French, the term has been applied to short pieces, in which some proverb or popular saying is taken as the foundation of the plot. They originated in the fondness of the higher classes of France for private theatricals, which became a sort of passion about the middle of the last century. Carmantelli was the most successful writer of proverbs at the time of their highest popularity. Those of M. Theodore Leclercq, at the present time, have met with considerable success.

PROVERBS, THE, OF SOLOMON. One of the canonical books of the Old Testament. According to the arrangement in its present shape, the first nine books form a species of introduction; those from the tenth to the twenty-fourth contain the proverbs of Solomon, properly so called; and the remainder furnishes a kind of appendix; including the thirtieth and thirty-first, which contain the proverbs of Agur, the son of Jakeh, and of king Lemuel.

PROVI'NCIA. Those countries were called by the Romans provinces which, having been reduced under their power, were subjected to government by magistrates sent from Rome. The laws of a province were generally settled by ten commissioners, dispatched from Rome in conjunction with the victorious general. In its modern acceptation, province signifies a grand division of a kingdom or state, comprising several cities, towns, &c. all under the same government, and usually distinguished by the extent either of the civil or ecclesiastical jurisdiction.

PROVI'SIONS, in the Navy, daily, 1 lb. of biscuit, 1 oz. of cocoa, ¼ oz. of tea, ½ of an imperial pint of spirits, or 1 imperial pint of wine, ¾ lb. of beef with ¾ lb. of flour, and ¾ lb. of pork with ½ a pint of peas on alternate days, or 1 lb. of fresh meat with 9 oz. of vegetables. Part of the flour may be exchanged for suet, currants and raisins; 1 pint of oatmeal, and 10 oz. of sugar a week. After ten days of salt provisions, an allowance of lemonade.

PROVI'SO. In Law, a condition inserted in a deed on which its validity depends, commencing usually with the words "provided that;" as also in acts of parliament.

PROVI'SOR. The title, in the ancient French Universities, of an officer charged with the management of their external affairs, both spiritual and temporal, and to a certain extent with their discipline also. The provisor of the Sorbonne was an officer of high importance among the clergy. The principals of Napoleon's lyceum had the title of provisors, and the modern royal colleges retain it for the same functionary.

PRO'VOST (contracted from Lat. præpositus, *placed over.*) The title of the chief municipal magistrates of Scotland, equivalent to mayor in England. The chief magistrates of Edinburgh and Glasgow are styled *Lord Provost.*

PROVOST OF A UNIVERSITY. See UNIVERSITY.

PRO'XENE. (Gr. προξενος.) In Grecian Antiquities, officers at Sparta who had the charge of superintending strangers. (Herodot. vi.) In the flourishing time of the Grecian republics, wealthy and distinguished men of particular states seem to have accounted it an honour to act as protectors of the citizens of foreign commonwealths: thus, Alcibiades was *proxenus* of the Spartans at Athens.

PRO'XIMATE PRINCIPLES. Distinct compounds which exist ready formed in animals and vegetables, such as albumen, gelatine, fat, &c., in the former; and sugar, gum, starch, resins, &c., in the latter, which are so called, without reference to their ultimate composition.

PRO'XY. (Lat. proximus.) In Parliamentary Law, every peer, spiritual or temporal, can (by license, supposed to be obtained from the king) constitute another lord of parliament, of the same order with himself, his proxy, to vote for him in his absence. Proxies cannot be used when the house is in committee, nor can a proxy sign a protest. By an order of 2 C. 2., no peer can hold more than two proxies. *See* PARLIAMENT.

PRUD'HO'MME. (Lat. homo prudens.) In France, during the middle ages, municipal tribunals composed of citizens exercising a sort of conciliatory or equitable jurisdiction, as arbiters of disputes, inspectors of police, &c., were termed councils of *prud'hommes.* In 1806, a court of this denomination was re-established at Lyons by a law of Napoleon; its principal office is the decision of disputes between masters and workmen in the silk manufacture.

PRU'NING. The art of cutting off parts of plants, and more especially of trees and shrubs, with a view to strengthening those which remain, or of bringing the tree or plant into particular forms, calculated to increase particular products. Pruning therefore varies according to the kind of plant or tree to be pruned, and according to the object in view. In the case of forest trees, the general object of pruning is to increase the quantity of timber in the trunk by diminishing the side branches, commencing at the lower part of the tree when it is quite young, and gradually advancing upwards as the tree increases in growth. In the case of hedges, the object is to produce a dense mass from the ground upwards, which is effected by shortening the side branches. In the case of pruning trees which are cultivated for the sake of their fruit or blossoms, the object is to thin out the branches so as to admit the light and air more freely to their leaves and blossoms, and to concentrate and increase the nourishment to the branches which remain. In the case of trees, or shrubs cultivated for the beauty of their shapes, whether natural or artificial, the object of pruning is to deprive the trees or shrubs of all those branches which deviate from or interfere with the natural shape, or with the form which is intended to be produced by art. In pruning with a view to produce fruit, it is necessary to know on what description of branches and buds the fruit is produced In some trees, as in the peach, it is generally produced on the wood of the preceding year; in others, as in the apple and pear, it is generally produced on wood of two years' growth; and in the vine it is produced on shoots of the current year. The general effect of pruning on plants is to increase their longevity; since the tendency of all vegetables is to ex-

haust themselves, and, consequently, to shorten their duration, by the production of seeds. In the operation of pruning, the shoots are cut off close to the buds, or at a distance from them not greater than the diameter of the branch to be cut off; because, without the near proximity of a bud, the wounds will not heal over. In shoots which produce their buds alternately, the cut is made at the back of the bud, sloping from it, so as that it may be readily covered by bark in the same or in the following year. This is readily done with a pruning knife, by a slanting cut, made at an angle of 45° with the direction of the branch; but, in the case of branches where the buds are produced opposite each other, either one bud must be sacrificed, or the branch must be cut off at right angles to its line of direction; and this is more conveniently done by the pruning shears. The operation of pruning may in many cases be superseded by rubbing off, or pinching out, the leaf-buds, so as to prevent superfluous shoots from being produced.

PRU'NING KNIFE. A knife the blade of which has a straight edge, formed of well tempered steel, and of no great breadth, with a narrow point, in order that it may be more readily introduced among crowded branches. Formerly, pruning knives were hooked at the point; but the cuts made by such knives had a tendency to crush the shoot, and leave a rough section, more readily injured by the air and water, and less likely to be speedily healed over. Such knives, when of a large size, were called pruning hooks.

PRU'NING SHEARS. Shears in which one of the blades moves on a pivot which works in an oblong opening, instead of a circular one, by which means a draw cut is produced similar to that effected by a knife, instead of the crushing cut produced by common shears, which fractures the section left on the branch, and renders it liable to become diseased or to decay, instead of being covered over with fresh bark. Pruning shears are particularly adapted for cutting spiny or prickly shrubs, such as the different species of thorns, gooseberries, or roses.

PRURI'GO. (Lat. prurio, *I itch.*) An itching of the skin with the eruption of small pimples. The term is also medically applied to irritation of various parts of the body from other causes, as from vermin, worms, &c.

PRU'SSIAN BLUE. This beautiful dark blue pigment was accidentally discovered in 1710 by Diesbach, a chemist of Berlin. The process for its preparation was first published in the *Philosophical Transactions* for 1724, by Dr. Woodward. It is made by adding solution of *ferrocyanuret of potassium* to persulphate of iron. The ferrocyanuret of potassium is prepared by gently igniting carbonate of potassa with animal matters, such as horns, hoofs, or dried blood, in iron vessels, by which cyanuret of potassium and some cyanuret of iron are formed; the soluble parts are then washed out with water, and sulphate of iron added until the Prussian blue which is formed ceases to be decomposed by the free potassa contained in the solution; the ferrocyanuret of potassium is then set to crystallize, and separated by repeated crystallization from sulphate of potassa. It is thus obtained in truncated octoedral crystals of a yellow colour, commonly called *Prussiate of potash*. It is much used as a test of the presence of metals, and especially of iron, the peroxide of which it throws down from its solutions in the state of Prussian blue. This compound has generally been considered as a ferrocyanate of the peroxide of iron; but, according to Berzelius, it is a double cyanuret; that is, a ferrocyanuret of the sesquicyanuret of iron. Ferrocyanuret of potassium (prussiate of potash) is composed of 2 atoms of cyanuret of potassium $(66 \times 2) = 132$, and 1 atom of cyanuret of iron $(28 + 26) = 54$, and has, therefore, the equivalent $(132 + 54) = 186$.

PRU'SSIC ACID. The composition and chemical characters of this acid are given under the head of *hydrocyanic acid.* Prussic acid is frequently used medicinally as a powerful sedative and anti-irritant, especially to allay cough in phthysis, and to mitigate the spasmodic action in whooping-cough; but from its poisonous nature it requires to be employed with much caution. The antidotes for prussic acid, where it has been taken as a poison, are solution of chlorine, by which it is chemically decomposed; and ammonia, which combines with it, and acts as a stimulant.

PRY'TANES. (Gr. πρυτάνεις.) The Athenian senate consisted of 500 persons, elected fifty from each of the ten tribes; each of these fifties took it by turn to preside with the title of Prytanes, having one tenth of the year assigned to it; or, more accurately speaking, 34 days were allotted to each of the first four tribes, and 35 to the last six; the Attic year consisting of 354 days. Each fifty was again subdivided into five bodies of ten, which, when prytanes, took it by turns to perform the duties of prohedri (προεδροι), seven days being allotted each. From these prohedri, again, was chosen by lot an epistates (επιστατης) or president, whose office lasted one day.

PSALM. (Gr. ψαλμος, from ψαλλω, *I sing.*) A sacred song or hymn, originally accompanied with music. The book of Psalms is called, in the Hebrew, *Thehillim* (*praises*), in conformity with the general object of the collection. It seems to have been an article of faith, with most of the early fathers, that the Psalms were all of them composed by David; a strange notion, which the internal evidence of several immediately refutes. The Jews divide them into 5 books, ending with the 40th, 71st, 88th, 105th, and last, respectively. They, as well as all Christians, retain the number 150; but the divisions have varied. There is an apocryphal 151st added in some Greek versions. The 119th and following psalms to the 134th, called by some "gradual psalms," or "psalms of the stairs," a term of which various explanations have been given, are thought by Calmet and others to have been composed on the occasion of the deliverance from Babylon; possibly by Esdras, who is considered as the first collector of the Psalms; but they were at least partially used before, as early as the reign of Hezekiah.

PSA'LMODY. A general term applied to the whole subject of psalm-singing, &c.

PSA'LTER. A book of devotion containing the psalms. See *Palmer's Origines Liturgicæ*, vol. i. p. 207.

PSALTE'RIUM. (Lat. *a psalter or psalm-book.*) The name of the manyplies or third cavity of the complex stomach of the ruminant quadrupeds, so called because it is occupied by numerous broad folds of membrane resembling the leaves of a book.

PSA'LTERY. A stringed instrument in use among the ancient Jews, by whom it was called *nablum* (which see). It resembled, according to Burney, partly the lyre and partly the harp.

PSE'PHOI. (Gr.) A general name given to several things made use of by the Greeks in giving their suffrages, and in their computations, as small stones, shells, beans, &c. They were synonymous with the *calculi* and *tabellæ* of the Romans, which see.

PSEUDEPI'GRAPHY. (Gr. ψευδης, *false;* and επιγραφή, *inscription.*) The ascription of false names of authors to works. This was carried to a great extent among the Christians of the fourth and following centuries. Thus, the verses known by the name of Sibylline are evident Christian forgeries; and it is extremely difficult to distinguish the spurious works of the Fathers from the true. (See Gieseler, *Text-book of Eccl. Hist.*, 1st period, chap. 3. sec. 52. for a good section on Christian pseudepigraphy; *Fabricii Codex Pseudepigraphus;* Barbier, *Dict. des Ouvrages Anonymes et Pseudonymes*, contains a notice of most works falsely ascribed to their alleged authors in the French language.)

PSEU'DOBLEPSIS. (Gr. ψευδης, and βλεψις, *sight.*) There are various forms of false vision, some apparently dependent upon nervous irritation, others upon organic derangement Specks, network, colours, and imaginary bodies floating or dancing before the eyes, distorted vision, double vision, are among the most common modifications of this complaint. They occur in plethoric as well as in debilitated habits, and are the consequence occasionally of intense study, of weakening evacuations, of debauchery, of hysteria, and of hypochondriasis; the treatment, therefore, which is required is very various. Attention to the stomach and bowels, local bleeding, camphor, ether, and other nervine stimulants, change of scene and occupation, varied exercise, are among the efficient remedies. A very alarming case of double vision, with coloured circles in rapid motion dancing before the eyes, of two years' continuance, and brought on by too intense application of study, gave way to cupping and to a journey to the Highlands.

PSEU'DO BULB. In Botany, an enlarged aerial stem, resembling a tuber, from which it scarcely differs, except in being formed above ground, in the epidermis, being often extremely hard, and in retaining upon its surface the scars of leaves that it once bore.

PSEUDODIP'TERAL. (Gr. ψευδης, *false,* δις, *twice,* and πτερον, *a wing.*) In Architecture, a term denoting a building or temple wherein the distance from each side of the cell to the columns on the flanks is equal to two intercolumniations; the intermediate range of columns which would stand between the outer range and the cell being omitted.

PSEUDOISODO'MUM. (Gr. ψευδης, ισος, *equal,* and δομος, *a house.*) In Ancient Architecture, a species of masonry in which the height, thickness, and length of the courses are different. *See* ISODOMUM.

PSEU'DOPODS, *Pseudopoda.* (Gr. ψευδης, and πους, *foot.*) A name applied to a tribe of Polygastric Infusories, including those in which the body, by various contractions and changes of form, produces pediform processes.

PSEUDOSCO'RPIONS, *Pseudo-scorpiones.* A family of Arachnidans, including those with an oblong body divided into several segments, with two or four eyes, and six or eight legs, as the book-crabs (*Chelifer*).

PSEUDO'THYRON. (Gr. ψευδης, and θυρα, *a door.*) In Architecture, a false door.

PSI'TTACINES, *Psittacini.* (Parrot tribe) The name of a tribe of Scansorial birds, of which the genus *Psittacus* is the type.

PSO'AS MUSCLE. (Gr. ψοαι, *the loins.*) A large muscle upon the fore part and sides of the lumbar vertebræ. It bends the thigh forwards, and assists in turning it outwards.

PSO'PHIA. (Gr. ψοφεω, *I make a noise.*) A subgenus of storks, having a shorter bill than the rest, with the head and neck covered only with a kind of down, and the circumference of the eye naked. They frequent wooded regions, and subsist on grains and fruits. The best known species (*Psophia crepitans*) is a native of South America, and is remarkable for the ambiguous sound which it emits from time to time, and whence its specific name is derived. This bird is easily tamed by the Spanish settlers in South America, and is even taught by them to guide and defend the common poultry from the rapacious birds, as a shepherd's dog guards his sheep from the wolves.

PSO'RA. (Gr.) The itch. *See* ITCH.

PSORIA'SIS. A rough scaly state of cuticle, sometimes continuous and sometimes in patches, generally accompanied by chaps or fissures.

PSY'CHE. (Gr.) In Mythology, a nymph whom Cupid married, after she had been persecuted by Venus. The word signifies the soul, of which Psyche was considered the personification. This beautiful allegory is first known to us by the romance of Apuleius: but it is presumed to be of much earlier origin from its occurrence in relics of art. Lafontaine made it the subject of a pastoral, and Mrs. Tighe recently of a poem.

PSYCHO'LOGY. (Gr. ψυχὴ, *the soul*, and λόγος, *discourse.*) In its larger acceptation, may be taken as synonymous with mental philosophy. The word is more frequently used in reference to the lower faculties of the mind, and the classification of the phenomena which they present. All psychology is built on experience, either immediate, or revived by the memory and imagination. But, in reflecting on our intellectual faculties, we discover in them certain laws, which, as soon as they are presented to us, we at once recognise as universal and necessary; certain conditions without the fulfilment of which we are sensible that no act of intellection could have taken place. This universality is something very different from the empirical truth, as a matter of fact, which we attribute to the laws of association, which are, indeed, universal, but which might, for aught we can see, have been different from what they are. Corresponding to this distinction, German writers have discriminated between a higher, or rational, and a lower, or empirical psychology: the first, that of Kant, who sought, in all our mental faculties, to determine that only which is necessary and immutable; the second, that of Hartley, who treats all our intellectual acts as alike objects of mere history, dependent for their validity only on the fact that they do really recur in such and such order. The psychology of Aristotle was of the latter description. He, consequently, regarded the science as forming one of the physical sciences, or those which are conversant with the contingent and changeable. Many pregnant psychological truths are discoverable in that philosopher's work on the soul; in particular, the doctrine of association, the master-light of all sound experimental psychology, owes its first enunciation to him. Among later writers who have made valuable contributions to the science may be enumerated Hobbes, Locke, Hartley, and Sir Thomas Brown. The value of these authors' writings in this peculiar province cannot be too highly appreciated. It is only when psychology intrudes upon the domain, or usurps the attributes, of the higher philosophy, that its claims need to be resisted. As a preparation for metaphysical and theological thought, and, indeed, as an indispensable requisite for the science of man, whether history, politics, or ethics, it is not easy to exaggerate its importance.

PSYCHOMA'NCY. (Gr. ψυχη, and μαντεια, *prophecy.*) A species of divination, in which the dead were supposed to appear as spirits, to communicate the wished for information.

PSYCHRO'METER. (Gr. ψυχρος, *cool*; μετρον, *measure.*) An instrument invented by Professor August of Berlin, for measuring the tension of the aqueous vapour contained in the atmosphere. It consists of two very sensible thermometers, one of which, when an observation is to be made, has its bulb kept moistened, but so that no drop of water remains suspended from it. The thermometers being then freely exposed to the air, the temperature indicated by each is observed, and also the height of the barometer, from which data the tension of the vapour is computed by means of this formula:—

$$e = e' - 0{\cdot}00081482\,(t - t')\,b\,;$$

where b is the height of the barometer (in Paris lines), t the temperature of the air (in centesimal degrees), t' the temperature of the wet bulb, e' the tension of vapour corresponding to the temperature t', and e the tension of the vapour actually contained in the air. The instrument is described in the work of August, *Sur les Progrès de l'Hygrométrie dans les Derniers Temps*, Berlin, 1830; also in the *Lehrbuch der Meteorologie* of Kœmptz; and *Quetelet's Correspondence Mathématique et Physique*, 3me série, tome 2.

PTERODA'CTYLE, *Pterodactylus.* (Gr. πτερον, *a wing*, δακτυλος, *a digit.*) The name of a genus of extinct reptiles, in which the second digit of the hand is of extreme length, and is considered to have supported an aliform expansion of the skin.

PTE'ROPODS, *Pteropoda.* (Gr. πτερον, and πους, *a foot.*) The name of a class of Mollusks, comprehending those which have a natatory wing-shaped expansion on each side of the head and neck.

PTERY'GIANS. *Pterygia.* (Gr. πτερυξ, *a wing.*) A name applied by Latreille to a group of Mollusks, corresponding to the Cephalopods and Pteropods of Cuvier, both of which have locomotive organs, composed of wing-like expansions of the skin.

PTERY'GODA. (Gr. πτερυξ.) Latreille has given this term to two small, hard, moveable bodies, in the form of little elytra, directed backwards, and terminating at the origin of the wings. They arise from the two sides of the anterior extremity of the trunk, near the exterior base of the two first legs, instead of from the second segment of the trunk, like true elytra. They are present in Lepidopterous and Strepsipterous insects.

PTERY'GOID. (Gr. πτερυξ, and ειδος, *form.*) Wing-shaped. The name is applied to processes of the sphenoid bone, which complete the osseous palate behind, and form distinct bones in the oviparous vertebrate animals.

PTI'SAN. (Gr. πτισσω, *I bruise.*) A weak diluent drink.

PTOLEMAIC SYSTEM. *See* ASTRONOMY.

PTOLEMA'ITES. A sect of ancient heretics among the Gnostics, who maintained that the Mosaic Law came partly from God, partly from Moses, and partly from the traditions of the Jewish doctors. (See *Mosheim's Church History.*)

PTY'ALISM. (Gr. πτυαλιζω, *I spit.*) An increased flow of saliva. Salivation.

PUBE'SCENT. (Lat. pubescens, *hairy.*) In Zoology, when a part or whole is covered with very fine recumbent short hairs.

PU'BLICANS. (Lat. publicani.) The farmers of the public revenue of Rome. They formed two distinct classes; the farmers-general of the revenues, who were regarded as belonging to one of the most honourable grades of citizens, and deputies or under publicans of an inferior caste, whose reputation was on a par with that of the most degraded citizens. Hence, in the New Testament, the τελωναι, a word rendered publicans by the Latin translators, are almost always placed in juxtaposition with sinners. (See *Milman's Hist. of Christianity.*) This term was also applied as a nickname to the Albigenses, which see.

PUBLIC SAFETY, COMMITTEE OF. (French Revolution.) This famous body was formed out of the convention, April 6. 1793, and invested with very general powers to provide for the supposed welfare of the state; even the power of arrest and imprisonment was soon conferred upon it. After the downfall of the Girondist party (*see* GIRONDISTES), this committee became the virtual government of France, by a decree of Dec. 4. 1793. Its members were, at this period, elected every month, but in general the same were re-elected. From this period its history is, in effect, that of the revolution. It appointed tribunals, composed of committees, invested with sovereign power to try offences against the state, over the whole country. It was in the committee of public safety that the opposition to Robespierre originated; but, on the overthrow of that personage, its powers were limited by the convention; and, on the introduction of the new constitutiton of October, 1794, it became extinct along with the assembly out of which it had been formed.

PUCK. In Mediæval Mythology, the "merry wanderer of the night," whose character and attributes are so beautifully depicted in the *Midsummer Night's Dream.* This celebrated fairy is known by a variety of names; as *Robin good-fellow* and *Friar Rush* in England; and in Germany, as *Knecht Ruprecht;* but it is by his designation of Puck, that he is most generally known both in England, Germany, and the more northern nations. He was the chief of the domestic tribe of fairies, or *brownies*, as they are called in Scotland; and innumerable stories are told of his nocturnal exploits, among which, drawing the wine, and cleaning the kitchen while the family were asleep, are the most prominent. The word is probably derived from the old Scandinavian pûki, *a boy;* it is also synonymous with pug, or monkey, whose form this fairy is said to have most frequently assumed.

PU'DDING-STONE. A conglomerate of rounded pebbles cemented together by a fine-grained and generally silicious or sandy paste. When select specimens are cut and polished, they resemble a section of a plum-pudding, and are often used for ornamental purposes, such as snuff-boxes and slabs.

PUE'RPERAL FEVER. A fever attended by peritoneal inflammation, which comes on about the third day

after delivery. The usual febrile symptoms are attended with great tenseness and tenderness of the abdomen; the milk disappears, and the bowels are usually affected by diarrhœa. It is most common in the autumn, and appears to be contagious. It is an alarming disease, and requires great promptitude and judgment in its treatment. Bleeding, modified according to the circumstances of the case, purging with calomel, saline sudorifics, and occasionally opium, to quiet pain and induce rest, are among the remedial means; but it often happens that great irritability of the stomach and bowels, or even incessant purging and vomiting, are predominant symptoms, and the fever assumes a typhoid character, in which case the system requires support from cordials.

PU'GGING. In Architecture, the stuff made of plaster laid on the sounding boarding under the boards of a floor, to deaden the sound between one story and another.

PU'GIL. (Lat. pugillus.) A quantity of any thing which may be taken up between the thumb and two fingers.

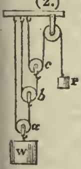
PUISNE JUDGE. (Norm. Fr. puisné, *younger*.) The judges and barons of the King's Bench, Common Pleas, and Exchequer, with the exception of the chief justices and chief baron, are so called.

PU'LLEY. In Mechanics, one of the six simple machines, or mechanical powers. It consists of a wheel, moveable about an axis, and having a groove cut in its circumference, over which a cord passes. The axle is supported by a box or sheave, called the *block*, which may either be moveable, or fixed to a firm support.

(1.)

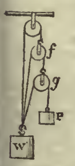
A single pulley serves merely to change the direction of motion; but several of them may be combined in various ways, by which a mechanical advantage or *purchase* is gained, greater or less, according to their number and the mode of combination. The purchase gained by any combination is readily computed by comparing the celerity of the weight raised with that of the moving power, according to the principle of virtual velocities, which is alike applicable to all machines of whatever kind. In fig. 1., which represents a system where the several portions of the cord are parallel to each other, suppose the weight W to rise 1 inch, the two blocks would approach each other by that quantity, and, consequently, the length of cord connecting a single pair of pulleys would be shortened by 2 inches, so that the power P would descend 2 inches. Let the number of pulleys in each block be n; then, while the weight ascends 1 inch, the power descends $2n$ inches, and, consequently, when there is equilibrium, the power is to the weight as 1 to $2n$.

(2.)



In the combination represented in fig. 2., the purchase is much greater. Here the pulleys are all moveable, and each is supported by a separate cord, having one end fastened to a fixed obstacle and the other attached to the succeeding pulley, excepting the upper block which is fixed. It is evident that, for every inch the weight on the first pulley a ascends, the second, b, ascends two; the third, c, ascends four, and so on; the velocity being doubled by each additional pulley. The purchase finally obtained is, therefore, $= 2^n$; or the power is to the weight as $1 : 2^n$.

The third combination, fig. 3., has still greater efficacy.



In this system, each cord is fastened to the weight, and, passing over a pulley, is attached to another pulley, excepting the last, which supports the power. While the weight W rises 1 inch, the first moveable pulley, f, will sink 1 inch, which allows the cord applied to it to slacken 2 inches, and this joined to the inch which the weight ascends allows the second moveable pulley, g, to descend 3 inches. This allows the next pulley in succession to descend 6 inches, which, joined to the 1 inch which the weight ascends, gives 7 inches for the descent of the third pulley. In like manner, it is found that the descent of the fourth pulley is 15 inches. Hence, one moveable pulley allows the weight to descend $2 \times 1 + 1 = 3$ inches; two such pulleys, $2 \times 3 + 1 = 7$ inches; 3 pulleys, $2 \times 7 + 1 = 15$ inches; four pulleys, $2 \times 15 + 1 = 31$ inches; and so on; so that the purchase obtained by n moveable pulleys is $2^{n+1} - 1$, or the power is to the weight as 1 to $2^{n+1} - 1$. The theoretical advantage thus computed is, however, in all the cases, greatly diminished by friction, and the rigidity of the rope.

The two last combinations are of little, if any, use in practice, but various modifications of the first are common. *Smeaton's pully*, or *Smeaton's tack*, as it is usually called, contains two rows of wheels, one under the other, in each block, and a single cord is made to pass over them in such a manner that the power and the weight both act in the same line with the centres of the two blocks, so that there is no tendency to twist. But this ingenious arrangement is open to several objections, and particularly the great amount of lateral friction of so many independent wheels. In White's pulley (see *fig.* 1.), the wheels in each block turn on the same axis, and consequently revolve in the same time; and they are of different sizes, their dimensions being so proportioned that a point on the circumference of any wheel moves with the velocity of the rope on that wheel. To effect this the diameter of the wheels in the upper block must be as the numbers 1, 3, 5, &c., and in the lower as 2, 4, 6, &c. Instead of separate wheels, the upper and lower blocks are cut in grooves in the above proportions, whereby the friction is reduced to that of one wheel in each block.

PU'LMOGRADES, *Pulmograda*. (Lat. pulmo, *a lung*, gradior, *I advance*.) The name of a tribe of Acalephans, including those gelatinous species which swim by the contraction of the vascular margin of the disk-shaped body, where respiration, also, probably takes place.

PU'LMONARIES, *Pulmonaria*. The name of the order of Arachnidans, including those which breathe by means of pulmonary sacs or lungs.

PU'LMONATES, *Pulmonata*. The name of an order of Gastropodous Mollusks, including those which breathe air, to which the blood is exposed while circulating through a vascular network which lines the internal surface of the bronchial cavity.

The order is subdivided into the *Pulmonata terrestria*, comprehending the Linnæan genera *Limax* and *Helix*, with *Clausilia*, Drap., and *Achatina*, Lam.; and the *Pulmonata aquatica*, comprehending the genera *Onchidium*, Buchanan; *Planorbis*, Cuv.; *Lymnæa*, Lam.; *Physa*, Drap.; *Auricula*, Lam.; *Conovulus*, Lam.

PU'LPIT. (Lat. pulpitum.) In Architecture, the raised part in a public building from which an oration is delivered. In the ancient theatre it was the higher part of the stage whereon the musicians stood.

PULSE. (Lat. pulsus.) The pulsation of the arteries, depending upon the impulse given to the blood by the action of the heart. (*See* HEART.) The pulse is usually felt by pressing the *radial artery* at the wrist, and the rapidity, regularity, and force of the circulation is thus judged of, and furnishes an important criterion of the phenomena and progress of disease. The range of the pulse as to *frequency*, in a healthy adult, is usually between 60 and 80, but there are persons whose pulses rarely beat 60 times in a minute, and others, not out of health, in whom the frequency exceeds 80; the pulse, in short, is extremely capricious, and before any correct inferences can be drawn from it, the peculiarities of each individual require to be carefully considered; slight mental affections, indigestion, irritability, and many other causes producing modifications of the pulse, do not admit of any general description. The terms *hard*, *full*, *soft*, and *wiry* pulse, are used to indicate other obvious modifications independent of the number of pulsations. The average rate of the pulse of a healthy infant is, for the first year, from about 120 to 108; for the second year, from 108 to 90; for the third, from 100 to 80; from the seventh to the twelfth year, the pulsations are about 70. When the pulse exceeds 140 beats in a minute it is not easy to count it precisely, and to this it attains in some febrile diseases.

An *intermitting pulse* is by no means uncommon, and often produced by trivial causes: with many persons in perfect health the pulse will be subject to very extraordinary irregularities; and there are cases on record in which a person's pulse which has always intermitted in a state of health has acquired regularity on the accession of disease. The state of the digestive organs has often a marked influence upon this condition of the pulse.

PULSE. Leguminous plants cultivated for their pods or seeds, such as the pea, bean, kidney-bean, &c.

PULVI'LLI, in Entomology, are the cushions of short hairs very closely set, or a membrane capable of being inflated, or very soft and concave plates, which cover the underside, or their apex, of the four first joints of the manus or tarsus, and sometimes even of the ends of the moveable spines situated at the apex of the *tibia*, which act so as to produce a vacuum, and enable the insect to suspend itself, or walk against gravity.

PU'LVINATED. (Lat. pulvinar, *a pillow*.) In Architecture, a term used to express a swelling in any portion of an order, such, for instance, as that of the frieze in the modern Ionic order.

PU'MICE. (Lat. pumex.) A porous volcanic product, consisting chiefly of silica and alumina, with traces of potash, soda, and oxide of iron.

PUMP. A machine for raising water. Though the forms under which this useful engine is constructed, and the mode in which the power is applied, may be modified

in an infinite number of ways, there are only three which can be considered as differing from each other in principle. These are, the *sucking pump*, the *forcing pump*, and the *lifting pump*, so called from the manner in which they act

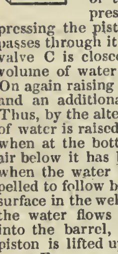
The *sucking pump*, or common household pump, is an apparatus of which the principle and construction will be evident from the annexed figure. A A is a pipe of any convenient length, the lower end of which reaches below the surface of the water in the well or reservoir; B is a barrel, generally of greater diameter than the pipe; C a valve opening upwards; D a piston moved by the rod E: in this piston there is also a valve opening upwards. When the piston is raised, the air in the barrel between the valves is expanded, and its tension consequently diminished; the pressure of the air in the pipe, therefore, opens the valve C, and the whole air in the pipe and barrel becomes less dense. In this state the atmospheric pressure on the surface of the water causes it to rise in the pipe, until the tension of the confined air becomes equal to the pressure of the atmosphere. On again depressing the piston, the valve in it opens, and the air passes through it from the barrel as it descends; but the valve C is closed by the downward pressure, and the volume of water which has entered the pipe remains. On again raising the piston, the same effect is repeated, and an additional quantity of water enters the pipe. Thus, by the alternating motion of the piston, a column of water is raised in the pipe until it reaches the piston when at the bottom of the barrel, and the whole of the air below it has been excluded. On raising the piston when the water has reached it, the fluid will be compelled to follow by the pressure of the atmosphere on its surface in the well. When the piston is again depressed, the water flows through the valve in it, and ascends into the barrel, and by the succeeding strokes of the piston is lifted up until it reaches and flows out of the spout F.

(1.)

Although in theory the limit of the height to which water may be raised by the sucking pump, from the surface of the fluid in the well to the highest position of the moveable piston, is about 34 feet (the height of a column of water which balances the pressure of the atmosphere), it is not found practicable, with pumps of the ordinary construction, to raise it more than about 28 feet. The difference arises from the difficulty of making the apparatus absolutely air-tight.

The *forcing pump* is represented in fig. 2. The piston-rod E D is attached to a solid plunger D, adjusted to the cavity of the barrel. A pipe G H, furnished with a valve F, opening outwards, communicates with the barrel at G. On elevating the plunger D, the water will ascend through the valve C, in the same manner as in the sucking pump, till the barrel is filled to D. Now, when the plunger is depressed the valve C will shut, and the water between D and C be forced through the valve F into the pipe G H. When the plunger is raised, the valve at F shuts, the pressure on its under side being removed, so that the water which was forced into the pipe by the previous stroke cannot return into the barrel. At the next stroke of the piston more water is again forced into the pipe, and so on till it is raised to the height required.

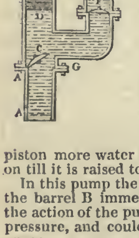
(2.)



In this pump the pipe A A may be dispensed with, and the barrel B immersed in the reservoir; in which case the action of the pump is independent of the atmospheric pressure, and could be maintained equally well in a vacuum.

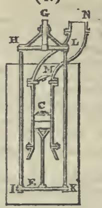
In order to produce a continued stream through the pipe G H, an air vessel, *m n*, may be attached to the lateral branch above the valve F, fig. 3. The pipe G H reaches to near the bottom of the air vessel; and when the water has been forced into the vessel by the action of the pump, until it reaches above the lower end of the pipe at G, it is evident that, as all communication is then cut off with the external atmosphere, every additional quantity of water thrown into the vessel will tend more and more to compress the air within it, which, acting by its pressure on the surface of the water, forces it through the pipe G H in a continued stream.

(3.)



The *lifting pump* is represented by fig. 4. The barrel of the pump is immersed in the water and fixed to an immoveable frame. The piston with its bucket and valve C, opening upwards, is attached at E to another frame, G H I K L, consisting of two strong iron rods, H I and L K, which move through holes in the frame-work to which the pump is fixed. An inclined branch M N, either fixed to the top of the barrel, or moveable by means of a ball and socket, is fitted exactly to the barrel, and furnished with a valve at M. Suppose the barrel immersed in the water to a certain depth: if the piston frame be now thrust down by the handle at G, the piston will descend, and the water be forced by its upward pressure through the valve C, so as to maintain the same level in the pump as in the well. But when the piston frame is elevated, the valve C will shut (as shown in the figure), and the water above C be *lifted up* with the piston, and forced through the valve M into the branch M N, from which its return will be prevented by the shutting of the valve M when the piston descends.

(4.)



In each of these different kinds of pumps which have been described, the total effort required to work the machine, independently of friction, is equal to the weight of a column of water, the base of which is equal to the area of a section of the working barrel, and the altitude equal to the distance between the surface of the water in the reservoir and the point to which it is raised. In the sucking pump the whole of this effort is expended in raising the piston; in the forcing pump, one part is expended in raising and the other in depressing the piston, and it is advantageous to dispose the machinery so that these two parts shall be nearly equal. In small pumps for domestic purpose, the strength of man is usually employed as the moving power; but in raising water from great depths, as the bottoms of mines, the steam engine is applied to this purpose. (*See* FIRE ENGINE.) For an account of the mechanism of different kinds of pumps, see *Gregory's Mechanics*, vol. ii.

The *chain pump* used in ships of war consists of an endless chain moving over a wheel on the gun deck, which is turned round by winches, and over a roller in the pump-well, having saucers or flat circular pistons at certain intervals. Near the pump-well, on the side on which the chain on turning the winches ascends, are a few feet of pipe; through this the saucers raise the column of water, which, being lifted over the upper orifice of the pipe, falls into the cistern, and thence into the waste-pipe, called the *pump-dale*, which carries it overboard. The descending portion of chain falls through another case called the *back case*. Chain pumps, in large ships, throw out a ton a minute.

PU'MPERNI'CKEL. The name of a species of bread peculiar to Westphalia: it consists of bran, has a little acidity, but is agreeable to the taste, and very nourishing; and remains moist for several months. It forms the chief food of the Westphalian peasants; but it is regarded as a great delicacy in other parts of Germany, whither it is exported in large quantities. They sometimes weigh 60 lbs. The term is said to be of French derivation, and originated in a French soldier having rejected the bread with disgust, exclaiming, "C'est bon pour Nickel;" *i. e.* for his horse.

PUN. A play upon words, the wit or point of which depends on a resemblance between the sound and syllables of two or more words, which have different, and perhaps opposite, meanings. *See* PARONOMASIA.

PU'NCHEON. In Architecture, a short post. The small quarters in a partition above the head of a door are called puncheons.

PUNCHEON. A measure of capacity for liquids, containing 84 gallons, or one third of a tun.

PU'NCTATE. (Lat. punctum, *a point*.) In Zoology, when a part is beset with many points, or minute impressions, which do not perforate the surface.

PUNCTUA'TION. In Writing, the dividing words, propositions, or sentences from each other by means of certain marks or points, designed to facilitate the apprehension, or to regulate the enunciation of written language. Points or stops are said to have been first used by Aristophanes, the Alexandrian grammarian; but the modern system of punctuation is due to Manutius, a learned printer, who lived at Venice in the 15th and 16th centuries. The marks most commonly in use are, 1. The comma (,), which is placed between the less important divisions of a sentence or passage; as, for instance, before and after qualifying propositions or clauses; between single words not connected by conjunctions; before conjunctions which unite sentences, &c. 2. The semicolon (;), which distinguishes the longer or more important members of a sentence; as when the latter part is an inference from, or qualification, explanation, or illustration of, the former. 3. The colon (:), which is chiefly used to distinguish such members of a sentence as are themselves divided by semicolons into two or more principal

parts. 4. The period or full stop (.), which stands at the end of a complete sentence. Besides these may be enumerated the note of interrogation (?) or inquiry; of exclamation (!), expressing admiration, endearment, or any considerable emotion; the parenthesis ( ), used when a clause is inserted which interrupts the progress of the sentence; with other marks, either less commonly used, or the rules for whose use are less easily defined.

PU'NDIT (more correctly written Pandit). The title of learned Brahmins in Hindoostan. The term is used ironically in England to designate any one who makes a vast show of learning without possessing it in reality.

PU'NIC WARS. The name given to the celebrated contests in which the Romans and Carthaginians were engaged for more than three centuries, and which finally terminated in the destruction of Carthage. The first commenced A.C. 264, and ended A.C. 241; the second lasted from A.C. 218 to A.C. 202; the third from A.C. 149 to A.C. 147, ending with the destruction of Carthage.

PU'NISHMENT. (Lat. pœna, *punishment.*) In Jurisprudence, the infliction of suffering, under legal sanction, upon those who have violated the law.

It is undoubtedly true, that both in legislation and in public opinion respecting punishment, the *vindictive* theory which considered it as a retribution for crime, and to be governed by our moral feelings of indignation against the offender, has far too generally prevailed, and that the primary end, the interests of society, has been overlooked. But we are not quite certain whether the present course of opinion does not run too exclusively in the contrary direction; and whether those who adopt the common formula, that "the object of all punishment is the prevention of the offence in future," have reflected on all the consequences of that position.

For instance, it is the common practice in this country as well as in others, to connect the administration of justice with the enforcement of the tenets of religion and morality. In passing sentence, wherever there is any peculiarity in the case calculated to call forth such observation, the judge rarely fails to comment on the moral deformity of the act; not merely in its tendency to injure society, but subjectively, as evidencing moral depravity in the person committing it. The solemnities of public worship which form part of the ceremonial; the public harangues of the judges (as, for instance, in the English custom of charging the grand jury); the language in which the jury is commonly addressed, both by the judge and the advocates; all these seem based on the assumption, that the moral quality of acts is one of the matters to be brought under their consideration. But if the judge has really no concern whatever with that moral quality, and is simply there to see that society may be guarded, as far as possible, from exposure to material injury by fraud or violence, all these ceremonies are utterly out of place. They must either be defended as politic devices, employing the machinery of religion to aid in terrifying offenders from the commission of crime; or as concessions to popular ignorance. And it is certain that in such a case they had far better be abolished altogether, as they strongly lead the mind to dwell on that false view of the object of punishment, which it is the object of Bentham and his school to extirpate.

Again, in popular estimation, the moral atrocity of an offence is one of the elements in the correct measure of punishment. On whatever ground philosophers may object to sanguinary laws, this plain objection is that which has always prevailed in the public mind. In the case of forgery, for example, the feeling of the majority triumphed in the end over the severity of the law, not because it was thought disproportioned to the injury inflicted on society, or to the importance of repressing the crime, but because it was thought not to deserve it in a moral point of view. Now all such expression of sentiment, on the theory in question, is founded on a wrong principle; and the writers who adhere to it are forced to admit this feeling as a disturbing cause, preventing the right doctrine from being fully carried out; they are forced to admit, as part of their definition of a good punishment, that it shall not be such as to shock the popular notion of moral justice; which is, in other words, to admit that penal laws must be governed in part by principles which they condemn as altogether wrong; a very mischievous concession for a legislator to make.

That the interest of society is the great object of punishment must be conceded on all hands. That the specific object of preventing the offence from being committed is a very important part of that general object, probably by far the most important, may also be conceded. But the question is, whether the general object does not comprehend other particular objects also; and whether a punishment, which should answer in the highest degree the advantage of repressing that particular offence, or class of offences, might not be imperfect notwithstanding.

This question can only be solved by deciding the great preliminary difficulty of political science, in which so many others are involved; whether the ruling power, which we call the state, or society, or the legislature, has or has not any *moral* authority. Those who conclude that it has nothing to do beyond preserving the personal security and property of individuals, of course deny that it has any. But those who believe that it has, also, what may be termed a paternal power, and is entrusted by Providence with the maintenance of religion and moral principle, must, consistently, admit that there may be a moral object in punishment beyond the mere prevention of the offence.

And it must be observed in passing, that those who do hold the state to possess such a moral authority, and have such moral duties imposed upon it, need not, therefore, hold those to be its principal objects. It may very well be that the primary object of the association of men in a political body is security and self defence; yet that association may have other ends not inconsistent with this. And although those other ends are in themselves incomparably the most important, it does not at all follow that they are the most important as regards the state. When men enter into a particular contract with each other, their mutual duties under that contract are primarily those connected with the object of that contract; they may have other and more important mutual duties, which yet, as regards that contract, are secondary. No religious man will deny that the connexion of master and servant involves some duties of a very exalted character; but the principal object of that connexion is, nevertheless, the rendering of service in lieu of a remuneration.

We have not space here to pursue this line of reasoning; but must proceed to take the moral vocation of the state as admitted, and consider the effect of that admission on the theory of punishment. In the first place, it would be a mistake to suppose that it justifies retribution as an object of punishment. No one can apportion retributive justice who cannot judge of the motives of actions. The moral authority of the state, even by those who have carried its divine character to the highest point, has only been likened to the paternal; and no father has the right to chastise a child by way of retribution. He has no right to punish at all, except with a view to reformation. Omitting this mistaken end, the real objects of punishment may be classed as follows: —

1. The interests of society; which must be subdivided into,

i. Its security from the injury to person or property occasioned by the crime.

ii. Its moral and religious improvement.

And 2. The reformation of the offender. This is admitted as one of the ends of punishment by all writers; but Bentham and his followers regard it as such only so far as it conduces to the security of society by preventing the repetition of the offence; those who embrace the higher view, both on this account, and also as the fulfilment of the duty of the state towards the offender himself. Considered in either view, it is clearly a secondary object only, the good of society being the first.

The security of society is attained by punishment in four ways:

1. By forcibly preventing the offender from repeating his offence: as by death, mutilation, or perpetual imprisonment.

2. By reforming the habits of the offender, and thereby taking away the desire.

3. By deterring the offender from repetition by the fear of fresh punishment.

4. By deterring others through example. And this last is clearly the chief practical end of all legal inflictions. The admission of other principles, while it seems necessary in order to satisfy our conception of the existence of the state as a moral agent, need not prevent the legislator from keeping this steadily in view.

Our limits forbid us from pursuing farther the analysis of punishment, and pointing out in what manner the different kinds and degree of it principally in use follow, or depart from, their legitimate ends. We will conclude with the classification of punishments given by Bentham, in his *Theorie des Peines*, to use the title of the work as given by his translator Dumont. If Bentham's theory be defective in its main principles (and although we have presented the reader with some arguments against it, we do not assert that they must be conclusive with all), it is at all events only from being imperfect, not erroneous; as far as it goes, it is logical, consistent, and definite. And as he was nearly the first writer who introduced anything like clearness or arrangement into the popular notions on penal laws, so we are inclined to think that, on the whole, he has done more for society in this particular than in any other of the various subjects to which he applied his reforming genius. It must not be forgotten that Sir S. Romilly and Sir J. Mackintosh were the pupils who carried his speculations into practice.

He divides punishments into corporeal and privative. The first of these are, 1. Simply afflictive, those which consist in the mere infliction of temporary pains, the lash, &c. 2. Complexly afflictive, in which pain is joined

with permanent loss: as in the old punishments of mutilation and disfigurement. 3. Restrictive, under which he classes together (perhaps rather inappropriately) imprisonment, or the total deprivation of liberty, and banishment, which deprives of a certain portion of liberty. 4. Active or laborious; such as the gallies, hard labour, &c. Transportation combines this character with the former. 5. Privative punishments are those which deprive the criminal, 1. Of life; 2. Of reputation *only;* such, perhaps, as the amende in French law. 3. Of property: fine, and confiscations. 4. Forfeiture of condition; which, more or less, accompanies infamous punishments in most countries: *e. g.* civil infamy, in France, is attended with various disabilities. These eight comprehend all the simple forms of punishment in ordinary use; but he adds a few, which he terms anomalous, and only mentions to hold them up to general reprobation. 1. What he calls *vicarious* punishments; as when the family of a suicide are punished by the forfeiture of his chattels. 2. Transitive; when the penalty passes to future generations: corruption of blood in the English law. 3. Collective, of which he gives, as an instance, the punishment of corporations for the acts of individual corporators; a more ordinary one is, the compelling the inhabitants of a hundred to make good the damages occasioned by a riot. 4. Fortuitous; where individuals wholly unconnected with the offender are implicated, as it were casually, in the consequences of his crime; of which he gives, as an instance, the avoidance of mesne conveyances by some kinds of confiscation, and consequent loss of innocent purchasers; and the imposition of deodands, where no negligence is imputed. (See also *Ed. Rev.* vol. xxii., where his work is reviewed; Lucas, *Système Pénal.*)

PU'PA. (Lat. pupa, *a puppet.*) A genus of land snails, so called from the resemblance of the shell to the pupe, or chrysalis of an insect. Several species are British, as *Pupa umbilicata*, Drap.; *P. marginata*, Drap.; *P. edentula*, Drap.

PUPE. (Lat. pupa.) The name of the oviform nymphs of Lepidopterous insects; also applied to Metabolian insects generally, when in the second stage of their metamorphosis.

PU'PIL. (Lat. pupa.) A term applied to the central opening of the eye, because it reflects the diminished image of the person who looks into it. It is the central aperture of the *iris*.

PU'PIPARES, *Pupipara*. (Lat. pupa, and pario, *I bring forth.*) Those insects are said to be pupiparous which produce their young in the condition of a pupe or nymph; as the forest-fly, *Hippobosca equina.*

PU'PIVORES, *Pupivora.* (Lat. pupa and voro, *I devour.*) The name of a tribe of Hymenopterous insects, comprehending those of which the larvæ live parasitically in the interior of the larvæ and pupæ of other insects.

PURA'NA. (Sanscrit, *a poem.*) The sacred books of India which contain the explanation of the Shaster (which see). There are eighteen books of the Puranas; chiefly filled with legends of the inferior gods and the heroes of Hindostan. (See *Mém. de l'Acad. des Inscr.* vol. xxxviii.) It should be stated, that Professor Wilson intimates his disbelief of the received opinion as to the great antiquity of the Puranas, and believes the writings now known under that name to be mere imitations of lost originals. (Preface to his translation of the *Vishnu Purana.*) See *Asiatic Journal*, Dec. 1840.

PURBECK LIMESTONE. *See* GEOLOGY.

PU'RCHASE, in Law, means, generally, the acquisition of lands or tenements by any other means than descent; as by devise, gift, deed, or agreement.

PU'RGATORY. A place appointed for the satisfaction of temporal punishments, which, according to the Roman Catholic church, are distinguished from the eternal, of which the latter only are remitted to us by the death of Christ. There is none perhaps of the peculiar articles of the Romish faith in favour of which so little can be advanced from the language of scripture; and it may be safely averred that it was not from that source that the opinion ever gained possession of men's minds. It seems to be a natural but too strict an inference from the imperfectly disclosed economy of the divine judgments, which we find to admit of every degree of severity in this life, and are liable to conclude from analogy must be subject to some equivalent adjustment in the next. Accordingly, we discover some imperfect recognitions of the idea in individual writers several centuries before it can be proved that it formed an established article of faith. Augustin is considered the earliest of these; and he speaks vaguely and inconsistently. It was first inculcated as a doctrine by Gregory the Great, who seems to have connected it with the then popular belief that the world was closely approaching to its end. It was much discussed between the Greeks and Latins at the council of Ferrara, 1438. The present Roman Catholic belief is thus expressed in the creed of Pope Pius IV.: —"Constanter teneo purgatorium esse, animasque ibi detentas suffragio fidelium juvari." To which it may be added, that the sins punished in Purgatory are of two kinds,—mortal, repented of; and venial. This article of the creed is derived from the canon of the council of Trent on the subject, sess. 25. The "Romish doctrine" of Purgatory is condemned by Art. 22. of our church. The reader will find the general argument for Purgatory well stated (among Protestants) by Hooker in his 3d Sermon: the latter part, in which he replied to it, is lost. It is also set forth with much learning and moderation in *Tracts for the Times*, No. 79.

PURIFICATION. An observance enjoined by the law of Moses upon occasion of certain accidental defilements, which are scrupulously recorded in the Levitical code. The purification was generally by water; and in the case of women, who were considered impure after childbirth for the space of forty days if delivered of a male, and eighty if of a female, the offering of a lamb and some other sacrifices was required. The purification of the Virgin Mary is a festival in the calendar, and is observed on the 2d of February, being forty days after Christmas. This festival was established in the 6th century, and is variously termed in ecclesiastical antiquities by the names of ὑπαπαντη, Festum Candelarum, Candlemas, the Presentation. The processions of this day were instituted by Gregory the Great. For an account of the ceremonies of purification among the Greeks and Romans, see the article LUSTRATION.

PU'RIM. The name of the solemn festival among the Jews in which they commemorate their deliverance from the wiles and stratagems of Haman, as recorded in the book of Esther. The observance of this festival has been religiously maintained by all the Hebrew race from its institution down to the present time. It is held in February.

PU'RIST. A name sometimes applied to rigorous critics of purity in literary style.

PU'RITANS. The name by which the dissenters from the church of England were generally known in the reign of Elizabeth and the first two Stuarts. The term was assumed, as the word implies, from the superior purity of doctrine and discipline which the more violent reformers claimed as their own; maintaining that they followed the word of God alone, purified from all human inventions and superstitions, of which they believed the English church to retain a considerable share, notwithstanding its alleged reformation. According to Fuller, the use of the name commenced about 1564. (See *Neale's History of the Puritans.*) *See* DISSENTERS.

PU'RLINE. In Architecture, a piece of timber lying on the principal rafters to support them in the middle.

PU'RPLE. (Gr. πορφυρα.) In Painting, a colour produced by the mixture of red and blue, and thence partaking of the hue of each. Among the ancients, purple was always the distinguishing badge of power and distinction; and, of all the various kinds in use, the Tyrian dye is the most celebrated. This colour was produced from an animal juice found in a shell-fish called murex, or conchylium, the quality of which, however, varied with the different coasts on which it was caught.

PURPLE OF CASSIUS. A compound of the oxides of tin and gold, obtained by adding protochloride of tin to a solution of chloride of gold. The true nature of the compound has not been determined; it is used as a purple colour for porcelain painting, and also for staining glass, to which it imparts a fine ruby red.

PU'RPURA. An eruption of small purple specks and patches, caused by extravasation of blood under the cuticle; it is generally attended by constitutional debility, and often by fever. Aperient medicines, and sometimes purgatives, carried to a greater or less extent, followed by mild tonics, and in some cases by wine, bark, and acids, are the principal remedies; but, in the treatment, much will depend upon the concomitant symptoms.

In Zoology, *purpura* is a generic name of the univalve Gasteropod which secretes the purple fluid which formed the base of the Tyrian dye.

PU'RPURE. Purple. In Heraldry, one of the colours or tinctures used in blazonry. It is equivalent to amethyst among precious stones, Mercury among planets. In engraving it is represented by diagonal lines from the sinister to the dexter side of the escutcheon.

PURPU'RIC ACID. A substance resulting from the action of nitric acid upon uric acid; it forms deep red or *purple* compounds with most bases.

PURPU'RIFERS, *Purpurifera.* (Lat. purpura, *purple*, fero, *I bear.*) The name of a family of Gastropodous Mollusks, including those species which secrete the purple substance forming the celebrated dye of the ancients.

PU'RSER. An officer in the British navy, whose chief duty consists in keeping the accounts of the ship to which he belongs; but he also acts as purveyor.

PURSUIVA'NTS. In Heraldry, a kind of probationers in the Heralds' College of England, not admitted to the full privileges of the college, but advanced by succession into its higher offices. They are styled *Portcullis*, *Rouge Dragon*, *Blue Mantle*, and *Rouge Croix.*

PURVE'YANCE, or POURVEYANCE. (Fr. pourvoir, *to provide.*) In English Law, the providing necessaries for the king's house. The right of purveyance, or pre-emption, *i. e.* of buying necessaries for the household, impressing horses and carriages for use, or, on payment of a settled price, even against the will of the owner, was a valuable part of the ancient prerogatives of the kings of England, especially in times when the court was frequently in progress. It was abolished by 12 Ch. 2. c. 24., and has only been occasionally revived since that time by temporary acts for special purposes. The name of "purveyor" had long before become so odious, that by 36 Ed. 3. c. 2. it was changed into "buyer."

PUS. (Lat.) A bland yellowish fluid, somewhat like cream, found in abscesses, and formed upon the surfaces of what are termed healthy sores; it is heavier than water, and viewed under the microscope, appears composed of translucent globules floating in a colourless fluid.

PUTA'MEN. In Botany, the inner coat, or shell, or stone of a fruit; commonly called the endocarpium.

PU'TLOGS. (Etym. uncertain.) In Architecture, short pieces of timber used in scaffolds wherever the scaffold boards lie. They are placed at right angles to the wall, one end of them resting on the ledges of the scaffold, and the other on holes left in the wall.

PUTREFA'CTION. (Lat. putrefactio.) The spontaneous decomposition of animal and vegetable substances, attended by the evolution of fœtid gases. The putrefaction (or putrefactive fermentation) of animal substances is usually attended by more fœtid and noxious exhalations than those arising from vegetable products. This appears principally referable to the more abundant presence of nitrogen in the former; and hence those vegetables which abound in nitrogeniferous principles (such as most, if not all, of the cruciform plants) exhale peculiarly nauseous effluvia: hence, also, such animal products as are destitute of nitrogen are either unsusceptible of what is commonly called putrefaction, or suffer it slowly and imperfectly. The formation of ammonia, or of ammoniacal compounds, is a characteristic of most cases of animal putrefaction; while other combinations of hydrogen are also formed, especially carburetted hydrogen, together with complicated and often highly infectious vapours or gases, in which sulphur and phosphorus are frequently discerned. These putrefactive effluvia are for the most part easily decomposed, and resolved into new and comparatively innocuous compounds, by the agency of chlorine; hence the importance of that body as a powerful and rapidly acting disinfectant.

The rapidity of putrefaction, and the nature of its products, are to a great extent influenced by temperature, moisture, and access of air; they do not ensue below the freezing point, nor in dry substances, nor under the entire exclusion of oxygen; and hence various means suggest themselves of retarding or preventing putrefaction, as well as of modifying its results: a temperature between 60° and 80°, a due degree of humidity, and free access of air, are the circumstances under which it proceeds most rapidly. The most effective antiputrefactives or antiseptics are substances which either absorb or remove a portion of the water or moisture, and enter into new combinations with the organic matter; hence the great efficacy of certain salts, sugar, alcohol, and several other applications, among which, perhaps, the most remarkable are some of the volatile oils, such especially as kreasote and other empyreumatic products obtained by the destructive distillation of wood, and pyroligneous acid, and pyroligneous spirit; the latter is eminently useful in the preservation of dead bodies for the purposes of dissection, and, when properly and sufficiently injected into the vessels, and externally applied, indefinitely suspends all the ordinary steps of the putrefactive process.

The astringent or tanning principle of vegetables is also a powerful preserver of most organic tissues; it enters into chemical combination with the albuminous and gelatinous membranes and fibres; and the resulting compound, of which leather furnishes a characteristic example, is comparatively little prone to change, although the tanning material itself, as well as the animal principles with which it unites, are separately liable to decay.

Among saline substances, the antiputrefactive powers of salt are commonly known: when a piece of flesh is salted, brine runs from it, in consequence of the energy with which the salt abstracts the component water of the muscular fibre; the flesh becomes indurated, and its susceptibility to putrefactive changes greatly diminished; it becomes at the same time less easy of digestion as an article of food. Corrosive sublimate is a far more powerful preservative than common salt; and it appears to act not by the mere abstraction of water, but by entering into chemical union with the fibre. Sulphate of copper and several other metallic salts are similarly efficacious; and the most putrescible substances, such as the brain for instance, after having been steeped in such solutions and dried, will remain without further change for an indefinite period: the poisonous nature of these and many other metallic salts prevents their employment in the preservation of articles of food.

It is probable that the ancient Egyptians employed several of the above-mentioned antiputrefactive and preservative substances in the preparation of their mummies, which have remained for so many hundred years without signs of decay or decomposition; yet in these and similar cases, when by the careful application of various solvents the preservative substances are removed, the flesh resumes its susceptibility of putrefaction.

The inhabitants of northern climates avail themselves of freezing to prevent the putrefaction of their food, and the supplies of game and other articles in the Russian markets are retained in a frozen state; our fishmongers resort to the same expedient for the preservation of their unsold fish, which is daily removed to the ice-house after having been exhibited in their shops; salmon is packed in ice for the purpose of transport and preservation.

It is curious to remark the wonderful influence of vitality in opposing those chemical changes which constitute putrefaction, and in retaining that arrangement of the organic elements requisite for the functions of life; when a part of the body dies, the phenomena of gangrene or mortification ensue; that is, of local putrefaction: the putrefactive changes are the more energetic in consequence of the proximity of the dead part to the living.

All organic tissues may be indefinitely preserved by cautious desiccation; and it is in consequence of the absence of component water that the animal part of bone resists putrefaction: dried bones may thus be stored up for ages, and when it is required to extract their nutritive parts, these are found unimpaired.

PU'TTY. In Architecture, a very fine cement used by plasterers, made of lime only. It differs from *fine stuff* in the manner of preparing it, and in its being used without hair. Also a composition used by glaziers, consisting of oil, whiting, &c.

PY'CNITE, or SHORLOUS TOPAZ. (Gr. *πυκνος, thick.*) A prismatic mineral found at Altenburg in Saxony.

PY'CNOSTYLE. (Gr. *πυκνος*, and *στυλος, a column.*) In Architecture, an arrangement of columns, in which the intercolumniations are equal to one diameter and a half of the columns.

PY'GMY. *See* PIGMY.

PYLA'GORAS. (Gr. *πυλαγορας*, so called from the assembly of the Amphictyons at Thermopylæ.) The title of one of the two deputies from each confederate at the Amphyctyonic Council. His functions comprised the diplomatic and deliberative duties of the mission: while the care of the sacred rites fell on his colleague, the Hieromnemon (*ἱερομνημων*).

PYLORI'DEANS, *Pyloridea.* (Gr. *πυλη, an entrance, ουρος, a guard*, and *ειδος, form.*) The name of a tribe of Lamellibranchiate Bivalves, comprehending those which have a shell open at both extremities.

PYLO'RUS. (Gr. *πυλη, an entrance*, and *ουρος, a guard.*) The aperture of the stomach into the duodenum; it guards, as it were, the entrance into the intestinal canal.

PYRA'LLOITE. (Gr. *πυρ, fire*, and *αλλος, another.*) A mineral which undergoes various changes of colour when heated.

PY'RAMID. (Supposed to be from Gr. *πυρ, fire*, from the resemblance of the form to a spire of flame; but for a more probable derivation of the word, see *infrà*, PYRAMIDS OF EGYPT.) In Geometry, a solid contained by a plane polygonal base and other planes meeting in a point. This point is called the vertex of the pyramid; and the planes which meet in the vertex are called the sides, which are necessarily all triangles.

The principal properties of pyramids are the following: — 1. Every pyramid is equivalent to one third of a prism having the same base and altitude. Hence, 2. All pyramids having equivalent bases and equal altitudes are equivalent. 3. The solid content of a pyramid is measured by the product of the area of the base into one third of the altitude. 4. If a pyramid is cut by a plane parallel to its base, the frustum (or part comprehended between the base and the section) is equal to the sum of three pyramids having for their common altitude that of the frustum, and of which the bases are respectively the lower base of the frustum, the upper base of the frustum, and a mean proportional between them. (See *Legendre's Geometry*, and Notes.)

Pyramids are denominated from the figures of their bases, being triangular, quadrangular, pentagonal, &c., according as the base is a triangle, a quadrangle, a pentagon.

PYRAMIDS OF EGYPT. Celebrated monuments of* massive masonry, which, from a square base, rise by regular gradations till they terminate in a point, but so

* Chambers and galleries have been explored in some of the principal pyramids. Belzoni was the first whose investigations of the pyramids excited general attention; but more recently the researches of Colonel Howard Vyse have been attended with greater success. The

that the width of the base always exceeds the perpendicular height. The Pyramids commence immediately south of Cairo, but on the opposite bank of the Nile, and extend in an uninterrupted range for many miles in a southerly direction, parallel with the banks of the river.

The three largest are situated in the vicinity of Ghizeh, not far from Cairo; and of these the loftiest is called the pyramid of Cheops, from the prince by whom it is supposed to have been erected. The sides of its base, which are in the line of the four cardinal points, measure at the foundation 763·4 feet; so that it occupies a space of more than 13 acres. Its perpendicular height is 480 feet, being, consequently, 43 feet higher than St. Peter's at Rome, and 136 feet higher than St. Paul's. Supposing this pyramid to be entirely solid, its contents would exceed three millions of cubic yards, and the mass of stone contained in it would be six times as great as that contained in the Plymouth breakwater! (*Egyptian Antiquities*, *Library of Entertaining Knowledge*, ii. 213.) This huge fabric consists of successive tiers of vast blocks of calcareous stone, rising above each other in the form of steps. The thickness of the stones, which is identical with the height of the steps, decreases as the altitude of the pyramid increases, the greatest height being 4·628 ft. and the least 1·686 ft. The mean breadth of the steps is about 1 ft. 9 in. The best authorities agree in estimating the number of steps or tiers of stone at 203. According to the information communicated to Herodotus by the priests, 100,000 men were employed for twenty years in the construction of this prodigious edifice; and ten years were employed in constructing a causeway by which to convey the stones to the place, and in their conveyance. (Lib. ii. § 124.)

The other pyramids are of inferior dimensions; but they are mostly all, notwithstanding, of vast magnitude—*instar montium eductæ:* they are not all of stone, some of them being of brick.

Many learned dissertations have been written, and many fanciful and a few ingenious conjectures have been framed, to account for the original use and object of these imperishable structures. But the difficulty of the subject is such, that hitherto no satisfactory conclusion has been arrived at. Even in the remotest antiquity their origin was matter of doubt, and nothing certain was known with respect to them or their founders. (*Plin. Hist. Nat.* lib. 36. § 12.) On the whole, however, it would seem to be most probable that they were intimately connected with the religion of the ancient Egyptians; and that they were at once a species of tombs and temples, but participating more of the latter than of the former character. (For some remarks on this part of the subject, see *Shaw's Travels*, p. 170., &c. 4to. edit.; and *Greaves's Pyramidographia*, in his Works, vol. i.)

It has long been customary to regard the Pyramids as monuments merely of the power and folly of the monarchs by whom they were raised, and of the bondage of their subjects. This, however, seems to be a very superficial prejudiced view of the matter. The varying magnitude of the Pyramids, the fact of their being scattered over a space extending lengthwise about 70 miles, and their extraordinary number, appear to show pretty conclusively that they must have been constructed from a sense of utility or duty; and not out of caprice, or from a vain desire to perpetuate the names or the celebrity of the founders. If we had a sufficient knowledge of antiquity, it would probably be found that the motives which led to the construction of the Pyramids were, at bottom, nearly identical with those which led to the construction of St. Peter's and St. Paul's; and that they are monuments of the religion and piety, as well as of the power of the Pharaohs.

The Pyramids were esteemed by the ancients as one of the seven wonders of the world, and most deservedly; for it is impossible to look at these stupendous structures without being overwhelmed with a sense of their sublimity. They are associated, too, with some of the most interesting events in the history of the human race. Herodotus, Plato, and Pythagoras beheld them with wonder and admiration; Alexander the Great and Napoleon marshalled their hosts under their shadow; and they are probably destined to survive long after the proudest monuments of the present generation have crumbled into dust.

The etymology of the word *pyramid* is involved in as great obscurity as the object of the structures themselves. The most usual derivations that have been assigned to the term almost all proceeded on the supposition that it is of Greek origin, than which nothing can be more erroneous. Perhaps the most probable conjecture is that of De Sacy, which is as follows: — The ις in πυραμις he regards as a Greek termination; the first syllable πυ he holds to be the Greek version of the Egyptian article *pi* (and so written by the Greeks from their wish to derive the word from πυρ, *fire*); and he refers the syllable ραμ to the root *ram*, which, in the Egyptian language, signified *separating* or *setting apart from common use:* consequently, the word *pyramid* will denote a *sacred place or edifice* set apart for some religious purpose. (De Sacy, *Observations sur l'Origine du Nom donné par les Grecs et les Arabes aux Pyramides d'Ægypte.*) See *M'Culloch's Geog. Dict.*, art. "Egypt," and the authorities there cited.

latter gentleman has opened and explored four new chambers in the great pyramid; he also opened the third pyramid of Ghizeh, of the previous opening of which no tradition exists.

PYRAMIDAL NUMBERS, in Arithmetic, are numbers formed by the successive sums of polygonal numbers, in the same manner as the polygonal numbers are formed from arithmetical progressions. Thus —

Arithmetical progression,	1, 2, 3, 4, 5, &c.
Polygonal numbers,	1, 3, 6, 10, 15, &c.
Pyramidal numbers,	1, 4, 10, 20, 35, &c.

See FIGURATE NUMBERS and POLYGONAL NUMBERS.

PYRENE'ITE. A mineral found in the limestone of the French Pyrenees; it appears to be a variety of the garnet.

PYRETO'LOGY. (Gr. πυρετος, *fever*, and λογος, *a discourse*.) The doctrine of fevers.

PYRE'XIÆ. (Gr. πυρ, *fire*, and εξις, *habit*.) Fevers; diseases attended by fever.

PYRI'TES. (Gr. πυρ.) Sulphurets of copper and iron, commonly distinguished as copper and iron pyrites. The former is the principal ore of copper; the latter is an abundant natural product of a brass yellow colour. When exposed to air and moisture, especially after having been heated, it absorbs oxygen, and yields sulphate of iron, or green vitriol. The term is derived from πυρ, *fire;* either because they sometimes spontaneously ignite, or as being hard enough to strike fire with steel.

PYROACE'TIC SPIRIT. A liquid formed during the destructive distillation of acetate of lead. When carefully purified, it has a peculiar spirituous odour, is limpid, and very inflammable; its specific gravity is 0·792, and it boils at 132°. It consists of 3 car. + 3 h. + ox. Hence 1 equivalent of acetic acid (4 car. + 3 h. + 3 ox.) corresponds to 1 equivalent of pyroacetic spirit and 1 of carbonic acid: hence dry acetate of baryta is resolved by heat into carbonate of baryta and pyroacetic spirit. The term *acetone* is now commonly applied to this compound.

PYRO-ACIDS. (Gr. πυρ.) The prefix *pyro* is usually applied to the products which are obtained by subjecting certain organic acids to heat. The acids are thus modified, and give rise to distinct classes of salts. Thus we have the pyrogallic, pyromalic, pyrotartaric acids, &c.

PY'ROCHLORE. (Gr. πυρ, and χλωρος, *green*.) A name given by Werner to the octoedral ore of titanium.

PYROLI'GNEOUS ACID. (Gr. πυρ, and Lat. lignum, *wood*.) This term is generally applied to the *acid liquor* which passes over along with tar and gaseous products when wood is subjected to destructive distillation. This acid liquor is an impure vinegar, from which acetic acid is obtained as follows: — The pyroligneous acid, freed from tar, is saturated with chalk or powdered slaked lime, filtered, and evaporated, by which an impure acetate of lime is obtained; this is gently heated, so as to destroy part of its empyreumatic matter without decomposing the acetic acid; it is then mixed with sulphate of soda, which yields, by double decomposition, sulphate of lime and acetate of soda; the acetate of soda is filtered off the sulphate of lime, evaporated, heated, and redissolved and crystallized. In this way a pure crystallized acetate of soda is by proper management obtained, which is mixed in a retort or still with a proper proportion of sulphuric acid, and a gentle heat applied, which causes the strong acetic acid to distil over, and sulphate of soda remains behind. This acetic acid is in a high state of concentration; it is lowered by the addition of water, and if intended for the table or for domestic use, as a substitute for other forms of vinegar, it is usually coloured with a little burned sugar. The charcoal which is the residue of this distillation of wood is of an excellent quality; — that employed in the manufacture of gunpowder is thus prepared. This manufacture of vinegar is now carried on upon a very large scale, and the greater part of the vinegar used for domestic purposes and in the arts, in many of which it is largely consumed, is derived from this source.

PYROLIGNEOUS SPIRIT. *See* PYROXYLIC SPIRIT.

PYROLU'SITE. A mineralogical term applied by some to the common black or binoxide of manganese, from the facility with which it is resolved by heat into oxygen and a suboxide.

PY'ROMANCY. (Gr. πυρ, and μαντεια, *prophecy*.) Among the classical ancients, a species of divination by means of the fire of the sacrifice; in which, if the flames immediately took hold of and consumed the victims, or if they were bright and pure, or if the sparks rose upward in a pyramidal form, success was said to be indicated. If the contrary took place, misfortunes were said to be presaged.

PYRO'METER. (Gr. πυρ, and μετρον, *measure*.)

An instrument for measuring the degrees of heat. According to this definition, the pyrometer is synonymous with thermometer; but though the two terms are sometimes applied indifferently to the same instrument, the term *pyrometer* is generally understood to denote either an instrument intended to measure higher temperatures than can be measured by the ordinary thermometer, or an instrument for comparing the expansions of different metals.

Various contrivances have been employed for the above purposes. Musschenbroek, the original inventor of the pyrometer, adopted the following method:—A prismatic rod (about six inches long) of the metal under trial being attached at one extremity to an immoveable obstacle, and heated by lamps, the other end is necessarily pushed forward; and this being fastened to the end of a rack playing into a pinion, communicates a revolving motion to an axle to which a train of wheel-work is attached, whereby the minutest expansion of the heated bar is rendered sensible, and measured by an index on a dial. The principle of this apparatus is sufficiently simple; but the uncertainty attending the motion of so many loosely connected wheels and pinions must have rendered its indications of little value; and the method is liable to a still more serious objection, namely, that the temperature communicated to the bar by the lamps is entirely unknown. Desaguliers, and afterwards Ellicott, made several improvements in the construction of the instrument, tending to give it a more equable motion and to increase its delicacy. Graham substituted a micrometer screw for the wheels and levers that had formerly been employed; and on this principle Mr. Smeaton contrived an ingenious apparatus, which is described in the *Phil. Trans.*, vol. xlviii

Various other forms of the pyrometer have been proposed, to render it better adapted for the measurement of expansion by heat; among which the most perfect perhaps are those contrived by Ferguson, De Luc, and particularly that employed by Ramsden for determining the expansion of the glass rods used in measuring the base on Hounslow Heath for General Roy's survey. (See *Phil. Trans.*, 1785.)

For ascertaining the temperatures of furnaces, and other very high temperatures, the pyrometers now described are inapplicable. In order to remedy this deficiency, Wedgwood availed himself of the property which clay possesses of contracting by heat, and remaining afterwards in that state of contraction. He found, by repeated trials, that fine porcelain clay contracted uniformly with the degree of heat applied to it; accordingly, by measuring the dimensions of a cylindrical piece of this substance (which may be done with great accuracy, by observing the depth to which it will sink between two scales of metal inclined to each other under a small angle), and the subjecting it to the heat of a furnace, and applying the scale again to it when cold, an indication of the degree of heat to which it has been subjected is given by the amount of its contraction. Wedgwood divided his scale into 240°; and, in order to compare it with that of Fahrenheit's thermometer, made use of a piece of fine silver fitted to the same mould as the pyrometric pieces of clay. Having determined the expansion of the silver between 50° and 212° of Fahrenheit's scale, the silver and clay were subjected to the same heat; and, by a comparison of the expansion of the one with the contraction of the other, he estimated that each degree of his scale was equal to 130° of Fahrenheit's. He also estimated that the zero of his scale corresponded with 1077·5° of Fahr.; and from these data comparative tables of the two scales are formed. The objections to this method are, that as clay is a heterogeneous mixture, it is not very probable (and there are no means of ascertaining the fact) that its contractions are equal at different temperatures; and that different portions of clay possess different degrees of contractibility. It was also surmised that a long or frequent exposure to inferior degrees of heat will cause it to contract, even after it has undergone the action of a high temperature; but this appears to have been disproved. (*Phil. Trans.*, 1782, 1784, 1786.)

Guyton Morveau invented a platina pyrometer as a substitute for Wedgwood's. In a solid plate of highly baked porcelain a groove was cut containing a flat bar of platina, an inch and three quarters in length, two tenths of an inch broad, and one tenth of an inch thick. One end of the bar abuts against the bottom of the groove, the other presses against the short arm of a bent lever, of which the long arm, moving on a pivot, becomes the index of the instrument, and marks the degrees on a scale fixed to the porcelain. With this instrument he made numerous experiments, the general result of which proved that Wedgwood had assigned by far too high a temperature for the degrees of his scale. (*Annales de Chimie*, tom. xlvi.; *Nicholson's Journal*, vol. vi.)

A pyrometer, invented by Professor Daniell, is described in the eleventh volume of *Brande's Quarterly Journal*. The part on which the heat acts consists of a rod or wire of platina, about ten inches in length, and about a seventh of an inch in diameter, placed within a tube of black lead ware, and having one end fixed at the bottom of the tube: to the other end is attached a fine wire of platina, which, after passing two or three times round the axis of a wheel, is fastened to a spring by which it is always preserved at the same degree of tension. The teeth of the wheel play into a pinion, the axis of which carries an index, whose revolution shows, on a greatly magnified scale, the expansion and contraction of the platina rod. With this instrument experiments were made to determine the fusing points of the different metals; the results agreed nearly with those of Morveau, but differed widely from those of Wedgwood. Mr. Daniell subsequently made great improvements upon this apparatus, or rather invented a second pyrometer, which is described in the *Phil. Trans.* for 1830, and the *Phil. Magazine* for 1831 and 1832.

For Mr. Prinsep's method of determining high temperatures from the fusing points of pure metals and different metallic alloys, see *Phil. Trans.*, 1828; or *Phil. Mag.*, new series, vol. iii. (See *Library of Useful Knowledge; Gregory's Mechanics; Encyc. Brit.*)

PYROMO'RPHITE. (Gr. πυρ, and μορφη, *form.*) Native phosphate of lead. When heated before the blowpipe, it fuses into a globule, which assumes a polyhedral crystalline form as it cools.

PY'ROPE. (Gr. πυρ, and ωψ, *the eye.*) A fiery or brilliant red garnet.

PYRO'PHORUS. (Gr. πυρ, and φερω, *I bear.*) A substance which spontaneously takes fire when exposed to air. *Homberg's* pyrophorus is made by mixing equal weights of alum and brown sugar, and stirring the mixture over the fire in an iron ladle till quite dry; it is then put into an earthen or coated glass bottle, and heated red-hot so long as a flame appears at the mouth; it is then removed, carefully stopped, and suffered to cool. The black powder which it contains becomes glowing hot when exposed for a few minutes to the air: the experiment succeeds best in a damp state of the atmosphere, and the ignition is frequently accelerated by breathing upon the powder. A mixture of 3 parts of lampblack, 4 of dried alum, and 8 of carbonate of potassa, may be substituted for the above, and calcined in the same way: 27 parts of sulphate of potassa and 15 of calcined lampblack, heated to redness in a crucible, and then carefully preserved out of contact of air, also yields a good pyrophorus.

It appears from Gay Lussac's experiments that the essential ingredient in pyrophorus is sulphuret of potassium; the charcoal and alumina only act by being interposed between its particles; but, when the mass once kindles, the charcoal takes fire and prolongs the combustion. An excellent pyrophorus is afforded by heating tartrate of lead red-hot in a glass tube, in which it may afterwards be hermetically sealed. When the tube is broken, and the black powder within it shaken out through the air, it burns with the emission of a dense smoke of oxide of lead. This curiously shows the spontaneous inflammability of minutely divided lead.

PYRO'RTHITE. (Gr. πυρ, and ορθος, *straight.*) A mineral resembling *orthite*, but differently affected by heat.

PYRO'SIS. (Gr. πυροω, *I burn.*) A disease of the stomach, attended by a burning sensation, and the throwing up of a quantity of saline and sour fluid; it is sometimes called *water brash* and *black water*: it is a variety of *heartburn.*

PYRO'SMALITE. (Gr. πυρ, οσμη, *odour*, and λιθος, *a stone.*) A native submuriate of iron, which, when heated, exhales the odour of chlorine.

PY'ROSOME, *Pyrosoma.* (Gr. πυρ, and σωμα, *a body.*) The generic name of certain compound Ascidians, remarkable for the brilliant phosphoric luminosity which they emit.

PY'ROTE'CHNY (Gr. πυρ, and τεχνη, *art*), signifies, in its widest sense, the art or science which teaches the management and application of fire to certain operations; but it is most usually restricted to those articles and instruments manufactured for amusement, or for grand public occasions. The origin of artificial fireworks is lost in obscurity. They were in general use in China long before their introduction to Europe, which is comparatively of recent date. The finest inventions of this kind are due to the celebrated Ruggieri, father and son, who executed in Rome and Paris, and the principal capitals of Europe, the most brilliant fire-works that were ever seen.

Fire-works are divided into three classes:—1. Those to be set off upon the ground; 2. Those which are shot up into the air; and 3. Those which act upon or under water.

The three prime materials of this art are, nitre, sulphur, and charcoal, along with filings of iron, steel, copper, zinc, and resin, camphor, lycopodium, &c. Gunpowder is used either in grain, half crushed, or finely ground, for different purposes. The longer the iron filings, the brighter red and white sparks they give; those being preferred which are made with a very coarse

file, and quite free from rust. Steel filings and cast-iron borings contain carbon, and afford a more brilliant fire, with wavy radiations. Copper filings give a greenish tint to flame, those of zinc a fine blue colour; the sulphuret of antimony gives a less greenish blue than zinc, but with much smoke; amber affords a yellow fire, as well as colophony and common salt; but the last must be very dry. Lampblack produces a very red colour with gunpowder, and a pink with nitre in excess. It serves for making golden showers. The yellow sand, or glistening mica, communicates to fire-works golden radiations. Verdigris imparts a pale green; sulphate of copper and sal-ammoniac, a palm-tree green. Camphor yields a very white flame and aromatic fumes, which mask the bad smell of other substances. Benzoin and storax are used also on account of their agreeable odour. Lycopodium burns with a rose colour and a magnificent flame; but it is principally employed in theatres to represent lightning, or to charge the torch of a fury. (See, for full information as to the various processes adopted in the construction of fire-works, *Ure's Dict. of Arts, &c.*, art. "Fire-works.")

PY'ROXENE. (Gr πυρ, and ξενος, *a stranger.*) The *augite*, supposed to have pre-existed in the volcanic minerals containing it, and not to have been formed by fire.

PYROXY'LIC SPIRIT. (Gr. πυρ, and ξυλον, *wood.*) This is one of the products of the destructive distillation of wood. Its specific gravity when rectified is 0·804: it boils at 150°; it burns with a blue flame, and may be used as a substitute for alcohol in lamps, for which purpose it is often sold under the name of naphtha. It is assumed to be the hydrate of a peculiar hydrocarbon which chemists have designated by the term *methylene* (from μεθυ, *wine*, and υλη, *wood*).

PY'RRHIC DANCE, called by the Romans Pyrrhica Saltatio. A species of warlike dance, said to have been invented by Pyrrhus to grace the funeral of his father Achilles, though this point is involved in obscurity. This dance consisted chiefly in such an adroit and nimble turning of the body as represented an attempt to avoid the strokes of an enemy in battle, and the motions necessary to perform it were looked upon as a kind of training for the field of battle. This dance is supposed to be described by Homer as engraved on the shield of Achilles. Lord Byron describes the Suliotes as still performing this dance (*Childe Harold*); and in the famous ode on the aspirations of Greece after liberty, he exclaims:—

> "You have the Pyrrhic dance as yet,
> Where is the Pyrrhic phalanx gone?
> Of two such lessons why forget
> The nobler and the manlier one?"

PY'RRHONISTS. The followers of Pyrrho, a philosopher of Elis, and disciple of Anaxarchus, who flourished about 300 B.C. Their tenets, which have come to us only through the reports of unfriendly writers, are said to have been so absurdly sceptical, that the Pyrrhonists would not put even as much confidence in the senses as was necessary for the preservation of their existence; but this seems partly refuted by the age at which Pyrrho himself died, which was 90 years. There is a summary of the doctrines of Pyrrhonism in the 2d vol. of the historical part of the *Encyc. Metropolitana*. *See* SCEPTICISM.

PYTHAGORE'ANS. The followers of Pythagoras, a native of Samos, born B.C. 570; said to have been the first Greek who assumed the title of a philosopher. Pythagoras, after travelling through Egypt and the East in search of instruction, finally fixed his abode at Crotona, one of the Dorian colonies in the south of Italy. He here attached to himself a large number of youths of noble descent, whom he formed into a secret fraternity for religious and political as well as philosophical purposes; and by their assistance produced many beneficial changes in the institutions of Croton and the other Græco-Italian cities. Of the strictly philosophical tenets of the Pythagoreans very imperfect records are preserved. Many of the doctrines ordinarily imputed to them are evidently the fabrication of the later Pythagoreans, a class of visionaries who lived during the decline of the Roman empire. The fragments of Philolaus, apparently a genuine follower of Pythagoras, have been collected by Boeckh; but these, combined with what accounts we can glean from Plato, Aristotle, and others, are far from being sufficient to give us the information necessary for a clear understanding of this very singular system. One point is sufficiently evident, that the Pythagoreans were the greatest mathematicians of their time, and that they sought in the study of mathematical relations that solution of the principal philosophical problems for which their contemporaries, the Ionic and Eleatic philosophers, sought, the first in physical, the others in ontological hypotheses. Bearing this peculiarity distinctly in mind, the student of the history of philosophy will be prepared for much in the Pythagorean doctrine which would otherwise seem capricious and unintelligible. To reduce the phenomena presented to the senses to harmony with the laws of reason is the first endeavour of philosophical thinkers: to determine its own limits, and the necessary laws of its operation, is among the last of the problems of which the reason enters on the solution. The relations of space and quantity, as they are the most obvious, are also the most distinct and definite forms, in which the laws of the outward world can present themselves to this faculty. We cannot, therefore, feel surprise when we discover in the early mathematicians that error which has more or less prevailed among all great mathematicians who meddled with philosophy—the error of striving to enlarge the domain of their favourite science beyond its legitimate bounds. Precisely as the atomic philosophers have endeavoured to explain all things by a diversity in the figure of their ultimate parts, the Pythagoreans seemed to have found, in the number and proportions of those parts, the true essence of the things themselves. Having proceeded thus far, they went a step farther. They perceived that the universe and its parts are obedient to certain laws, and that these laws can be expressed by numbers. By a mistake prevalent during every period of speculation, they mistook the necessary conditions of a thing's subsistence for the essence of that thing itself; and at once pronounced that numerical relations were not merely all that could be understood in outward phenomena, but were, in fact, all that was real in them. Units of number grew gradually into points in space, and these into material atoms. To every order of existence, even to many abstract conceptions, a distinct number was assigned. God is represented as the original unity; the human soul, the earth, the planets, the animal creation, have each their own peculiar arithmetical essence; as have also the abstractions *justice*, *opportunity* (καιρός), *opinion*, &c. In many of these *numbers*, it is not difficult to imagine a symbolical meaning; but how far any such meaning was contemplated by the Pythagoreans must remain matter of doubt.

The outlines of a dualistic scheme are discernible in a singular table of opposites (συστοιχία), preserved to us by Aristotle, in which the two principles of the universe are successively represented under the form of limit and the unlimited, odd and even, one and many, right and left, male and female, still and moved, straight and curved, light and darkness, good and evil, square and oblong.

But it would far exceed our limits to enumerate the various fanciful disguises under which the Pythagoreans voluntarily or involuntarily concealed the result of their meditations. Their moral system is more intelligible, being founded, as the tone of their general doctrines would lead us to anticipate, on the ideas of law and harmony. Every state, and every member of a state, is to exhibit, each in his degree, a miniature resemblance of the universal constitution of the world. This essentially Greek idea they sought to realize in themselvess by a long course of propædeutic discipline, in which music plays a conspicuous part. That the Pythagoreans were strongly influenced by their doctrines, is sufficiently apparent in the length of time during which their brotherhood continued. Philolaus, Lysis, Cleinias, Eurythes, and Archytes, in all probability genuine Pythagoreans, were contemporaries of Plato and Socrates. (See *Thirlwall's Hist. of Greece*, vol. ii. c. 12.; *Ritter's Hist. of Philosophy*, b. iv.; *Boeckh's Philolaus*, &c.)

The doctrine of *metempsychosis*, or the transmigration of souls through different orders of animal existence, is the main feature by which the Pythagorean philosophy is popularly known. It is, however, by no means certain that the genuine Pythagoreans held this doctrine in a literal sense. It may have been only a mythical way of communicating their belief in the individuality and *post mortem* duration of the soul.

PY'THIAN GAMES. One of the four great national festivals of Greece, celebrated every fifth year in honour of Apollo, near Delphi. Their institution is variously referred to Amphictyon, son of Deucalion, founder of the council of Amphictyons, and Diomed, son of Tydeus; but the most common legend is that they were founded by Apollo himself, after he had overcome the dragon Python. The contests were the same as those at Olympia, and the victors were rewarded with apples and garlands of laurel. As is well known, the priestess who delivered the oracle at Delphi was called Pythia. *See* DELPHI.

PY'THON. (Gr. πυθων.) The name of a genus of large non-venomous Ophidian reptiles, having anal hooks, and a double series of sub-caudal scutæ.

PYX. The name given to the box in which the host is kept by the Roman Catholic priesthood.

PYXI'DIUM. (Gr. πυξις, *a small box.*) A fruit which divides circularly into a lower and upper half, of which the latter acts as a kind of lid.

PY'XIS NAUTICA. The Mariner's Compass. A constellation of the southern hemisphere, formed by Lacaille.

PYX, TRIAL OF. *See* COINAGE.

Q.

Q. (Fr. queue, *a tail;* its form being that of O with a tail.) In all the languages in which it is used it is invariably followed by *u*. Q is used as an abbreviation for *question;* Qy. for *query;* Q. E. D. for *quod erat demonstrandum*, which was to be demonstrated, &c.

QUADRAGE'SIMA. (Lat. *fortieth.*) In the Calendar, a term applied to the time of Lent, because it consists of about forty days. *Quadragesima* Sunday is the first Sunday in Lent, and about the fortieth day before Easter.

QUADRA'NGLE. In Geometry, a plane figure having four angles, and consequently four sides.

QUA'DRANS. A division of the Roman *as*, consisting of one fourth of it, or three ounces when the *as* was of its full weight. (*See* As, Teruncius.) A farthing. Before Edward I. the smallest coin was a penny or starling. It was marked with a cross, so as to admit of being quartered; but, to avoid unfair cutting, halfpence and farthings were coined in the above reign.

QUA'DRANT. In Geometry, the fourth part of a circle; an arc of 90 degrees.

Quadrant is also a mathematical instrument, formerly much used in astronomy and navigation. The instrument is variously contrived and fitted up, according to the purpose for which it is intended; but it consists essentially of a limb or arch of a circle equal to the fourth of the circumference, and divided into 90°, with subdivisions. The mural quadrant is of considerable size (6 or 8 feet radius, for example), the axis of which moves in a wall or solid piece of masonry. Ptolemy, in the *Almagest*, describes a quadrant with which he determined the obliquity of the ecliptic. Tycho Brahe had a large mural quadrant for observing altitudes, and others which revolved on a vertical axis for measuring azimuths. Picart, in his measurement of the earth, used a quadrant for his terrestrial angles. In 1725 a mural quadrant, by Graham, was erected in the Royal Observatory at Greenwich, which, in 1750, was replaced by Bird's quadrant, with which Bradley made his celebrated observations. The quadrant has, however, of late years been entirely superseded by the *mural circle;* it having been found that the circle, on account of the symmetry of its form, and the advantage which it possesses of allowing the readings to be made at different parts of the limb, is an instrument much more to be relied on. (*See* Mural Circle.) *Hadley's quadrant*, in its principle and application, is the same as the *sextant*, by which it has been superseded. (*See* Sextant.) For further information respecting the quadrant, see Lalande, *Astronomie*, s. 2311.; *Vince's Practical Astronomy; Pearson's Practical Astronomy;* and the *Penny Cyclopedia.*

Quadrant, in Gunnery, or the *gunner's square*, is an instrument used for elevating and pointing cannon, mortars, &c. It consists of two rectangular branches of wood or brass, having a quadrantal arch between them, divided into 90°, and furnished with a thread and plummet. One of the branches being placed in the mouth of the piece, the degree intersected by the thread on the limb shows the elevation.

QUADRAN'TAL TRIANGLE, in Trigonometry, is a spherical triangle which has one side equal to a quarter of a circle, or 90°.

QUA'DRANT OF ALTITUDE. An appendix to an artificial globe, consisting of a thin pliable slip of brass, which is applied to the globe, and used as a scale for measuring the distances between points in degrees. It is graduated into 90°, the degrees being of the same length as those on one of the great circles of the globe. At the end where the division terminates a nut is rivetted on, and furnished with a screw, by which it is attached to the brass meridian of the globe at any point. This point being placed in the zenith, and the quadrant applied to the globe, its zero coincides with the horizon, and consequently the altitude of any point along its graduated edge is indicated by the corresponding division.

QUADRA'TIC EQUATION, in Algebra, is an equation of the second degree, or one which involves the second power, or square, of the unknown quantity.

Quadratic equations are of two kinds, *incomplete* and *complete*. The incomplete equation is that which contains only terms affected by the square, and not by the simple power of the unknown quantity. It is also called an *equation of two terms*, because, by means of proper reductions of the known quantities, it may always be put under the form $a x^2 = b$; or a *pure* quadratic, because, on dividing by the coefficient of x^2, it contains only the square of the unknown quantity in one term, or is of the form $x^2 = c$.

The *complete* quadratic equation consists of three terms, containing the square of the unknown quantity in one, the simple power in another, and the known quantities in a third. It is also called an *affected* quadratic, and its general form is $a x^2 + b x + c = 0$.

When the proposed equation consists of only two terms, the method of finding the value of the unknown quantity is obvious. Let the equation after reduction be $x^2 = p$, then $x = \sqrt{p}$. Now, if p be a number, its square root, which is the value of x, can either be found exactly, or to any required degree of approximation; and if p be an algebraic quantity, its square root will be found either exactly or approximately by the ordinary methods of extraction. There is, however, a circumstance respecting the sign of the root which must be attended to. The root of any quantity may be either positive or negative, because the square of $+a$ and of $-a$ is equally a^2; whence $\sqrt{a^2} = \pm a$, and the equation $x^2 = p$ gives two values of x, namely, $x = +\sqrt{p}$, and $x = -\sqrt{p}$.

As the square of any quantity, whatever be its sign, is always positive, it follows that a negative quantity can never be formed by the multiplication of any real quantity into itself, and hence an equation of the form $x^2 = -p$ can have no real root. When such an equation occurs in the solution of a problem in which only real quantities are concerned, it shows that some contradiction is involved, either in the data, or in the reasoning by which that result has been produced.

A complete quadratic equation is always reducible to the form $x^2 \pm a x = \pm b$; and in order to deduce from it the value of x, it is necessary to add some known quantity to both sides by which the first will be rendered an exact square. The square of the binomial $x + u$, is $x^2 + 2 u x + u^2$; on comparing this with $x^2 + a x$, it is evident that if we suppose $a = 2 u$, or $u = \frac{1}{2} a$, and consequently $u^2 = \frac{1}{4} a^2$, the quantities $x^2 + 2 u x + u^2$ and $x^2 + a x + \frac{1}{4} a^2$ will be equal; and therefore, since $x^2 + 2 u x + u^2$ is the square of $x + u$, so $x^2 + a x + \frac{1}{4} a^2$ must be the square of $x + \frac{1}{4} a^2$, which is equal to $x + u$. If, therefore, the proposed equation be $x^2 + a x = b$, let $\frac{1}{4} a^2$ be added to both sides, and it becomes $x^2 + a x + \frac{1}{4} a^2 = \frac{1}{4} a^2 + b$, which, on extracting the square root, gives $x + \frac{1}{2} a = \pm \sqrt{\frac{a^2}{4} + b}$; therefore, by transposition, $x = -\frac{1}{2} a \pm \sqrt{\frac{a^2}{4} + b}$.

In like manner, it will appear that if the proposed equation were $x^2 - a x = b$, the equation giving the value of x will be $x - \frac{a}{2} = \pm \sqrt{\frac{a^2}{4} + b}$; whence $x = \frac{a}{2} \pm \sqrt{\frac{a^2}{4} + b}$. The quantity b retains the same sign in the resolved as in the original equation.

From these considerations, the rules for the solution of quadratic equations in general follow so obviously that it is unnecessary to state them in form. The double sign, however, which appears in the root, and which shows that the unknown quantity in every quadratic equation has two distinct values, requires some further attention.

Taking an example in numbers, let the proposed equation be $x^2 + 2 x = 35$. Adding to each side the square of half the coefficient of x, or of 1, it becomes $x^2 + 2 x + 1 = 36$; whence $x + 1 = \pm 6$, and, consequently, $x = -1 \pm 6$; that is, $x = +5$, or $x = -7$. Now, if we transpose the absolute term of the proposed equation $x^2 + 2 x = 35$ to the left side, it becomes $x^2 + 2 x - 35 = 0$; and it is easy to see (and may be proved by actual multiplication), that $x^2 + 2 x - 35$ arises from the product of two factors $x - 5$ and $x + 7$; therefore $(x - 5)(x + 7) = 0$. But this last equation may be satisfied in two ways, viz. either by making $x - 5 = 0$, or by making $x + 7 = 0$. If $x - 5 = 0$, then $x = 5$; and if $x + 7 = 0$, then $x = -7$. There are two values of x, therefore, which alike satisfy the proposed equation nearly, +5 and − 7, and these are the two roots found above by the direct solution.

What has been now said in respect of the particular example is true of quadratic equations in general. Every expression of the form $x^2 + a x - b$ is decomposable into two factors, $x - p$ and $x + q$, in which p and q are quantities independent of x, and depending only on a and b. Hence the equation $x^2 + a x - 6 = 0$ is identical with the equation $(x - p)(x + q) = 0$; and this last is obviously satisfied alike by making $x - p = 0$, or by making $x + q = 0$, that is, by $x = +p$ or $x = -q$.

It follows, therefore, that every quadratic equation has necessarily two roots, and it is obvious that it can have no more than two; for if it could be supposed to have three, or any great number, then the expression $x^2 + a x - b$ would be resolvable into as many separate factors of the form $x - p$, $x - q$, $x - r$, &c. But this is evidently impossible; for the product of three such factors would necessarily contain the third power of x, or x^3, which the given equation does not. The resolution of equations into as many factors as there are roots is a

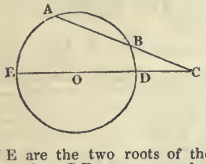
property belonging to equations of every degree. *See* EQUATIONS.

The consideration of the nature of the factors into which the proposed equation can be resolved leads to some important consequences. The hypothesis $x^2 + a x - b = (x - p)(x + q)$ gives $x^2 + a x - b = x^2 - (p - q) x - p q$; whence, since x is an indeterminate quantity, we must have $a = -(p - q)$ and $b = p q$. Now, since $+p$ and $-q$ are the two roots of the equation $x^2 + a x = b$, it is evident that $p - q$ is their sum, and $-p q$ their product; therefore, because $p - q = -a$, the sum of the two roots of any quadratic $x^2 + a x = b$ is equal to the coefficient of the second term, having its sign changed; and their product is equal to the absolute number or term which does not contain x, having its sign also changed.

The roots of quadratic equations may be exhibited by a geometrical construction. All quadratics belong to one of the four forms,

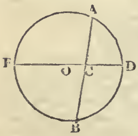
$$x^2 + a x = b c, \quad x^2 - a x = b c,$$
$$x^2 + a x = -b c, \quad x^2 - a x = -b c.$$

Now to construct the first form, let a circle be described on a diameter $= a$, or radius $= \frac{1}{2} a$: in the circle inflect a straight line, $A B = b - c$, and produce it to C, so that $A C = b$, and consequently $B C = c$; and draw C D E through the centre O, meeting the circle in D and E; then C D and C E are the two roots of the equation. For let $C D = x$, then $C E = x + a$, and the rectangle $C D \cdot C E = x(x + a) = x^2 + a x$. But by construction $C A \cdot C B = b c$, and by the property of the circle $C D \cdot C E = C A \cdot C B$; therefore, $x^2 + a x = b c$, which was the equation given.



To construct the second form, namely, $x^2 - a x = b c$, let $C E = x$; then $C D = x - a$, and, consequently, $C E \cdot C D = x(x - a) = x^2 - a x$; but, as before, $C E \cdot C D = C A \cdot C B = b c$; therefore $x^2 - a x = b c$, and the roots of the equation are C E and C D. In these two cases, if $b - c = 0$, the straight line C B A becomes a tangent to the circle; and if $b - c$ be greater than a, another line may be taken which is a mean proportional between b and c, and which will be the tangent to the circle, so that the construction is possible in all cases.

To construct the fourth form, $x^2 - a x = -b c$, let a circle be described with the radius $\frac{1}{2} a$ as before, and inflect in it a straight line $A B = b + c$; take $A C = b$, and through C and the centre O draw the diameter E D; then E C and C D are the two roots of the equation or values of x. For, since $E D = a$, if $E C = x$, then $C D = a - x$, and therefore $E C \cdot C D = x(a - x) = a x - x^2$. But $E C \cdot C D = A C \cdot C B = b c$; therefore $a x - x^2 = b c$; or $x^2 - a x = -b c$. The same construction gives the third form, $x^2 + a x = -b c$; but the two roots are in this case both negative, namely, $-E C$ and $-C D$.

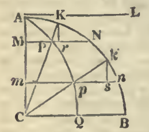


Hence it follows that every geometrical problem producing a quadratic equation can be constructed by means of a circle and straight lines; and, reciprocally, all problems respecting circles and straight lines may be resolved algebraically by means of quadratic equations.

QUADRA'TO, or QUA'DRO. (It.) In Music, a name given to the note B in the natural or diatonic scale, marked thus ♮, being a semitone minor higher than B mol or ♭.

QUADRA'TRIX. In Geometry, a transcendal curve, by means of which the quadrature of curvilinear spaces can be determined mechanically. The best known of these curves is the *Quadratrix of Dinostratus*, so called from its reputed inventor, a brother of Menechmus and disciple of Plato. This curve is generated as follows:—

In the circular quadrant C A B, suppose the radius C A to revolve uniformly about C, passing through the different positions C K, C k, &c., till it arrives at the position C B; and that during the same time a line A L, at right angles to C A, moves parallel to itself with a uniform motion from the position A L, passing through the different positions M N, m n, &c., and arriving at C B at the same instant that C K coincides with C B; then the continual intersection of the revolving radius and the parallel line will trace the quadratrix A P Q.



From this mode of describing the curve, it is easy to see how it may be applied to divide an angle into any number of equal parts. Let it be required, for example, to trisect the angle A C k. Having applied the quadratrix to C A, take A M equal to a third of A m, and through M draw M N perpendicular to A C, meeting the curve in P; join C P, and the angle A C P is equal to one third of A C k; for by the nature of the quadratrix A M : A m : : A K : A k.

The application of this curve to the quadrature of the circle depends on the property that the line C Q is a third proportional to the quadrantal arc A B, and the radius. Hence the arc $A B = \frac{C B^2}{C Q}$, and consequently the area of the quadrant $C A B = \frac{C B^3}{2 C Q}$.

If the quadratrix be continued beyond A, without the circle, it will consist of a series of infinite hyperbolic branches, cutting the axis C A produced, in points which are separated from each other by a space equal to 2 A C.

Other curves may be formed in a similar manner, by which the quadrature of the circle would be obtained. Thus, instead of supposing the lines M N, m n to be intersected by the radiants C K, C k, we may suppose straight lines drawn from K k parallel to A C, intersecting M N, m n in r and s; these intersections form a different curve, which is called the *Quadratrix of Tschirnhausen*.

Let $A M = x$, $M P = y$, and $A C = a$; then, since $x : a : : A K : A B$, or $\frac{1}{2}\pi$, we have $A K = \frac{\pi x}{2 a}$. Hence the equation of the quadratrix of Dinostratus is $y = (a - x) \tan. \frac{\pi x}{2 a}$; and that of the quadratrix of Tschirnhausen $y = a \sin. \frac{\pi x}{2 a}$. (Montucla, *Histoire des Mathematiques; Peacock's Collection of Examples; Leslie's Geometry of Curve Lines.*)

QUA'DRATURE, in Astronomy, denotes the position of the moon when she is 90° from the sun, or at one of the two points of her orbit equally distant from the conjunction and opposition.

QUADRATURE, in Geometry, signifies the determination of the area of a curve, or finding an equal square. The differential element of the area of a curve referred to rectangular co-ordinates is $y\,d\,x$; and since y is given in terms of x by the equation of the curve of which the area is proposed to be found, the problem of quadratures in general reduces itself to the integration of the differential $X\,d\,x$, in which X is an algebraic function of x and known quantities. In the applications of the higher geometry, a problem is conceived to be resolved when it is reduced to quadratures; that is, when the variable quantities have been separated, and its solution been made to depend on finding the values of one or more integrals of the form $\int X\,d\,x$. In the case of some curves, parabolas, for example, of different orders, expressed by the equation $y^m = a x^n$, the integral is found in finite terms; in regard to other curves, the circle, for example, it can be represented by a converging series; but it frequently happens, especially in the applications to physical astronomy, that the expression represented by X is too complicated to allow of the integral $\int X\,d\,x$ being found by a converging series; and when this occurs, the only thing that can be done is to find values of it for particular cases only, that is to say, for portions of the area corresponding to values of x, taken within certain limits. The method of quadratures accordingly forms an important branch of the Integral Calculus.

The *quadrature of the circle* is a problem of great celebrity in the history of mathematical science. The whole circular area being equal to the rectangle under the radius, and a straight line equal to half the circumference, the quadrature would be obtained if the length of the circumference were assigned; and hence the particular object aimed at in attempting to square the circle is the determination of the ratio of the circumference to the diameter. This ratio can only be expressed by infinite series, of which many have been given that converge with great rapidity. *See* CIRCLE.

It is necessary to make a distinction between the *definite* and the *indefinite* quadrature. The definite quadrature would be that which would give either the area of the whole circle, or of some particular portion of it, without giving that of every other portion; the indefinite quadrature would give the area of any sector whatever, or the length of any arc which could be assigned. James Gregory undertook to demonstrate that the definite quadrature is impossible; Huygens, however, objected to his reasoning; and the opinion of geometers seems to be, that no satisfactory demonstration has yet been given of the absolute impossibility of solving the problem. It has indeed been proved by Lambert and Legendre that the ratio of the circumference to the diameter, and its square, are irrational numbers. But irrational quantities may be

susceptible of geometrical construction; and if a straight line equal to the circumference of a circle having a given radius could be constructed geometrically, the quadrature of the circle would be accomplished, although the length of the line could not be expressed by a finite number. With regard to the indefinite quadrature, Newton has demonstrated in the *Principia* (though in a manner not altogether unobjectionable) that no curve which returns into itself, like the circle or ellipse, is susceptible of it.

Numerous pretenders to the discovery of the quadrature of the circle have appeared at various times, and occasionally present themselves even at the present day. They are only to be found among those who have an imperfect knowledge of the principles of geometry; and when their reasoning happens to be intelligible, their paralogisms are in general easily detected. With a view to discourage the futile attempts so frequently made on this and similar subjects, the Academy of Sciences of Paris, in 1775, publicly announced, that it would not examine in future any paper pretending to the quadrature of the circle, the trisection of an angle, the duplication of the cube, or the discovery of the perpetual motion; and shortly after the Royal Society adopted a similar resolution. For the history of this famous problem, see the third supplement to the 4th volume of Montucla.

It was stated in the article CIRCLE that the approximation to the numerical ratio of the circumference to the diameter had been computed by De Laguy to 128 places of decimals. It should have been added, that the approximation was carried by Vega to 140 figures; and Montucla mentions a MS. in the Radcliffe Library at Oxford, in which it is carried to 154 figures. Very recently (May, 1841) a paper was communicated by Mr. Rutherford of Woolwich to the Royal Society, in which the number is extended to 208 places of decimals, and which is presumed to be accurate to the last figure, the computations having been actually carried to 210 figures.

QUA'DRICORNS, *Quadricornia.* (Lat. quatuor, *four*, and cornu, *a horn.*) The name of a family of Apterous insects, comprehending those which have four antennæ. A species of antelope with four horns is called *Antilope quadricornis*.

QUA'DRIFORES, *Quadrifora.* (Lat. quatuor, and foro, *I pierce.*) A name given by Latreille to a family of Sessile Cirripeds, comprehending those in which the opercular covering of the tube is composed of four valves or calcareous pieces.

QUADRI'GA. (Lat. quatuor, and jugum, *a yoke.*) In Antiquity, a car or chariot drawn by four horses, which were harnessed all abreast, and not in pairs. The quadriga is often met with on the reverse of medals, which are thence termed *nummi quadrigati*, or *victoriati*, from there being a representation of a figure of Victory holding the reins.

QUA'DRI HY'DROCA'RBON. A liquid hydrocarbon, in which 4 atoms of hydrogen and 4 of carbon are so combined and condensed as to constitute one atom of quadri hydrocarbon.

QUADRILA'TERAL. (Lat. quatuor, *four*, and latus, *a side.*) In Geometry, a plane figure contained by four straight lines. It comprehends the square parallelogram, rectangle, rhombus, rhomboid, and trapezium. The most general properties of a quadrilateral figure are the two following: — 1. The sum of the four angles is equal to four right angles; 2. The sum of the squares of the sides is equal to the sum of the squares of the two diagonals together, with four times the square of the straight line which joins the middle points of the diagonals.

QUADRILA'TERALS, *Quadrilatera.* (Lat.) The name of a tribe of crabs (Brachyurous Crustaceans), comprehending those in which the carapace or shell is more or less square-shaped.

QUADRIPE'NNATES, *Quadripennes.* (Lat. quatuor, and penna, *a wing.*) The name of a section of Anelytrous insects, including those which have four wings.

QUADRIRE'ME. (Lat. quatuor, and remus, *an oar.*) A ship of war in use among the ancient Greeks and Romans; so called because it had four banks of oars. *See* GALLEY.

QUADRISU'LCATES, *Quadrisulcata.* (Lat. quatuor, and sulcus, *a furrow.*) A name applied to those Ungulate quadrupeds in which the hoof is divided into four parts, corresponding to the four digits.

QUADRI'VIUM. (Lat.) In the language of the schools, the four lesser arts, — arithmetic, music, geometry, and astronomy. *See* TRIVIUM.

QUA'DRUM. In Music, the same as *natural*, which see.

QU'ADRUMANES, *Quadrumana.* (Lat. quatuor, *four*, and manus, *hand.*) The name of an order of Mammals, comprehending those in which the four extremities are terminated by a hand; as the ape, baboon, &c. The hinder extremities are always terminated by more perfect hands than the fore extremities, in which the thumb is sometimes wanting, or, in the South American monkeys, incapable of being opposed to the other digits.

QUA'DRUPEDS, *Quadrupedia.* (Lat. quatuor, *four;* pes, *a foot.*) All Vertebrate animals with four extremities fitted for terrestrial progression were formerly so called, the scaly reptiles being distinguished, as oviparous quadrupeds, from the hairy warm-blooded viviparous four-footed mammals. But as there are both reptiles and mammalia which have only two legs, and as those of both classes which agree in having four legs differ essentially in the important characters on which classific distinctions are now founded, the term quadruped is no longer used in a strict zoological sense as indicative of a particular group of animals.

QUA'DRUPLE. In Arithmetic, fourfold: the product of any magnitude or quantity multiplied by 4.

QUÆ'STOR. A Roman magistrate whose office it was to collect the public revenue, whence their name (from quæro, *I seek*) was derived. Two quæstors were originally chosen by the kings in the earliest times of the city; and after their expulsion the appointment remained in the hands of the consuls till the year 307 A.C., when they began to be elected by the people at the Comitia Tributa. Soon after this two more quæstors were appointed to attend the consuls in war; and from this time they might be chosen indifferently from plebeians and patricians, the former class having been previously excluded. As the Roman empire was extended over all Italy and the other countries that finally owned its sway, the number of quæstors was increased, so that one was appointed to each consul or prætor when he went to his province; and this was done generally by lot, but sometimes the superior magistrate was allowed to choose his own quæstor. The quæstorship was the first step of preferment which gave admission into the senate; but it was sometimes held by those who had been consuls. Under the emperors the office underwent many changes; Augustus deprived them of the charge of the treasury, which he imposed on the prætors, and gave them the superintendence of the public records; but the former office was restored to them by Claudius.

QUA'GGA. The name of a Solipedous quadruped, or species of *Equus*, allied to the zebra.

QUA'GMIRE. Boggy ground saturated with water to such a degree as to be more like mud than firm soil.

QUAIL. A genus of Gallinaceous birds (*Coturnix*, Cuv.), allied to the partridge, but of smaller size, with a more slender beak and shorter tail, and without red eyebrows or spurs.

QUA'KERS, or FRIENDS. A religious sect, which had its origin in England about the middle of the 17th century, and spread, by the emigration of its members, who were exposed to many restrictions and persecutions in this country, over various parts of Europe and North America. The founder of the sect was George Fox, who being equally dissatisfied with the tenets of the established church and those of the Puritans, succeeded in attaching to himself various persons who agreed with him in the view which he took of the internal operation of religion on men's hearts, conceiving it to supersede all the observances of different denominations, nor to be evidenced in any degree by them. The Quakers, therefore, reject both the sacraments; nor do they appoint any order of ministers, but consider the instruction and edification of their congregations to be the province of whatsoever person of either sex conceives himself to be impelled thereto at the time by an internal suggestion of the Spirit. Upon doctrinal points, however, they assert themselves to maintain opinions coincident with those generally received by the orthodox. Their internal affairs are managed by yearly, quarterly, and monthly meetings, of which the former in this country is held in London, and embraces representatives for all the rest. A similar arrangement takes place among the females of the society, who are allowed a considerable share in the management of the affairs of their own sex.

This society is distinguished in its intercourse with the world by great seriousness of deportment, uniform soberness in dress, and generally a scrupulous avoidance of every thing which can encourage vanity and frivolity. They are all sensitively averse from all matters of ceremony, which they conceive to have their origin in flattery and deception. Their refusal to take judicial oaths used in former times to subject them to very severe penalties. Up to the accession of James II. their history is an unvaried series of persecutions; either such as they endured in common with other dissenters, or such as were peculiar to themselves in consequence of their refusal to pay tithes and to take oaths. Under James, the severity of the penal laws was relaxed; but William III. was the first prince who enacted laws for the especial relief of the Quakers. From this time, their affirmation is received in lieu of oath in judicial proceedings; and an alteration in the method of levying tithes has been provided, by which their scruples are satisfied. (See, among other authorities respecting the Quakers, *Fox's Journal; Barclay's Apology;* and *Sewell's History of the Rise, &c. of the Quakers* (1722). The Quakers of the present day are thought to be a decreasing sect. In 1836, the number of their congregations was estimated at 396. (*Congregational*

Magazine.) They are most numerous in Yorkshire, Lancashire, Durham, Cumberland, and Essex.

QUA'KING BOG. Peat bog in a growing state, and so saturated with water that a considerable extent of surface will quake or shake, when pressed on by the foot or any other body. Such bogs are unfit for any useful purpose till they are drained.

QUA'LITY. (Lat. qualis.) In Physics, some property or affection of bodies. Sensible qualities are those which immediately affect the senses; as figure, taste, &c.

Quality, in the philosophy of Kant, the *second* category (there being four in all), comprising the notions of existence or reality, non-existence or negation, and limitation.

QUA'NTITY. (Lat. quantus, *how much.*) A property of any thing capable of being increased or diminished. Quantity is distinguished into *continued* and *discrete*. It is continued when the parts are connected together, and is then called magnitude, which is the object of geometry. It is discrete when the parts have an unconnected and independent existence, forming multitude or number, which is the object of arithmetic. The quantity of matter in any body is proportional conjointly to the magnitude and density of the body, and is measured by its absolute weight. Quantity of motion is used synonymously with *momentum*, to denote the product of the quantity of matter in the moving body by its velocity. Algebraic quantities are the expressions of indefinite numbers.

Quantity. In Prosody, the amount of time in a syllable. Syllables are either short or long; the former being the unit or smallest measure of time, the latter consisting of two times. This distinction is clearly marked in the ancient languages; in which some syllables are necessarily long or short by position, others by the nature of the vowels which they contain; and, in the Latin language, some common, or susceptible of being sounded as long or short, according to certain rules of elegance or convenience. All the metrical system of the ancient languages is founded on quantity. In most modern languages there is, strictly speaking, no quantity, as distinct from emphasis or accent; the long syllables being those which receive the arsis, the short those which receive the thesis. In the German language, however, critics have endeavoured to establish a conventional system of quantity, and thus to adapt that language to regular versification in the ancient Greek and Latin metres. *See* Rhythm, Metre.

QUA'RANTINE. (Ital. quaranto, *forty.*) A period of time of variable length, during which a vessel from certain coasts or ports, said or supposed to be infected with certain diseases, is not allowed to communicate with the shore, except under particular restrictions. A ship in quarantine carries a yellow flag at the main; and when released from this condition, she is said to obtain *pratique.* The term is derived from the Ital. quaranto, *forty*, it being generally supposed that if no infectious disease break out within 40 days or six weeks, no further danger is to be apprehended. It is universally believed that the Venetians were the first to adopt regulations for guarding against the introduction of infected persons into their ports; but there is now no civilized country in which it is not practised. (For full particulars on the history and policy of quarantines, see the *Com. Dict.*

QUA'RE IMPEDIT. In Law, a writ lying for one who has a right of advowson against a person who hinders or disturbs him in his right by presenting a clerk when the church is void.

QUART. A measure of capacity, being the fourth part of a gallon. *See* Measures.

QUA'RTAN. (Lat. quartus, *fourth.*) A species of intermittent fever or ague, which returns every fourth day. *See* Ague.

QUARTA'TION. In Metallurgy, the separation of silver from gold by means of nitric acid. To extract the whole of the silver from gold by the action of nitric acid, it is necessary that there should be at least three parts of silver to one of gold, otherwise the gold protects the silver from the action of the acid; so that, in thus separating these precious metals, it is customary, where gold greatly predominates, to add silver till it constitutes at least three fourths of the alloy.

QUA'RTER. The fourth part of any thing. As a term of weight, it denotes the fourth of a hundred weight, or 28 pounds; as a dry measure, it signifies the fourth of a chaldron.

Quarter. The after part of the ship's side. *On the quarter*, implies the bearing or position of an object seen between aft and abeam.

QUARTER DAYS. The days usually regarded in England and most Continental countries (but not in Scotland) as beginning the four quarters of the year. They are, 1. Lady Day (25th of March); 2. Midsummer Day (June 24th); 3. Michaelmas Day (Sept. 29th); and, 4. Christmas Day (Dec. 25th).

QUARTER DECK. The portion of the uppermost deck of a ship between the main and mizen masts. This is the "parade" in men-of-war.

QUA'RTERING. In Heraldry, the division of a shield by two lines, fess-wise and pale-wise, meeting in the centre of the shield. In marshalling, whenever a husband can place his wife's arms on an escutcheon of pretence (*see* Escutcheon), the children may bear them quarterly, with their own: whence arises the great variety of quarterings in the shields of some families.

QUARTER MASTER. In the Navy, a petty officer, who, besides other duties of superintendence, *cons* the ship, and attends to her steerage.

Quarter-master. In the Army, an officer whose business it is to look after the *quarters* of the soldiers, and attend to their clothing, bread, ammunition, &c. There is a quarter master attached to every regiment, whether of foot, cavalry, or artillery.

QUA'RTER ROUND. In Architecture. *See* Echinus and Ovolo.

QUA'RTERS. The stations of a ship's crew in time of action, to which they are summoned by beat of drum, or by the boatswain's pipe.

QUARTERS and QUARTERING. (Fr. quartiers.) In Architecture, the upright posts in partitions to which the laths are nailed. Quarters are either single or double; the former being sawn stuff two inches thick, and four inches broad; the latter usually sawn to a scantling four inches square, or four inches by a less width. No quarters should ever be more than fourteen inches apart. *Quartering* is a term properly applied only to an assemblage of quarters, though it is not unfrequently used to denote the quarters themselves.

QU'ARTER SESSIONS OF THE PEACE. In Law, a court held by two justices at least, one of whom must be of the quorum, quarterly, in every county; having a jurisdiction originally in matters touching the breach of the peace only, but since extended by various statutes. (*See* Justices of the Peace.) Quarter sessions in boroughs, since the Municipal Corporation Act, are held by the recorders.

QUARTER STAFF. A weapon of defence; so called from the manner of using it, one hand being placed in the middle, and the other equally between the middle and end.

QUA'RTETT. A piece of music arranged for four voices or four instruments. Of the latter the most celebrated are arranged for two violins, — a tenor violin, and a violoncello; and many of the most distinguished composers, among whom we may mention Haydn, Mozart, Beethoven, Romberg, Spohr, Ries, Onslow, &c., have not disdained to devote their talents to this species of composition. The term *quartett*, though strictly any piece in four parts, is seldom applied except to instrumental pieces.

QUA'RTILE A'SPECT, in Astrology, denotes the aspect or appearance of two planets, whose positions are at a distance of 90° on the zodiac.

QUA'RTINE. The fourth envelope of the vegetable ovulum, beginning to count from the outside.

QUARTO. A name given to books composed of sheets of paper folded into four leaves. It is abbreviated 4to.

QUARTODECIMA'NTES. In Church History, those who *imitated the Jews* in celebrating Easter on the 14th day of the paschal moon, instead of the Sunday next following, were so called, after they had been excommunicated as heretics by the councils of Nice, Constantinople, and Ephesus. *See* Easter.

QUARTZ. A German term, now universally adopted in scientific language, and commonly applied in mineralogy to the purer varieties of silica, especially to rock crystal.

QUASIMO'DO. In the Roman Catholic Calendar, the first Sunday after Easter; so called because the *Introit* for that day begins with the words "Quasi modo geniti infantes." (1 Pet. ii. 1.) It is also called Dominica in albis, as being the day on which those who had been baptized on Easter Sunday deposited their white robes in the sacristy.

QUA'SSIA. The wood of the *Quassia excelsa*, or *amaru;* a native of South America, and some of the West Indian Islands. It yields an intensely bitter infusion, which may be made with one drachm of the shavings of quassia to a pint of boiling water: of this a wine-glass-full may be taken twice a day, with or without other additions, as a tonic. It is a good vehicle for most of the metallic salts, which are not decomposed by it, as by many other bitter vegetable infusions. A strong infusion of quassia, sweetened with brown sugar, is a safe and effective poison for flies.

QUATRAI'N. (Ital. quattrino.) In Poetry, a piece consisting of four verses, the rhymes usually alternate; sometimes also, especially in French poetry, intermixed, the first and fourth, second and third, rhyming together.

QUA'VER. (Sax. cpazian.) In Music, a character, ♪, whose measure is equal to half a crotchet, or one eighth of a semibreve.

QUEEN. (Anglo-Sax. cwen, *wife.*) 1. A female sovereign; entitled queen regnant, or queen regent. She has, in Great Britain, the same power, prerogatives, &c., as a king, which is expressly declared by stat. 1 Mar.

1. st. 3. c. 1. In France, where females do not succeed to the throne, the title queen regent has been given to the mothers of kings holding sovereign authority, or a portion of it, during the minority of their sons; as Catherine de Medicis in the reign of Francis II.; Mary de Medicis, in that of Louis XIII.

2. *Queen Consort.* The wife of a king. Her rights and dignities (in England, as well as most other countries) appear to be similar in many respects to those of the "Augusta," or Piissima regina conjux divi imperatoris, in imperial Rome. The English queen, like the Roman empress, is capable of receiving a grant from her husband, or making one to him; therein differing from all other wives. She can also purchase and convey land, &c., without his concurrence; and sue and be sued alone: in short, she is looked upon in all legal proceedings as a feme sole. But, except where she enjoys specific exemptions, she is only on a footing with other subjects; and this also is according to the Roman maxim, "Augusta legibus soluta non est." By the Statute of Treasons, 25 Ed. 3., to compass or imagine the death of the king's "companion," and also to violate and defile her, is treason. The queen, if accused of treason herself, is tried by the peers of parliament; as Ann Boleyn in 28 Hen. 8. The consort of George IV. was proceeded against by the method of a bill of pains and penalties. *Queen-gold* was a duty amounting to one full tenth of the value of fines, &c. on grants by the crown, anciently due to the queen; which Charles I. purchased of his consort Henrietta, in 1635, for 10,000*l*., but which was not revived after the restoration. The queen consort has a separate household, consisting of six ladies of the bed-chamber, a chamberlain, vice-chamberlain, mistress of the robes, master of the horse, and three equerries, attorney and solicitor general, &c.

3. *Queen Dowager.* The widow of a deceased king. She continues to enjoy most of the privileges which belonged to her as queen consort. Nor did she, in ancient times, lose her dignity on remarriage; for Catherine, queen dowager of Henry V., after she had married Owen Tudor, maintained an action by the name of Catherine Queen of England. But it is held that no man can marry a queen dowager without special licence from the king, on pain of forfeiture of lands and goods, according to an act of 6 H. 6., which, however, is not printed among the statutes. The revenue of a queen dowager is settled by statute. By 1 & 2 W. 4. c. 11. his late majesty was empowered to settle 100,000*l*. per annum on his queen, to commence at his decease.

4. *Queen Mother.* A queen dowager who is also mother of the reigning sovereign.

QUEEN POST. In Architecture, an upright post in a roof for suspending the beam when the principal rafters do not meet in the ridge. *See* Roof.

QUE'RCITRON BARK. The bark of the *Quercus nigra*, or American oak; it is a highly valuable dye stuff, and is used in the production of some of the most durable yellows.

QUE'RCUS. (Lat.) This is the most important genus of trees found in the cold countries of the world, on account of its producing the various kinds of timber called oak. The species are not, however, confined to Europe, or similar latitudes, but occur abundantly in the equinoctial parts of Asia and America; they have not, however, been found south of the equator. It is usually recognized by the cup in which the acorn is seated; but in some tropical species the acorn is so small as to be buried in the cup, when the fruit nearly resembles that of the chestnut (*Castanea*). The valuable oak of Great Britain is obtained from two native species: the one *Q. pedunculata*, the long-stalked or white oak; the other *Q. sessiliflora*, the sessile-fruited or red oak. A prejudice has arisen against the timber of the latter, which, however, appears to be unfounded, as it is found to be in point of strength and durability fully equal to the other. Oak timber, however, is affected very much by soil and climate; and hence we have oak of bad quality from both our native species. What is called wainscot oak is probably the timber of *Q. sessiliflora*, grown rapidly in the dense forests of Hungary; by some persons, however, it is supposed to be furnished by an oriental species called *Q. cerris*, or the mossy-cupped. The *Esculus* of Virgil, whose acorns were eatable, appears to have been a sweet-fruited variety of *Q. sessiliflora*. Besides the species already mentioned, the *Quercus ilex*, or European oak, the *Q. suber*, or cork tree, whose bark is in such extensive use, and the *Q. ballota*, or Spanish ilex, whose acorns are sweet and eatable, are the more important species. Those from North America, although fine trees, are inferior to the oaks of England as regards their timber, and require hotter summers than we have in those islands. Oak galls are produced upon *Q. infectoria*, in the Levant, by the puncture of a cynips. The species are excessively confused by botanists; but a full popular account of this genus will be found in *Loudon's Arboretum Britannicum*. For a few popular details, see also the article Oak, in this work.

QUESTION. The application of torture to prisoners under criminal accusation, according to the law of France before the Revolution. The question was of two kinds: one, where strong evidence, but insufficient of itself to justify a condemnation to death, existed against a prisoner on a capital charge; he might then be subjected to torture to produce confession. This was termed the question préparatoire. It was abolished by an ordinance of Louis XVI. in 1780. The other, termed question préalable or définitive, was applied to the prisoner when convicted of a capital offence, in order to make him discover supposed accomplices. It was abolished by the National Assembly. The preparatory question was also of two sorts:—one, avec réserve de preuves, in which case, if the criminal did not confess under the torture, the other evidence was considered as still subsisting against him, so as to justify his condemnation to some lighter punishment; the other, sans réserve de preuves, in which case, if he persisted in his denial, he was acquitted altogether. It was at the option of the judges, according to their opinion of the amount of evidence, to decide to which of these questions the accused should be subjected. The modes of torture applied varied in France, being fixed by the several parliaments within their separate jurisdictions. Those in common use at Paris were,—the question by water, which consisted in stretching the limbs of the sufferer on a board by means of screws, and forcing him to swallow large quantities of water; and the boots, in which his legs were inclosed in wooden cases, the whole tightly compressed with ropes, and wedges driven with a mallet between the two cases. The question varied in degree, being *ordinary* or *extraordinary*, at the discretion of the judges. Children and adolescents, old men, and women with child, were excepted from torture by the French law. And, by an ordonnance of 1670, the second application of the question was forbidden in all cases.

Torture has been applied, as a mode of extorting confession, in all countries into which the principles of the civil law have been imported; although the barbarity and uncertainty of the practice were remarked upon even in the best times of Roman jurisprudence. The observations of Cicero on the subject are well known; and Ulpian, the greatest authority on the civil law, speaks even more directly. "Res est fragilis et periculosa (the torture), et quæ veritatem fallit: nam plerique patientiâ sive duritiâ tormentorem ita et tormenta contemnunt, ut exprimi eis veritas nullo modo possit; alii tantâ sunt impatientiâ ut quidvis mentiri quam pati mallent." It is, however, an important remark, that as, by the strict principles of jurisprudence, the torture was only applied in cases where there already existed a mass of evidence against the prisoner, sufficient, in ordinary judgment, to warrant his condemnation, it did in fact afford him an additional chance of escape; and that, however great its absurdity on every supposition, its barbarity rather arose from its liability to abuse than its legitimate infliction.

The practice of judicial torture was not a part of the common law of England, except in one particular case. The rack is said to have been first introduced into this country by the dukes of Exeter and Suffolk, in the minority of Henry VI.; at all events, it was then first made a common engine of discovery in state matters. It was used, on warrant from the privy council, on prisoners in the Tower of London for a long period afterwards, and more especially in the reign of Elizabeth, to enforce confessions or accusation of accomplices from recusant priests, and others suspected of being engaged in treasonable plots against her. It was probably employed in the examination of Guy Fawkes, after the detection of the Gunpowder Plot; as has been conjectured, among other reasons, from the feeble and trembling hand in which the signature of that criminal to his last confession is written, when compared with that in which he subscribed his former declarations. On the trial of Felton for the assassination of Villiers, duke of Buckingham, the judges were consulted by the privy council as to the lawfulness of the infliction of torture; and on their asserting it to be illegal, it was not applied. there is, however, reason to suppose that it was used at least in one subsequent case in the reign of Charles I. (See *Jardine on Torture*, 1837.)

The exception to which allusion has been made, by which torture was in one case recognized by the common law, is the celebrated Peine Forte et Dure. It has, indeed, been said, and was asserted by the judges in 8 Hen. 4., that this infliction was only introduced in consequence of the first statute of Westminster; but it is at least highly probable that before that period, persons refusing to plead were subjected to imprisonment and ill-treatment to induce them to do so. After that statute, the judgment appears only to have been to strait and severe confinement; nor was it until the reign of Hen. 4. that its horrible character seems to have been fully determined by law. After that time, the prisoner was remanded to the place from whence he came, laid on the ground in a dark room, and "as many weights as he can

bear, and more," laid upon him; with no sustenance except a morsel of the worst bread and a draught of the worst water, on alternate days; and so to remain until he pleaded or died; which alternative, according to the later practice, was soon decided, as the weights laid on were sufficient to cause speedy death. The peine forte et dure was not unfrequently put in practice until the beginning of the last century; and as late as the commencement of the reign of George III. the enforcing prisoners to plead by squeezing their thumbs, and other modes of torture, was a common Old Bailey practice. By 12 G. 3. c. 20. any person standing mute, or not answering directly to the arraignment, incurred conviction.

QUI′CKLIME. Pure or caustic lime. *See* LIME.

QUI′CKSILVER. *See* MERCURY.

QU′IETISM. A name generally applied to the opinions of enthusiasts, who conceive the great object of religion to be the absorption of all human sentiments and passions into devout contemplation and love of God. This idea has found its admirers and encomiasts in all ages. A sect called by this name (in Greek, Hesychastæ) existed among the religions of Mount Athos; and in the 17th century it was given in France to a peculiar class of devout persons with a tendency towards a higher spiritual devotion, which seems to have arisen, in great measure, out of a natural opposition to the hierarchal coldness and positive morality of Roman Catholic religion at that time, especially under the influence of the Jesuits. A Spanish priest, Molinos, published at Rome a work entitled *The Spiritual Guide* (1675), of which the ardent language attracted a multitude of partisans. Its leading feature was the description of the happiness of a soul reposing in perfect *quiet* on God, so as to become conscious of His presence only, and untroubled by external things. He even advanced so far as to maintain that the soul in its highest state of perfection is removed even beyond the contemplation of God himself, and is solely occupied in the passive reception of divine influences. The work of Molinos was afterwards condemned on the application of the Jesuits. Akin to the ideas of Molinos seem to have been those of the French Quietists, of whom Madame de la Motte Guyon and Fénélon are the most celebrated names The former was at one time treated as insane, on account of some strange delusions which led her to represent herself (unless she was calumniated) as the mystical woman of the Apocalypse; at another, she was admitted to the intimacy of Madame de Maintenon, and high in court favour. Fénélon praised her in his treatise *Sur la Vie Intérieure* (1691), in which many of the most dangerous tenets of Quietism were contained. The writings of the latter upon this subject were finally condemned by Innocent XII.; and the example of the archbishop in submitting to the decision, and declaring himself satisfied and convinced by the opinion of the church, has been dwelt on by pious writers as a signal triumph of a truly religious mind. The dissolute conduct of some hypocritical priests, under the pretence of inculcating the tenets and practice of Quietism, brought it eventually into disrepute more than the repeated condemnations of the head of the Roman Catholic church.

QUI′NCUNX. The Latin term properly for that disposition of five objects in which they are made to occupy the four corners and point of intersection of the diagonals of a square; but the word is extended to any number of things so arranged in lines that the members of each succeeding line stand behind the spaces between those of the preceding one. Troops were frequently drawn up in this order; which was also a favourite arrangement for plantations of vines.

QUINDE′CAGON. In Geometry, a plane figure bounded by fifteen sides. The regular quindecagon is inscribable in a circle by elementary geometry. (*Euclid*, Book iv.)

QUINDECE′MVIRI. Roman magistrates, whose duty it was to take care of the Sibylline books, and consult them on critical occasions when the senate deemed their advice necessary. They were exempted from the privilege of serving in the army, and from other offices in the city; and their priesthood, which was probably in service of Apollo, lasted for life. Their number, as their name imports, was fifteen by Sylla's appointment; but originally they had been ten, an equal number being elected from patricians and plebeians; and by Julius Cæsar they were raised to sixteen.

QU′INIA, or QUININE. An alkaline base obtained from yellow bark; the *Cinchona cordifolia*. This substance, combined with sulphuric acid, forms the *sulphate of quinia*, which is now so extensively used as a medicine, and as a substitute for the various forms of Peruvian bark. To obtain quinia, bruised yellow bark is boiled in repeated portions of water, acidulated by sulphuric acid, till all its soluble matters are extracted; a little excess of quicklime is then added to the strained decoction, and the precipitate which is formed is collected, washed, and carefully dried; it is then digested in alcohol, which takes up the quinia, and from which it may be obtained in the form of a yellowish uncrystallizable substance by careful evaporation. It is dissolved in dilute sulphuric acid, and the sulphate of quinine, or quinia, crystallizes from its concentrated solution in fine silky prisms, which effloresce on exposure to air. Sulphate of quinia is difficultly soluble in water, and intensely bitter. It is administered as a tonic and febrifuge in doses of from one to five or six grains.

QUINQUAGE′SIMA SUNDAY, in the Calendar, is the seventh Sunday before Easter, and consequently *about* the fiftieth day before that festival; whence the origin of the term.

QUINQUA′TRUS. In Roman Classical Antiquities, the feast of Minerva, which began on the 14th of the Kal. of April, and lasted five days. It is in allusion to the well-known attributes of the goddess that Juvenal makes this the season in which her youthful votaries pray for forensic success.

> Eloquium et famam Demosthenes et Ciceronis
> Incipit optare, et totis Quinquatribus optat.

QUINQUENNA′LIA, or LUDI QUINQUENNALES. In Classical Antiquity, public games celebrated every five years. They were instituted by the emperors in commemoration of different events of their respective reigns. Medals struck on these occasions have been discovered, bearing the date of the reign of Posthumus.

QUINQUERE′MIS. (Lat. quinque, *five*, and remus, *an oar*: in Greek, πεντηρης.) The name of a class of Roman war ships which were rowed by five banks of oars, whence the name is derived. The substitution of the quinquereme for the trireme, as the ordinary war vessel, gradually took place in the course of the fourth century before Christ: in the interval between the Peloponnesian and first Punic wars. The number of vessels of this large class employed in the latter is perfectly surprising. According to Polybius, the Romans lost 700 in the course of it; the Carthaginians 500. In A.U.C.498 (the year in which Regulus was sent to Africa) the Romans had 330, the Carthaginians 350: each quinquereme of the former nation carried 300 rowers and 120 soldiers, in all 140,000 men; the Carthaginians, according to the same computation, amounted to 150,000: numbers which would be scarcely credible, were they not given by so exact an author. *See* TRIREME, GALLEY.

QUIN′QUINA. Peruvian bark. The bark of various species of *Cinchona*, which see.

QUI′NSEY. (Fr. squinance.) Inflammation of the tonsils. This is common inflammatory sore-throat: it is not infectious. It begins with pain on one side of the throat, and swelling of the tonsil, attended by febrile symptoms, which sometimes run high, especially as the tumefaction advances; there is great restlessness and anxiety, and often the utmost difficulty of swallowing even liquids, and of breathing. The disease has proved fatal by producing suffocation, but it generally terminates in resolution, or suppuration: in the latter case the abscess breaks, and a good deal of pus is discharged, and the patient is at once relieved of all his urgent symptoms; but it occasionally happens that the other side of the throat becomes affected, and goes through the same stages.

QUI′NTAIN. An ancient pastime, in which a post was erected, with a cross-piece turning upon a pivot on the top of it, to one end of which a sand-bag was suspended, and at the other a board was fixed. The play consisted in riding or tilting against the board with a lance, and passing without being struck behind by the sand-bag.

QUI′NTAL. An old denomination of weight, being the same with the *hundred* weight, or equal to 112 pounds.

QUINTESSENCE. A term applied by the older chemists to alcoholic tinctures or essences, made by digestion at common temperatures or in the sun's heat.

QUI′NTILE. In Astrology, an aspect of two planets distant from each other the 5th of the zodiac, or 72°.

QUI′NTILIANS. A sect of ancient heretics; so called from Quintilia, their founder and leader. Their chief peculiarities consisted in attributing extraordinary gifts to Eve for having eaten of the tree of knowledge, and in admitting women to the sacerdotal and episcopal office.

QUI′NTINE. (Lat. quintus.) A name given in botany to the fifth or innermost envelop of the vegetable ovulum, the most external being the first or primine.

QUI′NTUPLE. In Music, a species of time, now seldom used, containing five crotchets in a bar.

QUINZAINE. In Chronology, the fourteenth day after a feast day, or the fifteenth, if the day of the feast be included. But a different rule seems to have prevailed on the Continent. (See *Sir H. Nicolas's Chronology of History*, p. 105.)

QUI PRO QUO, or QUID PRO QUO. (Lat. *one for another*.) A conventional term borrowed from the French, who use it in the sense of an error committed by mistaking one thing or person for another; especially a verbal ambiguity.

QUIRI′NUS. An Italian warlike divinity, supposed by some to be the same as Mars. When the Romans deified Romulus they called him by this name, and the festivals instituted in his honour *Quirinalia*.

QUIRK. In Architecture, a piece of ground cut off from a square plot.

QUIRKED MOULDING. In Architecture, one whose convexity is sudden, being in the form of a conic section.

QUI TAM. (Lat. *who as well.*) In Law, a penal action, in which half the penalty is given to the crown and the rest to the informer. The plaintiff describes him as A. B. "qui tam pro domino rege quam pro se ipso,"— who sues as well for the king as himself.

QUIT RENT. (Lat. quietus redditus.) In Law, a small rent payable by tenants of manors in token of subjection. *See* Rent.

QUO'DLIBET. (Lat. *what you please.*) In the language of the schoolmen, questions on general subjects within the range of their inquiries were termed *questiones quodlibeticæ*, or miscellaneous. In French the word quodlibet, or quolibet, is retained, in the sense of a slight jeu d'esprit, pun, &c. What is termed in music a "pot-pourri" was also called in Germany a *quodlibet*.

QUOIN. (Fr. *coin.*) In Architecture, the corner or internal and external angle of a building, or of any part of a building.

Quoin. In Artillery, a loose wedge of wood put below the breech of a cannon, for the purpose of adjusting its elevation.

QUO'RUM. A term derived from the words used in the Latin form of the commission issued to justices of the peace; in which the expression occurred, "quorum unum A. B. esse volumus,"—"of whom we will that A. B. be one;" thus rendering it necessary that certain individuals (said to be of the quorum) should be present at the transaction of business. Hence when in an assembly, committees, &c. it is necessary that a certain number should be present to give validity to its acts, that number is generally said to constitute a quorum.

QUO'TA. (Lat. quot, *how many.*) That part which each member of a society has to contribute or receive in making up or dividing a certain sum.

QUOTI'DIAN. (Lat. quotidianus.) That form of ague which returns daily.

QUO'TIENT (Lat. quoties, *how often*), in Arithmetic, is the result of the operation of division; and may be either a magnitude of any denomination, or an abstract number. When a magnitude of any kind is proposed to be divided into any number of parts, and the divisor is consequently an abstract number, the quotient is of the same kind with the dividend or quantity proposed to be divided; but when the dividend and divisor are both things of the same denomination, or both magnitudes of any kind, the quotient is an abstract number, and is the ratio of the one magnitude to the other.

QUO WARRANTO. In Law, a writ, filed in the Court of King's Bench by the attorney-general, or an individual in his name, calling upon the person informed against to show by what title he holds any office, franchise, or liberty. The proceedings on a writ of quo warranto presenting many difficulties, it has been superseded in modern times by what is termed an information in the nature of a quo warranto.

R.

R. One of those letters belonging to the series called liquids or semivowels. It was called the *litera canina* by the Latins, from some fancied resemblance it bears in sound to the snarling of a dog. At the commencement of English words derived from the Greek through the medium of the Latin *r* is usually followed by *h*, to represent the force of ῥ, as in *rhetoric, rhapsody;* and the same observation applies to this letter when it occurs in the middle of an English word derived from a Greek compound, as in *diarrhœa*, from δια and ῥεω. This letter is susceptible of numerous interchanges, more especially in Latin; for a complete list of which see the *Penny Cyclopedia*. As an abbreviation, R. among ourselves stands for *rex* or *regina*, and in ancient times for Roma; R. P. for *respublica*, &c. In medicinal prescriptions, R. stands for *recipe* or *take*.

RA'BBI. A Hebrew term for doctor or teacher; the termination being properly the first pronoun possessive. This word, which is frequently found in the New Testament, is in use at the present day, the rabbis being the expounders of the law, and more particularly of the Talmud or commentaries of later doctors. *See* Talmud.

RA'BDOMANCY. *See* Rhabdomancy.

RACA. An ancient Syriac word, signifying vanity or folly, and pronounced by the Jews with certain gestures of indignation. Our Saviour, in using the word (Matt. v. 22.), intimates that whoever should apply this word to his neighbour, should be condemned by the council of the sanhedrim.

RACE'ME. (Lat. racemus, *a bunch of grapes.*) In Botany, a form of inflorescence, in which the flowers are stalked along a common unbranched axis, as in the hyacinth.

RACE'MIC ACID. (Lat. racemus, *a bunch of grapes.*) An acid found, together with the tartaric acid, in the tartar obtained from certain vineyards on the Rhine. It is the *paratartaric acid* of Berzelius. It is less soluble in water than tartaric acid, and differs in the form of its crystals and in its salts; yet it appears to be *isomeric*, and to have the same equivalent with the tartaric acid.

RACHI'LLA. (Gr. ῥαχις, *a spine.*) A branch of inflorescence; the zigzag centre upon which the florets are arranged in the spikelets of grasses.

RA'CHIS. (Gr. ῥαχις.) A branch which proceeds in nearly a straight line from the base to the apex of the inflorescence of a plant. It is also applied to the petioles of the leaves of ferns.

Rachis. A term applied by Illiger and other zoologists to the vertebral column of mammals and birds.

RACHI'TIS. (Gr. ῥαχις, *the spine*, the part principally affected.) The rickets. A disease generally confined to childhood, known by a large head, protruded breast bone, flattened ribs, tumid belly, emaciated limbs, and great general debility; the bones in general, and especially the spine, are variously distorted and deficient in bony matter: the system occasionally rallies from this state as growth advances, but there is more or less deformity left. Tonics, cold bathing, regular and proper exercise, very careful nursing, and occasionally rhubarb and tonic aperients, are the principal remedies; and where particular bones are inclined to bend, attempts must be made to throw the weight off them. This disease is frequently symptomatic of a scrofulous state of the glands and viscera; the stomach and bowels are always greatly deranged; and as there appears to be a deficiency of the hardening matter of the bones, various salts of lime, and even phosphate of lime, have been prescribed: the only apparent use of some of these remedies is to render the gastric juice less acrid and acid.

RACK. (Sax. wroccan, *to strain, torment*, &c.; evidently of the same origin as the Germ. rachen, Ang. *to wreak.*) An instrument of torture formerly used in England. According to Coke (who, however, merely reports the story on traditional authority) the rack was first introduced into the Tower by the Duke of Exeter, constable of the Tower in 1447; and thence called "the Duke of Exeter's daughter." (3 *Inst.* p. 34.) Stowe, in his Chronicle, says that the duke's daughter herself invented it. The earliest mention of the use of the "rack or brake" is by Holinshed, under the year 1467. But it first became common in the reign of Henry VIII. Under that prince, the remaining Tudors, James I., and Charles I., down to 1640, the rack was a common implement of torture for prisoners confined in the Tower, and inflicted by the warrant of the council or under the sign manual. The rack consisted of an oblong frame of wood, composed of four beams, a little raised above the ground; the sufferer was fastened by the hands and feet to the corners, where two cross beams joined the longer ones, sometimes by small cords attached to each finger and toe; and the cords were twisted by means of rollers, so as to raise him from the ground, and stretch his body with extreme violence, dislocating the limbs, and, according to the Jesuit writers, who have left the most vivid representations of the sufferings of their companions under the state-persecution of Elizabeth, sometimes extending the sufferer "more than a palm beyond his usual stature!" (Jenner, *Societas Europæa*, p. 12.; see also *Jardine's Reading on the Use of Torture in England*, 1837.) The Roman *equuleus* is often translated rack by English writers; but whether the equuleus was something similar to the English engine, or a wooden *horse* (as the derivation of the word implies), or, in short, what was its form and description, antiquaries have not been able to discover. (See among other authorities the learned treatise of Magius, *De Equuleo.*)

Rack. A railed convenience formed above the manger in a stable for the reception of the hay. It should be constructed with openings at the bottom for the seed or dust to pass through.

RACK. In Machinery, a rectilinear sliding piece, having teeth cut on its edge so that they may work with those of a wheel or pinion which drives or follows the rack. The rack may be regarded as a toothed wheel whose radius is infinite.

RACK RENT. *See* Rent.

RACO'VIANS. In Eccl. History, the Unitarians of Poland are sometimes so called; from Racow, a small city of that country, where Jacobus a Sienna, its head, erected a public seminary for their church in 1600. Here the "Racovian Catechism," originally composed by Socinus, and revised by his most eminent followers, was published. (Mosheim, *Eccl. Hist.* cent. 16. sec. 3.)

RA'DIANT. In Geometry, a straight line proceeding from a given point, or fixed pole, about which it is conceived to revolve. When several radiants forming a system are constrained to revolve in such a manner that all the intersections excepting one are carried along given

straight lines or curves called *directrices*, then the remaining intersection traces a curve whose equation is of an order which is a certain determinate function of the orders of the several directrices. Thus, if all the intersections but one are carried along straight lines, the remaining one describes a conic section. The theory of the description of lines of the second order by the intersection of radiants is given by Newton in the *Principia;* and the subject is treated more generally by Maclaurin in his *Geometria Organica*, and by some recent writers in the *Annales des Mathématiques*. See also *Leslie's Geometry of Curve Lines;* Carnot, *Essai sur la Théorie des Transversales*, &c.

RA'DIANT HEAT. When a hot body is suspended in the air, a quantity of heat is emitted in all directions by its surface, passing off in right lines like radii drawn from the centre to the circumference of a circle; these rays pass freely through the air without affecting its temperature; when they impinge upon surrounding bodies, they are either *reflected*, *absorbed*, or *transmitted*. The quantity of these rays, or of *radiant heat*, which is thus emitted, is greatly dependent upon the nature of the heated surface; it is smallest from polished metallic surfaces, and greatest from rough and unmetallic surfaces. The radiating power, for instance, of polished silver, heated up to 212°, being = 1, that of a surface of writing paper is about = P. Whether colour has or has not any effect upon this escape of heat from surfaces, is a doubtful question.

That this radiant heat is susceptible of *reflection*, may be shown by holding a piece of polished tin plate opposite a fire in such a position as admits the reflection of the flame to be seen in it, when an impression of heat is at the same time perceived upon the face; if the surface of the tin plate be roughened or covered with paper, scarcely any heat is then thrown off, but the plate itself becomes hot in consequence of the *absorption* of the rays. This terrestrial radiant heat, especially when it emanates from surfaces which are not luminous, as from a flask of hot water, for instance, is to a great extent arrested in its progress by a plate of transparent glass, in which respect it appears to be unlike *solar* heat, which passes freely through all transparent media; but there are some substances which do not thus impede its progress; among them, a transparent plate of rock-salt is most remarkable, the rays proceeding through it with little interruption; such substances, therefore, have been termed *thermophanous* bodies. (See Melloni, *Annales de Chim. et Phys.* vol. liii.)

RA'DIARIES, *Radiaria*, or *Radiata*. (Lat. radius.) The name given by Cuvier to the lowest organized of the primary divisions of the animal kingdom; because certain of the animals therein included have a radiated form of a part or the whole of their body. *See* ACRITA, NEMATONEURA, ZOOPHYTA.

RADIATING POINT. In Optics, any point from which rays of light proceed.

RADIA'TION. (Lat. radius, *a ray*.) In Physics and Meteorology, the emission of rays of light or heat from a luminous or heated body.

The theory of the radiation and conduction of heat, which long remained one of the most obscure parts of physical inquiry, has been reduced by the successive labours of Prevost, Leslie, Fourier, Biot, Laplace, Poisson, Melloni, Forbes, and others to a purely mathematical form, and thereby placed in the same rank with physical optics, with which, indeed, it has many principles in common.

The general laws of the radiation of heat, which have been established by experiment, are the following: — 1. Like all other emanations, its intensity, in a vacuum, varies in the ratio of the inverse square of the distance from the radiating point. In air and the gases, the decrease is a little faster in consequence of a partial absorption. 2. The amount of radiation, or the rate at which a body parts with its heat, is proportional to the excess of the temperature of the body above that of the medium in which it is placed. This principle was assumed by Newton; and it follows from it that if the times of cooling be taken in an arithmetical progression, the heat will decrease in a geometrical progression. The principle, however, is found by experiment to hold good only within a certain range of temperature, not exceeding 50° of Fahrenheit. At the higher temperatures Dulong and Petit found the rate of cooling to be more rapid than in the ratio stated. 3. All bodies placed in an enclosed space assume in time the temperature of the enclosure. 4. Heat is emitted from every point of the surface of a hot body in all directions, and the intensity of the heating ray is as the sine of the angle which it makes with the surface. This result, which is by no means obvious, was discovered by Leslie; and its physical cause is, that radiation takes place not from the surface alone, but from particles situated within a certain minute but sensible depth, which is different for different surfaces. 5. The intensity of radiation varies with the nature of the radiating body, and the state of its surface with regard to polish, colour, source of heat, &c. It is greatest for rough and dark surfaces, and least for bright surfaces of polished metal.

The velocity with which radiated heat is propagated through space is entirely unknown. It is certain, however, that it is very great, and probably not inferior to that of light.

The doctrine of the radiation of heat was first stated in a precise and satisfactory manner by Prevost of Geneva, about 1790. Its leading principle being that all bodies are perpetually exchanging their heat with one another, it is sometimes called the *theory of exchanges*. As this emission of heat cannot be attributed to the body which receives it, but for the same radiating body and the same state of surface depends only on the temperature of the body, we are led to suppose that radiation takes place with greater or less intensity at all temperatures; that it is reciprocal between distant bodies; and that it subsists when the temperatures are equal, though in this case no alteration of temperature takes place. By a close attention to the phenomena, we are also led to infer that the faculty of the emission (and also of the absorption) of heat belongs to *all* the molecules of a body; and consequently that radiation takes place not only at the surfaces, but also in the interior of solids and liquids, in the same manner as it takes place in air, or differing only in consequence of its more rapid absorption. Fourier and Laplace were thus led to view the constituent molecules of all bodies as so many foci of radiating heat. This heat is radiated by every molecule in every direction, and is propagated through the pores or void spaces of ponderable matter, until it is entirely absorbed by the molecules which it encounters. In solids and liquids the absorption takes place at very small distances; in air and the gases at very great distances. The mathematical theory of heat is founded on this hypothesis of molecular radiation.

Solar and Terrestrial Radiation.—The measure of heat received from the sun, and of that which is constantly escaping from the earth into the regions of space, are among the most important elements of meteorology. If the earth were not surrounded with the atmosphere, the quantity of solar light received at any time on a given portion of its surface would be proportional to the inclination of the ray to the surface, or to the cosine of the sun's zenith distance; but owing to the modifying effects of the atmosphere, it would appear from the results of experiments that so far from this law holding good, the force of the sun's direct radiation rather increases with the latitude. Professor Daniell (*Meteorological Essays*, p. 228.) suggests that as the cooling power of the air has been proved to be in proportion to its elasticity, it is reasonable to suppose that the difficulty with which heat passes through the atmospere is in the same ratio. The proportion of solar heat absorbed in traversingt he atmosphere vertically has been estimated by Leslie and Pouillet at 25 parts in 100; by Kämptz at 32; and by Prof. Forbes at 29.

The force of solar radiation is measured by the excess of the temperature which a body assumes when exposed to the direct action of the sun's rays above that which it would have in the shade. This excess may be roughly measured by two common thermometers, one placed in the shade, and the other exposed to the sun and having its bulb covered to prevent reflexion. The most accurate measurement is, however, given by the *actinometer*, an instrument invented by Sir J. Herschel, in 1824, for the dynamical measure of solar radiation. A description of this valuable instrument, and full directions for the method of using it, are given in the *Report of the President and Council of the Royal Society on the Objects of Scientific Inquiry in Physics and Meteorology*, 1840.

From certain experiments made by Pouillet at Paris, he inferred that the whole amount of solar heat annually radiated to the earth is equal to that which would suffice to melt a stratum of ice about 14 mètres or 46 feet thick encrusting the whole earth (*Elémens de Physique et de Météorologie*); but in a subsequent memoir (*Sur la Chaleur Solaire*) he estimated the same quantity at 31 mètres, or 102 feet.

The measure of terrestrial radiation is of equal importance with that of solar radiation, but no perfect instrument has yet been contrived for its determination. The best means consist in the daily register of the minimum temperature shown by a register thermometer, the bulb of which is placed in the focus of a parabolic metallic mirror pointed towards the clear aspect of the sky, and defended from currents. It may be supposed that the same atmospheric causes which obstruct the passage of radiant heat from the sun oppose also its transmission from the earth into space.

From the theory of terrestrial radiation, a curious deduction was made by Fourier, with regard to the temperature of the region of space through which the earth moves in its orbital revolution. On computing the temperature which it is necessary to suppose the planetary spaces to possess in order that the thermometrical state of the earth's surface may be such as is actually observed,

he found that the existing phenomena correspond to those which would result from the supposition that the regions of space have a temperature of about —58° Fahrenheit. Svanberg arrived at the same conclusion by a different process, but others have given very different estimates. Thus Poisson makes it —13° cent. or +8½° Fahr., and Pouillet supposes it to be below —115° cent. or —175° Fahr. (See *Leslie's Experimental Inquiry into the Nature and Propagation of Heat*, 1804; Prevost, *Essai sur la Calorique Rayonnante*, 1809; Fourier, *Théorie Analytique de la Chaleur*, 1822; Laplace, *Mécanique Céléste*, tome v.; Poisson, *Théorie Mathematique de la Chaleur*, 1835; *Kelland's Theory of Heat*, 1837; *Reports to the British Association* for 1832, 1835, and 1840.)

RA'DICAL (Lat. radix, *a root*), in Chemistry, is a term occasionally used as synonymous with *base:* thus sulphur and phosphorus are the *radicals* of the sulphuric and phosphoric acids. The term *compound radical* is applied to certain organic combinations; in this case compounds of hydrogen, carbon, or nitrogen constitute the principal radicals.

RA'DICAL BASS. In Music, the same as *fundamental bass*, which see.

RA'DICAL REFORMERS. In Politics, that political party in England which desires to have the abuses which, from lapse of time or any other cause, may have crept into the government, completely *rooted out* (as the origin of the term implies); all our institutions remodelled; and, in short, a larger portion of the democratic spirit infused into the constitution.

RA'DICAL SIGN. In Algebra, the symbol $\surd$, denoting the extraction of a root. It is a modification of the letter *r*, the initial letter of *radix* or root. To distinguish the particular root which is to be extracted, a number is prefixed to the symbol; thus, $\sqrt[2]{}$, $\sqrt[3]{}$, $\sqrt[4]{}$, &c. denote respectively the square root, cube root, fourth root, &c.; but as the square root or second root was the first considered, the number is usually omitted, and merely the symbol $\surd$ written. Fractional exponents are frequently used instead of the radical sign. A *radical quantity* is a quantity to which the radical sign is prefixed.

RA'DICLE. In Botany, that portion of an embryo which eventually becomes the descending axis or root. It is the lowest of the two opposite cones of which an embryo plant consists.

RA'DIOLITES. A genus of fossil shells; the inferior valve of which is in the shape of a reversed cone, the superior valve convex.

RA'DIUS. (Lat. *a ray*.) In Geometry and Trigonometry, the semidiameter of a circle, or a straight line drawn from the centre to the circumference. In the trigonometrical tables the sines, cosines, tangents, &c. of circular arcs are expressed in parts of the radius, which is usually assumed equal to 1. The radius is equal to the side of the inscribed hexagon; or it is equal to an arc of 57·29578°, or 57° 17′ 44·81″, the semicircumferences, or 180°, in parts of the radius 1 being 3·1415927.

RADIUS. In Osteology, a bone of the forearm; so called from its supposed resemblance to the spoke of a wheel. Its upper end, which is the smallest, is formed into a round hollowed head, and is articulated with the small head at the side of the pulley of the humerus, whilst the rounded border of it next the ulna is articulated with the lesser sigmoid cavity of that bone; its lower extremity is articulated with the bones of the wrist.

RADIUS OF CURVATURE. In the higher Geometry, the radius of curvature at any point of a curve line is the radius of the circle which *osculates* the curve at the given point (*see* OSCULATION), or has the same curvature as the curve at that point. The curvature of a circle being uniform, and inversely as the radius, the radius of the osculating circle enables us to judge of the curvature of any curve line at its different points. The general expression for the radius of curvature, *r*, of any plane curve defined by the equation $y = f(x)$, is

$$r = \frac{(dx^2 + dy^2)^{\frac{3}{2}}}{dx\,d^2y}.$$

(*See* EVOLUTE.) From this expression the value of r is readily found when the equation of the curve is given; it is a property of lines of the second order, that the radius of curvature is equal to the cube of the normal divided by the square of the semiparameter.

The expression for the radius of curvature of a surface represented by the equation $z = f(xy)$, at any point whose co-ordinates are x, y, z, is as follows: — Make

$$\frac{dy}{dx} = m,\ \frac{dz}{dx} = p,\ \frac{dz}{dy} = q,$$

$$\frac{d^2z}{dx^2} = r,\ \frac{d^2z}{dx\,dy} = s,\ \frac{d^2z}{dy^2} = t,$$

and let R denote the radius of curvature of a normal section of the surface; then

$$R = \frac{\sqrt{1 + p^2 + q^2}\left((1 + p^2) + 2pqm + (1 + q^2)m^2\right)}{r + 2sm + tm^2}.$$

RA'DIUS VE'CTOR. In Astronomy, is the straight line drawn from the centre of force to the point of the orbit, where the body is supposed to be. A body projected in space, and subjected to the action of a centripetal force, as gravity, which varies in the inverse ratio of the distance, describes a conic section which has one of its foci at the centre of force. In the parabola, let p denote the parameter; and in the ellipse and hyperbola, let a denote the semitransverse axis, and e the eccentricity; also let r denote the radius vector, and v the angle which it makes with the transverse axis; then the expression for the radius vector in the parabola, the ellipse, and the hyperbola respectively, is

$$r = \frac{\frac{1}{2}p}{1 + \cos. v},\ r = \frac{a^2 - e^2}{a + e\cos. v},\ r = \frac{e^2 - a^2}{a + e\cos. v}.$$

These expressions are called the *polar equations* of the three curves.

RA'DIX, or ROOT. *See* ROOT.

RAFT. A species of float formed of various logs or planks, fastened together side by side, so as to be conveyed from one point to another. This means of conveying timber to the sea-coast is advantageously practised in many places. The following notice of the plan adopted on the Rhine, of bringing the vast quantities of trees felled near its source down to the navigable stations on its banks, may be interesting to the reader: —

A little below Andernach the little village of Namedy appears on the left bank, under a wooded mountain. The Rhine here forms a bay, where the pilots are accustomed to unite together the small rafts of timber floated down the tributary rivers into the Rhine, and to construct enormous floats, which are navigated to Dordrecht, and sold. These machines have the appearance of a floating village, composed of 12 or 15 little wooden huts, on a platform of oak and deal timber. They are frequently 800 or 900 feet in length, and 60 or 70 in breadth. The rowers and workmen sometimes amount to 700 or 800, superintended by pilots, and a proprietor, whose habitation is superior in size and elegance to the rest. The raft is composed of several layers of trees, placed one on the other, and bound together: a large raft draws not less than 6 or 7 feet of water. Several smaller ones are attached to it, by way of protection, besides a string of boats loaded with anchors and cables, and used for the purpose of sounding the river and going on shore. The domestic economy of an East Indiaman or an English man of war is hardly more complete. Poultry, pigs, and other animals are to be found on board; and several butchers are attached to the suite. A well-supplied boiler is at work night and day in the kitchen; the dinner hour is announced by a basket stuck on a pole, at which signal the pilot gives the word of command, and the workmen run from all quarters to receive their messes. The consumption of provisions in the voyage to Holland is almost incredible; sometimes amounting to 40,000 or 50,000 pounds of bread; 18,000 or 20,000 of fresh, besides a quantity of salted meat; and butter, vegetables, &c., in proportion. The expenses are so great, that a capital of three or four hundred florins is considered necessary to undertake a raft. Their navigation is a matter of considerable skill, owing to the abrupt windings, the rocks, and shallows of the river; and some years ago the secret was thought to be monopolised by a boatman of Rüdesheim and his sons. (*Autumn on the Rhine.*)

RA'FTER. (Sax. ræꝼτeɲ.) In Architecture, an inclined piece of timber in the side of a roof; in the provinces called a *spar*. It is of various sorts, as will be seen under the art. ROOF, which see.

RAG-STONE. A dark grey silicious sandstone.

RAIL. In Architecture, the horizontal part in any piece of framing or panelling. Thus in a door the horizontal pieces between which the panels lie are called *rails*, whilst the vertical pieces between which the panels are inserted are called *styles*.

RAIL, or WATER-RAIL. (*Rallus aquaticus* of Lin.) A native species of a genus of Macrodactyle or long-toed waders, destitute of alar spines or a frontal shield.

RAI'LING. A fence or barrier made of posts and rails. The most ordinary fence of this description in the country is formed of wooden posts let into the soil, so as to stand upright, to which are nailed or morticed horizontal wooden rails, one above another, at such a distance as to prevent domestic animals from penetrating through them. In some cases one horizontal rail is fixed to the posts near the ground, and another near the top of the post, and the interval between them is rendered impervious to cattle by upright rails nailed to the top and bottom horizontal rail. Iron railings are generally formed in this manner.

RAILROADS, or RAILWAYS. Roads constructed of tracks of iron called *rails*, on which the wheels of carriages roll, and to which they are confined by ledges or *flanges* raised either on the rail or on the tires of the wheels.

Theory of Railways. — The object to be attained by the

construction of roads of every kind is to effect the transport of loads by the least possible expenditure of tractive force; and one road is better or worse than another, *ceteris paribus*, according as the same moving power is capable of drawing upon it a greater or less amount of load. Since the moving power, whatever it may be, is expended in overcoming the resistance which the carriages on which the load is borne offers, this object can only be attainable by the adoption of such expedients as will permanently diminish the amount of that resistance. The causes of resistance to the motion of a carriage along the road are the following: —

1. *Roughness or Unevenness of the Road Surface.* — All asperities formed by stones or other hard substances projecting above the general surface of the road produce a resistance to the moving power, since, when the wheels encounter them and pass over them, the weight of the load, resting as it does upon the wheels, must be raised through a height corresponding with such projections; and, when such projections are frequent or continued, this expenditure of the moving power is also continued, and the same species of resistance is produced as if the moving power had *continually* to raise an equivalent weight. In like manner, if cavities or *ruts* occur on the road surface, the wheels sink into them, and the moving power is constantly expended in raising the load out of these cavities. All roughness or unevenness of surface consisting of nothing more than a multitude of such projections and cavities more or less minute in magnitude, the same causes operate by such means in absorbing the moving power.

2. *Softness of the Road.* — However free the road surface may be from asperities or cavities, if its substructure be of such a nature that it will yield to the pressure of the wheels, a resistance will be produced to the moving power, the amount of which will be more or less, according to the degree in which this softness or yielding quality exists. The wheels sinking into a cavity produced in the soft surface of the road by their pressure, the moving power is affected in nearly the same manner as if it had to draw the load out of the cavity which it makes for itself, and a corresponding amount of resistance is the consequence.

3. *Acclivity of the Road Surface.* — When the surface of the road is not perfectly horizontal, but forms an inclined plane up which the load is to be drawn, a resistance will be produced by the gravity or weight of the load, which will be proportional to the steepness of the acclivity: thus, if the road surface rise, in the direction of the motion, one perpendicular foot in 50 feet of distance, then as much moving power will be absorbed in going over every 50 feet of distance as would lift the entire load through one foot of perpendicular height.

This cause of resistance differs from the former *causes*. In both the former the resistance to the moving power would be equally produced in whichever direction the load is drawn; but the effect of an acclivity is to increase the resistance only in the ascending direction. In the descending direction, on the other hand, it will have the effect of assisting the moving power, by causing the gravity of the load to co-operate with that power in overcoming the other resistance. In all roads, therefore, on which the traffic is equal in both directions, the advantage derived from descending acclivities is to be placed against the power expended in ascending them. The principles on which the question of the best possible arrangement of the acclivities on roads of different kinds depends are of great importance, not only with reference to the working of roads, but also in laying them out, or originally constructing them; and there is none about which there has been, and still is, a greater difference of opinion among engineers and men of practical science.

Such, therefore, being the sources of resistance, the qualities which must be imparted to a road, to diminish as much as possible the resistance to the moving power, must be the following: —

1st, Smoothness and evenness of the road surface.

2d, Hardness and durability of the road structure.

3d, Such an arrangement of the acclivities that the effect of the gravity of the load shall produce on the whole the least amount of resistance, or that it shall contribute the greatest amount of advantage to the moving power.

In ordinary roads formed of gravel, broken stone, or pavement, the entire surface is constructed in an uniform manner, so that every part of it is equally adapted to the motion of the wheels; and, as the tractive power commonly used is the strength of horses, the structure of the road must also be more or less made with a view to their qualities. Thus it might happen that the great degree of smoothness and hardness which would contribute most effectually to diminish the resistance of the carriages would be incompatible with the continued health and soundness of the horses working on it. The paved streets of a town, by reason of their hardness, produce less resistance to the motion of carriages than the softer gravel roads of the country, but they are incomparably more injurious to the horses which work upon them.

This difficulty is met by appropriating certain parts only of the road to the action of the wheels, and imparting to these, in the highest practicable degree, the qualities necessary to diminish the resistance, and to give the greatest durability to the road; and, on the other hand, to adapt that part of the road appropriated to the horses to the peculiar action of their feet, and to the circumstances of the structure and health of the animal.

This has been accomplished by constructing upon the roadway parallel tracks, with a width corresponding to the distance between the wheels, and between these tracks forming a path suitable to the horses.

Another advantage attending such an arrangement is, that the extent of the road surface adapted to the action of the wheels is extremely limited, and a greater amount of expense can be incurred in giving it the necessary smoothness, hardness, strength and durability, than could be at all practicable if these qualities were to be imparted, as in common roads, to the whole extent of the road surface.

Such are the general principles which have led, through a succession of stages of progressive improvement, to that most perfect of all the instruments of transport which human invention has yet devised, — the modern railway. Such a road consists of two parallel tracks of iron firmly maintained in their places, the upper surfaces of which are rendered in a very high degree smooth and level, a strength being given to them which renders them capable of sustaining enormous loads without being deranged in their structure or position. The carriages are maintained upon such tracks or ledges by means of a projecting flange which is constructed upon the inside of the tires of the carriage wheels, and which, by pressing on the inside of either rail, prevents the carriages from escaping from the rails. The general method of constructing such roads will be rendered most easily and agreeably intelligible by a brief view of their history from their first invention to their present state.

History of Railways. — About the middle of the 17th century, the transport of coals from the pits to the harbour was effected in the coal districts of Northumberland and Durham by laying down parallel tracks of timber with a horse path between them, the wheels being confined upon the beams or rails of timber by ledges or flanges projecting from the inside of the tire of the wheels. These timber rails were constructed in pieces of about 6 feet long with a section of about 4 inches square; they were supported on pieces of timber called *sleepers* laid at right angles to them transversely on the road. These sleepers were laid at about two feet apart, so that each pair of parallel rails was supported by three sleepers; besides giving support to the rails, these sleepers also had the effect of maintaining the rails in gauge, or in keeping them at a fixed distance asunder. The rails were fastened to the sleepers by pins driven quite through the rails, and half way through the sleepers, to preserve the uniformity of the upper surface of the rail; these wooden pins were planed off at the top.

The necessity of giving room for the flanges of the wheels, running as they did below the surface of the rail, and the small depth between the surface of the rail and the sleeper, rendered it impossible to protect the sleepers effectually from the action of the horses' feet by any covering of gravel or other material. The sleepers were consequently subject to be worn and destroyed. The rails also, being worn by the action of the wheels still more rapidly than the sleepers, required to be frequently replaced; and, each new rail being pinned down to the same sleeper, the ends of the sleepers were gradually perforated by so many holes that the sleepers were weakened and required to be soon replaced. These defects were remedied by the adoption of the double timber railway, which consisted in laying upon the surface of the timber rails, above described, additional rails of timber of equal scantling, attached to the lower rails by wooden pins, passing quite through the upper and half through the lower rails, in the same manner as the lower rails themselves were attached to the transverse sleepers. This change was attended with many advantages. Besides the increased strength given to the rails by the double timbers, the depth of the sleepers below the upper surface of the superior rail allowed the sleepers to be protected from the action of the horses' feet by covering them with broken stones, gravel, or other road materials. The structure of rails and sleepers also being stronger and more weighty, and held down by the road material with which the sleepers were covered, allowed a packing or ballasting to be driven under the rails, so as to give greater stability and firmness to the road. Another advantage obtained by this arrangement was, that when the superior rails were worn by the action of the wheels, they could be replaced by new ones without disturbing the inferior rails; and as the places of the joints, and those at which they were attached by pins to the inferior rails, could be varied at pleasure, the pin-holes made in the inferior rails would not come in the same place, or near each other, so as injuriously to weaken the latter.

The next improvement consisted in the addition of a plate or bar of iron, about two inches broad and half an inch thick, laid along the upper surface of the superior rail, and attached to it by nails or iron pins countersunk in it. The wheels of the carriages ran upon this iron rail, which formed a more durable surface than that of the wood. In the United States of America, railways of this construction are still in very general use. They are recommended in that country by the abundance and cheapness of timber, and the comparative high cost of iron. Such a road is tolerably efficient where the traffic is light, and can therefore be resorted to in localities and circumstances in which an adequate return could not be obtained for the capital necessary for the construction of the more perfect modern railway. In the construction of these timber railways in America many other improvements have been introduced, more especially in the substructure of the road. In laying out the roadway for the reception of the rails, two parallel trenches are cut along the line of way corresponding to the distance between the rails, and transverse trenches at right angles to these are cut to receive the sleepers: these trenches are respectively bottomed with a ballasting of broken stone, on which the rails and cross sleepers rest. This basis answers the double purpose of a firm and durable support for the road and an effectual means of drainage. The scantling of the timbers used for the rails is usually six inches in width by ten inches in depth: they are attached to the sleepers, so as to be at once kept from springing from them and from altering their gauge, by the following means:—A notch is cut in the sleeper corresponding to the size and form of the rail; and the rail, at the place where it is let into the sleeper, is formed with a vertical surface on the outside, and a levelled surface on the inside, increasing in width downwards. When let into the notch of the sleeper, the levelled part of the rail is forced into the corresponding cavity of the notch by a wedge driven between the outside edge of the rail and the outer surface of the notch.

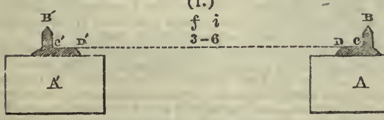
An expedient based upon the general principle of railways has been adopted, but from what date we are not informed, in the streets of some of the Italian cities, and more particularly in those of Milan. Parallel tracks of hewn stone are laid down to receive the wheels of carriages, and such a width is given to them as to be accommodated to any variations which are usual in the structure of carriages. This width is also such that the wheels are not liable to run off these flagged paths by any irregularity in the course which the horse takes in drawing the carriage.

Great facility of draught is obtained by this expedient, which has been of late years adopted with some improvement in England. A flagged trackway of this kind was constructed some years ago, and is still in operation, extending from the West India Docks, along the Commercial Road, towards the City of London, and a similar expedient has been more recently proposed to facilitate the application of steam power on common roads. Stone track ways of this kind have been accordingly laid down on some parts of the high road between London and Birmingham. This expedient has the advantage in one respect over railways, inasmuch as the carriages are not confined by flanges or any other expedient to the stone paths on which the wheels move, and consequently the same carriages which run upon them may also move on other parts of the road. Thus, one carriage may pass another, while both use the same line of stone rails, which cannot be effected when carriages are confined to the rails.

In the progress of improvement, the timber railway above described was succeeded by the last iron plate railway, or tramway, which was for a long period used exclusively in the coal districts, and in public works generally, and is still to a considerable extent adopted, especially in the railways which are carried through the workings of mines, and on which the product of the mine is conducted in waggons, being pushed by men or drawn by horses to the foot of the shaft.

The Plate Railway, or Tramway.—About the year 1770 tramways of cast iron came into use in the collieries in the north of England. These railways consisted of two rails of cast iron laid parallel to each other at a distance from three to three and a half feet asunder. They were usually supported either on timber or stone bearings. A cross vertical section of these as first used is represented at fig. 1.; where A A′ represents the timber supports,

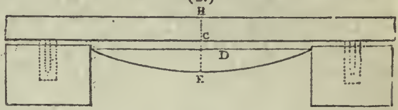
(1.)



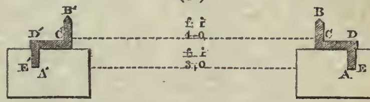
B C D, B′ C′ D′ represent the sections of the rails, C D, C′ D′ represent the horizontal plates attached by nails or pins to the sleeper. On this plate the wheel of the waggon rolled. The ledges B C, B′ C′ rose perpendicularly two and a half inches on the outside edge C′ of each plate C′ D′. These ledges, by pressing on the outside of the wheels, prevented the waggon from escaping from the road. They were subsequently raised on the *inside* of the horizontal plate, so as to act on the *inside* of the wheels.

In order to give such rails strength in the vertical direction, to supersede the necessity of a continued support beneath them, they were afterwards cast with a ledge beneath them, projecting downwards from the outside edge of the horizontal plate. A side view of such a rail is represented in fig. 2., and a cross section of the rails in fig. 3.

(2.)



(3.)



The upright ledges B C, B′C′ (fig. 3.) rising from the horizontal plates C D, C′D′, and coming within each wheel, kept the wheels on the rails; and the ledge D E, D′E′, projecting downwards, and increasing in depth towards the middle of the distance between the supports, as represented in fig. 2., gave the necessary strength to the rail. The outlines of this ledge formed each a curve, so that the strength at different points between the supports might be proportioned to the mechanical effect of the vertical pressure. The flanges B C, B′C′ are the same height throughout the whole length of the rail.

These tramways were for a long period constructed exclusively of cast iron; but, when improved methods of rolling malleable iron were contrived, they were formed by rolling; and for nearly twenty years back they have been constructed exclusively of wrought iron.

Edge Railway.—Within twenty years after the first introduction of tramways of iron, the form of rail called the *edge rail* was brought into use. This rail is constructed in the form of a bar of iron, whose width is considerably less than its depth, placed, as the name implies, with its narrow edge presented upwards. Owing to its depth being much greater than its width, its power, in proportion to its weight to resist vertical pressure, is very considerable. The wheels were retained on rails of this description by flanges projecting from the inside of their tires. These flanges, at the point where the wheels rest on the rails, descend below the rails; and the wheel cannot pass off the rail towards the outside, unless the flange rolls over the rail.

For a long period after their first adoption, edge railways were confined to the mining districts, and more particularly to the collieries, where they were used for the transport of the products of the mines to the places of shipment; but this species of road acquired vastly increased importance when passengers and goods came to be transported on it by locomotive engines, which took place between Liverpool and Manchester in the year 1830. Since that time, the construction of railways adapted for general traffic, at a speed which until within the last ten years would have been thought impossible, has been carried to a great extent in England, and in the United States. Lines of railway with the same object have likewise been projected, and some of limited extent constructed in different parts of Europe. The general flatness of Belgium offering the greatest facilities for the construction of this kind of road, lines of railway have been brought into operation between the chief towns of that country, and it is intended to continue these lines to Aix-la-Chapelle, from which a line was recently opened to Cologne. *The Times* of Dec. 16. 1841, gives a list of the various railroads projected, in progress, and completed, in Germany, down to that date.

In France, the only railways worked by steam power, adapted for passengers, which have yet been brought into operation, are the short lines connecting Versailles and St. Germain with Paris. Several others of greater extent are, however, in progress; among which may be mentioned, more particularly, the Paris and Havre line, by which, combined with the London and Southampton railway, the French metropolis will be accessible by a journey of twenty-four hours or less from London.

Within the limits of the present article, it would not be possible to trace, in the order of time, the succession of improvements by which the present methods of laying out and constructing railways for the swift transport of passengers by steam power have been attained. When

the Liverpool and Manchester line was first brought into operation, little, comparatively, was understood of the capabilities of such means of intercommunication; and that line may be regarded as an experimental railway, the results of which have supplied the data on which others have since been constructed and worked. The form, strength, and weight of the rails, — the mode of fixing them on the road, — the weight, power, and proportions of the engines, — the form, strength, and weight of the carriages and waggons, — the magnitudes of the trains, and the speed of transport, have all been subject to change from year to year, and almost from month to month, since the opening of that line in 1830 to the present time. We shall not therefore attempt to trace these improvements; but shall briefly explain the formation and construction of railways, according to the methods and principles at present generally received.

Of the Formation and Construction of Railways. — Whatever be the moving power to be used for the transport of loads upon a railway, its force must be proportioned to the average resistance of such loads, and it must be capable of varying its energy to the same extent as that resistance is subject to variation. The great perfection which has been attained in the construction of the rails, and in the methods of fixing them in their position upon the road, is such, that the resistance offered to the tractive power by loads moved on a straight and level railway may be regarded as practically uniform, so that the moving power by which a load is transported at a given speed on a straight and level line of railway is subject to a resistance as unvaried and as uniform as any to which moving powers are usually submitted in any of the processes of art; but as the amount of resistance to the tractive powers upon a straight and level railway is diminished by the perfection thus attained in the construction of the road, so, in the same degree, is any resistance produced by a departure from a perfect level more sensibly felt. Thus, if the resistance to the moving power on a straight and level railway, by a load moved at a given speed, be equal to the 250th part of the load, an acclivity which would rise at the rate of one foot in 250, or nearly at the rate of 20 perpendicular feet in a mile, would produce a resistance to the moving power, by reason of the ascent alone, equal to a 250th part of the load, and therefore equal to the resistance which the moving power would sustain on a level line. It follows, therefore, that, under such circumstances, in drawing a load up such an acclivity, the moving power would have to overcome twice the resistance opposed to it on a level; for the same causes which produce on a level a resistance amounting to the 250th part of the load equally produce this resistance in ascending the acclivity, in addition to which there would be an equal amount of resistance due to the ascent. If, therefore, under such circumstances, the moving power were required to draw the load up the acclivity at the same speed as that at which it drew it on the level, the machine exerting that power must be endowed with properties in virtue of which it is capable of varying its energy, without injury to its structure, in the proportion of two to one.

Whether such limits of variation in the resistance or in the moving power as are here referred to for the sake of illustration be those which are requisite in practice or not, it is apparent that *some* practical limits must exist to the variation of the resistance; and that, whatever these limits may be, corresponding limits must be imposed on the acclivities or *gradients*, as they have been called, which are admissible on the railway on which such moving power is to be applied. If the moving power be incapable of increasing its energy in a greater proportion than two to one; then the steepest gradients must not create more than twice the resistance on the level parts of the line; and, if the resistance on the level parts of the line be equal to the 250th part of the load, the steepest gradients ought not exceed one in 250. This, however, proceeds on the supposition that the *same speed* is required to be maintained in ascending the acclivities as on the level.

When a carriage of any kind changes the direction of its motion, it does not accomplish this by suddenly passing from motion in the one direction to motion in the other. Many mechanical effects, which will be sufficiently obvious, forbid this. The change of direction is, on the other hand, effected gradually, by causing the carriage to move in a curve. Now, in such a motion, it is evident that the wheels which traverse the outer part of the curve will in the same time move over a greater space than those which traverse the inner part; in fact, the inner and outer wheels move over arches of circles which have the same centre, the outer arch being longer than the inner. If the wheels, therefore, be (as they always are) of the same magnitude, the outer wheel must revolve oftener on its axle in passing over the curve than the inner; but, besides this, the position assumed by the wheels in passing round a curve is different from that which they have when moving in a straight line. If a four-wheel carriage move along a straight road, its axles will be at right angles to the direction of its motion, and therefore parallel to each other; but if it move in a curve, which it does in turning a corner, then its axles are no longer parallel, but each of them is directed to the centre of the curve which the carriage describes. The mechanism by which this effect is provided for by four-wheel carriages, used on common roads, is the perch or pivot on which the axle of the fore wheels is made to turn. By this pivot the fore axle may be placed at any required angle with the axle of the hind wheels. As the wheels of all such carriages revolve independently of each other, each upon its own axle, the wheels on the same axle may revolve at different speeds. These two provisions, therefore, are brought into play when a common carriage changes its direction. The outer wheels, in turning round the curve, move faster than the inner, and the axles throw themselves out of parallelism, and take the directions of the radii of the curve.

The peculiar structure of railway carriages excludes the possibility of either of these provisions for turning round a curve. To maintain in security the carriages on the rails, it has been found necessary to fix the axles truly square with the carriages, and therefore to exclude the pivot or perch by which a common carriage is turned. It has likewise been found necessary to key the wheels firmly upon the axle, so that the wheels and axle shall turn together, instead of the axle being fixed, as in a common carriage, and the wheels turning upon it. The mechanism of a railway carriage is therefore essentially adapted to rectilinear motion, and it contains no expedient by which it can move round a curve. When such a carriage, therefore, first encounters a curve, its tendency is to proceed in the continuation of the straight line in which it has previously moved, and which forms a tangent to the curve. If this tendency were allowed to take effect, the outer wheel would run off the rail on the outside of the curve, and the inner wheel would come off the rail in the space between the rails. This is prevented by the flange which projects from the tire of the outer wheel, and which, at the point where that wheel rests upon the rail, descends below the rail. When the wheel makes an effort, in virtue of the tendency to rectilinear motion, to pass off the rail, the flange comes in contact with the inside of the rail, and, by pressing upon it, throws the carriage inwards; and this taking place with the fore wheels, the direction of the body of the carriage is shifted, and it is thrown more nearly square with the rails. This action of the flange is continued while the carriage is passing round the curve, and it is to it alone that the change of direction of the carriage is due.

The tires of the wheels of railway carriages have usually a conical form given to them, becoming gradually smaller from the flange outwards; and, when a carriage rests straight upon the rails, the distance between the flanges of the wheels being less than the distance between the rails, a small space is left between the flanges and the rails, to allow some play to the flanges without letting them strike the rails. When the carriage comes to a curve, the flange of the outer wheel comes into contact with the outer rail, and the whole play of the flanges is given to the space between the flange of the inner wheel and the inner rail. In consequence of the conical form of the tires of the wheels, the outer wheels, in this case, rest upon a thicker part of the cone than the inner, and the actual diameter on which they revolve is consequently greater than that on which the inner wheels revolve. This effect has been generally regarded as an expedient sufficient to enable railway carriages to run round curves of a certain limited radius; but that this is an error may be easily shown, — if, to a four-wheel carriage, wheels of unequal diameter be attached, smaller wheels being put on the one side than on the other, and if such wheels were attached to their axles, so that the axles revolve with them, and if at the same time the axles be fixed square with the carriage, *such a carriage will be found to be incapable of moving in a curve, notwithstanding the inequality of its wheels.*

The pressure of the flange on the rail being, therefore, the only means of turning a railway carriage round a curve, and such pressure being attended by friction, and therefore by increased resistance to the moving power, curves as well as acclivities are a cause of resistance, and this resistance will be great in proportion to the rapidity of the curve or the shortness of its radius. But, independently of this effect of curves, a more serious objection to those whose radius is under a certain limit of magnitude arises from the liability of the carriages to run off, by the flange encountering any obstacle or inequality which would cause it to pass over the rails.

The *section* of a railway is therefore limited by those circumstances which govern its acclivities, already explained, and which are equally related to the amount of the resistance on level rails, and to the practical limits of the variation of the moving power; and the *plan* is, on the other hand, limited by the necessity of effecting every change of direction of the line by curves whose radius shall have such a magnitude as to exclude all danger of

the carriages running off the line. In the laying out of a railway, therefore, limitations of its section and plan must be kept constantly in view.

Since the natural surface of a country is rarely adapted to the conditions which have been thus shown to be necessary to the formation of a railway, an artificial surface must generally be formed by raising some and lowering other parts of the country through which the railway is to pass. The expedients by which this is accomplished are attended with more or less difficulty and expense, and the skill of the engineer is eminently required in the selection of such a course for a proposed line of railway as will be attended with the least expensive construction, due regard being had to the permanent expense of working and maintaining it.

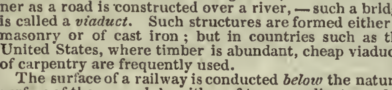
When a railway is proposed to be constructed between two points, which are called its *terminii*, the engineer makes himself generally acquainted with the country between these terminii, and selects that course for the line which, with least deviation from a straight line joining the proposed termini, will afford the greatest facilities for the formation of the artificial surface of the railway, limited as it must be in respect to its acclivities, and to the curves by which its various changes of direction are effected. This is first accomplished by an *eye survey* or general *reconnoissance* of the country. An instrumental survey is afterwards made along the direction which has been selected for the line, and a nearly accurate profile of the country from terminus to terminus, in the proposed direction, is obtained. This being accomplished and reduced to a drawing, as represented in fig. 4., a line

(4.)

A B C D E G H I K is drawn, regulated by the degrees of inclination which have been decided to be the best practical limits of the acclivities. This line will, as represented in the figure, in some places, as A B, C D, E F, G H, I K, pass above, and in others, B C, D E, F G, H I, below, the natural surface of the ground. It is therefore to be considered that, in the one case, the artificial surface of the line must be elevated above the natural surface; and that, in the other case, some expedient must be provided by which the artificial surface may pass at the requisite depth below the natural surface.

The surface of a railway is raised *above* the natural surface of the ground by either of two expedients; — 1st, by forming a mound of earth with sloping sides, having the railway on its summit, — this is called an *embankment* (fig. 5.); 2dly, by constructing a bridge by which

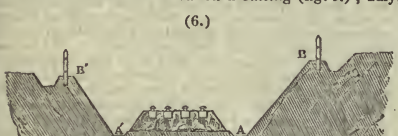
(5.)



the railway can be conducted, at the requisite elevation, above the natural surface of the ground, in the same manner as a road is constructed over a river, — such a bridge is called a *viaduct*. Such structures are formed either of masonry or of cast iron; but in countries such as the United States, where timber is abundant, cheap viaducts of carpentry are frequently used.

The surface of a railway is conducted *below* the natural surface of the ground by either of two expedients; — 1st, by forming an excavation, or artificial valley, with sloping sides, along the bottom of which the railway is constructed, — such an excavation is called a *cutting* (fig. 6.); 2dly,

(6.)



by undermining the ground and constructing a subterranean archway or vault of sufficient magnitude, the roof of which is usually lined with masonry, and along the bottom of which the railway is conducted, — such an archway is called a *tunnel*.

In laying out a railway, the disposition of its cuttings and embankments must be kept in view. In general, the material by which the embankments are formed is obtained from the cuttings; and, with a view to the saving of expense, the engineer so arranges his section that the quantity of stuff required for the formation of embankments shall be as nearly as possible equal to that supplied by the cuttings. If there be an excess of stuff from the cuttings, ground must be obtained in some position near the cuttings whereon it can be thrown. This is technically called *putting it to spoil*.

If, on the other hand, there be an excess of embankment, then the stuff necessary for the formation of such embankment must be obtained from some excavation made near the embankment expressly to supply the stuff for the embankment. This is called *side cutting*.

The distance along which the stuff obtained from a cutting is carried before it is laid down to form the embankment is called *the lead;* and the quantity of labour necessary to form an embankment out of an adjacent cutting is determined by the number of cubic yards of stuff necessary to form the embankment multiplied by the average *lead*, or the mean distance to which such stuff has to be carried.

Where a very low and long embankment occurs, it may happen that the *lead* is so long that the expense of forming the embankment from the nearest cutting would be greater than the expense of putting the cutting *to spoil*, and of forming the embankment from *side cutting*. These are questions which are determined in each individual case with reference to the price of land and labour.

When the elevation above the natural surface of the ground at which the railway must be carried is so great as to render an embankment impracticable, or attended with a disproportionate expense, a viaduct is resorted to; and, on the other hand, when the excavation necessary to give an open cutting would be productive of objectionable expense, then the railway is conducted under the ground through a tunnel.

The slopes A B, A′ B′, fig. 5, 6., forming the sides of embankments and cuttings, depend on the nature of the soil or strata through which the cuttings are made, and of which the embankments are formed. In general, every material has a certain angle at which it will rest, all more steep angles causing it to slip or fall: this angle is called, in mechanics, the *angle of repose*. In the strata through which railway cuttings are made, and from which embankments are usually formed, the slopes of the sides are rarely less than $1\frac{1}{2}$ foot horizontal to 1 foot vertical, and they vary between that and 2 feet horizontal to 1 foot vertical. When the material is gravel, sand, loose chalk, or gravelly clay, a slope of $1\frac{1}{2}$ to 1 is generally found sufficient; but with certain descriptions of clay, such as that called the London clay, a more gradual slope must be allowed. With such material, the slopes are constructed at $1\frac{3}{4}$ or 2 horizontal to 1 vertical; but in general it is better, even at increased expense of earthwork, to allow a sufficient slope in the commencement, and thereby avoid the continual expense attending *slips*, as the gradual decadence of the sides of cuttings and embankments is called.

The face of slopes, both of cuttings and embankments, should be covered with soil and sown with grass seeds, so as to produce a turf, which gives a further security against *slips*. They may be also, especially the slopes of embankments, planted with shrubs; care being taken, however, not to obstruct the ventilation of the road.

When the stratum through which a cutting is required to be made is rock or hard stratified chalk, it will stand with perpendicular sides; and, in such cases, cuttings of great depths may be made at a trifling sacrifice of land. The Olive Mount cutting on the Liverpool and Manchester railway is, at the deepest parts, above 100 perpendicular feet from the natural level of the surface to the level of the rails; and cuttings of still greater depth and much greater extent, through stratified chalk, are executed on the Brighton railway, of which the sides are perpendicular.

In most cases, however, where cuttings attain to these extraordinary depths, tunnels would be less expensive. It sometimes happens that the material of the cutting is required for an adjacent embankment; and, under such circumstances, if the sides of the cutting can be perpendicular, and the sacrifice of land small, it may be preferable to *tunnelling*. The materials from the Olive Mount cutting above mentioned were required for the formation of the broad green embankment adjacent to it.

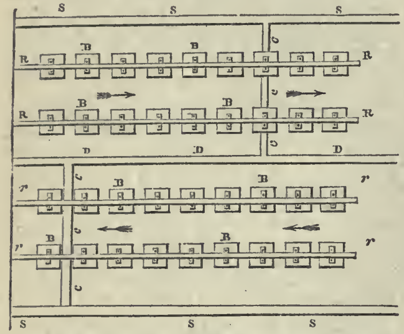
Drainage. — *The formation level*, as the artificial surface of the road intended to receive the rails and their supports is called, should be properly drained. This is effected by a centre drain, carried along the middle of the road, with cross drains at proper intervals communicating with side drains in the cuttings, and discharging the water down sloping drains descending the sides or embankments. The centre and cross drains are covered drains, formed either of brick or stone, or, more economically, of tiles made of a proper form for the purpose.

Road Structure. — The surface of the road being pre-

pared to receive the rails, the props or *chairs* which at fixed intervals form the support of the rails must next be laid down. These are sustained on supports of either of two kinds:—

1st, In cuttings, or on well-consolidated embankments, stone blocks are provided, roughly formed into a rectangular parallelopiped, the base of which is a square whose side is 2 feet, and the height of which is 1 foot. A bottoming of broken stone and gravel being spread to receive these, they are set upon it by raising them repeatedly by means of a lever, and letting them fall in the place where they are intended to rest, until they beat for themselves a solid and unyielding bed. It was the practice to lay these blocks so that their sides were parallel and perpendicular to the sides of the railway. In fig. 7.

(7.)

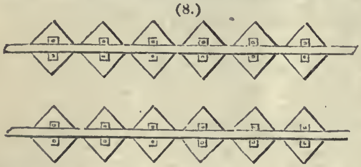


is represented the plan of a railway thus laid on blocks, showing its drainage, consisting, as is usual with railways having extensive traffic, of two lines. The line R R, R′ R′ is appropriated to carriages moving in one direction, and the line *r r*, *r′ r′* to carriages moving in the other direction. By thus causing carriages moving in the same direction to be confined to the same line, the collision of trains *meeting* is prevented. The centre drain running between the two lines of railway is represented at D D D. The cross drains are shown at C C C, communicating with the side drains S S S.

The blocks are represented at B B, supporting the rails, and laid with their sides parallel and perpendicular to the rails.

This arrangement has lately been superseded by the diagonal arrangement of blocks represented in fig. 8. It

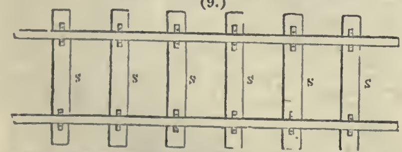
(8.)



is considered that this arrangement gives the block a better bearing on its bed; but the chief advantage attending it, as compared with the former position of the blocks, is that it renders the base of the block more accessible for repairing and adjustment, from time to time, when the road is in operation.

2dly, On embankments newly made, or other parts of the line where the foundation of the road is liable to yield under the operation of the traffic upon it, wooden sleepers, S S, fig. 9. extending across the road, are used instead of

(9.)



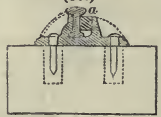
stone blocks to support the chains. These are usually formed of larch: the tree is split along the centre, so as to form two sleepers, one side of which is flat, and the other convex. They are usually from 8 to 9 feet long, and from 9 to 10 inches broad on the flat side; and from 4 to 5 inches deep, measured in the thickest part. They are laid across the road, with the flat side downwards. The chairs are fastened to them by pins on the convex side, in the same manner as they have been already described to be fastened to the blocks. Each pair of opposite chairs being thus connected, by being attached to the same sleeper, the rails are kept in gauge, notwithstanding the yielding of the foundation under the sleeper.

Until within a recent period, stone blocks were universally regarded as the best permanent support for the rails, wherever they could be laid upon a solid and durable foundation, and wooden sleepers were only resorted to as temporary supports, to be ultimately superseded by stone blocks whenever the foundation of the road should be properly consolidated. Opinion has, however, undergone some change on this subject, and wooden sleepers are now sometimes used in preference to stone blocks for permanent purposes: whether they will prove economical, when submitted to the trial of a long period of time, experience alone can decide.

The chairs which are the immediate supports or props on which the rails rest are attached to the centre of the upper surfaces of the blocks in the following manner:—Two holes are drilled in the blocks to a sufficient depth, about 2 inches in diameter, into which plugs of oak or other hard wood are driven; holes are then bored in these 3-8ths of an inch in diameter, corresponding in position with two holes in the chair of cast iron, which is to support the rail. Iron pins of half an inch in diameter are then driven through the holes in the chairs into the holes in the block, a piece of patent felt being placed between the chair and the block; and the chair is thus firmly fastened to the block.

The chairs are formed of cast iron, formed with a cavity corresponding to the magnitude and form of the rail: they vary very much in their size and form, according to the opinion or judgment of the engineer. A cross vertical section of one of the most common forms of chair, fixed on a block, now in use, with the rail resting in it, is represented in fig. 10.

(10.)



A great variety of expedients have been resorted to to maintain the rail fixed in its position in the chair. Pins and wedges of iron were first used of various forms, and applied in various ways. These, however, have now been very generally superseded by the simple contrivance of a wooden block or wedge driven in between the side of the chair, as represented at *a*, fig. 10. These wedges are prepared by previously passing them through a hydrostatic press, so as to harden them by exposing them to a severe pressure. Besides affording a very effectual fastening to the rail in the chair, these wedges, from the nature of the material, soften the jar which attends the transition of the wheels over the chairs.

Weight and Form of Rails. — The weight and form of the rails have been subject to great variation, since the extension of railways to the rapid transport of passengers. This has not arisen so much from ignorance of the mechanical properties of the metal thus applied, as from the varying weight and speed of the engines and loads transported upon them. The weight of the engines was, in the commencement, limited to 6 tons; but the most common weight of these machines at present is 12 tons; and their speed, as well as the amount of loads which they draw, have undergone a corresponding increase. The strength and solidity of the structure on which this extraordinary traffic is carried have necessarily undergone corresponding changes. The Liverpool and Manchester railway was first laid down with rolled iron rails, weighing 35 pounds per yard, supported on chairs 3 feet asunder. These were, however, soon found insufficient in strength, and they were replaced by rails weighing 50 pounds per yard, supported on bearings at the same distance asunder.

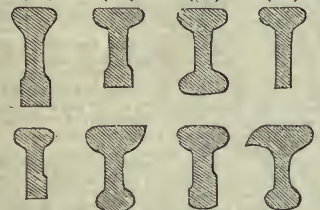
The distance between the bearings or chairs has also been subject to change. The necessary strength or weight of the rail will evidently depend on this distance; the greater the distance between the props, the greater must be the strength of the rail; and, so far as regards expense, the engineer has to balance the cost of heavier rails against the saving effected by a diminished number of blocks and chairs. But, independently of the consideration of expense, the effect upon the carriages and engines is to be considered. Between chair and chair, a slight flexure of the rail takes place, and the wheels have consequently to pass over a series of eminences, so as to give to the carriages a pitching motion, the intervals and degree of which must depend conjointly on the strength of the rails and the distance between the chairs.

The least distance between the chairs now used is 3 feet, and the greatest 5 feet; 50 lb. rails are very generally used on 3 feet bearings; 65 lb. rails on 4 feet bearings; and 75 lb. rails on 5 feet bearings. All these varieties of construction are used in different parts of the Liverpool and Manchester railway. The

Grand Junction railway, extending from Birmingham to Newton, is laid down uniformly with 65 lb. rails on 4 feet bearings, and the London and Birmingham railway has in different places all the above varieties.

The form of the rail has been much varied. The fish-bellied rail was considered to have the most advantageous form, when the Liverpool and Manchester railway was first brought into operation, and for some years afterwards. This form gives increased depth to the rail at the parts most distant from the supports; and, in theory, it is unquestionably the most correct, the strength of every part to resist vertical pressure being the same. But various practical objections have been found against it, which our limits will not allow us to examine or discuss; and the fish-bellied rail has accordingly been altogether superseded by the parallel rail, which is a rail whose cross section is the same at every part. Nothing can be more varied or more capricious than the forms given to the cross section of rails by different engineers. The figures 11 to 18. represent a few of this great variety.

(11.) (12.) (13.) (14.)

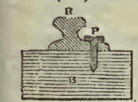


(15.) (16.) (17.) (18.)

The form, however, which has obtained most general favour at the present time is that which is represented in fig. 13., the cross section of which is nearly the same as the longitudinal section of a dumb bell. This form of parallel rail has the advantage of being capable of being reversed, either side being turned upwards.

In some rare instances, modern railways in England have been laid down on *continuous bearings*. The rails, in such cases, are supported immediately on the longitudinal truckers without chairs. This is the case in the Manchester and Bolton railway, and in the Great Western railway: a section of a rail, as attached to a longitudinal trucker support without a chair, is represented in fig. 19., where R is a section of the rail, P an iron pin attaching it to the trucker B. These pins are placed at regular distances along the outside base of the rail.

(19.)



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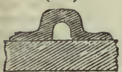


A section of the rail with its trucker support, used on the Great Western railway, is given in fig. 20. These rails are fastened to the truckers by screws on each side. They weigh from 40 to 50 lbs. per yard.

Gauge of the Railway.—The gauge, or the distance between the rails, on which depends the distance between the wheels of the carriages and engines, and to a certain extent their structure, has recently been a subject of much discussion. It is contended by some that all railways constructed in the same country ought to have the same gauge; that, though it is not contended that the gauge now in use is the best that could possibly have been adopted, yet that, extensive lines of road having been constructed with that gauge, more disadvantage will attend any departure from it than could be balanced by any advantages that could attend any other magnitude of gauge.

In the colliery railways in the north of England, the rails had been laid at 4 feet 8½ inches asunder; and on the Liverpool and Manchester railway, the first line intended for general traffic, was laid down by Mr. Stevenson with the same gauge. The lines of railway subsequently projected, extending from Liverpool and Manchester to Birmingham (and thence to London), to Preston, Wigan, Bolton, Leeds, and other places, were laid down with the same gauge, since the carriages and engines would necessarily have to pass from one to the other. But when railways began to be constructed in Belgium and other parts of the Continent, where the same reason for uniformity of gauge did not prevail, the same gauge nevertheless was adopted. The first conspicuous departure from this uniformity took place in the Great Western railway, extending from London to Bristol, which was laid down with a gauge of 7 feet; and the Eastern Counties railway next adopted a gauge of 6 feet.

The gauge of a railway can be regarded as nothing more than its linear modulus, or the index to its general scale. There is nothing *per se* to give one gauge a preference over another; but, as the magnitude of the gauge determines the general magnitude and scale of the railway, and of every thing connected with the railway, including waggons, coaches, and engines, bridges, viaducts, tunnels, cuttings, &c., and, in short, all the works, whether of a moveable and perishable or fixed and permanent nature, it is a matter of the greatest importance that it should be determined with a just regard to the traffic of the line.

Curves on Railways.—With a view to insure the public safety, the legislature has generally required that no curve shall be allowed upon a main line with a less radius than one mile: the exceptions to this are where one railway passes into another; and at the termini, or the entrance of depôts or stations. In such situations the trains must slacken their speed, and therefore a sharp curve is attended with less danger. It has appeared, however, that these restrictions upon the radii of curves have been more stringent than safety requires. In a course of experiments made by Dr. Lardner, within the last two years, it has been established that curves of a mile radius produce no sensible increase of resistance at the usual speed of railway trains, and therefore curves of considerably less radius may be traversed at that speed without danger. We may here state, that on the Newcastle and Carlisle railway there are many curves in the main line with radii under half a mile, which are traversed at the usual speed with perfect safety.

Motive Power on Railways.—The motive power on railways for general traffic is at present steam power, and is either locomotive engines, which move along the railway with the load which they draw; or stationary engines, which, by means of ropes extended along the line of railway, draw the loads in either direction. *See* LOCOMOTIVE ENGINE and STATIONARY ENGINE.

Resistance of Air to Railway Trains.—Until very recently, it has been considered by engineers that the resistance to railway trains was almost entirely due to friction and mechanical effects, and that that part of the resistance which depends on the atmosphere formed so inconsiderable a portion of the whole that it might be disregarded in practice. The result of a course of experiments, made within the last two years, by Dr. Lardner, the details of which may be seen in the *Proceedings of the British Association*, have, however, indicated a serious amount of resistance due to the air. If Dr. Lardner's conclusion shall be confirmed by further experience, the great expense attending the maintenance of very high speed on railways, and the improbability of attaining in the ordinary work of a line the extraordinary velocity which some persons now contemplate, will be apparent.

Speed of Railway Traffic. *See* LOCOMOTIVE ENGINE.

For the details of the structure and operation of railways, see the Treatise by Nicholas Wood, 3d edition, London, 1838; *The Steam Engine, &c.*, by Dr. Lardner, 7th edition, London, 1840.

RAILWAY, PNEUMATIC or ATMOSPHERIC. The name given to a system of locomotion on railways by means of the pressure of the atmosphere. A simple and ingenious apparatus for this purpose was invented a few years ago, and is now being exhibited on the West London Railway at Wormwood Scrubs. Those who desire to see a brief though clear account of this invention, with a resumé of the advantages likely to accrue from its being generally adopted, may consult the well-reasoned letter of Mr. Pim, addressed to the President of the Board of Trade (1841). (See also a treatise on this subject, by Mr. Samuda.)

RAIN. (Ger. regen.) In Meteorology, water falling from the atmosphere in drops.

The theory of rain is not yet very satisfactorily established. One of the most ingenious explanations, and indeed the only one which rests entirely on known principles, was proposed by Dr. James Hutton in the *Philosophical Transactions of Edinburgh* for 1787. It is now a well-ascertained fact, though it was only matter of conjecture to Dr. Hutton, that the capacity of air for moisture, or the quantity of moisture which a given volume of air will hold, increases with the temperature, but in a much faster ratio than the temperature; and hence it follows that if two equal portions of air at different temperatures completely saturated with moisture are mingled together, a precipitation must take place in consequence of the mixture, which will have the mean temperature of the two portions, being unable to sustain the mean quantity of vapour. For example, suppose that while the temperature increases in an arithmetical ratio, the capacity for retaining moisture increases in a geometrical ratio, and that at the temperature of 15 centesimal degrees air can hold 200 parts of moisture; then at 30 degrees it will hold 400 parts, and at 45 degrees 800 parts. Now, suppose two equal bulks of damp air, at the respective temperatures of 15 and 45 degrees, to be mixed together, the compound must contain 1000 parts of vapour, or either half of it 500 parts; and the temperature of the compound will be 30 degrees. But at this temperature the air is saturated with 400 parts, and consequently there will be a precipitation of 100 parts from each of the given bulks.

It is obviously not necessary that the commingled por-

tions of air should be fully saturated with moisture, as assumed in the above example; rain will be precipitated if the two masses approach the point of saturation, but the quantity will be proportionally less. It is also a consequence of the theory that for a given difference of heat the precipitation will be greatly increased at the higher temperatures; and this is conformable to experience, for showers are most copious during hot weather, and in tropical countries. The circumstances, therefore, on which, according to this theory, the quantity of rain precipitated in a given time depends are the following:—The previous dampness of the commixed portions of air; the difference of their respective temperatures; the elevation of their mean temperature; and the extent to which the combination takes place.

The principal objection to this theory is, that the quantity of rain which actually falls in a given portion of time is often very much greater than can be supposed to be produced by any probable extent of cooling that can take place in the free atmosphere in that time, unless, perhaps, we have recourse to the supposition of a cold and warm current driving swiftly in opposite directions, and continually mixing their conterminous surfaces. Sir J. Leslie (*Encyc. Brit.*, art. "Meteorology") computes that if two currents of moist air were driving along in opposite directions, with velocities whose sum is 30 miles an hour, the one having a temperature of 70° of Fahrenheit, and the other of 50°, the deposition of moisture in the space of an hour would be equal to the height of an inch. If the sum of the opposite velocities amounted to 60 miles an hour, and the intermingling influence extended to but a quarter of an inch at the grazing surfaces, there would still be produced in the same time a fall of rain reaching to half an inch in altitude. These quantities agree sufficiently with observation in certain cases; but the objection still recurs that rain frequently falls from clouds which appear to move very slowly, and when consequently the supposition of such velocities is inadmissible.

It is the opinion of Mr. Luke Howard, and some other writers on meteorology, that Dr. Hutton's theory is insufficient to explain the phenomena; and that the immediate cause of rain is to be ascribed, in many instances at least, to the electric action of the clouds on each other. They suppose the hygrometric moisture in the air to be kept suspended by the mutual repulsions of the electric atmospheres of the particles; and that when the electricity is from any cause withdrawn, the suspending power is likewise removed, and the particles coalesce and fall in consequence of their gravity. That rain is connected in some way or other with the electric state of the atmosphere, is a position which may be readily conceded; but as the disturbance of the electric equilibrium remains to be accounted for, this theory, as it at present stands, brings us no nearer to definite ideas.

Some extraordinary falls of rain have been recorded, the accounts of which, if not given on apparently unexceptionable testimony, would scarcely fail to be regarded as fabulous. On the 25th October, 1825, a fall of 30 French inches (32 English), within 24 hours, occurred at Genoa; and on the 9th October, 1827, there fell at Joyeuse, in the south of France, a quantity equal to 31 English inches within the space of 22 hours. (Prof. Forbes's Report on Meteorology, in the *Reports of the British Association for* 1840.)

A curious circumstance attending the fall of rain is, that the quantity collected in rain gauges placed at the surface of the ground is considerably greater than when the instruments are placed at some elevation above the surface. On an average of 13 years the quantity of rain which fell annually in the court of the observatory at Paris was 56 centimètres (22 English inches); while the mean quantity which fell on the terrace, at the height of 28 mètres (92 feet) above the court, was only 50 centimètres, or 8-9ths of the former quantity. A gauge placed on the top of York Minster, at an elevation of 212 feet 10 inches, showed a fall of 14·963 inches between February 1833 and February 1834; while two perfectly similar instruments, one placed on the top of the Museum of that city, at a height of 43 feet 8 inches, and the other on the ground, gave respectively 19·852 inches and 25·706 inches. (*Reports of the British Association for* 1834.) It is supposed that this phenomenon depends, in some measure at least, on the circumstance that the drops of rain, descending from the higher regions with the temperature belonging to the elevation, cause a condensation of vapour in the lower strata, and probably of fogs, which are always denser near the surface of the ground, and which yield a considerable deposition of water. Any hypothesis of this kind, however, is quite insufficient to explain the great difference observed at York between the products of the rain gauges on the ground and the top of the Minster, and which is most probably to be ascribed to some imperfection in the action of the instrument when exposed to gales of wind. It has been suggested that eddies are formed round the rim of the funnel, which have the effect of diverting part of the rain.

Rain drops vary in size from perhaps the 25th to the 3d part of an inch in diameter; and, like other falling bodies, descend with a continually accelerating velocity until the resistance of the air becomes equal to their weight, after which the descent is uniform. The terminal velocity is proportional to the square root of the diameter of the drop; but it is perhaps not possible to determine with certainty the actual terminal velocity corresponding to a drop of any given diameter.

The average quantity of rain which falls in a year at any given place depends upon a great variety of circumstances,—as latitude, proximity to the sea, elevation of the region, configuration of the country and of the mountain ranges, exposure to the prevailing winds; and in general on the different local causes which influence climate. Humboldt estimates that the average depth of rain which annually falls at the latitudes of 0°, 19°, 45°, and 60°, may be taken respectively at 98, 80, 29, and 17 inches; but this estimate must be regarded rather as a rough approximation to the ratio in which the quantity decreases on going from the equator, than as indicating the actual averages at any particular place; and it is observed that though the annual depth be greatest towards the equator, the number of rainy days in the majority of places increases with the latitude.

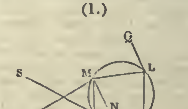
The greatest depth of rain which has been registered at any place in a year is at Maranham, lat. 2½° S., and which is stated by Humboldt to be 277 English inches. But this is greatly above the average, and indeed more than double the annual quantity which has been observed at any other locality. At St. Domingo the annual fall is estimated at 120 inches; at Cayenne, 116 inches; in the island of Granada, 112; at the Havannah, 91; at Calcutta, from 76 to 118; at Bombay, from 83 to 96; the island of Martinique, 87 inches; and at Sierra Leone, 86. Of European countries, Portugal appears to be the most humid, 123 inches having been observed at Coimbra in a year. The average depth at Paris is 19·1 inches (Arago, *Journal de Physique*, 1816); Berlin, 20·9; Brussels, 19; Florence, 41·3; Lyons, 39·5; Maestricht, 36·1; Marseilles, 18·4; Padua, 36·6; Petersburg, 18·2; Rome, 31·2; Rotterdam, 22·4; Stockholm, 18·7; Vienna, 17. For places in Great Britain the following averages were deduced by Dr. Dalton from observations of a number of years:—Manchester, 36·140 inches; Liverpool, 34·118; Lancaster, 39·714; Kendal, 53·944; Dumfries, 36·918; Glasgow, 21·331; London, 20·686. Mr. Howard gives the annual average at London equal to 24·9 inches; Professor Phillips at York, 25·7; and Mr. Adie at Edinburgh, 25 inches. (On the theory of rain, see Kämptz, *Lehrbuch der Meteorologie*; Muncke, in *Gehler's Physicalisches Wörterbuch*; *Daniell's Meteorological Essays*, &c.)

RAINBOW. (Germ. regenbogen; Lat. iris; Fr. arc en ciel.) The brilliant-coloured arch which makes its appearance when rain is falling in the region of the sky opposite to the sun, and the sun is shining at the same time.

This well-known meteor presents, when perfect, the appearance of two concentric arches; the inner being called the *primary*, and the outer the *secondary* rainbow. Each is formed of the colours of the solar spectrum; but the colours are arranged in the reversed order, the red forming the exterior ring of the primary bow and the interior of the secondary. The innermost bow is a segment of a circle whose radius subtends an angle of about 42°; the radius of the outer subtends an angle of about 51°; and the common centre is situated in the prolongation of the straight line which passes through the centre of the sun and the eye of the spectator. From the conditions invariably accompanying its appearance, the colours of the rainbow were known at an early period to be produced by the sun's rays passing through the drops of falling rain; but the phenomenon is a complicated one, and was not fully and satisfactorily explained until Newton had discovered the compound nature of solar light, and the different refrangibility of the component rays.

In order to explain the phenomenon of the rainbow, let us suppose a beam of light admitted through a small hole in the shutter of a darkened room to fall on a spherical globule of water at I (fig. 1.) in the direction S I, and trace the path of the light in the interior of the globule. On entering the globule at I it is refracted, and consequently decomposed, the rays of each colour being deflected under a different angle from its original direction. For the sake of perspicuity, we shall confine our attention to the red ray. Let I K be the direction of the ray after the first refraction. On meeting the surface of the drop at K a portion of the light will effect its escape, and be again refracted in the direction K P, while the remaining portion will be reflected by the surface in the direction K L, the lines I K, K L making equal angles

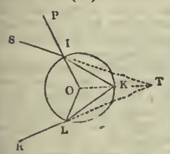
(1.)



with a tangent at K. But on arriving again at the surface at L, this portion of the ray which was reflected from K will be again divided into two parts; one part will escape at L, and be refracted in the direction L Q, while the other part will be reflected by the surface, and proceed in the direction L M. At M the phenomenon will be repeated; part of the remaining light will escape and be refracted in the direction M R, and the other be reflected in the direction M N. This process will be repeated indefinitely; but the intensity of the light is diminished at each successive impact, and after a few reflexions the quantity which emerges becomes insufficient to make an impression on the eye. All this may be shown experimentally by causing a beam of light to fall upon a glass cylinder filled with water, and placed in a darkened room; the red light emerging at the points K L M will be seen when the eye is placed in the straight lines K P, or L Q, or M R.

To apply this experiment to the explanation of the rainbow, it is necessary to determine the inclination of the emerging to the incident ray. We shall first take the case of two refractions with a single intermediate reflexion. Let S I (fig. 2.) be the incident ray, I K the direction after the first refraction, K the point of reflexion, L the point of emergence, and L R the direction of the emerging ray; also let S I and R L be produced to meet in T. The angle S T R is called the angle of deviation, and the object is now to find an expression for its value in terms of the angle of incidence. Let O be the centre; draw O I P and O L, and join O T, which will evidently pass through K. Let us now assume,

(2.)



$i = $ O I T $=$ S I P the angle of incidence,
$r = $ O K I $=$ O I K the angle of refraction,
D $=$ S T R the angle of deviation;

then, since O K I $=$ K I T $+$ K T I, and K I T $=$ O I T $-$ O I K, we have $r = i - r + \frac{1}{2}$ D, whence

$$D = 4r - 2i \quad . \quad . \quad . \quad . \quad (1.)$$

Here D is expressed in terms of r and i; but by the theory of refraction we have also the relation

$$\sin. i = n \sin. r \quad . \quad . \quad . \quad . \quad (2.)$$

(where n is the index of refraction for the red ray), so that the value of D depends only on that of i.

The angle of incidence, i, may have any value between 90° and 0. But it is obvious that between those values D must have a maximum; for when S I falls perpendicularly on the globule there is no deviation, and when S I merely touches the globule the deviation again vanishes. To find the determinate value of i at which the maximum takes place, differentiate the equation (1.), and make the differential of D equal to zero; this gives $d\,i = 2\,d\,r$. Equation (2.) also gives $\cos. i\,d\,i = n \cos. r\,d\,r$; whence we obtain, by eliminating $d\,r$, and dividing both sides of the resulting equation by $d\,i$, $n \cos. r = 2 \cos. i$. On substituting for $\cos. r$ in this equation its value found from (2.), the following expression is obtained: —

$$\cos. i = \sqrt{\tfrac{1}{3}\,(n^2 - 1)}.$$

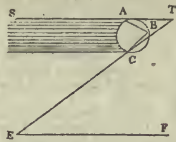
This is the value of i corresponding to the maximum deviation expressed in terms of n. But in respect of the red rays, the value of n is found experimentally to be $108 \div 81 = 1{\cdot}3333$; and the corresponding value of i given by the trigonometrical tables is $i = 59^\circ\ 23'\ 30''$. From this the values of r and D are readily deduced; and the three values are as follows: —

$$i = 59^\circ\ 23'\ 30'',\ r = 40^\circ\ 12'\ 10'',\ D = 42^\circ\ 1'\ 40''.$$

The next step towards the explanation of the phenomenon is, to show that no other light than that which falls on the drop under the angle of incidence corresponding to the greatest deviation, will be refracted in sufficient quantity to make a sensible impression on the eye. Now since S I is the incident ray, with respect to which the deviation is a *maximum*, the rays which are situated very near to S I, on either side, will enter the drop at very nearly the same angle of incidence, and consequently will emerge very nearly parallel to L R. With respect then to the pencil of light which falls on the drop at the angle of incidence, corresponding to the maximum deviation, all the rays of red light which it contains, and which emerge after the first reflexion, will on their emergence be parallel, and enter the eye situated in the straight line L R in sufficient number to make a vivid impression on the retina. But with respect to a pencil falling on the drop at a small distance from I, and consequently under a different angle of incidence, the red rays at their emergence will not be parallel, but divergent; and the light will consequently diminish in intensity as it recedes from the drop, and at the distance of the spectator will be much too faint to produce a distinct impression. It is on this delicate principle that the phenomenon principally depends.

The above principles being clearly understood, all the circumstances of the phenomenon admit of easy explanation. Let A B C (fig. 3.) be a section of a drop of rain made by the plane passing through the centre of the sun, the centre of the drop, and the eye of the spectator; and suppose the rays from the sun's centre to fall on it in the direction S A. Let E be the position of the eye of the spectator, whose back is turned towards the sun, and draw E F parallel to S A. Now suppose the line E T to be drawn so as to make with E F an angle of 42° 1′ 40″, and to meet the drop at C; then, since the whole of the anterior surface of the drop is illuminated by the rays S A, some one of those rays must fall on it under an angle of incidence, such that after being refracted at A, reflected at B, and again refracted at C, it will emerge parallel to C E, and consequently make with E F the maximum angle of deviation. The spectator will therefore see the red colour of the spectrum in the direction E C. But it is obvious that all these conditions will be fulfilled in respect of every drop of rain which the line E C will meet, on supposing it to revolve about E F as an axis at the same angle of inclination. Hence the red rays thus refracted form the surface of a cone, the axis of which is the prolongation of the straight line drawn from the centre of the sun to the eye; and as the eye of the spectator is at the apex of the cone, a circular segment of red light will be visible, the other part of the circle being cut off by the horizon.

(3.)



What has now been said has reference only to rays coming from the sun's centre; but the same thing must happen with respect to rays coming from every point of the sun's disk; and as the sun's diameter subtends an angle of about 30′, the spectator will consequently see a band of red light of the breadth of about 30′.

The explanation which has now been given of the appearance of the red light applies to all the other colours of the spectrum, the only difference being in the value of the index of refraction. For the violet ray, in passing from air to water, the index is $109 \div 81$; we have therefore $n = 1{\cdot}3468$; and on computing from this the values of i, r, and D, by means of the preceding formulæ, there results, appproximately,

$$i = 58^\circ\ 40'\ 3'',\ r = 39^\circ\ 24'\ 20'',\ D = 40^\circ\ 17'.$$

In this case, therefore, the angle of maximum deviation is less than for the red ray, and hence the violet is within the red. The breadth of the violet band will obviously be the same as that of the red, as both depend on the same cause; namely, the magnitude of the sun's apparent diameter.

As the red and violet are the rays whose indices of refraction are the least and greatest respectively, all the other prismatic colours will lie between these two, and occupy bands of the same breadth, but with considerable blending into each other; for the distance between the centre of the red and the centre of the violet, being equal to the difference between their respective angles of maximum deviation, amounts only to $42^\circ\ 2' - 40^\circ\ 17' = 1^\circ\ 45'$. The whole breadth of the interior or primary bow is this quantity plus the sun's apparent diameter, or about 2° 15′.

The size of the bow depends upon the height of the sun above the horizon. When the sun is in the horizon, the bow will be a semicircle to a spectator on a plane; but on the summit of a mountain, he may see a segment greater than a semicircle.

We have now to explain the formation of the exterior bow. In this case, the light suffers two reflexions in the interior of the globule, and the path of a ray, as represented in fig. 1., is S I K L M R. If we denote the angle of deviation, or the angle formed by S I and M R, the incident and emerging rays by D′, and take as before i and r to represent the angles of incidence and refraction, it is easy to find the equation,

$$D' = 6r - 2i - 180^\circ.$$

On proceeding from this by the same method as before to find the value of i corresponding to the *maximum* value of D′, the following equation is obtained: —

$$\cos. i = \sqrt{\tfrac{1}{8}\,(n^2 - 1)}.$$

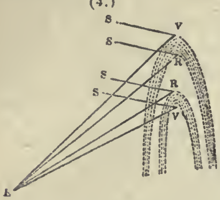
Substituting for the constant n its values in respect of the red and violet rays, the values of i, and consequently of r and D′, are obtained. They are as follows: —

red, $i = 71^\circ\ 50'$, $r = 45^\circ\ 27'$, $D' = -50^\circ\ 59'$;
violet, $i = 71^\circ\ 26'$, $r = 44^\circ\ 47'$, $D' = -54^\circ\ 9'$;

the minus sign indicating that the incident and emergent rays intersect before the drop.

From these values it appears that in the case of the exterior bow the deviation is least in respect of the red ray, and greatest in respect of the violet; the order of the colours is therefore reversed, the red occupying the innermost band, and the violet the outermost, as represented in fig. 4., where E R is the red and E V the violet ray, the eye of the spectator being at E. The breadth from the middle of the red to the middle of the violet is 3° 10′, or nearly double that of the interior bow. The interval between the red of the interior bow and the red of the exterior is 50° 59′ — 42° 2′, or 8° 57′. All these values, deduced as above from the theory of refraction, are found to agree exactly with those found by actual measurement.

(4.)



Dr. Halley, in the *Phil. Trans.* for 1700, has computed the diameters of the rainbows formed by three, four, and five reflexions; but these bows are rarely if ever seen, the light being too faint to make an impression on the eye. Supernumerary or spurious rainbows are sometimes seen within the primary and without the secondary bow, and having the same order of colours as the bows to which they respectively belong. They are explained by Dr. Young on the theory of the interference of light. (*Phil. Trans.* 1804; *Lect.*, vol. i. p. 470.) An inverted or distorted iris is sometimes observed lying on the ground, formed by the drops of dew suspended from the tops of the blades of grass, or from spiders' webs. In favourable circumstances lunar rainbows are sometimes seen; but their colours are faint and scarcely perceptible.

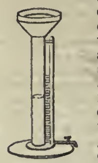
The first explanation of the true theory of the rainbow is usually ascribed (see *Newton's Optics*) to Antonio De Dominis, archbishop of Spalatro, whose work, *De Radiis Visus et Lucis*, was published at Venice in 1611, but stated to have been written twenty years previously. It would appear, however, from the account of this work given by Boscovich, Montucla, Priestly, and Biot, that the merit of De Dominis was confined to a vague statement or surmise, unsupported by experiment, that the interior bow is formed by two refractions and an intermediate reflexion. He gave no reason for the precise angle which its diameter subtends; and with respect to the exterior bow, his attempt to explain its formation is wholly erroneous. The true theory of the exterior bow, and the determination of the particular angles of deviation under which alone the rays transmitted to the eye are sufficiently dense to be visible, belongs to Descartes. The explanation given by Descartes, in his *Dioptrics*, is complete in every respect, excepting as to the cause of the colours, the theory of which was supplied by Newton's great discovery of the unequal refrangibility of the different rays. (See Montucla, *Histoire des Mathematiques*, vol. i. p. 700.; *Priestly on Vision*, p. 107.; *Biot, Traité de Physique*, tom. iii. p. 460.)

RAIN-GAUGE, also called OMBROMETER, UDOMETER, and PLUVIAMETER. An instrument for measuring or *gauging* the quantity of rain which falls at a given place.

"The *rain-gauge* may be of very simple construction. A cubical box of strong tin or zinc, exactly 10 inches by the side, open above, receives at an inch below its edge a funnel, sloping to a small hole in the centre. On one of the lateral edges of the box, close to the top of the cavity, is soldered a short pipe, in which a cork is fitted. The whole should be well painted. The water which enters this gauge is poured through the short tube into a cylindrical glass vessel, graduated to cubic inches and fifths of cubic inches. Hence, one inch depth of rain in the gauge will be measured by 100 inches of the graduated vessel, and 1-1000th inch of rain may be very easily read off.

"It is very much to be desired that, being of such easy construction, more than one of these gauges should be erected; or at least one placed with its edge nearly level with the ground, and another upon the top of the highest building, rock, or tree in the immediate vicinity of the place of observation, the height of which must be carefully determined, it having been satisfactorily ascertained that the height of the gauge above the ground is a very material element of the quantity of rain which enters it. The quantity of water should be daily measured and registered at 9 A. M." (*Report of the President and Council of the Royal Society on the Instructions to be prepared for the Scientific Expedition to the Antarctic Regions*, 1840.)

A convenient form of the instrument is represented in the annexed figure, where the rain which enters the funnel is collected in a cylindrical vessel of copper, connected with which at the lower part is a glass tube with an attached scale. The water stands at the same height in the cylinder and glass tube, and being visible in the latter, the height is read immediately on the scale; and the cylinder and tube being constructed so that the sum of the areas of their sections is a given part, for instance a tenth, of the area of the funnel at its orifice, each inch of water in the tube is equivalent to the tenth of an inch of water entering the mouth of the funnel. A stop-cock is added, by which the water is drawn off when the observation is made.



RAISING PLATE, or UPPER PLATE. In Architecture, the plate or longitudinal timber on which the roof stands raised or placed.

RA'JAH. The hereditary princes of the Hindoos are so termed. They belong to the caste of warriors, or Cshatriya, and are generally dependent on Europeans, except in those parts of the country which the European arms have not as yet penetrated. *See* CASTE.

RAKE, TO. The sea term for *incline*, and applies to the masts, stem, and stern-post, &c.; the bowsprit, instead of raking, is said to *steeve*. Masts generally rake aft, and in peculiar rigs only forward. The rake of the mast has an influence on the sailing of the vessel, and the masts of some schooners rake excessively. The principal effect seems to be to diminish the effect common to all the sails, of depressing the ship's head.

To *rake a ship*, is to fire into her head or stern in the direction of her length, or along her decks. It is similar to what engineers term enfilading.

RAM. In Hydraulics. *See* HYDRAULIC RAM.

RAMADAN, or RHAMADAN. The name given to the great fast or Lent of the Mohammedans. It commences with the new moon of the ninth month of the Mohammedan year; and, while it continues, the day is spent uninterruptedly in prayers and other devotional exercises. Even the night is passed by the more rigid of the faithful in the mosques, which are splendidly illuminated on this occasion; but, generally speaking, the arrival of sunset is the signal for a more than usually unlimited indulgence in the pleasures of the table; and, on the third evening of the fast, the grand vizier commences a series of official banquets. The Ramadan ends on the day preceding the only other great festival of the Mohammedans, — the *Bairam* (which see), equivalent to our Easter.

RAMAYA'NA (Sanscr. *the Career or Travels of Rama*), the oldest of the two great Sanscrit epic poems, describes the life and actions of the hero Rama, and his wife Sita; and especially Rama's expedition to Ceylon, to rescue Sita from the tyrant Rawana. The poem is thought to have been composed before the Christian era; but there is no certain indication of its age. A translation of it was commenced by Messrs. Carey and Marshman (printed at Serampore); and another by A. W. von Schlegel (Bonn, 1829).

RAM, BATTERING. *See* BATTERING RAM.

RAME'NTA. In Botany, thin, brown, foliaceous scales, appearing sometimes in great abundance upon young shoots, and particularly numerous and highly developed upon the petioles and the backs of the leaves of ferns.

RA'MISTS, or RA'MEANS. In Philosophy, the partisans of Pierre Ramé, better known by his Latin name of Ramus, royal professor of rhetoric and philosophy at Paris in the reign of Henry II. He perished in the massacre of St. Bartholomew. His system of logic was opposed to that of the Aristotelian party; and during the latter half of the 16th century a vehement contest was maintained between their respective adherents in France, Germany, and other parts of Europe. (Hallam, Introduction to the *Literature of Europe*, vol. ii. ch. 3.) "He conferred," says the same writer, "material obligations on science by denying the barbarous method of the schoolmen. What are the merits of his own method, is a different question." (*Ib.* vol. i. ch. 7.)

RAMNE'NSES, or RAMNES. The name of the first century of the 300 horsemen who constituted the cavalry of Rome under the early kings. Most probably the name also applied at first to the original century of patrician houses established by Romulus, and distinguished them from the Tatienses and Luceres; whose names, in like manner, must be supposed to extend not merely to the two remaining centuries of cavalry, but to the two centuries of tribes respectively instituted by Romulus, on the accession of the Sabines and Tarquinius Priscus. (See the histories of Niebuhr and Arnold.)

RAMP. (Fr. Rampe.) In Architecture, a concave bend or slope in the cap or upper member of any piece of ascending or descending workmanship.

RA'MPANT. (Fr.) In Heraldry, a term used to

describe lions, tigers, bears, &c., when represented as standing erect on their hind legs.

RA'MPART, or RAMPIER. In Fortification, the wall which surrounds a fortified place. It is built of the earth taken out of the ditch; though the lower part of the outer slope is usually constructed of masonry. The advantage of earth is, that the balls instead of splintering the work, and rebounding in various directions to the great injury of the besieged, pass forward into the earth, and bury themselves there. This also renders the rampart of earth much more durable under the fire of the besiegers than masonry would be. The usual height of the rampart is about three fathoms, and its thickness about ten or twelve feet. *See* FORTIFICATION.

RAMS' HORNS. In Fortification, the name given by Belidor to the tenailles. *See* TENAILLE.

RA'NA. (Lat. *a frog.*) The generic name of the tailless Batrachian reptiles, which have the hind legs longer than the fore, and webbed toes fitted for swimming, and not expanded at the extremity. Their head is flat, muzzle rounded, and the opening of their jaws large; the tongue in most of them is soft, and not attached to the bottom of the gullet, but to the edges of the jaw, with the free end turned backwards. There are but four toes to the anterior feet; the hind ones frequently exhibit the rudiment of a sixth.

There are no ribs to their skeleton, and a prominent cartilaginous plate supplies the place of a tympanum, and renders the ear visible externally. The eye is furnished with two fleshy lids, and a third, which is transparent and horizontal, concealed under the lower one. Inspiration is effected by the muscles of the throat, which, by dilating, draw in air by the nostrils, and by contracting while the nostrils are closed by the tongue compel the air to enter the lungs; expiration, on the contrary, is produced by the muscles of the lower part of the abdomen. The young frog, which is called a tadpole, is at first furnished with a long fleshy tail, and a small horny beak, having no other apparent limbs than little fringes on the sides of the neck. These disappear in a few days, and the hind feet of the tadpole are very gradually and visibly developed; the fore feet are also developed, but under the skin, through which they subsequently penetrate. The tail is gradually absorbed. The beak falls and discloses the true jaws, which at first were soft and concealed beneath the skin; and the branchiæ are absorbed, leaving to the lungs alone the function of respiration in which they participated. The eyes, which at first could only be discerned through a transparent spot in the skin of the tadpole, are now visible with their three lids. Tadpoles reproduce their limbs almost like salamanders.

The period at which each of these changes takes place varies with the species. In cold and temperate climates, the perfect animal passes the winter under ground, or in the mud under water, without eating or breathing; though if it be prevented from respiring during the summer for a few minutes by keeping its mouth open, it dies.

RA'NDOM SHOT. A shot discharged with the axis of the gun above the horizontal or point blank direction.

RANGE, in Gunnery, is the horizontal distance to which a shot or other projectile is carried. Were it not for the resistance of the air, the path described by a projectile acted upon by the force of gravity would be a parabola; and the greatest range would be obtained by discharging the projectile at an angle of 45° of elevation. But by reason of the atmospheric resistance, the path actually described is very different from a parabola, and the elevation which gives the greatest range can only be determined by experiment. *See* GUNNERY, PROJECTILES.

RANGE. A certain quantity of cable drawn up out of the cable tied and laid along the deck, equal in length to the depth of water, in order that the anchor, when let go, may reach the bottom without being checked.

RA'NGER. Formerly a sworn officer of the king's forests, whose principal duty it was to see and inquire of trespassers in his bailiwicks, and present them at the next court holden for the forest; but now merely an officer of state. *See* FOREST.

RA'NIDÆ. The family of Batrachian reptiles, having as the type the frog (*Rana temporaria*, Linn.). *See* RANA.

RA'NTERS. A sect which originated in a secession from the Wesleyan connection, on the ground that the Wesleyans paid too much attention to order and decorum in the conducting of public worship, and that they were deficient in zeal in obtruding the gospel on the minds of the people by open preaching in the streets and fields. The ministers of this party parade the streets, preaching, singing hymns, and inviting the populace to come to their places of worship. They admit of female preaching; a thing unknown to every other body of Methodists. They are most prevalent in America. Their chapels are about 400 in number; their preachers, 2700; their members, 34,000. (*Bourne's Hist. of the Prim. Methodists.*)

RA'NULA. (Lat. rana, *a frog*, to which it has been supposed to bear some resemblance.) A tumour under the tongue, generally arising from some obstruction of the ducts of the salivary glands; when they break they are apt to leave a very troublesome ulcer.

RANUNCULA'CEÆ. (Ranunculus, one of the genera.) Exogenous Polypetalous plants, in almost all cases herbaceous, inhabiting the colder parts of the world, and unknown in hot countries, except at considerable elevations. They are of great importance, in consequence of their usually poisonous qualities, as evinced by aconite and hellebore in particular, which are the roots of several species. Some of them are objects of beauty, as the larkspurs, ranunculus, anemone, and pæony. A few are simply astringent, as the coptis or gold thread of North America. The plants of this order are readily known by having an indefinite number of hypogynous stamens, separate carpels, exstipulate undotted leaves, and an herbaceous stem.

RANZ DES VACHES. (Germ. Kuhreigen.) The name of the simple and beautiful melody which the Swiss herdsmen are in the habit of playing on the Alpine horn, and sometimes of singing, when they drive out their herds to the mountains. It consists of a few simple intervals, and has a beautiful effect in the echoes of the Swiss mountains. The natives regard it almost with rapture, and are said to be seized with irrepressible longings to return to their native country when they hear it played in a foreign land.

RAPE. (Lat. raptus.) In Criminal Jurisprudence, a well-known and detestable offence committed against women. This offence has been most properly viewed by all legislators as one of the gravest character, and has been usually visited with the highest penalties. The accusation of rape, it is true, is one that may be easily made, and is, no doubt, sometimes preferred in cases where consent has been given. The proof, therefore, should be clear in proportion to the enormity of the crime; but when proved it is one that should very rarely indeed escape the utmost vengeance of the law. Capital punishment for this offence was abolished in 1841.

RAPE. An Anglo-Saxon territorial division, of which the etymology is uncertain. Sussex is the only county divided into rapes; each containing three or four hundred. These subsisted as military divisions at the time when Domesday Book was compiled. They were formerly under the superintendence of "rasse-reeves," subordinate to the sheriff of the county.

RAPE. A plant belonging to the cabbage family (*Brassica rapa*, Linn.), cultivated in fields for its seeds, which are crushed for oil; and sometimes for its leaves, which are fed off by sheep. In Belgium another species or variety of Brassica is cultivated for these purposes, called *cobya*, the *Brassica oleifera* of De Candolle.

RAPHE. (Gr. ῥαφη, *a suture.*) In Botany, the vascular cord communicating between the nucleus of an ovule and the placenta, when the base of the former is removed from the base of the ovulum.

RAPHE. In Anatomy, a term applied to parts which look as if they had been sewed or joined together.

RA'PHIDES. (Gr. ῥαφη.) Certain needle-like transparent bodies found lying in the tissue of plants. They were formerly thought to be peculiar organs, but are now known to be the crystals of various salts.

RAPTO'RES. (Lat. raptor, *a robber.*) Rapacious birds, or raveners. The name of the order of birds called *Accipitres* by Linnæus and Cuvier, including those which live by rapine, and are characterized by a strong, curved, sharp-edged, and sharp-pointed beak; and robust short legs, with three toes before and one behind, armed with long, strong, crooked talons.

RAREFA'CTION. In Physics, an augmentation of the intervals between the particles of matter, whereby the same number of particles occupy a larger space. The term is chiefly used in speaking of the aëriform fluids, the terms *dilatation* and *expansion* being applied in speaking of solids and liquids. In the free atmosphere rarefaction is caused by diminishing the pressure, and hence the air becomes rarefied at elevations above the general level. The limits to which rarefaction may be carried are not known; but it has been proved by experiments with the air-pump, that air may be rarefied so as to occupy a volume 13,000 times greater than it occupies under the ordinary pressure.

RASKO'LNIKS. (Russ. raskolo, *a division.*) The name of the largest and most important body of dissenters from the Greek church in the Russian dominions. They designate themselves Starowerzi, or *the Orthodox;* but differ from the Greek church only in the outward forms of religion, and in maintaining a more strict ecclesiastical discipline. This body was formerly subjected to persecution; but it is now treated with comparative toleration, though its members are still excluded from the service of the state. Their number is said to be about 300,000.

RASO'RES. (Lat. rado, *I scratch.*) Gallinaceous birds, or scratchers The name of an order of birds, including those which have strong feet, provided with obtuse claws for scratching up grains, &c., and the upper mandible vaulted, with the nostrils pierced in a mem-

branous space at its base, and covered by a cartilaginous scale. *See* GALLINACEÆ.

RAT. The name of a large, destructive, and very prolific species of the genus *Mus* (*Mus decumanus*, Linn.), introduced into the British Islands from Asia; not, as is commonly believed, from Norway. It has spread over all the country, and multiplied at the expense of the old British species called the "black rat" (*Mus rattus*, Linn.). *See* MUS.

RA'TCHET, in Clock and Watch Work, is the name given to an arm or piece of mechanism, one extremity of which abuts against the teeth of a *ratchet wheel*, and the other extremity is either freely jointed to a reciprocating driver for the purpose of communicating a continuous motion to the wheel, or is attached to a fixed centre to ensure the wheel against reverse motion. In the former case it is also called a *click* or *paul*, in the latter a *detent*.

RA'TCHET WHEEL. A wheel having teeth formed like those of a saw, against which the ratchet abuts. *See* RATCHET.

RATE OF A SHIP, in the Royal Navy. The navy is divided into three classes. Rated ships, commanded by captains; sloops and vessels, by commanders; and the third class by lieutenants. Rated ships are divided into six classes:—1st, all three-deckers; 2d, two-deckers, having 700 men and upwards (war establishment); 3d, ships having from 600 to 800 men; 4th, ships having from 600 to 400 men; 5th, ships having from 400 to 250 men; 6th, ships having under 250 men.

Rate of sailing of a Vessel, is measured by the *log*, which see. Various plans have been proposed for this purpose by various forms of the log itself, by the rise of water in tubes communicating with the sea, and (by Captain Burney) by the pressure upon a body towed astern and pulling on a spring. But the violence and irregularity of the pull, and the uncertainty in reading the result, have probably combined to set aside this last plan, which, in theory, seems to promise some advantages; because the pressure, increasing as the square of the velocity, would show very small changes of velocity: for the same reason, however, the mean result shown in a heavy sea would be too great. A certain and simple method of ascertaining the velocity at any instant, with precision, is one of the most important desiderata towards the perfection of naval science.

RA'THOFFITE. In Mineralogy, a species of garnet found in Sweden, accompanied by calcspar and hornblende.

RATIFICA'TION. (Lat. ratum, *determined*, facio, *I make*.) The solemn act by which a competent authority gives validity to an instrument, agreement, &c. The term is ordinarily used in international law for the sanction given by governments to treaties contracted by their representatives. In French law, ratification is defined the approbation or confirmation of what has been done or promised. Thus, in many instances, a person, on attaining his majority, ratifies acts done by himself or his guardian in his minority. And ratification is either express or tacit; the latter resulting, by implication, from his silence for ten years after attaining his majority.

RA'TIO (Lat.), in Geometry, is defined by Euclid (*Elements*, book v. def. 3.) to be "a mutual relation of two *magnitudes* of the same kind to one another in respect of *quantity*." This definition has been much criticised. Dr. Barrow (*Lectiones Math.*) calls it a metaphysical definition, inasmuch as it is not properly a mathematical definition, since nothing in mathematics depends on it, or can be deduced from it; and supposes that Euclid had probably no other design in making it than to give a general summary idea of ratio to beginners. It has been remarked, that as the word *quantity* in our language, if not quite synonymous with magnitude, has a signification only a little more general, the definition as above rendered is either tautological or unmeaning. Dr. Simson supposes it to be the interpolation of some unskilful editor. Leslie (*Elements of Geometry*) ingeniously supposes that the Greek word πηλικότης, which is usually translated *quantity*, may have reference to *multitude* or number, as well as to magnitude, and that Euclid's definition may be rendered as follows:—"Ratio is a certain mutual habitude of two homogeneous magnitudes with respect to *quotity*, or numerical composition." Dr. Wallis (*Opera Mathematica*, tom. ii. p. 665.) translates the same word by the Latin *quantuplicitas*, which refers to the number of times the one magnitude is contained in the other. Dr. Peacock (*Algebra*, p. 309.) remarks, that there is no geometrical definition of ratio by which the equivalence of different modes of representation may be ascertained as necessary consequences; and for this reason, ratios in geometry are only considered in connection with each other, as constituting, or not constituting, a proportion. In arithmetic and algebra, a ratio may be defined as the fraction whose numerator is the antecedent, and denominator the consequent of the ratio; and hence, in those sciences, the theory of ratios become identified with the theory of fractions. (For an account of what has been written on the subject of geometrical ratios, see *Camerer's Euclid*, Excursus ad lib. v. Berlin, 1825.)

RA'TION. In the Army, a portion of food and ammunition, &c., distributed to each soldier for his daily maintenance. The rations of officers vary according to the number of servants in their pay.

RA'TIONAL. In Arithmetic and Algebra, an expression in finite terms; or one in which no extraction of a root is left; or, at least, none such indicated, which cannot be actually performed by known processes. The contrary of these are called *surd* or *irrational* quantities. Thus, 2, 9, $12\frac{1}{3}$, are rational quantities; and $\sqrt{2}$, $\sqrt[3]{4}$, &c., are irrational or surd quantities, because their values can only be approximately, and not accurately, assigned.

RATIONAL HORIZON. In Geography, the plane passing through the centre of the earth parallel to the *sensible horizon* of the place to which it is referred. *See* HORIZON.

RA'TIONALISM. The interpretation of scripture truths upon the principles of human reason; which has become famous in the present day by the theological systems to which it has given birth in Germany. The history of the progress of the opinions of the reformed churches of that country may be found in Dr. Pusey's essay upon this subject. He conceives the polemical discussions which prevailed throughout those communities in the 17th and first half of the following century to have prepared the way for the reception of the low views of Christianity, as a moral system, which were derived from the writings of the concealed or avowed deists of this country,—Herbert, Tyndal, Morgan, Toland, &c.; and from the tone with which they were reviewed by the sincere, but odd, theologians of the orthodox party. From the middle of the last century there has arisen in Germany a succession of divines—Baumgarten, Michaelis, Semler, Eichhorn, Paulus, Bretschneider, &c.—who have endeavoured either to affix a lower and more human character to the invisible operations of God upon men through Christianity, or to reduce the accounts which we have of the foundation of our religion to the mixture of truth and error natural to fallible men. They have questioned the genuineness of almost all the separate parts of Scripture, and the accuracy of all their supernatural narratives. The discredit into which these theologians appear to have fallen arises, in a great measure, from the inability they have shown to produce a connected and consistent system of religion upon the low ground which they have taken up. Of later years a much more spiritual conception of the nature of scripture promises and Christian assistances is observable in the writings of German divines, under the operation of which their theological criticism has already assumed a more dignified and exalted tone. The sensation created by Strauss's *Life of Christ*, the latest, and in some respects the most remarkable production of the Rationalist school, may probably have aided in this reaction. (See the article "Rationalismus," in the *Conv. Lexicon*. The English reader may consult the writings of Mr. Hugh Rose and Dr. Pusey on the subject of German rationalism; *Atkinson's View of Universities in Germany; Hawkins's Germany*, and two articles in the *Church of England Quarterly Review*, Oct. 1837, and Jan. 1838.)

RA'TLINES. Small horizontal lines or ropes extended over the shrouds, thus forming the steps of ladders for going up and down the rigging and masts. To *rattle* the rigging, is to fix these ratlines.

RATTANS, or CANES. The long slender shoots of a prickly bush (*Calamus rotang*, Linn.), one of the most useful plants of the Malay peninsula and the Eastern islands. They are exported to Bengal, to Europe, and above all to China, where they are consumed in immense quantities. For cane-work they should be chosen long, of a bright pale yellow colour, well glazed, and of a small size; not brittle or subject to break. They are purchased by the bundle, which ought to contain 100 rattans, having their ends bent together, and tied in the middle. In China they are sold by the picul, which contains from 9 to 12 bundles. Such as are black or dark-coloured, snap short, or from which the glazing flies off on their being bent, should be rejected. When stowed as dunnage, they are generally allowed to pass free of freight. (*Milburn's Orient. Com.*, &c.) The imports into this country are very considerable. (See *Com. Dict.*)

RA'TTLESNAKE. One of the most deadly of poisonous serpents is so called, on account of the peculiar rattling instrument which it carries at the extremity of the tail, and which is formed of several horny flattened rings, loosely attached together, which move and rattle whenever the animal shakes or alters the position of the tail. These rings increase in number with the age of the animal, and it is asserted it acquires an additional one at each casting of the skin. The generic name of the rattlesnake, *Crotalus* (from the Greek κροταλος, a rattle), relates to the above-mentioned peculiarity. Two species are well distinguished; viz. the *Crotalus horridus* of the United States, and the *Crotalus durissus* of Guiana. The genus is peculiarly American. In common

with the boa, the rattlesnakes have simple transverse plates beneath the body and tail. Their muzzle is hollowed by a little round depression behind each nostril. The habits of the rattlesnake are sluggish; they move slowly, and only bite when provoked, or for the purpose of killing their prey. They feed principally upon birds, rats, squirrels, &c., which it is believed they have the power of fascinating.

RATTLESNAKE ROOT. The root of the *Polygala Senega*, a stimulant said to have proved a serviceable remedy in cases of the bite of the rattlesnake.

RA'VELIN, in Military Works, is a detached work composed of two embankments forming a salient angle. It is raised before the curtain on the counterscarp of the work, serving to cover it and the adjacent flanks from the direct fire of the enemy. When used to cover the approach to a bridge, it is called a *tête du pont*. It is also used in field fortification.

RAY, *Raia*. (Lat. radius, *a ray*.) A genus of cartilaginous Plagiostomous fishes, recognizible by their horizontally flattened and broad disk-shaped body, which is chiefly composed of the immense pectoral fins, the jointed and branched rays of which diverge, like the rays of a fan, and support a broad duplicature of the skin, which is continuous anteriorly with that of the side of the flattened head; whence the name of the genus. The *Raiæ* of Linnæus are now divided into many subgenera, of which the sting ray, eagle ray, electric ray, fire flare, skate, &c. are the respective types.

RAY. In Optics, a beam of light propagated in a straight line from some luminous point. A ray of white light may be divided by refraction into a number of distinct rays of different colours. *See* REFRACTION.

RA'YAH. The designation by the Turkish government of its non-Mohammedan subjects, who pay the capitation tax. Under Bajazet I. the taxable Rayahs in Turkey in Europe were numbered at 1,112,000; under Selim, the late sultan, 1,337,000.

RAZE'E. (Fr.) The term used for any vessel cut down to an inferior class, as a 74 to a frigate, &c. By razeeing, the draught of water is diminished, while the centre of gravity is lowered, and the qualities of the vessel have generally, though not invariably, been improved.

REACH. That portion of the length of a river in which the stream preserves the same direction.

REACTION. A term used in Mechanics to denote the reciprocality of force exerted by two bodies which act mutually on each other; or the general fact, collected from observation, that any two bodies repelling or attracting each other are made to recede or approach with equal momenta. Newton's third law of motion is, that "reaction is always contrary and equal to action, or that the mutual actions of two bodies are always equal, exerted in opposite directions." In the mathematical consideration of mechanics, this principle must be assumed as a necessary axiom or law; and, in fact, as is remarked by Dr. Young (*Nat. Phil.*), there would be something peculiar, and almost inconceivable, in a force which could affect unequally the similar particles of matter; or in the particles themselves, if they could be supposed of such different degrees of mobility as to be equally moveable with respect to one force, and unequally with respect to another. The principle may, therefore, as justly be termed a necessary law as an experimental fact.

REA'DER. In Ecclesiastical matters, one of the five inferior orders in the Romish church. In the church of England, a reader is a deacon appointed to do divine service in churches and chapels of which no one has the cure. There are also readers (priests) attached to various eleemosynary and other foundations.

REAL. *See* MONEY.

REA'LGAR. Red sulphuret of arsenic. It is found native, and is composed of 38 arsenic + 16 sulphur.

RE'ALISM, in Philosophy, has two distinct meanings, according as it is used in contradistinction to *idealism* or to *nominalism*; in the former case relating to the theory of perception, in the second to the theory of abstraction and generalization. For the first, see PERCEPTION, and IDEALISM; for the second, SCHOLASTIC PHILOSOPHY, THOMISTS, SCOTISTS, and NOMINALISTS.

REAL PRESENCE. *See* TRANSUBSTANTIATION.

REAL PROPERTY. Real property is commonly said to consist in "lands, tenements, and hereditaments;" of which terms the last is, in fact, coextensive with the term real property itself, expressing the same thing by the quality which the logicians would term its *difference*, viz. that it descends to the heir wherever held in perfect right: thus distinguished from all other species of full property, which, if possessed in equally absolute right, descend to the executors or administrators of the party. Hereditaments, then, are either corporeal or incorporeal; the first being land and its visible adjuncts recognized by the law as appertaining to it, consisting principally of whatever is fixed thereon; the second, to follow Blackstone's division, are chiefly ten,—advowsons, tithes, rights of common, rights of way, offices, dignities, franchises, corodies (pensions charged on ecclesiastical property, now obsolete), annuities charged on land, and rents reserved out of lands and tenements. The quality of the property which the man may possess in those objects included under the term real (technically called his estate) may vary in *tenure* or in *degree*. *See* FREEHOLD, COPYHOLD, FEE SIMPLE, &c.

REAM. A quantity of paper, consisting generally of twenty quires of twenty-four sheets each; but what is called the printer's ream contains 21½ quires, or 516 sheets. *See* PAPER.

RE'APING. Cutting down corn or pulse with a sickle, hook, or scythe, or by a reaping machine. These operations are more advantageously performed when the corn or pulse is not quite ripe, than when it is thoroughly ripe; because in the latter case the seeds are apt to drop out in the process of handling, turning, and drying.

REAR. The 3d or last division of a fleet, commanded by a rear admiral.

REAR GUARD. That part of an army, a regiment, or battalion, which marches after the main body. *Rear rank* signifies the last rank of a battalion, when drawn up in open order.

REA'SON. (Lat. ratio.) That particular faculty in man of which either the exclusive or the more intense enjoyment distinguishes him from the rest of the animal creation. Like most of the terms in the science of mind, that of reason has been employed in a great variety of significations. Dugald Stewart takes it in its widest sense, and comprises under it all the operations of the intellect upon the materials of knowledge which are furnished in the first instance by sense and perception. Its office is to distinguish the true from the false, right from wrong, and to combine means for the attainment of particular ends. According to this definition, therefore, the province of reason is coextensive with the range of human activity, and it directs itself to the three supreme objects of desire to man,—the good, the beautiful, and the true. Mr. Hume, however, withdraws the discernment of right and wrong, and of the beautiful and its contrary, from the domain of reason; and, on the other hand, also, denies the certainty of the truth which it enunciates, and limits its convincing force merely to a certain weight of probability. Locke's usage of the term, again, partaking as it does of the general looseness of his phraseology, is very different. In one passage reason is declared to be the faculty which finds out the means, and rightly applies them, to discover either the certain agreement or disagreement of two ideas, or their probable connection. But, in another place, it is said to be conversant with certainty alone; while the discovery of what, as probable, enforces a contingent assent or opinion, is ascribed to an especial faculty, which is called the judgment. Bird, on the other hand, confines the latter term to the apprehension of intuitive truth; but agrees so far with Locke as to make it one part of reason, whose other part is reasoning, both demonstrative and moral. On the whole, however, it is clear that in the mind of Locke the terms reasoning and reason were nearly, if not quite, equivalent. But reasoning and deduction are evidently not the source either of the dignity or the authority of the human intellect. The discursive faculty can never establish any other than a conditional truth, which predisposes some anterior and pre-established verity as its basis and verification. If there were not in the human mind something primary, unconditional, and absolute, to which all reasonings might be referred, as to their source and foundation, the discursive process would proceed into infinity, and its conclusions be, as Hume asserts that they are, without any power to enforce assent. But there are unquestionably in the human mind certain necessary and universal principles, which, shining with an intrinsic light of evidence, are themselves above proof, but the authority for all mediate and contingent principles. That which is thus above reasoning is the reason.

In the language of English philosophy, the terms reason and understanding are nearly identical, and are so used by Stewart; but in the critical philosophy of Kant a broad distinction has been drawn between them. Reason is the principle of principles; either speculatively verifies every special principle, or practically determines the proper ends of human action. Approximately, it may be called the sum of what, in Scotch philosophy, has been denominated the laws of man's intellectual constitution. The understanding, on the other hand, is coextensive with the vernacular use of reason. It is that which conceives of sensible objects under certain general notions, which again it compares one with another, or with particular representations of them, or with the objects themselves. It is, therefore, the faculty of reflection and generalization. But the act of comparison is called a judgment; and the understanding, when it enunciates its conceptions, becomes also the faculty of judging. But the truth of a proposition which is not identical, or the enunciation of a primary truth, cannot be immediately certain. To prove it, recourse must be had to other propositions

previously admitted; the understanding, that is, must deduce one judgment from another, and so becomes the discursive faculty, or reasoning. Further, in discovering these mediate truths, and in the regular and methodical disposition of them for the purpose of conclusion, as well as in the selection of means for the accomplishment of its ends, it exhibits itself as a power of adaptation.

By adopting this distinction between reason and understanding much of the difficulty involved in the consideration of instinct will be removed. Instinct is defined to be a natural impulse in animals, by which they are directed to certain actions necessary to the continuation of the individual and of the species, and enabled to perform them unerringly, independent of instruction and experience. To this definition it is usual to add,—without deliberation, and without a view to the end which their actions will effectuate. But these words, while they apply to the instinctive principle in its lowest manifestation, do not belong to it in its highest. That, in some cases, the spontaneity of the animal operates unconsciously, is fully established by experience. The solitary wasp does not itself feed upon flesh, and it cannot know that a larva is to issue from the egg which it is placing in the sand; but yet it deposits in the same hole with it the exact number of green worms that is sufficient for the sustenance of the wasp-worm until, being transformed into a fly, it will be capable of finding food for itself. In other cases, it is impossible to deny the presence of judgment and design, of reasoning and adaptation. It is essential to the nymphæ of the water-moth, or cod-bait, which, by means of the gluten which proceeds from its body, covers itself with pieces of straw or wood, and of gravel or light shells, that it should maintain itself in equilibrium with the water in which it lives. To accomplish this, when its coating is too light it is observed to add a piece of gravel, and a piece of wood when it is too heavy. The former cases may be designated as pure instinct, the latter as instinctive intelligence. Yet, however we may be constrained to assign understanding and intelligence to the operations of the inferior animals, they are manifestly destitute of reason. However exquisite may be the construction of the bee's cell, it is impossible to ascribe to it a knowledge of the mathematical principles of its construction. The bee is born an artist; and prior to, and independently of all instruction and experience, is perfect in its works, and chooses its means with an unerring certainty. But the acts of the rational creature proceed slowly, through diversified and oft-repeated experiments, to realize the principles of the act which are present to its mind; while the means it employs are as various as the individuals, and seldom the best and most appropriate. Again, the acts of the inferior animals are solely subservient to the continuation of the individual, or the propagation of its kind; whereas the works of the rational animal fall short of perfection in many respects, and are rendered still more difficult by a voluntary combination of the beautiful with the simply useful and necessary.

REBATE. (Fr. rabattre.) In Architecture, the groove, recess, or channel, sunk on the edge of any piece of material.

REBEC. A Moorish word, signifying a stringed instrument somewhat similar to the violin, having three strings tuned in fifths, and played with a bow. It was introduced by the Moors into Spain. It appears to have been much used at festive entertainments. Hence Byron, speaking of Seville, says,

Nor here war's clarion, but love's *rebec* sounds.

Milton, in *L'Allegro*, calls it the "jocund rebec."

REBE'LLION, CIVIL. In Scottish Law, by a peculiar fiction, a debtor who disobeys a charge on letters of horning to pay or perform in terms of his obligation is accounted a rebel, by reason of his disobedience to the king's command contained in the writ. The penal consequences formerly attaching to this construction of the law were abolished by 20 G. 2. c. 50.

REBELLION, THE GREAT. The revolt of the Long Parliament against the authority of Charles I., in English History, is commonly so denominated. Nevertheless, as arbitrary and unconstitutional acts were undoubtedly committed on both sides during the struggle which preceded the actual resort to arms, a constitutional lawyer may consider it questionable whether the parliament may be more justly said to have rebelled against the king, or the king against the state. The question is very fairly discussed by Mr. Hallam, in his *Constitutional History of England.* The commencement of the rebellion may be dated from the votes of the two houses concerning the militia (Feb. 1642), by which they endeavoured to seize on the military power of the realm; immediately after which the king left London for the north of England, and hostilities speedily began. (See *Clarendon*, vol. i. p. 2.) In the summer of 1642 the parties first took up arms; the king's standard was set up August 25., and the civil war was ended by the submission of the king to the Scots in April, 1646. The period of the rebellion is, however, extended, in ordinary language, so as to include the Commonwealth or Protectorate, down to the restoration of Charles II. in May, 1660.

RE'BUS. An antiquated species of ingenuity, a great favourite with our ancestors; being an enigmatical representation of a name or thing by using figures for letters, syllables, or parts of words: thus an eye, and a ton or barrel, represent the family name of Eyton; an instance of a rebus borne by way of device, as they very commonly were. (*See* DEVICE.) In heraldry, a coat of arms alluding to the name of the bearer (otherwise called *armes parlantes*) is also called a rebus; *e. g.* three trouts for Troutbeck, three cups for Butler, &c. The term is said to be derived from an annual practice of the priests of Picardy, which consisted in satirizing the people of their vicinity on the recurrence of the Carnival in ingenious squibs, entitled "De *rebus* quæ geruntur."

REBU'TTER. In Law, the fith stage of the pleadings in a suit, or the plaintiff's answer to the defendant's rejoinder. *See* PLEADING.

RECE'PTACLE, in Botany, has four different significations:—1. That part of a flower upon which the carpella are situated; or, in other words, the apex of the peduncle, or summit of the floral branch, of which the carpella are the termination. 2. The axis of the theca of *Trichomanes* and *Hymenophyllum*, among ferns. 3. That part of the ovarium from which the ovula arise, and which is commonly called the placenta. And, 4. That part of the axis of a plant which bears the flowers when it is depressed in its development; so that, instead of being elongated into a rachis, it forms a flattened area, over which the flowers are arranged, as in Compositæ.

RECE'SSION OF THE EQUINOXES. *See* PRECESSION.

RECE'SS OF THE EMPIRE. In History, the name given in judicial language to the decrees of the German diet. They are thought to have been so termed from being pronounced at the time when the diet was about to "recede," or separate. *See* DIET.

RE'CHABITES. A religious order among the ancient Jews, instituted by Jonadab, the son of Rechab, from whom they derived their name. It comprised only the family and posterity of the founder, who was anxious to perpetuate among them the nomadic life; and with this view prescribed to them several rules, the chief of which were,—to abstain from wine, from building houses, and from planting vines. These rules were observed by the Rechabites with great strictness. (See Jer. xxxv. 6.) In recent times, a branch of the body called *tee-totallers* has assumed the name of Rechabites.

RE'CIPE. The symbol ℞ at the head of a medical prescription generally means *recipe*, or "take." Dr. Paris says this character is a relic of the astrological symbol of Jupiter, a planet under the ascendency of which herbs were often collected or prepared. (*Pharmacologia.*)

RECI'PROCAL. In Arithmetic, the quotient resulting from the division of unity by any number. Thus, $\frac{1}{2}$ is the reciprocal of 2; and, conversely, 2 is the reciprocal of $\frac{1}{2}$.

RECI'PROCAL FIGURES, in Geometry, are two figures of the same kind (triangles, parallelograms, prisms, pyramids, &c.), so related that two sides of the one form the extremes of an analogy of which the *means* are the two corresponding sides of the other.

RECI'PROCAL PROPORTION, is when, of four terms taken in order, the first has to the second the same ratio which the fourth has to the third; or when the first has to the second the same ratio which the reciprocal of the third has to the reciprocal of the fourth. In works of arithmetic the case which give rise to this class of relations is called Inverse Proportion, or the Rule of Three Inverse.

RE'CITATIVE. (Lat. recitare, *to recite.*) In Music, a species of singing differing but little from ordinary speaking. It is used in operas, &c., to express some action or passion, or to relate a story, or reveal a secret or design; and though written in true time, the performer may alter the parts of the measure as he thinks most suitable to produce certain effects, those that accompany him being dependent on his pleasure.

RE'CKONING. In Navigation, the estimated place of a ship, calculated from the rate as determined by the log, and the course as determined by the compass, the place from which the vessel started being known. An elegant and ready method for solving this problem has been recently given by Professor Gill of New York, in the first number of his *Mathematical Miscellany*, much more accurate than the method usually given by writers on navigation. (*See* NAVIGATION.) *Dead reckoning* means the same as *reckoning*, due allowance being made for drift, lee-way, currents, &c.

RECLINA'TION (Lat. reclino, *I repose*), in Dialling, is the angle which the plane of the dial makes with a vertical plane which it intersects in a horizontal line.

RECLU'SE. The common title of a class of religious persons in Roman Catholic countries. *See* INCLUSI.

RECO'GNIZANCE. In Law, an acknowledgment of

a debt upon record. By a fiction of law, the obligation which a party enters into before a court of record or magistrate duly authorized, with condition to do some particular act, — as to appear at the assizes, keep the peace, &c., — is in the form of a recognizance; the party acknowledging himself to be indebted to the king, the plaintiff, &c., with condition that the obligation shall be void on performance of the thing stipulated.

RECOI'L, in Artillery, is the rebound or resilience of a piece of ordnance when discharged. This has been employed for the determination of the explosive force of gunpowder; but the method does not appear to be susceptible of much accuracy. *See* GUNNERY.

RE'COLLETS, or RE'COLLECTS. Monks of the order of St. Frances under a reformed rule. The first separation from the original body seems to have taken place towards the end of the 14th century, when some religious persons, desirous of returning to stricter discipline, assumed the title of Brothers of the Observance. From these originated the Recollects (living in a state of *recollection*, or reclusion), first established in Spain by the Count de Belalcazar, about 1484, and afterwards introduced into Italy. After much opposition, they acquired the possession of great wealth and court favour in France, during the 16th and 17th centuries.

RECORD. Literally an authentic account of any fact or transaction in writing, contained in rolls of parchment, wood, or any other durable substance, and preserved in a court of record. *See* ARCHIVES.

RECORD. In Law, the authentic testimony in writing, contained in rolls of parchment, of the judgment of a superior court, and of the other proceedings in a case. Records are said to be of three kinds: — judicial records; ministerial records on oath, being offices or inquisitions found; records made by conveyance or consent, as fines, recoveries, or deeds enrolled. (*See* COURT.) Trial by record is used where a matter of record is pleaded in any action, as a fine, judgment, &c.; and the opposite party pleads "nul tiel record," that there is no such record existing. On this issue is joined, which can be tried only by inspection of the record

RECORDA'RI FA'CIAS LOQUE'LAM. In Law, a writ to remove proceedings out of an inferior court to the King's Bench or Common Pleas. It is directed to the sheriff, commanding him to make a record of the plaint and other proceedings, and then to send up the cause. It is the common mode by which an action of replevin is transferred from the sheriff's to the superior courts.

RECO'RDER. The chief judicial officer of a borough or city, exercising within it in criminal matters the jurisdiction of a court of record; whence his title is derived. This jurisdiction is now made uniform in extent throughout all boroughs, and is rendered equal to that of the quarter sessions of a county. Recorders were formerly chosen without restriction by the corporations with which they were connected; but by the existing municipal system the appointment is vested in the crown, and the selection is confined to barristers of five years' standing.

RECORDER. The name of a musical instrument somewhat resembling the flageolet, formerly in use in this country. It had a peculiarly pleasing tone; hence Milton speaks of

> ——— The Dorian mood
> Of flutes and soft recorders.

The etymology of the term is involved in great obscurity.

RECO'VERY, or COMMON RECOVERY. In Law (*see* FINE), a mode of assurance in the form of a fictitious action, by means of which conveyances were made by various tenants possessed of limited rights in real property (by tenants in tail more particularly). The effect of a common recovery duly suffered was to raise an absolute bar, not only of all estates tail, but of all estates in remainder and reversion expectant on such estates tail; and to give the recoverer a fee-simple absolute. A common recovery, however, did not bar a springing use, or an executory devise. A common recovery also avoided all charges, leases, and incumbrances made by those in reversion or remainder. By 3 & 4 W. 4. c. 74. common recoveries are abolished, and a new mode of conveyance for the use of tenant in tail substituted for them. *See* ESTATE TAIL.

RE'CTANGLE. In Geometry, a right-angled parallelogram. When the adjacent sides are equal, it becomes a *square*. The area of a rectangle is numerically expressed by the product of the two numbers which express the lengths of its adjacent sides, and hence the term rectangle is sometimes, but incorrectly, used for product.

RECTIFICA'TION. In Geometry, the determination of a straight line, whose length is equal to a portion of a curve. It is effected by the integral calculus.

If the curve be entirely in one plane, the length of the arc is $\int\sqrt{dy^2+dx^2}$; or if it be a curve of double curvature, its length is $\int\sqrt{dx^2+dy^2+dz^2}$. In the former case, the equation of the curve being single will give a value of dy or dx, as may be found most convenient; and this being substituted in the above formula, and the expression integrated between the specified limits, the actual length is obtained. In the second case, the equations upon two of the planes of projection being given, the values of dy and dz can be obtained in terms of du (u being another variable), and the values of y and z in terms of u; then these substitutions being made, the process is the same as before. *See* INTEGRAL CALCULUS.

It will, however, very rarely happen that the rectification can be obtained in finite terms, as the substitutions generally introduce radical expressions into the differential, which are hardly ever so connected with the rational parts as to be susceptible of a finite integral; and hence it has been an object with mathematicians to transform the expressions into others, the successive terms of which are so related as to diminish at a very rapid rate. In this case, the approximation to the value of the arc is rendered comparatively easy. The first curve which was rectified was the semicubical parabola; and the merit belongs to a Mr. Neale, whose rectification was published in 1657. Two years later the same curve was rectified by Van Heureat, in Holland.

RECTIFICATION. A Chemical term, generally implying a second or more frequently repeated distillation; thus, "rectified spirit of wine," means spirit which has been redistilled, and by which it is to a great extent freed from water, or rendered stronger.

RECTILI'NEAL, or RECTILI'NEAR FIGURE, in Geometry, is a figure bounded by straight lines.

RE'CTOR (Lat. rector ecclesiæ, *ruler of the church*), is a person who hath the charge and care of a parish church. The other rector is a layman, or a college or corporate body (*see* art. TITHES). He is bound to provide a vicar to serve the church in his place, and to allow the small tithes, or a sufficient stipend, for his maintenance. The term *rector* is also employed in Scotland to designate the head master of a public school or academy.

RECTRI'CES. (Lat. rectrix, *a guide*.) The name of the tail feathers of a bird, which, like a rudder, direct its flight.

RE'CTUM. (Lat. *straight*.) The last portion of the large intestines; so named from an erroneous notion of the old anatomists that it was straight.

RECU'MBENT. (Lat. recumbo, *I lie down*.) In Zoology, when a part is leaning or reposing upon any thing.

RECU'RRENT NERVES. Two branches of nerves from the *par vagum*, in the cavity of the thorax, are so called; they are distributed to the muscles of the larynx and pharynx.

RECU'RRING DECIMALS, or CIRCULATING DECIMALS, in Arithmetic, are decimals which arise from the expansion of a fraction whose denominator includes one or more prime numbers, as factors, different from 2 or 5, and not included in the numerator. In this case the same figures are continually repeated in the same order. Thus, $\frac{2}{11} = \cdot181818$, &c.; $\frac{1}{7} = \cdot1428571428571$, &c., *ad infinitum*. Their value can always be found by taking one of the periods for a numerator, and as many nines for the denominator as there are figures in the period, and reducing the resulting fraction to its lowest terms. Thus, $\frac{142857}{999999}$ being so reduced, is found equal to $\frac{1}{7}$.

Recurring decimals were first noticed by Dr. Wallis; but their properties have not been extensively investigated.

RECU'RRING SERIES. In Algebra, a series in which the coefficients of the successive powers of x are formed from a certain number of the preceding coefficients according to some invariable law. Thus $a + (a+1)x + (2a+2)x^2 + (3a+3)x^3 + (5a+5)x^2 + \ldots$ is a recurring series, the coefficient of each term being the sum of the coefficients of the two preceding terms. The value of the terms of such a series can always be exhibited in a finite form. (See Euler, *Introductio in Analysin Infinitorum; Bourdon's Algebra*, &c.)

RECU'SANTS. In English History, a term applied to those who refused to acknowledge the king's supremacy as head of the church, chiefly Papists.

RED. One of the primary colours. *See* CHROMATICS.

RE'DAN. In Fortification, a kind of rampart placed in advance of the principal works to defend the least protected parts. The redan usually consists of a rampart of earth; and it is the simplest kind of field fortification. *See* FORTIFICATION.

RED BOOK. The name given to a book containing the names of all persons in the service of the state. The *Red Book of the Exchequer* is an ancient record, in which are registered the names of all those that held lands *per baroniam* in the time of Henry II.

RE'DDLE. A soft argillaceous mineral deeply tinged with red by oxide of iron. The best specimens, used as drawing chalk, are brought from Germany.

REDE'MPTORISTS. A religious order founded in Naples by Liguori in 1732, and revived in Austria in 1820. They are bound by the usual monastic vows, and devote themselves to the education of youth and the propagation of Catholicism. They style themselves members of the order of the Holy Redeemer (il Santo Redemptore), whence their name; but they are also often called *Liguorists*, from the name of their founder.

RED LEAD. An oxide intermediate between the protoxide and peroxide of lead. *See* LEAD and MINIUM.

RED MARL. New red sandstone. *See* GEOLOGY.

RED PRECIPITATE. The peroxide of mercury, obtained by the decomposition of nitrate of mercury by heat. *See* MERCURY.

REDOU'BT. In Fortification, a term applied to nearly every kind of work intended to fortify military positions; as also to works constructed within others to prolong their defence; or to detached works used to secure some piece of ground which would be useful to the besiegers, and thereby create delay in offensive operations.

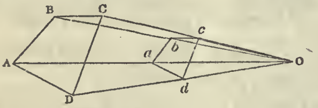
REDU'CING SCALE. A scale used by surveyors for turning links into roods and acres by inspection.

REDU'CTION. The process of converting a metallic oxide into metal by expelling its oxygen. In some cases it is effected simply by heat, but generally by the joint action of heat and some deoxidizing agent: upon the large scale, charcoal is almost always resorted to.

REDUCTION. In Arithmetic, the changing of quantities from one denomination to another.

REDUCTION OF FIGURES, in Practical Geometry, consists in describing figures similar to the given ones, but of different (generally smaller) dimensions. The pentagraph and the proportional compasses are the readiest and most accurate methods of performing these reductions; but in the absence of these, many different methods are taught in works of practical geometry. The simplest is here annexed.

Let A B C D be the figure to be reduced, and *a b* be



the line which is homologous to A B. At a convenient place on the paper draw *a b*, parallel to A B, and equal to the reduced line. Draw A *a*, B *b*, meeting in O, and from O draw lines to all the other angles of the figure; then draw *b c* parallel to B C, *a d* parallel to A D, &c.; and join the last two points. Then *a b c d* is the reduced figure sought.

If the proposed figure be curvilinear, inscribe any polygon within it, and draw the similar polygon as above directed; then trace the curve through the angles of the polygon.

REDU'NDANT HYPERBOLA. A line of the third order, having three pairs of asymptotic branches. Its properties may be seen in *Newton's Enumeratio*.

REEF, in Navigation, signifies to diminish the surface of the sails on the increasing of the wind. Sails attached to yards are reefed at the head. Strong horizontal bands of canvass, from three to six feet apart, extend across the sails; these are called *reef bands;* and there are usually four in each topsail, and two in the foresail and mainsail. The reef band is commonly pierced with two holes in each cloth (or breadth of canvass) in the sail; through each hole are drawn two *reef points*, — short pieces of flat rope, each having an eye in one end, and hung one before and the other abaft the sail, each passing through the eye in the end of the other. The sail being lowered and trimmed to the wind so as to shake; the extremities of the reef band are drawn up towards the *yard arm* by the ropes called *reef tackles;* the men then going out upon the yard, which they lean over while their feet are supported by the *foot ropes*, gather up the loose canvass of the sail till they reach the reef band, which they keep extended tight along the yard until the *earings* are *passed* or secured, the weather earing being passed first; they then tie the two reef points of each pair together over the yard, and the sail is reefed, the surface having been thus diminished by the depth of one reef. Gaff sails are reefed at the foot. The sail being lowered enough to slack the canvass, the earing which is on the after leech is brought or hove down to the boom end by a strong rope called a *reef pendant;* the men then standing wherever they can reach the foot of the sail, tie the points under it. When the yard is not lowered, as in reefing the courses, the sail is partly clued up for reefing.

REEF, or CORAL REEF, is also applied to a chain of rocks in various parts of the ocean lying near the surface. *See* GEOLOGY.

REEL. A lively dance peculiar to Scotland, generally written in common time of four crotchets in a bar, but sometimes in gig time of six quavers.

REEL. An angler's implement attached to the but of the rod, for the purpose of winding in the line when a fish is hooked. The barrel of the reel should be of sufficient diameter to wind in quickly, as a fish is often lost by not being able to bring him rapidly within reach of the landing net; especially where, as in fly-fishing, a great length of line has been thrown out.

RE-E'NTER. In Engraving, a word which denotes the passing of the graver into those incisions of the plate, so as to deepen them, where the aquafortis has not bitten in sufficiently.

RE-E'NTERING ANGLE. In Fortification, the angle of a work whose point turns inwards towards the defended place.

REEVE. (Ang. Sax. gerefa, *an officer or governor.*) A word of a very general application, entering into the composition of some titles yet in use. Hence *sheriff*, *i. e.* shire-reeve, the governor of a shire or county; borough-reeve, port-reeve, &c.

REEVE. The Sea term for putting a rope through a block, or any hole through which it is intended to run.

REFE'CTION. (Lat. reficio, *I restore.*) In the language of Ecclesiastical communities, a spare meal, sufficient only to maintain life; whence the hall in convents where meals are taken is termed *refectory.*

REFE'CTORY. (Lat. refectorium.) In Architecture, an apartment wherein meals are taken.

REFERE'NDARIES. In the early monarchies of Europe after the fifth century, public officers charged with the duty of procuring, executing, and despatching diplomas and charters. The office of great referendary, in the French monarchy, became merged in that of chancellor.

REFLE'CTING CIRCLE. An astronomical instrument for the measurement of angles by reflection. (*See* SEXTANT.) The term is also applied to a surveying instrument, invented by Sir Howard Douglas, which combines the advantages of the Hadley's quadrant and the protractor. The object of it is to protract, or lay down on the plan, the angles measured with the instrument from the instrument itself, without any intermediate step, or even a register of their values. The advantage of such an instrument must be obvious in military surveys, where expedition is important, while accuracy is thereby far more efficiently insured than by the old and more tedious process. It is also advantageously used in forming general sketches of a country.

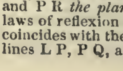
RE'FLEX. (Lat. reflecto, *I bend back.*) In Painting, the illumination of one body, or a part of it, by light reflected from another body. The foundation of the law of *reflexes* depends upon the knowledge that every body in light reflects that light, to a certain degree, in the same way that flame does. The stronger, therefore, the light on the body, the stronger will be the *reflex*, distances being equal. Again, the more directly the light falls on a body, the more influence it will have in imparting a reflex.

REFLE'XION, in Mechanics, denotes the rebound or regressive motion of a body from the surface of another body against which it impinges. In Natural Philosophy, the term is applied to the analogous motions of light, heat, and sound, when turned from their course by an opposing surface. The laws of the reflexion of light form the branch of science called *catoptrics;* those of the reflexion of sound are sometimes called *cataphonics*. *See* SOUND.

The simplest view which can be taken of the mechanical action whereby reflexion is produced, is to assimilate it to that which takes place when an elastic body impinges on another body which it cannot move out of its place. If light, heat, and sound are propagated by the pulses of an elastic medium, the same theory will apply to them; and it is to be remarked, that in all cases of reflexion the change of motion which takes place follows precisely the same laws as that which is produced by the impact of two elastic bodies.

Reflexion of Light. — When we consider only the *direction* of the rays of light after being reflected from a polished surface, and leave its *quantity* or *intensity* out of view, the laws of reflexion are extremely simple. Suppose A B (fig. 1.) to be a smooth polished surface, or mirror, and a ray of light proceeding in the direction L P to impinge on the surface at P, and to be reflected from it in the direction P R. Through the point P draw P Q a normal or perpendicular to the surface; then, adhering to the definitions adopted by most writers on optics, the angle L P Q is called *the angle of incidence*, Q P R *the angle of reflexion*, the plane in which are the two straight lines L P and P Q is called *the plane of incidence*, and the plane determined by Q P and P R *the plane of reflexion*. Now the two general laws of reflexion are these: — 1st, The plane of reflexion coincides with the plane of incidence; or the three straight lines L P, P Q, and P R, are in one plane. 2d, The angle

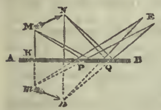
(1.)



of reflexion is equal to the angle of incidence, and on the opposite side of the normal. These laws hold true, whatever be the nature of the reflecting surface, or the origin of the light which falls on it. Experience offers no exception to them whatever; and all the phenomena of reflexion from mirrors or polished surfaces, whether plane or having any regular curvature, are readily deduced from them as simple geometrical consequences.

Reflexion from Plane Mirrors.—To determine the path of the reflected rays, and the formation of images by plane mirrors, suppose M N (fig. 2.) to be an object placed before the plane reflecting surface A B, and the eye to be situated at E. The rays of light which proceed from the point M, and are reflected to the eye at E, will impinge on the mirror at P, and appear to come from a point *m*, which, in respect of the plane A B, is symmetrical with M; that is to say, placed in the straight line which is drawn from M perpendicular to the surface, and at the same distance from A B on the opposite side. For let M K be the perpendicular, and let it be continued till it meet the prolongation of E P in *m*; then, from the equality of the angles of incidence and reflexion, the angles M P K and E P B (which are the complements of those angles) are equal; hence M P K = K P *m*; and the two right-angled triangles K P M and K P *m*, having also a common side, are every way equal; whence K *m* = K M. In like manner, the rays which issue from N, and are reflected to E, will appear to proceed from a point *n* symmetrical with N; and as the same thing is evidently true with respect to every other point of the object, a perfect image *m n* of the object will be formed on the opposite side of the mirror, and at the same distance. It will be observed that the image is not, properly speaking, reversed, like writing looked at through the opposite side of the paper: the spectator sees the same side of the object as if he stood in front of the mirror, and viewed the object directly; but, in the reflected image, right takes the place of left, and left of right.

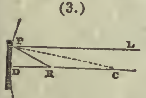
(2.)



Reflexion from Curve Surfaces. — In order to apply the two general laws of reflexion to the determination of the direction of a ray reflected from a curve surface, it is assumed that the reflexion takes place at each point of the surface in the same manner as it would from a plane touching the curve surface at that point, and the problem therefore becomes that of determining the direction of the normal at the given point; for, when the direction of the incident ray, and of the normal at the point of incidence, are both known, the plane of the reflected ray, and the position of the ray in that plane, are both given. The mirror may be concave or convex; and the incident rays may be parallel or divergent.

Let D (fig. 3.) be the centre of a concave mirror, D C its axis, C the centre of curvature at D; and assume the semidiameter of the mirror D P to be small in comparison of its radius of curvature C D. Now suppose a ray of light L P, parallel to the axis, to fall on the mirror at P; then, if we draw P C, and make the angle C P R = C P L or P C D, P R will be the direction of the reflected ray; for, by the nature of curvature, C P is a normal to the surface, the arc D P being small. But, on the hypothesis of D P being small, we have also R P = R D; and by reason of the equal angles R P C and R C P, R P = R C, therefore R D = R C; or R is a given point, and, consequently, all the rays which fall on the mirror parallel to C D are reflected into the same point R. From this property the point R, which bisects the radius C D, is called *the principal focus* of the mirror, or *the focus of parallel rays*. *See* Focus.

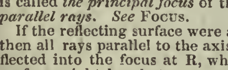
(3.)



If the reflecting surface were a portion of a paraboloid, then all rays parallel to the axis would be accurately reflected into the focus at R, whatever the extent of the surface might be; but, on account of the practical difficulty of grinding and polishing curve surfaces of any other form than the spherical, the concave and convex mirrors required for optical purposes are always spherical.

Suppose, next, the rays to diverge from a point in the axis of the mirror. Let L (fig. 4.) be the luminous point, C the centre of curvature, and P R the reflected ray. To find the point R, let I = L P C = R P C; and let R, C, L denote respectively the acute angles at the points indicated by these letters. We shall then have, obviously, R − I = C, and I + L = C; whence L + R = 2 C. Now, since D P is supposed to be an arc of a small number of degrees, D P may be regarded as a straight line perpendicular to L D; and since the angles R, C, L are also small, we may substitute for the arcs to which they respectively correspond their trigonometrical tangents, namely, $\frac{PD}{DR}$, $\frac{PD}{DC}$, $\frac{PD}{DL}$. Hence, if we assume D L = p, D R = q, D C = r, the radius of curvature, the above equation R + L = 2 C will become

(4.)



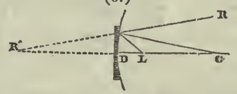
$$\frac{1}{p} + \frac{1}{q} = \frac{2}{r},$$

which gives the relation between p and q, r being a constant quantity for the same mirror. If, therefore, L be a given point, then p has a given value, and q is also determined; so that all rays diverging from the point L, and falling on the mirror, are reflected into the point R. As the two quantities p and q enter symmetrically into the equation, each being expressed in terms of the other by the same formula, the points R and L are interchangeable; that is, if R be taken as the radiating point, then L is the focus of the reflected rays. Hence L and R are called *conjugate points*, or *conjugate foci*.

Since the reciprocals of p and q always make up the same sum, when one of those quantities increases the other diminishes, and *vice versâ*. If, therefore, L approaches towards C, R will also approach towards C (the origin being supposed at D), and they will ultimately coincide at that point, so that a ray issuing from C would be reflected back on itself. If L recedes from C, then R recedes from C, or approaches D. Suppose L to be at an infinite distance; in this case $1 \div p = 0$, and the equation gives $q = \frac{1}{2} r$, or D R = $\frac{1}{2}$ D C; so that R becomes the *principal focus*, as it evidently ought; for when L is at an infinite distance, the rays L P are parallel to the axis.

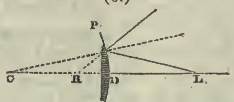
It is evident from the above equation that so long as p and q have the same sign, that is, so long as L and R are on the same side of the mirror, each of those quantities must be greater than $\frac{1}{2} r$. Suppose the radiating point L to be placed between D and C (fig. 5.), and let D L or p become less than $\frac{1}{2} r$. In this case, q must become negative; that is to say, the rays which emanate from L must become divergent after reflexion, and have the same direction as if they diverged from a point R′ on the opposite side of the mirror, and of which the distance q from D is determined by the equation $\frac{1}{p} - \frac{1}{q} = \frac{2}{r}$. This point R′ is called the *virtual focus* of the reflected rays.

(5.)



The same construction and equation (with the proper changes of sign) apply equally to convex and concave mirrors. Let L (fig. 6.) be the luminous point, from which diverging rays fall on the convex mirror P D, of which C is the centre of curvature. Denoting, as before, D L, D R, and D C, by p, q, and r respectively, and assuming the constant r to be positive, then, by exactly the same reasoning as above, we shall find the equation

(6.)

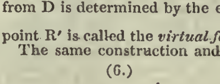


$$\frac{1}{q} - \frac{1}{p} = \frac{2}{r}.$$

In this case, p and q increase or decrease simultaneously; and if we suppose p to increase to infinity, or the incident rays to become parallel, then we have again $q = \frac{1}{2} r$; so that, for parallel rays, the conjugate focus is at the middle of the distance between D and C. When the mirror is convex, the conjugate focus is always the virtual focus.

From what has now been shown, it is easy to see in what manner images are formed by concave or convex mirrors. Let M N (fig. 7.) be an object placed before a concave mirror A B, beyond its centre of curvature C. On tracing the path of the rays M A, M D, M B, after reflexion, they will all be found to meet in the point *m* and those which proceed from N will in like manner be found to meet in *n*; whence rays diverging from every point of the object between M and N will meet, after reflexion, in a point situated between *m* and *n*; and in this manner an inverted image *m n* of the object will be formed. The magnitude of the image is to that of the object as *D m* to D M, or as the distance of the image from the mirror is to the distance of the object from the mirror; and the image will be more brilliant in proportion as the rays of light coming from the object are collected within a smaller space. If the object were

(7.)



placed at $m\,n$, then an enlarged image would be formed at M N. It is on this principle that reflecting telescopes and microscopes are constructed. *See* TELESCOPE, MICROSCOPE.

Intensity of reflected Light. — It has now been shown that the path of the reflected light can be determined in all cases with geometrical precision, when the form of the reflecting surface is known; but the case is very different when the question is to determine the quantity or proportion of the light which is thrown into a different direction by an opposing surface. The following laws, however, have been established by experiment: — 1st, The quantity of light regularly reflected increases with the angle of incidence, but does not vanish entirely when that angle becomes 0. 2d, It depends both on the nature of the medium through which the light is passing when it falls on the reflecting surface, and on that of the substance on which it falls. 3d, Bodies of different natures, placed in the same circumstances, reflect very different proportions of the incident light.

On this subject a great number of experiments were made by Bouguer, and more recently by Arago, Fresnel, Mr. Potter, and others. The following numerical relations are given by Bouguer: — When a beam of light, the intensity of which is represented by 1000, falls upon water so as to make an angle of 0° 30′ with the surface, the intensity of the reflected light is represented by 721; at an angle of 15° with the surface, by 211; at an angle of 30°, by 65; and at an angle from 60° to 90°, by 18. Of 1000 rays falling upon a surface of glass, and making an angle of 5° with the surface, 543 are reflected; 300 when the angle is 15°; 112 when 30°; 25 when 60°, or above. Of 1000 rays falling on a polished surface of black marble, 600 are reflected when the angle with the surface is 3° 15′; 156 when 15°; 51 when 30°; 23 when 60° and upwards. Mercury and metallic mirrors give a less rapid diminution. Of 1000 incident rays, 700 are reflected when the angle with the surface is very small; and about 600, or more than half, when the angle approaches to 90°, or the incident ray is nearly perpendicular to the surface. (*Traité d'Optique.* See also the *Edinburgh Journal of Science* for 1830 and 1832.)

In order to produce reflexion in a greater or less degree, the only indispensable condition is, that light pass from one medium to another having a different refractive power. In passing through a perfectly homogeneous medium, no reflexion takes place; but whenever there is a change of medium (and this change may occur in the same substance by an inequality of density in the different parts, or a different arrangement of the particles), more or less reflexion takes place at the surface which separates the two media. Thus, in passing through the atmosphere, the solar light undergoes an infinite number of partial reflexions before it arrives at the earth, as every successive thin stratum of air, by reason of its increasing density, forms, as it were, a different medium. *See* REFRACTION, ASTRONOMICAL.

If any surfaces could be formed of so perfect a polish as to reflect the whole of the incident light, the eye would be unable to distinguish them; and, unless by coming in actual contact with them, we should have no reason to suspect their existence. Bodies are only visible in consequence of rays irregularly reflected from their surfaces meeting the eye; for rays which are regularly reflected only show the luminous points from which they emanate, and not the surfaces on which they fall. If the lunar surface were as perfectly polished as a globule of pure mercury, the moon would present to us only a reflected image of the sun. *See* LIGHT, OPTICS.

REFORM ACT. In Politics. *See* PARLIAMENT.

REFORMA'TION. An important era in political and ecclesiastical history, when the doctrines and usages of the Romish church, then dominant throughout the western states of Christendom, were first successfully called in question. This event is commonly dated from the year 1517, when Luther began to oppose the pope and condemned the sale of indulgences. Mosheim assigns to it the date 1520, when Luther was excommunicated.

Prior to the Reformation, the pope claimed of divine right, and exercised, absolute authority over the whole Christian church, with the exception of those states and provinces in which the Eastern or Greek church was established. Not only was his authority regarded as supreme on subjects of doctrine and discipline, but his decisions were considered as infallible; and whoever ventured to question or gainsay them was treated as a heretic, and was liable to such canonical censures and temporal penalties as the canon law determined. Of course, the exercise of private judgment in religious and ecclesiastical matters, or the right of the people to peruse the sacred volume, was peremptorily denied. Nothing, therefore, could be more absolute than was the government of the Christian church under the see of Rome. His holiness, also, laid claim to supremacy even in temporal things throughout the wide range of his religious authority; though the exercise of this supremacy was not always quietly submitted to; nay, was sometimes resisted with success. He regarded all parts of the world not inhabited by Christians as uninhabited, and gave full power to those Christians who might occupy them to make war on the inhabitants; and the countries, if conquered, were parcelled out according to his sovereign pleasure. But while the absolutism claimed by the Roman pontiff was calculated to arouse jealousy and opposition, which, indeed, it did, in some degree, in different places and at various times, these feelings were greatly increased by several other causes: such as the immoral lives of the clergy; the facilities by which their immoralities were pardoned; the exorbitant wealth of the church; the great personal immunities of ecclesiastics, and their encroachments on the jurisdiction of the laity. These and similar circumstances, which the invention of the art of printing and the revival of learning had tended more thoroughly and widely to disclose, gradually prepared the public mind for that reformation of religion of which in this article we intend briefly to give an account.

Without minutely mentioning the frequent, but comparatively feeble opposition, to which the absolutism in the government of the church had, in various periods, given rise, it may suffice here to confine ourselves to an account of that course of opposition, in the 16th century, which terminated in the Reformation.

According to the doctrine of the Romish church, all the good works of the saints, over and above those necessary for their own justification, are deposited, together with the infinite merits of Jesus Christ, in one inexhaustible treasury. The keys of this treasury were committed to St. Peter, and his successors the popes, who may open it at pleasure, and by transferring a portion of this superabundant merit to any particular person for a sum of money, may convey to him either the pardon of his own sins, or a release for any one in whose happiness he is interested from the pains of purgatory. Hence the origin (which took place in the 11th century) of the sale of *indulgences*. Pope Leo X., under the pretence of raising contributions towards building the church of St. Peter at Rome, granted, in 1517, the right of promulgating those indulgences in Germany, together with a share in the profits arising from the sale of them, to the archbishop of Magdeburg, who, as his chief agent for retailing them in Saxony, employed Tetzel, a Dominican friar, of dissolute morals, but of great activity and energy of character. Tetzel, assisted by the monks of his order, executed the commission with great zeal, but with little discretion or decency; and, by disposing of them at a very low price, carried on for some time an extensive and lucrative traffic among the credulous and ignorant. The princes and nobles were irritated at seeing their vassals drained of their wealth to replenish the treasury of a profuse pontiff. Men of piety regretted equally the corruptions of the church and the delusions of the people. Even the most unthinking were shocked at the scandalous behaviour of Tetzel and his associates. But it was reserved to Martin Luther, formerly a monk of the Augustine order, and at that time professor of theology at Wittenberg, effectually to expose the artifices of those who sold, and the simplicity of those who bought indulgences, and to shake the foundations of the papal see itself. What were the motives which first induced this distinguished person to oppose this traffic cannot now be ascertained. The traffic was not a novelty, as it had been practised throughout Christendom for several centuries. Some writers have imagined, though with what justice is not evident, that his opposition was founded in jealousy, because this gainful trade had not been conferred on the Augustinians, to whom he belonged, but on the Dominicans, a rival order. But, whatever were his motives, his opposition at first was confined simply to the sale of indulgences. His memorable theses, ninety-five in number, against this practice were affixed to the doors of the cathedral of Wittenberg, 31st October, 1517; while from the pulpit he inveighed bitterly against the irregularities and vices of the monks who published indulgences, as well as against the abuse itself. The sentiments contained in his theses he proposed not as points fully established, or of undoubted certainty, but merely as subjects of inquiry and disputation: he appointed a day on which the learned were invited to impugn them, either in person or by writing; and to the whole he subjoined solemn protestations of his high respect for the apostolic see, and of his implicit obedience to its authority. No opponent appeared at the time prefixed. Meanwhile the theses spread over Germany with astonishing rapidity; they were every where read with the greatest avidity; and all admired the boldness of the man who had ventured to attack the plenitude of papal power. Meanwhile Tetzel, in opposition to Luther, published counter-theses at Frankfort on the Oder; Eckius, a celebrated divine of Augsburg, endeavoured to refute Luther's notions; and Prierias, a Dominican friar, master of the sacred palace and inquisitor-general, wrote against him with uncompromising virulence. But this

opposition was of little or no avail. Luther supported his views by arguments founded on reason or derived from scripture, and his cause was found daily to gain strength.

Leo, naturally fond of ease, and occupied in the pursuits of pleasure and ambition, paid little or no attention to the dispute that was thus raging in Germany, and at at first despised it as a mere monkish squabble. But the tidings of Luther's rapid success, and the clamours of the ecclesiastics for aid and vengeance, at length roused him from his apathy, and induced him to take prompt steps to put a stop to the spread of heresy. On the 21st Aug. 1518, he summoned Luther to appear at Rome within sixty days, before the auditor of the chamber and the inquisitor-general Prierias, who had written against him, whom he empowered jointly to examine his doctrines and to decide concerning them. This was evidently an unjust tribunal by which the decision was to be made; and through the influence of Frederick the elector of Saxony, who was favourable to the new doctrines, and of others, and by a submissive letter written to the pope by Luther himself, his holiness agreed to refer the hearing and determining of the cause to his legate in Germany, Cardinal Cajetan, a Dominican, eminent for scholastic learning.

The reformer accordingly appeared before Cajetan, who, after some discussion, commanded him to retract his opinions; but Luther, with that intrepidity of mind which was his grand characteristic, declared that he could not, with a safe conscience, renounce opinions which he believed to be true, nor should any consideration induce him to do what would be so base in itself, and so offensive to God. The result was, that Luther, who, with his friends, suspected that even the imperial safe-conduct would not be able to protect him from the legate's power and resentment, was induced to withdraw secretly from Augsburg and return to Wittenberg; previously to which, however, he prepared a solemn appeal from the pope ill informed at that time concerning his cause, to the pope when he should be better able to judge respecting it. (*Secken*, *Comment.* lib. i. p. 14.; *Lutheri Opera*, i. p. 160.) But so impatient were Luther's enemies at Rome that even before the sixty days had expired, he was there condemned as a heretic; and Leo, in several of the briefs and letters, had stigmatized him as a child of iniquity, and as given up to a reprobate mind. But Luther, convinced that his views were agreeable both to scripture and reason, was not to be deterred from teaching and promulgating his opinions both from the pulpit and through the press; and as every step taken by the court of Rome against him convinced him that Leo would soon proceed to the most violent measures, he had recourse to the only expedient in his power in order to prevent the effect of the papal censures. He appealed to a general council, which he affirmed to be the representative of the Catholic church, and superior in power to the pope, who, being a fallible man, might err, as St. Peter, the most perfect of all his predecessors, had erred. As opposition against him increased, and as the controversy advanced, Luther's views began to expand; and in his disputation with Eckius, he went so far as to question the supremacy of the pope over the church, as well as the doctrines of purgatory, auricular confession, and absolution; and he about the same time published several treatises, in which he more openly expressed his dissent. Luther may now be said to have embraced the fundamental tenet which now characterizes all sects of Protestants, and which was subversive of the slavish obedience in points of doctrine and discipline which had hitherto been paid to the holy see; namely, that scripture is the only rule of faith and manners, and that this rule is to be interpreted by the exercise of private judgment. A step was at this period (June, 1520) taken by the court of Rome fatal to the object which it had in view. The pope issued a bull condemning, as heretical and offensive to pious ears, forty-one propositions extracted out of Luther's works; all persons were forbidden to read his works on pain of excommunication; those who possessed a copy of them were commanded to commit it to the flames; and he himself, if he did not within sixty days publicly recant his errors and burn his works, pronounced a heretic, excommunicated, and delivered unto Satan; and all secular princes required, under pain of incurring the same censure, to seize his person, that he might be punished as his crimes deserved.

This sentence, while it did not disconcert or intimidate Luther, excited more indignation than terror among his followers, and gave a fresh impulse to the spread of the new doctrines. In some cities the people violently obstructed the promulgation of the bull; in others, the persons who attempted to publish it were insulted, and the bull itself was torn in pieces and trodden under foot. Luther, after renewing his appeal to the general council, published remarks on the papal bull; and being now persuaded that Leo had been guilty both of impiety and injustice in his proceedings against him, assumed a bolder tone, and declared the pope to be that man of sin, or Antichrist, whose appearance is foretold in the New Testament. He declaimed against his tyranny and usurpations, and exhorted all Christian princes to shake off such an ignominious yoke. Nor did he stop here. As Leo had, in execution of the bull, appointed Luther's works to be burnt at Rome, the latter, by way of retaliation, assembled all the members of the university of Wittenberg, and with great pomp, in presence of a vast number of spectators, cast the volumes of the canon law, together with the bull of excommunication, into the flames; and his example was imitated in several cities of Germany. This took place on the 10th of December, 1520; and on the 6th of the ensuing month the pope launched a second bull against him, by which Luther was finally expelled from the communion of the church. Thus separated from all connection with the see of Rome, Luther applied himself more assiduously than ever to the study of the word of God as the only standard of theological truth; and while he was thus enabled to attack with the greater success most of the peculiar papal doctrines, both theological and ecclesiastical, he exposed, at the same time, the immoral and secular lives of the clergy; and thus laid the foundation of that reformation of religion which at first he never contemplated, but which has been characterized "as a revolution in the sentiments of mankind, the greatest as well as the most beneficial that has happened since the publication of Christianity." (*Robertson's Charles V.*, 8vo. ed. vol. ii. p. 12.)

A spirit of inquiry having, by means of Luther's preaching and publications and the violent procedure of the court of Rome, been excited in the public mind, the progress of the reformed doctrines was rapid and general, and threatened to embrace the whole of Germany, notwithstanding the Emperor Charles V. co-operated with the pope to check and destroy them. Luther, too, was protected, from various motives, not merely by the Elector of Saxony, but by many other princes; and the new views were adopted and sedulously propagated by Melanchthon, Carlostadius, and other eminent men. Erasmus, too, though he did not long follow in the same course as the German reformer, and ultimately wrote against some of his views, yet discovered and exposed, with great learning and ability, many errors both in the doctrine and worship of the Romish church, and may be considered as his auxiliary in the work of reformation.

Under such circumstances it was that the imperial diet at Worms was held, January, 1521, to which the different princes were invited, in order to concert the most proper measures for checking the progress of those new and dangerous doctrines which threatened to disturb the peace of Germany, and to overthrow the religion of their ancestors. An attempt to condemn him in his absence was frustrated by a majority of the members of the diet; and Luther, under a safe-conduct, was summoned to appear before them. He did not hesitate to attend; but neither threats nor entreaties could induce him to retract any of his opinions, or to consent to their being tried by any other rule than the word of God. He was allowed to leave the city in safety; but an edict was published in the emperor's name, after his departure, putting him under the ban of the empire. The circumstances, however, in which Charles was placed, — the commotions in Spain, and the wars in Italy and the Low countries, together with the prudent precaution of the Elector of Saxony in concealing Luther in the castle of Wartburg, all concurred in preventing the edict being carried into effect. During his confinement his opinions continued to gain ground; and the Augustinians of Wittenberg ventured on an alteration in the established forms of public worship, by abolishing the celebration of private masses, and by giving the cup as well as the bread to the laity in administering the sacrament of the Lord's Supper. In a short time, however, the new views were condemned by the university of Paris, and a refutation of them was attempted by Henry VIII. of England. But neither of these intimidated Luther. He published animadversions on both with as much virulence as if he had been dealing with an ordinary adversary.

Meanwhile an attack no less violent, occasioned by a similar cause, was made on the Romish church in Switzerland. The Franciscans being intrusted with the sale of indulgences in that country, executed their commission with the same indiscretion and rapaciousness which had rendered the Dominicans so odious in Germany. But they were met and opposed (1518) by Zuinglius, a man not inferior to Luther himself in zeal and intrepidity, and who advanced with perhaps more daring and rapid steps to overthrow the whole fabric of the established religion. Notwithstanding that the universities of Cologne and Louvain pronounced his doctrines to be erroneous, the cantons of Zurich, Berne, Basil, and Schaffhausen embraced his opinions. Several conferences were at different times held between the Roman Catholics and the "Evangelicals," as the followers of Zuinglius

were called; and all of them tended to the spread of the reformed faith. After a conference held at Berne in 1528, the council of that canton, considering the result to be in favour of the Evangelicals, published ten theses, which embodied the substance of the Reformation in Switzerland; and most of the leading principles contained in them are acknowledged by the reformed churches generally, however widely they may differ among themselves on some abstruse points.

The Swiss and the German reformers were at first unacquainted with the proceedings of each other, though both were animated by the same spirit, and, in different places, pursuing a similar object. But, while they both resisted and exposed the usurpations and errors of the Romish church, and generally agreed in their sentiments, they entertained very different theological opinions; and thus was sown the seeds of those divisions which have since agitated the reformed churches. The chief subject of dispute between the two reformers was concerning the manner in which the body and blood of Christ were present in the Eucharist. Luther and his followers, though they rejected the papal belief of transubstantiation, were nevertheless of opinion that the body and blood of Christ were really present in the Lord's Supper, in a way which they could not pretend to explain. Zuinglius and his adherents repudiated the doctrine, and taught that the bread and wine used at the Eucharist were no more than external symbols to excite the remembrance of Christ's sufferings in the minds of those who received it. Both parties maintained their opinions with equal obstinacy; and as this dispute threatened to retard the great work of reformation, and to bring discredit on its adherents, the Landgrave of Hesse invited Luther and Zuinglius, with several of the most eminent of their respective followers, to a conference at Marburg, in order to promote unanimity and peace. After a disputation of four days, however, neither of the contending parties could be persuaded to abandon their views. But as both agreed in their sentiments not only as to the popish hierarchy, but as to the fundamental principles of Christianity, they parted in Christian charity, though not in brotherhood, agreeing to refrain from open controversy.

The struggle between the Roman Catholics and the reformers still raged in Germany. At the diet of the empire held at Spires in 1526, the emperor's ambassadors used their utmost endeavours to suppress all disputes about religion, and insisted on the vigorous execution of the sentence which had been pronounced against Luther and his followers at Worms. This attempt was successfully resisted by the majority of the members; and it was at last unanimously agreed to present an address to the emperor entreating him to call a general council without delay; and that the princes of the empire should in the meantime be allowed, in their respective dominions, to manage religious matters as they should think proper. These resolutions proved favourable to the cause of the Reformation, and gave an impetus to the expression of the public voice. The war in which at this time the emperor was engaged with the pope gave a decided advantage to the friends of the reformed faith, and greatly increased their number. At a diet, however, held in the same place in 1529, the power which had been given to princes of managing ecclesiastical affairs until the meeting of a general council was revoked by a majority of votes, and every change declared unlawful that should be made in the established religion before the determination of the approaching council was known. After many ineffectual remonstrances and arguments, six princes of the empire and thirteen imperial cities "protested" against this decision. Hence arose the denomination of "Protestants;" a term at first applicable only to the Lutherans, but now common to all who have separated from the church of Rome.

As the reformed doctrines in Germany had not yet been reduced to a system, the Elector of Saxony ordered Luther and other divines to commit to writing the leading articles of their religious system, along with the principal points on which they differed from the church of Rome. In compliance with this order, Luther delivered to the elector at Torgau seventeen articles, which had been agreed on at a conference at Sulzbach; hence called the Articles of Torgau. This declaration of the sentiments of the reformers was enlarged and rendered more minute and perspicuous by Melanchthon, who performed the task with equal ability and elegance.

In 1530, Charles convoked a diet of the empire at Augsburg, and directed the reformers to lay before it an account of their tenets in German and Latin. The work prepared by Luther and Melanchthon was presented to the diet; hence called the Confession of Augsburg, or *Confessio Augustana*, which was read aloud by the chancellor to the assembly. It contained twenty-eight chapters, of which twenty-one were illustrative of the religious opinions of the Protestants, and the remaining seven of the errors and superstitions of the papal faith. But after much disputation, not only was it rejected, but the diet published a decree condemning most of the peculiar tenets held by the Protestants, and forbidding any person to protect or tolerate such as taught them; enjoining a strict observance of the established rites, with other articles equally galling and tyrannical. But the Protestants were now too powerful a body, and their views had assumed so completely the form of a system that they were not easily dismayed. On the contrary, they assembled at Smalcalde, where they concluded a treaty of mutual defence, both religious and political, against all aggressors, and formed the Protestant states of the empire into one regular combination. Thus, in the year 1530, was the Reformation virtually established in Germany; first, by the publication of the Confession of Augsburg; and, second, by the league of Smalcalde, which made that creed the bond of union of a powerful political confederacy.

It may here be mentioned that the followers of Zuinglius, or Sacramentarians, as they were sometimes called, presented their confession of faith on the part of four cities, Strasburg, Memmingen, Lindau, and Constance; generally known by the Confession of Strasburg, or *Confessio Tetrapolitana*. The reformed cantons of Switzerland were not allowed to join the league of Smalcalde, inasmuch as they refused to sign the Confession of Augsburg; and thus the Swiss Evangelicals or Sacramentarians continued distinct from the Lutherans (as they still do), though they joined in a separate league with the city of Strasburg and the Landgrave of Hesse, who adopted their views. The Helvetic Confession of Faith, founded on the articles of Berne already referred to, was finally published in 1532. The reformed doctrines had early spread to Geneva; and John Cauvin, or Calvin, of that city, after the death of Zuinglius, carried them farther than the Swiss Protestants had done. He abolished all festivals except Sabbath, discarded all church ceremonies, used leavened bread for the sacrament, and taught the doctrines of predestination and election in all their rigour. (*See* PRESBYTERY, in this work.) Calvinism thus became the third great branch of the Reformation, Luther and Zuinglius being respectively at the head of the other two. The systems of Zuinglius and Calvin, however, gradually merged together, and they may now be considered as one, having the same confession of faith.

It would exceed the bounds to which we must necessarily confine ourselves in this article, were we to trace the history of the Reformed faith after the treaty of Smalcalde: that treaty, among other results (such as conferences, meetings of councils, particularly the celebrated council of Trent in 1549), gave rise to a war between the emperor and the Protestants. But the peace of Augsburg, in 1555, terminated those and similar calamities which had so long agitated the empire. The following are the leading articles of that peace: namely, that the Protestants who followed the Confession of Augsburg should in future be free from the jurisdiction of the pope, and from the authority and superintendence of the bishops; that all the inhabitants of the German empire should be at perfect liberty to judge for themselves in all matters, religious and ecclesiastical; that all persons, whatever be their religious opinions, should enjoy equal civil rights and privileges,—in other words, that a complete toleration in religious matters should obtain; and that all those who should persecute any person under religious pretences should be declared and treated as public enemies of the empire, invaders of its liberties, and disturbers of its peace. Thus was the Reformation finally established in many parts of Germany as it exists, without any very marked change either as to its extent or its principles, at the present day. The conditions on which this desirable object was obtained were honourable to both parties, both Catholic and Protestant, and, generally speaking, to the German character. This happy state of things was broken many many years after by the thirty years' war (1619—48); but the treaty of Westphalia, which terminated this war, confirmed the articles of the peace of Augsburg, and extended its benefits to the Calvinists as well as to the Lutherans. Equal religious rights and privileges were extended to all, as is still happily the case.

While these events were taking place in Germany and Switzerland, the spirit of inquiry, which had been evoked so signally in these countries, spread, and roused most of the nations of Europe to a greater or less extent from their mental inactivity or superstitious credulity: the doctrines of the Reformation found their way partially into France; also into Spain and Italy. Prior to Luther's death (1546) these doctrines had made many converts in the Netherlands; and in the time of Philip II. the "Seven United Provinces," which separated from the rest, proclaimed liberty of conscience, and adopted the tenets of Calvinism, to which they have ever since adhered.

About the year 1556, the Lutheran creed was adopted

as the state religion in Denmark and Norway. This creed was propagated in Sweden soon after Luther's rupture with the church of Rome, by Olaus Petri, one of his disciples. Both Lutheranism and Calvinism early gained an extensive footing in Poland, which they still retain. To Hungary and Transylvania a similar remark applies. The history of the Reformation in the British empire is well known, and need not be detailed here. Though the Protestant episcopal church is the established religion in Ireland, more than three fourths of the people of that country retain their hereditary attachment to the papal creed. Altogether, not more than a fourth of the population of Europe are Protestant; of the remainder, about two thirds still adhere to the Romish faith, — the two great exceptions being Turkey, where Mohammedanism is established; and the east of Europe and other contiguous provinces, where the Greek church prevails. Protestantism, besides, is the predominant religion in the United States, and in almost all the British colonies. See CHRISTIANITY.

Independently of the truth or falsehood of the doctrinal and other points on which the reformed church dissents from that of Rome, the Reformation was the cause of many interesting and important advantages. It burst the fetters by which the human mind had previously been bound, and restored it to liberty. It made religion an object of the understanding, and not of the eye; of the heart, rather than of the memory. "On the whole, the Reformation nas been an incalculable good to Europe; it has purified religion and morals; it has improved the intellect, and has guaranteed civil liberty." (*Dunham's Hist. of the Germanic Emp.* b. iii. c. 2.) It has contributed to improve even the church of Rome itself both in science and in morals. "The desire of equalling the reformers in those talents which had procured them respect; the necessity of acquiring the knowledge requisite for defending their own tenets, or refuting the arguments of their opponents; together with the emulation natural between two rival churches, engaged the Roman Catholic clergy to apply themselves to the study of useful science, which they cultivated with such assiduity and success, that they have gradually become as eminent in literature as they were, in some periods, infamous. The same principle occasioned a change no less considerable in the morals of the Romish clergy. Many of them have, in consequence, been distinguished for all the accomplishments and virtues which can adorn their profession; and differ greatly from their predecessors before the Reformation, both in their maxims and in their conduct." (*Robertson's Charles V.* vol. v. pp. 414-15.; *Hist. of the Great Reformation in Germany and Switzerland*, by D'Aubigné; F. Paul, *Hist. of the Council of Trent*, &c.)

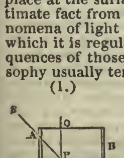
REFORMATION, JUBILEE OF THE. The two hundredth anniversary of the introduction of the Reformation at Geneva was solemnized under this title in August, 1835. The canton, since the Congress of Vienna, having become "mixed" in religion, the government took no part in this festival, the expenses of which were defrayed by voluntary subscription. Invitations were sent to the Protestant clergy of all countries, both Lutheran and Calvinist, to attend its solemnization: 61 were present from France, 12 from England, 3 from North America. The account of this great meeting is published under the title of *Jubilé de la Réformation de Génève*, Genev. 1835.

REFORMED CHURCH, comprises in a general sense all those bodies of Christians that have separated from the church of Rome since the era of the Reformation; but it is applied in a restricted sense to those Protestant churches which did not embrace the doctrines and discipline of Luther, and more particularly to the Calvinistic churches on the Continent.

REFRA'CTION. (Lat. refractus, *broken*.) In Mechanics, the change of direction which takes place in the motion of a body when it passes obliquely out of one medium into another of different density. The term is chiefly applied to the deviation from their rectilinear course of the rays of light in passing through transparent substances.

REFRACTION OF LIGHT. The deviation of a ray of light from its original path in entering a medium of a different density. This change of direction, which takes place at the surface of separation of two media, is the ultimate fact from which many of the most interesting phenomena of light receive their explanation. The laws by which it is regulated, and the investigation of the consequences of those laws, form the branch of natural philosophy usually termed *Dioptrics*.

(1.)



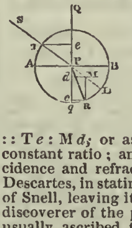
The phenomenon may be observed as follows: — Suppose a beam of light proceeding from a luminous point S (fig. 1.) to be admitted through a small hole A in the side of a vessel A B; then, the vessel being empty, the light will fall on the bottom at a point L in the same straight line with S and A. Now let water be poured into the vessel, and suppose the beam of light to fall on the surface of the water at P; then it will be seen that the light no longer continues its course in the same straight line, but is bent, or *refracted*, at P, and proceeds through the water in a straight line PR, more nearly perpendicular to the surface. A similar deviation takes place in all cases in which light passes from one transparent medium into another; but the magnitude of the angle R P L, or the amount of the refraction, varies according to the nature of the two media, and the degree of obliquity with which the incident ray falls on the surface of separation.

Through P draw Q P q a normal to the surface; then S P Q is *the angle of incidence*, R P q is *the angle of refraction*, and the following laws are found to be observed in all cases: —

1. The refracted ray P R is in the same plane with S P and P Q; that is, with the incident ray and the perpendicular to the surface at the point of incidence.
2. The incident ray S P and the refracted ray P R are always on opposite sides of the perpendicular Q P q.
3. Whatever be the inclination of the incident ray to the surface, the sine of the angle of incidence has to the sine of the angle of refraction a constant ratio.

These three laws, which hold good for curve surfaces as well as for planes, enable us to determine the path of the refracted ray with mathematical precision when the form of the surface and the nature of the refracting medium are both known. The two first are easily verified, and have been known from the days of Ptolemy. The third, which is very remarkable, was first enunciated in the *Dioptrics* of Descartes, published in 1637; but the discovery belongs to Willebrod Snell, professor of mathematics at Leyden, who died at an early age in 1626. Snell, indeed, made no mention of the sines of the two angles, but the relation which he affirmed to subsist is identical with the law as stated by Descartes. Through P (fig. 2.), the point of incidence, as a centre, let a circle be described meeting the incident ray in T and the refracted in R, and through R draw RM perpendicular to the surface A B, meeting P L in M; draw also R c, M d, T e, respectively perpendicular to Q q. Now the proposition affirmed by Snell was, that for every inclination of S P to the surface the line P R is to P M in a constant ratio. But P R = P T, and PT : P M :: T e : M d; or as T e : R c, therefore T e is to R c in a constant ratio; and these are obviously the sines of incidence and refraction respectively to the same radius.

(2.)



Descartes, in stating the law of the sines, made no mention of Snell, leaving it to be inferred that he himself was the discoverer of the property in question, which, in fact, is usually ascribed to him by the French authors. It is, however, by no means certain (though asserted by various writers) that Descartes was acquainted with what had been done by Snell, as the work of the latter existed only in manuscript when the *Dioptrics* made its appearance.

Let i denote the angle of incidence, r the angle of refraction, and let $n : 1$ be the constant ratio of the sines in passing from a given medium A into another given medium B; we have then, by the third law above stated, $\sin. i = n \sin. r$, for every value of i. The quantity n, which is constant for the same two media, is greater than unity when the refracting power of the first medium A is less than that of the second B, and *vice versâ*. Its value must be determined in every case by experiment; and as it is relative to both media, it is convenient for the purpose of comparing the refractive powers of different substances to refer them all to some common medium A, usually assumed to be an absolute void, and in this case the quantity n is called the principal index of refraction of the medium B, or simply *the index of refraction*. We have therefore this definition: —

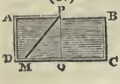
The index of refraction of any transparent substance is the ratio of the sine of incidence to the sine of refraction, when light passes from a vacuum into the substance.

As there is no known substance of such a nature that light entering it from a vacuum is refracted so as to make the angle of refraction greater than the angle of incidence, the index of refraction is always greater than unity. Of all known substances, that which possesses the greatest refractive power is chromate of lead, for which the index of refraction is 3; hence in the equation $\sin. i = n \sin. r$, all the values of n which have yet been experimentally determined lie between 1 and 3.

From the formula $\sin. i = n \sin. r$ some remarkable consequences are readily deduced. Suppose i to have its greatest value, namely $90°$, in which case the incident ray becomes parallel to the surface of the medium. We have then $\sin. i = 1$; and the formula becomes $1 = n \sin. r$, whence $\sin. r = 1 \div n$, which is the limiting value of r. In the case of water the index of refraction $n = 1{\cdot}336$ (or nearly $\frac{4}{3}$), and the arc whose sine is the reciprocal of this quantity is $48° \, 27' \, 40''$; consequently light cannot enter water more obliquely than under an angle of $48° \, 28'$

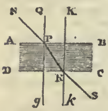
Thus, suppose a vessel A B C D (fig. 3.) to be filled with water, and a part of the surface A P to be covered over; then on drawing a line P M, making with the perpendicular P Q an angle M P Q = 48° 28′, the part A P M D will remain in perfect darkness, however the uncovered part of the surface P B may be illuminated.

(3.)



It is a principle in optics, that if a ray of light passes from a point A to a point B after any number of refractions or reflexions, a ray will pass from B to A by following precisely the same course in an opposite direction. From this it follows that if a ray of light S P (fig. 4.) falling on the exterior surface A B of a medium is refracted into the direction P R, then on arriving at the interior surface C D it will suffer another refraction, and escape from the medium in the direction R s, making with K k (the perpendicular to C D at R), the angle s R k equal to the angle S P Q. With respect to the surface C D, P R K becomes the angle of incidence, and k R s the angle of refraction; and if we suppose the ray to pass from the medium into a vacuum, and n to be the index of refraction of the medium, we have $\sin. i = \frac{1}{n} \sin. r$.

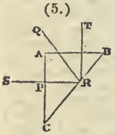
(4.)



Now since n is greater than unity, r is greater than i; and if we suppose those angles to increase until r, or the angle k R s, becomes a right angle, then $\sin. r = 1$, and we have $\sin. i = 1 \div n$ for the limiting value of i, beyond which the ray will not leave the surface at R; for if $\sin. i$ be greater than $1 \div n$, it follows that $\sin. r$ must be greater than unity, which is impossible. Hence it follows that if the ray P R fall upon the interior surface, making with the normal K R an angle greater than $1 \div n$, it will not leave the medium, but be reflected internally from R.

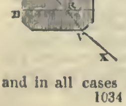
This property admits of various practical applications. For ordinary glass the value of n is about $\frac{3}{2}$, so that in passing from glass to air we have $\sin. i = \frac{2}{3} \sin. r$. Now let i increase until $r = 90°$, then $\sin. i = \frac{2}{3}$, whence $i =$ 41° 49′, which therefore is the limiting value of the angle of incidence when light passes from glass into air. Let A B C (fig. 5.) be a triangular glass prism having the angle at A a right angle, and the sides A B and A C equal, so that B and C are each angles of 45°; and conceive a ray of light S P to fall perpendicularly on the surface A C at P. This will continue its course through the glass in a straight line until it meets the side B C in R, making with R Q (the normal to B C) the angle of incidence S R Q = 45°. But this angle being greater than 41° 49′, the ray will not leave the medium, but be reflected at the interior surface in the direction R T, which, since the angles of incidence and reflexion are equal, will be perpendicular to S R, so that the ray will fall perpendicularly upon the surface A B, and pass through it without refraction. The prism thus produces the same effect as a diagonal mirror placed in the plane B C.

(5.)



When the index of refraction for each of two media has been determined, the refraction which takes place in passing from the one medium to the other is also known, the constant ratio of the sines of incidence and refraction being, in this case, the ratio of the indices of the two media. Let m be the index of refraction for the medium A, and n the index for the medium B; then, in passing from A into B, we have $\sin. i = \frac{n}{m} \sin. r$. Thus, the index of refraction for water is 1·336, and for amber 1·547; therefore in passing out of water into amber the constant ratio of the sines of incidence and refraction will be 1·158, the quotient which arises from the division of 1·547 by 1·336. An immediate consequence of this is, that when a ray of light enters a medium after having passed successively through several others, the path of the ray in the last medium will be the same as if it had entered that medium directly under the same angle of incidence as that by which it entered the first; and if the media are bounded by parallel surfaces, the direction of the ray after escaping from the last surface will be parallel to its primitive direction. Thus, let the ray S P (fig. 6.), entering the medium A at P, be refracted into the direction P R, and on entering the second medium B be again refracted into the direction R V, the path of the ray V X after leaving the second medium will be parallel to S P, provided the surfaces at P and V are parallel; and in all cases the ray will emerge at V under the same angle of obliquity as it entered the first surface at P.

(6.)



The principles which have now been laid down are sufficient to enable us to compute the path of a ray of light through any diaphanous substance, or through different substances in succession, when the index of refraction belonging to each substance is known. The following table (from *Brewster's Optics*, *Cab. Cyclopedia*, p. 370.) gives the indices of refraction for the greater part of the substances which have yet been examined.

TABLE of the Refractive Powers of Solid and Fluid Bodies.

	Index of Refraction.		Index of Refraction.
Realgar, artificial	2·549	Plate glass, from 1·514 to	1·542
Octohedrite	2·500	Crown glass, from 1·525 to	1·534
Diamond	2·439	Oil of cloves	1·535
Nitrite of lead	2·322	Balsam of capivi	1·528
Blende	2·260	Gum arabic	1·502
Phosphorus	2·224	Oil of beech nut	1·500
Sulphur melted	2·148	Castor oil	1·490
Zircon	1·961	Cajeput oil	1·485
Glass — lead 2 parts, flint 1 part	1·830	Oil of turpentine	1·475
Garnet	1·815	Oil of olives	1·470
Ruby	1·779	Alum	1·457
Glass — lead 3 parts, flint 1 part	2·028	Fluor spar	1·434
Sapphire	1·794	Sulphuric acid	1·434
Spinelle	1·764	Nitric acid	1·410
Cinnamon stone	1·759	Muriatic acid	1·410
Sulphuret of carbon	1·768	Alcohol	1·372
Oil of cassia	1·641	Cryolite	1·349
Balsam of Tolu	1·628	Water	1·336
Guiacum	1·619	Ice	1·309
Oil of anise seed	1·601	Fluids in minerals, 1·294 to	1·131
Quartz	1·548	Tabasheer	1·111
Rock-salt	1·557	Ether expanded to thrice its volume	1·057
Sugar melted	1·554	Air	1·000294
Canada balsam	1·549		
Amber	1·547		

TABLE of the Refractive Powers of Gases.

	Index of Refraction.		Index of Refraction.
Vapour of sulphuret of carbon	1.001530	Carbonic acid	1·000449
Phosgene	1·001159	Carburetted hydrogen	1·000443
Cyanogen	1·000834	Ammonia	1·000385
Chlorine	1·000772	Carbonic oxide	1·000340
Olefiant gas	1·000678	Nitrous gas	1·000303
Sulphurous acid	1·000665	Azote	1·000300
Sulphuretted hydrogen	1·000644	Atmospheric air	1·000294
Nitrous oxide	1·000503	Oxygen	1·000272
Hydrocyanic acid	1·000451	Hydrogen	1·000158
Muriatic acid	1·000449	Vacuum	1·000000

In the preceding remarks light has been regarded as a homogeneous substance, all the parts of which have the same index of refraction. This however, is not the case; refraction never takes place without a separation of the differently coloured rays, so that for every transparent body the index of refraction changes with the colour of the light. The numerical values of the indices, given in the above table, correspond to the yellow or green rays which occupy the middle of the dispersed pencil. For the different refrangibilities of the primary rays, see CHROMATICS, DISPERSION, SPECTRUM.

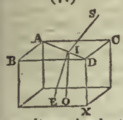
Double Refraction. — The phenomena and laws of refraction, which have yet been considered, belong to those cases in which a single refraction takes place on the entrance of light into a different medium, or in which a pencil of light on entering a refracting medium continues to form a single pencil, and to afford a single image of the object from which it proceeds. There are, however, a multitude of substances which, either in their natural state or under accidental circumstances, exercise a peculiar influence on light, causing it, in its passage through them, to follow two distinct paths, forming with each other an angle of greater or less amount. Such substances are called *doubly refracting substances*, and the phenomenon itself is called *double refraction.*

The substances or media which produce only single refraction belong to one or other of the four following classes: — 1. Gases and vapours. 2. Fluids. 3. Substances which have passed from the liquid to the solid state so rapidly as to prevent the molecules from taking a regular crystalline arrangement: for example, glass, glue, &c.; gums, resins, &c. 4. Crystals whose primitive form is the cube, regular octahedron, or rhomboidal dodecahedron, or which belong to the tessular system of Mohs. All other substances, as the salts, precious stones, crystals not belonging to the above-named forms; all bodies belonging both to the animal and vegetable kingdoms, in which there exists any disposition to a regular arrangement of the molecules, as horn, mother of pearl, &c.; and in general all bodies unequally compressed, or which have not the same structure in all directions, separate the light which they refract into two distinct pencils, which

pursue separate courses, and are governed by totally different laws.

In order to give an idea of this remarkable phenomenon,

(7.)



let A B C D X (fig. 7.) be a crystal of Iceland spar (carbonate of lime), having its faces made smooth either by cleavage or by grinding, and let it be laid on one of its faces on a sheet of white paper over a black spot O; then, on looking through the crystal, two spots will be seen, one at O, and the other at E. On turning the crystal round on its axis, but always keeping the same face on the paper, one of the images, O, will remain invariable, while the other, E, will appear to describe a circle about O. If instead of a round spot the object viewed be a straight line; then, on looking through the crystal, a double image of the line will be seen, one passing through O, and the other through E. On turning the crystal as before, it will be seen that the distance between the two lines varies, but that they always remain parallel to each other; and that in the course of a complete revolution of the crystal about its axis there are two positions in which the images will coincide, and two other positions, midway between the former, in which they will attain a maximum distance. These phenomena show that a ray of light, S I, on entering the face of the crystal at I, is separated by refraction into two pencils, I O and I E; and it is found that on emerging from the crystals the two pencils make the same angle with the surface, and continue their course in a direction parallel to each other and to the incident ray S I.

If we cause a beam of solar light to fall on the crystal, and examine the paths of the two pencils, it will be found that I O follows the laws of ordinary refraction, the sine of incidence being to the sine of refraction in a constant ratio, and the pencil continuing in the same plane with the incident ray and the normal to the surface at the point of incidence: hence I O is called the *ordinary* pencil. But I E is found to follow an entirely different law, and is therefore called the *extraordinary* pencil. If, for example, the incident ray S I is perpendicular to the face of the crystal, the ordinary refraction does not take place, the angle of incidence being zero; but in this case the angle of refraction of the extraordinary pencil, I E, is 6° 12′, and it is not in the same plane with the normal and the incident ray.

From a careful examination of the phenomena it is also found that although a ray of light falling on the face of the crystal is refracted generally into two pencils, there is one particular direction in which the incident ray undergoes only the ordinary refraction. This direction is parallel to A X, the shorter axis of the crystal, and is called the *axis of double refraction.* It is, therefore, to be observed that the axis of double refraction of a crystal is not a fixed line, but a determinate direction with reference to the faces of the crystal, every line parallel to A X forming an axis of double refraction. In some crystals the extraordinary ray is refracted *towards* the axis A X, in others it is refracted *from* it. In the first case the axis is called a *positive* axis of refraction; in the second it is called a *negative* axis.

In the crystal we have now been considering (Iceland spar), there is only one direction in which the double refraction does not take place, but in many other crystals there are two directions which have this property. In examining the phenomena of double refraction in a great number of crystallized substances, Sir David Brewster found that all those crystals whose primitive and simplest form has only one axis of figure, or one pre-eminent line about which the figure is symmetrical, have only one axis of double refraction. The primitive forms which have only one symmetrical axis of figure are the following:—

1. The rhomb with an obtuse summit; as Iceland spar, tourmaline, quartz, &c.
2. The rhomb with an acute summit; of which form are corundum, sapphire, ruby, cinnabar, and arseniate of copper.
3. The regular hexaedral prism; as emerald, beryl, arseniate of lead, &c.
4. Octohedron with square base; as zircon, oxide of tin, prussiate of potash, &c.
5. Right prism with square base; as arseniate of potash, phosphate of magnesia, &c.

In all these forms, and in the primitive forms to which they delong, the line A X is the axis of figure and of double refraction; and it is the only direction in which there is no double refraction. (See *Brewster's Optics*, p. 149.)

The property of possessing two axes of double refraction was discovered by Sir David Brewster in 1815, and he found that it belonged to all crystals, whether chemical bodies or mineral substances, which are included in the prismatic system of Mohs, or whose primitive forms are,

1. A right prism, base a rectangle.
2. A right prism, base a rhomb.
3. A right prism, base an oblique parallelogram.
4. Oblique prism, base a rectangle.
5. Oblique prism, base a rhomb.
6. Oblique prism, base an oblique parallelogram.
7. Octohedron, base a rectangle.
8. Octohedron, base a rhomb.

In all these forms there is no axis about which the crystal is symmetrical.

In all cases of crystals with two axes of double refraction, both the pencils are refracted according to the laws of extraordinary refraction. In a substance called analcime Sir D. Brewster found there were several planes along which if the incident ray passes it will not suffer double refraction, whatever be the angle of incidence. Each of these planes, therefore, may be considered as containing an infinite number of axes of double refraction, or lines in which there is no double refraction. No other substance has yet been found possessing the same property. (*Optics*, p. 155.)

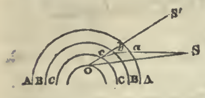
Another very remarkable property is, that in crystals which have only one axis of double refraction the axis has always the same position, being, in fact, in all cases, the axis of symmetry; but in crystals which have two axes of double refraction, the axes change their position according to the colour of the incident light. Sir John Herschel, to whom this discovery is due, found that in crystals of Rochelle salts the inclination of the two axes for violet light is 56°, while for red light it is about 76°. In other crystals, as nitre, the inclination of the two axes is greater for the violet than for the red rays; but in all cases the line which joins the extremities of the axes for all the rays is a straight line.

The property of double refraction was discovered by Bartholin, in 1669, and was first explained by Huygens on the hypothesis of the propagation of light by means of an elastic medium. The phenomena have been studied with great assiduity in modern times, and, in fact, the investigation of their laws forms one of the principal parts of physical optics, and has mainly contributed towards the establishment of the now generally received theory of undulation. Newton does not appear to have paid much attention to the subject, and his theory of emission does not very readily accommodate itself to the explanation of the phenomena; though it must be owned that the supporters of that theory have succeeded, by means of certain arbitrary hypotheses, in constructing mathematical formulæ which represent the greater part of the known facts. For the complete explanation of all the phenomena, the undulatory theory requires two postulates, or assumptions:—1. That the vibrations of the ether take place *transversely*, or in the direction perpendicular to the visual ray; and, 2. That the elasticity of the medium is unequally developed in the interior of the refracting crystal. The first of these assumptions is analogous to what takes place when a blow is given to a cord tightly stretched; the motion is communicated rapidly in the direction of its length, while the vibrations are at right angles to that direction. With respect to the second assumption, the facts which are known respecting the constitution of crystals render it exceedingly probable, *à priori*. All diaphanous bodies which refract light only in a single direction, and according to the Cartesian law, are found to have the same tenacity and the same elasticity in all directions, and their linear dilatations by heat are also the same; but it has been established that with respect to all crystallized substances, which possess the property of double refraction, the elastic force with which they resist compression is greater in certain directions than in others, and also that the linear dilatation corresponding to the same increase of temperature varies with the direction in which it is measured. These facts prove that the matter of the crystal possesses an elasticity varying with the direction; and it seems natural to suppose that the ether within it must have the same property. On these two assumptions, namely, transverse vibrations, and unequally developed elasticity of the medium, Fresnel has constructed a mathematical theory of double refraction, from which all the phenomena which have yet been observed are deduced as simple corollaries. (See *Sir J. Herschel's Treatise on Light*, *Ency. Metropol.*; *Airy's Mathematical Tracts*, 2d ed.; Pouillet, *Elemens de Physique*.)

REFRACTION, ASTRONOMICAL. Refraction, in Astronomy, is the apparent angular elevation of the celestial bodies above their true places, caused by the refraction of the rays of light in their passage through the earth's atmosphere.

It is found by experiment, that the refractive power of a gas, or aëriform substance, is proportional to its density. Now the earth's atmosphere is not a medium of uniform density, but of a density continually diminishing as the distance from the centre is increased. For the purpose of illustration, the atmosphere may be regarded as composed of a great but finite number of concentric spherical strata, each having a uniform density greater than that of the stratum by which it is enveloped, but less than

that of the stratum which it envelopes. Hence, on entering each successive stratum, the light must undergo a slight deviation from its rectilinear course, and the amount of all these deviations constitutes the phenomenon of astronomical refraction. Let A A, B B, C C, represent the boundaries of the successive strata, and suppose a ray of light proceeding from the star S to enter the highest stratum A A obliquely at a. If no deviation took place, the ray would continue to advance in the same straight line S a; but in consequence of entering a denser medium it is refracted, according to the law of Descartes, into a direction, $a\ b$, more nearly perpendicular to the surface of the spherical stratum. At b it again enters a medium of a greater density, and is refracted into the direction $b\ c$, still approaching the perpendicular to the surface. On arriving at c the phenomenon is repeated, and the ray is bent from the direction $b\ c$ into the direction c O; so that in passing from S to O the ray of light, instead of describing the straight line S O, describes the polygon S $a\ b\ c$ O, and to a spectator at O the star will appear to be situated at S′ in the direction O c. Hence the star appears to be elevated above its true place; and the angle S′ O S, which is the difference between its true and apparent elevations, is the *astronomical refraction*. If we suppose the number of the strata to become infinitely great, then the angular deviation at each successive stratum will become infinitely small; and the path of the ray, instead of being a polygon, will be a continuous curve, which, according to the laws of refraction, will lie wholly in the same vertical plane.



Since the ratio of the sines of incidence and refraction is constant, it is evident that the total effect will be the greatest when the luminous rays enter the atmospheric strata with the greatest obliquity; that is to say, when the object is seen in the horizon. At the zenith there is no refraction; in descending from the zenith to the horizon it continually increases, according to a certain law, which may be determined theoretically if the refractive power of atmospheric air at a given density and temperature, the dilatation of air by heat, and also the law of the variation of the density and temperature in ascending into the higher regions of the atmosphere, are supposed to be known. At a medium density, and at the temperature of melting ice, Biot and Arago found by experiment that for any altitude exceeding 10° above the horizon the law of atmospheric refraction is represented by the formula $r = 60''\cdot 6$ tan. $(Z - 3\cdot 25 \times r)$, in which r is the refraction corresponding to a given zenith distance Z. Bradley had given the formula $r = 57''$ tan. $(Z - 3\cdot 25\ r)$. From either of these it appears that the increase of refraction is nearly proportional to the tangent of the zenith distance, but at low altitudes the expression becomes much more complicated.

The following table given by Mr. Ivory (*Phil. Transactions* for 1838, part 2.) shows the amount of refraction at different zenith distances, the temperature being 50° of Fahrenheit, and the height of the barometer 30 inches. The correction (omitting some small terms) for the actual temperature and barometric pressure is obtained by multiplying the tabular refraction by $\frac{1}{1 + c\,(t - 50)} \cdot \frac{b}{30}$, where b is the observed height of the barometer reduced to the fixed temperature of 50° Fahr., t the temperature of the air on the same scale, and $c = \cdot 002183$.

Zenith Distance.	Refraction.	Zenith Distance.	Refraction.
10°	10·30″	82°	394·68″
20	21·26	83	445·42
30	33·72	84	509·86
40	48·99	85	593·96
45	58·36	85½	646·21
50	69·52	86	707·43
55	83·25	86½	779·92
60	100·85	87	866·76
65	124·65	87½	971·93
70	159·16	88	1101·35
75	214·70	88½	1262·6
80	320·19	89	1466·8
81	353·79	89½	1729·5

The existence of astronomical refraction was known at an early period, though its amount and laws have only been ascertained in recent times. Ptolemy, in his book on *Optics*, remarks that in consequence of refraction a star is brought nearer the zenith, and that the effect is greater in the case of a low than a high star; but as no mention is made of the subject in the *Almagest*, it was not then regarded as an element of astronomical calculation. Similar notions appear in the *Optics* of Alhazen. Walther was the first who began to estimate the effects of refraction near the horizon; and Tycho Brahe constructed, from observations, the first table. He supposed the horizontal refraction to be 34′, which is very near the truth (its mean amount being 33′); but he supposed it to vanish at the altitude of 45°, though its mean amount at that altitude appears, by the preceding table, to be nearly 1 minute. Dominic Cassini gave an empirical formula for computing the refraction at any altitude; but the solution of the problem on true principles was first undertaken, and, in fact, fully accomplished, by Newton, though his results did not represent the observations, in consequence of the imperfect knowledge which then existed respecting the physical constitution of the atmosphere.

REFRACTION, TERRESTRIAL. The atmospherical refraction, which has just been explained, is the effect produced by the whole atmosphere on a body placed entirely beyond it; but as the density of the atmosphere varies with the height, it is evident that the apparent place of any object placed on a different level from that of the observer must be affected in a greater or less degree by refraction. Whether the rays of light come from a more elevated object, and consequently pass from a rarer into a denser medium, or from an object depressed below the horizon of the observer, and consequently pass from a denser into a rarer medium, they are equally bent downwards, and consequently the apparent place of the object is raised. This refraction between terrestrial objects is called *terrestrial refraction;* and as the density of the air near the surface of the earth is liable to great irregularities from being irregularly heated, its effects give rise to many very remarkable phenomena. Among these are *looming* or *mirage*, the *fata morgana* (see the terms), and the occasional appearance above the horizon of distant objects which in the ordinary state of the atmosphere are invisible. Sometimes, in consequence of the rarefaction of the air in the neighbourhood of a surface of water, or of a building, or of the earth itself, a distant object appears to be depressed instead of being elevated; and occasionally it is at once both depressed and elevated, so as to appear double, in which case one of the images is generally seen in an inverted position, as if a reflexion had taken place. In very exact observations, as in geodetical surveys, it is found that the refraction is not always confined to the same vertical plane, but sometimes produces a deviation amounting to a few seconds laterally.

REFRACTIVE POWER, in Optics, is the degree of influence which a diaphanous body exercises on the light which passes through it. For the measure of this influence modern writers generally adopt the square of the index of refraction diminished by unity, or $n^2 - 1$, where n denotes the principal index of refraction. (*See* REFRACTION.) The reason of this is founded on certain dynamical considerations regarding the physical cause of refraction. According to the Newtonian theory of emission, the velocity of light is accelerated on entering a denser medium by reason of the increased molecular attraction; and the law of refraction is explained by supposing the index of refraction of any substance to be the ratio of the velocity of light in that substance to its velocity in a vacuum. Thus, let u denote the velocity of light in a vacuum, and v its velocity while passing through a diaphanous substance, then $v \div u = n$; or, since sin. $i \div$ sin. $r = n$, the sine of incidence is to the sine of refraction inversely as the velocity in a vacuum to the velocity in the medium. Now the increment of the *vis viva*, or the excess of the square of the new velocity above that of the former, is $v^2 - u^2$, and the ratio of this to the square of the former is $(v^2 - u^2) : u^2$, which is the same as the ratio of $n^2 - 1$ to unity.

According to the undulatory theory, the velocity of light is diminished on entering a denser body. In this case, $u^2 - v^2$ is the loss of *vis viva;* and the ratio $(u^2 - v^2) : v^2$, or $n^2 - 1$ to 1, is the ratio of *vis viva* which is lost to that which is retained. In either case, the ratio $n^2 - 1$ to 1 forms the measure of the *refractive power* of the substance of which n is the index of refraction.

Some modern authors employ the phrase *absolute refractive power* to denote the ratio of the refractive power of a substance (as above defined) to its density; that is to say, the ratio $(n^2 - 1) : D$, where D stands for the density of the body. Sir Isaac Newton (*Optics*, p. 247.) calls this the "refractive power of a body in respect of its density;" and, as it is a consequence of the theory of emission that the refractive power must be proportional to the density, the ratio $(n^2 - 1) : D$, according to this theory, is constant for the same medium; that is to say, its numerical value depends only on the nature of the medium, and is independent of its condition; so that a liquid and its vapour ought to have the same absolute refractive power, which is contradicted by the experiments of Arago and Petit.

The French authors use the term *puissance réfractive* to denote the refractive power, or the number $n^2 - 1$, while they express the *absolute refractive power*, or the ratio $(n^2 - 1) : D$, by the term *pouvoir réfringent*. It is convenient to have different names for the two things, which are totally different, at least in their numerical measures. Thus hydrogen gas has a smaller index of refraction, and consequently a smaller refractive power,

than any other substance; but its *absolute refractive power*, or *pouvoir réfringent*, is greater than that of any other substance. (For a table of the values of the ratio ($n^2 - 1$) : D for a considerable number of different substances, see *Brewster's Optics, Cab. Cyclopædia.*)

REFRA'IN. The burden of a song, &c. See BURDEN.

REFRANGIBILITY, in Optics, is the disposition of the rays of light to be refracted or bent in passing obliquely from one transparent medium into another; but the term is chiefly used to denote the degree of that disposition possessed by the differently coloured rays. *See* REFRACTION, SPECTRUM.

RE'FUGE, CITIES OF. Six cities appointed, according to the words of Moses, under the Jewish dispensation (Deuteron. xix. 2. 9.), for the safety of those who had caused the accidental death of any one. If a deliberate murderer fled to one of these cities, the elders of the city were to deliver him "into the hands of the avenger of blood." The cities are enumerated in Joshua, chap. xx.

REFUGÉE. A name which has been given in history and political phraseology indiscriminately to persons who flee from religious or political persecution in their own country, and take refuge in another. It was originally applied to the French Protestants (refugiés) who found an asylum in this country, and among various Continental nations, after the revocation of the Edict of Nantes by Louis XIV.

REGA'LIA. (Lat. rex, *a king*.) In Politics, the privileges, prerogative, and right of property, belonging, in virtue of office, to the sovereign of a state. The latter class of objects are most commonly termed *regalia minora*; as, in some countries, waifs, strays, and newly-formed land, &c.; in England, forfeitures, &c.: while the former are known by the epithet *majora*. *Regalia*, in English Heraldry, the royal insignia, crowns, sceptres, globes, crosses, &c. used at the coronation: also the crown jewels. *Regalia* of the church, the privileges which have been conceded to it by kings; sometimes the patrimony of a church.

REGA'RDANT. (Fr.) In Heraldry, literally looking behind; applied to any animal whose face is turned towards the tail in an attitude of vigilance.

REGA'TTA. (Ital.) A word used originally by the Venetians to signify a grand fête, in which the gondoliers contested for superiority in rowing their gondolas; but the term has been adopted into all the languages of modern Europe, in which it signifies a brilliant species of boat race. In England, festivities of this species are almost of weekly occurrence during the summer season.

REGEL, or RIGEL. A star of the first magnitude, constituting the left heel of the constellation Orion.

REGENERA'TION. In Theology, the new birth of man unto righteousness, following on the abolition of the original corruption of his nature. Similar language was used respecting the admission of proselytes to the privilege of Judaism: so, also, in other religions. The Sanskrit name for a Brahmin is said to signify "twice-born;" and Tertullian says that the heathens used baptism in their mysteries, "in regenerationem." When our Saviour admonished Nicodemus not to marvel at his words, "Ye must be born again," he added, with reference, doubtless, to the doctrines already taught among the Jews, "Art thou a master of Israel, and knowest not these things?" (John, iii. 10.) That baptism is "a sign of regeneration," as expressed in the 27th Article of the Church of England, is admitted by nearly all Christians. (Rom. vi. 4. 11.; Tit. iii. 5.; John, iii. 5.) But whether the new birth to which allusion is made in these solemn passages actually takes place by and through baptism; whether baptism, duly administered by those authorized, is in itself an "opus operatum," in the language of the schools; or whether the regeneration spoken of as the condition of our salvation takes place after, and independent of baptism, by the operation of the Spirit on the inner man — this is a question on which Protestants have never agreed among themselves, and which divides our church at this day. The former is the commonly received or Catholic doctrine; and has been so from very early times, as far as we can conclude from the language of the fathers and ancient forms of the church. But it does not appear to be positively declared by the Church of England, though inferred from various passages in the baptismal service.

RE'GENT. (Lat. rego, *I govern*.) The person who exercises the powers of a sovereign during the absence, incapacity, or minority of the latter. In most hereditary governments the maxim is, that this office belongs to the nearest relative of the sovereign capable of undertaking it; but this rule is subject to many limitations. The kings of France exercised at various periods the power of fixing, by ordinance or will, the regency, in case of their decease leaving issue under age; and also the period of their son's majority. Nevertheless, these wills have been at various times disregarded in favour of what was esteemed the principle of the monarchy. Thus, the testament of Louis XIII., by which he declared his wife future regent, but limited her power in the essential prerogative of the choice of a council, was set aside as to this limitation, and she was appointed regent with full prerogatives. The testament of Louis XIV., as to a regency during the minority of Louis XV., was set aside by the parliament of Paris immediately after his death. In England, the right to appoint the regent is now fully recognized to belong to parliament; although, in 1788, on the occasion of the first illness of George III., much discussion took place as to the absolute right which some supposed to inhere in the heir apparent. The regency, in the event of the demise of the present sovereign leaving issue, is vested by act of parliament in her Majesty's consort.

RE'GENT MA'STERS, or REGENTS. In the English Universities, a term borrowed from the ancient usages of the University of Paris. In that institution graduates in the faculties, within a certain period after their degree, had the privilege, which they were bound to exercise, of giving public lectures (docendi, legendi, regendi scholas). The same custom was adopted at Oxford and Cambridge; although the regent masters were at an early period succeeded in the performance of this office by the established professors. The regents still form the governing body of the universities, in the convocation and congregation at Oxford, and in the academical senate of Cambridge. *See* MASTER OF ARTS.

RE'GICIDE. (Lat. rex, *king*, and cædo, *I kill.*) The offence of slaying a king or other sovereign. The early Greek republics, unaccustomed to the legitimate rule of monarchs, saw, in the occasional subjugation which they underwent from successful partisans, a mere usurpation, or tyranny; and tyrannicide was with them only the slaying of a public enemy. And the hatred which attached itself in the minds of the Roman people to the royal name and authority made them regard the acts of the elder and younger Brutus, even to the latest days of the republic, and long after the establishment of the empire, as virtuous and honourable. Hence the perverted morality on this peculiar subject which continues to prevail, more or less, even to the present day, as false in logic as contrary to the plain rules of conscience; for it is obvious that, to each individual, a wealthy or powerful oppressor, who commits injuries against him and his friends for which the law can give him no redress, is just as fair a subject for illegal vengeance as a king to any member of the community. Yet no one ever sought seriously to set up the right of assassination in such cases; as Buchanan, Languet, Mariana, and others have done in that of kings. English history has three notorious instances of kings (Edward II., Richard II., and Edward V.) murdered by powerful and rebellious subjects. But France, above all other countries, is fertile in examples of regicide, effected or attempted by private individuals under the influence of religious and political fanaticism. Henry III. and IV. both fell by the hands of Roman Catholic zealots. The reader will find in the Discourse of Père Mathieu on the Death of the latter (lately republished in *Cimber, Archives Curieuses*), a singular example of the fanaticism of cruelty in the way of retaliation, excited, and not unnaturally, by the repetition of such monstrous and desperate acts. But the savage execution of Ravaillac did not deter Damien, in the reign of Louis XV., from attempting the same offence from the same motives. The murder of the Duc de Berri, and the repeated attempts on the life of Louis Philippe, from political enthusiasm, show but too plainly that the morbid passions which actuated these celebrated assassins have but taken in modern times another direction. The murder of Gustavus, king of Sweden, by Ankarstrom, is, perhaps, the most deliberate instance of this crime on record; for the criminal, though rancorous and determined, was no zealot. It must be added, that the application of the term regicide to the members of the commission which sat in judgment on Charles I., and to the majority of the convention which condemned Louis XVI., is a violation of that moral sense which judges unerringly of actions; whatever the character of their conduct might be, it was altogether different from assassination; and to confound Vane or Carnot with Ravaillac and Fieschi, under a similar designation, can serve no ends but those of temporary party malice.

RE'GIMENT. (Lat. rego, *I rule.*) A body of troops consisting (if infantry) of several battalions, or (if cavalry) of several squadrons, under the command of a colonel. The British army consists, at present, of three regiments of horse guards; sixteen regiments of cavalry, of which four are heavy dragoons, five light dragoons, four hussars, and four lancers; three regiments of foot guards, divided into the grenadier guards, the Scots fusiliers, and the Coldstream guards; and ninety-nine regiments of infantry, exclusive of the royal regiment of artillery, and the royal corps of marines. Many of the regiments in the British army are distinguished by the name of the counties or districts where the men were originally enlisted. Thus the 3d regiment is called the

East Kent regiment; the 6th, the Royal Warwickshire, &c. &c. No rule is established with regard to the number of men of which a regiment should consist: both in England and on the Continent this point is settled either by the exigencies of service in time of war, or the principles of economy in time of peace. In the British army, the three regiments of horse guards consist at present each of 32 officers, 53 non-commissioned officers, 351 privates, and 274 horses. The ordinary cavalry regiments have each at an average 27 commissioned officers, 31 non-commissioned officers, 304 privates, and 283 horses. The grenadier regiment of guards consists of three battalions; and has 96 officers, 177 non-commissioned officers, and 2080 privates. The other two regiments of foot guards consist also of two battalions each, and have each 61 officers, 109 non-commissioned officers, and 1280 privates. The royal regiment of artillery consists of nine battalions, having 449 officers and 6062 non-commissioned officers and men, exclusive of the horse brigade, the engineers, and sappers and miners. (*Stat. of the Brit. Empire*, vol. ii. p. 433.)

RE'GISTER, LORD; or LORD CLERK REGISTER. A Scottish officer of state, who has the custody of the archives; hence also termed custos rotulorum. He was of old the principal clerk of the kingdom, from whom other clerks derived their authority. The office was formerly at pleasure, but since 1777 for life. Salary 1200*l*. a-year. He is assisted in his duties by a resident deputy.

RE'GISTRY OF BIRTHS, MARRIAGES, AND DEATHS. Down to the year 1836, in consequence of the defects of the system of registration, no complete or accurate information could be obtained as to the amount of births, marriages, and deaths throughout England; but at that period the necessity of having it superseded by a better system was admitted, which was finally accomplished by the act 6 & 7 Will. 4. c. 80.

This act, passed in pursuance of the recommendation of a committee of the House of Commons on parochial registers (1833), embodies a plan for the effectual registration of births, deaths, and marriages in England and Wales. To give uniformity to the system, it is conducted under the superintendence of an officer resident in London; and there also a central place of deposit is provided for certified copies of all parochial registers, with ready means of finding any entry in them. It is provided that in every case of *birth* the following circumstances shall be recorded: — viz. the time and place of birth; the name (if any) and sex of child; name and surname of father; name and maiden surname of mother; rank or profession of father; the signature, description, and residence of the informant; and also the baptismal name of child, if added after registration of birth. In every case of *death* the register is to record the time and place of death; the name and surname, sex, age, and rank or profession of the deceased; *the cause of death;* and the signature, description, and residence of the informant. In all cases the entries must be signed by the informant, and also by the registrar, who discharges this duty without any immediate expense to the parties requiring registration, his remuneration being derived from moderate fees paid out of the poor's rates. The insertion of the cause of death, along with the period of death, and the residence, sex, age, and occupation of the deceased, will, in time, afford data of the utmost importance to medical science, and to the improvement of vital statistics.

The central office in London for the deposit of certified copies of registers, and the general supervision and conduct of the business of registration, is called the General Register Office. It is presided over by a registrar-general appointed under the great seal, having under him an assistant registrar, chief clerk, and a numerous body of subordinate clerks. From this office communications emanate to all superintending registrars, registrars of births and deaths, and registrars of marriages, who all act within their respective districts under the directions of the registrar-general, in whom is vested the power of dismissal.

There are at present 619 superintendent registrars, who may each appoint a deputy, with the approval of the registrar-general. Of these superintendents 562 have accepted the office as clerks of boards of guardians for the poor, or have been appointed by the guardians, and 57 have been appointed by the registrar-general. Each superintendent registrar serves within the district to which he is appointed, which comprises one or more registrar's districts.

There are 2197 registrars of births and deaths, who may each appoint a deputy, with the approval of the guardians, or of the poor law commissioners. Of these registrars, 1981 have been appointed by the boards of guardians established under the Poor Law Amendment Act; and 216 are registrars of temporary districts, appointed by the poor law commissioners. Each registrar is appointed to some one of the 2197 registrars' districts, into which the whole of England and Wales has been divided: and he must reside in that district, and register *all* births and deaths that occur in it.

Marriages are registered, 1st, By clergymen of the established church, of whom 11,694 have been furnished with books for this purpose. 2dly, By registrars of marriages, of whom there were, on the 1st of January, 1838, 716: these last are appointed by the superintendent registrars, and register marriages solemnized in their presence in registered places of worship, or in the superintendent registrar's office; 297 of the total number of 716 are also registrars of births and deaths. 3dly, By the registering officers of Quakers, of whom there are 90. And 4thly, By the secretaries of synagogues, of whom there are 36.

The clergyman, and the various officers, amounting in all to about 14,400, to whom the business of registration is committed, are bound to make quarterly deliveries of *certified copies* of all entries in their respective registers during the previous quarter, to the superintendent registrars of the district to which they respectively belong; and these certified copies are transmitted by the superintendent registrars to the registrar-general. The certified copies are made on separate leaves of paper of a uniform size and peculiar texture, having a distinguishing water-mark. On being received at the general register office in London (whither they are sent by post), they are carefully examined; and any defects being noted, are made the subject of communication with the person from whom the defective copy came, who is required either to furnish another copy, or a satisfactory explanation. They are then arranged, paged, and inserted in books for reference.

Alphabetical indexes of births, deaths, and marriages are prepared and kept in the general register office; and any person, on payment of 1*s*., may search these indexes for any entry, and, on finding it, may, if he wish, obtain, for 2*s*. 6*d*., a stamped copy of such entry, which will be "received as evidence of the birth, death, or marriage to which the same relates, without any further or other proof of such entry." There are separate alphabetical indexes for the births, the deaths, and the marriages in each quarter. The registrar-general is bound to furnish, once a year, one of the principal secretaries of state with a *general abstract account* of the births, deaths, and marriages registered during the foregoing year, to be laid before parliament. Three reports of the registrar-general have already been published; and, in a statistical point of view, the sound, accurate, and judicious information which they embody, cannot be too highly appreciated. (*Statistics of the Brit. Empire.*)

RE'GISTRY OF DEEDS, in Law, exists in England only in certain districts; in the three ridings of Yorkshire, and in Middlesex, it is established by act of parliament. It does not extend to copyhold estates, or to leases not exceeding twenty-one years in possession. The intention of the registry was to give notice to purchasers of incumbrances existing on estates. But its value, in this respect, is materially lessened by the prevalence of the equitable doctrine of *notice;* namely, that where a party is, either actually or constructively, aware of incumbrances not registered, he is bound by such knowledge.

REGISTRY OF SHIPS. *See* SHIPS, REGISTRY OF.

RE'GIUM DONUM. (Lat. *royal gift.*) An annual grant of public money in aid of the maintenance of the Presbyterian clergy in Ireland. It was instituted by William III. in 1690, and remodelled in 1790. The stipends are paid to ministers both of the "Synod of Ulster" and "Seceding Synod," the two principal divisions of the sect.

REGIUS PROFESSORS. The name given to those professors in the English universities whose chairs were founded by Henry VIII. In the Scotch universities, in which the patronage of by far the greater number of chairs is vested in the civil bodies, those professors are called regius professors who have been appointed by the crown.

REGLET. (Lat. regula.) In Architecture. *See* FILLET.

REGRATING. *See* FORESTALLING.

REGRE'SSION. (Lat. regressus, *a going backwards.*) In Astronomy, the *regression of the moon's nodes* is the motion of the line of intersection of the orbit of the moon with the ecliptic, which is retrograde, or contrary to the order of the signs. This motion of the nodes of the lunar orbit takes place with considerable rapidity, the whole revolution being accomplished in about 18½ years. The nodes of the planetary orbits also regress on the ecliptic; but, in the case of the planets, the regression is extremely slow, that of the nodes of Mercury, which is the most rapid, amounting only to about 42 seconds of a degree in a solar year. *See* NODE, PLANET.

REGULAR BODIES. *See* PLATONIC BODIES.

REGULAR FIGURES, in Geometry, are equilateral and equiangular polygons. Circles can be described within and about such figures; but such figures can be described by geometrical methods only in particular cases. General expressions for the radii of the circles

described within and about them (r and R), and for their areas and angles, can, however, be given in neat forms. Thus, if n denote the number of sides of the polygon, and if u° represent the nth part of 180°, we shall have, a being the side, $R = \frac{1}{2} a \operatorname{cosec.} u^\circ$, $r = \frac{1}{2} a \cot. u^\circ$, area $= \frac{1}{4} n a^2 \cot. u^\circ$.

Tables of the values of cosec. u° and cot. u°, computed from these expressions, may be seen in most works on mensuration adapted to the values of n as far as 12. (See *Hutton's Mensuration.*)

RE'GULARS. In the Roman Catholic Church, those that profess and follow a certain rule of life, and observe the three vows of poverty, chastity, and obedience, are so called.

REGULA'TOR. In Machinery, a general name for any contrivance of which the object is to produce the uniform movement of machines. The regulators most commonly applied are the *fly* and the *governor*, for which see the respective terms.

The regulator of a watch is the spiral spring attached to the balance. This ingenious contrivance, the invention of Hooke, has contributed as much to the improvement of watches as the pendulum to the improvement of clocks.

In a paper published in the *Memoirs of the Royal Astronomical Society*, vol. xi., the present Astronomer Royal has investigated the mathematical problem of the motion of the regulator applied to the clock-work by which motion is given to large equatorial telescopes. For this purpose absolute uniformity of motion is of very great importance. The construction usually adopted, in this country at least, depends on the same principle as that of the governor of the steam-engine. Two balls suspended from the upper part of a vertical axis by rods of a certain length, are made to expand by the rotatory velocity of the axis; and when the expansion reaches a certain limit, a lever is pressed against some revolving part, whereby a friction is produced which immediately checks the velocity. Now the uniformity of the rotatory motion of the spindle depends upon the assumption, that if upon the whole the retarding forces are equal to the accelerating forces, the balls will move in a circle, and in no other curve. But this assumption is incorrect; for the balls may move in a curve differing insensibly from an ellipse; and, in some instances, Mr. Airy observed the balls to revolve in an ellipse of considerable eccentricity. When this takes place, the rotatory motion of the spindle becomes exceedingly variable. This injurious effect may be partly counteracted by constructing the apparatus so that the revolutions shall be either very slow or very quick; the former method has the effect of giving greater smoothness of motion, but the second insures more completely that the object observed shall remain steady in the field of the telescope.

RE'GULUS. In Chemistry. The old chemists designated several of the brittle or inferior metals by this term, when freed from impurities and obtained in their metallic state: it is thus that they speak of *regulus of antimony*, *of bismuth*, &c.

REHABILITA'TION, in Foreign Criminal Law, is the reinstatement of a criminal in his personal rights which he has lost by a judicial sentence. Thus, in Scotland, a pardon from the king is said to rehabilitate a witness labouring under *infamia juris*. In France, persons condemned to imprisonment or compulsory labour may demand their rehabilitation five years after the expiration of their penalty: the demand is considered by the cour royale of the district, and pronounced upon by the king in his privy council. Various singular forms were attached to the process of rehabilitation in ancient times. There are extant letters of Charles VI. given in 1383, permitting a criminal whose hand had been cut off for homicide to replace it by another made in such fashion as he may choose.

REHEA'RSAL. The recital in private of an opera, oratoria, or, in short, any dramatic work, previously to public exhibition.

REIN-DEER. (Germ. rennthier.) *Cervus tarandus*, Linn. A large species of *Cervus* with branched, recurved, round antlers, the summits of which are palmated. These antlers are remarkable for the size of the branch which comes off near the base, and is directed forwards, called the brow-antler, and which is said to be used by the animal to clear away the snow from the hidden lichens which constitute the food of the rein-deer during the long and severe winter of Greenland, their native clime. As the female also possesses antlers of similar form, but smaller upon the whole than those of the male, their function as instruments to obtain food is rendered more probable, since in the deer which do not exist in arctic climes the females are destitute of antlers. These appendages of the rein-deer are annually shed and renewed in both sexes.

The length of a full-grown male is about nine feet, that of the head is fifteen inches. They are well clothed with hair, which becomes thicker, longer, and of a whiter colour in the winter season; at which time the male has a white beard, like the goat. The rutting season is at the beginning of winter, and the hind brings forth one, rarely two calves, in May or June.

The rein-deer is swift of foot, sharp-sighted, has an acute smell and hearing. It is more cautious and timid in herds than when solitary. It can swim well, and often crosses lakes and rivers.

The flesh of the rein-deer, which is held in great esteem by the Greenlanders, is usually eaten raw, or dried with the smoke of the *lichen nivalis*. The blood is boiled with berries mixed with the fat, which is also preserved separately and used as lard. The half-digested contents of the paunch of the rein-deer is the Greenlander's prime luxury; nor is the trail rejected. The hide of the rein-deer supplies the Greenlander with a beautiful material for his tent, his clothing, his bedding. The bones and antlers are worked into implements for domestic use, for fishing and hunting. The tendons are split into threads.

The Greenlanders likewise use the spare hides of the rein-deer as an article of barter.

REI'NECKE (The Fox). The name of a celebrated popular German epic poem, which, during the latter part of the middle ages and the early centuries of modern times, enjoyed an almost European reputation. It became first known through the medium of a Low German version in the 15th century; and it has, with few interruptions, ever since involved the German literati in discussions as to its origin, which are yet apparently far from being settled. It contains a humorous and satirical account of the adventures of Reinecke (the fox) at the court of King Nodel (the lion); exhibits the cunning of the former, and the means which he adopted to rebut the charges preferred against him, and the hypocrisy and lies by which he contrived to gain the favour of his sovereign, who loaded him with honours. The king, the officers of his court, and all his subjects are represented, as in *Æsop's Fables*, under the names of the animals best suited to their respective characters; and the poem is an admirable satire on the intrigues practised at a weak court. The most successful versions of this poem are those of Goethe, in hexameters; of Soltau, in the measure of the original; and the more recent attempt of Ortlepp. This poem appears, in some form or other, to have been known throughout Europe. For full information respecting it, the reader may consult Meon (*Roman du Renard*, Paris, 1826); and the *Reinhart Fuchs*, by Jacob Grimm (Berlin, 1834).

REINFO'RCE, in Artillery, is that part of a gun nearest to the breech, made stronger to resist the explosive force of the powder. *See* GUN.

REINFORCE RINGS, are flat hooplike mouldings on the reinforces on the side nearest the breech. There are usually two, the second being rather smaller than the first.

REIS-EFFENDI. The name given to one of the chief Turkish officers of state. He is chancellor of the empire and minister of foreign affairs, in which capacity he negotiates with the ambassadors and interpreters of foreign nations.

REITERS. (Germ. reuters, *riders*.) The German cavalry of the 14th and 15th centuries were so called; especially in France during the religious wars, in which they served on the Protestant side. At that period they were light-armed, and carried a long sword and carbine.

REJOI'NDER. In Law, the fourth stage in the pleadings in an action, being the defendant's answer to the plaintiff's replication. The next allegation of the plaintiff is called *surrejoinder*. *See* PLEADING.

RELAIS. In Fortification, a narrow walk of four or five feet wide, left without the rampart to receive the earth which may be washed down and prevent its falling into the ditch. It is sometimes for greater security pallisaded.

RELA'PSE (Lat. relabor, *I fall back*), is applied, in Ecclesiastical Law, to a heretic who falls back into an error which he has abjured.

RELATION, INHARMONIC. In Music, a term denoting that a dissonant sound is introduced which was not heard in the preceding chord.

RELE'ASE (Fr. relaisser), in Law, signifies, properly speaking, a discharge of a right: *e. g.* 1. A release of land is a discharge or conveyance of a man's right in lands and tenements to another that has some former estate in possession, on which principle the common mode of conveyance by lease and release is founded; *i. e.* releasing all the right of the releasor to a party already in possession under a lease for a year. 2. A release of a right of action; which may be pleaded in bar. (*See* PLEADING.) A release "of all demands" discharges all sorts of actions, rights, titles, conditions, executions, appeals, covenants, contracts, annuities, rents, recognizances, &c.

RE'LICS (Lat. reliquæ), in the Romish Church, are the remains of saints and holy men, or of their garments, &c., which are enjoined to be held in veneration, and are considered in many instances to be endued with miraculous powers. They are preserved in the churches, to which they are often the means of attracting pilgrimages,

and in very ignorant times and places have been actually made objects of adoration. The virtues which are attributed to them are defended by such instances from scripture as that of the miracles that were wrought by the bones of Elisha. (2 Kings, xiii. 21.)

RELIE'F, in Feudal Law, is derived from the Latin relevare, *to take up;* because the tenant, by payment of the relief, was said to take up the fief which had fallen to the lord by the death, &c. of his predecessor. "The heir," says Blackstone, "when admitted to the feud which his ancestor possessed, used generally to pay a fine or acknowledgment to the lord in horses, arms, money, or the like, for such renewal of the feud; which was called a relief, because it raised up and re-established the inheritance, or, in the words of the feudal writers, 'incertam et caducam hæreditatem relevabat.'" Reliefs, together with the other incidents of feudal tenure, were abolished in England by stat. 12 Car. 2. *See* FEUDAL SYSTEM.

RELIEF. In Architecture, the projection of a figure or ornament from the ground or plane on which it is sculptured. In Sculpture, when the whole of the figure stands out, the work is denominated *alto-rilievo;* when only half out, *demi-rilievo;* and when its projection is very small, it is called *basso-rilievo.*

RELIEF, *Rilievo.* In Sculpture, that species of sculpture in which the figures are engaged on or rise from a ground. There are three sorts of *rilievo*, — *basso-rilievo*, in which the figures or other objects have but small projection from the ground on which they are sculptured; *mezzo-rilievo*, in which the figures stand out about half their natural proportions, the other half appearing immersed in the ground; and, lastly, *alto-rilievo*, in which the figures stand completely out from the ground, being attached to it only in a few places, and in others worked entirely round like single statues; such are the metopæ of the Elgin marbles in the British Museum, which marbles also in the Panathenaic procession exhibit some exquisite examples of basso-rilievo.

RELIEF SYNOD. A respectable body of Presbyterian dissenters in Scotland, whose ground of separation from the established church was the violent exercise of lay-patronage which obtained in the latter. Though patronage, or the appointment of clergymen to church benefices by presentations, had been established by act of parliament in 1712, yet a minority of the clergy were opposed to that measure; at least to the intrusion of a minister into a parochial charge contrary to the sentiments of the people. The majority of the church, however, entertained different views, and rigorously enforced the provisions of the act of 1712. With this state of things the people generally, but particularly in rural districts, were dissatisfied; and hence the origin of the Secession church, and the Relief. *See* BURGHERS.

The origin of the Relief may be dated in 1752. Six of the ministers of the Presbytery of Dunfermline having refused, contrary to the express authority of the General Assembly of the Church of Scotland, to assist at the admission of Mr. Richardson to the parish of Inverkeithing (the people being unwilling to receive him as their pastor), were summoned before this venerable court for contumacy. They pleaded conscientious scruples; but this representation had no effect on the assembly; and, as an example to the church, one of the six recusants was peremptorily deposed from the office of the ministry, while the remaining five were suspended. Mr. Gillespie, minister of Carnock, the individual deposed, still claimed his pastoral relation to his flock; and though deprived of the use of the parish church, preached in the fields, attended not merely by his former hearers, but by many others attracted by the peculiar circumstances of the case. A chapel was afterwards built for him in the neighbouring town of Dunfermline, where he continued to preach till his death, and to oppose the law of patronage in the church. Mr. Gillespie for a few years stood alone; but in consequence of the violent settlement of a clergyman in the town of Jedburgh, the great body of the people of that place, forsaking the established church, gave a call (1759) to Mr. Thomas Boston, minister of a neighbouring parish, to be their pastor. Mr. Boston, for whom they erected a chapel, accepted the invitation, and withdrew from the church of Scotland. Owing to exactly similar circumstances, the people of the parish of Kilconquhar, in Fifeshire, followed the example set them in Jedburgh, and chose Mr. Collier to be their minister. On the 22d of November, 1759, Mr. Gillespie and Mr. Boston, with a lay elder from each of their congregations, met in a presbyterian capacity at Colinsburgh, in the last-mentioned parish, to induct Mr. Collier to his charge. On the evening of the same day these three ministers met, and agreed to form themselves into an ecclesiastical body, to be called the "Presbytery of Relief, for the relief of Christians oppressed in their Christian privileges." This sect gradually gained accession to their number from causes similar to those which we have already detailed, and at length formed themselves into a synod, which, at this date (1842), embraces eleven presbyteries, including 116 congregations; being, in point of numbers and influence, the third ecclesiastical body in Scotland. The founders of the Relief professed to differ from the established church on no point other than the right of patrons to appoint ministers against the inclinations of the people. This still constitutes the leading characteristic of the sect; but on this they have engrafted voluntary church principles, or are hostile to the principle of a national church, or to state endowments of religion. The Secession and Relief are at present engaged in considering overtures made mutually to each other for forming a union of the two denominations. The Relief Synod have a professor of divinity in their own connection. (*Smith's Hist. Sketches of the Relief Church; Hutchison's Compendious View of the Synod of Relief; Adam's Relig. World Displayed*, vol. iii. p. 223—32.; *M'Kerrow's Hist. of Secession*, v. i. p. 319—24. 326—28.)

RELIE'VING TACKLES. Temporary tackles attached to the end of the tiller in bad weather to assist the helmsman, and in case of accident happening to the tiller ropes. They are also strong tackles from the wharf, to which the ship is hove down, passed under her bottom and attached to the opposite side, to assist in righting her afterwards, as well as to prevent her from oversetting entirely.

RE'LIQUARY. A receptacle for the relics venerated in Roman Catholic churches. The difference between a *reliquary* and a *case* (Fr. châsse) used for the same purpose is, that the former is smaller in dimensions, and contains only small fragments; the latter in many instances entire bodies.

REMAI'NDER. The difference of two quantities left after the less is subtracted from the greater.

REMAINDER. A *remainder*, in Law, is a future estate in lands, tenements, or hereditaments, limited to arise after the determination of another estate; as if land be granted to A. for twenty years, and afterwards to B. and his heirs for ever, B. has a remainder in fee. An estate in reversion is the residue left in the grantor, to commence in possession after the determination of some particular estate granted out by him; as if A. being seised in fee-simple, gives to B. and his heirs male of his body (thus creating an estate tail), on the failure of such heirs male the land given reverts to A., who, therefore, prior to such failure, has an estate in reversion in the lands. Remainders are either *vested*, or *contingent;* vested or *executed*, where the estate is invariably fixed, to remain to a determinate person after the preceding estate (called the *particular* estate) is spent. In this case, the remainder man has a present interest, to be enjoyed *in futuro*. Contingent remainders, otherwise called *executory*, are defined to be "where the estate in remainder is limited to take effect either to an uncertain person, or upon an uncertain event; so that the particular estate may chance to be determined, and the remainder never take effect." The doctrines of law with reference to these estates have gradually been moulded into a system so intricate, and replete with the most refined distinctions, that it would be impossible to give a cursory view of this branch of our jurisprudence. An instance of a vested remainder is to be found in the example before cited of an estate granted to one party for a term of years, and afterwards to another in fee-simple. A contingent remainder limited to an uncertain *person* is where, for instance, there is an estate to A. for life, and afterwards to B.'s eldest son (then unborn). And in order to prevent the accumulation of future possible estates, the rule of law is, that no limitation by way of remainder or executory devise (*i. e.* a grant of a contingent remainder by will) shall be good which is to take effect after the determination of a life or lives in being and 21 years (the period of minority) afterwards. An instance of a contingent remainder limited on an uncertain event is where land is given to A. for life, and in case B. survives A. then to B. in fee.

The particular estate, which precedes (in legal language *supports*) a vested remainder, may be either of years, or of freehold: to support a contingent remainder it must necessarily be of freehold.

REMBLAI. (Fr.) A term used in Fortification to denote the earth or materials used in filling up a trench or excavation. It is opposed to *deblai*, which denotes the materials excavated.

REMEMBRANCERS. Officers of the Court of Exchequer, who perform various functions, the chief of which is to put the judges of that court in remembrance of such things as are to be called on or done for the king's benefit. They were formerly three in number, — the king's remembrancer, the lord treasurer's remembrancer, and the remembrancer of first fruits; but the duties of the second of these officers were merged in the first by 3 & 4 Will. 4. c. 99.

RE'MIGES. (Lat. remigo, *I row.*) The quill feathers of the wings of a bird, which, like oars, propel it through the air.

RE'MIPEDS, *Remipedes.* (Lat. rema, *an oar;* pes, *a foot.*) The name of an order of Coleopterous insects, in-

cluding those which have tarsi adapted for swimming. *See* NECTOPODS.

REMI'TTENT FEVER. Any fever which suffers a decided remission in its violence during the twenty-four hours, but without entirely leaving the patient, is called a *remittent;* it differs from an intermittent in there never being a total absence of fever. These fevers are most common in autumn, and they vary in degree from extreme mildness to alarming violence, and are both inflammatory and malignant. The remittent fever of children, or, as it is often called, the *infantile fever*, is generally symptomatic either of worms in the intestines, or of a foul state of bowels, arising from inattention to diet, or from the indigestible trash which children frequently indulge in: the tongue is very foul, the head aches, the belly is tumid, food is loathed; the child is drowsy all day, but restless and often delirious at night, and the bowels torpid. A proper system of purging is the most essential part of the treatment in these cases; and under it the symptoms, though often alarming and obstinate, gradually give way. Calomel, with scammony and jalap, aided, if necessary, by infusion of senna and aperient salts, are the principal remedies, and saline draughts and diluents in the intervals. If bilious diarrhœa ensue, with vomiting, the irritability of the stomach must be allayed by effervescing salines, and that of the bowels by very mild aperients; if the head is much affected, cold and evaporating lotions may be used. Good air, thorough ventilation, and light farinaceous diet, with the above treatment, generally effect a cure; but the disorder is often very obstinate, and continues for three weeks or a month. The *yellow fever*, or bilious remittent of hot climates, and especially of the West Indies, is another form of this fever: it appears to be produced by marsh miasma. In all these fevers particular symptoms occasionally present themselves, which require particular modes of treatment; and this must also be modified according to the inflammatory, malignant, nervous, or intermittent form which they may assume or pass into.

REMONSTRANTS. In Ecclesiastical History. *See* ARMINIANS.

RE'MPHAN. An idol worshipped by the Israelites while in the wilderness, according to the language of St. Stephen as recorded in the Acts, "Ye took up the tabernacle of Moloch, and the star of your god Remphan." In this passage commentators are agreed that St. Stephen quotes the words of Amos, "Ye have borne the tabernacle of your Moloch and Chiun, your images." Chiun and Remphan are therefore the same, and both are thought to be personifications of Sirius, the Dog-star. (*Enc. Brit.*) Chiun is supposed by some to be the same word as Chan or Khan, Chagan, König, "king"; Remphan or Raiphan, "high or exalted light."

RENAL GLANDS. There is a glandular body upon each kidney of a somewhat triangular shape, small in the adult, but in the fœtus longer than the kidney; it is called the renal, or supra-renal, gland or capsule: it has no excretory duct, and its use is unknown.

RENDERED. In Architecture. *See* RENDERED AND SET.

RENDERED AND FLOATED. In Architecture, plastering of three coats on brickwork.

RENDERED AND SET. In Architecture, a term used to denote plastering of two coats on naked brick or stone work. If the work is to be of three coats, it is called *roughing in*. *Pricking up* is the first of three-coat plaster on lath, or on brickwork, that has been previously rendered. The materials for rendering and pricking up are the same.

RENDERED, FLOATED, AND SET FOR PAPER. In Architecture, plastering of three coats; the first being lime and hair upon brickwork; the second, the same compound, with the addition of a little more hair, and then *floated* with a long rule; the third, *fine stuff* mixed with white hair.

RENNET, or RUNNET. The prepared inner membrane of the calf's stomach, which has the property of coagulating the albumen of milk and converting it into *curd and whey*.

RENT. (Lat. reditus; Fr. fermage, loyer des terres.) In Political Economy, and in ordinary language, the sum paid by the farmers or lessees of lands to the landlords.

In order to acquire clear and correct ideas with respect to the nature and origin of rent, it is necessary to discriminate between the sources whence it usually arises; that is, between the portion paid for the use of the natural and inherent powers of the soil, and the portion paid for the use of the buildings, fences, drains, roads, and other improvements made upon the soil. Two farms may be naturally of about equal goodness, and equally well situated; but if little or no capital have been laid out on the one, while a great deal has been judiciously laid out on the other, they will let for very different sums. It is usual, no doubt, to class all sums derived from land, whatever may be their origin, under the common name of rent; but it is obviously necessary, in an inquiry of this sort, to distinguish between the sums paid for the use of the land, and those paid for the use of the improvements, if there be any, made upon it. Landlords are, for the most part, capitalists as well as owners of the soil; and the sums paid to them by their tenants for the use of the capital expended upon the soil, though included under the term rent, are substantially and in fact profits, and depend wholly on the circumstances by which they are governed. *Rent really, therefore, consists of that portion of the gross sum paid for land, that is, paid for the use of the natural and inherent powers of the soil, or that would be paid for the land supposing it to be in a state of nature, and without any improvement upon it.* The owners of the soil receive this portion of their gross income not because they are capitalists, but because they are landlords. And we shall now briefly endeavour to exhibit the origin of this payment, or of rent, in the scientific and restricted sense of the term.

Origin of Rent.— On the first settling of any country abounding in large tracts of unappropriated land, rent, in the sense now explained, is unknown; and for this obvious reason, that no person will pay rent for what may be procured in unlimited quantities for nothing. In such countries, rent only begins to appear when the best of the unappropriated lands have become private property, and been occupied. Suppose, however, this comes to be the case; and that the population has increased, so that the demand for raw produce can no longer be supplied by the culture of the best lands: under these circumstances, it is plain either that population must become stationary, or that the price of raw produce must rise so as to enable inferior lands to be cultivated. No advance short of this will procure another bushel of corn; and competition will not, as will be immediately seen, allow prices to rise permanently above this level. Under the circumstances supposed, the inhabitants have but one alternative. If they pay a price sufficient to cover the expense of cultivating secondary lands, they will obtain additional supplies; if they do not, they must be without them.

Suppose, now, that the price rises so as to pay the expense of raising corn on soils which, in return for the same expenditure that would produce 100 quarters on lands of the first quality, will only yield 90 quarters; it is plain it will then be indifferent to a farmer whether he pay a rent of ten quarters for the first quality of land, or farm the second quality, which is unappropriated and open, without paying any rent. If the population went on increasing, lands which would yield only 80, 70, 60, 50, &c. quarters in return for the same expenditure that had raised 100 quarters on the best lands, might be successively brought under cultivation. And when recourse has been had to these inferior lands, the corn rent of those that are superior would plainly be equal to the difference between the quantity of produce obtained from them and the quantity obtained from the worst quality under tillage. Suppose, for example, that the worst quality cultivated yields 60 quarters, then the rent of the first quality will be 40 quarters, or 100 — 60; the rent of the second quality will, in like manner, be equal to the difference between 90 and 60, or 30 quarters; the rent of the third quality will be equal to 80 — 60, or 20 quarters, and so on; the produce raised on the land last cultivated, or by means of the capital last applied to the soil, being all the while sold at its necessary price, or at that price which is sufficient merely to cover the cost of its production, including therein the ordinary rate of profit on the capital of the cultivators. If the price were above this level, agriculture would be a peculiarly profitable business, and tillage would be immediately extended: if, on the other hand, the price fell below this level, capital would be withdrawn from the soil, and the poorer lands thrown out of cultivation. Under such circumstances, it is clear that rent could not enter into the price of that portion of the necessary supply of produce raised by means of the capital last applied to the soil. Its price is exclusively made up of wages and profits. The proprietors of the superior lands obtain rent; but this is the necessary result of their greater fertility. The demand cannot be supplied without cultivating inferior soils, the produce of which must necessarily sell for such a price as will afford the ordinary rate of profit to their cultivators. This price will, however, yield a surplus over and above the ordinary rate of profit to the cultivators of the more fertile lands; and it *is this surplus that forms rent.*

In so far, therefore, as rent is a return for the use of the soil, and not for the capital laid out on improvements, it results entirely from the necessity of resorting, as population increases, to soils of a decreasing degree of fertility, or of applying capital to the old land with a less return. It varies inversely as the produce obtained by means of the capital and labour employed in cultivation; increasing when the profits of agricultural labour diminish, and diminishing when they increase. Profits are at their maximum in countries like Australia, Indiana, and Illinois; and generally in all situations in

which no rent is paid, and the best of the good lands only are cultivated; but it cannot be said that rents have attained their maximum so long as capital yields any surplus in the shape of profit.

A quarter of wheat may be raised in Kent or Essex, or in the Carse of Gowrie, for a *fourth* or a *fifth* part, perhaps, of the expense necessary to raise it on the worst soils in cultivation in the less fertile parts of the country. The same article cannot, however, have two or more prices at the same time and in the same market. And it is plain that if the price be not such as will indemnify the producers of the wheat raised on the worst soils, they will cease bringing it to market, and the required supplies will no longer be obtained; while, if the price exceed this sum, fresh capital will be applied to its production, and competition will soon sink prices to their natural level — that is, to such a sum as will afford the common and ordinary rate of profit to the raisers of that portion of the required supply which is produced under the most unfavourable circumstances, or at the greatest expense. The cost of producing this portion governs the price of the whole crop. It is plainly, therefore, the same thing to the consumers whether, in an advanced stage of society, the excess of return over the cost of production on superior lands belong to a non-resident landlord or an occupier. It must belong to the one or the other. Corn is not high because rent is paid, but rent is paid because corn is high; because the demand is such, that it cannot be supplied without cultivating soils of a diminished degree of fertility as compared with the best. Suppose there is in any country an effectual demand for ten millions of quarters of corn; that nine millions may be raised upon lands that yield a high rent; but that it is necessary to raise the other million on inferior lands, which yield nothing but the common and average rate of profit to their cultivators. Under these circumstances, it is clear that the relinquishing of the rents payable by the cultivators of the superior lands would be no boon to the cultivators of those that are inferior. It would not lessen their expenses; that is, it would not lessen the capital and labour employed by them in the production of that portion of the required supply raised on their lands; and unless it did this, it is obviously impossible, supposing the demand not to decline, that it could lower prices. Although, therefore, landlords were to give up the whole of the rents, their doing so would have no influence over prices. Such an act would turn farmers into landlords, and landlords into beggars; but there its effect would stop. But the case is entirely different when the cost of production varies. If it diminish, the competition of the producers will infallibly sink prices in the same proportion. If it increase, no supplies will be brought to market, unless the price rise to a corresponding level. In no case, therefore, whether the demand be great or small, whether it be for one thousand or one million quarters, can the price of raw produce ever permanently exceed or fall below the sum necessary to pay the cost of producing that portion of the required supply that is raised on the worst land, or by means of the last capital laid out on the soil.

It has been objected to this theory, that though it may apply in unappropriated countries like New Holland, it will not apply in countries like England, where land is universally appropriated, and where, it is alleged, the worst qualities always yield some small rent to the proprietor.

It may be observed of this objection, that even if it were well founded it would not practically affect the conclusions previously established. There are in England and Scotland vast tracts of land which do not let for 6*d*. an acre; but to cultivate them would require an outlay of many thousands of pounds, and the rent would consequently bear so small a proportion to the expenses of production as to become altogether evanescent and inappreciable.

There can be no doubt, however, that there is in this, and most other extensive countries, a great deal of land which yields no rent. In the United States and Russia, such is unquestionably the case; and yet no one presumes the to say, that laws which govern rent in them are different from those which govern it in England and France. The poorest lands are always let in immense tracts. If it were attempted to let particular portions of these tracts separately, no one would offer for them; but they appear to yield rent, because, though they really fetch nothing, the more fertile spots with which they are intermixed may, in most cases, be let for a larger or smaller rent. But though every rood of land in Britain paid a high rent, it might still be truly affirmed that such rent did not enter into the price of raw produce. The rent of a country consists of the difference, or the value of the difference, between the produce obtained through the agency of the capital first applied to the land and that which is last applied to it. It would, as already seen, be exactly the same thing to a cultivator, whether he paid a rent of ten quarters to a landlord for land yielding, with a certain outlay, 100 quarters of corn, or employed the same capital in cultivating inferior land yielding only 90 quarters for which he paid no rent. Were it possible always to go on obtaining equal returns for every equal additional capital applied to the superior soils, no person, it is obvious, would ever resort to those of inferior fertility; and, under such circumstances, the largest population might be supported on the smallest extent of land. But, such is not the law under which food is obtained; and the fact, that in the progress of society new and less fertile land is invariably brought under cultivation, demonstrates that additional capital and labour cannot be indefinitely applied with the same advantage to the old land. The state of a country may be such, the demand for agricultural produce may be so great, that every quality of land yields rent; but it is the same thing, in respect of this theory, if there be any capital employed on land which yields only the ordinary rate of profit, whether it be employed on old or new land. And that there is every where a very large amount of capital employed in such a manner, is a fact of which there cannot be any doubt whatever. The owners and occupiers of land are influenced by the same principles in the employment of their capital and labour that influence other men. Like them, they endeavour, in prosecuting their own interest, so to adjust the capital they employ that the last quantity laid out may yield the common and ordinary rate of profit, neither more nor less. Suppose, for example, that a landlord occupies a farm which he might let for 200*l*. a year, producing, with a certain outlay of capital, 300 quarters of wheat. If the farm be managed with the requisite skill and attention, the wheat should, at an average, sell for so much money as is equivalent to the rent, the expense of labour, and the profit on the capital employed. Suppose, now, that the landlord finds that by laying out additional capital on the farm it may be made to yield 10, 20, 50, or 100 quarters more, he will make the outlay, provided the additional produce yield the ordinary rate of profit. He will not wait, before commencing the improvement, until prizes rise to a still higher elevation. It will be quite enough to induce him immediately to set about it, that they are such as afford a fair prospect of realizing the usual return on the capital to be expended. He will, in fact, act exactly as the merchant or manufacturer acts who sends another ship to sea, or builds another cotton mill, whenever he supposes that the capital so embarked will yield customary profits. And supposing that the farm is let to a tenant, he, it is obvious, will do the very same thing as the proprietor, if he obtain so much more profit as will, over and above the usual return, suffice to replace the capital itself previously to the termination of his lease. Whether he will employ this additional capital depends entirely on the circumstance of prices being such as will repay his expenses and profits; for he knows he will have no additional rent to pay. Even at the expiration of his lease, the fact of an additional capital having been employed would not occasion any rise of rent, unless in so far as some portion of it, by being permanently incorporated with the soil, may increase its productive powers; and were his landlord to require more rent because a greater moveable capital had been employed, he would cease to employ it, since by the supposition he gets only the same profit he might get by employing it in any other department of industry.

If we reverse the previous suppositions, and suppose that the owner of a farm finds that, owing to a fall in the price of corn, the capital employed in its cultivation does not yield the common and ordinary rate of profit, he will then, acting on the same principle that led him in the other case to increase the capital on the farm, withdraw a part, or it may be the whole of such capital: and supposing it to be let, the rent would be proportionally reduced at the end of the lease, or sooner.

It is not to be supposed that we mean to affirm that these results follow immediately, and without any difficulty, on a rise or fall of prices; on the contrary, they take place only by degrees; and are often productive, on the one hand, of peculiar advantages, and, on the other, of peculiar sacrifices. But, in purely theoretical inquiries, or such as have the establishment of principles for their object, such accidental circumstances may be overlooked; and it may, generally speaking, be said that the last portion of capital laid out on the soil yields only the common and average rate of profit. If, on the one hand, it were to yield *more*, fresh capital would be drawn to agriculture, and competition would sink prices to such a level that they would only yield this rate. If, on the other hand, the capital last applied to the soil should yield *less* than this common and average rate, it would be withdrawn, until, by the rise of price, the last remaining portion of capital left this rate to its owners: and hence it follows, that whether the last quality of land taken into cultivation yield rent or not, the last capital applied to the land yields only the common and average rate of profit; and, consequently, the price of the produce which it yields, and which determines the price of all the rest, is totally unaffected by rent.

It is farther said by those who have cavilled at this

theory, that it represents the cultivation of bad land as the cause of rent; whereas it is, they affirm, the growing demand of the population for food that is its cause, it being the rise of price consequent upon this increased demand that occasions the cultivation of bad lands, and the payment of a rent for those that are superior. This, however, is at best mere verbal trifling. The demand of the population for corn elevates its price to such a height as is necessary to obtain the required supply, and may, therefore, be truly said to be the cause of its being produced; but rent originates in the peculiar circumstances under which supplies of corn are produced. Were it not that it is most frequently necessary, in obtaining increased supplies of corn, to resort to soils of different degrees of fertility, or to apply capital, with a less return, to the old land, rent would be altogether unknown; nor, though the demand for corn were increased in a tenfold proportion, would prices be permanently elevated. It does, therefore, seem to be logically, as well as substantially correct, to affirm that the decreasing fertility of the soil is the immediate cause of rent, and that its amount is determined by the extent to which bad land is cultivated or good land forced.

This analysis of the nature and causes of rent discovers an important distinction between agricultural, and commercial, and manufacturing industry. In manufactures, the worst machinery is first set in motion, and every day its powers are improved by new inventions, and it is rendered capable of yielding a greater amount of produce with the same expense; and as no limits can be assigned to the quantity of improved machinery that may be introduced, as a million of steam engines may be constructed for the same, or rather for a less proportional expense than is required for the construction of one, competition never fails to reduce the price of manufactured commodities to the sum for which they may be purchased, according to the least expensive method of production.

In agriculture, on the contrary, the best machines, or best soils, are brought first into use; and recourse is afterwards had to inferior soils, or those requiring a greater expenditure to make them yield the same supplies. It is true that improvements in the construction of farming implements, the discovery of more efficient manures, and the introduction of more prolific crops and improved systems of management, increase in a high degree the productiveness of the soil, and proportionally reduce the price of raw produce; but a fall of price, though permanent in manufactures, is only temporary in agriculture. When the price of corn is reduced, all classes obtain greater quantities than before in exchange for their products, or their labour; hence the rate of profit, and consequently the accumulation of capital, are both increased; and this increase, by causing a greater demand for labour and higher wages, leads, in the end, to an increase of population, and a further demand for raw produce and an extended cultivation. Agricultural improvements obviate, sometimes for a lengthened period, the necessity of having recourse to inferior soils; still, however, this effect cannot be permanent. The stimulus which they at the same time give to population, and the natural tendency of mankind to increase up to the means of subsistence, is sure, in the long run, to raise prices, and, by forcing recourse to poor lands, rents also.

In illustrating this important distinction between agriculture and manufacturing industry, Mr. Malthus has set the theory of rent in a striking point of view. "The earth," he observes, "has been sometimes compared to a vast machine, presented by nature to man for the production of food and raw materials; but to make the resemblance more just, as far as they admit of comparison, we should consider the soil as a present to man of a great number of machines, all susceptible of continued improvement by the application of capital to them, but yet of very different original qualities and powers.

"This great inequality in the powers of the machinery employed in procuring raw produce, forms one of the most remarkable features which distinguishes the machinery of the land from the machinery employed in manufactures.

"When a machine in manufactures is invented which will produce more finished work with less labour and capital than before, if there be no patent, or as soon as the patent is over, a sufficient number of such machines may be made to supply the whole demand, and to supersede entirely the use of all the old machinery. The natural consequence is that the price is reduced to the price of production from the best machinery; and if the price were to be depressed lower, the whole of the commodity would be withdrawn from the market.

"The machines which produce corn and raw materials, on the contrary, are the gifts of nature, not the works of man; and we find by experience that these gifts have very different qualities and powers. The most fertile lands of a country, those which, like the best machinery in manufactures, yield the greatest products with the least labour and capital, are never found sufficient to supply the effective demand of an increasing population. The price of raw produce, therefore, naturally rises till it becomes sufficiently high to pay the cost of raising it with inferior machines and by a more expensive process; and, as there cannot be two prices for corn of the same quality, all the other machines, the working of which requires less capital compared with the produce, must yield rents in proportion to their goodness.

"Every extensive country may thus be considered as possessing a gradation of machines for the production of corn and raw materials, including in this gradation not only all the various qualities of poor land, of which a very large territory has generally an abundance, but the inferior machinery which may be said to be employed when good land is further and further forced for additional produce. As the price of raw produce continues to rise, these inferior machines are successively called into action; and as the price of raw produce continues to fall, they are successively thrown out of action. The illustration here used serves to show at once the necessity of the actual price of corn to the actual produce, and the different effect which would attend a great reduction in the price of any particular manufacture and a great reduction in the price of raw produce." (*Inquiry into the Nature and Progress of Rent*, p. 37.)

It appears, therefore, that in the earlier stages of society, and when only the best lands are cultivated, rent is unknown. The landlords, as such, do not begin to share in the produce of the soil until it becomes necessary to cultivate lands of an inferior degree of fertility, or to apply capital to the superior lands with a diminished return. Whenever this is the case, rent begins to be paid; and it continues to increase according as cultivation is extended over poorer soils, and diminishes according as these poorer soils are thrown out of cultivation. Rent, therefore, depends exclusively on the extension of tillage. It is high where tillage is widely extended over inferior lands, and low where it is confined to the superior descriptions only. But in no case does rent enter into price; for the produce raised on the poorest lands of a country, or by means of the capital last applied to the culture of the soil, determines the price of the entire crop; and this produce yields only the common and average rate of profit.

Influence of Situation on Rent.—In the previous statements we have, to simplify the consideration of the question, omitted to notice the influence of situation on rent. It is plain, however, that this is a very important element in determining its amount; and that difference of situation has precisely the same sort of influence over rent as differences of fertility. Thus, suppose two farmers employ equal quantities of capital, as 5000 quarters each, in the cultivation of farms of the same goodness,—the one situated in the immediate vicinity of London, and the other in Yorkshire; and suppose, farther, that London is the market to which the produce of both farms is sent, and that the cost of conveying corn from Yorkshire to London is 5*s.* a quarter: under these circumstances, if the gross produce of each farm were 1000 quarters, of which the landlord received one fifth part, or 200 quarters, as rent, the farm near London would fetch 50*l.* a year more than the farm in Yorkshire. For, as the corn raised in the districts adjacent to London is not adequate for its supply, its price in the city must suffice to pay those who bring any portion of the necessary supplies from the greatest distance, as well for the expenses of carriage as for those of production; and the farmer in the immediate vicinity, who gets this increased price for his produce, will have to pay a proportional increase of rent, in the same way that the occupierof good land has to pay an increased rent; when inferior lands are taken into cultivation.

It would, on many accounts, be desirable readily to distinguish between that portion of the gross rental of a country which is to be considered as rent, properly so called, or as the remuneration paid to the landlords for the use of the natural powers of the soil, and that portion which is the return to or the interest upon the capital laid out upon houses, fences, drains, roads, and other improvements. But how desirable soever, it is admitted by all practical men that it is quite impossible to make such a distinction with any thing approaching to accuracy. No two of the most expert agriculturists, supposing them to be desired to resolve the gross rental of a single improved farm into its constituent parts, would arrive at the same result. Improvements become so much blended with the natural powers of the soil, that the influence of the one cannot be separated from that of the other; and it is merely the joint value of the two that can be estimated. No doubt can, however, be entertained by any one who reflects for a moment on the vast sums, the many hundreds, or rather thousands of millions, that have been laid out upon the soil of Great Britain, that the payment made to the landlords for the use of its natural powers is inconsiderable, compared with that made to them on account of improvements;

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and hence the inequality and mischievous operation of taxes on rent. Two landlords receive equal rents from their estates; but the rent of one is principally a consequence of natural fertility, while that of the other is derived principally from outlays of capital. What, then, could be more unfair than to subject them both to the same equal tax? And yet the amount of their rents is the only criterion to which recourse could be had in fixing the amount of the tax; for all the tax collectors in the world could not separate between what was really rent, in the scientific sense of the term, and what was interest on capital. Such a tax would oppose the most effectual obstacle to improvements. Instead of carrying capital from other employments to the land, it would henceforth be carried from the land to them. The object would not then be to have an estate look well, but to have it look ill; and it may be said of estates as of individuals,

Pauper videri Cinna vult, et est pauper.

The effects that were formerly produced by the *taille*, and that are now produced by the *contribution foncière* in France, and the fluctuating land taxes imposed in other countries, abundantly confirm the truth of this statement. Their influence has been most disastrous.

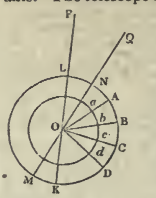
The theory of rent explained in this article was first promulgated and satisfactorily established in a tract on the corn laws, published at Edinburgh in 1777, by Dr. James Anderson, a native of Hermandston in Mid Lothian, editor of the *Bee* and other publications. But notwithstanding the clear and able manner in which he explained the theory, and its ingenuity and importance, his elucidations do not appear to have attracted the least attention; and seem, indeed, to have been completely forgotten. So much so was this the case, that when, in 1815, Mr. Malthus and Sir Edward West published tracts explaining the nature and origin of rent, they were universally believed to be the authors of the theory. Although, however, there is, we believe, no doubt as to their originality, still they were merely the expositors of a theory that had been clearly and ably explained above forty years previously to the publication of their tracts.

Rent, in Law, is defined "a certain profit issuing yearly out of lands and tenements corporeal," not necessarily, although by English usage generally, consisting in money. There are at common law three kinds of rents: 1. Rent-service; having some incident of feudal service connected with it, for which the landlord might distrain of common right. 2. Rent-charge, where the owner of the rent had no future interest or reversion expectant on the land; as where one having parted with his land reserved a rent, with a clause of distress in the deed, by which the land was *charged* with the payment of the rent. 3. Rent-seck, *reditus siccus*, which was rent reserved by deed without a clause of distress. But the common remedy of distress was extended to all these divisions of rent by 4 G. 2. c. 38. (*See* Distress.) The ordinary remedy by action is in *debt*, for the breach of the express contract; or *covenant* may be brought for the breach of a covenant to pay rent. And these actions may be brought at any time within twenty years after the cause of action shall have accrued. A "fee-farm-rent" is a rent issuing out of an estate in fee. The common term "rack-rent" has no particular legal acceptation, and merely means a rent at or near the full value of the premises demised.

REPE'AT. In Music, a character :𝄋: denoting the repetition of the part which it bounds. It is sometimes expressed by dots against the bar, and sometimes by the words *Da Capo*.

REPEATING CIRCLE. In order to diminish the effect of errors of graduation, and to obtain very accurate measurements by means of comparatively small, and therefore portable instruments, a method of observing was invented, or rather brought into use, by Borda, which is now extensively employed, especially in geodetical operations. The method, which consists in moving the telescope successively over portions of the graduated limb corresponding to the angle to be measured, and reading only the multiple arc, may be advantageously applied to circular instruments destined for very different purposes: as, for example, to an instrument for the measurement of the zenith distances of stars or terrestrial objects, or the distance of two trigonometrical stations, in which case it is simply called a *repeating circle;* to a reflecting circle used for observations at sea, when it becomes a *repeating reflecting circle;* or to a theodolite, when it becomes a *repeating theodolite*.

For the purpose of giving an idea of the principle of this method, we borrow the following illustration from Sir J. Herschel: — "Let P Q be two objects, which we may suppose fixed for purposes of mere explanation; and let K L be a telescope moveable on O, the common axis of two circles, A M L and A B C, of which the former, A M L, is absolutely fixed in the plane of the objects, and carries the graduations freely moveable on the axis. The telescope is attached permanently to the latter circle, and moves with it. An arm, O *a* A, carries the index or vernier, which reads off the graduated limb of the fixed circle. This arm is provided with two clamps, by which it can be temporarily connected with either circle, and detached at pleasure. Suppose now the telescope directed to P. Clamp the index O A to the *inner* circle, and unclamp it from the outer, and read off; then carry the telescope round to the other object Q. In so doing the inner circle, and the index arm, which is clamped to it, will also be carried round over an arc A B on the graduated limb of the outer equal to the angle P O Q. Now clamp the index to the *outer* circle, and unclamp the inner, and read off. The difference of readings will of course measure the angle P O Q; but the result will be liable to two sources of error, that of graduation, and that of observation, both of which it is our object to get rid of. To this end transfer the telescope back to P, *without* unclamping the outer circle; then, having made the bisection of P, clamp the arm to *b*, and unclamp it from B, and again transfer the telescope to Q, by which the arm will now be carried with it to C over a second arc B C equal to the angle P O Q. Now again read off; then will the difference between this reading and the *original* one measure *twice* the angle P O Q, affected with both errors of observation, but only with the same error of graduation as before. Let this process be repeated as often as we please (suppose ten times); then will the final arc A B C D read off on the circle be ten times the required angle, affected by the joint errors of all the ten observations, but only by the same constant error of graduation, which depends on the initial and final readings off alone. Now the errors of observation, when numerous, tend to balance and destroy one another: so that, if sufficiently multiplied, their influence will disappear from the result. There remains, then, only the constant error of graduation, which comes to be divided in the final result by the number of observations, and is therefore diminished in its influence to one tenth of its possible amount, or to less if need be." (*Astronomy*, *Cab. Cyc.*, p. 105.)



When the repeating circle is used for measuring zenith distances, it is constructed so as to be capable of being turned round on a vertical pivot, the direction of which passes through its centre, and to which its plane is parallel, and also of turning in its own plane about a horizontal axis. The instrument being placed in the same vertical plane with the star, the telescope is directed to the star and the bisection made; the telescope, which carries the verniers with it, is then firmly clamped to the circle, and the circle turned round 180° in azimuth about the vertical pivot. If the circle be now kept fast, the telescope unclamped and carried round till the star is again bisected, it is plain that the arc of the limb passed over by the verniers in consequence of this motion of the telescope will be double the zenith distance of the star. The same process is repeated as often as may be thought necessary. For the purpose of geodetical measurements the circle is usually furnished with two telescopes, one on the face, and the other on the back; and so placed that the optical axes of both are exactly in the plane of the circle. The circles used by Mechain and Delambre in the operations connected with the measurement of the French arc of meridian, were about 4-tenths of a mètre (nearly 16 inches) in diameter, and were divided into arcs equivalent to about 32 sexagesimal seconds, which were subdivided into tenths by the verniers.

The merit of first applying the ingenious principle of repetition to angular measurements belongs to Tobias Mayer; but it was Borda, as above stated, who first brought the instrument into general use.

For a description of the repeating circle, its adjustments, and the method of using it, see Biot, *Astronomie Physique*, tome i.; Delambre, *Astronomie*, or *Base Metrique*, tome i.; Puissant, *Traité de Géodésie; Raper's Practice of Navigation*, &c. The comparative advantages and defects of the instrument are very clearly stated in a paper by Troughton in the first volume of the *Memoirs of the Royal Astronomical Society*.

REPE'LLENTS. Applications to the surface of the body which appear to make disorders retreat inwards.

REPE'LLING POWER. *See* Repulsion.

RE'PENT (Lat. repo, *I creep*), in Zoology, is used in the same sense as creeping, and is applied to those animals which move with the body close to the ground, either without the aid of legs, or by means of more than four pairs of short legs.

RE'PETEND. In Arithmetic, that part of a *repeating decimal* which recurs continually ad infinitum. It is called a simple repetend when there is but one figure, as ·233. . . ad inf.; and a compound repetend when there

are more figures than one in the repeating period, as ·029029. . . . ad inf. It is usual to mark the first and last figures of the period by dots placed over them; thus the repetends above mentioned are written ·3̇, and ·0̇29̇.

REPLE'VIN, in Law, is an action of tort, in which the plaintiff seeks the recovery of goods illegally distrained. *See* ACTION.

REPLICA'TION. In Law, the third stage in the pleadings in an action, being the plaintiff's answer to the defendant's plea. *See* PLEADING.

REPO'SE. (Lat. repono, *I lie down.*) In the Fine Arts, the absence of that agitation which is induced by the scattering and division of a subject into too many unconnected parts, in which case a work is said to want repose. Where repose is wanting from this cause, "the eye," says Sir Joshua Reynolds, "is perplexed and fatigued, from not knowing where to rest, where to find the principal action, or which is the principal figure; for where all are making equal pretensions to notice, all are in danger of neglect."

REPRESENTA'TION. (Lat. representatio.) In Politics, the part performed by a deputy chosen by a constituent body to support its interests and act in its name on a public occasion. Thus a plenipotentiary represents the sovereign or the state which delegates him at a foreign court. But the most ordinary use of the word is to express the principal function of the delegate of a constituency in a legislative assembly. Representation, in this sense, was unknown to the political systems of the ancients, and seems to have originated in the necessities and usages of feudal times: the lord not being able to levy aid from his vassals without their consent, it became customary for these to delegate powers to individuals from among their numbers to attend his summons and confer with him respecting the aid required. Hence, in our own country, the representation of county freeholders by knights, of communities by their chosen burgesses, in parliament. The most complete early model of a representative feudal assembly is to be found in the parliament of the Sicilies under the Suabian kings; but England is the only country in which it has expanded regularly into a legislature.

The chief question, in political science, regarding the system of representation is, how far each delegate represents the opinions of the local body which sends him, and is bound to act in obedience to their directions. This was unquestionably the early notion of representation. But the constitutional principle of English statesmen has been in general very different. It is, that each member represents, not the local body, but the entire nation. The ties which bind him to his constituents are altogether subordinate to those which attach to him in a general character. He is bound to sacrifice not only the wishes, but the immediate and local interests of the body which sends him, if they are in opposition to the general good of the country. The most popular and best known exposition of this doctrine is perhaps to be found in Burke's famous speech to the electors of Bristol. It follows as a corollary, that constituencies act unconstitutionally in demanding pledges of candidates for their representation as to the part which they are to take on particular questions. But this, like other rules of constitutional conduct, must not be pressed too far. Constituencies, as well as representatives, are bound to use their powers for the general good of the nation; and there may be occasions, although rarely, on which those powers are best used by taking security of the representative that his conduct, on some very important and critical questions, will be in accordance with what they deem the national view. (See *Bentham's Rationale of Representation.*)

REPRESENTATION. In Painting and the other Arts, the transference to a plane of a solid mass, or the appearance of an object to the eye.

REPRIE'VE. (From the Fr. reprendre, *to take back.*) In Law, the suspension of the execution of sentence on judgment in a criminal case for a certain time. Reprieve at the will of the judge is arbitrary; and the latter has power to give it where he is dissatisfied with the verdict, in order to give time to apply to the crown for a pardon. Reprieve is also *ex necessitate legis;* as, a woman capitally convicted has a right to a reprieve during pregnancy; or when a party becomes insane between judgment and award of execution.

REPRI'SALS, LETTERS OF. In National Law, the capture of property belonging to the subjects of a foreign power in satisfaction of losses sustained by a citizen of the capturing state. (*See* LETTERS OF MARQUE.) Letters of reprisal are grantable by the law of nations, where the subject of one state has been oppressed or injured by the subjects of another, and where justice has been refused on application by letters of request. The mode of serving out letters of marque and reprisal in time of truce was regulated by statute 4 Hen. 5. c. 7., but has been long disused. The power of granting letters of marque and reprisal is sometimes given by proclamation of the king in council to the lords of the admiralty.

REPRI'SES. In Law, deductions or payments out of the value of lands; such as rent-charges, or annuities.

REPROBA'TION, in Theology, is a term commonly applied to the supralapsarian tenet of the consignment of all mankind to eternal punishment, with the exception of those whom God has arbitrarily selected for eternal happiness. *See* ELECTION, PREDESTINATION.

REPRODU'CTION. (Lat. reproduco, *I reproduce.*) This word, in Physiology, is sometimes used for generation; but it signifies properly the power which a fully developed organized being possesses to push forth and form anew parts of the body which have been cut off. Vegetables possess this faculty in an eminent degree, and animals have the power of reproduction in proportion as they resemble vegetables in the simplicity of their organization; thus the freshwater polype *Hydra viridis*, when divided into many pieces, reproduces all its characteristic organs out of each piece. Worms and other Annelides can reproduce many segments of the body. Snails can push forth new horns, and reproduce even a great part of the head. Lobsters and spiders thus gain new claws or legs. Newts and lizards reproduce their tails.

REPTA'TION. A mode of progression by advancing successively parts of the trunk, which occupy the place of the anterior parts which are carried forwards, as in serpents: also applied to the slow progression of those animals whose extremities are so short that the body touches the ground.

RE'PTILES, *Reptilia*. (Lat. repo, *I creep.*) The name of a class of cold-blooded Vertebrate animals, including all those which have lungs, and a heart composed of two auricles and one ventricle. Those which retain their gills during the whole or a part of their existence are termed *Batrachians* or *Amphibia:* the latter name Linnæus applied to the whole group, as well as to certain true fishes. (*See* AMPHIBIANS, CHELONIANS, SAURIANS, OPHIDIANS, and BATRACHIANS.) Cuvier, in characterizing the class of reptiles as defined by him, well observes, that as it is from respiration that the blood derives its heat, and the muscular fibre its susceptibility of nervous irritation, the blood of reptiles is cold, and the muscular energy less than that of quadrupeds, and much less than that of birds. Thus we find their movements usually confined to crawling and swimming; for though at certain times several of them jump and run with considerable activity, their habits are generally lazy, their digestion excessively slow, and their sensations obtuse. In cold or temperate climates, almost all of them pass the winter in a state of torpor. Their brain, which is proportionally very small, is not so essentially requisite to the exercise of their animal and vital faculties as to the members of the two first classes: their sensations seem to be less referred to a common centre, for they continue to live and to exhibit voluntary motions long after losing their brain, and even after the loss of their head. A communication with the nervous system is also much less necessary to the contraction of their fibres, and their muscles preserve their irritability after being severed from the body much longer than those of the preceding classes: their heart continues to pulsate for hours after it has been torn away, nor does its loss prevent the body from moving for a long time.

The smallness of the pulmonary vessels permits reptiles to suspend the process of respiration, without arresting the course of the blood; thus they dive with more facility, and remain longer under water than either the Mammalia or birds.

No reptile hatches its eggs. The young Batrachians on quitting the egg have the form and branchiæ of fishes, and some of the genera preserve these organs even after the development of their lungs.

The quantity of respiration in reptiles is not fixed, like that of the Mammalia and birds, but varies with the proportion of the diameter of the pulmonary artery compared to that of the aorta. Thus tortoises and lizards respire more than frogs, &c.; and hence a much greater difference of sensibility and energy is manifested in this class than can exist between one of the Mammalia and another, or between birds. *See* ERPETOLOGY.

REPU'BLIC. (Lat. respublica, *commonwealth.*) That form of government in which the supreme power is vested in the people. A republic may be either an aristocracy or a democracy: the supreme power, in the former, being consigned to the nobles or a few privileged individuals, as was formerly the case in Venice and Genoa; while, in the latter, it is placed in the hands of rulers chosen by and from the whole body of the people, or by their representatives assembled in a congress or national assembly. The free towns of the Continent, Hamburg, Frankfort, Lübeck, and Bremen, are instances of this latter form of government; but the most perfect example of it is to be found in the United States, in Texas, and in some of the South American confederations which have shaken off the Spanish yoke. In Switzerland, aristocracy is blended with democracy in the form of government.

REQUE'ST, LETTERS OF. In Ecclesiastical Law, an instrument by which the regular judge of a cause waives or remits his own jurisdiction, under the provisions of the Statute of Citations, 23 H. 8. c. 9.; in which event the jurisdiction of the appellate court attaches.

REQUESTS, COURT OF. 1. An ancient court of equity, inferior to the Court of Chancery, of which the lord privy seal was chief judge; taken away by 16 & 17 C. 1. c. 10. 2. The Court of Conscience, or of Requests, of London, for the recovery of small debts, was erected in the 9th year of H. 8., with jurisdiction between citizens and freemen in cases of debt or damages under 40*s*., extended in the reign of G. 3. to 5*l*. The local courts instituted in many parts of the kingdom for the recovery of small debts by summary process are hence called popularly Courts of Requests. Many of them are very recently erected, or in process of erection, under local acts. The number of causes tried in the Southwark Court of Requests in 1837, under 40*s*., was 14,474; above that sum, 3333.

RE'QUIEM. (Lat.) In the Roman Catholic Church, a mass performed for the repose of the souls of deceased persons. It is so called from the prayer commencing "Requiem æternam dona iis Domine." The term is also applied to grand musical compositions performed on solemn occasions in honour of deceased civil or ecclesiastical dignitaries. The requiems composed by Mozart, Jomelli, and Cherubini are well known.

RE'SCRIPTS. (Lat. rescribo, *I write back.*) In the Civil Law, answers of popes and emperors to questions in jurisprudence propounded to them officially. Those of the Roman emperors constitute one of the authoritative sources of the civil law.

RE'SCUE. In Law, in the more general sense, a species of resistance against lawful authority; as, by delivering one arrested out of the hands of those who have legal custody of him. In a more restricted application, the term rescue means the taking away and setting at liberty, against law, any distress taken for rent, or services, or damage feasant.

RESEDA'CEÆ. (Reseda, one of the genera.) A natural order of herbaceous or suffrutescent Exogens, inhabiting Europe and Asia. There are but three genera belonging to it; and of these but one species, the common *mignonette*, a Barbary plant, now an universal favourite for the sake of its peculiar fragrance, is the only species possessing any interest except to the botanist.

RESERVOIR. (Fr.) A tank, or pond, in which water is collected and preserved in order to be conveyed through pipes for the supply of a town, &c. Thus, Edinburgh is chiefly supplied with water by springs collected in a magnificent reservoir seven miles distant from the city. The term is also applied to a place where water is collected and preserved for the more regular supply of a fountain or drinking trough in seasons when it is not naturally abundant.

RE'SIDENCE OF CLERGYMEN ON THEIR BENEFICES, is enjoined by the common law of England, as well as by the canon law and many statutory provisions. These last are now consolidated by 1 & 2 Vict. c. 106. Under that act, an incumbent is considered to be non-resident if he is absent for one or more periods exceeding in the whole three calendar months in each year; and will be liable to the penalties unless he has obtained a licence for non-residence from the bishop, or is within any of the statutory exemptions. The licence may be given, when there is no house or fit place of residence, to reside in some fit or convenient house described in the licence, which must be within three miles of the church; or within two, if the church be in a city, market, or borough town. The statutory exemptions are in favour of a variety of officers of cathedral and collegiate churches; who may not, however, be absent on account of their residence and performance of duty elsewhere for more than five months. Licences for absence from the benefice may also be granted by the bishop, on petition, for a few other causes: incapacity of mind or body; the dangerous illness of a wife or child, part of the family, — in which case the licence is only for six months, and requires the archbishop's renewal; and in case a house convenient for residence cannot be procured within the benefice. The penalties are fixed in a graduated scale, being the prefixtures of portions of the value of the benefice, and may be proceeded for in the bishop's court. The bishop may also proceed by monition and sequestration.

RE'SIDUE. In Law, the remainder of a testator's estate after payment of debts and legacies: if this remainder be bequeathed to any one, he is styled the residuary legatee. If a legatee dies before the testator, the legacy is a lost or *lapsed* legacy, and sinks into the residue; and this provision of the law is extended to devises of real property by 7 G. 4. and 1 Vict. c. 26. (the Wills Act) s. 25. *See* LEGACY, WILL.

RE'SIN. (Gr. ῥητίνη; from ῥέω, *I flow.*) A proximate principle common in the vegetable kingdom, the ultimate components of which are carbon, oxygen, and hydrogen. There are many varieties of resin. Their general characters are fusibility and inflammability; solubility in alcohol, insolubility in water. They are generally separable into two distinct portions by the action of cold and of hot alcohol. They are valuable as ingredients in varnishes, and several of them are used in medicine. They are often naturally blended with modifications of gum, in which case they constitute the series of *gum resins*. The specific gravity of the resins varies between 1·0 and 1·4. They become negatively electric by friction. The commonest resin in use, usually called *rosin*, is obtained by distilling turpentine: the volatile oil passes over, and the resin remains in the still.

RESI'STANCE, in Mechanics, denotes generally a force acting in opposition to another force, so as to destroy it or diminish its effect. Resistance is sometimes considered as of two kinds, active and passive; the active resistance being that which corresponds to the useful effect produced by a machine, and the passive that which belongs to the inertia of the machine. Thus, in raising water from a well, the active resistance to the force employed is measured by the quantity of water which is raised; and the passive resistance by the force required to overcome the weight of the bucket and the rope, the friction of the pulley on its axle, &c.

RESISTANCE OF FLUIDS. In Hydrodynamics, the force with which a solid body moving through a fluid is resisted or retarded. Of all the different kinds of resistance which manifest themselves among bodies, there is none of greater importance than this, on account of its application to the theory of naval architecture.

Sir Isaac Newton was the first who gave a general theory of the motions and actions of fluids. (*See* HYDRODYNAMICS.) The Newtonian theory of the resistance of fluids, which is given in the second book of the *Principia*, is founded on the assumption of the perfect intermobility of the particles of the fluid, and the equal propagation of pressure in all directions. These are, indeed, the characteristic properties of fluidity; nevertheless, the results of the mathematical theory differ so widely in many cases from actual experiment, that some philosophers have called in question the accuracy of the principles from which they are derived. The theory, however, notwithstanding its defects, furnishes some propositions of great practical use, and, indeed, forms the groundwork of all our knowledge on the subject. We shall here give a general view of its leading principles.

It is evident that a solid body, in moving through a fluid, must communicate a motion to the fluid particles with which it successively comes in contact. Now, the quantity of motion communicated to the fluid is necessarily equal to that which is lost by the solid, and may therefore be taken as the measure of the resistance. To determine this quantity of motion, let us conceive a cylindrical or prismatic body, terminated by a plane perpendicular to its axis, to be propelled through a non-elastic fluid in the direction of its axis, so that the particles of the fluid strike against the plane perpendicularly: and let A denote the area of the anterior surface of the body, ρ the density of the fluid, and v the velocity of the motion, during the small interval of time dt. Then the space described by the body in the time dt is $v\,dt$; the volume of the fluid displaced in that time is $A\,v\,dt$; the mass of the fluid displaced is $\rho\,A\,v\,dt$; and the momentum or quantity of motion imparted to the fluid is $\rho\,A\,v\,dt \times v = \rho\,A\,v^2\,dt$. Let R denote the resistance of the fluid, we have then

$$R = \rho\,A\,v^2\,dt \quad . \; . \; . \; . \quad (1.)$$

From this equation it appears that the resistance upon a plane surface, moved perpendicularly through a non-elastic fluid at rest, is proportional to the density of the fluid, to the area of the plane, and to the square of the velocity.

We may deduce from equation (1.) a measure of the force of resistance by comparing it with the pressure of gravity. Let h denote the height from which a heavy body must fall in order to acquire the velocity v, and let g be the accelerating force of gravity (32 feet in a second); we have then (*see* FORCE) $v^2 = 2\,g\,h$, and by substituting this in equation (1.), we get

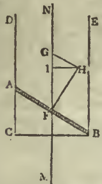
$$R = 2\,\rho\,A\,h \times g\,dt \quad . \; . \; . \; . \quad (2.)$$

Now, since g is the velocity generated by gravity in one second, $g\,dt$ is the velocity generated in the time dt; and since $2\,\rho\,A\,h$ expresses the mass of a prism of the fluid, having A for the area of its base and $2\,h$ for its altitude, $2\,\rho\,A\,h \times g\,dt$ is the quantity of motion which the prism would acquire by the free action of gravity in the time dt; in other words, its weight. We have, therefore, this proposition: *The direct resistance of an unelastic fluid on any plane surface is equal to the weight of a column of the fluid having the surface for its base, and for its altitude twice the height due to the velocity with which the surface moves through the fluid.* Let W be the weight of the unit of volume of the liquid; we have then

$$R = 2\,W\,A\,h \quad . \; . \; . \; . \quad (3.)$$

The above measure of the force of resistance is deduced

on the supposition that the direction of the motion is perpendicular to the plane. If the shock is received obliquely, the resistance will be greatly diminished. Let A B represent the profile of the plane, and M N the direction of the motion of the plane in stagnant water, or of a vein of fluid D C B E striking against the plane, supposed to be fixed. Let F be the intersection of M N with A B, and draw B C perpendicular to M N. Now, if A denote the area of the given plane A B, v the velocity of the motion, and R the direct resistance due to the velocity v (that is, the resistance which the plane would sustain if placed perpendicularly to M N); then (1.) we have $R = \varrho\, A\, v^2\, d\, t$. On F N take F G, to represent R. This force F G may be resolved into two, F H perpendicular and H G parallel to A B, of which the latter produces no effect on the plane; hence the resistance is diminished, by reason of the oblique impact, in the ratio of F H : F G, or of sin. i : 1 (i denoting the angle of incidence A F N). But, again, the absolute resistance is also proportional to the number of filaments which strike the plane; and it is obvious that the number which would strike it in the oblique position A B is less than the number which would strike it if directly opposed to the stream, in the ratio of B C : B A, or of sin. i : 1. Compounding this with the former ratio, the total diminution of resistance is as sin. $^2 i$: 1; that is, to say, the absolute resistance or pressure in the direction F H perpendicular to the plane is R sin. $^2 i$.



It still remains to find the effective impulse or resistance in the direction of the motion. Draw H I perpendicular to M N. The force in the direction F H may be resolved into F I and I H, of which the effective part is F I. Hence the effective impulse is to the absolute oblique impulse as F I to F H, or as sin. i : 1; consequently the effective impulse on the plane in the direction M N is R sin. $^3 i$. Let this be denoted by R′; we have then

$$R' = R \sin.\,^3 i = \varrho\, A\, v^2\, d\, t \times \sin.\,^3 i \quad . \ . \ . \ . \ (4.)$$

If we denote by A′ the area of the projection of the plane A B upon a plane perpendicular to M N, we have $A' = A \cos.\ A\,B\,C = A \sin.\ i$; and since $\varrho\, v^2\, d\, t = 2\, W\, h$, the above formula becomes, by substitution,

$$R' = 2\, W\, A'\, h \sin.\,^2 i \quad . \ . \ . \ . \ (5.)$$

From this last formula the effective oblique impulse in the direction of the stream upon any plane surface is easily computed. For other surfaces than planes, it is necessary to find an expression for the resistance on the differential element of the surface, which may be regarded as coinciding with its tangent plane; and the sum of all these resistances, found by the usual process of integration, will give the whole resistance on the surface. For a surface of revolution we have

$$d\, A' = 2\, \pi\, y\, d\, y \text{ and } \sin.\,^2 i = \left(\frac{d\, y}{d\, z}\right)^2;$$

therefore,

$$R' = 4\, \pi\, W\, h \int y \frac{dy^3}{d\, x^2}.$$

Numerous experiments have been made for the purpose of ascertaining how far this theory of the resistance of fluids agrees with the actual facts, or for forming an empirical theory for the guidance of the engineer. Of the details of these experiments our limits will not permit us to give an account; but the principal experimenters, and works in which the results may be found, are the following: Sir Isaac Newton (*Principia*, lib. ii.); Mariotte (*Traité des Mouvemens des Eaux*); Gravesande (*System of Natural Philosophy*); D. Bernoulli and Krafft (*Comment. Petropol.*); Borda (*Mém. de l'Acad. des Sciences de Paris*, 1763 and 1767); Condorcet, D'Alembert, and Bossut, by order of the French government in 1775; Bossut (*Hydrodynamique*); Du Buat (*Principes d'Hydraulique*); Robins (*Gunnery*); Don George d'Ulloa (*Examen Maritimo*); Coulomb (*Mém. de l'Institut*, tom. iii.); Vince (*Phil. Trans.*); Hutton (*Tracts*); Beaufoy (*Nautical and Hydraulic Experiments*); Russel (*Trans. of the Royal Society of Edin.* vol. xiv.), &c. The general results of the experiments may be stated as follows: —

I. The force of resistance on bodies moving in fluids is proportional to the square of the velocity, at least within the limits of 2 to 10 feet per second. This is in accordance with the theory.

II. The direct resistance on bodies moving with the same velocities is nearly in the ratio of the surfaces.

III. The resistances on surfaces moving obliquely do not by any means vary in the ratio of the squares of the sines of the angles of incidence, especially when the incidence is very oblique; and for such motions the theory must be entirely abandoned.

The above results are, however, considerably modified by various circumstances, of which the principal are the following: —

1. The form of the body. The Newtonian theory takes account only of the anterior surface of the body; but it was clearly established by the experiments of Du Buat that the form of the hinder part is not less efficacious in modifying the resistance. A prismatic body, having its prow and poop equal and parallel surfaces, being plunged horizontally into a stream, will require, in order to keep it immoveable, a force in the direction of its axis equal to the difference of the real pressures exerted on its prow and poop. If the fluid is at rest, this difference will be nothing, because the opposite dead pressures are equal; but in a stream there is superadded to the dead pressure on the prow the active pressure arising from the deflection of the filaments of the fluid, which being turned aside and rendered divergent by the obstruction of the anterior surface, a part of the pressure of the circumambient fluid is employed in turning them into the trough behind the body, and consequently there is less pressure on the posterior surface than if the body were at rest in stagnant water, so that the body is impelled backwards. This force is called by Du Buat the *non-pressure*, by Beaufoy the *minus pressure*. Now, the whole impulse to be withstood if the body is in a stream, or the resistance to be overcome if it moves in stagnant water, is the sum of the active pressure on the fore part and the non-pressure on the hinder part; and this does not depend solely on the form of the prow and poop, but also, and perhaps chiefly, on the length of the body. The non-pressure on a cube was found by experiment to be reduced to a fourth part, by making the length of the body triple of the breadth. The mere lengthening of a ship, without changing the form of the prow or poop, increases the speed.

2. Another circumstance which modifies the general results is the velocity of the body. It was ascertained, by Mr. Russel's experiments on canal boats, that the resistance does not follow the ratio of the squares of the velocities, excepting when the velocity is small and the depth considerable; but that the increments of the resistance are greater than those due to the squares of the velocities as the velocity approaches to a certain limit depending on the depth of the fluid; and that immediately after passing this limit the resistance suffers a sudden diminution, and becomes much less than that due to the square of the velocity. In a canal about five and a half feet deep this limit (which is the velocity of the wave generated by the motion of the body) was found to be from 11 to 12 feet per second, or about eight miles per hour.

3. A third cause which modifies the theory is the adhesion of the molecules of the fluid, which is most sensible when the motion is slow and the body small and very long. In such cases, it becomes necessary to add a term depending on the first power of the velocity.

4. The resistance is also influenced by the depth of the body under the surface of the water. When the body is near the surface the resistance is greater than when it is at the depth of six feet. When a body floats the fluid is heaped up, as it were, before the anterior surface, by which the resistance is increased.

5. In elastic fluids, as the density increases with the pressure, the density of the fluid before the anterior surface increases with the velocity, and the increments of the resistance are greater than in the ratio of the square of the velocity. In this case, also, we may conceive a velocity so great that the pressure on the posterior surface becomes negative, as in the case of a cannon ball projected with a velocity greater than that with which air rushes into a vacuum. When this takes place the fluid is not even in contact with the posterior surfaces of the ball, and the character of the resistance is wholly changed. *See* PROJECTILES.

6. When a body moves in a fluid a portion of the fluid adheres to the body, and accompanies it in its motion; whereby the form of the moving body is altered, and the resistance increased. The quantity of fluid thus dragged along is independent of the velocity, and was estimated by Du Buat, from experiments made on spheres vibrating in water, to increase the quantity of displaced fluid in the ratio of 1 to 1·6. His experiments on prisms also showed that the quantity of dragged fluid was proportional to the bulk of the moving body. Mr. Baily (*Phil. Trans.* 1832) gives, as the mean results of his experiments on pendulums swinging in air, the ratio 1 to 1·846 as the increase of the displaced fluid from this cause; and remarks that the quantity appeared to depend on the form as well as magnitude of the moving body, but not on its weight or specific gravity. This circumstance, which considerably modifies the resistance, though made known by Du Buat in 1786, was overlooked by other experimenters, until rediscovered by Bessel in 1826, when engaged on experiments to determine the length of the seconds' pendulum.

From the above considerations, it may be inferred that the resistance R opposed to any body moving through a fluid, considered as a pressure of so many pounds weight, will be expressed by an equation of this form,

$$R = (m + n)\, W\, A\, h;$$

where W is the weight in pounds of the unit of volume of the fluid (one cubic foot); A the area of the greatest transverse section of the body, expressed in square feet; h

the height in feet due to the velocity, so that $h = v^2 \div 64$; and m and n numerical coefficients, constant for bodies of similar figure, but variable for bodies of different figures, and to be determined by experiment for each kind of body; m having reference to the impulse and pressure on the anterior surface, and n to the non-pressure on the posterior part.* The following are a few of the cases for which values of m and n have been found.

When a thin plate is directly opposed to the impulse of a stream, the value of $m + n$ appears to increase with the area. If A is equal to a tenth of a square foot, $m + n = 1{\cdot}4$; and if $A = 1$ square foot, $m + n = 1{\cdot}9$. The value of $m + n$ for surfaces of larger dimensions has not been sufficiently determined. For a prismatic body terminated by two planes, the pressure against the anterior force remains constant; but the non-pressure, or value of n, diminishes as the length increases. For a cube held fast in a stream, Du Buat found $m + n = 1{\cdot}46$; and for a prism whose length was from three to six times the square root of its face, $m + n = 1{\cdot}34$. But when the bodies moved in still water, he found, as for the thin plate, $m + n = 1{\cdot}43$; for the cube, $m + n = 1{\cdot}17$; and for the prism, $m + n = 1{\cdot}10$.

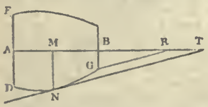
By means of these values the actual resistances are readily computed for each body, when the velocity is given. Suppose the velocity to be 3 feet per second, and the opposing surface in each case to be 1 square foot. For $v = 3$, we have $h = 9 \div 64 = {\cdot}1406$. With respect to W, the weight of an imperial gallon of water, at temperature 62° and under the mean pressure, is 10 lbs. avoirdupois; but an imperial gallon contains 277·27 cubic inches, whence the weight of a cubic foot of water is 62·3 lbs. avoirdupois. Hence, if the bodies are impelled through stagnant water with a velocity of 3 feet per second, the absolute resistances in each case are as under: —

For the thin plate	$R = 1{\cdot}43 \times 62{\cdot}3 \times {\cdot}1406 = 12{\cdot}5$ lbs.
For the cube	$R = 1{\cdot}17 \times 62{\cdot}3 \times {\cdot}1406 = 10{\cdot}2$
For the prism	$R = 1{\cdot}10 \times 62{\cdot}3 \times {\cdot}1406 = 9{\cdot}6$

The effect produced by the addition of a poop or prow was also determined by Du Buat. The addition of a poop to a prismatic body whose length is four or five times its breadth only diminishes the resistance by a tenth part. But when a prow consisting of two equal vertical planes, making with each other an angle of 60°, was added, the resistance was reduced to about a half. On giving the prow the form of a semicylinder, the resistance was also reduced about a half. The section of the prow being a triangle whose height was double the base or breadth of the prism, the resistance was reduced to two fifths. In general, a prow having a curved surface produces a greater diminution of the resistance than one of equal magnitude terminated by plane surfaces.

For a sphere moving in water or in air with a moderate velocity, the experiments give $m + n = 0{\cdot}6$; but this value increases when the velocity becomes great, as in the case of a projectile. The experiments of Bossut on the model of a ship moved in the direction of its axis gave $m + n = 0{\cdot}16$. This may be considered as the value corresponding to the solid of least resistance. For the effect with which solid bodies resist an effort tending to break or crush them, see STRENGTH OF MATERIALS; and for the resistance of the atmosphere on a projectile, see GUNNERY, PROJECTILE.

RESI'STANCE, SOLID OF LEAST. In Mechanics, the solid whose figure is such that in its motion through a fluid it sustains the least resistance of all others having the same length and base; or, on the other hand, being stationary in a current of fluid, offers the least interruption to the progress of that fluid. In the former case, it has been considered the best form for the stem of a ship; in the latter, the proper form for the pier of a bridge. The determination of the curve whose revolution gives the body having this property is a problem which can be solved by the ordinary methods of maxima and minima, when the law of resistance is assumed. On the hypothesis that the resistance is proportional to the square of the velocity, Newton gave the following construction:



— Let a curve D G be so taken that if from any point N in it an ordinate N M be drawn perpendicular to the axis A B, and from a given point G the line G R be drawn parallel to the tangent N T at N, cutting the axis in R; then if $MN : GR :: GR^3 : 4\,BR \cdot BG^2$, the solid generated by the revolution of this curve about the axis A B will be the solid of least resistance. (*Principia*, lib. ii. prop. 34.)

RESOLU'TION. (Lat. resolutio.) In Medicine and Surgery, this term implies the cessation or dispersion of inflammatory action without the formation of an abscess or mortification.

RESOLUTION. In Music, the writing out of a canon or fugue in partition from a single line.

RESOLUTION OF A DISCORD. The descent by a tone or a semitone, according as the mode may require, of a discord which has been heard in the preceding harmony.

RESOLUTION OF EQUATIONS. The finding the values which the unknown quantity or quantities must have, so as to fulfil the conditions expressed in the proposed equation; viz. of rendering the aggregate value of all the positive terms equal to the aggregate value of all the negative terms. These values are called the *roots of the equation*. See EQUATION.

RESOLUTION OF FORCES. *See* RESULTANT.

RESOLUTION, or SOLUTION, in Mathematics, is the orderly enumeration of the things to be done to obtain what is required in a problem. A problem may be divided into three parts, — the proposition, the resolution, and the demonstration.

RE'SONANCE. (Lat. resonans.) In Music, the returning of sound by the air acting on the bodies of stringed musical instruments.

RESPIRA'TION. (Lat. respiro, *I breathe*.) The function by which the nutrient circulating fluid of an organized body is submitted to the influence of air, for the purpose of changing its properties. The great end which appears to be answered by respiration is the removal of carbon, in the form of *carbonic acid*, from venous blood. This gas is accordingly found in the air which is expired from the lungs; and the blood, having lost its carbonic acid, at the same time loses its dingy hue, and acquires the florid red which characterizes arterial blood. It has been shown by Dr. Stevens that a peculiar attraction exists (not chemical) between oxygen and carbonic acid, which acts through membranes, and in consequence of which the carbonic acid appears to be attracted, as it were, out of the venous blood, by the oxygen of the air in the cellular structure of the lungs; while, at the same time, a portion of oxygen, probably equal in bulk to that of the emitted carbonic acid, is absorbed by the blood, and contributes to its arterial characters. The change from the arterial to the venous state, and consequently the formation of carbonic acid, appears to take place in the capillary junctions of the artery and vein; but how it is there effected we know not.

From the quantity of carbonic acid emitted from the lungs in a given time, it has been attempted to ascertain the quantity of carbon which is thus thrown off; but the usual estimates upon this subject, which place it at about 12 ounces in the 24 hours, are probably overrated, inasmuch as that quantity of carbon is more than exists in the food daily taken into the stomach. If we average it at 6 ounces, it will probably be nearer the truth; and 6 ounces of charcoal are equal to 22 ounces of carbonic acid gas. Besides carbonic acid, there is also a quantity of aqueous vapour thrown out with the expired air; this is probably chiefly produced by the superficial exhalents of the lungs, but it may also be partly derived from transpiration from the blood. It has not been satisfactorily ascertained whether nitrogen is taken up by the blood as well as oxygen, though experiments have rendered it probable that a portion of that component of the atmosphere is also absorbed.

RESPIRATION OF PLANTS. *See* BOTANY.

RESPIRATOR. An instrument fitted to cover the mouth, over which it is retained by proper bandages: it is constructed of a series of flattened silver or gilt wires, over and between which the air passes and repasses in the act of respiration and of speaking. It is presumed that the warm air emittted from the lungs imparts its excess of temperature to the small metallic bars, and that these in their turn impart heat to the cold air drawn through them at each inspiration; so that in this way the low temperature of the external air in cold weather is mitigated before it reaches the lungs, and its supposed noxious influence prevented. When a handkerchief is tied over the mouth, and we are obliged to breathe through the nose, the extreme low temperature of the external air is similarly mitigated before it reaches the lungs.

RESPONDE'NTIA. In Mercantile Law, a species of contract; which differs from bottomry, in that the loan is effected on the security of the freight, and not on that of the ship itself. *See* BOTTOMRY.

REST. In Music, a pause or interval of time, during which there is an intermission of the voice or sound. A rest may be for a bar, or more than a bar, or for a part of a bar only.

RESTITU'TION, WRIT OF, in Law, lies where judgment has been reversed, to restore to the defendant what he has lost. It can properly only be granted where the party cannot be restored by the ordinary course of law. Restitution of goods to a party robbed was unknown to the common law; but the stat. 21 H. 8. c. 11. first saw it. By the statute 7 & 8 G. 4. c. 29. s. 57., it is now in the power of the court to award a writ of restitution of goods and chattels, and to restore them in a summary manner, where a thief or fraudulent taker has been indicted on the part of the owner and convicted. Such restitution cannot be granted of a valuable security, where the property has passed into other hands by a boná fide trans-

action. But a writ of restitution will reach goods stolen, although they have been sold in market overt. Restitution can only be had from the person in possession of the goods at the time of and after the felon's conviction.

RESTORATION, THE, in English History, is applied by way of eminence to the accession of Charles II. to the throne after an interregnum of eleven years and four months, from Jan. 30. 1649, when Charles I. was beheaded, till May 29. 1660. The latter day is appointed in the liturgy of the English church as an anniversary festival in commemoration of the restoration of the monarchical form of government in these realms.

RESU'LTANT, in Dynamics, is the force which *results* from the *composition* of two or more forces acting upon a body. When the two forces act upon a body in the same line of direction, the resultant is equivalent to the sum of both; when they act in opposite directions, the resultant is equal to their difference, and acts in the direction of the greater. If the lines of direction of the two forces are inclined to each other, then, on taking in each direction from the point where they intersect a straight line to represent each of the forces respectively, and constructing a parallelogram of which these lines are the sides, the resultant is represented both in intensity and direction by the diagonal of the parallelogram passing through the point of intersection. By combining this resultant with a third force, a new resultant will be obtained; and in this manner the resultant of any number of forces may be determined. *See* COMPOSITION OF FORCES.

RESURRE'CTION. (Lat. resurgo, *I rise again.*) The history of the resurrection of our Saviour is detailed in the separate narration of each of the four Evangelists, and is also referred to and insisted on in the Acts of the Apostles, and in every one of the Epistles. The importance of this history, as an evidence of the truth of Christianity, is pointed out in a peculiar manner by Paley (*Evidences*, part 2. ch. 8.); namely, that it was alleged from the beginning by all the propagators of Christianity, and relied on as the great test of the doctrines which they taught; consequently, if the fact be untrue, they must all have been either deceivers, or deceived in a point on which it is morally impossible they could be so.

RESUSCITA'TION. (Lat. resuscitare, *to arouse.*) This term is generally used to signify the restoring to animation of persons apparently dead. The first and principal object in these cases is to aërate the blood by the artificial introduction of fresh air into the lungs, and to restore the natural function of respiration; the lungs, therefore, must be inflated, and proper stimulants applied when necessary; among these, in cases of drowning and of apparent death from exposure to cold, friction and warm bath are eminently important: after hanging, the vessels of the brain often require to be unloaded by venesection in the jugular vein. Electricity is sometimes resorted to, but generally hopelessly. In all these cases no time should on any account be lost, as every thing depends upon *prompt* treatment, as well as upon *proper* means; and many lives have been lost for want of immediate aid, and skill in applying it. The attempts to restore suspended animation should not be given up till unequivocal proofs of death are manifest. (*See* DROWNING.) The details of the management of different cases of apparent death are too extensive to come within our limits: upon this subject the reader may advantageously consult *Taylor's Elements of Medical Jurisprudence.*

RETA'INER. In old English Law, a servant not dwelling in the master's house or employed by him in any distinct occupation, but wearing his *livery* (*i. e.* hat, badge, or suit), and attending on particular occasions: an important relic of the times of private warfare. The giving liveries, or *retaining* this class of servants, was forbidden by many statutes with little effect. The statutes themselves were repealed by 3 Car. I. c. 1.; but the usage had nearly ceased.

RETAINER, or RETAINING FEE. In the language of the Bar, a fee given to a counsel to secure his services; or rather, as it has been said, to prevent the opposite side from engaging them. A *special* retainer is for a particular case expected to come on. A *general* retainer is given by a party desirous of securing a priority of claim on the counsel's services for any case which he may have in any court which that counsel attends. The effect of it is merely this, that if a counsel having a general retainer receive a special retainer on the other side, he cannot accept it until twenty-four hours after notice shall have been given of its arrival to the party so generally retaining him; when, if he does not receive a brief or a special retainer from the latter, he is bound to accept it. The same word in its strict legal acceptation signifies the engagement of an attorney by his client, which enhances the mutual duties implied by law between them.

RETARDA'TION. The act of hindering the free progress of a body, and ultimately, therefore, stopping it. It arises from the opposition of the medium *in* which the body moves, or from the friction of the surface *upon* which it moves. *See* FRICTION, RESISTANCE.

RE'TE MUCO'SUM. (Lat.) The soft and apparently fibrous matter, or layer, situated between the cuticle and the cutis; it is the seat of the colour of the skin. It is black in the negro, and the colouring matter is of such a nature as to admit of being bleached by the action of chlorine.

RE'TIARIES, *Retiariæ.* (Lat. rete, *a net.*) In Entomology, those spiders are so called which spin a web or net to entrap their prey.

RETIA'RIUS. (Lat. rete, *a net.*) The name of a class of Roman gladiators armed in a peculiar way. The retiarius was furnished with a trident and net, with no more covering than a short tunic; and with these implements he endeavoured to entangle and despatch his adversary, who was called secutor (from sequi, *to follow*), and was armed with a helmet, a shield, and sword.

RETI'CULATE. (Lat. rete.) In Zoology, when a surface has a number of minute impressed lines which intersect each other in various directions, like the meshes of a net.

RETI'CULATED WORK. In Architecture, that wherein the stones are square and laid lozengewise, resembling the meshes of a net. This species of masonry is scarcely ever practised in the present day; but it was very common among the ancients.

RETI'CULATES, *Reticulata.* (Lat. reticulum, *a net.*) The name of a section of Lithophytes, comprehending those in which the polype cells have a reticulate disposition on the surface of expanded plates.

RE'TICULE. In a telescope, a network of some fine fibres crossing each other at right angles, and dividing the field of view into a series of small equal squares. It has been long used for observations on the quantity of the enlightened parts of a luminary during eclipses; and is found, under most circumstances, well adapted for the purpose, when placed in a convenient position in respect to the object-glass of the telescope. The term reticule is also applied to a well-known article, formerly of net-work, but now of every description of materials, used by ladies.

RETI'CULUM. (Lat.) The name of the "honeycomb bag," or second cavity of the complex stomach of the Ruminant quadrupeds; so called because of the reticulate or honeycomb-like disposition of the mostly hexagonal cells which occupy its inner surface.

RE'TINA. (Lat. rete.) The pulpy expansion of the optic nerve in the interior of the eye; it is the seat of vision.

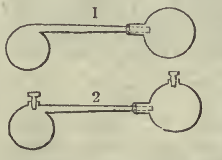
RETINASPHA'LTUM, or RETINITE. (Gr. ρετινη, *resin*, and ασφαλτον, *bitumen*, or *retinite.*) A substance discovered by Mr. Hatchett, associated with Bovey coal, and which has since been found in other coal strata. When digested in alcohol it yields a portion of resin, and asphaltum remains; it appears, therefore, to be a substance intermediate between resin and bitumen, and renders it probable that bitumens are of resinous origin.

RETINI'TIS. Inflammation of the retina.

RE'TIPEDS, *Retipedes.* (Lat. rete, and pes, *a foot.*) The name given by Scopoli to one of the divisions of a binary arrangement of birds, including all those which have the skin of the tarsi divided into small polygonal scales.

RETI'RED FLANK. In Fortification, a flank having an arc of a circle with its convexity turned towards the place.

RETORT. A chemical vessel employed in a variety of distillations. It is generally made of glass or earthenware, and sometimes is provided with a stopper so placed above the bulb as to enable substances to be introduced into it without soiling the neck; in this case it is called a *tubulated* retort. A *receiver* is usually annexed to it for the purpose of collecting the products of distillation. Fig. 1. represents a plain retort and receiver; in fig. 2. both are tubulated.



RETOUCH. In Painting, Sculpture, &c., a verb used to denote the reapplication of the master's hand to a work which he had theretofore considered in a finished state.

RETRACE. In Painting, &c., a verb used to denote the renewal of the outline of a drawing.

RETRENCHMENT. *See* FORTIFICATION.

RETROCE'DENT. A term applied in Medicine to those diseases which move about from one part of the body to another; as *retrocedent gout*, when it leaves the toe for the stomach.

RETROGRADATION. A term applied to the apparent motion of a planet when it is contrary to the order of the signs, or when the planet appears to move westward among the fixed stars. *See* PLANET.

RETU'RN, in Law, in its most usual signification, is applied to writs. The return to a writ is, properly speaking, a recital by the sheriff or other officer to whom

it was directed of what he has done in execution of it; as, for example, in cases of civil process, that the defendant cannot be found (technically called non est inventus), has no goods within the sheriff's bailiwick (nulla bona), and so forth. This is indorsed on the writ; and the writ is then delivered into the court whence it issued on the "return day," or day when the writ is returnable. The remedy against the sheriff for a false return is by action on the case. The return of members of parliament is thus, strictly speaking, the return by the sheriff, or other returning officer, of the writ addressed to him, certifying the election in pursuance of it. *See* Parliament.

Return. In Architecture, a projecture, moulding, or wall continued in a different or opposite direction.

REVE'ILLE. (Fr. literally *awake.*) The name given to the practice prevalent throughout all the European armies of beating the drum at daybreak, to awake the soldiers and put a stop to the challenging of the sentries. The equivalent tune played on the bugle in the evening, to summon the soldiers within their barracks, is called the *retreat*.

REVELA'TION, in a theological sense, is a communication of truth made by God to man; but it is understood that those truths only are revealed which are communicated by direct and special means, that is, by divine inspiration. Such fragments of the divine will and economy as are taught men by their own faculties and instincts are distinguished under the term *natural religion*.

RE'VELS, MASTER OF THE, or LORD OF MISRULE. The name of an officer formerly attached *pro tempore* to royal and other distinguished houses, whose duty it was to preside over the Christmas entertainments. This office was first permanently instituted in the reign of Henry VIII.; and appears to have gone out of fashion towards the end of the 17th century.

REVE'NDICATION. A term of the civil law, signifying a claim legally made to recover property, by one claiming as owner. The right of property must, generally speaking, be complete, to proceed to the action of revendication; thus, no such action can be brought for corporeal things until after delivery, by which they pass.

RE'VENUE. (Fr.) The name given to the income of a state derived from the customs, excise, taxation, and other sources, and appropriated to the payment of the national expenses. Most useful and comprehensive tables, showing the revenue and expenditure of Great Britain, will be found in the Parliamentary Papers printed every session.

RE'VEREND. (Lat. reverendus.) A title of respect given to the clergy. In Roman Catholic countries the members of the different religious orders are styled *reverend*. In England deans are *very reverend*, bishops *right reverend*, and archbishops *most reverend*. In Scotland, the principals of the universities and the moderator of the General Assembly for the time being are styled *very reverend*.

REVE'RSE. In Numismatics, the opposite to the obverse or face of the coin or medal. *See* Obverse, Numismatics.

REVE'RSION, in Law, is defined to be the residue of an estate in lands, tenements, or hereditaments, left in the grantor, to commence in possession after the determination of some particular estate granted by him.

REVE'RSION OF SERIES, in Algebra, is a method of expressing the value of an unknown quantity which is involved in an infinite series of terms, by means of another series of terms involving the powers of the quantity to which the proposed series is equal. Thus, if the proposed series be

$$z = a x + b x^2 + c x^3 + d x^4 + \dots \text{ad inf.} \quad (1.)$$

and if we assume

$$x = A z + B z^2 + C z^3 + D z^4 + \dots \text{ad inf.} \quad (2.)$$

the original series will be reverted on determining the coefficients A, B, C, D, &c.

The ordinary method consists in substituting the last series (2.) and its powers for x and its powers in the series (1.), and equating the coefficients, whereby the values of A, B, C, D, &c. are obtained. But this method, though given by Newton, by whom the problem was first proposed, becomes unmanageable after a few steps; and is moreover defective, inasmuch as it does not show the connection of the coefficients, nor the law by which they are formed. A general formula was given by Arbogast (*Calcul des Derivations*), whereby they may be continued with comparatively little trouble to almost any extent. The values of the first four coefficients are,

$$A = \frac{1}{a},\ B = -\frac{b}{a^3},\ C = \frac{2b^2 - ac}{a^5},$$

$$D = -\frac{5b^3 - 5abc + a^2 d}{a^7}.$$

(See also *Woodehouse's Principles of Analytical Calculation*, arts. 72 and 73.; and the *Penny Cyclopedia*, where the values of the coefficients are given to eleven terms.)

REVE'RSION, REVERSIONARY PAYMENTS. In the doctrine of Annuities, a reversion is a payment which is not to be received, or a benefit which does not begin, until the happening of some event, as the death of a person now living. Payments which are to be received at the end of a specified period of time are usually called *deferred payments*.

The present value of a sum of money to be received on the death of an individual of a given age depends evidently upon the chances which the individual has of surviving each future year of age, combined with the interest of money. The method by which the value is calculated, from an observed or assumed law of mortality, has been explained under the term Assurance; and for the sake of facilitating calculations of this kind, which are of very frequent occurrence in the affairs of life, extensive tables have been published, computed from various hypotheses of mortality, and at different rates of interest. Such tables are usually exhibited in the form of Annuity Tables, from which the solutions of all questions relating to assurances and reversions are easily deduced. *See* Annuity and Assurance.

Let A denote the value of an annuity of $1l.$ on a life of a given age, V the present value of $1l.$ to be received at the end of the year in which the life fails (the year being supposed to commence with the day on which the annuity is payable), r the rate of interest, and $v = 1 \div (1 + r)$; then

$$V = v(1 + A) - A, \text{ or } V = v - (1 - v) A.$$

Suppose, for example, that on the death of *A.*, whose present age is fifty-five, the sum of 5000*l.* is to revert to *B.* or his assigns, and that *B.* proposes to sell his interest in this reversion; and let it be proposed to calculate the sum which he ought now to receive, allowing the purchaser interest at the rate of 4 per cent. per annum. In the table given under the term Annuity the value of an annuity of $1l.$ on a male life aged fifty-five is 11·0392. At 4 per cent. we have $r = {\cdot}04$, and $v = 1 \div 1{\cdot}04$; therefore $V = \frac{12{\cdot}0392}{1{\cdot}04} - 11{\cdot}0392 = {\cdot}5370$. This is the value of the reversion of $1l.$; consequently, $5000l. \times {\cdot}5370 = 2685l.$ is the sum which *B.* should receive for his reversionary interest.

When the reversionary benefit consists of an annuity to commence upon the death of an individual, and to continue for a term of years certain, its value is found by computing the value of the annuity for the assigned period, and proceeding as in the above example; but when it consists of an annuity commencing upon the death of one individual, and terminable upon the death of another, it becomes necessary to have recourse to tables of annuities on joint lives. Thus, if *A.* becomes entitled upon the death of *B.* to an annuity of $1l.$ for the remainder of his life, the present value of the reversion, or of *A.*'s interest, is equal to B — A B; where B denotes the present value of the annuity on the life of *B.*, and A B the value of the annuity on the joint lives of *A.* and *B.*, that is, to continue only so long as both remain alive.

The four following rules give the solution of all the cases of reversionary annuities which can arise when three lives are concerned, and it is seldom that a case occurs in practice involving a greater number. It is to be observed, that the two letters A B standing together denote, as above, the value of an annuity on the joint lives of *A.* and *B.*, B P that of an annuity on the joint lives of *B.* and *P.*, A P Q that of an annuity on the joint continuance of the three lives *A.*, *P.*, *Q.*, and so on. Let R be the value of the reversionary annuity in each case.

1. On a single life *A.*, after the longest of two lives *P.* and *Q.*; $R = A - AP - AQ + APQ$.
2. On the longest of two lives *A.*, *B.*, after a single life *P.*; $R = A + B - AB - AP - BP + APB$.
3. On a single life *A.*, after two joint lives *P.*, *Q.*; $R = A - APQ$.
4. On two joint lives *A.*, *B.*, after a single life *P.*; $R = AB - ABP$.

When reversionary benefits are contingent on lives failing in an assigned order, as for instance an annuity to be received upon the death of *A.* provided he die while *B.* is living, the formula becomes more intricate, and could scarcely be explained without entering into details inconsistent with the nature of this work. For full information on the subject, see the Treatises of *Baily* (1813), and *Milne* (1816). We may remark, however, that the formulæ for the solutions of questions connected with this subject may be greatly simplified by the use of an appropriate notation: for examples of which see *De Morgan's Essay on Probabilities, Cabinet Cycl.*; and *Hardy's New and General Notation for Life Contingencies* (1840); in which last work the solutions of all the cases of annuities and assurances which can arise, when not more than three lives are concerned, are arranged in a convenient table.

REVE'TEMENT. In Fortification, a strong wall of brick or stone built round the lower part of the rampart, to support the earth and prevent it rolling into the ditch, as well as to increase the difficulty of escalade.

REVIEW. The name now commonly assumed, by literary usage, for periodical publications consisting of a collection of critical essays. The *Journal des Savans*, commenced at Paris in 1665 by M. de Sallo, is commonly cited as the first review properly so called. The most distinguished modern journals under the name of review in France are, the *Revue Encyclopédique*, the oldest of them (now extinct); the *Revue Française*, and *Des Deux Mondes*; and the *Revue Britannique*, which consists of translations from the English. In England the *Monthly Review* (established in 1749) was the first publication of its kind. The establishment of the *Edinburgh Review* in 1802, followed by that of the *Quarterly* in 1809, may be said to have commenced a new era in criticism: from that time reviews have been adopted as the organs for conveying the opinions of sects and parties in religion and politics, as well as in literature. All the leading works of this description (the *Edinburgh*, *Quarterly*, *Foreign Quarterly*, *British and Foreign*, *Westminster*, *British Critic*, *Church of England*, and *Dublin*) now appear quarterly, or nearly so. The management of reviews in England is in the hands of an editor; whose name, however, does not appear, the publisher being the party responsible. The articles are also always anonymous: the *Westminster* only, some time ago, adopted the practice of putting the initials of contributors, or initials assumed by them, at the foot of their papers. All these reviews adhere to their designation, the articles admitted being in the form of *reviews* on some work or works specified at the head, although, in point of fact, the latter are often not even noticed by the reviewer, his remarks being more in the form of a general essay than of a review. In this way they serve the purpose of affording governments or political parties the means of making statements of facts, or declarations of opinion, which do not involve them in the difficulties of direct responsibility, and yet are generally understood to convey their sentiments. The pay of writers in reviews is various, depending not only on the means of the review, but on the rules adopted by particular editors; for some have thought proper to equalize their rate of remuneration, others to retain in their own hands the power of estimating contributions according to their supposed value. The French "revues" are conducted on a different plan. Articles in general have the name of the contributor attached; and the form of a "review" is not preserved, tales, poetry, essays on the politics of the day, &c., being admitted indiscriminately.

But besides France and England, reviews have been long established in the other European states, and in America; but this species of publication has taken the deepest root in Germany, where reviews may be said, without exaggeration, to appear daily, though none of them possess the influence of our *Edinburgh* or *Quarterly Review*. The *Göttinger Gelehrte Anzeige*, which is the oldest, still exists, and maintains a high character for ability and impartiality.

REVIEW. In Military language, an inspection of the appearance and regular disposition of a body of troops assembled for that purpose.

REVISE. *See* CORRECTING.

REVI'VOR, BILL OF, in Law, is a continuance of an original bill in a court of equity, when by death some party to it has become incapable of prosecuting or defending a suit, or a female plaintiff has incapacitated herself by marriage from suing alone. A bill "of revivor and supplement" continues a suit upon an abatement, and supplies defects arisen from some event subsequent to the institution of the suit.

REVOCA'TION, POWER OF. In Law, a power contained in a voluntary deed of conveyance to uses, by which the grantor retains the liberty to revoke the uses granted by the deed. Voluntary estates made with power of revocation are held fraudulent under stat. 27 Eliz. c. 4. as against purchasers.

RE'VOLUTE. (Lat. revolvo, *I roll back.*) In Zoology, when a part is rolled outwards or backwards.

REVOLU'TION. In Politics, a word of somewhat indefinite meaning, but usually denoting an extensive change in the political constitution of a country accomplished in a short time, whether by legal or illegal means. The term *Revolution*, in English History, is applied by way of eminence to the year 1688, universally regarded as the great era of English liberty,—when William III. and Mary acceded to the throne on the forced abdication of James II.

REVOLUTION. In Geometry, the motion of a point or line about a centre.

REVOLUTION, in Astronomy, is used to signify the period in which a planet, satellite, or comet returns to the place in its orbit from which we estimate its setting out.

REVOLUTION, FRENCH (ERA OF THE). In Chronology, this was substituted for the Christian era in all public acts and documents, by a decree of the National Convention in 1793; and fixed at the 22d September, 1792, the day of the foundation of the French republic. It was abolished by Napoleon, and the Christian era restored in 1806.

REX SACRO'RUM. In Roman History, a priest appointed after the expulsion of Tarquin to superintend certain holy rites which had always been performed by the king in person. (*Liv.* ii. 2.)

RHABDOLO'GIA. (Gr. ῥαβδος, *a rod*, and λογος, *a description.*) The name given by Napier to a method of performing multiplication and division by means of a set of figured rods or scales. *See* NAPIER'S RODS.

RHA'BDOMANCY. (Gr. ῥαβδος, and μάντεια, *prophecy.*) Properly, divination by a rod or wand. Some persons have been believed to be endowed by nature with a peculiar sense or perception, by which they are enabled to discover things hid in the earth, especially metals and water. But a more prevalent opinion has been, that the discovery of these substances might be effected by means of a divining rod. The divining rod is a branch of a tree, generally hazel, forked at the end, and held in a particular way, by the two ends, in the hands of the adept; and is supposed to indicate the position of the substance sought by bending towards it with a slow rotatory motion, the adept, according to modern practice, being placed in contact with some metallic or other magnetic substance. The art is said to be occasionally practised in the south of France and Italy, under the names of metalloscopy, hydroscopy, &c. Campetti, an Italian, in the beginning of the present century, excited much attention by his professed powers of rhabdomancy.

RHAMNA'CEÆ. (Rhamnus, one of the genera.) A natural order of arborescent or shrubby Exogens, inhabiting all parts of the world excepting the arctic regions. The berries of various species of *Rhamnus* are violent purgatives; while the fruit of some, as the jujube, is harmless and eatable. *Rhamnus trangula* yields the best kind of charcoal for gunpowder. From the berries of *R. infectorius* and others a yellow dye is obtained, but in general the species are neither useful nor ornamental. They are all small-flowered polypetalous or apetalous plants, with four or five stamens alternating with the lobes of the calyx.

RHAMPHA'STOS. (Gr. ῥαμφος, *a beak.*) The name of a genus of Scansorial birds (*Toucans*) in the system of Cuvier, distinguished by an enormous beak, nearly as thick and as long as the body in some species. The compensation by which this disproportionate beak is rendered manageable and portable is an extremely light and cellular structure internally. It is arcuated near the extremity, and in old toucans is irregularly indented along the edges. The toucans are distinguished from the hornbills by the scansorial modification of their feet, in which two toes behind are opposed to two in front; and by their long, narrow, and ciliated tongue. They are confined to the hot climates of America, where they live in small flocks, feeding on fruit, insects, and the eggs and callow offspring of other birds.

RHAPO'NTICIN. A substance obtained from the *Rheum rhaponticum* in the form of yellow scales; insoluble in cold water and in ether, and tasteless and inodorous. It dissolves in 24 parts of boiling water, and in 2 of absolute alcohol.

RHA'PSODIST. (Gr. ῥαπτω, *I sew or string together;* ᾠδή, *a song.*) A class of persons who are said to have flourished in the age of Homer, whose occupation it was to compose or commit to memory poems, which they recited for the amusement of their auditors. It has been supposed that by means of persons of this class the poems of Homer were preserved till the invention of writing secured them more permanently, and among them is divided the honour of the authorship of the *Iliad* and *Odyssey* by those who deny the individuality of Homer. But the fact of the existence of such a class with higher pretensions than to the faculty of making short extemporaneous effusions is highly doubtful, as it rests mainly on the assumed fact that the art of writing was unknown in Ionia in the Homeric age.

RHEA. (Gr. ῥεω, *I flow.*) In Classical Mythology, daughter of Cœlus and Terra, wife of Saturn, and mother of Vesta, Ceres, Juno, Pluto, &c. She is frequently confounded with Ops, Terra, and Cybele. For the particulars of her history, see SATURN.

RHEA. The name of a genus of Struthious birds, of which the three-toed ostriches of South America are the representatives.

RHE'IN. An inodorous bitterish substance of a yellow colour, obtained by gently heating powdered rhubarb with 8 parts of nitric acid of the sp. gr. 1·37, evaporating to the consistence of syrup, and diluting with cold water.

RHE'TORIC. (Gr. ῥητορική, sc. τέχνη, *the rhetorical art;* from ῥητωρ, *an orator.*) In the widest sense in which the word is occasionally used by modern writers, the art of prose composition generally. In the most restricted and most etymological sense, the art of oratory, or of addressing public assemblies. In an intermediate sense, in which, perhaps, it is most commonly employed, the art of

argumentative composition. This comes nearest to the signification which Aristotle, the earliest extant writer of a formal treatise on rhetoric, attached to the title of his subject, when he defined it to be the art of discovering and employing topics of persuasion. He arranged these topics or means of persuasion under three heads. First, those which arise from the character of the orator himself; *i.e.* the character in which, by what must be termed rhetorical artifice, he places himself before his hearers. It is obvious that a speaker addressing an assembly, who is known by them to be actuated by honest motives, and to understand the subject on which he speaks, advances by the mere possession of these adventitious attributes a long way towards the end and aim of oratory, viz. persuasion. Hence it is that Aristotle presents, as one of the chief branches of rhetoric, the art by which the speaker or writer, as it were, invests himself with these attributes, and thus ensures a more favourable reception to his argument. The art of moving the passions by the use of such arguments and representations as are proper to excite each belongs also, in Aristotle's arrangement, to this division of his subject. In his second division he treats of argument itself, considered with respect to its cogency or inconclusiveness in point of form; and hence logic, in this point of view, becomes ancillary to, or a subdivision of, rhetoric. The third division of the subject exhibits the modes of persuasion arising from style, arrangement, delivery, and action; and to this third branch writers who have treated of rhetoric in its more limited sense have usually confined themselves.

As the work of Aristotle is the first, so it is the only systematic treatise on rhetoric which the ancients have left us, among whom the art was much more diligently cultivated than among the moderns. Public speaking was of infinitely greater importance in the classical commonwealths than in any modern state; even in our own, where most sedulously studied and most valued, it is but a subsidiary accomplishment. The true momentum of decision, that which convinces or dissuades, lies in the pen of the writer, rather than the voice of the orator; and whilst in the Grecian republics assemblies were actually swayed by oratory to determine on a particular course of action, its principal use now appears to be to arraign, to vindicate, or to explain the actions of individuals. French oratory, from the nature of its subject, is and always was confined within narrow limits. Probably pulpit oratory, in modern European society, answers most nearly to the classical notion of rhetoric; and, had it ever been subjected to systematic rules, would have been found most nearly to conform to those which the ancients have left us. Among the Romans, oratory did not begin to be cultivated as a science until just at the period when its political importance was about to cease. Rhetoric, under the Roman empire, was taught as a regular science; but its practical display was confined to the orators of the forum, among whom the art gradually declined, from the tendency of the civil law, during the last period of its development, to conduct all process by written rather than oral method. On the other hand, the rules of rhetoric were applied to the construction of declamations, a species of fictitious argument much in vogue during the decline of Roman literature; and of panegyrical harangues. The study of rhetoric, in this perverted sense of the word, *i.e.* of declamatory speaking or writing, found peculiar favour in the African and oriental schools of the Roman empire. Some of the early Christian writers, especially Tertullian, afford evident tokens of having acquired the art of composition under such discipline. *See* ELOQUENCE.

RHEU'MATISM. (Gr. ῥευματισμος.) A painful affection of the joints, attended by swelling or stiffness; and also affecting the muscular, tendinous, and fibrous textures. It is occasionally accompanied by fever, when it constitutes *acute rheumatism*, or *rheumatic fever;* in which case the joints are much swollen and excessively painful; the pulse frequent, but seldom hard; the perspiration usually abundant and acid; the tongue extremely foul, and the bowels costive; headach is seldom complained of, and delirium very rare. In this form of the disease its translation or metastasis to the heart is not uncommon. The treatment consists in occasional venesection; in the use of purgatives and sudorifics, and occasionally of tonics, more especially cinchona: calomel and opium are also largely, and often very successfully employed. *Chronic rheumatism* is not in general attended by any very remarkable constitutional symptoms. It occasionally leads to permanent distortion of the joints; affects the periosteum, tendons, and ligaments; and is most common in debilitated habits, when the health has been broken by previous disease or over exertion of body or mind. Opium, especially in the form of Dover's powder, is generally necessary in this disorder to procure rest. The bowels should be kept moderately active by warm purges, and tonics and alteratives cautiously administered. A course of sarsaparilla is often extremely serviceable: colchicum has been resorted to, but with most uncertain success.

RHINO'CEROS. (Gr. ῥιν, *a nose;* κεϱας, *a horn.*) The name of a genus of Pachydermatous mammals, characterized by one or two horny productions upon the nose. A species of hornbill is also called rhinoceros, on account of the remarkable recurved horny process which rises from its upper mandible.

RHINSBURGERS. The name of a sect of Christians which sprung up in Holland in the 18th century. They seem to have separated from the church for the mere sake of separation, for they held all its doctrines, but rejected all discipline; no other profession being required from its members than a belief that Christ is the Messiah, and that the scriptures are inspired. They allowed of no priests: any member (women alone excepted) might preach and expound in their meetings, which were held in so called *colleges of piety.* At one period they had formed eighteen of these in different towns; but from the large licence of the interpretation of scripture which they enjoyed, several ran into enthusiasm, and having no principle of cohesion they soon fell to pieces, and are now completely extinct. *See* SOCIETY.

RHIPI'PTERANS, *Rhipiptera.* (Gr. ῥιπις, *a fan;* πτεϱον, *a wing.*) A name proposed by Latreille to supersede that of *Strepsiptera,* by which Kirby designated a new order of insects which he had discovered. The new name has nothing to recommend it, since it signifies a character, founded on the presence of pterygoda, common to other orders of insects, as the Lepidopterans.

RHIZA'NTHEÆ. (Gr. ῥιζα, *a root;* ανθος, *a flower.*) A class of plants occupying a station between sexual and asexual species, and appearing to be an intermediate form of organization between Endogens and the lower orders of vegetation. They agree with the former in the presence of sexes, and in their flowers having sometimes a ternary structure; but they have scarcely any spiral vessels; and their seeds appear, as far as they have been examined, to consist of a mass of spores, without a special embryo. In their succulent texture, in their colour, often in their putrid odour when decaying, in the sporuliferous seeds, and in their parasitical habits, these plants resemble *Fungaceæ;* while in their flowers and sexes they accord with *Araceæ,* or similar Endogens. They are in all cases parasites, and destitute of proper leaves, in lieu of which some of them have scales imbricated over their stems. Notwithstanding their parasitical habits, some are of extraordinary size: the flowers of *Rafflesia arnoldi* are as much as nine feet in circumference.

RHIZO'MA. In Botany. *See* ROOTSTOCK.

RHI'ZOSTOMES, *Rhizostoma.* (Gr. ῥιζα, and στομα, *a mouth.*) A genus of *Medusæ,* including those which have the absorbing orifices of their nutrient canals of small size, and situated in great numbers on the branches of arms, or peduncles, extending from the centre of the inferior surface of the disk.

RHO'DIUM. (Gr. ῥοδον, *a rose;* on account of the rose-red colour of some of its salts, especially of the chloride, when dissolved in water.) A metal discovered in 1803, by Wollaston, associated with palladium in the ore of platinum. It is of a whitish colour, very difficult of fusion, and very hard. Its specific gravity is about 11, and its equivalent about 52. It has been used for the points of metallic pens.

RHO'MBOID. In Geometry, a quadrilateral figure which has its opposite sides equal. When its angles are right angles, it is called a *rectangle.*

RHOMB SPAR. A crystalline magnesian carbonate of lime.

RHO'MBUS. In Geometry, a plane figure bounded by four equal straight lines. When its angles are right angles, it becomes a square.

RHONCUS. (Gr. ϱογχος.) A rattling or wheezing sound: the term is chiefly applied to sounds occasioned by certain morbid states of respiration, as indicated by the stethoscope.

RHU'BARB. The root of the *Rheum palmatum,* and perhaps some other species, cultivated in China for the supply of the drug market. The varieties of rhubarb known in commerce under the names of Russian, Turkey, and Indian rhubarb, are all derived from one source; but the select pieces are sold under the name of Russian and Turkey rhubarb, and those of somewhat inferior quality as East Indian. To judge of the quality of rhubarb, it should be cut or broken; when good it is of a mottled reddish or brownish red colour; that which is very pale or very dark coloured, and either so soft as to be spongy, or hard and stony in texture, is bad. Rhubarb is a valuable article of the materia medica, being an aperient, and at the same time a tonic and astringent. The average dose of powdered rhubarb is twenty grains, which after its purgative operation leaves a certain astringent effect upon the bowels; hence its use in diarrhœa: from two to five grains operates as a tonic, and is very useful in some forms of dyspepsia. A mixture of one part of rhubarb with two of powdered sulphate of potash is an excellent aperient for children. It is occasionally given as a tincture or infusion; but the powder is the best form, either in a little plain, or peppermint, water, or in the form of pill.

RHUMB. A circle on the earth's surface making a given angle with the meridian of the place, marking the direction of any object through which it passes. The divisions on the compass card are called rhumbs. *See* MERCATOR'S CHART.

RHUMB LINE. In Naval Affairs, the track of a ship which cuts all the meridians at the same angle; called also the *loxodromic curve.* This being the simplest curve, is the route universally pursued; but a ship sailing on this curve never looks direct for her port until it comes in sight. *See* LOXODROMIC CURVE.

RHYME. (Gr. ῥυθμος, *measure;* or Germ. reim.) In Poetry, the correspondence of sounds in the last words or syllables of verses. The latter is the true rhyme of modern European languages. There are rhymed verses in the Latin classical poets, where the jingle seems intentional, and more distinct examples of it in the fragments of Roman military songs, &c., which have come down to us. But in the earlier period of the decay of the Latin language, when accent was substituted for metre in the rhythmical arrangement of the verse, rhyme made its way into the composition of church hymns, &c. It has been attempted, but with little success, to deduce this innovation from the Goths, and from the Arabians; but the former, like the old Teutonic races, probably used alliteration, but no rhyme in their verses; and the latter could not have influenced European literature until a period long after that in which rhyme first appears. A rhyme in which the final syllables only agree (*strain, complain*), is called a male rhyme; one in which the two final syllables of each verse agree, the last being short (*motion, ocean*), female; and the latter is sometimes extended in Italian poetry to three syllables (*femore, immemore*), when the verse is called *sdrucciolo.* In English such a licence is hardly permissible, except in burlesque poetry (see *Hudibras* and *Don Juan* for instances). By the strict rules of French prosody, the male and female species of rhymes must be alternately used, however intricate the disposition of the verse may be; although the last short syllable is generally mute, or very slightly sounded. Rhymes which extend not only beyond the three last syllables, but through the whole structure of the lines, are used in Arabian and Persian poetry. Rhymes in which the consonants of the last syllable in each verse are identical (*dress, address*) are vicious in English, but rather admired in French poetry. One more singularity of English poetry deserves notice: while from the irregularity of our spelling many syllables rhyme with each other, although widely dissimilar in orthography (*woo, pursue*), there are, on the other hand, rhymes which speak to the eye, and not to the ear; *i. e.* in which the orthography of the rhyming syllables is the same, but the pronunciation different; as, *wind, find; gone, alone.* In the following triplet of Dryden, —

> 'Tis nothing yet; then poor and naked come,
> Thy Father will receive his unthrift home,
> And thy blest Saviour's blood discharge the mighty sum,—

it will be seen that the first and third lines rhyme in a legitimate manner, although the last syllables are differently spelt; while the first and second rhyme to the eye only, and not to the ear. This is a licence only rendered admissible by precedent.

RHYNCHOPHORES, *Rhyncophora.* (Gr. ῥυγχος, *a beak,* and φερω, *I carry.*) The name of a family of Coleopterous insects, comprehending those which have the head prolonged in the form of a snout or proboscis.

RHYTHM. (Gr. ῥυθμος.) The consonance of measure and time in poetry, prose composition, and music, and by analogy in dancing. Each verse or each period may be considered as a whole, within which the poetical rhythm is regular and exact, within certain limited variations, the rhetorical less perfect, and the pleasure derived from it rather matter of taste and experience than of rule. Those parts which receive the ictus or stress of the rhythm are termed *arsis* (elevation), the remainder form the *thesis* (depression); the former is frequently denoted to the eye by the accent marked ′, when in a foreign or unknown word we wish to direct the voice in pronunciation to employ the correct emphasis. The smallest rhythmical division is the foot, by which every union of arsis and thesis is understood. A short syllable is an original unit of time; a long syllable contains two units. The number of feet enumerated in classical writers on metre amount to twenty-eight, including all the varieties which may be formed out of two, three, or four syllables, long and short, and varying from two to eight units of time. *See* FOOT, METRE.

RIAL. A gold coin current in the reigns of Henry VI. and Elizabeth: under the former its value was 10*s.*, under the latter 15*s.*

RIBS. In Architecture, curviform timbers to which, in an arched or coved plaster ceiling, the laths are nailed.

RIBS. A term for the timbers of a ship which spring from the keel, as the ribs of an animal from the back bone.

RIBS. In Anatomy, the lateral appendages of a vertebra, especially when developed so as to encompass the trunk. In the human subject there are twelve ribs.

RICE. *See* ORYZA.

RICE PAPER. This substance is said to be a membrane of the *Artocarpus incisa,* or bread-fruit tree. (*See* ARTOCARPEÆ.) It is brought from China in small pieces, dyed of various colours, and is used as a material for painting upon, and for the manufacture of several fancy and ornamental articles. It is sometimes erroneously stated to be prepared from rice. (See Brewster, *Edinb. Journ. of Science,* vol. ii.)

RICI′NIC ACID. One of the products obtained by distilling castor oil at a high temperature.

RICKETS. *See* RACHITIS.

RICOCHE′T FIRING, in Gunnery, is a mode of firing with small charges from pieces of ordnance elevated at small angles, as from 3° to 6°. It is a very destructive method; as the rebound causes the shot or shell to pass along a great space almost upon the ground, destroying all that it meets with in its way. The word signifies, literally, the sort of motion which is familiarly called ducks-and-drakes, as applied to a flat stone thrown on the surface of the water under a very small angle.

RIDEAU. In Fortification, a small elevation of earth extending itself lengthwise on a plain, serving to cover a camp from the approach of the enemy, or to give other advantage to a post.

RI′DER. A term used to signify any addition to manuscripts or other documents, inserted after their completion.

RIDGE. In Architecture, the upper horizontal timber in a roof, against which the rafters pitch.

RI′DING. The three divisions of the county of York are so termed, by a corruption of the Saxon word *trilhing* or *triding* (third part).

RIDO′TTO. (Ital.) A favourite public Italian entertainment, consisting of music and dancing; held generally on fast eves.

RI′FLE GUNS. Muskets or pieces of ordnance, whose barrels, instead of being a clear cylinder inside, are furrowed with spiral channels. The object is to give the ball a rotatory motion about an axis, in consequence of which it preserves its direction with much greater certainty than when fired from the common clear barrel. *See* GUN.

A body of men armed with rifles are called riflemen; but the term is most frequently applied to the military corps called the *rifle brigade,* and to the 60th regiment of the British army, which is dressed in green and armed with rifles.

RIG. The peculiar manner of fitting the masts and rigging to the hull of any vessel; thus schooner rig, ship rig, &c., imply the masts and sails of these vessels without regard to the hull.

RI′GGING. The system of cordage by which the masts are supported, and the sails extended or taken in. The rigging is hence divided into *standing rigging* and *running rigging.* The standing rigging consists of the *pendants,* short strong ropes first put over the lower mast heads, and having thimbles for hooking tackles to; the *shrouds, stays,* and *backstays.* The lower rigging implies that of the lower masts, the topmast rigging that of the topmast, and so on. The size, strength, number of ropes, &c. of the rigging, are all matters determined by experience. A complete description of rigging is to be found in the well-known work of Darcy Lever.

RI′GGING LOFT. The room or rooms in which the rigging is prepared.

RIGHT. In Geometry, a term sometimes used synonymously with straight, as *right line;* but generally as opposed to oblique. Thus, a *right angle,* the angle formed by two straight lines perpendicular to each other, or an angle of 90°; *right cone, cylinder, prism, pyramid,* &c., figures whose sides are perpendicular to the plane of the base.

Right-angled Triangle. A triangle having one right angle.

Right-angled Triangle. In Numbers. A favourite speculation of the Platonic school of mathematicians was to find rational numbers which should designate the sides of a right-angled triangle. Pythagoras gave the formulæ n, $\frac{n^2-1}{2}$, and $\frac{n^2+1}{2}$, where n is odd. Plato gave $2n$, n^2-1, and n^2+1, where n is either odd or even. Various other forms have been given by subsequent writers. The determination of such sets of formulæ forms a branch of the Diophantine Analysis.

RIGHT SPHERE. In Geography, the position of the sphere when the equator cuts the horizon at right angles.

RIGHT ASCENSION, in Astronomy, is the angle at the pole of the equator formed by two great circles, one of which passes through the first point of Aries, and the other through a celestial body, and is consequently measured by the arc of the equator intercepted between those circles. *Right ascension* and *declination* are the

two co-ordinates to which the positions of celestial objects are referred.

RIGHT, DIVINE. *See* DIVINE RIGHT.

RIGHT OF PRO'PERTY. (Lat. jus proprietatis; Fr. droit de proprieté.) In Political Economy, the right which states, bodies of individuals, and individuals have to the exclusive use and enjoyment of such lands, natural powers, and products as have been appropriated or set apart for any peculiar purpose.

Origin of this Right. — It would occupy the reader's time to no good purpose were we to state the different theories that have been advanced by jurists and writers on public law to account for the origin of this right.* This, indeed, appears to us to be sufficiently obvious. All the rude products furnished by nature have to be appropriated; and not one in a thousand, perhaps, of these products is, in its natural state, capable either of supplying our wants or administering to our comforts. Hence the necessity not only of applying labour in the appropriation of natural products, but in fashioning and preparing them so as to be useful; and hence, also, the origin of the right of property.

If a number of individuals be set down together on the shore of an unoccupied and unappropriated island, abounding with natural products, such as game, trees laden with fruit, &c., each will have quite as good a right as another to take the game or the fruit. But those who do so, or who have through their skill and industry appropriated a portion of the common stock, will obviously be entitled to the exclusive use of such portion. We shall not undertake to decide whether there be or be not a principle inherent in man that at once suggests to every individual that it is his duty not to interfere with what has been produced or appropriated by the labour of others; it is sufficient for us to know that the briefest experience would point out to every one the necessity of respecting this principle. If A. climb a tree and bring down fruit which as soon as he comes to the ground is taken from him by others, he will not again engage in any similar undertaking till he be well assured that he shall be permitted exclusively to profit by what has been obtained through his sole exertions; nor will others engage in any such undertaking without a similar assurance. No doubt, therefore, the right of property has had a very remote origin. The necessity for its establishment is so very obvious and urgent, that it must have been all but coeval with the formation of societies. All have been impressed with the reasonableness of the maxim which teaches that products acquired by the *labour* of a man's body, and the *work* of his hands, should be considered as exclusively his own. Even among the rudest savages the principle of *meum* and *tuum* is recognized; the bows and arrows of the huntsman, and the game he has killed, being regarded by him as his own, and his right to their exclusive possession being respected by his fellows. The right of property, like other rights, is, no doubt, perfected only by degrees, and is necessarily limited and adapted to the state of society at the time. Thus, among hunters, the *feræ naturæ* on which they subsist, not being bred under the care or inspection of individuals, are, so long as they run wild in the forest, the common property of the tribe, and only become the property of individuals after they have been appropriated or caught by their labour or ingenuity. As society advances, the right of property expands. The modern Tartars, like the ancient Scythians, estimate their wealth by the number of their cattle. Their right to the animals which they have domesticated and reared is deemed sacred and inviolable; but the pasture grounds belong, like the hunting grounds of the Indians, to the whole society; and as the flocks are driven from one place to another, the grounds may be successively depastured by the cattle of every different individual. The moment, however, that men began to renounce the pastoral for the agricultural mode of life, a right of property in land began to be established. The soil cannot be cultivated, its fertility cannot be increased, nor can it be made to produce those crops which yield the largest supplies of food and other necessary accommodations, without continuous labour, and persevering attention.

> ——— Pater ipse COLENDI
> Haud facilem esse viam voluit.

Hence the origin of property in land. Nothing, it is plain, could ever tempt any one to engage in a laborious employment; he would neither domesticate wild animals, nor clear and cultivate the ground, if, after months and years of toil, when his flocks had become numerous, and his harvests were ripening for the sickle, a stranger were allowed to rob him of the produce of his industry. The utility, or rather necessity, of enacting some general regulations, that should secure to every individual the peaceable enjoyment of the produce he had raised, and of the ground he had cultivated and improved, is, indeed, so very obvious, that it suggested itself to the first legislators. The author of the Book of Job places those who removed their neighbours' landmarks at the head of his list of wicked men; and the early Greek and Roman legislators placed these marks under the especial protection of the god Terminus, and made their removal a capital offence. (*Goguet, de l'Origine des Loix*, lib. i. art. 2.) Society may, in fact, be said to have grown out of the institution of a right of property in land. "Had not," says Mr. Justice Blackstone, "a separate property in lands, as well as moveables, been vested in some individuals, the world must have continued a forest, and men been mere animals of prey. Whereas now, so graciously has Providence interwoven our duty and our happiness together, the result of the institution of property has been the ennobling of the human species, by giving it opportunities of improving its rational faculties, as well as exerting its natural. Necessity begat property; and in order to insure that property recourse was had to civil society, which brought along with it a long train of inseparable concomitants, — states, government, laws, punishments, and the public exercise of religious duties. Thus connected together, it was found that a part only of society was sufficient to provide, by their manual labour, for the necessary subsistence of all; and leisure was given to others to cultivate the human mind, to invent useful arts, and to lay the foundation of society." (*Comment.* book ii. cap. 1.)

It is obvious, from what has now been stated, that the law of the land is not, as Dr. Paley has affirmed, the real foundation of the right of property. It has a much more remote and more solid foundation. It grows out of the circumstances under which man is placed; and could not be overthrown or set aside without depopulating the earth, and throwing mankind back into primæval barbarism. The obvious utility of securing to each individual the peaceable enjoyment of the land he has enclosed and cultivated, and of the produce raised or acquired by his labour, has undoubtedly formed the irresistible reason that has induced every people to make the right of property a part of the law of the land, and to guard it by the strongest sanctions. The security of property is, in truth, the principal foundation on which society rests. Until property had been publicly guaranteed, men must have looked on each other as enemies rather than as friends. The idle and improvident are always desirous of seizing on the earnings of the laborious and frugal; and if they were permitted to prosecute their attacks, they would, by generating a feeling of insecurity, effectually check both industry and accumulation, and sink all classes to the same level of hopeless misery as themselves. The security of property is, if possible, still more necessary to accumulation than to production. No man ever denies himself an immediate gratification, when it is within his power, unless he think that, by doing so, his present forbearance will obtain for him a greater accession of comforts and enjoyments, or that it will obviate some probable and considerable evil at a future period. Where the right of property is vigilantly protected, an industrious man who gains as much by one day's labour as is sufficient to maintain him two is not idle the second day, but accumulates the surplus produce above his wants as a capital; the increased consequence and enjoyments which the possession of capital brings along with it being, in the great majority of cases, more than sufficient to counterbalance the desire of immediate gratification. But, wherever property is insecure, we look in vain for the operation of the principle of accumulation. "It is plainly better for us," is then the invariable language of the people, "to enjoy while it is in our power, than to accumulate property which we shall not be permitted to use, and which will expose us to the depredations of those who exist only by the plunder of their more industrious neighbours."

The security of property is violated not merely when a man is deprived of the power of peaceably enjoying the fruits of his industry; it is also violated, and perhaps in a still more unjustifiable manner, when he is prevented from using the powers with which nature has endowed him in any way, not injurious to others, he may consider most for his own advantage. Of all the species of property which a man can possess, the faculties of his mind and powers of his body are most particularly his own. He should, therefore, be permitted to enjoy, that is, to use or exert, these powers at his discretion. And hence the right of property is as much infringed upon when a man is interdicted from engaging in a particular branch of business, as it would be were he unjustly deprived of the produce he had raised. Every monopoly which gives to a few individuals the exclusive power of carrying on certain branches of industry is thus, in fact, established in direct violation of the property of every one else. It prevents them from using their natural capacities, or powers, in the manner they may consider best; and as every man who is not a slave is justly held to be the best, and indeed only judge, of what is advantageous for himself, the principles of natural law

* The learned and curious reader may consult Puffendorff, lib. iv. s. 1—6.

and the right of property are both subverted by his exclusion from any employment. In like manner, the right of property is violated when regulations are made to force individuals to employ themselves or their capital in a particular way. The property of a landlord is violated if he be compelled to adopt any system of cultivation, even supposing it were really preferable to that which he was previously following. The property of the capitalist is violated when he is obliged to accept a lower interest for his stock than he might have obtained; and the property of the labourer is violated whenever he is obliged to engage in any particular occupation. It follows, too, that every restraint on the freedom of commerce is an infringement of the right of property. If I, the lawful owner of any given article, am prevented from exchanging for any other I may be desirous to obtain, the right of property is as much invaded as if I were debarred from making any direct use of the article. Had this circumstance been adverted to, it is probable the restrictive system would not have made quite so much progress as it has done.

Effects of the Insecurity of Property. — The finest soil, the finest climate, and the finest intellectual powers, can prevent no people from becoming barbarous, poor, and miserable, if they have the misfortune to be subjected to a government which does not respect and support the right of property. All those vast and fruitful countries, comprising the fairest portion of the earth, that stretch from the Black Sea to the Persian Gulph, and from the western shores of Morocco to the confines of China, once the seat of the most renowned empires, of arts and civilization, are now, through the want of security and freedom, become the most deplorable spectacles of extreme misery. "No care," says Mr. Kinneir, speaking of some of the most fertile provinces of Asia Minor, "is taken to improve the land; nor can this be matter of surprise, when we reflect that the farmer is liable to be turned out at a moment's warning, and is certain of being taxed, or rather plundered, in exact proportion to the yearly produce of his farm. It is not, indeed, uncommon, should there be a prospect of a plentiful harvest, for the crops upon the ground to be seized by the pacha, at a low valuation, and then put up to the highest bidder!" (*Journey in Asia Minor, &c.* p. 52.) The same intelligent traveller observes, in speaking of Syria, "that the Grand Seignior is the lord of the soil, and the *miri* or capitation tax, is regularly paid into the public treasury. The pachas derive their revenues from levying arbitrary contributions in money and in kind upon the merchants, citizens, villagers, and cultivators of the land. This unjust and uncertain mode of taxation is rendered still more afflicting by the manner of collecting it. The troops and followers of the pacha, a licensed banditti, disperse themselves over the country and villages, where they live at free quarters, and for every piastre that is received by their master at least three have been exacted from the unfortunate proprietor. Under such a system neither agriculture, commerce, arms, arts, nor sciences, can ever make the least progress; and it is deeply to be lamented that no successful effort has hitherto been made to wrest so noble a country from those who are so unworthy to possess it." (*Ibid.* p. 174.)

Had it been possible for arbitrary power to profit by the lessons of experience, it must long since have perceived that not only the wealth of its subjects, but its own, would be most effectually increased by maintaining the security of property. Were the governments of Turkey and Persia to establish a vigilant system of police, to secure to each individual the unrestrained power of disposing of the fruits of his labour, and to substitute a regular plan of taxation in the room of the present odious system of extortion and tyranny, industry would gradually revive; capital and population would be augmented; and a moderate land-tax, or reasonable duties on a few articles in general demand, would bring a much larger sum into the coffers of the treasury than all that is now obtained by force and violence. The *stated* public burdens laid on the Turks, Persians, &c., are light compared with those imposed on the English, Dutch, and French. But the latter know that when they have paid the taxes due to government they will be permitted peaceably to enjoy or to accumulate the residue of their wealth; whereas the subjects of eastern despotisms have, generally speaking, no security that, the moment after they have paid their stated contributions, the pacha, or one of his satellites, may not strip them of every additional farthing they possess! Security is the foundation, the principal element, in every well-digested system of finance. When maintained inviolate, it enables a country to support, without much difficulty, a very heavy load of taxes; but where there is no security, where property is a prey to rapine and spoliation, to the attacks of the needy, the powerful, and the profligate, the smallest burdens are justly regarded as oppressive, and uniformly exceed the means of the impoverished and dispirited inhabitants.

Power of bequeathing Property. — To perfect the right of property, it is necessary not only that an individual should have the power freely to dispose of it during his lifetime, but also that he should have power to bequeath it to others in the event of his death. *Nihil enim tam conveniens est naturali æquitate*, say the Roman jurists; *quam voluntatem Domini volentis rem suam in alium transferre, ratam haberi.* (*Instit.* lib. ii. tit. i. s. 40.) It is evident that the being enabled to bestow our property on those who occupy the chief place in our affections must have a powerful effect in stimulating industry. When a man is assured that he is not labouring for strangers, that the fruit of his industry will not fall into the hands of an unknown successor, but will descend to his children or his friends, he finds, as it were, his existence indefinitely extended, and continues with unimpaired energy to exert himself for the benefit of those who are to perpetuate his family and name, and whose welfare, perhaps, is as dear to him as his own. The power of bequeathing property connects the future with the present; without it, no undertaking would be entered upon which did not promise an adequate return during the lifetime of the projector. But in civilized societies the plans of the capitalist are not circumscribed by the brief duration of human life. He plants forests by which he can never expect to be enriched; he raises edifices fitted and intended to outlive many generations; and executes innumerable improvements, of which posterity alone can reap the benefit. And he does all this because he is permitted to name his successors; to transmit his property and effects to those with whom he is connected by the ties of kindred, affection, or gratitude, and in whose welfare he feels a deep interest.

Numerous difficult and important questions have, however, to be decided in framing regulations as to the bequeathing of property by will; and as our purpose at present is merely to point out the principle on which the power is conceded, we shall defer the notice of the conditions which should limit its exercise to the article SUCCESSION, LAW OF.

Property in Wild Animals. — It is clear from what has been previously stated, and from the nature of the thing, that nothing can be made property unless it be susceptible of appropriation; and, on this ground, it has sometimes been objected to the game laws, that they have made a property of that which being incapable of appropriation should belong to the community, or to the captors. In support of this view of the matter the rule of the Roman law has been appealed to, where it is laid down — *Feræ igitur bestiæ, et volucres, et pisces, et omnia animalia quæ mari, cœlo, et terra nascuntur, simul atque ab aliquo capta fuerint, jure gentium statim illius esse incipiunt; quod enim ante nullius est, id naturali ratione occupanti conceditur.* (*Instit.* lib. ii. tit. i. § 12.) But it is distinctly laid down in the same article whence we have borrowed this paragraph, that the proprietor of an estate has full power to prohibit any one from entering upon it to kill wild animals. Without this proviso, there would not, in fact, be any such thing as a real property in land; and this is, in truth, all that is meant when it is said that game is property. A partridge or hare is mine so long as it remains on my estate; but the moment it transfers itself to the estate of another, it becomes the property of the owner of such estate. Poachers are punished, not because they have killed wild animals, but partly and principally because in doing so they invade the right of property by killing it without leave on lands belonging to other parties, on which they had no right to enter, and partly because they have not paid the tax demanded by government from all who kill game.

It is sometimes indispensable for the interests of society to appropriate the whole or a portion of the landed property of one or more individuals to some public purpose, as the formation of a road, a canal, &c. But property should never be wantonly taken for such purposes, nor till the advantages to be obtained by its cession have been fully established before some competent tribunal; and when this has been done, full compensation should in every case be given to those who are thus called upon to give up their property for the promotion of the public interests.

Inconveniences of a Community of Goods. — Those schemes of policy that have been founded or projected either upon the principle of a communion of goods, or of an equal partition of the land among the different families belonging to the society, are bottomed on the most erroneous views, and would, if they could be acted upon, be an effectual bar to every improvement. Those who have advocated these schemes, struck with the evils arising from the violations of private property to which the ill-regulated cupidity of some and the wretchedness of others are perpetually giving birth, seem to have thought that the crimes and disorders that were thus occasioned might be advantageously and completely got rid of by abolishing the right of property, and obliging men to labour in common, and giving each in-

dividual an equal share of the produce raised by the joint labour of all. They imagined that they would, in this way, eradicate that selfishness which was so fruitful a source of mischief; that as no one could be either richer or poorer than his neighbour, no one would be the object of envy or attack; and that the principal sources of discord and crime being thus dried up, men would henceforth live together like brothers, and be anxious only to promote each other's welfare. But these expectations are wholly inconsistent with the nature of man, and cannot, therefore, be realized. We might as well attempt to eradicate the feelings of hunger, and of thirst, as of self-interest; and if we could eradicate it, we should eradicate the principle which impels man to labour, which prompts him to contrive, invent, and amass. There is plainly nothing blameable in our preference of ourselves to others. The desire of aggrandizement becomes injurious only when it prompts individuals to endeavour to advance their own interests by acting unjustly by their fellow-men; for, otherwise, it is the source of all that is most advantageous to society. And it is mainly for the purpose of obviating this abuse, and of protecting every one in the enjoyment of his property, that governments have been instituted. *Hanc enim ob causam*, says Cicero; *maxime ut sua tuerentur, respublicæ civitatesque constitutæ sunt. Nam etsi duce naturæ congregabantur homines, tamen spe custodiæ rerum suarum urbium præsidia quærebant.*

It is idle, therefore, to think that the feelings of self-interest can ever be eradicated from the human breast. All that the adoption of the system of those who propose to establish a communion of labour and of goods could do, would be to give the principle of selfishness a different direction from what it takes when left to itself; to render it a source of idleness and poverty, instead of labour and wealth. Suppose you have a community of a thousand individuals who live and labour in common: in this, as in all similar cases, it would be obvious to every individual that if, on the one hand, he made any unusual exertions, either of body or mind, he would reap only the thousandth part of the advantages derivable from them; while, on the other hand, it must be equally obvious, that if he contrive to avoid performing his due share of work, or obtain more than his fair proportion of its produce, he will be the *sole* gainer. Under such circumstances, it is clear not only that society could make no farther progress, but that it must gradually, and not very slowly, retrograde. The principle of self-interest would not be annihilated; on the contrary, it would be as strong as ever; but inasmuch as no one could henceforth expect to advance himself by industry, ingenuity, or frugality, a regard for his own interest would teach him to follow an opposite course, and would infallibly prompt him to labour as little and to consume as much as possible! The evils produced by such a system would be so intolerable that it could not be continued. But if it were, we should, instead of the industry, invention, and wealth produced by the establishment of private property, and the consequent efforts of individuals to advance themselves in the scale of society, have universal idleness, indifference, and the most abject misery. We should purchase an exemption from those crimes and disorders incident to an advanced stage of society, and which the adoption of good laws and a vigilant system of police go far to repress, by the annihilation of every thing that raises civilized man above the condition of the savage, and by subjecting all classes to the plague of universal poverty.

Inconveniences of Agrarian Laws. — The attempt to found a society upon an agrarian law, or upon the principle of maintaining an equal division of land amongst the different families of the society, is as much opposed to the nature of things as a communion of goods; but were the system in other respects as advantageous as it is the reverse, it could not be maintained for any considerable period. Though the first settlers of an unoccupied country were to adopt this plan, it would, in less than a dozen years, be wholly subverted, and there would be the greatest inequality in their fortunes. This would arise from differences of strength, talent, and conduct, from the varying numbers and conduct of children, and the other unforeseen accidents and occurrences which are always affecting the circumstances of individuals. It is absurd to suppose that an equality of condition could be maintained, notwithstanding the operation of such powerful causes of derangement, without resorting to the most atrocious system of tyranny, without equalizing the number of children, and abstracting a portion of the earnings of the industrious and frugal to bestow them on the idle and improvident. But it is unnecessary to dwell on such crude absurdities. The distinction of rich and poor is not, as some shallow sophists would seem to suppose, artificial, but real; it is as much a part of the order of Providence as the distinction of the sexes. It depends on the differences of the physical and mental powers and dispositions of different individuals, and of the different circumstances under which they happen to be placed; and to attempt to obliterate this distinction by encroaching on the right of property, and enacting agrarian laws, or laws of a similar tendency, is to attempt to accomplish what is in its nature impracticable, at the expense of great and certain mischief and inconvenience.

RIGHT, PETITION OF. A declaratory enactment passed by the parliament of 1628, to which this name was given by the framers, who were desirous to imply by it that the franchises therein specified were not newly acquired, and that the law was merely explanatory of the ancient constitution. It was calculated to protect the subject against forced loans, benevolences, taxes imposed without consent of parliament, arbitrary imprisonments, &c. Much delay and some evasion took place before Charles I. could be induced to give the royal assent to this measure.

RIGHTS, BILL OF. *See* Bill of Rights.

RIGI'DITY. In Mechanics, a resistance to change of form. In all theoretical investigations respecting the application of forces through the intervention of machines, those machines are assumed (except cords) to be perfectly rigid, so far as the forces employed are able to affect their integrity of form and structure. Rigidity is often, in the arts, called *stiffness*, and is opposed to flexibility.

The rigidity of cords, or the difficulty with which they are bent into any given curve, is the chief cause of the loss of power arising from their employment in machines. The law of their loss of force may be thus expressed: — The resistance arising from the stiffness of cords is as the weights which stretch the cords multiplied by the thickness of the cords, and divided by the radii of curvature of the surfaces over which they pass. It is, however, necessary to state that experiments exhibit great discrepancies with this theoretical law.

RI'GORISTS. In Ecclesiastical History, a name sometimes given to the extreme Jansenist party. (See *Mosheim*, vol. v. p. 221. transl. ed. 1790.)

RI'MOSE. (Lat. rima, *a cleft.*) In Zoology, when the surface of an animal or part resembles the bark of a tree, having numerous minute, narrow, and nearly parallel excavations, which run into each other.

RINFORZA'NDO. (It. *strengthening.*) In Music, a direction to the performer, denoting that the sound is to be increased. It is marked thus $<$; when the sound is to be diminished (*diminuendo*) this mark $>$ is used.

RING. In Geometry, the figure enveloping a sphere which moves with its centre always in a given curve, most commonly a circle. For the principal properties of this solid, see Hachette, *Géometrie Descriptive.*

The term is also sometimes applied to designate the area of the space between two concentric circles.

RING BONE. In Farriery, a callus growing in the hollow circle of the little pastern of a horse, just above the coronet.

RING OF SATURN. *See* Saturn.

RINGS, FAIRY. This name is given to irregular circles in pastures and lawns on which *Agarics* spring up, and which become much more verdant than the surrounding grass. They are caused by the centrifugal growth of the spawn of the *Agaric*, which radiates from a common centre, and bears the fructification, which is what appears above ground, only at the circumference. The verdure of the grass where these fungi grow seems to be caused either by their manuring the ground when they decay, or by the nitrogen they give off, which is an active stimulant to vegetation. The appellation of *fairy rings* was given to this phenomenon from their being regarded as the places where the fairies held their nocturnal revels.

RING SAIL. A small and light sail set on a mast on the taffrail. Also a studding sail set upon the gaff of a fore and aft sail.

RI'NGWORM. This disease appears in circular patches upon the neck, forehead, or scalp; it begins with clusters of little pustules, which form scabs, leaving a red pimply surface, and destroying the roots of the hair as it proceeds, which it does, if not prevented, over the greater part of the head. It is most common in children of a feeble flabby habit; but as it is communicable by contagion, it generally spreads rapidly in schools and families by the frequent contact of the heads of children, or by the use of the same caps, combs, towels, &c.; so that when it once appears, the diseased boys should be strictly removed from the others. The treatment consists in shaving the head, and using frequent and regular ablutions in the first instance, sponging the part with weak soap and water; when the scabbing begins, other applications must be used, the selection of which must entirely depend upon the degree of irritation and other circumstances. Solutions of nitrate of silver, sulphate of copper, iodide of potassium, or of iron, pitch and tar ointments, petroleum and naphtha, mercurial ointments of different kinds, and various other stimulants, as also sometimes sedatives, are resorted to, to get rid of the morbid state of the part; but so whimsical and obstinate is the disease, that it is impossible to lay down any mode of treatment which can be considered

as approaching to a specific. Except in particular cases no internal medicine has appeared to be of use.

RI'OT, in Law, is said to be a tumultuous disturbance of the peace by three persons or more assembling together of their own authority in order to assist each other against any one who shall oppose them in the execution of a private purpose, and afterwards executing the same in a violent and turbulent manner. A rout is said to be a disturbance of the peace by persons assembled together to do a thing, which, if executed, would make them rioters, and making some motion towards that object; an unlawful assembly, a similar disturbance by persons who neither execute their purpose, nor make any actual motion towards the execution of it.

RIPIE'NO. (It. *full.*) In Music, a term signifying full, and is used in compositions of many parts, to distinguish those which fill up the harmony and play only occasionally, from those that play throughout the piece.

RIPPLE-MARKS. The peculiar undulated marks, which the receding waves leave on the sea beach, and which are occasionally found in some of the older strata of rocks, and are considered as announcing a similar action at a remote period. The wind blowing over a sandy district sometimes occasions a similar appearance.

RITORNE'LLO. (It. *a return.*) In Music, properly a short repetition, such as that of an echo, or of the last words of a song, especially if such repetition be made after a voice by one or more instruments. But by custom this word is now used to denote all symphonies played before the voices begin, and which seem to prelude or introduce what follows.

RI'TUAL. (Lat. ritus, *a rite.*) A book in which the different rites or services of the church are contained.

RI'VER. (Lat. rivus.) In Physical Geography, an inland current of water, formed within a certain portion of the earth's surface by the confluence of brooks, small streams, or mountain torrents, and discharging itself into the ocean, a lake, marsh, or other river. There are few subjects in physical geography which present so wide a field for speculation as rivers, whether we regard them in an historical, political, economical, or scientific point of view. They are associated with the earliest efforts of mankind to emerge from a state of barbarism; but they are no less serviceable to nations which have reached the acmé of civilization. In the earliest ages they were regarded with veneration, and became the objects of a grateful adoration surpassed only by that paid to the sun and the host of heaven. Nor is this surprising; for in countries where the labours of the husbandman and shepherd depended for a successful issue on the falling of periodical rains, or the melting of the collected snows in a far-distant country, such rivers as the Nile, the Ganges, and the Indus were the visible agents of nature in bestowing on the inhabitants of their banks all the blessings of a rich and spontaneous fertility; and hence their waters were held sacred, and they received, and to this day retain, the adoration of the countries through which they flow. But it is by countries which have already made progress in civilization (to which, indeed, they largely contribute) that the advantages of rivers are best appreciated, in their adaptation to the purposes of navigation, and in their application to the useful arts. Like the veins and arteries of the human body which convey life and strength to its remotest extremities, rivers vivify, maintain, and excite the efforts of human industry; whether we regard them near their source as the humble instruments of turning a mill, in their progress as facilitating the transport of agricultural or manufacturing produce from one district to another, or as enriching the countries at their mouths with the varied products of distant lands. This has been so admirably expressed by Pliny, that we cannot refrain from embodying his words in our pages. "The beginnings of a river," he says, "are insignificant, and its infancy is frivolous: it plays among the flowers of a meadow; it waters a garden, or turns a little mill. Gathering strength, in its youth it becomes wild and impetuous. Impatient of the restraints which it still meets with in the hollows among the mountains, it is restless and fretful; quick in its turning, and unsteady in its course. Now it is a roaring cataract, tearing up and overturning whatever opposes its progress, and it shoots headlong down from a rock; then it becomes a sullen and gloomy pool, buried in the bottom of a glen. Recovering breath by repose, it again dashes along, till, tired of uproar and mischief, it quits all that it has swept along, and leaves the opening of the valley strewed with the rejected waste. Now quitting its retirement, it comes abroad into the world, journeying with more prudence and discretion through cultivated fields, yielding to circumstances, and winding round what would trouble it to overwhelm or remove. It passes through the populous cities, and all the busy haunts of man, tendering its services on every side, and becomes the support and ornament of the country. Increased by numerous alliances, and advanced in its course, it becomes grave and stately in its motions, loves peace and quiet, and in majestic silence rolls on its mighty waters till it is laid to rest in the vast abyss."

Most large rivers have their origin in very elevated mountains, or on high table lands, the height and direction of which chiefly determine their size and course. For full information on the various points involved in this subject, we beg to refer the reader to the article "Rivers" in the *Ency. Brit.*; and we shall in this place confine our remarks to some of their most striking peculiarities, — *periodical inundations, occultations,* and *reappearance.*

The *periodical inundations* of rivers depend on great falls of rain in mountainous regions, or on the melting of snows in the neighbourhood of their source. The period depends on the return of these seasons in different places. Within the tropics, the rainy season occurs usually about the time when the sun passes the meridian towards the tropics; and continues until his return to the same place. The rise of the Orinoco commences in May, its inundation begins in June, and the waters return to their channel in September; from which time they decrease until April of the succeeding year. In the Lower Mississippi, whose inundations begin in March, and are at their height in June, are found those enormous rafts of driftwood (formed during the inundations), which sometimes extend for ten or twelve miles in one mass, rise and fall with the stream, yet have a luxurious vegetation on their summits. The great rivers of Asia — the Ganges, the Indus, the Tigris, and Euphrates — have also their periods of inundation, depending on the circumstances determining the setting in of the rains on the mountains in which they originate. In the Ganges the waters begin to increase in April, and at the end of July the country, for an hundred miles along its banks, presents the appearance of a vast lake interspersed with insulated villages and woods. But of all inundations, those of the Nile are the most celebrated; nor is it possible to find any where among terrestrial objects a more striking instance of the stability of the laws of nature, than the periodical rise and fall of this mighty river. We know by the testimony of antiquity that the inundations of the Nile have been the same, with respect to their season and duration, for three thousand years. Indeed, their certainty regulates the public revenue; for when by means of nilometers it is ascertained that the waters promise an unusually prosperous season, the taxes are proportionally increased. Shortly after the commencement of the rains of Abyssinia, in June, the river begins to rise, and attains its greatest height in August. At Cairo the greatest rise is twenty-eight feet; but in the valley of the Nile, with a mean breadth of three or four leagues, it is only four feet. It decreases gradually until the following May; and as soon as the waters are within their usual channel, the soil, moistened and enriched by the sediment deposited from the inundation, is diligently cultivated by the natives. Pliny thus speaks of the inundation:—"Justum Incrementum est cubitorum 16, minores aquæ non omnia rigant: ampliores detinent tardius recedendo. Hæc serendi tempora absumunt: illæ non dant sitiente. Utrumque reputat provinciæ. In duodecim cubitis famem sentiant, in tredecim etiamnum esurit; quatuordecim cubita hilaritatem afferant, quindecim securitatem, sexdecim delicias." (*Hist. Nat.* lib. v. 9.)

The *engulphment and reappearance* of some rivers have attracted attention in every age; nor has any satisfactory explanation been yet assigned for this extraordinary phenomenon. In the Memoir of the Abbé Guettard, the phenomenon in question is accounted for by the spongy nature of the soil through which such rivers flow; thus the Guadiana, one of the largest rivers in Spain, suddenly disappears in the marshes near the village of Castillo de Cerrera, and after pursuing a subterraneous course for twelve or fourteen miles bursts again into day. Limestone districts afford many specimens of this phenomenon; one of the most striking of which is the occultation of the Rhone near the gorge called the *Perte.* There are also some curious instances in Derbyshire and Yorkshire. But no country surpasses Greece in the number of its subterranean streams, the peculiarities of which are often clothed in splendid mythological fictions by her ancient bards. The waters of many valleys in the Peloponnesus have no other outlets than ζεςεθρα, or chasms, which engulph them; such are the outlets of the valleys of Tegea, Mantinea, Asæa, Stymphalus, Peneus, &c. A familiarity with such phenomena, and a poetical temperament, readily led the ancient Greeks to conceive still more distant secret communications; and the imagination which peopled every grove, and animated every stream with presiding deities, could easily reconcile itself to the story of the river god Alpheus, who was said to pursue his favourite nymph Arethusa beneath the bed of the ocean from Greece to the shores of Sicily. (*Traill's Physical Geography.*)

We subjoin, from Dr. Traill's valuable Treatise on Physical Geography, a table showing the length of the course of twenty-two of the principal rivers of the

world, and the area of their respective basins, together with their proportional lengths in English miles; a calculation which has been obtained by multiplying them by 180, being the distance between the remotest sources of the Thames, which is assumed as unity, and its embouchure at the Nore.

Rivers.	Length.	Length in English Miles.	Proportional Magnitude of Basin.	Area of Basin in English Miles.
Europe.				
Thames - -	1	180	1	5,500
Rhine - -	4½	810	12½	70,000
Loire - -	4	720	8¾	48,000
Po - - -	2¼	400	5	27,000
Elbe - -	4½	820	9	50,000
Vistula - -	4¼	760	13½	76,000
Danube - -	9¾	1750	56	310,000
Dnieper - -	7¾	1390	36	200,000
Don - -	7½	1350	37	205,000
Asia.				
Wolga - -	14	2520	94	520,000
Euphrates - -	9¾	1750	42	230,000
Indus - -	11½	2070	72½	400,000
Ganges - -	10	1800	76	420,000
Kang-tse, or Great River of China -	21½	3870	138	760,000
Amour, Chinese Tartary - -	16	2880	164	900,000
Lena, Asiatic Russia	13½	2430	174	960,000
Oby, ditto - -	15	2700	236	1,300,000
Africa.				
Nile - -	18½	2330	90	500,000 uncertain.
America.				
St. Lawrence, including lakes -	22½	4050	109	600,000
Mississippi - -	19	3420	249	1,368,000
Plata - -	13½	2430	225	1,240,000
Amazon, not including Araguay -	22¾	4095	395	2,177,000

For an account of the phenomena of the Australian rivers, which, in apparent contrariety to the laws of nature in other parts of the world, become narrower the further they flow from their source, see the *Geog. Dict.*, art. "Australia."

River. In Hydraulics, a current of water flowing in an open channel. The velocity of a current of water flowing in an open channel depends on the volume of water, the form of the channel, and its inclination; and the determination of the relations subsisting among these three quantities is a problem of great practical importance, the solution of which must be derived partly from experiment, and partly from the general theory of the motion and resistance of fluids.

If water, whether flowing in pipes or open channels, suffered no resistance from the solid matter with which it comes in contact, the velocity would depend solely upon the accelerating force of gravity, and at any point of the channel would be in proportion to the square root of the difference of level between that point and the source. But this velocity, if not constantly impeded, would soon become enormous, and render rivers the immediate instruments of devastation and ruin to the earth. The Rhone, for example, which receives its principal waters at an elevation of 900 feet above the level of the sea, would enter the bay of Marseilles with a velocity of 164 miles in an hour, such being the velocity due to a heavy body falling from a height of 900 feet. Even the Thames, which has a descent of only 100 feet, would acquire a velocity of 54 miles in an hour.

The forces which tend to impede this constantly increasing velocity depend upon the quantity of surface exposed to friction and the velocity of the stream. Let l denote the length of a portion of the stream through which the velocity and the form of the channel remain the same, and c the length of the line of intersection of the channel with a vertical plane perpendicular to the stream (*i. e.* the perimeter or boundary of the transverse section *minus* the superficial breadth); then the surface exposed to friction is represented by $c\,l$. With respect to the velocity, it is found by experiment that the resistance is expressed by a function of the velocity made up of two parts, one depending on the velocity simply, and the other on its square. Hence, denoting the friction or resistance by f, and the mean velocity by v, and assuming m and n, two constant numbers, to be determined by experiment, the resistance will be expressed by this formula: —

$$f = (m\,v + n\,v^2)\,c\,l.$$

Now the force which opposes the velocity is the resistance, and the force which tends to accelerate it is the component of the weight in the direction of the slope; and as the velocity of the portion under consideration is regarded as uniform, these two forces must be equal to each other. Let a denote the area of the transverse section of the stream, then the bulk is $a\,l$, and its weight $g\,a\,l$; the resolved part of which in the direction of the slope is $g\,a\,l \sin. i$, where i is the inclination of the surface to the horizon. We have, therefore, $f = g\,a\,l \sin. i$, or $(m\,v + n\,v^2)\,c\,l = g\,a\,l \sin. i$; whence for any length l for which the area of the section, the slope, and form of the channel remain unchanged, we have $(m\,v + n\,v^2)\,c = g\,a \sin. i$.

If we assume $R = a \div c$ (the area of the section divided by the length of its boundary diminished by the width), then the formula becomes $m\,v + n\,v^2 = g\,R \sin. i$. This quantity R is what is usually called the *radius* of the section, and sometimes the *hydraulic depth*. It is the depth which the river would take if it flowed in a rectangular channel, whose breadth is equal to the bottom and sides of the actual bed.

The constants m and n have been determined experimentally by Prony (*Récherches Physico-Mathématiques sur la Théorie des Eaux Courantes*, Paris, 1804). On reducing his measures to English feet, and rejecting the term $m\,v$, which is small in comparison of $n\,v^2$, the formula becomes

$$v = 109{\cdot}53\,\sqrt{R \sin. i}.$$

Eytelwein (*Handbuch der Mechanik fester Körper und der Hydraulik*, Berlin, 1801) gives $v = 94{\cdot}87\,\sqrt{R \sin. i}$. As a sufficiently near approximation, we may assume $v = 100\,\sqrt{R \sin. i}$; and if we denote the fall in feet each mile by h, we shall have $\sin. i = h \div 5280$, and the formula will become on reduction $v = \frac{11}{8}\sqrt{R\,h}$ nearly. This gives the velocity in feet per second. To find the velocity in miles per hour, we must multiply by 3600, and divide by 5280, which gives $v = \frac{15}{16}\sqrt{R\,h}$; a formula found to be sufficiently conformable to experiments.

From the above formula the mean velocity v is given, when R and h are determined; or, generally, any one of the three quantities, the mean velocity, the hydraulic depth, and the fall, is determined in terms of the other two. It is necessary to observe, that the velocity is not the same in all the parts of the section of the stream. The filaments of water in contact with the bottom and sides of the channel are arrested by the friction, and in their turn retard the filaments next above them in consequence of their adherence or viscidity; so that the filaments which suffer the least retardation are those at the surface and nearest the middle of the stream. On the other hand, the hydrostatic pressure tends to give the greatest velocity to the filaments which are deepest under the surface. By the combination of these two causes, the greatest velocity in an open channel of a symmetrical form is at the middle, and at a small depth under the surface.

The mean velocity, which has been denoted by v, is that which, when multiplied by the area of the transverse section, gives the total quantity of water which passes through the section in a given time. Du Buat found that the greatest velocity is to the mean velocity of the whole section in the ratio nearly of 5 to 4; so that if the greatest velocity is experimentally determined, we may assume the mean velocity to be 4-5ths of the quantity given by the experiment. It was found by Du Buat that if from the square root of the velocity in the middle of the stream, expressed in *inches per second*, unity be subtracted, the square of the remainder gives the velocity at the bottom.

Since the mean velocity of a river is proportional to the square root of the hydraulic depth (the inclination remaining the same), it follows that on contracting the channel the velocity will be increased. When a river receives a permanent addition, the first effect is to increase the velocity, whereby the attrition on the sides and bottom is also increased; and the sides being generally of softer materials, the consequence is that the width, and sometimes, though more rarely, the depth, is increased until the resistance is again equal to the accelerative force, and the velocity becomes uniform.

It is frequently of great importance to determine the whole quantity of water furnished by a river, or, as it is called, the *discharge*. For this purpose the figure of the bed must be accurately determined, which may be done by soundings. This also gives the area of the section, and consequently the hydraulic depth. The velocity at the surface may be determined by means of a float; or at a small depth under the surface by the instrument called *Pitot's tube* (see the term), or by measuring the force of the current by means of a dynamometer.

See, in addition to the works above quoted, Bossut, *Traité d'Hydrodynamique*; Navier, *Leçons sur l'Application de la Mécanique*; Belidor, *Architecture Hydraulique*.

RIVO'SE. (Lat. rivus, *a brook.*) In Zoology, when the surface of an animal or part is marked with furrows which do not run in a parallel direction, and are rather sinuate.

RIXDOLLAR. (A corruption of Germ. reichsthaler, or *dollar of the empire.*) A silver coin of different values in different countries. *See* Money.

ROACH. The curve, or arch, which is generally cut

in the foot of some square sails, from one clue to the other, to keep the foot clear of stays and ropes.

ROAD, or ROADSTEAD. A place of anchorage. A vessel when at anchor is termed a roadster, in contradistinction to another under sail.

ROADS, are pathways formed through a country, by which passengers and commodities may travel, or be transported, with more or less facility and expedition, from one place to another. Roads are of various kinds, according to the state of civilization and wealth of the country through which they are constructed, and according to the nature and extent of the traffic to be carried on upon them, — from the rude paths of the aboriginal people, carried in direct lines over the natural surface of the country, passable only by foot passengers or pack-horses, to the comparatively perfect modern road, carried on an artificial causeway, and reduced to a nearly level surface at enormous expense by means of vast excavations, extensive embankments, bridges, viaducts, tunnels, and other expedients supplied by the skill and ingenuity of the civil engineer.

Advantages of Roads. — There is no expedient which more powerfully conduces to the advancement of a people in civilization, or to the extension of their prosperity and national wealth, than the construction of good roads, connecting the various centres of commerce and of industry about which they may have collected themselves. The invention of printing, the expedient of money, the adoption of a uniform system of weights and measures, would severally be ineffectual, or productive of advantages of a very limited extent, if the intercommunication of those whose feelings and ideas are expressed and conveyed in print, and among whom money is made to circulate, and whose commerce is stimulated and facilitated by the uniform module of quantity supplied by weights and measures, were not facilitated and expedited by the means of conveyance supplied by roads. Without roads, the interchange of advantages, moral, intellectual, and physical, which now takes place in all highly civilized countries between the rural and the urbane population, could not be maintained; without them, indeed, large towns or cities could not continue to exist. The supply of the population collected in such places with the various products of agriculture, necessary to their physical existence, could not be sustained. Nor, on the other hand, would the rural population affording that supply be benefited by a return in exchange of the refinements of the town, and the various articles of luxury and necessity obtained by commerce from every part of the globe.

But roads are not less necessary for the advancement of agriculture itself, than for the due maintenance of the necessary relations between the towns and the country. Without the aid of roads, it would be impossible to apply those arts to the soil by which increased powers of production are given to it. Without roads, the various kinds of manure, by which the scientific farmer knows how to raise augmented crops, could not be transported to his fields from the place, often distant and difficult of access, where such manures are found. Roads may then, in fact, be considered as a system of veins and arteries, by which all those principles necessary for the maintenance of the prosperity of a country are kept in circulation.

History of Roads. — The importance of roads to the welfare of nations was not unknown to the ancients. The senate of Athens, the government of the Lacedemonians, the Thebans, and other states of Greece, bestowed much care upon them; but, as might naturally be expected, the first great advances in the art of intercommunication by roads were due to a people essentially commercial. The invention of paved roads is traced to the Carthaginians. Rome, ever awake to the advantages to be gained from conquered people, followed in the steps of the Carthaginians, and vastly extended and improved their processes in the construction of roads.

The Via Appia, the Via Aurelia, and the Via Flaminia were the first great monuments of the Roman people in this department of art. Under Julius Cæsar, the capital of the empire was made to communicate with all the chief towns by paved roads; and during the last African war, a road of this kind was constructed from Spain through Gaul to the Alps. After this, these great lines of communication were extended through Savoy, Dauphiné, and Provence; through Germany, every part of Spain; through Gaul, and even to Constantinople; through Asia, Hungary, Macedonia, and to the mouths of the Danube. Neither did the interposition of seas obstruct the labour or daunt the enterprise of this great people. The lines of communication thus constructed to the shores of the continent of Europe were continued at corresponding points of the neighbouring islands and continents. Sicily, Corsica, Sardinia, England, Africa, and Asia were accordingly intersected and penetrated by roads, forming the continuation of the great European lines. These gigantic works were not mere paths prepared for the action of the feet of horses and the wheels of carriages, formed upon the natural surface of the ground, but were constructed on principles in some respects as efficient as those which modern engineering has supplied; forests were opened, mountains excavated, hill slowered, valleys filled up, chasms and rivers bestridden by bridges, and marshes drained, to an extent which would bear no mean comparison to the result of the great engineering enterprise of recent times.

English Roads. — The first roads of artificial construction in England were those formed by the Romans while it was a Roman province. A grand trunk road was carried through the country north and south, and another nearly at right angles to it east and west. These main lines were supplied with branches, extending in every direction which the conquerors found it expedient to render accessible to their arms. The Roman road called Watling Street commenced from Richborough in Kent, the ancient Ruterpiac, and being carried through London in a north-westerly direction, was continued to Chester. The road called Ermine Street commenced from London, and passing through Lincoln was carried thence through Carlisle into Scotland. The Foss Way passed from Bath, in a direction north-east, and joined the Ermine Street. The road called Ikenald extended from Norwich, in a southward direction, to Dorsetshire.

The example thus afforded by their conquerors was not followed by the Britons, who, unconscious of the many advantages attending facilities of intercommunication, relapsed into the barbarous neglect of roads; and while the Roman ways were allowed to fall into decay, new roads were not constructed. For many centuries, such intercourse as was maintained between the various parts of this country took place almost exclusively by rude paths, capable of being passed on foot, or at best by horses, carried over the natural surface of the ground in straight directions from place to place. Hills were surmounted, valleys crossed, and rivers forded, in the same manner as the savages of the most remote wilds of America now communicate with each other, or with the settlers. It was not till the reign of Charles II. that any attempt was made by the legislature to improve the roads of the country. In the 16th year of the reign of that monarch, the first turnpike-road was established by law, whereon toll was taken. It passed through Hertfordshire, Cambridgeshire, and Huntingdonshire. It was not, however, till about a century from the present time, that any great or effectual attempts were made to establish a system of good roads through the country. Till nearly the middle of the last century, most of the goods were conveyed from place to place in Scotland on pack-horses. Oatmeal, coals, turf, and even straw and hay, were conveyed in this way; but in carrying goods between distant places it was necessary to employ a cart, as all that a horse could carry on his back was not sufficient to defray the cost of a long journey. The time that the carriers usually required to perform their journeys seems now almost incredible: the common carrier between Selkirk and Edinburgh, a distance of thirty-eight miles, required a fortnight for his journey, going and returning. The road, for a considerable extent, lay along the bottom of the district called Galt Water; the bed of the stream, when not flooded, being the tract chosen, as the most level and easiest to travel in.

Nor were the means of travelling between large towns much better. In 1678, a contract was made to establish a coach between Edinburgh and Glasgow, a distance of forty-four miles. This coach was to be drawn by six horses, and the journey between the places, to and from, was engaged to be completed in six days; even so recently as the year 1750, the stage coach from Edinburgh to Glasgow took a day and a half to make the journey.

In the year 1763, there was but one stage coach between Edinburgh and London, which started once a month from each place, and took a fortnight to perform the journey. At the present time, after the lapse of not so much as eighty years, there are seven coaches daily start from each of these cities for the other; besides several steam ships of enormous magnitude, which sail weekly from each place, supplying all the accommodation and luxury of floating hotels, and completing the journey, in common with the coaches, in less than forty-eight hours. If each of the coaches be estimated as conveying ten passengers daily, the coaches alone would thus convey daily between these cities about 140 passengers, or above 4000 monthly. If an equal number be estimated as conveyed by the steam ships, we should have the present intercourse in passengers between London and Edinburgh amounting to about 8000 monthly; whereas, in 1763, the number conveyed by stage coaches between these places monthly could not have exceeded twenty-five, and by all the means of conveyance then existing probably did not exceed fifty.

It happens that the line of road now occupied by the Liverpool and Manchester Railway and its branches, and travelled daily by thousands of passengers, at a speed of twenty-five miles an hour, including stoppages, was, in the year 1770, travelled over by Mr. Arthur Young, who has left us in his Tour the following account of the state of the roads at that time: — "I know not in the whole

range of language terms sufficiently expressive to describe this infernal road. Let me most seriously caution all travellers, who may accidentally propose to travel this terrible country, to avoid it as they would the devil; for a thousand to one they break their necks, or their limbs, by overthrows or breakings-down. They will here meet with ruts, which I actually measured four feet deep, and floating with mud only from a wet summer. What, therefore, must it be after a winter? The only mending it receives is tumbling in some loose stones, which serve no other purpose than jolting a carriage in the most intolerable manner. These are not merely opinions, but facts; for I actually passed three carts broken down in these eighteen miles of execrable memory." With the exception of a few rare instances of important roads, constructed under special acts of parliament, the roads of England have not been constructed on any scientific principle, and are, in most cases, nearly coincident with the foot and horse paths adopted by the early inhabitants of the country. These rude paths having been formed at an early period, the only roads of communication between the chief towns were gradually improved, so as to be capable of being travelled over by wheel carriages. The natural surface of the ground was in time covered with an artificial coating of gravel or stones; hills too steep to be surmounted by carriages were either levelled, and the material obtained from their excavation thrown into the valleys, or the roads were carried round them; at a later period fences were added; and thus, by slow degrees, the old horse path grew into the modern road. How far removed from a truly good and scientific line of communication such a road must be, will be apparent to any one who considers what the principles ought to be on which a road should be laid down and constructed.

The Art of Road-making.—When it is proposed to construct a line of road extending between two places, the engineer upon whom such a duty devolves first makes himself well acquainted with the surface of the country lying between the two places, so as to obtain an acquaintance with the face of the country, somewhat approaching to that which would be supplied by a superficial model of it, which would exhibit all its inequalities and undulations of surface. He is then to select what he considers, all circumstances being taken into account, the best general route for the proposed road. But, previously to laying it out with accuracy, it is necessary to make an instrumental survey of the country along the route thus selected; taking the levels from point to point throughout the whole distance, and making borings in all places where excavations are required, to determine the strata through which such cuttings are to be carried, and the requisite inclinations of the slopes or slanting sides, as well of the cuttings as of the embankments to be formed by the material thus obtained. It is also requisite, in the selection of the route for the proposed road, to have regard to the supply of materials, not only for first constructing it, but for maintaining it in repair; thus, the position of gravel pits and quarries in the neighbourhood of the proposed line, and the modes of access to them, should be well ascertained.

The results of such an investigation should be reduced to a plan and section; the plan of the road being on a scale not less than 66 yards to an inch, and the section not less than 30 feet to an inch.

The loss of tractive power, and danger to travellers produced by steep acclivities, render it especially necessary that a proper limitation should be imposed upon the inclinations or acclivities on every line of road on which much traffic is carried on. As, however, this reduction of hills in a country where much inequality of surface exists is attended with a considerable outlay of capital, the engineer will have to balance the cost of constructing a road having the best possible inclinations against the advantages to be obtained in the permanent working of the road; and if the expected traffic be not such as to yield advantages proportionate to the capital absorbed, greater rates of inclination must be allowed to the hills, with a view to diminish the extent of the works, and to render the expense of constructing the road proportionate to the traffic expected upon it.

A dead level, even where it can be obtained, is not the best course for a road; a certain inclination of the surface facilitates the drainage, and keeps the road in a dry state. There is a certain inclination, depending on the degree of perfection given to the surface of the road, and on the structure of the carriages worked upon it, which cannot be exceeded without a direct loss of tractive power; this inclination or acclivity is that in descending which at a uniform speed the traces slacken, or which causes the carriages to press on the horses: the limiting inclination within which this effect does not take place is called the *angle of repose.*

On all acclivities less steep than the angle of repose, a certain amount of tractive force is necessary in the descent as well as in the ascent; and the mean of the two drawing forces, ascending and descending, is equal to the force along a level road. Thus, on such acclivities as much power is gained in the descent as is lost in the ascent; but on acclivities which are more steep than the angle of repose, the load presses on the horses during their descent, so as to impede their action, and their power is expended in checking the descent of the load; or, if this effect be prevented by the use of any form of drag or break, then the power expended on such drag or break corresponds to an equal quantity of mechanical power expended in the ascent, for which no equivalent is obtained in the descent.

On well-constructed roads, with carriages such as now are generally used in England, the angle of repose may be taken at about one in thirty-six; and this is consequently an acclivity which ought not to be exceeded on roads over which much traffic is carried.

The expedients by which the requisite inclinations are obtained on common roads are the same as those which are resorted to in the construction of railways. *See* RAILROADS.

The exact course of the road and the degree of its acclivities being determined, the next thing to be considered is the formation of its surface. The qualities which ought to be imparted to it are twofold,—first, it should be smooth; secondly, it should be hard; and the goodness of the road will be exactly in the proportion of the degree in which these qualities can be imparted to it, and permanently maintained upon it. An error prevailed among road engineers until a very recent period. It was considered that smoothness of surface alone was sufficient for the perfection of a road; and that, provided it could be made sufficiently durable, it was unimportant how soft or yielding the coating of the road might be. This error, into which, among others, Macadam himself fell, was based upon a neglect of one of the most important circumstances to be considered in the construction of a road. The main object to be attained by all roads is the diminution of the resistance which a carriage opposes to the tractive power. Other things being the same, it was sufficiently apparent that this resistance would be diminished by increasing the smoothness of the road surface. But roughness or unevenness of surface is not the only cause of resistance to the tractive power: if two roads have their surfaces equally smooth and even, but one is soft and elastic, so as to yield under the pressure of the wheel, recovering its form as the wheel advances, and the other is hard and unyielding, the resistance to the tractive power will be greater on the soft and yielding road than on the hard and unyielding road; and this augmentation of resistance will be in proportion to the softness of the surface. That this would be the case, admits of immediate demonstration on mechanical and mathematical principles; but, without resorting to these, it must be sufficiently apparent from the results of the most common experience. A surface of velvet may be as smooth and even as a surface of ice; but if an ivory ball be rolled on the latter, it will continue its motion much longer than on the former. In fact, the wheels of a carriage in passing along a soft road sink into its surface, as the ball would sink into the pile of the velvet; and although, in virtue of its elasticity, the surface of the road, like that of the velvet, may recover its smoothness after the pressure has been removed from it, still a resistance will be offered to the drawing or impelling power, which would not be produced by a hard and unyielding surface equally smooth.

Macadamization.—This process, which has received its name from Macadam, to whose labours the improvement of the roads of England within the last half century owes so much, consists in forming the road crust of stones, broken with a hammer into angular pieces of a small and uniform size. This method, however, is one which was long practised in various parts of Europe. When the stones of which the road crust is to be formed are broken to the proper magnitude and form, they are spread over the surface of the road in a layer of 3 or 4 inches thick. After this has been consolidated by carriages working upon it or by rollers, another layer of broken stones of equal depth is laid upon it; it is consolidated in like manner; and thus one layer is laid over another until an artificial crust is formed of broken stones of sufficient thickness to give the requisite strength to the road.

A coating or road crust thus formed might be constructed on any substratum whatsoever, and a smooth and apparently good road would be obtained. It was the practice of Mr. Macadam to disregard the nature of the substratum; and he maintained that if it was not such a bog as would not allow a man to walk over it, he would even prefer it to a hard bottom.

Telford's System.—The improvement in road-making which consisted in a due attention to the substratum or foundation of the road, so as to give increased facility to the tractive power by rendering its surface hard and unyielding, is due to the late Mr. Telford. The following is a description of the method of constructing such a road practised by that eminent engineer.

Upon the level bed prepared for the road materials a bottom course or layer of stones is to be set by hand, in form of a close firm pavement. The stones set in the

middle of the road should be 7 inches in depth; at 9 feet from the centre the depth should be 5 inches; at 12 feet, 4 inches; and at 15 feet, 3 inches; the entire width of the road being 30 feet. These stones are to be set on their broadest edges lengthwise across the road, and the breadth of the upper edge should not exceed 4 inches. All the irregularities of the upper part of this pavement are to be broken off by hammers, and all the interstices to be filled with stone chips firmly wedged or packed by hand with a light hammer; so that, when the pavement is finished, its cross section shall have a convexity of surface of about 4 inches in the centre above the extreme edges: 18 feet in the centre of this pavement are to be coated with a layer of hard broken stones, 6 inches deep; of these 6 inches, 4 must be first put on and worked down by carriages and horses in the ordinary traffic of the road, care being taken constantly to rake in the ruts until the surface has become firm and the crust consolidated. After this, the remaining 2 inches of stone may be put on; the whole of this stone, forming 6 inches of crust, is to consist of pieces broken as nearly as is practicable into a cubical form, and of such a magnitude that they can pass through a ring of 2½ inches internal diameter. The spaces on each side of the middle 18 feet are to be coated with broken stone or well-cleansed strong gravel up to the level of the footpath or other boundary of the road, so as to make the whole convexity of the road 6 inches in the middle above the level of the edges; and the whole of the materials thus formed and consolidated should be covered with a coating 1½ inch deep of good gravel, free from clay or earth.

Such was the method practised by Mr. Telford in the construction of great main roads, such as that between Holyhead and Shrewsbury. In the streets of towns, and other places where roads have to bear a still heavier traffic, such a road as that above described is found to be subject to a superficial wear, so rapid as to produce an intolerable quantity of dust in summer and of mud in winter. In such places recourse has been generally had to pavement. The first object to be secured for a durable pavement, as well as in other roads, is to secure a good foundation. The best method is to lay a foundation of gravel or broken stone, the bed of which should be formed with a convexity sloping to each side by a fall of about 1 in 50. After the first layer of broken stone is put on, the street should be open for carriages to pass over it until it is consolidated, all ruts being carefully raked in. The same process should be repeated with each successive layer, until a sufficiently solid foundation is obtained for the pavement. On this foundation a pavement formed of blocks of stone is laid, the blocks being 10 inches in depth, from 10 to 15 inches in length, and from 6 to 8 inches in width. Such is the structure which is requisite for the streets which are the main thoroughfares of a great city; a pavement with less strength of foundation, and formed of smaller blocks of stone, being used for the streets of less intercourse.

The many inconveniences produced in the great thoroughfares of London, such as Oxford Street, Holborn, Fleet Street, the Strand, &c., by reason of the rapid wear of every kind of pavement hitherto adopted, a suspension of the intercourse during the frequent repairs, the dust in summer and the mud in winter produced by a surface of broken stones, and the intolerable noise produced by every species of stone pavement, have lately excited much inquiry as to the possibility of constructing some road having sufficient strength for a traffic so enormous, sufficient durability to prevent the inconvenience of the frequent suspension of intercourse by the necessity of repairs, and presenting a surface which, while it would be free from the noise of a stone pavement, would not be attended with the inconvenience of dust and mud produced by a surface of broken stone. This problem appears to be in a great degree solved by the adoption of a pavement of wood. A short piece of Oxford Street was thus paved in the beginning of 1839; and after a successful trial of several months, the same pavement was extended nearly throughout the whole extent of that street; and at the present time (1842) this method of pavement is in process of construction in several other thoroughfares of London. The idea of a wooden pavement is not new. In the northern parts of Germany and in Russia such pavements have been long in use; some of the main streets of Petersburgh and Vienna have long been paved in this manner. A few years ago a series of experiments were made at New York, to determine the best description of paving for a street. One of the methods adopted was a tesselated pavement, formed of hexagonal blocks of pine wood, measuring 6 inches on each side of their transverse section, and 12 inches in depth. From the manner in which the timber is cut its fibres are vertical, and therefore the tendency to wear from vertical pressure is small. The blocks are coated with pitch or tar, forming a smooth upper surface.

Various methods have been proposed for laying the wood pavements of London; but as these methods are severally as yet only in process of trial, nothing is practically known of their respective merits. There appears, however, to be sufficient to justify a well-grounded expectation that wood pavements of some form or other will soon supersede all others for the great thoroughfares of towns.

Concerning the formation of roads of various kinds, their drainage, fencing, their management, repairs, &c., much might be said; but the limits which must be imposed on this article compel us to refer the reader for these details to Sir Henry Parnell's *Treatise on Roads*. See also the *Encyclopédie*, article "Chemin;" Bergier, *Histoire des Grands Chemins de l'Empire Romain; Annales des Ponts et Chaussées;* Anderson's *Commerce;* M'Culloch's *Treatise on Commerce*, *Library of Useful Knowledge;* Mr. Telford's *Reports*

ROA'STING, in Chemical Metallurgy, means the protracted application of heat to metallic ores, below their fusing points. It is generally resorted to to expel volatile matters, especially sulphur, arsenic, carbonic acid, water, &c.

ROB. A term of Arabic origin, applied by old pharmaceutical writers to thin extracts or inspissated juices.

RO'BBERY (from the Germ. rauben, *to rob*), in Law, is defined a felonious taking of money or goods of any value from the person of another, or in his presence, against his will, by violence or putting him in fear; and this, whether the fear be of injury to the person's property or character. But it is necessary that the fear be of immediate injury, not of some future injurious results; and then the money must, generally speaking, be taken immediately upon the threat made, and not afterwards given from fear of consequences. But the *extortion* of money by threat to accuse of an infamous crime was made robbery by 7 & 8 G. 4. c. 29. The law on the subject is now collected in the recent statute 1 Vict. c. 29.; and robbery is capital only when the robber "at the time, or immediately before or after," stabs, cuts, or wounds any person.

ROBES, MASTER OF THE. An officer in the royal household, whose duty, as the designation implies, consists in ordering the sovereign's robes. Under a queen, this office, which has always been one of great dignity, is performed by a lady, who enjoys the highest rank of the ladies in the service of the queen.

RO'C, or RU'KH. The well-known monstrous bird of Arabian mythology, of the same fabulous species with the simurg of the Persians. In the notes to vol. iii. of Mr. Lane's edition of the *Arabian Nights' Entertainments* are some curious extracts from the writers of old voyages of that nation; showing that the tale was either founded on, or supported by, the wonderful accounts of travellers. Even Sinbad's well-known adventure, when his crew broke the roc's egg, and were attacked in consequence by the enraged pair of birds, is borrowed from the serious narration of Ibn-El-Wardee. The roc is also described by Marco Paulo. (Marsden's transl., p. 707.) The size of this famous monster is, of course, described with all the luxuriance of oriental imagination. Ibn-El-Wardee makes one of its wings 10,000 fathoms long. Mr. Lane appears to think that this extravagant fiction was suggested by the condor; but the size and power of that bird are much exaggerated, even in the common accounts. The bearded vulture of Egypt seems a better archetype of the rukh. In a drawing from an illuminated Persian MS., which Mr. Lane has copied, the roc, or rather simurg, which is represented as performing the slight operation of carrying off three elephants in its beak and claws, is something like a cock, with eagle's wings and an extravagant tail. The simurg is a creature of importance in Persian mythology: it is the phœnix of oriental fable, one only living at a time, and attains the age of 1700 years. (See the notes to *Southey's Thalaba.*)

ROCELLIC ACID. An acid obtained from the *Rocella tinctoria*.

ROCHE'LLE SALT. The tartrate of soda and potassa. It is a double salt, composed of 2 equivalents of tartaric acid ($66 \times 2) = 132$, 1 equivalent of potassa $= 48$, and 1 of soda $= 32$. Its crystals, which are large and well-defined prisms, often presenting eight, ten, or twelve sides, include 8 equivalents ($9 \times 8) = 72$ of water.

ROCK. *See* Geology.

ROCK CORK. A variety of asbestos, which see.

ROCK CRYSTAL. A common mineralogical term applied to crystallized silica: it is also called *quartz*.

RO'CKET. In the Military Art, a very destructive species of fire-work, the best kind of which was invented by the late Sir William Congreve, and called after him the *Congreve rocket*. The body of the machine is cylindrical, and its head conical. It is filled with very inflammable materials; on the combustion of which, as in the common sky-rocket, the body is impelled forward with a continual acceleration.

ROCKING or LOGGING STONES. *See* Geology.

ROCK SALT. Common salt found in masses or beds in the new red sandstone, as in Cheshire and elsewhere. *See* Geology.

ROCK SHELLS. The common name of certain Uni-

valves, characterized by the long straight canal which terminates the mouths of their shells. *See* MUREX.

ROCKWORK. In Architecture, masonry wrought in imitation of rough stone, in various arrangements, and chiefly used in basements of buildings.

ROCKWORK, in Gardening, is applied to a quantity of stones, fragments of rock, or even vitrified bricks, piled together in such a manner as to form a nidus for the growth and display of alpine plants. When the pieces of rock are of such forms as can be connected together so as to present the appearance of stratification, that mode of arranging them may be adopted; and the soil and plants may be placed in vertical, oblique, or horizontal fissures, or on ledges, according to the lines of stratification. When, however, as is most frequently the case, land or water-worn stones are used, they may be distributed over a mound of earth, not uniformly, but in groups, with smooth surfaces of soil between, in the manner that may be observed in nature, where stones of different sizes are seen rising out of the surface of a green hill or hillock. When agglutinated masses of vitrified bricks are used, either alone or mixed with land stones of different sizes, they may be distributed over a mound, or along a bank of soil, in such a manner as to produce a varied surface, without attempting to imitate nature, and with interstices between them for inserting the plants. Imitations of conical hills, caverns, precipices, and even the Alps, on a small scale, have been made in rockwork; but these, and all other imitations of nature, require to be designed and directed by the eye and mind of an artist. In general the piles of stone called rockwork, in botanic and flower gardens, might with more propriety be called heaps of stones.

ROD. A measure of length, otherwise called a *pole*. It is 5½ yards, or 16½ feet; and four of these make the *Gunter's chain*.

RO'DENTS, *Rodentia*. (Lat. rodo, *I gnaw*.) The name given by Cuvier to the *Glires* of Linnæus, an order of Unguiculate Mammals, comprehending those which have two long chisel-shaped incisors in each jaw, and no canines, but a vacant interspace between the incisors and the molars; the lower jaw is articulated by a longitudinal condyle, in such a way as to allow of no horizontal motion, except from back to front, and *vice versâ*, as is requisite for the action of gnawing. The molars also have flat crowns, whose enamelled eminences are always transverse, so as to be in opposition to the horizontal motion of the jaw, and to increase the power of trituration. The genera in which these eminences are simple lines, and the crown is very flat, are more exclusively frugivorous; those in which the eminences of the teeth are divided into blunt tubercles are omnivorous; while the small number of such as have no points more readily attack other animals, and approximate somewhat to the Carnaria. The form of the body in the Rodentia is generally such that the hinder parts of it exceed those of the front, so that they rather leap than walk. In some of them this disproportion is even as excessive as it is in the kangaroos. In the whole of this class the brain is almost smooth, and without furrows; the orbits are not separated from the temporal fossæ, which have but little depth; and the eyes are altogether lateral. The inferiority of these animals is visible in most of the details of their organization. Those genera, however, which possess stronger clavicles have a certain degree of dexterity, and use their fore feet to convey their food to the mouth.

RODOMONTA'DE. A term that has passed into most European languages; from Rodomont, a boisterous character in the *Orlando Furioso*, — signifying a boastful mode of talking.

ROE. The ova of osseous fishes which are developed simultaneously and in great numbers are so called.

ROESTONE. A granular limestone, or oolite; which see. See also GEOLOGY.

ROGA'TIONS. (Lat. rogo, *I ask*.) In the Ritual, public supplications or litanies were anciently so termed, until the latter designation began to supersede every other. (Palmer, *Orig. Liturgicæ*, vol. i. p. 270.) In the Calendar, the three Rogation days are the Monday, Tuesday, and Wednesday next before Ascension-day.

ROGUE'S YARN. A yarn of a different twist and colour from the rest, and inserted in the royal cordage, to identify it in case of its being stolen.

RO'LLERS. The name given by seamen to unusually heavy waves, which set in upon a coast or island without wind. They are frequent at Ascension.

RO'LLING, in Mechanics, is when all the parts of the surface of one body come into successive contact with those of another, and under such conditions as that at every instant the portion of the two surfaces which *have been* in contact are exactly equal. When this condition is not fulfilled, the one surface is said to slide upon the other. The friction of bodies in rolling is much less than in that of sliding; and hence the advantage of wheels to all kinds of carriages. *See* FRICTION.

ROLLING. In Naval language, the lateral oscillation of a vessel. This motion, which is often very great when the vessel is running before the sea, endangers the masts, strains the sides, and loosens the decks at the waterways; it is also liable to cause the guns to break adrift. When the centre of gravity is too low, the oscillations begin and end violently. The changes in the stowage necessary to modify the nature or extent of the roll are made by seamen from experimental knowledge.

RO'LLING PE'NDULUM. A cylinder caused to oscillate in small spaces on a horizontal plane. Its mathematical expressions are interesting, but it has been applied to no important practical purpose.

RO'LLING TA'CKLE. A tackle or pulley hooked to the weather quarter of a yard, and to a lashing or strap round the mast near the slings or parral of the yard; the object of it is to keep the yard constantly over to leeward thereby depriving it of play and friction when the ship rolls to windward.

ROLLS, MASTER OF THE. A high officer of the Court of Chancery, second only to the lord chancellor. He is appointed by the crown by letters patent, and holds his office for life. The master of the rolls administers justice in a separate court called the Rolls. He has the power of hearing and determining originally the same matters as the lord chancellor, excepting cases of lunacy and bankruptcy; but all orders and decrees pronounced by the master of the rolls must be signed by the lord chancellor before they are enrolled. The master of the rolls is also the chief of the twelve masters in Chancery, and chief clerk in the Petty Bag Office: he is the keeper, also, of all the records of the Court of Chancery after the decrees and orders have been enrolled; and on that account he was anciently styled *guardien des rolles*. The master of the rolls ranks immediately after the chief justice of the King's Bench: his salary, by the stat. 6 Geo. 4. c. 84., is 7000*l*. a year.

Before the passing of the act 3 & 4 W. 4. c. 94. the master of the rolls did not hear motions, pleas, or demurrers; and whatever was presented for his decision, other than the hearing of causes, was brought before him by petition. By the above-mentioned act, however, this was altered; and motions, pleas, and demurrers are now heard by him in the same manner as by the other equity judges. By the act 1 & 2 Vict. chap. 94., entitled "An Act for the better Custody of the Public Records," the master of the rolls for the time being is entrusted with the custody both of the public records and those of the common law courts and Court of Exchequer.

ROMAN ALUM. An alum extracted from the volcanic rocks of the Solfaterra near Naples: it crystallizes in opaque cubes, and appears to contain more alumina than the common octoedral alum.

RO'MAN ARCHITECTURE. *See* ARCHITECTURE.

RO'MAN CA'THOLICS, ROMANISTS, OR PAPISTS. The names by which Protestants designate the members of the large and ancient church, which regards the bishop or pope of Rome as its infallible spiritual head, and assumes to itself the title of the Catholic, or universal. A rapid review of the external fortunes of this system, as connected with the holy see, will be found in the article PAPACY; the principal doctrines, also, by which it is distinguished are detailed under the several heads. (*See* TRANSUBSTANTIATION, MASS, PENANCE, PURGATORY, &c.) It will be sufficient in this place to point out the general argument upon which the Roman system has been erected.

The Roman doctors hold that the Scripture is not sufficient for its own interpretation. The books which compose the canon of the New Testament are, they conceive, desultory and incomplete; being many of them written for special occasions, at a period considerably later than the foundation of the religion in various districts, in some of which whole generations of believers may have passed away without having seen or heard of their precious contents. It is not to be supposed, however, that doctrines so important as those shadowed forth in the Epistles of St. Paul, or the Gospel of St. John, could have been left untaught to the churches which flourished before their publication or beyond their reach. It must be admitted, therefore, they argue, that the first preachers of Christianity must have been commissioned and instructed to deliver these same doctrines orally; and it is affirmed that several important doctrines are imperfectly developed in Scripture, and would not be understood, except for some such illustration by the way, the result of which is conveyed in the creeds of the first centuries. It is also affirmed that the practice of the primitive church, the infallibility of which is assumed, authenticates various articles of Roman belief, of which only very slight hints are to be found in Scripture, and such, perhaps, as would not have been discovered but for this very evidence from the usage. This line of argument is admitted also by many Protestants, the facts alleged being disputed, and opposite results obtained. It must be allowed, however, that the Catholics do not advance any article of belief without pointing out some supposed ground for it in Scripture, although the only shadow of

proof of this kind is in some cases to be found nowhere but in the writings which Protestants esteem apocryphal. But while Protestants may refer to the practice of the primitive church, and the traditions which must have circulated in those ages, as a genuine historical evidence of the scriptural interpretation of the earliest and purest times, they find too much contradiction in the individual witnesses to consider any one system *deduced therefrom* as infallibly right. The Romanists, on the contrary, attaching more importance to this kind of evidence, and labouring under the same difficulty in discriminating between genuine and corrupt traditions, take refuge in the idea of a spiritual head of the church, an authorized interpreter of tradition, an infallible expounder of the faith, and him they seat in the chair of St. Peter at Rome; maintaining that the dogmas which have been advanced from this source have always been those of the Catholic Church, and always authentic. In later times, however, a question has been much agitated respecting the relative authority of popes and councils; the superiority of each has been maintained by different classes of theologians, and it is certain that in some cases the decisions of popes have been ultimately reversed by councils. It is clear that there cannot be anywhere an authority competent to settle the question; but it is believed that the opinion now generally acquiesced in is, that the two are co-ordinate powers, and that infallibility resides in the decrees of a *pope in council*.

ROMA'NCE. In Literature, a work of fiction in prose or verse, containing the relation of a series of adventures, either marvellous or probable. A tale confined to the latter class of events has, indeed, been considered to be more strictly designated by the term *novel*. (*See* Novel.) But as our nomenclature for works of fiction is not very precise or accurate, the name romance is very frequently used to comprehend both.

The term romance is derived from the class of languages in which such fictitious narratives, in modern times, were first widely known and circulated. These were the tongues derived from the Latin, Italian, Spanish, French, which were all Roman dialects, in contradistinction to the European languages of Teutonic origin. But the "langue Romane" more properly signifies the dialect of southern France, Catalonia, &c., of which the Provençal was a variety.

The famous *Milesian Tales* of antiquity are thought to have been, in classical times, the class of writings nearest approaching to our modern romances. All the original Greek compositions of this kind have perished. But we have, in the *Golden Ass* of Apuleius, a Latin imitation of these, written in the later times of the Roman empire. It contains a series of wonderful adventures, sorceries, transformations, love, religion, &c.; and although it has been asserted that the romance, in its proper sense, was unknown to the ancients, it would be difficult to say in what respect, except the total absence of chivalrous sentiment, which is of modern growth, this curious fragment differs from those later inventions which we have agreed to call by that name.

The same may be said, and with even greater strictness, of the Greek pastoral romances; a class of works appertaining to a later period, of which the famous *Daphnis and Chloe* of Longus is the first known specimen. They contain narratives of amours, adventures, &c., usually intermixed with some supernatural interference; and they have the great characteristic of a modern novel, — a pair of lovers, by way of hero and heroine, whose attachment is generally brought to a happy termination.

The earliest modern romances were collections of chivalrous adventures, chiefly founded on the lives and achievements of the warlike adherents of two sovereigns, one of whom, perhaps, had only a fabulous existence, while the annals of the other have given rise to a wonderful series of fables,—Arthur and Charlemagne. These romances were metrical compositions in that branch of the modern French language termed the *langue d'oil*, which prevailed throughout the north of France, and especially in Normandy. Besides these, a great variety of smaller tales, some chivalrous, some marvellous, some simply ludicrous, termed *fabliaux*, exist in the same language. The date of these compositions extends from the 12th to the 15th centuries.

From the hands of these rhymers the tales of chivalry passed first into those of prose compilers, who reduced them into a form more resembling that of our modern romances. The French prose romances of chivalry, still confined to the same classes of subjects, belong to the 14th and 15th centuries. These, again, gave birth in two different countries to two widely differing series of works of imagination. In Italy, the poets termed Romanzieri, taking the adventures of the knights of Charlemagne as their subject, transferred the rude conceptions of their predecessors into one of the most finished and enchanting forms of poetry to which modern fancy has given birth. Boiardo, in the latter half of the 15th century, was the first of these poets; and the names of Pulci, Ariosto, and Tasso, three of the greatest in Italian literature, grace their long catalogue. In Spain and Portugal a new class of chivalrous romances was called into existence. Lobeira, a Portuguese, in the 14th century, composed the first four books of *Amadis de Gaul*. This famous word resembles in character the French romances of chivalry; but narrates the exploits of a new and entirely imaginary hero. *Amadis* was finished, and a long list of similar romances added to it, by subsequent Spanish and Portuguese writers. In these, while adventures became more and more marvellous, the fanciful spirit of chivalry was more and more carried into wild exaggeration. They became, however, so popular as to be transplanted into most European languages, and even in France to supersede the heroic tales of Arthur and Charlemagne. They declined with the advance of a better taste in literature after the art of printing had been for some time introduced; and were finally driven out of fashion by the wit of Cervantes, whose *Don Quixote* is aimed in great measure against them.

Meanwhile, a new species of fiction had acquired vogue in Italy, to which the term *novel* was first applied. This was the amorous or humorous tale; of which the *Decameron* of Boccaccio contains the earliest, and by far the most popular collection. The stories were derived from many originals; but especially from the *fabliaux*, of which mention has been already made. The Italian Novellieri are extremely numerous; but their compositions are always short, and would, in our modern language, be designated by the term *tale*, rather than novel or romance. They flourished in the 15th and 16th centuries. From these, again, was derived the comic satirical tale of Spain; a more sustained and longer class of composition, of which *Lazarillo de Tormes* and *Guzman d'Alfarache* are the best known specimens. But in these, which were also caricatures of the chivalrous romances, a long course of independent exploits of the hero formed the substance of the work, and not a story possessing an individual point and interest.

Don Quixote, of which the first part was published in 1609, was the joint result of the romances of chivalry, which it was intended to ridicule, and of the romances of low life, of whose character it contains a large intermixture. Although Cervantes had more in view, perhaps (the satirical object of his writing), than the direct delineation of manners and occurrences, such as we now expect in a novel, yet it may be fairly said that his immortal work is the first of its kind in which human nature is brought on the stage alike unadorned and undegraded; neither exaggerated by the ridiculous costume of chivalry, nor lowered by the familiar buffoonery of a comic tale. While, therefore, it has been the source of numerous imitations in its satirical character, its wide popularity has produced much more lasting effects in another manner: it gave the first example of a work of fiction in which the grave and gay events of life might be mingled together; and in which, also, the views and sentiments of the author might be conveyed through the medium of fictitious personages and events.

On the other hand, the chivalrous romance had been seized, at an earlier period, by a very different genius from that of Cervantes, and applied to another object. The fictions of Rabelais (the *Histories of Gargantua and Pantagruel*) cannot be termed romances; but their popularity was so great, that France was inundated for more than a century afterwards with Rabelaisian tales; and many of the elements of the modern low romance, comic hyperbole, eccentric humour, and much freedom and grossness of delineation, have been undoubtedly derived to us from Rabelais and his admirers. Swift and Sterne were both essentially imitators of this singular genius.

In the 17th century, Le Sage naturalized the Spanish romance in France. His works present a singular mixture of different styles, although all derived from the same country. In *Gil Blas*, for example (if that work be not actually of Spanish origin), we have something of the humour of *Don Quixote*, the form as well as much of the substance of *Guzman d'Alfarache*, &c.; and much intermixture of a class of tales of love and intrigue, which, coming originally from the Italian novellieri, had acquired a certain chivalrous colouring in passing through the hands of Spanish imitators. There is, moreover, a touch of French taste and philosophy, such as afterwards, when mixed with satire, gave birth to the modern philosophical tale or romance, of which Voltaire's writings contain the best known specimens.

After Le Sage, a new class of romances suddenly grew into fashion in France, the heroic; derived, indeed, in part from an earlier source, the pastoral romance of the 16th century. Of these, the *Clelie* and *Cassandre* of Mademoiselle Scudery were among the most popular examples, although they have long ceased to be read. This species of composition was, in fact, a revival of the old chivalrous romance, without its supernatural marvels, but with even greater exaggeration of sentiment. Its temporary success is rather to be attributed to a caprice of fashion than to the natural progress of taste. It was not, however,

wholly without its use, as it called back some degree of sentiment and high feeling into the romance, which was in danger of degenerating wholly into a comic cast.

During the 18th century, the romance and novel enjoyed a popularity, both in England and France, which threw comparatively into the shade every other species of fictitious literature. It would be impossible to continue such a sketch as the present, so as to trace out the various styles and species of those compositions which grew into vogue by the success of distinguished writers in each respective branch. In England, Richardson transferred into ordinary life somewhat of the refined sentiments which distinguished the heroic romance, and thus formed the basis of the modern English novel, properly so called, or novel of manners. His *Pamela* appeared in 1740; his last work, *Sir Charles Grandison*, in 1753. Fielding and Smollett, about the same time, revived the old comic romance, adapted to English scenes and characters. Sterne did the same by the humorous or Rabelaisian style of writing; but added an intermixture of pathos which had certainly never been joined before with so incongruous a companion. To these four writers, in conjunction with Goldsmith's *Vicar of Wakefield*, confessedly an independent original, almost all the English fictitious prose literature of the last century which is not imitated from foreign works may be said to owe its existence. In France, Marivaux, Prévost, and, with a worse taste than theirs, the younger Crébillon, formed the national manner in this class of writing for some time. Their productions have much of the same character with those of Richardson; but a far lower tone of morality, and less life-like description. But the popularity of the famous *Nouvelle Heloise* gave a new turn, not only in France, but over Europe, to the public taste in this branch of writing. Marivaux and Prévost may be said to have been Rousseau's models, as to the externals of his great romance; but its tone and sentiment are peculiarly its own. In France, after many inferior imitators, Madame de Staël, the first of female novelists, must be classed as the best and latest disciple of the school of Rousseau. In Germany, his style had even greater success; and he may be said to have called into life at once the taste and the power of that people and literature for fictitious composition. Wieland, Kotzebue, Goëthe (*Sorrows of Werther* and *Wilhelm Meister*), are all, though with much originality of their own, essentially followers of Rousseau; Lafontaine, and many other inferior writers, more direct imitators.

In our own times, while the novel of manners continues to maintain its empire in popular estimation, another species of romance—the historical—has likewise acquired a most powerful hold on the public taste, which, even more than the first, is chiefly of English original. The historical romance, in which fictitious scenes and personages are made to serve as vehicles for the historical portraiture of past times, had, especially in Germany, been cultivated with success before the writings of Sir Walter Scott; but it is to his adoption of this branch of composition, and the extraordinary talent which he devoted to it, that its present popularity and universal imitation are entirely owing.

ROMANCE'RO. In Spanish, the general name for a collection of the national ballads or *romances;* so called from the Roman or Romanic tongue, which, in the early part of the middle ages, seems to have been the common appellation of all the dialects spoken from the Alps to the western extremity of the Mediterranean. The *Romancero General*, the most celebrated of these collections, was published in 1604-14.

ROMANE'SQUE. (Fr.) In Painting, appertaining to fable or romance. In historical painting, it consists in the choice of a fanciful subject, rather than one founded on fact. The *romanesque* is different from *romantic;* because the latter may be founded on truth, which the former never is.

Romanesque, in Literature, is applied to the common dialect of Languedoc and some other districts in the south of France, which is a remnant of the old *Romanee* language, now nearly extinct. This term must not be confounded with *Romaic*, which is used to signify the language of modern Greece.

RO'MAN ORDER. *See* COMPOSITE ORDER.

RO'MAN SCHOOL. This school of painting, which, like the Florentine, addressed itself to the mind, is formed upon antique models. Its style was poetical; embellished with all the grandeur, pathos, and freedom from common matters, that the happiest imagination could conceive. In touch its masters were easy, correct in drawing, learned and full of grace. In composition it is sometimes whimsical, yet always elegant. The heads of the figures are always drawn with great respect to truth and expression, and it exhibits great intelligence in contrasting attitudes. It is in colouring that it displays the greatest marks of negligence, whilst in draperies it is eminently successful. At the head of this school was Raffaelle; and among its other principal masters were Giulio Romano, Zuccaro, M. A. Caravaggio, Baroccio, Andrea Sacchi (perhaps the best colourist of this school).

ROMA'NTIC, ROMANTICISM. By *romantic* is understood that singular intermixture of the wonderful and the mysterious with the sublime and beautiful which introduces us into an enchanted existence, and raises us above the bare realities of life by its dazzling peculiarities. Antiquity was a stranger to this feeling, nor had the classic languages any term to express it. *See* CHIVALRY.

Almost all authors concur in the difficulty of giving a precise signification to the term *romantic*. The *Dictionnaire de l'Academie Francaise* says, "Le romantique est un genre nouveau. *Romantique* se dit encore des écrivains qui affectent de s'affranchir des regles de composition et de style établies par l'example des auteurs classiques." This definition, though far from being precise, is perhaps the best that has hitherto been given; and instead of attempting to rival it, we shall content ourselves with placing it before the reader.

The term *romanticism*—an offshoot of romantic—is of recent invention, and is applied chiefly to the fantastic and unnatural productions of the modern French school of novelists, at the head of which are Victor Hugo, Balzac, "George Sand," &c., and their imitators in France and other countries.

ROMAN VITRIOL. Sulphate of copper, or blue vitriol.

ROMANZIE'RI. In Italian Literature, a series of poets who took for the subject of their compositions the chivalrous romances of France and Spain; and, with one or two exceptions only, those relating to the exploits of Charlemagne and his fabulous Paladins. The earliest of these poets flourished in the latter end of the 15th century. Boiardo, although not absolutely the first in order of time, is considered as having laid the groundwork, in his *Orlando Innamorato*, of the edifice of fiction raised by his successors. Pulci, in the *Morgante Maggiore*, was the first who allied the romantic incidents and sentiments of chivalry with light and humorous satire. Berni remodelled the work of Boiardo. Ariosto, in the *Orlando Furioso*, carried this species of poetry to the highest degree of perfection. These are the four principal Romanzieri; but many other poets of the same school flourished until the end of the 16th century. Tasso composed one of his early poems (*Il Rinaldo*) on the common model. In the beginning of the 18th century, the Abate Fortiguerra compiled his *Ricciardetto*, a poem of a semi-burlesque character, intended originally as a parody, but completed as a serious composition; and thus closes the list of the Romanzieri. All these poets adopted the ottava rima, invented by Boccaccio (*see* OTTAVA RIMA). In their poems the thread of the main narration is frequently interrupted by a multiplicity of minor adventures and intrigues; and this complication of plot appears to have constituted one of the characteristic features of the chivalrous epic. In most of them (from the time of Pulci) each book begins with a sort of prologue, more or less connected with the subject which follows: and these prologues form perhaps the greatest charm of the poem of Ariosto; effecting the transitions from one subject to another by means of some touch of pathetic or elevated reflections, or of light humour and playful satire, generally in the form of an address to the supposed audience, the poem being framed on the model of a tale recounted by a minstrel to an assembly of knights and ladies.

ROMA'NZOFITE. A mineral from Finland of a brown colour; it is a triple silicate of lime, alumina, and iron.

RO'NDEAU. (Fr.) In French Poetry, a little poem of thirteen verses, divided into three unequal strophes, with two rhymes (eight lines masculine and five feminine, or *vice versâ*). The two or three first words of the first verse serve as the burden, and recur in that shape after the eighth and thirteenth verses. There are also double rondeaux and single rondeaux; the latter an obsolete, but easier kind of verse. In Music, the term *rondeau* is applied to a light air, in which the first strain forms the burden, and as such is frequently repeated: it is also written *rondo*.

RO'NDEL. In Fortification, a small round tower, erected in some particular cases at the foot of the bastion.

ROOD. (Ang. Sax. rode, *beam;* used for the Cross.) The crucifix, sometimes also the image of a saint, was so called in old English churches. Roods were set in shrines or tabernacles, and the place where they stood was called the rood-loft, which was commonly over or near the passage out of the body of the church into the chancel. They were all ordered to be taken down in 1548 (Burnet, *Hist. of the Reformation*, vol. ii. book 1.); but restored for a short time under Queen Mary. (*Archæologia*, vol. i.)

ROOD. A square measure, the fourth part of a statute acre, and equal to 40 perches or square poles.

ROOF. In Architecture, the uppermost part of a building, containing the timber work, with its covering of slate, lead, tile, or other material. Carpenters, however, restrict their use of the word to the timber framing alone.

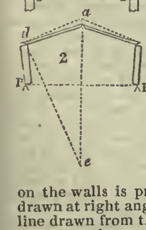
The inclination of the sides of a roof will, considering the species of covering to be the same in all, depend very

much on the temperature of the country to which it is to be adapted. In the southern countries of Europe roofs do not require much elevation, whilst as we proceed northward they require a far greater pitch. In the warm, or rather hot climates, buildings require nothing more than a terrace for their covering; but in the temperate climates, wherein the latitude exceeds 42 degrees, experience shows that the flat covering of a building cannot be practised with any expectation of durability. The rains of hot climates are violent, whilst those of temperate climates are searching. In the more northern latitudes the moisture, the driving nature of the rain, and, in addition, the duration of the snow on the roofs, require, it is obvious, a more considerable inclination. Such materials as lead, copper, zinc, and the like, which, supposing them one piece, as, in fact, when used, they ought to be, are not fair examples from which to draw inferences in the theory whereof we speak; for, if well executed, they must either of them be considered as one homogeneous piece: but in the case of tiles, whether of marble, stone, or clay, the case is far different. Without entering minutely into the details of this subject, we will merely observe, that supposing the inclination of a roof to be zero at the equator, if we add to it an inclination of three degrees for every climate from the equator to the polar circle, each climate being taken at 2° 42′ 30″, we obtain results which show that the roofs and pediments of temples of antiquity must have been well studied in that useful point of view which regarded their durability and impenetrability by rain. The *Encyc. Met.* we believe to have been the first instrument of promulgating this curious theory; and believing in it as we do, we can, if it be not true, only use the Italian saying, "si non è vero, è ben trovato." The theory would give an inclination to roofs at Athens of 16¼ degrees, and they are very nearly so inclined; the temple of Minerva being 16 degrees, and that of the temple of Eretheus 15½ degrees. In Rome, according to this theory, the inclination of a roof, and consequently pediment, should be 22 degrees; and experience finds it varying from 23 degrees to 24½. The advocates for the propriety of strictly copying Greek forms and details under the latitude of London will, if they have studied the æsthetics of the art, find no little difficulty in establishing their doctrines, after weighing this matter impartially. But our limits prevent further observation; we will merely subjoin a table conformable to the theory: —

Place.	Latitude to nearest Minute.	Length of longest Day.	Inclination of Roof, supposing Covering to be Roman Tiles.
Carthagena -	37° 36′	14h. 42m.	19° 12′
Palermo - -	38 7	14 48	19 48
(Latitude of Athens is 38° 5′)	- -	- -	(see above.)
Lisbon - -	38 42	14 50	20 0
Madrid - -	40 25	15 0	21 0
Naples - -	40 50	15 2	21 12
Rome - -	41 54	15 10	22 0
Paris - -	48 50	16 6	27 36
London - -	51 31	16 34	30 24
Amsterdam -	52 22	16 44	31 24
Edinburgh -	55 57	17 32	36 12
Petersburgh -	59 56	18 44	43 24

A roof, as respects its construction, involves some knowledge of mathematics. Of the general principles on which its proper construction depends, we shall here subjoin some account. The obvious mode of covering a building, where a greater or lesser inclination of the sides of the roof is required by the climate, is to place two sloping rafters C C upon the walls B B, as in the subjoined diagram (fig. 1.), meeting at the apex A; where we will suppose them so connected with a hinge as to be inseparable, but capable of descending by their gravity, as shown in No. 2. The walls are considered as solid masses, moveable on points P. If the walls be not of sufficient weight, the thrust that will be thus exerted on them by the tendency of the rafters to spread at their feet will throw the walls out of an upright, as in No. 2., and the whole assemblage will be destroyed. By the laws of mechanics, it is known that the horizontal thrust thus acting on the walls is proportional to the length of a line *de*, drawn at right angles to the rafter, intersecting a vertical line drawn from the apex, which it is manifest must increase as the roof becomes flatter. To counteract the thrust above mentioned, nothing more is necessary than to tie together the feet of the rafters, as in the following diagram (fig. 2.); in which A B is the tie in question, and thence is called a *tie-beam*. If the extent be not very great, the rafters may be kept from spreading by a minor tie, as at *a b*, called a *collar*. Beyond certain lengths or spans, however, it will occur to the reader that a tie-beam will itself have a tendency to bend, or sag, as the workmen call it, in the middle; and from this circumstance a fresh contrivance becomes necessary, which will be seen in the diagram below (fig. 3.), marked *c d*: this is called a *king post*, or more properly *king-piece*, inasmuch as it does not perform the office of a post, but rather of a tie, for it ties up the beam to prevent its bending. If the rafters be so long as to be liable to bend, two pieces *a a*, called *struts*, are introduced; which, having their footing against the sides of the king post, act as posts to support or *strut up* the rafters at their weakest points. The piece of framing thus contrived is altogether called a *truss*. It is obvious that by means of the upper joints of the struts we obtain more points of support (fig. 4.), or rather suspension; and that but for the compressibility of the timber, there would be no limit to the space which a roof might be made to cover. This compressibility takes place at those points where the fibres of the wood are pressed at right angles, or nearly so, with their direction, and many ways are adopted for avoiding this inconvenience. There is a species of roof, dependent in construction on the principles we have just described, which we shall here briefly notice, and whereof the following is a diagram (fig. 5.). This roof has three points of support, A, B, A; the posts A A, A A are called *queen posts;* the collar A B A is here a *straining piece*, instead of a tie, as it was in the example of ties first noticed, its operation being exactly the reverse of a tie. The *curb* or *mansard* roof is one in which a story is obtained, as may be seen in the annexed diagram (fig. 6.). Its principles are the same as those already mentioned, and do not here require further notice. In the execution of roofs the expense of trussing every pair of rafters would be unnecessary, and the practice would also load the walls with a far greater weight than would be expedient; it is therefore the custom to place these *principal* parts of a roof at certain intervals, which, however, should never exceed ten feet. The rafters which are actually trussed are called *principal rafters;* and by the intervention of the *purline* A in the diagram (fig. 7.), are made to bear the smaller or common rafters, which are notched down on it. These common rafters are received by or pitch upon a plate B, called a *pole-plate;* and the principal rafters, which fall on the tie-beam, are ultimately borne by the wall-plate C. When beams, in either roofs or floors, are so long that they cannot be procured in one piece, two pieces to form the required length are *scarfed* together, by indenting them at their joints and bolting them together; of which practice two modes are here subjoined (fig. 8.).

(1.)



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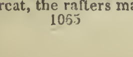

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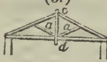
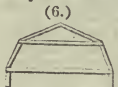


(4.)

(5.)

(6.)



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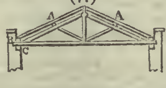

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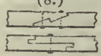


ROOK. The name of a well-known species of crow (*Corvus frugilegus*, Linn.), resembling in size and colour the carrion crow, but differing in having the base of the bill whitish and scurfy, and bare of feathers. "This," says Montague, "is acquired by the bird's habit of thrusting its bill into the ground after worms and various insects. The rook is content with feeding on the insect tribe, particularly the larvæ of the cockchaffer; and while following the plough to remove from the newly-made furrow this destructive grub, it more than repays the husbandman for the grain which it may afterwards pick up. The rook is gregarious at all seasons, resorting constantly to the same trees every spring to breed, when the nests may be seen crowded one over another upon the upper branches. It lays four or five eggs, much like those of the crow, of a greenish colour spotted and blotched with dusky. After their young have taken wing, they all forsake their nest-trees, returning to them again in October to roost; but as winter comes on, they generally select more sheltered places at night in some neighbouring wood, to which they fly off together." (Montague, *Ornithological Dictionary*.) The wood or grove of tall trees, in which rooks congregate and build their nests, is called a rookery.

ROOT. In Arithmetic, a number which being multiplied into itself any number of times produces another number, called a *power*, of which power the original number is the root. The root takes the name of the power whose root it is. Thus, it is called the *square root*, if the power is a square; the *cube root*, if the power is a cube, and so on.

ROOT. That part of the central axis of a plant which is formed by the descending fibres, and whose function is

to attract liquid food from the soil in which it is mingled. It differs from the stem in not having leaves or buds upon its surface, and in its tendency to burrow under ground, retreating from light; nevertheless, some kinds of roots are exclusively formed in air and light, as in the ivy, and other such plants.

ROOT OF AN EQUATION, in Algebra, signifies the value of the unknown quantity which enters into the equation. *See* EQUATION.

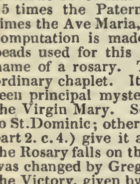
ROO'TSTOCK. In Botany, a prostrate rooting thickened stem, which yearly produces young branches or plants. It is common in *Iridaceæ* and Epiphytous *Orchidaceæ*, and is often confounded with the root. Ginger and orris root are common instances of it.

ROSA'CEÆ. (Rosa, one of the genera.) A large and important natural order of plants, the species of which are for the most part inhabitants of the cooler parts of the world. They are in some cases trees, in others shrubs, and in a great number of instances herbaceous perennial plants; scarcely any are annuals. No natural orders contain more species of general interest, in the beauty of their flowers or their perfume: there is the rose itself, and various species of the genera *Rubus*, *Spiræa*, *Potentilla*, *Geum*, and *Pyrus*. The apple, pear, plum, cherry, peach, nectarine, apricot, and similar valuable fruits, are the produce of others. The white thorn, with all its numerous exotic allies, belongs to the genus *Cratægus*. As medicinal plants, some are of considerable importance The root of *Potentilla reptans*, *Geum urbanum*, and others, is powerfully astringent; the bark of *Prunus coccomilia* has some reputation as a febrifuge; an Abyssinian plant called *Brayera anthelmintica* has energetic vermifugal qualities; and finally, prussic acid is obtained from the leaves and seeds of the almond, peach, plum, and other related species. This important assemblage of plants is distinguished by having several petals; separate carpels; distinct, perigynous, numerous stamens; alternate leaves, and an exogenous mode of growth.

RO'SARY. (Lat. rosarium, *a rose-bed.*) A Roman Catholic devotional practice; which consists in reciting 15 times the Paternoster, or Lord's Prayer, and 150 times the Ave Maria, or angelical salutation; but as the computation is made by means of beads, the string of beads used for this purpose has acquired the popular name of a rosary. The rosary is thus three times the ordinary chaplet. It is instituted in honour of the fifteen principal mysteries in the life of our Saviour and the Virgin Mary. Some have attributed its institution to St. Dominic; others (among whom is Mosheim, cent. x. part 2. c. 4.) give it a higher antiquity. The festival of the Rosary falls on the first Sunday in October. Its name was changed by Gregory XIII. from that of St. Mary of the Victory, given by Pius V. on its original institution in honour of the battle of Lepanto, which took place on that day.

ROSE. (Lat. rosa.) In Botany, the English name for the well-known and universally cultivated flower of the genus *Rosa*. (*See* ROSACEÆ.) It would occupy too much space to point out even cursorily the various ceremonies in which this flower plays a distinguished part; suffice it to say, that in the earliest ages it was regarded with even more favour than at the present times, and both at public and private festivals was considered an indispensable ingredient. (See the *Damen Lexicon.*) In architecture, the sculptured representation of this flower is found in the centre of each face of the abacus in the Corinthian capital, and is called the rose of that capital. Roses are also used to decorate the caissons in the soffitts of coronas and ceilings.

ROSE ENGINE. In Mechanics, an appendage to the turning lathe, by which a surface of wood or metal, as a watch-case, is engraved with a variety of curved lines. The assemblage of these lines presenting some resemblance to a full-blown rose, is called by the French *rosette;* and hence the engine by which the ornament is produced is called a rose engine. The mechanism by which the figures are produced is sometimes called a *camb*, and may be described as follows: "A wheel upon the axle C turns uniformly in the direction A B D E. A rod *m n* moves in guides, which only permit it to ascend and descend perpendicularly. Its extremity *m* rests upon a path or groove raised from the face of the wheel, and shaped into such a curve that as the wheel revolves the rod *m n* shall be moved alternately in opposite directions, through the guides, with the required velocity. The manner in which the velocity varies will depend on the form given to the groove or channel raised upon the face of the wheel; and this may be shaped so as to give any variation to the motion of the rod *m n* which may be required for the purpose to which it is to be applied." (*Lardner's Mechanics*, *Cab. Cyclopedia*, p. 250.)



The purpose of the machine is therefore to convert a uniform rotatory movement into a varied rectilinear and alternating movement. It is also used in machinery for spinning, and for lace-making.

ROSEMARY (Lat. ros marinus, *sea dew*), is the name given to a small evergreen shrub of the Labiate order, which inhabits rocky hills in the neighbourhood of the Mediterranean, and which is commonly cultivated in our gardens. It has very narrow green leaves, turned back at the edge and hoary underneath. The flowers are of a dull leaden blue, or even white. It has been employed in infusion as a remedy for headache, and is extensively employed in the manufacture of pomatums for promoting the growth of hair. Oil of rosemary is what gives the green colour to these preparations. It is also said to be one of the ingredients in Eau de Cologne. Narbonne honey is also said to owe its peculiar flavour to bees feeding on the blossoms of the rosemary. The grey bushes, mantled with dew drops, on the rocky coasts of France and Italy, are said to justify the singular name that has been given to the plant. It is the *λιβανωτὶς στεφανωματικὴ* of Dioscorides.

ROSE-NOBLE. A gold coin of the value of 6*s*. 8*d*., first coined in the reign of Edward III.

ROSEO'LA, called from its rose colour a *rash;* frequently symptomatic of different febrile complaints, of disordered stomach and bowels, of teething, and of any constitutional irritation. Acidulated drinks, mild aperients and sudorifics, and strict attention to the diet, with caution against the application of or exposure to cold, so as to cause a retrocession, are the principal points to be attended to.

ROSES, FESTIVAL OF. A rural festival of some parts of France, in which the best-behaved maiden of the town or village (called *La Rosiere*) is annually crowned with roses in the church, whither she is conducted with great pomp by the villagers. These festivals were originally celebrated on the 8th of June at Salency, a village of Picardy, under Louis XIII.; but they were afterwards introduced into Surêne, near Paris, whence they extended to many other places, and have latterly even penetrated to Moravia. The Persians have also an annual festival of roses, which consists of bands of youth parading the streets with music, and offering roses, as the Italians during the carnival *confetti*, to all they meet, for which they receive a trifling gratuity.

ROSES, WHITE AND RED. In English History, the well-known feuds that prevailed between the houses of York and Lancaster are so called, from the emblems adopted by their respective partisans; the adherents of the house of York having the white, those of Lancaster the red rose, as their distinguishing symbol. These wars originated with the descendants of Edward III.; and after extending over a period of more than eighty years, during which England formed an almost uninterrupted scene of bloodshed and devastation, were finally put an end to by the victory of Henry Tudor, earl of Richmond, over Richard III. in 1485, the victor uniting in his own person the title of Lancaster through his mother, and that of York by his marriage with the daughter of Edward VI. Since that period the rose has been the emblem of England, as the thistle and shamrock (see those terms) are respectively the symbols of Scotland and Ireland.

ROSE'TTA STONE (so called from Rosetta, a village of Egypt, where it was discovered by the French). The name given to the celebrated stone, now in the British Museum, which has played so distinguished a part in all modern hieroglyphical researches. It is a piece of black basalt, three feet in length, and about two feet and a half in breadth, and contains parts of three different sculptured inscriptions: one in sacred characters, or, as they are termed, *hieroglyphics;* the second in enchorial characters (*i. e.* in those of the country, or in modified conventional hieroglyphics); and the third in Greek. From the last, or Greek inscription, it appears that the inscriptions are either entirely or substantially identical, and form a royal decree which was ordered to be sculptured in the languages above specified. The inscriptions are a good deal mutilated, particularly the hieroglyphical; but they are still sufficiently distinct to allow the hieroglyphical and enchorial characters to be compared with each other and the Greek. As the discovery of this stone presented to the learned the first opportunity of viewing the Greek in juxtaposition to the Egyptian language, great hopes were entertained that a key would thereby be obtained to the deciphering of the numerous monuments of ancient Egypt. It would appear, however, from the investigations of Dr. Young and Champollion, whose attention has been deeply engrossed with this subject, that the Greek does not faithfully represent the enchorial text, but gives merely its substance. According to the Greek inscription, the stone was erected in the reign of Ptolemy Epiphanes

(A. C. 194), whose benevolence it describes, and enumerates his victories and the principal political transactions of his reign. *See* HIEROGLYPHICS.

ROSICRU'CIANS. A sect of visionary speculators who existed in Germany about the beginning of the 17th century. They ascribed, indeed, a much higher antiquity to themselves; but it is probable that if any body of philosophers who adopted this title ever existed in reality, they were the alchemists, fire-philosophers, or Paracelsists of the 16th century, who adopted this mode of giving vogue and fashion to their tenets. Germany was inundated with tracts, from 1600 to 1630, purporting to come from supporters or from enemies of this sect, in which their opinions and intentions are canvassed, but generally in a wild and unintelligible manner. From one of these, a *Treatise on the Laws of the Rosicrucians*, by Ritter von Maier (1618), we learn that the fraternity had six fundamental laws: — 1. That their chief end and object was to cure the sick without fee or reward. 2. That in travelling they were to change their habits and dress, so as to accommodate themselves to those of the countries in which they sojourned. 3. To meet once a year on a certain day and at a certain place, kept secret from the rest of the world. 4. To fill up vacancies in their body by electing fresh members. 5. To use the letters R. C. as their common symbol. 6. That the fraternity should remain undivulged for one hundred years from its foundation. It appears probable that the device of the rose issuing out of the cross, which was the same with Martin Luther's seal, was adopted for the purpose of attracting the notice of the religious: the rose was explained to represent the blood of Christ. It would appear from these laws that some species of secret Freemasonry was intended; and the Rosicrucians have been by some connected with the Freemasons; but there is, in point of fact, no evidence that any such society existed at all, and the name and other circumstances were probably only the device of some alchemists, who usually conveyed their own notions under cover of symbolical language. Andreä, a German scholar, is stated, in the *Conversations Lexicon*, to have been the original propagator of the reports concerning the Rosicrucian society. The Rosicrucians have been also connected in various ways, by public opinion, with the Cabalists, Illuminati, &c.; and the division of spiritual beings inferior to the angels into sylphs and gnomes, which furnished Pope with the machinery of the *Rape of the Lock*, is of Rosicrucian or Cabalistic origin. It is found in that singular work, the *Comte de Gabalis*, which obtained a sudden popularity in the beginning of the last century; in which the author professes himself a member of the Rosicrucian fraternity. (See Mosheim, *Eccl. Hist.* vol. v.)

ROSIN. *See* RESIN.

ROSTE'LLUM. (Lat. rostrum.) An elevated and rather thickened portion of the stigma of Orchidaceous plants, from which the peculiar gland separates by which the pollen masses of some species of that order are eventually held together. It was formerly supposed to be the point through which impregnation is effected; but this is now known to have been an error.

ROSTELLUM. The name of the mouth of the louse and similar Apterous insects, in which the ordinary trophi are replaced by an exarticulate retractile tube, from which a retractile siphuncle is protruded. The uncinated proboscis of the tape-worms (*Tæniæ*) is also so called.

ROSTER, in Military affairs, is applied to the plan or table by which all military duty is regulated.

RO'STRULUM (Lat. dim. of rostrum), in Entomology, is the name of the oral instrument of the flea and other *Aphanipterans;* in which the ordinary trophi are replaced by a bivalved beak, between the valves of which there are three lancet-shaped instruments.

ROSTRUM. (Lat.) Literally the prow of a ship, but metaphorically applied to the pulpit or pleading place in the Roman forum, which was decorated with the prows of vessels taken from the enemy. (See *Niebuhr's Roman History.*)

ROT. A term applied to a well-known disease peculiar to sheep. It is often called *great rot*, and *hydrophic rot*, &c.; but it is more popularly known by the single term of rot. Many causes have been assigned for it; as the *Fasciola hepática*, or fluke worm; some particular plants eaten as food; ground eating; snails, and other ingesta: but as most of the supposed deleterious herbs have been tried by way of experiment, and have failed to produce the disease, so it is attributable to some other cause. Neither is there satisfactory reason to suppose that the fluke worm is the original cause of it, but a consequence; since we know that the biliary vessels of other animals, as horses, asses, rats, &c., often have them: and above all, because that they are not always present in the rotted subject. From long experience, and the almost invariable effect produced by a humid state of atmosphere, soil, and product, we are warranted in concluding these are the actual and immediate agents: perhaps the saturated food itself is sufficient to do it. The morning dew has been supposed equal to it. Bakewell, when his sheep were past service, used to rot them purposely, that they might not pass into other hands. This he always readily did by overflowing his pastures. But great differences of opinion exist as to the quantity, form, and varieties of moisture productive of this fatal disease. It is said that land on which water flows, but does not stagnate, will not rot, however moist; but this is contradicted by the experience of Bakewell, who used merely to flood his lands a few times only to rot his sheep. It is also said they are safe from rot on Irish bogs, salt marshes, and spring-flooded meadows, which experience seems to verify. It is also said that the very hay made from unsound land will rot; but this wants confirmation. When salt marshes are found injurious, it is only in years when the rain has saturated or rather super-saturated such marshes. That putrid exhalations unaccompanied with moisture can occasion rot wants confirmation also; for these commonly go together, and it is difficult to separate their effects. It is not, perhaps, the actual quantity of water immediately received by land, but the capacity of that land to retain the moisture, which makes it particularly of a rotting quality.

The signs of rottenness are sufficiently familiar to persons about sheep. They first lose flesh, and what remains is flabby and pale; they also lose their vivacity. The naked parts, as the lips, tongue, &c., look livid, and are alternately hot and cold in the advanced stages. The eyes look sad and glassy, the breath is fetid, the urine small in quantity and high-coloured; and the bowels are at one time costive, and at another affected with a black purging. The pelt will come off on the slightest pull in almost all cases. The disease has different degrees of rapidity, but is always fatal at last. This difference in degree occasions some rotted sheep to thrive well under its progress to a certain stage, when they suddenly fall off, and the disease pursues the same course with the rest. Some graziers know this crisis of declension, as it has been called, and kill their sheep for market in the immediate nick of time with no loss. In these cases, no signs of the disease are to be traced by ordinary inspectors; but the existence of the flukes, and still more a certain state of liver and of its secretions, are characteristic marks to the wary and experienced.

The treatment of rot is seldom successful unless when it is early commenced, or when of a mild nature. A total change of food is the first indication, and of that to a dry wholesome kind: all the farinæ are good, as the meals of wheat, barley, oats, peas, beans, &c. Carrots have done good, mixed with these: broom, burnet, elder, and melilot, as diuretics, have also been recommended; but it is necessary to observe, that there is seldom any ventral effusion but in the latter stages of the complaint. As long as the liver is not wholly disorganized, the cure may be hoped by a simple removal of the cause, which has been shown to be a variable temperature, with excessive moisture of pasturage, which may also be aided by such remedies as assist the action of the biliary system. Salt acts in this way, and thus salt mashes are good: salt may also be given in the water. Salt appears the principal ingredient in Flesh's patent restorative for sheep; for it states it to be composed of turpentine, sal ammoniac, turmeric, quicksilver, brimstone, *salt*, opium, alkanet root, bark, antimony, camphor, and distilled water; but of this medley none of the articles can be in sufficient quantity to prove useful but the salt. In the more advanced stages of the disease, when the liver has become materially affected, it is prudent to rub the belly of each sheep with half a drachm of mercurial ointment every other day for a week. Give also the following every morning: — Watery tincture of aloes, half an ounce; decoction of willow bark, four ounces; nitric acid, twenty-five drops. (*Loudon's Ency. of Agriculture.*)

ROT. In Timber. *See* DRY ROT.

ROTA'TION. (Lat. rota, *a wheel.*) In Mechanics, the motion of a solid body about an axis. Rotatory motion is distinct from progressive motion, though both are frequently found to coexist in the same body. The planets, for example, at the same time that they have a progressive motion in their orbits, revolve also about axes passing through their respective centres of gravity. It is the rotatory motion of the earth about its axis which produces the alternations of day and night; and a slow but constant change of position in that axis, arising from the attraction of the sun and moon on a body not absolutely round, gives rise to the astronomical phenomenon of the precession of the equinoxes.

The determination of the circumstances of the rotation of a planet about its axis is a problem of physical astronomy, not less interesting or important than that of the planet's motion in its orbit. It was, in fact, long considered as the more difficult problem of the two; but, according to the methods of modern analysis, both form a part of the same theory, and their solutions are deduced from the same general equations of motion.

In relation to practical mechanics, the problem of rotation is also of great importance; inasmuch as it comprehends the methods of computing the performance of

machines, the forces necessary to overcome their inertia, and the proper relations and most advantageous disposition of their several parts, in order that the required effect may be produced by the smallest expenditure of power and the least strain or injury to the machine itself.

In all investigations relating to the motion of bodies about axes, the terms *moment of force*, *moment of inertia*, *angular velocity*, are of constant occurrence; it is therefore important to keep in view the exact meaning of those terms.

The *moment of a force* exerted in turning a body about an axis, is the product obtained by multiplying the force into the perpendicular from the axis upon the line of its direction; or it is the force multiplied into the leverage. Thus, if F be force supposed to act in a plane perpendicular to the axis, and h a line drawn from the axis perpendicular to the direction of the force, the moment of the force is $\mathrm{F}h$. But as force is measured by the velocity which it communicates to a given mass, this is usually expressed by $\mathrm{M\,V}h$; where V is the velocity which the force F communicates to the mass M, when directed to its centre of gravity, in the time which is assumed as unity.

The *moment of inertia* of a body in respect of a given axis, is the sum of all the products obtained by multiplying each element of the body into its distance from the axis. Thus, if m be one of the constituent elements of the body, and r the distance of m from the axis, then the moment of inertia is $\Sigma r m$; the summation denoted by Σ being extended to every element m. *See* MOMENT.

The different particles of a solid body revolving about an axis move with a velocity proportional to their respective distances from the axis; and the velocity of the particle whose distance from the axis is unity is the *angular velocity* of rotation. If this be denoted by ω, then the velocity of a particle whose distance from the axis is r will be $r\,\omega$.

These definitions being premised, we may now state a few of the more remarkable properties of rotatory motion. If the motion is produced by impulse, and the moving body is not acted upon by accelerating forces, so that the velocity is uniform, the fundamental theorem (which is easily deduced from the property of the lever) is,

$$\text{angular velocity} = \frac{\text{moment of impelling force}}{\text{moment of inertia}}.$$

In the case of a body turning about a fixed axis, it is supposed that the impelling force acts in a direction perpendicular to the plane passing through the axis of rotation and the point at which the force is applied. If the impelling force is not perpendicular to this plane, it must be resolved into two parts, one of which is perpendicular to the plane, and the other parallel to it; and it is only the former part which tends to produce rotation, the latter being destroyed by the resistance of the axis.

When all the different particles of a body are acted upon by accelerating forces (as in the case of a pendulum drawn aside from the position of rest and abandoned to the action of gravity), the angular velocity becomes a variable quantity, and is expressed by this formula,

$$\frac{d\,\omega}{d\,t} = \frac{\text{moment of the impelling forces}}{\text{moment of inertia}};$$

where $d\,\omega$ is the element of the velocity, and $d\,t$ the element of the time. The moment of the impelling forces is computed from this expression, $\Sigma m\,v\,h$; where m is the mass of an element of the body, h its distance from the axis of rotation, and v the velocity due to the accelerating force. From the above formulæ, it is obvious that the computation of the moment of inertia must enter into every question connected with rotatory motion.

Principal Axes. — Generally speaking, any change which is made in the position of the axis about which a body revolves must be accompanied with a change in the moment of inertia. Hence, if a point (which is not the centre of gravity) be taken in a solid body, all the axes which pass through that point (and they may be infinite in number) will have different moments of inertia, and there must exist one in respect of which the moment is a maximum, and another in respect of which it is a minimum. Those axes in respect of which the moment of inertia is a maximum or minimum are called the *principal axes of rotation*.

If for any point taken in a solid body, we proceed by the usual methods of maxima and minima to find the position (relatively to the principal lines of the body) of that line or axis about which the moment of inertia is the greatest or least possible, the analysis leads to a cubic equation, of which all the three roots are real. Hence, for every point of a body, however irregular, there are *three* principal axes. Further examination shows that these axes form a system of straight lines at right angles to each other. One of them is such that the moment of inertia with respect to it is the least possible; with respect to another, the moment is the greatest possible; and although with respect to the third the moment is not, strictly speaking, the greatest or least, yet it possesses this characteristic of maxima and minima, that its differential coefficient is nothing, or its value is not affected by a very small change in the position of the axis.

If the form and structure of the revolving body be such that the moments of inertia about two of the principal axes are equal, then every line in the plane of those axes passing through their points of intersection will be a principal axis. For example, in the spheroid of revolution, the polar diameter forms one of the principal axes; the two others are in the plane of the equator, and consequently equal; and it is obvious from the symmetrical form of the body that every equatorial diameter will have the same moment of inertia, or be a principal axis. If all three principal axes are equal, as in the case of a sphere when the point in which the axes meet is the centre, then every line passing through the same point is a principal axis. From this it follows that with respect to any point taken in a solid body there are either three principal axes, or else an infinite number.

It is a property of the principal axes, that if a body begins to revolve about any one of them it will continue to revolve about the same axis uniformly and perpetually, unless the motion is deranged by the action of a disturbing force. The centrifugal forces about a principal axis exactly counterbalance each other, and the axis remains unmoved without the aid of any support. There is, however, an essential difference in this respect between one of the axes and the two others. If a body begins to revolve about an axis very near to one of the axes for which the moment of inertia is the greatest or least possible, the axis of actual rotation will continue to oscillate about that principal axis, never deviating from it beyond certain narrow limits, and the angular velocity will only suffer small periodic alterations; but if the body begins to revolve about an axis which is very near to the intermediate principal axis, the axis of rotation will deviate from the principal axis indefinitely, and the velocity of rotation will not remain constant. Hence the rotation about two of the principal axes is stable; about the third unstable.

When a solid body revolves about a fixed axis, there are certain points in the body having determinate situations with respect to the axis of rotation and centre of gravity, which, on account of their remarkable properties, require to be distinguished. Thus, in computing the effects of machinery, it is often necessary to determine the situation of the point at which if the whole mass of the revolving body were concentrated the rotatory effect would remain unaltered. This point is called the *centre of gyration*. The *centre of oscillation* of a body suspended by an axis is the point at which if all the matter were collected the oscillations would be performed in the same time. The *centre of percussion* is the point at which if the body encountered an immoveable obstacle the motion would be arrested without producing any strain on the axle. For the properties of these centres, and the method of computing their positions, see CENTRE.

Motion of a Body entirely free. — If a body is retained by no fixed point, but is at liberty to move in any direction, and if a force be applied to it in a direction which passes through its centre of gravity, all the points of the body move forward in straight lines parallel to each other and to the direction of the impelling force. But if the direction of the force does not pass through the centre of gravity, the body will acquire two motions,— one progressive, and the other rotatory; and these two motions are entirely independent of each other, that is to say, each is performed exactly in the same manner as if the other did not exist. The progressive motion is the same as if the direction of applied force had passed through the centre of gravity, and the rotatory motion communicated to the body is the same as if the centre of gravity had been a fixed point. In consequence of this property the general problem of determining the motions of a body subjected to the action of given forces resolves itself into two; of which the first is to determine the motion of the centre of gravity of the moving body, and the second to determine at every instant the position of the axis and the velocity of rotation.

In the solution of the latter problem the following elegant theorem, first given by Frisi, is of important use: — When a body revolves on an axis passing through its centre of gravity, and a force is impressed tending to make the body revolve about another axis also passing through its centre of gravity, the body will revolve about neither, but on a third axis, which lies in the same plane with the other two, and so situated as to divide the angle which they contain into two parts, such that the sines of the parts are to each other in the inverse ratio of the angular velocities with which the body would have revolved about the said axes respectively. It is evident that this conclusion will hold good if the angular motions about both axes are impressed simultaneously; and as the velocity about the new axis may in like manner be compounded with another velocity about a different axis, it follows that if several angular motions about given axes are impressed on a body at the same time, the position of

the resultant axis and the velocity of rotation may be readily computed.

If the primitive axes are at right angles to each other, then the square of the angular velocity about the resultant axis is equal to the sum of the squares of the velocities about the primitive axes. These properties form the theory of the composition of rotatory motion. For their demonstration the reader may be referred to *Airy's Mathematical Tracts*, "Precession" and "Nutation;" or to the article "Rotation," in the new edition of the *Encyclopædia Britannica*.

The principal application of the theory of the rotation of bodies entirely free is to the planets, and particularly the earth. It is to be observed, however, that the change which is continually taking place in the position of the terrestrial axis of rotation is only in respect of fixed points in space; for it can be shown that since the earliest recorded astronomical observations, the position of the poles of rotation on the earth's surface has undergone no alteration whatever.

The principal works on the subject are *Euler's Theoria Motus Corporum Solidorum*, 1765; Vince, *Phil. Trans.*, 1780; Frisii, *Opera*, tom. ii., 1783; *Atwood's Treatise on the Rectilinear Motion and Rotation of Bodies*, 1784; *Landen's Mathematical Memoirs*, 1789; Laplace, *Mécanique Celeste;* Lagrange, *Mécanique Analytique;* Poisson, *Traité de Mécanique*, &c.

ROTATION OF CROPS. In Agriculture and Gardening, it is found that the same annual crop cannot be advantageously cultivated on the same soil for more than one or two years; and hence one kind of crop is made to succeed another. And the number of cultivated crops being limited, when the whole course has been gone through once it is again repeated; and hence the origin of the word *rotation*. But as the same number and kind of crops are not always grown in regular succession, but a change is frequently made according to general principles, the term used in that case is *succession of crops*. The principle on which the succession of crops is founded is, that every kind of plant not only extracts nourishment from the soil, but exudes into it excrementitious matter, which is found injurious to that species, though it may prove nutritious to another species. As a general principle of guidance in determining the succession of crops, it is considered advantageous that a crop cultivated for its leaves or roots should succeed one cultivated for its ripened seeds; that the cereal grasses should be succeeded by leguminous plants; taprooted plants, or plants bearing tubers, by fibrous-rooted plants; and plants which form a compact covering on the surface, such as corn and legumes sown broadcast, by plants which only partially cover the surface, such as crops grown in rows sufficiently wide to admit of cultivation between. It may also be adopted as a rule, that where land is to be subjected to a crop of the same plants for a number of years, as in permanent pasture, the plants composing the crop should be of several different kinds, by which means the excrementitious deposit of one species becomes the nutriment of another. Hence the propriety of sowing clover, ribwort, and other taprooted dicotyledonous herbage plants among pasture grasses.

RO'TATORIES, *Rotatoria*. (Lat. rota, *a wheel.*) Wheel animalcules. *See* ROTIFERS.

RO'TIFERS, *Rotifera*. (Lat. rota, and fero, *I carry.*) The name of a class of highly organized Infusorial animals, outwardly distinguished by certain ciliated appendages at the anterior part of the body, which seem to move in a rapid rotatory manner, and by their superior size. They are commonly termed "wheel animalcules."

ROTTEN STONE. An earthy mineral found near Bakewell in Derbyshire, in Wales, and at Albany in New York. It is much used for polishing metals; and consists, according to R. Phillips, of 86 alumina, 10 carbon, and 4 silica. It resembles tripoli.

ROU'BLE. A Russian silver coin of different values. It was first struck at Moscow in 1654. Catherine II. caused some gold coins to be struck with this name; but they are no longer current. *See* MONEY.

ROUE'. In the *beau monde*, a person devoted to a life of pleasure and sensuality, but not so completely vitiated in his character and manners as to be excluded from society. The term is said to have been first used in this sense by Philip of Orleans, the regent of France.

ROUGE. A species of lake prepared from the dried flowers of the *Carthamus tinctorius*, or safflower. Rouge is the only cosmetic which can be applied without ultimate injury to the complexion.

ROUGH-CAST. In Architecture, the plastering of walls with mortar and fine gravel, left rough without any smoothing.

ROUGHING IN. *See* RENDERED AND SET.

ROUGH STUCCO. In Architecture, stucco floated and brushed in a small degree with water.

ROUND. The property of a circle, sphere, or right cylinder, and indeed of any solid of revolution, though most commonly confined to the sphere and cylinder.

ROU'NDEL. In Heraldry, an ordinary in the form of a circle. It is improper to say a roundel or, gules, &c., describing it by its tincture; unless, first, in case of counterchanges; secondly, where the roundel is of fur, or of equal tinctures, as a roundel ermine, a roundel checky of or and azure, &c.; otherwise, roundels have distinguishing names, according to their tinctures. A roundel or is called a *bezant*, from the gold coins of the Greek or Byzantine empire: a roundel argent, a *plate;* gules, a *torteau*, a kind of cake; azure, *hurt*, a species of flower; vert, *pomme;* sable, *pellet;* purpure, *golpe*. A field or charge, with equidistant roundels, is said to be *bezanty*, *platy*, &c., according to the tincture.

ROU'NDELAY, in Poetry, is properly a short poem of thirteen verses; eight in one rhyme, and five in another. *See* RONDEAU.

ROUND HEADS. A nickname given to the Puritans at the time of the civil wars by the Cavaliers, from the close black skull-cap, reaching down to the ears, which was then worn by staid and serious persons; or, more probably, from the custom that prevailed among them of wearing the hair closely cut to the head.

ROUND ROBIN. (Fr. rond ruban.) A phrase originally derived from a custom of the French officers, who, on signing a remonstrance to their superiors, wrote their names in a circular form, so that it might be impossible to ascertain who had headed the list. It is now used to signify any act by which a number of individuals bind themselves to pursue a certain line of conduct.

ROUND TABLE, KNIGHTS OF THE. The name given to the famous order of knights that existed in England under the reign of King Arthur, by whom it was founded. The members of this order are said to have been forty in number, and derived their name from a huge round marble table round which they were accustomed to sit. Their adventures form the themes of much of the early romantic poetry and ballads of England; and our own times have been peculiarly fertile in clearing away much of the obscurity in which the well-known names of Tristram, Lancelot, and other members of this order were enveloped. Sir W. Scott's labours in this field are too well known to require any remark. (See *Schlegel's History of Literature*, which gives a masterly sketch of the influence of the Round Table on the romantic poetry of that and succeeding ages.)

ROUP. A Scotticism for auction.

ROW. To propel a boat by oars. Rowing is reckoned the most favourable application of human strength; the whole force is, however, not effective on the oar, as the part inside the actual fulcrum, which is in the water, acts as a backwater. Some nations take short strokes, which they rise up in making; the English prefer a long stroke sitting, which, to say the least, saves much exertion. As the theory of rowing involves the resistance of fluids, it is necessarily defective.

ROYAL. In Naval affairs, the sail above the top-gallant sail. The term *royal* is also applied, in artillery, to a kind of small mortar.

ROY'ALISTS. The name applied originally to the adherents of the Bourbon family after the revolution of 1792; but now in common use to designate the party attached to the claimants of the Spanish and Portuguese thrones.

ROYAL OAK, *Robur Carolinum*. In Astronomy, a constellation formed by Halley in the southern hemisphere. *See* CONSTELLATION.

ROYALS. The name given by way of eminence to the *first* regiment of foot in the British service: it is supposed to be the oldest regular corps in Europe. (*James's Military Dict.*)

RUBEFA'CIENTS. (Lat. rubefacio, *I make red.*) Substances which, when applied to or rubbed upon the skin, induce a redness or blush upon the part, not followed by blister.

RU'BELLITE. Red schorl or tourmaline. There is a magnificent group of crystallized rubellite in the British Museum, from the cabinet of the late Mr. Greville.

RUBE'OLA. The measles. This disease is preceded by fever, with swelling and inflammation of the eyes; an oppressive cough; and about the fourth day there is an eruption of small red points, perceptible to the touch, which continues for four or five days, and then goes off with desquamation of the cuticle; but the fever, cough, soreness of the eyes, and irritable state of bowels are apt to continue for some time after the entire disappearance of the eruption. The most alarming cases are those in which the inflammatory symptoms and fever run very high, and which sometimes require bleeding, or blisters and cupping upon the chest; or in which there is a putrid tendency, with a dark livid colour.

RU'BEZAHL. The name of a famous spirit of the Riesengebirge in Germany, who is celebrated in innumerable sagas, ballads, and tales, and represented under the various forms of a miner, hunter, monk, dwarf, giant, &c. He is said to aid the poor and oppressed, and shows benighted wanderers their road; but wages incessant war with the proud and wicked. The origin of the name is obscure. (See the *Tales of Musæus.*)

RU'BICEL. A term applied to the Brazilian ruby.

RU'BRIC. (Lat. ruber, *red.*) In the language of the old copies of manuscripts, and of modern printers, any writing or printing in red ink. The date and place on a title page being frequently in red ink, the word *rubric* has come to signify the false name of a place on a title page. Many books printed at Paris bear the *rubric* of Genoa, London, &c. But the most common use of the word is in ecclesiastical matters. In MS. Missals, the directions prefixed to the several prayers and offices were written or printed in red ink; and hence, the *rubric* familiarly signifies the order of the liturgy, in Roman Catholic countries as well as in England.

RU'BY. A crystallized gem of various shades of red, found chiefly in the sand of rivers in Ceylon, Pegu, and Mysore. Among lapidaries, the scarlet-coloured is sometimes called *spinelle ruby;* the pale or rose red, *balass ruby;* and the yellowish red, *rubicelle.* It is inferior in value and beauty to the red sapphire, or oriental ruby of the jewellers. It consists of 83 alumina, 9 magnesia, and 7 or 8 chromic acid; the latter gives its colour.

RUDDER. A heavy flat piece or frame of wood, hung upon the stern post by means of pintles and gudgeons, for the purpose of steering the ship. The rudder is turned round the stern post as an axis, by the tiller, which enters the rudder head. In vessels drawing much water the rudder is deep and narrow; in flat-bottomed vessels, it is shallow and broad. When carried to a considerable breadth, as in the Chinese vessels it is pierced with holes, which preserves an increased leverage with a diminished direct resistance from the water.

When the rudder is broken off by the ship getting aground, or by a heavy sea, a temporary one is made by a topmast and other spars placed parallel, and loaded at the bottom with pigs and ballast, and confined to the stern post by hawsers leading on each side of the keel.

Rudder Coat. A covering of tarred canvass loosely put round the rudder head to keep the water from entering by the aperture, while it admits of the rudder being turned freely round.

Rudder Pendants. Strong pieces of rope ending in chains, by which the rudder, if unshipped, is held to the ship's quarter.

Rudder Shock. A piece of wood fitting between the head of the rudder and the rudder hole, to prevent the play of the rudder in case of the tiller being removed.

RUDE'NTURE. (Fr.) In Architecture, the rope or staff with which the lower parts of the flutings of columns are often filled. See Cabling.

RUDIA'RIUS. (Lat.) The term applied to a discharged gladiator. The word is derived from the staff (*rudis*), which was given him in token of his dismission.

RUDO'LPHINE TABLES. A set of astronomical tables computed by Kepler, and founded on the observations of Tycho Brahé. They were called the *Rudolphine Tables* in honour of Rudolph II., emperor of Bohemia, who, upon the death of Tycho in 1601, conferred upon Kepler the title of imperial mathematician, and undertook to defray the expenses of their preparation. Owing to various causes the work was not completed until 1627, when the tables were published at Ulm. They are the first that were ever calculated on the hypothesis that the planets move in elliptic orbits, and they contributed greatly to the progress of modern astronomy. For a detailed account of this very remarkable production, see Delambre, *Astronomie Moderne*, tom. i. p. 557.

RUFF. The name of the male of the *Machetes pugnax*, which is distinguished at the breeding season by a ruff or tuft of wide-spreading feathers, projecting behind the eyes and from the upper part of the neck. The female is called the *reeve*. See Machetes and Tringa.

RULE, in Arithmetic, denotes a certain prescribed series of numerical operations, adapted to discover from the given conditions to which an unknown number is subjected what that number is. They are generally distinguished by particular names, according to the purposes for which they are given, or the particular nature of the business for which they are required; as the rules of interest, the rules of fellowship, &c.

Rule. In a monastic sense, a system of laws or regulations by which monasteries and other religious houses are governed, and which the monks, nuns, and novices vow at their entrance to observe. See Orders, Monastic.

Rule. In Law, an order of one of the three superior courts of common law. Rules are either general or particular; the former being such orders relating to matters of practice as are laid down and promulgated by the court for the general guidance of the suitors: the latter are such orders as are confined to the particular case in reference to which they have been granted. See Courts of Law, and Pleading.

RULE OF THREE, in Arithmetic, is the rule by which when three numbers are given a fourth is to be found, so that the four shall be in direct or inverse proportion, as the case may require.

RULES. In the Fine Arts, those laws and maxims founded on the general and fundamental truths of nature by which artists are guided in their compositions.

RULES, BRASS. Pieces of brass of different thicknesses made letter high, to print with. They are made in lengths of fourteen inches, but of late years lengths half as long again have been made. One of the edges is bevelled so as to print a fine line, and when a thicker line is required the bottom edge is placed uppermost, which is the full thickness of the brass; by this means lines of different thicknesses are obtained, and also double lines, a thick one and a fine one, when required. They are used for column lines in table work; to separate matter that requires to be distinct; and to be placed round pages.

In cases where diagrams are required, and there is no engraver within reach, they may be formed by a clever workman with brass rule. Of late years many ingenious and elaborate imitations of architectural drawings of buildings, with pillars, &c. have been made with brass rule; and in this department of art Mr. Ebenezer Parkes, of Fetter Lane, has displayed great skill and ingenuity.

RULE, CARPENTER'S. A folding ruler, generally used by carpenters and other artificers, having a variety of scales adapted to facilitate the calculations of most frequent occurrence by inspection. Sometimes it has a sliding piece in one of its legs, by which its use is greatly extended. See Sliding Rule.

RULE, GAUGING, is a rule adapted in the same manner to discover the contents of casks and other vessels. It is used by the officers of excise in surveying the articles in the process of manufacture that are liable to duties. See Gauging.

RUM. A spirituous liquor distilled from the fermented juice of the sugar cane, or from molasses. Its flavour is due to the presence of a peculiar volatile oil: its average proportion of alcohol fluctuates between 50 and 56 per cent. The rum consumed in the United Kingdom is entirely the produce of the West Indies, and to a great extent of Jamaica; and for this preference it is indebted partly to its superior quality, and partly to its being protected against rum of East India produce by a differential duty of 6*s*. per gallon; the duty on West India rum being 9*s*., that on East India rum being 15*s*. per gallon. The quantity of rum entered for home consumption for the years 1839-40, averaged 2,670,515½ gallons; the duty on it for the three years, 1837-38-39, averaged 1,372,540*l*.; and in 1840, the gross amount was 1,154,544*l*. The consumption of rum in this country has long been gradually declining.

RU'MEN. (Lat.) The name of the paunch or first cavity of the complex stomach of the Ruminant quadrupeds.

RU'MINANTS, *Ruminantia*. (Lat. rumino, *I chew the cud.*) The name given by Cuvier to the *Pecora* of Linnæus, an order of Ungulate Mammals, including those which have a complicated stomach of four cavities so disposed as to allow of rumination, and a cloven hoof.

RUMINA'TION. (Lat. rumino.) The act by which food once chewed and swallowed is a second time subjected to mastication. Digestion is always preceded by this action in the order of Mammals, hence called "Ruminants;" but very rarely, and as an exceptional case, in any other animal. The stomach of the Ruminants is specially organized for rumination, consisting of four distinct cavities, all of which communicate with a muscular canal at the termination of the œsophagus. Hard, solid, or coarsely masticated food, passes from the beginning of the muscular canal into the first cavity of the stomach, called the *rumen*, or paunch. Water is received into the second cavity, called the *reticulum*, and almost exclusively occupies the honeycomb cells of that cavity; it is gradually mixed with the coarsely divided food which is undergoing mastication in the rumen. When this is sufficiently advanced, a portion of the mass is received into the muscular canal at the termination of the œsophagus; it is there moulded into a ball, and propelled by a rapid and inverted action of the muscles of the gullet into the mouth, where it is more perfectly masticated, mixed with fluid, and again swallowed. It now passes directly into the third stomach, called the *psalterium*, from the broad leaf-like plates of membrane with which it is occupied; here the superfluous fluid, which otherwise might have too much diluted the gastric juice, is absorbed, and the subdivided cud passes gradually into the fourth or true digesting stomach, called the *abomasus*. In the camel tribe, water-cells are developed at the sides of the rumen, in addition to those of the reticulum, and the psalterium is not separated by any contraction from the abomasus.

RUMP PARLIAMENT. In English History, after the dissolution of Richard Cromwell's parliament, and his own demission of the protectorate, a council of officers, at whose head were Desborough, Lambert, and others, having seized the supreme authority, found it advisable to call together the remnant of the Long Parliament, which had been forcibly dissolved by Oliver. It

was assembled in May, 1659; and consisted of little more than seventy members, those who had been excluded not being allowed to resume their seats. This body soon became odious to the Presbyterian and Royalist parts of the nation, and by its own assumption of power displeased the officers who had called it again into being. It acted, however, with some vigour and determination, and defeated a variety of royalist conspiracies; but having ventured so far as to cashier Lambert and others of the leading officers, the troops again surrounded Westminster Hall, and expelled it, on the 13th October in the same year. But Fleetwood, who had the command of the army, being unable to keep together the distracted government, the officers once more invited the parliament to sit again, which it did on the 26th of December. It once more assumed absolute authority; but General Monk took part against it. On his invitation a good many of the excluded members went to the house (Feb. 21.), and thus placed the Independents, who had hitherto ruled it, in a minority; and having passed some measures reversing its former acts, the parliament dissolved itself. It got its nickname from being, as it were, the remnant and fag-end of the old Long Parliament, and was treated by the nation with general contumely and derision. But it cannot be denied that, utterly unable as it was to command the divided nation, it showed boldness and vigour in its conduct, which, with a little more popularity, would probably have ensured great successes. Vane and Hazlerig were its leading members.

RU'NCINATE. In Botany, hooked back, or curved in a direction from the apex to the base; as the lobes of the leaf of the dandelion.

RUNES (Germ. Runen), are properly the signs or letters of the ancient alphabet peculiar to the northern nations (Germans and Scandinavians). Schlegel deduces this alphabet from the Phœnicians. (*Lectures on Ancient and Modern Literature.*) Others have supposed it to have been derived from that of the Romans; but its originally consisting only of sixteen letters has been urged as an argument against this hypothesis. The runen inscriptions found in Germany (especially Northern Saxony) are thought by some to have tokens of an origin somewhat different from the Scandinavian. (*Grimm on the German Runes*, 1821.) The antiquity of both has been much disputed. Of those found in Gothland, it is said that the oldest are not earlier than A. D. 1200, the latest 1449: 1300 stones with Runic inscriptions have, it is said, been discovered in Sweden; many in Denmark; none in Lapland or Finland. Runic staves are massive sticks, generally of willow, inscribed with Runic characters, probably of magical import. (See *Conv. Lexicon.*)

RUPEE. A coin of different values, current in different parts of the East Indies. *See* MONEY.

RU'PIA. (Gr. ῥυπος.) An eruption of flattish vesicles, succeeded by an ill-conditioned discharge, which concretes into thin scabs easily rubbed off and regenerated; they generally occur as a consequence of poor diet and weak habit of body. Light nutritious food, tonics, and alteratives are the remedies.

RUPTURE. *See* HERNIA.

RU'RAL ECO'NOMY. The general management of territorial property, either by the proprietor or his agent. On a small scale, the agent is termed a bailiff or farm servant; and on a large scale, a land steward or factor. The duties of the latter are to collect the rents, and see that the different clauses in the leases by which the tenants hold their lands are fulfilled; and of the former, to cultivate the land in such a manner as to produce the greatest profit, or to fulfil the intentions of the proprietor as to the kind of produce which he considers it desirable to obtain. *See* AGRICULTURE.

RUST, in its ordinary acceptation, is the reddish peroxide which is found on the surface of iron when exposed to moisture.

RUST. In Horticulture. *See* MILDEW.

RU'STIC. (Lat. rus.) In Architecture, a term applied to work jagged out into an irregular surface. Work also which is left rough, without tooling.

RUTA'CEÆ. (Ruta, one of the genera.) A natural order of plants, composed principally of trees and shrubs inhabiting the warmer parts of the world, seldom of herbaceous plants. The species are sometimes very ornamental, especially those belonging to the genera *Correa*, *Boronia*, and *Diosma*. Some, as the common rue, the bucku plant, &c., are remarkable for having a powerful, peculiar, unpleasant odour, and antispasmodic quality; and a few have a febrifugal bark. The *Dictamnus albus*, or *Fraxinella*, is extremely fragrant, and gives off an inflammable vapour.

RUTIDO'SIS. (Gr. ῥυτις, *a furrow.*) A disease of the eye, in which the cornea appears shrunk and puckered. It is produced by a wound, or by a deficiency of the aqueous humour, which happens from old age or fevers, or occasionally from the action of an extremely arid atmosphere. After death it is produced by the evaporation of the aqueous humour through the cornea, and the consequent shrinking of that membrane.

RU'TILITE. (Lat. rutilus, *red.*) Native oxide of titanium.

RYA'COLITE. (Gr. ῥυαξ, *a stream*, and λιθος, *a stone.*) A name given to glassy felspar.

RYE (Ger. *roggen;* Du. *rog, rogge*), according to some, is a native of Crete; but it is very doubtful if it be found wild in any country. It has been cultivated from time immemorial, and is considered as coming nearer in its properties to wheat than any other grain. It is more common than wheat in many parts of the Continent; being a more certain crop, and requiring less culture and manure. It is the bread corn of Germany and Russia. In Britain it is now very little grown, being no longer a bread corn; and therefore of less value to the farmer than barley, oats, or peas.

RYOTS. (Arab. *a subject.*) The name given to the cultivators of the soil in Hindostan. Their social condition presents many singular and interesting features, to some of which we shall here advert. In all eastern countries the rulers may be said to be the proprietors of the soil; but in India the *cultivators* have a perpetual, hereditary, and transferable right of occupancy, so long as they continue to pay the share of the produce of the land demanded by the government. The value of this right of occupancy to the rural population depends on the degree of resistance which they have been able to oppose to the exactions of arbitrary governments. In Bengal and the adjacent provinces of India, from the peculiarly timid character of the inhabitants, and the open and exposed nature of the country, this resistance has been trifling indeed; and consequently the value of the right of occupancy in the peasant, or ryot, has been proportionally reduced. This, also, may be considered, though with some modifications, as being nearly the condition, in this respect, of the inhabitants of every part of the great plain of the Ganges, comprising more than half the population of Hindostan. But where the country is naturally difficult, the people have been able more effectually to resist the encroachments of the head landlord, or state, and to retain a valuable share in the property of the soil. This has been particularly the case along the ghauts, as in Bednore, Canara, Malabar, &c.; the inhabitants of which provinces not only lay claim to a right of private property in the soil, but have been generally ready to support their claim by force of arms. There can be no question, indeed, that the same modified right of property formerly existed every where; and it is indeed impossible that otherwise the land should ever have been reclaimed from the wilderness. But in those parts of India which could be readily overrun by a military force, the right of property in the soil has long been little else than the right to cultivate one's paternal acres for behoof of others, the cultivators reserving only a bare subsistence for themselves.

Under the Mogul emperors, the practice in Bengal was to divide the gross produce of the soil, on the *métayer* principle, into equal shares; whereof one was retained by the cultivator, the other going to government as rent or tax. The officers employed to collect this revenue were called *zemindars;* and in the course of time their office seems to have become hereditary. It may be remarked that, in Persian, zemindar and landholder are synonymous; and this etymology, coupled with the hereditary nature of their office, which brought them exclusively into contact with the ryot or occupier, as well as with the government, led many to believe that the zemindars were in reality the owners of the land, and that the ryots were their tenants. This, however, it is now admitted on all hands, was an incorrect opinion. The zemindars in reality were tax-gatherers, and were, in fact, obliged to pay to the government *nine tenths* of the produce collected from the ryots, retaining only one tenth as a compensation for their trouble; and, so long as the ryots paid their fixed contribution, they could not be ousted from their possessions, nor be in anywise interfered with.

But notwithstanding what has now been stated, the perpetual or zemindary settlement, established by Lord Cornwallis in Bengal, in 1793, was made on the assumption that the zemindars were the proprietors of the soil. His lordship, indeed, was far from being personally satisfied that such was really the case; but he was anxious to create a class of large proprietors, and to give them an interest in the improvement and prosperity of the country. It is clear, however, that this wish could not be realized without destroying the permanent rights of the ryots; for, unless this were accomplished, the zemindars could not interfere in the management of their estates. The interests of the zemindars, and the rights of the ryots, were plainly irreconcileable; and it was obvious that the former would endeavour to reduce the latter to the condition of tenants at will. But this necessary consequence was either overlooked or ineffectually provided against. The zemindars became, under condition of their paying the assessment or quit-rent due to government, proprietors or owners of the land. The amount of the assessment was fixed at the average

of what it had been for a few years previously, and it was declared to be perpetual and invariable at that amount. When a zemindar fell into arrear with government, his estate might be either sold or resumed.

That the assessment was at the outset, and still is too high, cannot well be doubted; and it must ever be matter of regret that the settlement was not made with the ryots, or cultivators, rather than with the zemindars; but, notwithstanding these and other defects, the measure was, on the whole, a great boon to India. Until the introduction of the perpetual system into Bengal, the revenue was raised in it, as it continues to be in the rest of India down to the present day, by a variable as well as a most oppressive land-tax. We all know what a pernicious influence tithe has had in this country; but suppose that, instead of amounting to 10, tithe had amounted to 50 per cent. of the gross produce of the soil, it would have been an effectual obstacle to all improvement; and the country would now have been in about the same state as in the days of Alfred, or of William the Conqueror.

In France, Italy, and other parts of Europe, where the *métayer* system is introduced, the landlord seldom or never gets half the produce, unless he also furnish the stock and farming capital, and, in most cases, the seed. But in India neither the government nor the zemindars do any thing of the sort: they merely supply the land, which is usually divided into very small portions, mostly about six, and rarely amounting to twenty-four acres. A demand on the occupiers of such patches for half the produce is quite extravagant; and hence the excessive poverty of the people, which is such as to stagger belief. Still, however, the perpetual system is vastly preferable in principle, and also in its practical influence, to any other revenue system hitherto established in India. It set limits to fiscal rapacity, and established, as it were, a rampart beyond which no tax-gatherer dared to intrude. The enormous amount of the assessment, and the rigour with which payment was at first enforced, ruined an immense number of zemindars. But their lands having come into new and more efficient hands, a better system of management was introduced, and the limitation of the government demand gave a stimulus to improvement unknown in any other part of Hindostan. This, in fact, was the grand desideratum. A land-tax, that may be increased should the land be improved, is all but certain to prevent any such improvement being made. This has been its uniform operation in every country in the world that has had the bad fortune to be cursed with such a destructive impost. But a heavy land-tax, provided it be fixed and unsusceptible of increase, is no bar to improvements, unless in so far as it tends to deprive the proprietors and occupiers of land of the means of making them. There is, in such a case, no want of security; and the cultivator is not deterred from attempting improvements, or of bringing superior enterprise and industry to operate on his estate, by the fear that the tax will, in consequence, be increased.

The truth of what is now stated has been fully evinced in Bengal during the last twenty or thirty years; for both the population and the land revenue of that part of our Indian empire have greatly increased. A great deal of waste land has been cultivated, and various works have been undertaken that would not be so much as dreamed of in any other part of our empire in the East. But, with all this, there has been but little, if any, improvement in the condition of the people of Bengal under our government. They, in fact, are practically excluded from at least all direct participation in the benefits resulting from the limitation of the assessment. They have merely exchanged one taskmaster for another. It is their landlords who have been the great gainers. The occupiers still, generally speaking, hold under the *métayer* principle, paying half or even more of their produce as rent; so that their poverty is often extreme, and their condition not infrequently inferior even to that of the hired labourer, who receives the miserable pittance of two annas, or about 3*d*. a day as wages.

It seems, however, as if there were some strange fatality attending the government of India: and that the greatest talents and the best intentions should, when applied to legislate for that country, produce only the most pernicious projects. The perpetual settlement carried into effect by Lord Cornwallis in Bengal was keenly opposed by Lord Teignmouth, Colonel Wilkes, Mr. Thackeray, Sir T. Monro, and others, whose opinions on such subjects are certainly entitled to very great respect; and it would seem that the Board of Control became, at length, favourable to their views. In consequence of this change of opinion it was resolved to introduce a different system, under the superintendence of its zealous advocate, Sir Thomas Monro, into the presidency of Madras, or Fort St. George. This new system has received the name of the *ryotwar* settlement. It proceeds on the assumption that government possesses the entire property of the soil, and may dispose of it at pleasure: no middlemen or zemindars are interposed between the sovereign and the cultivators; the ryots being brought into immediate contact with the collectors appointed by government to receive their rents. It is impossible for us to enter into the details of this system, which are complicated in the highest degree; but we beg to refer the reader for full information to the *Geog. Dict.*, art. "India, British."

RY'TINA. (Gr. ῥυτις, *a furrow*.) The name of a genus of herbivorous Cetaceans, of which a species inhabiting the coasts of Kamschatska (*Rytina stelleri*), with a wrinkled and furrowed integument, is the type.

S.

S. A sibilant articulation, found in all the languages of which we have any knowledge. S may be regarded as a species of semivowel, from its forming a kind of imperfect sound without the aid of any of the vowels; and from its peculiar quality of being able to be sounded before all the consonants, it has been termed by grammarians *suæ potestatis litera*. It is susceptible of numerous interchanges, both in the ancient and modern languages. As an abbreviation, S is used for *socius*, *societas*, *south*, *solo*, &c.

SA'BAISM, or SABÆISM. (From the Heb. zaba, *lord*; whence Sabaoth, &c., or *army*, *the host of heaven*.) The religion which has for its objects of worship the sun, moon, and other heavenly bodies. This belief prevailed in very remote ages in the Asiatic countries between the Euphrates and the Mediterranean; and Chaldæa, the native land of astronomy, was its most celebrated seat. Many allusions are made to this species of worship in the Old Testament, especially in the invectives of the prophets against the various forms of idolatry borrowed by the Jews from their heathen neighbours. (See *Sale's Preliminary Discourse to the Koran*.) There is a valuble memoir on the Sabaism of the ancient Persians by Foucher, *Mem. de l'Ac. des Inscr.* vol. xxv. p. 160. See also *Russell's Connexion of Sacred and Profane History*, vol. i.

SABA'OTH. A Hebrew word, signifying hosts or armies. It occurs in the New Testament as a designation of the Almighty (the Lord of Sabaoth).

SABA'SIA. In ancient Mythology, festivals in honour of various divinities, entitled Sabasii: the origin of which term is not clear. Mithras, the sun, is called Sabasius in ancient monuments, whence the word seems to have some connection with the root of Sabäism (see above); but Bacchus was also thus denominated, according to some, from the Sabæ, a people of Thrace: and the nocturnal Sabasia were celebrated in his name. Jupiter *Sabasius* is thought to be the same as *Ægiochus*; the Phœnician word tsebaoth signifying kids, as the Greek αἰξ a goat. But there is, probably, some more general oriental meaning, which has not yet been reached.

SABBATA'RIANS. In Ecclesiastical History, various sects have been so called; particularly a subdivision of the Anabaptists in the 16th century, who observed the Jewish sabbath. The *Sabbatians* of the 4th century were followers of Sabbatius, a Novatian bishop, who attempted to introduce some Jewish observance into the church. They are said to have had the singular peculiarity of abhorring the use of the *right* hand; whence they were called Αριστεροι, or left-handed.

SA'BBATH. A Hebrew word signifying *rest*, applied by the Jews to the seventh day of their week (our Saturday), on which they were commanded to abstain from all manner of work, because "in six days God created the heavens and the earth, and rested the seventh day." The universal practice of the Christian church from the earliest period, in conformity to what may be gathered from some passages in the Acts of the Apostles, has set apart the first day of the week (Sunday) for the especial worship of God, in memory of the resurrection of our Lord on that day. The obligation upon which the observance of Sunday rests has been placed upon different grounds. The most prevalent opinion supposes the commandment given to the Jews originally to be of universal obligation, as far as the observance of one day in seven. But there have been many divines in all ages who have held that all the formal obligations of Judaism, as well those of the commandments as those of the Levitical law, were abrogated on the advent of our Saviour, and consider the consent of the church and the practice of the Apostles to be the only sufficient authority for this observance. It is upon this principle that the Continental churches hold themselves justified in indulging in all sorts of worldly recreation on Sundays, after the services of public worship are concluded. Archbishop Whately has recently drawn attention to the subject by his able arguments against the popular opinions on which the observance of the Sabbath is made to rest.

The name *Sabbatarians* was given to some early sects of Judaising Christians, who insisted on the observance of the Sabbath (Saturday) under the new dispensation.

SABBA'TICAL YEAR. Every seventh year among the Jews was so called, because on that year the land was allowed to lie fallow, and the people were supported by the tripled produce of the year preceding. (Exod. xxiii. 10. Levit. xxv. 3. 20.)

SABE'LLIANS. Heretics of the 3d century, followers of Sabellius, whose system was an attempt to explain the doctrine of the Trinity by representing the Father as the sole person, and the Son and Spirit as attributes, or emanations from him. Thus they compared the Divinity to the sun; of which the Father would be analogous to the substance, the Son to the light, and the Holy Ghost to the heat. This scheme has been known in later times as that of the Modal Trinity; and some divines of the orthodox English church have found themselves entangled in it, when attempting to explain accurately the mysterious doctrine to which it refers. On the other hand, their opponents have been led, inadvertently in some cases, to make too formal a distinction of the Three Persons, and have thereby subjected themselves to the charge of Tritheism. (See *Mosheim*, transl. ed. 1790, vol. i. p. 305.)

SA'BIANS. A Christian sect, also called Christians of Saint John; thought by some to be the remnant of the Jewish Hemerobaptists found in Persia and Arabia, principally at Basra. (See *Mem. de l'Ac. des Inscr.* vol. xii.; and *Mosheim*, vol. iv.)

SA'BLE. A small quadruped, allied to the martin-cat, celebrated for the fine quality and rich colour of its fur, of which the hairs turn with equal ease in every direction. A single skin of the darker colour, though not above four inches broad, has been valued as high as 15*l*. The sable (*Mustela zibellina*, Linn.) is principally a native of the northern regions of Asia: it is hunted and killed for the Russian market, either by a single ball, a blunt arrow, or traps, by exiles or soldiers sent for that purpose in the deserts of Siberia. The skin is in the highest perfection from November to February. A nearly allied animal, called the "fisher," inhabits North America, and is similarly sought after and destroyed for its fur.

SABLE. In Heraldry, black: derived, probably, from the fur of the animal sable. One of the colours, or tinctures, employed in blazonry. It is equivalent to diamond among precious stones, Saturn among planets. In engraving, it is represented by vertical and horizontal lines crossing each other.

SACCHA'RIC ACID. (Lat. saccharum, *sugar*.) An uncrystallizable acid product, formed along with oxalic acid during the action of nitric acid on sugar.

SA'CCHAROID. (Lat. saccharum, and Gr. εἶδος, *form*.) A texture resembling that of loaf sugar; as saccharoid carbonate of lime, &c.

SACCHARO'METER. (Lat. saccharum, and Gr. μέτρον, *a measure*.) An instrument for determining the specific gravity of brewers' and distillers' worts.

SA'CCHARUM. *See* SUGAR.

SACCHOLA'CTIC ACID. (Lat. saccharum, and lac, *milk*.) An acid obtained by digesting sugar of milk in nitric acid. It is identical with that obtained from gum, and termed *mucous acid*.

SA'CER MO'RBUS. (Lat. *sacred disease*.) One of the names applied by the older writers to epilepsy, though other disorders were also occasionally similarly designated.

SACK. (Fr. *vin sec*, from which the term is generally supposed to be derived.) A Spanish wine of the dry kind. The important part which it plays in Shakspeare is well known. Falstaff calls it *sherris sack*, which means sherry sack; so called, says Blount, in his *Glossographia*, from Xeres, a sea town of Corduba, where that kind of sack is made. At a later period, sack seems to have been used as a general term for all kinds of sweet wines; and it has been conjectured that, instead of being a corruption of the French *sec*, as above noticed, it derives its name more probably from a common practice of the Spaniards, of putting their sweet wines into *sacks* made of goat skins, and thus transporting them from one place to another.

It may be interesting to observe, that the term *sack*, in the sense of a *bag*, is found in all the European and many Asiatic languages.

SA'CKBUT. A wind instrument of the trumpet species, but differing from the common trumpet in form and size. It is of low or bass pitch, and is drawn out or shortened by the means of sliders, according to the acuteness or gravity of the tone to be produced. It is, in fact, the trombone of the Italians.

SA'CRAMENT. (Lat. *an oath*.) The military oath taken by every Roman soldier, by which he swore to obey his commander and not desert his standard.

SACRAMENT. In Theology, a word which does not occur in scripture, nor possesses any exact equivalent there; but employed very early by writers in theology to signify certain distinctive ceremonies of the Christian faith. Our Saviour appointed the baptism of believers as an initiatory rite; he also commanded the observance of the supper of the Lord to be held in remembrance of him. These, then, are the badges by which Christian men are known, and by which they make profession of their belief. The expressions of scripture, moreover, with which the appointment of these ceremonies is attended, have been generally considered to attach some ulterior meaning to them. The one is called the second birth, the other is said to be the communion of the body and blood of our Saviour Christ; and the mysteries which seem to be concealed under these terms have been made the subjects of various interpretations. According to the general consent of ancient orthodoxy, the sacraments have in themselves a peculiar efficacy, conferring grace upon the recipient, and imparting to him the benefits of the Christian covenant. The Romish church is accused of holding the extreme opinion that this grace is conferred *ex opere operato*, by the mere act, the recipient remaining passive; that they fail of operation only where he is under the influence of positive sin; but that the administration of the Eucharist to a dying man unconscious of the whole proceeding, would have the same effect as if he received it in the most holy frame of mind. The English church requires the worthy acceptation of the person himself, as is expressly stated, with a tacit reference to this superstitious notion, in its twenty-fifth article. It guards, at the same time, against the idea very generally held among the Protestant churches abroad, and our own dissenting sects, in the words with which the article begins:—"Sacraments ordained of Christ be not only *signs* or *tokens of Christian* men's profession; but rather they be certain sure witnesses and effectual signs of grace, and God's will towards us, by the which he doth work invisibly in us, and doth not only quicken, but also strengthen and confirm our faith in him."

The question as to the number of such ceremonies must be settled by the definitions of a sacrament which theologians shall propound. It is agreed that a sacrament is a federal rite, instituted by Christ or the Apostles, with a direct appointment of *matter* by which some interior meaning is signified, and the *form* of manner of its application. This definition is conceived by Protestants to restrict the number to two only: the Romanists extend it to seven, adding to Baptism and the Lord's Supper Confirmation, Penance, Orders, Matrimony, and Extreme Unction.

SA'CRED WAR. The most remarkable known by this name in classical history is that which commenced with the seizure of Delphi by the Phocians, B. C. 357, and was ended by the conquest of the Phocians by Philip of Macedon, B. C. 346, according to the chronology of Clinton. (*Fasti Hellenici*.)

SA'CRIFICE. Generally any offering made to the Deity; but more properly that of a victim upon an altar, accompanied by customary ceremonies and forms of prayer, with the idea of gratifying God and averting his displeasure. In the scriptures we meet with offerings, both of fruits and of animals, antecedent to any command or institution of God; such as those of Cain and Abel, of Noah and the Patriarchs: many of which, nevertheless, are described as acceptable to him. In the Levitical Law, however, sacrifices are ordained by divine appointment; and a question arises as to the probability of a similar command having been in fact given to our first parents. The universality of the practice undoubtedly requires either the supposition of an original revelation, or the discovery of a common principle impelling all men alike to the adoption of what at first sight seems to militate against our ideas of reason, and the absurdity of which has, we know, been represented in the strongest light by the sages of all nations at a certain period of the intellectual development of each. Those divines who consider the appointment to have emanated directly from God conceive it to have been, from the first, typical of the last and greatest sacrifice,—that of our Saviour on the cross. It may fairly be asked of those who look for logical reasons for all divine appointments, whether, upon human principles, it seems the more probable that the sacrifice of Christ being predetermined, the notion should be familiarized to mankind by ordaining a previous practice; or that, the practice existing and having a meaning of its own in all minds, the new revelation should be accommodated to our notions by adopting that very practice for its foundation? If, on the other hand, we follow the general current of modern opinion upon this subject, and inquire for some general principle of our nature to account for the universal reception of the ideas, we may discover it perhaps in the perpetual sense of obligation with which the enjoyment of prosperity is properly accompanied, and which in some minds takes the form of grateful acknowledgment, and the devotion to the giver of some portion of the gifts by which we are ourselves gratified; and in others becomes an uneasy scruple, and suggests the voluntary surrender of a part with a view to the more secure enjoyment of the remainder.

SA'CRILEGE. (Lat. sacrilegium.) The profanation of any thing or place consecrated to the service of God.

SA'CRISTY. (Lat. sacer, *sacred*.) In Architecture,

an apartment attached to a church, in which the consecrated vessels of the church, and the garments in which the clergyman officiates, &c., are deposited.

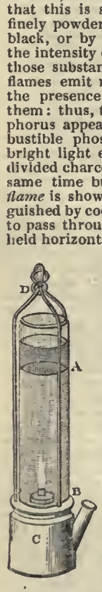
SA'CRUM. The posterior bone of the pelvis, articulated to the last lumbar vertebra, and firmly united on each side to the hip bones; below, the *os coccygis* is attached to it. It probably derives its name from having been offered by the ancients in sacrifices. In young subjects it is composed of five or six pieces united by cartilages, but in more advanced age it becomes one bone.

SADDER. A work in the modern Persian tongue, comprising a summary of various parts of the *Zendavesta*, or sacred books of the ancient Persians (which see). The authority and character of the Sadder are supposed to be very small: some attribute it to the Parsees, and give it an antiquity of several centuries; others consider it a more modern forgery. (See *Mem. de l'Ac. des Inscr.* vol. xxxviii.)

SA'DDLE. In Sea Language, a lump of wood acting as a seat or rest to the heel of a boom, and shaped accordingly.

SA'DDUCEES. A peculiar sect of religionists among the Jews. It is remarked that during the time that prophets are recorded to have arisen among the Jews, there is no account of the existence of any sects among them: they frequently fell away into total idolatry; but whenever recalled from that corruption, they appear to have reverted in a body to the pure religion of their ancestors, and never to have been separated in religious distinctions among themselves. The most ancient sect was that of the Sadducees, whose founder, Sadok, lived about 250 years B.C. He appears to have restricted the providence of God to the distribution of the temporal rewards and punishments which form the main feature of the old dispensation. In the time of our Saviour his followers entirely rejected the doctrine of a resurrection. They were assimilated also to the Epicureans in maintaining the perfect freedom of human actions; and like those pagan philosophers were few in number, and only of the highest and most literary classes. They were distinguished also from the Pharisees by the rejection of traditions, and by strict adherence to the written law alone. (See *Milman's Hist. of Christianity*, vol. i. p. 75. 211.)

SA'FETY LAMP. A lamp invented by Sir H. Davy, which is so constructed as to burn without danger in an explosive atmosphere. Flame may be considered as vapour or aëriform matter in a state of intense ignition; the temperature, therefore, of flame is always very high. It is, however, independent of its luminosity; for some of the dimmest flames, those of pure hydrogen gas, and of alcohol, for instance, are those which are hottest; and that this is so may be shown by projecting into them finely powdered substances, such as magnesia or lamp black, or by holding in them fine platinum wire, when the intensity of their temperature is rendered evident by those substances becoming white hot. And whenever flames emit much light they derive that property from the presence of finely divided matter diffused through them: thus, the intense brilliancy of the flame of phosphorus appears to depend upon the particles of incombustible phosphoric acid diffused through it; and the bright light emitted by a gas flame depends upon finely divided charcoal, which is ignited by the gas and at the same time burned. The correctness of this *theory of flame* is shown by the circumstance of its being extinguished by cooling; and this is best effected by causing it to pass through a piece of fine wire gauze, which, when held horizontally in the midst of the flame, extinguishes its upper part: the inflammable vapour or gas, and the soot or carbon, pass through, but in passing are so far cooled as to be extinguished; they may, however, be rekindled by applying a flame above the wire gauze. That the wire gauze merely acts by its cooling power, is shown by the flame passing through it when it acquires a white heat, or when its meshes are not fine enough to exert a due cooling power; it is also found that very hot flames, such as that of hydrogen, will pass through tissues which are impervious to flames of a lower temperature, such as that of a common candle or a gas flame. (*See* FLAME.) The application of these principles to the construction of the safety lamp is as follows:— The flame of a small oil lamp C is surrounded by a cylinder of wire gauze A B (doubled at A, where likely to become hottest, and protected by the stout wire frame D), and burns within it, the air having free ingress and egress. When it is immersed in an explosive atmosphere, such as that of a coal mine infested by fire damp, the inflammable gas enters from without and burns *in* the cage; but, in consequence of the cooling power of the wire gauze, no flame can pass *outwards* so as to ignite the surrounding atmosphere: the miner, therefore, is warned of his danger by the appearance of the lamp. As long as the external atmosphere is safe, the lamp burns as usual; but upon the approach of the fire damp the flame is more or less enlarged; and in the most explosive condition of the surrounding air the cylinder appears filled with a blue lambent flame, which flickers within it, the wick of the lamp appearing for the time extinguished. It is, however, rekindled as the air becomes more pure; or should the fire damp greatly predominate, it may be entirely extinguished. Before this happens, however, the miner is duly apprised of his danger, and has time to retreat. (See *Davy on the Safety Lamp.*)



SAFETY VALVE. *See* STEAM ENGINE.

SA'FFLOWER. The dried flowers of the *Carthamus tinctorius*, or bastard saffron, used as a dye stuff, and in the preparation of the pigment called *rouge*.

SA'FFRON. The prepared stigmata of the *Crocus sativus*. The stigmata of this purple crocus are of a deep orange colour, and when in quantity have a peculiar and very characteristic odour; they are used in medicine, chiefly as a rich yellow or orange colouring matter. Saffron is now chiefly imported from the south of Europe, especially Spain; it was formerly largely cultivated in this country in the vicinity of Saffron Walden in Cambridgeshire. Saffron is often largely adulterated with the petals of other plants, especially with those of the marigold.

SA'GA. The general name of those ancient compositions which comprise at once the history and mythology of the northern European races. Their language is different from the modern Danish, Swedish, and Norwegian, and is more powerful and expressive than either of these later dialects. Of the mythological sagas the most famous are the saga of Regnar, Lodbrok, the Hervarar saga, the Voluspa saga, and the Wilkina saga. The historical are very numerous; the Jomsvikingia saga and the Kaflinga saga comprehend much of the early annals of Norway and Denmark; the Eyrbiggia saga is the chief historical document of ancient Iceland. It is, however, to be remembered, that the chief object of the relators is the interest of the narrative; so that as mere histories they are of imperfect value. Many of them are collected in the great work of Snorre Sturleson called *Heimskringla*. The most classical period of these compositions is considered by antiquaries to fall within the 12th and 13th centuries.

SAGA'PENUM. A fetid gum-resin brought from Persia and Alexandria, probably the produce of a species of *ferula*. It is occasionally used in medicine as a nervine and stimulating expectorant. Its odour somewhat resembles that of assafœtida, but it is much weaker.

SA'GGER. A clay used in making the pots in which earthenware is baked, and which are called *saggers* or *seggers*.

SAGGING TO LEEWARD. A Nautical term, denoting the movement by which a ship makes considerable lee-way.

SAGI'TTA. (Lat. *arrow*, or *dart.*) One of Ptolemy's 48 constellations in the northern hemisphere. *See* CONSTELLATION.

SAGI'TTA. A term used by the older writers on trigonometry to denote the *versed sine* of an arc; from its resemblance to an arrow standing on the chord of the double arc.

SAGITTA'RIUS. (Lat. *the Archer.*) One of the twelve constellations of the zodiac. It is represented on celestial globes and charts by the figure of a centaur in the act of shooting an arrow from his bow.

SAGI'TTATE. (Lat. sagitta, *an arrow.*) In Zoology, a part of an animal is so called when it is triangular and hollowed out at the base, with posterior angles.

SA'GO. A species of fecula or starch obtained from the cellular substance of an East Indian palm tree, the *Sagus farinifera*. It is usually granulated, and known in the trade under the name of *pearl sago*.

The tree, when at maturity, is about 30 feet high, and from 18 to 22 inches in diameter. Before the formation of the fruit, the stem consists of an external wall about 2 inches thick, the whole interior being filled up with a sort of spongy medullary matter. When the tree attains to maturity, and the fruit is formed, the stem is quite hollow. Being cut down at a proper period, the medullary part is extracted from the trunk, and reduced to a powder like sawdust. The filaments are next separated by washing. The meal is then laid to dry; and being made into cakes is baked and eaten. For exportation, the finest sago meal is mixed with water, and the paste rubbed into small grains of the size and form of coriander seeds. This is the species principally brought to England, for which market it should be chosen of a reddish hue, and readily dissolving in hot water into a fine jelly. Within these few years, however, a process has been invented by the Chinese for refining sago, so as to give it a fine pearly lustre; and the sago so cured is in the highest estimation in all the European markets. It is a light, wholesome, nutritious food. It is sent from the islands where it is grown to Singapore, where it is granulated and bleached by the Chinese. The export

trade to Europe and India is now principally confined to that settlement. (*Ainslie's Mat. Indica; Crawfurd's East. Archip.* vol. i. pp. 383—393., vol. iii. p. 348.; *Bell's Review of the Commerce of Bengal, &c.*)

The consumption of sago has undergone an almost incredible increase within the last twenty years, which is wholly ascribable to the reduction in the interval of the oppressive duties by which the article was formerly loaded. — (*Papers published by the Board of Trade.*)

SA'GUM. The military dress of the Roman magistrates and dignitaries; a cloak fastened at the breast with a clasp. The same name was given to the ordinary dress of several barbarous nations. Thus Tacitus says of the Germans, *tegumen omnibus sagum;* and Varro and Diodorus Siculus represent it as the costume of the Gauls.

SA'HLITE. In Mineralogy, a variety of augite from the silver mine of Sahla in Sweden.

SAIL. A surface obtained by canvass, mat, or other material, by the action of the wind on which, when extended, the vessel is moved. A sail extended by a yard hung (*slung*) by the middle and balanced, is called a *square sail:* a sail set upon a gaff or a stay, is called a *fore and aft sail;* which terms refer to the position of the yard, gaff, or stay, when the sail is not set. The upper part of every sail is the *head*, the lower part the *foot;* the sides in general are called *leeches;* but the weather or side edge of any but a square sail is called the *luff*, and the other edge the *after leech*. The upper two corners are *earings*, but that of a jib is the *head;* the lower two corners are in general *clues;* the weather clue of a fore and aft sail, or of a course while set, is the *tack*. The edges of a sail are strengthened by a rope called the *bolt rope*. The ropes at the upper and lower edges are the head and foot ropes of the sail. The canvass or sail-cloth is made in *bolts;* and the qualities are numbered from No. 1., which is the strongest, and is used for storm sails, to No. 8., which is used for the smallest sails, as small studding sails, &c., which the seamen commonly call *flying kites*. The cloths in a square sail are seamed vertically; in a fore and aft sail they are parallel to the after leech. In this way the strain of the sheet diffuses itself over the canvass both along and across the cloths. Discussions have, however, arisen as to the best mode of seaming. When a seam opens, the sail often splits. Captain Cowan took out a patent for *horizontal* seaming; he remarks (*Essay on the Construction of Sails, &c.*) that such sails when they split remain full, and are less liable to blow away, and that they also were found to last much longer. The plan, however, has not been approved. *Diagonal* seaming, which has also had its advocates, is defective in principle; for it must bring the strain of a sheet either on a single cloth, or entirely across the stitches.

Sails take their names from the mast, yard, or stay upon which they are stretched. Thus, the principal sail extended upon the main mast is called the *main sail;* the next above, which stands upon the main-top mast, is the *main-top-mast sail;* above which is the *main-top-gallant sail;* and above all, the *main royal*. In like manner, there are the *fore sail*, the *fore-top sail*, the *fore-top-gallant sail*, and the *fore royal;* and similar appellations are given to the sails supported by the *mizzen* or after mast. The *main-stay sail*, *main-top-mast stay-sail*, &c., are between the main and fore masts; and the *mizzen stay-sail*, *mizzen-top-mast stay-sail*, &c., are between the main and mizzen masts. Between the fore-mast and bowsprit are the *fore stay-sail*, the *fore-top-mast stay-sail*, the *jib*, and sometimes a *flying jib* and *middle jib*. Square sails extended by yards under the bowsprit and jib-booms are called *sprit sails;* and the *studding sails* are those which are extended upon the different yards of the main mast and fore mast.

To *make* sail, is to set sail. To *shorten* sail, is to take in some sail. To *loose* sails, is to spread or hang out the sails that had been furled to air them, or for the purpose of setting afterwards. To *strike* sail, is to lower the yard or gaff of a sail when set, in token of salute.

The common theory of sails which assumes the impact of columns of air is radically defective; for it is a fact familiar to sailors that the reef points, or any light stuff by accident in the same situation, hang vertically in the hollow of the sail, as in a calm, thereby proving that the sail is filled with a mass of air, quiescent or nearly so, and maintained in a state of statical pressure; whereas if the common theory were true, the points would lie flat to the canvass, as weeds are pressed against the bank of a stream. Hence it follows that (as all sailors believe who have not mixed with their practice the fragments of imperfect theories) there is a certain extent of hollow or *belly* which increases the effect of the sail. It of course adds to the effect of sails to wet them, by swelling the threads and closing the pores: this practice is often resorted to in chase.

SAI'LING. In Navigation, the art of directing a ship on a given line laid down in a chart. It is called *plane sailing* when the chart is constructed on the supposition that the earth's surface (or rather the surface of the ocean) is an extended plane; and *globular sailing*, when the chart is a globular chart, or constructed on the supposition that the earth is a sphere. *See* NAVIGATION.

SAILING ORDER, or ORDER OF SAILING. Any determinate order preserved by a squadron of ships. It usually implies 1, 2, or 3 parallel columns, but is at the disposition of the admiral.

SAINFOIN. (*Hedysarum onabrychis.*) A plant of the family of the *Leguminosæ*. It will not thrive well except when the soil or subsoil is calcareous, and is consequently not generally met with in this country; though it is extensively cultivated on the Cotswold Hills, and on the chalk soils of Dorset, Hants, Wilts, &c. It generally remains for eight or ten years,— a much longer period than it does in France. It is made into hay, the after crop being eaten by cattle.

SAINT JOHN, KNIGHTS OF; or HOSPITALLERS. A military order of religious persons. They derived their name from a church and monastery dedicated to St. John the Baptist, founded at Jerusalem about 1048 by merchants from Amalfi, the brotherhood of its members being devoted to the duty of taking care of poor and sick pilgrims. The order was instituted as a military brotherhood by Raymond du Puy, its principal, early in the 12th century. It was divided into three ranks—knights, chaplains, and servitors; and in its military capacity it was bound to defend the church against the infidels. It possessed various possessions and settlements at different times in different parts of the East. In the 13th century, being driven from Palestine, the knights of this order fixed their principal seat first in Cyprus, and afterwards at Rhodes, where they remained from 1309 to 1522, when the island was captured by Solyman II. After several changes of settlement, they were fixed in 1530 by Charles V. at Malta and its dependent islands; whence they took the name of Knights of Malta. Here they maintained themselves until 1798, when the island was taken by Napoleon. The order, however, continued to subsist, notwithstanding the loss of its sovereign possessions both in Malta and in Tuscany: the seat of the chapter is now at Ferrara. Before the French Revolution the number of knights was estimated at 3000. The temporal powers of the order were chiefly concentrated in the hands of the grand master; but he was, in fact, controlled by the governors of the eight languages. These were, of Provence, Auvergne, France, Italy, Aragon, Germany, Castile, and England. The lands were divided into priories, commanderies, and bailliages. The spiritual power was exercised by the chapter, consisting of eight ballivi conventuales. The knights were under the rules of the order of St. Augustine; but Protestants were not bound to celibacy. They were required to be necessarily of good descent; but those whose proofs of noble ancestry were unquestionable were termed *cavalieri di giustizia*, while others who could not show such proofs might be admitted on account of their merits as *cavalieri di grazia*. *See* HOSPITALLERS.

SAINTS. (Lat. sancti, *holy persons.*) Pious men, who, according to a custom early prevalent among Christians, were commemorated with honour after their death in the services and ceremonies of the church. This distinction was originally applied to the apostles and eminent martyrs and confessors, whose places of burial were regarded with pious affection by the faithful in the neighbourhood, and memorials or relics of whom were carefully cherished among them. The observance of particular days in the honour of the saints was also a very early custom; but the natural feeling which prompted this and other tributes of gratitude and respect towards them became gradually corrupted. The intercession of the saints was supposed to have power with God, and individuals put themselves under the especial patronage of one or more amongst the number, which in later times was vastly augmented, giving to them the honour and worship due to God alone, and conceiving themselves sufficiently protected by the influence of their prayers. It was affirmed that miracles were performed at their tombs and by their relics, and the greatest rivalry and contention arose between the votaries of the shrines of different saints, and sometimes those of the same. For the manner of enrolment among the number of saints, see art. CANONIZATION. (See *Bingham and Palmer's Origines Liturgicæ*, as to the progress of the invocation of saints in the church, vol. i. 276, &c.)

SAINT SIMONIANS. Claude Henri, Count de S. Simon, of the ancient family of that name, born in 1760, was engaged during the greater part of his life in a series of unsuccessful commercial enterprises, a traveller, and in the early portion of his life a soldier in America; but having dissipated a considerable fortune, and been unable to draw the attention of the public to a variety of schemes, political and social, which he was constantly publishing, he attempted suicide in 1820: he lived, however, a few years longer, and died in 1825, leaving his papers and projects to Olinde Rodriguez. St. Simon's views of society and the destiny of mankind are contained in a variety of works, and especially in a short treatise entitled

the *Nouveau Christianisme*, published after his death by Rodriguez. This book does not contain any scheme for the foundation of a new religion, such as his disciples afterwards invented. It is a diatribe against both the Catholic and Protestant sects for their neglect of the main principle of Christianity, the elevation of the lower classes of society; and inveighs against "l'exploitation de l'homme par l'homme," the existing system of individual industry, under which capitalist and labourer have opposite interests and no common object. The principle of association, and just division of the fruits of common labour between the members of society, he imagined to be the true remedy for its present evils. After his death these ideas were caught up by a number of disciples, and formed into something resembling a system. The new association, or St. Simonian *family*, was chiefly framed by Rodriguez, Bazar, Thierry, Chevalier, and other men of talent. After the revolution of July, 1830, it rose rapidly into notoriety, from the sympathy between the notions which it promulgated and those entertained by many of the republican party. In 1831, the society had about 3000 members, a newspaper (the *Globe*), and large funds. The views of the St. Simonian family were all directed to the abolition of rank and property in society, and the establishment of associations (such as the followers of Mr. Owen in this country have denominated co-operative), of which all the members should work in common and divide the fruits of their labour. But with these notions, common to many other social reformers, they united the doctrine, that the division of the goods of the community should be in due proportion to the merits or capacity of the recipient. Society was to be governed by a hierarchy, consisting of a supreme pontiff, apostles, disciples of the first, second, and third order. It was not until about this period (1830) that they begun to invest these opinions with the form and character of a religion; but shortly after having done so they went into great extravagances. There was a disunion among them as to the fittest person to preside in the society; and consequently Messrs. Bazar and Enfantin divided, for some time, the duties and dignity of the "Supreme Father," as he was termed. But on the 19th Nov. 1831, Bazar and many others left the society, of which Enfantin remained the supreme father. Their doctrines and proceedings now became licentious and immoral to the last degree. On the 22d Jan. 1832, the family was dispersed by the government. Enfantin and Rodriguez were tried on various charges, and imprisoned for a year. The former afterwards collected again a part of the society at Menilmontant; but it broke up for want of funds. Some former members of the St. Simonian association are now in places of rank and consideration: some of the most extravagant have gone to the East; but Enfantin, we believe, has no followers.

SA'LAMANDER, *Salamandra*. (Gr. σαλαμανδρα.) The name of a genus of Batrachian reptiles, now limited to the terrestrial species of long-tailed Caducibranchiate Batrachians, or those which lose their gills before arriving at maturity, but retain their tails. This appendage is changed in the progress of growth in the true salamander from a compressed to a rounded form. The female brings forth the young alive, which are hatched in the oviduct; and the sexes frequent the water at the season of reproduction. *See* BATRACHIA and TRITON.

SAL AMMO'NIAC. Muriate of ammonia; hydrochlorate of ammonia. A compound of 17 of ammonia and 37 hydrochloric acid. Its name is derived from the Temple of Ammon, in Egypt, where it was originally made by burning camels' dung: it is now largely manufactured in this country. *See* AMMONIA.

SALEP. *See* SALOP.

SAL GEM. Common salt.

SALICA'CEÆ. (*Salix*, the principal genus.) A natural order of Achlamydaceous Exogens, distinguished by a two-valved capsule, and numerous seeds tufted with long hairs. The genus *Salix* comprehends the plants called osiers, sallows, and willows, and is of great economical value, not only for the purposes of the basket-maker, but because several species have a bark which has been found by Davy to contain as much tannin as the oak; and a crystallizable principle called *salicine* has been obtained from *Salix helix* and others, which, according to Magendie, arrests the progress of a fever with the same power as the sulphate of quinia. The poplars, aspens, and abele trees also form a part of this order.

SA'LICIN. A bitter crystallizable substance extracted from willow bark. It exists in several species of willow; and a similar substance has been extracted from the bark of the poplar, especially of the *Populus tremula*. Its ultimate elements are carbon, hydrogen, and oxygen, so that it differs from the vegeto-alkalis in containing no nitrogen.

SA'LIC LAW. The law of that community of the nation of Franks which inhabited the country between the Meuse and the Rhine,—the law of the Ripuarian Franks governing those who dwelt between the Rhine and the Loire. The origin of the name Salian, given to this portion of the Franks and their law, is uncertain: some derive it from the river Saale, in Saxony, on the banks of which they suppose them to have inhabited before the period of their emigration westward. The body of law in question was republished and reformed by Charlemagne in 798, and is still preserved, both in the earlier and in the remodelled shape. The most celebrated portion of it is contained in the title 62. *De Alode*, where it is declared that "no portion of the inheritance in Salic land (terra salica) can fall to females; but that the whole must pass to the males." What those lands were which are intended by the term Salic, has afforded room for infinite discussion among French antiquaries. It is supposed by Ducange that they were those lands which were acquired by Franks at the period of the conquest, and held by military service only. But it seems that the exclusion of females was only to take place where males were to be found in the same degree of kindred to the ancestor. However this may be, the fundamental law which excludes females from succession to the crown of France received, in very early times, the appellation of the Salic law, and was supposed by her lawyers to be derived from the provisions of this ancient code. It was, indeed, a custom prevalent from the earliest times, as we learn from Tacitus, among the Germanic tribes. It was observed in France under the first race; but the first occasion on which it was publicly canvassed was in 1316, when Jeanne, the daughter of Louis Hutin, was excluded from the crown in favour of Philip V., her uncle. In 1328 it was contested by Edward III., who claimed by a prior title to Philip of Valois, if females were admissible; being the son of Isabella, sister of Louis Hutin. From this pretension arose the wars between England and France, which occupied the whole of the following century. In 1593 the famous arrêt of the parliament of Paris was pronounced, by which all treaties made to transfer the crown to a foreign dynasty were declared null, as contrary to the "Salic" and other fundamental laws. The same law has been recognized in all countries of which the crown has devolved upon the royal house of France, and forms now the foundation of the pretensions of the Infante Don Carlos to the throne of Spain. It was also considered as established in those great fiefs of the crown of France which had been granted to princes of the blood by way of apanage; and by this means, on the death of Charles duke of Burgundy, leaving a daughter only, the dukedom of Burgundy proper reverted to Louis XI. as a male fief. (See *Mem. de l'Ac. des Inscr.* vol. xx.; *Meyer's Origines Judiciaires; Hallam's Middle Ages.*)

SALICO'QUES. The French term for the family of Macrourous or long-tailed Crustacea of which the shrimp (*Crangon vulgaris*) is the type.

SA'LIENT. (Lat. salio, *I leap.*) In Heraldry, a term used to describe a beast when represented as leaping or springing.

SALIENT ANGLE. In Geometry and Fortification, an angle of a polygon projecting *outwards* in reference to the centre of the polygon. An angle pointing *inwards* is called a *re-entering angle.* All the angles of any regular figure, as the triangle, square, hexagon, &c., are salient.

SALIE'NTIA. (Lat. salio, *I leap.*) The third order in the Mammalogical system of Illiger, including the Marsupial genera *Hypsiprymnus* and *Halmaturus*, or the potoroos and kangaroos, whose progression is by successive leaps.

SALI'FEROUS ROCKS. The new red sandstone system of some geologists. *See* GEOLOGY.

SALIFI'ABLE BASE. This term, which is of frequent occurrence in chemistry, is chiefly applied to those metallic oxides which combine in definite proportions with the acids, so as to form distinct salts: ammonia, and the vegeto-alkalis are also, upon the same principle, salifiable bases.

SA'LII. The Roman flamens, or peculiar priests of Mars. They were twelve in number, and were instituted by Numa to guard the *ancile*, or sacred shield of Mars. They used on solemn occasions to proceed through the city dancing, whence they derived their name (from *salire*, to dance).

SALI'VA. (Lat.) The fluid secreted into the mouth by the salivary glands; its principal use is to lubricate the parts, and to assist in rendering the food of a proper consistency to be swallowed.

SALIVA'TION. The excessive flow of saliva which is produced by the continuous use of mercury and of some other remedies.

SA'LIX (Lat. *a willow*), is a genus of plants consisting of numerous species, all either trees or bushes, occurring abundantly in all the cooler parts of the northern hemisphere. Some of them, like *S. alba*, acquire the dimensions of the largest forest trees; others are lost among the grass with which they grow, as *S. herbacea*. They are the last kind of ligneous plants that disappear before the rigours of an arctic climate, the only tree found on Melville Island, nine inches high, having

been a willow (*Salix arctica*). Few extend into warm regions, the *Salix babylonica*, or weeping willow, being the best known instance. Their timber, when they form any, is light, tough, soft, and unfit for purposes of construction; it is chiefly used for turnery, and for coarse in-door purposes. Many species have long flexible shoots, and are called osiers, under which name they are extensively employed by the workers in wicker; others are not flexible, but form small trees or rough bushes, named sallows. The latter, called *Saules marçeaux* by the French, yield the best kind of charcoal for military purposes; they are all, however, burnt for the preparation of this substance. The bark of *S. helix*, *fragilis*, *pentandria*, and others, has been found useful in intermittent fevers; and as these maladies are most common in the low marshy places where salices abound, it has been supposed that they are the means which the Creator has given us for protecting ourselves against such disorders. The species intermix very freely, forming mules and hybrids, which have led botanists to create a prodigious number of false species.

SALLY PORTS, in Fortification, are underground passages leading from the inner works to the outward ones, for the troops to sally out. They are othewise called *postern gates*.

SA'LMON. (Lat. salmo.) The excellent and highly valuable fish so called in England is the *Salmo salar* of Linnæus, not of Rondeletius. Both species exist in our rivers, the latter having been recognizably and accurately defined under the name of *Salmo eriox*, or bull trout, which it is to be hoped will be retained for this species, notwithstanding that the name of *Salmo salar* may have been applied to it by the older ichthyologist.

The normal locality of the salmon is at the mouth or estuary of the larger rivers, which, in the season of sexual excitement, they ascend, sooner or later, in the summer months, according as circumstances may influence their coming into breeding condition. At first they ascend only so far as the tide wave reaches, and retire with the ebb; but as the quantity of roe and milt increases, the instinct which teaches the fit locality for oviposition becomes more imperative, and few are the natural obstacles which the salmon does not overcome in its endeavour to reach it.

The great value of the fish renders an accurate knowledge of it, under the disguise of its immature form and markings, of the highest importance; but the difficulties which attend the observation of the migratory inhabitants of the water have only very lately been overcome in the present instance. The proof that the small Salmonoid fish, called the parr, is, as many naturalists had suspected, the young of the salmon, has been elicited by the careful and repeated observations and experiments of Mr. Shaw of Drumlanrig, of which the following condensed account is taken from the *Transactions of the Royal Society of Edinburgh*.

In the river Nith, Dumfries, the salmon oviposits in the month of January. On the 10th of January, Mr. Shaw observed a female salmon of about 16 lbs. weight, and two males of at least 25 lbs., engaged in depositing their spawn. The spot which they had selected for that purpose was a little apart from some other salmon which were engaged in the same process, and rather nearer the side of the stream, although still in pretty deep water. The two males kept up an incessant conflict during the whole of the day for possession of the female, and in their struggle frequently drove each other almost ashore, and were repeatedly on the surface, displaying their dorsal fins and lashing the water with their tails. — The female throws herself at intervals of a few minutes upon her side; and while in that position, by the rapid action of her tail she digs a receptacle in the gravel for her ova, a portion of which she deposits, and again turning upon her side she covers it up by the renewed action of the tail; thus alternately digging, depositing, and covering the ova, until the process is completed by the laying of the whole mass, an operation which generally occupies three or four days. The embryo fish, conspicuous by the two dark eye-specks and the vascular vitelline sac, presented some appearance of animation in the ovum on February 26th, that is, forty-eight days after having been deposited; and on 8th April, or 90 days after impregnation of the ova, the young were excluded. The head is large in proportion to the body, which measures $\frac{5}{8}$ths of an inch in length; the vitellicle is $\frac{2}{8}$ths of an inch in length, and resembles a light red currant; the tail is margined like that of the tadpole, with a continuous fin running from the dorsal above to the anal beneath. The vitelline sac and its contents are absorbed by the 30th May, or in about fifty days, until which time the young fish does not leave the gravel. The terminal fringe-like fin now begins to divide itself into the dorsal, adipose, caudal, and anal fins; and the transverse bars on the sides of the body make their appearance. At this period the young salmon measures an inch in length, and is very active, and continues in the shallows of its native stream till the following spring, when it has attained the length of from three to four inches, and is called the "May parr:" they now descend into deeper parts of the river, but remain there over the second winter. In April, the caudal, pectoral, and dorsal fins assume a dusky margin; the lateral bars begin to be concealed by a silvery pigment; and the migratory dress, characteristic of the salmon fry or smolt, is assumed. The fish now begin to congregate in shoals, and to migrate seaward.

The full-grown salmon averages a weight of between 25 lbs. and 35 lbs.; but instances are recorded of their attaining to 55 lbs., 60 lbs., 70 lbs., 74 lbs., and 83 lbs. The last-cited weight was that of a female salmon, which came into the possession of Mr. Groves, the fishmonger, in Bond Street, about the season of 1821; it was a short fish for the weight, but of very unusual thickness and depth. When cut up, the flesh was fine in colour, and proved of excellent quality. *See* FISHERIES.

SA'LMONOIDS, *Salmonidæ*. A family of soft-finned Abdominal fishes, of which the salmon is the type, having their upper jaw formed in the middle by the intermaxillary, and at the sides by the maxillary bones, both of which support teeth; they are also characterized by a posterior small adipose dorsal fin, and the body is covered with regular cycloid scales. They pass, by almost imperceptible gradations, into the Clupeoid or herring family, with which they have been united by M. Agassiz, to form a common group termed *Halecoids*. Those species of Salmonoids which, like the Clupeoids, inhabit the sea, not only approach the land, but ascend the rivers to near their source, in order to deposit their ova.

SALO'N, or SALOON. (It. salone.) In Architecture, a large state apartment; or, as its name imports, a great hall, or one for the reception of works of art, and usually running up through two stories of a house. *Salon* is also applied to the reunions of the French capital, which have always exercised considerable influence upon the country in all that relates to fashion, literature, and even politics. M. Guizot's admirable little work upon the Salons of Paris is well known. It was recently well reviewed in the *Journal des Débats*.

SA'LOP. The prepared root of the *Orchis mascula*. It consists principally of a modification of gum, much resembling *tragacanth*, with a small quantity of starch; it is sometimes used as an article of food.

SALP, *Salpa*. (Lat. salpa, *a stock-fish*.) A name applied to a genus of soft-shelled or tunicated Acephalous Mollusks, which float in the sea, protected by a transparent gelatinous coat, perforated for the passage of water at both extremities.

SA'LPINX. (Gr. σαλπιγξ, *a trumpet*.) The Eustachian tube, or channel of communication between the mouth and ear.

SAL SEIGNETTE. Tartrate of potassa and soda. *See* ROCHELLE SALT.

SALT. (Lat. sal, Germ. salz.) This term, though in ordinary language limited to common salt, or sea salt, is applied in chemistry to all combinations of acids with alkaline or salifiable bases. The term has also been extended to certain binary combinations of chlorine, iodine, bromine, and fluorine with the metals; and these have been called *haloid salts* (from ἁλς, *sea salt*, and ειδος, *form*), inasmuch as modern chemistry has taught us that sea salt belongs to this class. Certain definite combinations of the sulphurets with each other have of late been called *sulphur salts;* but the former appellation of *double sulphurets* is, perhaps, more properly applicable to such compounds.

Sea salt is a compound of 1 equivalent of sodium = 24, and 1 of chlorine = 36; its equivalent, therefore, is (24 + 36) = 60: and it is a chloride of sodium. The circumstances which gave rise to the notion of its containing muriatic acid and soda, and being therefore a muriate of soda, will be apparent by reference to the article MURIATIC ACID. For rock-salt, *see* GEOLOGY.

The nomenclature of salts has reference to the acids which they contain; *sulphates*, *nitrates*, *carbonates*, &c., implying salts of the sulphuric, nitric, and carbonic acids. The termination *ate* implies the maximum of oxygen in the acids, and *ite* the minimum: thus the salts of sulphurous and nitrous acids are called *sulphites* and *nitrites*. When salts contain 1 equivalent of acid and 1 of base, they are called *neutral salts;* where 1 equivalent of acid is combined with 2 of base, they are termed *basic salts*, *subsalts*, or *disalts;* and where there are 2 equivalents of acid and 1 of base, the salt is a *supersalt*, or *bisalt*. Thus, the terms *subacetate* and *diacetate of lead* are synonymous; so are *supercarbonate* and *bicarbonate of potash*. Many salts are *hydrous;* that is, they contain a definite proportion of water of crystallization; others are destitute of water, and are dry or *anhydrous salts*. Some salts attract moisture when exposed to air, and are said to *deliquesce;* others suffer their water to escape and become opaque, or pulverulent: these are called *efflorescent salts*.

Salt is, next to bread, the most important necessary of life. It is one of the most important British minerals,

and is procured in immense quantities, both from fossil beds and brine springs, in Cheshire and Worcestershire. Previously to the discovery of the fossil beds during the 16th century, and subsequently, a good deal of salt continued to be made by the evaporation of sea water in salt pans, at Lymington and many other places; but the works at these places are now all but abandoned; while not only has the quality of the article in question become greatly improved, but, instead of being imported as formerly, it is now largely exported. The consumption of Great Britain only, exclusive of Ireland, amounts to about 180,000 tons; and the foreign exports to about 300,000 tons per year, of which the United States, Canada, the Low Countries, Russia, Prussia, and Denmark are the chief consumers. Previously to 1823, an oppressive tax of 15*s*. per bushel, or about thirty times the original cost price of the article, was imposed on salt; but in that year it was reduced to 2*s*., and two years subsequently was totally repealed. During the existence of the duty, the retail price of salt was 4½*d*., it is now only ½*d*. per lb.

In ancient Rome, salt was subjected to a duty, *vectigal salinarium* (see Burman, *Dissertatio de Vectigalibus Pop. Rom.* c. 6.); and it has been heavily taxed in most modern states. The *gabelle*, or code of salt laws formerly established in France, was most oppressive. From 4000 to 5000 persons are calculated to have been sent annually to prison and the galleys for offences connected with these laws, the severity of which had no inconsiderable share in bringing about the Revolution.

SA'LTATORY. (Lat. salto, *I leap*.) In Zoology, the extremities of an animal which by their form and proportions are adapted for leaping are called *pedes saltatorii;* as the hind legs of the kangaroo, cricket, &c.

SA'LTIGRADES, *Saltigrada*. (Lat. saltus, *a leap*, and gradior, *I walk*.) The name of a tribe of spiders which seize their prey by leaping upon it from a distance.

SA'LTIRE. In Heraldry, an ordinary in the form of a cross of Saint Andrew: formed by two bends, dexter and sinister, crossing each other. Charges having length (swords, batons, &c.) placed in the direction of the saltire, are said to be borne *saltire-wise*.

SALT MARSH. Land under pasture grasses or herbage plants, subject to be overflown by the sea, or by the waters of estuaries or the outlets of rivers, which in consequence of proximity to the sea are more or less impregnated with sea salt.

SALT MINE. *See* Geology.

SALT OF LEMONS. Binoxalate of potassa is usually sold under this name, and is used for the removal of iron-moulds and other stains from linen; it is generally effectual, and does not corrode.

SALT OF SORREL. Oxalate of potash.

SALTPE'TRE. (Lat. sal, *salt*, and Gr. πέτρα, *a stone*, from its being found in certain stony soils.) Nitrate of potash. An anhydrous salt composed of 1 equivalent of nitric acid = 54, and 1 of potassa = 48. *See* Nitre.

SALT, SPIRIT OF. *See* Muriatic Acid.

SALT SPRINGS. *See* Geology.

SALU'TES. In Military and Naval Discipline, an exhibition of respect performed in different ways, according to circumstances. In the army, the officers salute their superiors by dropping the point of their sword. In the navy, the usual mode of salutation is by firing a certain number of guns, which is regulated according to the rank or station of the individual. (See *Miles's Epitome of the Naval Service of England*, 1841.)

SA'LVAGE, in Mercantile Law, is defined to be a compensation to be made by the shipowners or merchant to other persons by whose assistance the ship or lading may be saved from impending peril, or recovered after actual loss. Salvage may become due—1. On rescue from perils of the sea. In this case, the salvor, or rescuer, has a lien on the goods preserved until a recompence is made him. The amount of this recompence may be fixed by a jury; but if the salvage happen at sea, or between high and low water mark, the court of admiralty has also jurisdiction to fix the amount on suit brought; and by 12 Anne, st. 2. c. 18., and other statutes, summary powers for the same purpose are given to inferior officers in certain cases. 2. On rescue from the hands of enemies. In this case, the old law was, that if a ship was retaken from enemies before it was taken home or condemned by the captor, the original owner could recover her on payment of salvage to the recaptor; but if retaken at a later period, she became lawful prize to the recaptors. But by 13 G. 2. c. 4. s. 18., and other statutes, the right of the original owner has been extended to all cases of recapture. Salvage, on recapture by a king's ship, was fixed, in 1793, at one eighth, and by a private vessel at one sixth.

SALVATE'LLA. (Lat. salus, *health*.) A vein of the arm terminating in the fingers. It was formerly regarded as having peculiar influence on the health when opened.

SAL VOLATILE. Carbonate of ammonia. The term is often applied to a spirituous solution of carbonate of ammonia flavoured with aromatics.

SAMANÆ'ANS, SARMA'NES, GERMA'NES. Names given by different classical writers to a sect of philosophers of India. Clement of Alexandria derives the name from Gr. σεμνος, *venerable*. But it is more probably oriental; the word schamman, in India, signifying a philosopher. The Samanæans are particularly distinguished by those who mention them from the Brahmins. Saint Jerome and Clement of Alexandria represent them as priests of Buddha; and the same name appears in the *Cha-Men* of the Chinese, and *Sammono-Codom* of Siam. (*See* Buddhists.) There is a memoir on the subject by M. de Guignes. (*Mem. de l'Ac. des Inscr.* vol. xxvi. See also *Hist. de l'Acad. des Inscr.* vol. xxxi.; and *Mem.* vol. xl.)

SAMA'RA. An indehiscent superior fruit, being a few-seeded, indehiscent, dry nut, elongated into wing-like expansions; as in the fruit or "key" of the ash-tree, &c. From this root is formed the word *samaroid*, expressing a resemblance to a samara.

SAMA'RITANS. The inhabitants of the city and district of Samaria to the north of Judea. The city was the capital of the kings of Israel; and after the captivity of that portion of the Jewish nation, a colony of Luthites, who are supposed to be Scythians, was settled in the country by the kings of Assyria. It is stated that they were instructed in the Jewish religion by a priest who was sent to them for that purpose by Esarhaddon, in order to avert the anger, as was supposed, of the god of the country. The Samaritans professed belief in the Pentateuch only, but no idolatrous practices are imputed to them; and it was probably their spurious origin which excited against them the jealousy and affected contempt of the Jews, to which many passages of the New Testament so pointedly refer.

SA'MIAN EARTH and STONE. A species of marl from the island of Samos.

SA'MSON'S POST. A strong pillar resting on the kelson, and supporting a beam of the deck over the hold, and thus acting to keep the cargo in its place. Also a temporary or moveable pillar carrying a leading block for various purposes.

SA'MUEL, BOOKS OF. Two canonical books of the Old Testament. The first twenty-four chapters of the first book contain all that relates to the prophet Samuel himself, beginning with the government of Eli. The second book, together with the remainder of the first, carries on the history of the Jews to the death of David. It is traditionally said that the prophet Samuel composed the first part, and the prophets Gad and Nathan the remainder.

SANCTIFICA'TION, in Theology, denotes the state of those Christians who, having lost the inclination to vice, have become pure and holy, and wholly devoted to works of goodness. This state is produced by the special operation of the Holy Ghost, and ensues upon *justification;* which see.

SA'NCTUARY. (Lat. sanctus, *holy*.) The innermost chamber of the tabernacle, and in after times of the temple, among the Jews, in which was kept the ark of the covenant, and which was regarded as the especial residence of the Most High. It is also called the Holy of Holies, and was never entered except once a year, and then only by the high priest on the day of the great expiation of the sins of the people. For the mystical signification of this act, see Hebr. ix. 24.

By the Roman Catholics, the part of the church immediately round the altar is called the sanctuary, which is supposed in many respects to bear an analogy to that of the Jews.

From the time of Constantine downwards, certain churches have been set apart in many countries to be an asylum for fugitives from the hands of justice. This seems to have been originally intended only to prevent sudden violence, and to give time for the regular administration of the law, and perhaps, in the case of certain delinquencies, for the intercession of the church. But in England, particularly down to the Reformation, any person who had taken refuge in a sanctuary was secured against punishment, if within the space of forty days he gave signs of repentance and subjected himself to banishment.

SAND. (Germ.) Finely divided silicious matter constitutes common river and sea sand; particles of other substances are often blended with it, and sometimes it becomes calcareous from the prevalence of carbonate of lime.

SA'NDALS. A species of slippers worn by the ancient Jews, Greeks, and Romans. They consisted of a sole with a hollow part at one extreme, to embrace the ancle and leave the upper part of the foot bare. Originally sandals were made of leather; but they afterwards became articles of great luxury, being made of gold, silver, or other precious stuff, and most beautifully ornamented.

SA'NDARACH. The resin of *Callitris quadrivalvis* is so called. The powder of this resin is sometimes used under the name of *pounce*, to prevent ink from sinking into paper.

SANDEMA'NIANS. In Ecclesiastical History, the followers of Robert Sandeman, who published his opinions

in 1757 in a series of letters. They are of a highly Antinomian character; and their distinguishing opinion is well expressed in Sandeman's epitaph, where "the ancient faith," for which he "long and boldly contended," is said to be "that the bare work of Jesus Christ, without a deed or thought on the part of man, is sufficient to present the chief of sinners;" faith, according to them, being only a simple assent to the divine testimony concerning the Redeemer. The real founder of the Sandemanians was John Glass, the father-in-law of Sandeman. The adherents of the former have retained the name of Glassites, but are confined entirely to Scotland, from which church their founder originally dissented; whereas the followers of Sandeman have extended to England and America as well as Scotland. This sect has never been numerous, and it is now, we believe, nearly extinct.

SA'NDERLING. The name of a small wading bird, a species of *Tringa* (*Tr. arenaria*, Ill.), which frequents many of our shores, but is not a plentiful bird.

SANDIVER. The impurities which collect upon glass during its fusion in the furnace are so called.

SA'NDPIPER. A name applied to different species of the genus *Tringa*, but properly restricted to the *Tringa hypolecuus* of Linnæus, which is the type of the subgenus *Totanus*.

SA'NDSTONE. Stone composed of agglutinated grains of sand, which may be calcareous or siliceous. *See* GEOLOGY.

SA'NGIAC. A Turkish officer, governor of a sangiacate, or district forming part of a pachalic. There were two hundred and ninety such districts in the Turkish empire before the recent losses of territory on the side of Greece and the Caucasus.

SANGUISO'RBEÆ. (Sanguisorba, one of the genera.) A natural order of herbaceous or undershrubby Exogens, usually combined with *Rosaceæ*, as a sub-order; but apparently distinct, on account of the constantly apetalous flowers, indurated calyx, and solitary or almost solitary carpels. Their general character is that of astringency. Burnet, the *Sanguisorba officinalis*, is sometimes grown as a pasture plant.

SANGUISU'GES, *Sanguisuga*. (Lat. sanguis, *blood*, and sugo, *I suck*.) The name of a family of Hemipterous insects, including those which suck the blood of animals: also applied to a family of Abranchiate Annelidans, of which the leech (*Sanguisuga medicinalis*, Sav.) is the type.

SA'NHEDRIM. (Heb.) The highest judicial tribunal among the Jews, consisting of seventy-one members, including the high priest. Its origin is referred by some writers to the institution by Moses of a council of seventy persons on the occasion of a rebellion of the Israelites in the wilderness. (See *Milman's Hist. of Christianity*, i. 339. &c.)

SA'NIES. (Lat.) A thin, unhealthy, purulent discharge from wounds or sores.

SA'NSCRIT. The learned language of Hindostan. The literal meaning of the word Sanscrita is *polished*, and it is used by grammarians in the sense of "regularly inflected or formed." (*Colebrooke's Remains*, vol. ii. p. 2.) And it is a question whether, in its present form, it was ever a *spoken* language, although the theory of Schlegel is, that it was imported by the conquering or Brahminical caste. It constitutes the most ancient literature of the Hindoos, and is radically connected with the various dialects of Hindostan, so that they may be regarded as more or less deflected from it. Colebrooke, however, is of opinion that "there seems no good reason for doubting that it was once universally spoken in India;" and he says, that "those who are learned in Sanscrit, at the present day, deliver themselves with such fluency as is sufficient to prove that it may have been spoken in former times with as much facility as the contemporary dialects of the Greek language, or the more modern dialects of the Arabic tongue." Nine tenths of the "Hindustani," it is said, may be traced to the Sanscrit; the remaining tenth is thought to be, perhaps, founded on the old "Hindi" language, which Sir W. Jones thought anterior to it, conceiving the Sanscrit to have been introduced by conquerors in some very distant age. In the Hindoo drama, the gods and saints are made to speak in Sanscrit; while women, benevolent genii, &c. speak another dialect, and the lower personages a third. (See also *Professor Wilson's Hindoo Theatre*, Introduction.) The attention of European inquirers was directed to the Sanscrit and its cognate language by Sir William Jones. Since his time the study has made great progress in England, where it has been especially furthered by the labours of Houghton, Wilkins, and Wilson; and more in Germany, where Frederic Schlegel (*Sprache, &c. der Indier*, 1808) was the first to excite the spirit of investigation. He was followed by his brother, A. W. Schlegel (who edited the *Bhagavat Gita*, translated into English by Mr. Wilkins), and many others. Among recent German philologists, Bopp deserves the highest name for his researches in this direction. (See *Quart. Rev.* vol. xlv. &c., where it is said that in the course of thirty years nearly 700 works on, and translations from the Sanscrit, have appeared.) The intricate connection of Sanscrit with the principal varieties of the Caucasian speech, and especially the Zend, Greek, and Sclavonic, has greatly added to the interest respecting it.

SANS-CULOTTES, or BREECHESLESS. A name first given in ridicule to the Jacobins and other extravagant patriots in the French Revolution, and afterwards assumed by them as a title of honour; like the old nickname of "gueux" (*beggars*), in which the revolters of the Netherlands prided themselves. We have never been able to ascertain the real history of this famous appellation, but we believe that Camille Desmoulins was one of the first who rendered it popular: his blasphemous application of it at his trial is well known. It acquired great celebrity after the "journée" of the 20th June, 1792, when one of the principal standards borne by the insurgents was a pair of black breeches, with the inscription, "Tremblez, tyrans! voici les Sans-Culottes." Subsequently the French nation adopted it with the utmost gravity in the original Republican calendar. The five supernumerary days (the twelve months containing thirty a piece), were named Sansculottides; and were festivals dedicated to "Genius," "Labour," "Actions," "Rewards," "Opinion." In Leap-years there was to be a sixth Sansculottide, the festival of the Revolution. Future generations will find some difficultyin believing the narrative of the ludicrous farces with which national caprice interspersed the great tragedy of the French Revolution.

SA'NTALIN. The colouring matter of red sandal or saunders wood, from which it is separated by digesting the rasped wood in alcohol, and then adding water to the tincture; it falls in the form of a bright red precipitate, soluble in alcohol and in alkaline solutions.

SA'NTONIN. A proximate vegetable principle, obtained from the seed of the *Artemisia santoniea*. It is white, crystallizable, bitterish, and very little soluble in water, but more so in alcohol.

SAP. The fluid which is absorbed by the roots from the earth, then sent upwards into the stem, and afterwards conveyed from the leaves, where it is assimilated and altered, to the bark. In its crude state it consists of little except water holding earthy and gaseous matter in solution, especially carbonic acid; but as it rises through the tissue of the stem it dissolves the secretions it meets with in its course, and thus acquires new properties, so that by the time it reaches the leaves it is entirely different from its state when it first enters the root. The course taken by the sap in its passage through the stem is by the whole of the tissue included within the bark, provided it is all permeable; but as, in many plants, the central part of the stem becomes choked up with solid matter deposited in the tissue, it usually happens, especially in trees, that the course of the sap is confined to the outer part of the wood, hence called sapwood. It is not certainly known through what kind of tissue the upward motion of the sap takes place, but it is probable that it is carried onwards through all the tubes and vessels of the wood and their intercellular passages. The dotted vessels of the wood seem more especially destined to fulfil this office when the sap is in rapid motion; but as they afterwards become empty, while the ascent of the sap continues, there can be no doubt that the woody tubes or pleurenchyma offer the most constant means by which the sap is conveyed. In Fortification, *sap* is a trench or approach made under cover of gabions, &c.

SAPAN WOOD. A dye-wood produced by certain species of *Cæsalpina*. It has long been used in India, and resembles Brazil-wood in its colour and properties.

SAP GREEN. The inspissated juice of the berries of the buckthorn (*Rhamnus catharticus*). It is used by water-colour painters as a green pigment.

SAPHE'NA. (Gr. σαφης, *visible*.) The large vein of the leg which ascends over the external ancle.

SAPINDA'CEÆ. (Sapindus, one of the genera.) A natural order of exotic trees and shrubs, the larger part of which occur in South America. They usually have compound leaves and inconspicuous flowers, resembling those of European maples; and many of them are climbing plants. The order is poisonous in various degrees; nevertheless, the arillus of *Blighia sapida* is an esteemed fruit in Africa and the West Indies, where it is called the *akee*. The most singular property observed in the order is that of having an astringent quality, and forming a lather when agitated in water, whence the name of the typical genus, — from sapo, *soap*.

SA'PONIN. A peculiar substance contained in the root of the *Saponaria officinalis*. It is the cause of the lather which that root forms with water.

SAPOTA'CEÆ (Sapota, the name of one of the species), are a small natural order of Exogenous trees, inhabiting the West Indies and other tropical countries. They in some cases produce eatable fruits, known by the colonial names of sapodilla, marmalade apple, star apple, Surinam medlar, &c. Their juice is white, like milk; and, unlike the secretions of most lactescent families of plants, may be used for alimentary purposes. The fruit of some

yields a greasy substance; whence one of them, *Bassia*, has gained the name of *shea*, or butter tree, in Africa.

SAPPARE. In Mineralogy, a term applied to the *cyanite*.

SAPPERS AND MINERS, ROYAL. The name given to the non-commissioned officers and privates of the corps of Royal Engineers. Their duties consist in building fortifications, in executing field works, and in performing similar operations, under the direction of their superior officers. They were first embodied at the end of the American war, under the name of "Royal Military Artificers;" and after being formed into independent companies, were stationed at Portsmouth, Chatham, and some other military and naval arsenals. In 1812 they received their present designation; and, at the same time, an institution was formed at Chatham for instructing the men in all the duties of military engineering. This corps consists of 13 companies, each of 68 men: some of which are employed in the colonies; others in the mechanical operations connected with the survey at present carried on by the Board of Ordnance; and others remain at Sandhurst and Addiscombe, to execute the various military works undertaken for the instruction of the cadets of these seminaries.

SA'PPHIC. The name given to a species of verse; from Sappho, the famous Greek poetess, by whom it was said to be invented. It consists of eleven syllables of five feet, of which the following is a plan: —

–⏑ | – – | –⏑⏑ | –⏑ | –⏑ |.

This measure was afterwards introduced into Latin, and received, as the reader is aware, great improvements in the hands of Horace and Catullus. The rules for the composition of Greek are much less strict than those for the composition of Latin sapphics. The sapphic strophe consists of three sapphic verses, followed by a *versus Adonicus*, or Adonian verse; which see. This species of verse has been successfully imitated in German and English.

SA'PPHIRE. (Gr. σαφειρος.) A very hard gem, consisting essentially of crystallized alumina. It is of various colours; the *blue* variety being generally called the sapphire, the *red* the oriental ruby, the *yellow* the oriental topaz.

SAPRO'PHAGANS, *Saprophaga*. (Gr. σαπρος, *decomposing matter*, and φαγω, *I eat*.) The name of a tribe of Coleopterous insects, comprising those which feed on animal and vegetable substances in a state of decomposition.

SA'PWOOD, is the external part of the wood of Exogens, which, from being the latest formed, is not filled up with solid matter, or with the colouring principles which are deposited in wood after a certain time. For these reasons, sapwood is that through which the ascending fluids of plants move most freely; and not being solidified by the earthy and other substances eventually incorporated with wood, is quickly decomposed when exposed to the action of air and moisture. Hence for all building purposes the sapwood is, or ought to be, removed from timber. The sapwood or unsolidified wood of all trees is much the same in its power of resisting decomposition, that of the oak and lignum vitæ perishing as quickly as poplar and other valueless timber; and chemists have ascertained that if the hardest heartwood is reduced to its original condition of sapwood by the abstraction of the matter of solidification, all those properties which give heartwood its value are destroyed.

SA'RABAÏTES. A kind of oriental monks or cœnobites, described by Cassian in his *Institutions;* and supposed to be the same with those called Remoboth by St. Jerome (Epist. xviii.) and Eust., and characterized as vicious and ignorant. They seem to have been seceders from the ordinary monastic life, who formed a species of society rather resembling that of the Moravians of the present day, and without community of goods. (*Waddington's Hist. of the Church*, ch. xix.)

SA'RABAND. (Span.) In Music, a composition in triple time very similar to a minuet. When denoting music for the dance, it is to the same measure which usually terminates when the beating hand rises; being thus distinguished from the *courant*, which ends when the hand falls.

SARCOCE'LE. (Gr. σαρξ, *flesh*, and κηλη, *a tumour*.) A tumefaction of the testicle.

SA'RCOCO'LLA. (Gr. σαρξ, and κολλα, *glue*.) The concrete juice of the *Penæa sarcocolla*, a plant growing in the northern parts of Africa. It somewhat resembles gum arabic; but it is soluble in alcohol, and its aqueous solution is precipitated by tannin.

SA'RCOLITE. (Gr. σαρξ, and λιθος, *a stone*.) A variety of zeolite of a flesh colour.

SARCO'LOGY. (Gr. σαρξ, and λογος, *a discourse*.) The history or doctrine of the fleshy parts of the body.

SARCO'PHAGUS. (Gr. σαρξ, and φαγω, *I consume*.) In Antiquities, a stone receptacle for a dead body. The name originates in the use of the lapis Assius, stone of Assos (in Asia Minor), said to have been prepared in antiquity for this purpose, on account of its supposed property of corroding dead bodies, so as to consume them entirely in forty days; which, together with other incredible qualities, is ascribed to it by Theophrastus and Pliny. One of the most celebrated specimens of this object of art is the great sarcophagus taken by the British in Egypt in 1801, commonly called that of Alexander: it is deposited in the British Museum. Dr. Clarke, the traveller, wrote an essay to prove that the Macedonian conqueror had really been entombed in it; but this opinion seems unfounded.

SARDO'NIC LAUGH. A convulsive laugh, said to have been first observed in those who ate the herb *sardonia*, which grows in Sardinia.

SA'RDONYX. (Gr.) A reddish yellow or orange coloured chalcedony or carnelian; it is often blood red by transmitted light.

SA'ROS. An ancient astronomical period, the origin and exact length of which are unknown, though they have been the subject of much disputation. George Syncellus, who wrote in the eighth century, cites a passage from Berosus, reported by Julius Africanus, in which mention is made of three periods, — the *Sossos*, the *Neros*, and *Saros;* and the Saros is stated to be 3600 years. According to Lalande (*Astronomie*, § 1572.), Syncellus also cites Anianus and Panodorus, who assigned the lengths of these periods as follows: — the Sossos, 60 days; the Neros, 600 days; and the Saros, 3600 days, or 9 common years, 10 months, and 11 days. Legentil, after Fugeres, supposes the Saros to be 10 years; Freret supposed it to be 19¾ years; Giraud, 3600 Julian months, which make 3711 lunations, or 31 years. Suidas states that the Saros was a period of lunar months equal to 18½ years; and Halley (*Phil. Trans.* No. 194.), adopting the same notion, and supporting himself by a passage in Pliny, supposes it to be identical with the lunar period of 18 years, or rather of 223 lunations, which corresponds almost exactly to 242 *nodical* revolutions of the moon (*see* MOON), and consequently brings back the eclipses in the same order. But Goguet (*Origine des Loix, &c.*) remarks, that the statement of Suidas is not supported by that of any ancient author; and that there is no reason to suppose that Pliny, in the passage in question, had the Saros in view. By some authors the Saros has been confounded with the *Metonic cycle*.

SARRACENIA'CEÆ (Sarracenia, one of the genera), are curious herbaceous plants, inhabiting the bogs of North America, and having their leaves hollowed out into tubes or pitchers open at the upper end. Their flowers are something like those of *Papaveraceæ*, to which they are doubtless allied.

SARSAPARI'LLA. The root of the *Smilax sarsaparilla*. Several varieties of this drug are imported from South America: that which is now generally preferred is the reddish fibrous root, known in the market under the name of *Jamaica* or red sarsaparilla. What is termed *Lisbon* sarsaparilla is less fibrous, and more mealy and white in the interior. This root, though long employed in medicine, seems only lately to have been properly estimated. It was formerly regarded as a specific in syphilis; but this opinion is now given up, and it is used as a powerful and valuable alterative medicine in many disorders of debility, but more especially in those cachectic habits which present symptoms formerly mistaken for venereal — such as pains of the bones, nodes of the periosteum, loss of strength and flesh, and other characters of what is sometimes called a broken constitution. In these cases a course of sarsaparilla has often effected a cure, especially if resorted to in time, when all other remedies, and more especially mercurials, had failed. It must be taken in pretty large doses, that is, in quantities not less than an ounce to an ounce and a half a day, and persevered in for six, eight, or ten weeks; or a quantity of extract or syrup, or other preparation equivalent to that weight of the dried root: a concentrated liquid extract, and a syrup, are now prepared, which are the best forms. They are apt to disagree with weak stomachs; but generally, by proper management and perseverance, this difficulty may be got over. Where it agrees, the strength is gradually regained, the pains and other symptoms abate and vanish; and the only other effect observed is, either that the bowels are rather more open than usual, or the flow of urine or the perspiration increased.

SARTO'RIUS MUSCLE. (Lat. sartor, *a tailor*.) A muscle of the thigh attached at the upper extremity to the edge of the anterior superior spinous process of the ileum, and at the lower to the inner side of the head of the tibia. It is concerned in bending the leg obliquely inwards, and in crossing the thighs; thence called sartorius, or the *tailor's muscle*.

SASH. (Fr. chassis.) In Architecture, a piece of framing for holding the squares of glass in a window. It is of two sorts — viz. that called the French sash, which is hung like a door to the sash-frame; and that in which it moves vertically from being balanced by a weight on each side, to which it is attached by lines running over pulleys at the top of the sash-frame. When in a window both the upper and lower sashes are moveable the sashes are said to be double hung, and single hung when only one of them moves.

SASH-FRAME. In Architecture, the wooden frame into which the sashes are fitted.

SA'SSAFRAS. The wood of the *Laurus sassafras*, a native of North America, and growing abundantly upon the banks of the river Sassafras; whence its name. It has a warm aromatic flavour, and the decoction is diuretic and diaphoretic. It was formerly used in cases of stone in the bladder (hence its name has by some been derived from saxum, *a stone*, and frangere, *to break*). It has also been extolled as an antisyphilitic remedy, and in rheumatic and cutaneous affections: it is now scarcely ever employed except as an ingredient in the compound decoction of sarsaparilla.

SA'SSOLIN. Native boracic acid, from the vicinity of Sasso in Florence.

SA'TAN. A Hebrew word signifying enemy or adversary; and used as such, without any reference to the Evil Power itself, in one or two passages of the Old and New Testament. The equivalent term in Greek for this word is διαβολος, literally *one who accuses or calumniates;* whence the word *devil* is derived.

SATELLI'TE (Lat. satelles, *an attendant*), in the Solar System, is the attendant of a planet; a body which revolves about the planet, and follows it in its orbit round the sun. Hence the satellite is sometimes called a secondary planet, or merely a *secondary;* the planet about which it revolves being the *primary*.

The planets which are accompanied by satellites are the Earth, Jupiter, Saturn, and Uranus. The Earth has one satellite, namely, the Moon; Jupiter has four; Saturn seven; and Uranus certainly two, if not six. For the Earth's satellite, see MOON.

Satellites of Jupiter. — These bodies were first observed by Galileo, and their discovery followed immediately that of the telescope. With a telescope of ordinary power they may be seen (unless when eclipsed by the shadow of the planet, or concealed behind its disc), on any clear night, at different distances from the planet, and arranged nearly in a straight line, in which they appear to oscillate backwards and forwards with different velocities, and performing unequal excursions; so that their arrangement with respect to the planet, or *configurations*, are constantly changing. Sometimes they are observed to pass before Jupiter, in which case they cast a shadow on his disc like a small round black spot, whence they are inferred to be opake bodies illuminated by the sun; at other times they pass behind the planet and are concealed from our view; and all these phenomena occur in regular order, and, with respect to each satellite, after the same intervals of time.

An attentive examination of the apparent motions of the satellites soon renders it evident that they revolve round Jupiter in small but unequal orbits, the planes of which are nearly coincident with that of the equator of the planet, which is inclined in a small angle to the ecliptic. Observation also shows that the motions of the satellites about their primary are regulated by the same laws as are observed by the planets in their revolutions round the sun. The orbits are ellipses of small eccentricity, of which Jupiter occupies one of the foci; the areas described by the radius vector are proportional to the times of description; and the squares of the periodic times are respectively proportional to the cubes of the mean distances. Thus Jupiter and his satellites form a system in miniature entirely analogous to that of the sun and planets.

The satellites are distinguished as the *first*, *second*, *third*, and *fourth*, according to their respective distances from Jupiter, the first being that which is nearest the planet. The following table shows their mean distances (in terms of the equatorial radius of Jupiter), times of revolution, masses as compared with Jupiter, and diameters in English miles: —

Satellite.	Mean Distance.	Periodic Time.	Mass.	Diameter in Miles.
		Days.		
1	6·04853	1·76914	0·000017	2508
2	9·62347	3·55118	0·000023	2068
3	15·35024	7.15455	0·000088	3377
4	26·99835	16·68877	0·000043	2890

The mean distances are found by measuring the angular distances from Jupiter at the time of the greatest elongations, and the masses were determined by Laplace from the theory of gravitation. On account of the minuteness of their apparent diameters it is difficult to determine their true diameters with precision. The second, which is the smallest, at the mean distance of the planet subtends an angle of rather less than 1″; and the third, which is the largest, an angle of less than 1·5″. (*Memoirs Royal Astronomical Society*, vol. iii. p. 301.)

Small as the satellites of Jupiter are in comparison of the primary planet, they are in themselves bodies of considerable magnitude. As compared with the Earth their diameters may be approximately stated as follows:—That of the first rather less than $\frac{1}{4}$, of the second $\frac{1}{4}$, of the third $\frac{1}{3}$, and of the fourth rather more than $\frac{1}{3}$. The third is about the size of Mars. These four moons must present to the inhabitants of Jupiter a spectacle of endless variety.

Although their orbits are doubtless elliptical, the eccentricities of the first and second are so small as to be insensible to observation. That of the third is sufficiently sensible; and that of the fourth still greater, but subject to considerable variations. The direction of the motions of the satellites in their orbits is from west to east, according to the general analogy of the planetary system; and from observed periodical defalcations of light to which they are subject, it has been inferred that, like our own moon, each of them revolves about its axis in the same time as that in which it completes a sidereal revolution about the planet.

From the preceding table it will be seen that the periodic time of the first satellite is nearly half of that of the second, and that of the second nearly half of that of the third. The mean angular motions of these three satellites, therefore, form very nearly the progression 1, $\frac{1}{2}$, $\frac{1}{4}$; so that the mean motion of the first satellite, added to twice that of the third, is very nearly equal to three times the mean motion of the second. Another equally singular analogy is, that the mean longitude of the first, *minus* three times that of the second, *plus* twice that of the third, is always very nearly equal to two right angles. These two results subsist equally in respect both of the sidereal and synodical motions and longitudes; and it follows as a consequence of the last, that for a great number of years at least, the three first satellites cannot be eclipsed at the same time, for in the simultaneous eclipses of the second and third the first will always be in conjunction with Jupiter, and *vice versa*.

On account of the shortness of the periods of revolution, the eclipses of the satellites (especially of the first) take place very frequently; and they are phenomena of considerable importance in astronomy, from their affording signals by means of which the differences of terrestrial longitudes are determined, in the same manner as in the case of an eclipse of the moon. The method, however, is not capable of the same precision as is afforded by lunar observations.

The eclipses of Jupiter's satellites have also an historical interest, from having led Rœmer to the important discovery of the successive propagation and velocity of light. When Jupiter is in opposition with the sun, and his distance from the earth consequently *less* than his distance from the sun by the whole radius of the earth's orbit, the eclipses are observed to happen about 16 m. 26 sec. earlier than they happen when the planet is in conjunction, and its distance from the earth *greater* than its distance from the sun by the same quantity. This phenomenon can only be explained by supposing that light occupies 16 m. 26 sec. in traversing the earth's orbit, and consequently 8 m. 13 sec. in coming from the sun to the earth, which gives a velocity of about 192,000 miles in a second. The theory, with its consequences, has been amply confirmed by Bradley's discovery of the aberration. *See* ABERRATION.

Satellites of Saturn. — Saturn, as already mentioned, is accompanied by seven satellites. The most distant, which is by far the largest, was discovered by Huygens in 1665. Four others were first seen by Dominic Cassini about twenty years afterwards; but the two interior ones, which can only be seen under very peculiar circumstances, and with the aid of the most powerful telescopes, were discovered by Sir William Herschel, in 1789. On account of the difficulty of observing the satellites of this planet, their theory has been little studied. The third law of Kepler, which connects the periods and distances, is found to be preserved, as in the system of Jupiter. The planes of their orbits coincide nearly with that of the ring, with the exception of the seventh, which makes an angle with that plane of about 3 or 4 degrees. The orbit of this last is sensibly elliptical, the eccentricity being ·049. Owing to the obliquity of the orbits to Saturn's ecliptic, the satellites are not eclipsed in every revolution, but (with the exception of the two interior ones) only fall into the shadow of the planet at the times when the ring is seen from the earth nearly edgewise. The following table shows their mean distances from Saturn in terms of the equatorial radius of the planet, and their periods of sidereal revolution:—

Satellite.	Mean Distance.	Periodic Time.		
		d.	*h.*	*m.*
1	3·351	0	22	38
2	4·300	1	8	53
3	5·284	1	21	18
4	6·819	2	17	45
5	9·524	4	12	25
6	22·081	15	22	41
7	64·359	79	7	55

The two interior satellites appear to just skirt the exterior edge of the ring. The seventh, like the satellites of Jupiter, exhibits periodical changes in the intensity of

its light, whence it is inferred that it revolves on its axis in the same time in which it completes its orbital revolution.

Satellites of Uranus. — Sir John Herschel remarks, that with the exception of the two interior satellites of Saturn, the attendants of Uranus are the most difficult objects to obtain a sight of, of any in our system. Their existence was first discovered by Sir William Herschel, who suspected their number to be six; but he was only able to obtain micrometrical measures of the distance of two of them, and only those two have yet been seen by any other astronomer. Sir W. Herschel's observations are given in the *Phil. Trans.* for 1788 and 1797, and again in the vol. for 1815. They were made between the years 1787 and 1798; and from the latter period until 1828, the planet having been unfavourably situated, these satellites remained unobserved, and had even fallen out of notice. Between the latter year and 1834 a series of observations, recorded in the *Memoirs of the R. Astr. Society*, vol. viii., were made by Sir John Herschel for the purpose of verifying his father's results, which, with respect to two satellites, were confirmed in the amplest manner. The periodic times deduced from his observations are respectively 8 d. 16 h. 56 m. 31·3 sec., and 13 d. 11 h. 7 m. 12·6 sec. The orbits are nearly circular, and almost perpendicular to the ecliptic, being inclined to that plane in an angle of $78^{\circ} 58'$; and what is extremely remarkable, as contrary to the otherwise unbroken analogy of the solar system, the motions of the satellites in their orbits are *retrograde*, or from east to west. The following table shows the distances (in radii of Uranus) and periods of all the satellites, according to Sir William Herschel. (*Herschel's Astronomy*, *Cab. Encyc.*)

	Mean Distance.	Sidereal Period.			
		d.	*h.*	*m.*	*s.*
1?	13·120	5	21	25	0
2	17·022	8	16	56	5
3?	19·845	10	23	4	0
4	22·752	13	11	8	59
5?	45 507	33	1	48	0
6?	91·008	107	16	40	0

SATIN. A closely woven silk, generally dressed with gum, especially when intended for ribands, dresses, &c.

SATIN SPAR. A fibrous variety of carbonate of lime assuming a silky appearance when polished.

SATIRE, in Literature, has been defined a representation of vice, or of the ridiculous, either in the form of discourse or put in dramatic action. The word satire must not be confounded as to its etymology with the satyri of the Greeks, which were burlesque dramatic pieces, in which the persons represented a band of satyrs. (*See* DRAMA.) The modern word satire, Latin satira, is derived from the *lanx satura*, — a dish full of various fruits and herbs which was carried in procession at the feasts of Ceres. Whence the word came to signify a poem full of miscellaneous matter without orderly method; and in this sense only it was probably employed by Lucilius, the first writer of satires: although the title so usurped by him was afterwards only applied to poems of a similar character with his own, viz. containing moral reflection, interspersed with critical touches directed against real or imaginary personages.

Satire, in the literary sense of the word, as designating a species of composition, is usually confined to a species of poetry; but prose works, of which the contents are of a satirical character, are often comprehended under the same appellation. Dramatic writings, also, are not satires in the stricter sense of the word, although their contents be of a satirical character. According to their subjects, satires are divided into political and moral; and these again severally subdivided into personal and general. Political satires, in almost every language, have been nearly confined to prose; the moral satire alone has found its appropriate vehicle in verse. The only Greek satirist, of whom any fragments have reached us, was Archilochus; and his attacks were evidently directed against individuals. Aristophanes possessed a vein of satirical power, both in the indignant and ludicrous strain, which has never been surpassed; and his dramas contain not only sarcasms on individuals, but also political and ethical lessons of the highest value. But the moral satire, properly so called, was invented by the Romans, not only in form, but in substance also, and by them carried to perfection; and it is remarkable that the only species of Roman poetry which has any degree of originality, is that which would seem to have accorded the least with the grave and austere turn of the genuine Roman character.

Of the three Roman satirists whose works have reached us, Horace, the earliest, excels in conveying moral and prudential lessons in beautiful and precise language, in light allusions to the follies or excesses of his time; sometimes, though rarely, assuming the comic character, but generally evincing more of the indefinable quality termed by us humour, than is shown by any other classical writer, with the exception of Aristophanes. Whether the various personages introduced by Horace, for the most part rather as examples to be shunned than as individuals to be held up to laughter or contempt, were intended to represent to his readers, by allusions now undiscernible, actual characters known to them, is a matter not easily ascertainable. The same may be said with respect to Juvenal, whose selected victims are for the most part exalted or notorious personages of the generations immediately preceding his own; and it is not ascertained, although it has often been conjectured, that their names were intended to conceal those of cotemporaries of his own. Juvenal, without either wit or humour, excels in the deep tones of moral indignation befitting the scandalous excesses of the times in which he lived: his exalted notions of virtue, and even of sanctity, are so far superior to the ordinary standard of moral excellence to be drawn from classical writers, that it has been conjectured that he, as well as Persius, had made some acquaintance, either directly or indirectly, with the lessons of Christianity. Persius, although he occasionally rises into very elevated flights of poetry, does not afford many examples of the peculiar excellences of the satirist.

In the literature of the modern nations, the fate of satire has been similar to that which has befallen many other species of composition. The name and form of the ancient satire have been preserved by many writers, who have produced, for the most part, little besides cold or exaggerated imitations of antiquity. But the true spirit of satire, in its moral beauty, its humour, and its delicate irony, has been inherited by others, who had too much originality of thought to tie down their genius to an antiquated form of writing. Thus in France, Boileau is or was generally cited as the prince of satirists: his satires are closely formed on the model of Horace, and are elegant and correct in style. Besides him, Regnier and many other writers have adopted the same line. But the true satirists of France are Rabelais, in his inimitable romances; Montaigne the essayist, endowed with much of the delicate and harmless sarcasm of Horace; and, in later times, Voltaire. So in England, although we possess satirists of considerable merit, who have adopted the form of the ancient satire, our true national satirists are to be found among our essayists and novel-writers. Bishop Hall, in the reign of Elizabeth, and Donne, in that of James, published collections of satires, directed partly against the actual follies or vices of their times, but too closely paraphrased, for the most part, from the Latin, to admit of much original observation. Withers, among our early satirists, is the only other writer who is at all remembered. Among our modern poets, Pope founded his satires on the model of those of Horace, and of some of his English predecessors. His style and train of thought were rather French than Roman. His works of this description are, in point of form, mere imitations; but they are admirable for their point and the beauty of the verse, and not unfrequently contain pungent personal allusions, without which, unfortunately, a professed satirist can attract little notice and produce little effect. Johnson in his two well-known imitations of Juvenal, Churchill, and Young, are the latest writers of any note who have composed in the form of the ancient satire. But of all these writers, not one possesses a genuine or national character, except perhaps Churchill; while Swift, Fielding, &c., are, in our literature, what Horace and Juvenal were in those of the Romans, — the painters of existing manners, and the representatives of public opinion respecting them. The literary satire may, perhaps, be mentioned as a separate species of composition, containing either rules of writing, or critical observations on the defects of individual writers. Some of Horace's satires and epistles (as well as his *Ars Poetica*) belong exclusively, others partially, to this class; and have given birth to a series of similar productions, down to the *English Bards and Scotch Reviewers* of Lord Byron. (See as to the Roman satire, *Quart. Rev.* vol. lii.; *Mem. de l'Ac. des Inscr.* vol. xxxix.)

SA'TRAP. The title given by the Greek writers to the governors of provinces under the Persian kings before the conquests of Alexander. The satrapies of that empire are enumerated by Herodotus. The name is thought by some to be derived from a Persian word, signifying "fixed star." (*Mem. de l'Ac. des Inscr.* vol. xxxi.)

SA'TURDAY. The seventh day of the week, held by the Jews as their sabbath. It was dedicated by the Romans to Saturn; whence its name.

SA'TURN. An Italian deity having many points of similarity with the Grecian Kronos (Κρονος), with whom he is accordingly frequently identified. He seems to have been originally the god of earth (of which his wife Tellus, Ops, or Rhea was the goddess), and presided over tillage, of which the sickle he carried was the symbol. The treasury at Rome was in his temple.

The Grecian Kronos was the youngest son of Heaven and Earth, and the father of Jupiter, Juno, Neptune, and

Pluto. He usurped the sovereignty, and was in his turn deposed and imprisoned by Jupiter. His reign was celebrated by the ancient poets as the golden age.

The whole history of this deity is probably allegorical. The name itself with a slight variation signifies time (χρόνος); and his attribute of the sickle, together with the account of his being the son of Heaven, by whose luminaries time is measured, and the husband of Rhea (flowing), and of his devouring his own progeny, are corroborative of this conjecture.

Niebuhr regards Saturn and Ops as the god and goddess of the earth, its vivifying and its receptively-productive powers. (*Rom. Hist.* vol. i. p. 66., Cambr. transl.) Creuzer makes Saturn the great god of nature, in many respects assimilated to Janus. He is the god who suffices for himself, — the god who is satisfied with his own powers. (*Symbolik*, par Guigniaut, vol. iii. p. 499.) Hence the derivation of the name from the Latin satur, *full, satisfied*.

SATURN. One of the principal planets in the solar system, and the ninth in the order of distance from the sun. Though less brilliant than Venus and Jupiter, Saturn is still a conspicuous object in the heavens, and has accordingly attracted the attention of astronomers since the first dawn of the science.

Saturn revolves at the distance of about 890 millions of miles from the sun, the mean radius of his orbit being 9·538786 times that of the earth's orbit; and the period of his sidereal revolution is 10759·2198174 mean solar days, or about 29½ years. The orbit is nearly circular, its eccentricity being only ·0561505 (half the major axis being unity); and it is inclined to the ecliptic in an angle which, at the beginning of the present century, was 2° 29′ 35″·7, and is subject to a decrease of 0·155″ annually.

The diameter of Saturn at his mean distance from the earth subtends an angle of about 16·2″; whence his true diameter is 9·982 times that of the earth, or about 76068 miles, and consequently his volume is nearly a thousand times that of the earth. From the theory of his perturbations, his mass compared with that of the sun is found to be ·000284738; whence his density is inferred to be to that of the sun as 55 to 100, or about ⅛th of the density of the earth.

From the observation of certain dark spots on his surface, Saturn is found to revolve about an axis in 10 hours 29 m. 16·8 sec. This rapid rotation of so large a body gives rise to a great centrifugal force at the equator of the planet, and accordingly his form is that of a spheroid considerably flattened at the poles, the ratio of the polar to the equatorial diameter being nearly that of 11 to 12. The inclination of his equator to the plane of the ecliptic is 31° 19′, or nearly 28° 49′ to the plane of his orbit.

When seen through a good telescope, the disc of Saturn appears striped with dark belts, somewhat similar, but broader and less strongly marked than those of Jupiter. From their parallelism to his equator, it is inferred that they subsist in his atmosphere, and are probably determined by currents similar to our trade winds.

Saturn is attended by seven satellites; but the two nearest the planet can only be seen in certain favourable circumstances, and with telescopes of the very highest power. *See* SATELLITE.

Saturn's Rings. — Saturn presents a phenomenon to which there is nothing analogous in the rest of the solar system. This consists of two flat, broad, and very thin rings, both lying in the same plane, and concentric with each other and with the planet. They are separated from the body of the planet by an interval equal to about two and a half times the diameter of the earth, and from each other by a much smaller interval. The plane in which they lie is inclined to the ecliptic in an angle of 28° 40′; and hence they present themselves obliquely to the earth, under the form of an ellipse, the breadth of which, when greatest, is nearly equal to half the length. The following are the dimensions of this extraordinary appendage, as given by Sir John Herschel (*Treatise of Astronomy*, *Cab. Cycl.*), from the micrometrical observations of Struve, with the exception of the thickness of the rings, which was deduced from his own observations: —

	Miles.
Exterior diameter of exterior ring - -	= 176418
Interior diameter of exterior ring - -	= 155272
Exterior diameter of interior ring - -	= 151690
Interior diameter of interior ring - -	= 117339
Equatorial diameter of the planet - -	= 79160
Interval between the planet and interior ring	= 19090
Interval of the rings - -	= 1791
Thickness of the rings not exceeding -	= 100

As the plane of this double ring maintains its parallelism during the revolution of the planet, the angle under which it is presented to the sun is continually changing, and hence the varieties which take place in its apparent form and magnitude. The points in which it intersects the ecliptic are in 170° and 350° of longitude; consequently, whenever the planet comes into either of those longitudes (and it must pass through both in each revolution), the plane of the ring passes through the sun, and only the thin edge is illuminated. In this case, the whole quantity of light which is reflected from it is insufficient to render it visible, and it entirely disappears, even in the most powerful telescopes. On the 29th April, 1833, Sir John Herschel records, "The disappearance of the rings is complete, when observed with a reflector 18 inches in aperture and 20 feet in focal length." A little before or after the planet is in this position, the ring is seen as a fine straight line of light drawn across the disc of the planet, and projecting on each side like *ansæ* or handles. As the planet continues to recede, the sun's rays fall upon the ring more obliquely, and the luminous line gradually opens out into an ellipse, which becomes wider and wider until it attains its maximum, when the longitude of Saturn is 80° or 260°. In following out these phenomena, it is, however, necessary to take into account the position of the earth relatively to the sun and the plane of the ring; for it is evident, in the first place, that the ring will only be visible when the sun and earth are both on the same side of it; and, in the second place, that it will become invisible when its plane passes through the centre of the earth, as none of the light reflected from its sides can then reach us. On this account the disappearance of the ring is generally double, the earth passing twice through its plane in the same revolution. The successive disappearances of the ring form a period of about 15 years, or half the times of Saturn's revolution in his orbit. At present (1840), the north side of the ring is illuminated; in December, 1847, it will be invisible; and in April, 1855, the south side will become visible. The two sides of the ring have thus alternately fifteen of our years of sunshine, and fifteen years of darkness.

The singularity of Saturn's appearance was first noticed by Galileo, to whom the planet appeared *triple*, or as a large body placed between two small ones. The explanation of the phenomena by means of the ring was first given by Huygens. Some astronomers have thought they observed numerous dark divisions in the ring; so that instead of two there must be a number of concentric rings. Struve states, that he could perceive no traces of such division in the great Dorpat refractor.

That the ring is composed of solid ponderous materials is proved from the circumstances of its casting a dark shadow on Saturn on the side nearest the sun, and receiving the shadow of the planet on the opposite side. The ring must therefore be under the influence of the planet's attraction, and also liable to be deranged by the disturbing action of the satellites, the largest of which does not move in the same plane. Hence it is an interesting problem in physical astronomy to determine the conditions under which its equilibrium is maintained. Laplace has shown, from the theory of gravitation, that in order to maintain the stability of the ring, it is necessary that the planet's attraction be counteracted by a centrifugal force arising from a very rapid rotation of the ring in its own plane. Observation has confirmed the result of theory; for from the motions of certain dusky spots on its surface it has been found that the ring revolves in 10 hours 29 m. 17 s., which is very nearly the period assigned by Laplace, and that in which a satellite would revolve at a distance equal to that of the middle of the ring. Laplace also showed that in order to resist the tendency to subversion of the equilibrium, it is necessary to suppose the ring to be of unequal density or thickness in its different parts, so that the centre of gravity may not coincide with the centre of figure; for if it were perfectly similar throughout, its equilibrium would be disturbed by the slightest force, as the attraction of a satellite; and as it would have no tendency to recover itself, it would ultimately be precipitated on the planet. This inequality of form would seem to be indicated by observation, for it has been noticed that the two arms of the ring sometimes appear to be dissimilar. According to Bessel, the mass of the ring is equal to about the 1-118th part of that of the planet. For further information, see *Herschel's Treatise on Astronomy*.

SATURNA'LIA, the festival of Saturn, was celebrated at Rome about the middle of December, and occupied at different times one, three, and five days. It was a season of complete liberty and rejoicing. No business was done: friends visited and made presents to each other; and, what was most remarkable, slaves were permitted to jest with their masters, and were even waited on at table by them.

SA'TYRS. In Classical Mythology, divinities, or rather supernatural personages, represented with the heads, arms, and bodies of men, and the lower parts of goats. They were under the peculiar government of the god Bacchus. Some antiquaries have fancied that the notion of satyrs arose from the introduction of ourang-outangs by the real Bacchus, on his return from his conquest of India, and derive the name from the Heb. sahurim, *hairy men;* Bacchus, according to tradition, having remained some time in Palestine during his return. In the same

way we may perhaps account for St. Augustin's story, of a satyr having been seen and caught in his own time in the deserts of Africa. In Grecian Dramatic Literature, the name satyr is applied to a theatrical piece, in which the chorus consisted of satyrs: of a semi-burlesque character, to judge of it by the only specimen left to us, the *Cyclops* of Euripides. It was customary for the tragedian to present at the same time three tragic pieces and one satyr, forming a tetralogy. In Zoology, the ourang-outang (*Simia satyrus*, Linn.) is sometimes called satyr.

SAUCISSON. In Fortification, a long pipe or bag filled with gunpowder for the purpose of firing a mine. The term is also applied to a fascine, longer than the common ones, used for raising batteries and repairing breaches.

SAU'NDERS or SANDAL WOOD. The white or scented sandal wood is the produce of the *Santalum album*. It is brought from the East Indies. When distilled with water it yields a thick essential oil, smelling something like roses. Red saunders or sandal is the wood of the *Pterocarpus santalinus*, also a native of India. Its colouring matter is insoluble in water, but soluble in alcohol, and is used to impart a red tinge to certain tinctures. The resinous exudation of this tree constitutes one of the varieties of *dragon's blood*.

SA'URIANS, *Sauria*. (Gr. σαυρος, *a lizard*.) The name of an order of reptiles, including all those which are covered with scales and have four legs, as the crocodile and lizard. The mouth of the saurians is always armed with teeth, and their toes are generally furnished with claws; they have all a tail more or less long, and generally very thick at the base. A few species, exceptions to the general character, have only two legs. The most gigantic and singular species of the Saurian order are now extinct.

SAUSSURITE. A variety of nephrite named in honour of Saussure, who discovered it on the banks of the lake of Geneva in rounded masses.

SAVA'NNAHS. The name given to those vast systems of plains watered by the Missouri and Mississippi. These savannahs are greatly diversified in appearance; but they have some general features, which the reader will find systematically described in Mr. Flint's work on America.

SAVINGS BANKS. *See* BANK, SAVINGS. (See also Dégerando, *De la Bienfaisance Publique*, vol. iii. l. 2. ch. 4.)

SAXIFRAGA'CEÆ. (Saxifraga, one of the genera.) A natural order of herbaceous Exogens, chiefly inhabiting the mountainous regions of Europe and the northern parts of the world. They are nearly allied to *Rosaceæ*, from which they differ in having polyspermous, didymous, partially concrete carpels, and albuminous seeds, and in wanting stipules. The root of *Heuchera Americana* is a powerful astringent, whence it is called in North America alum root; other species are pretty herbaceous plants: none of them are of general interest.

SAXON ARCHITECTURE. *See* ARCHITECTURE.

SAXON BLUE. A solution of indigo in concentrated sulphuric acid: it is much used as a dye stuff.

SCABI'NUS. The Latinized form of the old German word schoppe, in French échevin. Judicial officers of various descriptions in the middle ages bore this title, especially in the "communes," or municipalities. See as to its history, *Meyer's Instit. Judiciaires; Mem. de l'Ac. des Inscr.* vol. xxxvii.

SCA'BROUS. (Lat. scaber, *rough*.) In Zoology, when a surface is rough to the touch, from granules scarcely visible.

SCA'FFOLDING, in Architecture, is the temporary combination of timber-work, by the means of upright poles and horizontal pieces, on which latter are laid the boards for carrying up the different stages or floors of a building, and which are *struck* or removed as soon as they have answered their purpose. The scaffolding used for carrying up buildings on the Continent has always been more scientifically and solidly constructed than that used in this country. But great improvements have latterly taken place; and there seems to be a prevalent notion here, in the present day, that for large buildings a little more skill should be displayed than that which emanates from the combination of uninstructed Irish labourers.

SCAGLIO'LA. (It.) In Architecture, a composition; sometimes called also *Mischia*, from the mixture of colours employed in it, being made to imitate marble. The Florentines claim the invention of this art, but it had been practised in Lombardy previous to its introduction at Florence. Lanza says that it was invented by Guido Sassi, who died at the age of 65, in 1649, at Carpi, in the state of Modena, and that he commenced by executing cornices and other members of architecture which had all the appearance of the finest marbles; whereas its introduction at Florence was not till the middle of the 18th century. Scagliola is composed of gypsum or sulphate of lime, calcined and reduced to a fine powder, with the addition of which to water a fine paste is made. When columns are made with this composition, a frame or cradle is first formed, which is lathed round, and coated with lime and hair, raised up in some parts with small projections. On this, when dry, is laid a composition consisting of pure gypsum, calcined and passed through a sieve, and, as wanted, mixed with glue or isinglass; it is floated with wooden moulds of the proper form, during which operation the colours, by which the imitation is obtained, are put on. When this is set the work is smoothed with pumice-stone with one hand of the workman, while the other is employed in washing it with a sponge and water. It is then polished with tripoli, charcoal, and a piece of fine linen, and afterwards with a piece of felt dipped in oil and tripoli, and finished off with pure oil laid on with cotton wool.

SCALD (*Skâlld*), signifies in the ancient Norsk language a poet. In the old northern literature, those mythological poems of which the writers are known are properly called songs of the Scalds, while those of unknown authors are termed Eddas. It appears from Tacitus that the ancient Germans had those three classes of poems which were found at a later era in Scandinavia, namely, relating to the gods, to heaven, and to historical subjects. The Scalds whose remains have come down to us are very numerous. Their poems are partly alliterative, and partly rhymed; and this latter circumstance seems to indicate works of comparatively recent date. The historical value of their poems is considerable; but they are written in a peculiar vein of exaggeration, and in a metaphysical and almost enigmatical fashion, which appears to have been characteristic of the poetical art of the north. (*See* EDDA, SAGA.) The most complete list of the Scalds, and commentary on Scaldic poetry, is to be found (according to the *Conversations Lex.*) in the *Fundgruben des Orient.* vol. i.

SCALE. (It. scala, *a ladder*, or *series of stairs*.) In Music, a progressive series of sounds rising in acuteness or falling in gravity from any given pitch to the greatest practicable distance, through such intermediate degrees as create an agreeable and perfect succession, wherein all the harmonical intervals are conveniently divided. See the words DIATONIC and CHROMATIC.

SCALE. In Mensuration, a line or rule of a definite length, divided into a given number of equal parts, and used for the purpose of measuring other linear magnitudes. It becomes a *standard scale* when all its divisions have been examined and compared with some *standard measure*. (*See* MEASURE.) The scales of thermometers are graduated from some arbitrary point or zero (as that which indicates the temperature of freezing water), from which the heat is counted upwards or downwards in degrees, which are also arbitrary.

The term *scale* is also applied to a mathematical instrument, consisting of an assemblage of lines and figures engraved on a plane rule, by means of which certain proportional quantities or arithmetical results are obtained by inspection. Of these the principal are the *plane scale*, the *diagonal scale*, *Gunter's scale*, &c. For the construction and uses of these various scales, see *Robertson's Description and Use of Mathematical Instruments*.

In Arithmetic, *scale* signifies the order of progression on which any system of notation is founded; as the *binary* scale, the *denary* scale, &c. *See* BINARY ARITHMETIC, NOTATION.

SCALE, in Zoology, is properly applied to the plates, generally thin, small, and umbricated, which defend the skin of fishes. They are substances of different texture which are developed beneath the true epiderm, and appertain to the system of the rete mucosum. The so-called scales of serpents and other reptiles are modifications of the epidermis, and are sometimes termed "scutes." Fishes have been classified according to the structure of their scales. See the words CTENOID, CYCLOID, GANOID, PLACOID.

SCALE'NE. (Gr. σκαληνος.) In Geometry, a scalene triangle is a triangle of which the three sides are unequal. A cone or cylinder is also said to be scalene if its axis is inclined to its base; but in this case the term *oblique* is more frequently used.

SCALE'NUS. A muscle of the neck, situated between the transverse processes of the cervical vertebræ and the upper part of the neck.

SCALPEL. (Lat. scalpare, *to carve*.) A dissecting knife.

SCALPRUM. (Lat. *a knife*.) In Mammalogy, the cutting edge of the incisor teeth.

SCA'MMONY, in Pharmacy, is the gum-resin of the *Convolvulus scammonea*, chiefly imported from Aleppo and Smyrna in packages, called *drums*, weighing about 100 pounds each. It is of a dark olive colour, and when wetted and rubbed should easily form a milky solution: it is very apt to be adulterated, and an article entirely fictitious is often sold under the name of scammony. Scammony is an excellent drastic purge, and is generally administered in combination with other purgatives in doses of three or four grains.

SCA'NDALUM MAGNA'TUM. In Law, an action

which still lies, although for a long period it has never been resorted to, on the stat. 2 Ric. 2. stat. 1. c. 5., and statute of Westminster the First, 3 E. 1. c. 34., for words spoken in derogation of a peer, a judge, or other great officer of the realm; which need not be such as would be actionable at common law in the case of a private person. "The Duke of Richmond v. Castellow," in the eighth year of Queen Anne, seems to have been the last instance of this species of action.

SCANSO'RIALS, *Scansores*. (Lat. scando, *I climb*.) Climbing birds. The name of an order of birds, including those which have the toes arranged in pairs, two before and two behind; a conformation of the foot which is admirably adapted for the act of climbing.

SCANT. In Naval language, the term applied to the wind when it is barely fair.

SCANTLING. (Fr. echantillon.) In Architecture, the measures of breadth and thickness of a piece of timber or other material. It is also the name of a piece of timber when under five inches square.

SCANTLING. In Naval Architecture, the scale or dimensions of the breadth and thickness of the timbers. Thus two ships of different sizes may have the same scantling.

SCA'PE. In Botany, a peduncle, which, in plants destitute of a stem, rises above the ground and supports the flowers upon its apex, as in cowslip. Also a synonym of *Scapellus*.

SCAPEMENT, or ESCAPEMENT. *See* HOROLOGY.

SCAPHITE. (Gr. σκαφη, *a boat*.) A genus of elliptical-chambered shells, belonging to the family of Ammonites, having the inner extremity coiled up in whorls embracing one another, and the outer extremity continued nearly in a horizontal plane, and then folded back, so as sometimes to touch the spire of the opposite end of the shell. The transverse plates are numerous, and are pierced by a marginal siphuncle at the back of the shell, and their edges are deeply cut and foliated. These beautiful shells, which thus resemble the ancient form of a boat, are almost peculiar to the chalk formation.

SCA'POLITE. A mineral, originally from Arendahl in Norway, the crystals of which are often collected in groups of parallel, diverging, or intermingled prisms; hence its name, from σκαπος, *a rod*, and λιθος, *a stone*.

SCA'PULA. (Lat. *the shoulder*.) In Comparative Anatomy, the bone which passes from the shoulder joint in a direction towards the vertebral column. It is broad and flat, generally triangular, sometimes subquadrilateral, in the Mammalia; narrow, and commonly sabre-shaped, in birds; narrow and straight in Saurian reptiles; a round, strong, and straight column, in Chelonian reptiles; variously shaped, and articulated to the back of the skull in most fishes.

SCA'PULARS, or SCAPULAR FEATHERS, in Ornithology, are those which take their origin from the shoulders and cover the sides of the back.

SCA'PULARY. A portion of the dress of the monastic orders, consisting of two bands of woollen stuff, of which the one crosses the back or shoulders, and the other the stomach. According to the Abbé Fleury (*Mœurs des Chretiens*), the scapulary originated with St. Benedict, and was a large and heavy covering of the shoulders, worn by the early monks in their rural labours for the convenience of carrying loads, and to protect the tunic. Simon Stock, an Englishman, general of the Carmelites in the 13th century, first introduced, under the authority of a vision, the notion that the scapulary is an especial sign of devotion to the Virgin Mary. Since that time it has been not an uncommon superstition that whoever dies wearing it is sure of salvation. The scapulary of lay persons consists of two little pieces of stuff on which the name of the Virgin is embroidered.

SCA'PUS. (Lat. *a stalk*.) In Ornithology, the stem or trunk of a feather, including the hollow base or quill, "calamus," which is inserted into the skin, and the solid exserted stem supporting the barbs, or "rachis."

SCAPUS. In Architecture, the same as the *shaft* of a column, which see.

SCARABÆ'IDANS, *Scarabeidæ*. (Lat. scarabæus, *a beetle*.) The name of a family of Coleopterous insects, of which the genus *Scarabæus* is the type; it corresponds with the great tribe of *Lamellicorns*. See that word.

SCARABÆ'US. In Antiquities. The use and meaning of the scarabæus, as a symbol, are, as yet, among the mysteries of archæological science. The Egyptians, it is said, found in it an emblem of the world instinct with the seeds of life; because the kind of beetle represented by it forms a ball of earth in which to deposit its eggs. It is also called a type of the sun. However this may be, it was habitually worn by the ancient Egyptians and Etrurians as an amulet. According to Mrs. Hamilton Gray (*Tour to the Sepulchres of Etruria*, 1840), several different styles of the scarabæus are traceable. The ancient Egyptian scarabæus was plain, or inscribed with characters; and was made of opaque stone, basalt, or porphyry. The Etrurian scarabæus (found in quantities in the sepulchres) was of semitransparent stone, cornelian, onyx, sardonyx, agate, or jasper. It is almost always engraved, generally with the figure of a god or genius, supposed to be the chosen protector of the individual who wore it: sometimes with whole scenes, such as the labours of Hercules, races, &c.; sometimes with Etruscan words or names; and occasionally with Egyptian divinities, — Isis or Horus. Lastly, the modern Egyptian scarabæus of Roman times was generally of precious or semi-precious stones, and rudely engraved; and seems to belong to an age when the religious use of the scarabæus was forgotten, and it was retained only as an ornament. In the Etruscan scarabæi themselves, according to the same authoress, there are three distinct styles of art remarkable, — the rude or native Etruscan, the Grecian, and that of a period of decline.

SCA'RAMOUCH. (Ital. scaramuccia, *skirmish*.) A personage in the old Italian Comedia dell' Arte, dressed in the Spanish or Hispano-Neapolitan costume, and representing a military personage, a poltroon and braggadocio, who always ended by receiving a beating from the hands of Harlequin. The most celebrated Scaramouch of the Italian theatre at Paris was Tiberio Flurelli, a Neapolitan, who had the honour of making Louis XIV. laugh when an infant; and whose agility was such that he was able, according to his biographers, to give a box on the ear with his foot at the age of 80.

SCARFING. In Architecture, the formation of a beam out of two pieces of timber; usually employed when it cannot be conveniently procured in one length. It is usually performed by indenting the pieces where they are joined to each other, and bolting them together in the opposite direction.

SCARFSKIN. The cuticle or epidermis. *See* SKIN.

SCARIFICA'TOR. An instrument used in cupping; it consists of 10 or 12 lancets, which are discharged through apertures in its plane surface by pulling a kind of trigger, so that in passing they make a number of incisions in the part to which the instrument is applied.

SCARLATI'NA, or SCARLET FEVER. This highly contagious disease assumes two forms. In the one it comes on with the usual symptoms of fever, such as languor, chills and heat, thirst, nausea and vomiting; and on the third or fourth day a scarlet efflorescence appears upon the skin, which in three or four days ends in the cuticle peeling off in branny scales: the febrile symptoms and soreness of the throat, if any had been observed, then give way, and the patient gradually recovers. It is, however, not uncommonly followed by dropsical swelling of the body, which is but of short continuance. In the other form of this disease the febrile symptoms are at first more alarming: there is bilious vomiting, great soreness and ulceration of the throat, quick and small pulse, laborious breathing; and the eruption, instead of mitigating the symptoms, is accompanied by their dangerous increase. The body becomes swollen, and the nose and eyes inflamed; the breath grows fœtid, and the inflammation of the throat terminates in greyish sloughs, which give it a speckled appearance. Under an aggravation of such symptoms, the patient is cut off; or his recovery is very slow, and dropsical swellings and glandular tumours follow, and leave him in a very precarious state. It occasionally happens that the putrid symptoms run very high; the rash is livid, and accompanied by petechiæ; the breath highly fœtid, the throat gangrenous; and other symptoms announce a highly malignant form of the disease.

In the milder form of scarlet fever, the bowels should be cleansed by saline aperients, and the patient kept in a moderate temperature, as near 60° as possible, and in a clean and open room. If the throat is much affected, an emetic should be given as early as possible, and the bowels opened by small doses of calomel and antimonials. When the heat of the body is much above the usual standard, or very distressing, sponging with cold water, judiciously resorted to, has proved eminently useful. Acidulated gargles must be used for the throat; and the dilute acids, with light preparations of bark and tonics, at the decline of the eruption, are required. Where the malignant symptoms run high, cordial tonics, acids, wine, and the other treatment of putrid fevers must be adopted.

Scarlet fever is distinguished from measles by the greater extent and want of elevation of the eruption, and by its not congregating into semilunar patches; nor is there the cough, and running from the eyes and nose, which usher in the measles. It seizes those of all ages, but children and young persons are most subject to it; and it appears at all seasons of the year, but in autumn is often epidemic. It may attack the same person more than once.

SCARP. In Fortification, the interior slope of the ditch. *See* ESCARP.

SCE'LIDES. (Gr. σκελος, *a leg*.) In Mammalogy, the lower, posterior, or pelvic extremities.

SCENE. In Dramatic Literature (from the Gr. σκηνη, *arbour*), dramatic representations, having, it is supposed, originally taken place on spots of ground shaded with boughs of trees. The imaginary place in which the ac-

tion of the play is supposed to pass; also a division of a drama: properly speaking, whenever the action changes to a new scene or place. But in the French theatre, and those framed on its model (in which unity of place is observed), every entry of an actor constitutes a new scene. On the English stage, the subdivision called a scene is extremely arbitrary; the scenes in most plays being far more numerous than the actual changes of scene, while at the same time the French rule is not observed, and actors enter in the middle of a scene. The scenes in a play are numbered as subdivisions of the act. *See* ACT.

SCENE PAINTING. A department of the art of painting governed by the laws of perspective, applied to the peculiar exigencies of a theatre. It is conducted chiefly in water colours, and admits of the most striking effects, which indeed, in scene painting, is almost all that is required.

SCENERY. The appearance of a place or of objects, or the representation of a spot wherein an action is performed. *See* LANDSCAPE.

SCE'PTICISM. (Gr. *σκεπτομαι, I examine.*) In the History of Philosophy, a name given to that tendency of thought or system of doctrines the object of which is, by denying the existence of all grounds of knowledge, to introduce universal doubt and suspension of assent. Schools of scepticism have existed at several different periods in the progress of philosophical inquiry. The first who received or adopted the name was Pyrrho, a contemporary of Alexander the Great, and his successors, who taught in Athens about the year 300 B.C. Our chief notices of his opinions are derived from the writings, in verse, of his disciple Timon, preserved to us by Sextus Empiricus. He was led to his sceptical views partly by the contradictions observable in the impressions on our senses, and partly by the incompatibility of the principles of different schools with each other. To a complete suspension of judgment in speculation (*ἐποχή*) he united a corresponding state of indifference in feeling (*ἀταραξία*), and made virtue and happiness to consist in the absence of mental perturbation. Either he or his scholars endeavoured to present a synopsis of their sceptical views in ten general forms, or commonplaces, all of which, however, may be included in one or other of the two sources of doubt mentioned above.

The school of Pyrrho seems to have expired with his disciple Timon; though many of his views were espoused and maintained by the later academy. (*See* ACADEMICS.) About the middle of the third century of the Christian era, we meet with a school to which the name of the later sceptics has been assigned. This sect seems to have originated with one Ænesidemus, a physician. It was, in fact, a school of physicians, who, in opposition to the *Methodic* sect, adopted a strictly empirical mode of treatment, and sought in sceptical considerations a justification of their practice. The grounds of this scepticism have been recorded by Sextus Empiricus It regarded not so much the validity of the notices given by the senses (to which their empirical method imposed on them a necessity of yielding their assent), as the general form and method of science. Syllogism they regarded as utterly void, inasmuch as the conclusion must have been contained in the induction on which the major proposition was founded. Perfect induction was impossible; imperfect was unsatisfactory. They also attacked, with considerable acuteness, the received doctrines of cause and effect, and of the nature of God; chiefly in opposition to the Stoics, the most dogmatical of the ancient sects. Their morality, like their speculative creed, was a system of mere sensualism. This school may be considered as the last purely Grecian sect. After them an oriental element was introduced into philosophy, which materially altered its character and bearing. The most celebrated sceptics of modern times are, Montaigne (A.D. 1580); Glanville, an Englishman, who flourished about the period of the Restoration; Bayle, and Hume. Of these Mr. Hume has the merit of producing the most systematic and comprehensive scheme of scepticism the world has yet seen. According to this philosopher, all the objects of consciousness may be reduced to two classes,—1. the impressions on the senses; and, 2. ideas, or copies of those impressions, which differ from their originals only in being less vivid. All knowledge, save that of mathematical relations, consists in the arrangement of these impressions according to the order of their succession. Of the connection between any two links of this succession we know nothing; that to which we give the name of causation being, in fact, nothing more than habitual sequence relatively to the phenomena, and custom, or often-repeated association, in relation to ourselves. All inquiry into things in themselves, or their grounds,—in other words, all metaphysical speculation, is consequently founded on delusion. The writings of David Hume, which contain his sceptical speculations, are his *Treatise on Human Nature*, and the early part of the second volume of his *Essays*. (See *Ritter*, book x. ch. 1.)

SCE'PTRE. (Gr. *σκηπτρον, a staff to lean on.*) A well-known emblem of sovereignty. Achilles, as is well known, swears by his staff or sceptre in the first book of the *Iliad*. Tarquin the elder first assumed the sceptre among the Romans. According to Justin, it was originally a spear. The sceptre of the Merovingian kings, as represented on monuments, is a rod, probably of metal, of the height of the bearer, and slightly curved like a crosier.

SCHAA'LSTEIN. A mineralogical synonym of *table spar* (tafel-spath of the Germans). It occurs in grey laminated masses or concretions, chiefly at Dognatscha in the Bannat.

SCHEELE'S GREEN. A green pigment obtained by mixing arsenite of potassa with sulphate of copper. It is an arsenite of copper.

SCHEE'LIUM. A name sometimes applied to tungsten, in honour of Scheele, who discovered it.

SCHELLING, THE PHILOSOPHY OF, teaches the identity or *indifference* of the ideal and real. Its author, Frederick Wilhelm Joseph von Schelling, was born January 27th, 1775, and studied successively at Tubingen, Leipzig, and Jena. In the latter place, he was a pupil of Fichte. Schelling lived till recently at Munich, under the patronage of the King of Bavaria, who ennobled him, and advanced him to the dignity of geheime rath, or privy councillor; but he has within the last few months accepted of an invitation from the Prussian monarch to reside at Berlin, where his lectures are said to excite the most lively interest among the Prussian literati.

It is extremely difficult to understand the true import and significancy of any particular system of philosophy, if it is considered in itself, and apart from its connection with the general history of philosophy, which, from its earliest origin to its latest development, will be found to constitute a close and compact whole. This general truth is particularly applicable to the philosophical development of Germany, the unity of whose literary pursuits seems to supply the want of a true political unity. The concatenation of views and opinions, from Leibnitz and Spinosa to the philosophers of the present day, is easily traceable; but it will be sufficient for the elucidation of Schelling's philosophy to begin with the critical theory of Kant. The transcendental idealism of this philosopher formed the transition from the empiricism of the eighteenth century, and effected, as it were, a compromise between the scepticism of Hume and the realism which it succeeded to. Without denying or asserting the existence of a material world, Kant was content with confessing an ignorance at all events of its nature. He taught that all that man can know of outward objects is, that they furnish the material ground of his conceptions; to which the mind furnishes, on its part, the form, in congruity with its original and connatural laws. Of things themselves, or, as Kant calls them, of phenomena, man absolutely knows nothing; all that he can do is to note the modes under which they appear to him. But while the criticism of the pure reason seemed to lead to a speculative idealism, that of the practical reason appeared to possess a mystical tendency. The principles of the latter work may thus be summed up:—A consideration of the exigencies of man's moral nature enforces the validity of those ideas of God, immortality, and a future state of retribution, which the speculative reason does indeed project, but cannot legitimate. The latter tendency of the Kantian philosophy was worked out by Haman and Herder, but found its culminating point in Jacobi's Philosophy of Faith (*Glauben's Philosophie*), which had many adherents in Germany, and extensively influenced the prevailing ideas of philosophy. According to Jacobi, the end and aim of true philosophy is a knowledge of God. Now, the pursuit of this object must set out from feeling and intuition, for there is no speculative method which can give a demonstration of God; for God is infinite, but the understanding finite; and all mediate knowledge by reasoning, which is a procedure of the intellect, cannot attain to the infinite. Reasoning, moreover, cannot do more than establish the correspondence of certain identical propositions from which it passes, step by step, and on the presumption of whose truth it proceeds. The element, therefore, of all human knowledge is faith; an original instinct of man's nature, which immediately reveals to him the divine; and, in spite of any suspicions of the validity of sensuous testimony, enforces a belief in the existence of an external world. The philosophical merits of Jacobi consist in this, that he did not, with Kant, regard God as a mere abstraction, but as a living spirit, whose presence is manifest within man himself; and further, in the way that he insisted on the validity of the immediate perceptions of consciousness, in opposition to the absolute authority of the finite understanding. However, true philosophical science cannot admit of any such contrariety of intellect and feeling; and to establish their identity, or at least to combine them in unison, was the problem which Fichte attempted to solve. But the predominant character of the latter's

philosophy lies in the way in which he carried, to its extreme result, the idealistic tendency of Kant. In the *Wissenschaftslehre* we have a system of pure and absolute idealism. The existence of a material world is here denied unconditionally; the real exists only so far as it is necessarily conceived by us; so that the external world is purely a creation of our conceptions, and the real is a product of the ideal. To use the language of Fichte, — the ego is absolute, and posits itself; it is a pure activity. As its activity, however, has certain indefinable limits, when it experiences this limitation of its activity it also posits a non-ego, and so originates the objective world. The ego, therefore, cannot posit itself without at the same time projecting a non-ego; which, consequently, is in so far the mere creation of the ego. With the mediate knowledge of reflection, by which Fichte attained to this speculative result, he combined for practical ends the authority of immediate consciousness. As, he argued, it is from the impulse of the ego to activity that the non-ego arises, the absolute ego is also in the same relation to the intelligent ego as a cause is to its effect. But although the absolute practical ego is absolutely free, and the sole principle of all reality, so as to posit the world in opposition to itself, and to be its cause, it has, nevertheless, a subjective limit to its operation. This is the idea of duty which the consciousness immediately announces to man as an unconditional authority and obligation; which, however, is not subversive of the freedom of the ego, but is simply an impulsive motive to its activity. Now, so far as the ego attempts to realize this duty, it tends to a moral order. He who does his utmost to establish this moral order, comes near to the Deity, and enters upon his true and proper life.

Such was the point to which speculation had attained when Schelling appeared as a philosophical writer. The subjective thought had been made the supreme and only principle, before which all objective entity was driven into the back ground; and the subjectivity of the idea was the only real existence acknowledged. For this subjective idealism Schelling, however, did but substitute an objective idealism, by giving objectivity to the idea itself, and declaring every entity to be also rational thought. Kant had spoken of the objective as unknowable; Fichte had denied its existence; and Schelling identified the ideal and the real. Fichte had confined himself to giving a derivation of nature and its laws out of an absolute and spontaneous activity of the ego. Schelling maintained that not only must the laws of consciousness be immediately cognizable in the objective world, as laws of nature; but conversely, also, the laws of nature must be immediately demonstrable in the consciousness as laws of the subjective. Man finds himself in nature, and nature in himself. Besides Fichte's method, therefore, of descending from the ego, Schelling held it to be necessary to ascend from nature up to ego. The former method is given in his transcendental philosophy, the latter in the *nature-philosophy*, which make up his system of identity. The general principles of this system are as follows: — That true and perfect science, which it has always been the object of philosophy to realize, must be one which has its authority in itself, embraces all things, and is perfectly correspondent to its object; for truth is impossible without a perfect agreement of the knowing and the known. Now, as all philosophy must proceed on the assumption that the cognizant mind is capable of true cognition, it follows that the knowing subject cannot, in its essence, be opposed to the object known; and that, consequently, it must be possible to know the real essence of things. The essence, therefore, of that which thinks and that which exists, of thought and entity, soul and body, is one and the same. By means of this essential oneness, or, in the terminology of Schelling, of this absolute identity and indifference of thought and being, the ideal and real, and in consequence of the mind being, in substance at least, homogeneous with things without it, the former is capable of representing in cognition the latter, such as they are in truth and in their essence. The knowledge thus gained is a pure intellectual intuition; it is not mere reflection, which, by its nature, cannot go beyond its data. Rising above phenomena to the ideas of the absolute, which is their identical origin, it is able to apprehend the essence of things. However, it is by reflection that man becomes conscious of these ideas through the aid of the senses; and this art of unfolding ideas by reflection constitutes Dialectics. One of the duties of this art is to trace the identical principle in its regular development, and to determine every branch of knowledge, in relation not only to the fundamental idea of the truth, but also to the cognate sciences. The true method of philosophy is the method of construction, and without it no safe step can be taken in speculative science. This method is to become fully conscious of the laws of mind, which are inherent in it; and, agreeably to them, to shape every special science conformably to the existence of things. By such a method philosophical science is possible; and this is a science of the existent agreeably to the ideas (*Wissenschaft von ideen*); that is, a science of God, and of his relation to the world, and of man and nature. According to the *nature-philosophy*, the Absolute, or God, is both thought and entity, without either unity or difference, out of which all contrariety has proceeded, and into which it will again return. As the Absolute is the sole and eternal essence of all things, every true entity, and therefore nature also, is divine, without a participation in which there can be no existence. In the eternal generation of things, the Absolute has revealed itself in infinite ways in space and time. This revelation is a living development of the infinite according to certain contraries of the subjective and the objective, the ideal and the real. These contraries strive to combine together in different proportions, and so acquire different names, according to the varying preponderance or polarity of the ideal and real. Things, consequently, are not different in their essence, but merely quantitatively, or in degree. The preponderance of the objective constitutes unconscious nature; that of the subjective is spirit. The more complete the combination of these contraries, the more perfect are the objects. The most perfect union of them, or their absolute indifference, is found in the universe; and this complete identification and reunion of them is the full revelation of God. Man, lastly, is a copy of the universe (*microcosm*), in so far as, in a manner of his own, he unites together the ideal and the real.

The philosophy of Schelling appears, then, to be directly opposed to that of Kant, from which, however, it is directly descended, not only in the nature of the knowledge which it assumes to be possible, but also with respect to the objects of that knowledge. In its essence it pretends to give a true image of the object known, and embraces, therefore, both nature and the world of man and spirits. In its method of exposition, also, it pretends to imitate the true course of the development of nature, in which every thing passes by coherent and successive steps (or *powers*, A, A^1, A^2, &c.) from the undeveloped to the developed and the perfect; and, beginning from the lowest grades of entity, passes to its higher developments.

Such is an outline of the system of Identity, as propounded by Schelling upwards of thirty years ago, and which has exercised so important an influence on the mind of Germany. There is, however, good reason to believe that the opinions of its author have been materially modified in the interval; and though, influenced by some singular feeling of reserve, which may, in fact, be said to have characterized him throughout life, Schelling has hitherto refrained from embodying his *new* views in any distinct or tangible form, yet the unaccountable leniency with which he treats his opponents in the celebrated *Vorrede* to Beckers's translation of *Cousin's Vorrede*, and the covert but ill-concealed hostility therein displayed to some of the principles on which both his own system and that of Hegel are based (see *infra*), coupled with the (unacknowledged, it is true, but still sufficiently authentic) revelations of some of his most distinguished pupils, — all these circumstances have given rise to the supposition that the long silence which he has maintained towards the public will speedily be broken by a recantation of his *old*, and his avowal of a *new* system. This conjecture has been materially strengthened by his recent call to Berlin; and the rumours which have reached us of the nature of his lectures leave little doubt of the fact, though his present views have not been sufficiently developed to warrant us in hazarding an opinion respecting them.

A brief statement of the manner in which the theory of Schelling was further modified by Hegel may be well appended here, and will complete it as a general view of the modern philosophy in Germany. In the *Encyclopædia of Philosophical Sciences*, which Hegel published in 1817 at Berlin, and designed as a manual for the use of his class, he gives a general view of his system, and clearly exhibits its ultimate tendency. "Logic," he says, "is the basis of ontology." The idea in itself and potentially is the primary substance, but *in actu* it passes into the real. The ideal is to be examined, 1st, subjectively, as it exists in the mind; 2d, objectively, or in *other*, *i.e.* in its outward manifestation; and 3d, absolutely, as it is realized in art, religion, and philosophy. Schelling had made triplicity in unity to be the law which the principle of identity follows in its outward development, and this trinary law forms also a conspicuous element of the Hegelian system. Thus he makes thought to be threefold: 1. *Formal thought*, which is independent of all subject matter, or, in the language of Hegel, of *all contents;* 2. The *notion*, or thought more fully determined; 3. The *idea*, or thought in its totality and fully determined. The last is the concrete, which is a self-developing and organical system, containing in itself all *momenta* or germs of further development. Philosophy is the right evolution of this concrete, and its true method is the dialectical momentum. The history of philosophy, apart

from its accidental media of schools and professors, is nothing less than the actual development of philosophy itself. The several systems successively recorded are but so many gradations of progress, and the latest system is the sum and perfection of all anterior ones. Thus the theories of Schelling and Hegel are essentially based on the same principle; the absolute identity of thought and being. According to the former, the mind is in full possession both of truth and reality, the knowledge of which it attains by self-consciousness in the intellectual intuition. For the latter, Hegel substituted his *dialectical momentum*, or the logical development of the idea. Generally, Hegel stood in the same relation to Schelling as Wolff did to Leibnitz. The cold and rigorous formalism of Fichte was displaced by Schelling for a loose and illogical style of political enthusiasm. Hegel, however, rightly insisted on the necessity of a scientific and systematic form as an indispensable condition of an exact science of truth. (Michelet, *Geschichte der letzten Systeme der Philosophie in Deutschland;* Jacobi, *Briefe uber die Lehre des Spinosa;* Fichte, *Die Wissenschaftslehre ; Die Bestimmung der Menschen ;* Schelling, *System des transcendentalen Idealismus ; Bruno, Oder über die göttliche und natürliche Princip. der Dinge ;* Hegel, *Phenomenologie des Geistes ; Encyclopædie der Philosophischen Wissenschaften.* For some of the more recent views attributed to Schelling, see *Stahl's Philosophie des Rechts nach geschichtlicher Ansicht, &c. &c.*)

SCHEME. (Gr. σχημα.) A plan or representation of any geometrical or astronomical figure; a diagram.

SCHE'RIF. (Arab. *lord*, or *master*.) A title given in the East, by prescriptive usage, to those who descend from Mahomet through his son-in-law and daughter, Ali and Fatima. They are also called Emir and Seid, and have the privilege of wearing the green turban. (*See* EMIR.) The chiefs of Mecca and of Medina, who are always supposed to belong to this sacred family, are styled the scherifs of those cities.

SCHERO'MA. A dryness of the eye, arising from a deficiency in the secretion of the lachrymal glands.

SCHIAH. *See* SUNNIAH.

SCHILLER SPAR. (Germ. schillern, *to change colours.*) A mineral of a pearly lustre and changeable hues. Hornblend and Labradorite are varieties of it.

SCHI'RRUS. (Gr. σκιρρος.) An induration of a gland, forming an indolent tumour, not readily suppurating, and at first unattended by discoloration of the skin.

SCHISM. (Gr. σχιζω, *I cleave.*) Separation from the true church: of which, as of heresy, it may be said that Christians are not agreed whether the mere act constitutes the crime, or whether it is only a wilful and obstinate separation that deserves to be so denominated. The chief schisms enumerated by Roman Catholic authorities are those of the Novatians, the Donatists, the Luciferians, the Greek church, and the Protestants. The great schism of the West in the 14th century holds also an important place in the history of the Papacy. *See* ANTIPOPE.

SCHI'SMA. (Gr. σχισμα.) In Music, an interval equal to half a comma; therefore eighteen of them are required to make a complete tone.

SCHIST. (Gr. σχιστος.) A Geological term adopted from the German, and applied to the varieties of slate; hence also the term *schistose rocks*, applied to those which have a slaty texture. *See* GEOLOGY.

SCHI'ZOPODS. (Gr. σχιζω, *I divide*, and πους, *a foot.*) The tribe of long-tailed Decapod Crustaceans, including those which have the legs slender and filamentous, accompanied by an external articulated branch as long as the limbs, which thus appear doubled in number; fitted for swimming, and not cheliferous, the eggs being carried beneath them, and not under the tail. The opossum shrimps (*Mysis*) are examples of this tribe.

SCHO'LARSHIP. *See* BURSARS.

SCHOLA'STIC PHILOSOPHY. That method of philosophizing which arose in the schools and universities of what are commonly called the dark ages. The father of the schoolmen was John Scotus Erigena, a native of Ireland, who lived in the ninth century. He first introduced among his contemporaries, from what source is unknown, the philosophy of Aristotle, which he combined with the doctrine of the new Platonists, and out of the combination constructed a complete system of Pantheism. These speculations were at first regarded by the church with an evil eye; nor was it before the expiration of the following century that they were applied to the purpose of explaining and supporting the leading facts of Christianity. It was probably the necessity which was felt of combating heretics with their own weapons, that caused the universal adoption of the Aristotelian philosophy by the great religious authorities of the day. It is at any rate certain, that the subtlety and ingenuity of the early schoolmen were confined to the task of constructing a scientific basis for the doctrines of the church out of the materials afforded by that system. The scholastic philosophy may be said to have expired with the conclusion of the 14th century, at least as to its influence on the leading minds of the age. Four distinct periods have been observed in the course of its development; the first beginning with its earliest commencement, and including the names of Berengarius, and Archbishops Lanfranc, Anselm, and Hildebert. The second era commences with the rise of the sect of Nominalists, the founder of whom was Johannes Roscellinus, and their most distinguished member the celebrated Peter Abelard. The third period is marked by the introduction into Europe of the writings of the Arabian philosophers, and the translation into Latin of the versions of Aristotle's writings, with the complete ascendency of realism (which see), and the now undisputed supremacy of Aristotle. The greatest names in this period, which embraces nearly all the 13th century, are those of Albertus Magnus, Thomas Aquinas, and Duns Scotus, with the respective followers of the two latter, the Thomists and Scotists. The glaring realism of Scotus roused the independent spirit of an Englishman, William of Ockam, to a closer investigation of the internal conditions of thought, and in him led to what may be considered a transition state between the formation of the old schoolmen and the tendency towards nature and experience which distinguishes modern speculations. The acuteness of this man restored the victory to the Nominalists. His nominalism, however, differed from that of Roscellinus and Abelard in the admission that "universals" have a foundation of reality in the subjective conditions of the intellect, though not an outward nature; whereas, according to the former, a general term was a name only, — a "flatus vocis." An excellent account of the leading principles of the scholastic philosophy, and the mode of its combination with the Catholic doctrines, is to be found in Dr. Hampden's *Bampton Lectures* (Oxford, 1833). The learned author, however, does not sufficiently explain the points in which the scholastic notion of Aristotle's philosophy deviates from the genuine doctrines of that profound thinker, especially with regard to the doctrine of *emanation*, a purely oriental dogma, grafted on the Grecian philosophy of the new Platonists of the Latin empire. (See *Tennemann's Geschichte der Philosophie.*)

The scholastic theology, to adopt the definition of Mr. Hallam (*Introduction to the Literature of Europe in the* 15*th*, 16*th, and* 17*th Centuries*), was, "in its general principle, an alliance between faith and reason; an endeavour to arrange the orthodox system of the church, such as authority had made it, according to the rules and methods of the Aristotelian dialectics, and sometimes upon premises supplied by metaphysical reasoning." The scholastic philosophy, according to the same author, "seems chiefly to be distinguished from this theology by a larger infusion of metaphysical reasoning, or by its occasional inquiries into subjects not immediately related to revealed articles of faith. There can be no doubt that the sudden rise and expansion of the scholastic method was favourable to the growth of mental vigour and illumination; since it substituted rigid reasoning, although on premises for the most part fanciful, for that mere acquiescence in authority which had distinguished the theology and the scanty remnant of philosophy which subsisted in the ages immediately preceding. France, Germany, England, and at one period Spain, were the principal seats of the scholastic controversies: in Italy they had less influence. Our own island has indeed the honour of having produced an unusual proportion of the chief names in this department of literature. The best known among these are Duns Scotus, before mentioned; and William Ockam, one of the last of the distinguished schoolmen who flourished in the 14th century. In the 14th century, the dialectic method of the schools was applied by some learned legists to the science of jurisprudence. Bartolus and Baldus have the highest reputation among the scholastic jurists.

SCHO'LIASTS. (Gr. σχολη, *leisure.*) The name given to the old grammarians, or critics, who used to write annotations on the margin of the manuscripts of the classical authors of antiquity, called scholia; the fruits, as it were, of leisure.

SCHO'LIUM. (Lat.) In Geometry, an explanatory observation, or excursive remark, on the nature and application of a train of reasoning.

SCHOOLS, FREE AND ENDOWED. Free schools are such as afford a gratuitous, or nearly gratuitous education, to the children of the place, from whatever source the funds be derived; endowed schools, those of which the funds arise out of royal or private endowment. The greater portion of these, in England, are also grammar schools; viz. schools in which elementary education in the classical languages is afforded, according to the intentions of the founder. A few among these have acquired, in popular phraseology, the designation of public schools. Most of these schools were founded or endowed in the century and half following the Reformation. Nearly 500 are described by Mr. Carlisle in his work on these institutions.

SCHOOLS, INFANT, are said to owe their origin to

Mr. Robert Owen of New Lanark. They have now been in operation since the year 1820. Their number is roughly estimated at 150 in England, 70 in Scotland, and 50 in Ireland, each school having on an average about 100 scholars, generally between two and seven years of age.

SCHOOLS, NATIONAL. After public attention had been drawn to the advantages of Dr. Bell's system of mutual instruction in schools, chiefly through the activity of Mr. Lancaster, two societies were formed in England for carrying it into general operation. The British and Foreign School Society was founded by Dissenters in 1805; the National Society, by members of the establishment, a few years later. The instruction of the former, in religion, is confined to those points in which all are agreed; that of the latter is founded on the liturgy and catechism of the established church. The schools of these two societies are now extensively spread over the face of the kingdom. The education given by them is nearly gratuitous, but certain small payments are in some cases exacted. Mr. Hill, in his work on the state of education in England, estimates the children attending schools of the former union at 60,000 or 80,000, and those of the National Schools at about 170,000; but these calculations seem to be founded chiefly on probabilities. The same writer estimates the average length of education in these schools at about two years for each child. Reading, writing, and arithmetic, with religious knowledge according to the principles of the respective institutions, form the amount of education generally given; but in some schools geography, and even the elements of geometry, are taught; and attempts have been made to add instruction in various branches of manual industry. Each society has a model school, and establishment for training teachers. That of the British and Foreign is in the Borough Road: the principal one of the National in the Sanctuary, Westminster; but it has others in different places.

SCHOOLS, NORMAL. Schools for the education of persons intended to become schoolmasters, teachers, or professors in any line. Normal schools form a regular part of the establishments for education in many Continental states, especially in Germany. The normal school of Paris was suppressed in 1821, but revived a few years afterwards under the name of preparatory school, and has now (since the event of 1830) resumed its original title.

SCHOOLS OF ART. See these under the heads Dutch School, Flemish School, &c.

SCHOOLS, PUBLIC. This is a name of not very definite application, by which a certain number of schools are designated, conferring a classical education, having on the average a larger number of boys, and frequented by the children of persons of rank and wealth. The principal are, 1. The three colleges, two of royal and one of private foundation,—Eton, Winchester, and Westminster. 2. Some or all of the great metropolitan endowed schools, —Charter-House, St. Paul's, Merchant Tailors', Christ's Hospital (although the last is no longer frequented except by children of the less wealthy classes). 3. Certain endowed grammar-schools in the country, raised by fashion and old reputation to the rank of public,—Harrow. Rugby, Shrewsbury, and perhaps two or three more; but here the designation becomes extremely arbitrary.

SCHOOLS, SCOTTISH PAROCHIAL. In the reign of James IV. (1494), the Scottish legislature enacted that all barons and substantial freeholders should send their children to school from the age of six to nine years, and afterwards to the academical institutions. But it was not until 1615 that the foundations of the present system were laid by an act *empowering* the bishops, together with a majority of the landlords, or "heritors," to establish schools in every parish. In 1696, by another statute, the establishment of such schools was *directed*. The appointment of the schoolmaster was vested in the heritors and minister; the burden of the expense of erecting the school and a dwelling-house for the master, and paying to the latter a salary of not less than 5*l.* 11*s.* 1*d.* nor more than 11*l.* 2*s.* 2*d.* per ann., being supported by the former. The general supervision of the schools was intrusted to the presbyteries in which they were situated. Besides the salary (which has been raised to a maximum of 34*l.* 4*s.* 4½*d.*, and minimum of 25*l.* 13*s.* 3⅝*d.*), the master is supported by trifling fees from the scholars. Reading, writing, and arithmetic, some of the branches of practical mathematics in ordinary use, and even a slight amount of classical learning, have been usually taught in these parish schools. Such is a short outline of the system, of the results of which, in the general education and morality of the poorer classes, Scotland has been so justly proud.

SCHOOLS, SUNDAY. First set on foot by Mr. Robert Parkes of Gloucester. According to Mr. Hill, in his recent work on national education, the number of children at present frequenting Sunday schools varies from 800,000 to 900,000. The average length of a Sunday-school education he estimates at four years; the education given is almost uniformly confined to reading alone; but many Sunday schools appear to have evening schools connected with them, open two or three times a week, in which writing and arithmetic are taught.

SCHOO'NER. A small sharp-built vessel, with two masts of considerable length and rake, with small top-masts, and fore and aft sails. A schooner carries a square fore-top sail and topgallant sail.

SCHORL. (Swed. scorl, *brittle.*) A mineral usually occurring in black prismatic crystals; it is brittle, and has much lustre, and becomes electric by heat and friction. *See* Tourmaline.

SCIÆNOI'DS, *Sciænoides.* The name of a family of Acanthopterygian fishes, of which the genus *Sciæna* is the type. This family is nearly allied to the Percoids; but both the vomer and palatine bones are without teeth; the bones of the head are generally cavernous, and the muzzle more or less enlarged and obtuse.

SCIA'TICA. (Gr. *ισχιον, the hip.*) A rheumatic affection of the hip joint.

SCI'ENCE (Lat. scientia), in its most comprehensive sense, is applied to the knowledge of many, methodically digested and arranged so as to become attainable by one. The knowledge of reasons and their conclusions constitutes *abstract*, that of causes and effects and of the laws of nature *natural* science. The term science is, however, more particularly used in contradistinction to *art* and *literature*. As distinguished from the former, a *science* is "a body of truths, the common principles of which are supposed to be known and separated, so that the individual truths, even though some or all may be clear in themselves, have a guarantee that they could have been discovered and known, either with certainty or with such probability as the subject admits of, by other means than their own evidence." (*See* Art.) As distinguished from *literature*, science is applied to any branch of knowledge which is made the subject of investigation with a view to discover and apply first principles. (*See* Literature.) The various sciences will be found under their particular heads.

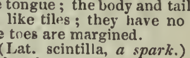
SCI'LLITIN. The bitter principle of the squill (the bulb of the *Scilla maritima*), to which its medical properties of an expectorant and diuretic are referable. It is a white substance, of a resinous appearance.

SCINCOI'DS, *Scincoides.* A family of Saurian reptiles, of which the genus *Scincus* is the type. They have short feet, a non-extensible tongue; the body and tail are covered with equal scales, like tiles; they have no impressed lateral line, and the toes are margined.

SCINTILLA'TION. (Lat. scintilla, *a spark.*) In Astronomy, the term applied to the *twinkling* or tremulous motion of the light of the larger fixed stars; by which they appear as if the rays of light coming from them were not continuous, but produced by particles succeeding each other at intervals with a sort of vibratory movement. The planets, excepting perhaps Venus sometimes, have not this twinkling appearance; and they are thus readily distinguished from stars of the first magnitude. It arises from the extreme smallness of the apparent diameters of the fixed stars, and depends in some measure on the state of the atmosphere. In countries where the atmosphere is very pure and dry, and at considerable altitudes, the scintillation is observed to be much diminished, and the stars shine with a steady clear light.

SCIO'GRAPHY. (Gr. *σκια, a shadow*, and *γραφω, I describe.*) In Painting, &c., the art of casting and delineating shadows with truth, and upon mathematical principles.

SCI'ON. (Lat. scindo, *I cut off.*) The first young shoot produced during the year by a tree; or, more commonly, a part of a branch prepared for the purpose of being grafted upon some other tree.

SCIO'LTO. (It. *free.*) In Music, a term which, applied to counterpoint, signifies that it is free from syncopated or tied notes, or that it is not constrained by general rules. When applied to notes, it signifies that they are not tied together 

SCIO'PTIC or SCIOPTRIC BALL. (Gr. *σκια, shadow*, and *οπτομαι, I view.*) A name sometimes given to a mechanical contrivance, used in the *camera obscura*, for the purpose of giving motion to a lens in every direction.

SCI'RE FA'CIAS, in Law, is a judicial writ, which lies in various cases; most commonly to call on a party to show cause to the court whence it issues why execution of judgment passed should not be made out. It is not granted until a year and a day after judgment given.

SCI'SSEL. The clippings of various metals produced in several mechanical operations concerned in their manufacture. The slips or plates of metal out of which circular blanks have been cut for the purpose of coinage are called scissel at the mint.

SCI'URINES, *Sciurini.* Squirrel tribe. The name of a family of Rodents, of which the genus *Sciurus* is the type. They are distinguished by their very narrow

lower incisors, and by their long and bushy tail. They have four toes before, and five behind. The thumb of the fore foot is sometimes marked by a tubercle. The molars are tuberculated.

SCLE'RODERMS, *Sclerodermi*. (Gr. σκληρος, *hard*, and δερμα, *skin*.) A name given by Cuvier to a family of Plectognathic fishes, comprehending those which have the skin covered with hard scales.

SCLERO'TICA. (Gr. σκληρος.) One of the membranes of the eye. *See* Eye.

SCOLOPA'CIDÆ. (Gr. σκολοπαξ, *a woodcock*.) Snipe tribe. The name of a family of wading birds, of which the genus *Scolopax* is the type. The snipes proper have a straight beak, the nasal furrows extending to near its point, which is a little inflated externally, so as to extend beyond the lower mandible. The point is soft, and very sensible.

SCOLOPE'NDRÆ. (Gr. σκολοπενδρα.) The generic name of the Centipedes.

SCO'MBEROIDS, *Scomberoides*. Mackerel tribe. The name of the family of fishes of which the genus *Scomber* is the type. They are characterized by having a smooth body covered with small scales, and a very powerful tail and caudal fin; and include species of the greatest utility to mankind, in consequence of their abundance and flavour.

SCO'NCES. In Fortification, small forts for the deence of a pass, river, or other place.

SCO'PA. (Lat. *a little brush*.) In Mammalogy, a fasciculus of long flaccid hairs, which may grow from any limited part of the body or extremities.

SCO'PIPEDS, *Scopipedes*. (Lat. scopæa, *a broom*, and pes, *a foot*.) The name of a tribe of Melliferous insects, including those which have the tarsi of the posterior feet furnished with a brush of hairs.

SCO'RPIO. In Astronomy, the eighth sign of the zodiac, and one of the ancient zodiacal constellations. When this constellation rises, Orion sets; hence the mythological fable of the death of Orion, who perished by the sting of a scorpion. *See* Constellation.

SCOT. (Sax. sceat, *part* or *portion*, in the sense of contribution.) This old word has passed into various ordinary expressions, such as "scot-free," &c., and at one time found its way into the Italian language (Dante, *Purgatorio*). In English law it is still retained in the phrase "inhabitants paying scot and lot," which has long been held to mean paying parochial rates, and constitutes one of the old rights of voting in various boroughs existing before the Reform Act.

SCO'TER. A name of the black duck, or black diver (*Anus nigra*, Linn.), now the type of the subgenus *Oidemia*, Flem.

SCO'TIA. (Gr. σκοτια, *darkness*.) In Architecture, the name of a hollow moulding, chiefly used between the tori in the bases of columns. It takes its name from the shadow formed by it, which seems to envelop it in darkness. It is sometimes called a casement; and often, from its resemblance to a common pulley, *trochilus*.

SCO'TISTS. An old scholastic sect, followers of Duns Scotus, "the subtle doctor," one of the leading champions of Realism in the 13th century. He held that the "universal" existed not "*in posse*" only, but "*in actu*;" not depending in anywise on the conditions of the understanding, but presented to it as an outward reality. In this respect his realism differs from that of his predecessor, Thomas Aquinas, whose doctrines he combats in other respects. *See* Thomists.

SCOTODI'NIA. (Gr. σκοτος, *darkness*, and δινος, *giddiness*.) Giddiness, with imperfect vision.

SCREEDS. (Etym. uncertain.) In Architecture, wooden rules for running mouldings. Also the extreme guides on the margins of walls and ceilings for floating to, by the aid of the rules. They are always necessary for running a cornice when the ceiling is not floated.

SCREEN. (Fr. escran.) In Architecture, a partition usually wrought with rich tracery, placed behind the high altar of a church, and also before small chapels and tombs. Sometimes, as at Easter, they are placed temporarily at the sides of choirs.

SCREW. In Mechanics, one of the six mechanical powers, consisting of a spiral ridge or groove, winding round a cylinder, so as to cut every line on the surface parallel to the axis at the same angle. The screw may be formed either on the outside or inside of the cylinder; in the former case, it is called the *exterior* or *male* screw; in the latter, the *interior* or *female* screw. The action of the screw resembles that of the wedge, or inclined plane; but as the cylinder has always a handle attached to it, the screw is in reality a compound of the inclined plane and lever; and if the direction of the power be parallel to the base of the cylinder, and perpendicular to its radius, an equilibrium is produced when the power is to the resistance or pressure as the interval between the adjacent threads is to the circumference described by the point to which the power is applied. Hence the mechanical advantage afforded by the screw is proportional jointly to the fineness of the threads and the smallness of the cylinder relatively to the length of the lever or handle. It is to be observed, however, that by diminishing the distance between the threads, or diminishing the diameter of the cylinder, we diminish also, in both cases, the strength of the screw; and hence there is obviously a limit to the increase of power. But the action is greatly increased by means of the contrivance called a *double screw*, or, from the name of its inventor, *Hunter's screw*, which consists in the combination of two screws of unequal fineness of thread, one of which works within the other. In this case the power does not depend upon the interval between the threads of either screw, but on the difference between the intervals in the two screws, and may be increased to almost any extent.

The *endless screw* consists of a screw combined with a wheel and axle in such a manner that the threads of the screw work into the teeth fixed on the periphery of the wheel. Suppose the power applied to the handle of the screw, and the weight attached to the axle of the wheel, then there will be equilibrium when the power is to the weight as the distance between the threads multiplied by the radius of the axle is to the length of the lever, or handle, multiplied by the radius of the wheel.

The *water screw*, or *screw of Archimedes*, is formed by winding a flexible tube round a cylinder in the form of a screw. If the machine, thus constructed, be placed obliquely, so as to make with the vertical an angle equal to that which the spiral makes with the lines parallel to the axis of the cylinder, there will be in each convolution of the spiral a part parallel to the horizon. If any body, then, be placed within the spiral at this part, it will remain at rest; and if the screw be turned the body will ascend, because the part of the screw behind it becomes more inclined than the part before it, and it is consequently urged forward. This simple but ingenious contrivance is usually employed for the purpose of raising water to a small height, but it may be employed to raise any substance that can pass within the tube; and it is evident that the action may be increased by placing several tubes or spiral channels (for they may be formed of wood or iron) on the same cylinder. The principle has been recently applied to the propelling of steam-vessels.

The *micrometer screw* is a contrivance adapted to astronomical or optical instruments, for the purpose of measuring angles with great exactness. The very great space through which the lever of the screw passes in comparison of that which is described by the cylinder in the direction of its length, renders the screw of immense use in subdividing space into minute parts.

As a mechanical power, the screw has innumerable applications; but it is employed with most effect in all cases in which a very great pressure is required to be exerted within a small space, and without intermission. Hence it is the power generally used for expressing juices from solid substances, for compressing cotton and other goods into hard dense masses for the convenience of carriage, for coining, stamping, printing, &c.

SCRIBES. The copyists, and at the same time the interpreters of the law, in the later periods of the Jewish history. They were held in great honour among that people, and ranked with the priests themselves in their estimation. In the New Testament, we find them generally referred to in connection with the Pharisees, to which sect they appear generally to have belonged, and with whom they coincided in temper and sentiments. Some ancient writers conceive the scribes to have formed peculiar sects in themselves; but there is no authority for this opinion.

SCRI'BING. (Lat. scribo, *I write or scratch*.) In Architecture, fitting the edge of a board to another board in the same plane as the edge. In joiner's work, it is the fitting one piece of wood to another so that their fibres may be respectively at right angles.

SCRI'PTURES. The Holy Scriptures, or writings of the Old and New Testament. The Canonical Scriptures, which, having been duly authenticated, are inserted in the canon or rule by which the faith of a believer is determined. *See* Bible, New Testament, Old Testament.

SCRI'VENER. (From the Lat. scribo, *I write*; apparently through the Spanish escribano.) Money scriveners, in old English usage, were parties who received money to place it out at interest, and supplied parties who wished to lend money on security. Money brokers and attorneys who practise in this manner have been held to be within the statutes relating to scriveners. In this sense, the word is obsolete. The last regular scrivener is said to have been a person of the name of Jack Ellis, a cotemporary of Dr. Johnson, mentioned in *Boswell's Life*. The city company of scriveners remains to attest the ancient importance of the business.

SCRO'FULA. This disease was originally termed χοιρας, or *swine disease*, by the Greeks; and later nosologists have translated it by the term scrofula. It consists in indurated glandular tumours, especially about the neck, which, when they suppurate, discharge a white curdled matter, unlike healthy pus. Scrofula is not con-

tagious, but often an hereditary disease, and dependent upon a peculiar predisposition in the constitution: its first appearance is usually between the third and seventh years of the child's age, and it seldom shows itself after the age of puberty. It is most common among delicate children with fair complexions, and those disposed to rickets. It is rare in warm climates, and seems to be favoured by cold and variable countries. It is promoted by every thing that debilitates; and when its exciting causes are by any accident not brought into action, it may even remain dormant through life, and not show itself till the next generation. In mild cases the glands, after having suppurated, slowly heal; in others the eyes and eyelids are inflamed, and the joints become affected, the disease gradually extending to the ligaments and bones, and producing a hectic and debilitated state, under which the patient sinks; or it ends in tuberculated lungs and pulmonary consumption. In the treatment of the mild and simpler forms of scrofula, the diet should be nourishing and invigorating, and a dry situation and sea air are to be sought for; great attention should be paid to the clothing, so as to avoid colds and coughs; and tonics and gentle stimulants, with mild narcotics, and occasionally the alkalis, should be prescribed. Iodine has sometimes appeared of much service, but it requires the greatest circumspection in its internal use; it may be applied externally, as may also sea water and other saline lotions. Chalybeates and mercurials are frequently prescribed; and much benefit has, in some instances, been derived from a course of sarsaparilla.

SCROPHULARIA'CEÆ. (Scrophularia, one of the genera.) A natural order of herbaceous or shrubby monopetalous Exogens, inhabiting all parts of the world, except the coldest. The stamens are either didynamous or unsymmetrical; nevertheless, the affinity of the order is undoubtedly with *Solanaceæ*, through the medium of the tribe *Salpiglossideæ;* so that it becomes necessary to separate them by a mere artificial distinction, considering as *Solanaceæ* such genera as have a plaited corolla and five stamens, and as *Scrophulariaceæ* all those in which the fifth stamen is wanting, or the æstivation of the corolla imbricated. They are generally acrid, bitterish plants. The leaves of some are purgative, and even emetic, a property so much increased in digitalis that its effects become highly dangerous; and nearly all the tribe turn black in drying. Many of the genera, such as digitalis, calceolaria, &c., are valued by gardeners for their beautiful flowers.

SCRU'PLE. A denomination of weight; the third part of a dram, and equal to twenty grains. *See* WEIGHTS.

SCRU'TINY. (Lat. scrutor, *I examine.*) In the Primitive Church, an examination in the last week of Lent of the catechumens who were to be baptized on Easter-day; used chiefly in the ancient church of Rome. In parliamentary language, an examination of the votes given at an election by an election committee, at which the bad given on both sides are rejected, and the poll corrected accordingly, is called a *scrutiny*.

SCUD. The name given by seamen to loose vapoury clouds driven swiftly along by the winds. *To Scud*, signifies to run directly before the wind in a gale. As the object is to keep before the sea, the fore sail or foretop sail is set: the latter or the maintop sail is often necessary, as the fore sail is often becalmed from the height of the waves.

SCU'DO. *See* MONEY.

SCULL. An oar, so short that one man can work a pair. It most generally implies an oar placed over the stern of a boat, and worked from side to side; the blade, which is turned diagonally, being always in the water. In China, where the method is well understood, large boats are impelled by a single scull with considerable velocity.

SCU'LPTURE. (Lat. sculpo, *I carve.*) The art of carving in wood, stone, or other materials. The origin of sculpture is so remote, that at this period there neither exists the probability of any authentic account of it being satisfactorily deduced, nor even the indication of that nation in which it first appeared. Though idolatry may have favoured its early advances, and rendered it powerful assistance, we are not indebted to religion alone for its invention. In Egypt, indeed, it may be said that its progress was impeded by the restraints and shackles with which religion invested it. "The monstrous shapes and sorceries" of "fanatic Egypt" clearly barred its perfection in the country, where a bird's head was combined with the body of a lion, and cats' and wolves' heads were joined to the divine form of man. It was in Greece only that the unnatural junction of the two noblest animals was successful, and grace and dignity resulted from the attempt in creation of a centaur. The first artist on record as a sculptor is Bezaleel, who, with Aholiab (see Exodus, xxxi.), formed the cherubim that covered the mercy-seat; but, previous to these, the art of moulding and working in metal was long known. The presents to Rebekah consisted of jewels of silver and gold; Judah gave to Tamar his signet and his bracelets; in Egypt "Pharaoh took off his ring from his hand, and put it upon Joseph's hand." Then, as to the art of moulding or carving, from the use of idols, we know it must have existed in Asia, and in Egypt from the time of Abraham and Jacob. The *teraphim*, which Rachael stole from her father (Gen. xxxi. v. 19. 30.), were, according to the best commentators, carved images in a human form, and household deities, like the penates and lares of the Romans many centuries afterwards. The commandment will doubtless occur to the reader, "Thou shalt not make to thyself any graven image;" as well as the address of Moses to the Israelites, "For ye know how we have dwelt in the land of Egypt, and how we came through the nations which ye passed by; and ye have seen their abominations, and their idols of wood and stone, silver and gold, which were among them."

Some of the most extraordinary specimens of early sculpture on record are described by Diodorus as the works of Semiramis; but they are too wonderful to allow of our implicit reliance on the author. She is said to have had representations in brick on her palace of every sort of animal in relief. These were afterwards so coloured to nature as to have the appearance of life. In the midst of them was represented Semiramis piercing a tiger with a dart, and near her Ninus killing a lion with his lance. In another part of the same palace were placed the statue of Jupiter Belus, those of Ninus, Semiramis, and the principal officers of the state, the whole executed in bronze. We are also told that, by command of this princess, a temple was raised at Babylon, on the top whereof three massive statues were placed of Jupiter, Juno, and Rhea. That of Jupiter was forty feet in height. Stupendous as these works are stated to have been, we gather from the same author an account of the execution of one which throws them into insignificance. One of the sides of the mountain Bagistan was extremely rough and steep, and seventeen stadia in height; this she caused to be reduced to a smooth surface, and then sculptured into a figure of herself, attended by one hundred of her guards. It is to be observed that Diodorus relates this story on the authority of Ctesias. Doubtful as it is, the same sort of scheme was proposed to Alexander by the architect Dinocrates, as related by Vitruvius in the preface to one of his books.

Of the sculpture of the Persians little notice is necessary. In the article PAINTING we have mentioned that it was contrary to the tenets of their religion to make in any way representations of the human form. In Persepolis there are, however, some extraordinary sculptures, bearing considerable resemblance to the style of the Egyptian bassi-relievi in the palace of Thebes, allowing for the difference of dress; but they contain nothing in science or imitation particularly worthy of our notice. The earliest sculpture to which we can refer, and on which we can reason, is that of the Egyptians. Herodotus tells us, that they erected the first altars and temples to the gods, and carved the figures of animals in stone. The abundance and variety of the specimens still in existence of their sculpture, minute and colossal, domestic and religious, prove them to have been a nation with prodigious resources, and distinguished for their wisdom and affection for the arts. The greater portion of their sculpture seems to have been sacred; that is, representations of the divinities, and their attributes and qualities. In respect of the dimensions of some of their statues, Herodotus mentions one before the temple of Vulcan at Memphis, and another at Sais, placed there by king Amasis, each of the height of seventy-five feet. The part of the sphinx, near the great pyramid, still out of the sand, that is, from the throat upwards, rises to the height of twenty-five feet. At Thebes the sitting statues of Memnon, the mother and the sons of Osymandyas, are each fifty-eight feet high. A long catalogue might be added to these: we will, however, only add, that in the British Museum is a closed hand, which must have been part of a statue sixty-five feet high. Grace of form, elegance, and symmetry, are not to be found in Egyptian sculpture. The faces of their statues have a resemblance to the Chinese, and their bodies are formed with large bellies. They generally stand equally poised on both legs, having one foot advanced; the arms either hanging down straight on each side, or if one be raised, it is at a right angle across the body. Some of their statues are seated, and some are kneeling; the position, however, of the hands is rarely different from what we have described. The faces of them are generally flat; the brows, eyelids, and mouths formed of simple curves slightly marked, and with little expression. The tunics and draperies are frequently without folds.

The arts of Egypt seem to have been in a progressive state of improvement from about or before the period of Moses to the invasion and subjugation of the country by Cambyses, a thousand years afterwards. Winckelman thinks that there were two distinct styles; the first ending with the conquest just mentioned, and the second commencing at that period, and ending after the time of Alexander the Great. In the first of these styles he de-

scribes the forms as straight, stiff, and ungraceful. The sitting figures have the legs always parallel; the feet are squeezed together, and the arms fixed to the sides. In the females the left arm is generally folded across the breast, and the draperies exhibit very little skill or knowledge. In the second style the hands become more elegant; the feet are placed at a greater distance from each other, the arms hang more freely, and the figure is generally clothed with a tunic robe and mantle. The material usually employed is granite or basalt: the statues are not only formed with the chisel, but polished carefully; and the eyes are sometimes formed of different materials from the statues themselves. Small figures are frequently found, to which the name of penates has been given; they are sometimes composed of wood, sometimes of baked earth, and some are covered with a green enamel.

"Winckelman," says Flaxman in his Second Lecture on Sculpture, "has remarked that the Egyptians executed quadrupeds better than the human figure; for which he gives the two following reasons: first, that as professions in that country were hereditary, genius must have been wanting to represent the human form in perfection; secondly, that the superstitious reverence for the works of their ancestors prevented improvement. This is an amusing but needless hypothesis; for there are statues in the Capitoline Museum with as great a breadth, and choice of grand parts, proper to the human form, as ever they represented in their lions or other inferior animals. In addition to these observations on Egyptian statues, we may remark, the forms of their hands and feet are gross; they have no anatomical detail of parts, and are totally deficient in the grace of motion. This last defect, in all probability, was not the consequence of a superstitious determination to persist in the practice of their ancestors; it is accounted for in another and better way." This "better way" of the professor is from their being deficient at the time in geometry, which, *he* says, "will naturally account for that of motion in their statues and relievos, which can only be obtained by a careful observation *assisted by geometry*." We confess we are not convinced with the reason given; and with all respect for the splendid talents of the professor, whose own knowledge of geometry, from his curious definition of the centre of gravity in the human figure, we apprehend to have been exceedingly limited, we rather prefer the hypothesis of Winckelman. The Egyptian bassi-relievi are usually sunk from the surface of the material employed, which practice most probably obtained from their being cut in very hard stone, such as granite or basalt, and from the distance they were usually placed above the eye. In the first case, cutting the ground away from the figure would have occupied quite as much time as carving the figure itself; and in the second case, the range of the outline created a greater breadth of shadow and distinctness to the spectator. These bassi-relievi, or hieroglyphics, when found on the walls of tombs, relate the profession, actions, and funeral of the deceased; on those of palaces, the wars, negotiations, triumphs, processions, trophies, with the civil, military, and domestic employments of kings; on those of temples they were the records of theology; and on obelisks they are hymns to the gods, or eulogies of their kings.

The only correct notions that can be obtained on the subject of Phœnician sculpture is from a contemplation of the medals of the Carthaginians, who were a colony from Phœnicia; though perhaps these may mislead us. The Phœnicians, known by the name of Canaanites in Scripture, were at a very early period advanced in civilization. When Moses sent out the spies to search the land of Canaan, they returned with an account, "that the people be strong that dwell in the land, and the cities are walled and very great." It was from Chaldea, according to the authorities cited by Jacob Bryant, that the arts of the Phœnicians were derived having first been transplanted to Egypt. Beautiful in their own persons, they were, unlike the Egyptian races, themselves models for their artists, and their situation and character were favourable to the progress of the art. Their extraordinary and successful spirit of commerce led to its cultivation, and some of the statues that decorated their temples were celebrated in history. Winckelman is of opinion that the Etrurians, or ancient Tuscans, carried sculpture to a certain degree of perfection much earlier than the Greeks. The same Dædalus who has the reputation of having taught this art to the Greeks, has a similar good office assigned to him by historians towards the Etrurians; for, in order to escape the resentment of Minos king of Crete, he is reported to have taken refuge in Sicily, whence he passed over into Italy. Etrurian art proves that the first attempts towards sculpture were in clay, whereof innumerable specimens have been found in Rome and its environs; and as the Romans in the early period of their existence as a people were entirely ignorant of the arts, no doubt is left of these specimens being the work of the Etrurians or Volscians. Clay was for a long time the only material used — "nulla signa, statuæve, sine argillâ;" and Pliny and Varro tell us that the Hercules, the Jupiter Capitolinus, the quadriga on the top of his temple, and all the other statues of the gods before the temple of Ceres was erected, were "Tuscanica omnia." Many of the Etruscan statues bear so striking a resemblance to those of Greece, that antiquarians have thought it probable they must have been brought from that country, or from Magna Græcia into Etruria, about the period of the conquest of Greece by the Romans, when Italy became almost saturated with the magnificent spoils of art which that country yielded. The Etruscan sculpture is in two distinct styles of art. In the first or earliest style, the general lines, or contours, are exceedingly stiff and straight, and the attitudes exhibit any thing but a feeling of ease in the figure: the form of the head is entirely devoid of beauty, the outlines not well rounded; their figures are almost invariably too slender; the form of the head is oval, the chin piked, the eyes flat, with some degree of tendency towards squinting. All these defects indicate an infant state of the art, and it is not extraordinary to see the very same defects in the works of the Gothic sculptors. The second style of Etruscan art is conjectured by Winckelman to be contemporary with the age of Phidias; but it is to be observed that this conjecture is in no way borne out or supported by proof. In this style the joints are strongly marked, the muscles raised, the bones perfectly distinguishable, and considerable knowledge of the science of anatomy is displayed. The statues of the gods are executed with delicacy, and there is a show of great power without violent distension of the muscles. The attitudes, however, are far from natural, and the action constantly overstrained. To this Millin adds a third period in the history of Etruscan art, commencing at the conquest of Greece by the Romans, at which time the Etruscan artists became acquainted with the works of the Grecians, and, adopting their style, became at first their imitators, and afterwards their rivals. To the Italian artists of this period Horace is supposed to allude in one of his satires. In concluding this succinct account of the sculptures of Etruria, to exhibit the extent to which it was cultivated it is only necessary to state, on the authority of Pliny, that when the Romans conquered Volsinium, one of the twelve cities of Etruria, they carried away from that city alone about 2000 statues.

Before turning to the sculpture of the Greeks we may notice, as bearing some resemblance to the Egyptian sculpture, that of the Hindus. It is not, however, intended to compare the one with the other; for the latter is far more deficient than the former, both in science and resemblance to nature. The stupendous excavations at Ellora, which have been mentioned in the article ARCHITECTURE, and those at Elephantis and other parts of India, are well known by representations which have been published in this country. They are by some considered of very high antiquity, and are decorated profusely with mythological sculpture, whereof the subjects are symbols, allegorical figures, and groups expressive of the attributes and energies of divinity, according to the Brahmin doctrines. The reader who is desirous of further information on this subject may profitably consult *Moore's Hindu Pantheon*, which contains upwards of 1500 outlines of Hindu painting and sculpture faithfully delineated from the originals.

As we have seen, the first dawn of the art was on the soil of Phœnicia and Egypt: we have now to trace it to its meridian splendour on the shores of Greece. In Egypt the forms of the human figure, and its "face divine," far removed from beauty and intellectual expression, a burning climate, and institutions inimical to improving on the model, restrained the art within very narrow bounds; whereas in Greece the beautiful forms of the male and female models, the genial and delicious climate, were among the leading physical causes of the supereminent success of the Greeks. With them, says D'Agincourt, "au lieu de noirs scarabées, du chacal, ou de la hyène féroce, du hideux crocodile, c'étaient les diligentes ouvrières du mont Hymette, le noble coursier, le taureau vigoureux, le cerf agile, l'élégant et doux chevreuil, qui peuplaient les rives émaillées de ses fleuves, ses riantes collines, ses forêts ombragées." With them, unlike the attachment to the combinations of human with the brutal forms of Egypt, the softest desires, the noblest and liveliest emotions of the heart, found continual nourishment in the splendid and affecting spectacles which the religion of the nation constantly exhibited. The institution of public games, at which all men of consideration and celebrity, and of whatever rank, contended for honours, and the beauty of form to be seen at them, which was an unceasing object of contemplation, raised them into a nation of connoisseurs. No crowns, no honours decreed by a congregated assemblage of intelligence, awaited the monotonous labours of the Egyptian sculptor: his works were to be executed in conformity with the practice of former ages. Egypt abounded with artisans, Greece with artists.

Greek sculpture has usually been arranged under three epochs, which we shall here enumerate. We of course pass over the rude and unfashioned representations of the

divinities of the primitive ages, which Pausanias tells us were little more than blocks of stone, though regarded to the last with the greatest reverence, and to be seen as late as the time of Adrian at Thebes, Argos, and other cities; and which, indeed, were rather symbols than representations. Neither do we think it here necessary again to touch upon the works of Dædalus and Endæus, about which we can now form no just conception, except that the material they employed was wood. About 775 B.C., Dipœnis and Scyllis the Cretan became celebrated for their marble statues, which retained much of the ancient style in the advancing position of the legs, the general form of the figure, and particularly in the vertical folds of drapery, whose edges were zigzag. Soon after this period sculpture received the most elaborate finishing, though the character of the face and limbs was not much changed from the tasteless and barbarous style of former times. Flaxman conjectures that the colossal busts of Hercules and Apollo in the British Museum may have been the works of Dipœnis and Scyllis. It is not difficult to conceive the progressive improvement in an art so much cultivated, between the time of which we are now speaking and the first epoch in which Ageladas, the master of Polycletus, appeared. Ageladas, with whom has been confounded Eladas or Geladas, the master of Phidias, was a native of Argos, and cotemporary with Pisistratus. It was at this period that art approached the personification of ideal beauty by the choice of forms from many models, so that the excellence found in each might be combined in one. Its cultivation had become an object of necessity in most of the Grecian states, induced greatly by a practice introduced about this era, of honouring with a statue every individual who had received three crowns in the public games. Such a custom afforded the artist the opportunity of contemplating some of the most perfect examples of living beauty, from which were afterwards deduced those canons of proportion on which all future art has been unable to improve. Within the interval of which we have just spoken appeared the sculptor Callimachus, to whom Vitruvius assigns the merit of having invented the Corinthian capital. (*See* ARCHITECTURE.) "The better drawing of the figure, with a more careful attention to its parts, more precision and variety of attitude, a less elaborate curling and dressing the hair, the form of the figure better shown through the drapery, are all certain signs of a near approach to the age of Phidias."

The second epoch of sculpture among the Greeks was in the age of Phidias, who flourished about 490 years before the Christian era,—a period peculiarly splendid in history, as abounding with statesmen, warriors, artists, philosophers, and poets; among whom will doubtless occur to the reader the names of Socrates, Plato, Pericles, Miltiades, Cimon, Themistocles, and Xenophon. The emulation among such rare talents as then appeared was highly favourable to the growth and perfection of genius. Athens, destroyed by the army of Xerxes, rose under the auspices of Pericles in renewed and far greater grandeur. Phidias, the pupil of Eladas the Argive, though by some it is thought that honour belongs to Hippias, was employed by Pericles in the superintendence of the public works; and the admiration of his powers was so universal with the ancients, that Quintilian says, speaking of his Athenian Minerva and Olympian Jupiter at Elis, "Cujus pulchritudo adjecisse aliquid etiam receptæ religioni videtur, adeo majestas operis deum æquavit." Plutarch affirms that Callicrates and Ictinus executed the work of the Parthenon; and this, as far as relates to the latter, is confirmed by Pausanias. The statue, however, of Minerva, of ivory and gold, within the temple, was the work of Phidias himself; and, excepting his Jupiter at Elis, his most celebrated production, some have doubted that Phidias himself ever worked in marble; but although his chief material was bronze when he did not use ivory, it is certain that he occasionally wrought in marble. The great reputation of Phidias was founded upon his representations of the gods, excelling more in them than in human forms; and in his works in ivory it is said he was unrivalled. Polycletus, the scholar of Ageladas above mentioned, and cotemporary of Phidias, assisted in the perfection of style of the second epoch. He was of Sicyon, and especially celebrated for his Doryphoros, or lance-bearer, and his Diadumenus, or youth binding a fillet round his head. The first was so esteemed by artists, that it was called the "canon," from which they studied their proportions. There is, however, some doubt whether it be this or another statue to which this honour was paid. The cotemporaries of these great men were Callon, Phragmon, Gorgias, Lacon, Myron, Pythagoras, Scopas, and Perelius. In a passage of Pliny, Alcamenes is classed with Critias, Nestocles, and Hegias, who are called the rivals of Phidias. The name of Colotes is preserved as another of his scholars.

The third epoch is that in which we become acquainted with the names of Praxiteles and Lysippus, and in which what Winckelman calls the *fine style* was introduced. The graces of youth and beauty were the delight of Praxiteles; and in his marble statues at the Ceramicus of Athens, he is said to have excelled himself. His Venus of Cnidos was so endowed with charms, that her suitors were seaborne from all quarters to pay homage at her shrine. This statue, which had been rejected by the Coans on account of its being naked, was refused to Nicomedes by the citizens of Cnidos in payment of a debt of immense amount. It remained at Cnidos in the time of the Emperor Arcadius, about 400 A.D. Flaxman in his Lectures observes of it, that it "seems to offer the first idea of the Venus de Medicis, which is likely to be the repetition of another Venus, the work of this artist." A satyr, Cupid, Apollo (the lizard-catcher), and Bacchus leaning on a fawn, are known works of this master. Cotemporary with Praxiteles was Lysippus, so celebrated for the group of horses still to be seen in the front of St. Mark's church at Venice. This epoch, though that which Winckelman calls of the fine style, is not in grandeur comparable to its predecessor. The refinement of art was carried almost to its utmost limit: greater delicacy and voluptuousness may indeed have been and was introduced into the female forms, but in dignity and simplicity of feeling it is inferior to the extraordinary productions of the age of Phidias. After this period several of the finest groups and statues were nevertheless executed: one of them, the Laocoon (*see* LAOCOON), is in a very high class of art, and perhaps not inferior to any group known. The principal schools of sculpture were Athens and Rhodes; from which latter school came the Laocoon, the Torso Farnese, and the Colossus. To what extent the Rhodians were sculptors may be conjectured from the circumstance of the Romans carrying off from this little island 3000 statues. After the death of Alexander the Great, 324 years before Christ, the arts of design seem to have declined from their meridian excellence. Apelles found an asylum in Egypt with Ptolemy, a prince whose liberality induced artists to repair to his dominions, and whose example in this respect was followed by his successor; but under the detestable tyranny of the seventh of that dynasty, the artists abandoned Alexandria altogether. The alternate favour and disgrace which they experienced under the kings of Syria, and those of Bithynia and Pergamus, was repeated in Sicily under Agathocles and Hiero II., till the taking (212 B.C.) of Syracuse by Marcellus, who was the first to appreciate Greek statues as invaluable ornaments to the "eternal city."

At the conclusion of the Macedonian war, 500 marble and bronze statues graced the triumph of the conquerors. Mummius and Scylla left no place unstripped of all in the shape of art upon which they could lay their hands; and within a very comparatively circumscribed period Rome became the rendezvous of all artists who had any pretensions to talent, for it was the only place in which they could obtain employment.

The Romans had no natural taste in the fine arts, nor any style of their own originally; and down to a late period they employed the Etrurians in all works of art. Tibullus characterized the art in its early age by the line,

Stabat in exigua ligneus æde deus;

and even to its last hour it may be truly averred that sculpture never shone in Rome except with a borrowed light. Volsinium, one of the twelve cities of Etruria (the modern Bolsena), was called the city of artists; and it was this depôt which for a long time supplied the Romans with architects, painters, and sculptors, and taught the Romans at an early period what little they knew of art. Before the 5th century of its existence the use of marble was scarcely known in Rome; but in the 6th, the Romans began to spread themselves towards the regions inhabited by Grecians, and imbibed a taste for the expensive materials used by that nation.

The year 146 B.C. was signalized by the entire reduction of Greece under the dominion of the Romans. Sixty-six years previously a dawn of luxury and taste had opened at Rome by the introduction, through Marcellus, of statues from Syracuse; but though the increasing luxury of the Romans created a constant demand for fresh objects of the art, its history in the city is but a melancholy continuing decline of it, its energies and beauties being destined to expire among the people of a strange land. The only occupation then left for Greek artists was to be found in Rome, whither they were invited, and where abundance of them were to be seen. Among them Pliny (l. xxxv. c. 12. and xxxvi. c. 5.) mentions the name of Pasiteles, a sculptor, who wrote five volumes, containing a catalogue raisonnée of the finest works of art known in his time. Pasiteles excelled as a modeller in metal. The silver statue he executed of Roscius, as also his vases, were highly celebrated. Archesilaus, Topirus, and Evander, all Athenians, were among his cotemporaries in the Augustan age. The first of these who excelled in marble is extolled by Pliny for his care in modelling before he began upon the block. He was the friend of Lucullus, for whom he executed a group,

described by Varro, representing a lioness with cupids sporting round her, and endeavouring to force her to drink. Still, however, the passion for ancient Greek statues prevailed with the Romans. Martial says, in speaking of a statue of Hercules,

Non est farina recens, nec nostri gloria cœli:
Nobilis Lysippi munus, opusque vides.—(Lib. ix. Ep. 45.)

Under Augustus the art had not been entirely divested of grand and noble feeling; but after his time it partook very much of the character of his successors as they appeared. Licentious and obscene under the sway of the vicious, debauched, and cruel Tiberius; under Caligula it became so grossly flattering, that ancient Greek statues of the gods were decapitated to make room for the head of this emperor. Under Nero (to whom, however, we perhaps are indebted for the preservation of the Apollo of the Vatican and the Borghese gladiator, which were found in his villa at Antium) it became so outré and extravagant, that some of the statues of Lysippus were actually gilt. It has been conjectured that the Apollo and gladiator above mentioned were part of the spoils from the temple at Delphi. The reigns of the three emperors that succeeded Nero were of such short duration, that had they been so minded they had not sufficient time to inflict any very serious injury on the arts. Vespasian, whose only blemish was avarice, which is even extenuated by the laudable and patriotic use he made of his revenues, cultivated the arts as well as literature. The Temple of Peace, which was really a temple of the arts, was by him decorated with the choicest specimens of Greek painting and sculpture. The reigns of his son Titus and of Trajan were also favourable to sculpture. The latter was the patron of Apollodorus, from whose hand is the sculpture on the column that bears the emperor's name and records his military exploits. Trajan, moreover, had the liberality and good sense to erect statues in honour of the eminent men of his time. The works of this period were, however, rather architectural than sculptural, such as temples, palaces, triumphal arches, &c., and the sculpture chiefly in request was for their decoration; a want certainly not calculated to retrieve the art from its sinking state, but rather to encourage bold and offhand execution at the expense of simplicity and expression. Adrian was so great a lover of the arts, that he did not think it beneath his character as emperor himself to exercise those of painting and sculpture for his amusement. He not only restored the principal buildings at Athens, but extended his fostering care to the temple of Jupiter at Olympia, where he caused to be erected a colossal statue of the god in gold and ivory. The statue of Antinous, so generally known, was the work of this reign. Antoninus and Marcus Aurelius were appointed by Hadrian as his successors; under them the art revived for a time, and has acknowledged her gratitude to the last by his bronze statue at the Capitol. The former crowded with the choicest specimens of sculpture he could procure his villa at Lanuvium. How sculpture was encouraged at this time may be gathered from the innumerable busts of these emperors that have reached us. Commodus had likewise been honoured with a multitude of statues, but these upon his death were decreed by the senate to be all destroyed. Only thirteen years afterwards, under Septimius Severus, the decay of the art became very manifest: its decline continued during the reign of Alexander Severus, though two busts of him, which were discovered a few years since, are not without merit. During the next half century, the rapid succession of twenty emperors, scarcely one of whom died a natural death, gave to sculpture little chance of a revival. In fact, by the end of the 4th century it was extinct; of which no other proof is necessary than the arch of Constantine and the statues of that prince, through whose removal of the capital of the empire to Constantinople Rome no longer swayed the sceptre of the fine arts. If the Romans do not deserve the admiration in which the Greeks are held for their knowledge of the fine arts, they deserve our gratitude for their instrumentality in preserving some of the noblest productions of the art of sculpture. There are two epochs under which the taste of the Romans for the fine arts may be classed: the first beginning with the capture of Syracuse by Marcellus, and ending at the time of Julius Cæsar; the second, that of the Augustan age, in which all the polite arts flourished.

From the 4th to the 13th century, if there were materials sufficiently authentic, the history of the arts, as we have shown also in the articles ARCHITECTURE and PAINTING, is such a blank as to be scarcely worth the trouble of tracing. In the 13th century, however, the clouds of darkness began to separate, opening a dawn for their revival in the 14th, which was soon afterwards to bring on the blaze of day. We shall divide our account of the art from this period into three epochs.

First Epoch.—The Roman power having been entirely destroyed in the West of Europe, Italy became divided into republics and principalities, whereof the chief were Venice, Genoa, and Pisa, these being the earliest in fully establishing liberty. The last, however, was foremost in founding a schoool of native art. The Pisans, who possessed considerable extent of coast, had beaten the Saracens in Africa, Sardinia, Majorca, Minorca, and Sicily; and had thus acquired the treasures with which they commenced the erection of their cathedral, which was finished in 1092, about seven years after that of St. Mark at Venice had been consecrated. Schools of painting, sculpture, and architecture, soon arose after this period, and the cause of religion found employment for the talent they produced. It has been conjectured that Buschetto, whom the majority of writers and weight of argument prove to have been a Greek, though thought by some to have been an Italian, was the founder of the school at Pisa. The reputation of this school was raised to the greatest height by the appearance of Nicolo de Pisa, the pride and glory of the 12th century, and the first who on its restoration gave dignity and importance to sculpture. That the Grecian fragments which the Pisans had acquired soon enabled Nicolo to discriminate between them and the style of Buschetto, is evident from some remains of his work in the Campo Santo. In 1225 he was employed at Bologna in decorating the sarcophagus of St. Dominic, in which his admiration and successful imitation of the antique shine forth. He was afterwards engaged on the bas-reliefs of the pulpits at Pisa and Sienna, and on the façades of the cathedrals at Orvieto and Lucca. The time of his death is uncertain. Giovanni, the son of Nicolo, succeeded his father, to whom in some respects he was more than equal. Their figures, especially those of their draped females, are elegant, and exhibit "an originality of idea and a force of thought seldom met with when schools of art are in the habit of copying from each other." The school of Pisa is not limited to the two we have just named. Arnolfo the Florentine, the brothers Agostino and Agnolo, and Andrea Ugolino, all deserve to be recorded. Andrea executed in bronze the oldest gate of the baptistry at Florence, on which is represented the life of St. John. This work is designed with much grandeur and simplicity, and almost if not quite equal to his master; but in his marble statues he is inferior. Giovanni da Balduccio, scholar of Nicolo or Giovanni, was of this epoch: his first works were at Milan, where afterwards, in 1339, he executed the mausoleum of St. Peter the Martyr. In the 14th century Giotto established a school, distinguished by good drawing, which prepared Florence for a perfect re-establishment of the art. Of it was Orgagna, a name ever to be remembered for his celebrated loggia at Florence, who was also eminent for his works in sculpture. A school at Sienna, towards the end of this century, produced Jacopo della Quercia, whose principal works were at Bologna, Lucca, and especially Sienna, where a fountain which he designed was so admired that he acquired the name of Jacopo della Fonte. From his hand is the bas-relief in the façade of San Petronio at Bologna. The 15th century was a splendid era for the production of every thing that was great and intelligent, and most especially for the art of sculpture. The love of liberty and knowledge seemed to animate the whole of the Italian republics; and as if the republic of the arts were not excluded from the common sentiment, no individual master seems so to have outstripped his rivals as to have impressed the art with his own particular style.

This period brings us to the *second epoch*, at the beginning whereof we find six great artists engaged in a competition for executing the bronze doors of the baptistry at Florence, in which, after a year's trial, Lorenzo Ghiberti bore away the palm from his rivals. Among these was Donatello, a Florentine, one of the most distinguished restorers of the art. "Some of his works," says Flaxman, no incompetent judge, "both in bronze and marble, might be placed beside the best productions of ancient Greece without discredit." His alto-relievo of two singing boys in the Duomo at Florence is, in point of character, sentiment, drawing, and drapery, of extraordinary beauty. The marble statue he executed of St. George standing upright, equally poised on both his legs, with his hands resting on the shield before him, so excited the admiration of Michael Angelo, that after contemplating it in deep silence for a considerable length of time, he suddenly exclaimed "March." Lorenzo Ghiberti, the contemporary, and, as we have before mentioned, successful rival of Donatello, in the gates (1401) to the baptistry of San Giovanni, has immortalized himself by that work, which, from the eulogy bestowed on it by Michael Angelo, bears the appellation of the "Gates of Paradise." This undertaking occupied forty years of his life, and still, notwithstanding the criticism of Reynolds, remains one of the noblest monuments of modern art. The subjects are from the Old and New Testaments; and the complaint of Reynolds is, that "the landscape and buildings occupy so large a portion of the compartments that the figures remained but secondary objects, entirely contrary to the principle of the ancients." Brunelleschi, the intimate friend of Donatello, known better by his high acquirements as an architect, was not less a sculptor of considerable eminence: at Florence, in the church of St. Maria Novella, is an admirable crucifix by him in wood. In

1450, Andrea Verrocchio and Dominico Ghirlandaio were found amongst the first rank of sculptors in Florence. The former of these two, the master of Pietro Perugino and Leonardo da Vinci, executed at Venice the famous figure of Bartolomeo Cogleone da Bergamo on horseback. The latter was the master of Michael Angelo da Buonarotti, whom we have once more (*see* ARCHITECTURE and PAINTING) to introduce to the reader's notice as the most eminent of modern sculptors, as well as of architects and painters. The miraculous works of this extraordinary man seem rather the result of inspiration than of genius, and with him is introduced

The *third epoch*, in which the perfect restoration of the art was accomplished. The historian of the painters, sculptors, and architects wrote the life of Buonarotti while he was yet living, and thus apostrophises for his so doing: — "Let none be surprised that I have here written the life of Michael Angelo, who is yet living. Indeed it cannot be expected that he will ever die, and therefore it has appeared to me proper to do him this little honour; for when in common with other men his life shall pass away, he will be immortal in his immortal works, the fame of which, as long as the world lasts, will live with glory in the mouths of men and in their records, in contempt of envy and despite of death." Michael Angelo was nobly descended, and at the early age of 15 was patronized by Lorenzo de Medici, who took him into his house, and whilst living continued his friend. His career in sculpture was commenced by a sleeping Cupid, a Bacchus, and young fawn, the colossal David, and a group of a Madonna sitting with the dead Christ on her knees; works which raised him immediately above his cotemporaries. It is not our purpose here to touch upon the productions of Michael Angelo in the other two arts which occupied a great portion of his time, and which it appears he afterwards regretted; for Condivi, his biographer, observes, "Che mi rammenta udirlo dire che quando la, (the basso-relievo of the battle of Hercules with the Centaurs,) viede, cognosce quanto torto egli abbia fatto alla natura a non seguitar prontamente l'arte della scultura." Julius II. on being raised to the papal chair employed Michael Angelo on a mausoleum, which it was intended to place under the centre of the dome of St. Peter's. It was projected on a most magnificent scale; but being subjected to many delays, and the pope dying, only one of its sides was completed, which was afterwards erected in the church of St. Pietro in Vincolâ by order of his nephew. In this monument is found the celebrated Moses and some other statues, two of which in the present day are in the gallery at the Louvre. It is mortifying to know that a large portion of this artist's time was wasted at the quarries of Pietra Santa, owing to the misconduct of the underlings of Leo X. Cardinal Giuliano di Medici, in 1523, engaged him on the sacristy and library of San Lorenzo. In the Capella dei Depositi, or sacristy, are the statues of Lorenzo and Giuliano di Medici seated, and in Roman military habits: the former is conceived with a simplicity worthy of the highest era of Grecian art. The recumbent statues of Daybreak and Night, under the statue of Giuliano in the same chapel, "are grand and mysterious: the characters and forms bespeak the same mighty hand and mind evident throughout the ceiling of the Sistine Chapel and Last Judgment. Even this mighty master was doomed to experience ill-treatment from his employers, his last years having been attended with mortification, and chequered with vexation and trouble. Universal in his accomplishments, he was mainly useful in defending the city of Florence when it was besieged by the Prince of Orange. Having arrived at the advanced age of eighty, and withdrawn from all employment except the conduct of the works at St. Peter's, which he retained to prevent the intrigues for marring his design from being successful, he gratified the pious inclination of his mind, and derived amusement in his leisure hours from working on an enormous block of marble a group of four figures, consisting of the dead body of our Saviour, supported by Joseph of Arimathea attended by the two Marys; a composition of infinite grandeur and pathos, which he lived not to finish. His death occurred on the 15th of December, 1563, almost 90 years of age. "Michel," says Ariosto, "piu che mortal, Angel divino." Besides the honour he conferred on seven popes by serving them, he was the friend of Solyman emperor of the Turks, Francis I. king of France, the emperor Charles V., the princes of the republic of Venice, those of Italy, particularly the duke of Tuscany, reigning at the time of his death. His body having been buried in the church of the Holy Apostles at Rome, where the pope meditated a magnificent tomb to his memory, was privately removed to Florence, where funeral obsequies were celebrated over it with every demonstration of pomp and splendour. The ceremony took place in the church Della Croce, attended by all the members of the Academy, the church being decorated for the occasion with a catafalco, and the choicest examples of painting and sculpture. The panegyric was pronounced by Benedetto Varchi. Flaxman, in his Tenth Lecture on Sculpture, closes his account of him thus: — "The character and works of Michael Angelo have been dwelt on at greater length, because, as his mental and bodily powers continued far beyond the usual date of human life, his diligence attained to so much greater perfection in the principles of art. Anatomy, the motion and perspective of the figure, the complication, grandeur, and harmony of his grouping, with the advantages and facility of execution in painting and sculpture, besides his mathematical and mechanical attainments in architecture and building, together with the many and prodigious works he accomplished, demonstrate how greatly he contributed to the restoration of art." After this epoch, or perhaps almost belonging to it, appeared Giovanni da Bologna, a sculptor of extraordinary merit, and eminent particularly for his works in bronze and marble. His Venus coming from the Bath is delicate and graceful; and the group of the Rape of the Sabines in the grand piazza at Florence is extremely well composed, and possesses a fine undulation of line. The Mercury he executed, rising to fly, is energetic and original. There are many small works extant by this artist. Benevento Cellini, one of the strangest and most eccentric fellows that ever existed in the world, appeared about this period. He was chiefly employed as a goldsmith and sculptor in metals; but was frequently employed on large figures and groups, of which the Perseus holding the head of Medusa in his left hand at Florence is a splendid instance of his talent. Other real disciples of the great Tuscan master were Raphael di Monte Lupo, his favourite pupil, who assisted in the execution of the two statues of the Virtues on each side of the Moses; Nicolo di Tribolo, who made the bronze gates of the cathedral at Bologna; Giovanni dell' Opera, who received that name from the prolific chisel he wielded; and Vincenzo Dante. Of his school also are Baccio Bandinelli, a man of considerable talent, but of course greatly inferior to Michael Angelo, though he set himself up as a rival and competitor; Baccio di Monte Lupo, who among his works executed the crucifix in the church of San Lorenzo; Andrea Contucci, a clever and occasionally successful imitator of Michael Angelo, and founder of the school of Loretto; Francesco Rustici, a pupil of Leonardo da Vinci, but whose works evince a devotion to the style of Michael Angelo Buonarotti, and who introduced it into France; and Jacopo Tatti, commonly called Sansovino, who was the head of the Venetian school of sculpture. As an architect he was an artist of surprising talents, as is manifest from his works at Verona; his sculpture, however, is deficient in purity, though not in richness of composition. His principal pupils were Danese Cattaneo and Alessandro Vittoria. The principles of the school were diffused through Italy, and were equally to be seen in Lombardy and Naples: in the latter city the principal masters were Marliano Nola and Girolamo St. Croce. At Milan were Agostino Busti and Guglielmo della Porta, whose reputation was raised by the statues executed by him on the tomb of Paul the Third at St. Peter's. These have been esteemed as among the best examples of modern sculpture. Torregiano, who also belongs to this period, was of a vagabond disposition, but a man of genius; he was invited over to England, where he wrought upon the tomb of Henry VII. at Westminster, for which he received the sum of 1000*l*. From Benvenisto Cellini we learn that he was handsome, but of consummate impudence, having the manner of a bravo more than of a sculptor; and to crown all, what with his strange gestures, shrill voice, and a certain trick of knitting his brows, he was enough to frighten any one who came in contact with him. When he quitted England he visited Spain, says Vasari, and, distinguishing himself by many clever works, had a commission in marble from the Duke d'Arcus of a Madonna and Christ of the size of life, with great assurances that he should be rewarded according to his merit. The duke being a grandee of the first class, the sculptor considered he should be proportionately rewarded. After considerable study and application the work was finished to his own satisfaction; whereon, with impatience to possess himself of the treasure, the duke forthwith sent for it, and to display his generosity to the greatest advantage, two of his servants were loaded with the money in payment for it. The bulk was pleasing in appearance to the artist; but upon being opened the bags were found to contain only brass maravedi, amounting to the trifling sum of thirty ducats. Vexation and disappointment roused the indignation of Torregiano, who, looking on the present more as an insult than a reward due to his merit, snatched up his mallet, and heedless of the perfect workmanship with which it had been finished, as well as the sacred character of the subject, broke it in pieces, and sent the lacqueys away with their load of brass to recount the tale to their master. The grandee, enraged at the merited indignity with which the artist had treated him, and it may be horrified at the sacrilegious nature of the act, presented him to the Inquisition as an infidel and a heretic. Torregiano pleaded the right of an author over a work of his own creation, but without success: he was condemned to lose his life. Torregiano baulked, however,

the holy office of its victim by starving himself to death in his prison. This occurred in 1522, at which time he was fifty years old. In England we also had Giovanni da Padua in the following reign.

Spain produced some celebrated sculptors in the 16th century, their first native artist being Berruguette, a pupil of Vasari and Buonarotti. Berruguette's disciple, Paul de Cespides, is reputed the greatest sculptor that Spain ever produced.

It does not appear that Germany produced any sculptors of eminence before the 17th century. But in France, Jacques d'Angoulème, who had been at Rome, where he had a competition even with Buonarotti; Jean Gougeon, who finished the Fountain of the Innocents at Paris in 1550, and was one of the victims in the massacre on St. Bartholomew's Day; Jean Cousin, whose works, though deficient in force and truth, yet exhibit much grace and delicacy; and German Pilon, whose detail is remarkable for its beauty,—are names that entitle that country to a high rank among the nations of Europe, in which all the works of sculpture that were produced are so many testimonies of the influence which the genius of Michael Angelo exerted over the arts.

At the commencement of the 17th century, Bernini, a native of Naples, born in 1598, raised himself to employment before unknown. Endowed with all the qualities necessary for becoming a great artist, and desirous of distinguishing himself by the foundation of a new school, he plunged into caprice and complexity, and preferring effect to simplicity, effaced all traces of the style which from the time of Buonarotti had prevailed in Europe. His draperies founded on the paintings of the Bolognese school, his affected style, the violent expression in which he delighted, are the marks of an ambitious artist, whose only aim was to be striking. He deluged Italy with his works, and corrupted it with his taste till his death in 1680. The most celebrated cotemporaries of Bernini were Alguardi and Fiammingo. The latter is much esteemed for his representations of youth, and particularly of infants. At Naples he executed a concert of cherubs, and two infants on a monument at Rome, which are his most admired works: the latter was particularly admired by Rubens, who says of it, "Nature rather than art appears to have sculptured them, and the marble is softened into life." Rusconi in Italy succeeded to Bernini, and was the artist most in request at the beginning of the 18th century. His greatest work was at St. Giovanni Laterano, where he was assisted by Monnot, Le Gros, Moraldi, Moratti, Ottoni, and Rossi, pupils of the preceding school. The further progress of sculpture seemed now impossible; in short, the art seemed to have departed, though men whose names are not worth recording, with all the pretensions of artists, still hovered about the scenes of its former glory.

In France, Anzirevalle Adrian, Della Bella, and Tacca, pupils of Giovanni da Bologna, occupy the interval up to the beginning of the reign of Louis XIV.—one extremely creditable to the French school. In the remaining period of that monarch's reign, the principal sculptors were Gerardon, born at Troyes in 1630, and Puget, born at Marseilles in 1622; the latter of whom, from his fiery and energetic style, received the appellation of the Michael Angelo of France. These two were the head of the school of the succeeding sculptors of France; among whom was Falconet, celebrated for his writings, and for the equestrian statue he executed at St. Petersburg of the Czar Peter. The unfortunate Louis XVI., previous to the Revolution, was a great patron of sculpture, and had projected a collection of statues of the most eminent characters of the country. Pigal, the sculptor of the day, had executed some of them before the dreadful period which stopped in France for a time the cultivation of the arts. The school of Pigal was of considerable extent and influence, Mouchy, Bocquet, Moette, Chaudet, and Lebrune being members of it, and continuing the art to within a generation of the present time. Cotemporary, or nearly so, with these in Germany, were Rauchmuller of Vienna, Schluter of Berlin, Millich, Bartel, and others; subsequent to whom are Ohnmacht, Sonnenschein, and Nahl, all sculptors of much reputation. Our knowledge of Spanish sculptors is so limited, from their reputation not travelling away from their own country, and in it indeed being little known, except in Madrid and the chief cities, where the principal employment for them is the decoration of churches, that we apprehend little interest would be created by an enumeration of them. In England, up to a late period, the most celebrated sculptors were foreigners. Cibber, Roubiliac, and Scheemacher had the sway; and monuments of their genius, especially of the second, are the pride of some of our churches. The art, however, seemed to be near its dissolution, when Antonio Canova, in 1787, revived in Rome the purity without which it is worthless. This justly admired artist was born in 1757 at Possagno, a village amidst the Asolani hills, at the foot of the Venetian Alps. Pietro, his father, and Pasino, his grandfather, were sculptors, whose labours were chiefly confined to the churches of the district. Deprived of his father when only three years of age, he was indebted to his grandfather for the early instruction and employment of the chisel, by which he acquired great mechanical dexterity. Attracting the notice of the patrician Giovanni Faliero, he was by him placed with Torretto, one of the best Venetian sculptors of that day. Toretto soon afterwards died, and young Antonio then studied under Toretto's nephew, Ferrari. But he soon broke through the trammels of the art as it was then practised; and the rapidity of his progress having induced his patron to find a more appropriate theatre for the exercise of his powers, the young artist was sent to Rome in December, 1780, soon after which time the Venetian government granted him a pension of 300 ducats for three years. At this period the fashionable sculptors of Rome were Agostino Penna, Pacili, Bracci, Sibilla, and others, whose productions are already forgotten; so that in the way of emulation Canova had little to excite his talents. Before the period had expired for which his pension was granted, the zeal of Volpato had been successful in procuring for him the commission to execute the monument of Clement XIV. (Ganganelli). Thus was afforded to the young sculptor an opportunity of exhibiting his powers to a public who were fortunately capable of appreciating his merit. Before the expiration of the 18th century he had produced an amazing quantity of works, at which time it was not the practice (one afterwards introduced by him) to employ inferior workmen to reduce the block to the last shape of the superficies. The enumeration of his works would occupy much more space than can be here assigned to them: they were generally deficient in energy, but abounding in grace and elegance; and in his monumental sculpture there is vast originality of invention, whilst it is free from extravagance. His females are voluptuous, but not offensively so; his execution of them exquisite. In the monument executed in memory of the archduchess Christina of Austria, there is a pathos in the composition, whose figures are linked together with the chain of nature, worthy the divine Raphael himself. Canova died at Venice on the 13th of October, 1822; and his remains were removed to his native place, in which he had erected, at his own expense, a splendid church. Albert Thorwaldsen, a cotemporary of Canova, but much his junior, a native of Denmark, has by his great, though irregular and erratic genius, raised himself to eminence in Rome as well as in his own country. His powers in basso-relievo are great; but in extending the principles of the art, we cannot assign to him a niche in the temple of fame by the side of the man whose merits we have just discussed.

In England the respectable artists, Bacon, Banks, and Nollekens, were followed by Flaxman,—a name honourable to the arts of this country. Intense feeling and simplicity characterize all his works; and in epic sculpture we think he very far surpassed Canova. He was born at York in 1755, and died in 1826. The lectures which he delivered as professor of sculpture at the Royal Academy have been published. In the present day we apprehend the sculpture of our country, supported as it is by the talents of Westmacott, Lough, Rennie, Chantrey, and many others, will bear comparison with those of any other country in Europe.

SCULPTURE, PRACTICE OF. What has been said under the article PRACTICE OF PAINTING, relative to anatomy, comparative anatomy, symmetry, invention, expression, and drapery, equally applies to the art of sculpture, and need not be here repeated. We shall, therefore, merely state the different methods practised in producing a work in this art.

A model as large as the intended figure or group is first made in clay. It is placed on a stand called the sculptor's easel; and the general form is got out with the hand and fingers, small box-wood tools being made use of to touch the parts that the fingers cannot reach. The clay is kept moist, to prevent its shrinking, till the model is completed. The model is then moulded in plaster of Paris, before it begins to dry, whence a matrix is formed, into which plaster is introduced; and the matrix being broken away from it, the model in clay is thus transferred into one of plaster. This becomes the standard from which the artist takes all the measurements for the figure he is about to execute. The block of marble and the model being now placed on stands, with a graduated rod, which moves on a frame perpendicular to it, and has a point attached to it which can be made to advance and recede at pleasure, certain prominent points are selected and marked in the model, and their distance measured on the frame longitudinally and vertically, and also the distance that the point on the rod is advanced or receded to touch a given point. This being found on the outside of the rough block, the particular point is drilled down to as great a distance as was measured in the model. This operation being repeated for a great number of points, the surface is worked away to all the several points found as above, till at last it begins to assume the general form of the model. As the sculptor

approaches the surface which is to be left when finished, more caution and finer tools become necessary, till at length it is brought into a state for his finishing touches. The process which we have described of bringing the shapeless block into something like the form it is ultimately to bear, and which is an operation purely mechanical, is performed by inferior workmen, by which the artist's labour and time are much spared. It is only with such a genius as Michael Angelo that the making a model could be dispensed with.

SCU'PPER. A hole in the ship's deck or side to carry off the rain, or water shipped.

SCU'RVY, *Scorbutus*. This disease, once so common in our navy, is now of very rare occurrence. It generally appears connected with debilitating causes, and especially unwholesome food, want of exercise, and by cold and moisture. It begins with indolence, sallow looks, and loss of strength and spirits; the gums become spongy, the teeth loose, the breath fœtid; eruptions appear on different parts of the body; and at length the patient sinks under general emaciation, diarrhœa, and hæmorrhages. In the prevention and cure of this disease, much is effected by attention to diet and cleanliness. Fresh vegetables, farinaceous substances, and brisk fermented liquors, good air and due exercise, are among the principal remedial means. Acids, and especially lemon juice, have been much extolled; but the researches of Dr. Steevens have rendered the propriety of acid diet somewhat doubtful.

SCU'TATE. (Lat. scutum, *a shield*.) In Zoology, when a surface is protected by large scales.

SCUTE'LLUM. (Lat. scutum.) A term used by Gærtner to denote the small cotyledon on the outside of the embryo of wheat, inserted a little lower down than the other more perfect cotyledon, which is pressed close to the albumen.

SCUTIBRA'NCHIANS, *Scutibranchiata*. (Lat. scutum; branchiæ, *gills*.) A name given by Cuvier to an order of hermaphrodite Gastropodous Mollusks, including those which have the gills covered with a shell in the form of a shield.

SCU'TIGERS, *Scutigera*. (Lat. scutum; gero, *I carry*.) The name of a genus of unequal-legged Chilopodous Myriapods, which frequent houses and outbuildings in the South of Europe, and prey upon insects, wood-lice, and other small creatures.

SCU'TIPEDS, *Scutipedes*. (Lat. scutum, *a shield*; pes, *a foot*.) The name given by Scopoli to one of the divisions in his binary system of ornithology, including those birds which have the anterior part of the leg covered with segments of unequal horny rings terminating on each side in a groove.

SCU'TTLE. An opening in the ship's side or deck to admit light or air, or for communication.

To scuttle the decks, implies to cut holes to let the water down from them into the hold, as in the case of shipping a heavy sea, or of fire.

To scuttle a vessel, is to cut a hole in her for the purpose of sinking her.

SCUTTLE-BUTT. A cask of water with a large hole in it placed for use in a ship.

SCU'TUM. (Lat.) The shield of the Roman heavy-armed legionaries: was made of wood, defended with plates of iron, and covered with leather. It was either oval (ovatum), or of semi-cylindrical shape (called imbricatum). Polybius appears to make the latter sort 4 feet long, and it is evident that it covered a great part of the body. In the centre was a boss of brass or iron, projecting from the shield. From this classical word is derived the modern term *esquire*, through the middle ages: Lat. scutiger, *shield-bearer*.

SCY'LLA. In Mythology, the daughter of Nisus, king of Megara, who threw herself into the sea for love of Minos, king of Crete, and was turned into a bird. Also a poetical monster, half man half dragon, who inhabited the coast of Italy opposite Charybdis, according to the well-known legend in the *Odyssey*. The modern town of Scilla stands near the cave dreaded by the early navigators as the habitation of this monster.

SCY'PHUS. (Gr. σκυφος, *a cup*.) The cup of a narcissus. Also, in Lichens, a cup-like dilatation of the podetium, bearing shields upon its margin.

SCY'TALE. (Gr. σκυτος, *a skin*.) An instrument used by the Lacedæmonians for the conveyance of secret instructions to their commanders. The construction of it was as follows:—When a general was sent out, a black rod was given him, while another of exactly similar dimensions was preserved at home. When instructions were to be sent out, a strip of parchment was wrapped round the rod, and on the folds the orders were written; which accordingly could not be interpreted unless the parchment were rolled on a similar rod.

SEA. In Geography, a part of the great ocean. *See* Ocean Tides.

Sea. The term used by sailors for a single wave, or for general agitation. In a *long sea*, the waves are distant; in a *short sea*, they are closer and more upright: a *cross sea* is composed of waves moving in different directions.

SEA ANEMONE. The name of a highly organized Polype of the genus *Actinia*.

SEA BOAT. A term applied by seamen to a vessel, as respects her qualities in bad weather.

SEA DEVIL. The seaman's name of a large cartilaginous fish of the Ray tribe, the type of the genus *Cephaloptera*, Cuvier; also applied to the angler (*Lophius piscatorius*, Linn.).

SEAL. (Lat. sigillum.) In Gem Sculpture, a stamp cut or sunk on stone, capable of yielding an impression to any soft substance. When a gem is selected for cutting, it is put into the hands of the lapidary to reduce it to shape and smoothness. It is then fixed with mastic to a piece of wood to serve as a handle, and the subject is sketched upon it with a copper point or a diamond. The tool is a lathe somewhat resembling a turning lathe, into the end of the spindle whereof points, knobs, or circles can be inserted. The gem is then applied to the end of one of these tools, according to the nature of the cutting required, wetted with diamond-dust and olive oil, and by frequent working the subject is wrought. Frequent impressions are of course taken during the progress, to show the excesses or defects. These, however, are not necessary in working cameos, because the prominences are obvious to the eye. The tools are soft iron or copper; and the powder of the ruby, or other hard stones, is often substituted for diamond powder.

Seal. In Zoology, the English name for a genus of Marine Carnivorous Mammiferous Quadrupeds, otherwise called *Phocidæ*. The variety of seals is very great, and they are found in vast numbers in the seas round Spitzbergen, and on the coasts of Labrador and Newfoundland. As it frequents the British shores, it is well known, and has been repeatedly described. Seals are principally hunted for their oil and skins. When taken in the spring of the year,—at which time they are fattest,—a full-grown seal will yield from 8 to 12 gallons of oil, and a small one from 4 to 5 gallons. The oil, when extracted before putrefaction has commenced, is beautifully transparent, free from smell, and not unpleasant in its taste. The skin, when tanned, is extensively employed in the making of shoes; and when dressed with the hair on, serves for the covering of trunks, &c. *See* Fisheries.

SEAL, GREAT. All charters, commissions, grants of land, franchise, liberties, &c., letters patent, and letters close, of the king, pass the great seal. The usual course is, that a grant, or letters patent, pass by bill; which is prepared by the attorney or solicitor general under warrant from the king. It is then subscribed at foot with the sign manual, and sealed with the privy signet. In this stage it is next, in some cases, taken directly to pass the great seal; in other cases, an extract of the bill is taken to the keeper of the privy seal, who makes out a writ or warrant thereupon to the chancery, where it passes the great seal. Then the sign manual is a warrant to the privy seal, and that to the great seal. There are, however, some grants which only pass through certain offices, as the Admiralty or Treasury, under the sign manual, requiring neither privy nor great seal. The keeper of the great seal has, by 5 Eliz. c. 18., the same place and jurisdiction as the lord chancellor of England: since that statute, therefore, both offices cannot exist at the same time in different persons, which was not unfrequently the case before.

SEALING-WAX. The wax used for sealing letters, legal instruments, &c. The best *red* sealing-wax is made by melting in a very gentle heat 48 parts of shell-lac with 19 of Venice turpentine and 1 of Peruvian balsam; 32 parts of the finest cinnabar, thoroughly levigated, are then stirred in, and the whole well mixed. When it has cooled down, it is either rolled into sticks, or shaped in brass moulds. The best *black* sealing-wax is a mixture of 60 parts of shell-lac and 30 of ivory black; it may be perfumed with a little Peru balsam or styrax. The earliest application of sealing-wax to its present use seems to have been made about the year 1553. The first printed account of it is said by Berzelius to have appeared in 1563. The great seals applied in tin boxes to certain legal documents are made of a mixture of 15 parts of Venice turpentine, 5 of olive oil, and 8 of wax melted together, and coloured with red lead.

SEAL, PRIVY. All charters, pardons, &c., which require the great seal, pass first through the hands of the keeper of the privy seal; and other instruments of less consequence pass the privy seal only. A warrant to issue money out of the king's coffers, under the privy seal, is sufficient. The keeper of the seal is now an officer of state, with the title Lord Privy Seal. By 2 W.4. c. 49. the offices of clerks of the signet and privy seal are to be abolished as soon as vacancies occur in them.

SEA'MAN. A man brought up to the sea, and capable of discharging the duties of that life. A complete seaman is called an *able seaman*, and is rated A. B.; one less competent, an *ordinary seaman*; and a man fresh from the shore, a *landsman*. The reader will find in the *Com. Dict.* full particulars respecting the enrolment, wages, and in short all the statistics of seamen.

SEAMS. The spaces between the edges of planks: these in a ship are caulked, and then covered with pitch.

SEAMS. In Geology, thin layers which separate thicker strata.

SEAMEW. A name for the gull. *See* LARUS.

SEARCH WARRANT, in Law, is granted by a justice of the peace, under 7 & 8 G. 4. c. 29., to search for goods stolen, or respecting which other offences specified in the act have been committed. The warrant is granted on the oath of a credible witness, that he has "reasonable cause to suspect" the goods to be in the possession and on the premises of a certain individual.

SEA SICKNESS. Nausea and retching, which attack most persons on first going to sea; sometimes continuing only a day or two, but often lasting the whole of a long voyage. The most effective antidote, or remedy, consists in lying in the horizontal position. In some persons its violence is prevented by small doses of opium, or by soda water, or saline draughts in the act of effervescence; liniments and plaisters containing opium applied to the pit of the stomach are also recommended, as mitigating, or even preventing, this most annoying malady. The violence of the attacks not only varies in different individuals at different times, but the same person who escapes in one voyage shall suffer severely in another. The cause of sea sickness is probably referable to the influence of the motion of the vessel upon the circulation of the blood: it has been compared to the sickness occasioned by swinging. For some ingenious observations upon this subject, see Dr. Wollaston's Croonian Lecture, in the *Philosophical Transactions* for 1810.

SEASONS. (Fr. saisons.) The four quarters of the year, — spring, summer, autumn, winter. The seasons are considered as beginning respectively when the sun enters the signs Aries, Cancer, Libra, and Capricorn; so that the *spring* season commences about the 21st of March, *summer* about the 22d of June, *autumn* about the 23d of September, and *winter* about the 23d of December.

SEA UNICORN. The name of the narwhal (*Monodon monoceros*, L.).

SEA URCHIN. The name generally applied to the different species of *Echinus*.

SEBA'CEOUS GLANDS. Small cuticular glands which secrete a greasy matter, serving to protect and soften the skin or cuticle.

SEBA'CIC ACID. One of the acids produced during the destructive distillation of fat.

SECA'LE. (Lat.) The ergot or clavus of rye. *See* ERGOT.

SE'CANT (Lat. seco, *I cut*), in Trigonometry, is a straight line drawn from the centre of a circle to one extremity of an arc, and produced until it meets the tangent to the other extremity. The secant of an arc is a third proportional to the cosine and the radius; hence, if the radius be taken as unit, the secant is the reciprocal of the cosine. *See* TRIGONOMETRY.

SECE'DERS. *See* BURGHERS.

SE'COND, in the Sexagesimal Arithmetic, is the 60th part of a minute, or *prime*. Thus a degree of a circle, and an hour of time, are each divided into 60 minutes, and each minute into 60 seconds. In the old treatises on astronomy, the seconds are sometimes denominated *second minutes* (minutæ secundæ); while the minutes, being the first division of the unit, are the *primes* (minutæ primæ). Following out the analogy, the sixtieth part of a second was called a *third;* but this term is not found in modern works. It was formerly usual to denote minutes and seconds, both of time and arc, by the characters ′ and ″; but these are now generally used only to indicate minutes and seconds of arc, those of time being indicated respectively by the abbreviations *m.* and *sec.*

SE'COND. In Music, a musical interval; being the difference between any sound and the next nearest, whether above or below it. It may be either major or minor.

SE'CONDARIES, or SECONDARY QUILLS. (*Secondariæ*, Linn.) The large feathers of the wing which arise from the bones of the antibrachium or fore-arm, and principally from the ulna, are so called.

SE'CONDARY CIRCLES, in Astronomy, are great circles of the sphere perpendicular to another great circle, which is regarded as the primary, and consequently passing through its poles. The secondaries of the ecliptic are the circles on which the latitudes of celestial objects are measured.

SE'CONDARY ROCKS or STRATA. A series of stratified rocks with certain characters, by which they are distinguished as a class from the *primary* rocks, which are beneath them, and from the *tertiary* rocks, which lie upon them. *See* GEOLOGY.

SE'COND COAT. In Architecture, either the finishing coat, as in laid and set, or in rendered and set; or it is the floating when the plaster is roughed in, floated, and set for paper.

SE'COND SIGHT (called in Gaelic Taischitaraugh; from taisch, *an unreal* or *shadowy appearance*). A well-known Highland superstition. In all ages the idea has prevailed that persons endowed with the power of divination did not only foretel by instinct, but had sometimes an actual and mysterious vision of distant or future events; as in the lines of Lucan, which describe the presages before the battle of Pharsalia:—

> Euganeo, si vera fides memorantibus, augur
> Colle sedens . . . .
> Venit summa dies, geritur res maxima, dixit:
> Impia concurrunt Pompeii et Cæsaris arma.

But the peculiarity of the Highland superstition seems to consist in this, that persons were supposed to be endowed with the faculty who were in no other respect feared or reverenced for their supernatural powers: it was regarded as a mere natural power, like superior sharpness of sight or hearing. The inhabitants of the Western Islands were thought to be peculiarly gifted with it. It could not be exerted at pleasure; the power came on the seer involuntarily, and often to his extreme terror and suffering. Nevertheless, certain rules were in fashion for the interpretation of the visions; such, for instance, as that mentioned by Sir W. Scott, that if a seer saw a figure with its back to him, on altering the position of his own plaid if the figure appeared with its plaid similarly arranged the vision regarded the seer himself. Martin, in his *Description of the Western Islands*, seems to have brought this superstition into notice in England. It is well known how Johnson undertook the defence of it, in his *Journey to the Western Islands;* but, in despite of evidence which neither Bacon, Boyle, nor Johnson were able to resist, the *taisch*, with all its visionary properties, seems to be now universally abandoned to the use of poetry. The exquisitely beautiful poem of *Lochiel* will at once occur to the recollection of every reader. (Notes to the *Lady of the Lake*.) It is finely described by Collins in his ode on the *Superstitions of the Highlands*. But the classical bard of the second sight is Sir Walter Scott. (See especially his noble ballad *Lord Ronald*, the character of Allan Macalister in the *Legend of Montrose*, &c. &c.) How far the belief in second sight is preserved at the present day, we cannot tell. Mr. Logan, in his *Scottish Gael*, only says, "It is not so prevalent as formerly." (Vol. ii. 340.)

SE'CRETARY. An officer employed in writing letters, despatches, &c., under the orders of his superior. The title of secretary was first used to denote a public minister in France, where the three clerks of the privy council were also termed secretaries as early as the 14th century.

SE'CRETARY, LORD. A high officer in the kingdom of Scotland, resembling the great prothonotary in foreign courts. This office was kept up after the Union, but has been disused since 1746.

SE'CRETARY OF STATE. One of the highest officers of the British crown. This office, however, is comparatively modern in point of importance; the secretary of state having been originally what his name implies, a mere servant of the privy council. There was only one until the reign of Henry VIII., who added another; but their functions were limited to preparing business for the council board, which they attended afterwards with their proposals. Under Elizabeth, they became members of the council. Queen Anne raised the number to three, by the appointment of a secretary for Scotch affairs, — an office which did not long continue; and one for the American department was appointed in the reign of George III., but abolished in 1782. At present there are three secretaries of state. 1. The Secretary for the Home Department. 2. The Colonial Secretary. 3. The Secretary for Foreign Affairs. In each of these departments there are two under-secretaries, one of whom remains in office on a change of ministry. The clerks in the Home Office are divided into senior and junior; but no such distinction obtains in the other two. Each of the principal secretaries has 6000*l.* a year. The Alien Office is annexed to the Home Department: the State Paper Office belongs alike to those of all the departments. The Secretary for Home Affairs has the custody of the privy signet; and the Privy Signet Office, in which grants, letters, &c., sealed with the privy signet, are made out, is in his department. The principal secretaries are always ex officio cabinet ministers. Their position in the English government is, in fact, identical with that of the ministers of home and foreign affairs, &c., in France and other Continental countries. The Secretary at War is attached to the War Office. His salary is 2480*l.*; and he is also frequently, though not always, a member of the cabinet. The secretary of state for Ireland is also keeper of the privy seal of that part of the kingdom, and chief secretary of the lord lieutenant. His office is divided into two departments, military and civil, in each of which an under-secretary is placed. Like the secretary at war, he is, though more rarely, sometimes a member of the cabinet.

SECRE'TION. (Lat. secretio.) The process by which substances are separated from the blood in animals, or from the sap of vegetables.

In some cases a secretion appears to be a mere separation of water, and of other substances held in solution by it, from the blood; but in others the process is much more elaborate and intricate. A highly complicated glandular structure is requisite; and the proximate or ultimate elements of the blood are arranged into new combinations, so as to constitute a new and distinct product, of which no traces are to be found in the healthy blood. The animal secretions are arranged by Bostock under the heads aqueous, albuminous, mucous, gelatinous, fibrinous, oleaginous, resinous, and saline. Magendie's classification of the secretions comprises, 1. Exhalations, as from the skin, the surfaces of the closed cavities of the body, and the lungs; 2. Follicular secretions, which are either cutaneous or mucous; and, 3. Glandular secretions, such as milk, bile, urine, saliva, &c. *See* PHYSIOLOGY and BOTANY, &c.

SECT. A term used in ordinary language to signify any body which separates from the established religion of a country. In this sense, the word appears to be derived from Lat. seco, *I cut;* sectarians being, as it were, *cut off* from the general mass. But, on the other hand, the term was anciently applied to the *followers* of some distinguished person; in which sense, the idea of *cutting off* wholly disappears, and the word then seems to be derived from Lat. sequor, *I follow*. The chief sects, both of philosophers and religions, will be found noticed under their respective heads.

SE'CTION (Lat. sectio.), in Geometry, denotes the line formed by the intersection of two surfaces, and likewise the surface formed when a solid body is cut by a plane. When a plane is cut by a plane, the section is a straight line; when a sphere is cut by a plane the section is a circle; and when a cone is cut by a plane, the section may be a triangle, a circle, an ellipse, an hyperbola, or a parabola, which five figures are consequently called the *conic sections*. (*See* CONIC SECTIONS.) Vieta gave the name of *angular sections* to the branch of analysis which has for its object the investigation of the sines and chords of the multiples and submultiples of a given arc. On this subject the student may consult the work of Poinsot, entitled *Recherches sur l'Analyse des Sections Angulaires*, Paris, 1825. — *Section of a Ratio*, and *Section of a Space*, are terms that were employed by Apollonius of Perga, who wrote two books with those titles; the former of which was restored by Dr. Halley, and the latter by Willebrord Snell.

SECTION. In Architecture, the projection or geometrical representation of a building, supposed to be cut through, so as to exhibit its interior.

SE'CTOR. (Lat.) In Geometry, the *sector of a circle* is a portion of the area of the circle bounded by two radii and the intercepted arc. Sectors of different circles are said to be *similar* when the sides or radii include equal angles. The area of a sector is equal to that of a triangle whose base is equal to the length of the contained arc, and altitude equal to the radius of the circle.

SECTOR. A mathematical instrument, of considerable use in making diagrams, laying down plans, &c. Its principal advantage consists in the facility with which it gives a graphical determination of proportional quantities; and hence it is called by the French *the compass of proportion*.

The instrument consists of two rulers (generally of brass or ivory), representing the radii of a circular arc, and moveable round a joint, the middle of which forms the centre of the circle. From this centre there are drawn on the faces of the rulers various scales; the choice of which, and the order of their arrangement, may be determined by a consideration of the uses for which the instrument is chiefly intended. The scales usually put on sectors are of two kinds, — single and double; that is to say, such as are drawn only on one of the limbs, and such as are drawn on both limbs. The first kind, however (comprising, for example, a line of inches, of chords, sines, logarithms, &c.), are not peculiar to the sector, but are merely placed there for convenience, and may be used whether the instrument is shut or open. Of the lines repeated on both limbs the principal are the following: — 1. A line of equal parts, by which, with a pair of compasses, we are enabled, on the principle that similar triangles have their homologous sides proportional, to find a third proportional to two given lines, a fourth proportional to three given lines, to diminish a line in any given proportion, &c. 2. A scale of chords, which enables us to protract an angle of any given number of degrees, to find the degrees which any given angle contains, to cut off an arc of any magnitude from the circumference of a given circle, &c. 3. Scales of sines, tangents, and secants, whereby the lengths of those trigonometrical lines corresponding to a given arc of a circle of any radius are determined. 4. A line of polygons, whereby the proportional length of the side of any regular polygon (of not more than twelve sides) to the radius of the circumscribing circle is found.

The sector may be used in trigonometry for obtaining a rough solution of all the cases of right-angled plane triangles; and it is also conveniently applied to the construction of various geometrical problems. For a description of its different uses, see *Robertson's Treatise of such Mathematical Instruments as are usually put into a Portable Case*.

SECTOR. In Astronomy, an instrument constructed for the purpose of determining with great accuracy the zenith distances of stars passing within a few degrees of the zenith, where the effect of refraction is small. *See* ZENITH SECTOR.

SE'CULAR EQUATION, SECULAR INEQUALITY. (Lat. seculum, *a century*.) In Astronomy, any deviation from the mean motion or mean orbit of a celestial body is called an *inequality*, and the numerical expression of the magnitude and period of the inequality is called an *equation*. The equations representing the motions of the bodies of the solar system are of two kinds, *periodic* and *secular:* the first being those which pass through all their changes and return to the same state in a comparatively short period of time; and the second such as change their values so slowly that the variation only becomes sensible after the lapse of centuries, and require for the accomplishment of the series of their changes a length of time which in some cases astronomers have not yet ventured to calculate. Thus the lunar *evection*, which depends on the position of the transverse axis of the moon's orbit in respect of the line of the syzygies, is a *periodic* inequality, passing through all its different values in about 31 days 19½ hours; but the acceleration of the moon's mean motion, depending on a slow variation of the eccentricity of the earth's orbit, is a *secular* inequality, amounting only to about 10 seconds in a century. The secular inequalities are in fact periodic as well as the others; but they proceed so slowly that the observations of many hundreds, or even thousands of years, would be insufficient to make known their periodicity. The discovery of their true nature is one of the results of the theory of gravitation.

SE'CULAR GAMES, in Antiquity, were games celebrated once in a hundred years. They lasted three days and three nights, during which period sacrifices were offered up, and theatrical shows exhibited, and combats in the circus, &c. took place. Valerius Publicola, the first consul created after the expulsion of the kings, A. U. C. 245, was the first who celebrated them at Rome. Some authors maintain that the *seculum*, or age, consisted of 100, and others of 110 years; but it is certain several Roman emperors did not allow so long an interval as either period to elapse. Thus, Augustus celebrated secular games A. U. 736, Caligula 64 years later, and Domitian 26 years afterwards; on which occasion Tacitus assisted in the capacity of juris-decemvir. According to Zosimus, the emperor Septimus Severus was the last who celebrated them; but other writers have stated that under the emperor Philip, A. U. 1000, these games were held with more magnificence than had ever been before witnessed. They were celebrated, in all, eight times.

The original sæculum of the Etruscan augurs is said by some to have been measured by the longest life of those who were born at its commencement; and they had a peculiar tradition, that the duration allotted to nations was measured by a certain number of these sæcula. (Plutarch, *Sylla;* Censorinus, *De die Natali*.)

SECULARIZA'TION. In Politics, the appropriation of church property to secular uses. In most European states such appropriations have taken place on a great scale within the last century. In England, the only great secularization has been that made under Henry VIII.

SE'CULAR POEMS, in Antiquity, were those recited at the celebration of the secular games. Of this species of poem the Sapphic Ode of Horace, at the end of his book of *Epods*, is a noble specimen. Several editions of Horace give the name *secular poem* to the 21st Ode of the first book. (See *Niebuhr's Rome*, 2d edition, p. 288.)

SECULAR REFRIGERATION. The periodical cooling and consequent consolidation of the crust of the globe: a term used by geologists in reference to the supposed central heat, and even fluidity of the globe, and to the phenomena of its gradual refrigeration.

SECULAR YEAR. The same with Jubilee, — kept once in a century.

SECU'NDINE. (Lat. secundus.) In Botany, the outermost but one of the enclosing sacs of the ovulum, immediately reposing upon the primine. Mirbel considers it the second integument formed by the ovule; Schleider says it is the first, and that the primine or first integument of Mirbel is formed afterwards.

In Zoology, the fœtal membranes collectively are sometimes termed *secundines*.

SECU'RIFERS, *Securiferi*. (Lat. securis, *a hatchet;* fero, *I bear*.) The name of a tribe of *Terebrantia*, or boring Hymenopterous insects, comprising those in which the females have a saw-shaped or hatchet-shaped terebra or appendage to the posterior part of the abdomen, for the purpose of preparing a place to receive the eggs, and of depositing them therein.

SECU'RIPALPS, *Securipalpi.* (Lat. securis, *a hatchet;* palpo, *I feel.*) The name of a family of Coleopterous insects, comprehending those in which the maxillary palps terminate in a joint which is elongated and hatchet-shaped.

SE'DATIVES. (Lat. sedo, *I assuage.*) Medicines which assuage pain; generally by inducing sleep and diminishing irritability.

SE'DENTARIES, *Sedentaria.* (Lat. sedeo, *I sit.*) The name of a section of spiders (*Araneidæ*), comprehending those which remain motionless in the hiding-place of their web until called forth by an entangled prey.

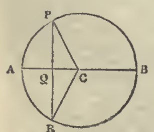
SEDGE BIRD. The name of the *Sylvia phragmitis*, Bech. This species of warbler visits this country about the middle of April, and emigrates in September. It frequents the sedgy banks of rivers, and constructs a nest composed of a little moss intermixed with dry stalks, lined with dry grass, and occasionally a few hairs. It lays five or six eggs of a light brown colour, mottled with darker shades of the same. It is sometimes called *reed bunting.*

SEDI'TION. (Lat. se, *apart*, and ire, *to go.*) In Law, a general and not strictly technical word, comprising, in common language, offences against the state which do not amount to high treason. The distinction between the two offences was not very accurately adhered to or defined until later times. Sedition is of the like tendency with treason, but without the *overt acts* which are essential to the latter. Thus, there are seditious assemblies, seditious libels, &c., as well as direct or indirect threats and acts amounting to sedition; all punishable as misdemeanours. The acts 39 G. 3. c. 79. (by which the famous Corresponding Societies were suppressed) and 57 G. 3. c. 19. were passed to prevent seditious meetings and assemblies.

SEE. (Lat. sedes, *a seat.*) The name usually given to the diocese of a bishop in England. It was originally applied exclusively to the papal chair at Rome; but it has long been used in its present wide signification.

SEED, is the reproductive part of a plant resulting from impregnation, and containing the embryo or rudiment of a future plant; or, in other words, it is the ovulum in its most perfect and finally organized state. It is a form of reproductive matter peculiar to flowering plants, its equivalent in flowerless plants being the spore. It is commonly said that as the seed is the part intended by nature to multiply the races of plants, special contrivances are provided for ensuring its dispersion and migration from place to place; such, for instance, as being discharged with force by the sudden explosion of the case or seed-vessel in which it is generated, having membranous wings that render it buoyant, and so on. But this idea, although to a certain extent true, is frequently misapplied to seed-vessels, as in the instance of the dandelion, the ash tree, the sycamore, &c.: in these latter cases the part to which the name of seed is given is a true pericarp or seed-vessel. On the other hand, many kinds of seed-vessels, such, for instance, as those of corn, of labiate and boraginaceous plants, &c., are miscalled seeds, or naked seeds.

SE'GMENT. (Lat.) In Geometry, a part cut off from a figure by a line or plane. The segment of a circle is a part of the area comprised between an arc and its chord; and segments of different circles are said to be *similar* when their arcs have the same ratio to the circumferences of their respective circles, or when they contain the same number of degrees. The area of a circular segment may be found as follows: — Let P R be the chord of a circle whose centre is C, and let A B be the diameter perpendicular to P R, and meeting it in Q; and put $x = $ A Q, $y = $ P Q, $z = $ A P, $r = $ A C the radius, and $\pi = 3{\cdot}14159$, the ratio of the circumference to the diameter. Now the area of the segment P A R is evidently equal to the difference between the sector A P C R and the triangle P C R; but the area of the sector $= r z$ (the radius into half the arc), and the triangle $= y\,(r - x)$; therefore the segment $= r z - r y + y z$. When the radius of the circle and the chord of the segment (that is, r and y) are known, this expression is easily calculated from a table of sines, for the angle A C P is found from its sine $= y \div r$; and when the angle is given the arc z is obtained from this proportion, $z : \pi r :: $ A C P : 180°. With respect to x, we have from the property of the circle $x = \surd(r^2 - y^2)$.



The superficial and solid contents of a segment of a sphere are found thus: — Let S be the spherical surface of the segment of the sphere whose centre is C by the plane P Q R. The symbols having the same values as above, the circumference of the circle P Q R is $2\,\pi\,y$; and the differential of the surface is $d\,$S $= 2\,\pi\,y\,d\,z$. But from the nature of the circle, $y\,d\,z = r\,d\,x$; hence $d\,$S $= 2\,\pi\,r\,d\,x$, and S $= 2\,\pi\,r\,x$; so that the surface of the segment is found in terms of the radius of the sphere and the altitude of the segment.

Let U denote the solid contents of the segment; then, since the area of the circle P Q R is $\pi\,y^2$, the differential of the segment is $d\,$U $= \pi y^2\,d\,x = 2\,\pi\,r\,x\,d\,x - \pi\,x^2\,d\,x$; whence U $= \pi\,x^2\,(r - \frac{1}{3}x)$.

SEGNO. (Ital. *a mark.*) In Music. *See* AL SEGNO.

SEGUE. (It. *it follows.*) In Music, a word which, prefixed to a part, denotes that it is immediately to follow the last note of the preceding movement. When minims, crotchets, &c. are subdivided by a stroke drawn through their tails, so as to make them into abbreviated groups, the term indicates that the following notes are divided similarly to those first marked.

SEIDLITZ WATER. The mineral water of Seidlitz, a village of Bohemia: sulphate of magnesia, sulphate of soda, and carbonic acid, are its active ingredients. It is often taken as an agreeable and effective aperient. The article sold under the name of *Seidlitz powders* is intended to produce the same effect, though very different in composition. These powders are generally sold in different-coloured papers: one blue, containing 2 drachms of the potassa-tartrate of soda mixed with 2 scruples of bicarbonate of soda; the other red, containing 35 grains of finely powdered tartaric acid. The former powder is dissolved in half a pint of water, and the latter in a separate wine-glass-full; the solutions are then mixed, and taken in the act of effervescence.

SEI'GNIORY. (Fr. seigneurie.) In Lower Canada, the right of feudal superiority in real estate. The term "fief" is applied both to the land held of a seigneur, and to the dominium directum, or right of direct seigniory, reserved to him who has granted the land in fief. The king has the paramount seigniory in all the feudal lands. By 6 G. 4. c. 59. persons holding fiefs or seigniories may on application to the king obtain a commutation and release of feudal burdens, and the fief or seigniory may be regranted in common socage. The land held in seigniory is said to amount to more than 15,000 square miles.

SEIGNORAGE. An ancient prerogative of the crown, whereby it claimed a per-centage upon every ingot of gold or silver brought to the mint to be coined. Upon gold it amounted under Edw. III. to 5*s.* per lb. weight, of which a fifth was appropriated to the master of the mint: upon silver it varied from 1*s.* to 1*s.* 3*d.* &c., but the amount varied in different reigns. The term *seignorage* is used in common language to signify *profit.*

SEI'SIN, in the Common Law of England, signifies possession, either actual (seisin in deed) or in law; as where lands have descended to a party who has not entered into actual possession of them, or is by wrong disseised of them.

SEISMO'METER. (Gr. σεισμος, *an earthquake.*) An instrument for measuring the shock of earthquakes and other concussions. (*Edin. Phil. Trans.* vol. xv. p. 219.)

SE'JANT. In Heraldry, a term employed to describe beasts when represented in a sitting posture. *Sejant-rampant*, sitting with the two fore feet lifted up, &c.

SELA'CIANS, *Selacii.* (Gr. σελαχος, *a species of scaleless fish.*) The name given by Cuvier to the tribe of Chondropterygians which includes the rays and sharks.

SELE'NE. (Gr. *the moon.*) In Grecian Mythology, the goddess of the moon. Her Latin equivalent was *Luna.* She was represented sometimes as the wife, the sister, and the daughter of Helios, the sun; and was identical with Artemis or Diana, which see.

SELENITE. (Gr. σεληνιτης.) One of the mineralogical synonyms of crystallized sulphate of lime.

SELE'NIUM. (Gr. Σεληνη, *the moon.*) A substance discovered in 1818 by Berzelius. In its general chemical habitudes it bears a resemblance to sulphur. It has hitherto been obtained in very small quantity, and generally occurs in some of the varieties of iron pyrites. It is a brittle opaque substance, tasteless, and inodorous; having something of the appearance of lead, but of a deep red colour when reduced to powder. Its specific gravity is about 4·3. At 212° it becomes soft and tenacious, and at 220° is perfectly liquid; at 650° it boils and sublimes. It is insoluble in water, and unaltered by air; and when heated by the blowpipe, so as to become oxidized, it exhales a strong odour of horse-radish. Its equivalent is about 40. It forms an oxide and two acids; the *selenious acid* being a compound of 1 equivalent of selenium and 2 of oxygen, and the *selenic acid* of 1 and 3. It also combines with hydrogen, forming the *hydroselenic acid*, a gaseous compound of 40 selenium + 1 hydrogen. Its odour at first resembles sulphuretted hydrogen, but it afterwards powerfully irritates the nose, excites catarrhal symptoms, and destroys the sense of smell. Dr. Prout has suggested the possibility of the evolution of this compound by volcanos, and its diffusion through the atmosphere as productive of certain forms of the epidemic disorder called influenza.

SELENO'GRAPHY. (Gr. Σεληνη, *the moon*, and γραφω, *I describe.*) The description of the surface of the moon, as geography is a description of the surface of the earth.

SELEU'CIDÆ, ERA OF THE. In Chronology, the era of the Seleucidæ, otherwise called the Macedonian era, dates from the epoch of the first conquests of Seleucus Nicator in Syria, about 311 years before Christ. It was followed generally by the Greek colonies bordering on the Levant; and by the Jews till the 15th century, by whom it was called the *era of contracts*. There is considerable difference of opinion among authors respecting the month and day on which the year of this era commenced, so that it is frequently not possible to fix the correspondence of dates; but according to the computation most generally followed, the year 312 of the era of the Seleucidæ began on the 1st of September in the Julian year preceding the first year of our era. Hence to reduce a Macedonian date to the common era, subtract 311 years and 4 months.

SE'LLA TURCICA. A cavity in the *sphenoid* bone; it is surrounded by the four clenoid processes, and contains the pituitary gland.

SE'LLI. The priests of Jupiter, who delivered his oracles at the sacred grove of Dodona in Epirus.

SE'LTERS or SELTZER WATER. A mineral water from Seltzer, about ten miles from Frankfort on the Maine. It is an agreeable beverage, from the quantity of free carbonic acid which it contains, and which covers its slightly saline taste. Common salt, with the carbonates of magnesia, lime, and soda, are the saline ingredients.

SE'LVAGE. A piece of very flexible kind of rope, composed of yarns not twisted together, but laid parallel, and confined by external marline

SE'MAPHORE. (Gr. σημα, *a sign*, and φερω, *I bear*.) A term mostly used synonymously with *telegraph*, but which, as its derivation imports, may be applied to any means whatever employed to communicate intelligence by signals. *See* TELEGRAPH.

SEME'. (Fr. *sown*.) In Heraldry, a term employed to describe a field or charge powdered or strewed over with figures, such as stars, billets, crosses, &c.

SEMEIO'TIC. (Gr. σημειον, *a sign*.) That which relates to the signs or symptoms of diseases.

SEMI-A'RIANS. A branch of the great Arian heresy, who denied the ὁμοούσιον, or *consubstantiality* of the Son with the Father; but admitted the ὁμοιούσιον, or *similarity of substance*. (*See* art. ARIANS; and Mosheim, *Eccl. Hist.* vol. i. trans. 1790, p. 44. *See* HOMOOUSIANS.)

SE'MIBREVE (*i. e.* half a breve). In Music, a note whose length is half that of a breve. It is the integer whose fractions and multiples express the time of other notes. *See* MUSIC.

SE'MICIRCLE. In Geometry, the half of a circle; or the figure bounded by the diameter and half the circumference.

SEMICO'LON. *See* PUNCTUATION.

SEMICU'BICAL PARABOLA. In Analysis, a curve of the second order: defined by this property, that the cubes of the ordinates are proportional to the squares of the corresponding abscissa; or by the equation $y^3 = a x^2$. The curve is the evolute of the common parabola.

SE'MIDIA'METER. In Geometry, half of the diameter; or the part of the diameter of any figure comprehended between the centre and the extremity of the diameter.

SEMIDIAPA'SON. (Gr.) In Music, a defective octave, or one diminished by a minor semitone.

SE'MIDIAPE'NTE. (Gr.) In Music, the same as *defective fifth*; which see.

SE'MIDIATE'SSARON. (Gr.) In Music, a defective fourth, properly called a *false fourth*.

SEMIDI'TONO. (Gr.) In Music, the same as a *minor third*.

SEMIME'TAL. A term applied by the old chemists to the brittle metals.

SE'MIMI'NIMA. In Music, a half minim or crotchet.

SE'MINYMPH. Lyonnet so calls the nymphs of those insects which undergo but slight changes in passing to the perfect or imago stage.

SEMIO'PAL. A silicious mineral nearly resembling the common opal.

SEMIPA'LMATE. (Lat. semi, *half*, and palma, *a palm*.) In Zoology, when the toes are connected together by a web extending along only their proximal half. The term *semi* being frequently used in the composition of zoological terms with the same meaning, it is only requisite to refer to the term to which it is prefixed.

SEMI-PELA'GIANS. A sect who differ from the Pelagians, from whom they are derived, in maintaining the necessity of the divine grace towards the practice of virtue; but at the same time conceive that this grace may be obtained by an effort of the human will. (*See* CALVINISTS, PELAGIANS, &c.; and Mosheim, *Eccl. Hist.* vol. ii. trans. 1790, p. 92.)

SE'MIQUA'DRATE, or SEMIQUARTILE. In the language of Astrology, an aspect of the planets when distant from each other half a right angle, or 45°. The terms *semiquintile* and *semisextile* have a similar meaning; the first denoting the *half of a fifth* of the complete circle, that is, 36°; and the second the *half of a sixth*, or 30°.

SE'MIQUAVER. In Music, a note whose duration is half that of a quaver.

SE'MISOSPI'RO. (It.) In Music, a small pause equal to the eighth part of a bar in common time.

SE'MITONE. (Gr.) In Music, the half of a tone; though, strictly speaking, that is not a proper definition of it, inasmuch as semitones are of three sorts, — greater, lesser, and natural. In keyed instruments which have their sounds fixed, the semitones afford the means of a new sort of scale between the different tones, by which their defects are partially remedied.

SEMIVO'WEL, is said of those consonants which, like vowels, can be pronounced independently, or without the aid of any other letter. To this class belong *b*, *d*, *c*, *g*, *k*, *p*, *s*, *t*, *v*, *x*, and *z*.

SEMO'NES, in Roman Classical Antiquity, were deities holding a middle place between the twelve supreme gods and heroes. To this class belonged such gods as Vertumnus, Priapus, the Fauns, Satyrs, &c. The word *semones* is a contraction of Lat. semi, *half*, and homo, *man*.

SEMU'NCIA. A small Roman coin, equivalent to half an ounce, being 1-24th of the Roman pound.

SENA'RIA. (Lat.) In ancient Architecture, the pipes of aqueducts, whose diameter was an inch and a half, or six quarters; when they were seven quarters they were called *septenaria*, and so on, according to the number of quarters of inches in their diameter.

SE'NATE. (Lat. senatus; i.e. *assembly of elders*.) The deliberative assembly of the Roman people. The members of this council were originally chosen from the patricians, and were probably single representatives of each of the houses of that order: a plebeian senator is first mentioned A. U. C. 355. At the foundation of the city their number was 100, which was doubled on the admission of the Sabines, and increased to 300 by Tarquinius Priscus; but the more ancient members and those admitted by this last king were distinguished by the titles of *patres majorum* and *patres minorum gentium*, or senators of the greater and of the lesser houses respectively. In the last ages of the republic the members of the senate amounted to above 400, and were still farther raised by the emperors to 1000. The members of the senate were originally chosen by the kings, and afterwards the election fell into the hands of the consuls, military tribunes, and finally of the censors; but the fact of having held certain magistracies, as the quæstorship, and all superior posts, gave a right to this privilege. Under the regal government the senate deliberated on such affairs as the king proposed to them, and he was said to act according to their counsel. On the establishment of the republic the whole power of the state was thrown into its hands, the different magistrates using the authority they enjoyed merely as its delegates. The first constitutional check imposed on it was the power of intercession, or negativing their proceedings, granted to the tribunes of the commonalty. Still while Rome was free the authority of the senate, though subordinate to the assembly of the people, remained very great. It assumed the guardianship of public religion; the management of the revenue; the appointment of governors to the provinces, whose constitution it settled; the direction of diplomatic affairs, and many other functions of importance. Under the emperors its power became, in general, little more than nominal; yet the assembly still existed till the occupation of Italy by the Goths in the 13th century after the foundation of Rome: and in the last ages of its existence, after the seat of empire had been transferred to Byzantium, it seems to have been the centre of what remained of the old national spirit. After that time its existence as a council ceased, though the name of senator was still retained by some noble families of Rome as an empty but high-sounding title. The senatorial badges were the laticlave or tunic with a purple band, black buskins reaching up to the middle of the leg, and a silver crescent on the foot.

The affairs of the Italian and provincial towns of the Roman empire, in imitation of the capital, were administered by senates. See as to these provincial senates, or curiæ, *Savigny's Hist. of the Roman Law*, vol. i.

SENATE. In many republican constitutions of modern times, the upper house of the national assembly has been so called. The senate of the United States (*see* CONGRESS) is composed of two members for each state of the Union. The senators are chosen by the state for six years. The American senate, besides its legislative functions, is also a species of executive council, assisting the president; its consent being necessary for the ratification of treaties, appointment of ambassadors, judges of the supreme court, heads of departments in the administration, &c. It is also the high court of impeachment for public functionaries.

SE'NEGA ROOT. The root of the *Polygala senega*. Rattlesnake root. It is brought from North America: it has a peculiar pungent flavour, and promotes the flow

of saliva. In large doses, it nauseates and purges. It is occasionally used in stimulating gargles; and in America, as an antidote,— probably a very inefficient one,— to the effects of the bite of the rattlesnake.

SE'NEGIN. The bitter acrid principle of the *Polygala senega*, or rattlesnake root.

SE'NESCHAL. A French title of office and dignity, derived from the middle ages, answering to that of steward, or high steward, in England. They were originally the lieutenants of the dukes and other great feudatories of the kingdom; sometimes termed baillis, or bailiffs. When the kings recovered the rights of suzerainty, and especially the judicial authority, in those provinces which had been previously governed by these great nobles, the bailiffs and seneschals continued as royal judges and superintendents, both military and financial; but their powers, like those of the dukes and counts whom they succeeded, were gradually encroached on by the crown.

SENNA LEAVES. The leaves of the *Cassia senna*. They are imported from Alexandria, whither they are brought from Upper Egypt. They are largely mixed with the leaves of the *Cynanchum oleafolium*, or *Argel*, which are thick, and not ribbed like the genuine senna leaves. They have a nauseous, mucilaginous, bitter taste, and yield a pale brownish green infusion. The true senna leaves are distinctly ribbed, thin, generally pointed, and when chewed have a peculiar nauseous flavour, and yield a dark brown infusion. It is a griping, nauseating, and somewhat drastic purge, and a most valuable addition to. or vehicle for, other purgatives.

SE'NSES. (Lat. sentio, *I feel.*) The faculties are so called by which we become acquainted with the properties and states of external things. They are five in number, — sight, hearing, taste, touch, and smell: for the physiology of which, the reader is referred to the articles; such as EYE, EAR, SMELL, &c. See also NERVOUS SYSTEM. We can only here advert to the fact, that the late Dr. Thomas Brown of Edinburgh and Sir C. Bell have propounded the novel doctrine of a sixth sense, called the *muscular* sense (our whole muscular frame being supposed to be a *distinct* organ of sense); — a doctrine which had almost fallen into oblivion, but to which Mr. Whewell has recently declared his adherence in his *Philosophy of the Inductive Sciences*, &c. This part of the subject is ably treated in the *Edin. Review*, vol. lxxiv.

SENSITIVE PLANT. This name is generally applied to a small annual, called *Mimosa pudica*, inhabiting the tropics of America. It has a stem about a foot and a half high, covered with stiff hairs; the leaves are bipinnate in a somewhat digitate manner; and the flowers are collected in small pink balls. It derives its name from the irritability of its leaves, which collapse and fold up when touched, or even when irritated by casting on them the focus of a burning glass; or by exposing them to the vapour of hydrocyanic acid. The cause of this irritability has been investigated by Dutrochet (*Mémoires pour servir à l'Hist. Anat. et Phys. des Végétaux, &c.* vol. i. 534.), who refers the phenomenon to the action of endosmose, and to the operation of a "fibrous tissue capable of moving inward under the influence of oxygenation." Without attempting to analyze the speculations of this author, which, however curious, can scarcely be said to throw much new light upon the subject, it will be sufficient to explain the nature of the phenomena themselves. When the leaf of a sensitive plant is at rest, it consists of many leaflets spreading flat, and connected in pairs along the sides of certain common leaf-stalks. When one of these leaflets is irritated, the pair to which it belongs rise upward, and apply their faces to each other; this is rapidly followed by the same action in the succeeding leaflets, and in the course of a few seconds the whole of the leaflets are in a state of collapse; then the leaf itself suddenly bends downwards; and if the plant is in very good health, the shock thus communicated to one leaf will extend to those immediately above and below it. After a time the leaf resumes its original position. Upon the approach of night, that is to say, upon the withdrawal of light, the leaf falls of itself into the same state, without any special irritation. This kind of irritability is by no means confined to the *Mimosa pudica;* on the contrary, some other species of the same genus, as the *M. dormiens, sensitiva, casta, somnians, palpitans*, &c. possess the same property, as is indicated by their names. And among the Leguminous order, it is also found beyond the genus *Mimosa*, as in the *Hedysarum gyrans*, whose three leaflets are in a continual state of dancing or balancing during the day. In fact the folding their leaves at night, which is universal in all the compound-leaved species of this order, is the same thing feebly exercised. Nor is such irritability confined to this order; the ternate and pinnate leaved species of *Oxalis*, the *Diandra muscipula*, and numerous other plants, exhibit similar phenomena.

SE'NSUALISM. In Mental Philosophy, that theory which resolves all our mental acts and intellectual powers into various modifications of mere sensation. The best known, and the most elaborate attempt of this kind which has been made in modern times, is that of Condillac, who conceived that he was following out the principles of Locke into their legitimate consequences. For this belief it cannot be denied that there exists at least plausible ground. Locke does indeed draw a distinction between sensation and reflection, as separate sources of "ideas;" but his account of reflection is so vague, and its existence apparently so unsupported in his system, as to justify the attempt to reduce it to mere revived sensation. The writings of Condillac may be regarded as a fair *reductio ad absurdum* of the theory which attempts to explain the existence of our mental phenomena independently of conditions in the mind itself. The theory opposed to sensualism is called *intellectualism.*

SE'NTENCE. In English Law, the decree or judgment of the ecclesiastical or admiralty courts is so termed; also, in popular language, the judgment of a criminal court allotting the punishment of a convicted person.

SE'NTRY. (Lat. sentio, *I perceive.*) The name given to a soldier when placed on guard. In all the countries of Europe, sentries are relieved every two hours.

SE'NZA (It. *without*), in Music, signifies without; as *senza stromenti*, without instruments; *con è senza violini*, with and without violins.

SE'PALS. The divisions of that portion of a flower called the *calyx*.

SE'PARATISTS. A religious sect which originated in Dublin about the year 1803. Their principle, like that of most sects at their commencement, was to return more nearly to what they conceived to be the primitive form of Christianity. There is nothing very peculiar in their tenets, beyond their withdrawal from the fellowship of other Christian bodies. In the year 1833 an act of parliament was passed for their relief in the matter of oaths.

SE'PARATISTS, or MOTAZALITES. The name of one of the chief heretical sects of the Mohammedans. They were the followers of Wasel Ebn Orta, who dissented from the main body of the Mohammedans about the 40th year of the Hegira. Their leading tenets consisted in rejecting the eternal attributes of God; in denying the great doctrine of predestination, so zealously cherished by all the orthodox Mussulmans; and in asserting the free agency of man. This sect is said to have been the first inventors of scholastic divinity, and are subdivided into several inferior sects, which mutually brand one another as infidels. (*Sale's Koran*, Preliminary Discourse, vol. i. p. 212.) The great opponents of the Separatists were the Sefatians, who maintained the eternal attributes of God (hence they were called *Sefati*, or Attributists); but who afterwards adopted a belief in the outward resemblance of God to created beings. This sect was afterwards subdivided into various sects, the chief of which were the Asharians, Moshabbehites, Keramians, Jabarians, and Morgians: for an account of which the reader is referred to the *Preliminary Discourse* above mentioned.

SE'PIA. In the Fine Arts, a species of pigment prepared from a black juice secreted by certain glands of the *sepia* or cuttlefish, which the animal ejects both to darken the water when it is pursued, and as a direct means of annoyance. That this juice was used as ink by the ancients is well known.

> Tunc queritur, crassus calamo quod pendeat humor,
> Nigra quod infusa vanescat *sepia* lympha;
> Dilutas queritur geminet quod fistula guttas.
>
> *Pers.* Sat. III.

Compare Pliny (*Nat. Hist.* l. ii. c. 29.), where he says that it was the property of this fish, when it was enclosed by a net, to shed a black juice, which so darkened the water that the fisherman could not see it. All the varieties of the sepia yield this juice; but the *Sepia officinalis*, which is so common in the Mediterranean, is chiefly sought after, from the profusion of colour which it affords. It is insoluble in water, but is extremely diffusible through it, and is very slowly deposited. When prepared with caustic lye, it forms a beautiful brown colour with a fine grain, and has given name to a species of drawing now extensively cultivated for landscapes and other branches of the fine arts. The honour of the invention of the sepic drawing is due to Professor Seidelmann of Dresden, who discovered it at Rome in 1777.

SE'PIADÆ. (Gr. σηπια.) Cuttle-fish tribe. The name of the family of Decapodous Dibranchiate Cephalopods of which the cuttle-fish (*Sepia officinalis*) is the type. They are characterized by the rudiment of a shell, in the form of a friable calcareous plate, imbedded in the back part of the mantle, and of which the material called *pounce* is made.

SE'PIOLA. (Dim. of sepia, *a cuttle-fish.*) The name of a genus of Decapodous Dibranchiate Cephalopods, of which the species are of small size, and are characterized by short, rounded, advanced subdorsal fins, and a short internal horny style.

SE'PIUM. The bone or internal shell of the cuttle-fish.

SE'POY. (A corruption of the Indian word sipahi, *soldier.*) The designation of the native troops in the service of the East India Company. They were so called as early as 1708 (see *Mill's British India*, book iv. ch. 1.), although at that period they do not seem to have been as yet disciplined in the European fashion, nor, indeed, until long after other European powers had set the example. (See the *United Service Journal* for 1836, vol. i. p. 461., where there is a valuable paper on the "History and Character of the Indian Army.") The first Sepoys (says the author) who were raised and regularly disciplined by the English, seem to have been carefully chosen either from among the Mohammedan portion of the population, or from among the higher castes of Hindoos, a considerable proportion of the latter being Rajpoots, the most warlike of Indian races. But the necessities of the service have subsequently introduced a greater mixture in their ranks. The character of the Sepoys as soldiers has been the subject of much discussion. According to a writer in the same periodical (1831, vol. iii. p. 3.), "the Sepoys have justly been celebrated for excellent qualities; as, for instance, patience and fortitude under difficulties and privations. But, on the other hand, if we analyze the account of the wars in which they have been employed, we shall find that they seem to possess passive rather than active courage; for instance, that in line they will remain steady under fire: in a broken or close country, however, where skirmishers and small detachments are necessarily most employed, they are found wanting." Others, however, disagree even from this modified dispraise. At all events, their fidelity and respect for their officers have generally been found of the highest and most durable character; the famous mutinies of Vellore in 1806, and Barrackpore in 1825, having been both, it is generally thought, provoked by the mismanagement of their superiors. Some, indeed, allege that these qualities received a severe shock in 1796, when a considerable alteration was made in the organization of the Indian army, and a larger proportion of British officers introduced, so that the internal economy of their battalions ceased to be superintended by their own "subadars." The Sepoys of Madras, says Sir J. Malcolm (*Quarterly Rev.* vol. xviii.), still remember with pride the campaigns of Clive and Coote, which are far beyond the memory of the present generation. The native Indian cannot rise higher than the rank of ensign, or cornet. The native cavalry is of more recent introduction, and seems scarcely to merit the praise of steadiness, which all agree in bestowing on the infantry. (See also *Williams's Indian Army;* Alison, *Hist. of the Revolution*, chap. li.; *Sir J. Malcolm's Political History of India*, vol. ii. chap. x.)

SEPS. (Lat. *a species of serpent.*) The name of a genus of Saurian reptiles, which have a long round serpentiform body, and four very short legs, each terminated in the common seps (*Seps chalcides*) by only three toes.

SEPTA'RIA. Nodules of indurated and slightly ferruginous marl, with interior fissures generally filled with some crystallized mineral, such as carbonate of lime, quartz, sulphate of baryta, &c.; thus dividing the section of the nodule into *septa*, or distinct partitions. When calcined and reduced to powder, these septaria furnish the valuable mortar called *Roman* or *Parker's cement*, which has the property of hardening under water.

SEPTE'MBER (Lat. septem, *seven*), so called from its being the seventh month in the Roman year as established by Romulus, which began with March, is the ninth month in the calendar of Numa. Several of the Roman emperors gave names to this month in honour of themselves; but, unlike the month of August, whose ancient name of Sextilis has been quite merged in that of Augustus, the name of September has outlived every other appellation.

SEPTE'MBRISTS. The name given to the agents in the dreadful massacre which took place in Paris on September 2. 1792, during the French Revolution. The numbers that perished in this massacre have been variously given; but the term has become proverbial throughout Europe for all that is bloodthirsty and malignant in human nature.

SEPTE'MVIRI EPULONUM. Certain priests in ancient Rome were so called, whose duty consisted in preparing the sacred feasts at games, processions, and on other solemn occasions. They were assistants to the *pontifices*, certain of whose privileges, such as the right of wearing the *toga prætexta*, they enjoyed. Their office was instituted A. U. C. 557; and at first they were only three in number, which was increased to seven, it is supposed, by Sylla.

SE'PTIC. (Gr. *σηπτος*, *putrid.*) A term applied by the old chemists and physiologists to certain substances supposed to promote putrefaction.

SEPTUAGE'SIMA. (Lat. *seventieth.*) In the Ecclesiastical Calendar, the third Sunday before Lent; the first Sunday in Lent being termed Quadragesima (fortieth), the three preceding ones Septuagesima, Sexagesima, and Quinquagesima.

SE'PTUAGINT. (Lat. *seventy.*) The Greek translation of the Old Testament made at Alexandria for the advantage of the Jews of Egypt, who had lost the use of the Hebrew language. According to the old tradition, this version was the work of seventy-two interpreters, who were shut up in separate cells by the command of Ptolemy Philadelphus, and there completed the whole translation alone, in which, upon examination, they were all found to agree to a letter; — a prodigy which established the inspiration of the work. It is supposed, however, by modern critics, that this version of the several books is the work not only of different hands, but of separate times; although the general design may have been that which we have mentioned. The authority of the Septuagint, as compared with the Hebrew text, from which it differs in many points, has been the subject of much controversy. It is from this version that the authenticity of the Apocrypha, which are not found in the Hebrew, is asserted by Roman Catholic writers. The quotations of the Old Testament which are found in the New are for the most part given in the words of the Septuagint. (See *Prideaux' Connection.*)

SE'PTUM. (Lat. *a partition.*) In Botany, any partition separating a body into two or more cells in a direction parallel with the longer axis. Partitions parallel with the shorter axis are called *phragmata*.

SEPTUM. In Anatomy the plate or wall which separates from each other two adjoining cavities; as the septum transversum, or diaphragm, between the chest and the abdomen; the septum narium, between the two nasal passages; the septum ventriculosum in the brain, and in the heart, &c. The partitions of chambered shells are also called *septa*.

SE'PULCHRE. *See* TOMB.

SE'PULCHRE, SAINT, HOSPITALLERS OF THE. An order of knighthood, originally instituted in Palestine, afterwards established in France by Louis VII., and united by Pope Innocent VIII. to that of Malta; but the order still continued to exist in France, and was taken under protection by Louis XVIII. in 1814.

SE'PULTURE, RITES OF (Lat. sepelio, *I bury*), signify literally the ceremonies performed in depositing the bodies of the dead *in the earth;* but the expression is applied in a more extended signification to all ceremonies of this kind, whether they consist in *interment*, *incremation*, or *embalming*. A veneration for the dead has characterized the history of every age and country; and the different kinds of funeral rites that prevail among different nations are intimately connected with their religious feelings, and form important testimonies at once of their modes of thinking and degrees of civilization. The three chief modes of treating the dead that have prevailed from the earliest ages down to the present times, are burning, interment, and embalming*; and all these modes were accompanied by ceremonies differing according to the genius or taste of the different people, but bearing, notwithstanding, such strong features of resemblance, as sufficiently to indicate the universality of the feeling which led to their adoption. The peculiar solemnities of the Greeks and Romans, among whom both incremation and interment prevailed, though the former was by far the most frequent, need not be detailed in this place. Among the Romans, the importance of burial to the dead may be gathered from the belief, that the souls of the unburied wandered a hundred years on the borders of the Styx before they were admitted to the infernal regions. The practice, peculiar to the Egyptians, of embalming their dead, has been noticed under MUMMY; and the custom still prevalent in India — which it may be truly said monopolizes the cruelties of funereal observances — of immolating women on the funeral pile of their husbands, will be found under SUTTEE. The practice of interment has been adopted by all the nations that have embraced Christianity. *See* CEMETERY.

SE'QUENCE. (Lat. sequentia.) In Music, a similar succession of chords ascending or descending diatonically.

SEQUESTRA'TION. In English Law, a species of execution for debt in the case of a beneficed clergyman, issued by the bishop of the diocese on the receipt of a writ to that effect. The profits of the benefice are paid over to the creditor until his claim is satisfied. *Sequestration* is also, in Chancery, the setting aside from both parties the matter in controversy.

SEQUESTRATION. In Scottish Law — 1. A species of diligence (*i. e.* a process), used where two or more creditors are in competition for the property of a land estate, the

* The singular usage adopted by the followers of Zoroaster, and still preserved in Thibet, is worthy of particular notice. From an idea that the pure elements of earth and fire would be contaminated by being made the instruments of dissolution, the corpse is laid upon a platform erected for the purpose, and enclosed with massy walls, and there abandoned as a prey to the wolves and the vultures. (*Schlegel's History of Literature.*)

owner of which is in insolvent circumstances; or where the right to a land estate is the subject of litigation. In these cases the court may, on application, sequestrate the rents, and employ a factor to collect them. 2. Sequestration is also the process whereby the whole estate, both heritable and moveable, of a bankrupt, is distributed equitably amongst his creditors. It is granted on application to the court of session by the bankrupt, with the concurrence of one or more creditors, or on their application, and on citation of the bankrupt; and is analogous to a fiat in bankruptcy in English law.

SE'QUIN. (Ital. zecchino; derived from zecca, *a mint.*) The gold pieces of Venice were originally so called; afterwards the name was extended to other gold coins in use in the Mediterranean, as those of the Pope, the Sultan, Florence, and Genoa. *See* MONEY.

SERA'GLIO. An Italian corruption of the oriental word *serai*. The palace of the Turkish sultan in Constantinople is thus designated by European writers. The principal gate of the seraglio is the Babi Humayun, or Sublime Gate, whence the ordinary title of the Turkish government is derived.

SE'RAPHIM, or JESUS, ORDER OF THE. An ancient Swedish order of knighthood, instituted in 1334; but dormant from the period of the Reformation until 1748. The number of knights, besides the king and members of the royal family, is limited to twenty-four.

SE'RAPHINE. A keyed musical wind instrument of the organ species, adapted to the size of a chamber.

SE'RAPHS, or SERAPHIM. (Heb. *to purify.*) In the Celestial Hierarchy, the angels of the highest rank. They are represented as surrounding the throne of God, whose messengers they are, and as being more immediately inspired with the Divine love, which they communicate to the inferior inhabitants of heaven. They are almost invariably spoken of in connection with the *cherubim*, whom they resemble both in rank and attributes.

SERA'PIS. An Egyptian deity. The image and worship of this god were brought from Sinope in Pontus to Alexandria, in the last year of Ptolemy Soter, in consequence, it is said, of a vision of Ptolemy I. According to some accounts, this image was a statue of Jupiter; but however this may have been, Serapis was clearly, as Sir G. Wilkinson expresses it (*Anc. Egypt.* iv. 360.), "at most a Græco-Egyptian deity." And there is no foundation for the notion entertained by some early Christian fathers, that he represented the Patriarch Joseph (which they supported by an argument drawn from the ornament in the shape of a bushel which the images of this god usually bore on the head); or for that of some modern antiquaries, that it was another name for Apis. (*Plut. de Is. et Osir. Quart. Rev.*, July, 1840.)

SE'RASQUIER. The name given by the Turks to the commanders-in-chief of their armies. It is compounded of two Persian words, signifying *head of an army.*

SERENA'DE (Span. serenata; from Lat. serenus, *clear*), signified originally music performed in the open air on a *serene* evening; but it is now universally applied to a musical performance made by gentlemen in a spirit of gallantry under the windows of ladies whom they admire. This practice, which was formerly very general in Spain and Italy, has latterly fallen greatly into disuse in these countries; but it is still very common in the German university towns, where the students are in the habit of assembling in the evening under the windows of a favourite professor, and offering him a musical tribute.

SERE'NE, SERENE HIGHNESS, SERENITY. (Germ. durchlaucht.) Titles of courtesy in European etiquette of considerable antiquity. Before the dissolution of the German empire, Serene and Most Serene Highness were the appropriate addresses of princely houses holding immediately of the empire. Since that period the rules of princely etiquette have become more uncertain; but it appears to be the general principle that these titles belong of right to members of the families of sovereign houses in the confederacy, and also to members of ci-devant sovereign houses *now mediatized;* and that sovereign princes can moreover concede these appellations to princes not sovereign within their own dominions, but not so as to give them a title to it out of them. But the distinctions as to the mode in which these titles are to be employed in addressing superiors, equals, and inferiors, are extremely complicated.

SERF. (Lat. servus.) The French name for the lowest class of slaves in the dark ages; those who were incapable of holding property, attached to the land, and liable to feudal services of the lowest description. In England this appears to have been the general character of the condition of the *villeins;* but in France and Germany Mr. Hallam thinks that the villeins, properly so called, were a superior class, only bound to fixed payments and duties in respect of their land. (*Middle Ages*, chap. ii. part 2. *See* VILLEIN.) The emancipation of this class in France was extremely gradual. Louis Hutin enfranchised them on the royal domains by edict in 1315; but it does not appear to have been carried immediately into execution, and a limited kind of servitude existed in some places down to the Revolution. The "serfs," or "gens de main morte," on some estates (*e.g.* in part of Champagne and Nivernois), could not leave their habitations, and might be followed by the lord in any part of France for the *taille*, or villein tax, which in some localities was not permanent, but *a volonté.* (See, as to the progress of enfranchisement, a memoir by Duprey, *Hist. Ac. I.* 38.)

SERGE. A cloth of quilted woollen, extensively manufactured in Devonshire and other English counties.

SERGEANT. *See* SERJEANT.

SE'RIES (Lat. *order*), in Arithmetic and Algebra, is a progression of numbers or quantities which succeed each other according to some determinate law. Thus, the progression of the natural numbers 1, 2, 3, 4, 5, &c. constitutes a series; the law of which is, that any term is greater by unity than the preceding. As the law which connects the terms may be varied in an infinite number of ways, it follows that series may have an infinite number of different forms: thus, an *arithmetical* series is one in which each term differs from the preceding by a constant number or quantity; a *geometrical* series is one in which each term is a multiple of the preceding by a constant factor.

The usual form of a series is a set of terms connected by the signs + or −. When the number of terms is greater than any assignable number, the series is said to be *infinite*.

A *converging series* is one in which the successive terms become less and less, each being smaller than that which immediately precedes it.

A *diverging series* is one in which any term is greater than the preceding.

A *recurring series* is one in which each term is a certain constant function of two or more of the preceding terms. Thus, $1 + 3x + 4x^2 + 7x^3 + 11x^4 +$ &c., is a recurring series, every term being formed in the same manner from the two immediately preceding. This series is formed by the expansion by division of the algebraic fraction $\frac{1 + 2x}{1 - x - x^2}$.

An *exponential series* is one whose terms depend on exponential quantities; a *logarithmic series* is one whose terms depend on logarithms; and a *circular series* one whose terms depend on circular functions, as sines, cosines, &c.

The *general term* of a series is a function of some indeterminate quantity x, which, on substituting successively the numbers 1, 2, 3, &c. for x, produces the terms of the series.

In general, the principal questions which arise respecting series are to find the sum of all the terms, or of a given number of them; and the exposition of the methods which have been invented for this purpose forms an extensive and important part of every treatise on the calculus. The student may be recommended in particular to Euler's *Introductio in Analysin Infinitorum*, and *Calculus Differentialis;* and the third volume of Lacroix's *Calcul Différentiel et Integral.*

SE'RJEANT. (Lat. serviens.) Serjeant-at-law is the highest degree in the common law, and all must proceed through this degree before attaining the dignity of judge. The Court of Common Pleas is open to serjeants only for the purpose of pleading. This exclusive privilege was attempted to be taken away in 1834, and for five years the court was thrown open. But after solemn argument, it was decided by the privy council that this enlargement was unwarranted; and the former practice again prevails. Serjeants-at-law are now made by the king's writ, commanding them to take their degree. No precise time seems now necessary to permit a barrister to become a serjeant. (See Serjeant Manning's learned work, *Serviens ad Legem.*)

SERJEANT. In the Army, a non-commissioned officer, both in infantry and cavalry regiments, whose duty it is to form the ranks and to instruct recruits in discipline. On parade they act as fuglemen, in going through the evolutions. The serjeant-major is a non-commissioned officer, who acts as assistant to the adjutant; but originally he was a field officer, corresponding in rank to the modern major. Colour-serjeants are certain non-commissioned officers appointed to attend the officers who have charge of the colours of the regiment.

SERJEANT, KING'S. One or more of the serjeants-at-law, whose presumed duty is to plead for the king in causes of a public nature, as indictments for treason, &c.

SE'RJEANTS-AT-ARMS. Officers whose duty is to attend the person of the king, the lord-high-steward when sitting in judgment on a traitor, &c. The whole number is restricted by an ancient law (13 R. 2.) to thirty. Two of these are allowed by the king to attend at the houses of parliament during their sittings, and each has a deputy. In the House of Lords, the practical maintenance of decorum below the bar, near the throne, and in the gallery, devolves upon the gentleman and

yeoman usher, with their assistants; so that "the serjeant-at-arms attending the House of Lords" has less conspicuous duties to perform than those which devolve upon "the serjeant attending the House of Commons:" both, however, execute the commands of the house to which they belong, as regards the apprehension or custody of all persons committed by order of parliament. In the House of Commons, the serjeant-at-arms is an officer of considerable importance, enjoying large emoluments, assisted by a deputy and several subordinate officers. During the sittings of the house he occupies a chair below the bar, and he directs a large proportion of the arrangements connected with the maintenance of order in the approaches to the house and the offices adjacent. He is at once the executive and the ceremonial officer of the lower house; but his discretionary powers are not extensive, for almost all his more important duties are performed under the immediate direction of the house itself, communicated through the speaker. The office is usually held by a gentleman of the military profession, seldom under the rank of a field officer.

SERJEANTY, GRAND AND PETTY. In English Law, feudal tenures. Tenure by grand serjeanty was where the tenant held land of the king by service, to be performed in his own person, in his wars, &c.; such as to bear a banner or spear, or to assist at his coronation. Tenure by petit serjeanty was where the owner was bound to contribute some small thing towards military service, &c.; such as a sword, dagger, bow, or spear. Tenure by grand serjeanty was preserved by stat. 12 C. 2., which abolished the other feudal tenures, and still subsists in some cases; as, for instance, the family of Dymoke hold the lands of Scrivelsby by the service of attending as champions at royal coronations.

SE'RMON. In Ecclesiastical usage. The use of the sermon or homily as a portion of the communion service is said to be of remote antiquity. This ancient custom fell into partial disuse during a great part of the middle ages. The Homilies of Elfric, archbishop of Canterbury in the 10th century, were long used in the English church; but these became antiquated; and in the year 1281, says Mr. Palmer (*Orig. Liturg.* vol. ii. ch. 4.), preaching seems to have been generally omitted. In that year Archbishop Peckham ordered, in his Constitutions, that four sermons should be delivered during the year. But for some time prior to the Reformation preaching was again coming more into use; and the publication of homilies by authority seems to have completely restored the ancient practice. *See* Homily.

SERON. A buffalo's hide, used for packing drugs and other articles.

SERO'SITY. (Lat. serum.) The liquid which exudes from the serum of the blood when it is coagulated by heat. It is water holding some of the salts of the blood and a trace of albumen in solution.

SE'RPENS, or SERPENS OPHIUCHI. In Astronomy, one of the ancient constellations in the northern hemisphere.

SERPENT. In Zoology, a general name for the species of the order *Ophidia*.

Serpents are divided into spurious, or *Pseudophidians*, and true, or *Ophidians* proper. The *Pseudophidians*, although presenting the well-marked external characters of the order, retain an imperfect pelvis, a small sternum, scapulæ, and coracoids or clavicles, hidden beneath the skin; whereby, as well as in the structure of the skull, they approach the Saurian order. The common blind-worm (*Anguis fragilis*) is a native representative of the *Pseudophidian* family.

The true serpents have neither sternum nor vestige of the scapular arch: they have no third eyelid, nor tympanum; but the auditory ossicle exists beneath the skin, and its handle passes behind the tympanic bone. Several species retain a vestige of hind-limbs, which in some even shows itself externally in the form of a small hook. The chief subdivisions of the true *Ophidians* are, — the *Amphisbænæ*; the *Tythlopes*; the *Roles* (*Tortrix*); the *Boas*; the *Pythons*; the *Colubers*; the *Acrochords*; — all which tribes are non-venomous. The *Pseudoboas*, *Rattlesnakes*, *Trigonocephali*, and *Vipers* are the venomous tribes; and are distinguished by having the superior maxillary bones short and moveable, supporting fewer teeth than in the non-venomous serpents, and having the first of the short series larger than the rest, sometimes the only conspicuous fang, and traversed by the duct of a poison-gland, around which duct the tooth is, as it were, longitudinally folded, so as to appear perforated by a canal. The last tribe of true serpents includes the *Hydrophides*, or sea-snakes, which have likewise a poison-gland and duct, the latter being inclosed by the first instead of the first of the maxillary series of teeth. The tail of the sea-snakes is flattened vertically, and forms their chief organ of swimming. No species of this family has yet been discovered which exceeds seven feet in length.

The remains of an extinct genus of serpents (*Palæophis*), indicating species of from ten to twenty feet in length, have been discovered in the Eocene tertiary formations in Suffolk, Kent, and Sussex. (See Mr. Owen's Paper in the *Geological Transactions*, 2d Series, vol. vi. p. 209.)

In antiquity the serpent played an important part. By some nations it was regarded as the emblem of cunning, deceit, and wickedness (compare the narration of the fall of man in Genesis with the Persian saga of Ahreman and Ormuzd); by others, such as the Egyptians and Phœnicians, it was looked upon as a good genius (αγαθοδαιμων), and worshipped as the emblem of fertility; while by the Greeks and Romans, whose mythology originated undoubtedly from Egypt and the East, it appeared under a variety of symbolic representations. With the latter the serpent was the well-known emblem of the healing art; and in the present time a serpent with its tail in its mouth is regarded as an emblem of eternity. The serpent appears also to have held a place in the Scandinavian mythology, where it was regarded as a symbol of the human passions. In the early ages of the Christian church, a sect of the Gnostics, also, worshipped the serpent, whence they were called Ophites (from Gr. οφις, *a serpent*). (See *Mosheim's Geschichte der Schlangenbrüder der ersten Kirche.*)

Serpent. (So called from its form.) A musical brass wind instrument, serving as bass to the horns or cornets. It is most generally covered with leather, and has three parts, — a mouth-piece, neck, and tail. The compass is two octaves, produced by six holes stopped with the fingers.

SERPENTA'RIUS. One of the ancient northern constellations, represented on the globes by the figure of a man grasping a serpent (*serpens*) in his hand. *See* Constellation.

SE'RPENTINE. A magnesian rock of various colours, and often speckled like a serpent's back. *See* Geology.

SERPI'GO. *See* Ringworm.

SERPU'LEANS, *Serpulea*. (Lat. serpo, *I creep*.) The name of a family of Cephalobranchiate Anellidans, inhabiting cylindrical and tortuous calcareous tubes; generally parasitic on shells.

SE'RRATE. (Lat. serra, *a saw*.) In Zoology, when a part is cut into teeth like a saw, or is armed with teeth whose sides are unequal.

SER'RICORNS, *Serricornes*. (Lat. serra, *a saw*; cornu, *a horn*.) The name of a family of Coleopterous insects, comprehending those which have serrated or saw-shaped antennæ.

SERTULA'RIA. (Lat. sertum, *a wreath*.) The name of a genus of compound tubular Polypes; restricted, in modern zoology, to those species in which the cells are arranged on two sides of the stem, either opposite or alternate.

SE'RUM. (Lat.) The fluid which separates from blood during its coagulation. *See* Blood.

SE'RVILE. A Spanish political nickname; applied, in the first instance, to those who opposed the changes advocated by the liberal party in the cortes of 1808 and the following years.

SE'RVITES. (Servants of the blessed Virgin.) A religious order, instituted in Tuscany in A. D. 1233, under the rule of St. Augustin. The monks wore a black habit, in commemoration of the widowhood of the Virgin. (*Mosheim*, cent. xiii. part 2.)

SERVITOR. (Lat.) An under graduate, who is partly supported by the college funds, is so called at Oxford. The servitors at Oxford are the same class as the sizars at Cambridge.

SE'RVITUDE, in the Civil Law, is divided into real or predial, mixed, and personal: the first being the subjection of an inheritable thing to certain duties or services towards another inheritable thing; the second, that of an inheritable thing towards a person; the third, that of a person towards a person or thing, *i. e.* slavery, whether by dependence on a person or on the soil. The word *servitude* is equally applicable to the duty or burden, and to the right of exacting it: *e. g.* the right of way which A. enjoys on the land of B., and B.'s liability to permit that right to be exercised, are both designated by the term *servitude*; the first active, the latter passive. Real servitudes are numerous, and fall into several classes or divisions. They are, for example, either *visible*, such as the right to light and air, sewers, &c.; or *latent*, such as the right of way, right of drawing water, &c., which appear only when they are exercised. They were also divided by the Romans into urban, which affected dwellings in the city; and rustic, appertaining to land and farm building. Of mixed servitudes only three species were recognized by their writers on jurisprudence, — usufruct, use, and habitation.

SE'SAMOID BONES. (Gr. σησαμη, *a seed or grain*, and ειδος, *form*.) Small bones found at the articulations of the great toes, and occasionally at the joints of the thumbs. Little tendinous ossifications are sometimes met with in other parts, especially in the advanced age of laborious persons.

SE'SAMUM. (Gr. σησαμον.) A genus of plants of the natural family *Pedalinæ*. They are supposed originally to have been natives of India; but are now cultivated in many countries. Their seeds, which are employed as an article of diet, and yield an oil of a very fine quality, form an extensive article of commerce in the East. All the species are annuals. The term *sesame* has long been familiar to all the readers of the *Arabian Nights' Entertainments*.

SE'SIA. (Gr. σης, *a moth*.) The name of a genus of Lepidopterous insects.

SE'SQUI (Lat.), applied to words, signifies one integer and a half; as sesqui granum, *a grain and a half*, &c. In Chemistry this term is used to designate compounds in which an equivalent and a half of one substance are combined with one of another; thus, sesquicarbonate of soda is a salt composed of one equivalent and a half of carbonic acid with one of soda.

Sesqui. In Music, a whole and a half; which, joined with *altera*, *terza*, *quarta*, &c., is much used in the Italian music to express a set of ratios, particularly the several species of triple time.

Sesqui. In Geometry, the expression of a ratio in which the greater term contains the less once, and leaving a certain aliquot part of the less over. Thus, if the part remaining is half the less term, the ratio is called *sesquialtera*; if the part remaining be a third of the less term (as in the ratio of 4 to 3), the ratio is called *sesquitertia*, and so on. These terms are nearly obsolete. *Sesquiduplicate*, however, sometimes occurs in modern treatises, and signifies the ratio in which the greater term is twice and a half times the less; as the ratio of 10 to 4, or of 15 to 6.

SE'SSILES, *Sessilia*. (Lat. sedeo, *I sit*.) The name of a division of the class *Cirripeds*, comprehending those species which are not suspended by a pedicle.

SE'SSION, COURT OF. The supreme civil court of Scotland, having jurisdiction in all civil questions, of whatever nature. It was constituted by an act of the Scottish parliament in 1537. It was intended to supply the place of the previously existing courts, and more especially of a judicial committee of parliament called the "lords of session;" whence the name of the court and the titles of the judges. Originally it consisted of seven laymen and eight churchmen, including the president. In 1640, however, an act was passed providing for the exclusion of churchmen from the court; and though repealed in 1661, the principle laid down in it has ever since been acted upon. Other important improvements were introduced at different periods, particularly after the Revolution, when the right of appeal from the court to parliament was, for the first time, recognized. At the Union power was given to all individuals who considered themselves aggrieved by judgments of the Court of Session to appeal to the H. of Lords; and it is a curious fact that at this moment, and for a lengthened period, the principal judicial business of the H. of Lords has consisted in hearing and deciding Scotch appeals. Originally, and down to 1808, the whole fifteen judges sat together in one court; but in that year an act was passed dividing the court into two chambers, the lord president presiding in the first division of seven judges, and the lord justice-clerk in the second of six; the two remaining judges trying cases in the first instance, or, as it is technically termed, sitting as lords-ordinary. Since then the number of judges has been reduced to thirteen; four belonging to each of the divisions, and five acting as lords-ordinary. The judges were at first chosen by the Scotch parliament; but since 1554 they have been appointed by the crown. They are either, as already stated, called lords of session, or senators of the college of justice; which last embraces the whole body of barristers (advocates) and attorneys or solicitors who practise before the court. They must be twenty-five years of age; and, by the Treaty of Union, no person can be named to the office unless he have served as an advocate or principal clerk of session for five years, or as a writer to the signet for ten. The salaries of the ordinary judges have recently been raised to 3000*l*. a year each; those of the lord justice-clerk and lord president being respectively 4000*l*. and 4500*l*.

At its outset the Court of Session was intended to serve as a standing or perpetual jury for the trial of cases; the introduction of petty juries into the trial of civil cases in Scotland being only of very recent date, as well as of limited application. It was, in fact, unknown till 1815, when a special or jury court was instituted, for the trial of cases involving questions as to the value of property, or damages, or the determination of some fact. But in 1830 this court was suppressed, and the Court of Session now avails itself of the assistance of petty juries in the trial of the above description of cases. *See* Justiciary, Court of.

SE'SSION OF PARLIAMENT. The period between its meeting and prorogation. All the acts passed in a session are legally considered as forming a single statute; each separate act being designated as a chapter, and its subdivisions as sections. *See* Parliament.

SESSIONS OF THE PEACE. In English Law, the term "Session of the Peace" is applied to designate a sitting of justices of the peace for the execution of those duties which are confided to them by their commission, and by charter or statute. Such are, — 1. A petty (or petit) session, which is a private meeting of two or more justices of the peace for the execution of some power vested in them by law; many acts of parliament requiring the concurrence of a plurality of justices, and there being other occasions on which, although not strictly necessary, it is considered usual and expedient. One of the most important instances of the first kind is the holding parties to bail against whom a charge of felony has been entertained. 2. A special session; which is principally distinguished from the former by being public, instead of on the private motion of the justices, it being necessary that notice should be given to every magistrate of the division. Special sessions are held to grant licences, execute the provisions of the Highway Act, appoint overseers of the poor, and for many other purposes. 3. Quarter sessions. (See that article; and see Justice of the Peace.)

SESTE'RTIUM. (Contracted from mille sestertiorum.) The sum of 1000 sestertii; usually estimated at about 8*l*. English.

SESTE'RTIUS. A sesterce; a Roman silver coin, equal in value to two *asses* and a half, or nearly twopence of English money.

SE'TA (Lat.), is a term used by botanists in various senses. It is the stalk that supports the theca, capsule, or sporangium of mosses; the awn or beard of grasses, when it proceeds from the extreme point of a palea or glume; sometimes the glandular aculeus of roses, and also the abortive stamens or rudimentary perianth of Cyperaceous plants.

SETA'CEOUS. (Lat. seta.) In Entomology, the antennæ which resemble a bristle are so called.

SET FAIR. In Architecture, the coat of plaster used after roughing in and floated, or pricked up and floated. It should be well trowelled, to answer well for colour.

SE'THIANS. In Ecclesiastical history, a sect of Christian heretics, who sprung up in Egypt in the second century, strongly imbued with the principles of Gnosticism; but whose chief peculiarity consisted in their belief in the identity of Jesus Christ with Seth, the son of Adam, whence they derived their name. They continued to exist about 200 years, during which period they had many followers.

SE'TICERS, *Seticera*. (Lat. seta, *a bristle*; Gr. κερας, *a horn*.) A term applied by Latreille to a family of Lophyropodous Crustaceans, including those in which the superior antennæ are long and setaceous.

SE'TIGERS, *Setigera*. (Lat. seta, *a bristle*; gero, *I carry*.) The name of a tribe of Anellidans, including those which, like the earthworm, are provided with bristles for progressive motion. The *Setigera* are the first tribe of the Abranchiated order of Anellidans.

SE'TIREMES. (Lat. seta, *a bristle*; remus, *an oar*.) A name given by Kirby to the natatory legs of certain aquatic insects, which are fringed with bristles.

SET OFF. In Law, a species of defence to a civil action, by which a party acknowledges the justice of the plaintiff's demand, but sets up a demand of his own against the plaintiff sufficient to counterbalance either the whole or a part of it.

SE'TON. (From Lat. seta, *a bristle*; because bristles or horse hairs were formerly used to keep open the wound.) A seton is an artificial ulcer, made by passing a skein of thread under a portion of the skin by means of an instrument called a seton needle: the thread is occasionally anointed with irritating substances, in order to keep up a discharge from the sore.

SETO'SE. (Lat. seta, *a bristle*.) In Zoology, when a surface is beset with stiff scattered hairs.

SE'TTING. In Architecture, the quality of hardening in plaster. Also the fixing of stones in walls or vaults.

SE'TTING COAT. In Architecture, the best sort of plastering on ceilings or walls; in inferior work it is made of *fine stuff*, and when the work is very dry a little sand is used. A setting coat may be either a second coat on laying or rendering, or a third upon floating. The term *finishing* denotes the third coat, where stucco is used; that of *setting*, where the work is for paper.

SE'TTLEMENT. In Law, the right which an individual acquires to parochial assistance, under the statutes for the relief of the poor, in that parish or district to which he legally belongs, and in which he is said to have the settlement.

The law of settlements has recently undergone considerable alterations by the Poor Laws Amendment Act 4 & 5 W. 4. cap. 76. But that act does not, except in certain cases, take away settlements already possessed by virtue of the law as it previously stood under a great variety of enactments. It is, consequently, necessary to consider in how many modes a settlement may now be legally acquired; and, also, what modes of settlement were recognized before the passing of the act in question

The first species of settlement is by birth; all persons who have not obtained a settlement elsewhere by other means being legally settled in the parish or district wherein they were born. Before the passing of the late act, bastard children were deemed to be settled in the parish where they were born: they now have, and follow, the settlement of their mother until they attain the age of sixteen, or acquire settlements in their own right. 2. Settlement by parentage. All legitimate children are settled in the parish where their parents are settled, until they become emancipated. Emancipation takes place on attaining the age of twenty-one, if living separate from the parents; or marriage; or gaining a settlement in the party's own right; or contracting some other relation inconsistent with the notion of a subordinate situation in the parental family. 3. Settlement by marriage. A woman acquires the settlement of her husband; and after his death she retains his last settlement, unless she acquires a new one for herself. 4. Settlement by apprenticeship. This is acquired by a person who has been bound an apprentice, and has inhabited, under such apprenticeship, in any town or parish; the place where he has resided the last forty days being that in which he is settled. Actual service with the master is not necessary; but if he have served elsewhere, it must be with the master's permission. Apprenticeship in the sea service or fishing trade does not, since the recent act, confer a settlement. 5. Settlement by renting a tenement. A person *bonâ fide* occupying and renting a tenement, at the rent of 10*l*. per annum at least, for the term of a year, the rent for a year having been actually paid (and the tenement having been actually occupied by him for a year also), acquires a settlement by dwelling forty days in the parish in which such tenement is situated. Since 4 & 5 W. 4., no settlement can now be acquired by renting a tenement, unless the person occupying it has been rated to and has paid the poor's rate for one year at least. 6. Settlement by estate. A person having, by descent or devise, &c., an estate in lands or tenements, either freehold, copyhold, or for years, acquires a settlement in the parish in which it is situate by forty days' residence. But no such settlement is acquired by the purchase of an estate, unless bought for 30*l*. at least, *bonâ fide* paid. And, by the late act, no person possessing such a power of acquiring a settlement shall retain it longer than he shall inhabit within ten miles of the parish. 7. Settlement by being charged with and paying parish taxes and levies in respect of a tenement of the value of 10*l*.; such as poor rate, church rate, or land tax. These are now the only modes of acquiring a settlement: but two more must be mentioned, by which a settlement could formerly be acquired, as the settlements so gained still continue in force. 1. By hiring and service. This could be obtained by any unmarried person lawfully hired into any parish or town for the space of a year, provided he continued in service under such hiring for the space of a year, and resided in the parish forty days. 2. By serving an office. This was obtained in any place by executing any public annual office.

Poor people coming from one parish to another, and endeavouring to settle themselves in the latter, may, if they become actually chargeable, be removed by an order of two justices to that in which they were last legally settled; and all persons who think themselves aggrieved by such order of removal (usually the parish to which the removal takes place) may appeal against such order to the next general or quarter sessions of the peace. It is doubtful, indeed, since the statute 4 & 5 W. 4., whether any but the parish can appeal. The parish appealing is bound to give sufficient notice of the intended appeal, and also (since the stat. 4 & 5 W. 4.) to state in writing the legal grounds on which the order is contested. The sessions must either quash or affirm the order of the justices; and the order of the sessions can only be quashed by the Court of King's Bench, either on a special case, granted by the sessions, for the reference of a point of law to the superior court, or on certiorari, for defects appearing on the face of the order.

A *certificate* is a written acknowledgment, by the churchwardens and overseers, that a particular person is legally settled in their parish. A certificate-man cannot gain a settlement in the parish to which the certificate is directed, except by renting a tenement of the annual value of 10*l*. *See* Poor Laws.

SE'TTLEMENT, ACT OF. In English History, the statute 12 & 13 W. 2. c. 2., by which the crown was limited to the Princess Sophia, duchess dowager of Hanover (youngest daughter of Elizabeth, queen of Bohemia, who was daughter to James I.), and the heirs of her body, being Protestants,—on the failure of issue of the Princess Anne, then next in succession. The duchess died in the reign of Queen Anne; and her son, George I., was consequently called to the throne.

SETT OFF. In Architecture, the horizontal projection left in carrying up a wall, where the thickness of it diminishes at its different stages or stories.

SE'VENTH. In Music, an interval; whereof there are four species. First, the defective seventh, consisting of three tones and three greater semitones. Second, the minor seventh, consisting of seven degrees and six intervals, diatonically taken; four being tones, and the rest greater semitones. Third, the major seventh, being only a major semitone less than the octave. Fourth, the extreme sharp seventh, which is only a comma less than the octave.

SEVEN YEARS' WAR. In History, a war carried on in Germany between two alliances, headed respectively by Austria and Prussia, from the year 1756 to 1763, when it was ended by the peace of Hubertsburg. It was signalized chiefly by the extraordinary campaigns of Frederick II., the Great King of Prussia. His principal ally throughout the struggle was England; while he was, at one period, assailed by the forces of Austria, France, the Empire, Sweden, and Russia. When the forces of the Prussian sovereign had been almost annihilated by this coalition, the death of the Russian empress, Elizabeth, caused the withdrawal of Russia from the alliance of his enemies, and thus brought about the termination of the war without material advantages gained by any party.

SEWER. In Architecture, a subterraneous conduit, or channel, to receive and carry off the superfluous water and filth of a city. The sewers of Rome have been the models of those of the modern cities of Europe. They are as old as the elder Tarquin. These *cloacæ* had, between the Quirinal, Capitoline, and Palatine hills, many branches, which joining in the Forum, now the Campo Vaccino, were received for conveyance into the Tiber by a larger one, called the *cloaca maxima*. It must be admitted, however, that it is erroneous to designate the Roman cloacæ by the term sewers. They were rather drains, made to carry off the stagnant water of the pestilential marshes which occupied much of the low ground near the Tiber, and the spaces between the Aventine, Palatine, and Capitoline hills. The height and width of the cloaca maxima are equal, each measuring 13½ feet.

SEXAGE'SIMA. (Lat. *sixtieth*.) In the Calendar, the eighth Sunday (nearly sixty days) before Easter.

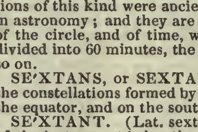
SEXAGE'SIMAL ARITHMETIC. A method of computation proceeding by sixties (as the common arithmetic proceeds by tens), and used by the ancient Greek astronomers for facilitating arithmetical calculations, particularly division and the extraction of roots; operations which, when performed on numbers expressed by the complicated Greek notation are attended with great labour and difficulty.

SEXAGE'SIMAL FRACTIONS, are such as have 60, or some multiple of 60, for their denominator. Fractions of this kind were anciently the only fractions used in astronomy; and they are still retained in the division of the circle, and of time, where the degree, or hour, is divided into 60 minutes, the minute into 60 seconds, and so on.

SE'XTANS, or SEXTANT. In Astronomy, one of the constellations formed by Hevelius. It is placed across the equator, and on the south side of the ecliptic.

SE'XTANT. (Lat. sextans, *the sixth part*; the limb of the instrument being the sixth part of a complete circle.) An instrument for measuring the angular distances of objects by reflexion. The sextant is capable of very general application; but it is chiefly used as a nautical instrument for measuring the altitudes of celestial objects, and their apparent angular distances. It is an instrument of the utmost importance in navigation.

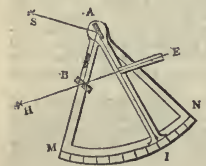
The principle of the sextant, and of reflecting instruments generally, depends upon an elementary theorem of catoptrics; viz. if an object be seen by reflexion from two mirrors which are perpendicular to the same plane, the angular distance of the object from its image is double the inclination of the mirrors. Thus, let A and B be sections of two mirrors perpendicular to the same plane, and inclined to each other in the angle A I B; a ray of light coming from the sun and falling upon the mirror A, in the direction S A, will be reflected in the line A B; and falling upon B, it will again be reflected in the direction B E. Let A B be produced to D, and S A prolonged to meet B E in E. Now, since the angles of incidence and reflexion are always equal (*see* Reflexion), we have D B E = 2 D B I, and B A E = 2 B A I; but D B E = B A E + B E A, and D B I = B A I + B I A, consequently B A E + B E A = 2 B A I + 2 B I A; and therefore, since B A E = 2 B A I, we have also B E A = 2 B I A; that is to say, the angular distance between the object S and its image seen by the eye at E, in the direction E B H, is the double of the in-



clination of the mirrors. It may be remarked, that the place of the image, as seen from E, is independent of the situation of the mirrors on the plane, so long as the line of the intersection of their planes and their inclination to each other remain constant.

From what has been now said, it may be seen that if a convenient method could be devised for measuring the inclination of two mirrors perpendicular to the same plane, when they are so placed that the image of an object S is brought to coincide with an object H seen directly, we should at once have a reflecting instrument for measuring angular distances. Such instruments are the *sextant*, the *quadrant*, the *reflecting circle*, respectively so called from the extent of the arc which the graduated limb embraces.

The contrivance adopted for this purpose in the sextant is to attach the frame of the mirror B to the plane of the sector of a circle A M N, and the frame of the mirror A to a radial bar A I revolving in the plane of the sector round a pin passing through the centre. Both frames are generally supplied with the means of adjusting the planes of the mirror vertically, and B is generally also capable of being turned by a delicate motion a small way round a pin passing through the frame of the sector.



The arc or *limb* M N of the sector is graduated; and the revolving radius or *index* carries at its extremity a vernier scale, applying to the graduations on the limb, and subdividing them into such smaller portions as may be desired.

The method of finding the zero point of the limb may be understood generally from the following considerations: — The angle E (see the first figure) being double the angle I, it follows that when the mirrors are parallel, or the angle I is nothing, the angle E is nothing also, and S and its image will appear as one object, the one exactly covering the other. It is therefore only necessary to turn round the radial bar which carries A till the image of a distant object seen by reflexion from B is in accurate conjunction with the object itself, seen directly; and the point on the limb at which the index then stands is the zero point of the arc. If it is not also the zero of the numbered graduations, its distance from the numeral zero is called the *index* error of the instrument, and is to be applied as a correction to all angles measured.

In graduating the limb, half degrees are marked as whole ones, and the smaller divisions accordingly; so that the angle read from the instrument is not the inclination of the mirrors, but the distance of the object from its image. In this class of instruments, therefore, 90° are indicated by an arc of 45°, 120° by an arc of 60°, &c.

The mirror A is completely silvered behind; but B is silvered on that half only which is next the plane of the instrument, the upper part being left clear, that objects, such as H, may be seen *through* it, as well as the images of others, as S, by reflexion *from its surface*. The mirror B is so placed by the maker that when A is parallel to it, the index which carries A either exactly or nearly corresponds with the zero of the divisions as they are numbered on the limb. When the index has been set by hand nearly in the position requisite for measuring any proposed angle, it is clamped to the limb by a screw acting on a spring, and moved slowly by a tangent screw till it attains accurately the required position.

Such being the general principles of the instrument, we shall now briefly describe the different parts of it, as constructed by the best makers, and the methods of adjusting and observing with it.

The only important object to be aimed at in the frame is to combine lightness with sufficient strength. The frames are generally of brass, and cast in one piece from a model; but the late Mr. Troughton introduced thin double frames parallel to each other, and connected by pillars. These frames are very light; but it may be doubtful whether they sufficiently fulfil the condition of strength.

In all good instruments the index is strengthened by an *edge bar* along its length. The graduations are made on a slip of gold, silver, or platina, which is *let in* to a groove in the limb. Instruments of this kind are now all graduated by a dividing machine.

The frame of the sextant is supported by three feet, one near each end of the limb, and the third at the centre, where it serves also as a sheath to cover the central pin (with its fastening screw) round which the index revolves. A handle parallel to the frame is attached to the back of it, to hold the instrument by when observing.

The revolving mirror A is attached by three screws to the head of the index. In common instruments only two of these screws are fastening screws, and the third is used as an *adjusting* screw for placing the mirror perpendicular to the plane of the instrument. But in the better class of instruments all three are *fastening* screws, the maker himself placing the mirror in its perpendicular position.

The other mirror, B, is attached to the frame of the sector, and in some instruments is incapable of lateral motion, being only provided with the means of placing it perpendicular to the plane of the instrument; so that the position of its plane with respect to the graduations may be regarded as permanent. The vertical adjustment is effected by a screw, which sometimes acts on the frame; and in some instruments directly on the mirror, on which it presses by means of a spring. In other instruments the frame of this mirror turns round an axis passing through the frame of the instrument; so that when the index is set to zero on the limb, B can be set parallel to A, and the index error, therefore, reduced to nothing. This mirror B is called the *horizon glass* by seamen, and the adjustment we have been speaking of is called the *parallel adjustment* of the horizon glass. It is a most important adjustment, and one that requires continual attention, being liable to be altered by very trifling causes.

In common quadrants, a sight vane with two holes is placed (as at E) opposite B, one hole at the same distance from the plane as the upper edge of the silvered part of the mirror, and the other opposite the middle of the unsilvered part. But the best instruments, instead of the sight vane, are furnished with telescopes, which screw into a socket attached to a piece of brass passing through the frame of the instrument; and by means of a screw the socket can be raised or depressed, so that the telescope can be placed with more or less of the object-glass opposite the silvered or the unsilvered part of the index glass, as the varying brightness of the objects observed may render necessary.

The telescopes are of two kinds. One, a direct telescope, which is simply an opera-glass; and having a narrow field of view, is generally used in the more ordinary sort of observations, such as observing altitudes. The other is an inverting or astronomical telescope, which has a large field of view, and is that which dexterous observers use exclusively. It is commonly supplied with two eye-pieces; one of considerable power, and chiefly for determining the index error, and the other for observing with. In the frames of each eye-piece are two pairs of wires, each pair perpendicular to the other, dividing the field of view into nine spaces, of which that in the middle is square; and it is important that in all observations made with this instrument the contact of the image seen by reflexion, and of the object seen directly, should be made as near the middle of this square as possible, at any rate at the same distance as the centre of the square from the plane of the instrument.

It is essential, also, that the telescope should be parallel to the plane of the instrument; and in the collar into which the telescope is screwed there are two screws for making this parallel adjustment. The adjustment is not very liable to alter, but no careful observer will omit to examine it at every convenient opportunity.

Both the mirrors are supplied with coloured glasses of different degrees of shade, framed and placed in such a position that they can be turned down before the mirrors, either singly or combined. The eye-pieces of the telescopes are also supplied with coloured shades, set in caps, which are screwed on the eye-piece. They are used in taking the index error by means of the sun, and in observing the sun's altitude from an artificial horizon.

Adjustment of the Sextant. — 1. To set the index glass, when it admits of adjustment, perpendicular to the plane of the instrument.

Place the index about the middle of the limb; and looking obliquely into the index glass, the part of the limb will be seen by reflexion in the glass, as well as directly. If the part of the limb seen directly and its image in the glass appear as one continued frame, the mirror is in adjustment; but if the reflected image appears to incline downward, it shows that the face of the glass inclines backward from the perpendicular; if upwards, that it inclines forward, and the adjustment must be made by the screw supplied for the purpose.

2. To set the horizon glass perpendicular to the frame of the instrument.

Having carefully adjusted the index glass, or seen that it is in adjustment, screw the telescope into its socket; adjust the eye-piece to distinct vision; screw the dusk shade cap on the eye end of the telescope, or turn down shades before the mirrors; and looking towards the sun, bring the index near to zero; move it steadily backwards and forwards, and the reflected image of the sun will be seen to pass over his disk, as viewed directly. If the two circular disks accurately cover each other in passing, the perpendicular adjustment of the horizon glass requires no adjustment; but if they pass a little aside of each other, so that two different-coloured lines appear on each side of the overlapping middle part, the mirror B must be turned by the appropriate screw

till the disks accurately cover each other, when the adjustment will be complete. This adjustment may also be effected by making a bright star and its image coincide with each other; but in this case it is scarcely necessary to say that the darkening shades must be turned aside.

3. To set the telescope parallel to the plane of the instrument. This adjustment is effected by two screws in the collar which attaches the telescope to the limb of the sextant, and diametrically oppose each other in a line perpendicular to the plane of the instrument. By tightening the upper one the object end of the telescope is inclined towards the instrument, and the contrary effect is produced by tightening the lower one. To make the adjustment, turn round the eye-piece of the telescope till two of the wires in its focus appear parallel to the plane of the instrument (and of this the eye can judge with sufficient accuracy); then take two objects, as two bright stars, or the sun and the moon, whose distance in either case should not be less than 90°, in order that any error in the adjustment may become more apparent, and bringing the image of one of the objects in accurate contact with the other object on the wire next the instrument, *instantly* bring them to the other wire; and if they are also in accurate contact upon that wire, it may be concluded that the axis of the telescope is parallel to the plane of the instrument. If the objects are the sun and moon, and they separate at the farther wire, it shows that the object end of the telescope inclines towards the plane of the instrument, and the contrary if they overlap, and the error must be corrected by turning the proper screws in the collar.

The above are all the adjustments which this class of instruments admits of, and they are essential to every instrument of the kind. We have now only to state how, in practice, the index error of the instrument may be most conveniently and accurately determined.

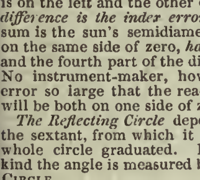
Having effected the perpendicular adjustment of the horizon glass by the method above explained, bring the border of the sun's reflected image to coincide with the sun seen directly both on the right and left side; and, reading the index at both observations, if one reading is on the left and the other on the right of zero, *half the difference is the index error*, and the fourth part of the sum is the sun's semidiameter; but if both readings are on the same side of zero, *half the sum is the index error*, and the fourth part of the difference is the semidiameter. No instrument-maker, however, will leave the index error so large that the readings for the sun's diameter will be both on one side of zero.

The Reflecting Circle depends on the same principles as the sextant, from which it differs chiefly by having the whole circle graduated. In some instruments of this kind the angle is measured by repetition. *See* REPEATING CIRCLE.

But the only instrument of this kind that can be now said to be in general use in this country is Troughton's reflecting circle; in which, by means of three equidistant indexes, and by observing alternately with the face of the index direct and reversed, *six times* the required angle is obtained, without reference to the index correction. After what has been said above on the principles of reflecting instruments generally, the following short account of this instrument will be sufficient.

All the indexes move round together; and, of course, the apparatus for slow motion, or the tangent screw, is only requisite for one of them, which is called the *leading* index, and which, for the sake of convenience, stands at or near zero on the limb when the revolving and fixed mirrors are parallel.

In the annexed figure let B D, B E, and B F, be the positions of the indexes when the revolving mirror is parallel to the fixed one K L; and let A C and M N be two positions of the revolving mirror when it is equally inclined to K L. Then the arcs D G, D G′, E H, E H′, F I, F I′, passed over by B D, B E, and B F, will be all equal; and if, when the mirror has the position M N, the face of the instrument be reversed, M N and K L will have the same relative position to each other that A C and K L have; and consequently if an object is seen by reflexion from A C and K L, it will also, when the instrument is reversed, be seen by reflexion from M N and K L to an eye placed in the same situation. Hence the degrees on the arcs G G′, H H′, I I′, which are the differences of the readings of the observations in the direct and reversed positions, are each the measure of double the distance of the object from its reflected image. The degrees being numbered round the circle from 0 to 720°, and the indexes placed very nearly at equal distances from each other, it is customary in practice to read the degrees, with the minutes and seconds, from the leading index only, and to read only the minutes and seconds at the other indexes.



SE′XTILE ASPECT, in Astrology, is the aspect of two planets when they are distant from each other the sixth part of a circle, or sixty degrees.

SE′XTON. (Lat. sacristanus, sacrista.) A church officer, who is properly the keeper of holy things belonging to divine worship, and said to be the same with the *ostiarius* in the Romish church. A sexton is usually appointed for life (whether by the minister or others, according to custom), and in such case a mandamus lies to restore him to his office.

SFORZA′TO. (It. *forced.*) In Music, a term written over a note to signify that it is to be played or struck louder than the rest.

SFUMA′TO. (It. *smoky.*) In Painting, a term applied to that style of painting wherein the tints are so blended that the outline is scarcely perceptible, the whole presenting an indistinct misty appearance. Guercino's works present some of the finest examples of the style.

SGRAFI′TTO. (It. *scratched.*) In Painting, a species of painting in which the ground is prepared with dark stucco, on which a white coat is applied; which last being removed with an iron instrument, the chipping it away opens to the black ground and forms the shadows, giving it the appearance of a chiaro-scuro painting. The principal pictures of Polidoro da Caravaggio are executed in this manner, which is capable of great effect, and is extremely durable, though it must be conceded the appearance is rather harsh.

SHABRACK. The cloth furniture of a cavalry officer's charger. The term is of Hungarian origin.

SHA′DDOCK. The fruit of the *Citrus decumaria:* it is a species of orange.

SHA′DOW. In Optics, a portion of space from which light is intercepted by an opaque body. As the rays of light proceed in straight lines, every opaque object on which light falls is accompanied with a shadow on the side opposite to the luminous body; and the shadow appears more intense in proportion as the illumination is stronger, because any object placed within it contrasts more strongly with the surrounding objects on which the light is suffered to fall.

As every point of a luminous body is a separate focus of illumination, it follows that an opaque object illuminated by the sun, or any other source of light which is not a single point, must have an infinite number of shadows, though not distinguishable from each other; and hence the shadow of an opaque body received on a plane is always terminated by a *penumbra*, or partial shadow, the extent of which is greater in proportion to the magnitude of the luminous body, the distance of the opaque body from the plane on which the shadow falls, and the degree of obliquity with which the luminous rays fall on the plane.

Shadows are said to be *right*, or *versed*, according to the position of the planes on which they are thrown. The shadow of an upright body projected on the plane of the horizon is a right shadow; and that of a body on a vertical plane to which the body is perpendicular, as that of a bar of iron fixed perpendicular in a wall, is a versed shadow. In both cases, the length of the shadow is to the height of the opaque body as the cosine to the sine of the angle which the luminous ray makes with the plane. The ancient geometers availed themselves of this property of shadows to measure the altitudes of objects.

Coloured Shadows.— In certain states of the atmosphere the shadows of opaque objects projected on a white surface are frequently observed, about the time of sunrise or sunset, to be of a blue colour. This curious observation appears to have been first made by the celebrated painter Leonardo da Vinci, and is also noticed by Otto Guericke in his *Magdeburg Experiments;* but no further notice seems to have been taken of the phenomenon until about a century later, when it again occurred to Buffon. Happening to be standing on an eminence about the time of sunset, he perceived the shadows of the trees on a white wall about 30 or 40 feet distant to be coloured with a light green, inclining to blue. The next morning, at sunrise, he repeated the observation; but instead of finding the shadows green, he found them blue, or rather the colour of lively indigo. Afterwards he often observed the shadows both in the morning and evening, but always observed them to be blue; and he remarks that any one may see a blue shadow, if he will hold his finger before a piece of white paper at sunrise or sunset. The phenomenon has since been frequently observed; and it is usually ascribed to the aërial colour of the atmosphere, which enlightens the shadows, and in which the blue rays prevail. (See *Priestly's History of Light, &c.*, 1762.) For remarks on shadows with luminous borders, *glorified shadows*, and other optical phenomena of the same kind, see Prof. Forbes's Report on Meteorology in the *Reports of the British Association for* 1840.

SHADOW. In Painting, the form which a solid object projects on a surface or surfaces by being interposed

between the surface or surfaces and the sun, or other luminous body; the doctrines whereof have received the name of *sciography*. *Shade* is a term applied to that portion of the object which is not obvious to the luminous body.

SHAFT. In Architecture, that part of a column between the base and capital, sometimes called the *trunk* of the column. The shaft of a column always diminishes in diameter from about a third of its height. Sometimes it has a slight swelling (*see* ENTASIS) in the lower part of its height. In the oldest Doric columns, the diminution was so considerable as to give the column a conical appearance. In the Doric edifices at Athens, the upper diameter is not more than a quarter less than the lower diameter; in the temples of Jupiter Nemeus, between Argos and Corinth, not more than a fifth less. In Ionic and Corinthian columns, the difference of the upper and lower diameters varies from a fifth to a twelfth. The ancients seem to have regulated the diminution in some proportion to the absolute height of the column, for no particular law seems to have prevailed in terms of the lower diameter.

SHAFT. In Mines. A shaft or pit is a prismatic or cylindrical hollow space, the axis of which is either vertical or much inclined to the horizon. The dimension of the pit, which is never less than 32 inches in its narrowest diameter, amounts sometimes to several yards. Its depth may extend to 1000 feet, and more. Whenever a shaft is opened, means must be provided to extract the rubbish which continually tends to accumulate at its bottom, as well as the waters which may percolate down into it; as also to facilitate the descent and ascent of the workmen. For some time a wheel and axle erected over the mouth of the opening, which serve to elevate one or two buckets of proper dimensions, may be sufficient for most of these purposes; but such a machine becomes ere long inadequate. Horse-whims, or powerful steam-engines, must then be had recourse to; and effectual methods of support must be employed to prevent the sides of the shaft from crumbling and falling down. (*Ure's Dict. of Arts, &c.*)

SHAG. The English name of a species of cormorant (*Pelicanus graculus*, Linn.).

SHAGREE'N. A species of leather, supposed formerly to have been prepared from the skin of the *shagree*, a species of whale. It is prepared from horse or ass skin, its granular appearance being given by embedding in it, whilst soft, the seeds of a species of chenopodium, and afterwards shaving down the surface: it is dyed with the green produced by the action of sal ammoniac on copper filings. It was formerly much used for watch, spectacle, and instrument cases, and was made chiefly in Astracan.

SHAH. (In Persian, *prince*.) The title given by European writers to the monarch of Persia, who in his own country is designated by the compound appellation of *Padishah*, which see.

SHAH-NAMAH. (*The Book of Kings.*) The most ancient and celebrated poem in the modern Persian language, by the poet who received as a title of honour the name "Firdousi" (*of Paradise*), by which he is known. Its date is supposed to be about A. D. 1000. A complete translation into English, in four volumes, was published by Capt. Macan, Calcutta, 1829.

SHAKE. In Music, a quick alternate repetition of the note above with that over which the mark *tr* is placed, commonly ending with a turn from the note below.

SHAKERS. In Ecclesiastical History, a sect said to have originated by a secession from the body of Quakers, in 1747, in Lancashire; who received their nickname from the peculiar contortions of body which they adopted in their religious exercises. Anne Lee, the great female leader of this sect, joined the society in 1758; and considering herself persecuted in England, went, with a few followers, to New York in 1774, and died ten years afterwards, at which time her sect had made great progress in America. She was considered as the woman spoken of in Revelations. The sect appears to have fallen into obscurity, although a few congregations still remain.

SHALE. A crumbling variety of slate.

SHA'MANISM, or SCHAMANISM. A general name applied to the idolatrous religions of a number of barbarous tribes, comprehending those of Finnish race,—the Ostiaks, Samojeds, and other inhabitants of Siberia as far as the Pacific ocean. These nations generally believe in a Supreme Being, but to whom they attribute little share in the immediate government of the world: this is in the hands of a number of secondary gods, both benevolent and malevolent towards man. They appear to have very uncertain and fluctuating opinions respecting these last. Thus, those tribes which dwell on the frontier of Russia are said to admit Saint Nicholas among their gods. The *shamans* or priests possess the power of propitiating such as are malignant. These priests are called by various names in different tribes. The general belief respecting another life appears to be, that the condition of man will be poorer and more wretched than in the present; hence death is an object of great dread. Women are esteemed very inferior to men by all these nations. The magic drum of the priests is well known. For one of the latest accounts of these remote people, see *Von Wrangel's Journey to the Polar Sea.*

SHAMMY, or SHAMOY. The tanned or tawed skin of the Chamois goat. Any soft pliable leather now passes under the name. *See* LEATHER.

SHAMPOOING. A name given to an operation in the East, which consists in pressing the joints and rubbing them, so as to mitigate pain, and restore tone and vigour to the parts.

SHAMROCK. The popular emblem of Ireland: as the rose of England, and the thistle of Scotland. It is generally supposed to have been the plant called white clover, *Trifolium repens*; but it appears to have been rather the wood sorrel, *Oxalis acetosilla*.

SHANK. In Architecture. *See* FEMUR.

SHANK PAINTER. The rope or chain which passing round the shank of the anchor, lying horizontally, confines it to the ship's bow.

SHARP. In Music, a character ♯, which prefixed to a note signifies that it is to be sung or played a semitone higher than it naturally would have been without such character.

SHEAF. In Mechanics, a solid cylindrical wheel fixed in a channel and moveable about an axis, as in the block of a pulley.

SHEA'RING. The term in Scotland for reaping.

SHEARING SHEEP. The operation of clipping off the wool from the bodies of ewes and lambs; generally performed in the beginning of summer, when the animals are not likely to suffer from being deprived of their warm covering, and when there is sufficient time for the wool to grow again before winter.

SHEATH, in Botany, is a term applied to a petiole when it embraces the branch from which it springs, as in grasses; or to a rudimentary leaf which wraps round the stem on which it grows, as in the scapus of many Endogenous plants.

SHEATHING. The covering laid on the ship's bottom to defend it from the worms. Sheets of thin copper nailed on with copper nails constitutes, at present, the sheathing of all the better kinds of vessels. Lead has been used; and large-headed iron nails, called scupper nails, are used still for the same purpose on the bottoms of old hulks, piles, &c. Zinc and different compositions have been proposed as substitutes for copper; and Sir H. Davy ingeniously suggested the application of pieces of zinc or iron upon different parts of the copper surface, which by the action of the sea water render the latter metal electro-negative, and capable, therefore, of resisting the oxidizing and corrosive agencies of the substances held in solution. The pieces of iron or of zinc so applied have been properly called *protectors;* but by occasioning the precipitation of earthy matters upon the copper, while they effectually *protect it* they render its surface favourable to the adhesion of weeds, barnacles, &c., and sometimes to such an extent as to interfere with the passage of the ship through the water: upon such grounds Sir Humphrey's valuable suggestion has been neglected. When vessels are laid up in dock the protectors are in successful use. Sheathing formerly was composed of thin fir boards.

SHEEP. *See* OVIS.

SHEER. The curve which the line of ports, or of the deck, presents to the eye when viewing the side of the ship. When these lines are straight, or the extremities do not rise, as is most usual, the ship is said to have a straight *sheer*.

SHEER HULK. A hulk permanently fitted with sheers for masting and dismasting ships.

SHEERS. Two masts or spars lashed together at or near the head, and raised to a vertical position, for the purpose of lifting the masts into or out of a vessel.

SHEET. The rope attached to the after mast or leeward mast clue or corner of a sail, to extend it to the wind. In the square sails above the courses, the ropes attached to both clues are called *sheets:* in all other cases the weathermost one is called a *tack*.

SHEET ANCHOR. The third of the four large anchors generally carried by a ship.

SHEIK. (In Arabic, *elder or eldest.*) A title of dignity properly belonging to the chiefs of the Arabian tribes or clans. The heads of monasteries are also termed, in some instances, sheiks among the Mohammedans. It is also the title of the higher order of religious persons who preach in the mosques. The mufti of Constantinople bears the title of Sheikh-ul-Islam.

SHEKEL. The name of a weight and coin in use among the Jews. The weight of the shekel was about ½ oz. in English avoirdupois weight; and the value of the coin was 2*s.* 7*d.* There were two standards of the shekel: the shekel of the *sanctuary*, which was used in calculating the offerings of the temple, and all sums connected with the sacred law; and the *royal* or *profane* shekel, used for all civil payments. Various opinions are entertained respecting the relative value of these two stan-

dards; but nothing certain can be averred on the subject. Wener and Michaelis, without, however, any sufficient reason, as it appears, are of opinion that the shekel used in commercial transactions differed from both of these. (See Wener, *Biblisches Realwörterbuch*, art. "Sekel.")

SHEKI'NAH. The Jewish name for the Divine presence, which rested, in the shape of a cloud, over the "propitiatory," or "mercy seat," as it is rendered in our translation (Leviticus, xvi. 2.). The Jews reckon it among the five particulars which were present in the first temple, and wanting in the second. (See *Prideaux' Connection*, l. 3.) On this account God is so often said in Scripture to "dwell between the cherubim;" that is, between the images of cherubim on the mercy seat. (1 Sam. iv. 4.; Psalm lxxx. 1. &c. See also *Mem. de l'Ac. des Inscr.* vol. xxxviii.)

SHE'LDRAKE. The common name of the species of duck called *Anas tadorna*, which is the type of the subgenus *Tadorna* of Ray and modern ornithologists. This elegant species frequents many parts of our coast, and remains throughout the year. The female commonly selects a rabbit-hole in which to deposit her eggs, which are sometimes as many as sixteen in number. The sheldrake feeds on small fish, marine insects, and sea-weed.

SHELL. The hardening principle of shell is generally carbonate of lime nearly pure. The animal principle, in the porcellaneous shells, is a small quantity of soluble gelatine; in the mother of pearl shells, it is albuminous. The latter, therefore, when steeped in dilute muriatic acid, leave a membranous or cartilaginous residue; but the former are entirely soluble. For the form, structure, and mode of growth of shell, see CONCHOLOGY.

SHELL. In Artillery, a hollow sphere of iron, which, being filled with gunpowder and fired from a mortar, bursts into pieces; when the powder is exploded, and produces a very destructive effect. The charge is introduced through a hole in the shell of about an inch in diameter, and fired by means of a fuze. The fuze is a wooden tube made to fit the hole, and filled with a composition of sulphur, saltpetre, and mealed powder; and is cut of such a length that the shell is calculated to explode just before or immediately after it reaches the ground.

SHELL MARL. A deposit of clay and other substances, mixed with shells, which collects at the bottom of lakes.

SHE'RBET (a word borrowed from the Persian), signifies a favourite beverage in the East, bearing some resemblance to our lemonade, made of water, lemon-juice, and sugar, with the addition of some other ingredients, such as rose water, to give it a delightful perfume.

SHE'RIFF (originally shire-reeve, from the Saxon, meaning the reeve or governor of the shire), is the title of that functionary who acted at first only as the deputy of the earl, hence styled in Lat. *vice-comes*; but has long been the chief civil officer in each county, where he is styled bailiff of the crown, and where he is specially entrusted with the execution of the laws and the preservation of the peace: for which purposes he has at his disposal the whole civil force of the county, — in old legal language the *posse comitatus*. The most ordinary and important functions of the sheriff, which he universally exercises by a deputy, called under-sheriff, for whose conduct he is responsible, consist, 1st, In the execution of writs issuing from the superior courts, or awarded by the judges on their consent, to take effect within the county. 2. In the holding of the sheriff's court. The sheriff himself only executes in person such parts of his office as are either purely honorary, such as attendance upon the judges on circuit (for whose lodging he is also bound to provide); or as are of some dignity and public importance, such as the presiding over elections and the holding of county meetings, which it is in his power to call at any time. The county courts are incident to the jurisdiction of the sheriff. Until recently they could only hold pleas of debt or damages under the value of 40*s*., except in replevin, or actions by virtue of a particular writ termed a *justicies*. But it is now enacted, by 3 & 4 W. 4. c. 42., that in any action depending in a superior court for a debt or demand, not exceeding 20*l*., it shall be lawful for the court to direct that the issue joined shall be tried before the sheriff of the county in which the action is brought. *See* COURTS.

Sheriffs were originally chosen by the freeholders of the county, except in some few counties where the office was hereditary, as it still is in Westmoreland. The system of popular election was abolished in the reign of Richard II., and sheriffs have long been appointed by the crown upon presentation of the judges, in a manner partly regulated by law, partly by custom; but sheriffs may also be nominated by the crown without recommendation of the judges, and are then familiarly styled *pocket sheriffs*. Those appointed in either way are bound under a penalty of 500*l*. to serve the office, except in specified cases of exemption or disability. The description given of the office as it is in England applies to Ireland without variation, except as to the time of its origin.

SHE'RIFF DEPUTE. In Scotland, the principal sheriff of a county. He is named by the crown, must be an advocate of three years' standing, and receives a salary varying from 350*l*. to 1200*l*. per annum. He is entitled to name sheriff substitutes; executes writs, returns juries, &c.; decides on claims for enrolment in the county lists of parliamentary voters, and exercises a certain criminal jurisdiction. He holds also civil courts for the recovery of small debts, and a court of record, the jurisdiction of which extends to all personal actions, and possessory actions for the recovery of real property.

SHE'RRY. A Spanish wine made from the grapes of Xeres in Andalusia. Genuine sherry is a rich dry wine, containing from 20 to 23 per cent. of alcohol: there are many varieties, and it is extensively imitated and adulterated. *See* WINE.

SHEW-BREAD. In the Old Testament. The name given to the twelve loaves of bread, one for each of the twelve tribes of Israel, which were appointed to be placed every Sabbath "on the pure table before the Lord," for the sustenance of the priests. They appear to be the same with that which is called "shew-bread" in 1 Sam. 21., where the act of David in taking these loaves for the nourishment of himself and his followers is related.

SHI'BBOLETH. (Heb. *a flood*.) The name given to a sort of test or criterion by which the ancient Jews sought to distinguish true persons or things from false. The term originated thus: — After the battle gained by Jephtha over the Ephraimites (see Judges, xii.), the Gileadites commanded by the former secured all the passes of the river; and on an Ephraimite attempting to cross, they asked him if he was of Ephraim. If he said no, they bade him pronounce the word *Shibboleth*, which the Ephraimites from inability to give the aspirate called *Sibboleth*; and by this means he was detected and instantly thrown into the river. In modern times this word has been adopted into the language of politics, in which it signifies those political opinions on which all the members of a party are agreed, or the watch-word by which it is intended to unite them.

SHIELD. (Germ. schild.) A well-known piece of defensive armour, very extensively used before the invention of gunpowder, and still employed by many nations among which military art has made imperfect progress. It would be endless to detail the various materials and shapes of which it has been constructed at different periods. The ancient Greek shield, as described in Homer, was large and massive, sufficient to cover the man from the face to the knee, composed of leather, inlaid in some instances with metal. That of the Roman legionary was four feet high, and two and a half broad, formed of wood covered with leather, and strongly guarded with bosses of iron or bronze. The ancient Britons and other nations of antiquity wore round, light, basket-like shields, often of wicker-work; more resembling the parma or lighter shield of the Romans. The Norman shield, as used in England down to the time of Henry II., was "of the form called kite or pear-shape," flatter at first, afterwards approaching to the semi-cylindrical. Heraldic devices were first borne on it, so far as is distinctly ascertained, in the reign of Henry II. (*Pictorial Hist. of England*, i. 640.) In that of Edward IV. the shield had become triangular: the point of the triangle was rounded off about the end of the 14th century. Afterwards the shape of the shield, as worn by knights, became more and more fantastic. In actual service it fell gradually into disuse: sword and buckler fight, the favourite pastime as well as warlike practice of former days, became obsolete after the rapier and dagger had been introduced in the reign of Elizabeth. The Highlanders carried the target with the broad sword to a much later period.

SHIELDS. In Botany, little coloured cups or lines with a hard disk, surrounded by a rim, and containing the fructification of lichens.

SHILLING. An English silver coin equal to twelve pence, or the twentieth part of a pound sterling. Among the ancient Saxons, the value of the shilling was only five pence; it afterwards underwent many alterations, containing sometimes sixteen pence, and often twenty pence. The period when it obtained its present value is assigned to the reign of Edward I. Many other countries besides England have a coin of this name; of these, perhaps, the Hamburgh schilling is the best known. Its value is 1*d*. English.

SHI'LOH. (Hebr. differently rendered — *Son*, *He who is sent*, or *the Sent*, or *the Peaceable*, or *the Prosperous*.) The name given to the Messiah by Jacob in his prophecy, Genesis, xlix. 10.

SHINGLE. (Germ.; or perhaps from Lat. scindendo.) The coarse gravel, or accumulation of small stones, found on the shores of rivers or the sea: in the latter case the term *sea-beach* is applied.

SHI'NGLES. A corruption of the French word *ceingle*, which means *a belt*. This eruptive disorder is generally ushered in with febrile symptoms, followed by an itching or tingling sensation of some part of the body, occasioned by patches of little red pimples, forming in the course of twenty-four hours small transparent ve-

sicles; these succeed each other till they at length form a kind of belt round some part of the trunk or abdomen; they often form small ulcerations and scabs, continuing their progress for three or four weeks. This disorder is not contagious, and generally very slight; but in irritable habits the itching occasions want of rest and fever, and it is sometimes attended by a deep-seated pain of the affected part. The cause of shingles is generally obscure, though it may sometimes be referred to indigestion and suppressed perspiration: young persons are most subject to it. Gentle aperients and diaphoretics, strict attention to the diet, and occasional anodynes, are the only internal remedies generally required; and, externally, a little cold cream or fresh spermaceti ointment, or the occasional application of a very weak Goulard's lotion, is all that is necessary.

Shingles. In Architecture, small slabs of wood, or quartered oaken boards, used instead of slates or tiles for covering churches or spires. They are sawn to a certain scantling, or rather cleft to about an inch thick at one end, and shaped like wedges, four or five inches broad and eight or nine inches long.

SHIP. A general term for all large vessels, but restricted by seamen to such only as have three complete masts; *i. e.* lower, top, and top-gallant masts. As we cannot here give a complete description of so complex a fabric, and as the reader will have become familiar with the forms of ships from prints, we shall merely attempt to convey some general ideas on the subject. After the hull has been completed, a slight account of the construction of which has been given under Naval Architecture, the ballast, which is necessary in most ships to keep them upright when under sail, and which is in men-of-war in iron pigs, is spread over the bottom of the hold, chiefly towards the middle of the length. The masts are then taken in. On the ballast are laid loose pieces of wood, called *dunnage*, on which rest the iron tanks containing the water to drink, or water casks. The hold in large ships is divided by partitions into the fore, main, and after holds. At the fore extremity, in men-of-war, are the gunner's, boatswain's, and carpenter's store rooms, containing arms, supplies of rope, bolts, pump gear, and other materials of the fittings, or for repairs. In this part also is the fore powder magazine, when there are two. In the fore hold are stowed water, wood for firing, and, separated by a strong partition, coals. In the main hold are stowed water, stores, chain cables, &c. In the after hold are the provisions; and, in the *spirit room*, the spirits: here also is the powder magazine. In the narrow and shallow after extremity is stowed the bread or biscuit. The spare sails are kept in a space called the *sail room*, over the fore hold. The hemp cables are kept in the cable tiers, on a deck over the main hold. These decks immediately over the holds constitute generally the fore and after *cock pits*. In large ships the whole deck is called the *orlop* deck. On the *lower* deck, which is next above the former, the men mess and sleep. In frigates, and smaller vessels, this deck is a little below the water; in two and three deckers, it is three or more feet above the water, and is the lower gun deck.

In merchant ships the arrangements depend, of course, on the size of the vessel and the nature of the cargo. In all these vessels, however, the place allotted to the crew is in the fore part, and is called the *fore peak*. Ships are, in general, constructed for the purposes of burden, expedition, and war; the latter class, which must possess also, in part, the qualities of the other two, exhibit the finest models. The largest ships, of 120 guns, carry three complete rows or tiers of heavy cannon (32-pounders), and are thence called three-deckers; of late years some still heavier guns have been introduced. Each deck has from 15 to 17 guns on each side. The middle of these decks is called the *middle* deck; and the deck next above this, or which is next below the uppermost deck, the *main* deck. Guns are also carried on the upper deck, of which the fore part is called the *forecastle*, and the part abaft the main mast the *quarter* deck. The deck over this last, extending from the after extremity to a little before the mizzen mast, is called the *poop*. The after parts of these decks, from and including the mizzen mast, are the cabins of the admiral, captain, and the officers; the latter being called the *ward room* in ships of the line, and the *gun room* in frigates. The length of a ship of the largest class is about 200 feet at the water line, extreme breadth 54 feet, and draught of water about 26, and the height of the truck above the water 210 feet. The whole weight of such a ship, with her crew and provisions, is about 4600 tons, of which the hull or shell is about half. The men, with their effects, amount to 100 tons; and the guns, arms, and powder, to 500 tons. The 32-pounder (long gun), and carriage, weigh 72 cwt., and the carronade one third of this. Two-deckers carry from 70 to 90 guns. In bad weather the ports of the lower deck are defended by heavy lids called *ports*, which are firmly secured from within, the guns being then run in and secured from motion. Frigates carry one tier of guns on the main deck, besides guns on the upper deck; vessels of the lower classes carry their guns on the upper or open deck.

Fine sailing ships have gone upwards of 13 knots (or sea miles of 6080 feet) an hour, in a squall; and upwards of 10 knots on a bow line, that is, the sails being sharply trimmed when the direction of the wind makes an angle of about 67° with that of the ship's head.

The principal scientific works on ships are, Bouguer, *Traité du Navire;* Euler, *Scientia Navalis;* Id. *Théorie de la Construction et de la Manœuvre des Vaisseaux;* Don George Juan, *Examen Maritimo*, and a French translation, with notes, by L'Eveque; *Chapman's Naval Architecture*, &c. Much general information is to be found in *Charnock's Marine Architecture*, and many other works contained in any good catalogue, under the heads Naval Architecture, Seamanship, especially in *Darcy Lever's Seamanship*, &c. But the subject has as yet been but imperfectly treated, and many points of great practical importance, and unconnected with the particular properties of fluids, have not been discussed.

SHIP, ARMED. In the English usages of war, a private vessel occasionally taken into the service of government in time of war, armed and equipped like a regular ship of war, and commanded by an officer of the navy, with the rank of master and commander.

SHIP-BUILDING. *See* Naval Architecture.

SHIP MONEY. The celebrated tax imposed by Charles I. without authority of parliament, which proved one of the most immediate causes of the discontents that ended in the great rebellion. This device was first put in practice in 1634. It was by a writ, directed to the sheriff of every county, to provide a ship for the king's service; accompanied by written instructions, appointing a sum of money to be levied instead. This writ was framed by Attorney-General Noy. The tax was paid for about four years without opposition; when the question of its legality was raised by the refusal of Hampden to pay his share. It was argued before the judges in the Exchequer Chamber, of whom a great majority gave judgment for the crown. The act "whereby all the proceedings in the business of ship-money were adjudged void, and disannulled, and the judgments, enrolments, and entries thereupon vacated and cancelled," was one of the first proceedings of the Long Parliament. (See *Clarendon*, books i. iii.)

SHIPS, REGISTRY OF. In Commercial Navigation, the registration or enrolment of ships at the custom-house, so as to entitle them to be classed among, and to enjoy the privileges of, British-built ships.

The registry of ships appears to have been first introduced into this country by the Navigation Act (12 Car. 2. c. 18. anno 1660). Several provisions were made with respect to it by the 7 & 8 Will. 3. c. 22.; and the whole was reduced into a system by the 27 Geo. 3. c. 19.

It may be laid down in general, that a vessel, in order to be admitted to registry, and consequently to enjoy the privileges and advantages that exclusively belong to a British ship, must be the property of his Majesty's subjects in the United Kingdom or some of its dependencies; and that it must have been built in the said United Kingdom, &c., or been a prize vessel legally condemned, or a vessel legally condemned for a breach of the slave laws.

The great, and perhaps the only original object of the registration of ships, was to facilitate the exclusion of foreign ships from those departments in which they were prohibited from engaging by the navigation laws, by affording a ready means of distinguishing such as were really British. It has also been considered advantageous to individuals, by preventing the fraudulent assignment of property in ships; but Lord Tenterden has observed, in reference to this supposed advantage, that "the instances in which fair and honest transactions are rendered unavailable, through a negligent want of compliance with the forms directed by these and other statutes requiring a public register of conveyances, make the expediency of all such regulations, considered with reference to private benefit only, a matter of question and controversy." (*Law of Shipping*, part i. c. 2.)

SHIPWRECK, in the open sea, arises from the water leaking in at the bottom of a ship faster than the pumps can discharge it; or from the sea coming over one of the decks, and getting below in great quantity; or from the vessel being overset by the wind. In the labouring of a weak ship in a heavy sea the seams of the sides and bottom open, and the caulking works loosen. When the loss of a mast occurs, the ship is often left entirely to the action of the waves. People unused to the sea look with admiration on the strength and solidity of a ship; but those who have experienced the violent shocks of the waves, and are conversant with the effects of incessant agitation upon any fabric, and the straining effects of the masts and sails on the hull, are rather surprised that such a machine should hold together for so many years.

When the ship is wrecked near the shore, the object is to land the crew. The first method proposed was, we

believe, Bell's, in 1791. A mortar was fired from the ship, carrying a shell with a rope attached, by which communication with the shore might be established. Captain Manby, in 1808, employed the mortar on shore, where alone, it is obvious, its action could be depended upon; and methods have since been adopted for winding the rope on a cone for disengaging it without impediment, which had been found the chief difficulty.

SHIRE. A territorial division. (From the Anglo-Saxon scyran, *to divide;* whence the verb *to sheer.*) In modern language, shire is synonymous with county; but some smaller districts in the north of England retain the provincial appellation of shires: as Richmondshire, in the North Riding of Yorkshire; Hallamshire, or the manor of Hallam, in the West Riding, which is nearly coextensive with the parish of Sheffield. *See* COUNTY.

SHIRE CLERK. An officer appointed by the sheriff to assist in keeping the county court.

SHIRE MOTE. The Shire Meeting; *i. e.* sheriff's court.

SHOOTING STARS. Well-known meteors, of which the origin and nature are involved in great obscurity, and which have, of late years, excited extraordinary interest by their periodical appearances in unusually great numbers.

Phenomena of Shooting Stars. — The apparent magnitudes of these meteors are widely different. The greater part of them resemble stars of the 3d, 4th, 5th, and 6th magnitudes; but some occur which surpass stars of the 1st magnitude, and even exceed Jupiter and Venus in brilliancy. In some of them the globular form can be easily recognized: these are, in every respect, similar to *bolides* or *fire-balls;* and, in fact, it is impossible, from their appearances, to make any distinction between the larger shooting stars and the smaller individuals of the class of meteors to which the name of fire-balls is usually appropriated. *See* FIRE-BALLS.

Shooting stars appear to be equally numerous in every climate. The weather seems to have no influence upon their number. They are observed at all times of the year; but, generally speaking, they appear to be more abundant in the end of summer and autumn than at the other seasons.

Some of the shooting stars leave a luminous train behind them, which marks their path through the sky with a milk-white light. These trains for the most part disappear in a few seconds; but sometimes they continue longer, and even for several minutes. In the case of actual fire-balls, Dr. Olbers observed trains which continued from six to seven minutes; and Brandes, in one instance, estimated that fifteen minutes elapsed between the extinction of the fire-ball and the disappearance of the luminous train. The trains in general assume the form of a cylinder, the interior of which is void of luminous matter; and not unfrequently, before their disappearance, they take a curved form. The most probable explanation is, that they are caused by a gaseous matter left behind by the meteor, and bent by currents of air.

The older philosophers had formed various theories to explain these remarkable phenomena. By some they were supposed to be the products of an oily sulphurous vapour existing in the atmosphere, which being disposed in thin layers, and becoming inflamed by some means, would exhibit the appearance of a clear brilliant spark passing rapidly from one point to another. About the middle of the last century, when the effects and phenomena of electricity began to be better understood, Beccaria and Vassali, among others, regarded the shooting stars as merely electrical sparks; an hypothesis which was soon shown to be untenable. At a later period, when the inflammable nature of the gases became known, Lavoisier, Volta, Herbert, Toaldo, Gren, and others, referred these meteors to hydrogen gas, which, by reason of its inferior density, they supposed must be accumulated in the higher regions of the atmosphere. Dalton, however, showed that such accumulation cannot take place, inasmuch as all the gases which constitute the atmosphere must be equally diffused through its whole extent, according to the law of Mariotte. Deluc maintained that certain phosphoric exhalations generated in the earth, and becoming inflamed in the sky, formed the true essence of the shooting stars.

In this state the subject remained when Chladni published his celebrated work on the causes of the masses of iron and other similar substances found in Siberia by Pallas, in which he clearly established, by comparing the circumstances of a great multitude of observations, that the fire-balls are meteors having their origin beyond our atmosphere; that, in fact, they are masses of nebulous matter moving in space with planetary velocities, which, when they come in the way of the earth in its revolution about the sun, and enter the atmosphere, are inflamed by its resistance and friction, and become luminous, sometimes scattering masses of stone and iron on the ground. Halley, Wallis, Pringle, Maskelyne, and others, had previously assigned a cosmical origin to these meteors, but without suspecting that masses of stone and iron fell from them. The close resemblance which the greater part of the shooting stars present to fire-balls, at once induced Chladni to consider these phenomena also as cosmical; that is to say, as small masses of matter not having their origin in our atmosphere, but entering it from without, and which are either entirely consumed in it, or become extinguished when they have passed beyond it.

These conclusions, however, required to be confirmed by a more accurate investigation of the phenomena; for as yet no exact determination had been made of the actual average heights of the shooting stars above the earth, or of their orbits, velocities, or magnitudes. In the year 1798 this important but difficult inquiry was undertaken by Professors Brandes of Leipsig, and Benzenberg of Düsseldorf (both at that time students in Göttingen). Having selected a base line (about nine miles in length), they placed themselves at its extremities on appointed nights, and observed all the shooting stars which appeared, tracing their courses through the heavens on a celestial map, and noting the instants of their appearances and extinctions by chronometers previously compared. The differences of the paths traced on the maps afforded data for the determination of the parallaxes, and consequently the heights and the lengths of the orbits. On six evenings, between September and November, the whole number of shooting stars seen by both observers was 402; of these 22 were identified as having been observed by each in such a manner that the altitude of the meteor above the ground at the instant of extinction could be computed. The least of the altitudes was about 6 English miles. Of the whole there were 7 under 45 miles; 9 between 45 and 90; 6 above 90; and the highest was above 140 miles. There were only two observed so completely as to afford data for determining the velocity. The first gave 25 miles, and the second from 17 to 21 miles in a second. The most remarkable result was, that one of them certainly was observed not to *fall*, but to move in a direction away from the earth.

By these observations a precise idea was first obtained of the altitudes, distances, and velocities of these singular meteors. A similar but more extended plan of observation was organized by Brandes in 1823, and carried into effect at Breslau and the neighbouring towns by a considerable number of persons observing at the same time on concerted nights. Between April and October about 1800 shooting stars were noted at the different places; out of which number 62 were found which had been observed simultaneously at more than one station in such a manner that their respective altitudes could be determined, and 36 others of which the observations furnished data for estimating the entire orbits. Of these 98, the heights (at the time of extinction) of 4 were computed to be under 15 English miles; of 15 between 15 and 30 miles; of 22 between 30 and 45; of 33 between 45 and 70; of 13 between 70 and 90; and of 11 above 90 miles. Of these last two had an altitude of about 140 miles, one of 220 miles, one of 280, and there was one of which the height was estimated to exceed 460 miles.

Of the 36 computed orbits, in 26 instances the motion was downwards, in one case horizontal, and in the remaining 9 more or less upwards. The velocities were between 18 and 36 miles in a second. The trajectories were frequently not straight lines, but incurvated sometimes in the horizontal and sometimes in the vertical direction, and sometimes they were of a serpentine form. The predominating direction of the motion of the meteors from north-east to south-west, contrary to that of the earth in its orbit, was very remarkable, and is important in reference to their physical theory.

A similar set of observations was made in Belgium in 1824, under the direction of M. Quetelet, the results of which are published in the *Annuaire de Bruxelles* for 1837. M. Quetelet was chiefly solicitous to determine the velocity of the meteors. He obtained six corresponding observations from which this element could be deduced, and the results varied from ten to twenty-five English miles in a second. The mean of the six results gave a velocity of nearly seventeen miles per second, a little less than that of the earth in its orbit.

Another set of corresponding observations was made in Switzerland on the 10th of August, 1838; a circumstantial account of which is given by M. Wartmann in *Quetelet's Correspondance Mathématique*, for July, 1839. M. Wartmann and five other observers, provided with celestial charts, stationed themselves at the observatory of Geneva; and the corresponding observations were made at Planchettes, a village about sixty miles to the north-east of that city. In the space of seven and a half hours, the number of meteors observed by the six observers at Geneva was 381; and during five and a half hours, the number observed at Planchettes by two observers was 104. All the circumstances of the phenomena — the place of the apparition and disappearance of each meteor, the time it continued visible, its brightness relatively to the fixed stars, whether accompanied with a train, &c. — were carefully noted, and the trajectories projected on a large

planisphere. The extent of the trajectories described by the meteors was very different, varying from 8° to 70° of angular space. The velocities appeared also to differ considerably; but the average velocity was supposed by M. Wartmann to be 25° per second. It was found, from the comparison of the simultaneous observations, that the average height above the ground was about 550 miles; and hence the relative velocity was computed to be about 240 miles in a second. But as the greater number moved in a direction opposite to that of the earth in its orbit, the relative velocity must be diminished by the earth's velocity (about 19 miles in a second). This still leaves upwards of 220 miles per second for the absolute velocity of the meteor, which is more than eleven times the orbital velocity of the earth, seven and a half times that of the planet Mercury, and probably greater than that of the comets at their perihelia.

Such are the principal facts which have yet been established respecting the heights, velocities, and orbits of the shooting stars; and it is from these chiefly that we are enabled to form any probable conjectures respecting their origin. And since it is now established that no difference is observable between the larger shooting stars and small fire-balls, both having similar altitudes and velocities, and presenting absolutely the same appearances, we may assume them to be of the same nature, and that whatever has been proved respecting fire-balls will apply equally to the larger shooting stars. Whether the meteoric appearances to which the latter term is applied may not include objects of totally different natures, is a question admitting of doubt. It is possible that among the shooting stars there may be objects which are merely electric sparks, or which have their origin in spontaneously inflammable gases, known or unknown, existing in the atmosphere; but the greater part of them must be considered as identical with fire-balls.

Physical Theory of the Shooting Stars. — Some philosophers, as already stated, have ascribed an atmospheric origin both to the shooting stars and fire-balls; but the observations of Brandes, and more particularly those of Wartmann, which prove that many of them appear at altitudes far beyond the limits which can be assigned with any probability to the atmosphere, have rendered this supposition altogether untenable. Another hypothesis respecting their origin is, that they are bodies projected to our earth from volcanoes in the moon. Dr. Olbers was the first, perhaps, who showed the possibility of this hypothesis. On computing the forces necessary to overcome the moon's attraction, he found that a body projected from the moon with a velocity of about 8500 feet in a second would not fall back on the lunar surface, but recede from it indefinitely; and that in order to reach the earth it is only necessary that the projectile should have the velocity of 8300 feet, which is quite conceivable, being only about four or five times that of a cannon ball. The hypothesis of the lunar origin of meteoric stones was adopted by Laplace, Berzelius, Benzenberg, and others; but the observed velocities of the shooting stars have rendered this origin extremely improbable with respect to them. In order to enter our atmosphere with a velocity of 20 miles in a second, it may be shown that if they come from the moon they must have been projected from the lunar surface with a velocity of about 120,000 feet in a second, which may be regarded as altogether impossible.

It thus appears that those shooting stars and fire-balls which have the planetary velocity of from 20 to 40 miles in a second, cannot with any probability be regarded as having their origin in the moon. Whether any individual bodies moving with a smaller velocity may have a lunar origin, is a question which cannot be decisively answered. "To me," says Dr. Olbers, "it does not appear at all probable; and I regard the moon, in its present circumstances, as an extremely peaceable neighbour, which, from its want of water and atmosphere, is no longer capable of any strong explosions."

The hypothesis first suggested by Chladni is that which appears to have met with most favour, having been adopted by Arago and other eminent astronomers of the present day to explain the November phenomena. It consists in supposing that, independently of the great planets, there exist in the planetary regions myriads of of small bodies which circulate about the sun, generally in groups of zones; and that some of these zones intersect the ecliptic, and are consequently encountered by the earth in its annual revolution. The principal difficulties attending this theory are the following: — First, that bodies moving in groups in the circumstances supposed must necessarily move in the same direction, and consequently, when they become visible from the earth, would all appear to emanate from one point and move towards the opposite. Now, although the observations seem to show that the predominating direction is from north-east to south-west, yet shooting stars are observed on the same nights to emanate from all points of the heavens, and to move in all possible directions. Secondly, their average velocity (especially as determined by Wartmann) greatly exceeds that which any body circulating about the sun can have at the distance of the earth. Thirdly, from their appearance, and the luminous train which they generally leave behind them, and which often remains visible for several seconds, sometimes for whole minutes, and also from their being situated within the earth's shadow, and at heights far exceeding those at which the atmosphere can be supposed capable of supporting combustion, it is manifest that their light is not reflected from the sun; they must therefore be self-luminous, which is contrary to every analogy of the solar system. Fourthly, if masses of solid matter approached so near the earth as many of the shooting stars do, some of them would inevitably be attracted to it; but of the thousands of shooting stars which have been observed, there is no authenticated instance of any one having actually reached the earth. Fifthly, instead of the meteors being attracted to the earth, some of them are observed actually to rise upwards, and to describe orbits which are convex towards the earth; a circumstance of which, on the present hypothesis, it seems difficult to give any rational explanation.

From the difficulties attending every hypothesis which has hitherto been proposed, it may be inferred how very little real knowledge has yet been obtained respecting the nature of the shooting stars. It is certain that they appear at great altitudes above the earth, and that they move with prodigious velocity; but every thing else respecting them is involved in profound mystery. From the whole of the facts, M. Wartmann thinks that the most rational conclusion we can adopt is, that the meteors probably owe their origin to the disengagement of electricity, or of some analogous matter, which takes place in the celestial regions on every occasion in which the conditions necessary for the production of the phenomena are renewed.

The presumptions in favour of the cosmical origin of the shooting stars are chiefly founded on their periodical recurrence at certain epochs of the year, and the extraordinary displays of the phenomena in various years on the nights of the 12th or 13th of November. We shall here merely state the principal circumstances accompanying those of 1799, which put the notion of a *lunar* origin entirely out of the question.

On the morning of the 12th of November, 1799, before sunrise, Humboldt and Bonpland, then on the coast of Mexico, were witnesses to a remarkable exhibition of shooting stars and fire-balls. They filled the part of the heavens extending from due east to about 30° towards the north and south. They rose from the horizon between the east and east-north-east points, described arcs of unequal magnitude, and fell towards the south; some of them rose to the height of 40°, all above 25° or 30°. Many of them appeared to explode, but the larger number disappeared without emitting sparks: some had a nucleus apparently equal to Jupiter. This most remarkable spectacle was seen at the same time in Cumana, on the borders of Brazil, in French Guiana, in the channel of Bahama, on the continent of North America, in Labrador, and in Greenland; and even at Carlsruhe, Halle, and other places in Germany, many shooting stars were seen on the same day. At Nain and Hoffenthal in Labrador, and at Neuhernhut and Lichtenau in Greenland, the meteors seem to have approached the nearest to the earth. At Nain they fell towards all points of the horizon; and some of them had a diameter which the spectators estimated at half an ell. (See *Humboldt's Recueil des Voyages, &c.* vol. ii.)

Under the term FIRE-BALLS, the reader will find an account of a not less stupendous exhibition which took place in North America on the night of the 12th of November, 1833. In 1834, a similar phenomenon occurred on the night of the 13th of November; but on this occasion the meteors were of a smaller size. In 1835, 1836, and 1838, shooting stars were observed on the night of November 13th in different parts of the world; but though diligently looked for on the same nights in 1839 and 1840, they do not appear to have been more numerous than on other nights about the same season of the year.

The second great meteoric epoch is the 10th of August, first pointed out by M. Quetelet; and although no displays similar to those of the November period have been witnessed on this night, there are more instances of the recurrence of the phenomena. In the last three years (1838, 1839, 1840), shooting stars were observed in great numbers both on the 9th and 10th; but they appear in general to be unusually abundant during the two first weeks of August. The other periods which have been remarked are the 18th of October, the 23d or 24th of April, the 6th and 7th of December, the nights from the 15th to the 20th of June, and the 2d of January.

Halley first suggested the idea that the shooting stars may be observed as signals for determining differences of longitude by simultaneous observations; and Maskelyne in 1783 published a paper on the subject, in which he calls the attention of astronomers to the phenomena, and distinctly points out this application. The idea was revived by Benzenberg in 1802; but so long as they were

regarded merely as casual phenomena, it could scarcely be hoped that they would be of much use in this respect to practical astronomy. As soon, however, as their periodicity became probable, the phenomena acquired a new interest; and some recent attempts to determine longitudes in this manner have proved that the method is not to be disregarded. (*Monthly Notices of the R. Astr. Society for January*, 1841.)

See an interesting paper on this subject by Dr. Olbers, in *Schumacher's Jahrbuch* for 1837; also the *Annuaire du Bureau des Longitudes* for 1836; *Mem. de l'Academie de Bruxelles* for 1838; *Schumacher's Astronomisches Nachrichten*, vols. xvi. and xvii.; and the various Scientific Journals.

SHORE. In Architecture, a piece of timber or other material placed in such a direction as to prop up a wall or other heavy body.

SHOT. Any kind of missile discharged by an instrument; but the term usually denotes balls for fire-arms.

SHOT LOCKERS. Long pieces of wood pierced with holes like cups, in which the shot are placed, along the sides and round the hatchways.

SHOU'LDER. In Fortification, the angle of a bastion included between the face and flank.

SHO'VELER. The name of a species of duck, remarkable for the length and terminal expansion of the bill; whence the name of *Spathulea*, proposed for the subgenus of which it is the type. It is the *Anus clypcata* of Linnæus.

SHRA'PNELL SHELLS, in Gunnery, are shells filled with a quantity of musket balls, which, when the shell explodes, are projected about 150 yards further. They are fired from guns, mortars, and howitzers, and have been found most effective. A six-pounder spherical case contains twenty-seven musket balls, which, when the shell explodes, do as much injury as an equal number of muskets, at a distance far beyond the reach of musketry. (*Ency. Brit.* art. "Gunnery.")

SHREW. *See* SOREX.

SHRIKE. A name for the *butcher birds*, or species of *Laniaries*.

SHRINE. (Lat. scrinium, *a desk or cabinet;* whence also *screen.*) Properly, the receptacle of the remains or relics of a saint. Shrines are of two sorts: portable, used in processions, called in Latin *feretra;* and fixed, in churches. The appropriate place for shrines, in the churches of the middle ages, was generally in the eastern part, in the space behind the high altar. Such is the situation of the celebrated shrine of the three kings of Cologne; and such was that of the shrines at St. Alban's, Canterbury, Durham, and Westminster, before the Reformation. (*Archæologia*, vol. i.)

SHROUDS. The large ropes supporting a mast laterally; they take the names of their respective masts, as the lower main shrouds, &c.

SHROVE TUESDAY. The Tuesday after Quinquagesima Sunday, and immediately preceding Ash Wednesday; so called from the Sax. shriven, *to confess*, because on that day confession was made preparatory to the fast of Lent. The custom of ringing the bells for this occasion was long retained in many parishes, particularly in London; although the vulgar name of "pancake bell" shows that little was left of the solemnity beyond the dinner on pancakes which followed it. See *Brand's Popular Antiquities*, for an account of the various shrovetide or carnival amusements of this country.

SHRUB. A small low dwarfish tree, which, instead of one single stem, frequently puts forth from the same root several sets or stems.

Shrub is also the name given to a species of sweet wine or liqueur, of which rum forms the chief ingredient.

SHUTTLE. An instrument used by weavers, which guides the thread it contains, so as to make it form the woofs of stuffs, cloths, linen, and other fabrics, by throwing the shuttle alternately from left to right and from right to left across between the threads of the warp, which are stretched out lengthwise on the loom. In the middle of the shuttle is a kind of cavity, called its eye or chamber, in which is enclosed the *spoul*, which is part of the thread destined for the woof.

SHWAN PAN. The calculating instrument of the Chinese. It is similar in shape and construction to the Roman abacus, and is used in the same manner. *Sec* ABACUS.

SI. In Music, the name for the seventh sound, added by Le Maire, a Frenchman, at the latter end of the 17th century, to the six ancient notes, ut, re, mi, fa, sol, la, of Guido; by means whereof, some authors say, much inconvenience in the ancient gamut is avoided.

SI'ALAGOGUE. (Gr. σιαλον, *saliva*, and αγωγος, *a leader.*) Medicines which increase the flow of saliva.

SIBE'RITE. A mineralogical synonym of rubellite or red tourmaline, the finest specimens of which have been found in Siberia.

SI'BYL. The name given to certain prophetic women said to have lived in early ages in Greece and Italy. Some authors recount as many as ten of them. The most celebrated were the Sibyl of Cumæ, fabled to have been consulted by Æneas, and the prophetess who offered her books to Tarquin the Proud. (See, among many authorities, the *Mém. de l'Ac. des Inscr.* vol. xxiii.)

SI'BYLLINE BOOKS. Documents supposed to contain the fate of the Roman empire. Nine of them are said to have been offered by an old woman, called Amalthæa, to Tarquin the Proud; but Tarquin refusing to give the price she asked, she went away, and burnt three of them. Returning with the remainder, she offered them to the king on the same terms as before; and on his second refusal departed again, and returned with three, which she still offered at the same price as the original nine. The king, struck with her conduct, at last acceded to her offer, and entrusted the care of the books to certain priests (the quindecemviri). They were preserved in a stone chest beneath the temple of Jupiter Capitolinus, and were consulted in times of public danger or calamity. They were destroyed by the fire that consumed the Capitol in the Marsic war. After this calamity, ambassadors were sent to collect such fragments of Sibylline prophecies as they could pick up in various countries; and from the verses thus collected Augustus formed two new books, which were deposited in two gilt cases in the temple of the Palatine Apollo. Sibylline verses are often quoted by Christian writers, as containing prophecies of Christianity; but these are spurious, a forgery of the 2d century.

SICI'LIAN VE'SPERS. In Modern History, the name commonly given to the great massacre of the French in Sicily, in A. D. 1282. They were the soldiers and subjects of Charles of Anjou, who had made himself master of the island after the defeat and death of Conradin. The insurrection broke out on the evening of Easter Tuesday, whence the name. Its consequence was the expulsion of Charles; and the islanders placed themselves under the protection of the king of Arragon.

SIDE'REAL. (Lat. sidus, *a star.*) Something relating to the stars.

The *sidereal day* is the time in which the earth makes a complete revolution on its axis, in respect of the fixed stars or any fixed point in space. (*See* DAY.) "If the sidereal day be taken equal to 24 sidereal hours, the mean solar day will be equal to 24 h. 3 m. 56·55 sec. of those hours; and if the mean solar day be taken equal to 24 mean solar hours, the sidereal day will be equal to 23 h. 56 m. 4·09 sec. of those hours. Or, in all cases, if we wish to determine, in sidereal time, the value of any given interval expressed in mean solar time, and *vice versâ*, we shall have

$$\text{sidereal time} = 1{\cdot}00273791 \times \text{mean solar time},$$
$$\text{mean solar time} = 0{\cdot}99726957 \times \text{sidereal time.}\text{"}$$

(*Baily's Astronomical Tables*, 1827.)

The *sidereal year* is the time in which the earth performs a complete revolution, relatively to the fixed stars, in its orbit; namely, 365·2563612 mean solar days, or 365 d. 6 h. 9 m. 9·6 sec., being 20 m. 19·9 sec. longer than the tropical year. *See* YEAR.

SIDE'ROCALCITE. (Gr. σιδηρος, *iron;* Lat. calx, *lime.*) The name given by Kirwan to the *brown spar* of Werner.

SIENITE, or SYENITE. (From Syene in Egypt, whence the Romans obtained it for architectural purposes.) A granitic aggregate of quartz, felspar, and hornblende. *See* GEOLOGY.

SIERRA. A Spanish term, signifying a chain of hills, and prefixed to the names of several places in Spain, and other parts discovered or colonized by the Spaniards.

SIESTA. (Span.) The name given to the practice indulged in by the Spaniards, and the inhabitants of hot climates generally, of resting two or three hours in the middle of the day, when the heat is too oppressive to admit of their going from home.

SIGILLA'RIA. Fossil plants found in the coal formation.

SIGN. In Algebra, a symbol indicating an operation to be performed, or a relation subsisting between two quantities. Of the former kind, those most commonly used are, $+$ for addition, $-$ for subtraction, $\times$ for multiplication, $\div$ for division, $\sqrt{}$ for the square root, $\sqrt[3]{}$ for the cube root, $\sqrt[n]{}$ for the *n*th root, &c. The signs denoting a relation are, $=$ equal to, $>$ greater than, $<$ less than, &c.

SIGN. In Astronomy, a portion of the ecliptic or zodiac, containing thirty degrees, or a twelfth part of the complete circle. The first commences at the point of the equator through which the sun passes at the time of the vernal equinox; and they are counted onwards, proceeding from west to east, according to the annual course of the sun, all round the circle. The names of the twelve signs, in the order in which they follow each other, with the characters by which they are indicated on globes, and in the almanacs and books of astronomy, are as follows:— *Aries* ♈, *Taurus* ♉, *Gemini* ♊, *Cancer* ♋, *Leo* ♌, *Virgo* ♍, *Libra* ♎, *Scorpio* ♏, *Sagittarius* ♐, *Capricornus* ♑, *Aquarius* ♒, *Pisces* ♓.

It is to be remarked, that the above are also the names

of the twelve constellations of the zodiac; and in ancient times (above 200 years before our era), the places of the signs and the constellations were coincident; but owing to the motion of the earth's equator, by which the equinoctial points are carried backwards on the ecliptic about 50·6″ annually, the intersections of the ecliptic and equator, and consequently the commencement of the signs, now correspond to different stars, the first point of the sign Aries being at present near the beginning of the constellation Pisces. On this account care must be taken not to confound the signs of the zodiac, which are fixed in respect of the equinoxes, with the constellations, which are moveable in respect of those points. *See* CONSTELLATION.

The *ascending signs* are the six beginning with Capricornus, through which the sun passes while advancing from the winter to the summer solstice, and is, consequently, acquiring altitude with respect to inhabitants of the northern hemisphere. The other six, beginning with Cancer, are called the *descending signs*.

SI'GNALS, NA'VAL, imply a system of symbols addressed to the eye, as flags, boards, lights, &c., for establishing communication at distances too great for the voice. Guns are also used for the same purposes. The first signals seem to have been merely distinguishing flags for certain ships. In the system of signals instituted by James II. for orders to the fleet, the purport depended on the part of the ship at which they were exhibited; a condition very detrimental to the use of signals at sea. A code composed of *numeral* flags and pendants, *i. e.* in which each symbol had a number assigned to it, seems to have been the first step towards a general system, as before this plan each admiral instituted his own code. In 1815, Sir Home Popham's code was adopted. This added several *literal* or alphabetical flags and pendants, which greatly extended the means of communication, but necessarily rendered the signals indistinct, and their purports deceitful, in many cases, from the increased difficulty of distinguishing each flag from the rest. In 1826, in consequence of some plans having been submitted by admirals for a more efficient system, the code now in use, which is considered as an improvement on its predecessor, was adopted. In 1828, Admiral Raper published his code, which was one of those under consideration. The principle of this system, which is undeviatingly adhered to, is, that the manner of combination of the flags and pendants of which the signal is composed *i. e.* their order or arrangement, points out the subject of the signal, or, as the author terms it, the *point of service* to which the signal relates; while the *numbers* of the individual symbols indicate the number of the signal in its class. The numbers are denoted, as usual, by the colours; but when these fail, from haze or distance, the number is supplied by *numeral distant signals*. From the distinctness attending the small number of symbols (the smallest possible for complete numeral signals), the precision obtained from classification by which the simplicity of each signal is proportioned to its importance, and the saving of the time often wasted in vain attempts to distinguish the precise disposition of the colours of each flag, this system has been considered by some competent judges as the sole thoroughly efficient method.

In the merchant service, signals are of less extensive utility than in the royal navy, their chief employment being to express the names of vessels, latitude and longitude, and a few other such particulars; and it were much to be desired that governments would agree to establish universal signals on like points of general interest. The code in use is Captain Marryatt's.

Ingenious systems have been published by Lieut. C. Phillips, R. N., for the ships of all nations; and also by Admiral Sir C. Ekins, entitled *Universal Signals*, the symbols being black and white only. From what little acquaintance we have had with foreign signals, we consider them by no means in advance of our own.

SIG'NATURE. (Lat. signatura.) In Music, the flats and sharps placed after the clef, at the beginning of the staff, which affect, throughout the movement, all notes of the same letter.

SIGNATURE. In Printing, a letter of the alphabet placed at the bottom of the first page of each sheet of a work, to denote, alphabetically, the order of the sheets.

It is customary to commence with B on the first sheet of the body of the work, and to go regularly through the alphabet, with the exception of the letters J, V, and W, which are never used as signatures; and which had, in fact, no existence in the alphabet at the time of the invention of printing; 𝔍, expressing both I and J; 𝔘, both U and V; and 𝔘𝔘, the double letter W. If the work extend to more sheets in number than there are letters in the alphabet, the succeeding sheets go on with a second alphabet, which commences with A, and both the letters are usually given; in this manner, A A, or A a, and sometimes, to avoid the repetition, thus, 2 A. If a third alphabet be necessary, it is always, at the present day, placed with the number before it, as 3 A. The printer's first alphabet consists of twenty-two letters, and the second and succeeding ones of twenty-three.

As a guide to the bookbinder, there are other signatures used in a sheet besides the first. In a sheet of octavo the first page has B, the third has B 2, the fifth has B 3, and the seventh has B 4: in a sheet of twelves they are carried to B 6, B 5 being the first page of the offcut; and however numerous the pages may be in a sheet with one signature, when they are all inserted, they are continued to the last odd page before the middle of the sheet, but never carried beyond the middle. In general they are all omitted except the two first, to show the first fold of the paper, and the first on the offcut. Small capitals are more frequently used for signatures than large capitals, as disfiguring the foot of the page in a slighter manner. Sometimes figures are used instead of letters, but not often; the *Gentleman's Magazine* is an instance. (*Savage's Dict. of Printing.*)

SI'GNET, THE PRIVY. One of the king's seals in England, used in sealing private letters and grants under the sign manual. It is in the custody of the Secretary of State for the Home Department. (*See* SEAL, SECRETARY.) The signet in Scotland is the seal by which the king's letters and writs for the purpose of justice are now authenticated. Hence the title of clerks to the signet, or writers to the signet; whose business is nearly the same with that of attorneys in England. They were anciently clerks in the office of the Secretary of State, by whom writs were prepared; and when the signet became employed in judicial proceedings, they obtained a monopoly of the privileges of acting as agents or attorneys before the Court of Session.

SIGN MANUAL. The royal signature, superscribed at the top of bills of grants or letters patent; which are then sealed with the privy signet or great seal, as the case may be, to complete their validity. But there are some grants which pass through certain offices, as the Admiralty or Treasury, under the sign manual only.

SIGNOR. The Italian term equivalent to the English *Lord*, *Sir*, or *Mr.*, the French *Monsieur*, and the German *Herr*. *Signoria* was anciently the appellation of the chief council of Venice, Genoa, and Lucca.

SILENA'CEÆ. (Silene, one of the genera.) An order of Polypetalous Exogenous plants, with opposite undivided leaves, and a stem with tumid nodes. The principal part of the order consists of uninteresting weedy plants; but it also contains the genera *Dianthus*, of which the garden pink, clove, and piccotee are species; the *Agrostemma*, *Saponaria*, and some other plants cultivated for their beautiful flowers.

SILE'NTIARY. Among the Romans, the title of office of a class of slaves attached to wealthy houses. In the court of the emperors, there was a body of officers attached to the household styled silentiaries. Thence the title came to functionaries of higher authority, and was borne by cabinet secretaries in the Lower Empire, and in the courts of Charlemagne and other western potentates who derived their code of ceremonial from Byzantium. Members of the privy council seem to have been sometimes called by this name under the Plantagenets in England.

SILE'NUS. (Gr. Σίληνος.) A Grecian divinity, the foster-father and attendant of Bacchus, and likewise leader of the satyrs. This deity was remarkable for his wisdom, his drunkenness being regarded as inspiration. He was represented as a robust old man in a state of intoxication, and riding on an ass, with a can in his hand. Silenus, says Mr. Bryant, is only a corruption of a masculine form of Σεληνη, *the moon*. By some speculative mythologists the drunken companion of Bacchus is converted into a sage, who was honoured as a dæmon after his decease. (*Theopompus in Ælian*, cited in Bryant, *Anc. Mythol.* vol. iii. p. 328.) There was an order of priests called Sileni, of the same class with the Curetes.

SI'LEX, or SI'LICA. (Gr. χαλις, *a pebble* or *stone*.) The earth of flints. This important substance constitutes the characteristic ingredient of a great variety of siliceous minerals; among which rock-crystal, quartz, chalcedony, and flint may be considered as silica nearly pure. It also predominates in many of the rocky masses which constitute the crust of our globe, such as granite, the varieties of sandstone, and quartz rock. Although silica has none of the ordinary or more obvious acid properties, yet, as it combines in definite proportion with many salifiable bases, and expels carbonic acid when fused with the carbonated alkalies, it is very commonly termed *silicic acid*, and its various compounds have been denominated *silicates*. When pure and colourless rock-crystal is heated red hot, and quenched in water, it becomes opaque and friable; and if in this state it be reduced to powder, it presents one form of pure silica. If in this state (in which it is perfectly insoluble in water) it be fused with three parts of carbonate of potash, it forms a glass which is soluble in water, and from this solution (formerly called *liquor of flints*) the concentrated acids throw down the silica in the form of a *gelatinous hydrate*; but if the solution be diluted, and the acid gradually added, the alkali may be

perfectly neutralized without any deposition of the silica, which, therefore, is thus exhibited in a very soluble state: when, however, the solution is evaporated to dryness, the silica remains in a state as insoluble as before. This solubility of hydrated silica, whilst when dry it is perfectly insoluble, may serve to explain the occasional occurrence of silica in mineral waters, and its deposition in various chalcedonic incrustations. But silica presents another very remarkable character; which is, that if we reverse the above proportions, and fuse together a mixture of one part of carbonate of potash and three of powdered rock-crystal or calcined flint, we then obtain a transparent and fusible compound, which is insoluble in water, and which, in fact, is glass.

Plate glass and *window glass*, or, as it is commonly called, *crown glass*, are silicates of soda or potassa; and *flint glass*, of which our common glass utensils are made, is a similar compound, with a large addition of silicate of lead. *See* Glass.

Silica, in its ordinary or *anhydrous* state, is insoluble in all acids except the *hydrofluoric*, which immediately acts upon it, and forms an extraordinary gaseous compound, the *fluosilicic* acid. Silica was long considered as an elementary form of matter; but Sir H. Davy found that when the vapour of potassium was brought into contact with pure silica heated to whiteness, silicate of potassa was formed, and a dark-coloured matter separated, which was afterwards found to be the base of silica, and to which the terms *silicium* and *silicon* have been applied. It is probably not metallic, and bears a greater analogy to boron than to any known principle. Silicon is a nonconductor of electricity, incombustible in air and oxygen, and not acted upon by any single acid; but it is readily soluble in a mixture of the nitric and hydrofluoric acids. It is, however, rapidly oxidized by and burns vividly at a temperature below redness, when in contact with fused soda or potassa. The exact equivalent of silica has not been very satisfactorily determined, but we are probably not very incorrect in regarding silica as a compound of equal weights of silicon and oxygen. In that case, if it be regarded as a protoxide, it is obvious that 8 will be the equivalent of its base, and silica will consist of 8 silicon + 8 oxygen, and be represented by the equivalent 16. But if silica be regarded as a compound of 1 atom of silicon and 3 atoms of oxygen, and Berzelius has shown that some analogies favour this view, then 24 will be its equivalent, and 48 that of silica. The *chloride of silicium*, and its *bromide*, are limpid fuming liquids; the former very volatile. The *sulphuret* is a white earthy-looking substance.

SILHOUETTE. In the Fine Arts, a name given to the representation of an object filled in of a black colour, and in which the inner parts are sometimes indicated by lines of a lighter colour, and shadows or extreme depths by the aid of a heightening of gum or other shining medium. This sort of drawing derives its name from its inventor, Etienne de Silhouette, the French minister of finance in 1759. Representations of this sort may be well enough taken from the shadow of a person thrown on a piece of paper placed against a flat surface or wall. The likeness may be still better taken, if on a reduced scale, by means of the instrument called a pantograph.

The invention of what is called a *silhouette* is, however, ascribed to a remote period, being said to have been the method whereby the daughter of a Greek potter drew the outline of her lover's portrait on a wall; and has been placed at the time of the renewal of the Olympic games, shortly before the expulsion of the Bacchiades from Corinth, about 776 B.C. It is to be observed that Sicyon and Corinth were the first cities in which painting flourished; and that Crato of Sicyon, Philocles of Egypt, and Cleanthes of Corinth, were considered the inventors of *monochromes*, or silhouettes, as they have been more recently called, which were applied to large objects. The Etruscan vases furnish to an amazing extent, and in boundless variety, some of the most beautifully drawn and elegant monochromes or silhouettes that have ever been executed.

SILI'CIFICÆ. Substances petrified or mineralized by siliceous earth.

SILI'CULA. (Lat. siliqua, *dim.*) A fruit exactly similar to that called a siliqua, except that it is shorter, and contains fewer seeds. It is never more than four times as long as broad, and usually much shorter.

SI'LIQUA. (Lat.) A one or two celled, many-seeded, linear fruit, dehiscent by two valves separating from a replum; the seeds are attached to two placentæ adhering to the replum, and opposite to the lobes of the stigma.

SILK. (Lat. sericum; from Seres, the supposed ancient name of the Chinese.) A fine glossy thread or filament spun by various species of caterpillars or larvæ of the *Phalæna* genus. Of these, the *Phalæna atlas* produces the greatest quantity; but the *Phalæna bombyx* is that commonly employed for this purpose in Europe. The silkworm, in its caterpillar state, which may be considered as the first stage of its existence, after acquiring its full growth (about three inches in length), proceeds to enclose itself in an oval-shaped ball, or cocoon, which is formed by an exceedingly slender and long filament of fine yellow silk, emitted from the stomach of the insect preparatory to its assuming the shape of the chrysalis or moth. In this latter stage, after emancipating itself from its silken prison, it seeks its mate, which has undergone a similar transformation; and in two or three days afterwards, the female having deposited her eggs (from 300 to 500 in number), both insects terminate their existence. According to Reaumur, the *phalæna* is not the only insect that affords this material, — several species of the *aranea*, or spider, enclose their eggs in very fine silk.

Raw silk is produced by the operation of winding off, at the same time, several of the balls or cocoons (which are immersed in hot water, to soften the natural gum on the filament) on a common reel, thereby forming one smooth even thread. When the skein is dry, it is taken from the reel and made up into hanks; but before it is fit for weaving, and in order to enable it to undergo the process of dyeing, without furring up or separating the fibres, it is converted into one of three forms, — viz. *singles*, *tram*, or *organzine*.

Singles (a collective noun) is formed of *one* of the reeled threads, being twisted, in order to give it strength and firmness.

Tram is formed of two or more threads twisted together. In this state it is commonly used in weaving, as the *shoot* or *weft*.

Thrown silk is formed of two, three, or more singles, according to the substance required, being twisted together in a contrary direction to that in which the singles of which it is composed are twisted. This process is termed *organzining;* and the silk so twisted, *organzine*. The art of throwing was originally confined to Italy, where it was kept a secret for a long period. Stowe says it was known in this country since the 5th of Queen Elizabeth, "when it was gained from the strangers;" and in that year (1562), the silk throwsters of the metropolis were united into a fellowship. They were incorporated in the year 1629; but the art continued to be very imperfect in England until 1719. (See *post.*)

1. *Historical Sketch of the Manufacture.* — The art of rearing silkworms, of unravelling the threads spun by them, and manufacturing the latter into articles of dress and ornament, seems to have been first practised by the Chinese. Virgil is the earliest of the Roman writers who has been supposed to allude to the production of silk in China, and the terms he employs show how little was then known at Rome as to the real nature of the article:—

> Velleraque ut foliis depectant tenuia Seres.
> *Georg.* book ii. lin. 121.

But it may be doubted whether Virgil do not, in this line, refer to cotton rather than silk. Pliny, however, has distinctly described the formation of silk by the *bombyx*. (*Hist. Nat.* lib. xi. c. 17.) It is uncertain when it first began to be introduced at Rome; but it was most probably in the age of Pompey and Julius Cæsar: the latter of whom displayed a profusion of silks in some of the magnificent theatrical spectacles with which he sought at once to conciliate and amuse the people. Owing principally, no doubt, to the great distance of China from Rome, and to the difficulties in the way of the intercourse with that country, which was carried on by land in caravans, whose route lay through the Persian empire, and partly, perhaps, to the high price of silk in China, its cost, when it arrived at Rome, was very great; so much so, that a given weight of silk was sometimes sold for an equal weight of gold! At first it was only used by a few ladies eminent for their rank and opulence. In the beginning of the reign of Tiberius, a law was passed —*ne vestis serica viros fœdaret* — that no man should disgrace himself by wearing a silken garment. (*Tacit. Annal.* lib. ii. c. 33.) But the profligate Heliogabalus despised this law, and was the first of the Roman emperors who wore a dress composed wholly of silk (*holosericum*). The example once set, the custom of wearing silk soon became general among the wealthy citizens of Rome, and throughout the provinces. According as the demand for the article increased, efforts were made to import larger quantities; and the price seems to have progressively declined from the reign of Aurelian. That this must have been the case, is obvious from the statement of Ammianus Marcellinus, that silk was, in his time (anno 370), very generally worn, even by the lowest classes: *Sericum ad usum antehac nobilium, nunc etiam infimorum sine ulla discretione proficiens.* (Lib. xviii. c. 6.)

China continued to draw considerable sums from the Roman empire in return for silk, now become indispensable to the western world, till the 6th century. About the year 550, two Persian monks, who had long resided in China, and made themselves acquainted with the mode of rearing the silkworm, encouraged by the gifts and promises of Justinian, succeeded in carrying the eggs of the insect to Constantinople. Under their direction they were hatched and fed; they lived and

laboured in a foreign climate; a sufficient number of butterflies were saved to propagate the race, and mulberry trees were planted to afford nourishment to the rising generations. A new and important branch of industry was thus established in Europe. Experience and reflection gradually corrected the errors of a new attempt; and the Sogdoite ambassadors acknowledged, in the succeeding reign, that the Romans were not inferior to the natives of China in the education of the insects, and the manufacture of silk. (Gibbon, *Decline and Fall*, vol. vii. p. 99.)

Greece, particularly the Peloponnesus, was early distinguished by the rearing of silkworms, and by the skill and success with which the inhabitants of Thebes, Corinth, and Argos carried on the manufacture. Until the 12th century, Greece continued to be the only European country in which these arts were practised; but the forces of Roger, king of Sicily, having, in 1147, sacked Corinth, Athens, and Thebes, carried off large numbers of the inhabitants to Palermo, who introduced the culture of the worm and the manufacture of silk into Sicily. From this island the art spread into Italy; and Venice, Milan, Florence, Lucca, &c. were soon after distinguished for their success in raising silkworms, and for the extent and beauty of their manufactures of silk. (*Gibbon*, vol. x. p. 110.; *Biographie Universelle*, art. "Roger II.")

The manufacture of silk appears to have been introduced into Spain at a very early period by the Moors, particularly in Murcia, Cordova, and Granada. "The last town, indeed, possessed a flourishing silk trade when it was taken by Ferdinand in the 15th century. The French having been supplied with workmen from Milan, commenced, in 1521, the silk manufacture; but it was not till 1564 that they began successfully to produce the silk itself, when Traucat, a working gardener at Nismes, formed the first nursery of white mulberry-trees, and with such success that in a few years he was enabled to propagate them over many of the southern provinces of France. Prior to this time, some French noblemen, on their return from the conquest of Naples, had introduced a few silkworms with the mulberry into Dauphiny; but the business had not prospered in their hands. The mulberry plantations were greatly encouraged by Henry IV.; and since then they have been the source of most beneficial employment to the French.

James I. was most solicitous to introduce the breeding of silkworms into England, and in a speech from the throne he earnestly recommended his subjects to plant mulberry-trees; but he totally failed in the project. This country does not seem to be well adapted to this species of husbandry, on account of the great prevalence of blighting east winds during the months of April and May, when the worms require a plentiful supply of mulberry-leaves. The manufacture of silk goods, however, made great progress during that king's peaceful and pompous reign. In 1629 it had become so considerable in London, that the silk throwsters of the city and suburbs were formed into a public corporation. So early as 1661 they employed 40,000 persons. The revocation of the edict of Nantes, in 1685, contributed in a remarkable manner to the increase of the English silk trade, by the influx of a large colony of skilful French weavers, who settled in Spitalfields. The great silk-throwing mill mounted at Derby, in 1719, also served to promote the extension of this branch of manufacture; for soon afterwards, in the year 1730, the English silk goods bore a higher price in Italy than those made by the Italians, according to the testimony of Keysler. It would be impossible, within our limits, to give an account of the gradual progress of the silk manufacture from that period down to the present time. Upon this subject, the reader will find ample details in the *Commercial Dictionary*; meantime we may remark, that a great revolution was effected in the manufacture in 1825. Previously to that epoch the legislative enactments with respect to it were the most contradictory and impolitic that can well be imagined. The importation of foreign silks was prohibited under the severest penalties; but the advantage that this prohibition was believed, though most erroneously, to confer on the manufacturer, would, under any circumstances, have been more than neutralized by the imposition of oppressive duties on the raw material. This vicious system was productive of a twofold mischief; for, by teaching the manufacturers to depend on custom-house regulations for protection against foreign competition, it made them indifferent about new discoveries and inventions, while, owing to the exorbitant duties on the raw material, and the want of improvement, the price of silks was maintained so high as to restrict the demand for them within comparatively narrow limits. In 1825, however, a new and more reasonable order of things was introduced. The duties on the raw material were greatly lowered; at the same time that foreign silk goods were allowed to be imported on payment of a duty of 30 per cent. *ad valorem*. This new system was vehemently opposed at its outset, and it was confidently predicted that it would occasion the ruin of the manufacture; but the result has shown the soundness of the principles on which it was bottomed. The manufacturers were now, for the first time, compelled to call all the resources of science and ingenuity to their aid; and the result has been that the manufacture has been more improved during the last dozen years than it had been in the whole previous century, and that it has continued progressively to increase.

The total quantity of raw silk imported for home consumption in 1838 was 3,595,816 lbs. The total number of individuals directly engaged in the manufacture has been estimated at upwards of 207,000; but we incline to think that this is very decidedly beyond the mark. The value of the silks annually produced may, perhaps, be estimated at from 10,000,000*l*. to 12,000,000*l*. (For full particulars as to the history and manufacture of silk, see Porter's treatise on the subject in *Lardner's Cyclopædia*.)

SILL. (Sax. ſyl.) In Architecture, the horizontal piece at the bottom of a framed case, such as that of a door or window. This word is also used to denote the bottom piece of a quarter partition. *Ground sills* are those timbers on the ground on which are placed the posts and superstructure of a timber building.

SI'LLIMANITE. A mineral named after Professor Silliman, from Saybrook in Connecticut; it is of a brown or dark grey colour, and composed of silica and alumina, with a trace of oxide of iron.

SILT. The name given to the sand, clay, and earth which accumulate in running waters.

SILU'RIAN. The name given by Murchison to a series of rocks forming the upper subdivision of the sedimentary strata found below the old red sandstone, and formerly designated the *greywacke series*. These strata are well developed in that part of England and Wales formerly included in the ancient British kingdom of the *Silures*. *See* GEOLOGY.

SILU'RIDANS, *Siluridæ*. (Lat. silurus, *a sheath-fish*.) The name of the family of fishes of which the genus *Silurus* is the type, and which includes the electric silurus (*Malapterurus electricus*). They are chiefly distinguished by the want of true scales, having merely a naked skin, or large osseous plates. A strong osseous spine forms the first ray of the dorsal and pectoral fins, except in the genus *Malapterurus*.

SILVA'NUS. A rural Italian deity; so called from Lat. sylva, *a wood*. He also presided over boundaries.

SI'LVER. (Germ. silber.) A white, malleable, ductile, and tenacious metal, of a brilliant lustre when polished, and soft when pure. Its specific gravity is 10·5. It is not altered by air or moisture, but is blackened or tarnished by sulphuretted hydrogen. When melted in open vessels it has the curious property of absorbing oxygen, which it gives out when it congeals. This is the cause of the appearance of granular crystallization which silver assumes when hastily cooled: a small *per-centage* of copper entirely prevents the effect. The only pure acids which act upon silver are the nitric and sulphuric. The nitric acid dissolves silver without the aid of heat, nitrous gas is evolved, and a dense colourless solution obtained, from which tabular crystals of nitrate of silver may be procured by evaporation. These crystals are anhydrous, and consist of 118 oxide of silver and 54 nitric acid, the equivalent of silver being 110. When melted, and cast into sticks or quills, they form the *lunar caustic* of the surgeons. Any gold which the silver might have contained, being insoluble in nitric acid, remains in the form of a black powder, and this simple process enables us readily to separate those metals. Silver is not attacked by cold sulphuric acid; but when granulated silver is heated in concentrated sulphuric acid, one portion of the acid is decomposed and imparts oxygen to the silver; sulphurous acid is evolved, and the oxide of silver dissolves in the residuary acid, forming a sulphate of silver. It is a difficultly soluble salt, forming anhydrous acicular crystals. In this case, the gold also remains undissolved; and as sulphuric is much cheaper than nitric acid, it is used for the separation of those metals upon the large scale. The solutions both of the nitrate and sulphate of silver are decomposed by the immersion of several of the other metals. Copper is generally used for the purpose; which, when immersed in the solution of silver, causes its separation in the form of a grey metallic powder, which is sometimes technically called *water silver*. Chlorine and all the soluble chlorides, when added to solutions of silver, occasion a white curdy precipitate, which is distinguished by the rapidity with which it blackens by exposure to light. The substance thus formed is a chloride of silver, composed of 110 silver + 36 chlorine, the equivalent of chloride of silver being 146. It is not decomposed by heat alone; but when carefully melted it concretes into a horny substance, formerly called *luna cornea*. Chloride of silver may be easily decomposed either by mixing it in a moist state with zinc filings, or by fusing it with carbonate of soda or potash: in either case metallic silver is obtained. The insolubility of chlo-

ride of silver renders a solution of nitrate of silver an admirable test of the presence of common salt or other chlorides in mineral waters; and, on the other hand, a solution of common salt is used to detect silver when in solution. A solution of two drachms of nitrate of silver in an ounce of water, coloured by a little sap green or Indian ink, forms marking ink; and when written upon linen, previously prepared by the application of a weak solution of carbonate of soda with a little starch or gum in it, soon forms black indelible letters. When a nitric solution of silver is mixed with alcohol, an effervescence ensues, and *fulminating silver* is precipitated. This most dangerous compound (a peculiar cyanate of silver) ought never to be meddled with in quantity, and always with the utmost circumspection; it explodes with violence upon the slightest friction of hard bodies, or when struck, rubbed, or heated.

The numerous uses and applications of silver are well known. In its pure state it is too soft for coin, plate, and most ornamental purposes, and is therefore, in such cases, alloyed with copper, by which, in proper proportion, its colour is not materially impaired, and it is considerably hardened. The standard silver of our coin is an alloy of 11 oz. 2 dwts. of pure silver, and 18 dwts. of copper, to the pound Troy; and this weight is coined into 66 shillings.

Silver is found *native*, and in the state of *sulphuret*, constituting the varieties of black and vitreous silver ore. It also occurs in combination with several other metals, and more especially with the sulphurets of lead; so that the lead of commerce is seldom quite free from traces of silver, and many such lead ores are worked as ores of silver.

SIMARU'BA. The bark of the root of the *Quassia simaruba*, a native of the West Indies. This is a tough, fibrous, bitter bark; the infusion is occasionally used in medicine as a tonic.

SIMARUBA'CEÆ. (Simaruba, one of the genera.) A natural order of arborescent or shrubby Exogens, inhabiting the tropics. The species are intensely bitter. The wood of quassia is well known. A plant called *Paraiba* in Brazil, the *Simaruba versicolor* of St. Hilaire, possesses such excessive bitterness that no insects will attack it; and *Picræna excelsa* is another species of the order, which is employed in medicine for the same property.

SI'MIA. (Lat. simus, *flat-nosed.*) The generic name applied by Linnæus to all the Quadrumanous Mammals, except the lemurs. The Linnæan *Simiæ* are divided into numerous subgenera, to none of which the name *Simia* is now applied, except by some modern naturalists to the orangutans (*Simia satyrus*), and *S. moris*.

SI'MILAR. (Lat. similis, *like.*) In Geometry, similar rectilineal figures are such as have their several angles respectively equal, each to each, and their sides about the equal angles proportional. The areas of two similar figures are to each other as the squares of their homologous sides. *Similar segments of circles* are such as contain equal angles. *Similar curves* are curves whose equations are of the same form, and the ratio of the constants in those equations equal. Hence all circles are similar, and all parabolas are similar; because, in both cases, only one constant enters into the equation of the curve. *Similar solids* are such as are contained by the same number of similar planes, similarly situated, and having like inclinations to one another. Such solids are to one another as the cubes of their homologous sides.

SI'MILE. (Lat. *like.*) In Rhetoric, the same as *comparison*, which see.

SIMI'LITER. (Lat. *in like manner.*) In Law, the technical designation of the form by which either party, in pleading, accepts the issue tendered by his opponent. The one having concluded his plea, replication, &c., by tendering issue in the common form, by "putting himself upon the country," *i. e.* praying that the truth of the facts may be inquired of by a jury, the other adds the similiter, which is in the form,—"And the said A. B. as to the plea, &c. of the defendant (or plaintiff) above pleaded, and whereof he hath put himself upon the country, doth the like." *See* PLEADING.

SIMI'LITUDE, in Geometry, signifies the relation of figures similar to each other.

SIMONIANS. The name given to the followers of Simon Magus, who pretended to be the great virtue and power of God sent from heaven to earth. Their system was a medley of the philosophy of Plato, the mythological fables of the heathens, and of Christianity. The sum of their doctrines, as enjoined by their founder, was, that from the Divine Being, as a fountain of light, flow various orders of eternal natures, subsisting within the plenitude of the Divine essence; that beyond these in the order of emanation are different classes of intelligences, to the lowest of which belongs the human soul; that matter is the most remote production of the emanative power, which, on account of its infinite distance from the fountain of light, possesses sluggish and malignant qualities, which appear the divine operations, and are the cause of evil; that it is the great design of philosophy to deliver the soul from its imprisonment in matter, and restore it to that divine light from which it was derived; and that for this purpose God had sent us one of the first *æons* into the world. He believed also in the transmigration of souls, and denied the resurrection of the body. (*Encyc. Brit.*) We have specified at greater length the opinions of this sect than they seem properly entitled to; but considering that it was the first heresy in the Christian church, a resumé of its views was considered not to be out of place.

SIMONIANS, SAINT. *See* SAINT SIMONIANS.

SI'MONY. In Law, an unlawful contract for the presenting a clergyman to a benefice. When such presentation is made corruptly, for money, gift, or reward, by stat. 31 Eliz. c. 6. such presentations are void, and the crown shall present for that turn. And by 12 Ann. 8. t. 2. c. 12. if any one, for money or profit, procures in his own name the next presentation to any living ecclesiastical, and is presented thereupon, the contract is simoniacal. The term is derived from Simon Magus, who was punished, as is related in the Acts, for attempting to obtain the gifts of the Holy Spirit by bribing the apostles. It is generally remarked, however, that the practices against which our laws are directed bear no precise similarity to this.

SIMOON, or SIMOOM. A hot arid wind which blows in Arabia, Syria, and the adjacent countries, and chiefly about the time of the equinoxes. The simoon, which is identical with the *khamsin* of Syria and the *samiel* of the Turks, and resembles in many respects the *sirocco* and *sorana* of other countries, derives its qualities from blowing over sandy deserts heated intensely by the sun. Sometimes it blows in squalls, bearing along with it quantities of burning sand and dust. In the desert it is greatly dreaded; and the only chance of safesty the traveller has is to fall down with his face close to the ground, and to continue as long as possible without drawing breath. It is described by Bruce, Volney, Charind, Malcolm, and other travellers.

SIMPLI'CIMANES, *Simplicimani.* (Lat. simplex, *simple;* manus, *a hand.*) A name given by Latreille to a tribe of Caraboid beetles, comprehending those in which, in the male, the two anterior tarsi are dilated.

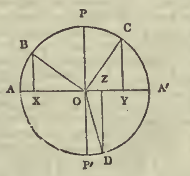
SIMPLI'CITY. (From Lat. simplex.) In the Fine Arts, that quality in works of art through which the elements whereof it is composed are arranged in the most natural order; and in which the ideas and images are presented to us so that the principal objects are not eclipsed by the accessories, and the details are in due subordination to the whole. Simplicity is the reverse of excess and exaggeration, and may be properly called a negative quality in art.

SI'NAPISIN. A peculiar principle extracted from mustard seed (*Sinapis alba*). It is a white crystallizable inodorous substance, of a bitter taste, accompanied by the flavour of mustard. It is supposed to contain sulphur, carbon, nitrogen, hydrogen, and oxygen.

SI'NAPISM. (Lat. sinape, *mustard.*) A mustard poultice.

SI'NCIPUT. The anterior region of the upper part of the head, from the vertex to the eyes in Mammals, and from the vertex to the base of the beak in birds.

SINE. (Lat. sinus, *the bosom.*) In Trigonometry, the sine of any arc of a circle is the straight line drawn from one extremity of the arc perpendicular to the radius passing through the other extremity. Thus, in the circle A B C D, let O A and O B be two radii, and let B X be perpendicular to O A; then B X is the sine of the intercepted arc A B. In like manner, if C Y and D Z be perpendicular to A O, or its prolongation O A′; then C Y is the sine of the arc A B C, or of A′ C, the supplement of A B C, and D Z the sine of A C D, or of A′ D.



Draw the diameter P O P′, and suppose the arc A B to increase from 0 to 360°. It is evident that as the arc A B increases from A to A P, or from 0 to 90°, the sine B X increases from zero to O P, where it becomes equal to the radius; and hence the radius is called the *sinus totus*, or whole sine. Between P and A the sine again diminishes as the arc is increased, and vanishes at A′. From A towards P′ it again increases till it becomes equal to the radius O P′, and from this position decreases until it again vanishes at A. Hence it appears that the origin being supposed at A, the sine is positive in the first and second quadrants, or from 0 to 180°; and negative in the third and fourth, or from 180° to 360°.

If we conceive another circle to be described about the same centre O, the two lines O A and O B would intercept on it an arc similar to A B; and if, also, we suppose the radius of this second circle = 1, and denote the inter-

cepted arc by ϕ; then we shall have evidently sin. ϕ : 1 : : B X : B O, or sin. $\phi = \frac{BX}{BO}$. But the arc whose radius is 1 is the measure of the angle at the centre; therefore the sine of the angle A O B is the ratio of B X to B O, or A O. This definition of the sine of an angle is adopted in some of the best recent works on trigonometry.

The sine of an arc is the half of the chord of the double arc. Ptolemy, in the graphical constructions in the *Analemma*, makes use of the semichords instead of the chords; but the introduction of the sines into trigonometrical calculation was an important improvement, of which the credit appears to be due to the Arabian astronomer Albategnius. (Delambre, *Astronomie du Moyen Age*, p. 12.) The term *sine* has been variously derived; the Arabic name is *gib*, or *dgib*, signifying *a fold*, of which *sinus* is the Latin translation. (*Hutton's Mathematical Tables*.)

For the analytical expressions of the sines of the sums and differences of two arcs, of multiple arcs, and of the other trigonometrical lines, see TRIGONOMETRY.

SI'NECURE. In Politics, an office without any duties attached to it. The term is properly ecclesiastical, and applied to a benefice without care of souls; in which sense it is also still employed.

SINE DIE. (Lat. *without day.*) In Legal and Parliamentary Usage, an adjournment or prorogation *sine die* means without any specified day for resuming the subject, or reassembling.

SI'NGULAR TERM. In Logic, a term which stands for one individual. A singular proposition is one which has for its subject either a singular term, or a common term limited to one individual by a singular sign. *See* TERM, PROPOSITION.

SINI'STER (Lat. literally *left*), is used in its ordinary signification for unlucky; though the Romans in the rites of divination attached to it the opposite meaning. Thus *avis sinistra*, or a bird on the left hand, was esteemed a happy omen; and *intonuit lævâ*, it thundered, on the left hand, indicated the same. *Sinister*, in Heraldry, is used to designate the left-hand side or part.

SINKING FUND. A provision made by parliament, consisting of the surplusage of other funds, intended to be appropriated to the payment of the national debt. *See* FUNDS.

SINO'PLE. In Heraldry, the Continental designation for the colour green; by English heralds called *vert*. The name is said to be derived, through the importation of the Crusades, from the town of Sinope, in Asia Minor.

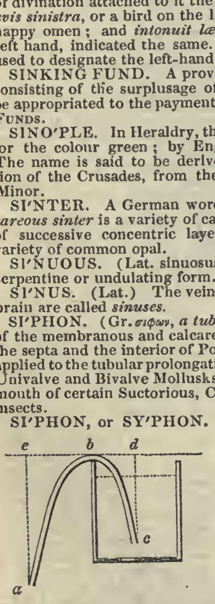
SI'NTER. A German word implying a *scale*. *Calcareous sinter* is a variety of carbonate of lime composed of successive concentric layers. *Silicious sinter* is a variety of common opal.

SI'NUOUS. (Lat. sinuosus.) In the Fine Arts, of a serpentine or undulating form.

SI'NUS. (Lat.) The veins of the dura mater of the brain are called *sinuses*.

SI'PHON. (Gr. σιφων, *a tube.*) In Zoology, the name of the membranous and calcareous tubes which traverse the septa and the interior of Polythalamous shells. Also applied to the tubular prolongation of the mantle in certain Univalve and Bivalve Mollusks; and by Latreille to the mouth of certain Suctorious, Crustaceous, and Apterous insects.

SI'PHON, or SY'PHON. In Hydraulics, a simple and well-known instrument, chiefly used for the purpose of drawing off liquids from casks. The siphon is simply a bent tube, *a b c*, having one end longer than the other. To use the siphon, the tube is in the first place filled with the liquid, and the open end *a* stopt by the hand, or by a cock, in which state the liquid will not flow from the other extremity. The end *c* is then immersed in the liquid, and the stop removed from *a*; upon which, if *a* be at a lower level than *c*, the liquid will immediately begin to flow out at *a*, and will continue to flow until the vessel is drained down to the level of *c*.



The principle of the siphon may be explained as follows: — The lowest section of the fluid within the tube at the extremity *c* is subjected to two unequal pressures in opposite directions: first, the pressure due to the weight of the liquid in the branch *b c*, which pressure is equal to the line *c d*, perpendicular to the horizontal line drawn through the highest part of the tube, and tends to force the liquid out of the tube; secondly, the pressure of the external liquor at *c*, which is equal to the atmospheric pressure, or the weight of a column of liquid of about 34 feet in height, together with the weight of the column reaching from *c* to the surface of the liquid in the vessel, which, however, we may leave out of consideration. Hence, if the line *c d* be less than 34 feet (if the liquid be water), the last pressure will preponderate, and the liquid will be forced into the tube by a pressure equal to the weight of the atmosphere diminished by the weight of a column of the fluid equal to *c d*. In like manner, the pressure upon a section of the liquid at *a* is equal to the weight of the atmospheric column diminished by the weight of a column of the fluid equal in height to *a e*. If, therefore, *a e* be greater than *c d*, the pressure at *c* will be greater than the pressure at *a*, and the liquid will be forced through the tube.

From this explanation it is obvious that the limits within which the siphon can act are determined by the specific gravity of the fluid. Water cannot be raised by the siphon to a greater height than 34 feet, nor mercury to a greater height than 30 inches. It is also obvious that the comparative diameters of the two branches, and their oblique lengths, are of no importance, the action depending only on the difference of their perpendicular heights.

Sometimes the siphon is made with both branches equal, and turned up at the extremities; in which case, so long as the extremities are kept on the same level, it will continue always full and ready for use. This form of the instrument is called the *Wurtemberg siphon*, from its having been first used at that place.

SIPHONA'PTERANS, *Siphonaptera*. (Gr. σιφων, α priv., and πτερον, *a wing.*) A name given by Latreille to an order of insects, including those Apterous species which have a mouth in the form of a siphon.

SIPHO'NIFERS, *Siphonifera*. (Gr. σιφων; Lat. fero, *I bear.*) A name given by D'Orbigny and Ferussac to an order of Cephalopods, including all those species which have a siphon contained within a polythalamous shell.

SIPHONOBRAN'CHIATES, *Siphonobranchiata*. (Gr. σιφων, and βραγχια, *gills.*) The name of an order of Gastropods, including those in which the branchial cavity terminates in a tube or siphon more or less prolonged, by which the respiratory current of water is received and expelled.

SIPHO'NOPHORES, *Siphonophora*. (Gr. σιφων, and φερω, *I bear.*) A name given by Escholtz to an order of Acalephes, to which he refers those species that have no central digestive cavity, but simply isolated tubes.

SIPHO'NOSTOMES, *Siphonostoma*. (Gr. σιφων, and στομα, *a mouth.*) The name of a family of Crustaceans, comprehending those which have a siphon-shaped mouth for suction. By M. de Blainville the term is applied to those Gastropods which have the opening of the shell prolonged into a siphon.

SIPHORHI'NIANS, *Siphorhinii*. (Gr. σιφων, and ῥιν, *a nose.*) A name applied to a tribe of swimming birds, including those which have the nostrils prominent and tubular.

SIP'UNCLE, *Sipunculus*. The name of a genus of worms which burrow in the sands of the sea-shore, and are classed with the *Echinoderms* by Cuvier, and with the *Entozoa* by M. de Blainville. They differ from the soft-bodied *Echinoderms* chiefly in the absence of ambulacral pores.

SIR. The term used in England, either out of respect or formality, in addressing any one. More particularly, it is the distinguishing appellation of knights and baronets, to whose Christian names it is prefixed. The derivation of this word has greatly puzzled etymologists. The Lat. herus, *master* (whence the Germ. herr), and senior, whence *signor*, *siore*, *sire*, *sir*, and the Gr. κυριος, *lord*, are specimens of the origin which has been assigned to this term. The second is undoubtedly correct. Since the 16th century, the word *sire* has been used in prose only in addressing sovereign princes.

SI'REN. The generic name of certain Perennibranchiate reptiles which have only one pair of feet, and retain the external gills; they are peculiar to the southern provinces of the United States.

SIRE'NE. In Acoustics, an instrument for determining the velocity of aërial vibration, corresponding to the different pitches of musical sounds. "In this elegant instrument the wind of a bellows is emitted through a small aperture, before which revolves a circular disc pierced with a certain number of holes, arranged in a circle concentric with the axis of rotation, exactly equidistant from each other, and of the same size, &c. The orifice through which the air passes is so situated that each of these holes, during the rotation of the disc, shall pass over it, and let through the air; but the disc is made to revolve so near the orifice that in the intervals between the holes it shall act as a cover, and intercept the air. If the holes be placed obliquely, the action of the current of air alone will set the disc in motion; if perpendicular to the surface, the disc must be moved by wheel-work, by means of which its velocity of rotation is easily regulated, and the number of impulses may be exactly counted. The sound produced is clear and sweet, like the human voice. If, instead of a single aper-

ture for transmitting the air, there be several, so disposed in a circle of equal dimensions with that in which the holes of the disc are situated that each shall be opposite one corresponding hole when at rest, these will all form sounds of one pitch, and being heard together will reinforce each other. The sirene sounds equally when plunged in water and fed by a current of that fluid as in air; thus proving that it is the number of impulses only, and nothing depending on the nature of the medium in which the sound is excited, that influences our appreciation of its pitch." (Sir John Herschel's Treatise on Sound, *Encyc. Metropolitana.*)

The sirene, as thus described, was invented by Baron Cagniard de la Tour. An instrument on the same principle, and for the same purpose, had formerly been devised by Professor Robison; but the construction was much less elegant and commodious. A current of air passing through a pipe was alternately intercepted and permitted to pass by the shutting and opening of a stop cock.

SI'RENS. (Gr. Σειρῆνες; probably from σειρα, *a chain*, to signify their attractive power.) Melodious divinities, who dwelt on the shores of Sicily, and so charmed passing mariners by the sweetness of their song that they forgot their homes, and remained there till they perished of hunger. Their history has been variously described. According to Homer, in the *Odyssey*, as Ulysses and his companions were on their homeward voyage from Æaca, they came first to the island of the Sirens: but they passed in safety; for, by the directions of Circe, Ulysses stopped the ears of his companions with wax, and had himself tied to the mast before approaching the island; so that, although when he heard the song of the Sirens he made signs for his companions to unbind him, they only secured him the more closely in compliance with his previous instructions. Thus he listened to the songs of the Sirens, and escaped notwithstanding. Hence it was feigned that they threw themselves into the sea from vexation at the escape of Ulysses, an oracle having predicted that they should live only so long as their strains had power to arrest all who heard them. But according to other poets, they threw themselves into the sea from rage and despair on hearing the more melodious song of Orpheus. Originally there were only two Sirens; but their number was afterwards increased to three, and their names are given with great variety. See the speculations of Bryant on the subject, *Anc. Mythol.* ii. 277., and iii. 237.

SI'RIUS (called also *Canicula*, or *Canis Candens*, the *Dog-star*). A star of the first magnitude in the constellation of *Canis Major*, or the Great Dog, and the brightest in the heavens. The Egyptians observing that the Nile begins to swell at a particular rising of this star, paid it divine honours, and named it *Sirius;* from *Siris*, one of the appellations of the Nile.

SIRO'CCO. (Ital.) A soft relaxing wind, chiefly experienced in the south of Italy, Malta, and Sicily. It blows from the south-east or south; and having been heated over the sandy deserts of Libyia, it becomes occasionally moist in its passage across the Mediterranean, and oppresses the inhabitants of the above-named countries with excessive languor, and a sinking of the mental energies. The setting in of the sirocco is followed by a considerable rise of the thermometer, and is attended with a haze which obscures the atmosphere. *See* SIMOON.

SIRVE'NTE. In the Literature of the Middle Ages, a species of poem in common use among the Troubadours, usually satirical, and divided into strophes of a peculiar construction. *See* TROUBADOUR.

SI'STRUM. (Gr. σεῖστρον; from σείειν, *to shake.*) A kind of timbrel, which the Egyptian priests of Isis used to shake with their hands at the festivals of that goddess.

SI'SYPHUS. In Ancient Mythology, one of the descendants of Æolus, respecting whom a variety of opinions prevails. By some he is said to have resided at Epyra in the Peloponnesus; others maintain that he was a Trojan prince, who was punished for betraying state secrets; while others allege that he was a notorious robber, slain by Theseus. Be this as it may, all the ancient poets are agreed that he was distinguished for his craftiness and cunning; and that his punishment in Tartarus for his crimes committed on earth consisted in rolling a huge stone to the top of a high hill, which constantly recoiled, and thus rendered his labour incessant. The term Sisyphus is supposed to be derived from Gr. σισοφος (by a common duplication for σοφος, *wise*), and to signify *overwise.*

SI'TTA. (Gr. σιττα.) The name of a bird in Aristotle, which Gesner determined to be the nuthatch. Linnæus retains the term for the genus of which the nuthatch (*Sitta Europæa*, L.) is the type.

SIVA. In Hindoo Mythology, a title given to the Supreme Being, considered in the character of the avenger or destroyer. Sir William Jones has compared Siva to Jupiter; but he appears to share many of the attributes of Pluto. Under the name of Mahadeva, he is exhibited also as a type of reproduction: to destroy, according to the Vedantas of India, the Sufis of Persia, and even to many European schools of philosophy, being only to generate or reproduce under another form. *See* VISHNU, BRAMA.

SIVATHE'RIUM. (Siva; and Gr. θηριον, *a wild beast.*) The name of an extinct genus of Ruminantia found in fossil remains in the tertiary strata of the Sivalik Sub-Himalayan range. It surpassed all known ruminants in size, and had four horns.

SI'ZARS. The lowest class of students at Cambridge. At Oxford the same class go in different colleges by the denominations of servitors, &c. They are such as have certain allowances made in their battels (college bills), through the benefactions of founders or other charitable persons. In college phraseology, a size is a portion of bread, meat, &c. allotted to a student; and hence the name sizar. The sizars at Cambridge are almost entirely on the same footing with independent students; at Oxford they are somewhat lower, and some relics of their former degraded condition still subsist in certain colleges in the customs of bringing up dishes to dinner, dining off the remnants of the fellows' dinners, &c.

SIZE. A sort of varnish, paint, or glue, used by painters, and in many other trades. It is made of the shreds and parings of leather, parchment, or vellum, boiled in water and strained.

SKE'LETON. (Gr. σκελλω, *I make dry.*) The desiccated support or framework of an animal body, which, usually consisting of different parts, may be joined together by the dried natural ligaments, when it is termed "a natural skeleton;" or may be articulated artificially, when it is termed "an artificial skeleton." In the lowest-organized animals, as the *Polygastria* and *Polypi*, the skeleton, when it exists, commonly consists of a single piece. In the *Polygastria* it is external, in the form of a case, and consists of pure silex. In the *Polypi* it is sometimes external, sometimes internal; and is composed of either pure carbonate of lime, or with a small additional proportion of phosphate of lime, and these earths are combined with a greater or less proportion of gelatinous animal matter. In the *Isis* the skeleton consists of numerous separate calcareous joints, connected together by portions of uncalcified gelatin. In many of the Lithophytous *Polypes* innumerable minute spiculæ, of various but definite forms, are scattered through the fleshy investment of the main internal skeleton. In the *Echinoderms* the skeleton is external, as regards the viscera; but is covered by an organized skin. It is chiefly remarkable for the great number of pieces of which it is composed, and the regular and beautiful forms in which they are combined; it likewise supports numerous tubercles or spines: it is composed of carbonate and phosphate of lime, with a gelatinous basis. In *Insects* the skeleton is partly internal, but chiefly external; and its hardening material is a peculiar animal principle, called "chitine." In cabinets of dried insects it is the natural skeleton that is preserved. In *Crustacea* the skeleton, which bears the same relative position to the animal as in insects, is rendered denser and more brittle by being consolidated with the carbonate and phosphate of lime. In the *Mollusca* the skeleton is generally external, but sometimes internal; it is hardened by the carbonate of lime, with a very slight trace of the phosphate of lime, and constitutes the shell. The beauty, durability, and variety of form of this modification of the skeleton, have rendered the shells of the *Mollusca* at all times a favourite object of collectors, and the subject of a distinct branch of natural history, under the name of "Conchology." The skeleton of mollusks is either in one piece, as in the univalve mollusks; or in two pieces, as in most bivalves; or in many pieces, as in the multivalve chitons, and others. In the *Cephalopods*, besides the shell, which offers remarkable varieties of form and substance, there is likewise a rudiment of true internal skeleton in a cartilaginous condition. In the Vertebrate animals, there is always an internal skeleton destined to protect the central part of the nervous system, and to form the fulcrum and support of the locomotive members. In a few fishes it is cartilaginous; in the rest of the Vertebrates it is osseous, or consolidated by a large proportion of phosphate and a small proportion of carbonate of lime, and some other hardening salts. (*See* BONE.) This is termed the "endo-skeleton." In most fishes, in several reptiles, as the crocodilians, and in the armadillos amongst the Mammalia, osseous plates are developed in the substance of the skin; these are analogous to the skeleton of most of the Invertebrate animals, and form a more or less complete protecting case, called the "exo-skeleton."

SKETCH. (It. schizzo.) In Painting, &c., the first delineated idea of the artist's conception of a subject, in which are usually distinguishable the fire and enthusiasm with which the subject is expressed and felt.

SKEW BACK. In Architecture, the sloping abutment, in brickwork and masonry, for the ends of the arched head of an aperture.

SKEW BRIDGE. In Engineering, the name given to a kind of bridge introduced upon railroads, when the

railway intersects any existing communication at right angles. Such bridges were occasionally built before railroads were introduced; but their general introduction has rendered the use of skew bridges universal in cases where it may be necessary or unavoidable to preserve as straight or direct a line as possible. The *Ency. Britannica* contains an elaborate article upon this subject.

SKIN. The external covering of the body. It is divisible into three parts or membranes. The exterior is called the scarfskin or cuticle: it is an albuminous membrane. Immediately underneath it is a thin layer of soft or pulpy matter, called the *rete mucosum* (mucous network), which is the seat of colour: it lies upon the *cutis*, or true skin, which is a gelatinous texture.

SKIP. (Fr. esquiver.) In Music, a passage from one sound to another by more than a degree at one time.

SKI'RTING. In Architecture, the narrow vertical board on the floor round the sides of an apartment.

SKO'LEZITE. (Gr. σκολος, *twisted.*) A mineral which occurs crystallized and massive. It is colourless and translucent, and when heated before the blowpipe shrinks up into wormlike contortions.

SKO'RODITE. (Gr. σκοροδον, *garlic;* in allusion to its odour when heated.) An arseniate of iron.

SKO'RZITE. A mineralogical synonym of a variety of epidote, from Skorza.

SKULL. The bony case which contains the brain: it forms the forehead, and every part of the head except the face. It consists of eight bones; namely, the frontal and occipital bones, upon its fore and back part; the two temporal and two parietal bones, forming the temples and the sides of the skull; and the sphenoid and ethmoid bones, concerned in the formation of the orbits and nose.

SKY LARK. The name of a species of the genus *Alauda* (see that word); the *Alauda arvensis* of Linnæus.

SKY SAIL. A small sail sometimes set above the royal.

SLAB LINE. A small rope leading through a block under the lower yards, and thence to the foot of the sail, for the purpose of *tricing* it up.

SLACK. Small coal under the size of an egg.

SLAG. The imperfect glassy or vitrifiable compounds which are produced during the reduction of metallic ores by various fluxes. In the neighbourhood of large smelting works, especially of iron and copper, the slags, which are abundantly produced, are sometimes used as building materials, and for making and mending roads. They often contain a considerable relative proportion of metal.

SLA'NDER. In Law, a malicious defamation of a man by words spoken. It is not actionable unless it impute some crime punishable by law; or some infectious disease, such as leprosy or the like, which may have the effect of excluding from society the person slandered; or be uttered concerning him in his trade or business in such a way as to impair his means of livelihood; or, lastly, unless it be attended with special damage. In this case, such special damage must be averred upon the pleadings. If special damage be not proved by the plaintiff, he will not, in any action for words spoken, when the verdict is under 40 shillings, be allowed more costs than damages. A defendant cannot be proceeded against criminally for words spoken, unless they have a direct tendency to a breach of the peace, as by containing a challenge to fight; or are of a seditious or grossly immoral character; or are spoken of a magistrate in the execution of his duty.

SLATE. *See* GEOLOGY.

SLA'VERY, properly so called, is the establishment of a right, which gives to one man such a power over another as makes him absolute master of his life and property. But the condition of a slave is susceptible of innumerable modifications; and there are few nations, whether of ancient or modern times, among whom slavery has been long established, that have not enacted certain laws for limiting the power of a master over his slave. Slavery has existed from the earliest periods of authenticated history, and its origin has generally been ascribed to a state of war. In the rudest stages of society, the difficulty of subsistence was so great that the lives of captives were seldom spared; but as society advanced, and luxuries began to be introduced, the aid of labourers became requisite, and it was found more profitable to employ than to slay a captive. Thus the Latin word servus, *a slave*, appears to have been derived from servo, *I preserve*, and to have meant a person whose life was preserved on condition of giving his labour to his conqueror; so that a state of slavery, how repulsive soever to our present feelings, probably formed at one time an important mitigation of the horrors of barbarism. But in proportion as society rose in the scale of civilization, the state of slavery sprung from a variety of causes. Thus, in several countries, those who had been convicted of crimes were often doomed to perpetual slavery; and as a necessary corollary of this principle of slavery, it was laid down as a fundamental regulation, that slaves could only beget slaves; and hence the principle of hereditary bondage. It would be foreign to the purpose of this work to enter into details upon the different phases which slavery has exhibited in the various countries in which it has existed, or to point out the malignant influence it has exercised upon the character of every nation among whom it has been tolerated. Upon this subject the reader will find ample details in the third volume of the *Cours d'Economie Politique* of M. Storch, Paris, 1823; and with regard to slavery as practised among the Romans, he may consult with advantage the elaborate little volume of Mr. Blair on this subject. The species of slavery which existed during the feudal ages, and which is still to be found in some European countries, will be found noticed under the heads SERF, SERVITUDE, and VILLEIN, in this work; and for some details of negro slavery, see *infra*, and NEGROES.

The British legislature, as is well known, passed an act in 1834 for the emancipation of Negro slaves throughout our dominions; by which, after passing through a preliminary term of compulsory apprenticeship, they were eventually raised to the condition of full citizenship.

SLAVE TRADE, generally denotes the trade in slaves carried on by European nations between the western coasts of Africa and the American settlements; abolished, as far as Great Britain is concerned, in 1808.

The European slave trade is, however, generally supposed to have been commenced by the Portuguese about the end of the 15th century. About 1508 the Spaniards began to import Negroes into America, to supply the place of the Indians, whose numbers were rapidly diminishing under the severity of the toil to which they were exposed by their conquerors. Sir John Hawkins, one of Queen Elizabeth's most famous captains, seems to have been the first Englishman of note who embarked in this traffic, having been concerned in the sale of Negroes to the Spaniards in the West Indies. In the same reign the African Company was first chartered, for the purpose of trade with Guinea. This company carried on a trade in Negroes with the English settlements in America from the beginning of the 17th century to the year 1732, when that traffic was abandoned by it, and chiefly carried on from that time by private traders. It was not until the latter end of the 18th century that the atrocities of this trade began to engage the attention of parliament. In 1788 an act was passed to regulate it; and after twenty years' animated discussion, it was at last totally abolished in 1807. The United States of America and Denmark had preceded us in this righteous act. (See *Clarkson's History of the Abolition of the Slave Trade.*)

The slave trade is now prohibited by the laws of most European nations, except Portugal; and by the law of that country it can only be carried on within certain geographical limits. Nevertheless it is extensively carried on by contraband dealers; and no measure can be reasonably expected to put a stop to it short of its being declared* piracy by the common consent of civilized states. To obtain this result ought to be one of the most prominent objects of English diplomacy, both for the sake of humanity, and in order to protect the interests of our own colonies, which suffer severely from competition with those European possessions into which an unlimited importation of slave labour takes place. But it must be admitted that Sir Fowell Buxton, whose name ranks so high among the opponents of the slave trade, appears to confess that even this measure would prove ineffectual, from the difficulty of execution. We can do no more here than advert to the scheme recently proposed, received with acclamation by a great portion of the public, and taken up by government, of establishing a legitimate trade with central Africa by the channel of the Niger. We can only say that those who expected the slightest effect to be produced on the progress of this abominable traffic by any such measure, must have estimated both end and means in a very different manner from ourselves; but the official report of Captain Trotter has recently announced the utter failure of the expedition, owing to the destructive influence of the climate; and the general opinion seems to be, that henceforth those who may induce their fellow-countrymen to embark in any similar adventure will involve themselves in very serious responsibility. According to some recent estimates, about 75,000 slaves are supposed to be annually carried from their homes in Africa to supply the American markets, including those who perish by the way. There can, however, be no doubt that this estimate is very greatly exaggerated; and we question whether, taking those exported from the east coast to Arabia, &c. into account, the average number of slaves carried from Africa during the seven years ending with 1841 can have been as high as 40,000 a year; and now, no doubt, even this exportation will be very materially reduced. The principal import-

* This most desirable act has been recently accomplished; the whole of the European states having agreed to enforce the strictest measures in regard to the *right of search*, and to regard those engaged in the trade as pirates. From this humane declaration the United States have hitherto withheld their assent.

ing countries are Cuba, Portorico, and Brazil. Publications on the slave trade are so numerous, that it is difficult to make a selection for purposes of reference. Perhaps (after *Clarkson's History*) the student could not find the account of its progress better given than in successive numbers of the *Edin. Review*, especially vols. xxi. xxiii. xxiv. xxxvi.; though it must be admitted that there is in these, and most works on the subject, a strong tendency to exaggeration. There is a good article on the international law of the slave trade in the *Law Magazine* for August, 1841.

SLEEP. (Germ. schlaf.) That state of the body in which the functions of sensation and volition are suspended, while the vital functions retain their usual activity: the operations of the mind, if not at perfect rest, are disconnected with external objects.

Healthy or natural sleep usually comes on with a peculiar sense of muscular lassitude, gaping, and desire of repose; the eyelids fall, and there is general muscular relaxation. The sense of hearing is that which is longest retained; and we generally hear what is going on about us, and even feel inclined to take occasional part in conversation, long after the eyes are closed.

The quantity of sleep required by different individuals is various, from six to nine hours being the average proportion. Indolent listless persons, and especially those who indulge in the luxuries of the table, and are in good health, will often slumber away from eight to ten hours daily; while others of active dispositions, and who live abstemiously, will be satisfied with four or five hours of sleep: and such persons are generally more disturbed by dreams than the former. Very young children sleep away much of their time, and so also do many old persons. Sleep is often prevented by intense thought, by anxiety, and other mental affections; and also by hunger, and by the application of cold to a part of the body. When a person has been over-fatigued by bodily exertion, sleep is also often courted in vain; and there are many stimuli by which its accession at the usual times is prevented or retarded, such as strong tea, coffee, small doses of opium, and several other articles of medicine and diet. Bodily exercise and mental tranquillity, a full meal, the absence of light, noise, and other disturbing causes, are circumstances generally favourable to sleep; but in all these respects various habits often greatly interfere, and persons accustomed to very active lives when suddenly deprived of their usual occupations often sleep worse than before, indolence becoming an apparent stimulant. A distended stomach keeps some individuals awake; and others cannot sleep in a dark room, or in the quiet of the country, who have been used to a night lamp, and to the rumbling of carriages over a London pavement.

The proximate cause of sleep has been discussed by several eminent physiologists, but without any very satisfactory results: it is, in fact, as entirely beyond our grasp, as are the other functions of the nervous system. *See* DREAMS.

SLEEPER. In Architecture, a piece of timber whereon are laid the ground joists of a floor. *Sleepers* are also pieces of timber, now rarely used, in foundations crossed by planks, &c., and at right angles to them, where the soil is bad. Formerly the term was used to denote the valley rafters of a roof.

SLI'CKENSIDE. A provincial term applied by the Derbyshire miners to a species of galena, or sulphuret of lead.

SLIDE. In Music, a grace used in the German school, and consisting of two small notes moving by degrees.

SLI'DING KEEL, is a narrow oblong frame or platform, let down vertically through the bottom of a small vessel, like a deepening of the keel throughout a portion of her length. Its use is, like that of the leeboard, to sustain the vessel against the lateral force of the wind.

SLI'DING RULE. A mathematical instrument or scale, consisting of two parts, one of which *slides* along the other, and each having certain sets of numbers engraved on it, so arranged that when a given number on the one scale is brought to coincide with a given number on the other, the product or some other function of the two numbers is obtained by inspection. The numbers may be adapted to answer various purposes; but the instrument is chiefly used in gauging, and for the mensuration of timber.

SLING. (Ger. schlinge.) A weapon made of a strap and two strings, by means of which a stone or other missile is projected with much greater velocity than could be given to it by the hand without such assistance. The velocity with which the projectile is discharged is the same as that with which it is whirled round in a circle having the string for its radius, and may therefore be computed when the time of revolution and the length of the string are given. The sling was known as a weapon of offence in the earliest ages.

SLIPS. In Geology, masses of strata separated vertically or aslant.

SLOAM. Layers of clay between those of coal.

SLOOP. A vessel with one mast like a cutter; but having a jib stay, which a cutter has not. Also the general name of ships of war below the size of frigates.

SLOPS. Clothes and bedding supplied from the ship's stores to the seamen, but at their expense.

SLOUGH. A Surgical term applied to the separation which ensues between dead and living parts.

SLUE. In Naval language, *to slue* is to turn a cylindrical piece of timber, as a mast or boom, about its axis, without moving it out of its place.

SLUICE. (Lat. clausus, *shut up*.) In Hydraulics, a frame of timber, stone, or other solid substance, serving to retain and raise the water of a river or canal, and, when necessary, to give it vent.

SLUR. In Music, an arch ⌒ connecting two or more notes not on the same degree, indicating to the performer that in playing they are to be united as much as possible.

SMACK. A vessel with one mast, commonly rigged as a sloop, and used in the coasting trade, or as a tender in the royal navy. The vessels of this name that have long plied between Leith and London are well known, and have always been noted for their security.

SMALLPOX. Called also *Variola*, from varius, *changing colour*; because it changes and disfigures the skin. There are two forms of this disease, generally called by medical men the *distinct* and the *confluent*; in the former the pustules are separate, in the latter they coalesce. *Distinct smallpox* begins with the usual symptoms of inflammatory fever; that is, pains in the back and loins, sickness, drowsiness, headach, pain upon pressure about the region of the stomach, and in infants one or more epileptic fits. About the end of the third day little red spots, much resembling flea-bites, make their appearance upon the face and head, which spread during the fourth day over the breast, body, and limbs; about the fifth day a small circular vesicle forms upon each little point, depressed in the centre, surrounded by an inflamed margin, and containing a colourless fluid, and at this time the eruptive fever disappears; about the sixth day the throat becomes sore, and the saliva viscid; and about the eighth day the face is swollen, and the pustules round, prominent, and prevalent; about the eleventh day the pustules attain their full size (about that of a pea), and the matter which they contain becomes opaque and yellow, and a dark central spot appears on each; the swelling of the face subsides, and is transferred to the hands and feet, and more or less secondary fever now ensues. After this the pustules become rough, break, and scab over, and a dark brown spot remains for some days; and if the pustules have been large an indentation is left: the remaining symptoms gradually subside, and about the seventeeth or eighteenth day the secondary fever disappears.

Confluent smallpox is ushered in by a fever of a typhoid rather than of an inflammatory character; all the incipient symptoms are aggravated; delirium or coma attends them; and in infants there is diarrhœa, and in adults salivation. The eruption is very irregular in its progress and appearance, and usually preceded by red patches upon the face, from which the pustules emerge on the second day in the form of clusters somewhat resembling measles. Their progress is rapid; but instead of being circular and well-defined, they are flat and irregular in shape, and contain a brownish fluid very unlike pus: the intermediate spaces between the clusters are generally pale and flaccid. The tumefaction of the face and running of saliva are greater than in the distinct species; and the fever does not cease upon the appearance of the eruption, but about the ninth day it generally becomes aggravated, the eruption livid, and accompanied by petechiæ or purple spots; and about the eleventh day from the commencement of the disease it often terminates fatally.

This disease is the effect of a specific contagion, and is produced either by inoculation, or by exposure to the effluvia from persons suffering under it: in the latter case it is usually called the *natural smallpox*. When the distinct smallpox goes regularly through the stages above described it is rarely dangerous, except from mismanagement; but it often leaves a tendency to inflammatory disorders, and in a scrofulous habit it excites that disorder into activity. Any of the symptoms which have just been described as characterizing confluent smallpox are alarming; so is a sudden disappearance of the eruption, or change in its appearance, followed by depression or delirium. In treating the distinct smallpox the febrile symptoms are to be moderated by cool air, saline and mild acid and diluting drinks, and very gentle aperients. Bleeding and purging are in almost all cases to be decidedly avoided. Great irritability may occasionally be allayed by small doses of opium and camphor, or, which is preferable, by muriate of morphia: this will also check diarrhœa, should it supervene. The confluent form generally requires more or less of the treatment which is adopted in low or putrid fever. Obstinate vomiting, which is sometimes not only a troublesome but alarming symptom, is best encountered by the saline draught in the act of effervescence, with a few grains of aromatic confection, and a few drops of tincture of opium.

SMALT. (Germ. schmalz.) A fine blue colour used

in painting and printing upon earthenware, and applied to several other purposes in the arts. The finest smalt is made by fusing glass with oxide of cobalt, by which a very deep blue compound is obtained, which when finely powdered acquires a beautiful azure colour. Common smalts are prepared by fusing mixtures of zaffre, sand, and pearlash.

SMARAGD. (Gr. σμαραγδος.) In modern times used as a synonym of emerald (which see); but applied by the ancients to various other precious stones, such as fluor spar, green vitrified lava, green jasper, and green glass. The passage of Pliny (*Nat. Hist.* xxxvii. 5.) in which Nero is said to have been in the habit of viewing the gladiatorial combats *in a smaragd*, is generally understood to signify a smooth polished mirror made of some of the above substances; but it has been maintained that the emperor was short-sighted, and used a concave eyeglass formed of the smaragd. The smaragd is found in various parts of Europe, Asia, and America; but particularly in the Ural mountains, and in the mines of Chili and Mexico.

SMART TICKET. A certificate of a seaman's having received a wound or hurt.

SMELL. This sense resides in the mucous or pituitary membrane which lines the nostrils, and the surface of which is more or less convoluted or extended in various orders of animals. In the human subject this membrane is highly vascular, and largely supplied, especially in its upper parts, with nervous filaments, or ramifications of the olfactory trunk, which has its origin, by three distinct roots, from the posterior, inferior, and internal parts of the anterior lobe of the brain, and proceeding towards the perforated plate of the ethmoid bone, divides into the small threads just mentioned.

The physiology of odours is a curious and intricate subject, requiring much more experimental investigation than it has hitherto received. The air is the great vehicle by which their various influences are transmitted in the act of inspiring to the olfactory surfaces, and for the diffusion of most odours a certain degree of humidity in the air appears absolutely essential. There is scarcely any sense the degree of perfection of which varies so much in different individuals as that of smell, some being painfully alive to those odorous influences which are not even perceived by others. An obtuseness of this sense is also very frequent, and its almost entire absence by no means uncommon; this is especially the case in certain catarrhal complaints, and in some other affections of the lining membrane of the nose.

SMEW. The name of the diver called *Mergus albellus* by Linnæus. *See* MERGUS.

SMILA'CEÆ (Smilax, one of the genera), form a small natural order of Endogenous plants with weak or twining stems and reticulated leaves, not distinguishable from those of Exogens. The drug called sarsparilla, or sarza, is the root of various species inhabiting South America, and is held in high esteem for its diuretic, demulcent, alterative qualities.

SMOKE. (Low Germ. smuke.) Smoke has been defined as the visible effluvium or sensible exhalation of any thing burning. The term is commonly applied to those results of the combustion or ignition of pit coal which escape from chimneys, and which constitute a serious and well-known evil and nuisance in large towns, manufacturing districts, and almost every where where large quantities of coal are consumed. Coal is often a very complex substance; but, putting aside its occasional and adventitious ingredients, carbon, hydrogen, nitrogen, and oxygen may be regarded as its ordinary and essential constituents; and the results of its *perfect* combustion would therefore be carbonic acid steam and nitrogen. These substances would constitute invisible and incombustible gases and vapour, and would therefore escape from the chimney top, and blend with the atmosphere, without being perceived. But it unfortunately happens that from the way in which coal is burned its combustion is far from being perfect, and that besides the above-mentioned products inflammable gases and vapours, together with large quantities of very finely divided carbon, constituting soot and black and brown smoke, are vomited forth from the chimney shaft, not only contaminating the air, and making all neighbouring objects black and dirty, but also occasioning great loss of fuel; so that the smoke of London is not only a nuisance, but a very expensive one, and ought to be put down by legislative enactments, several of which have been from time to time suggested, but unfortunately never enforced, and are at this moment a mere dead letter.

The neglect which this subject has encountered has arisen chiefly out of the difficulty of enforcing and inculcating rational doctrines upon the subject of combustion, and of getting persons to adopt new systems of construction in regard to furnaces and fire-places, new methods of stoking and managing the fire, and new kinds of fuel; and it is astonishing to observe the obstinacy and perverseness which prevail in these respects amongst the masters as well as the men. There is another cause too, which no doubt has had its influence in retarding th adoption of means for diminishing the smoke nuisance which is the shoals of quacks and ignorant empyrics an impostors who have embarked in these speculations; s that till stringent and coercive measures are adopted i regard to it, founded upon scientific and rational principles, we must be content to continue breathing a tainte air, which fouls the organs of respiration, encrusts ou buildings, and covers our books, pictures, and every ar ticle of furniture with an enamel of soot, and whicl dims the atmosphere to such an extent as materially t shorten the duration of metropolitan daylight.

That all these evils may be got rid of admits of n doubt, and ultimately with economy and convenience though the first introduction of the remedies will pro bably be attended by many practical difficulties, and con siderable inconvenience and expense. One remedy, an the most obvious, consists in the substitution of coke anthracite, and certain other smokeless fuel, for the bi tuminous and eminently smoke-generating varieties o coal now in common use. Another is, the constructio of fireplaces and furnaces which shall not indeed burn smoke, but prevent its formation. It must be allowe that there are many practical difficulties in the way, rathe perhaps of the application than of the invention or per fection of these contrivances; but experience has show that none of these are of such a nature or magnitud that they may not be overcome by perseverance and skill They all merge into one common principle, that of mix ing air with the combustible vapours and gases generate by the action of heat on pit coal, so that by virtue of a du supply of oxygen they may be made to burn with flame and become entirely converted into incombustible an transparent invisible vapours and gases, instead of being as they now are, only partially burned, by which thei carbon is precipitated, and escapes, together with th other imperfectly consumed matters, into the air. Th foundation of a *practical* inquiry into the subject of th prevention of smoke has been laid by Mr. C. W. Williams of Liverpool (*Essays on the Combustion of Coa and Prevention of Smoke*). The theoretical details ar essentially blended with the whole doctrine of heat; bu the investigations which most essentially bear upon them will be found in *Sir H. Davy's Researches into the Philosophy of Flame.*

SMOKE SAIL. A small sail hoisted before the funne of the galley, when the ship is at anchor head to wind to screen the quarter deck from the smoke.

SMORZATO. (It. *extinguished.*) In Music, a term denoting that the violin bow is to be drawn to its full extent, but gradually lighter till the sound is nearly lost.

SMU'GGLING. The offence of defrauding the revenue by the introduction of articles into consumptio without paying the duties chargeable upon them. It may be committed indifferently either upon the excise or customs revenue.

Origin and Prevention of Smuggling. — This crime which occupies so prominent a place in the criminal legislation of all modern states, is wholly the result o vicious commercial and financial legislation. It is the fruit either of prohibitions of importation, or of oppressively high duties. It does not originate in any depravity inherent in man; but in the folly and ignorance o legislators. A prohibition against importing a commodity does not take away the taste for it; and the imposition of a high duty on any article occasions a universal desire to escape or evade its payment. Hence the rise and occupation of the smuggler. The risk of being detected in the clandestine introduction of commodities under any system of fiscal regulations may always be valued at a certain average rate; and wherever the duties exceed this rate, smuggling immediately takes place. Now, there are plainly but two ways of checking this practice, — either the temptation to smuggle must be diminished by lowering the duties, or the difficulties in the way of smuggling must be increased. The first is obviously the more natural and efficient method of effecting the object in view; but the second has been most generally resorted to, even in cases where the duties were quite excessive. Governments have uniformly almost consulted the persons employed in the collection of the revenue with respect to the best mode of rendering taxes effectual; though it is clear that the interests, prejudices, and peculiar habits of such persons, utterly disqualify them from forming a sound opinion on such a subject. They cannot recommend a reduction of duties as a means of repressing smuggling and increasing revenue, without acknowledging their own incapacity to detect and defeat illicit practices; and the result has been, that instead of ascribing the prevalence of smuggling to its true causes, the officers of customs and excise have almost universally ascribed it to some defect in the laws, or in the mode of administering them, and have proposed repressing it by new regulations, and by increasing the number and severity of the penalties affecting the smuggler. As might have been expected, these attempts have, in the great majority of cases, proved signally un-

successful. And it has been invariably found that no vigilance on the part of the revenue officers, and no severity of punishment, can prevent the smuggling of such commodities as are either prohibited or loaded with oppressive duties. The smuggler is generally a popular character; and whatever the law may declare on the subject, it is quite ludicrous to expect that the bulk of society will ever be brought to think that those who furnish them with cheap brandy, geneva, tobacco, &c. are guilty of any very heinous offence.

"To pretend," says Dr. Smith, "to have any scruple about buying smuggled goods, though a manifest encouragement to the violation of the revenue laws, and to the perjury which almost always attends it, would, in most countries, be regarded as one of those pedantic pieces of hypocrisy, which, instead of gaining credit with any body, seems only to expose the person who affects to practise them to the suspicion of being a greater knave than most of his neighbours. By this indulgence of the public, the smuggler is often encouraged to continue a trade which he is thus taught to consider as in some measure innocent; and when the severity of the revenue laws is ready to fall upon him, he is frequently disposed to defend with violence what he has been accustomed to regard as his just property; and from being at first rather imprudent than criminal, he at last too often becomes one of the most determined violators of the laws of society." (*Wealth of Nations*, vol. iii. p.491.)

To create by means of high duties an overwhelming temptation to indulge in crime, and then to punish men for indulging in it, is a proceeding completely subversive of every principle of justice. It revolts the natural feelings of the people; and teaches them to feel an interest in the worst characters — for such smugglers generally are, — to espouse their cause, and avenge their wrongs. A punishment which is not proportioned to the offence, and which does not carry the sanction of public opinion along with it, can never be productive of any good effect. The true way to put down smuggling is to render it unprofitable, to diminish the temptation to engage in it; and this is not to be done by surrounding the coasts with cordons of troops, by the multiplication of oaths and penalties, and making the country the theatre of ferocious and bloody contests in the field, and of perjury and chicanery in the courts of law; but by repealing prohibitions, and reducing duties, so that their collection may be enforced with a moderate degree of vigilance, and that the forfeiture of the article may be a sufficient penalty upon the smuggler. It is in this, and in this only, that we must seek for an effectual check to illicit trafficking. Whenever the profits of the fair trader become nearly equal to those of the smuggler, the latter is forced to abandon his hazardous profession. But so long as prohibitions or oppressively high duties are kept up, or, which is, in fact, the same thing, so long as *high bounties* are held out to encourage the adventurous, the needy, and the profligate to enter on this career, we may be assured that armies of excise and custom-house officers, backed by the utmost severity of the revenue laws, will be insufficient to hinder them. (For full particulars respecting the law of smuggling, &c. see the *Com. Dict.*)

SMUT. A disease incidental to corn crops, by which the farina of the grain in the whole body of the seed is converted into a black soot-like powder. If an ear of corn affected by this disease be smartly struck with the finger, the powder will be dispersed like that of the fungus known as *Lycoperdon bonista*, the common puff-ball found in pastures, but darker; and if a portion of the powder be moistened and examined with the microscope, it will be found to consist of innumerable minute transparent globules. Some attribute the smut to the richness of the soil, and others consider it as a hereditary disease transmitted by one generation to another through the seed. Willdenow and Mirbel regard it as a small fungus; but Bauer believes it to be a proper disease, indicated by a morbid swelling of the ear. Some cultivators steep the grain of smutty corn in a weak solution of arsenic before sowing; but others deny the efficacy of this preparation. Smutty grain is separated from such as may be used for seed, or for grinding into flour, by being rapidly whirled round in a cylinder lined with brushes; or by steeping in water, when the smut from its lightness floats on the surface. The safest mode for the farmer to pursue is never to sow grain from a field in which the smut has prevailed.

SNAKE ROOT. This term is applied to the root of the *Aristolochia serpentaria*, a native of Virginia: it is a fibrous, aromatic, and bitterish root. The infusion is occasionally used as a tonic and diaphoretic: in typhoid fevers it is a good adjunct to Peruvian bark, and to quinia.

SNAKE WOOD. The wood of the *Strychnos colubrina*. Supposed to be an antidote to the poison of certain snakes.

SNEE'ZING. A convulsive action of the respiratory organs, brought on by irritation of the nostrils. Violent fits of sneezing have occasionally attacked persons, and are even said to have proved fatal; recourse must in such cases be had to soothing the nasal membrane by the application of warm milk and water, or decoction of poppies.

SNIPE. The common name of the *Scolopax gallinago*, Linn. This bird is a plentiful species in most parts of Great Britain. In wet seasons it resorts to the hills and higher grounds; in ordinary seasons it frequents marshes. Its principal food is worms, in quest of which it penetrates the soft earth with its long and slender bill, which is especially organized for that purpose.

SNOW. (Ger. schnee.) Congealed water, which falls from the bosom of the atmosphere. Very little is yet known respecting the formation of this meteor. It has not been ascertained, for instance, whether the clouds which produce it are composed of vesicular vapours, or of frozen particles; nor whether the flakes are completely formed before they begin to descend, or receive an increase in passing through the lower strata of the atmosphere. The temperature of the flakes, and the circumstances which determine their form and volume, are likewise unknown. The only observations which may be considered as in any degree complete are with reference to the different forms which the flakes assume. This subject was considered by Kepler, Hooke, Cassini, Muschenbroek, and many others; but the most interesting series of observations we possess are those of Scoresby (*Account of the Arctic Regions*, 1820), who has reduced the different forms into classes, and given a number of excellent representations of the flakes in different states. Generally speaking, when examined with the microscope they present modifications of stelliform and hexagonal crystals; and frequently they consist of a star of six rays formed of prisms united at angles of 60°, from which other prisms shoot at similar angles, giving the whole an appearance of exquisite beauty and great regularity. The variety of modifications is probably owing to the state of the atmosphere when the snow is formed. If the crystallization takes place when the air is calm, the crystals will be regularly formed; on the contrary, they will be irregular and imperfect when the air is much agitated. Sometimes the flakes present no traces of crystallization.

Snow is much less dense than ordinary ice. The bulk of a given weight of ice is only about a ninth part greater than that of the water from which it is formed, while the bulk of new-fallen snow is ten or twelve times greater than that of the water obtained by melting it.

At moderate elevations above the sea, and in the mean latitudes, snow most frequently falls after some days of pretty hard frost, and when the temperature of the air, though still a few degrees above the freezing point, is sensibly mitigated. On this circumstance is founded the remark that it cannot snow in very severe cold; and though the remark does not always hold good, it will do so generally, for two reasons: — in the first place, the air which comes from very cold regions contains a small portion of watery vapour; and secondly, because the formation of clouds, by diminishing the radiation, necessarily mitigates the severity of the cold.

As snow can only be formed when the temperature of the atmospheric strata containing the aqueous vapour is below the freezing point, it is obvious that if the snow in falling passes into strata of a higher temperature, it will be melted before arriving at the surface of the earth. Hence it follows that it never snows in the torrid zone, nor in the heats of summer, excepting on the tops of very elevated mountains.

Red Snow. — It had been remarked by the ancients that snow sometimes assumes a red tint, and Pliny ascribes the cause to age: — *Ipsa nix vetustate rubescit.* Many modern observers have described and examined this curious phenomena, which appears to be met with in all parts of the world. Saussure observed red snow on the Bevern in 1760, and on St. Bernard in 1778; and he supposed the colouring matter to consist of a vegetable dust. Ramond met with it in the Pyrenees, Captain Ross in Baffin's Bay; Parry, Franklin, and Scoresby collected it in still higher northern latitudes; and it has been found abundantly in New Shetland in latitude 70° south. Among the Alps it is generally found in low sheltered spots, and penetrating to the depth of two or three inches; or rather the strata in which it is found (for it occurs overlaid at considerable depths) seldom exceed two or three inches in thickness. The colouring matter of this singular substance has been examined by Wollaston, R. Brown, De Candolle, Thenard, Bauer, &c. Dr. Wollaston first remarked that it is composed of minute spherical globules, which have a transparent envelop, and are divided into seven or eight small cells filled with a species of red oil insoluble in water. Mr. R. Brown and De Candolle supposed the globules to be a kind of algæ. Mr. Bauer (*Phil. Trans.* 1820) found the globules to be exactly identical in snow collected in Baffin's Bay and New Shetland; and he supposed them to be small mushrooms of the genus *Uredo*, forming a peculiar species, to which he gave the name of *Uredo nivalis.*

Snow Line, or Limit of Perpetual Snow.— Since the temperature of the atmosphere continually diminishes in ascending from the surface into the higher altitudes, there must be in every latitude a certain limit of elevation at which the air attains the temperature of freezing water. This limit is called the snow line, or line of perpetual congelation; and the mountains which rise above it are covered with perpetual snow. Within the tropics the temperature varies little throughout the year, and hence the snow line is distinctly marked; but in countries remote from the equator the limit of congelation rises in summer and descends in winter through a band or zone of considerable breadth. The line of *perpetual* congelation is of course the summer limit. The altitude of the snow line, however, is not dependent upon latitude alone; but also on the configuration and aspects of the mountain chains, the extent and temperature of the surrounding plains, the quantity of snow that falls annually, and the multitude of causes which influence the climate of a country. (*See* CLIMATE.) On the Himalaya chain, for example, the limit of perpetual congelation on the northern side is at an elevation exceeding by upwards of 4400 feet that on the southern side, though the latter is directly exposed to the sun; a circumstance which Humboldt ascribes to the radiation from the great plain of Thibet, the general serenity of the climate, and the rarity of snow in an exceedingly cold and dry atmosphere. No dependence, therefore, can be placed on any general rule for estimating the height of the snow line, and it affords an exceedingly fallacious indication of the altitude of mountains. The following table is given by Humboldt in his *Fragmens Asiatiques*, p. 549. The elevations stated are the heights of the line of perpetual congelation above the level of the sea, and the measures are reduced to English feet.

Mountain Chains.	Latitude.	Elevation.
		Feet.
Cordilleras of Quito	0° — 1½° S.	15,730
Cordilleras of Bolivia	16 — 17¾	17,060
Cordilleras of Mexico	19 N.	15,030
Himalaya { Northern side	31	16,940
Himalaya { Southern side		12,470
Pyrenees	43	8,950
Caucasus	43	10,870
Swiss Alps	46	8,760
Carpathians	49	8,500
Altai range	50	6,395
Norway { Interior	70	3,518
Norway { Coast	71½	2,302

(See, in addition to the works already cited, Humboldt, *Mémoire sur la Limite de Neige perpetuelle dans les Montagnes de l'Himalaya, et les Regions Equatoréales*, in the *Annales de Chimie*, tome xiv.)

SOAP. (Gr. σαπων, Lat. sapo.) This useful compound is obtained by the action of alkaline upon oily substances. There are, accordingly, a great variety of soaps; but those commonly employed may be considered under the heads of, 1. Fine white soaps, scented soap, &c.; 2. Coarse household soaps; 3. Soft soaps. The materials used in the manufacture of white soaps are generally olive oil and carbonate of soda: the latter is rendered caustic by the operation of quicklime, and the solution thus obtained is called *soap ley*. The oil and a weak ley are first boiled together, and portions of stronger ley are gradually added till the soap, produced by the mutual action of the oil and alkali, begins to become tenacious and to separate from the water; some common salt is then generally added to promote the granulation and perfect separation of the soap; the fire is then drawn, and the contents of the boiler allowed to remain for some hours at rest, so that the soap may more completely collect. When it is perfect it is put into wooden frames or moulds; and when stiff enough to be handled, it is cut into oblong slices and dried in an airy room. Perfumes are occasionally added, or various colouring matters stirred in whilst the soap is semifluid to give it a mottled appearance. The Spanish soap is *marbled* by stirring into it a solution of sulphate of iron, which is decomposed by the soap, and black oxide of iron separated in streaks and patches through the mass. The action of the air converts the exterior into red oxide, whilst the interior long retains its black colour: hence a slice of this soap presents a black mottled centre, surrounded by a reddened external layer.

Common household soaps are made chiefly of soda and tallow; or if potash is used, a large addition of common salt is made to harden the soap, which it probably effects by the transference of soda. Yellow soap has a portion of rosin added to it. Soft soaps are generally made with potash instead of soda, and fish oil. The common soft soap used in London is a compound of this kind; it has a tenacious consistence, and appears granulated. Soap is soluble in pure water and in alcohol; the latter solution *jellies* when concentrated, and is medicinally known under the name of *opodeldoc*. When carefully evaporated the soap remains in a gelatinous state, which forms, when dry, the article sold under the name of *transparent soap*.

The earths and common metallic oxides form *insoluble soaps;* and accordingly these are precipitated when earthy and metallic salts are added to solution of soap. It is the sulphate of lime and carbonate of lime in common spring water which thus render it unfit for washing, and give it what is termed *hardness;* and, upon this principle, a spirituous solution of soap is a simple and valuable test of the fitness of any river or spring water for the purposes of the laundry. If it merely renders the water slightly opalescent, as is the case with rain and other soft waters, it may be used for washing; but if it become milky, it is usually too hard to be conveniently employed; and when we wash or shave with hard water, the separation of the insoluble calcareous soap is extremely disagreeable: it adheres to the skin, and soils instead of cleansing it.

The chemical nature of soap has been laboriously examined by Chevreul, who has shown that the alkali in the process of saponification converts the oil into peculiar *acids*, as he terms them; the elain of the oil forming *oleic acid*, and the stearine *margaric acid:* so that soluble soaps are oleates and margarates of soda and potash. He has enumerated several other fatty acids similarly produced.

All new soaps contain a considerable portion of adhering water, a great part of which they lose when kept in a dry place; hence the economy and excellence of *old* soap; and hence the dealers in soap generally keep it in a damp cellar, that it may not lose weight by evaporation; or, as it is said, sometimes immerse it in brine, which does not dissolve it, but keeps it in its utmost state of humidity.

Soap may be considered as a necessary of life; in all civilized countries its consumption is immense. According to Pliny, the invention of soap must be ascribed to the Gauls, by whom, he says, it was composed of tallow and ashes, though the German soap was considered the best. Hence the Lat. sapo, which by a slight transposition of letters has become *soap*, is probably derived from the old German sepe (now written *seife*). The great seats of the soap manufacture in Great Britain are Liverpool, London, Runcorn, Bristol, Bromsgrove, Brentford, Hull, and Glasgow. Thus, of 154,796,853 lbs. of hard soap made in 1839, Liverpool furnished 43,546,119 lbs.; London, 38,065,175 lbs.; Runcorn, 11,034,324 lbs.; Bristol, 7,512,440 lbs.; Bromsgrove, 5,854,213 lbs.; Brentford, 4,938,444 lbs.; Hull, 4,666,435 lbs.; and Glasgow, 5,858,844 lbs. Of 14,874,963 lbs. of soft soap made in the same year, Liverpool furnished about one half, the rest being supplied by Glasgow, Bradford, Aberdeen, Paisley, &c. The manufacture of hard soap is subject to a duty of 1½*d.* per lb., that of soft soap to a duty of ⅞*d.* per lb.

SOAP STONE. A mineralogical synonym of steatite.

SOAVE, SOAVEMENTE. (It. *sweet, sweetly.*) In Music, a term denoting to the player that the music to which it is prefixed is to be executed with sweetness.

SO'BRIQUET. In French, a burlesque appellation or *nickname*. The word has been variously derived from the Lat. subridiculum, subrusticum, and the Gr. ὑβϱιστιϰον, &c. There is a curious dissertation in vol. xiv. of the *Histoire de l'Academie des Inscrip.* on the authority of these appellations in history.

SO'CAGE (Mod. Lat. socagium; from the Anglo-Saxon soke, or *plough*), denotes, according to Blackstone, in its original and most extensive signification, a tenure by any certain and determinate service. The sokemen at and immediately before the Norman conquest appear to have been in the lowest ranks of free cultivators of the land, being classed along with the villein in a law of Edward the Confessor. But by the time when the works of Bracton and the author of *Fleta* were compiled, socage had come to signify any tenure not military or quasi-military; *i.e.* either where military services were due (tenure in chivalry or by knight service), or other services of an honorary kind, such as by the French feudal law were due on what were called imperfect fiefs (tenure by grand serjeanty). Socage, therefore, comprehended various descriptions of tenure, and has been generally divided into *free* and *villein* socage. In free socage, the services were certain, and, in the feudal sense, not base or dishonourable, as the payment of an annual rent; and none of the feudal incidents of wardship, &c. were demandable in respect of lands so held, although certain aids and reliefs were peculiar to socage as well as to knight service. By the stat. 12 C. 2. c. 24., when military tenures were abolished, all sorts of tenures held of the king and others (except frank-almoign, copyhold, and the honorary part of grand serjeanty) were turned into tenure by free or common socage. Villein socage was a species of tenure in lands held of the king by certain villein services, but certain and determinate; from which mixed species of tenure arose that in ancient demesne. Lands so held are deemed to be in certain respects copyhold; and these were within the exceptions of the statute 12 Charles 2., and still subsist.

SOCI'ETY. (Lat. socius, *a companion.*) The term usually applied to an association formed for the promotion of some object, either literary, religious, benevolent, political, or convivial. Associations formed for commercial purposes are usually styled *companies;* which see. Literary societies extend their attention to all the sciences and literature generally, or to particular divisions of each. The chief literary societies of Europe have been noticed under ACADEMY. The purposes for which *benevolent* and *religious* societies are formed will be best inferred from the epithets with which they are connected; thus *temperance* societies are established with a view to promote sobriety, *mendicity* societies for the relief of the indigent, &c. There is no feature, perhaps, which distinguishes a civilized from a savage state more than the establishment of such societies; and in this view England has a right to claim a place in the foremost ranks of civilization, whether we regard the number or the principles of the management of its religious and benevolent institutions. It would be impossible in this place to give even the names of the chief societies of this nature scattered throughout the country; but the reader will find an account of them in the various reports published from time to time by their respective directors, and embodying a mass of information respecting them at once amusing and instructive.

Societies formed for *convivial* or *political* purposes are most usually denominated *clubs,* — a term which may be truly said to be exclusively English, and which embraces so many complex ideas that it is all but impossible to reduce it within the limits of a precise definition. The origin of clubs may be said to date from the end of the 17th century. It would be superfluous to call to the reader's remembrance the beau ideal of a club which Addison has drawn in the *Spectator,* — the Kit-Kat club, which numbered among its members all the most distinguished persons of the day; the Scriblerus club, of which Swift, Harley, Pope, Gay, and Arbuthnot were members; or that still nearer our own times originally held at the Essex Head, which was ennobled by the genius of Johnson, Burke, Reynolds, Goldsmith, Wyndham, and Fox. They were originally instituted solely for convivial purposes; but in the course of time the term *club* was successively adopted by various political associations, both in this country and on the Continent. Since the commencement of the present century, the chief clubs have been either of an avowed political character, as the Carlton, Boodle, and the Reform clubs; or devoted exclusively to certain classes, as the United Service, the Oxford, and Cambridge; or open to all gentlemen on election, without regard to political party or profession, as the Athenæum, Wyndham, &c. There are about forty clubs in the metropolis. They consist each of a limited number of members, varying from 1000 to 1500, who are admitted by ballot, and pay from ten to twenty-five guineas on their admission, and an annual subscription varying from five to ten guineas. We need scarcely add, that the club-houses are, generally speaking, splendid edifices, which add much to the magnificence of the streets and squares in which they are situated.

The latest appropriation of the term *club* has been made by several associations,—such as the Roxburgh club of London, the Bannatyne of Edinburgh, and the Maitland of Glasgow,—which were formed for the purpose of printing original MSS., which would not otherwise have seen the light, or of rescuing rare productions from oblivion by reprinting them from scarce and valuable editions.

SOCI'NIANS. The followers of Socinus, the uncle and the nephew, both of the same name, and celebrated for similar opinions concerning the nature of Christ. The nephew, Faustus Socinus, was the principal founder of the sect. He was an Italian, born at Sienna in 1539; who, after publishing a treatise upon the nature of the Saviour, desired to be admitted into a society of Unitarians already existing in Poland. Their opinions do not appear to have precisely corresponded with his, and admission was refused him; nor did he effect during his lifetime the institution of any distinct congregation; but the views which he disseminated in his writings were gradually referred to and adopted by many ministers and religious communities, especially in Poland, where Crellius, Wolgozenius, and others published a Socinian system of theology, comprised in the *Bibliotheca Fratrum Polonorum.*

Since the death of Socinus, the theologians who have asserted the mere humanity of Christ have been generally denominated Socinians. The doctrines, however, to which that appellation can with strictness be applied are not precisely equivalent to those of the modern Unitarians. The Socinian denies the existence of Christ previous to his birth of the Virgin Mary: he allows, however, that that birth was miraculous, and considers the Saviour as an object of peculiar reverence and an inferior degree of worship. By the term Mediator, as applied to Christ, he understands that in establishing the new covenant he was the medium between God and man; and of his sacrifice he says that as the Jewish sacrifices were not made for the payment of sins, but for the remission of them, so also the death of Christ was designed for the remission of sins through God's favour, and not for the satisfaction of them as an equivalent. (See *Mosheim,* vol. iv. transl. 1790, p. 485. &c. art. "Unitarians.")

SOCK. (Lat. soccus.) The name given to the peculiar kind of shoe worn by the ancient Roman comedians; hence used metaphorically for comedy itself. *See* BUSKIN.

SO'CLE. (It. zoccoli, *a shoe.*) In Architecture, a square member, whose breadth is greater than its height; used instead of a pedestal for the reception of a column. It differs from a pedestal in being without base or cornice.

SOCRATIC PHILOSOPHY, in a more extensive sense, is used to comprehend the whole development of philosophy of Greece from Socrates to the Neo Platonists. The title is so far just, as all the schools of this period, with the single exception of the Epicurean, called themselves by the name of Socrates, and arrogated to themselves the merit of exclusively propagating the true doctrines of Socrates. But in a narrow and more proper signification, it signifies the peculiar direction and method which Socrates gave to philosophical inquiry. Rightly to understand this, a brief retrospect of the previous state of philosophy is requisite. By the due course of things, the Ionian and other earliest philosophers of Greece directed themselves to the study of external nature; which, as the outward condition of man's existence, attracts and constrains his attention, and so becomes the root and source of his intellectual life also. In this state of mental development man is led to identify himself with the physical objects which are around him, and to form a single and exclusive science, — that of universal nature. But on a wider range of observation, man began to perceive that his faculty of reason is not a physical power, but different in kind, and peculiar to himself. And so the belief in the affinity of man to the powers of the surrounding world was gradually weakened. Philosophy, then, had now arrived at the point where either the distinction of the ethical and the physical must be set forth in clear evidence; or else, by adhering to the previous direction of thought, the light which had been, however unconsciously, kindled must be obscured and extinguished. To the latter result the labours of the Sophists directly tended; for Archelaus, the physiologist, had opened the way, by his disquisitions into the nature and constitution of law and custom, in which, starting from a physical point of view, he declared reason to be simply a power of nature, and right to have no other foundation than might. Such attempts, however, served to stimulate rather than to repress that inquiry into the nature of the moral and rational, as distinct from the physical, while other considerations were at this period establishing them as independent sciences. But to admit the claims of both as two conflicting sciences, with equal pretensions to universality, was inconsistent with the unifying tendency of philosophy; and a more scientific range of thought was required, adapted to reconcile and combine their opposite conclusions. Such a view could only be presented by logical or dialectical investigations, which, from the nature of science itself, might show that it is essential to the completeness and perfection of science that it should embrace both nature and reason at once. It is this perception of the unity of science which constitutes the true merit of Socrates as a philosopher. In all the accounts of him which either Xenophon or Plato furnish, we invariably discern the attempt, at least, to embrace every question within the light of universal science; and to prove that every species of knowledge, if legitimate, can be pointed out and shown to be a necessary member of the general idea of science.

It was not the object of Socrates to establish any perfectly evolved system of doctrine, so much as to awaken by his discourses a new and more comprehensive pursuit of science, which, no longer one-sided and confined to special branches of inquiry, but convinced of its universality, should direct itself to all that is knowable. But beneath this conviction of the universality of science, and the oneness of its object-matter, we distinctly trace that division of the latter into dialectics, physics, and ethics, which his successors more distinctly established. To these heads, therefore, without expressly ascribing them to Socrates, it will be convenient, for the purpose of classification, to refer his several doctrines.

Under the head of dialectics, we have, on the testimony of Aristotle (*Met.* xiii. 4.), to ascribe to Socrates two of the very first principles of science,—the inductive method of proof, and the definition of ideas. The object which Socrates had in view by the latter was, by the definition of ideas, to determine what the thing is in itself, or its essence. As to the former, we are told by Xenophon that when Socrates wished to come to a decision on any point, his investigations proceeded from propositions generally received as true; and if we are told that he often preferred to take up trifling and improbable po-

sitions, it was from a conviction that every thought, however imperfect as a work of reason, must necessarily involve the idea of certainty. Another feature of the Socratic method was to place the particular idea to be examined in a great variety of combinations; a procedure which is evidently based on a conviction of the connection of all scientific thought, and implying that every particular thought must, if it contain any degree of certainty, maintain its validity under every possible combination. Such was the true Socratic method of dialectics, which derived its name from the *form* of dialogue (διαλέγειν) in which it was accidentally worked out; while, on the other hand, the term *Socratic method* has, in modern times, been confined to signify nothing more than this outward form of arguing by question and answer, to the exclusion of its essential characteristics. Socrates, indeed, did not evolve any systematic doctrine of the form and subject-matter of science. He was satisfied with exercising his disciples in its form, and with infixing on their minds the pregnant truth, that the legitimacy of every branch of knowledge must be tested by its agreement with all others; and that every thought of man must give an account of itself, and have its root in a knowledge of his own and the divine nature.

This knowledge was the end of his physical inquiries, which were based on the general principle that all the objects of nature are only so far worthy of inquiry as they exhibit traces of intelligence and design. The self-knowledge which the Delphian oracle had enjoined upon him Socrates held to be impossible, while man is ignorant of the universal principle whence are the issues of all things, and, consequently, of the system of nature in the midst of which man is placed. In order to oppose the atheism which prevailed in his day, Socrates examined the causes of the existing unbelief, and referred to the proofs of divinity which the wise order of natural things exhibits. As the prevailing scepticism had its origin in the denial of whatever is unseen and imperceptible to the outward senses, he argued that the soul, which is the ruling principle within man, is yet not discernible; but still its existence is admitted, and it participates in the divine nature. Whoever, therefore, can get rid of the weak desire of seeing the Deity under some palpable form, may easily recognize his operations within his own mind, where God has implanted a consciousness of his presence. But he further held, that not only man, but the whole universe, is under the rule of an intelligent governor; that all is formed for some wise end, and affords evidence of that supreme reason from which man's rational soul derives and has its being. In the consideration of individual things, not less than of the universe, the sole question with Socrates was to establish intelligence as the ruling principle of all. This affords an explanation of his low estimate of the existing physiology, which has not unfrequently been objected to him. His contempt for it was grounded on the same reason as Bacon's aversion for the schoolmen. It stopped at secondary causes, and did not remount to the one first cause, which Socrates believed could only be found in intelligence beneficently disposing all things for the best. Although the earlier philosophers did not entirely neglect the marks of design which may be discovered in the universe, still they confounded nature with intelligence. Socrates, on the contrary, laboured to show that reason is above nature, and that the natural is merely subservient to intellectual ends. Whatever is without reason is contemptible; and the corporeal is of no value except so far as it ministers to the rational soul. Into the nature of the divine essence he did not inquire, but was content with asserting the principle, that the Deity is the supreme reason, and must be honoured by man as the source of all things, and of all phenomena, and as the end of all human endeavours. Lastly, from the divinity within man, the intelligence visible in the universe, and the worthlessness of body, except as an instrument of reason, Socrates deduced the immortality of the soul as a necessary consequence.

The object-matter of Socrates' disputations exhibit a great preference of ethical to physical topics. This may partly be explained by the fact, that in ethics a scientific spirit of inquiry had yet to be awakened, while physics had been long and extensively cultivated. Partly, also, it had its origin in the mental state of Athens at this period. The art of sophistry, which Socrates was seeking to overthrow, was based on the monstrous dogmas, that there is no truth for man; that he is the wisest who, rejecting all hope of it, is skilful enough to hide from others his own ignorance and incapacity by an ingenious display of artifices and forms. Successfully to combat these pernicious views, an appeal must be made to those general principles of belief which are implied in and indispensable to the right conduct of life; a strong hold must be taken of what is fixed and indestructible in man in his moral convictions. But, content with thus awakening man to a consciousness of the moral destiny of man, and his moral responsibility, he did not seek to construct an elaborate system of ethics. Having projected the ideal of science, both in its extent and form, he contributed little to its realization, either as a whole, or in its parts. A few propositions are necessary, however, to exhibit the true spirit of the Socratic ethics. Man naturally strives after happiness; but in this we must distinguish between accidental good fortune (εὐτυχία), and that which results from science and industry (εὐπραξία). The essence, therefore, of the moral act consists in the free agency of man. All virtue is one; and no act performed without a clear perception of its nature and tendency is either good or evil. There is no merit in a virtuous action unless it has been undertaken as such, intentionally and knowingly, the will being determined thereto by the notion of good. But this natural sense of right may be overborne by a stronger motive. This innate perception of good, therefore, like all other human faculties, stands in need of education to expand and strengthen it. Virtue may be taught, since it consists in the science of good.

SOD. The grassy surface of the soil pared off with a portion of the earth; in other words, turf.

SO'DA. Natron; mineral alkali. This important and useful substance is an oxide of sodium. Sodium was discovered by Davy in 1808. It is a metal much resembling potassium in its general characters. It is soft, malleable, fusible at 190°, and burns when heated in contact of air. When thrown upon water it does not burn, but floats about upon the surface, and rapidly disappears, being converted into soda, which is dissolved in the water, and gives it an alkaline reaction. The specific gravity of sodium is 0·97. By the quantity of hydrogen evolved during the action of sodium on water, we learn that soda, or oxide of sodium, consists of 1 equivalent of sodium = 24, and 1 of oxygen = 8. The equivalent of soda, therefore, is 32. The commercial demands for soda are chiefly supplied from two sources: the combustion of marine vegetables, such as common sea-weed and the *Salsola soda*, which furnish the impure alkalies called *kelp* and *barilla*; and the decomposition of common salt, or rather perhaps of sulphate of soda, obtained by the decomposition of salt by sulphuric acid. Carbonate of soda forms large rhombo-prismatic crystals, composed of 32 soda + 22 carbonic acid + 90 water. They fuse in their water of crystallization at about 150°, and it may be entirely expelled by exposure to heat. They effloresce when exposed to air. Sulphate of soda, or Glauber's salt, is the result of the action of sulphuric acid upon common salt. (*See* MURIATIC ACID.) It consists of 32 soda + 40 sulphuric acid; and the crystals are constituted of 72 dry sulphate and 90 water: they are efflorescent, and soluble in about 3 parts of cold water. When sodium is introduced into chlorine it immediately combines with it to form chloride of sodium, or common salt; if heated in the gas, it burns very vividly: 24 parts of sodium combine with 36 of chlorine to form 60 parts of this important and well-known compound. (*See* SALT.) When chlorine gas is passed into a weak solution of caustic soda it is absorbed, and a useful bleaching and disinfecting solution is obtained, which has been called *Labarracque's disinfecting soda liquid*.

SO'DALITE. A mineral composed chiefly of silica, alumina, and soda.

SODA WATER. This common and refreshing beverage is, as usually prepared, a supersaturated solution of carbonic acid gas in water. True *soda water* was formerly prepared (and is still by some manufacturers) for medical use, chiefly as a remedy for heartburn, and certain forms of dyspepsia and calculous complaints; and consisted of one, two, or three drachms of carbonate of soda, dissolved in a pint of water highly impregnated with carbonic acid. This is often a valuable remedy; but would sometimes be attended by mischievous results, especially if indulged in to the extent to which some persons pursue the use of soda water. The mere aqueous solution of carbonic acid, which is made by forcing the gas into water by a condensing pump, and under a pressure of six or eight atmospheres, is an agreeable and generally speaking harmless diluent.

SOD-BURNING. Burning of turf taken from the surface of worn-out pasture lands for the sake of the ashes as manure, &c.

SODIUM. *See* SODA.

SOFFITT. (It. soffitta, *overlaid*.) In Architecture. *See* LACUNAR.

SO'FI. A Persian word, which is employed to designate religious persons, otherwise termed Dervishes. It is probably a corruption of the Greek sophos, *wise*. Sofi was the surname borne by the ancestors of the kings of Persia of the race preceding that which now occupies the throne; and Shah Ismael Sofi, the first monarch of that race, also bore it; hence by European writers of the 16th and 17th centuries it was used erroneously as a title of the king of Persia.

SO'FISM, or SUFISM. The mystical doctrines of the class of Mohammedan religionists called Sofis. This name is indeed generally applied in the East to persons living together in a monastic way, and professing an

ascetic life. But the tenets peculiarly denoted by the name of Sufism are those of a sect which is said to be gaining ground extensively in oriental countries, especially among the educated classes of Mohammedans. These tenets, like those of the Quietists and other Christian sects of mystics, are founded on a notion of the union of the human soul with the divinity by contemplation and the subjugation of the appetites; but, as has been too frequently the case among Christians also, they have afforded a cover for the most licentious lessons of refined debauchery. In the last volume of Mr. Buckingham's *Oriental Travels*, containing a narrative of his journey in Mesopotamia, will be found a singular account of one of these monastic philosophers, his doctrines and conduct. The principles of Sufism appear also to have a remarkable affinity, in some respects, with those pantheistic notions which are prominent in the system of the Bramins, and seem to form the very foundation of the still more widely extended religion of Buddha.

SO'FTENING. In Painting, the blending of colours into each other.

SOIL. The primitive earths in a state of mixture with organized matter fit for the growth of plants. The surface of the earth in every country on which plants have grown and decayed is properly denominated soil; while the earth at a foot or more beneath the surface, commonly called subsoil, is comparatively without organized matter, and is therefore properly denominated earth, clay, sand, gravel, lime, or mixed earth, rocks, or stones, as the case may be.

SOIRÉE. (Fr. soir, *evening*.) The term originally given by the French to certain evening parties held for the sake of conversation only, music, dancing, and similar entertainments being excluded; but the word has been since introduced into all the languages of modern Europe, and is now employed to designate most descriptions of evening parties in which ladies and gentlemen are intermixed, whatever be the amusements introduced. It is frequently applied in England to the public meetings of certain societies held for the advancement of their respective objects, at which tea and other refreshments are dispensed during the intervals of business.

SOKE. A territorial division, now subsisting in Lincolnshire. This term, according to the etymology given by Bracton, designated a precinct in which a particular lord exercised justice.

SOL. In Music, the fifth note of the gamut.

SOLANA'CEÆ. (Solanum, one of the genera.) A natural order of herbaceous or shrubby Exogens, inhabiting all parts of the world excepting the arctic regions. They are chiefly known from *Scrophulariaceæ* by their curved or spiral embryo, the plaited estivation of the flower, and the flowers being usually regular, with the same number of stamens as lobes. The first of these characters, however, is not of universal importance; the plaited corolla and symmetrical flowers are better marks of distinction. This order contains nightshade, henbane, mandrake, tobacco, stramonium, the potato, and the tomato, the leaves of all which are narcotic and exciting, but in different degrees,—from *Atropa belladonna*, which causes vertigo, convulsions, and vomiting; tobacco, which will frequently produce the first and last of these symptoms; henbane and stramonium, — down to some of the Solanum tribes, the leaves of which are so inert as to be used as kitchen herbs. Even in the potato plant, the narcotic acrid principle is found in the stem and leaves, and even in the rind of the tuber. But the principal part of the latter consists of starch; and the small quantity of deleterious matter being volatile and near the surface, is readily driven off by the heat used in cooking.

SOLA'NIA. The active principle of the *Solanum dulcamara*, or woody nightshade. It is a white alkaline substance, insoluble in water, but soluble in alcohol: its combinations with the acids are bitter.

SOLA'NO. A hot oppressive wind which occasionally blows in the Mediterranean, and particularly on the eastern coast of Spain. The solano is a modification of the sirocco.

SOLA'NUM TUBERO'SUM. The botanical name for the plant of which the potato is the root. The potato, which is at present to be met with everywhere in Europe, and forms the principal part of the food of a large proportion of its inhabitants, was entirely unknown in this quarter of the world till the latter part of the 16th century. It is a native of America; but whether of both divisions of that continent is doubtful. (Humboldt, *Nouvelle Espagne*, liv. iv. c. 9.) Some authors affirm that it was first introduced into Europe by Sir John Hawkins, in 1545; others, that it was introduced by Sir Francis Drake, in 1573; and others, again, that it was for the first time brought to England from Virginia by Sir Walter Raleigh, in 1586. But this discrepancy seems to have arisen from confounding the common or Virginian potato (the *Solanum tuberosum* of Linnæus) with the sweet potato (*Convolvulus battatas*). The latter was introduced into Europe long before the former, and it seems most probable that it was the species brought from New Granada by Hawkins. Sweet potatoes require a warm climate, and do not succeed in this country; they were, however, imported in considerable quantities, during the 16th century, from Spain and the Canaries, and were supposed to have some rather peculiar properties. The kissing comfits of Falstaff, and such like confections, were principally made of battatas and eringo roots. On the whole, we are inclined to think that we are really indebted for the potato (as well as for tobacco) to Sir Walter Raleigh, or the colonists he had planted in Virginia. Gerarde, an old English botanist, mentions in his *Herbal*, published in 1597, that he had planted the potato in his garden at London about 1590; and that it succeeded there as well as in its native soil, Virginia, whence he had received it. Potatoes were at first cultivated by a very few, and were looked upon as a great delicacy. In a manuscript account of the household expenses of Queen Anne, wife of James I., who died in 1618, and which is supposed to have been written in 1613, the purchase of a very small quantity of potatoes is mentioned at the price of 2*s*. a pound. The Royal Society, in 1663, recommended the extension of their cultivation, as a means of preventing famine. Previously, however, to 1684, they were raised only in the gardens of the nobility and gentry; but in that year they were planted, for the first time, in the open fields in Lancashire, — a county in which they have long been very extensively cultivated.

Potatoes, it is commonly thought, were not introduced into Ireland till 1610, when a small quantity was sent by Sir Walter Raleigh to be planted in a garden in his estate in the vicinity of Youghal. Their cultivation extended far more rapidly than in England; and have long furnished from 3-5ths to 4-5ths of the entire food of the people of Ireland!

Potatoes were not raised in Scotland, except in gardens, till 1728, when they were planted in the open fields by a person of the name of Prentice, a day labourer at Kilsyth, who died at Edinburgh in 1792.

The extension of the potato cultivation has been particularly rapid during the last forty years. The quantity that is now raised in Scotland is supposed to be from 10 to 12 times as great as the quantity raised in it at the end of the American war; and though the increase in England has not been nearly so great as in Scotland, it has been greater than during any previous period of equal duration. The increase on the Continent has been similar. Potatoes are now very largely cultivated in France, Italy, and Germany; and, with the exception of the Irish, the Swiss have become their greatest consumers. They were introduced into India some sixty or seventy years ago; and are now successfully cultivated in Bengal, and have been introduced into the Madras provinces, Java, the Philippines, and China. But the common potato does not thrive within the tropics, unless it be raised at an elevation of 3000 or 4000 feet above the level of the sea, so that it can never come into very general use in these regions. This, however, is not the case with the sweet potato, which has also been introduced into tropical Asia; and with such success, that it already forms a considerable portion of the food of the people of Java, and some other countries. So rapid an extension of the taste for, and the cultivation of an exotic, has no parallel in the history of industry: it has had, and will continue to have, the most powerful influence on the condition of mankind. But upon this part of the subject we must refer the reader for full particulars to the *Com. Dict.*, art. "Potatoes," from which the above historical sketch has been taken.

SOLAR CYCLE. A period of twenty-eight years. *See* CYCLE.

SOLAR SYSTEM, in Astronomy, consists of the sun, and all the celestial bodies whose motions are controlled by its gravitation, viz. the planets, satellites, and comets. *See* SUN, PLANET, &c.

SO'LDER. Plumbers' solder is an alloy of three parts of lead and one of tin; it is more fusible than lead, and readily adheres to clean surfaces of that metal when it is fused. Fine solder is a mixture of two parts of tin and one of lead; it fuses at 360°. It is used in the process of tinning copper. Hard soldering, or brazing, by which two surfaces of copper are made to adhere, is done by fusing together brass and zinc. When this solder is used, the copper requires to be heated to near its point of fusion.

SOLDIER. (Lat. soldarius; literally, *one who serves for pay*.) In general language, a person equipped and maintained by the state for the purpose of defending it from foreign aggression, of putting down intestine commotion; or, in short, of protecting its interests either at home or abroad, according to instructions issued by the civil government. *See* ARMY, ENLISTMENT, &c.

SO'LEA (Lat. *a slipper*), in Mammalogy, is the inferior surface of the foot or hoof.

SOLEA. The name of a genus of flat fishes (*Pleuronectidæ*), characterized as follows: — "Both eyes on

the right side; the mouth distorted on the side opposite the eyes; small teeth in both jaws, but confined to the under side only; form of the body oblong; dorsal and anal fins extending to the tail." The common sole (*Solea vulgaris*, Cuv.) is taken by trolling, and in enormous quantities, along our coasts, principally from Sussex to Devonshire; and excepting towards the latter end of February, and the beginning of March, when the soles are spawning, and are rather soft and watery, they are in good condition for the table throughout the year.

SO'LECISM. In Rhetoric and Grammar (Gr. *σολοίκισμος*, said to be derived from the name of a town in Cilicia, whose inhabitants spoke a barbarous Greek), a violation of the idiomatic rules of grammar or construction in writing or speaking a language. Quintilian distinguishes solecism from barbarism, the latter word being applied to the erroneous use of single words.

SOLENA'CEANS, *Solenacea*. (Gr. *σωλην*, *a tube*.) The name of a family of Dimiary Bivalve Mollusks, of which the razor shell (*Solen*) is the type; they are distinguished by the great length of the respiratory tubes, whence their name.

SOLENOID. (Gr. *σωλην*, and *ειδος*, *appearance*.) In Electro-Dynamics, a name given by Ampère to a system of small electrical currents, equal and equidistant, and returning into themselves, the planes of which are normals to any given line, whether a straight line or curve, upon which their centres are situated, and which forms the axis of the *solenoid*. (Despretz, *Traité de Physique*, 1836.)

SOLFATA'RA. A volcanic vent emitting sulphur and sulphurous compounds. The term is borrowed from Solfaterra, the celebrated mountain of Naples called by the ancients *Phlegræi Campi*.

SOLFE'GGIO. In Music, the system of arranging the scale by the names ut, re, mi, fa, sol, la, by which musical students are taught to sing, these notes being represented to the eye by lines and spaces, to which the syllables in question are applied. (See art. MUSIC, under which will be found a diagram of the scale under the arrangement in question.)

SOLI'CITOR. The professional designation of persons admitted to practise in the court of Chancery in the conduct of suits, &c., who are styled attorneys in the courts of common law. (*See* ATTORNEY.) The *solicitor-general* is an officer of the crown, who holds by patent, and ranks next to the attorney-general, with whom he is, in fact, associated in the management of the legal business of the crown and public offices. He receives some particular fees on pleadings, and on the enrolment of patents, &c.; but the division of business between him and the attorney-general is chiefly regulated by usage founded on convenience. He is the officer on whom generally devolve the maintenance of the rights of the crown in revenue cases, patent causes, &c. The earliest date at which the name of this officer occurs, so far as is known, is the year 1461. In Scotland, the term solicitor is synonymous with attorney in England. They are inferior to the *writers to the signet*, and practise in the inferior courts.

SO'LID. In Physics, the term *solid* is applied to that condition of matter in which the attractive forces of the molecules are greater than the repulsive, and the molecules consequently cohere with greater or less force. The other states of matter are the *fluid*, in which the attractive and repulsive forces are balanced; and the *gaseous*, in which the repulsive prevail.

SOLID. In Geometry, a magnitude which has three dimensions; length, breadth, and thickness. The boundaries of solids are surfaces. *Regular solids* are those which are terminated by regular and equal planes. They are five in number, viz. the tetraedron, the hexaedron, the octaedron, the dodecaedron, and the icosaedron. *See* PLATONIC BODIES.

SO'LID ANGLE, in Geometry, is an angle made by the meeting of more than two plane angles which are not in the same plane in one point.

SO'LID PROBLEM. In Geometry, a problem which cannot be constructed by the intersections of circles and straight lines, but requires for its geometrical construction the description of one or more conic sections. The algebraic solution of a solid problem leads to a cubic or biquadratic equation. Problems which admit of being constructed by the intersection of two circles, or of a straight line and circle, are called plane problems, and their equations are of the second degree.

SOLIDU'NGULATES, *Solidungula*. (Lat. solidus, *solid*; ungula, *a hoof*.) The name of a tribe of Mammals, including those with only a single hoof on each foot; as the horse, ass, &c.

SOLI'LOQUY. *See* MONOLOGUE.

SO'LIPEDS. Synonymous with *Solidungulates*, which see.

SOLLE'CITO. (It. *afflicted*.) In Music, a term denoting that the movement to which it is affixed is to be performed in a mournful manner. It also means that the music is to be performed carefully.

SO'LO. (It. *alone*.) In Music, a movement, or part of a movement, in which only one voice or instrument is employed.

SO'LSTICE. (Lat. solstitium.) The time at which the sun is at its greatest distance from the equator, and when its diurnal motion in declination ceases. This happens at midsummer and midwinter; or when the sun arrives at the tropic of Cancer and the tropic of Capricorn.

SOLSTI'TIAL POINTS, are those points of the ecliptic at which the sun arrives at the time of the solstices. They are the first points of Cancer and Capricorn.

SOLU'TION. (Lat. solvere, *to untie*.) In Mathematics, the construction of a proposed problem, or the expression of its conditions by an equation which gives the value of the unknown quantity.

SO'MMITE. A mineralogical name of the *nephelin* of Somma and Vesuvius. *See* NEPHELINE.

SOMNA'MBULISM. (Lat. somno ambulare, *to walk in one's sleep*.) This is a species of dreaming, in which the bodily as well as the mental functions are affected. There are many remarkable cases of this kind on record, some of which would appear perfectly incredible, were they not attested not only by creditable, but by competent and scientific witnesses. Somnambulism has been defined, as "a state in which the mind retains its power over the limbs, but possesses no influence over its own thoughts, and scarcely any over the body, excepting those particular members of it which are employed in walking." Dr. Abercromby, in his excellent *Inquiries concerning the Intellectual Powers and the Investigation of Truth*, observes, in regard to this singular affection, that although the mind is fixed upon its own impressions as in ordinary dreaming, the bodily organs are more under the control of the will; so that the individual acts under the influence of his erroneous conceptions, and holds conversation in regard to them. He is also, to a certain degree, susceptible of impressions from without, through his organs of sense; not, however, so as to correct his erroneous impressions, but rather to be mixed up with them. Dr. Abercromby observes, that the first degree of somnambulism generally shows itself by a propensity to talk during sleep; the person giving a full and connected account of what passes before him in dreams, and often revealing his own secrets or those of his friends. Walking during sleep is the next degree, and that from which the affection derives its name. He gets out of bed, often dresses himself, and goes out of doors, walks frequently over very dangerous places in safety; sometimes he gets out of a window, walks along a parapet, gets to the roof of the house, and returns through similar risks to his apartment. On awaking in the morning he is either utterly unconscious of having stirred during the night, or remembers it as a mere dream. These cases are comparatively common; but sometimes the transactions of the somnambulist are carried much further: he will mount his horse and ride, or go to his usual occupations, such as threshing, saddle-making, playing on musical instruments, composing verses, and so forth.

Although somnambulists are generally insensible to any thing that is said to them, they are sometimes capable of holding conversation, especially in those cases where the affection occurs, as it sometimes does, in the daytime. In these attacks the individuals are generally unconscious of external impressions, or at all events extremely confused in their notions of external things. They frequently speak intelligibly, but in reference to the impressions which are present in their own minds. They sometimes repeat poetry, and other matters of which they were supposed to be perfectly ignorant; or they hold conversations with imaginary beings, or relate circumstances which were supposed to have been entirely unnoticed or forgotten. Some have been known to sing in a style superior to any thing to which they could attain when awake; and there are, says Dr. Abercromby, some well-authenticated instances of persons in this condition expressing themselves correctly in languages with which they were imperfectly acquainted.

For the details of individual cases of this extraordinary disorder, we must refer to Dr. Abercromby's instructive volume already quoted, and the authorities therein cited. It is impossible to give any explanation of the extraordinary condition of the faculties which such cases exemplify, or to point out any general plan of treatment applicable to them.

The more ordinary cases of somnambulism are sometimes cured by tying the patient to some part of the bed, or by securing the doors and windows; so that after ineffectual attempts to make his escape he is induced to return to bed, and remains quiet. The state of the stomach and bowels, and of the nervous system, requires careful examination and proper treatment: in some cases intestinal worms appear to have been connected with nocturnal disturbances bearing a close analogy to somnambulism, and which have disappeared after the successful operation of vermifuge remedies.

SO'MNUS, in Classical Mythology, the poetical god of sleep, is the son of Erebus and Nox, or of Nox alone. He dwells with his brother Death in a palace at the

western extremity of the earth. Homer makes Juno seek him in the isle of Lemnos, whither he had repaired for love of the nymph Pasithea. Ovid makes him dwell in a cavern among the Scythians or Cimmerians; Statius in Æthiopia.

SONA'TA. (It. sonare, *to sound.*) In Music, a composition executed wholly by instruments. It is generally a free composition for exhibiting the composer's powers, without confining him within the rigid rules of counterpoint, or measure.

SO'NNET. (It. sonetto.) In Poetry, a short composition of fourteen or fifteen lines, deca or endecasyllabic, rhymed according to an intricate but not always precisely similar arrangement. It is the oldest form in which the Italian language was used; but was, at a still earlier period, employed, although not commonly, by the Provençal poets. In Italy, Dante and the Tuscan poets his contemporaries brought the sonnet into public estimation, about the beginning of the 14th century; but by them it was invariably employed as the vehicle of thoughts wrapped in very obscure language, and probably of a symbolical nature, though generally, in their outward signification, breathing the spirit of romantic and chivalrous love. By Petrarch, in the course of the same century, the sonnet was carried to perfection in point of form and polish; although applied by him, as it had been by his predecessors, almost exclusively to the subject of his figurative and mystical passion. Since the time of Petrarch the sonnet has been a favourite form of composition in Italy, especially for the purposes of occasional poetry. In France it has had little success; or rather the French sonnet is a different poem, less regular in its construction than the Italian. In Germany and England the comparative poverty in rhymes of their respective languages has rendered it unusual; but Milton has given to it a dignity peculiarly his own, together with much of the melody and tenderness which characterize his Italian models. The proper sonnet is divided into two quatrains, with four lines and two rhymes each, and two terzines, each with three lines and a single rhyme. Pieces of a similar metrical structure in octo-syllabic lines are termed by the Italians Anacreontic sonnets. It is sometimes said that there is " hardly an educated Italian who has not composed a sonnet."

SO'PHIST. (Gr. σοφιστης; from σοφος, *wise.*) A Greek word, originally signifying a person of talent and accomplishments. It was afterwards restricted to a bad sense, and applied to a class of men who arose in Greece in the fifth century B.C., and taught the youth in the principal cities various arts and acquirements for hire. It has hence come to be the general designation of all such as cultivate any branch of science or philosophy with a view to outward advantages, careless of the truth of what they advance, except in so far as it may contribute to those purposes. The first Greek who assumed the name of *Sophist* was Protagoras, a native of Abdera, who flourished about the year 440 B.C., and obtained numerous pupils and auditors, especially in Athens. Of those who followed the same occupation the most celebrated were Hippias of Elis, Gorgias of Leontium, Prodicus of Ceos, and Euthydemus of Chios, with his brother Dionysiodorus. None of the writings of these men have survived; but we have abundant notices in the writings of their contemporaries, especially Plato, Xenophon, and Aristophanes, of the nature and tendency of the doctrines and principles which they communicated to the youth of Greece. Of the truth of these accounts the Grecian history of the latter part of the fifth century furnishes us with a melancholy testimony. It is, indeed, to the changes which had begun to take place in the internal and external relations of the Greek states, that the prevalence and success of the Sophists are mainly to be attributed. The changes in the distribution of property which these revolutions rendered necessary excited the passions and gave scope to the energies of the young and enterprising; at the same time that the political alterations tended to shake men's confidence in those moral principles which among the Greeks were intimately bound up with their civil institutions. We accordingly find the leading feature of the sophistic doctrine to be a dislike to every thing fixed and necessary, in ethics as well as philosophy. Prescription was represented as the sole source of moral distinctions, which must consequently vary with the character and institutions of the people. The *useful* was held to be the only mark by which one opinion could be distinguished from another. An absolute standard of truth is as absurd a notion in speculation as an absolute standard of morals in practice: that only is true which seems so to the individual, and just as long as it so seems. " Man is the measure of all things." These and similar doctrines they maintained with great subtlety and acuteness, and found numerous disciples among those who were well prepared for the admission of tenets which swept away at once all the remnants of those prejudices which might still interpose a barrier between their passions and their gratification. Considered as a link in the chain of philosophical development, the Sophists were doubtless the involuntary cause of the greater depth and soundness of the subsequent Grecian philosophy. The success which they had found in demolishing the systems of their predecessors proved the necessity of laying the foundations of human knowledge deeper than heretofore had been done; and it is thus to the Sophists that we may attribute the more critical and cautious spirit which distinguishes the doctrines of Plato and Aristotle from those of Heraclitus or Parmenides. (See Ritter, *Hist. of Ancient Philosophy*, book vi.; *Mem. de l'Ac. des Inscr.* vol. xiii. xxxii.; *Ed. Review*, vol. xxxiv.)

SOPORI'FICS. (Lat. sopor, *sleep.*) Medicines which induce sleep.

SO'PRA. (It. *above.*) In Music, a term frequently used for description; as *nella parte di sopra*, in the higher or upper part; *di sopra*, above; *contrapunto sopra il sogetto*, counterpoint above the subject, &c.

SOPRA'NO. (It. sopra.) The upper or treble part in composition.

SO'RBIC ACID. The acid of the berries of the *Sorbus ancuparia*, or mountain ash. It is identical with the *malic acid.*

SORBO'NNE. A college at Paris for the study of theology; so called from the village of Sorbonne, in Champagne, where its founder, a priest named Robert, was born about the beginning of the 13th century. He made a provision for the instruction of sixteen poor clerks in theology; and his college is said to be the first example of what was afterwards the common character of all the English colleges, the institution of a cænobium for regular clergy. The college of the Sorbonne was adorned with various new edifices and enriched with a library by Cardinal Richelieu, in 1629. His monument in the church is considered a chef-d'œuvre of French art. (See Mosheim, *Eccl. Hist.* vol. iii. transl. 1790, p. 53. &c.) This great college of theology exercised a high influence in ecclesiastical affairs, and on the public mind, especially in the 16th and 17th centuries; insomuch that the sceptical wits of the 18th usually employ the name as synonymous with the spirit of bigotry itself. Its proverbial celebrity for acuteness in theological disquisition is attested by the lines of our own Butler:—

For he a rope of sand could twist
As firm as learned Sorbonist.

SO'RCERER. (Lat. sortitor, from sors, *a lot;* whence *sorcery.*) Properly one who practises sortilege, or divination by lot (which see); but, in the ordinary language of the middle ages, one exercising magical powers (*see* MAGIC), especially by the aid of evil spirits. The *sorcerer* of the middle ages was, generally speaking, a personage of distinction, while the *witch* was degraded and loathsome. The species of sorcery which is still practised in the East, especially in Egypt, by means of the magic mirror, has recently attracted much attention. The most complete account of it will be found in *Lane's Modern Egypt.*

SORDINI. In Music. *See* CON SORDINI.

SORE'DIA. In Botany, heaps of powdery bodies found in lichens lying upon any part of the surface of the thallus.

SO'REX. (Lat. sorex, *a field-mouse.*) A Linnæan genus of the order *Bestiæ*, now forming an extensive tribe of Insectivorous Ferines (*Carnassiers*) in the system of Cuvier, and subdivided into different genera. The original generic term is confined to the shrews, or shrew-mice, which are the type of the family (*Soricidæ*), and are characterized by having the two superior middle incisors curved and indented at the base, the two inferior incisors prolonged and procumbent. Behind the upper pair of incisors there are five little conical teeth on each side, and two similar teeth behind the lower pair of incisors: the molars, which are beset with sharp cusps, are four on each side above, and three below. The true shrews are further characterized by lateral, and sometimes anal and femoral scent-glands. The principal genera, now distinct, which would have ranked with the Linnæan *Sorex*, are *Myogalea, Condylura, Tupaia, Gymnura, Macroscelis, Cladobates, Solenodon, Crossopus, Crocidura.* Of these *Gymnura* belongs rather to the family of hedgehogs, and *Condylura* to that of the moles.

SORI. (Gr. σωρος, *a heap.*) The small heaps of reproductive granules found growing upon the fronds of Polypodiaceous ferns.

SORI'TES. (Gr. σωρος, *a heap.*) In Logic, an abridged form of stating a series of syllogisms, of which the conclusion of each is a premiss of the succeeding one: *e. g.* $A = B$, $B = C$, $C = D$; therefore $A = D$. This is a sorites, consisting of two distinct syllogisms, which, drawn out at length, would stand thus: $A = B$, $B = C$; therefore $A = C$; and $A = C$, $C = D$; therefore $A = D$.

SO'RREL, SALT OF. Binoxalate of potash.

SO'RTES HOME'RICÆ, VIRGILIANÆ, SANCTORUM, &c. A species of sortilege or divination was practised in antiquity by opening at random a favourite author, and applying the first passage which met the eye to the circumstances of the inquirer as an oracular answer: termed by the Greeks στοιχειομαντεια. They

chiefly used Homer for this purpose. Thus Socrates when in prison, hearing the line of Homer repeated,

ἠματι κεν τριτατῳ, Φθιην ἐριβωλον ἱκοιμην,

interpreted it to foretel his own death within three days, by a play on the word Phthia. Among the Romans, Virgil was chiefly consulted, and many celebrated instances are preserved. Adrian, when desirous to know on what terms he stood with his patron, the emperor Trajan, consulting the *Æneid,* opened at the verses respecting Numa, "Nosco crines incanaque menta Regis Romani," &c.; and thence drew the augury of his future elevation to the empire. Alexander Severus, according to Lampridius, obtained a similar presage from the lines "Excudant alii spirantia mollius æra," &c. The anecdote of the ominous passages discovered by Charles I. and Lord Faulkland, when opening Virgil in the public library at Oxford, is well known (see *Welwood's Memoirs*). In Christian times, the Sortes Sanctorum came in fashion. They were obtained by consulting the inspired writings in the manner before described; sometimes, also, the inquirer went into a church while service was performing, and drew a prognostic from the first words he heard. In this way, St. Anthony was directed to adopt a life of solitary devotion. These practices became the occasion of much superstition. They are condemned by St. Augustine in his Epistle to Januarius; but are nevertheless continually mentioned, with evident credulity and approbation, by early ecclesiastical writers. Gregory of Tours, among other similar stories, has one of the French prince Meroveus, which shows the ceremonious manner in which they were sometimes performed. That prince having fled to the basilica of St. Martin, placed separately on the saint's tomb the Psalms, the book of Kings, and the Gospels, and, spending three days and nights at the tomb in fasting and devotions, on the fourth day he opened these sacred books; from each of which he drew a discouraging prediction. Elections to the episcopal offices, and other solemn proceedings, seem to have been sometimes decided in the same manner in the dark ages. And after this abuse had ceased, it was long a common practice, on the consecration of a bishop, after the book of the Gospels had been laid on his head, to consider the first verse which offered itself as a prognostic of his behaviour and the fortunes of his episcopacy. Thus the death of Albert, bishop of Liege, was intimated by the ominous occurrence of the passage respecting the execution of John the Baptist; and that prelate was accordingly put to death by Henry VI. The Sortes Sanctorum had been, however, forbidden by the council of Vannes in the 5th century, and that anathema was repeated on many later occasions, in which the consulting of the scriptures is classed with other profane and magical modes of divination. There is an essay on Sortes in the *Mem. de l'Ac. des Inscr.* vol. xix. *See* STICHOMANCY.

SORTIE, or SALLY. In Military language, a term borrowed from the French to signify a sudden attack made by the inhabitants of a besieged city upon the besiegers.

SO'RTILEGE. (Lat. sors, *lot;* lego, *I collect.*) Divination by lots. A very ancient mode of exploring future events, and which has been supposed by superstitious persons in modern times to derive countenance from various incidents in sacred history, especially the choice of St. Matthias by lot to the place of an apostle (Acts, i. 26.). The different modes in which sortilege has been practised will be found detailed under that word, in a learned article in the *Enc. Metropolitana;* and *see* SORTES.

SOSPI'RO. (It. *a sigh.*) In Music, the same as Rest, which see.

SOSTEN'UTO. (It. *sustained.*) In Music, a term which, affixed to a note, indicates that it is to be held out in an equal and steady manner.

SOTHIC YEAR. In Chronology, the Egyptian year of 365 days (said to have been introduced into Greece by Orpheus) was so called from Sothis, the Dog-star, at whose heliacal rising it was supposed to commence. (*Bryant's Ancient Mythology*, vol. iv.)

SO'TTO. (It. *below.*) In Music, a term frequently used for description; as *sotto il sogetto*, below the subject; *nella parte di sotto*, in a lower part.

SOUND. (Fr. son.) The sensation produced by the vibrations of the air or other medium with which the organ of hearing is in contact. The doctrine of sound is usually treated under the head *acoustics;* a branch of physics which has for its object the determination of the laws by which the peculiar motions which give rise to the sensation of sound are produced in bodies and conveyed to our ears, and the manner in which they act on those organs; in other words, to explain the origin, propagation, and perception of sound.

Although, strictly speaking, sound is only a sensation excited in the auditory organ, yet in treating of the subject it is usual to transfer the name from the sensation to the motion which gives rise to it. We shall therefore speak of sound as if it proceeded from the *sounding* body; and speak of a body as sounding when its particles are in that state of vibration which is requisite for making an impression on the ear, either immediately or through the medium of some other elastic substance.

Phenomena of Sound. — In order that a body may produce sound, it is necessary that its particles be in a state of rapid vibration; and in order that these vibrations may be communicated to the auditory organ, it is necessary that air or some elastic medium be interposed between the vibrating body and the ear. Hauksbee having suspended a bell under the receiver of an air-pump, found the sound become feebler in proportion as the air was removed, and again become stronger as the air was readmitted, and also that when the bell was suspended in a vessel full of air, and placed under the receiver, no sound was transmitted when the air between the vessel and the receiver was exhausted. This experiment has been repeated by Biot, with a more perfect apparatus, and with every attention to the circumstances by which it is influenced; and it was found that when the exhaustion was complete no sound was perceptible, even when the ear was brought close to the receiver. Hence it appears that sound cannot be communicated through a perfectly void space. But although air is the medium through which sound is usually communicated, this only happens because it is the medium with which the ear is usually in contact; and many other media are found by experiment to perform the office even more perfectly. Franklin having plunged his head under water, caused a person to strike two stones together beneath the surface, and at more than half a mile distance heard the blows distinctly. Colladon by plunging a few feet into the water a thin tin cylinder closed at the lower end, but having the upper open to the air, was enabled to hear the sound of a bell struck under water at the distance of 2000, 6000, and even 12,000 mètres (about 9 miles); namely, across the whole breadth of the lake of Geneva, from Rolle to Thonon. The conducting power of wood along the fibres is very remarkable. Let a person bring his ear close to the end of a fir deal, however long, and he will distinctly hear the slightest scratch made with the point of a pin at the other end, although the sound may be so feeble as to be inaudible to the person who makes it. Miners at work in one shaft often hear the sound of the pickaxe in another through the solid rock; and in general all solids tolerably compact are good conductors of sound.

Sounds are propagated to great distances and with remarkable distinctness over a surface of water, or ice, or frozen snow. In the account of Parry's third polar expedition, it is stated that two persons could hold a conversation across the harbour of Port Bowen, a distance of 6696 feet, or about a mile and a quarter. Instances are also recorded of sounds propagated to almost incredible distances over land. Derham relates the following: — Guns fired at Carlscroom were heard across the southern extremity of Sweden, as far as Denmark, a distance of 120 miles. Dr. Hearn, a Swedish physician, relates that he heard guns fired at Stockholm at the distance of 30 Swedish or 180 English miles: the cannonade of a sea-fight between the English and Dutch, in 1672, was heard across England as far as Shrewsbury, and even in Wales, a distance of upwards of 200 miles from the scene of action.

The diminution of the intensity of sound in rarefied air is rendered manifest not only by experiments with the air-pump, but also by the phenomena observed at great altitudes in the atmosphere. Saussure relates, that at the summit of Mount Blanc the report of a pistol was not louder than that of a small cracker in the plain below; and Gay Lussac, having ascended in a balloon to an altitude of nearly 23,000 feet, far above the clouds and away from all solid substances, observed the intensity of the sound of his voice to be greatly enfeebled.

It is matter of familiar observation that sounds are not propagated through the air instantaneously, but occupy a sensible portion of time in passing from one station to another, greater in proportion as the stations are more remote. The blow of a hammer on an anvil is not heard by an observer at some distance, until a sensible time has elapsed after the hammer has been seen to descend; and the flash of a gun fired a mile off is seen several seconds before the report is heard. But all sounds, whatever be their loudness or pitch, are propagated with the same velocity through the same medium. In listening to the music of a concert, the sounds follow each other in the same order and at the same intervals; and the same measure and harmony are perceived, at whatever distance the hearer may be from the orchestra. Biot caused several airs to be played on a flute at the end of a pipe 3120 feet long, which were distinctly heard at the other end without the slightest derangement in the order or intervals of sequence of the notes. This could not have been the case if there had been the smallest difference in the velocity of their propagation.

Numerous experiments have been made for the purpose of determining the actual velocity of sound through the

atmosphere. The usual mode of making the experiment is to observe the interval between the flash and the report of a cannon fired at a known distance. In this manner the Florentine academicians, in 1660, found the velocity to be 1148 English feet per second. These experiments were repeated in France in 1698, by Cassini, Huygens, Picard, and Roemer, who found 1172 feet; and Flamsteed and Halley at the royal observatory of Greenwich, from experiments made at the distance of 3 miles, found the velocity to be 1142 feet per second. This result was confirmed by Derham (*Phil. Trans.* 1708), who found the same velocity by a mean of observations made at more remote distances. In 1737, the Academy of Sciences of Paris directed farther experiments to be made by Cassini de Thury, Maraldi, and Lacaille; and on this occasion the experiments were for the first time made so as to eliminate the effect of the wind by reciprocal observations; that is to say, by firing cannon at both ends of the line, either simultaneously or at short intervals. They also appear to have been the first who observed and recorded the temperature of the air at the time of the experiment; a very essential element, as will presently be seen. The result at which they arrived gave the velocity equal to 1106 English feet per second, at a temperature between 4° and 6° of Reaumur, or between 41° and 44½° of Fahrenheit. When the proper reduction is made for temperature, this agrees very nearly with the best modern observations.

Various other experiments were made in different countries in the course of the last century (viz. by Bianconi in Italy, in 1740; by Condamine at Quito and Cayenne, in 1740 and 1744; by Mayer in 1778, and Muller in 1791, in Germany; by Espinosa and Bauza in 1794, at Chili); but as the observers had not the means of determining minute intervals of time with the precision which has been attained in more recent experiments, and besides neglected some circumstances which influence the result, it is unnecessary to state the details.

Since the beginning of the present century, the velocity of sound has been measured in various countries; in Germany, by Benzenberg at Dusseldorf in 1809, and by Myrbach and Stamfer at Saltzburg in 1822; in France, by directions of the Bureau des Longitudes, in 1822; in Holland, by Moll, Vanbeek, and Kuytenbrewer, in 1823; in England, by Dr. O. Gregory at Woolwich, in 1824; in the East Indies, by Mr. Goldingham, in 1821; and at Port Bowen, in the polar regions, by Parry and Foster, in 1825. The results of these measurements, when reduced to the same temperature, agree very nearly with one another; but the experiments made in France and Holland are by far the most circumstantial and satisfactory. In the French experiments, two stations in the neighbourhood of Paris were chosen, Villejuif and Montlehéry; and the signals were made by firing a gun from each station alternately, at an interval of five minutes. The observers at Villejuif were Prony, Arago, and Mathieu; and at Montlehéry, Humboldt, Gay Lussac, and Bouvard. The observations commenced at 11 o'clock on the nights of the 21st and 22d of June, and were continued on both nights during two hours; but in many instances the reports were not heard, at least by all the observers. The intervals between the flashes and reports were observed by means of stop watches of a peculiar construction, which permitted the seconds to be divided and noted. The mean of all the observations gave 54·6 seconds for the time which sound took to travel from the one station to the other. The distance between the stations was afterwards determined by Arago, and found to be 9549·6 toises (11⅓ miles); whence the velocity is 174·9 toises, or 340·88 metres in a second. But this is the velocity belonging to the mean temperature, which was 16° centigrade (61° Fahrenheit), and corresponds to a velocity of 331·12 metres (1086·1 English feet), at the temperature of freezing water. The details of these experiments are given in the *Connaissance des Temps* for 1825.

In the Dutch experiments, a clock with a conical pendulum was used, which gave the means of determining the time to the hundredth of a second by suddenly arresting the motion of the index without stopping the clock. As in the French experiments, guns were fired from each extremity of the line; but instead of being fired alternately, they were in the present case fired simultaneously, so that any error that might be feared from a variation in the state of the atmosphere or the wind was entirely eliminated. The state of the hygrometer was also observed. The interval between the stations was 57839 feet (nearly 11 miles); and the mean of all the experiments reduced to the freezing temperature, and for dry air, gave for the velocity of sound 1089·42 feet in a second. The details are given in the *Phil. Trans.* for 1824.

Dr. Gregory's observations are given in the *Transactions of the Cambridge Phil. Soc.* for 1824. The signals were not reciprocal; but the velocity of the wind was measured by an anemometer, and allowed for. The distances were also very much smaller (varying from 2700 to 13460 feet); nevertheless the results agree very well with those above mentioned. Mr. Goldingham's experiments at Madras are much less certain; his method consisted in taking a mean of the velocities observed daily in calm weather, during a long time, by the firing of the morning and evening guns at two stations visible from Madras, and a mean of all the observed temperatures for the reduction. (*Phil. Trans.* for 1823.) Benzenberg's experiments are given in *Gilbert's Annalen*, new series, v. 383.; and those of General Myrbach in the *Jahrbuch des Polytek. Instituts zu Wien*, vol. vii. The experiments of Parry and Foster are given in detail in *Parry's Journal of a Third Voyage, &c.* The mean result deduced by Dr. Moll (*Phil. Trans.* 1828) gives the velocity equal to 1035·2 feet in a second, at the temperature of 17·7° Fahr., which corresponds to 1092 feet at 32°; but the circumstances were unfavourable. The following table exhibits in one view the results of the principal experiments now described. The numbers are taken from a more extended table given by Sir John Herschel in the *Ency. Metropolitana*, art. "Sound;" to which admirable treatise we refer the student for information on all points connected with this important subject.

Date of Observation.	Observer.	Distance of Stations in Feet.	Velocity per Second in English Feet at the temperature of freezing water.
1809.	Benzenberg -	29764	1093
1821.	Goldinham - -	29547 13932	1086·7
1822.	Myrbach - -	32615	1092·1
1822.	Arago, Mathieu, &c.	61064	1086·1
1823.	Moll, Vanbeek, &c. -	57839	1089·42
1823.	Dr. Gregory - -	from 2700 to 13460	1088·05
		Mean of the whole	1089·2

These results agree remarkably well with each other, the greatest deviation from the mean being less than 4 feet, and the mean of the whole being almost identical with the determination of Moll and Vanbeek. "We may, therefore," says Sir John Herschel, "adopt 1090 feet without hesitation (as a whole number), as no doubt within a yard of the truth, and probably within a foot." This is the velocity with which sound travels in dry air, at the temperature of freezing water. But the velocity increases with the temperature (as will be shown presently), at the rate of 1·14 foot, very nearly, for each degree of Fahrenheit's scale. Hence at the temperature of 62° (the standard temperature of the British metrical system), the velocity is 1124½ feet. We may therefore assume the velocity of sound at this standard temperature, as determined by the best experiments, to be 1125 feet per second.

Theory of Sound. — It has already been stated that sound is produced by the vibrations of the molecules of a solid body communicated to the atmosphere or other elastic medium, and conveyed by it to the ear. The physical theory of sound, therefore, resolves itself into two parts: 1st, the state or condition of the vibrating body; and 2d, the mode in which this mechanical action is propagated through the medium to the organ of sense.

State of Sonorous Body. — In order that a body may give out sound, its particles must be put into a state of rapid vibration. If the frequency of the vibrations is under a certain limit, no sound will be produced; above that limiting velocity of vibration, sound is produced; and experience shows that the quality of the sound becomes more and more acute as the vibrations are more rapid, until a second limit of velocity is attained, beyond which the human ear is affected with no sensation of sound. To prove this experimentally, let a thin plate of tempered steel have one of its ends firmly fixed in a vice, and let the other end be drawn a little aside from the position of rest. As soon as the force by which the plate is bent is removed, the plate commences a series of vibrations, which become smaller and smaller until the position of rest is again attained. But the vibrations are all performed in equal times; and if sufficient length is given to the plate, they take place so slowly as to admit of being accurately counted. On shortening the plate, they become more rapid; and long before they attain that degree of rapidity which is necessary for the production of sound, it becomes impossible to count them directly; but it is demonstrable that when a plate of metal of equal thickness throughout is made to vibrate in the manner now supposed, the time of a vibration is directly proportional to the square of the length of the plate, and consequently the number of vibrations in a given time is inversely as this square; so that if the number in a second corresponding to any length of the plate has been counted, the number corresponding to any other given length can be readily computed. In this manner it has been found that a metallic plate begins to sound when the number of vibrations in a second is 32; and at this velocity of vibration, the sound

which it gives is of the same pitch as that of an organ pipe 32 feet in length, open at both ends. (By *vibration*, we here understand the passage of the plate from the extreme excursion on one side of the position of rest to the opposite, and not the going and returning, or complete vibration.)

This appears to be the minimum velocity of vibration capable of producing sound. The other limit, or maximum velocity at which sound ceases to be appreciable, is not so easily determined. Until recently it has been usual to fix it at 8200 vibrations in a second; but M. Savart has discovered that by increasing the amplitude of the vibrations, acute sounds may be distinguished at a velocity of 24,000 vibrations in a second; and it is possible that the limit may still be considerably above this number. By means of an ingenious apparatus, Savart has succeeded in determining the number of vibrations producing a sound of any given pitch with great exactness.

Several other means exist of determining the absolute number of vibrations in a given time, corresponding to different musical sounds; of which one of the most certain, and most frequently had recourse to, depends on the mathematical relation subsisting between the time of vibration, the length of the cord, and the tension of vibrating cords. Let n denote the number of vibrations in a second, g the accelerating force of gravity (32 feet in a second), l the length of the cord, w its weight, t its tension (or the weight by which it is stretched); then a formula equivalent to the following was demonstrated by Brook Taylor (*Methodus Incrementorum*, p. 93.): —

$$n = \sqrt{\frac{g\,t}{l\,w}}.$$

In this formula g is known, and t, l, and w are measurable quantities, so that n is completely determined; but a more convenient expression is obtained by substituting the diameter and density of the cord for its weight. Let r be the radius of the cord, δ the density of its matter, and π the ratio of the circumference to the diameter, or $\pi = 3{\cdot}14159$; then $w = \pi\,\delta\,g\,r^2\,l$, and the above formula becomes

$$n = \frac{1}{r\,l}\sqrt{\left(\frac{t}{\pi\,\delta}\right)}.$$

From this it results that the number of vibrations in a second is proportional directly to the square root of the tension of the cord, and inversely to its length, to its thickness or diameter, and to the square root of its density.

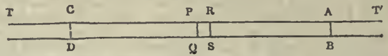
In the *Memoirs of the Berlin Academy* for 1822 and 1823, are given the results of a great number of experiments made in this manner by M. Fischer, for determining the velocity of vibration corresponding to different musical sounds. The rapidity of vibration giving the diapasons (that is, the concert pitches) of various orchestras at Berlin was found to be as follows: — Berlin Theatre 437·32, Great French Opera 431·34, Feydeau 427·61, Italian Theatre 424·17 vibrations per second. The reach of the voice of a man usually extends from sol_1 to fa_3 in the musical gamut; and that of a woman from re_3 to la_4. Taking the diapason of the Italian Opera as the standard, the rapidity of vibration corresponding to these several notes is as follows: — Sol_1 190·8, fa_3 678·4, re_3 572·4, la_4 1606 vibrations per second. But the voices of some singers reach much higher than la_4, and consequently the rapidity of vibration with respect to them will be higher in proportion.

Some of the most acute sounds, or highest tones which the ear can distinguish, are given by the wings of insects; and they correspond to the astonishing rapidity of 12000 or 15000 vibrations in a second. When we reflect how extremely probable it is that the tympanum of the ear vibrates in unison with the sounds that affect it, we cannot fail to be struck with admiration of the wonderfully delicate organization of a substance which possesses the power of adapting itself to all velocities of vibration, from 32 times in a second up to 24,000, the number found by Savart to be sensible. The limits, however, at which very acute sounds cease to be audible appear to vary considerably in respect of different individuals, some being altogether insensible to sounds which painfully affect others. (See a very interesting paper on sounds inaudible to certain ears by Dr. Wollaston in the *Phil. Trans.* for 1820.)

The mathematical problem, to determine the vibrations of a stretched cord, is one of very great difficulty. After exercising the talents of Dr. Brook Taylor, D'Alembert, Euler, Daniel Bernoulli, and others, it was completely solved by Lagrange, in the first volume of the *Turin Miscellanies*, and all the deductions from theory are found to be confirmed by experiment. The subject of the vibrations of solids has been recently examined experimentally by M. Savart, and the results given in a series of most important memoirs communicated to the French Academy of Sciences, and printed in different volumes of the *Annales de Chimie*. *See* VIBRATION.

Propagation of Sound. — In order to convey an idea of the manner in which the vibratory motions of a sonorous body are communicated to the atmosphere or other elastic medium, let us conceive a tube, T T′, of an indefinite

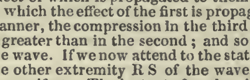
(1.)



length, and open at both ends, to be filled with air of a uniform temperature and density throughout. Let us also suppose a piston, P Q, which closely fits the tube, and is moveable within it along the direction of the axis, to be propelled suddenly from the position P Q to R S; and to simplify the consideration, let the distance P R be supposed one foot, and the time in which the piston moves from P Q to R S to be one second. Now, assuming the air within the tube to have been in a state of rest before the piston began to move, let us consider what will be its state at the instant when the piston arrives at R S. If the air in the tube were acted upon as a perfectly hard body, any motion communicated to the particles at one extremity would be instantaneously conveyed to the other; and when the piston arrived at R S a quantity of air, equal to that which was contained between P Q and R S, would be expelled at T′, and all the particles within the tube would come to rest at the same time with the piston. But in consequence of the compressibility of the air the motion is not communicated to the distant particles instantaneously, but only after a sensible interval of time; and we may conceive the tube to be so long that when the piston has arrived at R S no air has yet been propelled from the tube at T′. In fact, the disturbance or compression of the particles, which takes place at the instant the piston begins to move, is propagated along the tube with a certain determinate velocity, depending on the elasticity of the air, and when the piston reaches R S will only have reached to a certain determinate distance. Let A B be the section of the tube which the first compression has reached at the instant the piston comes to R S; then, at the instant of time on which we have to fix our attention, the column of air between R S and A B will be in a state of compression, and between A B and the end of the tube at T′ it will still remain in its natural state. The column of air between R S and A B, which is thus modified by the stroke of the piston, is called a *wave* or *undulation*, and R A is the *length* of the wave.

On attending to the state of the molecules in the column R A, it will readily be seen that they are not subjected to the same degree of compression through its whole length. Conceive the wave to be divided into a very great number of thin layers by sections parallel to R S or A B, and that the piston, in passing from the position P Q to R S, has produced the effect, not instantaneously, but by a great number of successive small impulses. At the instant the piston comes to R S the disturbance has by hypothesis been propagated only to A B, and consequently the particles in the infinitely thin layer next to A B have suffered only the slightest degree of compression, or that caused by the first impulse of the piston. In the second layer next to A B the molecules of air are in a state of greater compression; inasmuch as they have sustained not only the compression due to the first impulse of the piston, but also that which is due to the second, the effect of which is propagated to them at the same instant at which the effect of the first is propagated to A B. In like manner, the compression in the third layer preceding A B is greater than in the second; and so on to the middle of the wave. If we now attend to the state of the molecules at the other extremity R S of the wave, a similar effect will be manifest. The instant after the piston stops, the layer next to R S has communicated all its velocity to the one preceding it, and remains at rest; or, at the moment of the arrival of the piston at R S, sustains only the compression due to the last impulse. The next layer in succession sustains the compression due to two impulses of the piston, — the last, and last but one. By following out this mode of reasoning, it will readily appear that the particles in the state of greatest compression are those towards the middle of the wave; and that if upon S B, as an axis (fig. 2.), we raise a great number of perpendiculars, *a a*, *b b*, *c c*, &c., each proportional to the compression at the corresponding point of the column, the curve drawn through the summits of these perpendiculars will represent the law of compression; and hence is of the form represented in the annexed diagram, the parts on each side of the middle ordinate *b b* being perfectly symmetrical.

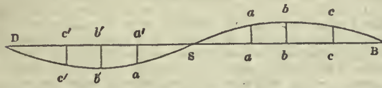
(2.)



If we now attend to the motions developed on the other side of the piston, it will be easily seen that similar phenomena must take place; but in a reverse order, inasmuch

as the air within the tube on that side must be rarefied, instead of being compressed by the motion of the piston from P Q to R S. Let C D (fig. 1.) be a section of the tube, so that the column C R is equal to R A; then, as the velocity of propagation depends only on the nature of the medium, it is obvious that at the instant in which the piston arrives at R S the disturbance of the molecules will only have extended to C D. The whole column between C D and R S will be rarefied by the withdrawal of the piston of air between P Q and R S; but the rarefaction will be greatest at the middle of the column, for the very same reasons that the condensation is greatest at the middle of the column between R S and A B. If, therefore, we represent the rarefaction by

(3.)

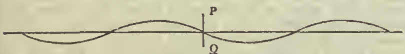


negative ordinates, $a' a'$, $b' b'$, $c' c'$, &c. (fig. 3.), the state of the column of air between A B and C D (and this is all which is modified by the passage of the piston from P Q to R S) will be represented by the double curve D b' S b B, the small part between P Q and R S being neglected as insensible. There are thus two distinct waves or undulations caused by the motion of the piston: the wave S B *before* the piston is called the *condensed wave*, and S D *behind* the piston is called the *rarefied wave*. But some writers on acoustics consider both these as belonging to the same wave; and therefore understand by the term wave the whole mass of particles between C D and A B (fig. 1.) which have been disturbed by the motion of the piston from P Q to R S.

As every thin stratum of air in the tube, by reason of its elasticity, communicates to the stratum before it the impulse which it has received from the one behind it, all the particles will successively be affected in the same manner; and at the end of a second interval, equal to that in which the piston has passed from P to Q, the motion will be communicated over another space equal to R A, or the wave will have moved forward its whole length, retaining always the same form; and, supposing the piston to have in this second interval remained at rest at R S, all the particles in the space R A will have returned to their original state of quiescence.

If, instead of supposing the piston to remain at rest at R S, we suppose it to be drawn back, in the second interval of time, to its original position at P Q, then all the phenomena now described will be repeated in the reverse order; that is to say, the compressed wave will be to the left of the piston, and the rarefied wave to the right; and the state of the particles within the tube, with respect to their compression, as modified by the advanced and subsequent retreat of the piston (the complete vibration), will be represented as under (fig. 4.).

(4.)



We have now only to suppose this forward and backward motion of the piston to be performed with the same rapidity as the vibrations of an elastic plate or stretched cord, and the phenomena now described will give an idea of the mode in which sound is transmitted through the atmosphere.

From this illustration (imperfect as it is) of the nature of the motions communicated to the air by the vibrating body, it is easy to see that the particles of air in the tube do not change their places *inter se*, but acquire a vibratory motion, backwards and forwards, along the length of the tube. It is also obvious that the vibrations of the air through which sound is transmitted must be precisely equal in number to those of the sounding body; and as soon as the vibrations cease those of the air cease likewise. But so long as the body vibrates, or the reciprocal motion of the piston is continued with the same velocity, a continued musical sound will be heard; and this will be precisely the same at whatever part of the tube the ear is situated, all the waves being perfectly similar.

It is also evident that sound is propagated not only in straight lines, like light, but in every possible direction. Air being equally elastic in all directions, each point of a sonorous wave may be regarded as a new centre, from which rays are propagated on all sides. A sound heard from the opposite side of a mountain is not conveyed through the mountain, but through the air in curved or crooked lines along secondary rays.

Sounds differ from one another in three respects,—pitch, intensity, and quality. The pitch, or tone, depends on the length of the wave; or, which comes to the same thing, on the number of vibrations in a given time (for the velocity being constant, the length of the wave multiplied by the number of vibrations in a given time is constant). The gravest tone which the ear can distinguish corresponds to a wave of about thirty-two feet in length, and the most acute to one of about half an inch. Two sounds, however different in loudness or quality, are always in perfect unison when the undulations by which they are conveyed are precisely of the same length. The intensity or loudness does not depend on the length of the wave, but on the degree of compression which the air receives; that is, on the violence of the impulses, or the length of the stroke of the piston in the above illustration. The *quality* of sound (the *timbre* of the French authors) is less easily explained. It probably depends on the greater or less abruptness of the impulses, or of the changes of velocity and density of the strata of air between the two extremities of the wave.

Theoretical Determination of the Velocity of Sound.— The investigation of the velocity of sound through the atmosphere (or any gaseous medium) is based upon this fundamental proposition of dynamics, viz. that the velocity of the pulses in an elastic medium is as the square root of the elasticity divided by the density of the medium. Let $v =$ the velocity, $e =$ the elasticity, $d =$ the density; and the proposition gives $v = \sqrt{(e \div d)}$. Make $g =$ the measure of gravity (386·29 inches per second), $w =$ weight of the unit of volume of air, $h =$ height of the homogeneous atmosphere (*i. e.* of a column of air of the same density throughout, and whose weight exercises on the base a pressure $= e$); we have then $e = h\, w$, $d = w \div g$; and the above equation becomes $v = \sqrt{(g\, h)}$. But this is the velocity which a heavy body acquires by falling in vacuo from a height $= \frac{1}{2} h$; therefore, the velocity with which sound is propagated through the air is the same as that which a heavy body would acquire by falling through half the height of the homogeneous atmosphere. This proposition was given by Newton in the *Principia* (lib. ii. prop. 47.), but from a theory wholly inapplicable. The correct demonstration was first given by Lagrange.

In order to convert this formula into numbers, it is necessary to determine h. Let $b =$ the standard height of mercury in the barometer, and $m =$ the ratio of the density of mercury to the density of atmospheric air under the same pressure; then $h = m\, b$, and the velocity becomes $v = \sqrt{(g\, m\, b)}$. At the temperature of freezing water (32° Fahr.), and under a barometric pressure of 29·927 inches, the value of m is found by experiment to be 10,466. But we have also $g = 386{\cdot}29$ inches; whence at that temperature $v = 10{,}998$ inches, or 916 feet.

Since the velocity, as above stated, is proportional to the square root of the elasticity divided by the density, an alteration in the height of the barometer, while the temperature remains the same, will produce no change in the velocity; for an increase of pressure, and consequently of elasticity, is accompanied by a proportional increase of density. An increase of temperature, however, by increasing the elasticity without changing the density, is accompanied by an augmentation of velocity. The correction for a difference of temperature is found as follows: Let t denote the number of degrees of temperature on Fahrenheit's scale above 32°, and a a constant coefficient; then the elasticity at the freezing temperature being e, the elasticity at the temperature t will be $e\,(1 + a\,t)$. But the value of a is found by experiment $= {\cdot}00208$; therefore the elasticity is $e\,(1 + {\cdot}00208\,t)$; and the formula for the velocity becomes $v = \sqrt{g\, m\, b\,(1 + {\cdot}00208\,t)}$; or, introducing the above value of $g\, m\, b$, $v = 916\,(1 + {\cdot}00104\,t)$.

The velocity of 916 feet at the freezing temperature, thus deduced from theory, falls short of the experimental velocity (which has been shown above to be 1089 feet) by 173 feet, or about a sixth part of the whole quantity. This discrepancy was remarked by Newton, who attempted to account for it by supposing the spherical molecules of air to be perfectly elastic solids, through which sound is propagated instantaneously; but the true solution of the difficulty was reserved for Laplace. The explanation given by Laplace is, that the compression of the air which takes place in the vibration disengages a portion of latent heat, which thus becomes sensible, and modifies the law of the elasticity, and accelerates the velocity. On submitting this to calculation, he found that the formula for the velocity of sound must be multiplied by a certain factor, namely, the square root of the quotient which is found by dividing the number which expresses the specific heat of the air (or other gas) under a constant pressure by that which expresses its specific heat under a constant volume. Let $k =$ this factor; then Laplace's formula for the velocity of sound is

$$v = \sqrt{g\, m\, b\,(1 + {\cdot}00208\,t)\,k}.$$

The value of k for atmospheric air, as determined by Dulong (*Lamé*, vol. ii. p. 87.), is 1·421; hence $\sqrt{k} =$ 1·192, and the formula in numbers is

$$v = 916 \times 1{\cdot}192\,(1 + {\cdot}00104\,t) = 1092 + 1{\cdot}14\,t,$$

which is almost identical with the experimental determination.

Velocity of Sounds through Liquids and Solids.— The

following general formula for the velocity with which sound is propagated through any elastic compressible body, whether liquid or solid, was found by Laplace: — Let b denote (as before) the standard height of the barometer, D the density of mercury at the freezing temperature, d the density of the medium, and c the *compressibility* of the medium, that is, the diminution of bulk it sustains by an additional pressure equal to one atmosphere; then the formula is $v = \sqrt{\frac{g\,b\,D}{c\,d}}$; or, (since $g = 386{\cdot}29$ inches, $b = 29{\cdot}927$ inches, $D = 13{\cdot}568$), $v = 396{\cdot}04\ \sqrt{(1 \div c\,d)}$ inches, or $33\ \sqrt{(1 \div c\,d)}$ feet per second. Applying this to the case of water, we have $c = {\cdot}000049589$ (Herschel, *Ency. Metrop.*), and $d = 1$; whence $v = 4687$ feet per second. This result agrees very nearly with the velocity determined by Culladon and Sturm by direct experiment on the propagation of sound through the lake of Geneva, the velocity actually observed by them being 1435 mètres, or 4708 English feet, which differs from the theoretical velocity only by 21 feet,—a space described by the aqueous pulse in the 200th part of a second.

By the above formula the velocity of sound through any medium of which the compressibility is known is readily computed. According to Chladni the velocities of sounds in different solids, that of air being taken as unity, are as follows: — Tin = 7½, silver = 9, copper = 12, iron = 17, glass = 17, baked clay = 10-12, woods of different kinds = 11-17. But the velocity of propagation through cast-iron tubes was determined experimentally by Biot, and found to be only about 10½ times its velocity in air. (See *Herschel's Treatise on Sound;* Chladni, *Traité d'Acoustique;* Biot, *Traité de Physique;* Pouillet, *Elémens de Physique;* Lamé, *Cours de Physique*, &c.)

SOUND. In Geography, a strait or inlet of the sea; applied specially to the strait which connects the German Sea with the Baltic.

SOUND BOARD. A thin board placed over the head of a public speaker to strengthen or extend the sound of his voice.

SOUTH. One of the four cardinal points of the compass; the direction in which the sun always appears at noon to the inhabitants of the northern hemisphere without the tropic.

SOUTHCO'TTIANS. In Religious History, the followers of Joanna Southcott, whose singular life and influence, although now nearly forgotten, deserve to be kept in record as examples of the contagious effects of fanaticism. She was born at Gittisham, in Devonshire, in 1750; and seems to have first persuaded herself of her miraculous calling in 1792. From that time she was in the habit of publishing pamphlets in an enthusiastic strain; traversed the west of England, preaching and prophesying, with a select body of followers, and gradually collected about her a considerable number of disciples. She came to town about 1803, when she announced a meeting, which she called her trial, for the purpose of satisfying the world of the reality of her mission. Several such meetings took place, the last in 1804; and many persons, including several clergymen, attested their belief in her pretensions. After this she became the founder of a church, which had a chapel in Duke's Place, where service was performed by a Mr. Tozer, a Dissenting clergyman of Exeter, who followed her to London. At last she announced her supernatural pregnancy; and this strange announcement took great hold on the public imagination, in consequence of Dr. Reeve and other medical men having declared their belief that she was actually pregnant in her 65th year. The excitement produced in London, in the summer of 1814, by the whole affair, was to be paralleled only by that which other delusions as absurd and impious have at different times occasioned. Her death, in December of that year, did not undeceive her disciples: even when her body was opened, four days after it, and no trace discovered to verify her assertions, many of them continued to proclaim their belief in her future reappearance. Her sect continued to exist for many years, nor are we aware that it is yet extinct. Many of its followers wore long beards, and a peculiar costume.

SO'VEREIGN. In Politics, a person, or body of persons, in whom the legislative authority rests in every state. A sovereign state is one in which the jurisdiction of that person or body, within the limits of the state, is absolute and uncontrolled by any foreign authority. The states which composed the German empire were termed, in the language of politics, "mi-souveraines;" because their sovereignty was qualified by their subordination, in some respects, to the imperial authority. The same term should seem applicable to the several states in the American Union, which are commonly, but improperly, termed sovereign; as, on some definite subjects, the power of their legislative bodies is subordinate to that of congress, or the sovereign body in the federal government.

SOVEREIGN. An English coin of the value of twenty shillings, the standard weight of which is 5 pennyweights and 3·27 grains, or 123·374 troy grains.

SO'WING. Depositing seed in the soil for the purpose of producing plants. The operation of sowing is generally performed in spring, in order that the plants may have the advantage of the coming summer. The seed is either scattered abroad, or deposited in rows or drills: on a small scale by the hand, and on a large scale by a sowing machine. Some seeds which are of large size are planted singly. The covering of seeds is greater or less, according to their size and the texture of the soil. Where the soil is somewhat firm, and the seed is pressed into it by a roller or by other means, and where the climate is moist, very little covering is necessary; but where the soil is loose, and the climate dry and warm, the covering should be twice or thrice the thickness of seeds. As the seeds of plants are the natural food of birds, insects, and vermin, in a state of culture artificial protection is required from their natural enemies.

SOWING MACHINE. A machine for depositing seeds in the soil, either equally over its surface or in rows. The simplest machine, and perhaps the most efficient for sowing seeds broadcast, is a hollow cylinder, pierced with holes, about the average size of the seed to be sown. This will deposit them at a greater or lesser distance asunder, according to the velocity with which it is turned round. Machines for sowing seeds in rows are termed drills. See DRILLS.

SPA. A place celebrated for its mineral waters, situate about seven leagues from Aix-la-Chapelle. The term is now generally applied to places at which there are mineral springs.

SPACE (Lat. spatium), signifies generally extension in all directions. Sometimes it has a less general signification; thus Euclid says, two straight lines cannot inclose a space, that is, an area.

SPACE. In Music, the void between the lines in a musical staff. The spaces are four in number, and the lines five.

SPA'DIX. A form of inflorescence in which the flowers are arranged around a fleshy rachis, and enclosed within a kind of bract called a spathe, as in palms and araceous plants.

SPAHI'S, or SIPAHIS. A part of the Turkish cavalry were so called. The word has the same derivation with *Sepoy*.

SPAN, in ordinary language, signifies a measure taken from the space between the thumb and the middle finger, both being extended. In Architecture and Engineering, it is applied to the extent or spread of an arch between its piers or abutments.

SPA'NDREL. (It. spandere, *to spread.*) In Architecture, the space about the flanks or haunches of an arch or vault above the intrados, and not higher than its crown.

SPA'NKER, or DRIVER. The name of the gaff sail set on the mizzen mast of a ship.

SPA'NNER. An iron instrument used in the manner of a lever to tighten the nuts upon screws. There is usually a notch at either end of the spanner, to suit nuts and screw-heads of different sizes.

SPAR. (Germ. spath.) A mineralogical term, applied to certain crystallized substances which easily break into cubic or prismatic, or other fragments, with polished surfaces; hence also the term *spathose*, applied generally to minerals of a sparry fracture.

SPAR, FLUOR, or DERBYSHIRE. Fluoride of calcium. *See* FLUOR SPAR.

SPAR, HEAVY. Sulphate of baryta. *See* BARYTA.

SPAR, ICELAND. Rhomboidal carbonate of lime.

SPA'ROIDS, *Sparoides*. The name of a tribe of Acanthopterygian fishes, of which the genus *Sparus* is the type. The palate is edentulous, but the jaws are generally well armed with teeth: sometimes these are all of a conical form, adapted for killing and lacerating; sometimes they are all rounded and obtuse, fitted for bruising. In some species, the anterior teeth are shaped according to the laniary type, and the posterior ones are grinders; in others, the anterior teeth resemble the human incisors. The genera of Sparoid fishes are chiefly founded on these dental modifications.

SPA'RROW-HAWK. The name of the *Falco nisus* of Linnæus, *Accipiter fringillarius* of Ray; which latter name is retained in modern ornithology for the subgeneric denomination of this small Raptorial bird.

SPARS. In Architecture, a term used in the provinces to denote the common rafters of a roof, as distinguished from the principal rafters.

SPASM. (Gr. σπασμος, *a cramp.*) An involuntary contraction of the muscles, generally attended by pain.

SPATA'NGUS. (Gr. σπαταγγος, *a species of Echinus.*) The name of a genus of *Echinidæ*, or sea-urchins, having the mouth situated laterally, and but four rows of pores.

SPATHE. In Botany, a large and coloured bractea situated at the base of a spadix, enclosing the latter, and supposed to perform the office of corolla.

SPA'TULATE. (Lat. spathulum, *a broad knife to spread salve with.*) In Zoology, when a substance or part of an animal is flattened, and broader and rounder at the apex, narrow at the base.

SPEA'KER. The presiding officer in each house of parliament is so termed. The lord chancellor, keeper of the great seal, or other person holding the king's commission, is ex-officio speaker of the House of Lords; and if there be none such, it is said the house may elect. He can speak and vote on any question. The speaker of the House of Commons is chosen by the house. Formerly, it was customary (see *Hatsell's Precedents of Parliaments*, vol. ii.) that persons holding high offices under the crown should be elected to this dignity. The speaker chosen must be approved of by the crown. The speaker cannot speak or vote except in a committee, when he is out of the chair; or in case of an equality of voices, when he exercises the privilege of giving a casting vote. The office of the speaker of the House of Commons, in addition to keeping order and controlling the debates of the house, is to issue warrants to the clerk of the crown to make out new writs for the election of members when seats are vacant. This power he exercised only by virtue of orders of the House of Commons, until the passing of the stat. 10 G. 3. c. 41., by which he was enabled to issue the writs during a recess. *See* PARLIAMENT.

SPEA'KING TRUMPET. *See* TRUMPET.

SPE'CIALTY. In Law, any instrument in writing under seal. Specialty creditors are those who have their debts secured to them by deed, in opposition to creditors on simple contract. The advantages of the former security are, that it has priority in the distribution of assets; and that specialty debts in general are not presumed satisfied until after the lapse of twenty years, whereas simple contract debts are buried in six by the Statute of Limitations.

SPECIE. A term used for gold and silver coin, in contradistinction to *paper money*.

SPE'CIES. (Lat.) In Logic, a predicable which is considered as expressing the whole essence of the individuals of which it is affirmed. The essence of an individual is said to consist of two parts: 1. The material part, or genus; 2. The formal or distinctive part, or difference. The genus and difference together make up, in logical language, the species: *e. g.* a "biped" is compounded of the genus "animal," and the difference "having two legs." It is obvious that the names *species* and *genus* are merely relative; and that the same common terms may, in one case, be the species which is predicated of an individual, and in another case the individual of which a species is predicated: *e. g.* the individual, Cæsar, belongs to the species man; but man, again, may be said to belong to the species animal, &c., as we contemplate higher and more comprehensive terms. A species, in short, when predicated of individuals, stands in the same relation to them as the genus to the species; and when predicated of other lower species, it is then, in respect of these, a genus, while it is a species in respect of a higher genus. Such a term is called a subaltern species or genus; while the highest term of all, of which nothing can be predicated, is the "summum genus;" the lowest of all, which can be predicated of nothing, the "infima species." The difference which, together with the genus, makes up the species, is termed the "specific difference." *See* PREDICABLE, LOGIC.

SPECI'FIC. In Medicine, this term is applied to remedies the effects of which upon particular diseases are little liable to fallacy and uncertainty; hence cinchona is called a specific in certain forms of intermittent fever, and mercury in syphylis, &c. A *specific character* is that which peculiarly and certainly distinguishes one thing from another.

SPECIFIC GRAVITY. *See* GRAVITY.

SPE'CTACLES. An optical instrument, consisting of two lenses set in a frame, for assisting or correcting the defects of imperfect vision. The lenses are convex or concave, according to the nature of the defect to be remedied. In old age the pupil of the eye becomes flat, and the rays of light are consequently not refracted sufficiently in passing through it to meet on the retina and produce distinct vision. This defect is remedied by a convex lens, which produces a slight convergency of the rays before they enter the eye. Short-sighted people, on the contrary, require concave lenses; because, in their case, the indistinctness of vision proceeds from too great a curvature of the pupil, which causes the rays to meet in a point before they reach the retina, — a defect which is remedied by giving the rays a slight divergency before they enter the eye.

Spectacles appear to have been first used about the latter end of the 13th century; but the date and author of the invention are not certainly known, and have been much disputed. It seems most probable that the first hint of their construction and use was taken either from the writings of Alhazen, who lived in the 12th century, or of Roger Bacon, who died about 1292. A passage in the *Opus Majus* of the latter renders it certain, at least, that he was acquainted with the use of crystalline lenses in magnifying minute or distant objects. (See *Smith's Optics*, "Remarks," art. 8. 5—90.)

SPE'CTRES, *Spectra*. A name given by Stoll and Latreille to a family of Orthopterous insects, comprehending those which have a linear and attenuated body, like the ghost of an insect.

SPE'CTRUM. (Lat. spectrum, *image*.) In Optics, the name given to an elongated image of the sun or other luminous body, formed on a wall or screen by a beam of undecomposed light received through a small hole, and refracted by a prism. For the different colours and fixed lines of the solar spectrum, see CHROMATICS; and for the refrangibility of the different rays, REFRACTION.

SPE'CULUM. (Lat. speculum, *a mirror*.) In Optics, the term *speculum* is usually appropriated to reflectors formed of polished metal; while the term *mirror* is used to signify a reflector of glass. For the focal distances and laws of reflexion of spherical specula, see REFLEXION; and for a description of the method of casting and polishing large specula for reflecting telescopes, see Sir W. Herschel's Description of his Telescope in the *Phil. Trans.* for 1795; Brewster's edition of *Ferguson's Lectures;* and Lord Oxmantown's Account of Experiments on the Reflecting Telescope, in the *Phil. Trans.* for 1840.

SPE'CULUM METAL, with which mirrors for reflecting telescopes are made, is an alloy of two parts of copper and one of tin; its whiteness is improved by the addition of a little arsenic.

SPELL. (Ang. Sax. spel, *story* or *tale*.) Any form of words, written or spoken, supposed to be endowed with magical virtues. This superstition seems common to every race of man; but it was more peculiarly prevalent among the ancients. The lines of Horace —

> Sunt verba et voces, quibus hunc lenire dolorem
> Possis, &c. —

probably refer to the belief in the efficacy of magical words in alleviating pain and disease. There is an amusing article upon this subject in the *Encyclopædia Metropolitana*.

SPE'LTER. The commercial term for zinc.

SPERMACE'TI. This substance concretes or crystallizes spontaneously out of the oil of the spermaceti whale. It is purified first by pressure, then by fusion and boiling with a weak alkaline ley. When melted in masses, it concretes in crystalline plates of a silvery lustre and unctuous feel. It fuses at about 100°. It dissolves in boiling alcohol; and as the solution cools it separates in brilliant scales, to which Chevreul has given the name of *cetine*.

SPERMI'DIUM. (Gr. σπερμα, *a seed*.) A kind of small seed-vessel, resembling a seed, and more commonly called an *akenium*.

SPHA'CELUS. *See* GANGRENE.

SPHÆRISTE'RIUM. (Gr. σφαιρα, *a sphere or ball*.) In ancient Architecture, a circular court for playing tennis, or other exercises. *See* BALL.

SPHENE. Native silico-calcareous oxide of titanium.

SPHENO'ID BONE. (Gr. σφην, *a wedge*.) One of the bones of the head; so called from its being wedged in, as it were, amongst the other bones. It is of a most irregular shape, and very complicated in its processes and connections with the other bones. When removed, it is something of the figure of a bat with its wings extended. It is connected with all the bones of the skull, and with those of the palate, cheeks, and upper jaw.

SPHERE. (Gr. σφαιρα.) In Geometry, a solid body described by the revolution of a semicircle about its diameter; or it may be defined to be a body bounded by a surface of which every point is equally distant from a single point within the surface, called the centre of the sphere. If r denote the radius of the sphere, and x, y, z the rectangular co-ordinates, the origin being at the centre, the equation of the surface is $x^2 + y^2 + z^2 = r^2$.

The following are some of the principal properties of the sphere: — 1. The surface of the sphere is equal to four times the area of one of its *great circles;* i. e. of a section made by a plane passing through its centre. 2. The curve surface of any zone, or portion contained between two parallel planes, is equal to the curve surface of a cylinder of the same height with the height of the zone, or the distance between the planes, and of the same diameter with the sphere. Hence it follows that the whole surface of the sphere is equal to the curve surface of the circumscribing cylinder. 3. The solid content of a sphere is equal to that of a pyramid whose altitude is the radius, and whose base is equal to the surface of the sphere; and hence the content of the sphere is one third of the product of its radius into its surface. 4. The sphere is equal to two thirds of its circumscribing cylinder.

Let r denote the radius of the sphere, s its superficies, c its solid content, and π the ratio of the semicircumference to the radius $= 3{\cdot}14159$; then, since the area of a circle of which r is the radius is πr^2, the properties above stated give the relations which follow; viz.

$$\text{Surface} = s = 4\pi r^2 = 12{\cdot}56637 \times r^2,$$

$$\text{Content} = c = \tfrac{1}{3} r s = \tfrac{4}{3}\pi r^3 = 4{\cdot}18859 \times r^3.$$

If we suppose the diameter $= 1$, and consequently $r = \frac{1}{2}$, these relations become $s = \pi$, $c = \frac{1}{6}\pi$.

SPHERE. In Astronomy, the concave expanse of the heavens, which, having no definite limit, appears to the eye as the interior surface of a sphere enclosing the earth, which is placed at the centre. The ancients gave the name of sphere to the orbits of the several heavenly bodies; thus, the sphere of Jupiter, the sphere of Saturn, the sphere of the fixed stars. In the Ptolemaic astronomy, the different spheres were supposed to be solid and transparent, moving about their common centre independently of each other, and each carrying its appropriate body along with it.

SPHERE, in Geography, denotes a representation of the earth on the surface of a globe, which has also represented on it an assemblage of circles showing the positions of the equator, ecliptic, meridians, &c. The ancients gave different appellations to the sphere, according to the inclination of the earth's axis to the horizon. When the poles are in the horizon, it was called a *right sphere;* when the poles are in the zenith and nadir, a *parallel sphere;* and in every other position, an *oblique sphere.*

SPHE'RICAL. Relating to a sphere. Thus, a *spherical angle* is an angle formed on the surface of a sphere by the intersection of two great circles, or circles whose planes pass through the centre; and a *spherical triangle* is a triangle formed by the intersecting arcs of three such circles. For the properties of spherical triangles, see TRIGONOMETRY.

SPHE'RICAL EXCESS, in Trigonometry, is the sum by which the three angles of any triangle on the surface of a sphere or spheroid exceeds two right angles. Let the three angles of a spherical triangle be denoted respectively by A, B, C, and let E represent the spherical excess; then, by the above definition, $E = A + B + C - 180^{\circ}$. Now, in any spherical triangle the sum of the three angles is always greater than two and less than six right angles; consequently E may have any value not exceeding four right angles.

In Geodesy, the angles of each triangle are determined by instrumental measurement, and are consequently subject to the errors of observation. But in order to compute the sides of the triangle with the requisite accuracy, it is necessary that the amount of the error in the sum of the three angles be known; and it is therefore necessary to determine the spherical excess independently of extreme precision in the values of the angles. Let S denote the area of the triangle, r the radius of the sphere, and π the ratio of the circumference to the diameter ($= 3{\cdot}14159$); then, by trigonometry,

$$S = \frac{A + B + C - 180^{\circ}}{180^{\circ}} \times r^2 \pi;$$

whence, since $E = A + B + C - 180^{\circ}$, we have $E = \frac{S \times 180^{\circ}}{r^2 \pi}$ in degrees, or $E = \frac{S \times 648000''}{r^2 \pi}$, expressed in seconds. In any triangle that can be measured on the surface of the earth S is very small in comparison of r^2, and E is therefore a very small quantity, seldom amounting to more than five or six seconds (though, in some of the large triangles of the British survey, where the sides were nearly 100 miles in length, it amounted to upwards of 30''); and therefore an approximate knowledge of the value of S, and of the radius r, within the limits of any probable error, will suffice to give E correct to the 100th part of a second. Hence, for computing the value of E, the triangle may be considered a plane one, and the value of S computed from approximate values of two of its sides and the included angle. If, therefore, a and b denote the number of feet in the sides opposite the angles A and B respectively, we shall have $S = \frac{1}{2} a\, b \sin. C$; and if we also assume $m = 648000 \div 2\, r^2 \pi$ (where r is expressed in feet), the logarithm of E in seconds will be found from this formula,

$$\log. E = \log. a + \log. b + \log. \sin. C + \log. m.$$

For the middle of England, the radius of an arc intersecting the meridian at an angle of 45° is 20,941,000 feet, nearly. Assuming this to be the value of r, then $\log. m = 9{\cdot}62860$.

SPHE'RICS. In Geometry, the doctrine of the properties of the sphere considered as a geometrical body, and, in particular, of the different circles described on its surface. *See* TRIGONOMETRY.

SPHE'ROID. (Gr. σφαιρα, and ειδως, *form.*) In Geometry, a solid generated by the revolution of an ellipse about one of its axes. If the generating ellipse revolves about its major axis, the spheroid is *prolate*, or oblong; if about its minor axis, the spheroid is *oblate*.

Let $2\,a$ be the axis of revolution, and $2\,b$ the diameter of the generating ellipse perpendicular to the axis; then the origin of the co-ordinates being at the centre, and x being taken on the semi-axis a, the equation of the surface of the spheroid is

$$\frac{x^2}{a^2} + \frac{y^2 + z^2}{b^2} = 1.$$

Let k^2 denote the ratio of the difference of the squares of a and b to the square of a; that is, make $a^2 k^2 = a^2 - b^2$, and put $\pi = 3{\cdot}14159$: then the whole surface S of the spheroid is expressed by the following series, in which the upper signs are to be used if the spheroid is oblong (that is, if a is greater than b), and the under signs if the spheroid is oblate: viz.

$$S = \pi\, a\, b \left(1 \mp \frac{1}{2\cdot3} k - \frac{1}{2\cdot4\cdot5} k^2 \mp \frac{3}{2\cdot4\cdot6\cdot7} k^3 - \&c.\right)$$

The solid content of any spheroid, whether oblate or oblong, is equal to two thirds of its circumscribing cylinder, and is therefore equal to $\frac{4}{3}\pi\, a\, b^2$. And since the content of a sphere, of which the radius is equal to a, is $\frac{4}{3}\pi\, a^3$, it follows that the content of the spheroid is to the content of a sphere whose diameter is equal to the axis of revolution as $b^2 : a^2$.

The oblate spheroid being the figure assumed by the earth and the other planets, its properties are of great importance in astronomy and geodesy. Newton demonstrated that the attraction of a sphere on any exterior body is the same as if all the matter in the sphere were collected into a point at the centre; but this property does not hold true of spheroids, and the calculation of the effects of attraction is thereby rendered greatly more difficult. *See* GRAVITATION.

In geodetical operations, it is necessary to have regard to the curvature of the spheroidal surface of the earth. Supposing the elements of the spheroid (that is, the polar and equatorial axes) to be known, the curvature of the surface at any place of which the latitude is given is determined by the following formulæ:—

Let a be half the polar axis, b the radius of the equator, e the ellipticity, or a number such that $b = a\,(1 + e)$ (*see* ELLIPTICITY), and l the given latitude. Also, let r be the radius of curvature in the direction of the meridian, r' the radius of curvature in the direction perpendicular to the meridian, and R the radius of curvature of a normal section, making with the meridian an angle $= \theta$; then

$$r = a\,(1 - e + 3\,e \sin.^2 l) \;.\;.\;.\; (1.)$$

$$r' = a\,(1 + e + e \sin.^2 l) \;.\;.\;.\;.\; (2.)$$

$$R = \frac{r\, r'}{r \sin.^2 \theta + r' \cos.^2 \theta} \;.\;.\;.\;.\;.\; (3.)$$

Dividing the numerator and denominator of this last expression by r', substituting $1 - \sin.^2 \theta$ for $\cos.^2 \theta$, and converting the result into a series, of which it is sufficient to retain only the two first terms, we obtain the following, which is more convenient for calculation,

$$R = r\left(1 + \frac{r' - r}{r'} \sin.^2 \theta\right)$$

SPHERO'METER. (Gr. σφαιρα, and μετρον, *measure.*) In Physics, an instrument for measuring with great precision the thickness of small bodies, the curvature of optical glasses, &c.

SPHE'RULITE. A term applied by some mineralogists to a variety of obsidian or pearlstone, which occurs in rounded grains.

SPHIGMO'METER. (Gr. σφιγμος, *the pulse.*) An instrument for counting the arterial pulsations.

SPHI'NCTER. (Gr. σφιγχω, *I close.*) A term applied by anatomists to several muscles which close or contract the orifices which they surround.

SPHINX. A fabled monster, half woman and half lion, said by the Grecian poets to have infested the city of Thebes, devouring its inhabitants till such time as a riddle it had proposed to them should be solved. This was done by Œdipus, who slew the sphinx, and was, by the gratitude of the Thebans, chosen their king. The Grecian sphinx was probably borrowed from Egypt; where the enormous figure, now half buried in the sand, was probably the archetype of the more elegant monster of Greece. This figure is close to the Pyramids of Ghizeh, and was disinterred by the late Mr. Belzoni, but has been again nearly covered. It has been said (on the authority of Pliny) that the sphinx represented the Nile in a state of flood; that event regularly occurring under the signs of the Virgin and Lion. But others contend that the original Egyptian sphinx was male (Androsphinx), like the specimen described by Herodotus, book ii. (*Wilkinson's Ancient Egyptians.*) But the greater part of the enormous number around the temples of Luxor (1500 in a single avenue) are said to be female. (*Libr. of Entertaining Knowledge.*) Sphinxes are also represented with the heads of rams and hawks (Criosphinx, Hieraco-sphinx). The Egyptian sphinx had no wings; these appendages were added by the Greek artists.

SPHRAGI'STICS. (Gr. σφραγις, *a seal.*) The science of seals, their history, peculiarities, and distinctions, especially with a view to the means which they afford of ascertaining the age and genuineness of documents to which they are affixed. Ancient seals were chiefly impressed on common wax of different colours; sealing-wax came into use in the sixteenth century. This branch of diplomatics owes its origin to Heineccius, who

published a work on the subject in 1709. Gercken's treatise, styled *Anmerkungen über die Siegel zum Nutzen der Diplomatik* (Augsburg, 1781), will be found a useful guide.

SPICCA'TO. (It. *divided.*) In Music, a term indicating that every note is to have its distinct sound. When used in relation to instruments played with a bow, it is to be understood that every note is to have a bow distinct from the preceding or succeeding one.

SPI'DER. *See* ARACHNIDÆ.

SPIKE. In Botany, a form of inflorescence in which all the flowers are sessile along a common axis, as in *Plantago*.

SPI'NDLE. In Geometry, a solid generated by the revolution of a curve line about its base or double ordinate. The solid generated by the revolution of a curve about its axis is called a *conoid*. In Mechanics, *spindle* denotes the axis of a wheel or roller.

SPINE. *See* VERTEBRÆ.

SPINE'L. (Fr. spinelle.) A subspecies of the ruby. It is of various colours, such as red, brown, yellow, and sometimes blue; its colouring matter is sometimes oxide of chromium, but generally oxide of iron. It usually contains from 80 to 84 per cent. of alumina, and from 8 to 10 of magnesia.

SPINELLA'NE. A term applied by some mineralogists to a dodecaëdral variety of zeolite of a blueish or brownish colour, found near Andernach on the Rhine. Its essential components are silica, alumina, and soda.

SPINES. Branches that, being imperfectly formed, lose their power of extension, become unusually hard, and acquire a sharp point. They are very different from aculei, or prickles, which are a kind of hardened hair. In leaves, they are processes formed either by an elongation of the woody tissue of the veins, or by a contraction of the parenchyma: in the former case, they project beyond the surface or margin of the leaf, as in the holly; in the latter case, they are the veins themselves become indurated, as in the palmated spines of *Berberis vulgaris*.

SPINE'T. A musical stringed instrument with a key-board, &c., similar in construction to a harpsichord; from which, indeed, it little differs, except in being much smaller. Its general form is that of the harp, and it was originally called the *couched harp*.

SPI'NNERS, or SPINNERETS. In Entomology, organs with which insects form their silk or webs. In spiders they consist of two retractile pieces issuing from anal protuberances, and giving out the threads.

SPINNING. *See* COTTON MANUFACTURE.

SPINNING JENNY. *See* COTTON MANUFACTURE.

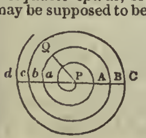
SPINO'SISM. In Philosophy, the system of Benedict Spinosa, a Jew of Amsterdam, born in 1634, which is developed in his work on ethics. In it he deduces by strictly mathematical reasoning, from a few axioms, the well-known principles, that "there can be no substance but God; whatever is is in God, and nothing can be conceived without God." Hence his scheme is called with justice Pantheistic. In fact, as Mr. Hallam observes, "he does not essentially differ from the Pantheists of old. He conceived, as they had done, that the infinity of God required the exclusion of all other substance; that he was infinite *ab omni parte*, and not only in certain senses." "It was one great error of Spinosa," says the same writer, "to entertain too arrogant a notion of the human faculties; in which, by dint of his own subtle demonstrations, he pretended to show a capacity of adequately comprehending the nature of what he denominated God. And this was accompanied by a rigid dogmatism, no one proposition being stated with hesitation; by a disregard of experience, at least as the basis of reasoning; and by a uniform preference of the synthetic mode." (*Literature of Europe*, vol. iv. p. 243. &c.; and see *Brucker's History of Philosophy*, vol. iii.; *Stewart's Introductory Essay to the Encyclopædia Britannica*.)

SPI'NTHERE. A mineral of a greenish grey colour, found in the department of the Isere in France.

SPI'RACLES, or SPIRACULA. (Lat. spiro, *I breathe*.) In Entomology, the breathing pores of insects are so called.

SPIRAL. In Geometry, the name given to a class of curves distinguished by this general property, that they continually recede from a centre or pole, while they continue to revolve about it. Spirals receive different names from the properties by which they are characterized, or from their inventors; thus, the *equable spiral*, the *hyperbolic spiral*, the *logarithmic spiral*, the *spirals of Cotes*, &c.

Equable spiral, or *spiral of Archimedes*. This curve may be supposed to be generated as follows:—If a straight line P A B C turn uniformly about its extremity P, a point in the straight line which advances from P with a uniform motion and arrives successively at *a*, A, *b*, B, *c*, C, *d*, will describe the spiral. The point P is called the pole, and the portion of the revolving line intercepted between the pole and any point of the curve is the *radiant*, or radius vector at that point. Let Q be a point in the spiral, make the radiant P Q $= u$, and let θ be the angle described by the revolving line while the travelling point advances from P to Q; then, since from the definition the radiant u and the angle θ are both proportional to the time, they are proportional to each other; and the polar equation of the equable spiral is $u = a\,\theta$, where a is a constant. If we suppose $u = r$ when the revolving line has made a complete revolution, or when $\theta = 2\pi$; then $a = r \div 2\pi$, and the equation becomes $u = \frac{r}{2\pi}\,\theta$.



Some of the principal properties of this spiral are the following:—1. The area of the spiral P a A b Q is equal to $\frac{u^3}{6a} = \frac{\pi u^3}{3r}$. If $u = r$, this becomes $\frac{1}{3}\pi r^2$; or the area generated while the revolving line makes one revolution, is equal to a third of a circle whose radius is r. If $u = 2r$, the expression for the area becomes $\frac{2}{3}\pi (2r)^2$; and the spiral area is therefore the third part of a space that is double of a circle described with a radius $= 2r$. And generally the whole area generated by the radiant, from the beginning of the motion till after any number of revolutions, is equal to the third part of a space which is the same multiple of the circle whose radius is equal to the greatest radiant as the number of revolutions is of unit. 2. The arc of the spiral between its origin and the radiant u is equal to that of a parabola whose *latus rectum* is $2a$ included between the vertex and an ordinate $= u$, and the corresponding area of the spiral is equal to one half the corresponding area of the parabola. 3. The subtangent to any point Q of the spiral is equal to the arc of a circle described by the radiant P Q; and hence at the termination of the first, second, third, fourth, &c. revolutions, the corresponding subtangents are as the series of square numbers, 1, 4, 9, 16, &c.; for the second, third, fourth, &c. the subtangents are equal to 2, 3, 4, &c. circumferences, whose radii are at the same time doubled, tripled, quadrupled, &c.

The equable spiral was proposed by Conon to Archimedes, who, in his treatise Περι Ελιχων, has investigated its quadrature, and some of its chief properties.

The *hyperbolic spiral* belongs to a class of spirals of which the general equation is $u = a\,\theta^{-n}$. If we suppose $n = 1$, we have $u = a\,\theta^{-1}$, or $u\,\theta = a$, which is the equation of the hyperbolic spiral; and from which it follows, that if from a point in a straight line, given by position, arcs be described of a given length, and having each one extremity in the given straight line, the locus of their other extremities will be in the spiral.

This curve was proposed by James Bernoulli, and has been called the hyperbolic spiral, from the analogy between its polar equation and the equation to rectangular co-ordinates of the common hyperbola, when referred to its asymptotes; namely, $x\,y = $ A, a constant area.

The *logarithmic spiral* differs from the equable spiral in this respect, that the point which describes the curve, instead of advancing equably along the uniformly revolving straight line, is carried along it with a velocity increasing in proportion to the distance from the centre. This curve, which was noticed by Des Cartes, has many remarkable properties, of which the more abstruse were investigated by James Bernoulli. *See* LOGARITHMIC SPIRAL.

For the investigation of the properties of spirals, see *Leslie's Geometrical Analysis; Peacock's Examples of the Differential and Integral Calculus; Maclaurin's Fluxions*, &c.

SPI'RAL VESSELS, in Plants, are membranous tubes with conical extremities, lined in the inside by a fibre twisted spirally, and capable of unrolling with elasticity; their function is that of the conveyance of air. They are found in almost any part of plants except the bark; but are most abundant in leaves and flowers, and least common in the stem and root, except in the medullary sheath of the former.

SPIRE. (Gr. σπειρα, *a twisting*.) In Architecture, among the ancients, the base of a column: also the astragal or torus of the base. In modern architecture, it is an erection above the tower of a church, which diminishes gradually as it rises; sometimes rising in the form of a plain slender pyramid, polygonal on the plane.

SPI'RIFER. The name of a genus of extinct Palliobranchiate mollusks, characterized by the shell having two internal calcareous spiral appendages.

SPI'RIT OF WINE. *See* ALCOHOL and FERMENTATION.

SPI'RITO, SPIRITO'SO (It. *spirit, with spirit*), in Music, denotes, when affixed to a movement, that it is to be performed in a spirited manner.

SPI'RITS. All inflammable liquors obtained by distillation, as brandy, rum, geneva, whisky, &c., are comprised under this designation. The manufacture of spirits is placed under the surveillance of the excise, and a very large revenue is obtained from it. The following statis-

tical accounts relative to spirits, &c., for the year ending Jan. 5. 1841, are extracted from a return laid before the House of Commons: — 1. It appears that during that period the total gallons of proof spirits distilled in the United Kingdom, and produced from malt and from a mixture of malt with unmalted grain, amounted to 22,021,394 gallons, of which 5,918,435 gallons were distilled in England, 8,821,530 gallons in Scotland, and 7,281,449 gallons in Ireland. 2. The total gallons of proof spirits on which duty was paid for consumption in the United Kingdom amounted to 21,859,337 gallons; the total amount of duty paid thereon having been 5,208,040*l*. Of these 21,859,337 gallons, there were 8,278,148 on which duty was paid for home consumption in England, 6,180,338 in Scotland, and 7,404,051 in Ireland. 3. The total number of gallons of proof spirits (made from various grain, &c.), imported into England from Scotland, was 2,056,640; into England from Ireland, 370,441; into Ireland from Scotland, 762,358; and into Scotland from Ireland, 6459; the gross total amount of duty paid upon all which was 1,028,294*l*. 4. The total number of gallons of proof spirits permitted out from distillers' stocks in England amounted to 5,864,950; and the total number of gallons proof of British brandy and spirits of wine, permitted out from rectifiers' stocks in England, was as follows, viz. British brandy 308,063 gallons, and spirits of wine 236,007 gallons. 5. The total number of proof gallons of foreign spirits (including rum, brandy, geneva, &c.) which paid duty in the United Kingdom, amounted altogether to 3,644,410; the net amount of duty paid upon which was 2,440,942*l*. Of this duty, England paid 2,352,550*l*., Scotland 66,134*l*., and Ireland 22,258*l*. If to the above quantities there be added the spirits of the manufacture of the United Kingdom, and of Jersey and Guernsey, the gross total number of gallons of spirits of all kinds that paid duty in the year 1840-41 will amount to 25,517,326, and the net amount of such duty to 7,654,233*l*. (For full particulars as to the operation of the duties upon spirits, see the *Com. Dict.*) *See* DISTILLATION.

SPI'RITUALISM, as distinguished from *Materialism*. That system according to which all that is real is spirit, soul, or self; that which is called the external world being either a succession of notions impressed on the mind by the Deity, or else the mere educt of the mind itself. The first is the spiritualism of Berkeley; the second, which may be called pure egoism, that of Fichte.

SPI'RULIDÆ. The name of a family of Dibranchiate Cephalopods, of which the genus *Spirula* is the type. They are chiefly characterized by having a spiral discoid chambered shell developed in the substance of the mantle, instead of a calcareous or horny plate.

SPLANCHNO'LOGY. (Gr. σπλαγνον, *an entrail*, and λογος, *a discourse*.) The doctrine of the viscera.

SPLAYED. (*Displayed, spread out.*) In Architecture, a term used to denote an angle which is cut off, or oblique.

SPLEEN. A spongy viscus, of an oval form, the use of which is unknown; placed in the human subject in the left hypochondrium, between the eleventh and twelfth false ribs. *Spleen* is also used for a species of hypochondriasis to which the English are said to be particularly open.

SPLENI'TIS. Inflammation of the spleen.

SPLE'NIUS. A flat muscle, situated between the back of the ear and the lower and posterior part of the neck.

SPLENT COAL. An inferior kind of cannel coal from the Scotch collieries.

SPLICE. In Naval language, to join the end of a rope with the end or bight of another, by untwisting the strands of both and laying them up again involved.

To *splice the main brace*, a term applied to an extra allowance of spirits in cases of cold or wet.

SPLINT. A piece of wood or pasteboard, so shaped as to support a broken or debilitated limb.

SPLINTERY. That fracture of minerals which is nearly even, but exhibits small splinters or scales thicker at one extremity than the other, and adhering by their thicker ends to the broken surface.

SPO'DUMENE. A mineral found in laminated masses, hard, brittle, translucent, and of various shades of green or grey. It was first discovered at Utoë, in Sweden. It consists of silica and alumina, with 8 to 10 per cent. of lithia. Before the blowpipe, it exfoliates into little scales of an ash colour: hence its name, from σποδυω, *to reduce to ashes*. It is also called *triphane*.

SPOLIA'TION, WRIT OF, in English Law, is obtained by one of the parties to a suit in the ecclesiastical courts suggesting that his adversary has wasted the fruits of a benefice, or received them to his prejudice. The suit founded on this writ lies for one incumbent against another, where they both claim by one patron, and the right of patronage is not in question.

SPO'NDEE. (Gr. σπονδη, *a libation.*) In Greek and Latin Poetry, the name of a foot consisting of two long syllables. It was so called because it was originally employed in the hymns sung in honour of the gods during the offering up of a sacrifice, for which it was admirably fitted from its grave structure. *Spondaic verse* is an hexameter line, in which the two last feet are spondees; instead of the usual termination, a dactylus and a spondee.

SPO'NDYLUS. (Lat. spondylus, *a spindle* or *shell fish*.) The name of a Linnæan genus of the Vermes Testacea, comprehending the spring oysters; characterized by having a strong tooth on each side of the depression lodging the elastic ligament of the hinge of the shell. The genus is included in the Ostracean family of the Acephalous Testacea by Cuvier, and has been subdivided by Lamarck into the genera *Spondylus* proper and *Plicatula*. Some of the species of *Spondylus*, as the water-clam (*Sp. varius*), form a series of chambers by secreting successive layers of nacreous shell at a distance from each other, the last chamber containing a quantity of fluid, which escapes by very slow evaporation through the pores of the calcareous shell.

SPONGE (Fr. eponge, Germ. schwamm), is a cellular fibrous tissue produced by small animals, almost imperceptible, called Polypi by naturalists, which live in the sea. This tissue is said to be covered in its recent state with a kind of semifluid thin coat of animal jelly, susceptible of a slight contraction or trembling on being touched; which is the only symptom of vitality displayed by the sponge. After death this jelly disappears, and leaves merely the sponge; formed by the combination of a multitude of small capillary tubes, capable of receiving water in their interior, and of becoming thereby distended. Sponges occur attached to stones at the bottom of the sea, and abound particularly upon the shores of the islands in the Grecian Archipelago. Although analogous in their origin to coral, sponges are quite different in their nature; the former being composed almost entirely of carbonate of lime; while the latter are formed of the same elements as animal matters, and afford on distillation a considerable quantity of ammonia.

Dilute sulphuric acid has been recommended for bleaching sponges, after the calcareous impurities have been removed by muriatic acid. Chlorine water answers better.

The sponges of commerce are usually prepared before they come to the market, by being beaten and soaked in dilute muriatic acid with a view to bleach them, and to dissolve any adherent portions of carbonate of lime. Three kinds are found commonly in the market, and known as the Turkey; the variety of the same, which is very rare; and the West Indian. On examining the living sponge of commerce with a power of about 500 linear, the fleshy matter will be distinctly observed, having in its interior gemmæ, which are considered to be the young. These are occasionally given off from the mass of living matter. The greater portion of the mass of sponge consists of small cylindrical threads or fibres, various in size. The spiculæ are not found within these, but in the large and flattened fibres, and varying in number from one to three or more, imbedded in their substance. Sometimes one spiculum projects a half or more from the side of the fibre, and is then only covered with the animal matter at the base, or half way up. The fibres of the West Indian species of sponge have been clearly proved to be solid. In the rare variety of Turkey sponge, the fibres are possessed of vessels which anastomose in various directions, differing much in size, and not imbedded in horny fibre, but in a separate sheath. This true vascular tissue performs very important functions in the economy of the animal during life. In some of the tubes of sponge have been observed small globules, the largest of which measured the 1666th of an inch, and the smallest the 50,000th of an inch. They were accidentally perceived to move from right to left. (See a Paper read by Mr. Bowerbank at a meeting of the Microscopical Society in 1841.)

SPONGE TENT, is formed by dipping sponge into hot melted wax plaister, and pressing it till cold between two iron plates: it is then cut into pieces, and used for dilating wounds.

SPO'NGIÆ. The name of a class of aquatic Zoophites composed of the different genera and species of sponge.

SPO'NGIOLE. In Botany, the lax cellular tissue and mucus situated at the extremities of roots, having the property of absorbing fluid like a sponge; whence the name.

SPO'NSIONS. In International Law, acts and engagements made on behalf of states by agents not specially authorized, or exceeding the limits of the authority under which they purport to be made, are so called by writers on this branch of jurisprudence. Such conventions must be confirmed by express or tacit ratification; the latter of which is implied from the fact of acting under it as if bound by its stipulations; but mere silence is not, in general, held equivalent to ratification. Such are the official acts of admirals and generals suspending or limiting hostilities, capitulations of surrender, cartels of exchange, &c. (See Grotius, *De Jure Bel. et Pac.* lib. iii.;

Vattel, liv. ii.; Wheaton, *On International Law*, vol. i. p. 291.)

SPO'NSORS. In the Roman Catholic, Greek, Lutheran, and Calvinistic Churches on the Continent, and in the Church of England, the name given to the parties who at the baptism of infants make a profession of the Christian faith in their name, and guarantee their religious education. (See *Neander's Church History*, vol. i. part 2.) In the Presbyterian Church, baptism is administered without sponsors.

SPOO'NDRIFT. The light spray blown off the waves in a violent wind.

SPO'RADIC. (Gr. σπειρω, *I sow.*) A term applied to such diseases as attack a few persons at a time.

SPORANGI'UM. (Gr. σπορα, *a seed*, and αγγειον, *a vessel.*) The case in which the reproductive matter of ferns, mosses, and many other Cryptogamic plants is enclosed. Sporangiolum is the same part, when so small as to be microscopic.

SPORI'DIA. (Gr. σπορα, and ειδος, *form.*) A term used in describing Algæ and Characeæ, to denote the granules which resemble sporules, but which are of a doubtful nature. Also in describing Fungi, to indicate the immediate covering of the sporules.

SPORIDIO'LA. The sporules or reproductive granules of Fungi.

SPO'RTUM, SPORTULA. In Roman Antiquities. It was an ancient usage in Rome for rich men to distribute victuals on certain occasions among their poor clients, each of whom attended for the purpose with a wicker basket (sportum). Afterwards this dole was generally commuted for money; and the sum thus distributed, about 100 quadrantes, or eighteen pence English, was called *sportula*.

SPO'RULES, or SPORES. (Gr. σπορα, *a seed.*) The reproductive bodies of Asexual or Cryptogamic plants; differing from seeds in not being generated by impregnation, and in having no definite and predetermined points of growth, but springing forth into young plants from any part of their surface.

SPOTS ON THE SUN. *See* SUN.

SPRING. In Astronomy, one of the four seasons of the year. For the northern hemisphere, the spring season begins when the sun enters Aries, the first of the northern signs, or about the 21st of March, and ends at the time of the summer solstice. *See* SEASONS.

SPRING. In Mechanics, a piece of mechanism, formed of tempered steel or some other elastic substance, applied mostly for the purposes of producing resistance, or of preventing a shock from the collision of hard bodies, or of giving motion to mechanism by its effort to unbend itself. For the law of the force exerted by a spring, see ELASTIC CURVE.

SPRING. In Natural History. *See* FOUNTAIN.

SPRING. In Naval language, a rope or hawser by which a ship is held at one part, as the bow or quarter, in order to keep her in a particular position, or to turn her in a short compass.

SPRINGING. In Architecture, the lower part of an arch; or that part from which it rises.

SPRING TIDES. The tides at the times of the new and full moon. At these times the sun and moon are in a straight line with the earth, and their joint effect in raising the waters of the ocean is a maximum, and the tides are consequently the highest. *See* TIDES.

SPRIT SAIL. This is generally a four-cornered fore-and-aft sail, supported diagonally by a piece of wood called the sprit. Ships formerly carried sails on their sprit-sail yards.

SQUA'DRON, in Military affairs, signifies a body of cavalry, averaging from one to two hundred men. In naval matters, it is applied to a detachment of ships employed on a particular expedition.

SQUALL. The Sea term for a gust of wind, or for a short temporary increase in the force of the wind.

SQUA'MA. (Lat. *a scale.*) The bracteæ of an amentum; also used occasionally for any kind of bracted or rudimentary leaf which has a scaly appearance.

SQUA'MMIPENNES. (Lat. squama; penna, *a fin.*) The name of a family of Acanthopterygious fishes, comprising those which have the dorsal and anal fins covered with scales.

SQUA'MOUS. (Lat. squama, *a scale.*) In Zoology, when a surface is covered with small scales.

SQUARE. In Geometry, a four-sided rectilineal figure, of which all the angles are right angles, and all the sides equal

SQUARE MEASURES. The squares of the lineal measures. *See* MEASURE.

SQUARE NUMBER, in Arithmetic, is the product of a number multiplied by itself. Thus, the squares of the natural numbers, 1, 2, 3, 4, 5, &c., are respectively, 1, 4, 9, 16, 25, &c. The square numbers are the first series of figurate numbers derived from the progression 1, 3, 5, 7, 9, &c., in which the common difference of the terms is 2. (*See* FIGURATE NUMBERS.) Among the properties of square numbers the following may be mentioned:—Every odd square number is of the form $8n+1$, or when divided by 8 leaves 1 for the remainder. Every even square number is of the form $4n$, or is divisible by 4. Every square number ends with one or other of the following digits, 0, 1, 4, 5, 6, 9. No number of the form $2m^2+3n^2$ can be a square.

SQUARE-RIGGED. The term for a vessel carrying *square sails*, which are extended by yards suspended horizontally, or slung by the middle.

SQUARE ROOT. In Arithmetic, the square root of any number is the number which being multiplied into itself produces the given number. Thus 12 is the square root of 144, $\frac{1}{3}$ is the square root of $\frac{1}{9}$, and ·05 the square root of ·0025. When the given number is not an exact square, the root may be found to any degree of approximation by the process for extracting the square root, which is taught in every book of common arithmetic. *See* QUADRATIC EQUATION.

SQUILL. The root of the *Scilla maritima*. Squills are imported from the Levant; they have a nauseously bitter and very acrid flavour, and are generally cut into slices and dried for pharmaceutical uses. There are two varieties, the red and the white; which, however, do not appear to differ materially in composition. In large doses squill is purgative and emetic; but it is chiefly employed in smaller doses as a powerful expectorant, and as a diuretic in combination with other remedies. Half an ounce of oxymel of squills is sometimes prescribed as an emetic in cases where the bronchiæ are much loaded with viscid mucus, and in the chronic coughs of old people.

STA'BAT MATER DOLOROSA. The first words of a celebrated Latin hymn of the church, in rhymed lines of eight syllables without metre; said to have been composed by a Franciscan monk named Jacopone, in the 14th century. It has been set to music by nearly all the greatest composers; but the best known of all their compositions is that of Pergolesi, commenced by him when nearly on his deathbed, and finished by another hand. The stabat mater is performed in the ecclesiastical services of the Roman church during Holy Week.

STACCA'TO. (It. *separated.*) In Music, a term denoting that the notes to which it is affixed are to be detached in a striking way from each other, being much like *spiccato*, which see.

STACK. Corn in the sheaf piled up in a circular or rectangular figure, brought to a point or ridge at top, and afterwards thatched to protect it from the influence of the weather, and more especially from rains. The term is also sometimes applied to hay piled up in the same manner; which, however, in most places, is called a *rick*. The foundation of a corn stack is commonly made on a platform of wood or iron, raised on props to protect it from the moisture of the soil, and also from rats and mice; in which respect stacks of corn differ from ricks of hay, which are built always on the ground.

STA'DIUM. (Gr. σταδιον.) A measure of length in use among the ancient Greeks and some other nations, the precise value of which is unknown; though there are some data from which a rough approximation to its value may be made. The most ancient measurement of an arc of the terrestrial meridian is that of Eratosthenes, and the result gave the length of the circumference of a great circle = 250,000 stadia. But the circumference of the earth's equator is known to be nearly 25,000 English miles; whence, supposing the measurement of Eratosthenes to be correct, a stadium is the tenth part of an English mile. Posidonius found by another measurement the circumference of the earth to be 240,000 stadia: on the same supposition of an accurate determination, this gives about $9\frac{1}{2}$ stadia to the English mile. But it is to be remarked, that little dependence can be placed on these ancient measurements; for Ptolemy estimated the circumference of the earth at 180,000 stadia, which is only 3-4ths of the result found by Posidonius. The stadium is, however, supposed to have been different at different places. (See Paucton, *Metrologie;* also the *Quarterly Review*, No. 5.) The best account of the stadium, and the ancient mode of measuring distances, is to be collected from the various memoirs of Danville, in the *Mém. de l'Acad. des Inscr.* vols. xxiv. xxviii. xxxvi.; and *Histoire de l'Acad.* vols. xxvii. xxxi.

STADIUM. In Ancient Architecture, an open area used for exercises by the Grecian youth. With the Romans it was much in the form of the circi, but most of the Grecian stadia were enclosed by merely an earthen mound. Vitruvius informs us that its length was much greater than its breadth; the lists were formed by a bank or terrace. Though the stadium mostly formed part of a gymnasium, it sometimes formed a separate structure, and was built at great cost and with considerable elegance; witness that on the Corinthian Isthmus mentioned by Pausanias, as well as that of Herodis Atticus at Athens, which was of large dimensions, and constructed of Pentelican marble. Besides this, mention is made by that author of several others.

STA'DTHOLDER. (Dut. stadhouder, *city-holder.*) The name formerly given to the commander-in-chief of the military forces in the republic of the United Netherlands. William I. Prince of Orange had been made governor or stadtholder of the three provinces of Holland, Zealand, and Utrecht; and during the war of Independence, he was continued in that office by the goodwill of those provinces. After his death the Earl of Leicester was declared stadtholder by the States General; while some of the separate provinces appointed Prince Maurice, son of their former governor. For a century and a half afterwards the office was conferred and withdrawn by the several provinces at many different times, although always confined to members of the house of Orange. William IV. Prince of Orange, in 1747, was the first general hereditary stadtholder; in 1794, the office ceased in the French conquest; in 1814, the present head of the house of Orange (who recently abdicated in favour of his son) was raised to the throne by the title of King William I. The power of the stadtholder varied in different provinces, and at different periods.

STAFF. In Music, the five lines and spaces between them on which music is written.

STAFF. In Architecture. *See* RUDENTURE.

STAFF. In Military affairs, those officers attached to the commander of an army to assist him in carrying his plans into execution. They consist of a quartermaster-general, adjutant-general, majors of brigade, &c. The importance of the judicious selection of a staff is ably demonstrated in the preface to *James's Military Dictionary.*

STAFF ANGLE. In Architecture, a square rod of wood standing flush with the wall on each of its sides, at the external angles of plastering on the inside of apartments, to prevent the angles thereof being broken or damaged.

STAIRS. In Architecture, steps for ascending from the lower to the upper part of a house. When these are enclosed with walls or balustrades, with landing-places for communication between the several stories of a building, the whole is called a staircase. Vitruvius makes no mention of staircases in his Treatise on Architecture; and indeed with the ancients they formed no feature in the interior, being generally on the outside of the houses. Those of which traces remain are narrow, and so inconvenient that in some cases the steps are a foot in height. In modern architecture, they are often constructed with great display of skill and magnificence, and are no small test of the skill and power of the architect. Those stairs which proceed in a right line of ascent are called *fliers;* when they wind round a solid or open *newel* they are called *winders. Mixed stairs* are such as partly wind and partly fly.

STALA'CTITES. Conical concretions of carbonate of lime attached to the roofs of calcareous caverns, and formed by the gradual dropping of water holding the carbonate in solution: from *σταλασσω, I drop.*

STALA'GMITE. Stalactical formations of carbonate of lime, found upon the floors of calcareous caverns.

STALK. In Architecture, an ornament resembling a stalk in the Corinthian capital, from which the volutes and helices spring. It is sometimes fluted.

STALL. In Architecture, a seat raised on the sides of the choir or chancel of a church, mostly appropriated to a dignitary of a cathedral or collegiate church. Sometimes stalls are placed near the high altar, for the priest and deacon or subdeacon to rest whilst the service in certain parts is carried on by the choristers. In churches of the kinds named there is generally a series of them. At St. George's Chapel, Windsor, a stall is appropriated to every Knight of the Garter after his election and installation.

STA'LLAGE. In Law, a duty paid for the liberty of setting up moveable stalls or tables, or the like, in a fair or market; due to the owner of the soil as such, to set up stalls without whose licence is trespass. When the stalls are fixed into the ground, the duty is termed *pickage.*

STALL-FEEDING. Cattle kept in stables, and tied up separately, which have their food brought to them, are said to be stall-fed. The advantages of this mode of fattening cattle are very great, both to the farmer or feeder and to the public; because much less food is wasted, and a much greater quantity of manure is produced. The disadvantages are, that more manual labour is required for cutting and carrying the food from the field to the stable; and that the flesh of the animals, for want of exercise in the latter, is not considered so wholesome or high-flavoured as that of cattle which have pastured at large. To remedy this defect of stall-feeding, the most enlightened farmers, instead of rendering their cattle fixtures by tying them up to stakes, put two or three together in small yards, with a shed at one end, in which they can take exercise, shelter, or repose, according to their inclination. By this mode an equal quantity of manure is produced with less labour, and the flesh of the cattle is reckoned wholesome. When herbage plants or grasses are cut over only two or three times in the course of a season, instead of being continually cropped by the bite of cattle during the whole summer, the amount of vegetable produce is found to be much greater, because the plant while growing perfects a sufficient number of leaves to nourish the root; and when this produce is given to cattle in racks, in stables, sheds, or small courts, much less of it is wasted than if it were eaten on the spot where it grew. Hence any given surface of cultivated land will produce a much greater quantity of butcher meat under crops to be mown than under herbage to be pastured; and stall-feeding, therefore, is one of the greatest modern improvements that has been introduced into husbandry. There can be little doubt that, with the progress of rural improvement, it will ultimately become universal; and then, and not till then, will the butcher meat of warm climates be equal to that of such climates as that of Britain. In warm climates, at present, cattle cannot be fattened by pasturing.

STA'MENS. (Lat.) The male apparatus of a flower. They are situated immediately within the petals, and consist each of a filament, the anther, and the pollen; of which the two latter are essential, and the former not. They are a modified form of the petal, and are placed next it on the inside next the centre of a flower. Independently of their physiological importance, they are much used as good marks of discrimination in systematical botany.

STAMINI'DIA. (Lat. stamen.) Those bodies which are supposed to be, in *Hepaticæ*, and other Cryptogamic plants, the equivalent of anthers in more perfect plants.

STAMP DUTIES. Duties imposed on pieces of parchment and paper on which many species of legal instruments are written; on newspapers, advertisements, cards, dice, &c. The stamp duties have been consolidated and altered by a great variety of acts of parliament; and by 4 & 5 W. 4. c. 60. the boards of stamps and taxes are united into a single one.

The manner in which the stamp duties on legal instruments are chiefly secured is by prohibiting the reception of them in evidence, unless they bear the stamp required by the law. Should the instrument, after being stamped and executed, be altered, a restamping will in certain cases be requisite: thus, a mere mistake may be altered without a stamp; but any change in the terms of a contract, or any fresh conveyance by indorsement on a former one, requires a fresh stamp. The objection to an instrument arising from the want of a stamp must be taken at the trial before the instrument is read; but it is sufficient for the purpose of evidence that the instrument when produced on the trial should be properly stamped, although it may not have been stamped when it was executed; except in cases where the commissioners of stamps are prohibited, by express enactment, from affixing in this manner a subsequent stamp. When an instrument has been lost, and it is proposed to give secondary evidence of its contents, it is necessary first to give evidence that it was duly stamped; but this fact may be presumed from circumstances: and where an instrument is withheld by an adversary after notice to produce, it is always taken as against him that it is so stamped. An unstamped instrument, though inadmissible in evidence of its contents, may yet be received in evidence for collateral purposes. Thus, in indictment for forgery of an instrument, the instrument may be produced, although unstamped; and an agreement, although unstamped, is admissible for the purpose of proving usury, &c. (See *Starkie on Evidence.*)

STA'NCHIONS. The Sea term for upright supports in general.

STAND. A Sea term, used variously; as, for example, a sail is said to *stand* well or ill. A ship is said to *stand* towards or from the shore or any object (for *to sail*). To *stand on*, to continue the course. To *stand by*, to be ready.

STA'NDARD. In Botany, the upper and erect petal of that form of corolla which is called Papilionaceous, from its fancied resemblance to a butterfly.

STANDARD. *See* BANNER, FLAG.

STA'NDARD OF MONEY. *See* MONEY.

STA'NISLAUS, SAINT. A Polish order of knighthood, founded by Stanislaus, king of Poland, in 1765; renewed by the emperor Alexander in 1815.

STA'NNARIES. (Lat. stannum, *tin.*) The stannary courts of Devon and Cornwall are courts of record for the administration of justice among the tinners. They are held before the lord warden and his substitutes. The privileges of the tinners were confirmed by 33 E. 1. The appeal from the lord warden lies to the privy council of the Prince of Wales, and thence to the sovereign.

STA'NNIC ACID. Peroxide of tin.

STA'NZA. (Ital. stanza, *station.*) In Poetry, a series or number of verses connected with each other in a poem, of which the metre is constructed of successive series similar in arrangement. The stanza, however, must be understood to form a shorter division than the classical strophe, to which this definition would be equally applicable. The term is of Italian origin, and

signifies literally a *station* or *resting place*: it is so called from terminating with a full point or pause. The *ottava rima*, which consists of six lines in alternate rhyme ended by a couplet, the lines being deca- or rather hendeca-syllabic, is the principal Italian stanza. (*See* OTTAVA RIMA.) The Spenserian stanza (which was perhaps invented by the poet from whom it derives its name, but certainly first applied by him to the construction of a regular poem) consists of eight deca-syllabic verses and an Alexandrine at the end; the first and third verses forming the first rhyme; the second, fourth, fifth, and seventh another; and the eighth and ninth a third rhyme. Lord Byron has given both to the Ottava and the Spenserian stanza in English verse a peculiar and original character.

STANZA. In Architecture, an apartment or division in a building. The series of divisions of the Vatican, for instance, are called the *stanze* of the Vatican.

STAPES. A stirrup. One of the bones of the internal ear is so called, from its shape.

STAPHYLO'MA. (Gr. σταφυλη, *a grape*.) A disease of the eyeball, in which the cornea becomes opaque and tumid, forming a white projection, sometimes resembling a grape in shape; it occasionally increases to a great extent, and requires to be removed by an operation.

STA'PLE, signified originally a public market, whither merchants were obliged to carry their goods for sale; but it is now applied to the chief commodities either grown or manufactured in any country.

STAR. (Gr. αστρον, Ger. stern.) In a popular sense, the term star is used to designate any celestial body whatever, including the planets; but in astronomy it is applied only to those self-shining bodies which are situated beyond the sphere of solar attraction, and consequently do not participate in the motions of the solar system.

One of the first results of the observation of the heavens was, that the stars maintain always the same positions relatively to each other. Hence they were called *fixed stars*, in distinction to the *planets*, or *wandering stars*, which are constantly changing their places in the firmament. The fixity of the stars is, indeed, not absolute; for modern observations have detected some changes of relative position among them; but these changes are so minute, that in general they only become sensible after the lapse of a number of years, by a comparison of positions determined with the most perfect instruments at the beginning and end of the interval. They are consequently altogether inappreciable to unassisted vision, and the discovery of their existence has not rendered a change of language necessary: astronomers still speak of the *fixed stars*.

Apparent Magnitude of the Stars. — The first circumstance which arrests the attention of the observer of the stars is the great differences of their apparent magnitudes or their relative brightness. In order to establish a gradation in this respect, and for the convenience of description and reference, astronomers divide them into classes or orders, which are called magnitudes. A few of the most brilliant are denominated stars of the *first magnitude*; those of an inferior degree of brightness are of the *second magnitude*; and so on down to the 6th or 7th, which, according to the established convention, comprehend all the stars visible to the naked eye. The gradation is, however, still continued among those which are only visible in the telescope, and magnitudes from the 8th to the 16th are familiar to those who are in the practice of using powerful instruments. It is, however, to be remarked, that this classification is not based on any photometrical determination, but is entirely arbitrary. "Of a multitude of bright objects," says Sir John Herschel, "differing, probably, intrinsically, both in size and splendour, and arranged at unequal distances from us, one must of necessity appear the brightest, one next below it, and so on. An order of succession *must* exist; and it is a matter of absolute indifference where, in that infinite progression downwards from the brightest to the invisible, we choose to draw our lines of demarcation. All this is matter of pure convention. Usage has, however, established such a convention; and although it is impossible to determine exactly, or *à priori*, where one magnitude ends and another begins, and although different observers have differed in their magnitudes, yet, on the whole, astronomers have restricted their first magnitudes to about 15 or 20 principal stars, their second to 50 or 60 next inferior, their third to about 200 yet smaller, and so on; the numbers increasing very rapidly as we descend in the scale of brightness, the whole number of stars already registered, down to the 7th magnitude inclusive, amounting to 15,000 or 20,000." (*Astronomy, Cabinet Cyclopædia*, p. 374.)

Arrangement and Nomenclature of the Stars.—In order to indicate the quarter of the heavens in which any star is situated, astronomers, in the earliest ages of the science, had recourse to the method of forming them into groups, to which they gave the name of *constellations*, or *asterisms* (*see* CONSTELLATION), and distinguished the different groups one from another by appellations borrowed in general from mythology, and suggested by vague resemblances or fanciful analogies, the origin of which it is now difficult or impossible to trace. A few of the brightest stars received particular names; some of which, conferred by the Greeks and Arabs, have been preserved, as Sirius, Rigel, Aldebaran, Arcturus, Capella, &c.; but it is obvious that this nomenclature could not be carried to any great extent. The system which has prevailed in modern times, and been generally adopted by astronomers in their charts and catalogues, was invented by Bayer, whose *Uranometria*, containing charts of all the constellations, was first published at Augsburg in 1603. It consists in distinguishing the stars belonging to each constellation by the letters of the alphabet, beginning with the brightest, which is called α. The next brightest is called β, the next in order of brightness γ, and so on; and when the letters of the Greek alphabet were exhausted, Bayer had recourse to the Roman, and then to the Italian. It is to be observed, that the order of the letters indicates only the relative brightness of stars in the same constellation, without reference to other parts of the heavens. Admitting the principle, it might have been simpler to have employed the ordinal numbers 1, 2, 3, 4, &c. for distinguishing individual stars. But great perplexity is caused by the irregular forms of the constellations, whose numerous contortions and interlacings with each other baffle the efforts of memory, and which seem, as Sir J. Herschel remarks, "to have been purposely named and delineated to cause as much confusion as possible."

Distribution of the Stars. — The stars are very irregularly distributed over the celestial sphere. In some regions spaces of considerable magnitude occur in which scarcely a single star is to be seen, while in others they are crowded together, so as to present to the unassisted eye the appearance of a confused mass of light. A great and rapid increase of number is in general perceptible as we approach the borders of the Milky Way, where they appear, when viewed through a powerful telescope, to be crowded almost beyond imagination. (*See* MILKY WAY.) Besides the general increase which takes place towards this region, there are in several parts of the heavens patches or clusters of stars, where great numbers are condensed into a very narrow space. A telescope turned upon the Pleiades shows fifty or sixty large stars crowded together within a small area, and comparatively insulated from the rest of the heavens. The constellation Coma Berenices is a similar group, though more diffused. Another occurs in the constellation Cancer, and is called Præsepe, or the Beehive, from the great number of stars it presents in the telescope. In the sword-handle of Orion there is also a group of the same kind, but in which the individual stars can only be distinguished in a telescope of considerable power; and in various parts of the heavens there are found luminous spots in which no star can be distinguished with ordinary telescopes, but which, when viewed through very powerful instruments, are found to consist of stars crowded together so as to occupy almost a definite outline. Many of them, says Sir J. Herschel, "are of an exactly round figure, and convey the complete idea of a globular space filled full of stars, insulated in the heavens, and constituting in itself a family or society apart from the rest, and subject to its own internal laws. It would be a vain task to count the stars in one of these *globular clusters*. They are not to be reckoned by hundreds; and on a rough calculation, grounded on the apparent intervals between them at the borders (where they are not seen projected on each other) and the angular diameter of the whole group, it would appear that many clusters of this description must contain at least ten or twenty thousand stars compressed and wedged together in a round space, whose angular diameter does not exceed 8 or 10 minutes; that is to say, in an area not exceeding the tenth part of that covered by the moon." (*Astronomy*, p. 400.)

Number of the Stars. — Hopeless as any attempt to count the number of the "starry host" may appear to be, it has nevertheless been sometimes made. Of the stars visible to the naked eye at any one time, the number probably does not exceed a few thousands; but in the telescope they are prodigiously multiplied. Sir W. Herschel estimates that in a zone not exceeding two degrees in breadth, but including a portion of the Milky Way, the number which passed through the field of his telescope in a single hour amounted to 50,000. On account of their irregular distribution this estimate furnishes a very imperfect datum for inferring the whole number in the sphere; but it has been supposed that not fewer than 75 millions may be visible in a good telescope. Baron Zach, indeed, was of opinion that there may be 1000 millions in the entire heavens. But it is abundantly obvious that all estimates of this sort are nothing better than fanciful conjectures; and instead of a limit being found to the number of the stars, there is an infinitely greater probability that if an observer could transport himself to the remotest visible star, he would there behold a firmament not less rich than the one he left

behind. "Every increase," says Sir J. Herschel, "in the dimensions and power of instruments, which successive improvements in optical science have attained, has brought into view multitudes innumerable of objects invisible before; so that, for any thing experience has hitherto taught us, the number of the stars may be really infinite, in the only sense in which we can assign a meaning to the word." (*Astronomy*, p. 373.)

Parallax and Distance of the Stars. — The distance of the fixed stars from the earth has in all ages been an object of interest and inquiry. The element from which the distance can be deduced is the annual parallax, or the angle subtended by the diameter of the earth's orbit at the distance of the star (*see* PARALLAX); but this distance is so great that if we except one or two instances, perhaps still doubtful, all the attempts of astronomers to determine it have hitherto been fruitless. The instance in which the observations have *most probably* shown the annual parallax to have a measurable value is that of the double star 61 Cygni, observed by Bessel at Königsberg in 1839 and 1840. The value of the parallax obtained by this celebrated astronomer was 0·3483″ (a little more than the third part of a second), from which it results that the distance of the star is 592,000 times the mean radius of the earth's orbit; a distance so enormous, that light, which is propagated with a velocity of 192,000 miles in a second, would require $9\frac{1}{4}$ years to traverse it. (*Monthly Notices of the Royal Astr. Society*, May, 1840.) Now there is every reason to believe that this is one of the nearest of the fixed stars; and it is no extravagant supposition that there may be others still visible which are a thousand times more remote. If, therefore, one of these were annihilated, some ten thousand years would elapse before its extinction could be perceived at the distance of the earth.

Proper Motions of the Stars. — On comparing the places of the stars determined by recent observations with the positions assigned to them in the older catalogues, it is found that many of them have undergone a very sensible displacement. Within the last fifty years the double star 61 Cygni, above mentioned, has moved through 4′ 23″ of right ascension; and as the motion appears to be uniform, its rate is therefore about 5·3″ annually. Another star (μ Cassiopeiæ) has an annual proper motion of 3·74″. The number of stars in which such motion has been detected, though of smaller amount than in the above instances, is very considerable. Out of 2959 stars in the catalogues of Bradley and Piazzi, Bessel found 425 having a proper motion of not less than 0·2″. The discovery of the existence of such changes in the places of the stars gives rise to some interesting speculations relative to the constitution of the universe. That the stars gravitate to each other like the bodies of the solar system is rendered certain from the phenomena of binary stars; and when we admit the prevalence of this force among them, we are led to suppose a centrifugal force to be necessary to counteract the tendency to a general collapse produced by their mutual gravitation. Hence we conclude that the proper motions must be performed in circular or elliptic orbits round some very remote centre; and as every appearance leads us to suppose the stars to be bodies of the same nature as our own sun, it becomes extremely probable that the sun with its attendant system is transported through space with a similar motion. Now the translation of the solar system would necessarily give rise to an apparent change of the positions of the stars; for in consequence of the diminution of distance, they must appear to recede from that point of the heavens towards which the sun's motion is directed, and to converge and become more condensed in the region diametrically opposite. Sir William Herschel was of opinion that this is what actually takes place, and that a general recess of the principal stars from the point occupied by ζ Herculis is already indicated by the catalogues, and consequently that the solar system is carried forward in the direction of that star. It seems, however, to be the opinion of astronomers at present, that the observations are not yet sufficient to establish the certainty of this motion; but whether the supposition shall be confirmed or not, it is evident that the proper motions which have been remarked cannot be all accounted for in this way. They appear, indeed, to be subject to no one assignable law, but to be directed to many different and even opposite points of space. It is a curious circumstance, and was first noticed by Bessel, that a large proportion of the stars which have a proper motion are double stars. In the *Memoirs of the Royal Astron. Society*, vol. ii., a list is given of all the stars whose proper motions, as determined by comparison of the observations of Bradley and Mayer with Piazzi's catalogue, exceed half a second either in right ascension or declination.

Variable and Periodic Stars. — The proper motions are not the only indications of the existence of active forces in the stellar regions. Many stars have been observed whose light appears to undergo a regular periodic increase and diminution of brightness, amounting in some instances to a complete extinction and revival. Of this kind one of the most remarkable is the star *Omicron* in the constellation Cetus, or the Whale, which has a period of about 334 days. At its greatest brightness it is a star of the second or third magnitude, and continues in this state about a fortnight, when its light begins to wane, and at the end of three months it becomes for some time invisible to the naked eye. Algol, in the constellation Perseus, appears for about 62 hours as a star of the second magnitude; its light then suddenly diminishes, and in about $3\frac{1}{2}$ hours it is reduced to the fifth magnitude: it then begins to revive, and in the space of $3\frac{1}{2}$ hours more it is restored to its original state, thus accomplishing its period in about 69 hours. The star δ Cephei has a period of about 5 days $8\frac{1}{2}$ hours, and β Lyræ one of 6 days 9 hours. A star in the breast of the Swan has a period of about 15 years, during five of which it is invisible. Various other similar instances have been remarked; and recently Sir John Herschel has pointed out α Cassiopeiæ and α Orionis (the latter of the first magnitude) as variable stars. (*Monthly Notices of the Royal Astr. Society*, May 1839, and June 1840.)

Several hypotheses have been suggested to account for these variations. Newton suggested that the stars revolve about axes of rotation, like the sun and planets; and that parts of their surfaces may be covered with spots, or be less fitted to emit light. Maupertuis supposed that their figure is not globular but flat, and that the variations of brilliancy depend on the angle made by the flat sides with the visual ray. Others, again, have imagined that the partial obscurations may be occasioned by dark bodies or planets revolving about them in regular periods.

Temporary Stars. — On examining ancient catalogues it is found that some stars formerly distinguished by their splendour have entirely disappeared, no stars being now found in the places which they are set down as having occupied. Others have suddenly shone forth with extraordinary brilliancy, and after a longer or shorter period have gradually died away, and become extinct. A phenomenon of this kind about 125 years B. C. induced Hipparchus to undertake the formation of his catalogue. In the year 389 of our era a star suddenly blazed forth near α Aquilæ, and remained for three weeks as bright as Venus, and then disappeared. But one of the most remarkable instances is that of the star which appeared in 1572, and was observed by the astronomer Tycho Brahé. It suddenly shone forth in the constellation Cassiopeia, attained a splendour equal to that of Jupiter and Venus when nearest the earth, and could be seen by the naked eye at mid-day. Its brightness gradually diminished, and at the end of sixteen months it disappeared, and has never been seen since. During the time of its visibility, its apparent place remained unchanged. All the phenomena attending it are fully described by Tycho in his work entitled *De Nova Stella Anni*, 1572. A similar phenomenon occurred in the year 1604, in the constellation Serpentarius, of which an account is given by Kepler (*De Stella Nova in Pede Serpentarii*, Pragæ, 1606). For various other instances of a similar kind, and also of stars set down in the catalogues, but which cannot now be found, the reader is referred to *Lalande's Astronomie*, tome i. p. 259.

Double and Multiple Stars. — Many of the stars which appear to the naked eye, or in telescopes of feeble power, merely as bright points, are found, when observed with high magnifying powers, to be composed of two, and some of them of three or more stars, in close juxtaposition. This appearance may arise from the circumstance of two stars being situated in nearly the same line of view; for it is evident that two stars thus placed would appear as a double star, however great the real distance between them may be. It was suggested by Galileo that the variations (if sensible) of the apparent distance between two contiguous stars would furnish a good method of determining the annual parallax; and a series of observations on double stars was undertaken by Sir William Herschel with a view to this question. The result, however, was a discovery of a very different kind; for instead of finding an alternate increase and decrease of the apparent distance between the two stars, which would be the consequence of an annual parallax, he observed in some instances a regular progressive change from year to year in one direction. By reason of the slowness of the apparent motion, a considerable interval elapsed before he was able to determine its laws; but it was explicitly announced by him in 1803 that there exist sidereal systems composed of two stars, one revolving round the other, or both about a common centre. Subsequent observations have fully confirmed this discovery; and in some instances even the ellipticity of the orbits and the periods of revolution have been determined. Some of these binary systems, as they are called, have periods of great length, and which, consequently, have been inferred from observations continued during the description of only a small part of their orbits. Thus, γ Leonis has an angular motion of about only 3-10ths of a degree in a year, and consequently requires 1200 years to complete its revolution. The star γ Virginis, which consists of two stars of

nearly the same magnitude, has a period of 629 years. The period of 61 Cygni is 452 years, and that of Castor 252 years. There are others, however, having much shorter periods, and which have already been observed through their entire orbits. The star η Coronæ, for example, has a period of little more than 43 years, and has consequenly completed nearly two revolutions since its discovery as a double star by Sir William Herschel in 1761; ζ Ursæ Majoris has a period of about $58\frac{1}{4}$ years, and 70 Ophiuchi one of about 80 years. Since the time of Sir William Herschel, the observation of double stars has been a subject of much interest in astronomy, and catalogues containing some thousands of them have been published, giving the apparent distances of the two bodies, and their angles of position, or the direction of the straight line which joins them, by comparing which with future observations their orbits and periods will become known. (Herschel and South, *Phil. Trans.* 1826; Herschel, *Memoirs of the Royal Astronom. Society*, vol. iii.; Struve, *Catalogus Stellarum Duplicium et Multiplicium*, Petropoli, 1837.)

About 40 or 50 of the double stars are already known to form binary or revolving systems; and there are others presenting phenomena still more remarkable. Struve has enumerated 52 triple stars; and systems have been observed compounded of five and even more stars, all appearing to revolve about a common centre.

Some of the binary systems afford curious instances of contrasted colours, the colour of the smaller star being frequently complementary to that of the larger. In such instances the larger star is usually of a ruddy or orange hue, and the smaller one blue or green. Sir J. Herschel thinks it probable that the colour of the small star is the effect of the brighter light of the large one; for it is a general law of optics that when the retina is under the excitement of any bright-coloured light, feebler lights for the time appear coloured with the complementary tints. This opinion seems strengthened by the fact that though insulated stars of a red colour, almost as deep as that of blood, appear in many parts of the heavens, no green or blue star (of any decided hue) has been noticed unassociated with a companion brighter than itself.

Intrinsic Light of the Stars.—On account of the distance of the stars, it is not possible to form any idea of their actual magnitude; for when viewed through good telescopes they appear simply as luminous points without any sensible disks. Their light may, however, be compared with that of any other luminous object; and Dr. Wollaston found by photometrical experiments the light of Sirius, the brightest of the fixed stars, to be to that of the sun in the ratio of 1 to 20,000,000,000. Now the proportion of light received from any luminous body being inversely as the square of its distance, it follows that the sun would require to be removed to 141,400 (the square root of the above number) times its actual distance, in order that its light should be equal to that of Sirius. But the parallax of Sirius, if sensible at all, is undoubtedly less than 1″, whence it is easily calculated that the distance of Sirius cannot be less than 200,000 times the distance of the sun from the earth: from this it follows that the light of Sirius cannot be less than the double of that emitted by the sun. Dr. Wollaston, assuming a smaller and more probable limit of the parallax, supposes the light of Sirius to be equal to that of fourteen suns. (*Phil. Trans.* 1829; *Herschel's Astronomy*, p. 380.)

The observation of the places of the stars has formed the principal business of the astronomer in all ages; for as it is to them that the motions of the planets and all the other bodies of the solar system are referred, the knowledge of their exact relative positions is the foundation of all our astronomical theories, and of all the applications of the science to the practical purposes of geography and navigation. The discovery of their proper motions could only be made after instruments and methods of observation and theory had been brought to a state of great perfection, and is consequently of recent date. For our knowledge of binary and other systems of connected stars, and, in general, of all the facts which have been brought to light respecting the physical constitution of the stars, we are chiefly indebted to the two Herschels; and so pre-eminently distinguished have been the labours and discoveries of these illustrious astronomers in this department of observation, that it is now usually called the Herschelian branch of astronomy, in contradistinction to the observation of positions which forms the business of national observatories. *See* Astronomy, Nebula.

STARBOARD. The right-hand side of a ship, looking forwards.

STARCH. (Germ. stärke.) Starch is one of the commonest proximate principles of vegetables. It is characterized by its insipidity, and by insolubility in cold water, in alcohol, and in ether. It dissolves in, or at least forms a gelatinous compound with water, heated to 175°; and this solution, even when much diluted, is rendered blue by iodine. This admirable test of the presence of starch is not effective in hot solutions; and by boiling the blue colour disappears, but returns in strong solutions as they cool. The term *starch* is commercially applied to that obtained from wheat, which for this manufacture is ground and diffused through vats of water, where it undergoes a slight fermentation, and acquires a peculiar sour smell. A part of the gluten and albumen of the grain is thus separated in the form of a viscid scum; the starch being in the form of a finely divided white powder, is gradually further separated by washing in large quantities of water, from which it is ultimately allowed to settle, and put into boxes lined with linen to drain; it is then cut into squares, which are dried first in airy chambers upon porous bricks, and afterwards rolled up in papers and *stove* dried; it is in this latter operation that the starch acquires that peculiar columnar texture and fracture, which is well exhibited on opening a paper parcel as it comes from the stove. A little *smalt* is generally added to the starch, by which it acquires a very pale blue tint, and is better adapted to conceal or cover the yellow tint acquired by worn linen. Starch may be obtained from many other grains, and from potatoes and several other esculent vegetables. *Arrow root* is the starch of the *Maranta arundinacea; sago*, of the *Sagus farinifera*, an East Indian palm tree; and *tapioca* and *cassava* of the *Jatropha manihot.* Viewed under the microscope, the varieties of starch exhibit a more or less distinct globular appearance, and are said to be made up of little spherical particles of soluble starch, enveloped in an insoluble membrane, which protects the interior from the action of cold water, but which is broken or burst by hot water. In the process of germination, and by various chemical agents, starch may be converted into a species of gum and of sugar.

Starch is charged with a duty of $3\frac{1}{4}d.$ per lb.; and its manufacture is, consequently, placed under the control of the excise. Every maker of starch for sale must take out an annual licence, which costs 5*l.* Notice must be given to the excise of the erection, and of all changes in the construction of workshops, implements, &c. used in the manufacture of starch, under a penalty of 200*l.* All starch, before it is put into any stove or place to dry, must be papered and sealed, or stamped by the officer, under a penalty of 100*l.* Any person forging or counterfeiting such stamp or seal is guilty of felony, but with the benefit of clergy. Any person knowingly selling any starch with a forged or counterfeit stamp, &c. forfeits 500*l.* No quantity of starch exceeding 28 lbs. to be removed from one place to another, unless the word *starch* be marked on the package in legible letters three inches long, under forfeiture of the package, and of the cattle and carts conveying the same. Any dealer in starch receiving any quantity exceeding 28 lbs. not marked as above, shall forfeit 200*l.* Starch-makers are to make weekly entries of the starch made by them, under a penalty of 50*l.*; and are to make payment of the duties within a week of such entry. Cockets granted for shipping starch to be carried coastwise are to express the quality, quantity, weight, the mark of the package, by whom made and sold, and to whom consigned; and if shipped without such cocket, it may be seized. No starch is to be imported, unless in packages containing at least 224 lbs. stowed openly in the hold, on pain of forfeiture, and of incurring a penalty of 50*l.* No starch is to be exported, unless the package as originally sealed or stamped by the officer be entire, and unless the officer mark the word *exportation* upon it. The duties must have been paid on all starch exported; but the exporter is entitled to an excise drawback of $3\frac{1}{4}d.$ per lb. (*Burn's Justice of the Peace*, Marriott's ed., tit. "Starch.")

STAR CHAMBER, COURT OF (Curia camera stellatæ; from the ornaments of the ceiling of the room in which at one period it sate), was originally the privy council itself, "sitting in the star chamber," and there exercising important criminal jurisdiction, and administering equitable relief. It is mentioned as early as the reign of Edward III. In the third year of Henry VII. an act was passed giving determinate criminal powers, extending chiefly to state offences and misdemeanors of a public kind, to the court of star chamber. The judges were four high officers of state, with power to join a bishop and a temporal lord of the council, and two justices of the courts of Westminster, to their number. They proceeded by bill and information without the assistance of a jury. The sittings of the privy council itself, as a criminal court, were after this gradually abandoned, and its powers transferred to the star chamber. This court continued to exercise very extensive jurisdiction, both in political matters and in private concerns, during the reigns of Henry VIII. and his successors, until it was finally dissolved by 16 Car. 1. c. 10., together with what remained of its cognate jurisdictions. (*See* Council, Privy.)

STA'RKEY'S SOAP. A compound of turpentine, or oil of turpentine, and alkali.

STA'ROST. A title under the Polish republic enjoyed by noblemen who were in possession of certain castles and domains called starostics. These were grants

of the crown, and only conferred for life, but generally renewed after the demise of a possessor to his heirs.

STA'RSTONE. A very rare variety of sapphire, which, when cut and viewed in a direction perpendicular to the axis, presents a peculiar reflection of light in the form of a star.

STA'TER. (Gr. στατηρ.) An ancient Greek measure of value. It was undoubtedly a coined piece of money at an early period. The common gold currency in the republican times of Greece consisted of staters. The Attic golden stater weighed two drachms, and is estimated at twenty silver drachms; but the value of the coin struck by different states with this denomination varied greatly.

STATES, or ESTATES. In modern European History (French états, Germ. stände), those divisions of society, professions, or classes of men, which have partaken, either directly or by representation, in the government of their country. Their number has varied in different countries. In France, and most other feudal kingdoms, there have been three estates (nobles, clergy, commonalty), members of the ancient national assemblies. Hence the well-known appellation *tiers état* (third estate) for the last. In Sweden there are at this day four: nobility, clergy, citizens, peasants. In most countries the ancient system of assemblies convoked from separate estates disappeared by the progress of absolute government in the 16th and 17th centuries; and in modern monarchical constitutions the English system of government, by king, lords, and commons, or analogous powers, has prevailed. But the states have been reconstituted of late years in some German monarchies and grand duchies, the electorate of Hesse Cassel, &c.

STATES-GENERAL. In French History, assemblies which were first called A.D. 1302, and were held occasionally from that period to the year 1614, when they were discontinued, till they were summoned again at an interesting period, viz. in the year 1789. These states-general, however, were very different from the ancient assemblies of the French nation under the kings of the first and second race. There is no point with respect to which the French antiquaries are more generally agreed than in maintaining that the states-general had no suffrage in the passing of laws, and possessed no proper jurisdiction. The whole tenor of the French history confirms this opinion. *See* ASSEMBLY, DIRECTORY.

STA'TICS. (Lat. stare, *to stand.*) The branch of Mechanics which has for its object the investigation of the conditions of equilibrating forces, or the conditions under which several forces applied to a rigid body mutually destroy each other.

There are three general principles on which the theory of equilibrium may be grounded: these are, 1. The principle of the lever; 2. The principle of the composition of forces; and 3. The principle of virtual velocities.

Principle of the Lever. — The equilibrium of a straight horizontal lever, loaded at its extremities with weights which are reciprocally proportioned to their distances from the fulcrum, was demonstrated by Archimedes (*see* LEVER); and it is easy to extend this principle to the bent lever, when the fulcrum is at the angular point, and to show that if the two arms be urged in opposite directions by two forces perpendicular to the arms, and reciprocally proportioned to their lengths, there will be equilibrium. Now, it is an axiom in statics that a force may be regarded as acting at any point whatever in the line of its direction; and hence it follows that any two forces, applied at any points whatever in a plane which is only moveable round a fixed point, and having any directions whatever in that plane, will be in equilibrium when they are to each other reciprocally as perpendiculars drawn from the fixed point to the lines of their direction; for the perpendiculars may be regarded as the arms of a bent lever having the fixed point for its fulcrum. This general principle, which is also called the *principle of moments*, suffices for the resolution of all the problems of statics, and is indeed the only one which was rigorously demonstrated previous to the discovery of the composition of forces; that is to say, previous to the publication of the *Principia* in 1687.

Composition of Forces. — The second general principle consists in this, that any two forces acting together upon the same point of a body, are equivalent to a single force represented in intensity and direction by the diagonal of a parallelogram, of which the two given forces are represented by the sides. This equivalent of the two forces is called their resultant; and as the resultant may be combined with a third force acting on the same point, and the resultant of this composition with a fourth, and so on, it follows that any number of forces applied to the same point have a single resultant, or may be replaced by a single force. (*See* FORCE.) This principle was not known to the ancients. Galileo demonstrated that a body moved by two uniform velocities, the one vertical and the other horizontal, must acquire the velocity represented by the hypothenuse of the right-angled triangle, whose sides represent respectively the two velocities. This is a particular case of the principle. Newton proved it to be true generally, and substituted the composition of forces for that of motions; and in the second corollary to the third law of motion, he shows how the laws of equilibrium may easily be deduced from it. The *Nouvelle Mécanique* of Varignon, published in 1725, contains the first complete theory of the equilibrium of forces in different machines, deduced solely from the principle of the composition of forces. The simplicity of the principle, and the facility of its application to all questions connected with equilibrium, caused it to be almost immediately adopted; and it is the basis of all the modern treatises of statics.

Virtual Velocities. — The third general principle on which the conditions of equilibrium may be made to depend consists in this, that forces acting in opposite directions destroy each other when they are inversely proportional to the velocities which they would respectively communicate to the body in the first instant of its motion, if the equilibrium were destroyed. This principle applies almost self-evidently to the conditions of equilibrium of the lever, pulley, and other simple machines. Its generality was first remarked by John Bernoulli. It has been adopted by Lagrange, as the basis of his *Mécanique Analytique;* and it has the advantage over the others of being capable of representation in a single general formula, which includes the solution of every question that can be proposed relative to the equilibrium of forces. Lagrange, however, remarks that it is not sufficiently self-evident to be erected into a primitive principle; but it may be regarded as a general expression of the laws of equilibrium deduced from the two former. *See* VIRTUAL VELOCITY.

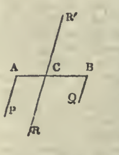
The general problem of statics may be thus enunciated: — *To find the equations of equilibrium of a body urged by any number of forces having any directions whatever in space.* We shall briefly indicate the steps by which the equations which express the conditions of equilibrium are obtained, adopting the principle of the composition of forces.

1. A force which acts on any point of a solid body may be regarded as applied at any point in the line of its direction, provided the different points of the line are invariably connected, as is the case with any two points of a rigid body. This, as already stated, may be assumed as an axiom.

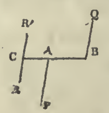
2. If a material point is urged by two forces acting in the same straight line, and in the same direction, the effect will be the same as if the point were urged in the same direction by a single force equal to their sum; and if the two forces act in opposite directions, the effect will be the same as if the two forces were replaced by a single force equal to their difference acting in the direction of the greater. The single force into which the others are compounded is called the *resultant;* and as a third force may be compounded with the resultant of two, another with the new resultant, and so on, it is obvious that any number of parallel forces acting on a point have a single resultant.

3. It has been shown in the article FORCE (p. 462.) that a force acting in any direction can always be decomposed into three others respectively parallel to three straight lines given in space, provided no two of these lines be parallel. Hence it follows that whatever be the number or the direction of the forces which act upon a solid body, they may be all replaced by three sets of parallel forces acting in given directions. We have therefore only to consider the theory of parallel forces.

4. When two parallel forces P and Q, acting in the same direction, are applied to the extremities of a rigid straight line A B, the resultant R will be equal to their sum, parallel to their common direction, and will divide the line A B into two parts in C, so that the distance of the points of application from C are reciprocally as the forces, or so that A C : C B : : Q : P. Thus, if A P and B Q be taken to represent the forces, and C R the resultant, we have C R = A P + B Q; and the two forces will be in equilibrium with a force C R′, equal to C R, and acting in the opposite direction.



5. When two parallel forces P and Q, acting in opposite directions, are applied to the extremities of a rigid straight line A B, there are two cases for consideration. If P and Q are unequal, they have a resultant which is parallel to their direction, equal to their difference, and applied at a point C in A B produced, which is such that A C : C B : : Q : P, or A C : A B : : Q : P − Q, and the two forces represented by A P and B Q will be in equilibrium with a force C R′ equal and opposite to C R. But if the two forces P and Q are equal, the point C, determined as above, is at an infinite distance, and



there is consequently no resultant. In this case, therefore, the two forces P and Q cannot make equilibrium with any single force.

The system of two equal and parallel forces applied in opposite directions at the extremities of a rigid straight line is very important in statics. For the sake of facilitating calculation, the two forces may be transferred to other points in the lines of their direction, so that the line joining the new points of application shall be perpendicular to the direction of the forces. Under this form, the system has been designated by the French mathematicians a *couple;* and its consideration has introduced great simplicity into the theory of equilibrium. We shall here state the principal properties of couples, referring for the details of demonstration to the *Elémens de Statique* of Poinsot.

6. Def.: — A couple is a system of two equal parallel forces acting in opposite directions, and applied perpendicularly to the extremities of an inflexible straight line of a given length.

7. It is obvious from the definition that the efficacy of a couple depends on two things; the intensity of the forces, and the length of the straight line or lever to the extremities of which they are applied. Now the force multiplied into the leverage is the *moment*, or the measure of the effect produced. Let the force be denoted by F, and the length of the straight line by a, then F a is the statical moment of the couple. And if there be another couple $F' a'$, such that $F : F' :: a' : a$, then $F a = F' a'$; or the statical moments of the two couples are equal, and the one may be substituted for the other without disturbing the conditions of equilibrium.

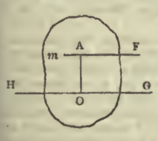
8. Any couple applied to a solid body may be transported, parallel to itself, to any position in its own plane, or in any other parallel plane; and it may be turned round through any angle in those planes without altering in any manner its effect on the body to which it is applied, provided the new points of application are invariably connected with those to which the couple was originally applied.

9. Two couples situated any where in the same plane, or in parallel planes, may be composed into a single couple equal to their sum, if they tend to turn the body in the same direction, or equal to their difference if they tend to turn it in opposite directions. Hence, by successive composition, any number of couples acting in parallel planes may be replaced by a single couple, the statical moment of which will be equal to the difference between the sum of the moments of all the couples tending to turn the body in one direction, and the sum of the moments of those which tend to turn it in the opposite.

10. Two couples situated any where in two planes which intersect each other may always be compounded into a single couple; and if we represent the moments of the two couples respectively by two straight lines, making an angle equal to that of the two planes, and complete the parallelogram, the moment of the resulting couple will be represented by the diagonal, and the plane of the resulting couple will divide the angle formed by the plane of the component couples into two parts respectively equal to the parts into which the diagonal divides the angle of the parallelogram. From this it is obvious that by successive composition any number whatever of couples, applied in any manner to a solid body, may be replaced by a single couple.

11. Reciprocally, any couple may always be resolved into two others situated in given planes, provided these planes and the plane of the proposed couple meet in the same or in parallel straight lines.

12. From the principles above stated, we draw this important conclusion, — viz. that when a solid body is urged by any number of forces having any directions whatever, the whole may be reduced to one force and to one couple. For let m be one of the points of a solid body, and conceive a force F represented in intensity and direction by the straight line m F to be applied at m. Take O any point whatever in the solid body or invariably connected with it, and draw O A perpendicular to m F, and conceive the force F to be applied at A in the same direction m F. Now suppose another force G represented by O G, equal and parallel to m F, to be applied at O, and let a third force H represented by O H, equal to O G, but acting in the opposite direction, be also applied at O. These two auxiliary forces will not alter the statical condition of the body, because the one exactly destroys the effect of the other. But the system of three forces F, G, H may now be conceived as consisting of a single force G applied at O, and of a couple formed by the two forces F and H applied at the extremities of the lever O A. Let O A be denoted by a, then the statical moment of this couple is F a; and by

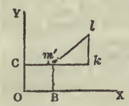


(9.) we may conceive it to be moved in its own plane until the centre of the arm O A coincides with the point O.

In like manner, if the other points m' m'' &c. of the solid body be respectively urged by forces F' F'', &c., acting in any directions whatever, each of these forces may be replaced by a single force acting at O, and by a couple having its centre at O. Now (2.) all the force acting at O will have a single resultant R applied at the same point, and all the couples having their centre at O may be compounded into a single couple, which has its centre at the same point (9). Therefore, finally, the whole of the forces acting on the solid body may be reduced to one force and to one couple; and in order that the body may remain at rest, it is necessary that the efforts of the resulting force and the resulting couple be severally destroyed. It is to be observed, that the resultant R cannot destroy the couple, or be in equilibrium with it; and, in general, the resultant and the couple will be situated in different planes.

From this it appears that the conditions necessary for the equilibrium of a body urged by a number of forces are these: — 1. That the resultant of all the forces at the point O be nothing; and 2. That the moment of the couple be nothing. When the first of these conditions is satisfied, there can be no progressive motion; and when the second is satisfied, there can be no rotatory motion about an axis. In order to express these conditions by equations, an expression for the single resultant, and an expression for the single couple, must be deduced from the conditions of the proposed problem, and the results severally made equal to nothing. We shall now show the general forms of these expressions, and for simplicity we shall first suppose all the forces to act in the same plane.

Let there be any number of forces F', F'', F''', &c. applied respectively at the points m', m'', m''', &c. of a system of points invariably connected; and suppose all the points to be in one plane, and all the forces to act in the same plane, but to have any directions whatever in that plane. From a point O taken arbitrarily in the plane draw the rectangular axes O X, O Y; then, whatever the direction of the force F', it may be resolved into two forces respectively parallel to these axes. Let the force F' be represented in intensity and direction by the line $m' l$, and let $X' = m' k$ be its component parallel to the axis O X, and $Y' = k l$ its component parallel to O Y. In like manner let X'' and Y'' be the components of a second force F'' resolved in the same manner, X''', Y''' those of a third F''', and so on; then, instead of the system of forces F', F'', F''', &c., we shall have two groups of parallel forces, namely, X', X'', X''', &c. parallel to O X, and Y', Y'', Y''', &c. parallel to O Y.



Now if x' and y' be the co-ordinates of the point m', so that $x' = $ O B, and $y' = $ O C (m' B and m' C being respectively perpendicular to O X and O Y); then (12.) the force X' may be replaced by an equal force applied at O, and by a couple whose statical moment is $X' \times$ O C $= X' y'$. In like manner the force Y' may be replaced by an equal force applied at O, and by a couple whose statical moment is $Y' \times$ O B $= Y' x'$. Each of the remaining forces X'', X''', &c. Y'', Y''', &c. may evidently be replaced in a similar manner. But it is evident that the group of forces X', X'', X''', &c. applied at O, may be represented by a single force X equal to their sum (those which fall to the right of the axis O Y being considered as positive, and those which fall in the opposite direction as negative), and those of the group Y', Y'', Y''', &c. by a single force Y (having due regard to the signs), and the first condition of equilibrium requires that we have $X = 0$, $Y = 0$ (for the resultant of X and Y can only be nothing when these quantities are severally $= 0$); that is to say, we must have the two following equations: —

$$\left.\begin{array}{l} X' + X'' + X''' + \&c. = 0 \\ Y' + Y'' + Y''' + \&c. = 0 \end{array}\right\} \ldots (a)$$

With respect to the two sets of couples $X' y'$, $X'' y''$, &c., $Y' x'$, $Y'' x''$, &c., since they are all situated in the same plane, it follows from the principle stated in (9.) that they may all be compounded into a single couple whose statical moment is equal to the sum of the statical moments of the component couples; and since the second condition of equilibrium requires that the moment of this resultant couple be nothing, the following equation must be satisfied: —

$$X' y' + X'' y'' + \&c. - Y' x' - Y' x'' - \&c. = 0 \ldots (b)$$

The effort exerted by each of these separate couples is to turn the system round an axis passing through the point O, and perpendicular to the plane X O Y; and the sum of the efforts being nothing, there is consequently no rotatory motion communicated.

The equations which have now been obtained for the equilibrium of a system of forces all acting in the same plane are easily rendered general. Let F', F'', F''', &c.

be the forces, having any directions whatever in space, applied to the points of a solid body; through a point O in the body, or invariably connected with it, draw three rectangular axes, O X, O Y, and O Z; and let each of the forces F′ be resolved into three others parallel to those axes, and denoted respectively by X′, Y′, Z′; then the first condition of equilibrium obviously requires the three equations,

$$\left.\begin{array}{l} X' + X'' + X''' + \&c. = 0 \\ Y' + Y'' + Y''' + \&c. = 0 \\ Z' + Z'' + Z''' + \&c. = 0 \end{array}\right\} \ldots (c)$$

With respect to the couples formed by transporting the resolved forces from their points of application to the point O, it is manifest that as the directions of the forces are now in planes parallel to three rectangular planes, X O Y, X O Z, and Y O Z, the couples may all be transferred to those three planes; therefore, by the same reasoning as above, it is easy to see that in each plane there will be two sets of couples tending to turn the body about an axis perpendicular to that plane. Thus, in the plane X O Y, there will be, as before, the two sets of couples $X'y'$, $X''y''$, &c., $Y'x'$, $Y''x''$, &c.; and, similarly, in the plane X O Z there will be the two sets $X'z'$, $X''z''$, &c., $Z'x'$, $Z''x''$, &c.; and in the plane Y O Z the two sets $Y'z'$, $Y''z''$, &c., $Z'y'$, $Z''y''$, &c. Now, supposing all these couples compounded into one, it is manifest that the moment of this resulting couple can only be nothing when the sums of the moments of the couples in each plane are respectively nothing: hence we have this second set of equations,

$$\left.\begin{array}{l} X'y' + X''y'' + \&c. - Y'x' - Y''x'' \&c. = 0 \\ Y'z' + Y''z'' + \&c. - Z'y' - Z''y'' \&c. = 0 \\ Z'x' + Z''x'' + \&c. - X'z' - X''z'' \&c. = 0 \end{array}\right\} \ldots (d)$$

These two systems of equations (c) and (d) contain the conditions necessary for the equilibrium of any solid body. When the first system (c) is satisfied, there can be no progressive motion; and when the system (d) is satisfied, there can be no rotation about an axis.

These two systems of equations are usually given under a different form. Let α', β', γ', be the three angles which the direction of the force F′ make with lines parallel to the three axes O X, O Y, O Z; we shall then have for the components of the force F′,

$$X' = F' \cos. \alpha',\ Y' = F' \cos. \beta',\ Z' = F' \cos. \gamma'.$$

Denoting the analogous angles in respect of the force F″ by α'', β'', γ'', we shall have similar expressions for the components of that force; and so on. Hence the six equations (c) and (d) become

$$\left.\begin{array}{l} F' \cos. \alpha' + F'' \cos. \alpha'' + \&c. = 0 \\ F' \cos. \beta' + F'' \cos. \beta'' + \&c. = 0 \\ F' \cos. \gamma' + F'' \cos. \gamma'' + \&c. = 0 \end{array}\right\} \ldots (c')$$

$$\left.\begin{array}{l} F'(y' \cos. \alpha' - x' \cos. \beta') + F''(y'' \cos. \alpha'' - x'' \\ \quad \cos. \beta'') + \&c. = 0 \\ F'(z' \cos. \beta' - y' \cos. \gamma') + F''(z'' \cos. \beta'' - y'' \\ \quad \cos. \gamma'') + \&c. = 0 \\ F'(x' \cos. \gamma' - z' \cos. \alpha') + F''(x'' \cos. \gamma'' - z'' \\ \quad \cos. \alpha'') + \&c. = 0 \end{array}\right\} (d')$$

Our limits will only permit of our giving a general indication of the manner in which the above equations are applied to the solution of particular problems.

1. If the body is retained by a fixed point, we have only to assume the fixed point as that in respect of which the preceding transformations are made. The effort of the resultant of the different forces will then be annihilated by the resistance of the fixed point, and consequently there will be equilibrium if the resultant couple is nothing, or if the three equations (d′) are satisfied.

2. If the body is retained by two fixed points, the line which joins them will constitute a fixed axis in the body. On taking the point O any where on the axis, the resultant of the forces applied at O will again be destroyed by the resistance of the axis; but in order that equilibrium may take place, it is not now necessary that the resulting couple be nothing,—it is sufficient that it be situated in any plane which contains the axis; for when this condition is fulfilled its arm coincides with the axis and is fixed, and consequently the effect of the forces applied at its extremities will be annihilated.

3. Lastly, if the body, in other respects free, be subjected to touch an invariable plane, it is not necessary for equilibrium that the equations (c′) be satisfied; it will be sufficient if the resultant of the forces be perpendicular to the plane, provided it also fall within the interior of the space which limits the points of contact of the body with the plane, for in this case it will be destroyed by the plane's resistance. The second system of equations (d′) must, however, be satisfied; since the resistance of the plane can only generate a normal resistance, which, therefore, is incapable of destroying the action of the couple.

Of all the forces which act upon bodies, that which most frequently comes under our observation is terrestrial gravity, under the influence of which all bodies, when unsupported, fall to the ground in vertical lines. A solid body acted upon by gravity presents the case of an infinite number of connected points urged by parallel forces; for though gravity is directed towards the centre of the earth, yet, by reason of the great magnitude of the earth in comparison of such bodies as usually come under consideration, the direction of the forces acting on the different points may all be regarded as parallel. All these forces have therefore a single resultant, which, in respect of every particular body, passes through a given point, called the centre of gravity. The determination of the centres of gravity of different bodies, and of their various properties, consequently forms a considerable portion of every treatise on statics. For the general formulæ, see CENTRE OF GRAVITY. (See Poinsot, *Elémens de Statique;* Biot, *Notions de Statique;* Poisson, *Traité de Mécanique;* Lagrange, *Mécanique Analytique; Whewell's Mechanics;* and the references under the term MECHANICS.)

STA′TION. (Lat. stare, *to stand.*) In Astronomy, a planet is said to be at its *station*, or to be *stationary*, when its motion in right ascension ceases, or its apparent place in the ecliptic remains for a few days unaltered. The real motions of the planets are always in the same direction from west to east; but owing to the motion of the earth from which they are seen, their *apparent* motions, though generally from west to east, or direct, are sometimes from east to west, or retrograde, and in changing from one of these directions to the other the planet appears for some short time to stand still. The distance of the earth and of a planet from the sun being given, and also their periodic times, the determination of the arc of retrogradation, or the times at which the planet will appear stationary, is an easy problem; but to the ancient astronomers, who were unacquainted with the relative distances of the planets, and who, moreover, supposed the earth to be the centre of motion, the phenomena of the stations and retrogradations occasioned great embarrassment, and the principal object of the various systems which were propounded previous to that of Copernicus was to give a satisfactory explanation of them. *See* EPICYCLE, PLANET.

STATION, in Surveying, is the place selected for planting the instrument with which an angle is to be measured.

STATION, in the Church of Rome, is applied to certain churches in which indulgences are granted on certain days.

STATION, is applied to those resting-places on railways at which a halt is made for the purpose of receiving or letting down passengers or goods. The last stations on a railroad are called the *termini*.

STATIONARY ENGINE, in contradistinction to "Locomotive Engine," expresses a steam engine in a fixed position, which draws loads on a railway by a rope or other means of communication extended from the *station* of the engine along the line of road.

On railways worked by locomotive engines, inclined planes sometimes are constructed of an acclivity too steep to be worked with advantage by these machines: such a plane occurs on the London and Birmingham railway, between the passenger station at Euston Square and the depôt and station for goods at Camden Town. Similar inclined planes are constructed on the Liverpool and Manchester railway, between the quay at Liverpool and the station at Edge Hill, and between the passenger station at Lime Street and the same place. In these cases a stationary engine is placed at the summit of the inclined plane, by the power of which acting on a rope carried along the plane the trains of carriages and waggons are drawn to the summit.

But it is not only on planes whose acclivity forbids the advantageous application of locomotive engines that stationary engines are used as a moving power on railways. In some situations, where a line of railway is sufficiently level, they are applied in preference to locomotive power. Thus the railway extending from the India House in London to Blackwall, whose acclivities do not exceed sixteen feet per mile, is worked throughout its entire length by stationary power.

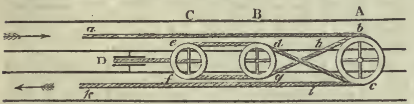
When a line of railway is to be worked by stationary engines the whole line is resolved into a succession of stages of certain lengths, at the end of each of which a stationary steam engine is placed; or, more generally, *two* such engines are provided, in order that the occasional suspension of one for the purpose of repairs may not interrupt the traffic of the road. The power of these engines is applied to give motion to a drum, or cylinder, or wheel, on which a rope is wound. This rope extends along the road, being supported at short intervals on iron sheaves or pulleys, by which its friction and consequent wear and resistance are diminished.

There are several methods by which the stationary engine is made to draw the train by a rope.

The plan adopted by Mr. Stephenson to draw the trains of goods from the quay at Liverpool to the station at Edge Hill, up an inclined plane of about a mile in length, is by an *endless rope*. At the foot of the machine a wheel is laid down in a horizontal position, revolving on a ver-

tical axis, having a groove on its circumference of a proper magnitude to receive the rope. The diameter of this wheel is equal to the distance between the centres of the two lines of rails; so that when the rope is extended between each line it will fall into the groove at the ends of that diameter of the wheel which is at right angles to the line of road. Thus, the rope being brought round the groove of the wheel for half its circumference, is carried up each line of rails midway between the rails.

At the summit of the plane, a similar wheel is similarly placed, round which the rope is conducted; but, instead of being merely carried half round this wheel, it is brought round two other wheels of less diameter, by means of which the necessary tension is given to it. Let A repre-



sent the great wheel at the top of the plane, and let *a b* represent the rope passing up the plane between one line of rails and falling into the groove of the wheel at *b*. It is carried round the wheel A to *c*, and thence passes diagonally to *d*, where it falls into the groove of a smaller wheel B, from whence it is carried to *e* and half round another wheel C, equal to B; and from *f* it is conducted to *g*, where it falls again into the groove of the wheel B, from whence it passes diagonally to *h*, and half round a second groove in the great wheel A to *i k*, from whence it is carried down the other line between the rails.

The steam engine is thrown into connection with the axle of the wheel, to which it imparts continued revolution. The adhesion of the rope to the grooves makes this motion cause the rope to be drawn in the direction of the arrows. Any train of carriage, therefore, attached to the rope *a b* would be drawn in one direction, and a train attached to *i k* would be drawn in the other direction. The tension of the rope is regulated by a weight suspended by a rope passing over a vertical wheel D, and attached to the axle of the wheel C. This weight hangs in a pit, and continually draws the wheel C from the wheel D. By this means, however the rope may vary its length by moisture or other hygrometric causes, it will necessarily have the same tension.

The new tunnel at Liverpool, extending from the engine station at Edge Hill to the passenger station at Lime Street, is differently worked, but also by an endless rope. The distance from the Lime Street station being 2200 yards, a horizontal shaft is extended across the whole width of the two lines of railway at Edge Hill. The extremities of this shaft are continued on either side into two buildings, where stationary engines are erected. A motion of revolution may be given to the shaft by either of those engines separately, or by both of them simultaneously. Upon the shaft, and in the centre of one of the lines of railway, a grooved wheel, 19½ feet in diameter, is fixed with its plane vertical. The rope, which constantly ascends the plane between the rails of the line appropriated to ascending trains, passes over this wheel, and, being brought under it, is returned nearly to the point where it first comes upon it. It is there conducted into the groove of another wheel 4 feet in diameter, placed in front of the greater wheel. By this arrangement the rope embraces nearly the whole circumference of the greater wheel, and an adhesion is obtained sufficient to draw a load of one hundred tons up the plane. After the rope passes over the smaller wheel, it is carried round a horizontal wheel placed upon a carriage running backwards and forwards upon a railway, which wheel is drawn by a weight similar to that described in the preceding case, by which a uniform tension is given to the rope. After passing round this horizontal wheel, the rope is then directed to the centre of the other line of railway by two other horizontal wheels, and, after passing down the plane, is conducted by two other horizontal wheels at Lime Street into the centre of the ascending line, along which it is conducted, as already described, to the large shaft wheel at the top of the plane.

By either of the contrivances here described a railway of any extent may be worked by stationary engines driving endless ropes; and as the rope is at the same time moving in contrary directions along the two lines of railway, trains may be drawn by the same engine at the same time in contrary directions. In case of such a rope being applied to an inclined plane, the weight of the descending train would act upon the ascending train, leaving the moving power to act against the difference of their weights only. If, in such a case, the descending load were greater than the ascending load, the latter would not only descend by its gravity without any moving power, but would draw the ascending load up. A plane worked in this way without an engine is called a self-acting plane. Railways composed of self-acting planes are very frequent in mining districts, where the level at which the mineral product is obtained is much more elevated than that at which it is shipped. The weight of the mineral itself is, in such cases, used as the moving power, the loaded waggons in their descent drawing the empty waggons in the contrary direction.

When an endless rope is not used, the power of the engine is applied to a drum or cylinder, called a rope-roll, on which the rope is coiled. In such cases, the rope being carried along the line of rails, has its extremity attached to the train to be drawn; and the engine, as it works, turns the rope-roll on which the rope is gradually coiled, and the train is thus drawn towards the engine. When the train has arrived there, the whole of the rope will be coiled on the rope-roll. In order to move the train in the other direction, a similar engine is placed at the other extremity of the railway along which the train is moved; and the train is drawn back by the other engine in the same manner. But, in order to unroll the rope from each rope-roll, the train, in returning, is made to draw the rope after it. Thus the two engines reciprocally draw the train backwards and forwards between them; each engine, while it draws the train in one direction, unrolling the rope from the rope-roll of the other.

There are various other expedients that have been suggested and practised for working railways by *stationary* engines and ropes, but all of them partake more or less of the principle of one or other of these here described. The speed attainable by such means was formerly very limited; but the application of ropes and the machinery connected with them has been much improved, and, if it were otherwise desirable, a line of railway could now be worked at an average speed of from fifteen to twenty miles an hour by a series of stationary engines and ropes. Nor would it be necessary in passing each station to stop the train, expedients being devised by which the train may be transferred from one rope to another without stopping it.

STA'TIONERY. The name given to all the materials employed in the art of writing, but more especially to those of pens, ink, and paper. The term *stationery* is derived from the business of booksellers having been anciently carried on entirely in stalls, or *stations*. The Stationery Office in London is the medium through which all government offices, both at home and abroad, are supplied with writing materials; and at the same time it contracts for the printing of all reports and other matters laid before the House of Commons, &c. It consists of a comptroller, a storekeeper, and about thirty clerks and other subordinate officers; and has a branch establishment at Dublin.

STATION POINTER. An instrument used in maritime surveying, for expeditiously laying down on a chart the position of a place from which the angles subtended by three distant objects, whose positions are known, have been observed. It consists of three scales, which move about a common centre, two of them carrying each a divided circular arc, and the third two verniers adapted to the arcs, by means of which the scales can be opened so as to form two angles of any inclination. Suppose the angles of the scales to be made equal to the two measured angles, and the instrument to be laid on the chart, so that the edges of the three scales coincide with the positions of the observed objects, the centre marks the position of the spot from which the objects were observed. (See *Simms's Treatise on Mathematical Instruments*, p. 98.)

STA'TIONS. In Ecclesiastical Antiquities (from the Roman statio, *a soldier keeping guard*). The weekly fasts of Wednesdays and Fridays. These were omitted between Easter and Whitsuntide. They terminated at three in the afternoon; hence sometimes called *semi-jejunia*. Saturday was made a station day by the council of Elvira; which, it is said, led to the gradual neglect of the Wednesday station in the Western church. (*Riddle's Christian Antiquities*, 624.)

STATI'STICS. (Lat. status, *state, condition*.) The name given to the science which exhibits the state or condition of a country or nation, principally in relation to its extent, population, industry, wealth, and power.

By a statistical account of a country, we mean a work describing its situation and extent; its natural and acquired capacities of production; the quantity and value of the various articles of utility and convenience existing and annually produced in it; the number and classes of its inhabitants, with their respective incomes; its institutions for the government, improvement, defence, and maintenance of the population; with a variety of subsidiary statements and details. A science embracing so great a variety of objects is not easily defined or limited; nor is it possible to draw any distinct line of demarcation between what should be left out of statistical works, and what should be included in them. Much must always depend on the object in view, and on the good sense and discrimination of the author. Statistics has many features in common with geography and politics, and embraces that sort of mongrel science

that has been called political arithmetic. Some authors, and, among others, the economist M. Say, contend that any description, however brief, of the territory of a country is foreign to statistics, and belongs exclusively to physical geography. But this is evidently a most erroneous statement. How can we acquire any accurate or comprehensive knowledge of the capacities of production enjoyed by a country, if we be unacquainted with its situation, soil, climate, and native products, and with its facilities for bringing them to market and exchanging them with others? So far from being alien to, this knowledge lies at the very foundation of the science; and any work which should omit it, however well it might be executed, would have no claim to be considered as a complete statistical work. Those topographical details which are essential in a geographical work would, however, be totally out of place in one devoted to statistics. One of the principal objects of the latter is to exhibit the means and sources of the national wealth, its amount and distribution; and these would not be in any respect promoted by indulging in topographical details. Hence, in statistical works, a short notice of the principal divisions of the country, with reference especially to its climate, soil, native products, agriculture, including the method of holding and occupying lands, manufactures, and population, is generally sufficient. This much, however, cannot be dispensed with. It is the foundation on which all the rest of the building is to stand; and the completeness of the other, and more elevated parts, will generally depend more on the compactness and solidity of this than on any thing else.

Opinions differ as widely as to the mode in which statistical treatises should be drawn up, as with respect to the topics they should embrace. Some contend that their object is limited to an exposition of the state of a country, province, or place, at some given period; and that, consequently, all historical and theoretical discussions should be rigidly excluded. The Germans, who are supposed to be the great authorities in statistical matters, mostly compose their works on this plan; but it, notwithstanding, appears to us to be radically objectionable, and to be calculated to deprive the science of all that is most interesting and instructive. Nor need we travel beyond the sphere of German statistical works for ample proof of what is now stated. They are, in fact, with few exceptions, the most worthless rubbish imaginable. We have accounts, sometimes accurate and sometimes not, but usually put forward with equal confidence, of a variety of minute facts; but as we have no explanation of the circumstances under which they originated, they communicate, even when accurate, little useful information: and it would not be more idle to attempt to form any notion of St. Peter's or St. Paul's from an account of the number of tons of stone, brick, and mortar in each, than it would be to attempt to form any opinion of the state of Prussia, Austria, or any other German state, from the details respecting it supplied by German statistical writers. They tell us, for example, that so many looms were at work in such a town or place at such a time; but the chances are, not a word will be said as to whether the number of looms was increasing or diminishing; and supposing that were stated, it is all but certain that not a word will be said explanatory of the causes by which this result has been brought about, though this be, in fact, of ten times more importance than anything else. This species of statistics presents us with a skeleton, instead of a living animated body. It is of importance, no doubt, to know the amount of population, the sum paid in taxes, the rate of wages, &c. in a country or district at any given period; but it is only by comparing these statements with others of the same sort, applying to different epochs, that we learn whether such country be advancing or retrograding: and it is only by comparing details peculiar to one country with those peculiar to another, that we learn in what respects they agree and differ, and that the attention of the politician and economist is called to those circumstances that retard the progress of the one, and accelerate that of the other. Those who make a parade of subdivisions would call this *comparative statistics*, and would contend that it should not be mixed up with descriptive statistics. But to be really good, and possessed of interest enough to make it be read, a work must embrace both. They should not be so intermixed as to create confusion; but unless they be combined in due proportions, the principles on which the comparisons are made expounded, and the circumstances that produce the discrepancies pointed out, and their influence correctly appreciated, no details, however accurate, can be of much value. It is the easiest thing possible to pile figures on figures; but unless deduced from correct data, they serve only to mislead; and they do this the more easily, that they have a scientific air about them, and that most people shrink from the irksome task of examining whether tabular statements be correct or not. There is nothing, indeed, about which one should be so sceptical as the greater number of what are called statistical facts and details, or with respect to which a sound and searching criticism is so necessary. The reader would do well generally to look with suspicion and distrust on most statements, how imposing soever they may appear, unless he be informed of the sources whence they have been derived, and of the principles on and the mode in which they have been compiled.

It would be easy to illustrate what has now been said by references to the statements in parliamentary and other official documents, many of which are altogether false; while many more, from the conditions to which they apply not being clearly set forth, are, though not absolutely incorrect, fitted only to mislead.

Perhaps the least valuable book ever published on any important subject was that of Dr. Colquhoun *On the Wealth and Resources of the British Empire*. It is, from beginning to end, a tissue of extravagant hypotheses, exaggeration, and absurdity. Nothing was too difficult for this intrepid calculator. Under his transforming hand every thing was reduced to figures; and matters as to which it is impossible to obtain any certain information, and of which he knew nothing, were set down as if they had been ascertained with absolute precision! And yet the most extravagant of his statements were for a while regarded as well-established truths. The book obtained an extensive circulation; it was translated into German, and the German doctors continue to refer to it as if its authenticity were alike unquestioned and unquestionable.

In justice, however, to the German writers on statistics, it should be stated that the circumstances under which they are placed do not really admit of their publishing the best class of works. In Prussia, Austria, and most German states, the press is subject to a rigorous censorship; and no statements of a political kind are allowed to be published that might give offence to government, or that would be likely to call the attention of the reader to the defects in the organization of the state. This sufficiently accounts for the absence of such discussions in German works, and their anti-critical character. But this certainly is no reason why the writers of other nations, not laid under any restraints, should adopt such emasculated works as models for their treatises.

Indeed it would seem to be considered by some writers that every thing in statistics may be estimated in figures, and exhibited in tabular statements! But the truth is, that but a few of the more prominent facts, in regard to the situation of any great country, can be so exhibited. A grand object in every good statistical work should be, not merely to state what is, but *why it is*; to trace and exhibit causes as well as effects; to show how advantageous results may be best brought about, and how those of an opposite character may be best avoided.

It may be said, perhaps, that this would encroach on the province of the politician and political economist. But, in our estimation, a certain admixture of politics and political economy is indispensable to statistics. Without such admixture, most statistical works are little better than worthless: if they are to be excluded, a good almanac may be taken as the model of a good statistical work.

Arthur Young, in his *Travels in France*, Townsend, in his *Travels in Spain*, and Volney, in his *Syria and Egypt*, indulge largely in discussions that depend more or less on politics and political economy. But, nevertheless, no one can doubt that the books in question belong to the class of travels, of which, indeed, they are among the very best specimens. And why should it be otherwise with statistical works? If their writers know what they are about, they will use political science not to supersede, but to illustrate, explain, and give utility to their statistical details.

A really good statistical work can only be compiled by a writer who to great talent and good sense adds the most extensive information, and hence the extreme rarity of such works; but, when properly executed, they are alike instructive and interesting. *Est enim cognitio reipublicæ et privato homini et publico utilissima et maxime necessaria, atque scientiam illam, qua duce cognitionem reipublicæ nobis comparamus, imprimis dignam esse, quam studiosius colamus et prosequamur, non est, quod jure negare vel adeo dubitare possimus.* (Mone, *Hist. Statisticæ*, p. 4.)

We subjoin a few of such of the more interesting particulars in the statistics of the United Kingdom, and of Europe generally, as may be exhibited in a tabular form. The details are mostly derived from official returns.

STATISTICS.

I. Table exhibiting the Area, Population, &c. of England and Wales.

Counties.	Area in Acres.	Population, 1801.	Population, 1821.	Inhabited Houses, 1841.	Population, 1841. Males.	Population, 1841. Females.	Population, 1841. Total.	Acres of Land to an Individual in 1841.	Rent of Land per Acre in 1810.
England.									L. s. d.
Bedford	296,320	63,393	83,716	21,235	52,169	55,768	107,937	2·745	0 18 10¾
Berks	481,280	109,215	131,977	31,472	79,674	80,552	160,226	3·003	0 16 11
Buckingham	472,320	107,444	134,068	31,071	76,316	79,673	155,989	3·027	1 1 0½
Cambridge	548,480	89,346	121,909	33,112	81,513	82,996	164,509	3·334	0 16 8¼
Cheshire	673,280	191,751	270,098	73,590	193,089	202,211	395,300	1·703	1 0 6
Cornwall, exclusive of Scilly Islands	851,200	188,269	257,447	65,641	164,451	176,818	341,269	2·494	0 13 3¾
Cumberland	974,720	117,230	156,124	34,444	86,206	91,706	177,912	5·478	0 9 7½
Derby	657,920	161,142	213,333	52,910	135,639	136,563	272,202	2·417	0 18 10
Devon	1,654,400	343,001	439,040	94,637	252,752	280,979	533,731	3·099	0 14 8¾
Dorset	643,840	115,319	144,499	34,559	83,442	91,301	174,743	3·684	0 15 2¼
Durham	702,080	160,361	207,673	57,450	159,874	164,403	324,277	2·165	0 14 4¾
Essex	981,120	226,437	289,424	67,602	172,299	172,696	344,995	2·843	0 18 5½
Gloucester	805,120	250,809	335,843	80,856	205,374	225,933	431,307	1·866	1 0 0
Hants	1,040,000	219,656	283,298	66,589	174,724	180,216	354,940	2·930	0 11 5
Hereford	552,320	89,191	103,243	23,461	57,257	57,181	114,438	4·826	0 15 11¾
Hertford	403,200	97,577	129,714	30,155	77,619	79,618	157,237	2·564	0 16 11½
Huntingdon	238,080	37,568	48,771	11,897	29,154	29,545	58,699	4·055	0 16 11½
Kent	996,480	307,624	426,016	95,547	272,415	275,746	548,161	1·817	0 17 4¼
Lancaster	1,130,240	672,731	1,052,859	289,166	814,857	852,207	1,667,064	·677	1 1 5¾
Leicester	515,840	130,081	174,571	44,649	105,613	110,242	215,855	2·389	1 7 1¼
Lincoln	1,671,040	208,557	283,058	73,038	181,802	180,915	362,717	4·607	0 18 10
Middlesex	180,480	818,129	1,144,531	207,670	738,970	837,646	1,576,616	·114	1 18 10
Monmouth	317,440	45,582	71,833	24,880	70,608	63,741	134,349	2·362	0 12 9
Norfolk	1,295,360	273,371	344,368	85,922	199,055	213,566	412,621	3·139	0 14 2¾
Northampton	650,240	131,757	162,483	40,903	98,886	100,175	199,061	3·266	1 1 4¾
Northumberland	1,197,440	157,101	198,965	48,704	121,271	128,997	250,268	4·785	0 15 2½
Nottingham	535,680	140,350	186,873	50,541	121,660	128,113	249,773	2·144	0 19 11½
Oxford	483,840	109,620	136,971	32,141	80,383	81,190	161,573	2·944	1 0 7
Rutland	95,360	16,356	18,487	4,297	10,743	10,597	21,340	4·468	1 0 9½
Salop	859,520	167,639	206,153	47,203	119,357	119,657	239,014	3·596	0 16 11¾
Somerset	1,052,800	273,750	355,314	81,632	209,421	226,581	436,002	2·414	1 5 8½
Stafford	757,760	239,153	345,895	97,676	258,729	251,477	510,206	1·485	1 0 0
Suffolk	969,600	210,431	270,542	64,081	154,107	161,022	315,129	3·076	0 14 3¾
Surrey	485,760	269,043	398,658	95,375	278,186	304,427	582,613	·833	0 15 2
Sussex	938,240	159,311	233,019	54,066	147,572	152,198	299,770	3·129	0 12 1¼
Warwick	574,080	208,190	274,392	81,445	195,967	206,154	402,121	1·427	1 2 8¼
Westmoreland	487,680	41,617	51,359	10,848	28,234	28,235	56,469	8·636	0 9 0½
Wilts	874,880	185,107	222,157	50,986	128,904	131,103	260,007	3·364	0 18 6¾
Worcester	462,720	139,333	184,424	46,962	114,753	118,731	233,484	1·981	1 2 3¾
Yorkshire	3,735,040	858,892	1,173,187	315,082	788,830	802,754	1,591,584	2·346	0 16 7¾
Total of England	32,243,200	8,331,434	11,261,437	2,753,295	7,321,875	7,673,633	14,995,508	Av. 2·150	Av. 0 17 3½
Wales.									L. s. d.
Anglesey	173,440	33,806	45,063	11,488	24,369	26,521	50,890	3·408	0 7 6
Brecknock	482,560	31,633	43,603	10,634	26,911	26,384	53,295	9·054	0 5 1¾
Cardigan	432,000	42,956	57,784	15,102	31,997	36,383	68,380	6·317	0 4 8½
Caermarthen	623,360	67,317	90,239	23,407	50,795	55,687	106,482	5·854	0 7 2¼
Caernarvon	348,160	41,521	57,958	16,869	39,600	41,468	81,068	4·294	0 5 2½
Denbigh	405,120	60,352	76,511	18,485	44,617	44,674	89,291	4·537	0 9 0¾
Flint	156,160	39,622	53,784	13,320	33,636	32,911	66,547	2·346	0 15 2¼
Glamorgan	506,880	71,525	101,737	35,205	89,028	84,434	173,462	2·922	0 8 4½
Merioneth	424,320	27,506	34,382	8,467	19,247	19,991	39,238	10·814	0 3 11
Montgomery	536,960	47,978	59,899	13,650	34,252	34,968	69,220	7·757	0 6 5½
Pembroke	390,400	56,280	74,009	18,882	40,343	47,919	88,262	4·423	0 8 2¾
Radnor	272,640	19,050	22,459	4,687	12,738	12,448	25,186	10·825	0 6 3
Total of Wales	4,752,000	541,546	717,438	188,196	447,533	463,788	911,321	Av. 5·214	Av. 0 6 10
Total of England	32,243,200	8,331,434	11,261,437	2,753,295	7,321,875	7,673,633	14,995,508	Av. 2·150	Av. 0 17 3½
Total of England & Wales	36,995,200	8,872,980	11,978,875	2,941,491	7,769,408	8,137,421	15,906,829	Av. 2·325	Av. 0 15 11¼

II. Table exhibiting the Area, Population, &c. of Scotland.

Counties.	Area in Acres. Land.	Area in Acres. Lakes.	Area in Acres. Total.	Population, 1801.	Population, 1821.	Inhabited Houses, 1841.	Population, 1841. Males.	Population, 1841. Females.	Population, 1841. Total.	Acres of Land to an Individual in 1841.	Rent of Land per Acre in 1810.
											L. s. d.
Aberdeen	1,254,400	6,400	1,260,800	123,082	155,387	32,193	89,528	102,755	192,283	6·523	0 3 8¾
Argyle, and Islands	2,002,560	51,840	2,054,400	71,859	97,316	18,514	47,654	49,486	97,140	20·615	0 1 11
Ayr	664,960	3,840	668,800	84,306	127,299	30,247	78,970	85,552	164,522	4·041	0 10 1½
Banff	412,800	1,280	414,080	35,807	43,561	11,228	23,425	26,651	50,076	8·243	0 3 10¼
Berwick	282,880	—	282,880	30,621	33,385	7,405	16,527	17,900	34,427	8·216	0 16 5
Bute	103,040	2,560	105,600	11,791	13,797	3,067	7,108	8,587	15,695	6·565	0 3 7¼
Caithness	439,680	6,400	446,080	22,609	30,238	6,962	16,993	19,204	36,197	12·146	0 1 5
Clackmannan	30,720	—	30,720	10,858	13,263	3,593	9,331	9,785	19,116	1·607	1 0 10¼
Dumbarton	145,920	19,840	165,760	20,710	27,317	7,986	22,505	21,790	44,295	3·294	0 6 1½
Dumfries	801,920	6,400	808,320	54,597	70,878	14,375	34,097	38,728	72,825	11·011	0 7 9¾
Edinburgh	226,560	—	226,560	122,954	191,514	38,903	102,709	122,914	225,623	1·004	1 4 6¼
Elgin	302,720	4,480	307,200	26,705	31,162	8,133	16,071	18,923	34,994	8·650	0 4 1¼
Fife	298,880	1,920	300,800	93,743	114,556	28,965	65,735	74,575	140,310	2·130	1 2 5¼
Forfar (Angus)	568,320	2,560	570,880	99,127	113,430	36,153	79,234	91,166	170,400	3·335	0 9 1¾
Haddington	174,080	—	174,080	29,986	35,127	8,009	17,253	18,528	35,781	4·865	1 0 9
Inverness, and Islands	2,594,560	122,240	2,716,800	74,292	90,157	19,182	45,506	52,109	97,615	26·579	0 1 1½
Kincardine	243,200	1,280	244,480	26,349	29,118	7,274	15,804	17,248	33,052	7·358	0 13 1¾
Kinross	46,080	4,480	50,560	6,725	7,762	1,806	4,194	4,569	8,763	5·258	0 9 10½
Kirkcudbright	525,760	8,000	533,760	29,211	38,903	8,159	18,838	22,261	41,099	12·792	0 7 3¾
Lanark	604,880	1,920	604,800	146,699	244,387	81,531	208,369	218,744	427,113	1·416	0 9 10½
Linlithgow	76,800	—	76,800	17,884	22,685	5,309	13,766	13,082	26,848	2·860	1 1 7¼
Nairn	124,800	1,920	126,720	8,257	9,006	2,235	4,232	4,986	9,218	13·538	0 1 10½
Orkney and Shetland	819,200	25,600	844,800	46,844	53,124	11,571	26,843	33,953	60,796	13·474	0 0 4¾
Peebles	204,160	—	204,160	8,735	10,046	2,119	5,122	5,398	10,520	19·406	0 5 7½
Perth	1,656,320	32,000	1,688,320	126,366	139,050	29,172	65,339	72,812	138,151	11·989	0 5 6¾
Renfrew	144,000	1,280	145,280	78,056	112,175	24,626	72,725	82,030	154,755	·930	0 17 7¾
Ross and Cromarty, and Islands	1,846,400	57,600	1,904,000	35,343	68,828	16,377	36,861	42,119	78,980	23·378	0 1 1¼
Roxburgh	457,600	320	457,920	33,682	40,892	8,662	21,930	24,073	46,003	9·947	0 10 1
Selkirk	168,320	960	169,280	5,070	6,637	1,446	3,972	4,017	7,989	21·069	0 4 8¾
Stirling	312,960	8,320	321,280	50,825	65,376	15,837	41,070	41,109	82,179	3·808	0 11 4¼
Sutherland	1,222,560	30,080	1,152,640	23,117	23,840	4,972	11,307	13,359	24,666	45·510	0 0 6
Wigtown	288,960	4,800	293,760	22,918	33,240	7,440	18,258	20,921	39,179	7·375	0 8 6¾
	18,944,000	408,320	19,352,320	1,599,068	2,093,456	503,451	1,241,276	1,379,334	2,620,610	Av. 7·228	Av. 0 5 1½

III. TABLE exhibiting the Area, Population, &c. of Ireland.

Provinces and Counties.	Area in Statute Acres.	Lakes.	Extent in Acres exclusive of Lakes.	Population, 1821.	Population, 1831. Males.	Population, 1831. Females.	Population, 1831. Totals.	Inhabited Houses, 1831.	Acres of Land to an individual in 1831.	Rent of Land per Acre in 1831. L. s. d.
Leinster.										
Carlow -	;219,863	—	219,863	97,070	48,327	51,026	99,353	13,275	2·682	0 15 0
Dublin - -	248,631	—	248,631	335,892	173,856	206,311	380,167	39,861	·654	1 0 1½
Kildare -	392,435	—	392,435	99,065	54,472	53,952	108,424	17,155	3·619	0 13 0
Kilkenny -	513,686	—	513,686	182,046	93,977	99,709	193,686	31,007	2·652	0 17 0½
King's - -	528,166	248	527,918	131,088	71,287	72,938	144,225	24,256	3·660	0 12 0
Longford -	263,645	15,892	247,753	107,570	55,310	57,248	112,558	19,418	2·201	0 12 3
Louth - -	206,261	—	206,261	101,011	52,439	55,042	107,481	22,040	1·652	0 16 0
Meath - -	567,127	—	567,127	159,183	88,993	87,833	176,826	29,796	3·207	0 18 0
Queen's -	396,810	—	396,810	134,275	72,469	73,382	145,851	23,783	2·721	0 14 0
Westmeath -	386,251	16,334	369,917	128,819	67,700	69,172	136,872	23,803	2·703	0 13 7
Wexford -	564,479	—	564,479	170,806	87,995	94,718	182,713	29,923	3·089	0 14 0
Wicklow -	494,704	—	494,704	110,767	61,052	60,505	121,557	18,412	4·070	0 12 0
Totals -	4,782,058	32,474	4,749,584	1,757,592	927,877	981,836	1,909,713	292,729	Av. 2·487	Av. 0 14 7½
Munster.										
Clare - -	802,352	18,655	783,697	208,089	128,446	129,876	258,322	40;358	3·034	0 11 3
Cork - -	1,769,563	—	1,769,563	730,444	396,714	414,018	810,732	118,879	2·183	0 13 7¼
Kerry - -	1,148,720	14,669	1,134,051	216,185	131,696	131,430	263,126	41,294	4·310	0 6 1
Limerick -	674,783	—	674,783	277,477	153,625	161,730	315,355	44,801	2·140	0 18 8
Tipperary -	1,013,173	11,328	1,001,845	346,896	197,715	204,850	402,563	60,264	2·489	0 17 8½
Waterford -	471,281	—	471,281	156,521	85,217	91,837	177,054	24,848	2·662	0 12 6
Totals -	5,879,872	44,652	5,835,220	1,935,612	1,093,411	1,133,741	2,227,152	330,444	Av. 2·620	Av. 0 13 0¼
Ulster.										
Antrim -	758,866	49,790	709,076	262,860	152,178	164,731	316,909	55,971	2·178	0 16 0½
Armagh -	328,183	18,394	309,789	205,450	111,618	117,222	228,840	39,571	1·407	0 11 6¼
Cavan - -	473,449	21,987	451,462	195,076	113,174	114,759	227,933	38,917	1·981	0 13 7½
Donegal -	1,165,107	—	1,165,107	248,270	141,845	147,304	289,149	50,171	4·029	0 6 0
Down - -	611,404	158	611,246	325,410	169,416	182,596	352,012	62,629	1·736	0 16 0
Fermanagh -	471,348	48,797	422,551	130,997	73,117	76,646	149,763	25,781	2·821	0 12 3
Londonderry -	518,270	9,565	508,705	193,869	106,657	115,355	222,012	39,077	2·291	0 12 2¾
Monaghan -	327,018	7,844	319,204	174,697	95,679	99,857	195,536	35,225	1·632	0 13 3¾
Tyrone - -	754,395	27,261	727,134	261,865	149,410	155,058	304,468	54,663	2·388	0 14 6¼
Totals -	5,408,070	183,796	5,224,274	1,998,494	1,113,094	1,173,528	2,285,622	402,005	Av. 2·285	Av. 0 12 3¼
Connaught.										
Galway - -	1,510,592	77,922	1,432,670	337,374	204,691	209,993	414,684	67,114	3·455	0 12 1½
Leitrim -	420,375	25,568	394,807	124,785	69,451	72,073	141,524	24,200	2·790	0 10 7¾
Mayo - -	1,355,048	57,940	1,297,108	293,112	179,595	186,733	366,328	62,367	3·541	0 8 5¾
Roscommon -	609,405	24,787	584,618	208,792	123,031	126,582	249,613	41,369	2·342	0 13 0
Sligo - -	434,188	8,260	425,928	146,229	83,730	88,035	171,765	29,588	2·480	0 10 8¼
Totals -	4,329,608	194,477	4,135,131	1,110,292	660,498	683,416	1,343,914	224,638	Av. 3·077	Av. 0 10 9¾
Gen. Totals -	20,399,608	455,399	19,944,209	6,801,990	3,794,880	3,972,521	7,767,401	1,249,816	Gen. Av. 2·568	Gen. Av. 0 12 9

IV. The following Account of the Area and Population of the different European States has been compiled from the latest and best authorities, and will, we believe, be found nearly accurate. There are no means whatever of compiling any similar account for any one of the other quarters of the world.

States, and their Designation.	Area in Square Miles (English).	Population. (Latest Returns.)	Pop. to the Square Mile.
United Kingdom of Great Britain and Ireland.			
Great Britain - - - - - -	87,412	(1841) 18,532,335	212·0
Ireland - - - - - -	31,874	8,205,382	257·4
Isle of Man and Channel Islands - - -	1,096	124,079	113.2
Total U. K. - -	120,382	26,861,796	223·1
Russia (including Poland) - - - -	2,000,000	49,000,000	24·5
Austria (including Lombardy, &c.) - -	257,368	(1839) 36,519,560	141·9
France (including Corsica) - - - -	203,736	(1836) 33,540,908	164·6
Prussia - - - - - - -	107,921	(1838) 14,330,146	132·7
Spain - - - - - - -	182,270	12,286,941	66·9
Turkey (including Servia, Wallachla, and Moldavia) -	210,585	15,000,000	71·2
Sweden and Norway - - - -	291,164	(1833-9) 4,259,772	14·6
Belgium (including parts of Limburg and Luxemburg) -	13,214	(1836) 4,242,600	321
Portugal - - - - -	36,510	3,550,000	97·2
Holland (including parts of Limburg and Luxemburg) -	13,598	(1838) 2,915,396	214·4
Denmark (including Holstein and Lauenburg) - -	21,856	(1834-5) 2,033,265	93
Germany.			
Bavaria - - - - - -	29,637	(1837) 4,315,469	145·2
Hanover - - - - - -	14,734	(1838) 1,706,280	122·5
Wirtemberg - - - - -	7,640	(1836) 1,634,654	214·2
Saxony - - - - - -	5,759	(1837) 1,652,114	287·5
Baden - - - - -	5,904	(1838) 1,263,100	213·9
Hesse-Cassel - - - -	4,430	— 704,900	159·1
— Darmstadt - - -	3,240	— 783,400	241·1
Mecklenburg Schwerin - - - -	4,833	— 482,652	99·8
Oldenburg - - - - -	2,417	— 267,660	110·7
Nassau - - - - -	1,753	— 379,262	216·3
Other German States - - - -	10,282	— 970,190	191·6
Italy.			
Naples and Sicily - - - - -	42,132	(1837) 7,975,850	189·3
Sardinia and Piedmont (including Monaco) - -	29,130	(1838) 4,650,368	159·6
Papal State - - - - -	17,210	2,732,436	158·7
Tuscany - - - - - -	7,686	(1836) 1,436,785	186·9
Parma - - - - -	2,268	(1833) 465,673	205·7
Modena - - - - -	2,092	403,000	192·7
Lucca - - - - - -	413	(1836) 158,900	385
San Marino - - - - -	22	7,600	345·4
Swiss Confederation - - - -	14,950	(1836) 2,125,480	142·1
Greece - - - - - -	17,900	926,000	51·1
Malta and Gozzo - - - -	118	120,000	1016·9
Ionian Islands - - - - -	999	208,100	208·3
Cracow - - - - -	488	(1837) 131,462	269·4
Andorre - - - - -	200	7,000	35
Total - -	3,684,841	240,048,719	65·1

STA'TUARY. (From statue.) The art of carving or otherwise forming statues.

STATUE. (Lat. statua, from sto, *I stand.*) In Sculpture, a representation in relief in some solid substance, as marble or bronze, or in some apparently solid substance, of a man or other animal. There are various species of statues: — 1. Those smaller than nature. 2. Those of the same size as nature. 3. Those larger than nature. 4. Those that are three or more times larger than nature, and are called *colossal*. The first were by the ancients confined to men and gods generally. The second were confined to the representation of men celebrated for their learning and talents, who had rendered service to the state, and were executed at the public expense. The third were confined to kings, emperors, and, when more than twice the size of nature, to heroes. The fourth species were confined to statues of the gods, or of kings and emperors represented under the form of gods. *Equestrian statues* are those in which the figure is seated on a horse. *See* SCULPTURE.

STA'TUS QUO. In Politics, a treaty between two or more belligerents, which leaves each party in possession of the same territories, fortresses, &c. as it occupied before hostilities broke out, is said to leave them "in statu quo ante bellum," in the same state as before the war.

STA'TUTE. (Lat. statuo, *I establish.*) An act of parliament made by the king by and with the advice of the lords and commons. But some ancient statutes are in the form of charters or ordinances, proceeding from the crown, and in which the consent of the lords and commons is not expressed. 1. As to the time from which statutes run, if no time was expressed for the operation of a statute to commence, it was of force anciently from the first day of the session, and consequently had a retrospective operation. By 33 G. 3. c. 13. it now has force from the day on which it receives the royal assent. 2. Statutes are divided into public and private; a distinction which rests rather on conventional usage and difference in the formalities of passing them, than on any principle; and public acts themselves may be either local or general. There may be a private clause in a general act. Statutes are also said to be *declaratory* of the law as it stood at their passing; *remedial*, to correct defects in the common law, subdivided into *enlarging* and *restraining;* and *penal*, imposing prohibitions and penalties. But these, again, are rather distinctions of an arbitrary character than of any legal effect, although some legal maxims have been founded on them; *e. g.* that penal statutes, or clauses in statutes, are to be construed strictly, remedial statutes liberally, &c. A few other rules laid down by learned authorities in the construction of statutes are, — that they are to be construed out of the words themselves, according to the true intent of the makers; that when the words of a statute are doubtful, general usage may be called in to explain them; that the purview of the whole act is to be considered, and not particular words or clauses only; that doubtful words are to be construed with reference to the object of the act; that the *preamble*, or recital at the commencement, is to be considered, as it generally indicates the evil which it was meant to remedy, and consequently affords an insight into the meaning of the framers; that repeal of former statutes by implication shall not be favoured, &c. Statutes are numbered according to rather an inconvenient arrangement: the entire acts of one session are considered as forming two collections or volumes, one of public and one of private acts; each act forming a distinct "chapter," and subdivided into sections.

STAUROLITE. (Gr. σταυρος, *a cross*, and λιθος, *a stone.*) The mineral called *cross-stone*, *harmotome*, and *Andreasbergolite*. It is a silicate of baryta and alumina, with traces of lime and potash, and forms small quadrangular prisms crossing each other: the most characteristic specimens are from Andreasberg, in the Hartz.

STAUROTIDE. (Gr. σταυρος, *a cross*, and ειδος, *form.*) A name given by Haüy, and other mineralogists, to the prismatic garnet, or *grenatite*. It occurs in four and six-sided prisms, sometimes crossing each other at right angles. It is a silicate of alumina and lime, with the oxides of iron and manganese. It occurs in primary rocks, and is distinguished from garnet by its form and difficult fusibility.

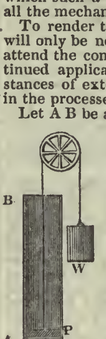
STAY. A strong rope from the mast head, leading forward to support it from falling aft. It takes the name of the mast, as the fore stay, main-topmast stay, &c. *To stay*, means to tack. To be *in stays*, is to be in the act of tacking. To *miss stays*, signifies to fail in attempting to tack.

STEAM. The elastic fluid into which water is converted by the continued application of heat.

All liquids whatever, when exposed to a sufficiently high temperature, are converted into vapour. The mechanical properties of vapour are similar to those of gases in general. The property which is most important to be considered, in the case of steam, is the elastic pressure. When a vapour or gas is contained in a close vessel, the inner surface of the vessel will sustain a pressure arising from the *elasticity* of the fluid. This pressure is produced by the mutual repulsion of the particles, which gives them a tendency to fly asunder, and causes the mass of the fluid to exert a force tending to burst any vessel within which it is confined. This pressure is uniformly diffused over every part of the surface of the vessel in which such a fluid is contained: it is to this quality that all the mechanical power of steam is due.

To render the chief properties of steam intelligible, it will only be necessary to explain the phenomena which attend the conversion of water into vapour by the continued application of heat, under the various circumstances of external pressure which present themselves in the processes of nature and art.

Let A B be a tube or cylinder, the magnitude of whose base is a square inch, and let a piston P move steam-tight in it; let it be imagined that under this piston, in the bottom of the cylinder, there is an inch depth of water, which will therefore be in quantity a cubic inch; let the piston be counterbalanced by a weight W acting over a pulley, which shall be sufficient to counterpoise the weight of the piston and its friction in the cylinder; and let the weight W be so arranged that from time to time its amount may be diminished to any required extent. Under the circumstances here supposed, the piston being in contact with the water, and all air being excluded from beneath it, it will be pressed down by the weight of the atmosphere, which we shall assume to be 14¾ lbs. Let it be also supposed that a thermometer is placed in the water under the piston, and that the tube A B is transparent, so that the indications of the thermometer may be observed. The temperature of the water under the piston being reduced to that of melting ice, which is 32° of the common thermometer, let the flame of a lamp be applied under the tube, and let the time of its application be noted. If the thermometer be now observed, it will be seen slowly and gradually to indicate an increasing temperature of the water, the piston maintaining its position in contact with the water unchanged. This augmentation of temperature will continue until the thermometer indicates the temperature of 212°. Let the time be then noted. It will be found that after that epoch, the water will cease to increase in temperature, notwithstanding the continued application of the lamp, the thermometer not rising above 212°. But another effect will begin to be manifested; the piston P will be observed gradually to rise, leaving a space apparently vacant between it and the water. The depth of the water will, however, be at the same time gradually diminished, and the diminution of its depth will be found to bear constantly the same proportion to the ascent of the piston. This proportion will render the circumstances here supposed to be that of 1700 to 1. If the application of the lamp be continued, and the tube have sufficient length, the water will, after the lapse of a certain time, altogether disappear from the bottom of the tube; and when that occurs, the piston will have risen to the height of 1700 inches, being 1700 times the original depth of the water.



The tube will now, to all appearance, be empty; but if the apparatus were weighed, it would be found to have the same weight as at the commencement of the experiment. The water, therefore, must still be contained in the tube, though it has assumed an invisible form. To demonstrate its presence, let the lamp be removed; immediately the piston will begin to descend, and the inner surface of the tube will be covered with a dew, which speedily increasing, will fall to the bottom in drops of water. The piston meanwhile will continue to move downwards, sweeping before it the water from the sides of the tube; and at length will recover its first position, having under it, as at the beginning, a cubic inch of water.

In the above process, the elevation of the piston is produced by the elastic force of the steam, into which the water was gradually converted by the lamp. The space between the piston and the water during its ascent, though apparently empty, was filled with steam; which, like air and most other gases, is a colourless and invisible fluid. The proportion of the elevation of the piston to the diminution of depth of the water being 1700 to 1, proves that the water in passing into steam increases its volume in that proportion. When the water altogether disappeared, the height of the piston from the bottom of the tube was 1700 inches; and as the tube under the piston was then filled with the steam into which the water had been converted, it is apparent that the cubic inch of water, in this case, was converted into 1700 inches of steam.

The pressure of the atmosphere above the piston was, in this case, overcome by the elastic force of the steam, and the piston, bearing that pressure upon it, was raised to a height of 1700 inches. In the evaporation, therefore,

of this cubic inch of water, a mechanical force has been evolved equivalent to $14\frac{3}{4}$ lbs. raised to the height of 1700 inches.

From the moment at which the water began to be converted into steam the thermometer, having then attained 212°, ceased to rise. Nevertheless, the application of the lamp was continued, and therefore the same quantity of heat per minute was still supplied to the water. Since the water did not increase in temperature, it may be asked what became of this continued supply of heat received from the lamp? It may be said that it was imparted to the steam into which the water was converted; but if the thermometer were raised out of the water, and held in the steam between the water and the piston, it would still indicate the same temperature of 212°. We thus arrive at the extraordinary and unexpected fact, that notwithstanding a large supply of heat imparted to water during its evaporation, that heat is sensible neither in the water itself nor in the vapour into which the water is converted.

The quantity of heat which is thus absorbed in converting water into steam is easily determined, the interval of time being noted which elapsed between the first application of the lamp and the moment at which the thermometer ceased to rise. Let us suppose that interval to be an hour; the interval being also noted between the moment the thermometer ceases to rise and the process of evaporation begins, and the moment at which the last particle of water disappears from the bottom of the tube and the evaporation is completed, it will be found that this interval is $5\frac{1}{2}$ hours; and in general, whatever may be the length of time necessary to raise the temperature of the water from 32° to 212°, $5\frac{1}{2}$ times that interval will be necessary for the same source of heat to evaporate the same quantity of water. It follows, therefore, that *to evaporate water under a pressure of* $14\frac{3}{4}$ *pounds per square inch requires* $5\frac{1}{2}$ *times as much heat as is necessary and sufficient to raise the same water from* 32° to 212°.

Since the difference between 212° and 32° is 180°, and since $5\frac{1}{2}$ times 180° is 990°, it follows that to convert the water into steam after it has attained the temperature of 212°, as much heat must be supplied to it as would be sufficient, if it were not evaporated, to raise it 990° higher. The heat thus absorbed in evaporation, and not sensible to the thermometer, is said to be latent in the steam; and the phenomena which have been just described form the foundation of the whole theory of *latent heat.* That this large quantity of heat is actually contained in the steam, though not sensible to the thermometer, admits of easy demonstration, by showing that it may be reproduced by converting the steam into water. If a cubic inch of water, in the form of steam at the temperature of 212°, be introduced into the same vessel with $5\frac{1}{2}$ cubic inches of water at the temperature of 32°, the steam will be immediately converted into water; the temperature of the $5\frac{1}{2}$ inches of ice-cold water will be raised to 212°, and there will be found in the vessel $6\frac{1}{2}$ cubic inches of water at 212°. Thus, while the steam, in reassuming the liquid form, has lost none of its temperature, it has nevertheless given up as much heat as has raised $5\frac{1}{2}$ cubic inches of water from 32° to 212°. It is therefore demonstrated that this quantity of heat was actually in the steam; and that it was its presence there in the latent state, by some agency not yet explained, that conferred upon the water in the vaporous form the property of elasticity.

We have here supposed that the pressure under which the water in the tube was evaporated was the mean pressure of the atmosphere, or $14\frac{3}{4}$ lbs. per square inch. Let us now suppose that the piston resting on the water is loaded with a force of $14\frac{3}{4}$ lbs., besides the pressure of the atmosphere, which may be done by taking $14\frac{3}{4}$ lbs. from the counterpoise W. If the same process be followed as before, it will now be found that the thermometer will not cease to rise when it has attained 212°; nor will the piston then begin to ascend. The thermometer will, on the other hand, continue to rise until it has attained 250°. It will then, as in the former case, cease to rise; the piston will ascend, and the water will begin to be converted into steam; the proportion, however, between the ascent of the piston and the diminished depth of the water, or, in other words, between the volume of steam produced and the volume of water producing it, instead of being 1700 to 1, will now be about 930 to 1, being little more than half the former proportion. The force against which the elasticity of the steam, in the present case, acts, is $29\frac{1}{2}$ lbs.; and this force is raised about 930 inches by the evaporation of a cubic inch of water. In the former case, a force of $14\frac{3}{4}$ lbs., being half the present force, was raised to 1700 inches by the evaporation of the same quantity of water. If the double force, instead of being raised 930 inches, had been raised only 850 inches, or half the first elevation, then the mechanical effect evolved would in both cases be precisely the same, the double resistance being raised through only half the space; but the actual height through which the double resistance is raised being 930 inches instead of 850, a greater mechanical effect is produced in the one case than in the other, in the proportion of 930 to 850, being an advantage on the part of the steam of greater pressure of about 8 per cent.

If the pressure under which the evaporation is produced were further varied, it would be found that with every increase of pressure the temperature at which the evaporation would commence would be augmented, and that with every diminution of pressure that temperature would be diminished. It would be also found that the volume of steam produced by a cubic inch of water would be less with every increase of pressure under which the evaporation is made; and that the diminution of volume would be nearly, but not in quite so great a proportion, as the increase of pressure. In like manner, if the pressure be diminished, the volume of steam produced by a cubic inch of water will be augmented in nearly, but not quite so great a proportion, as that of the diminution of pressure. From all this, it obviously follows that the mechanical effect evolved by the evaporation of a given volume of water under different pressures is very nearly the same; greater pressures, however, having a slight advantage over lesser ones.

It has been seen that $14\frac{3}{4}$ lbs. are raised to a height of 1700 inches by the evaporation of a cubic inch of water under the pressure of $14\frac{3}{4}$ lbs. per square inch. Now, 1700 inches are nearly equal to 142 feet; and $14\frac{3}{4}$ lbs. raised 142 feet is equivalent to 142 times $14\frac{3}{4}$ lbs. raised one foot, which is equal to very nearly 2100 lbs. raised one foot. To use round numbers, it may then be stated, that by the evaporation of a cubic foot of water a mechanical force is produced equivalent to a ton weight raised a foot high; and that this force is very nearly the same, whatever be the temperature or pressure under which the evaporation takes place.

In the following table, calculated by Dr. Lardner, and given by him in the Appendix to the 7th edition of his work on the *Steam Engine*, is exhibited the temperatures at which water is evaporated under different pressures, the volume into which the water expands by evaporation, the mechanical effect evolved expressed in lbs. raised one foot.

Total Pressure in Pounds per Square Inch.	Corresponding Temperature.	Volume of the Steam compared to the Volume of the Water that has produced it.	Mechanical Effect of a Cubic Inch of Water evaporated, in Pounds raised One Foot.
1	102·9	20868	1739
2	126·1	10874	1812
3	141·0	7437	1859
4	152·3	5685	1895
5	161 4	4617	1924
6	169·2	3897	1948
7	175·9	3376	1969
8	182·0	2983	1989
9	187·4	2674	2006
10	192·4	2426	2022
11	197·0	2221	2036
12	201·3	2050	2050
13	205·3	1904	2063
14	209·1	1778	2074
15	212·8	1669	2086
16	216·3	1573	2097
17	219·6	1488	2107
18	222·7	1411	2117
19	225·6	1343	2126
20	228·5	1281	2135
21	231·2	1225	2144
22	233·8	1174	2152
23	236·3	1127	2160
24	238·7	1084	2168
25	241·0	1044	2175
26	243·3	1007	2182
27	245·5	973	2189
28	247·6	941	2196
29	249·6	911	2202
30	251·6	883	2209
31	253·6	857	2215
32	255·5	833	2221
33	257·3	810	2226
34	259·1	788	2232
35	260·9	767	2238
36	262·6	748	2243
37	264·3	729	2248
38	265·9	712	2253
39	267·5	695	2259
40	269·1	679	2226
41	270·6	664	2268
42	272·1	649	2273
43	273·6	635	2278
44	275·0	622	2282
45	276·4	610	2287
46	277·8	598	2291
47	279·2	586	2296
48	280·5	575	2300
49	281·9	564	2304
50	283·2	554	2308
51	284·4	544	2312
52	285·7	534	2316
53	286·9	525	2320
54	288·1	516	2324
55	289·3	508	2327
56	290·5	500	2331
57	291·7	492	2335
58	292·9	484	2339
59	294·2	477	2343
60	295·6	470	2317

Total Pressure in Pounds per Square Inch.	Corresponding Temperature.	Volume of the Steam compared to the Volume of the Water that has produced it.	Mechanical Effect of a Cubic Inch of Water evaporated, in Pounds raised One Foot.
61	296·9	463	2351
62	298·1	456	2355
63	299·2	449	2359
64	300·3	443	2362
65	301·3	437	2365
66	302·4	431	2369
67	303·4	425	2372
68	304·4	419	2375
69	305·4	414	2378
70	306·4	408	2382
71	307·4	403	2385
72	308·4	398	2388
73	309·3	393	2391
74	310·3	388	2394
75	311·2	383	2397
76	312·2	379	2400
77	313·1	374	2403
78	314·0	370	2405
79	314·9	366	2408
80	315·8	362	2411
81	316·7	358	2414
82	317·6	354	2417
83	318·4	350	2419
84	319·3	346	2422
85	320·1	342	2425
86	321·0	339	2427
87	321·8	335	2430
88	322·6	332	2432
89	323·5	328	2435
90	324·3	325	2438
91	325·1	322	2440
92	325·9	319	3443
93	326·7	316	2445
94	327·5	313	2448
95	328·2	310	2450
96	329·0	307	2453
97	329·8	304	2455
98	330·5	301	2457
99	331·3	298	2460
100	332·0	295	2462
110	339·2	271	2486
120	345·8	251	2507
130	352·1	233	2527
140	357·9	218	2545
150	363·4	205	2561
160	368·7	193	2577
170	373·6	183	2593
180	378·4	174	2608
190	382·9	166	2622
200	387·3	158	2636
210	391·5	151	2650
220	395·5	145	2663
230	399·4	140	2675
240	403·1	134	2687

From what has been above explained, it is apparent that the quantity of sensible heat in steam is augmented with every increase of pressure under which the evaporation takes place; but if the interval of time be observed which elapses between the first application of the lamp to the ice-cold water in the experiment above described, and the moment at which the last particle of water disappears by evaporation from the bottom of the tube, it will be found that this interval is exactly the same, whatever be the temperature or pressure under which the evaporation takes place. It follows, therefore, that the actual quantity of heat necessary to convert ice-cold water into steam is the same, whatever be the pressure of the steam; but as the temperature of steam increases and diminishes as the pressure is increased or diminished, it follows that this given quantity of heat is differently distributed between sensible and latent heat in steam of different pressures. As the pressure is increased the sensible heat is augmented, and the latent heat undergoes a corresponding diminution, and *vice versâ*. The sum of the sensible and latent heats is, in fact, a constant quantity; the one being always increased at the expense of the other. It has been shown that in converting water at 32° of temperature, and under a pressure of $14\frac{3}{4}$ lbs. per square inch, it was necessary first to give it 180° additional sensible heat, and afterwards 990° of latent heat, the total heat imparted to it being 1170°. Such, then, is the actual quantity of heat which must be imparted to ice-cold water to convert it into steam. The actual temperature to which water would be raised by the heat necessary to evaporate it, if its evaporation could be prevented by confining it in a close vessel, will be found by adding 32° to 1170°. It may, therefore, be stated that the heat necessary for the evaporation of ice-cold water is as much as would raise it to the temperature of 1202°, if its evaporation were prevented. If the temperature of red-hot iron be, as is supposed, about 800°, and that all bodies become incandescent at the same temperature, it follows that to evaporate water it is necessary to impart to it 400° more heat than would be sufficient to render it red hot if its evaporation were prevented. As the mechanical effect evolved by water evaporated at all pressures is nearly the same, and as the quantity of heat necessary to effect that evaporation is also the same, it follows that the same quantity of fuel employed in the evaporation of water is productive of very nearly the same mechanical effect, whatever be the pressure of the steam.

Since the heat imparted to water in evaporation is necessary to sustain it in the form of vapour, it follows that if any portion of that heat be taken from it, the steam will not be lowered in temperature, but a portion of it will be reconverted into water; a process which is called *condensation*. To illustrate this, let us suppose the tube A B to be filled with steam of 212° of temperature, produced from a cubic inch of water evaporated under the pressure of $14\frac{3}{4}$ lbs. on the piston. If, by the application of external cold, or any other means, a quantity of heat be extracted from this steam, say as much as would be sufficient to evaporate the tenth of a cubic inch of water, then a tenth part of the steam in the tube will be condensed and deposited in the liquid state in the bottom, the piston will descend through a tenth of its entire height, and the steam remaining uncondensed will still have the temperature of 212° and the pressure of $14\frac{3}{4}$ lbs. per square inch, while the water in the bottom of the tube produced by the condensation will also have a temperature of 212°. The heat, therefore, which has been thus abstracted is the heat which was latent in the steam formed by the water thus deposited. And in the same manner, any heat which is drawn from the steam will be latent heat; a corresponding condensation will take place until all the steam has been condensed, and the piston brought into contact with the bottom of the tube. After that, any abstraction of heat must be made at the expense of the sensible heat of the water.

It has, in some works, been stated that by mere mechanical compression steam will be converted into water. This is, however, an error, since steam, in whatever state it may exist, must possess at least 212° of heat; and as this quantity of heat is sufficient to maintain it in the vaporous form, under whatever pressure it may be placed, it is clear that no compression or increase of pressure can diminish the actual quantity of heat contained in the steam; and it cannot, therefore, convert any portion of the steam into water.

If steam, by mechanical pressure, be forced into a diminished volume, it will undergo an augmentation both of temperature and pressure, the increase of pressure being greater than the diminution of volume; in fact, any change of volume which it undergoes will be attended with the change of temperature and pressure indicated in the above table. The steam, after its volume has been changed, will assume exactly the pressure and temperature which it would have in the same volume if it were immediately evolved from water. Thus, let us suppose a cubic inch of water converted into steam under a pressure of $14\frac{3}{4}$ lbs. per square inch, and at the temperature of 212°. Let its volume be then reduced by compression in the proportion of 1700 to 930. When so reduced, its temperature will be found to have risen from 212° to 250°, and its pressure will be increased from $14\frac{3}{4}$ lbs. per square inch to $29\frac{1}{2}$ lbs. per square inch; but this is exactly the state, as to pressure, temperature, and density, as the steam would be in if it were immediately raised from water under the pressure of $29\frac{1}{2}$ lbs. per square inch. It appears, therefore, that in whatever manner, after evaporation, the density of steam be changed, whether by expansion or contraction, it will still remain the same as if it were immediately raised from water in its actual state.

The circumstance which has given rise to the erroneous notion that mere mechanical compression will produce a condensation of steam is, that the vessel in which steam is contained must necessarily have the same temperature as the steam itself. If then the steam contained in the vessel be suddenly compressed, it will undergo as sudden an elevation of temperature; and the vessel containing it not receiving at the same time, from any external source, a corresponding increase of temperature, it will rob the steam of a portion of its heat, and a partial condensation will be produced, and will be continued until the temperatures of the steam and the vessel containing it shall be equalized.

Since water, in passing into steam, suffers a great enlargement of volume, steam, on the other hand, in being converted into water undergoes a corresponding diminution of volume. It has been seen that a cubic inch of water, evaporated at the temperature of 212°, swells into 1700 cubic inches of steam. It follows, therefore, that if a close vessel, containing 1700 cubic inches of such steam, be exposed to cold sufficient to take from the steam all its latent heat, the steam will be reconverted into water, will shrink into its original dimensions, and will leave the remainder of the vessel a vacuum. This property of steam has supplied the means, in practical mechanics, of obtaining that amount of mechanical power which the properties of the atmosphere confer upon a vacuum. If by any means whatever the space in a cylinder under the piston be rendered a vacuum, the atmospheric pressure will take effect above the piston, and will urge the piston downwards with a force amounting to about 15 lbs. on each square inch of the surface of the piston. To render

steam available for this purpose, it is only necessary to inject it into the cylinder until it expels from the cylinder all the atmospheric air or other uncondensable gases which the cylinder contains; and when that is effected, the pure steam which remains in the cylinder being suddenly condensed by the application of cold, leaves the cylinder a vacuum, and gives effect to the atmospheric pressure above the piston, as before explained. This is, in fact, the principle of the atmospheric engine.

The temperature and pressure of steam produced by immediate evaporation, when it has received no heat, save that which it takes from the water, have a fixed relation one to the other. If this relation were known, and expressed by a mathematical formula, the temperature might always be inferred from the pressure, or *vice versâ*. But physical science has not yet supplied any principles by which such a formula can be deduced from any known properties of liquids. In the absence, therefore, of any general relation established by direct reasoning, empyrical formulæ have been proposed which express, with more or less precision, this relation in different parts of the thermometric scale.

When the pressure under which the evaporation takes place does not exceed one atmosphere, or 15 lbs. per square inch, the relation between the temperature and the pressure will be expressed with sufficient accuracy by the following formulæ, proposed by Southern:—

$$P = 0{\cdot}04948 + \left(\frac{51{\cdot}3 + T}{155{\cdot}7256}\right)^{5{\cdot}13}$$

$$T = 155{\cdot}7256 \times \sqrt[5{\cdot}13]{P - 0{\cdot}04948} - 51{\cdot}3\,;$$

where P expresses the pressure in pounds per square inch, and T the temperature by Fahrenheit's thermometer.

For pressures exceeding one atmosphere and not exceeding four, the relation is expressed by the following formulæ, proposed by Tredgold:—

$$P = \left(\frac{103 + T}{201{\cdot}18}\right)^6$$

$$T = 201{\cdot}18\sqrt[6]{P} - 103\,;$$

or by the following formulæ,

$$P = \left(\frac{98{\cdot}806 + T}{198{\cdot}562}\right)^6$$

$$T = 198{\cdot}562\sqrt[6]{P} - 98{\cdot}806.$$

For pressures extending from four to fifty atmospheres, the following formulæ have been proposed by Messrs. Dulong and Arago:—

$$P = (0{\cdot}26793 + 0{\cdot}0067585\ T)^5$$

$$T = 147{\cdot}961\sqrt[5]{P} - 39{\cdot}644.$$

Biot has proposed a more general fomula, which expresses the relation between the pressure and the temperature, whatever be the pressure under which the evaporation takes place. Let p be the pressure, expressed in millimètres, of mercury at the temperature of melting ice; let t be the temperature of the water, taken on the centesimal air thermometer; and let a, a_1, a_2, b_1, b_2 be constant quantities, whose values shall be determined by the following conditions:—

$$\begin{aligned} a &= 5{\cdot}96131330259 \\ \log. a_1 &= \bar{1}{\cdot}82340688193 \\ \log. b_1 &= -\,0{\cdot}01309734295 \\ \log. a_2 &= 0{\cdot}74110951837 \\ \log. b_2 &= -\,0{\cdot}00212510583. \end{aligned}$$

The relation between p and t will then be expressed by the following formula,

$$\log. p = a - a_1\, b_1^{20 + t} - a_2\, b_2^{20 + t}.$$

M. Biot compared the temperatures and corresponding pressures, calculated by this formula, with the series determined by an extensive course of experiments undertaken by MM. Arago and Dulong by order of the French government, to those of the experiments of Taylor at lower temperatures, and to a numerous series of MSS. observations of M. Gay-Lussac, extending from the boiling point to temperatures considerably below that of melting ice, and found that the calculated and observed results corresponded within the limits of error of the experiments themselves. The formula first given above offer, however, much greater facility for practical calculation, and afford as accurate results as are required for all ordinary purposes.

The same difficulty which attends the establishment of a general formula expressing the relation between the temperatures and pressures of steam, also attends the determination of one expressing the relation between the pressure and the augmented volume into which the water expands by evaporation. Empirical formulæ have accordingly been likewise proposed to express this relation. The late Professor Navier proposed the following formula for this purpose.

Let V express the number of cubic inches of steam produced by one cubic inch of water, and let P express the pressure of this steam in kilograms per square metre; then we shall have

$$V = \frac{1000}{0{\cdot}09 + 0{\cdot}0000484\ P}.$$

This formula gives sufficiently accurate results when applied to pressures much above one atmosphere. It fails to give the same accuracy, however, when applied to lower pressures.

The following formulæ have been proposed by M. de Pambour:—

$$V = \frac{10{,}000}{0{\cdot}4227 + 0{\cdot}00258\ P},$$

which will apply to low pressures; and

$$V = \frac{10{,}000}{1{\cdot}421 + 0{\cdot}0023\ P},$$

which will be applicable to high pressures. In each of these P is expressed in pounds per square foot.

Dr. Lardner proposes the following modified formula, V and P retaining their signification:—

$$V = \frac{3875969}{164 + P},$$

which may be used in reference to low-pressure engines of every form, as well as for high-pressure engines which work expansively.

When the pressure is not less than 30 lbs. per square inch, the following formula will be more accurate:—

$$V = \frac{4347826}{618 + P}.$$

In the preceding observations steam has been considered as receiving no heat except that which it takes from the water during the process of evaporation, the amount of which, as has been shown, is 1170° more than the heat contained in ice-cold water. But steam, after having been formed from water by evaporation, may, like all other material substances, receive an accession of heat from any external source, and its temperature may thereby be elevated. If the steam to which such additional heat is imparted be so confined as to be incapable of enlarging its dimensions, the effect produced upon it by the increase of temperature will be an increase of pressure; but if, on the other hand, it be confined under a given pressure, with power to enlarge its volume, subject to the preservation of that pressure, as would be the case if it were contained in a cylinder under a moveable piston loaded with a given pressure, then the effect of the augmented temperature will be, not an increase of pressure, but an increase of volume; and the increase of volume in this latter case will be in exactly the same proportion as the increase of pressure in the former case.

These effects of elevated temperature are common not only to the vapours of all liquids, but also to all permanent gases; but, what is much more remarkable, the numerical amount of the augmentation of pressure or volume produced by a given increase of temperature is the same for all vapours and gases. If the pressure which any gas or vapour would have were it reduced to the temperature of melting ice be expressed by 100,000, then the pressure which it will receive for every degree of temperature by which it is raised will be expressed by $208\frac{1}{3}$; or, what amounts to the same, the additional pressure produced by each degree of temperature will be the 480th part of its pressure at the temperature of melting ice. From these data it is easy to obtain an algebraical expression by which the augmentation of pressure in a given volume, or, what is the same, the augmentation of volume under a given pressure for every increase of temperature, may be calculated.

Let v be the volume of any elastic fluid at the temperature of 32°; and let it be then supposed to be raised by the application of heat to the temperature T, if under a given pressure. Let its augmented volume be V. The increase of volume will then be $V - v$, while the increase of temperature will be $T^\circ - 32^\circ$. But since the increase of volume for *one* degree of temperature is $\frac{v}{480}$, the increase for $T^\circ - 32^\circ$ will be $\frac{v}{480} \times (T^\circ - 32^\circ)$; and therefore the augmented volume V will be

$$\begin{aligned} V &= v + \frac{v}{480}\,(T^\circ - 32^\circ). \\ &= v\left\{1 + \frac{T^\circ - 32^\circ}{480}\right\}. \end{aligned}$$

If V' be the volume at any other temperature T', we shall have

$$V' = v\left\{1 + \frac{T'^\circ - 32^\circ}{480}\right\}.$$

From whence we infer

$$\frac{V}{V'} = \frac{T + 448}{T' + 448};$$

by which, when the volume of steam at any one temperature is known, the volume at any other temperature may be found, supposing that the steam receives no accession of water by evaporation.

Steam which thus receives additional heat after its separation from the water from which it is evolved has been called by Dr. Lardner *superheated steam*, to distinguish it from *common steam*, which is that usually employed in steam engines. *Superheated steam* admits of losing a part of its heat without suffering partial condensation; but *common steam* is *always* partially condensed if any portion of heat be withdrawn from it. For further details on these properties, see *Lardner on the Steam Engine*, 7th ed. p. 168. *et seq.*; also Appendix. See also *Lardner on Heat*, chap. viii., *Cabinet Cyclopædia*.

In the mechanical operation of steam, which has been already explained, the pressure, density, and temperature of the steam are supposed to remain the same during its action, and the mechanical effect is produced by the continual increase of the quantity of steam produced by evaporation. Thus, the piston in the apparatus represented in the figure is moved upwards, not by any change in the temperature, density, or pressure, but by the increased volume required by the continual production of steam. It has been proved that by this process alone the evaporation of a cubic inch of water, whatever be the pressure under which it takes place, evolves a mechanical force equivalent to a ton weight raised a foot high. But if, after this evaporation has been completed, the steam be separated from the water which produced it, and the load on the piston be gradually diminished, the steam would expand by moving the piston upwards in virtue of its excess of pressure, and this expansion will continue until the pressure of the steam shall be reduced to equality with the load on the piston. All mechanical effect developed in this process is due to the steam itself, independently of any further evaporation.

To make this important quality of the expansive action of steam understood, let us suppose the piston loaded with a pressure amounting to four times that of the atmosphere, including that of the atmosphere itself. If the water under the piston be evaporated under this pressure, it will have a temperature of about 291°, and by its evaporation the piston will be raised 40 feet. This will, therefore, be the whole mechanical effect arising from the immediate evaporation of the water. But when the evaporation has been completed, and the piston, with its load of four atmospheres, stands suspended at 40 feet above the bottom of the tube, let a pressure equal to that of one atmosphere be removed from the piston. The remaining pressure of three atmospheres being less than that of the steam below the piston, the piston will be raised, and will continue to rise until it has attained a height of about 50 feet, and the temperature of the steam thus expanded will fall to about 275°; and its pressure being reduced to that of three atmospheres, it will cease to rise. By this process, therefore, a mechanical force has been obtained from the steam equal to the weight of three atmospheres raised 10 feet, in addition to the effect obtained by immediate evaporation; but the expansive action does not stop here. Let it be supposed that the piston is again relieved from the pressure of another atmosphere, the superior pressure of three atmospheres below will cause it to rise, and it will ascend to the height of about 75 feet, the temperature of the steam falling to about 250°, and its pressure being reduced to two atmospheres. A further mechanical effect equivalent to the weight of two atmospheres raised to about 25 feet, has thus been obtained; and it is evident that by constantly and gradually diminishing the load on the piston, an additional effect may be always obtained from a given amount of evaporation, to an extent which is only limited by practical circumstances which restrain the application of this expansive principle. Since the cost of producing steam as a mechanical agent depends chiefly on the quantity of fuel necessary to effect the evaporation of a given volume of water, it follows that all the mechanical effect obtained by this principle of expansion is so much power added to the steam without further expense. Its importance, therefore, will be obvious in the economy of steam power. For the manner of rendering it available in steam machinery, see STEAM ENGINE.

History of Steam. — The nature and properties of steam were altogether unknown to the ancients. Some accounts have come down to us bearing a very early date of engines; such, for example, as that proposed by Hero of Alexandria, in which the mechanical agency of steam was more or less used; but it does not appear that those who invented and applied these machines comprehended the properties of vapour, or had any correct notion of the phenomena produced by the application of heat to liquids. Even at a much more recent period the effects produced by steam were ascribed, not to the vapour of water, but to the force of air which was supposed to be expelled from water by heat. In the beginning of the 17th century, De Caus proposed the construction of a machine by which a column of water was raised by the elastic force of steam; but there is no sufficiently distinct explanation of the properties of vapour in his description of that machine to warrant the conclusion that he comprehended the elasticity of the vapour of water. About the middle of the same century, Lord Worcester published the description of a high-pressure steam engine, which has since formed so remarkable a feature in all histories of that machine. Towards the latter end of that century, however, the actual properties of vapour began to be gradually unfolded. In 1683, Sir Samuel Moreland published a description of the force of steam, in which he assigned very nearly the exact numerical proportion in which water increases its volume when evaporated under the pressure of a single atmosphere. A few years after this, Papin discovered the method of producing a vacuum by the condensation of steam; and in the course of the next half century the elastic force of steam, and the circumstances attending its condensation, became gradually better understood, having been applied to mechanical purposes by Savery, Newcomen, and others. About the middle of the 18th century, the celebrated Watt applied himself to the improvement of the steam engine, and by various experiments determined the relative volumes of steam as commonly used in steam engines, and the quantity of heat absorbed in evaporation and evolved in condensation. About the same period Dr. Black was engaged in his well-known investigations respecting the phenomena of heat, and had discovered the phenomena and found the theory of latent heat, which served to explain the effects which Watt had also observed. During the latter part of the 18th and the beginning of the present century, the physics of heat, and more especially those principles immediately connected with steam, were rapidly advanced. The relation between the temperatures and pressures of the vapour of water throughout the common range of the thermometric scale was determined by Dalton, and confirmed by Gay-Lussac, Prof. Robison, Ure, Southern, and others. The discovery of the law in virtue of which the pressure of all gases and vapours increases in proportion to their density at a given temperature was due to Mariotte, and is known as Mariotte's law. The discovery of the remarkable fact that all gases and vapours receive the same increase of pressure or volume for each degree of temperature was first discovered by Dalton; but was immediately afterwards discovered also by Gay-Lussac, who was not informed of Dalton's proceedings. The most important course of experiments which has since been made were undertaken by a committee of the French Institute, consisting of MM. Prony, Arago, Gerard, and Dulong, in consequence of an application from the French government to the academy to point out the best means of preventing accidents from the bursting of the boilers of steam engines. The experiments were conducted chiefly by Arago and Dulong, and were certainly not only the most delicate as to their management, but the most hazardous which science and art owe to the courage and zeal of philosophers. Steam was produced of a sufficient pressure to force a column of mercury up a glass tube to the height of nearly 43 feet; an atmosphere being measured by a column of mercury measuring 29·922 inches. The following table exhibits the temperatures and corresponding pressures of steam, as determined by these experiments, up to fifty atmospheres.

Pressure in Atmospheres.	Temperature.	Pressure in Atmospheres.	Temperature
1	212°	13	380·66°
1½	234	14	386·94
2	250·5	15	392·86
2½	263·8	16	398·48
3	275·2	17	403·83
3½	285	18	408·92
4	293·7	19	413·78
4½	300·3	20	418·46
5	307·5	21	422·96
5½	314·24	22	427·28
6	320·36	23	431·42
6½	326·26	24	435·56
7	331·7	25	439·34
7½	336·86	30	457·16
8	341·78	35	472·73
9	350·78	40	486·59
10	358·88	45	499·14
11	366·85	50	510·6
12	374		

The last six temperatures in the above table are deduced by calculation from the formula $e = (1 + 0·7153t)^5$, in which e expresses the elasticity in atmospheres, and t the temperatures in centième degrees, beginning from 100°, and proceeding upwards. The methods employed in this magnificent course of experiments will be found detailed in the *Annales de Chimie et de Physique*, tome xliii. p. 74.

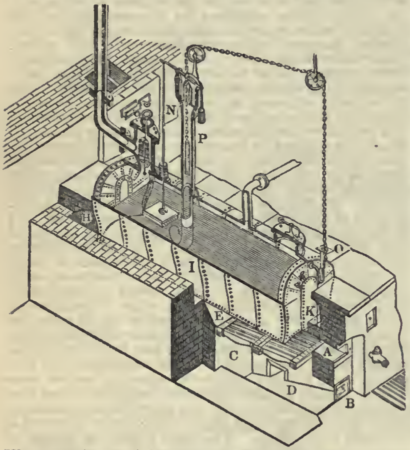
The committee seized the opportunity presented by

the apparatus used for these experiments for testing Marriotte's law, as applied to atmospheric air; and they found that it agrees with experiment as far as a pressure of twenty-four atmospheres.

For further details respecting the properties of steam, see *Dr. Lardner on the Steam Engine*, 7th edition; *Lardner on Heat, Cabinet Cyclopædia; De Pambour on the Steam Engine;* various articles on Steam and Vapour, in the Philosophical Transactions in the *Proceedings of the Institute of France;* the *Annales de Chimie et Physique;* the *Annales de Mines;* the *Journal des Ponts et Chaussées*, &c. &c.

STEAM BOILER. A vessel in which water is converted into steam for the purpose of supplying steam engines, or for any other purposes for which steam is used in the arts, or in domestic economy.

The most common form of boiler used for steam engines is that called the *waggon boiler*, an isometric view of which is given in the cut. The form of boiler adopted by



Watt consisted of a semi-cylindrical top, flat perpendicular sides, flat ends, and a slightly cancave bottom. That which is represented in the cut has sides a little concave. The steam used in these boilers does not exceed the pressure of the atmosphere by more than 5 lbs. per square inch; and the sides and ends, though not so favourable to strength as the cylindrical form, are sufficiently strong for this pressure. In a boiler of this form the air and smoke, passing through flues that are carried round it, are in contact at one side only with the boiler. The brickwork or other materials forming the flue must therefore be non-conductors of heat, that they may not absorb any considerable quantity of heat from the air passing in contact with them.

The grate and a part of the flues are rendered visible in the figure, by the removal of a portion of the surrounding masonry in which the boiler is set. The interior of the boiler is also shown by cutting off one half of the semi-cylindrical roof. The door by which fuel is introduced upon the grate is represented at A, and the door leading to the ash-pit at B. The fire-bars at C slope downwards from the front at an angle of about 25°, giving a tendency to the fuel to move towards the back of the grate. The ash-pit D is constructed of such a magnitude, form, and depth, as to admit a current of atmospheric air to the grate-bars sufficient to sustain the combustion.

The fuel, when introduced at the fire-door, is laid on that part of the grate next the fire-door which is called the *dead plates.* There it is submitted to the process of coking, by which the gases and volatile matter are expelled from it; and being carried by a current of air admitted through small apertures in the fire-door over the burning fuel in the hinder part of the grate, they are burnt. When the fuel in the front of the grate has been thus *coked* it is pushed back, and a fresh feed is introduced upon the dead plates. The coal thus pushed back soon becomes vividly ignited, and by continuing this process, the fuel spread over the grate is maintained in the most active state of combustion in the hinder part of the grate. By such an arrangement the smoke produced by the combustion will be burnt before it enters the flues. The flame and heated air proceeding from the fuel rushing to the back of the furnace pass over the fire-bridge E, and being carried through the flue, pass below the concave base of the boiler. This bottom flue is very nearly equal in width to the base of the boiler, the space left near the corners being only what is sufficient to support the weight of the boiler resting on the masonry. The bottom of the boiler being concave, the flame and heated air rise to the upper part of the flue by the effect of their high temperature, and *lick* the bottom from the fire-bridge to the further end.

The flue rises at the back of the boiler, and returns along the side from H to I. It then passes in front of the boiler at K to the opposite side, along which it is again carried from the front to the back of the boiler. At the back it finally turns upwards to the base of the chimney.

By this arrangement the flame and heated air are made to circulate round the boiler; and the length and magnitude of the flues should be such that when it arrives at the chimney its temperature shall be reduced, as nearly as is consistent with the maintenance of the draught, to the temperature of the water with which it is in contact.

The magnitude of the grate and ash-pit must be determined by the rate at which the evaporation is to be produced in the boiler. There is no well-established rule for this. Some engine-makers allow a square foot of grate surface for each cubic foot of water to be evaporated per hour, while others only allow half this for the same evaporation and the same quantity of fuel. Practice varies between these limits.

To facilitate the raking out of the grate, the bars are placed with their ends towards the fire-door. They are made of cast iron about two inches broad on the upper surface, and with intervals of half an inch between them.

They taper downwards, the spaces between them widening, to facilitate the fall of the ashes between them. The height of the centre of the bottom of the boiler above the front of the grate is usually about two feet, and about three feet above the back of it.

Between the evaporating power of the boiler and the magnitude of surface it exposes to the action of the fire, there is a relation not yet satisfactorily ascertained. That part of the surface immediately over the grate is probably the most efficient in producing steam. The tendency of the flame to rise would naturally bring it more in contact with those parts of the boiler which are horizontal in their position, and which form the tops of the flues, than with those which are vertical or lateral. In the boiler here represented the most efficient surface would therefore be the bottom of the boiler. Engine-builders vary much in the quantity of surface which they allow for a given rate of evaporation. Some allow twelve and some eighteen square feet of surface for each cubic foot of water per hour to be evaporated.

The capacity of the boiler is appropriated to a two-fold purpose: 1. to contain the water to be evaporated; 2. to contain a quantity of ready-made steam to supply the engine. The proportion of the steam space in the boiler to the volume of the cylinder has been variously estimated. It is held by some that it will be sufficient if it be five times the volume of the cylinder, while others allow double that quantity.

For every cubic foot of water per hour intended to be evaporated, water space should be allowed in the boiler for at least five cubic feet; so that one fifth of the contents are evaporated per hour.

The surface of the water in the boiler must be matter of careful and exact regulation. It should *always* be *above* the range of the flues. When the heat in the flues acts upon a part of the boiler which is not in contact with water, steam being a slow recipient of heat, the heat accumulates in the boiler plates, and raises their temperature to an injurious degree. The plates may be by this means softened, so as to cause the boiler to burst; or the difference between the expansion of these highly heated plates and of those in contact with water may cause the joinings of the plates to open and the boiler to leak. By whatever means, therefore, the boiler be fed, the level of the water ought never to be allowed to fall below the highest flue.

Since the level of the water in the boiler ought to be maintained in a steady position, it is evident that the magnitude of the feed must be equal to the quantity of water evaporated. If, therefore, one fifth of the water in the boiler be evaporated per hour, that quantity ought to be introduced by the feeding apparatus in the same time. To regulate the feed with safety and certainty, it is necessary to provide an indicator of the level of the water in the boiler.

This is accomplished by a float which rests on the surface of the water suspended by a wire, which passes steam-tight through a small hole in the top of the boiler, and is connected by a flexible chain or string, passing over a wheel with a counterpoise, which is only capable of balancing the weight of the float when the latter is sustained by its buoyancy in the water. The position of the counterpoise will depend on that of the float; when the latter falls the counterpoise must rise, and *vice versâ*. The position of the counterpoise, therefore, will always indicate that of the float, and of the surface of the water on which the float rests.

There are other methods of indicating the quantity of water to the *eye* and the *ear* (see *Lardner on the Steam Engine*, p. 266. *et seq.*); but that which is most deserving of notice is one in which the indicator is made to govern the feeder, so as to supply water to the boiler in the same proportion as that in which it is evaporated. The wire supporting the float on the surface of the water above described, represented at N in the figure, is attached to the arm of a lever, of which the opposite arm is connected with a common puppet valve placed in the bottom of the small feeding cistern. When the surface of the water falls, the float falls with it, and draws down the arm of the lever, which raises the opposite arm and opens the valve. Water from the feeding cistern flows into the boiler through the tube P, and continues to flow into it until the level of the surface has been raised so high that the float no longer pulls down the arm of the lever, and therefore the valve in the bottom of the cistern is closed. In the actual operation of this self-acting feeder, however, the surface of the water so adjusts itself that the float opens the valve just so much as is necessary, and sufficient to admit as much water from minute to minute as is consumed by evaporation, and therefore the level of the water is maintained in a fixed position.

To secure the safety of boilers it is necessary to provide means for preventing the pressure of the steam contained in them from exceeding a certain limit, and also for indicating its pressure at all times. The former object is attained by safety valves, which are of various forms. The safety valve is a common puppet valve placed on the top of the boiler, which opens upwards, and which is held down by a pressure proportional to the limit within which the steam is intended to be kept. When the pressure of the steam exceeds that limit, this valve is raised by it, and the steam escapes until its pressure is reduced to below that of the valve. The magnitude of the aperture of the valve should be sufficient to enable the steam to escape faster than under any possible circumstances it could be generated. Safety valves differ one from another, chiefly in the manner in which the required pressure upon them is produced. In some weights of the requisite amount are placed directly upon the valve, as represented in the figure under N. In some the valve is held down by the elasticity of one or more springs. In others a lever presses on the valve by a sliding weight, the pressure being varied at discretion by shifting the position of the weight; and in others the lever which acts on the valve is held down by a spring similar to that of the common spring balances, which may be screwed up to any required tension. In *all* boilers true safety valves should be provided, one of which should be placed out of the reach of the engineer, so as to impose a major limit to the pressure which he can give to the steam.

The most ordinary indicator of the pressure of the steam in low-pressure boilers is the *mercurial steam gauge*, represented at O in the figure, which consists of a glass tube bent into the siphon form, the bent part and a portion of each leg being filled with mercury. One leg communicates with the steam within the boiler, and the other is open to the atmosphere. The difference between the levels of the columns of mercury in the two legs is always a measure of the difference between the pressure of the steam and that of the atmosphere. If the tube be of iron, which is most generally the case, the position of the surface of the mercury in it is indicated by a float having a wooden rod rising from it.

This indicator cannot be conveniently applied to high-pressure boilers, since the column of mercury supported by the pressure of the steam would have too great a height. In these boilers a thermometer is immersed, by which the temperature of the steam is indicated; and this becomes an indicator to its pressure, since the pressure varies with the temperature. *See* STEAM.

The safety of high-pressure boilers is sometimes provided for, by inserting in them a plug of metal capable of being fused at that temperature above which the boiler is exposed to the danger of explosion. If the water and steam exceed that temperature, the metal of the plug or of its solder will melt, and it will fall out, and the steam will escape from the opening which it leaves. An alloy composed of one part of lead, three of tin, and five of bismuth, will fuse at the common temperature of boiling water; and alloys of the same metals in various proportions will fuse at different temperatures from 200° to 400°.

When a boiler ceases to be worked and the furnace is extinguished, the space within it appropriated to steam will be left a vacuum by the condensation of the steam with which it was previously filled. The external pressure of the atmosphere acting on the boiler would, under such circumstances, have a tendency to crush it inwards. To prevent this a safety valve is provided, opening inwards, and balanced by a weight to keep it closed until it be relieved from the pressure of the steam within.

To render the strength of the fire proportional to the evaporating power, a plate called a *damper* is placed with its plane at right angles to the flue, so that by raising and lowering it like the sash of a window the space for the passage of air through the flue is increased or diminished. The force of draft and that of the fire can, therefore, be varied merely by shifting the position of the damper.

Such a damper can be regulated by hand, but more uniformly by connecting it with a float placed on a column of water or mercury, which measures the force of the steam, as represented in the figure, where the chain suspending the damper is seen at O and the float at P. If the force of the steam be suddenly increased, such a column will raise the float and lower the damper; and if the force of the steam be too feeble, the contrary effect will be produced. Such an apparatus is called *a self-regulating damper*.

The form of boilers is sometimes cylindrical, having an oval flue conducted through them from end to end. The ends are hemispherical. Such a form is favourable to strength, and is better adapted than the waggon shape to high-pressure boilers.

(For the boilers of railway engines, *see* LOCOMOTIVE ENGINE; and for those of marine engines, *see* STEAM NAVIGATION. For more minute details respecting steam boilers, see *Lardner on the Steam Engine*, 7th edition; also *Tredgold*, second edition, Appendix.)

STEAM CARRIAGE. A name usually applied to locomotive engines adapted to work on common roads.

The principle of the construction of these is, in its general conditions, similar to that of the locomotive engine used on railways (*see* LOCOMOTIVE ENGINE); but the engine adapted to common roads must have the same power, with a much less weight; or, in other words, the ratio of the weight of the engine to the evaporating power of the boiler is much less than in the case of railway locomotives.

Although the attempt made to adapt the steam engine as an accessory power on common roads has not hitherto been productive of any practical result of a permanent nature, this has not arisen so much from the failure of steam power to accomplish the traction of carriages, as from the greater expense of that power, as compared either with horse power on common roads or with steam power on railways. At the time when the construction of railways throughout the country was extensively undertaken, and when the great power and economy of the locomotive engine upon them was demonstrated by the results of the traffic on the Liverpool and Manchester railway, several projects for the application of the locomotive engine on common roads were in progress, and were attended with effects which presented a fair prospect of ultimate success. The establishment of the great lines of railway communication throughout the kingdom, by engrossing the traffic of all those districts in which the locomotive engine on common roads promised greatest advantage, and on which, if any where, it would have taken the place of horse power, discouraged speculators, and most of the projects which had been in progress fell to the ground. Among these were the steam carriages of Mr. Gurney, Col. Maceroni, Mr. Hancock, Dr. Church, Mr. Ogle, Mr. Russell, and various others.

The engine in steam carriages generally acts either directly on the wheels, and causes them to revolve, and thereby propels the carriage; or it acts on cranks formed on the axle of the wheels, and the wheels being keyed upon the axle are compelled to revolve with it. In either case, the revolution, whether of the wheels or the axle, is produced by a connecting rod jointed on the end of the piston rod, and receiving motion from the piston rod. The wheels are generally driven by two pistons working in two cylinders, so that one is at its dead point when the other is in the position most favourable for its action. The arrangement of this part of the machinery being similar to that of the railway locomotive, need not be here more fully described.

The steam carriages of different projectors differ one from another, chiefly in the boilers, and in the apparatus for generating the steam and admitting it to the cylinder. Mr. Gurney's boiler consisted of a series of strong iron tubes placed side by side, so as to form the bars of the grate of the furnace. These were connected with another system nearly at right angles to them, forming the back of the furnace; and these again with a third system, forming the roof of the furnace. The tubes forming the grate bars had their ends inserted in a strong iron cylinder, having it axis horizontal, and its length extended across the front of the furnace under the fire-door; and the tubes forming the roof of the furnace were inserted in a similar cylindrical vessel, extending in like manner across the front of the furnace *above* the fire-door. These two cylinders were likewise connected by upright cylinders of less diameter placed at each side of the fire-door. This system of tubes and cylinders being filled with water, the heat of the furnace acting on the tubes surrounding the fireplace, and the heated air and flame being afterwards conducted above the tubes forming the roof of the fireplace, before it escaped into the chimney steam was produced in the tubes, which by its lightness passed from them to the cylindrical vessel extending over the fire-

door. From that vessel the steam passed into a larger cylindrical vessel above it, called a *separator*, its purpose being to disengage the pure steam from the spray of water with which it is generally mixed when it first escapes from the boiling water in a state of violent agitation.

Every part of this boiler being cylindrical, has the form which is most favourable to strength, and which, within given dimensions, contains the greatest quantity of water. The tubes surrounding the furnace can freely expand in the direction of their length, without being loosened at the joints, and without straining any part of the apparatus. Proper means of opening the tubes at their ends are provided, by which they may be scraped on the inside, and cleansed from any deposit which may be left in them by the water evaporated in them.

In these engines the draught of the furnace was produced by projecting the waste steam into the chimney; but instead of dismissing it directly from the eduction pipe of the cylinder to the chimney, it was conducted to a receptacle called a *blowing box*. This box served the same purpose as the upper chamber of a smith's bellows. It received the steam from the cylinder in alternate *puffs*, but it let it escape into the chimney in a continued stream by a number of small jets. A regular draught was by this means produced, and no noise was perceived.

The pipe through which the boiler is fed was carried through this blowing box in a spiral form, so that an extensive thread of the feeding water was exposed to the heat of the waste steam as it passed from the cylinders. In passing throught his box the feeding water was raised from 60° to 212°, at which temperature it was forced into the boiler.

A steam carriage constructed by Mr. Gurney, weighing 35 cwt., working for eight hours, was found, according to Mr. Gurney's statement, to do the work of about thirty horses. The engine was placed on a carriage separate from that which bore the passengers, and the one drew the other after it in the same manner as the railway engine draws its train. Mr. Gurney stated that the weight of an engine sufficient to draw after it a carriage containing eighteen passengers would be about a ton; so that the gross weight of the whole, the engine and carriage for passengers taken together, would not exceed that of a common stage coach and four horses.

In the steam carriage proposed by Mr. Hancock, and which was worked for some time on the New Road and other roads about London, the engine and passengers were placed in the same carriage. In the boiler the subdivision of the water, so as to expose a sufficient surface to the action of the fire, was accomplished by dividing a case or box by a number of thin plates of metal like a galvanic battery, the water being allowed to flow between every alternate pair of plates, the intermediate spaces forming the flue through which the flame and hot air pass. In fact, a number of thin plates of water are exposed on both sides to the most intense action of flame and heated air; so that steam of a high pressure is produced in great abundance, and with considerable rapidity. The plates forming the boiler were bolted together by strong iron ties, extending across the boiler at right angles to the plates. The distance between plate and plate was two inches.

There were ten flat chambers of this kind for water, and intermediately between them ten flues. Under these flues was the fire-grate, six square feet in magnitude. The water spaces were filled to about two thirds of their depth with water, and the other third was left for steam. The water chambers throughout the whole series communicated with each other at top and bottom, and were held together by two large bolts. By releasing these bolts at any time, the chambers fell asunder; and by screwing them up, they might be all made tight again.

These boilers were constructed to bear a pressure of 400 or 500 lbs. per square inch; but the safety valve was screwed up to a pressure not exceeding 100 lbs. per inch. There were 100 square feet of surface exposed to the fire. The stages which the engine performed were eight miles, after which a fresh supply of water and fuel was taken in.

Mr. Nathaniel Ogle of Southampton obtained a patent for a locomotive carriage, which he worked for some time experimentally. In his evidence before the House of Commons, he has there described his contrivance. "The base of the boiler and the summit are composed of cross pieces, cylindrical within and square without; there are holes bored through these cross pieces, and inserted through the whole is an air tube. The inner hole of the lower surface, and the under hole of the upper surface, are rather larger than the other ones; round the air tube is placed a small cylinder, the collar of which fits round the larger aperture on the inner surface of the lower frame and the uuder surface of the upper framework. These are both drawn together by screws from the top; these cross pieces are united by connecting pieces, the whole strongly bolted together; so that we obtain in 1-10th of the space, and with 1-10th of the weight, the same heating surface and power that are now obtained in other and low-pressure boilers with incalculably greater safety. Our present experimental boiler contains 250 superficial feet of heating surface, in the space of 3 feet 8 inches high, 3 feet long, and 2 feet 4 inches broad, and weighs about 8 cwt. We supply these two cylinders with steam communicating by their pistons with a crank axle, to the ends of which either one or both wheels are fixed, as may be required. One wheel is found to be sufficient, except under very difficult circumstances and when the elevation is about 1 foot in 6, to impel the wheel forward.

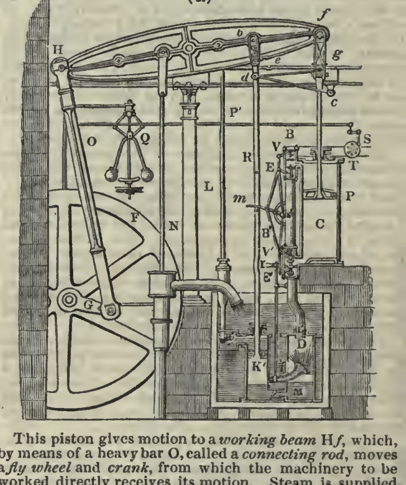
"The cylinders of which the boiler is composed are so small as to bear a greater pressure than could be produced by the quantity of fire beneath the boiler; and if any one of these cylinders be injured by violence, or any other way, it would become merely a safety valve to the rest. We have never, with the greatest pressure, burst, rent, or injured our boiler; and it has not once required cleaning, after having been in use twelve months."

For more full details respecting steam carriages, see *Lardner on the Steam Engine*, 7th edit.; also a Treatise on *Elemental Locomotion*, by Alexander Gordon, C.E.

STEAM-ENGINE. A machine in which the mechanical power developed in the evaporation of water is rendered available as a moving power. Steam engines vary much in magnitude, form, and proportions, as well as in the details of the machinery by which the power of the steam is adapted as a prime mover. We shall first explain those forms of steam-engine most generally used in the arts and manufactures, and shall afterwards give a succinct account of the history of the invention and progressive improvement of this machine. The forms of engine, and the mode of its application to transport by land and water, have been consigned to separate articles. *See* LOCOMOTIVE ENGINE, RAILWAYS, and STEAM NAVIGATION.

Double-acting Condensing Steam Engine.—This form of engine is that which is almost invariably used as a moving power in all manufactures in this country. It consists of a cylinder represented in section at C, in which a moveable piston P is driven upwards and downwards by the force of steam supplied by a boiler placed near the engine. *See* STEAM BOILER.

(1.)



This piston gives motion to a *working beam* H*f*, which, by means of a heavy bar O, called a *connecting rod*, moves a *fly wheel* and *crank*, from which the machinery to be worked directly receives its motion. Steam is supplied from the boiler to the cylinder by the steam pipe S. The *throttle-valve* T in that pipe, near the cylinder, is regulated by a system of levers connected with the *governor* Q. This governor is an apparatus consisting of two heavy balls attached to the ends of rods which are kept revolving on a vertical shaft by a cord or band, or by a train of cogged wheels connected with the fly-wheel. The velocity with which the balls of the governor revolve is therefore always proportional to that of the fly-wheel, and of the machinery driven by it. If by reason of too rapid a supply of steam an undue speed be imparted to the fly-wheel, the balls are whirled round with a corresponding velocity; and by reason of their centrifugal force they recede from the vertical spindle round which they turn, and acting thereby on the system of levers which connect them with the throttle-valve T, they partially close the latter, check or diminish the supply of steam to the cylinder, and moderate the velocity of the machine. If, on the other hand, the motion of the engine be slower than is requisite, owing to a deficient sup-

ply of steam through S, then the balls, not being sufficiently affected by centrifugal force, fall towards the vertical spindle, and acting on the system of levers in the contrary way, they turn the throttle-valve T more fully open, and admit a more ample supply of steam to the cylinder, so as to increase the speed of the engine to the requisite limit.

The piston P is accurately fitted to the cylinder, and made to move in it steam-tight by packing, with which it is surrounded. This piston divides the cylinder into two compartments, between which there is no communication by which steam or any other elastic fluid can pass. A case B B′ placed beside the cylinder contains the valves by means of which the steam which impels the piston is admitted and withdrawn as the piston commences its motion in each direction. The *upper steam-box* B is divided into three compartments by two valves ; above the upper steam-valve V is a compartment communicating with the steam-pipe S. Below the exhausting valve E is another compartment communicating with a pipe called the *eduction pipe*, which leads downwards from the cylinder to a vessel called the condenser, which we shall presently describe. By this eduction pipe the steam is withdrawn from the cylinder after it has driven the piston. By the valve V a communication may be opened or closed between the boiler and the top of the cylinder, so as to admit or intercept the supply of steam from the one to the other. By the valve E a communication may be opened or closed between the top of the cylinder and the condenser, so that the steam in the top of the cylinder, may either be permitted to escape into the condenser or confined in the cylinder. The continuation S′ of the steam-pipe leads to the *lower steam-box* B′, which like the upper is divided into three compartments by two valves V′ and E′. The upper compartment communicates with the steam-pipe S′, and the lower with the eduction-pipe. By means of the valve V′ steam may be admitted from the steam-pipe S′ to the bottom of the cylinder, and by means of the valve E′ this steam may be permitted to escape to the condenser.

The four valves V, E, V′, and E′ are in the engine represented in the figure connected by a system of levers with a single handle or *spanner*, *m*, which being pressed upwards or downwards opens and closes the valves in pairs. Thus when it is pressed *down* the levers connected with it raise the upper exhausting valve E and the lower steam valve V′, and close the upper steam valve V and the lower exhausting valve E′. On the other hand, when the spanner *m* is pressed *up* it opens the upper steam valve V and the lower exhausting valve E′, and at the same time closes the upper exhausting valve E and the lower steam valve V′.

The cylinder is closed at the top, and the piston-rod P, being accurately turned, runs in a steam-tight collar furnished with a shifting box, by means of which it is surrounded by a packing of hemp and constantly lubricated with melted tallow. A funnel is screwed on the top of the cylinder, through which, by opening a stop-cock, melted tallow is permitted to fall from time to time on the piston so as to lubricate it.

The condenser D is submerged in a cistern of cold water ; at its side there enters a tube I′ governed by a cock I, which being opened or closed to any required extent a jet of cold water may be allowed to play in the condenser. This jet throws the water upwards towards the lower orifice of the eduction pipe L′. From the bottom of the condenser D proceeds a tube having a valve M in it opening outwards ; this tube leads to the *air-pump* K′, which is a pump submerged in the same cistern with the condenser, worked by a piston having a valve in it opening upwards. The piston-rod R of the air-pump is carried upwards, and attached at *d* to a system of jointed rods called the *parallel motion*, to which is also attached at *g* the great steam-piston rod. On the rod of the air-pump is placed projecting pins, which as it alternately ascends and descends strike the spanner *m*, and thereby open and close the valves V, V′, E, E′, in pairs, as already described.

The upper part of the air-pump cylinder communicates by a valve opening outwards with a small cistern K, called the *hot well*, for a reason which will presently appear. A pump L, called the hot water pump, descends into the hot well and is worked by the great working beam to which its rod is attached.

If the machine thus arranged continued to be worked for any length of time, the cistern of water in which the condenser and air-pump are immersed would become warm, and the condenser would be rendered incapable of doing that for which alone it is useful, viz. of reducing the steam to water *by cold*. To prevent this a pump N is provided, called the *cold water pump*, by which a supply of cold water is constantly kept flowing into the cistern, the heated water being at the same time allowed to escape by a waste pipe. By this means the temperature of the water in the cold cistern is kept so low as to be capable of effectually condensing the steam.

The piston being supposed to be at the top of the cylinder, the spanner *m* will be raised by the lower pin on the air-pump rod, and the valves V and E′ will be opened, and at the same time the other pair of valves V′ and E will be closed. Steam will therefore be admitted above the piston, and the steam which had previously filled the cylinder below the piston will be drawn off to the condenser. It will there encounter the jet of cold water, which is kept constantly playing there by keeping the cock I sufficiently open. It will thus be immediately reduced to water or condensed (*see* STEAM), and the cylinder below the piston will remain a vacuum. The steam, therefore, admitted from the steam-pipe through the open valve V to the top of the cylinder, will press the piston to the bottom of the cylinder. As it approaches that position the spanner *m* will be struck downwards by the upper pin on the air-pump rod, and the valves V and E′ previously open will be closed, while the valves V′ and E previously closed will be opened. The steam which has just pressed down the piston, and which now fills the cylinder above the piston, will then flow off through the open valve E by the eduction-pipe to the condenser, where it will be immediately condensed by the jet of cold water which constantly plays there, and steam from the boiler admitted through the open valve V′ will fill the cylinder below the piston and press the piston upwards. When the piston has reached the top of the cylinder the lower pin on the air-pump rod will have struck the spanner *m* upwards, and will thereby have closed the valves V′ and E and opened the valves V and E′. The piston will then be in the same situation as in the commencement, and will again descend, and so will continue to be driven upwards and downwards by the steam.

While this process is going on in the cylinder a quantity of warm water is formed in the condenser, by the mixture of condensed steam with the cold water admitted through the condensing jet I′. It has been shown (*see* STEAM) that any quantity of water in the state of steam being condensed by cold water, will raise nearly six times its own weight of cold water from the freezing to the boiling point by the latent heat which is rendered sensible in the process of condensation. But since the jet of cold water, instead of being at the temperature of melting ice, is at the common temperature of the atmosphere, say 50°, and it is necessary to reduce the temperature of the water in the condenser to at least 100° (otherwise steam would be produced by it, which would seriously resist the motion of the piston), and to reduce water from 212° to 100° by mixture with water at 50° would require a quantity of the latter about twice the former, it follows that the quantity admitted through the jet must be more than twenty times the quantity which passes through the cylinder in the form of steam.

The warm water which is thus formed in the condenser, if allowed to accumulate there, would soon choke it up and stop the action of the machine. To prevent this the air-pump is provided ; when the air-pump piston ascends it leaves below it a vacuum, and the *foot-valve* M being relieved from all pressure, the weight of the water in the condenser forces it open, and the warm water flows from the condenser into the lower part of the air-pump, from which its return to the condenser is prevented by the closed valve. When the air-pump piston descends its pressure on the liquid under it will force open the valve in it, through which the warm water will pass ; and when the piston descends to the bottom of the pump-barrel the warm water which was below it will pass above it, and cannot return, as the valves which open upwards will be kept closed by its weight. When the piston next ascends it will raise the water thus collected above it, and will throw it through the valve into the hot well K.

The hot-water pump L is usually a suction and forcing pump, and draws up the warm water from the hot well, and drives it through a pipe called the feed pipe to a cistern placed over the boiler, from which the boiler derives its feed of water. *See* STEAM BOILER.

The system of jointed rods *c d e f g*, called the parallel motion, have for their object the maintenance of the rods of the steam-piston and air-pump in a truly vertical position. The steam-piston rod imparts motion to the beam, and the air-pump rod receives motion from it. The beam, however, moving as it does alternately upwards and downwards on an axis, every point on it must move alternately in the arc of a circle whose centre is in the axis of the beam. If the ends of the rods of the steam-piston and air-pump were immediately attached to the beam, they would move therefore not in truly vertical straight lines, but in the arcs of circles, and by reason of the curvature of such arcs they would be alternately reflected to the right and to the left. Such an effect would be quite incompatible with that smoothness and precision which are essential to the effective action of the steam engine. By the parallel motion the ends of these piston rods are not immediately attached to the working beam ; a rod *c d*, called the *radius rod*, moves on a fixed centre *c* attached to the framing of the engine ; a bar *d b* connects the other end of this radius rod with a pivot *b* on the

beam, so that as the beam ascends and descends the pivots b and d each moves in an arc of a circle, and these pivots are thereby drawn aside, but always in contrary directions. These deflections of the ends of the bar $d\ b$ are neutralized at its middle point e, which neither deviates to the right nor to the left, but moves in a vertical straight line. To this point e the end of the air-pump piston is attached.

At the end of the beam to another joint f is attached a bar $f g$, equal to $b\ d$, connected by pivots with another beam $d g$ equal in length to $b f$, so as to form the jointed parallelogram $b\ d\ g\ f$. By this arrangement, as the beam ascends and descends the point g is moved in a manner altogether similar to the point e, only that it moves through a greater space in the proportion of the distance of g from the axis of the beam to that of e from the same point. The point g, therefore, to which the steam-piston is attached, is moved upwards and downwards in a truly vertical straight line, while the end f of the beam with which it is connected is moved upwards and downwards in the arc of a circle.

When the piston is at the top of the cylinder the crank G placed on the axis of the fly-wheel F is at its lowest position, and when the piston is at the bottom of the cylinder it is in its highest position. In each of these positions the action of the steam on the piston could not impart any motion to the crank; for the connecting rod O being then in line with the crank, any force given to it, being necessarily exerted in the direction of its length, would only produce a pressure or strain on the crank-pin without the least tendency to turn the crank round the axis of the fly-wheel. In these positions the machine is therefore placed in a dilemma, in which the moving power ceases to have any influence on the object it is intended to move.

The machine is extricated from this dilemma by the inertia of the fly-wheel; that wheel being a large mass of matter, having once received a certain velocity of rotation on its axis, has a tendency to retain such motion, and will, in fact, retain it until it has been deprived of it by the continued resistance of friction and the air. When, therefore, the crank arrives at either of the positions above mentioned and the moving power ceases to be effective, the inertia of the fly-wheel causes it to continue its motion, and the crank is immediately turned out of the extreme position it had assumed, and thrown into a position in which the power of the piston on it becomes effective.

The functions of the fly-wheel are, however, not confined to carrying the machine thus through the dead points by the energy of the force it has received from the piston when the crank was in a more favourable position; it likewise equalizes by the same property the unequal effect of the crank: it is only when the crank forms a right angle with the connecting rod that it is fully effective. As that angle changes its leverage changes, until at length the leverage is reduced to nothing at those extreme positions just mentioned. When the crank is in and near the position in which it is rectangular to the connecting rod, its action is shared between the fly-wheel and the machinery driven by the engine, a part being engaged in accelerating and therefore giving momentum to the fly-wheel. As it passes towards the dead points this momentum taken up by the fly-wheel is given back to the crank in aid of the moving power, at those positions of the crank where the effect of the moving power upon it becomes enfeebled. In this manner the fly-wheel in the steam engine becomes a perfect equalizer of the mechanical action of the machine.

Although the system of rods called the parallel motion appears in the figure to consist only of one parallelogram $b\ d\ g\ f$ and one rod $c\ d$, it is in fact *double*, a similar parallelogram and radius rod attached to corresponding points, and acting in the same manner on the other side of the beam; but from the view given in the cut, the one set of rods hides the other. The two systems of rods thus attached to the beam are connected by cross rods, the ends of which form the pivots or joints, and extend between the parallelograms. The ends of these cross rods only are visible in the figure. It is to the middle of one of these rods, the end of which is represented at e, that the air-pump piston is attached; and it is to the middle of another, the end of which is represented at g, that the steam-piston rod is attached. These two piston rods, therefore, are driven not by either of the parallelograms, but by the bars extending between them.

To the working end H of the beam is attached the *connecting rod* O, formed of cast iron, the lower end of which is attached to the crank G by a pivot. The weight of the connecting rod is made to balance the weight of the piston rods of the air-pump and cylinder, and the weight of the piston rod N of the cold water pump, balances the weight of the piston rod L of the hot water pump. Thus, so far as the weight of the moveable parts of the machine is concerned, the engine is in equilibrium, and the piston would rest indifferently in any position in the cylinder.

The axis of the fly-wheel on which the crank is formed is square in the middle, where the wheel is attached to it; but has cylindrical necks at each end, which rest in bearings supported by the framing of the machine, in which bearings the axis revolves freely. On the axis of the crank is placed the fly-wheel, and connected with its axle is the governor Q already described.

The manner in which the crank affects the connecting rod at the dead points already mentioned produces an effect of great importance in the operation of the engine. When the crank approaches the lowest point of its play, and at the same time the piston is approaching the top of the cylinder, the motion of the crank pin becomes nearly horizontal, and consequently its effect in drawing the connecting rod and the end of the beam downwards, and the piston upwards, is extremely small. The consequence of this is, that as the piston reaches the top of the cylinder its motion becomes very rapidly retarded; and as the motion of the crank pin at its lowest point is actually horizontal, the piston is brought to a state of rest by this gradually retarded motion. A similar effect is produced at the other dead point. This suspension of motion at each end of the stroke affords time for the process of condensation to be effected, so that when the moving power of the steam upon the piston can come into action the condensation shall be sufficiently complete. As the piston approaches the top of the cylinder, and its motion becomes slow, the working gear is made to open the lower exhausting valve; the steam enclosed in the cylinder below the piston, and which has just driven the piston upwards, presses usually with a force of about 17 lbs. per square inch, while the uncondensed vapour resists with a force of about 2 lbs. per square inch. The steam will therefore have a tendency to rush from the cylinder to the condenser through the open exhausting valve, with an excess of pressure amounting to 15 lbs. per square inch, while the piston pauses at the top of the cylinder. This process goes on; and when the piston has been made to descend by the motion of the fly-wheel a sufficient distance from the top of the cylinder to call the moving force of the steam into action, the exhaustion will be complete, and the pressure of the uncondensed vapour in the cylinder will become the same as in the condenser. The pressure of the steam, and of the uncondensed vapour, varies within certain limits, and therefore the amount here assigned to them must be taken merely as an example.

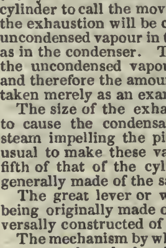
The size of the exhausting valves should be such as to cause the condensation to be completed when the steam impelling the piston is called into action. It is usual to make these valves with a diameter equal to a fifth of that of the cylinder, and the steam valves are generally made of the same magnitude.

The great lever or working *beam* was so called from being originally made of oak. It is now, however, universally constructed of cast iron.

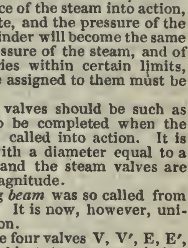
The mechanism by which the four valves V, V′, E, E′, are opened and closed, is subject to great varieties. Sometimes they are opened alternately in pairs by two distinct levers, and driven by two pieces attached to the air-pump rod; but more generally the admission of steam to the cylinder is regulated by a single moveable piece, called a *slide*.

Slides are very various in their form and arrangement; but that which has come into most general use is one which is called from the form of its cross section the D valve. This slide is represented in vertical section in figs. 2 and 3.

(2.)



(3.)

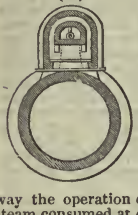


The rod E, by which the slide is moved, passes through a stuffing box F. The moveable piece or slide G is represented by a vertical section a, being a hollow passage through it extending from the top to the bottom; S is the mouth of the great steam pipe coming from the

boiler; P is the pipe leading to the condenser; T H is a hollow space formed within the slide, always in communication with the steam pipe S, and consequently always filled with steam from the boiler. A transverse section of the slide and cylinder is represented in fig. 4., where *a* represents the top of the passage marked *a* in fig. 2.

In the position of the slide represented in fig. 2. the steam filling the space T H has access to the top of the cylinder, but is excluded from the bottom. The steam which was below the piston, passing up the passage *a*, escapes through the tube P to the condenser. When the piston has descended the rod E moves the slide downwards, and throws it into the position represented in fig. 3. The steam in T H has now access to the bottom of the cylinder; while the steam above the piston, passing through P, escapes to the condenser. In this way the operation of the piston is continued, and the steam consumed at each stroke only exceeds the capacity of the cylinder by what is necessary to fill the passages between the slide and the cylinder. The steam filling the space T H has a tendency to press the slide back, so as to break the contact of the rubbing surfaces, and thereby to cause the steam to leak from the space T H to the back of the slide; this is counteracted by the packing *x* at the back of the slide.

(4.)

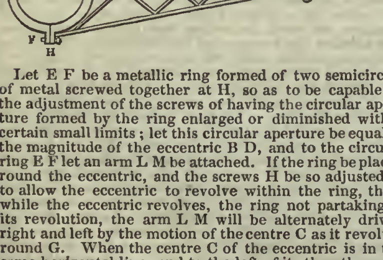


In engines of very long stroke, the extent of the rubbing surface of slides of this kind renders it difficult to keep them in steam-tight contact, and to ensure their uniform wear. In such cases, therefore, separate slides on the same principle are provided at the top and bottom of the cylinder, moved, however, by a single rod of communication.

A great variety of slides and cocks for regulating the admission of steam to the cylinder may be seen described in Dr. Lardner's work on the *Steam Engine*, p. 227—242.

The method of working the valves by pins attached to the air-pump rod already described has been, except in the case of engines of great magnitude and power, superseded by a contrivance called an *eccentric*, by means of which the slides or valves receive motion from the axle of the fly-wheel.

An eccentric is a metallic circle attached to the axle of the fly-wheel, so that its centre shall not coincide with the centre round which the axle revolves. Let us suppose that G (fig. 5.) is a square revolving shaft; let B D be a circular plate of metal, having a square hole cut in it through which the revolving shaft G passes; and let C be the centre of this circular plate. By the revolution of the shaft this centre C will be carried round it in a circle, the radius of which will be C G.



Let E F be a metallic ring formed of two semicircles of metal screwed together at H, so as to be capable by the adjustment of the screws of having the circular aperture formed by the ring enlarged or diminished within certain small limits; let this circular aperture be equal to the magnitude of the eccentric B D, and to the circular ring E F let an arm L M be attached. If the ring be placed round the eccentric, and the screws H be so adjusted as to allow the eccentric to revolve within the ring, then, while the eccentric revolves, the ring not partaking of its revolution, the arm L M will be alternately driven right and left by the motion of the centre C as it revolves round G. When the centre C of the eccentric is in the same horizontal line, and to the left of it, then the position of L M will be that which is represented in fig. 5. But after half a revolution of the main axle the centre C will be thrown to the right of G, and the point M will be moved to the right to a distance from its former position equal to twice C G. Thus, as the eccentric revolves, the ring, together with the arm L M, will be alternately driven right and left, through a space equal to twice the distance between the centre of the eccentric and the centre of the revolving shaft.

If we suppose a notch formed at the extremity of the arm L M, capable of embracing a lever N M moveable on a pivot at N, the motion of the eccentric would give to such a lever an alternate motion from right to left, and *vice versa.* If we suppose another lever N O connected with N M, and at right angles to it, forming what is called a *bell crank*, then the alternate motion of M from right to left will impart a corresponding motion upwards and downwards to the end O of the lever N O. If this last point O were attached to the vertical rod of the slide, it would move the slide upwards and downwards. The extent of this motion might be regulated at pleasure by varying the length of the arms of the levers, and the moment at which it would commence to move in either direction would be determined by the position of the eccentric on the fly-wheel shaft.

Expansive Engine.—As the operation of the steam engine has been explained, the power which moves the piston is the immediate force with which vapour is produced in the boiler. Each quantity of water which is successively evaporated obtains the space requisite for it in the form of steam, by pressing towards the cylinder an equal quantity of steam previously contained in the boiler; and it is the force with which the steam is thus pressed forward that impels the piston. But it has been shown (*see* STEAM) that great additional mechanical power will be obtained from the steam, if, besides this moving power which results from immediate evaporation, the expansive power of the steam separated from the water be used. This is accomplished by closing the valve through which steam flows from the boiler to the cylinder before the piston has completed its stroke. Thus, let us suppose that when the piston has advanced through half its stroke the steam valve be closed, the steam which is then acting upon the piston will still urge it forward; but as the piston advances, this steam assuming a proportionally augmented volume will acquire a gradually diminished pressure, so that through the remaining half of the stroke the piston will be urged by a pressure progressively decreasing, and at the termination of the stroke it will be a little less than half the force with which the piston was impelled while the steam valve was open.

Since the force of the steam from the moment the steam valve is closed is thus continually diminished, its moving power might be so much attenuated that it would be incapable of overcoming the resistance so as to complete the stroke; this would happen if the steam were cut off when only a small fraction of the stroke has been made, unless the pressure of the steam while the valve is open exceeds the resistance in a proportionate degree. It is for this reason that the expansive principle cannot be brought into operation to any considerable extent, unless steam be used of a greater pressure than is commonly adopted in low-pressure engines. It is also apparent that with an equal volume of cylinder greater length of stroke should be given when the expansive principle is used.

The mechanism by which the expansive principle is brought into practical operation consists merely in the adaptation of valves or slides which shall stop the admission of steam when the required fraction of the stroke has been made by the piston, but which shall leave the communication with the condenser open till the stroke is completed. If separate valves be used, this is accomplished by adapting the pins or other mechanism by which they are worked to open and close them independently of each other at the proper times. If slides be used, it is effected by regulating the form and aperture of the slide, so as to cover and uncover the passages to the cylinder at the proper times. Each species of valve, and each form of slide or cock, has its own peculiar provisions for accomplishing this, the details of which may be seen by a reference to *Lardner on the Steam Engine*, p. 232. *et. seq.*

Single-acting Steam Engine. — When the steam engine is applied to the purpose of pumping water, which in the first periods of its invention was its only practical application, the force which it exerts is only required in raising the pump rods with their load of water, their own weight being more than sufficient for their descent. As the pump rods are attached to the working end H (fig. 1.) of the beam, the force of the steam is only required to draw up that end, and therefore to draw down the end at which the steam piston is attached; the steam, therefore, being only required to press the piston downwards, it is not admitted from the boiler below it, as in the engine already described, which for distinction is called the double-acting engine. During the down stroke of the single-acting engine the performance of the machine is precisely similar to that already described; steam is admitted through the upper steam valve above the piston, while the space in the cylinder below the piston is kept in free communication with the condenser by keeping the lower exhausting valve open. The operation, therefore, of the upper steam valve, and the lower exhausting valve, is precisely the same as in the double-acting engine.

When the piston has reached the bottom of the cylinder, the two former valves being closed, a valve called the equilibrium valve is opened, by which a free communication is made between the top and bottom of the cylinder: by this means the steam which fills the upper part of the cylinder being allowed to flow equally to the lower part will press with the same force on both sides of the piston, and will therefore have no tendency whatever to move it. Under these circumstances the preponderating weight of the pump rods suspended from the other end of the beam will draw the piston to the top of the cylinder; while it is ascending the steam which was above will pass through the equilibrium valve below it, and when the piston has reached the top of the cylinder the cylinder under the piston will be filled with the same steam which previously had driven the piston down. In order to accomplish the next down stroke, the equilibrium valve is closed, and the upper steam valve and lower exhausting valve are opened; the steam pressure acts above the piston, and a vacuum is produced below it, and the piston descends as before.

Single-acting engines are frequently worked with expansion. In the application of this principle to them the upper steam valve is closed before the lower exhausting valve; but both these valves are open together. The mechanism for working the expansion valves does not materially differ in its principle from that already described in the double-acting engine.

The great theatre of the operation of single-acting engines is the mining districts, and especially that of Cornwall. The Cornish pumping engines are constructed of enormous power, and carry out the expansive principle to a great extent. Engines are there used for the drainage of mines with cylinders from 7 to 8 feet in diameter, and from 10 to 12 feet in the stroke. Steam having a pressure of from 20 to 30 lbs. per square inch, and upwards, is used for impelling them, and is cut off at a third or fourth of the stroke. A system of careful inspection has been for some years established by the mining companies, with a view to the improvement of the efficiency of the engines, and monthly reports of the performance of the engines have been regularly printed. The effect of this has been to stimulate the activity and skill of all concerned in the manufacture and working of these machines, and a rapidly progressive improvement in them has taken place. The efficiency of these engines is estimated by the number of pounds weight of water which they are capable of elevating one foot high by the combustion of a bushel of coals. This has been termed the *duty* of the engine. In 1769, when Mr. Watt first directed his attention to the steam engine, Smeaton computed that the average duty of the engines then in use was about 5½ millions; from that time to the year 1800, a period of thirty years, Mr. Watt's improvements in the steam engine were made, and the duty was gradually encreased to 20 millions, or very nearly quadrupled. In 1813, the system of inspection first mentioned was commenced, and the average duty was the same as in 1800. From this time to 1826, the engines underwent a progression of slow but steady improvements, and the duty was increased to 30 millions. This state of improvement continued; and, in 1828, the average duty had risen to nearly 77 millions. The increase since that time has been slower: the average duty for the last few years has been from 80 to 90 millions; but in one well-conducted experiment, it was found that by the combustion of a bushel of coals an amount of mechanical power was produced which raised the inconceivable load of 125 millions of pounds weight one foot high. Thus, by the improvements of Watt and their immediate consequences, the power of the steam engine was, within the space of seventy years, increased about 25 fold.

Non-condensing Steam Engines. — The form and structure of non-condensing engines differ in nothing from that of double-acting condensing engines, except in the absence of the condensing apparatus; that is to say, the condenser, the air-pump, and the cold water and hot water pumps. The steam, after it has impelled the piston, instead of being conducted to a cold vessel to be condensed, is simply allowed to escape into the atmosphere, and is commonly ejected into the chimney of the furnace.

The operation of such a machine is extremely simple. The valves by which the steam is admitted to, and allowed to escape from the cylinder, are exactly similar to those of the double acting engine. In the down stroke of the piston the upper steam valve being open admits steam from the boiler above the piston, and the lower exhausting valve allows the steam below it to escape through a tube which leads to the chimney, up which it rushes. In the up stroke, the lower steam valve being open admits steam from the boiler below the piston, and the upper exhausting valve being open allows the steam above the piston to escape to the chimney.

It is evident, in such a machine, that the piston is always resisted by the pressure of the steam escaping to the chimney. As such escape cannot be effected except by steam of greater pressure than that of the atmosphere, it follows that the piston is always resisted by a force somewhat greater than the atmospheric pressure. The steam which urges the piston is therefore only effective by the excess of its pressure above that of the escaping vapour, which may be taken at about 16 lbs. per inch, but which varies in different engines.

As the steam used in non-condensing engines must, of necessity, have a pressure considerably exceeding that of the atmosphere, such machines have been generally called *high-pressure engines;* while those which condense the steam have been, on the other hand, called *low-pressure engines.* These terms are not, however, correctly expressive of the nature of these engines respectively. Many engines in which condensation is used, especially those in which the expansive principle is applied with much effect, are worked with steam of a high pressure, not unfrequently with a pressure amounting to from two to three atmospheres. It is therefore not correct to call such machines low-pressure engines. It is, however, true that engines worked without condensation must, of necessity, be worked by steam of a pressure which is generally called *high pressure.*

All locomotive engines, without exception, used on railways or common roads, are high-pressure non-condensing engines. *See* Locomotive Engine and Steam Carriage.

High-pressure non-condensing engines are almost universally used for inland navigation in the United States. *See* Steam Navigation.

Rotatory Steam Engine. — This term is sometimes applied to the double-acting engine working a crank and fly-wheel, as distinguishing it from the single-acting engine used for pumping. But it is more properly applied to an engine in which a motion of rotation is produced immediately by the action of the steam, without the intervention of such mechanism as the working beam, crank, and fly-wheel. This is usually effected by a piston which, instead of moving longitudinally in the cylinder, revolves within the cylinder on an axis which coincides with the geometrical axis of the cylinder itself. The mechanism is so contrived that this piston shall revolve in steam-tight contact with the sides and ends of the cylinder; and that while steam from the boiler constantly presses it on one side, the steam on the other side shall continually escape to the condenser, if it be a condensing engine, or to the chimney, if it be a non-condensing engine. The various contrivances for rotatory engines which have been suggested differ one from the other only in the mechanical expedients by which these ends are attained. Such machines are very numerous and various; but as none of them have yet been found to be attended with sufficient practical advantages to force them into any use beyond the experimental trials of their inventors, it is sufficient here to have indicated the general principle of their structure.

Atmospheric Engine. — The engine so called was the first form of steam engine which was ever brought into extensive and durable practical application; and in districts where fuel is cheap and abundant the simplicity of its structure still keeps it in partial use. Steam, in the atmospheric engine, is only used as an agent for the production of a vacuum, in order to give effect to the atmospheric pressure.

The atmospheric engine, which is only applied to pumping, consists of a cylinder open at the top, having a piston which moves in it air-tight and steam-tight. The piston is thus maintained by being lubricated by oil or melted tallow poured above it. Supposing the piston to be at the bottom of the cylinder, steam is admitted from the boiler by a proper valve. This steam, having a pressure not much exceeding that of the atmosphere, will balance the pressure of the atmosphere above the piston, and will be sufficient also to overcome the friction of the piston with the cylinder. Under such circumstances the preponderating weight of the pump-rod at the other end of the beam draws the piston to the top of the cylinder, in the same manner as the piston is drawn up in the single-acting steam engine already described. The piston being thus suspended at the top of the cylinder, the valve admitting steam from the boiler is closed, and another valve or cock is opened, by which a jet of cold water is thrown into the cylinder. This immediately condenses the steam, and leaves a vacuum under the piston. The atmospheric pressure above it consequently takes effect, and forcing the piston to the bottom of the cylinder, draws the pump-rods, with their load of water, up. When the piston arrives at the bottom of the cylinder, the cock admitting the jet of cold water is closed and another is opened, by which the warm water formed by the mixture of the condensed steam with the cold water of the jet is discharged into a reservoir from which the boiler of the engine is fed. The steam is then again admitted from the boiler, the piston ascends, and so the process is continued.

The cocks or valves above mentioned are opened and closed at the proper times by means of a rod or beam,

called the *plug frame*, attached to the working beam, which is placed and which moves in a manner similar to the rod of the air-pump in the steam engines already described.

History of the Steam Engine. — Various attempts at the mechanical application of steam on a small scale were made at very early periods in the history of mechanical science. Hero of Alexandria has left a description of a small machine, in which a motion of continued rotation was imparted to an axis by the reaction of steam issuing from lateral orifices in arms placed at right angles to the revolving axis. The date of this invention is about a century before the birth of Christ. Branca, an Italian engineer, about the beginning of the 17th century, proposed to give motion to a wheel by a blast of steam blown against its axis; and about the same period De Caus, a French engineer, described a machine by which a column of water might be raised by a pressure of steam confined in the vessel above the water to be elevated. There is nothing, however, in the descriptions and developments which these projectors have left, to demonstrate that they were acquainted with those physical properties of elasticity and condensation (*see* STEAM) on which all the power of steam, as a mechanical agent, depends. In the middle of the 17th century, or somewhat later, the celebrated Marquis of Worcester published in his work, called *A Century of Inventions*, a description of a steam engine to be worked by steam of high pressure, which, though not minute and explicit in its details, is still such as it is difficult to conceive being written by any one unacquainted with the elastic force of steam. (See *Lardner on the Steam Engine*, p. 23. *et seq.*) Towards the close of that century, Papin, a French engineer, who was employed by the Landgrave of Hesse, in Germany, and was professor of mathematics at Marbourg, directed his attention to the properties of steam, and conceived the idea of obtaining a moving power by introducing a piston into a cylinder and producing a vacuum under it by the sudden condensation of steam by coal. In fact, he conceived the notion of the principle of the atmospheric engine; but there is no evidence of his having carried that or any other machine into practical application, even so far as the construction of a model, until after machines worked by steam had been constructed elsewhere.

The first actual working steam engine of which there is any record was invented and constructed by Thomas Savery, an Englishman, to whom a patent was granted for it in the year 1698. Savery reproduced the method of forming a vacuum by the condensation of steam, apparently without being aware of the paper written by Papin. He combined this with the elastic pressure of steam as applied by Lord Worcester, and constructed an engine, which, for a time, was used to a considerable extent for raising water. Papin's steam engine consisted of a strong iron vessel formed in the shape of an egg, having a tube or pipe at the bottom, which descended to the place from which the water was to be drawn, and another at the top, which ascended to the place to which it was to be elevated. This oval vessel was filled with steam supplied from a boiler, by which the atmospheric air by which it was previously filled was first blown out of it. When the atmospheric air was thus expelled, and nothing but pure steam was left in the vessel, the communication with the boiler was cut off, and cold water was poured on the external surface of the vessel. The steam within it was thus condensed and a vacuum produced, and the water was drawn up from below in the usual way by suction. The oval steam vessel was thus filled with water; a cock at the top of the lower pipe was then closed, and steam was introduced from the boiler into the oval vessel above the surface of the water. This steam being of high pressure, forced the water up the ascending tube, from the top of which it was discharged; and the oval vessel being thus again filled with steam, the vacuum was again produced by condensation, and the same process was repeated by using two oval steam vessels which would act alternately; one drawing water from below, while the other was forcing it upwards, an uninterrupted discharge of water was produced.

Owing to the danger of explosion, from the high pressure of the steam which was used, and from the enormous waste of heat by unnecessary condensation, these engines soon fell into disuse.

The demand for a moving power for the drainage of the mines less expensive and more efficacious than that of horses, which was then generally used, became at this time pressing, and probably led to the invention of the atmospheric engine already described. This machine was invented by Newcomen, a blacksmith, and Cawley, a glazier, at Dartmouth, in Devonshire. In the first engine constructed by them the condensation was effected by the affusion of cold water upon the external surface of the cylinder, which was introduced into a hollow casing by which it was surrounded: the discovery of condensation by jet within the cylinder, one of the most important steps in the improvement of the steam engine, was accidental. It happened that a small hole occurred in the bottom of the cylinder of an engine, by which the water let in to cool its external surface oozed in, forming a little jet. The effect was a much more rapid and perfect condensation than ever was or could be effected by external cold. Thenceforward, the method of condensation by jet was adopted, and has ever since been used.

In the early atmospheric engines, the cocks by which the steam was admitted and condensed, and by which the injected water and condensed steam were drawn off, were worked by hand; and as the labour was light and monotonous, and required no skill, boys were employed for the purpose, called *cock boys*. It happened that a cock boy, by name Potter, having an itch for play, and endowed with more ingenuity than industry, imagined that by tying strings to the cocks, and connecting them with the working beam above the cylinder, regulating the action by carrying them under or over certain pipes, he could make the beam, as it ascended and descended, open and close the cocks more regularly and effectually than he found himself able to do. This he accordingly accomplished, and was habitually absent from the engine-house, enjoying himself with his playfellows, when his employers were giving him credit for most extraordinary industry and regularity in the discharge of his duties. The engine, in fact, by this expedient, nearly tripled its efficacy. Thus, by the ingenuity of a child, the steam engine was first endowed with those qualities of an automaton which have ever since rendered it an object of admiration and interest. The atmospheric engine, thus improved, held its place as the great instrument for the drainage of mines until the epoch which was rendered memorable by the inventions and discoveries of the immortal Watt.

Watt was a mathematical instrument maker in Glasgow; and, being employed by the university of that place, it chanced, about the year 1763, that the model of an atmospheric engine used at the lectures of the professor of natural philosophy required some repairs, to make which it was placed in the hands of Watt. In the experiments which it became his duty to make with this model, he was struck with the fact that the quantity of steam it consumed for each stroke of the piston was many times more than the contents of the cylinder. The large quantity of water necessary to be injected in order to complete the condensation also excited his surprise. This led him to make experiments, by which he soon arrived at the discovery of some of the most important phenomena connected with the evaporation of water. He made a near approximation to the proportion of the volume of steam to that of water. He ascertained with great precision the latent heat of steam, and consequently determined the quantity of water necessary to condense any given quantity of steam. Filled with astonishment at these results, and more particularly at the nature of latent heat, and at the great amount of the latent heat of steam, he repaired to Dr. Black, then professor of natural philosophy in the university, and communicated to him the result of his discoveries. He then, for the first time, learned Black's celebrated theory of latent heat, and found that he had himself thus accidentally discovered one of the most striking facts on which that theory rested.

Considering the atmospheric engine in an economical point of view, Watt was forcibly impressed with the waste of expense which appeared to arise in the unnecessary consumption of steam involved in its operation. In the theory of that engine, one cylinderful of steam ought to be sufficient for each stroke of the piston. Watt, on the other hand, found that the actual consumption was at the rate of four or five cylinderfuls per stroke. On examination, he discovered the source of this waste to arise from the necessity, in order to make the piston ascend, not only to condense the steam, but to cool the whole mass of the cylinder down to 100°; and, to make the piston descend, it was necessary not only to fill the cylinder with steam, but to raise the temperature of the cylinder and piston from 100° to 212°. He soon perceived that this enormous waste of fuel was the inevitable consequence of condensing the steam in the cylinder.

Reflection on these circumstances happily led him to the idea of condensing the steam in a separate vessel, which should be kept immersed in a cistern of cold water, and in which a jet of cold water might be kept constantly playing, with the addition of a pump to draw off the injected water and condensed steam from such vessel. In fact, all the details of the steam engine as already described were soon carried into practical effect, and engines constructed according to these principles.

At the time of this invention the steam engine had never been used, except for the purpose of raising water. It became a substitute for horse power in working pumps. Although Watt perceived, in the first instance, the ease with which it might be adapted as a general moving power, his first efforts were to get it adopted in the mining districts for drainage. His first engines were, accordingly, the single-acting engine above described;

and it was not until about the year 1784 that he took a patent for the double-acting engine, which is adapted to give a motion of rotation to a shaft, and therefore capable of giving motion to every kind of mill work.

Notwithstanding the manifest advantages attending these improvements of Watt, the mining and manufacturing interests were slow and reluctant in their adoption of them; and, at the end of twenty years from the date of his first improvement, Watt and his partners found that the manufacture of the steam engine had not only not been a source of commercial profit, but had entailed upon them a loss of capital to the amount of about 50,000*l*. An application was made to parliament, on this ground, for an extension of the patent, which was, after much opposition, granted till the year 1800. Various improvements in the more minute details of the machinery of the engine succeeded this; and Watt lived to reap an ample reward for his ingenuity and perseverance, and to be acknowledged as one of the greatest benefactors of the human race.

The engine, as applied to drainage and to manufactures, has received no important improvement in its principle since it was dismissed from the hands of Watt. Those principles which he suggested and applied have been carried out to their fullest extent, and the efficiency of the engine has been proportionally increased. The engine has been successfully adapted to navigation. For an account of application to that purpose, see STEAM NAVIGATION.

For the details of the form and construction of the boilers by which steam is generated, and from which it is supplied to the different kinds of engines, see STEAM BOILER.

For further and more minute details respecting the structure and operation of steam engines of every variety of form, and respecting the history of the invention and progressive improvement of the steam engine, see *Lardner on the Steam Engine*, 7th edition, London, 1846.

STEAM GUN. A contrivance by which balls, or other projectiles used in warlike operations, may be projected by the expansive force of steam.

This invention, which is due to Mr. Jacob Perkins, so well known for various ingenious and useful contrivances in the mechanical arts, having been first brought forward since the general peace which succeeded the battle of Waterloo, has never been submitted to the test of actual experience either in military or naval operations, and consequently has not received the benefit of that stimulus to improvement which is always so necessary to bring mechanical contrivances of a novel kind to perfection, and which can only be derived from their practical application on a large scale. Of the probable or possible utility of the steam gun nothing, therefore, can be inferred from that safest source of information — experience; and we are left to judge of it by the general properties of vapour, and by the experiments on a small scale to which it has been submitted.

If a strong close iron vessel, having two valves, one opening inwards and the other outwards, the latter being loaded with some definite pressure, be *completely* filled with water, such a vessel may be heated to the temperature corresponding to the pressure with which the valve is loaded without causing any portion of the water in it to be converted into steam. To render the effect more easily understood, let us suppose that the valve is loaded with a pressure of fifty atmospheres. The temperature of water evaporated under that pressure being 510° (*see* STEAM), the vessel may be raised to any temperature not exceeding 500°, without having any of the water contained in it converted into steam. If the temperature to which the water is raised be 500°, and a cubic inch of water at common temperature be forced into the vessel through the valve which opens inwards, water being sensibly incompressible, a cubic inch of water at 500° will be forced out at the valve which opens outwards. This water being no longer subjected to the pressure which kept it in the liquid state, will suddenly expand and flash into steam, which at first will have a pressure of 45 atmospheres, but as it expands will have its pressure diminished in nearly the same proportion as the volume into which it swells shall be increased. Since, however, 500° is not sufficient heat to enable the whole of the water thus ejected to pass into steam (*see* STEAM), that part of it which will take the vaporous form will take the requisite amount of latent heat from the sensible heat of that portion which remains in the liquid state. As this latter portion will still retain a considerable temperature, it may be conducted to a vessel containing the feed for the heated vessel just mentioned, from which it will be again forced into that vessel.

Such was the principle of Mr. Perkins's *generators;* by which term he denominated those close vessels in which water was raised to a high temperature without being converted into steam.

Now if the valve through which the heated water is ejected be supposed to be in communication with the barrel of a gun or piece of ordnance, in the same manner as the barrel of an air gun is in communication with the hollow metallic ball in which air is compressed, a ball may be projected by the expansive force of the water ejected from the valve, in the same manner exactly as the ball of an air gun is projected by the expansive force of the compressed air.

As the water may be ejected from the valve either in a constant stream or by a rapid succession of jets, the balls may be discharged from the barrel as rapidly as it is possible for them to be brought under the action of the steam; and since the heating of the barrel only tends to increase the elastic force of the steam, there appears to be no other practical limit to the action of such an engine of offence except that which may be imposed on the heating power applied to the generator.

Of the abstract practicability of applying steam in this manner as an offensive engine there can be no doubt. Both theory and experiment conspire to establish it; but of the comparative efficacy, convenience, and economy of it, compared with gunpowder, many doubts will present themselves to all who duly reflect on the circumstances and purposes of war on the one hand, and the phenomena attending the explosion of gunpowder and the evaporation of water on the other. Not to mention any other, the fact that the steam gun cannot be brought into action until the generator has been raised to a high temperature by the application of an adequate furnace, would at once give to gunpowder an advantage over steam which would limit the application of the latter to a very few cases indeed, such as those of siege and other protracted military operations. In naval warfare it might possibly be more frequently available; but even in that case, great improvements in the details of its mechanism should be made before its use could be attempted with any reasonable prospect of advantage.

The steam gun is exhibited on a small scale in most mechanical museums and other exhibitions of a like kind; and such will probably be the limit of its use for a long period to come.

STEAM NAVIGATION. The art of applying the power of steam to the propulsion of boats and vessels in general, as well for inland communication by rivers and lakes, as for the general purposes of national commerce on the seas and oceans by which the various parts of the globe are separated.

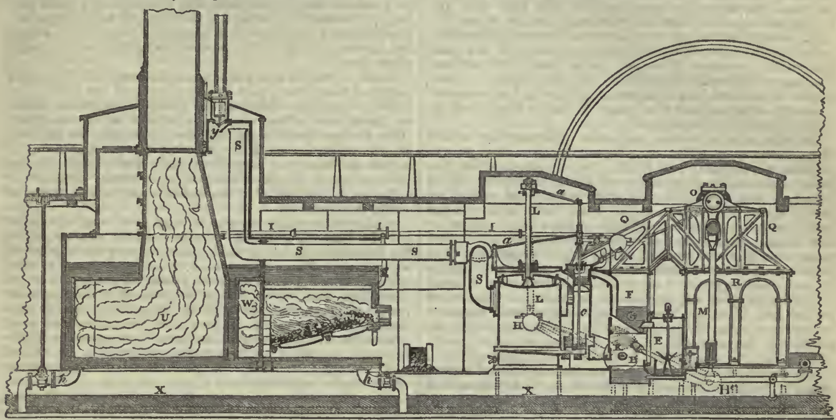
The manner in which the steam engine is rendered an instrument for the propulsion of vessels must, in its general features, be so familiar to every one as to require but short explanation. A shaft is carried across the vessel, being continued on either side beyond the timbers; to the extremities of this shaft on the outside of the vessel are attached a pair of wheels, constructed like under-shot water wheels, having fixed upon their rims a number of flat boards called *paddle boards*. As the wheels revolve, these paddle boards strike the water, driving it in a direction contrary to that in which it is intended the vessel shall be propelled. The moving force imparted to the water thus driven backwards by reaction on the vessel propels it. On the paddle shaft are constructed two cranks or winches, placed at right angles one to the other, so that whenever one of them is thrown into the highest or lowest position the other is horizontal. These cranks are worked by strong iron rods called *connecting rods*, which are themselves either driven directly by the pistons of two steam engines, or are worked by those pistons; thus the medium of working becomes similar to those used in the ordinary land engines. (*See* STEAM ENGINE.) The two cranks being placed at right angles, it follows that when one piston is at the top or bottom of its stroke, and the crank driven by it in the highest or lowest position, the other will be at the middle of its stroke, and the crank driven by it will be in the horizontal position. One of the pistons is therefore always in a position to produce the most advantageous effect on the crank at the moment that the other piston loses all power over the crank driven by it; and in the same manner it may be seen that while the power of one piston is augmented from zero to its greatest effect, the power of the other is decreasing from its greatest effect to zero. Thus the combined action of the two pistons is nearly uniform in its efficiency. If one engine only were used the motion of the wheels would be unequal, being most rapid when the piston is at the middle of the stroke and slowest at the extremities.

The steam engines used for navigation may be either condensing engines or non-condensing engines. If the latter are used, steam must be used having a pressure above the atmosphere of from 15 to 20 lbs. per square inch. Boilers in which steam is produced under this pressure are considered in Europe so unsafe, that non-condensing engines with low-pressure boilers are almost universally used for navigation. In America, however, high-pressure boilers with non-condensing engines are generally used.

The arrangement of the parts of marine engines is different in several respects from land engines. Steam

vessels being generally employed to navigate the open seas, and being, therefore, subject to the vicissitudes of tempestuous weather, the machinery must be protected by being placed below the deck. The space allotted to it being thus limited, great compactness is necessary. The paddle shaft being very little below the deck, the working beam and connecting rod could not be placed above it. The beam is therefore placed below the cylinder, and is driven by the pistons by means of a cross head attached to the piston rod, from the ends of which the rods of the parallel motion (*see* STEAM ENGINE) are carried downwards to the end of the beam. From the other end of the beam the connecting rod is presented upwards towards the crank.

The general arrangement of the parts of a marine engine will be easily understood by reference to the figure, in which is represented in section a marine engine with its boiler, as placed in a steam vessel. The



sleepers of oak supporting the engine are represented at X; the base of the engine is secured to these by bolts passing through them and the bottom timbers of the vessel. S is the steam pipe leading from the steam chest in the boiler to the slides *c*, by which it is admitted to the top and bottom of the cylinder. The condenser is represented at B, and the air-pump at E. The hot well is seen at F, from which the feed is taken from the boiler. L is the piston rod connected by the parallel motion *a* with the beam H, working on a centre K near the base of the engine. The other end of the beam H drives the connecting rod M, which extends upwards to the crank, which it works upon the paddle shaft O. The framing by which the engine is supported is represented at Q R.

The nature and operation of the several parts just mentioned will be understood by reference to the explanation of the structure and operation of the double-acting steam engine, given under the head STEAM ENGINE; for, in fact, the marine engine, such as is here represented, is nothing more than a double-acting condensing steam engine, adapted in its form to the circumstances in which it is used in navigation.

The beam exhibited in the figure is shown in dotted lines, as being on the further side of the engine. A similar beam similarly placed, and moving on the same centres, must be understood to be at this side, connected with the cross head of the piston in like manner by a parallel motion, and with a cross piece attached to the lower end of the connecting rod and to the opposite beam. The eccentric, which works the slides, is placed upon the paddle shaft O; and the connecting arm which drives the slides may be easily detached when the engine requires to be stopped. The section of the boiler grate and flues is represented at W U. The safety valve *y* is enclosed beneath a pipe carried up beside the chimney, and is inaccessible to the engine-man. The cocks for blowing aft the salt water from the boiler (a process which we shall presently explain) are represented at *h*, and the feed pipe at I. Those parts will be fully understood by reference to the explanation given under the head STEAM BOILER.

To save space, marine boilers are constructed so as to produce, within the smallest possible dimensions, the necessary quantity of steam. With this view a more extensive surface in proportion to the capacity of the boiler is exposed to the fire. The flues by which the flame and heated air are conducted to the chimney are so constructed, that the heat shall act upon the water on every side in thin oblong shells or plates. This is accomplished by constructing them so as to traverse the boiler backwards and forwards several times before they issue into the chimney. The bottom of the boiler is not, therefore, one uniform flat or arched surface, as in land boilers; but is divided by a number of plates placed in a vertical position side by side, having spaces between them alternately appropriated to the water to be heated and the air from the fire. This division is in some boilers not only made in the bottom on a level nearly with the furnace, but another stratum of similar flues and water spaces is constructed above the level of the furnace; so that the heated air first traverses the lower stratum of flues, and afterwards, being conducted upwards, traverses the upper stratum before it issues into the chimneys.

In steam vessels, instead of effecting the necessary evaporation by a single boiler, it is usual to provide two, three, four, or more independent boilers, according to the magnitude of the vessel and the power of her engines. By this means, when at sea, the engines may be worked by some of the boilers while others are being cleaned or repaired.

The greatest inconvenience and difficulty attending the application of the steam engine to navigation arises from the necessity of supplying the boilers with sea water. This water is injected into the condenser for the purpose of condensing the steam, and it is thence mixed with the condensed steam conducted as feeding water into the boiler. Sea water holds in solution certain alkaline substances, of which the principal is muriate of soda, or common salt. This forms about three per cent. of the water. This salt not being evaporated with the water, remains in the boiler, and enters into solution with the water remaining in it, rendering that water a solution more and more concentrated the longer the boiler is worked. At length the water in the boiler becoming saturated, the salt will begin to be precipitated in the form of sediment; and if this were continued, the boiler would finally be filled with salt.

Besides the deposition of salt in a loose form, some of the alkaline substances have an attraction for iron, and a crust is thereby formed on the inside of the boiler. This crust obstructing the passage of heat from the fire to the water, gives the boiler plates an undue or unequal temperature, causes them to open in the seams, and softens them, so as to expose the boiler to a liability to leak or even to burst.

These effects can only be prevented by either of two methods: 1st, by so regulating the feed of the boiler that the water it contains shall not be suffered to reach the point of saturation, but shall be so limited in its saltness that no injurious incrustation or deposit shall be found; 2ndly, by the adoption of some means by which the boiler may be worked by fresh water. This end can only be attained by condensing the steam by a jet of fresh water, and working the boiler always by the same water.

The method by which the water is prevented from being over salted has been usually to discharge into the sea a certain quantity of over-salted water (called *brine*), and to supply its place by sea water introduced through the condenser, and which, being mixed with the condensed steam, is rather less salted than ordinary sea water. To effect this cocks, called *blow-off cocks*, are placed in the lower part of the boiler where the brine collects. The pressure of the steam is sufficient to force the lower strata of water out through these cocks when they are open, and this process is called *blowing out*. It is, or ought to be practised, at such intervals as will prevent the water from becoming over salted.

The improper observance of this process is attended with injurious effects at sea. If too much water be blown out, a proportionate loss of heat and waste of fuel is incurred. If insufficient water be blown out, incrustation takes place, and its injurious consequences ensue. The Messrs. Seaward of Limehouse use a glass hydrometer gauge, to indicate the saltness of the water in the boiler by showing its increase of density compared with ordinary sea water. A vessel containing one ton of water is placed so as to communicate on one side with the boiler, and on the other with the sea. In this vessel is a cock, which turned in one direction *opens* the communication with the boiler, and *closes* that with the sea; and turned in the other direction *opens* that with the sea, and *closes* that with the boiler. By this means the engineer is enabled to discharge a definite and ascertained quantity of brine, and the gauge indicates when a sufficiency has been discharged.

But the most effectual method of keeping the boilers from being over salted is by means of the *brine pumps* of Messrs. Maudslay and Field. This method, which has been successfully applied in the Great Western (plying between Bristol and New York), consists of pumps by which water is drawn from the lower parts of the boiler and driven into the sea. These pumps are worked by the engine, and their operation is constant. The feed pumps are likewise worked by the engine; and they bear such a proportion to the brine pumps, that the quantity of salt discharged in a given time in the brine is equal to the quantity of salt introduced in solution by the water of the feed pumps. By these means the same quantity of salt is constantly maintained in the boiler, and consequently the strength of the solution remains invariable.

To save the heat of the brine, the current of heated brine is conducted from the boiler through a tube, which is contained within that by which the feed is introduced. The warm current of brine, therefore, as it passes out, imparts a considerable portion of its heat to the cold feed which comes in; and it is found by this expedient that the brine discharged into the sea may be reduced to the temperature of 100°.

This expedient is so effectual that where the apparatus is properly constructed, and kept in a state of efficiency, it may be regarded as nearly a perfect preventive against incrustation.

A method of condensing the steam without a jet, by cold surfaces, was practised by Mr. Watt, but abandoned because its effect was not sufficiently instantaneous. This was revived by Mr. Samuel Hall of Basford, with a view to working marine boilers with fresh water. The steam from the cylinder was drawn through a great number of small tubes, which were constantly surrounded by cold water. Being by this means condensed, without being mixed with any injected water, it was carried to the feeding cistern to be reconducted to the boiler. In this manner the same water circulated constantly through the boiler, condenser, and feeding cistern, and it was only necessary to make good the waste produced by leakage. The same supply of fresh water, therefore, would always work the boiler, the very small quantity of waste being made good by the distillation of sea water.

These condensers were adopted in several steam vessels. In some they were abandoned after the experience of a few months; and the results have failed to produce their use to any considerable extent, notwithstanding that the object their projector professed to attain was admitted to be one of great importance.

One of the remedies proposed against incrustation was the use of copper boilers. The attraction which produces the adhesion of the calcareous matter to the surface of iron has no existence in copper, and all the saline matter precipitated in a copper boiler will therefore pass away through the blow-off cocks. Besides the injuries attending incrustation, an evil of another kind attends the accumulation of soot mixed with salt in the flues. In the seams of the boiler there are always numerous apertures of dimensions so small as to be incapable of being rendered staunch by any practicable means, through which the water within the boiler filters, and the salt which it carries with it, mixed with the soot, forming a compound which rapidly corrodes the boilers. The evil is not removed by copper boilers, in which it equally prevails.

As the voyages accomplished by steam vessels have increased in length, the economy of fuel in working them has become a subject of vastly augmented importance. So long as steam navigation was confined to river or channel transport, or to coasting voyages, the speed of the vessel was a paramount consideration, at whatever expenditure of fuel it might be obtained; but since steam navigation has been extended to ocean voyages, where coals must be transported sufficient to keep the engine in operation for a long period of time without a fresh relay, greater attention has been bestowed on economising it. Since the resistance of a steam vessel to the moving power produced by the action of the paddle wheels varies with the state of the weather, the consumption of steam in the cylinders must undergo a corresponding variation; and if the production of steam in the boilers be not proportioned to this, the engines will either work with less efficiency than they might do under the actual circumstances of the weather, or more steam will be produced than the cylinders can consume, and the surplus will be discharged to waste through the safety valves. The firemen of a marine engine must therefore in a certain degree discharge the functions of a self-regulating furnace, rendering the force of the fire always proportionate to the wants of the engine. None but the most industrious and skilful stokers can be expected to accomplish this.

Until within a few years of the present time the heat radiated from every part of the surface of the boiler was allowed to go to waste, and to produce injurious effects on those parts of the vessel to which it was transmitted. This evil has been lately removed by coating the exterior of the boilers with felt, prepared for the purpose, by which the escape of heat from the surface of the boiler is very nearly if not altogether prevented. This felt is attached to the plates of the boiler by a thick covering of white and red lead.

A form of marine engine was some years ago proposed by Mr. Thomas Howard, in which steam was produced by projecting water in small quantities on the surface of a piece of mercury maintained at a temperature of from 400° to 500°. The steam thus produced contained much more heat than was necessary to sustain it in the vaporous form. The engine was worked expansively, and by condensation; but as the project does not appear to have produced any practical consequences of permanent importance, we need not here notice it further.

The method by which the greatest amount of practical effect can be obtained from a given quantity of fuel must mainly depend on the extended application of the expansive principle. (*See* STEAM, STEAM ENGINE.) The difficulty of the application of this principle in marine engines has arisen from the objections entertained in Europe against the use of steam of high pressure under the circumstances in which an engine must be worked at sea. To apply the expansive principle with great effect, it is necessary that the moving power at the commencement of the stroke shall considerably exceed the resistance, its force being gradually attenuated till the completion of the stroke, when it will finally become less than the resistance. This condition may be fulfilled without resorting to steam of high pressure, if a sufficient quantity of piston surface be used. This method of rendering the expansive principle available for navigation, and compatible with low-pressure steam, has recently been brought into operation by Messrs. Maudslay and Field. Their improvement consists in adapting two steam cylinders in one engine to work a single crank, both pistons ascending and descending together, the piston rods being both attached to the same horizontal cross head moving in guides.

Mr. Francis Humphrys has obtained a patent for a form of marine engine, by which some simplification in the machinery is attained, and the same power comprised within more limited dimensions, a matter of great moment in long voyages. In this engine, there is attached to the piston of the cylinder, instead of a piston rod, a hollow casing, which moves through a stuffing box in the cover of the cylinder. The cross section of this casing is a very narrow and elongated ellipse, extending across the cylinder, or rather a long narrow slit with rounded ends. One end of the connecting rod is attached immediately to the centre of the piston, while the other end is attached to the crank placed above the cylinder; the connecting rod, therefore, works within the casing just mentioned; and instead of being, as usual, driven by a piston rod, it is driven by the *piston itself*.

To obtain from the moving power its full amount of mechanical effect, it would be necessary that it should be exerted against the water in a horizontal direction, and with a motion contrary to the course of the vessel. No system of mechanical propellers has, however, yet been contrived capable of perfectly accomplishing this; patents have been granted for numerous ingenious mechanical combinations to impart to the propelling surfaces such angles as appear to the respective contrivers to be the most advantageous. In most of these, the complexity has been a fatal objection. No part of the machinery of a steam vessel is so liable to become deranged at sea as the paddle wheels; and therefore that simplicity of construction which is compatible with those repairs which are possible on such emergencies is quite essential for safe practical use.

In the ordinary paddle wheel, the paddle boards have the planes so placed as to radiate from the axle of the wheel. In fact, the geometrical axis of the wheel is the common line of intersection of the planes of all the paddle boards. On entering and leaving the water, therefore, these boards will be oblique to the water, and this obliquity will be increased with the immersion of the wheels.

When the vessel is in proper trim, the immersion should be equal to the depth of the lowest paddle board; and if this immersion can be preserved unaltered, nearly the whole of the propelling power will be effective with the common wheels. In river navigation, or in general in smooth water, and when the trip is so limited that the fuel consumed has no sensible effect on the immersion, this steady immersion may be preserved, and in such cases the common wheel is a highly advantageous propeller; but in a heavy rolling sea, the motion of the vessel will produce a constant change of immersion in the wheels, and in long voyages the fuel consumed will lighten the vessel, so as to produce a considerable change in her trim.

To remove this inconvenience, and economize as much as possible the propelling effect of the paddle boards, it would be necessary so to construct them that they may enter and leave the water edgeways, or as nearly so as possible: such an arrangement would be, in effect, equivalent to the process called feathering, as applied to rowing. Any mechanism which would effectually accomplish this would cause the paddles to work in almost perfect silence, and would very nearly remove the inconvenient and injurious vibration which is produced by the action of the common paddles. But the construction of feathering paddles is attended with great difficulty under the peculiar circumstances in which such wheels work. Any mechanism so complex that it could not be easily repaired with such implements and skill as can be obtained at sea would be attended with great objections, and the efficiency of its propelling action would not compensate for the damages which must attend the helpless state of a steamer deprived of her propelling agents.

Feathering paddles have been projected by a vast number of ingenious persons, and a greater number of patents have been granted for this than perhaps for any other contrivance whatever connected with the application of steam power to the useful arts; yet it is remarkable that in no case has there been so signal a failure in attaining the desired end. Some inventors have failed by not clearly understanding the mechanical conditions to be fulfilled by a perfect wheel, and others by the complexity and expense attending the construction of the wheels they proposed. The common paddle wheel, with very slight modifications, still maintains its place as the almost universal propelling instrument for steam vessels.

About the year 1832, a paddle wheel, with mechanism for shifting the paddle boards as the wheel revolved, was brought into partial use in the admiralty steam vessels. This was called Morgan's paddle wheel: the inventor was Elijah Galloway. Its propelling effect in a rough sea was found to be superior to the common wheel, but in smooth water the difference was not considerable. The expense of this wheel excluded it altogether from commercial vessels; and it seems to have been found, in practice, to have been attended with other objections, for it has been gradually relinquished by the government vessels, and is now, we believe, quite discontinued.

About the year 1833, Mr. Field, of the firm of Maudslay and Field, proposed the *split paddle*, which is now coming into very extensive use. In this wheel each paddle board is divided into two or more narrow slips arranged one behind the other, like the laths of a Venetian blind or the steps of a step-ladder. These wheels are as efficient in propelling when at the lowest point as the common paddle boards; and when they emerge, the water escapes simultaneously from each narrow board, and is not thrown up, as is the case with the common paddles.

The limit of the extent of the voyages capable of being made in one uninterrupted trip by a steam vessel will evidently depend on the efficiency of the fuel. As the means of economising this are improved, this limit will be more extended. In 1835, when it was first proposed to cross the Atlantic from Bristol to New York in a single trip, it was considered by persons who had given much attention to the subject that, in the state of steam navigation at that time, the expense would be so enormous, and the tonnage of the vessel so engrossed by the fuel, that the success of the project as a commercial speculation intended for permanent operation throughout all seasons of the year was more than doubtful. A long interval, however, elapsed before the experiment was brought into full operation; and, in the meanwhile, much improvement was effected in the application of the steam engine to navigation. The experiment has been happily at length brought into full practical effect by two companies. What the commercial result has been to the speculators, we are not able to say.

At the time referred to in 1835, those who were doubtful of the expediency of attempting the passage to New York recommended a trial of a line to Boston, touching at Halifax. This has since been accordingly effected, with every prospect of permanent success.

Steam Navigation in America. — The problem of the application of steam power to water transport presented itself in the United States under conditions very different from those under which it offered itself in Europe, and its solution has been accordingly productive of very different results. While the chief object of the commercial interests in Europe was the establishment of lines of steam vessels connecting the great cities and coast towns of the British dominions with each other, and with those of the Continent, and, as the art advanced, to extend the same social and commercial benefit to the coasts of the chief countries of Europe, so as to stimulate the social intercourse of nations too long disunited and struggling in unprofitable warfare, and thereby to diffuse equally among all the benefits of general commercial intercourse, America, standing alone in her vast extent of territory, having no near neighbours with whom to cultivate social or commercial relations, regarding her immense country intersected by some of the most noble rivers in the world, enriched by the largest sheets of inland water which can be found upon the globe, — thus situated, she saw that *inland navigation*, river and lake transport, was the great application of steam by which her rising and enterprising population would be most benefitted, and by which the necessary intercourse could be maintained between her great western emporiums erected on the banks of the Mississippi and Ohio; her more northern settlements on the coasts of the gigantic lakes Ontario, Erie, Michigan, and others; and on the eastern rivers, the Hudson, the Delaware, and the Susquehanna. It was therefore to the construction of steam boats suitable to such internal navigation that American genius was directed; and in this it has been eminently successful.

The American river steamers are in general long narrow boats with a small draught of water, supporting a platform or deck of vast magnitude projecting on either side considerably beyond the limits of the boat on which it rests. The paddle wheels are large, and are usually impelled by a single engine placed with its boiler and machinery *above the deck*. The engines are almost universally non-condensing high-pressure engines, and many of them are worked expansively. The fuel is generally wood; but in many cases, especially in the eastern vessels, coal. In the structure of the machinery there is much rudeness and simplicity, and none of that extreme precision of construction and fine finish is to be found which is almost always observable in European vessels. Owing to the form of the boats and the smooth water in which they work, a much greater average speed has been attained than in the sea-going steamers of Europe. Although we have reason to know that in common reports the average rate of the American steamers has been grossly exaggerated, there is no doubt that their rate of going is very considerable. On the Hudson, between New York and Albany, are the fastest steamers in the United States; and it is probable that if the average speed of these vessels, taken in all circumstances of weather and tide, be stated at thirteen geographical miles an hour, it is not overrated.

The principal theatres of river steamers in the United States are the Hudson and the Mississippi, with its branches. The Hudson is navigated by steam from its mouth at New York to a distance of about 160 miles, the chief point of traffic being the city of Albany, situated on its western bank, at about 145 miles from New York. Although this extent is not considerable, the intercourse upon it is quite enormous during the seasons of the year in which the river is open. It is obstructed by the frost during the winter months.

The Mississippi is navigated by many hundred steamers of very large tonnage. This steam traffic is carried on through a distance of nearly 2000 miles from the mouth at New Orleans. The towns of Natchez, Cincinnati, Louisville, Juttsburgh, and numerous others, maintain, by this means, an easy and constant intercourse with the capital of the southern states.

The steamers on the Mississippi and the Ohio are constructed with even less attention to safe engineering principles than those of the western rivers, and, consequently, more frequent and fatal accidents arise from explosion and other causes.

The dimensions of the steamers which ply on the Hudson are generally as follows: — The length of deck from 150 to 250 feet; the breadth of beam from 20 to 30 feet; and the depth of the hold from 8 to 10 feet. They are generally, but not always, worked by a single engine; the length of stroke is never less than 8 feet, but the most common length is 10 feet; the diameter of the piston varies from 40 to 66 inches, and the diameter of the paddle wheels from 20 to 25 feet; the breadth, or rather the thickness of the wheel, varies from 12 to 14 feet, giving a great extent of surface to the paddle boards, which have usually a dip of 2½ feet; the draught of water of these boats varies from 6 to 9 feet; the steam is generally worked expansively, being cut off at half the stroke, and often sooner; the wheels are said to make, on an average, from 25 to 30 revolutions per minute.

The Ohio steamers are inferior in magnitude to those on the western waters; their number must be very considerable. About seven years since, the number plying

on the river and its branches was about 200; and that number has probably since been nearly doubled. "Economy," says Mr. Stevenson in his *Engineering Tour*, "would seem to be the only object which the constructors of these boats have in view; and therefore, with the exception of the finery which the cabins generally display, little care is expended in their construction, and much of the workmanship connected with them is of a most imperfect and insufficient kind. When the crews of these frail fabrics, therefore, engage in brisk competition with other vessels, and urge the machinery to the utmost extent of its power, it is not to be wondered at that their exertions are often suddenly terminated by the vessel taking fire and going to the bottom, or by an explosion of the steam boilers. Such accidents are frequently attended with an appalling loss of life, and are of so common occurrence that they generally excite little or no attention."

The steamers of the Mississippi vary in magnitude from 100 to 700 tons; and, unlike the light mould of the Hudson steamers, they are heavily built, so as to give them abundant tonnage for goods. They are built with a flat bottom, with a draught of from 6 to 8 feet of water. A deck is supported by the hull at about 5 feet above the level of the water, and the space in the hull under this deck is appropriated to the cargo. The whole of the steam machinery is placed on this deck; the engine standing in the middle of the vessel, and the boilers and furnaces towards the bow. That part of the lower deck towards the stern is occupied by the crew and deck passengers, and is generally a scene of great filth and squalor. From the front of the paddle boxes, a staircase leads to a gallery or balcony of about 3 feet in width, which surrounds a structure raised upon the deck, and extending nearly the whole length of the vessel, presenting the external appearance of a long wooden house, the doors and windows of which open on this balcony. This structure is, in fact, the great cabin, extending from the two smoke funnels to within about 30 feet of the stern; this latter space, extending quite to the stern, is appropriated to the ladies' cabin. The large cabin, which contains the gentlemen's berths, is also used as the chief dining room. From the balcony just mentioned staircases on either side lead to the third, or upper deck, 30 feet above the level of the water. The wheel house, in which the steersman is placed, is erected on the fore part of this deck, and the motion is communicated to the helm by ropes or iron rods.

The engines are constructed with very small cylinders, worked with steam of great pressure. The diameter of the cylinder is often under 18 inches, while the length of stroke is from 5 to 6 feet. The safety valve is usually loaded with 100 lbs. per square inch, which, at the discretion of the captain, is sometimes increased to 150 lbs. Some of the large boats on the Mississippi are equal in magnitude to those on the Hudson, having a length of 230 feet, and a breadth of beam of 28 feet. With this great magnitude of deck and a capacity of not less than 1000 tons, they do not draw above 8 feet of water. For further details respecting steam navigation in general, and in the United States, see *Dr. Lardner on the Steam Engine*, 7th edition; Appendix to *Tredgold on the Steam Engine*; and *Stevenson's Civil Engineering in North America*.

STEA'RIC ACID. (Gr. στεαρ, *fat*.) One of the acids produced in the process of saponification by the action of alkalies upon *stearine*.

STE'ARINE. (Gr. στεαρ.) That part of oils and fats which is solid at common temperatures.

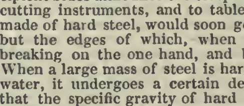
STE'ATITE. (Gr. στεαρ.) A soft mineral of an unctuous or soapy feel; hence called *soapstone*. It is a hydrated silicate of magnesia and alumina.

STEATO'MA. (Gr. στεαρ.) A tumour, the contents of which are of the appearance and consistency of hard fat.

STEEL. (Germ. stahl.) This most useful and curious substance is a compound of iron and carbon: their relative proportions vary in steel of different qualities; but in that used for ordinary purposes, the carbon rarely exceeds 2 per cent., and is generally below it. Certain kinds of iron are preferred to others in this manufacture; but this relates entirely to its purity, which is the essential requisite. Steel is made by a process called *cementation*, which consists in filling a proper furnace with alternate strata of bars of the purest malleable iron and powdered charcoal: atmospheric air is carefully excluded from the boxes containing the bars, and the whole kept for several days at a red heat. By this process carbon, probably in the state of vapour, penetrates, and combines in the above small relative proportion with the iron, the texture of which, originally fibrous, becomes *granular*, and its surface acquires a *blistered* character. The malleability of steel falls far short of that of iron; but it is harder, and more sonorous and elastic, and susceptible of a higher polish, and has less tendency to rust. At a red heat it admits of hammering into various forms, and of being *welded* or united by the blows of the hammer to another piece of steel or iron. Blistered steel, rolled or beaten down into bars, forms *shear steel*; and if melted, cast into ingots, and again rolled out into bars, it forms *cast steel*, which, when well prepared, has the great recommendation of perfect uniformity of texture, and a finer and closer grain. The peculiarity of steel, upon which its high value in the arts in great measure depends, is its property of becoming, by sudden quenching in water, when at a bright red heat, extremely *hard*, and of being again *softened* down to any requisite degree by the application of a certain temperature, which may be indicated by a thermometer, commencing at about 300°, and terminating at a dull red heat. This process is often called *tempering*; and the workman is sometimes guided in the extent to which it is carried by the *colour* of the polished surface of the heated steel, which is at first rendered of a pale straw tint, then yellow, brownish, purple, and blue, as the temperature rises from one extreme to the other. The latter colour indicates extreme softness and elasticity, such as belongs to watch springs, some sword blades, &c.; pale straw indicates great hardness, as for razor blades; yellow is somewhat softer, and shows a fit temper for penknives; and the incipient blues announce the temper that belongs to coarser cutting instruments, and to table knives, any of which, made of hard steel, would soon get spoiled and notched, but the edges of which, when duly tempered, resist breaking on the one hand, and bending on the other. When a large mass of steel is hardened by quenching in water, it undergoes a certain degree of expansion, so that the specific gravity of hard steel is somewhat less than that of soft. It has been attempted to improve the quality of steel for certain purposes by adding to it small portions of other metals: hence the term *silver steel*, &c.; but none of these alloys have on the whole proved superior to well-made common steel. There is a kind of steel imported from India, known under the name of *wootz*, the cutting instruments of which are celebrated for the toughness and durability of their edge. It appears probable that its peculiarities depend upon the presence of a little aluminum. When the surface of some kinds of steel is washed over with a weak acid, it acquires a peculiar mottled or *damasked* appearance, as if its texture consisted of an intimate mixture of two different kinds of steel, or of fine fibres of steel and iron. Steel, alloyed with a little nickel, often puts on this appearance; but these and some other imitations of the celebrated *Damascus* sword blades have not led to any important improvements in the manufacture of our cutting instruments. (See Stodart and Faraday, *Phil. Trans.* 1822.)

STEEL ENGRAVING. The art of engraving on steel. *See* ENGRAVING.

STEEL YARD. A balance by which the weights of bodies are determined by means of a single standard weight. The instrument, which is represented in the annexed figure, is a lever having unequal arms.



The load whose weight is to be determined is suspended from the extremity B of the short arm; and in weighing the constant weight or counterpoise P is slid along the longer arm until the equilibrium is established. Divisions traced on this arm indicate the weight at B corresponding to each position of P.

In the Roman steel yard, or *statera*, the lever was so constructed that the centre of gravity was brought immediately over the point of support; and the system being accordingly balanced upon its fulcrum F, the effect of the weight of the lever was neutralized. The longer arm was then divided into parts, each equal to the shorter arm, and those again equally subdivided. Suppose now the length of the shorter arm, or the distance F B, to be one inch, and the constant weight P to be one pound; then if P be placed at the distance of five inches from F, it will make equilibrium with a load of five pounds suspended from B; for, from the property of the lever, when the equilibrium is established the weight P is to the load at B as the distance of B from F is to the distance of P from F. Whatever proportion, therefore, F P has to F B, the same proportion has the weight suspended from B to the constant weight P.

The steel yard in common use is constructed somewhat differently, the beam being seldom made so as to balance itself on the fulcrum F; but the error that would arise on this account is compensated by beginning the divisions at that point where the weight P being placed the equilibrium is established. If, therefore, when P is removed the longer arm preponderates, the divisions commence from a point between F and B. For the purpose of increasing the range, there are also in general two fulcra, from either of which the beam may be suspended, and two corresponding scales of division are marked on opposite sides of the longer arm.

For weighing heavy loads the steel yard is a convenient instrument; but for smaller weights it is susceptible of less accuracy than the common balance. It should be con-

structed so that the point of support F, and the point of suspension at B, may be in the same straight line with the divisions of the beam.

STEEL YARD, MERCHANTS OF THE. A company of London merchants to whom the *steel yard* (see above) was assigned by Henry III. A. D. 1232. They were all foreigners, chiefly Flemish and German, and were long the only exporters of the staple commodities of England.

STEENING, or STEANING. In Architecture, the brick or stone wall or lining of a well.

STEEPLE. In Architecture, a tower of various forms, usually attached to churches and other public buildings, in which bells are frequently but not always suspended.

STEER. To keep the ship on a given direction. This is done by moving the rudder by the tiller, which last is moved from that side to which the ship's head is required to be moved.

STEERAGE. The steering of the ship. Also a place below in the fore part of ships, as distinguished from the *chief cabin*; but the term is of uncertain acceptation.

STEGANO'GRAPHY. (Gr. στεγανος, *covered*, and γραφω, *I write*.) The art of writing in cypher. *See* CYPHER.

STE'GANOPODS. (Gr. στεγανος, *covered*, πους, *a foot*.) The name of a family of swimming birds (*Natatores*) in the system of Illiger, including those species in which all the four toes are connected by the same web. It corresponds with the genus *Pelecanus* of Linnæus.

STEINHEILITE. A mineral of a blue colour; a variety of *iolite*.

STE'LA. (Gr. στηλη, from ἵστημι, *I stand*.) In Architecture, a small column without base or capital, usually with an inscription to record an event, or to perpetuate the memory of some deceased person. The ancients also used them for marking distances. There are several specimens of stelæ in the British Museum.

STELLA'TÆ. In Botany, a natural order of Exogens, also known under the name of *Galiaceæ*; which see.

STELLE'RIDANS, *Stelleridæ*. (Lat. stella, *a star*.) Star fishes. The name of the family of Echinoderms of which the genus *Asterias* is the type.

STE'LLIONATE. In the Roman law, a general term comprehending all sorts of fraud committed in matters of agreement which were not designated by any more special appellation. The name is said to be derived from *stellio*, a lizard, because the fraudulent man is comparable to that animal for versatility and address. The six common species of stellionate enumerated by Roman writers were, 1. When one sells the same thing to two purchasers; 2. When a debtor pledges to his creditors something which does not belong to him; 3. When one abstracts or damnifies something which he has pledged to creditors; 4. Collusion by two parties to the prejudice of a third; 5. When a vendor substitutes an object of less value for that which he has engaged to sell; 6. A wilful false declaration in an instrument.

STEM. In Music, the upright or downright line added to the head of a musical note; the head being that part filled in black or left open, as the case may be.

STENELY'TRANS, *Stenelytra*. (Gr. στενος, *narrow*; ελυτρον, *a sheath*.) The name given by Latreille to a family of Coleopterous insects, comprehending those in which the elytra become narrow at the posterior part of the body.

STENO'GRAPHY. (Gr. στενος, and γραφω, *I write*.) The art of short-hand, otherwise termed *tachygraphy*. This art has been practised from remote antiquity, and is said to have originated in the hieroglyphics of the Egyptians. Numerous systems of stenography have been invented in more recent times, many of them of great simplicity; but it would be out of place here to enter into any details respecting them.

STEP. A block of wood, or in large ships of late years a strong solid platform, upon the kelson, supporting the keel of the mast. It was found that the weight of the mast, yards, &c., added to the enormous force upon the rigging, especially during strong winds, forced the keel down.

STEPPES. (Russ.) The name given to the vast system of plains peculiar to Asia; synonymous with the prairies of North America and the Ilhanos of South America. The steppes of Russia are not unlike the heaths of Germany, being in part susceptible of cultivation, and affording pasturage for numerous herds of nomadic tribes.

STERCO'RIANISM. In Ecclesiastical History, a nickname which seems to have been applied in the Western church, in the 5th and 6th century, to those who held the opinion that a change took place in the substance of the consecrated elements, so as to render the divine body subject to the act of digestion. (See *Mosheim*, vol. ii. transl. 1790, p. 342.)

STERELMI'NTHANS, *Sterelmintha*. (Gr. στερεος, *solid*, and ελμινς, *an intestinal worm*.) The name of a class of internal parasitic animals or Entozoons, comprising those which are composed of a solid parenchymatous substance, in which the nutrient and generative canals are simply excavated, and not freely suspended in an abdominal cavity.

STEREOGRA'PHIC PROJECTION. (Gr. στερεος, *solid*; γραφη, *description*.) The projection of the sphere upon the plane of one of its great circles, the eye being situated at the pole of that circle. *See* PROJECTION.

STEREO'GRAPHY. In the Descriptive Geometry, the representation of solids on a plane.

STEREO'METER. (Gr. στερεος, *solid*, μετρον, *measure*.) In Hydrodynamics, an instrument invented by M. Say, a French officer of engineers, for determining the specific gravity of liquid bodies, porous bodies, and powders, as well as of solids. The instrument may be described as follows: — Let A E be a glass tube, about three feet long, and open at both ends, the upper part A B being about 4-10ths, and the lower 2-10ths of an inch in diameter. The upper edge is ground smooth, so that it can be shut air-tight by a piece of ground plate glass; and the upper part A B communicates with the lower by a very narrow slit at B, which allows air to pass, but prevents the passage of sand or water. In using the instrument, a powder (for instance) is placed in the tube A B, and the lower part B E is plunged into a vessel containing mercury till the fluid rises exactly to B. The ground glass cover is then placed upon the mouth A, and there is now no air in the tube except what is mixed with the powder. Supposing the barometric pressure to be 30 inches; let the tube be elevated until the mercury stands within it at a point C, 15 inches above its surface in the open vessel, and it is manifest that the air within the tube is pressed with exactly half an atmosphere. It consequently expands to twice its original bulk, and hence the tube A B now contains only half the quantity of air it contained at first. The part B C must therefore contain the other half, or the air in B C is equal to the air mixed with the powder in A B; and being half the original quantity under half the original pressure, it fills the same space which the whole occupied previous to the expansion. Let the powder be now removed from A B, and the process repeated when the tube is filled with air. The quantity of air being now greater, will, when expanded to twice its bulk, fill a larger space than B C, and the mercury will rise only to some point D; but as the expanded air occupies exactly the same space in B D or B C as the whole occupied in A B under twice the pressure, it follows that the cavity C D = B D — B C is equal to the bulk of the solid matter in the powder. If, therefore, we now find the number of grains of water which would fill the part C D, we determine the weight of water equal in bulk to the solid matter in the powder; and by comparing this with the weight of the powder, we obtain its specific gravity. (*Ency. Brit.* art. "Hydrodynamics.")

Say's stereometer was first described in the *Annales de Chimie* for 1797. An instrument on exactly the same principle was afterwards brought forward by Sir John Leslie under the name of a *coniometer*.

STE'REOTYPE. (Gr. στερεος, *solid*, and τυπος, *a figure*.) Masses of letters, called letter-press plates, of the size of a page, cast from a plaster mould, in which an exact representation of the types has been made, and thus forming the permanent plates from which books are afterwards printed. As the art of printing (*see* PRINTING) began with the impression of whole blocks, it may be said that in its progress towards perfection it has again reached the same point by the introduction of stereotype plates. The origin of the more modern invention is involved in greater obscurity than might at first sight appear probable from its comparatively recent date. By some writers the merit of the invention is ascribed to the Dutch, who had adopted the plan of printing with solid or fixed types in the 17th century; but it was not till the end of the last, and the commencement of the present century, that the process was perfected and generally introduced. In this useful invention, the most prominent names are Ged of Edinburgh, Tulloch and Foulis of Glasgow, Didot in Paris, and Wilson and Earl Stanhope in London. The process of stereotyping is very simple. A page of any work proposed to be stereotyped is set up with moveable types in the ordinary way. A plaster cast is then taken from it, which, being first dried, is immersed in fluid metal. The cast or plate, after being sufficiently cooled, is then withdrawn from the mould, and, at a subsequent stage, carefully examined with a view to removing any imperfections previous to its being printed from. The plaster used for forming the mould is pulverised gypsum, mixed with water to the consistence of cream. After the form of types has been surrounded with a brass frame, and slightly oiled on the surface, the fluid plaster is poured upon it, and, by the application of a brush, made to fill every cavity of the letters, the superfluous portion being scraped off. When the plaster has set sufficiently hard, it is by means of the frame lifted off the face of the type and detached from it. It is then

baked to dryness in an oven; and when quite hot it is placed in an iron box, or casting pot, which has also been heated in an oven. The box is now plunged into a large pot of melted type metal, and kept about ten minutes under the surface, in order that the weight of the metal may force it into all the finer parts of the letters. The whole is then cooled; the mould is broken and washed off; and the back of the plate turned smooth on a lathe, or planed by a machine. (*Conversations-Lexicon.*)

STE'RLING. The legal description of the English current coin, of which the most probable derivation is from *Easterling*, the popular name of the Baltic and German traders who visited London in the middle ages; but in what manner it came to be so applied is unknown. Camden says from the employment of German artists in coining. The silver penny was first called Esterling.

STERN. In Naval affairs, the after extremity of a vessel.

STE'RNA. A genus of web-footed birds, having a bill as long as or longer than the head, almost straight, compressed, and pointed; the mandibles of equal length, the upper one slightly inclined towards the point; nostrils pierced towards the middle of the bill; legs small, naked to above the knee; three anterior toes, united by an indented web; the hind toe free; wings very long and pointed; tail more or less forked. From the two latter characters, the species of *Sterna* are sometimes called "sea swallows:" their proper English name is "tern."

STERNO'XI. (Gr. στερνος, *sternum*, and οξυς, *pointed.*) The name of a tribe of Coleopterous insects, comprehending those in which the sternum is prolonged into a point at both extremities.

STE'RNUM. (Lat. sternum, *the breast bone.*) In Comparative Anatomy, the simple or compound bone which completes the thoracic cage anteriorly, and serves as a medium of union to a greater or less number of the ribs. The sternum is not present in the skeleton of Fishes, Amphibians, or Ophidians. In Saurians, the anterior portion is generally expanded, to be joined to the broad coracoids and clavicles. In Chelonians, this part of the skeleton is remarkably developed, and very complex, and constitutes the greater part of the plastron or floor of their defensive osseous case. In Birds, also, it is more or less complex at the beginning of its development; but the different ossifications are soon blended together, and form a single broad bone, principally remarkable for the keel-like process developed from the middle line of its under surface. This keel is subservient to the attachment of the muscles of the wing, and bears a direct proportion to the powers of flight; except where the wings, as in the penguin, are used as fins. In the Struthious birds, the keel of the sternum is wanting.

In Mammalia, the sternum is generally simple, and consists of a single chain of ossicles; except in the orang-utang, and occasionally in man, where a double series of ossifications are originally developed in the body of the bone, but which afterwards become confluent. The upper portion, or *manubrium sterni*, remains long distinct from the main body of the sternum; in man, the cartilaginous appendage of the lower edge of the sternum is called xiphoid or ensiform.

STE'THOSCOPE. (Gr. στηθος, *the chest*, and σκοπεω, *I explore.*) A cylinder of cedar wood, about 12 inches long, and 1 in diameter; perforated throughout its length, and divided into two parts for the convenience of using the whole or half its length. The end of each part terminates in a funnel-shaped cavity. Its use is adverted to under the head AUSCULTATION.

STEWARD, LORD HIGH, was anciently the first officer of the crown in England, with the Latin title of Magnus Seneschallus. The office was at one period annexed to the lordship of Hinkley, in Leicestershire, held by the family of De Montfort; but on the rebellion and fall of that noble house, it was in effect abolished as a permanent dignity, and is now only revived *pro hâc vice* on the occasion of a coronation, or the trial of a peer. In the former case, the lord high steward's commission is to settle matters of precedence, &c.; in the latter, to preside in the House of Lords.

STEWARD, LORD, OF THE HOUSEHOLD. An officer of the king's household in England; in Norman French, Seneschal. He is steward of the marshalsea or court of the household; an office which he performs by deputy. In his department is the counting house where the expenses of the king's household are taken; within which is the board of green cloth, an ancient court which has jurisdiction of offences committed within the king's palaces and verge of the court.

STHE'NIC DISEASES. Those which are the result of inflammatory or increased action; as opposed to asthenic, or diseases of debility.

STIBIUM. Antimony.

STI'CHOMANCY. (Gr. στίχος, *a line*, and μάντεια, *prophecy.*) Divination by lines or passages in books taken at hazard. Among the Romans, verses from the Sibylline books were written on slips of paper, which were thrown into a vessel; and future events were conjectured from the interpretation of one of these slips drawn out at hazard. Of the same kind were the *Sortes Virgilianæ, Homericæ*, &c.; a sort of literary superstition by which the works of authors were consulted, and the meaning of a line casually taken assumed as indicative of the fate of the person discovering it. Verses of the Bible selected in this way by chance have been, and are still, frequently taken by the superstitious as oracular. This sort of divination has been called *bibliomancy*, or *sortes biblicæ*. It was condemned by the council of Vannes in 465, and other early synods; but was long afterwards practised in France at the elections of bishops, abbots, &c. The custom of drawing by lots verses from the Bible on such occasions is said to have prevailed as late as 1740, in the cathedrals of Ypres, St. Omer, and Boulogne. *See* SORTES, SORTILEGE.

STICK, GOLD. The colonels of the two regiments of Life Guards are so called, whose duty it is to be in immediate attendance on the sovereign on all state occasions. These colonels do duty for a month alternately; the one on duty being called the *gold stick in waiting*. The field officer of the Life Guards, when on duty, is called *silver stick*. The term originated in the custom of the sovereign presenting the colonel of the Life Guards with a gold stick on his receiving the regiment.

STI'GMA. (Gr. στιγμα.) An impression such as that made by branding with an hot iron. Stigmatizing was a common practice among the ancients to mark their slaves as property; and it is pursued at the present day among slave-drivers. It was customary also to stigmatize the votaries of some of the gods with some recognized emblem of their divinity, such as the ivy of Bacchus, trident of Neptune, &c.; or with the initial of their names, or some mystical number. It is supposed that reference is made to this practice by St. John, Rev. ch. 13. *See* TATTOOING.

STIGMA. In Botany, the upper extremity of the style without a cuticle, in consequence of which it has almost uniformly a humid and papillose surface. It is the part upon which the pollen falls, and where it is stimulated into the production of the pollen tubes, which are indispensable to the act of impregnation.

STI'GMATA. In Theological language, the marks of the wounds of our Saviour. The text at the end of the Epistle to the Galatians, "From hence let no man trouble me, for I bear in my body the marks of the Lord Jesus," seems to have given rise to the superstitions promulgated in the Roman Catholic church respecting the impression of the stigmata on favoured saints; of which the legend of St. Francis of Assisi affords the most remarkable instance.

STILE. In Architecture, the vertical piece in framing or panelling. *See* RAIL.

STILL. (Lat. stillare, *to drop.*) An apparatus for the distillation of liquids upon the large scale. It includes the *body*, or *boiler*, which is usually set in brick-work over a furnace, and to which is annexed the *head*, forming the communication between the boiler and *condenser* or *worm pipe*; from the extremity of which the distilled liquid passes in successive drops, or a small continuous stream, into the *recipient*. There are an infinite variety of stills adapted to particular purposes, of which the most important are the distillation of spirituous liquors. (See *Ure's Dict. of Arts, &c.*)

STILT BIRD. The name of the *Himantopus melanopterus*, significative of its very long and slender legs.

STI'NKSTONE. A bituminous carbonate of lime, which exhales a fetid odour when rubbed.

STINT. In Coal Mines, a measure of work used under ground, 2 yards long and 1 broad, which each miner clears before he removes to another place, and which is proved by a boy appointed for the purpose, who is colloquially called "the judge."

STIPEND (Lat. stipendium), signified originally the pay of soldiers. In a legal sense it is applied to the salary or allowance given to some person for transacting the business of another; but in Scotland the term is almost exclusively confined to the provision made by law for the established clergy. *See* PRESBYTERY.

STI'PPLING. In Engraving, the method of producing shadows by means of dots of greater or less size, according to the intensity of shadow required. By this method the resemblance to chalk drawings is produced.

STI'PULA. In Botany, a small appendage situated upon each side of the base of a petiole, most commonly of a less firm texture than the latter, and having a subulate termination: the word is also used in describing *Hepaticæ*, to denote the appendages which are occasionally present at the bases of the leaves, but of which they seem rather to be lobes than distinct organs.

STOCK DOVE. The name of the wild species called *Columba Œnas* by Linnæus.

STOCK EXCHANGE. The name given to the system whereby the purchase, sale, and "carrying over"

of stock and shares are effected by certain parties called brokers. This curious and complicated subject may be explained and discussed under three different heads: — viz. first, the parties engaged in stock transactions, whether brokers or jobbers; secondly, money and time bargains; thirdly, the rules and regulations by which these operations are conducted.

The Clearing-house in Lombard Street affords the greatest facilities to the transactions of the Stock Exchange, inasmuch as, without its intervention, difficulties and embarrassments would present themselves in the final settlement or adjustment of those transactions of an almost insurmountable character. By means of this clearing-house, all the great monetary transactions of the day are brought to a close by 5 o'clock in the afternoon; whereas in the ordinary mode of paying or receiving money, whether in notes or hard cash, their settlement might not be finally effected for several days afterwards, to say nothing of the security afforded to all parties concerned by the operation of the clearing-house.

The members of the Stock Exchange are divided into two distinct classes: — viz. the brokers, and the jobbers. It is the business of the brokers to receive and to execute the orders of merchants, bankers, capitalists, and private individuals, who are "out of the house;" the Stock Exchange being amongst its own members honoured with that dignified appellation!

The jobbers remain stationary in the "house," and ready to act upon the orders thus received by the brokers. And here it may be as well to explain the nature and character of the business transacted by these jobbers, who, being men possessed of more or less capital, endeavour to turn it to account in the manner we are about to explain. It is their business to be always prepared to make a price to the brokers whenever the latter present themselves: the readiness which they display in offering to do business to large amounts at the apparently small difference of 1-8th per cent. would appear extraordinary, were it not that they are so numerous that an eager competition is excited amongst them for the favours of the brokers. When one of the latter appears in the market, he is surrounded by a knot of jobbers, who announce themselves ready to buy or sell whatever amount of stock he has to deal in at a price varying only 1-8th per cent. For instance, if a broker has to do business in 5000*l*. Consols (the market price being about 90), the jobber offers to buy his 5000*l*. at 90, or to sell him that amount at 90⅛, without being in the slightest degree aware whether the orders of the broker are to buy or to sell, and thus taking upon himself the risk of selling that which he does not possess, or of buying what he does not intend to keep; his only object being to undo his bargain, at a difference of 1-8th per cent., or even less, with another broker, who may have to effect an operation the very reverse of the other, which 1-8th or even 1-16th constitutes his profit.

Without the intervention of the jobber, therefore, it will be seen that there would exist a vast difficulty in effecting the transactions which daily take place. The jobbers are, in fact, the "middle men," who stand in the house in the character of dealers, always ready to buy or sell, thus obviating the necessity of the broker's going in quest of a second broker, with whom he might transact his business; or, in other words, whom it might suit to buy what the other broker had to sell, or *vice versâ*. Again, even if one were at hand, he might not be able to concur in the actual amount of stock which the other wished to deal in; whereas the jobber is ready to do business to any amount, even to the smallest fraction, and hence a great deal of time is saved. It often happens that a broker who has to dispose of shares not currently dealt in is frequently obliged to wait for months before he can find a purchaser; whereas, in the case of stock, the jobbers offer themselves as buyers or sellers at a moment's notice, and thus offer facilities for transactions in the public funds which could not be effected without them.

Having thus endeavoured to explain the difference between broker and jobber, and confined our attention hitherto to money transactions, we next proceed to describe the nature of "time bargains," which form so essential a feature in stock business. Indeed, the very existence of the Stock Exchange, as at present constituted, depends upon speculations in time bargains; for where there exists a body of 600 members, the actual *bonâ fide* business would not be sufficient to provide employment for them all, notwithstanding the magnitude of the national debt. Time bargains consist of purchases and sales of stock made for a certain fixed period, regulated by the committee. There can be little doubt that they had their origin in the business which has always been transacted in the funds during the periods when the stocks are shut. For instance, Consols usually close about the beginning of June and December; that is to say, the transfer books at the bank are shut for the space of five or six weeks, in order to afford time for the preparation of the dividend warrants, which are paid in the following July and January. Hence it is clear that a person wishing to buy or sell that particular stock during the period referred to would be unable to effect his object; but in order to secure the price of the day, he buys or sells the stock "for the opening," that is, for actual transfer on the day on which the transfer-books are reopened. This mode of doing business is legitimate enough; but this practice has no doubt given rise to operations of the greatest magnitude, founded, not on actual necessities, but merely on speculation; and this method being found convenient for one period, has been continued on other occasions, without, however, possessing the same pretext for its adoption. Periodical dates have consequently been fixed upon by the committee, similar to the "opening," at intervals of about six weeks, making altogether about eight "settling days," as they are called, in the course of a year. On these settling days are arranged and adjusted all the bargains made during the preceding six weeks for that particular day; those who sold stock having to deliver it on the one hand, and those who purchased having to accept and pay for it on the other. But as the majority of the speculators have no intention of doing either the one or the other, their bargains having been of a purely speculative character, founded on their anticipations of a rise or fall in the value of the securities, so whatever difference may exist between the price at which a party commenced his speculation and that at which he finally closed it is settled on this important day; and his operations most likely not having been confined to the same jobbers, but having been effected with several, it becomes necessary to balance them with the parties concerned, and much the same process takes place on this occasion as that practised at the bankers' clearing-house, by establishing balances between each other. Whatever balance remains unsettled is adjusted by the name of the *bonâ fide* purchaser of the stock (who intends to pay for it) being passed from one broker, or jobber, or speculator to another, until it comes into the hands of the party who intends to deliver or transfer the stock; by which means all the intermediate persons through whose hands it passes (the price given by the purchaser being marked on the ticket) are enabled to close their accounts with each other at that particular price, and to pay and receive the differences accordingly. In short, all transactions kept open until the settling day *must* then be closed; and the party who delays this operation until the last moment is often exposed to a loss, from the difficulty of finding others who, having adjusted their own accounts, are unable or unwilling to enter into a fresh transaction on this "day of reckoning," whereby he is compelled to pay something extra in the price to those who have it in their power to afford him this facility, in order to enable him to settle his account.

But, as many of the bargains made for this particular day are really *bonâ fide* transactions, the stock bought and sold being, in point of fact, delivered by the actual holder and taken by the new purchaser, let us briefly explain how this is effected. This process is one of daily occurrence, and is not necessarily confined to a settling day, although on such occasions it usually amounts to a considerable item, from its having extended over a wider period. In either case, however, the following is the way in which the matter is settled between the broker and his principal who has sold stock: — The broker usually passes his check for the proceeds of the sale to his principal, taking the precaution of crossing it, *i. e.* writing a banker's name across the check. When, however, Bank of England notes are demanded in lieu of crossed checks (as is sometimes the case), the bargain is made accordingly: in this case, the jobber who buys the stock provides them either by borrowing of those who happen to have large balances at their bankers', or from their own private bankers. The notes so borrowed by the jobber are then paid over to the broker, and by him to his principal. This operation is, however, seldom resorted to by men of business where there is no reason to doubt the credit of the party drawing the check.

The jobber, on the other hand, having sold the stock to some other broker, who buys for his principal, receives in return his check; so that, by this simple process of passing four checks, — viz. that of the purchaser to his broker, that of the broker to the jobber, that of the jobber again to the broker who first sold the stock, and that of the latter to his principal, — the whole transaction is completed.

To advert to another technical peculiarity appertaining to the Stock Exchange which may appear puzzling to the reader; the use, namely, of the terms "bull" and "bear." A *bull* is one who speculates for a rise; whereas a *bear*, on the contrary, is he who speculates for a fall. The "bull" would, for instance, buy 100,000*l*. Consols for the settling day, or, as it is technically termed, "for the account," with the object of selling them again during the intervening period at a higher price. The "bear," on the other hand, would sell the 100,000*l*. stock (which, however, he does

not possess) "for the account," with a view of buying them in for the purpose of balancing the transaction at a lower price than he originally sold them at. In stirring periods, when fluctuations of 4 or 5 per cent. often occur during "one account," vast profits may be realized, or equal losses sustained, by these gambling operations.

The transactions in the foreign market are carried on much in the same way as in that of the English stocks, with the exception that the settling days are much more frequent, occurring, as they do, once in every fortnight. The foreign "house" is quite of modern origin; but it is subject to the same rules and regulations as the English, with a few exceptions. The dealings are there carried on in all the foreign stocks, as well as in railway, mining, and other shares. The jobbers are distinct from those in the English house, although there is nothing to prevent them from dealing in both, if they possess sufficient intelligence to enable them to give their attention in two places at once.

In connection with time bargains may be noticed that important branch of business which goes under the denomination of "continuation," or "carrying over." This is nothing more than interest for money borrowed or lent on security of stock. The rate of this continuation or interest varies according to the abundance or scarcity of money, and the nature of the security offered. For instance, on British stocks, even when money is very scarce, it seldom exceeds the rate of 5 per cent. per annum from one account to another; whereas in the foreign market, where the security consists of foreign bonds of various and doubtful descriptions, it ranges from 5 to 10 per cent., or even more on particular occasions, when it reaches 15 per cent. per annum.

There are several causes which tend to produce this extraordinary variation in the rates of continuation; for in the case of Consols, which constitute the only stock for speculation in time bargains in the English market, the price varies so little in comparison with the value of the stock, in the course of an "account," that the security is considered good in itself; and therefore no extra charge is superadded by the party who lends his money. This is not the case with regard to foreign stocks, which are constantly fluctuating in value, a fact to be accounted for by the extremely precarious nature of this description of property. Most of the bonds in circulation in the foreign house have ceased to bear any interest whatever, and many of them bear upon them the marks of their shame and disgrace, in the shape of the arrears of interest, called *coupons*, overdue for several years. It is not, therefore, to be wondered at that foreign securities of this description do not command the same credit as our own English stocks; and it must hence follow, as a matter of course, that parties who wish to raise money upon them must consent to pay a higher rate of interest for the accommodation.

A great deal of business is transacted in this way; and some brokers, who possess the means of obtaining large sums of money without much difficulty, devote their entire attention to it. The process by which the operation is effected is simple, both in the English and foreign market. The present rate of continuation in the Consol market is 9-16ths per cent. until the opening; and if a person, we will suppose, wishes to lend money on that stock, from the shutting (on the 2d of December) to the opening (on the 14th of January, 1842), his broker procures him 1,000*l.* Consols as security, for which he furnishes the money at the actual price of the day, which is 90, making 900*l.*, and resells at the same time the said 1000*l.* stock for the opening (on the 14th of January) at $90\frac{9}{16}$, making 906*l.* 12*s.* 5*d.*, and thereby leaving a difference in his favour of 5*l.* 12*s.* 6*d.* for the loan of 900*l.* during the above period of forty-four days, which will be found to be at the rate of 5*l.* 3*s.* 8*d.* per cent. per annum. On foreign securities the principle is the same. Supposing he lends on the security of Spanish bonds, he receives as security 5100*l.*, for which he pays on the 30th of November, at the price of $24\frac{1}{2}$ per cent., 1249*l.* 10*s.*; but sells it to the same party for the 15th of December (the next settling day) at $24\frac{9}{16}$, producing 1252*l.* 13*s.* 9*d.*, leaving a difference in his favour of 3*l.* 3*s.* 9*d.*, or 1-16th upon the stock bought and resold, which, for fifteen days, is equal to 1-8th per cent. per month, or 12-8ths per cent. per annum, equal to 76*l.* 10*s.*, being at the rate of about 6*l.* 2*s.* 6*d.* per cent. per annum interest. This calculation is made upon the current rate of interest for the "continuation" of that stock on the 30th of November, which was considered as extremely low.

The continuation on shares, in which a great deal of business is also done, varies but little from the above; but a difficulty here arises, which offers a great obstacle to the lending of money for short periods.

The *stamps* which by law are necessary for the due transfer of property of this description, and without which transfer there could be no security to the lender of money, are so onerous, and press so heavily on all *bonâ fide* transactions, that notwithstanding the many attempts made at various times to evade them, they operate materially against the parties who lend money upon them, and, in fact, neutralize all profit for short periods.

Persons who have sold shares or stock, if they are not in immediate want of their money, frequently avail themselves of this method of "continuation," in order to obtain interest for it until they actually deliver the stock. On the other hand, speculators for the rise are by this means able to carry over their purchases from one account to another; and although it may appear strange that they should be paying at the rate of 5 and even 10 per cent. per annum interest on a stock which, in the instance of Consols, pays them only 3 per cent., and in that of Spanish pays them actually nothing, still, when viewed solely in the light of speculations, the rise in either security, if it take place, will more than compensate for this apparent inconsistency.

The proceedings of the Stock Exchange are regulated by a committee consisting of thirty members, who are elected from the general body every Lady-day, each member having one vote. They take care that the rules and regulations enacted for the admission and expulsion of members, and for the settlement of disputes, are properly observed; and although some of their laws are at variance with the established laws of the country, they are not so strictly enforced by the committee as to bring them into collision with the courts of justice: they fully answer the purpose for which they were intended, and all members previously to their admission subscribe to the conditions there laid down.

All members, on being admitted, are obliged to produce three securities of 300*l.* each for the first two years of their probation, which 900*l.* becomes forfeited in the event of their failure, and goes to the creditors of the new member. In consequence of their being interdicted from engaging in any other business, on becoming members of the Stock Exchange they are no longer subject to the bankrupt laws; and therefore, in the event of failure, all their assets are secured to the creditors *in* the house, to the exclusion of those *out* of it. This rule is enforced in order to secure the house from the loss which would ensue to its members, were the legal creditors (if any existed) to step in and lay claim to their property.

The tendency of the above regulation is to insure honesty amongst its members. Should any principal have reason to complain, he has only to appeal to the committee, who instantly take cognizance of the matter, and subject it to the strictest investigation. Defaulters whose conduct has been dishonourable are punished, and an example is made of them by publicly affixing their names in the house on what is termed the *black board:* this is the heaviest disgrace which a member can possibly experience. (For this elaborate account of the procedure of business in the Stock Exchange, we are indebted to the *Times* of 1841.)

STOCKS. A well-known kind of punishment. The practice of confining men by the legs was so common as to have given the ordinary name to a chain of any kind in several languages: *e.g.* Gr. πέδη, Lat. compes, Engl. fetter; all from πούς, *foot*. The stocks in England have been, generally speaking, rather used for restraint than punishment, constables being empowered to put disorderly persons into them; but it is likewise ordered by some statutes as a punishment on conviction. It is now almost disused; though, we believe, not entirely in remote districts.

STO'ICS. A celebrated sect of antiquity; so called from the *stoa* or *porch* in Athens, which was the scene of the discourses of their founder Zeno of Cittium (B.C. 300). The Stoics are proverbially known for the sternness and austerity of their ethical doctrines, and for the influence which their tenets exercised over some of the noblest spirits of antiquity. To give a connected and systematic account of the philosophical principles on which they grounded their moral precepts is a less easy task than, from the notoriety of the latter in some of their main features, might have been anticipated. Their speculations were not confined to ethical subjects, but aimed at embracing the whole circle of human knowledge; physics, theology, and logic, no less than morals and politics. Their system, as far as we can gather from the notices preserved by Cicero, Diogenes, and others, appears to be an attempt to reconcile a theological pantheism and a materialist psychology with a logic which seeks the foundations of knowledge in sensible experience, and a morality which claims as its first principle the absolute freedom of the human will. Of the mode in which they combined dogmas apparently so inconsistent into a philosophical whole, we have accounts sufficient to inspire us with respect for the earnestness and strength of character possessed by the leaders of their sect, and with admiration of their subtlety, ingenuity, and depth. We discern, at the same time, in all their speculations, equally a narrow and controversial spirit, most unlike the critical but comprehensive impartiality which marks the philosophical writings of their great predecessors; of Plato, and, in a still more eminent degree, of Aristotle. The

philosophy of the Stoics was essentially polemical. On every side it presented an armed front to an opponent. It sought to confute the academic scepticism by the strenuous assertion of the truth of sensible perceptions, and the validity of the judgments to which they lead by a vigorous protest in favour of the common sense of mankind as opposed to the theories of the schools. Sensation, they affirmed, is not merely a passive affection of the mind; it becomes, under certain conditions, perception or *comprehension* (κατάληψις), — a faculty whereby the mind reaches beyond itself, and *lays hold*, as it were, on outward being. From the acquisitions of sensible experience are formed conceptions and judgments of successive stages of generality, which it is the province of the reason to construct into philosophical system. Such is the stoical logic, which is consequently a *material*, and not, as with Aristotle, a *formal* science. An equally controversial bearing is perceptible in the remainder of their philosophy. Their greatest enemies, the Epicureans, had adopted the *mechanico-corpuscular* theory of Democritus, which accounted for all physical phenomena by the varieties in size and figure of the ultimate atoms of which all substances are the aggregate. The fortuitous concretions which thus became the first cause of all things, had attracted the partialities and won the assent of a sect averse in all things equally to limitation or constraint. The Stoics espoused the opposite doctrine of a one all-pervading substance, a permeating ether, a creative fire, the source of life and law to the material universe. On this they built their doctrine of a universal providence, excluding chance in the least things as in the greatest, and directing all events by irresistible necessity to the promotion of perfect good. The same hypothesis furnished them with a ground for the first principle of their ethical doctrines. "Live according to nature" is, with the Stoics, the expression of the coincidence which ought to exist between the human will and the universal reason, which, as we have seen, they identified with the life and power of nature. This coincidence is virtue, the only good; as vice, its opposite, is the only evil. All things else are in themselves indifferent; being approved or disapproved only by comparison. Virtue is the perfect harmony of the soul with itself; vice is, in its essence, inconsistent and self-contradictory. The wise man, the ideal of human perfection, is absolutely, and without qualification, free. His actions are determined by his free will. with a power as irresistible as that by which universal nature is guided and animated. In the one no less than in the other, freedom and necessity are one.

In these doctrines the controversial character to which we have adverted is sufficiently obvious. Much, however, that is exaggerated and paradoxical, both in the tenets of the Stoics and in those of their opponent Epicurus, is to be accounted for by a reference to the political circumstances of the age in which both lived. The pressure of public calamity and the utter extinction of national life in Greece, while they precluded all healthful exercise of the duties of a citizen, — duties which had entered so largely into the calculation of the earlier Greek moralists, — would drive the more virtuous and thoughtful part of mankind to seek in the development of the individual life for that satisfaction which they sought elsewhere in vain. It is easy to conceive that the same circumstances which would recommend to minds of a certain order the good-humoured apathy and the tranquil voluptuousness of the garden, might, with men of sterner temperament. be the occasion of drawing forth all the energies of their will. and of placing those energies at once in distincter consciousness to themselves, and in sharper antagonism with the evil that surrounded them. In the declining period of the republic, as well as in the darkest periods of the empire, we find the noblest Romans seeking for consolation in the doctrines of one or the other of these rival sects. Brutus, Seneca, Epictetus, and the philosophic emperor Aurelius, are among the names of the most celebrated Roman Stoics. Little, however, was done by the Romans to advance the speculative part of the stoical philosophy, which was indebted for its systematic form to Cleanthes and Chrysippus.

The chief sources of information concerning the doctrine of the earlier Stoics are the philosophical works of Cicero; for their logic, the *Academic Questions;* for their ethics, the treatise *De Finibus*, and the *Tusculan Questions;* and for their theology and physics, the books *De Natura Deorum*, and *De Fato*. See also *Diog. Laert.* l. vii. Plutarch, *Adv. Stoicos*, &c.; Ritter, *Hist. of Ancient Philos.* xi. part 5.

STO'LA. (Gr. στολη.) A dress of which the name was borrowed by the Romans from Greece, but acquired in their language a peculiar signification; being the habit appropriated to women. It was a long vest, coming down to the ankles; was worn within doors, and covered by the palla or cloak when they went out; as described by Horace, *Sat.* l. i. 2.: —

Ad talos stola demissa et circumdata pallâ.

Common prostitutes, at least in the age of Horace, were not permitted to wear this distinguishing garb of the Roman lady. The stole is a robe worn by deacons in the Roman Catholic church. *See* VESTMENTS.

STOLE, GROOM OF THE. An officer of the king's household in the lord chamberlain's department. He is first lord of the bedchamber; his title is derived from the long robe (stola) worn by his majesty on solemn occasions. His original duty, likewise, was to put the king's shirt on of a morning, which, in his absence, devolved on another lord of the bedchamber.

STO'MACACE. (Gr. στομα, *the mouth*, and κακος, *evil.*) A fetor of breath, arising from ulcerated gums. Mouth-washes, with tincture of myrrh and borax, and the internal use of tonics, are the remedies which relieve it.

STO'MACH, *Stomachus*. (Gr. στομα, *the mouth;* and χεω, *I melt*, from its receiving the contents of the mouth and melting them down into nutriment.) The human stomach is a somewhat oblong and rounded membranous bag, situated in the epigastric region. It is largest on the left side (or *cardiac* end), and gradually diminishes towards the right or lower orifice, which is called the *pylorus*. Like the intestines, the stomach has three coats or membranes, connected together by cellular membrane. The exterior or peritonæal coat is a dense firm membrane; the internal or villous coat is soft, mucous, and vascular; the central coat is muscular, and the glands of the stomach are situated between it and the villous coat. The stomach is largely supplied with nerves which come from the eighth pair and sympathetic. The are chiefly from the cæliac, and are accompanied by veins which empty themselves into the vena portæ. The lymphatics of the stomach proceed directly to the thoracic duct. *See* ANATOMY and DIGESTION.

STOMACH PUMP. A small pump or syringe with two apertures, the valves of which are so arranged as to admit of liquids being drawn out of, or injected into the stomach, by means of a flexible tube.

STO'MAPODS, *Stomapoda*. (Gr. στομα, *a mouth;* πους, *a foot.*) The name of an order of the class *Crustacea*, comprehending those in which the maxillary feet are formed like the first four thoracic feet.

STO'MATA. Passages through the epidermis of plants, having the appearance of an areola, in the centre of which is a slit that opens or closes, according to circumstances, and lies over a cavity in the subjacent tissue. They are universally regarded as spiracles or breathing pores.

STONE BORERS; called also *Lithophagi*. Molluscous Bivalves, which, by means of a fleshy foot, on which they turn as on a pivot, perforate or bore into rocks.

STONE-CHAT. A species of warbler, forming the type of the genus *Saxicola* of Bechstein. It is the *Sylvia rubicola* of Latham; *Motacilla rubicola* of Linnæus. Also called the "chick stone."

STONE CURLEW. The name of a large species of plover, the *Ædicnemus crepitans* of Temminck. It appears in England at the latter end of April; frequents open hilly situations; makes no nest, but lays two eggs on the bare ground; and emigrates in small flocks about the end of September.

STONE GALLS. A technical term applied to nodules of clay occurring in sandstone; they often fall out on exposure to weather, and render the stone unfit for architectural purposes.

STONE IN THE BLADDER. *See* CALCULUS.

STOO'KING. The Scotch term for setting up sheaves of corn in stooks, that is, shocks. The operation is performed soon after the corn is cut; it being previously tied into bunches or sheaves.

STOOL. The root of a timber tree, which throws up shoots. Coppice wood consists chiefly of the shoots sent up by the roots of stools of trees or shrubs which have been cut over by the surface. In general all Dicotyledonous trees are endowed by nature with the property of sending up shoots from the stump or stools; but this is not the case with most of the Gymnosperms or Coniferous trees. A wood of pines or firs, therefore, when once cut down, can never be renewed, except by seeds.

STO'RAX. A fragrant balsamic exudation from the *Liquidambar styraciflua*. It is generally much adulterated.

STORK. An English name, equivalent to the *Ciconia* of modern ornithologists. The white stork (*Ciconia alba*) is that species which visits, though rarely, in England.

STORM. The causes of those violent commotions of the atmosphere to which we give the names of storms, tempests, hurricanes, tornados, &c., are involved in great obscurity, chiefly from the difficulty of obtaining a precise knowledge of the various circumstances with which they are accompanied. In order to ascertain the general laws of these phenomena, it would be necessary to determine, in a great number of particular instances, the place and time at which the storm begins and ends, the path it describes, the extent of atmosphere disturbed, the di-

rection and force of the wind, and the barometric pressure at every part of the disturbed column during the whole time of its continuance. But several of these points could only be determined from the comparison of a great number of simultaneous observations on that tract of the earth's surface over which the storm passes; while, from the nature of the thing to be observed, it is evident that a few insulated observations is the most that can be expected in almost any case. Besides, a storm for the most part passes over some part of the sea, where, unless a ship unfortunately happens to be caught in it, no observation can be made, or even evidence be obtained of its existence.

It is in the torrid zone that storms display the greatest violence, and rage with most destructive fury. In our latitudes they are comparatively rare, and in the polar regions they seldom amount to more than a strong wind.

Until recently it was generally believed that during a hurricane the wind at every part of the agitated mass blows in a rectilinear and parallel direction, and a storm was considered to be sufficiently explained when it was described as a wind blowing with a velocity of 100 or 120 miles in an hour. A comparison of the recorded accounts of the circumstances attending several storms has of late years shown that this idea was erroneous, and that the phenomena are considerably more complicated.

Franklin appears to have been the first who remarked that storms travel in a direction opposite to the actual movement of the wind at the time the storm is raging; and he ascribed the phenomenon to a great but partial rarefaction of the air, arising from the sudden precipitation of vapours, or other causes, the consequence of which would necessarily be a simultaneous rush of wind from all quarters to fill up the vacuity; and the mass of air being thus set in motion by a sort of aspiration, the gale will be first felt at those places towards which it blows. (*Letters and Papers on Philosophical Subjects.*) In a work on winds and monsoons, published in 1801, Colonel Capper was led, from a comparison of the details respecting the hurricanes at Pondicherry and Madras in 1760 and 1773, to remark that these hurricanes must have been whirlwinds, whose diameters could not exceed 120 miles, and that the velocity of the wind at any point was due to the rotatory velocity of the vortex. He also supposed that, besides the gyratory movement which forms the characteristic of the whirlwind, a storm has probably also progressive motion. Colonel Capper's speculations, however, appear to have met with little attention until the subject was taken up by Mr. Redfield of New York, who, in a series of papers recently published in the American journals, has diligently collected and examined a great number of observations relative to the storms of the West Indies and North American coasts, and arrived at the similar conclusions. The following general phenomena appear to be established: — 1. The severest hurricanes originate in tropical latitudes to the north or east of the West India Islands. 2. They cover simultaneously an extent of surface from 100 to 150 miles in diameter, acting with diminished violence towards the exterior, and increased energy towards the interior of that space. 3. The tract over which the hurricane passes is not a straight line. South of the parallel of 30° north latitude, it proceeds in a westerly course inclined to the north; but when it comes to about this parallel, it changes rather abruptly to the north and eastward, and continues to incline gradually more to the east. The average progressive velocity appears to be from fifteen to twenty-five miles per hour. 4. The duration of a storm at any particular place depends of course on the extent of the mass of agitated air, and the progressive velocity; and storms of smaller extent move with even greater rapidity than large ones. 5. The direction of the wind in a hurricane is not in the direction of its progress. When the progressive motion of the storm is westward, the wind at the commencement is from a northern quarter, and during the latter part of the gale from a southern quarter of the horizon. When the progressive motion is eastward, the phenomena are reversed; the wind blows at first from a southern quarter, and towards the end of the gale from a northern quarter of the horizon.

From these phenomena, and particularly the last, Mr. Redfield concludes that the great body of the storm whirls in a horizontal circuit round a vertical or somewhat inclined axis of rotation, which is carried forward with the storm; and that to a spectator placed at the centre the direction of the rotation is invariably from *right to left*. It is to be understood, however, that the phenomena now described and the conclusion drawn from them apply only to the northern hemisphere.

Another fact deserving of attention is, that the barometer, in all latitudes, sinks during the first half of the storm in every part of its track, and rises during the second. This phenomenon is ascribed to the effects of the centrifugal force of rotation; and such is the regularity of its occurrence, that it has been considered as affording of itself a strong proof of the rotatory character of the motion.

Colonel Reid of the engineers having been officially employed to restore the government buildings at Barbadoes blown down by the great hurricane of 1831, was led to investigate the subject generally; and in his work, entitled *An Attempt to develop the Laws of Storms, &c.*, he has collected and given the results of an immense number of details, obtained from an examination of ships' logs furnished to him by the admiralty, and other sources. These results he considers as confirming in all respects the conclusions of Mr. Redfield respecting the gyratory motion of the gale from right to left; its progressive motion in a curve line, first westward, and then towards the north and east; the position of the vertex of the curve at or near the 30th degree of latitude; and the fall of the barometer during the first half of the storm, and its rise during the second. Colonel Reid has also given an account of several great hurricanes in the southern hemisphere, from which it appears that the southern storms follow exactly the same laws as the northern, but in a reversed order. The direction of the rotation is from *left to right;* the centre of the gyrating mass advances first eastwards, then turns towards the south, and falls off towards the south-west and west, the vertex of the curve being at the 30th degree of south latitude. In the northern hemisphere, the West Indies and Atlantic coast of North America appear to be the places where storms most frequently rage; in the southern, the focus of storms appears to be placed near the Mauritius.

The uniformity of the direction of the rotatory motion of the hurricane, and its opposite direction in the opposite hemispheres, was explained by Mr. Redfield from theoretical considerations respecting the origin of storms, which he supposes to be produced by the mingling and collision of two atmospherical currents near the outer border of the trade winds; namely, the superior or equatorial stream, and the polar stream, which constitutes the trades. On looking at the curves representing the paths of the hurricanes on the charts projected by Mr. Redfield and Colonel Reid, it is difficult not to believe that the direction of their progressive motion is mainly determined by the configuration of the American continent.

The fact of the whirling character of storms has been controverted by Mr. Espy, another American writer on the subject, who advocates Franklin's theory of progressive motion in radial lines. Mr. Espy states, that on comparing simultaneous observations in the middle of storms and all round their borders, he found that the wind blows *inward* on all sides of a storm towards the central parts, — towards a point, if the storm be round; and if oblong, towards a line extending through its greatest diameter; and that he had traced the effects of seventeen storms, without finding a single exception to the general rule. Professor Bache of Philadelphia maintains the same opinion; and has described a tornado which occurred at New Brunswick in 1835, in which he could find no proof of rotation, the objects thrown down by the wind being all directed to a centre. It is not improbable that there may be hurricanes of both characters. An outline of Mr. Espy's theory is given in the *Report of the British Association for* 1840.

Independently of the interest which attaches to the subject in a meteorological point of view, a knowledge of the general laws which regulate the phenomena of storms would be of immense importance, inasmuch as it would enable the navigator to avoid those tracts of the ocean in which they chiefly prevail at particular seasons, or at least, if surprised by a storm, to steer on the course by which he may soonest escape from it or fall into its wake. On either theory the direction of the wind at the commencement of the gale must indicate, with considerable certainty, the quarter where the storm is raging with greatest fury. (See, in addition to the works already cited, *Silliman's Journal* from 1831; Prof. Forbes's Reports on Meteorology, in the *Reports of the British Association* for 1832 and 1840; and the *Edin. Review*, vol. lxviii.) See also WIND.

STO'RTHING. The parliament of Norway. It is elected once in three years, and sits every year for the despatch of business. The election is double; every qualified person (an owner or liferenter of land paying taxes in the country, and every one possessing land or houses of 150 rix dollars value in towns) joining in the election of councillors, who elect out of their own body the representatives of the country. These must be from 75 to 100 in number. The storthing, when elected, divides itself into two houses: one fourth, chosen by the rest, joining the laything, or upper house; the remainder the odelsthing, or lower house. The storthing has the usual powers of a legislative assembly in a constitutional country, and the king has only a suspensive veto; which, if the storthing passes a law three times in six successive years, becomes of no effect.

STORY. In Architecture, a subdivision of the height of a house, comprehending the height ascended by one flight of stairs.

STORY POST. In Architecture, a vertical post to support a floor or superincumbent wall.

STOVE. (Dutch, *stove*.) A receptacle for the combustion of fuel for the purpose of heating houses, &c. The common fire-grate for the combustion of coal, with its various appendages, is generally called a *stove;* hence *register stoves*, *Bath stoves*, &c. These are often, and indeed generally, very unscientifically constructed, and calculated to consume a large quantity of fuel, with a proportionate waste of heat. They are generally intended to diffuse warmth principally or entirely by *radiation*, and should be placed as near the ground as possible; while the different parts into the contact of which the burning fuel is brought should be of fire-brick, or some similar composition, which is a bad conductor but a good radiator of heat. It is manifest that in our common fireplaces the enormous volume of hot air which passes up the chimney is not available as a source of heat; hence, in colder climates, and where greater economy of fuel is studied, the fireplace is frequently closed in, and contained in an iron box which projects into the room, while the heated air before it finally enters the chimney is made to circulate through tubes or pipes, to which it communicates much of its excess of heat, and these again impart it to the surrounding air. What are termed *German stoves* are usually made upon such principles; and in them the fuel is often introduced, and the air required for the support of its combustion admitted, on the outside of the room in which the stove with its flues and heating surfaces is placed.

In *Arnott's stoves* the heat is similarly but more scientifically economized. There is only enough air admitted to keep up the slow combustion of the fuel, and the heat is communicated to the radiating surfaces of the stove; so that before the air which has passed through the fuel finally enters the chimney it has been deprived of the greater part of its available heat. These stoves are also so constructed as, by means of thermometric or self-acting registers, to adjust with much nicety the supply of air, so that neither more nor less may enter than is required to maintain the combustion of a given quantity of fuel.

In *Feetham's air-stoves* the common open fire is retained; but the heat is to a certain extent economized by by causing the hot air before it enters the chimney to communicate a portion of its heat to an iron box, over which a current of air passes and is sent warm into the room.

It is manifest that our common open fires must act as powerful ventilators, and that the large quantity of air which is driven up the chimney must be supplied in some way or other through the apartment in which the fire is burning. This supply of air is generally left to chance, and finds its way into the room by crevices in the doorways and window sashes, or between the boards of the floor, or any similar accidental passage through which it can make its way; and as, in London at least, the air always abounds in fuliginous particles, these are carried in along with it, and show its track by the blacks which it deposits. If this supply of air is inadequate, and it generally is so in new and well-built houses, in consequence of the tightness of the doors, windows, and floors, the chimney of necessity smokes, and the door or window requires to be left open to prevent such an effect. This evil may usually be effectually prevented by admitting fresh air from without through some proper and adequate channel, and various ornamental or concealed apertures may be contrived for the purpose; in the best arrangement of which, however, much practical as well as theoretical skill is often essential.

When rooms are warmed by German or Arnott's stoves, the ventilating powers of which are very inferior to the open grate, *ventilation* requires to be strictly attended to. Where buildings are warmed by currents of hot air sent up from stoves on the basement story, great attention should also be paid to ventilation; and in such cases the leading object should be to send in a large volume of air very moderately heated (to about 100°), rather than a small quantity of very hot air: the latter does not readily mix with the surrounding cold air, but forms a distinct and rapidly ascending column, which does not diffuse itself where most wanted; and it is apt to have a disagreeable and burned odour, arising from the charring of the particles of organic dust which are carried with the air over the too highly heated surfaces of the stove or flues. A little aqueous vapour, sent in along with the warm air by placing a saucer of water in some convenient situation, is often effectual in preventing the disagreeable sensation occasioned by respiring too dry an atmosphere.

Stove. In Horticulture, a structure in which plants are cultivated that require a considerably higher temperature than the open air in Britain and similar climates. There are two or three kinds of stoves, but the principal are the dry stove and the damp stove. The dry stove is a structure, the atmosphere of which is heated to the temperature of from 55° to 60° during winter, in which are chiefly cultivated succulents; such as the different species of *Ceretus*, *Cereus*, *Staphelia*, *Euphorbia*, *Mesembryanthemum*, and other succulents having similar habits. During winter these plants require very little water, and during summer they require intense heat, and abundance of air and water during fine weather. The damp stove, sometimes also called the bark stove, requires a temperature of between 60° and 70° during winter, with a proportionate increase during summer; accompanied, in both seasons, with a high degree of atmospherical moisture. This moisture is produced partly by evaporation from the bark bed in which the plants are plunged, but chiefly by watering the floor of the house, and by syringing the plants. During summer the plants in the bark stove require all the light which the atmosphere in this country is capable of producing, together with abundance of air, as in the dry stove. Both stoves are heated by smoke flues, or by hot water or steam, circulated in metallic or other tubes. The plants cultivated in the moist stove are exclusively those of the tropics; and those which require the highest degree of heat are chiefly Monocotyledonous plants, such as the *Scitamineæ*, which include the ginger, plantain, banana, sugar cane, palms, *Orchidaceæ;* and such Dicotyledonous plants as the bread fruit, the yam, mangosteen, and other East Indian plants. The bark bed is chiefly employed for producing a uniform degree of moisture and heat to the roots, and also as a reservoir of heat for the atmosphere of the house in case of any diminution from the flues, water or steam pipes, or the sun. Stoves of every description require a constant degree of attention from the gardener throughout the year, more especially such as are devoted to the palms, the banana, the pine apple, and the *Orchidaceæ*.

STRABI'SMUS. (Gr. *στϱαβιζειν*, *to squint*.) An unnatural obliquity in the axis of the eye, arising from various causes. It may often be, to a great extent, overcome, especially in children, by blindfolding the sound eye, presuming one only to be affected. In very bad cases, especially those of squinting inward, and such are by far the most common, an operation which has lately been introduced is often effectual in greatly relieving the deformity; it consists in dividing the internal rectus muscle of the eyeball, which is done by a proper scissors without externally wounding the eyelid.

STRAIGHT ARCH. In Architecture, the arch over an aperture, whose intrados is straight, but with its joints drawn concentrically, as in a common arch.

STRAIGHT JOINT FLOOR. In Architecture. *See* Floor.

STRAI'NING PIECE. In Architecture, a piece of timber, whose office is to prevent the nearer approach of two pieces of timber in an assemblage of framing; such is the collar in a queen post roof. *See* Roof.

STRAIT, in Geography, signifies a narrow pass or frith separating one country from another.

STRA'MONY, or THORN APPLE. The *Datura stramonium:* an indigenous narcotic plant, the seeds and leaves of which are used in medicine. The dried leaves are occasionally smoked, like tobacco, for the relief of spasmodic asthma; and an extract of the seeds is used as a sedative in some painful chronic affections. *See* Daturia.

STRA'NGURY. (Gr. *στϱαγξ*, *a drop*, and *ουϱον*, *urine*.) A difficulty in voiding urine.

STRATH, in Scotland, is generally understood to signify a valley of considerable size, whose appellation is determined by some river running through it, or some particular characteristic.

STRA'TUM. When different rocks lie in succession upon each other, each individual forms a *stratum*. *See* Geology.

STREAK. The appearance which arises from scratching a mineral with the point of a knife. The streak is *similar* when the colour of the scratch is the same as that of the mineral, but *dissimilar* when the colour varies.

STREAM TIN. Native oxide of tin, or tinstone, which is found in rounded particles and masses, mixed with other alluvial matters. The finest grain tin is procured from this ore.

STRE'LITZ. (Rus. plural strelitzy, said to be derived from strelai; It. strale, *an arrow*.) A soldier of the ancient Muscovite militia was so called. The strelitzy were the only standing army of the empire; and, like the Turkish janissaries, constantly interfered with its government. Their last revolt was in 1698, during the absence of the Czar Peter I., who, on his return, cashiered the corps altogether.

STRENGTH, in Mechanics, is used in the same sense as force or power. Thus strength of animals is the muscular force or energy which animals are capable of exerting; strength of materials is the resistance which bodies oppose to a force acting upon them.

Strength of Animals. — It is obviously a matter of much importance to be able to estimate with tolerable accuracy the effort which an animal of the average strength employed in labour is capable of exerting, and accordingly very numerous observations have been made on the subject; but this species of force is subject to

variation from so great a number of circumstances, both physical and mechanical, that the results given by different authors present very little agreement with each other, though they are of great value as affording data for determining the modes in which animal labour is most advantageously employed.

The force which an animal is capable of exerting against an obstacle is greatest when the animal stands still. When it begins to move, a considerable part of its strength is expended in the transference of its own body; and the greater the velocity with which it moves, the less will be the load which it is capable of transporting. There must, also, be a certain velocity at which it can only move when it carries no load. Now, if from the total effect of the muscular force exerted we subtract the part which represents the transference of the weight of the animal's body, the remainder, which is called the *useful effect*, will be obviously measured by the load which the animal is capable of transporting to a given distance in a given time; therefore, putting w = the weight, v = the velocity, and t = the time, the useful effect is represented by the product $w\,v\,t$, and will be greatest when this product is a maximum. In order to determine this maximum it is necessary to establish a relation between w and v (for the time t may be taken as unity). The empirical formula given by Euler for representing the relation between the load and the moving power in machines generally may be adopted for this purpose, as it has been found to agree tolerably well with experiment. Let P denote the power of the animal, or the greatest load it is capable of moving, and c the greatest velocity with which it can move unloaded; then the equation between w and v is $w = \mathrm{P}\left(1 - \frac{v}{c}\right)^2$; and the product $w\,v$ becomes a maximum when $3\,v = c$, or v is one third of c. *See* MACHINE.

In order to compare the effects produced by different animals, or by the same animal under different circumstances, it is usual to express the effect numerically in terms of some conventional unit, which, as being the measure of a force, is called the *dynamic unit*. Thus, in the product $w\,v\,t$, we call w = 1 lb., v = 1 foot, and t = 1 minute; the measure of the force will be the effort necessary to raise or transport a pound through one foot of space in one minute of time. For example, Desaguliers asserts that a man can raise a hogshead of water 10 feet high in a minute. Now a hogshead of water, vessel included, weighs about 550 lbs.; and 550 lbs. raised through 10 feet must require the same exertion of muscular force as 5500 lbs. raised through one foot; therefore, the useful effect, which in this case is the whole effort, as the man stands still, is expressed by 5500 dynamic units, and may thus be compared with any other effort which is capable of being similarly expressed. Instead of a pound, a foot, and a minute, we might assume a hundred weight, a yard, a day, or any other denominations that may be convenient.

Strength of Men. — The measure of human force has been the subject of numerous experiments, principally by Desaguliers, Lahire, Guenyveau, Coulomb, Schulze, Buchanan, &c., whose results may be found in most treatises on practical mechanics. These results differ very widely, as indeed might be expected, considering the very great differences of the force which different individuals are capable of exerting, — differences which depend not only upon age, constitution, and habit, but even upon climate, temperature, and food.

Of the different modes of estimating human strength, the most practically useful is the observation of the average effect produced daily by a labourer who continues his exertions for a number of successive days. We shall state a few of the results; and for the sake of comparison reduce them to dynamic units, assuming the unit to be 1000 lbs. avoirdupois transported to the distance of one foot in one minute.

According to Coulomb, a man walking on a level road may travel at the rate of 30 miles per day, or 264 feet per minute, and continue his exertions 10 hours a day. Taking the weight of the man at 150 lbs., the quantity of action is 23,760 dynamic units.

If instead of walking on a level road he mounts a stair, the velocity is reduced to 26·4 feet per minute, and the labour can be continued only 8 hours a day. In this case, the effect produced is 1901 dynamic units.

A man walking on a level road, and carrying on his back a weight of 90 lbs., travels at the rate of a mile and a half per hour, or 132 feet per minute, and continues his exertions 7 hours per day. The *useful effect* is consequently 4989 dynamic units.

A man climbing a stair, and carrying on his back a load equal to his own weight or 150 lbs., proceeds at an average rate of only 7 feet per minute, during 6 hours a day. The useful effect is consequently 378 dynamic units.

A labourer transporting materials in a wheelbarrow, and returning unloaded for a fresh burden, transports a load of 130 lbs. with a velocity of 90 feet per minute, working 10 hours a day. The useful effect is consequently 7020 dynamic units.

The force which a man exerts in dragging a load has been variously estimated. Schulze estimates the absolute effect, or that which the man can exert for a short time without moving, as equal to a pressure of about 107 lbs.; Bernoulli at 75 lbs.; and Guenyveau found the absolute force of traction, when exerted by means of a rope passing over the shoulder, to be from 110 to 132 lbs. Allowing the accuracy of Euler's formula above given, and assuming the action to be a maximum when the velocity is 2 miles per hour, we shall have $c = 6$; and if we also assume the absolute force P = 72 lbs., then the formula will become $w = 2\,(6 - v)^2$, in which w represents the number of pounds corresponding to the force developed when the velocity is v miles per hour. Thus when $v = 0$, we have $w = 72$ lbs.; when $v = 2$, we have $w = 32$ lbs.; and when the velocity is 4 miles per hour, the force of traction becomes 8 lbs. In the extreme cases the formula is inaccurate, but for moderate velocities it affords a tolerable approximation.

The greatest velocity with which a man can walk for a length of time, having no load to drag, is, according to Schulze, 5·37 feet per second; according to Bernoulli, 6·56 feet; according to Guenyveau, from 6·56 to 9·84 feet per second, or from $4\frac{1}{2}$ to $6\frac{2}{3}$ miles per hour.

According to Mr. Buchanan (*Repertory of Arts*, vol. xv.), the effective strengths of men in working a pump, in turning a winch, in ringing a bell, and rowing a boat, are respectively as the numbers 100, 167, 227, 248. The last is one of the most advantageous modes in which human force can be exerted.

Porters in London carry from 200 lbs. to 300 lbs. at the rate of 3 miles per hour; chairmen walk at the rate of 4 miles an hour with a load of 150 lbs. each; and it is said that an Albanian porter will carry from 700 to 900 lbs., stooping forward and assisting his steps with a short staff.

The following results of experiments on the comparative strength of men of different countries, with Regnier's dynamometer, are given by M. Peron: — England, 71·4; France, 69·2; Timor, 58·7; Van Dieman's Land, 51·8; New Holland, 50·6.

Strength of Horses and other Quadrupeds. — Of all animals employed as first movers, the horse is, beyond question, the most useful, and that whose labour is susceptible of the most numerous and varied applications. It is therefore very important to ascertain his average force; and accordingly a great number of estimates have been published, both of the amount of labour he is capable of performing, and of his absolute muscular power. For the purpose of determining the latter, the dynamometer may be conveniently used; but as the action of the animal is very quickly reduced by continued exertion, it is more usual to estimate it according to the amount of daily labour performed. Desaguliers and Smeaton estimate the strength of a horse as equivalent to that of five men; the French authors have commonly stated it as equal to that of seven men; and Schulze makes it equal to that of fourteen men in drawing horizontally. According to Desaguliers, a horse's power is equivalent to 44,000 lbs. raised 1 foot high in one minute; Smeaton makes this number 22,916, Hachette 28,000, and Watt 33,000. This last estimate is what is commonly understood by the term *horse power* as applied to steam engines.

The quantity of action which a horse can exert diminishes as the duration of the labour is prolonged. Tredgold gives the following table, showing the average maximum velocity with which a horse unloaded can travel, according to the number of hours per day: —

Time of March, in Hours.	Greatest Velocity per Hour, in Miles.	Time of March, in Hours.	Greatest Velocity per Hour, in Miles.
1	11·7	6	6·0
2	10·4	7	5·5
3	8·5	8	5·2
4	7·3	9	4·9
5	6·6	10	4·6

The useful effect a horse is capable of producing depends much on the manner in which his strength is applied. One of the best modes is to make him draw a loaded carriage. The carriers in Scotland usually transport in a single-horse cart weighing about 7 cwt. the load of a ton, and travel at the rate of 22 miles per day. Neglecting the weight of the animal and of the cart, and supposing the journey to be accomplished in 10 hours, the useful effect reduced to dynamic units (1000 lbs. one foot in one minute) is 260,198 dynamic units.

Navier gives the following results: — A horse drawing in a cart a load of 1540 lbs. (700 kilogrammes) travels at the rate of $216\frac{1}{2}$ feet per minute, during 10 hours per day. Here the useful effect is 200,046.

A horse harnessed in a coach, and drawing a load of 770 lbs. avoirdupois, goes at a trot at the rate of 433 feet per minute, during $4\frac{1}{2}$ hours per day. The useful effect is consequently 90,020.

A horse carrying on his back a load of 264 lbs. can travel at the rate of 216⅔ feet per minute, 10 hours a day. The useful effect is 34,294 dynamic units. Going at a trot with double the velocity, during 7 hours a day, and carrying a load of 176 lbs., the useful effect is 32,007.

A horse harnessed in a mill, going at a pace of 195 feet per minute, and exercising a force equal to a pressure of 99 lbs., during 8 hours a day, produces a useful effect represented by 9266 dynamic units.

On the strength of mules, oxen, and the other animals employed in industry, there are few correct observations. The following are the principal results. Taking the useful effect of the daily labour of a man according to Coulomb's estimate as unity, then the comparative effects of the labour of some of the other animals applied in the same manner are thus estimated: —

For carrying loads in a horizontal plane.

Strength of a man	1	(Coulomb.)
— of a horse	4·8	(Brunacci.)
— of a horse	6·1	(Wesermann.)
— of a mule	7·6	(Brunacci.)

For transporting burdens with a wheel carriage.

Man with a barrow	1	(Coulomb.)
Horse in a 4 wheel waggon	17·5	(Wesermann.)
Horse with a cart	24·3	(Brunacci.)
Mule with a cart	23·3	(Brunacci.)
Ox with a cart	12·2	(Brunacci.)

The above comparisons are probably nearer the truth than the following, which are usually quoted from Hassenfratz (*Encyclopédie Méthodique*): —

In carrying loads on a horizontal plane.

Strength of a man	1	Strength of a dromedary	25
— of a horse	8	— of an elephant	147
— of a mule	8	— of a dog	1
— of an ass	4	— of a reindeer	3
— of a camel	31		

In drawing a weight along a horizontal plane.

Strength of a man	1	Strength of an ox	4 to 7
— of a horse	7	— of a dog	0·6
— of a mule	7	— of a reindeer	0·2
— of an ass	2		

On the subject of animal power and the best modes of its employment, reference may be made to the following works: — Coulomb, *Sur la Force des Hommes* (*Mém. de l'Acad.*); Prony, *Architecture Hydraulique;* Hachette, *Traité des Machines;* Guenyveau, *Essai sur la Science des Machines;* Coriolis, *Calcul. de l'Effet des Machines;* Borgnis, *Traité de la Composition des Machines;* Wesermann, *Taschenbuch für Strassen und Wegbaubeamte.*

STRENGTH OF MATERIALS. The force with which a solid body resists an effort to separate its particles, or destroy their aggregation, can only become known from experiment; nevertheless, if we assume an hypothesis to represent the manner in which the elementary particles are arranged and cohere, general formulæ may be deduced, which will represent the comparative strength of bodies of different forms and dimensions, or submitted to the action of forces applied in different manners, and will consequently be of great use in practical mechanics.

There are four different ways in which the strength of a solid body may be exerted: first, in resisting a longitudinal tension, or force tending to tear it asunder; secondly, in resisting a force tending to break the body by a transverse strain; thirdly, in resisting compression, or a force tending to crush the body; and fourthly, in resisting a force tending to wrench it asunder by torsion. We shall consider these separately.

1. *Longitudinal Tension.* — The resistance opposed by a solid body to a longitudinal strain is usually termed the *absolute strength*, or force of direct cohesion, of the body. Two points may be proposed for investigation: first, to determine the quantity by which a body of a given length is stretched or elongated under the action of a given force or weight; and secondly, the effect required to separate the parts or produce rupture. Experiments have usually been directed to the last of these only, but the first may be determined indirectly from experiments on flexure. In bodies of a fibrous structure, as the woods, the cohesive force differs greatly, according as the effect is applied in the direction of the fibres, or at right angles to it. When the strain is exerted in the direction of the fibres, the cohesive force obviously depends on two circumstances only — the strength of each fibre, and their number; and in general, in bodies of the same substance and structure, the strength is proportional to the transverse area of the body, and to a certain constant which must be determined by experiment.

Suppose the body to be a prism or cylinder, and let A be the area in square inches of a section perpendicular to its length, or to the direction of the force; W the weight in pounds which produces rupture; and s the absolute strength of the substance, or the weight in pounds which would overcome the cohesive force of a rod whose transverse section is one square inch; then $W = s\,A$, or $s = W \div A$. In a rectangular beam whose breadth and thickness are respectively a and b, we have $A = a\,b$; whence $W = s\,a\,b$, $s = W \div a\,b$. In a cylindrical rod whose radius is r, we have $A = \pi r^2$ ($\pi = 3{\cdot}14159$); whence $W = s\,\pi r^2$, and $s = W \div \pi r^2$.

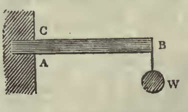
Under the term COHESION we have already given a table of the values of s in respect of different woods and metals. For further information, the reader is referred to *Barlow's Treatise on the Strength of Timber, &c.* (1837); but a much more ample collection of experimental results will be found in the work of Navier, *Resumé des Leçons, &c., sur l'Application de la Mécanique à l'Etablissement des Constructions et des Machines.* We may remark, that although the longitudinal tension is, with respect to mechanical action, the simplest of all the strains to which a solid body can be subjected, it is the most difficult to submit to experiment, by reason of the enormous forces required to produce rupture, and, in the case of fibrous bodies, the difficulty of applying those forces in the direct line of the fibres. If the fibres are not all subjected to the same strain, it is obvious that the direct cohesion will be estimated at less than its real value; and, as Mr. Barlow remarks, it is probably owing to this circumstance that so little agreement is found in the results of experiments.

2. *Transverse Strength.* — When a body suffers a transverse strain, the mechanical action which takes place among the particles is of a more complicated nature. Galileo was the first who attempted to give a rational explanation of this action, and to submit the strength of the materials used in the mechanical arts to the measures of geometry and arithmetic. He assumed that all solid bodies are composed of numerous small parallel fibres, perfectly inflexible and inextensible; and that when they break the several fibres give way in succession, the body turning on the last which give way as on a hinge, and the strain on each fibre, previous to the rupture, being proportional to its distance from the quiescent fibres. From this it follows that the resistance of a beam to a transverse strain is in the compound ratio of the strength of the individual fibres, the area of the cross section, and the distance of the centre of gravity of the cross section from the points round which the beam turns in breaking.

The first who attempted to submit the theory of Galileo to actual experiment was Mariotte, whose results were published in his *Traité sur les Mouvements des Eaux*, 1680. These experiments attracted the attention of Leibnitz, who, in the *Acta Eruditorum* for 1684, pointed out defects of the theory, and proposed a different hypothesis. Leibnitz assumes that every body before it breaks admits of a certain degree of extension, and consequently the fibres are neither inflexible nor inextensible. He further assumes a principle first proposed by Hooke; namely, that the strength of each fibre under the action of a straining force varies with the degree of extension, or is proportional to the distance of the fibre from the fixed point about which the beam is supposed to turn. In this hypothesis, the beam is still supposed to turn about its upper or lower edge, or that all the fibres, excepting the quiescent ones, are in a state of tension; although it had been remarked by Mariotte (and is indeed sufficiently obvious), that when flexure takes place part of the fibres only are in a state of tension, another part being compressed, so that the line about which the beam turns is somewhere within the section of fracture. Professor Robison appears to have been the first who distinctly showed that the position of the *neutral axis* is a necessary datum in the solution of the problem.

Although it cannot be doubted that the hypothesis of Galileo is at variance with the precise fact, yet it is found to be sufficient for practical purposes; and indeed the results which it gives appear to agree nearly as well with experiment as those which are derived from a more refined theory and more elaborate calculations. It has, therefore, on account of its great simplicity, been very generally adopted by writers on mechanics. We shall here briefly state the principal results.

Suppose a prismatic beam A B to have one end firmly fixed in a wall, and a weight W to be suspended from the other end, the beam lying horizontally. According to the hypothesis, the fibres are inflexible and inextensible, so that no bending takes place; and when the rupture commences the fibres first give way at the upper side C, and the beam turns about A as upon a hinge. The two forces brought into action are, therefore, the weight W acting at the end of the lever A B, and the resistance of the particles in the section A C; and at the instant previous to the rupture the two forces are in equilibrio, or their respective moments of rotation are equal. Now, the resistance of any fibre in the section A C is the absolute strength of the fibre multiplied into its distance from the point A; therefore the whole resistance of the beam is formed by multiplying each differential element of the area into its distance from the point A, and into the abso-



lute strength, and taking the sum of all the products. But this is equivalent to the product of the area of the section by the distance of its centre of gravity from A, and by the absolute strength; hence if we put $A =$ the area of the section, $c =$ the distance of its centre of gravity from the lowest point, $s =$ the absolute strength of the unit of surface, the resistance to fracture is $s\,c\,A$. Let $W =$ the breaking weight in pounds, and $l = A\,B$, the length of the beam; then the moment of the force tending to produce fracture is $W\,l$, and the equation of equilibrium is $W\,l = s\,c\,A$; whence $W = s\,c\,A \div l$, or $s = W\,l \div c\,A$.

In a rectangular beam whose breadth is b, and thickness or depth d, we have $A = b\,d$, $c = \frac{1}{2}\,d$; whence $W = s\,b\,d^2 \div 2\,l$; or the strength of the beam is directly as its breadth and the square of its depth, and inversely as its length.

In a square beam $b = d$, whence $W = s\,b^3 \div 2\,l$.

In a square beam whose diagonal is vertical, we have $A = a^2$, and $c = \frac{1}{2}\,a\sqrt{2}$; whence $W = s\,a^3\sqrt{2} \div 2\,l$. The beam ought, therefore, to be stronger in this position; but this result of the theory is contradicted by experience.

If the beam be cylindrical, and r be the radius of its section, then $A = \pi\,r^2$, and $c = r$; whence $W = \pi\,s\,r^3 \div l$.

In a cylindric tube, the radii of whose external and internal surfaces are respectively r and r', we have $A = \pi\,(r^2 - r'^2)$, $c = r$; whence $W = \pi\,s\,r\,(r^2 - r'^2) \div l$.

From the two last cases it may be shown that the strength of the tube is to the strength of the same quantity of matter formed into a solid cylinder in the ratio of r to $\sqrt{(r^2 - r'^2)}$; so that a tube may be much stronger than the same quantity of matter in a solid form. This principle furnishes an explanation of many facts in the economy of nature. To obtain the greatest strength with the least possible weight, the bones of animals and the quills and feathers of birds have the form of hollow tubes; and the same arrangement is observed in many of the vegetable tribes, as the *Gramina*.

In the preceding formulæ the weight of the beam is neglected, as inconsiderable in comparison of the weight applied; but since in similar beams of the same substance the strength increases as the square of the depth, while the weight increases as the cube, there is consequently a limit, which if a beam of a given shape and of a given materials were to reach it could only bear its own weight, and would be broken by any further increase.

Suppose a beam A B to be laid horizontally on two props, and to be broken by a weight placed at equal distances between them, the pressure will be equally shared between the props; and since by the hypothesis fracture takes place without bending, the effect will be the same as if the beam had been fixed at the middle, and each end acted upon by a force equal to half the weight, but directed upwards. The breaking weight is consequently double of that which would be required to break a beam of half the length having one end fixed in a wall; or the transverse length of the beam when supported at one end is four times as great as that of the same beam supported at one end only, and having the weight suspended from its other extremity. In this case, therefore, when the beam is rectangular, $W = 2\,s\,b\,d^2 \div l$; when the beam is square, $W = 2\,s\,b^3 \div l$; when cylindrical, $W = 4\,\pi\,s\,r^3 \div l$; and so with the other cases.

When the horizontal beam, instead of being merely supported, is firmly imbedded in a wall at each end, the resistance will be equal to that of the same beam merely supported at each end, added to the resistance of two beams of half the length fixed at one end only, and acted upon by half the weight. For it is manifest that three fractures must take place,—one in the middle, and one at each end; and the strain in the middle is equal to that of the supported beam, which has just been shown to be $2\,s\,b\,d^2 \div l$; and that at each end is one fourth of this, or $\frac{1}{2}\,s\,b\,d^2 \div l$; therefore the whole weight W, under which if suspended from the middle the beam will give way, is $W = 3\,s\,b\,d^2 \div l$.

On the same principle it may be shown that when a beam is supported at both ends, the weight which it is able to bear at any point is inversely as the rectangle under the segments into which it is divided by that point. Hence a beam supported at both ends is weakest in the middle, the rectangle under the segments at that point being a maximum. It also follows that when the pressure is equally distributed over the whole beam, twice the weight will be required to break it.

When the beam, instead of being laid horizontally, is inclined, its strength is increased in the ratio of unity to the square of the cosine of the angle of inclination. This consequence of the theory, however, can obviously hold only within certain limits; inasmuch as it would give the strength equal to infinity when the inclination is a right angle, or when the load is applied endwise.

In the hypothesis of Galileo, from which the preceding results have been deduced, the beam is supposed to be absolutely inflexible, which is not the case with any material substance; and although the results are sufficiently accurate in their application to architectural or mechanical purposes, yet in the comparison of experiments to determine the ultimate strength of different substances it becomes necessary to take the elasticity and consequent incurvation into the estimate. Mr. Barlow, assuming that the flexure takes place only at the section of fracture, and that the fibres remain inextensible in every other point, deduces the following formulæ for the transverse strain, which agree very well with the experiments.

As before, let l denote the length, b the breadth, and d the depth of the beam, all in inches; and let Δ be the angle of deflection, W the breaking weight, and S the resistance of a rod whose section is one square inch, W and S being expressed in pounds; then,

1. When the beam is fixed at one end and loaded at the other, $S = W\,l\cos.\Delta \div b\,d^2$;

2. When the beam is supported at each end, and loaded in the middle, $S = W\,l\sec.^2\Delta \div 4\,b\,d^2$;

3. When the beam is fixed at each end and loaded in the middle, $S = W\,l\sec.^2\Delta \div 6\,b\,d^2$.

The angle of deflection being small, its secant in the ordinary applications may be considered as equal to unity; and if we also write $\frac{1}{2}\,s$ instead of S in the above formulæ, they will become the same as those deduced from the hypothesis of Galileo.

The preceding results have reference to the absolute strength of the beam, or to the weight which it can just support without being broken; but it is also very important to know the amount of deflection which a given weight will produce in a beam of a given material and of given dimensions. Suppose a prismatic beam to be firmly fixed at one end, and to have a weight suspended from the other; then, if we adopt the hypothesis that the extension of the fibres at each point is proportional to the straining force, the curvature at the different points and the law of the action which takes place may be deduced from the properties of the elastic curve. (*See* Elastic Curve.) The following results of theory are confirmed by the experiments of Dupin and Barlow.

1. The deflections of a beam loaded with different small weights are proportional to those weights. 2. The deflection, *ceteris paribus*, is directly as the cube of the length, inversely as the cube of the depth, and inversely as the breadth. Hence if l denote the length, b the breadth, d the depth, and k the deflection (that is, the distance to which the loaded end of the beam is drawn below the horizontal line), all expressed in inches, and if w be the weight in pounds which the body can support without its elasticity being impaired, then k is proportional to $w\,l^3 \div b\,d^3$; or if we assume E as the constant modulus of elasticity, $E = w\,l^3 \div k\,b\,d^3$.

The deflection of a beam fixed at one end and loaded at the other is double that of a beam of twice the length supported at both ends and loaded at the middle with a double weight, supposing the strain to be the same in both cases; consequently, when the weights are the same, the deflection in the first case is to that in the second as 4 : 1; and when the length and weight are both the same, the deflections (which vary as the cubes of the lengths) will be to each other as 32 : 1. In the case of the beam supported at both ends, the formula therefore becomes $E = w\,l^3 \div 32\,k\,b\,d^3$.

From the table of *data* given by Barlow (*Strength of Timber*, p. 150.) we extract the following mean results of experiments (on beams supported at both ends), made in the dock-yard at Woolwich, for determining the elasticity and strength of various species of timber.

Description of Wood.	Elasticity. $E = \dfrac{w\,l^3}{32\,k\,b\,d^3}$	Strength. $S = \dfrac{W\,l}{4\,b\,d^2}$
Teak - - -	301800	2462
Poon - - -	211200	2221
English Oak - -	109200	1181
Ditto, another specimen	181400	1672
Canadian Oak - -	268600	1766
Ash - - - -	205600	2026
Beech - - -	169200	1556
Elm - - -	87480	1013
Pitch Pine - - -	153200	1632
New England Fir -	273900	1102
Riga Fir - - -	166100	1108
Mar Forest Fir - -	108700	1262
Larch - - -	131600	1149
Norway Spar - -	182200	1474

From the mean of a number of experiments by Tredgold the values of E and S, for rectangular cast iron bars, were found to be $E = 2254000$, $S = 7620$.

3. *Resistance of Bodies to Forces tending to crush them.* — The resistance of a body to a crushing force might be supposed, *à priori*, to follow the same law as the absolute force of cohesion, and consequently to depend only upon the area of the section and the force of aggregation of the

particles. It is found, however, by experiment, that the thickness of the body (or length, if the force is applied endwise) has an important influence on the amount of pressure it is capable of bearing. Very thin plates are readily crushed; and the resistance appears to increase with the thickness up to a certain maximum, after which it diminishes. The theory of the resistance of pillars, which is of great importance on account of its application to architectural purposes, was investigated by Euler; and, according to the hypothesis adopted by him, the strength varies directly as the fourth power of the diameter or side, and inversely as the square of the length. This is confirmed by the recent experiments of Mr. Hodgkinson (*Phil. Trans.* 1840) in respect of pillars of wrought iron, or timber; but in the case of pillars of cast iron, the powers of the diameter and length were somewhat different. Mr. Hodgkinson found from a mean of experiments that a solid uniform pillar of cast iron, whose transverse section is one square inch, is destroyed by a weight of 98922 lbs., or 44·16 tons. Assuming this as a unit of measure, he gives the following formula (as representing his experiments), in which s is the strength or weight in lbs. that would crush the pillar, d the diameter, and l the length; viz. $s = 98922 \times d^{3\cdot55} \div l^{1\cdot7}$. This formula applies to pillars of which the lengths are twenty-five times the diameter and upwards, and which are perfectly flat at the ends. When the ends of a pillar are rounded, so that the load bears only on the middle fibres, the strength is greatly reduced. In pillars whose length is thirty times the diameter, or upwards, Mr. Hodgkinson found the strength of those with flat ends to be about three times greater than the strength of others of the same dimensions with round ends, the mean ratio being 3·167. In shorter pillars the ratio was not constant. The strength of a pillar is slightly increased by placing discs on the ends to increase the bearings.

Mr. Hodgkinson gives the following results of his experiments on the resistance to a crushing force of short pillars of some of the most common descriptions of wood, the force being applied in the direction of the fibres.

Description of Wood.	Strength per Square Inch, in lbs.
Alder	6831 to 6960
Ash	8683 — 9363
Bay	7518 — 7518
Beech	7733 — 9363
English Birch	3297 — 6402
Cedar	5674 — 5863
Red Deal	5748 — 6586
White Deal	6781 — 7293
Elder	7451 — 9973
Elm	10331
Fir (Spruce)	6499 — 6819
Mahogany	8198 — 8198
Oak (Quebec)	4231 — 5982
Oak (English)	6484 — 10058
Pine (Pitch)	6790 — 6790
Pine (Red)	5395 — 7518
Poplar	3107 — 5124
Plum (Dry)	8241 — 10493
Teak	12101
Walnut	6063 — 7227
Willow	2898 — 6128

The results in the first column were deduced in each case from experiments upon cylinders of wood turned to one inch diameter, and two inches long, flat at the ends. The wood was moderately dry. The second column gives the mean strength from similar specimens after being turned and kept dry in a warm place two months longer. The great difference in the strength frequently seen in the two columns shows strongly the effect of drying upon wood, and the great weakness of wet timber.

Mr. Tredgold found that cast iron is crushed by a weight of 93,000 lbs. upon a square inch, and will bear 15,300 lbs. without permanent alteration.

4. *Strength of Torsion.* — The resistance which bodies oppose to a force tending to wrench them asunder has frequently been made the subject of experiment. The following results, showing the comparative strength of various metals, as ascertained by resistance to torsion, is given by Mr. Rennie. For the law according to which the elasticity is evolved in the case of slender metallic wires or threads of fibrous substances, when the twisting force is less than is necessary to produce a permanent change of structure, we refer to the term TORSION.

Lead	1000
Tin	1438
Copper	4312
Brass	4688
Gun metal	5000
Swedish iron	9500
English iron	10125
Cast iron	10600
Blister steel	16688
Shear steel	17063
Cast steel	19562

Mr. Banks (*on the Power of Machines*) states, as the mean result of several experiments, that a bar of cast iron, one inch square, is wrenched asunder by a weight of 631 lbs. avoirdupois, applied at the extremity of a lever two feet in length. Other experiments on the force of torsion are given by G. Bevan (*Phil. Trans.* 1829), and Savart (*Annales de Chimie*, August, 1829).

For further information on this subject, in addition to the works already quoted, see Rondelet, *Art de Bâtir*; Girard, *Traité Analytique de la Résistance des Solides*; Tredgold, *Elementary Principles of Carpentry*, and *Practical Essay on the Strength of Cast Iron*; Banks, *Treatise on the Power of Machines*; Hodgkinson, *Transactions of the British Association*, vol. vi.; and *Phil. Trans.* 1840, &c.

STREPSI'PTERANS, *Strepsiptera*. (Gr. στρεπτος, *twisted*; πτερον, *a wing*.) The name given by Kirby to the order of insects which he discovered to possess rudimental elytra in the form of linear and spirally twisted scales.

STRETCHER. In Architecture, a brick or stone laid horizontally with its length in the direction of the face of a wall.

STRETCHING COURSE. In Architecture, a course in which the bricks or stones are laid horizontally with their lengths in the direction of the face of the wall. *See* HEADERS and HEADING COURSE.

STRE'TTO. (It. *narrow*.) In Music, a term indicating that the measure to which it is affixed is to be performed short and concise, hence quick. It is the opposite of *largo*.

STRI'ATE. (Lat. stria, *a groove*.) In Zoology, when a surface is painted or impressed with several narrow transverse streaks.

STRIGÆ. (Lat.) In Architecture, the flutings of a column.

STRIGI'DÆ. The name of the family of Nocturnal Raptores of which the owl (*Strix*) is the type.

STRING BOARD. In Architecture, a board with its face next the well-hole in a wooden staircase, which receives the ends of the steps.

STRING COURSE. In Architecture, a course running quite along the face of a building, the projecture whereof is small in proportion to its height.

STRO'BILE, or STRO'BILUS, is the fruit of the fir tree, to which the common name of cone is assigned. It may be defined to be a spike of very imperfect flowers subtended by bracts, which are woody, pressed close to each other, and in many cases consolidated.

STRO'MBUS. The name of a shell-fish in Pliny. This term was applied by Linnæus to a genus of the Vermes Testacea, characterized by the form of the shell, of which the aperture is much dilated, the lips expanding, and produced into a groove leaning to the left. The Mollusca to which this character is applicable form a group of Pectinibranchiate Gastropods in the system of Cuvier, which has been subdivided into the genera *Strombus* proper, *Pterocera*, Lam., &c.

STRO'NGYLUS. A genus of intestinal worms in Rudolphi's classification, characterized by having a cylindrical body, the anal extremity of which, in the male, is surrounded by a kind of pouch of a varied shape, from which is protruded a small filament or spiculum, probably subservient to generation. The mouth is orbicular, sometimes armed with spines, as in the *Strongylus armatus*, which infests the mesenteric arteries of the horse and ass, producing aneurisms; sometimes the mouth is surrounded by tubercles or papillæ, as in the *Strongylus gigas*, which is sometimes found in the kidney of the human subject.

STRO'NTIA. An earth contained in a mineral, generally of a pale green tint and radiated crystalline texture, found at Strontian in Argyleshire. It is a carbonate of strontia. Strontia is the oxide of a metallic base, the properties of which are very imperfectly known, called strontium; the equivalent of strontia, or oxide of strontium (composed of 44 strontium and 8 oxygen), is 52. It has a caustic taste, an alkaline reaction, and a degree of solubility in water intermediate between lime and baryta. The salts of strontia are generally obtained by dissolving the natural or artificial carbonate in the acids; those which are soluble give the flame of burning bodies a fine rose red colour: the nitrate of strontia is used for this purpose, and with beautiful effect, in theatrical exhibitions and fire-works. The sulphate of strontia is found native: it is an insoluble white powder when artificially prepared. Some of its native varieties have a pale blue tint, whence the term *cœlestine*. A colourless prismatic crystalline variety, of great beauty, is found associated with the native sulphur of Sicily.

STRO'NTIANITE. Native carbonate of strontia.

STRO'PHE. (Gr. στροφή, *a turning*.) A division of a Greek choral ode answering to a stanza. The name is derived from στρέφειν, *to turn*, because the singers turned in one direction while they recited that portion of the poem; they then turned round and sung the next portion, which was of exactly the same length and metre as the preceding, and was termed the antistrophe (ἀντι-

στροφή, from ἀντί, *opposite*). These were sometimes followed by another strophe and antistrophe, sometimes by a single stanza called the epode (ἐπῳδός).

STROPHI'OLÆ. In Botany, synonym of *Caruncula*, which see.

STROPHU'LUS. (Lat.) The *red gum*; an eruption peculiar to infants.

STRUMA. (Lat.) In Anatomy, an enlarged gland.

STRUMA. In Botany, a swelling that is present in some leaves at the extremity of the petiole, where it is connected to the lamina; as in *Mimosa sensitiva*. The term also used in describing mosses to denote a dilatation or swelling that is at times present upon one side of the base of the theca.

STRUT. In Architecture, a piece of timber obliquely placed from a king or queen post to support a rafter. It is sometimes called a brace. *See* ROOF.

STRUTHIO'NIDÆ. (Struthio, *an ostrich*.) The name of a family of terrestrial birds, incapable of flight, with very short or rudimental wings, and long and strong legs; including the ostrich and other congeneric species which constitute the order *Cursores* of Kirby, and the family *Brevipennes* in the system of Cuvier.

STRY'CHNIA. A poisonous vegetable alkaloid, discovered in 1818 by Pelleter and Caventou in the seed of the *Strychnus ignatia* and *Nux vomica*, and also in the upas poison. It is almost insoluble in water, but very soluble in boiling alcohol, from which it is deposited by careful evaporation in small white crystals. It is so virulently poisonous that half a grain blown into the throat of a rabbit occasioned death in five minutes; its operation is accompanied by lock-jaw and by other tetanic affections. The chemical equivalent of strychnia is about 238. It probably consists of 30 atoms of carbon, 16 hydrogen, 3 oxygen, and 1 nitrogen.

STU'BBLE. The root ends of stalks of corn, left in the field standing as they grew after the corn has been reaped by the sickle or scythe. In some parts of the country only a small portion of the straw is cut off with the ears of corn, and the stubble in that case is a foot or eighteen inches in length; but in others the corn is cut as close to the surface as possible, in which case the stubble is quite short. In general long stubble is a symptom of bad farming, because a quantity of straw is in this case left waste in the field, which might have been carried home and rotted into manure.

STU'CCO. (Ital.) In Architecture, a term applied to many sorts of calcareous cements. The sense in which it is most commonly used in this country is to denote the third coat of three-coat plaster, consisting of fine lime and sand. The better sort is hand-floated twice and well trowelled. There is a species called bastard stucco, in which a small portion of hair is used. (*See* FINISHING.) Rough stucco is merely floated and brushed with water, but the best is trowelled stucco.

STUDDING SAILS, called also Steering Sails, are narrow sails set temporarily at the outer edges of the square sails.

STUFA. (Ital.) A jet of steam issuing from a fissure in the earth: these jets are not uncommon in volcanic districts.

STUFF. A Commercial term, applied to various woven fabrics; it especially signifies a light woollen cloth formerly much used for curtains and bed furniture.

STU'RGEON. (Lat. sturio, from the German stoer, *a sturgeon*.) The type of a genus of Cartilaginous fishes, with free gills, having the body more or less covered with bony plates in longitudinal rows. The mouth is placed beneath the snout, is small and edentulous; but is protractile. Soft feelers or cirri are attached beneath the snout. The bodies of the vertebræ retain the primitive condition of an undivided gelatinous cord. The sturgeons ascend the larger rivers of Europe in great abundance, and are the objects of important fisheries. The flesh of most of the species is wholesome and agreeable food; their ova are converted into caviar, and their air-bladder affords the finest isinglass.

The sturgeon which is occasionally captured on our east coast is the *Accipenser sturio* of Linnæus. *See* ACCIPENSER.

STURIONIANS, *Sturionii*. (Lat. sturio, *a sturgeon*.) The name of the family of Cartilaginous fishes of which the sturgeon is the type.

STY. A little boil or tumour projecting from the edge of the eyelid.

STYLAGA'LMAIC. (Gr. στυλος, *a column*, and αγαλμα, *an ornament*.) In Architecture, a term used to denote figures which perform the office of columns. *See* CARYATIDES.

STYLE. (Lat. stylus, or stilus.) A kind of pencil made use of by the Romans for writing on waxed tablets. It was made of brass or iron, with one end sharp for writing, and the other blunt and smooth to make erasures with; hence to *turn the style* is a phrase used by ancient writers, signifying to make corrections.

In Literature, the word style may be defined to mean the distinctive manner of writing which belongs to each author, and also to each body of writers, allied as belonging to the same school, country, or age. It is that which, to use the expression of Dryden, individuates each writer from all others. The style of an author is made up of various minute particulars, which it is extremely difficult to describe, but each of which adds something to the aggregate of qualities which belong to him. Collocation of words, turn of sentences, syntax, rhythm; the relation, abundance, and the character of his usual figures and metaphors; the usual order in which thoughts succeed each other; the logical form in which conclusions are generally deduced from their premises; the particular qualities most insisted on in description; amplification and conciseness, clearness and obscurity, directness and indirectness, exhaustion, suggestion, suppression; — all these are features of style, in the largest sense of the expression, in which it seems to comprehend all peculiarities belonging to the manner in which thought is communicated from the writer to the reader. Excellence of style, particularly of the rhetorical parts of style, was more cultivated by the ancients than the moderns; and less, perhaps, at the present day, than at any former period since the English language began to be written in prose with correctness and elegance. Since the period when Bolingbroke, Junius, Johnson, Gibbon, and Burke became established as models, a certain superficial sameness of style, wanting in the roughness and vulgarity, but also in the force and individuality of old English composition, seems to prevail to such an extent as to render modern writing extremely monotonous and artificial. But it should never be forgotten that whatever quality may command a temporary popularity, no work, either in poetry or prose, has ever permanently maintained its hold on public admiration without excellence of style.

STYLE, in the Calendar, is a manner of reckoning time. The reformation of the calendar by Julius Cæsar consisted chiefly in restoring the equinox to its proper place in the month of March. This reformation took place in A. U. C. 707, which year was made to consist of fourteen months, in order to fill up the deficiency which had been produced by the former method of computing, and was styled the "year of confusion." By the Julian calendar an intercalary day was added to every fourth year (leap year). In consequence of this erroneous intercalation, the equinox receded a day in about 130 years; and, in the beginning of the sixteenth century, the vernal equinox fell on the 10th instead of the 21st of March. The calendar was reformed by Gregory XIII. in 1577. By this reformation ten days were dropped in the year 1582, the 15th of March being reckoned immediately after the 4th; and it was arranged that every 100th year (which by the former calendar was a leap year) should be a common year, except the fourth, *i.e.* 1600 remained a leap year; but 1700, 1800, were common years; and 1900 will be a common year likewise, after which the cycle of four centuries will again commence. The Gregorian calendar was immediately adopted in Catholic countries; but by Protestant nations the old style was for a long time continued. England adopted the *New Style* in 1752 by statute, after debates in parliament, of which a curious notice will be found in *Lord Chesterfield's Letters*. Previously to this time, dates according to the old style are frequently denoted by the initials O. S.; or thus, $\left.\begin{matrix}10\text{th}\\22\text{d}\end{matrix}\right\}$ of January, 1750, the upper line denoting the old, and the latter the new style. This mode of dating will still be found in the despatches and public papers of Russia and Greece, which are the only European states in which the Julian year is still in use. The time of the two styles now varies thirteen days. For further information on this subject, see CALENDAR.

STYLE, in Dialling, is the gnomon which projects the shadow on the plane of the dial. *See* DIAL.

STYLE, in Botany, is that elongation of the ovarium which supports the stigma. It is an extension of the midrib of the carpellary leaf, or is formed by the rolling up of the attenuated extremity of the latter.

STYLE. In the Fine Arts, the mode in which an artist forms and expresses his ideas on and of a given subject. It is the form and character that he gives to the expression of his ideas, according to his particular faculties and powers. Style may be almost considered as the refinement of *manner* (*see* MANNER): it is a characteristic essence by which we distinguish the works of one master from another. From literature this word has passed into the theoretic language of the fine arts; and as in that we hear of the *sublime*, *brilliant*, *agreeable*, *historic*, *regular*, *natural*, *confused*, and other styles, so we have almost the same epithets applied to styles of art. Indeed this is not wonderful, since the principles of taste, in both the one and the other, are founded in nature; and it is a well-known saying, that poetry is a speaking picture. This word is improperly used as applied to colouring and harmony of tints: we speak of the style of a design, of a composition, of draperies, &c.; but not of the style of colouring, but rather the *method*

or *manner* of colouring. The definition of this word by Sir Joshua Reynolds is as follows: — "Style in painting is the same as in writing, — a power over materials, whether words or colours, by which conceptions or sentiments are conveyed." But we can scarcely consider this definition sufficiently general.

STY'LITE. (Gr. *στυλος, a column.*) The title given to a peculiar class of anchorites from the places on which they took up their solitary abodes, being the tops of various columns in Syria and Egypt. This strange method of devotion took its rise in the second century, and continued to be practised by many individuals for a great length of time. The most famous among them was one St. Simeon, in the 5th century, who is said to have lived thirty-seven years upon various columns of considerable height in the neighbourhood of Antioch.

STYLO. Names compounded of this word apply to the muscles attached to the styloid process of the temporal bone.

STY'LOBATE. (Gr. *στυλος, a column*, and *βασις, a base.*) In Architecture, a term signifying the uninterrupted base below a range of columns.

STY'PTICS (Gr. *στυφω, I restrain*), in Medicine and Surgery, are remedies used for checking a flow of blood.

STYRAX. *See* STORAX.

STYX. (Gr. Στυξ.) In Mythology, a nymph: the daughter, according to Hesiod, of Oceanus and Thetis; but other mythologists relate the genealogy differently. She dwelt in a rock palace in the infernal regions, from whence one of the infernal rivers burst forth. This river, Styx, was one of the ten arms or branches of Oceanus. The gods of Olympus swore by the water of Styx; and a deity who took this oath in vain was banished from the heavenly mansions for ten years, to endure various torments. The river Styx has been sought for in various places; but the most remarkable stream of the name was in Arcadia. It forms a terrific waterfall.

SU'BALTERN. (Lat. sub, *under*, and alter, *other.*) Literally an inferior officer, but generally applied to all officers under the rank of captain.

SUBBRA'CHIANS, *Subbrachia.* (Lat. sub, and brachium, *the arm.*) The name of the order of Malacopterygious fishes comprising those which have the ventral fins situated either immediately beneath and between, or a little in front or behind the pectoral fins.

SUBCLA'VIAN. An Anatomical term applied to vessels, nerves, &c. under the shoulder or armpit.

SUB-CO'NTRARY SECTION. In Geometry, if an oblique cone on a circular base be cut by a plane not parallel to the base, but inclined to the axis, so that the section is a circle, then the section is said to be *sub-contrary.* The part of the cone thus cut off is similar to the whole cone; the plane of the section and the base of the cone being equally inclined to the axis, but the inclination being in opposite directions.

SUBDO'MINANT. (Lat. sub, *under*, and dominans, *governing.*) In Music, that note which is a fifth below the key note. It is a species of governing note, inasmuch as it requires the tonic to be heard after it in the plagal cadence. In the regular ascending scale of seven notes it is the fourth; the term, however, has its origin from its relation to the tonic as the fifth below.

SUBDU'PLICATE RATIO. In Arithmetic and Algebra, the subduplicate ratio of two numbers is the ratio of their square roots. Thus, the subduplicate ratio of the numbers 9 and 16 is the ratio of 3 to 4; and of the numbers a and b, it is the ratio of $\sqrt{a}$ to $\sqrt{b}$.

SU'BERIC ACID. (Lat. suber, *cork.*) An acid substance into which cork is converted by the long-continued action of nitric acid.

SU'BERIN. A name given by Chevreul to the cellular tissue of cork after the various soluble matters have been removed by the action of water and alcohol.

SU'BITO. (It. *suddenly.*) In Music, a term of direction; as *volti subito*, turn (the leaf) quickly.

SUBJECT. (Lat. subjicio, *I throw under.*) In the Fine Arts, that which it is the object and aim of the artist to express.

SU'BJECTIVE and OBJECTIVE. Terms expressing the distinction which in analyzing every intellectual act we necessarily make between ourselves, the conscious *subject*, and that of which we are conscious, the *object.* "I know," and "something is known by me," are convertible propositions; every act of the soul which is not thus resolvable belongs to the emotive part of our nature, as distinguished from the intelligent and percipient. For the distinction between subject and object, all-important in intellectual philosophy, and the neglect of which has been the cause of infinite confusion and perplexity, we are indebted to the schoolmen; from whom it was derived, through Wolf and Leibnitz, by Kant and the modern German philosophers.

SUBJECT OF A PROPOSITION, in Logic, is the term of which the other is affirmed or denied. *See* TERM, PROPOSITION, LOGIC.

SUBLAPSA'RIANS or INFRALAPSARIANS. In Ecclesiastical History. The greater number of the divines of the reformed or Calvinist churches have held that God *permitted* the fall of Adam, without positively predetermining it; a doctrine which has been termed sublapsarian, in opposition to the high Calvinistic or supralapsarian view. (*Mosheim*, cent. xvii. sect. 2.) *See* SUPRALAPSARIANS.

SUBLIMA'TION. (Lat. sublimatio.) A process by which solids are by the aid of heat converted into vapour, which is again condensed, and often in the crystalline form. This operation is frequently resorted to for the purpose of purifying various chemical products, and separating them from substances which are less volatile.

SUBLI'ME. (Lat. sublimis.) In the Fine Arts, high or exalted in style. That which in art is raised above the higher standard of nature or its prototypes. Sublimity is incompatible with our ideas of elegance, grace, or any of the other sources of beauty, though these may all enter into an object wherein those and many other qualities may be combined with sublimity. They have been, however, not unfrequently considered as some of the sources of the sublime. The nod of Jupiter, in the hands of such a master as Homer, is an indication of sublimity; but when Longinus tells us, that, as applied to literature, the constituent ingredients of sublimity are boldness in thought, the pathetic, proper application of figures, use of tropes and beautiful expressions, and, last, musical structure and sounds, we are inclined to think he had very indistinct notions of it himself. We cannot better exemplify the meaning of this term than by referring the reader to the works of Michael Angelo in the Sistine Chapel, wherein, as Fuseli has truly said, "His line is uniformly grand; character and beauty were admitted only as far as they could be made subservient to grandeur. The child, the female, meanness, deformity, were by him indiscriminately stamped with grandeur. A beggar rose from his hand the patriarch of poverty; his infants teem with the man, his men are giants." The *terribile via*, hinted at by Agostino Caracci, is indeed the sublime.

SUBME'DIANT. (Lat. sub, *under*, and medius, *middle.*) In Music, the middle note between the tonic and subdominant descending. It is the greater sixth in the major scale, and the lesser sixth in the minor scale.

SUBMU'LTIPLE, in Arithmetic and Geometry, is the same with *aliquot part* or *measure;* or it is such a part of a quantity as can be expressed by a whole number, as a third, a fourth, &c.

SUBNO'RMAL, in Geometry, is that part of the axis of a curve line which is intercepted between the ordinate and the normal. If y be the ordinate, and x the absciss of any curve, the expression for the subnormal is $y\,\frac{dy}{dx}$. The subnormal is always a third proportional to the subtangent and the ordinate. *See* SUBTANTENT.

SUBO'RDINARY. In Heraldry. According to some writers on this imaginary science, an ordinary, when it comprises less than one fifth of the whole shield, is termed a subordinary.

SUBORNA'TION. (Lat. sub and orno, *I provide, furnish, procure;* a meaning not classical.) Subornation of perjury, in Law, is the procuring a man to take a false oath amounting to perjury. The offence of subornation is not complete unless the oath be taken, so as to bring the offender within the stat. 2 G. 2. c. 25.; but it is a misdemeanor to attempt to procure false testimony.

SUBPŒ'NA. In Law, a writ of which there are several sorts. *Subpœna ad testificandum* is the common progress, both in equity and in the courts of common law, to compel the attendance of a witness. *Subpœna duces tecum* is a writ of the same nature with the former, with a clause requiring the witness to bring with him and produce books and papers. An action of damages lies against parties disobeying this writ.

SUB-SE'MITONE. In Music, the leading note or sharp seventh of the scale. It is a term more used by the German than by other writers.

SU'BSIDY. (Lat. subsidium, *assistance.*) In Politics, pecuniary aid granted by one government to another in pursuance of a treaty. The grants of public money made to the sovereign, or taxes imposed in this country, were called subsidies.

SU'BSTANTIVE COLOURS, are those which, in the process of dyeing, remain fixed or permanent without the intervention of other substances; they are opposed to *adjective colours*, which require to be fixed by certain *intermedes*, or substances which have a joint affinity for the colouring matter and the material to be dyed. *See* DYEING and MORDANT.

SU'BSTANTIVE, or NOUN SUBSTANTIVE. In Grammar, that part of speech which denotes a *substance* or *subject*, as distinguished from an *attribute* or *predicate*. *See* GRAMMAR.

SUBSTITU'TION, is defined by writers on the Civil Law to be the designation of a second, third, or other heir, to enjoy, in default of a former heir, or after him. Taken in this general sense, it includes all those modes of disposition which are expressed in our law by the

terms *entail*, *remainder*, *executory devise*, &c. Substitutions were of two classes: 1. *Vulgar* or common, by which a testator named a second devisee to receive the succession, if the first were unable or unwilling to do so; 2. Fidei-commissary, in which the second devisee was named to receive the succession *after* the first. *See* FIDEI-COMMISSUM.

SUBSTITUTION, in the language of Algebra, signifies the replacing of one quantity by another which is equal to it, but differently expressed.

SUBSTITUTION, CHORD OF. In Music, a name given to the chords of the ninth major and minor.

SUBSTRA'TUM. A stratum lying under another. The term *subsoil* is generally applied to the matters which intervene between the surface soils and the rocks on which they rest; thus clay is the common substratum or subsoil of gravel.

SU'BSTYLE, in Dialling, is the straight line formed by the intersection of the face of the dial with the perpendicular plane which passes through the gnomon. *See* DIAL.

SUBTA'NGENT, in Geometry, is the part of the axis of a curve intercepted between the tangent and the ordinate. The general expression for the subtangent of any curve whose equation is $y = F\,x$ (y the ordinate being a function of x the absciss) is $y\dfrac{dx}{dy}$.

SUBTE'NSE. (Lat. sub and tensus.) A term sometimes used in Trigonometry to denote the chord of an arc. *See* CHORD.

SUBTRA'CTION. (Lat. subtraho, *I draw away*.) In Arithmetic, the taking of one number or quantity from another in order to find their difference. The operation is precisely the reverse of addition.

SUBU'LICORNS, *Subulicornes*. (Lat. subula, *an awl*; cornu, *a horn*.) The name of a family of Neuropterous insects, including those which have awl-shaped antennæ.

SUBU'LIPALPS, *Subulipalpi*. (Lat. subula, and palpus, *a feeler*.) The name of a section of Caraboid beetles, including those which have the exterior palps or feelers awl-shaped.

SUCCEDA'NEUM. A medicine or remedy substituted for another.

SUCCE'SSION, APOSTO'LICAL. In Theology. By these words is meant the uninterrupted succession of priests in the church by regular ordination, from the first commission given by our Saviour to the Apostles, and recorded in the Gospels, down to the present day. And the doctrine of "the apostolical succession," as it is popularly called, means the belief that the clergy so regularly ordained have a commission from God to preach the gospel, administer the sacraments, and guide the church; that through their ministration only we can derive the grace which is communicated by the sacraments. It follows, of course, that those sects of Christians which have no regular succession (having seceded from Romanism without retaining ministers regularly ordained, or having subsequently interrupted the succession, that is, all Protestant bodies, except the church of England) have, properly speaking, neither church nor sacraments, since they possess no apostolical authority.

This doctrine was, by admission on all hands, of very great antiquity in the church; but whether that antiquity is primitive or not, is matter of discussion at the present day. The arguments from Scripture cannot alone be relied upon by either party. As to the historical part of the question, those Epistles of Ignatius which the learned have in the most part agreed to regard as genuine (commonly called the Greater), are much referred to by the maintainers of the doctrine in support of it. They do not, indeed, declare it in express terms; but the strict and repeated injunctions to honour and obey the bishop and presbytery, together with some insulated expressions (such as, "If a man be not within the altar, he faileth of the bread of God," &c.), have been thought important in the controversy; and, as Mr. Keble observes, "the discovery of those remains probably lent considerable force to the course of opinions among the clergy of England in favour of the doctrine in the 17th century."

At the Reformation it was almost entirely lost sight of; and that the succession was actually preserved in England is rather owing (humanly speaking) to political causes than to any deliberate intention on the part of the then leaders of the church. In fact, the Romanists contest the validity of English ordinations, partly on the ground that the succession was actually interrupted at the accession of Elizabeth; but there is no need to discuss an historical question on which there seems to be no substantial doubt whatever. The church of England does not affirm the doctrine in her articles; and the language of art. 19., although not excluding it, is plainly not such as would have been used by framers who wished to inculcate it. Many expressions of her services, borrowed as they are from ancient liturgies, more or less distinctly point towards it. The first school of Anglican divines did not rely on it in their controversy with Puritanism. They rather rested their argument on the fact, that the church *had* in early times appointed the episcopal government and regular ordination, and that it could not, therefore, be wise or prudent to swerve from it. It was at this point that Hooker took up the subject. Whether he actually held the tenet or no, has been much controverted. His recent editor (Mr. Keble) contends that he did; but, at the same time, admits that there is a marked difference between his language and that of the succeeding school of Laud, Hammond, and Leslie. (Preface to *Hooker*, p. lxxvii.) Under that school, it became the rallying point of high churchmen, and was zealously maintained by the divines of that section of the church down to and long after the Revolution. But since that time, without being renounced, it had certainly long ceased to be brought prominently forward in ecclesiastical controversy, until within the last seven or eight years.

In fact, the opposite ground had been constantly taken by ordinary Protestant reasoners, both in and out of this country, in their contests with the church of Rome. Chillingworth, as is well known, argues against the Romanist tenet, that "succession is a certain and perpetual mark of the true church," by maintaining that it is impossible to prove it; that is, that it is impossible that any individual can feel certain that *his* orders were derived by regular succession from the Apostles. If we assume, with the Romanist, *à priori*, that the church must have regular succession because of Christ's promise to it, then there is no room for such doubts; but if we are endeavouring to insist on the fact of succession as a test of the truth of a church, then it cannot be denied that this argument presents difficulties not easily surmounted.

SUCCESSION, LAW OF. In Political Economy, the law or rule according to which the succession to the property of deceased individuals is regulated. Generally speaking, this law obtains only in cases where a deceased party has died intestate, or in cases where the power of bequeathing property by will is limited by the legislature. It is plain that in cases of intestacy, where the deceased either leaves a number of descendants, or where he leaves no direct descendants, the law, in order to prevent endless disputes and litigation, must interfere to regulate the succession to the property; and it will necessarily follow that the succession will be determined in different countries by local circumstances, depending partly on the peculiar state and institutions of each country, and on the views entertained by its legislators of what is just and proper, and most conducive to the public advantage. Hence it is to no purpose in a matter of this kind to look for any general or fixed principles. The succession to the property of those dying intestate, and the power of bequeathing property by will or testament, depend wholly on the rules and regulations enacted in each country; and these necessarily vary with the varying circumstances of different countries and conditions of society.

In most countries a preference has been given, in regulating the succession to property vacant by intestacy, and in defining the power to leave property by will, in favour of male heirs; and in some countries, and especially in modern times, a marked predilection has been shown in favour of the eldest son, or, as it is usually termed, in favour of the *right of primogeniture*. Among the Jews, the eldest son was entitled to a double share of the paternal inheritance; but among the Greeks, Romans, and our Saxon ancestors, all inheritances, whether consisting of land or moveables, were equally divided, in some cases among all the male children, and in others among all the children, whether male or female. The growth of the feudal system appears, however, to have put an end to this rule of inheritance in most European nations. When titles of nobility were created, it was necessary to limit their descent to the eldest son; and it was also necessary that the estate required to maintain the dignity of the possessor of the title should descend according to the same rule of primogeniture. And even when estates were not held by noble proprietors, various inconveniences were found to result from their partition, in the division of military services; the number of infant tenants incapable of performing any kind of duty; and, more than all the rest (though its importance was the last to be perceived), the injurious influence of the system of equal partition in occasioning the too great subdivision of the land, in emancipating the younger sons from the control of their parents, in tempting them to remain at home and to indulge in the pleasures and idleness of a country life, and lastly, in overspreading the country with a proud and a beggarly gentry. In consequence, the old rule of succession to landed property was changed in most countries; and in England, except in Kent and a few other places, when a person dies intestate his estate descends entire to his eldest son. And it will be afterwards seen, notwithstanding the statements of Adam

Smith and others to the contrary, that this rule, though not without its disadvantages, is, on the whole, the best that can be devised.

Females being incapable of performing any personal feudal service, it is the common rule, when a person seised of an estate dies intestate leaving only daughters, that they should succeed as co-heiresses. Such is the law of England; and, when thus limited, little harm can ensue from the subdivision that is thus occasioned.

It has, speaking generally, been the usual practice in cases of intestacy to divide the money or other moveable property in equal portions among the children or kinsmen of the deceased, without respect to sex or seniority. This, however, though a general, is by no means to be regarded as a constant rule. Thus, in the case of the Jews, daughters were excluded from all participation in the inheritance, and, apparently, were left to depend on the bounty of their father's heirs. (Michaelis, *Law of Moses*, i. 420.) In Athens, also, daughters inherited nothing when there were sons alive; and when there was no son, and a daughter succeeded to the inheritance, she was bound to marry her nearest relation, so that the property might not be taken out of the family. (Michaelis, *ubi suprà.*) In Rome, however, all sorts of property were divided equally between sons and daughters. And as the inconveniences found to result in modern times from the splitting of landed property do not follow at all, or in anything like the same degree, from the subdivision of moveable property, it is the practice in this and most modern countries to admit females of the same propinquity to share in the succession to such property, when left intestate, equally with males, excluding all preference on account of primogeniture.

These notices, brief and imperfect as they necessarily are, will probably be sufficient to give the reader a general idea of the rules that have been most commonly followed in regulating the succession to property in cases of intestacy, or where there is no power to bequeath property by will or testament. Inasmuch, however, as this power exists to a greater or less extent in most civilized countries, we shall now proceed shortly to state some of the more important principles and limitations that either have been or should be attended to in the construction of such documents.

Bequeathing of Property by Will.—The power of bequeathing property by will or testament (the *libera testamenti factio*) is not usually recognized in the earlier stages of society. A man's property is then, for the most part, divided in equal shares among his children, who succeed to it as matter of right; and in their default it is inherited by his surviving relations, or nearest of kin. But experience begins at length to manifest the inconveniences resulting from the enforcement of this strict rule of succession, and power is, in consequence, given to persons possessed of property to make testaments, or to dispose of a part at least of their personal or real estate by will. At first, however, this power is usually confined within very narrow limits, being in general restricted to the making of alterations in the shares falling to the children or kinsmen of the testator; that is, to the increasing of the portion of some to the diminution of that of others. Thus, in Athens, there was no power to devise property from the natural heirs previously to the age of Solon; and that legislator confined the privilege to those who died without leaving issue. In Rome, three centuries elapsed before a citizen could dispose of his property by a deed *mortis causa*, except in an assembly of the people; and in that case his will, as Montesquieu has remarked, was not really the act of a private individual, but of the legislature. "With us in England, till modern times, a man could only dispose of one third of his moveables from his wife and children; and in general no will was permitted of lands till the reign of Henry VIII., and then only of a certain portion: for it was not till after the Restoration that the power of devising real property became so universal as at present." (*Blackstone*, book ii. cap. i.) In Scotland, down to a comparatively recent period, almost all landed property was inalienable from the lineal heir.

Not only, however, is the power of testators usually augmented as society advances, but in some countries they are permitted to exercise a nearly absolute control over the disposal of their property, and even to bequeath the whole, or the greater part of it, to strangers, to the exclusion of their children and relations, as is substantially the case at this moment in England. This, however, is an extension of the power of bequeathing, as to the policy of which much difference of opinion is entertained. It is contended that no one who has any property to dispose of should be allowed to throw his children destitute upon society; that the fear of total disinheritance should not be rendered an instrument of tyranny in the hand of fathers; and that before allowing a man to leave any portion of his fortune to strangers, he should be compelled to make an adequate provision for the individuals he has been the means of bringing into the world, and to whom, independently altogether of any considerations of personal merit or demerit, he is under the most sacred obligations. But though it must be owned that this is a question of considerable difficulty and nicety, and with respect to which it does not seem possible to come to any conclusion that will not be liable to objections, yet, on the whole, it would seem that the reasoning of those who argue in favour of the unlimited power of bequeathing to strangers is the most satisfactory and convincing; or if any restriction be laid on this, it would appear to be enough to enact that parents possessed of property should be obliged to appropriate a portion thereof sufficient to bring up and educate their children till they come to maturity, or be in a condition to provide for themselves, when all compulsory obligations on the part of the parents should cease. None but the strongest possible reasons can ever justify a legislature in giving their sanction to any measure having a tendency to weaken the spirit of industry and economy in the people. It is plain, however, that if it interfere to regulate the disposal of property, it must unavoidably do this: if it be enacted that how undutifully soever a man's children or relations may have behaved, they shall notwithstanding be entitled to the whole or a certain proportion of his fortune, this will, in the first place, render every one less anxious about the accumulation of that wealth which he is not to be permitted to dispose of at pleasure than he would otherwise be; and, in the second place, the securing of a certain provision to children, independently of their conduct, must in so far render them independent of their parents, and weaken that parental authority, which, though occasionally abused, is yet, in the vast majority of instances, exercised in the mildest and most indulgent manner, and with the best effect. The more, therefore, that this subject is inquired into, the more, we apprehend, it will be found that it is always the safest policy to abstain as much as possible from making the relations of private life the object of legislative enactments. The humanity of the law is but a sorry substitute for parental affection. If children be ordinarily well-behaved; if they be not extremely deficient either in filial affection or common prudence, we have, in the principles and instincts inherent in our nature, a sufficient security that but few parents will be found disposed to leave their property to others to their exclusion. The interference of the legislature in their behalf appears therefore to be, speaking generally, quite unnecessary. In countries like England and Holland, in which the greatest latitude is given to the power of bequeathing, the instances are extremely rare in which an affectionate and dutiful family have suffered from the circumstance of their father being permitted to leave his fortune to strangers; and it would be most impolitic to attempt to obviate an evil of such rare occurrence by exempting children from the constant influence of a salutary check on their vicious propensities, and compelling a man to bestow on profligacy, extravagance, and idleness, that property which is at once the fruit and the appropriate reward of virtue, economy, and industry.

The advantages resulting from the unrestrained power of bequeathing property by will are so striking as hardly to require to be pointed out. Perhaps, however, we may be excused for laying the following passage, from the valuable though little known work of M. Luzac, *De la Richesse de la Hollande*, before the reader. It strongly corroborates what has now been stated. "La liberté de tester, celle de disposer à volonté de ses biens, par un acte de dernière volonté peut encore être mise au nombre des causes, qui ont contribué à animer l'industrie des habitans. Quelque indifférent que l'on soit sur le partage des biens que l'on laisse en mourant, l'idée de pouvoir en faire jouir ceux qu'on veut en gratifier, est sûrement un aiguillon qui doit exciter au travail, ou du moins prévenir qu'on se dégoûte d'accumuler des richesses. Pourquoi travaillerai-je à augmenter ma fortune si je suis obligé de la laisser à ceux qui ne m'en sauront aucun gré, et qui ne la meriteront pas? *La liberté de disposer librement de ses biens par testament, est peut-être la principale cause que les fortunes des particuliers sont plus considérables en Hollande que par tout ailleurs.*" (i. 304.)

Entails.—The recognition of the right to bequeath property to any particular heir has, in several countries, been followed by an acknowledgment of the right of the proprietor of an estate to name an indefinite series of heirs, and to prescribe the conditions on which they shall be entitled to hold the property. This right is founded by lawyers on the maxim of the civil law, that every one has the absolute disposal of his own property: *unusquisque est rei suæ moderator et arbiter*. This, however, is not a natural but a civil right; and it is not to be judged of by referring to abstract or imaginary principles, but by its practical operation and real influence over the condition and interests of society. To enter fully into an examination of the advantages and disadvantages incident to the practice of entailing, would far exceed the narrow limits within which an article of this description must be confined; but we may, notwithstanding, glance at one

or two of the principal topics that should be attended to in forming a correct conclusion as to the influence of entails.

In the first place, it is alleged in their favour that they stimulate exertion and economy; that they hold out to honest industry and ambition the strongest and safest excitement, in the prospect of founding an imperishable name and a powerful family, and of being remembered and venerated by endless generations as their chief and benefactor; and, in the second place, it is said that entails form the only solid bulwark of a respectable aristocracy, and prevent generations from being ruined by the folly or misfortunes of an individual.

Now, it is not to be denied that the prospect of founding a powerful family, and of securing property, accumulated during a course of laborious and successful exertion and economy, from the risk of being squandered by the inconsiderate projects or extravagance of any future individual, must act as a very powerful spur to the industry and ambition of the *original founder* of a family. But here the beneficial influence of the system stops; its operation on the subsequent holders of the property is entirely different. An heir of entail is in a great measure emancipated from the influence of parental authority; his chance of succeeding to the property of his ancestors does not depend on the circumstance of his having deserved it, of his being industrious or idle, dissipated or sober. The succession to entailed estates is not regulated by the principle of *detur digniori.* Their occupiers have no power to change the established order of succession; they cannot exclude the worst to make room for the best of their descendants, but must submit to see the properties of which they are in possession descend, as, in fact, they not unfrequently do, to the most worthless and undutiful of their children or relations. Granting, therefore, that the institution of entails has a tendency, as it undoubtedly has, to make *one generation* active, frugal, and industrious, it is clear to demonstration that it must exempt every succeeding generation, that is, every succeeding heir of entail, from feeling the full force of some of the most powerful motives to such conduct. A system of entail makes the succession to property depend, not on the good or bad conduct of the individual, but on the terms of a deed written a couple of centuries, perhaps, before he was in existence. Its effect is, therefore, to substitute a species of fatalism in the place of an enlightened discrimination, to throw property indifferently into the hands of the undeserving and the deserving; and it is plainly impossible it can do this without weakening the motives which stimulate men to act the part of good citizens, and strengthening those of an opposite description. When, therefore, we refer, as we ought, to the decisive criterion of public utility, it is immediately seen that the industry of *one* generation is not to be purchased by the idleness of *all* that are to come after it; and that it is not much less injurious to allow an individual to appoint his remotest heirs, than it would be to deprive him of the power of nominating his immediate successors.

As to the second point, there can be no doubt that a system of entail affords the best attainable security for the permanence of property in particular families; and as individuals possessed of property act, generally speaking, with more independence, and are less liable to be biassed by purely selfish considerations than those who are comparatively poor, it would seem that the privilege of executing a perpetual entail of a certain amount of property might, with propriety, be allowed to noble families. Indeed, we are disposed to think that in the case of such families it would be advantageous to carry this principle a good deal farther; and that no individual should be advanced to the peerage unless he were able to establish a *majorat*, or to entail such an extent of landed property on the heirs of the title as might be sufficient to secure them, supposing they acted with ordinary prudence, from falling into a state of poverty, and becoming mere dependents on the crown. But though the power of entailing were conceded to noble families vested with the prerogative of hereditary legislation, it might be confined within certain limits, and made to vary with the entailer's rank in the peerage. Neither is there the shadow of a reason, on political grounds, for conceding this power to others. A system of perpetual entail is, in a general point of view, certainly injurious; and though constitutional considerations may require the privilege to be granted, under proper modifications, to a particular class, they can never require that it should be granted to all. It is not possible to interfere to protect the families of the commons from the casualties to which they are subject, by sanctioning a system of perpetual entail, without producing mischievous results. It is the duty of government to adopt such regulations as may most effectually call forth industry and economy among all classes of its subjects; but it is no part of its duty to inquire whether the frugality of those on the box, and the extravagance of those in the coach, bid fair to make them change places; and still less to attempt to prevent it by throwing artificial ramparts round the property of the latter.

In Scotland the practice of entailing has been carried to a very great extent, and in some counties hardly an acre of land is now to be met with that is not burdened with the fetters of a perpetual entail, chalking out an endless succession of heirs. Latterly, indeed, the system has been so far modified by the interference of the legislature, that money is allowed to be be raised on the security of entailed estates for the effecting of necessary improvements, and certain provisions may made for widows and younger children. In consequence of these modifications, and of the abolition of the practice of letting entailed lands by fine, the practice is by no means so injurious as has been supposed, and as it has been frequently represented. Still, however, there can be no doubt of its extreme inexpediency in a public point of view; though, owing to the number of third parties interested in the succession to entailed estates, the question as to the abolition of entails is one of the greatest difficulty.

In England, on the other hand, it seems as if the legislature had hit the happy medium between giving too much and too little power to those who have accumulated property over its disposal by will. An English gentleman may entail an estate on such heirs as are in existence when the deed is executed, or till the first unborn heir be 21 years of age; but here the destination stops, and the heir in possession has then the absolute disposal of the property. This gives to every one that degree of power over his property which is required to inspire him with the desire of accumulating a fortune; at the same time that it takes from him the power of legislating for future ages, or of creating rules to be obeyed in all time to come.

French Law of Succession.—We have already seen that it has been the practice in most countries, as society advanced, to relax the restraints imposed in early and less enlightened ages on the bequeathing of property by will. But the modern legislators of France have followed a different course, and have confined the power of testators within the narrowest limits. They have, in fact, gone far to make that rule of the Roman law, as to equal partition among all the children, that obtained in cases of intestacy, the imperative rule of succession to all property, whether landed or moveable.

According to the new French law, a person with one child may dispose at pleasure of a moiety of his property, the child inheriting the other moiety as matter of right; a person having two children is only allowed the absolute disposal of a third part of his property; and those having more than two must divide three fourths of their property equally amongst them, one fourth part only being left at their own disposal. The property of those dying intestate is equally divided amongst their descendants, without respect of sex or seniority.

This law was intended to subvert the foundations of that feudal aristocracy whose ascendency had been very prejudicial to France; and as the influence of an aristocracy must always be mainly dependent on the magnitude of their property, it was certainly well fitted to accomplish its object. It is seldom, however, that a law adapted to a particular emergency may be maintained with advantage as a general rule of national policy; and it would be singular were a device originally fallen upon for the express purpose of splitting estates found beneficial for regulating the succession to property in a great kingdom. Considered in a general point of view, this law seems infinitely more objectionable than a system of perpetual entail. By interfering to so extreme an extent in the disposal of a man's property, it must plainly lessen the motives to accumulation; while, by rendering all the children in a great measure independent, it weakens the parental authority, and has the same injurious operation in reference to an entire family that the law of entail has in reference to a single child. When the property of the father must be divided, all his descendants are aware, from their earliest infancy, that they are, without any peculiar merit or exertion on their part, to obtain a certain provision; and can any one doubt that this sort of certainty must tend to paralyse their efforts, and to render the younger children at least less enterprising than they would be, did they know that their condition in society was to depend principally on themselves, and that they had no security, other than their own deserts, for obtaining any thing from their parents? But even these do not seem to be its worst effects. The inevitable tendency of this, and of every similar system, is to occasion too great an increase of agricultural population; at the same time that it operates to reduce landed property into such minute portions as neither to afford sufficient employment to the families occupying them, nor to allow of their being cultivated and improved in the best and most efficient manner. The strong predilection entertained by the great bulk of the children of persons engaged in the business of agriculture for the pursuits of their fathers has been remarked by every

one in any degree familiar with rural affairs; and it is obvious that the existence of a law making the division of estates compulsory affords the greatest facilities for gratifying this inclination. It will give to many, who might otherwise have been obliged to emigrate, or to resort to some other employment, the power of continuing in that line of life in which they have been educated, and which is endeared to them by those early associations that exert so strong an influence over future conduct. Should a family be unusually large, or should the share of the paternal property falling to each of the children be insufficient to enable them to maintain themselves in nearly the same class as their father, some of the more adventurous spirits will probably be disposed to sell their portion, and to engage in other pursuits. But experience shows that, in the great majority of cases, they continue to reside on the little properties obtained from their ancestors; and the fair presumption seems to be, that the process of division and subdivision will continue, until the whole land has been parcelled out into patches, and filled with an agricultural population, destitute alike of the means and the desire of rising in the world.

It is no doubt true that the condition of the agriculturists of France, at this moment, is decidedly superior to what it was previously to the Revolution. But it cannot be truly affirmed that this improvement has been in any respect owing to the law of equal inheritance. It has taken place, not in consequence of that law, but in despite of it. The abolition of the feudal privileges of the nobility and clergy, and of the gabelle, corvées, and other oppressive and partial burdens and imposts, was of the greatest service to proprietors and farmers; and, in addition to these advantages, a great part of the property of the church and of the emigrants came into their hands at very low prices; so that small properties were augmented, and fresh energy given to agricultural pursuits. Still, however, it is certain that the rapid subdivision of landed property, and the continually increasing excess of the agricultural population, caused by the law of compulsory succession, have gone far to neutralize the effects of these advantageous circumstances, and form at this moment one of the most deeply-seated evils in the social condition of the people of France.

In every respect, therefore, this law would seem to be most inexpedient; and certainly the experience of France does not tend in any respect to shake our belief in the wisdom of those who contend that the interference of the legislature in respect to wills should, in all ordinary cases, be confined within the narrowest limits; and that in this, as in most other things, their object should rather be to prevent abuses, than to enact rules for the guidance of individuals in the distribution of their property under ordinary circumstances.

Bequeathing of Property for Charitable Purposes. — In the article FOUNDATIONS in this work, we have briefly glanced at some of the more prominent considerations that should be attended to in the endowment of hospitals, and in the appropriation of property for purposes of public utility. No doubt it is of the greatest importance, in a national point of view, that property should be bequeathed for such objects; and it would be easy to show that England has derived, and is deriving, the greatest advantage from the bequests of private individuals for the promotion of education, the support of the poor, and other charitable purposes. Still, however, it seems abundantly obvious that such bequests should in all cases be subject to the control of the state. It is difficult indeed, or rather impossible perhaps, to define, *à priori*, how far interference should be carried in such cases; but that, speaking generally, it is indispensable even to the proper carrying out of the views of the testators, is abundantly obvious.

To regard the instructions in the wills of those who have established foundations as immutable laws, which are in no case to be altered, is, in truth, to permit the ignorance, folly, or presumption of an individual to become a standard for all future ages, and to regulate the studies and the institutions of a more advanced and enlightened period by his crude conceptions and views. Surely, however, it is needless to say, that no select number of men, and still less individuals, should be allowed to erect themselves into infallible legislators for every succeeding generation. The regulations of the great Alfred and the other benevolent individuals who founded the Universities of Oxford and Cambridge may have been excellent at the time when they were framed; but had they been strictly adhered to, their chairs must now have been filled with Aristotelian doctors, and lecturers on the Ptolemaic system of the world and the infallibility of the Pope!

It is impossible to doubt the pious and benevolent views of many of those who, in the middle ages, left their property to monastic institutions; but still less is it possible to hesitate applauding the conduct of the reformers, who diverted this property to other purposes, and who justly considered that the terms of a will dictated in a comparatively barbarous period should not be permitted to consecrate and hallow a system which had been discovered to be most inimical to the interests of true religion, and productive only of injurious consequences.

The establishment of foundling hospitals is another instance of the same kind. They were projected, and have been kept up, with the best intentions; but it admits of demonstration, and is now, indeed, generally admitted, that they have been productive of an incomparably greater amount of crime and of mortality than they have obviated.

Even as respects the educational foundations established in many parts of England, no one can doubt that their utility is in very many instances greatly narrowed, and in not a few wholly nullified, by the injudicious rules laid down for their government; and, in fact, there is nothing that stands in greater need of revision and amendment than the constitution and administration of foundations.

SUCCE'SSION. In Civil Law. In that jurisprudence, and those modern systems which are derived from it, there is no distinction between moveable and immoveable property, considered as a subject of succession. Succession, whether of real or personal property, is either *ab intestato*, or by testament. The order of succession ab intestato, according to the civil law (*see* DESCENT), is to be found in the laws of Justinian (*Novell*, 118. 127, &c.). It admits three classes of successors, — descendants, ascendants, and collaterals, who are preferred in that order in the succession; so that if a man leave any descendants, all ascendants and collaterals are excluded; and ascendants exclude collaterals, except brothers of the whole blood and their children. The children of the deceased partake equally. Stepchildren are strangers to the succession of their step-parents. Children, the issue of several marriages, succeed equally to the property of their father; but severally to the property of their respective mothers. Grandchildren take *per stirpes*, or by right of representation; *i. e.* if a child die in the parent's lifetime, his children divide his share equally. Among descendants, he or she of the nearest degree is preferred, and there is no right of representation. Brothers and brothers' children per stirpes divide with parents; but it is doubtful whether or no more distant ascendants divide with them. Succession among collaterals is said not to extend beyond the 10th degree. The wife (by *Novell*, 53. c. 6.) succeeds, under certain circumstances, to a fourth.

SUCCI'NEA. (Lat. succinum, *amber.*) A genus of freshwater Gastropods, so called from the transparent texture and amber colour of the shell. Of this genus two species (*Succinea amphibia*, Drass., and *Suc. oblonga*) are British, and to be found occasionally in the river Wandle, and in Greenwich marshes.

SU'CCINIC ACID. (Lat. succinum.) An acid obtained among the products of the destructive distillation of amber; when pure it is a white crystalline substance. Its salts are termed *succinates;* of these the *succinate of ammonia* is occasionally used as a test for iron. It precipitates the peroxide of that metal in the form of a brown insoluble succinate.

SU'CCINITE. (Lat. succinum.) An amber-coloured garnet.

SUCKING PUMP, or SUCTION PUMP. The common construction of the pump, in which the two valves open upwards. *See* PUMP.

SUCTO'RIANS, *Suctorii.* (Lat. sugo, *I suck.*) The name of a tribe of Cartilaginous fishes, comprehending those which, like the lamprey, have a circular mouth adapted for suction.

SU'ET. The fat situated about the loins and kidneys, which is harder and less fusible than that from other parts of the same animal. That of the ox and sheep is chiefly used; and when melted out of its containing membranes it forms tallow, and is largely used in the manufacture of candles and the ordinary soaps. Beef and mutton suet, when fused, concrete at a temperature of about 100. Like other kinds of fat, it is a compound of carbon, oxygen, and hydrogen.

SUFFE'TES. (Said to be from the Phœnic. schopetim.) Certain Carthaginian magistrates, whose office bore considerable analogy to that of the Spartan kings and Roman consuls. Their number was two, and they were elected annually from the noblest families of the state. The functions of the suffetes seem principally to have been confined to the management of civil affairs. Thus it was their province to assemble the senate and preside in it, and also to propose the subjects of debate, and collect the votes; but there are instances recorded of suffetes leading the armies of their country. All the cities of note in the Carthaginian dominions had likewise their suffetes; but these, of course, were invested merely with municipal authority. (See *Mém. de l'Ac. des Inscr.* vols. xxxiv. xxxviii.)

SU'FFRAGAN. In Ecclesiastical Usage, every bishop is said to be suffragan, relatively to the archbishop of his province; thus the bishop of Carlisle is suffragan to the

archbishop of York, &c., either on account of the suffrages given by them in the provincial synods, or because they cannot be consecrated without the *suffrage* or consent of the archbishop. Titular bishops, ordained to assist a bishop in his spiritual functions, are also commonly, but rather improperly, styled suffragans; a title adopted by the stat. 26 H. 8. c. 14.

SU'FFRAGE. *See* PARLIAMENT.

SUFFRAGO. (Lat. suffrago, *the pastern.*) In Mammalogy and Ornithology, the joint of the tibia with the tarsus.

SUFFRU'TICOSE. (Lat. suffrutex, *an undershrub.*) Any plant which is not exactly either a shrub or an herbaceous plant; that is, which has not hard woody twigs and complete buds like the one, nor perishable succulent twigs like the other. Lavender is an instance of a suffruticose plant.

SU'GAR. (Fr. sucre, Germ. zucker.) The great commercial demand for sugar is almost exclusively supplied from the sugar cane (*Arundo saccharifera*), which contains it in greater quantity and purity than any other plant, and consequently affords the greatest facilities for its extraction. A large quantity of sugar is contained in the sap of the American maple (*Acer saccharinum*), and in the juice of the beet-root (*Beta vulgaris*), from both of which it may be economically obtained; it has also been extracted from grapes or raisins, and, as is well known, is contained abundantly in many ripe fruits and esculent vegetables. It is, however, in these, seldom so pure or in such quantity as to admit of ready separation.

The process, as carried on in our West India islands, consists in pressing out the juice by rolling mills, and carefully evaporating it till it has acquired the proper consistency for crystallizing; lime water is added during this operation, to neutralize any free acid, and to facilitate the separation of certain vegetable matters, which, in consequence of the action of the lime, rise more readily to the surface, and admit of being skimmed off. When duly concentrated, the syrup is run off into shallow wooden coolers, where it concretes; it is then put into barrels with holes in the bottom, through which a quantity of treacle or molasses gradually drips, and the remaining sugar acquires the granular crystalline state; it is packed into hogsheads, and comes to us under the name of *raw* or muscovado sugar. The following is a sketch of the process by which raw sugar is purified in this country. Raw sugar is chosen by the refiner by the sharpness and brightness of its grain; it is put into a copper pan or boiler, previously charged with a certain quantity of lime water, with which a portion of bullocks' blood has been well mixed by agitation, and is suffered to stand a night to dissolve. Early in the morning fires are lighted under the pans, and when the liquid boils the coagulated albumen of the blood rises to the surface and carries the impurities of the sugar with it. The liquid is kept gently simmering, and continually skimmed, till a small quantity, taken out in a metal spoon, appears perfectly transparent: this generally takes from four to five hours. The clear syrup is then run off into a cistern; the pans are reduced to half their former size, by taking off a moveable front, and a smaller portion of the purified syrup returned into each; the fires are now increased, and the sugar made to boil as rapidly as possible, till a small quantity taken on the thumb is capable of being drawn into threads by the fore-finger; the fire is then damped, and the boiling syrup carried off in basins to the *coolers;* a fresh quantity is then pumped into the pans and evaporated as before. In the coolers the sugar is violently agitated with wooden oars till it appears granulated. It is upon this agitation that the whiteness and fineness of grain in the refined sugar principally depend; the crystals are thus broken down whilst forming, and the whole converted into a granular mass, which permits the coloured liquid saccharine matter to run off, and which would be combined with the solid if it were suffered to form into larger crystals. This granular texture likewise facilitates the percolation of water through the loaves in the after process, which washes the minutely divided crystals from all remaining tinge of molasses. That this is the real theory of the whitening of sugar by the process of refining appears from a comparison with the process for making *sugar candy.* In this the raw material is cleared and boiled as above; but instead of being put into coolers and agitated, it is poured into pans, across which threads are strung, to which the crystals attach themselves; these are set in a stove, and great care is taken not to disturb the liquid, as upon this depends the largeness and beauty of the candy. In this state it is left for five or six days exposed to a heat of about 95°; when it is taken out and washed with lime water. This takes off the molasses from the outside; but a great quantity is combined in the crystal, and the consequence is that candy is never whiter than the sugar it is made from. When the sugar has attained the granular state in the coolers, as above described, it is poured into conical earthen moulds, which have been previously soaked a night in water; in these it is again stirred, for the purpose of extricating the air-bubbles, which would otherwise adhere to the surface and render it rough; when sufficiently cold, the loaves are carried to some of the upper floors of the manufactory, and the paper covers being removed from their points, they are set with their broad ends upward upon earthen pots. The first portions of the liquid molasses soon run down, and leave the sugar much whitened by the separation; afterwards, pipe-clay mixed with water to the consistence of cream is put upon the base of the loaves to the thickness of about an inch; the water from this clay gradually filters through the loaf, and carrying with it all remaining tinge of molasses, runs into the pot, the clay being of no other use than to retain the water and prevent its too rapid percolation, by which too much of the solid sugar would be dissolved. This process, called *claying*, is repeated four or five times, according to the nature of the sugar and the degree to which it has been boiled. When the loaves are thus cleansed from all relics of colour they are suffered to remain some time for the water to drain off; when this is completed, they are set with their points upwards, when all remains of it are equally diffused throughout; they are then *stove-dried* at a temperature between 95 and 100. The syrup, or drainings collected in the pots, is mixed with the raw sugar in the next boilings: it is divided according to its fineness; the first runnings, which are the foulest, being reserved for the coarsest loaves; while the last, being little else than clear syrup, is boiled into loaves of the same fineness as those from which it ran. The lowest syrups are boiled into what is called *bastard sugar*, from which the molasses runs with very little mixture of solid sugar: this it is which is sold under the name of *treacle*, being quite incapable of further crystallization. The average produce of 100 cwt. of raw sugar treated as above is 63 lbs. of refined, 18 of bastard, 27 of molasses, 4 loss in dirt, &c.

Mr. Howard, in his patent process for the refining of sugar, introduced a variety of modifications and improvements, the principal of which depended upon boiling under diminished atmospheric pressure, so that no part of the syrup was liable to be burned or otherwise injured by heat; he also employed recently precipitated aluminous earth to abstract part of the colouring matter; well-burned charcoal, especially animal charcoal, has been found very serviceable for the latter purpose, and a number of other improvements in and modifications of the process of refining have more lately been adopted.

The chemical characters of sugar are well defined, especially those of the crystallizable or cane sugar. Its specific gravity is about 1·6. It dissolves in all proportions in water, is less soluble in alcohol, and is recognized by its purely sweet taste. It is blackened by sulphuric acid; and when about one part of this acid is added to two of thick syrup, the mixture presently boils up into a black frothy mass, which is little else than carbon, acid, and water. In respect to ultimate composition, sugar belongs to that important class of proximate vegetable principles which are theoretically regarded as compounds of carbon and water; that is, of carbon and of oxygen and hydrogen, in the same relative proportions as they exist in water. The following shows the results of Dr. Prout's analysis of the finest loaf sugar in a dry and pure state, with its probable atomic constitution:—

	Atoms.	Equiv.	Theory.	Expt.
Carbon -	- 9	54	42·86	42·85
Hydrogen -	- 8	8	6·35	6·35
Oxygen -	- 8	64	50·79	50·80
	1	126	100·00	100·00

Several other varieties of sugar have been chemically examined; such as grape sugar, honey sugar, mushroom sugar, manna liquorice sugar, &c.

Consumption and Supply. — Sugar is to be ranked rather as a necessary than as the most desirable of luxuries; and a larger sum is, we believe, expended on sugar in this country than on anything else, excepting corn and butcher's meat. The sugar consumed in England is all derived from the *Arundo saccharifera*, or sugar cane, and was, for a lengthened period, almost wholly supplied by our colonies in the West Indies; but latterly we have derived very extensive supplies from the Mauritius and India. Foreign sugar is virtually excluded from our markets by the prohibitory duty with which it is loaded.

Besides the West Indies, South America, especially Brazil, the East Indies, the Mauritius, Java, Siam, the Philippine Islands, &c. are the countries which export by far the largest supplies of cane sugar, though it either is or may be produced in most tropical countries, and it is also cultivated to some extent in some countries within the temperate zone. During the last war, when the nations of the Continent experienced very great difficulty in getting supplies of sugar from tropical countries, attempts were made to raise it at home from beet-root; and this sugar being exempted from the heavy duty laid on colonial sugar, its culture has latterly

been very greatly extended, especially in France. But the general opinion seems to be, that were beet-root sugar subjected to the same duty as colonial sugar, its culture would have to be abandoned. We subjoin

An ACCOUNT of the Quantities of the different Descriptions of Sugar entered for Consumption in the United Kingdom during each of the Eleven Years ending with 1840; with an Account of the Amount of Duty received on the same, the average Price of Muscovado Sugar in Bond, &c.

Years.	Quantities entered for Consumption.				Nett Revenue from Duties on Sugar.	Average Prices of British Muscovado Sugar.
	British Plantation (incl. Mauritius).	East India.	Foreign.	Total.		
	Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*L.*	*L. s. d.*
1830	3,590,041	131,979	24	3,722,044	4,767,342	1 4 11 per cwt.
1831	3,667,396	113,536	79	3,781,011	4,650,590	1 3 8 —
1832	3,575,329	79,600	605	3,655,534	4,394,338	1 7 8 —
1833	3,553,450	98,283	71	3,651,804	4,414,302	1 9 8 —
1834	3,620,522	121,007	50	3,741,579	4,559,392	1 9 5 —
1835	3,757,851	98,680	31	3,856,562	4,667,900	1 13 5 —
1836	3,378,144	110,222	33	3,488,399	4,184,165	2 0 10 —
1837	3,684,712	270,055	43	3,954,810	4,760,565	1 14 7 —
1838	3,491,225	418,375	65	3,909,665	4,656,891	1 13 8 —
1939	3,348,298	477,252	49	3,825,599	4,586,936	1 19 2 —
1840	3,074,198	518,320	2316	3,594,834	4,449,070	2 9 1 —

	L.	s.	d.	
Duty on British plantation and Mauritius sugar from 1830 to 1840	1	4	0	per cwt.
Duty on East Indian sugar from 1830 to 13th of August, 1835	1	12	0	—
Duty on ditto of any British possession within the limits of the East India Company's charter into which the importation of foreign sugar is prohibited, and imported from thence from 13th of August, 1835, to 1840	1	4	0	—
Duty on ditto of any other British possession within those limits, and imported from thence from 13th of August, 1835, to 1840	1	12	0	—
Duty on foreign sugar from 1830 to 1840	3	3	0	—

Additional 5 per cent. on the above rates from 16th of May, 1840.

SU'ICIDE, or SELF-MURDER. (Lat. suicidium.) Few chapters in the history of the human mind are more singular than that of suicide, as showing the kind of honour and estimation which a practice so unnatural has attained in the feelings of many nations. The rank which religious suicide has held from immemorial antiquity, and still holds, in the opinion of the Hindoos, has been too often described, and is too familiar in its most notorious and painful instances, to need more than adverting to on the present occasion. It is said that the practice is condemned by their older books; if so, the traditionary sentiments of the people have been formed on some different model. The suicides of the Hindoos have proceeded partly from fanaticism, partly from an apathetic philosophy; those of the ancient Scandinavians, esteemed equally honourable, from the overflow of courage in warriors, who could endure any evil except the approach of helpless and unwarlike old age.

Among the Greeks, the first inquirers who reasoned out the principles of human life and action by a train of philosophical investigation, singularly vague and discrepant opinions on this subject seem to have prevailed; as might have been expected from a people to whom religion furnished so very few fixed data of reasoning, and by whom abstract truth was pursued with such unequalled ingenuity and earnestness. Socrates, the great master of ethics, was emphatic in his condemnation of suicide. Plato speaks in a more dubious strain: writing as a lawgiver, he reprobates it; and in his arguments on the subject is to be found the well-known illustration which has figured ever since in all such discussions, in which he compares it to the desertion by a soldier of his post; yet he expressly excepts from his censure those cases in which it is committed under the pressure of immitigable calamity. Pythagoras, at an earlier period, denied its lawfulness. (See *Athenæus*, l. iv.) In the later days of Greek philosophy, both Stoics and Epicureans found arguments for its defence in their respective principles. The former sect was most notorious for its tenets on this subject; Zeno and Cleanthes, its great masters, having both put an end to their own lives, as Democritus had done before them, from the mere tedium of old age.

Cum jam matura vetustas
Admonuit memorem motus languescere mentis,
Sponte suâ letho caput obvius obtulit ipse.

The argument of an Epicurean philosopher on the topic may be collected from *Cic. Tusc. Disp.* v. 41.; and, indeed, may be compressed in the pithy Greek motto for a drinking party, 'Η πῖθι, ἢ ἄπιθι — *drink, or begone.* "Stoical academics" (says Dr. Moore in his *Essay on Suicide*, i. 233.), "if such an expression be warrantable, would plead a dismission whenever their diginity was affronted or their glory diminished; whilst Epicurean academics would care nothing about such matters, as long as their personal indolence and tranquillity were not superseded." The influence of Greek philosophy had, as is well known, a great share in producing that tendency to suicide which distinguished the higher society of Rome in the later days of the commonwealth. The "Roman death," as it is emphatically called, was not really a national habit; the older manners of the commonwealth repudiated it; its prevalence was owing to foreign doctrines, acting on minds affected by the violent passions, engrossing luxuries, and rapid vicissitudes of fortune which distinguished that momentous era. Virgil returns to the Pythagorean view; and, without inveighing against suicide, represents it as a sad and mournful death, the perpetrators of which are doomed to a long and shadowy existence, — without torment, but without enjoyment; one which they would willingly exchange for the bitterest poverty and labour in the cheerful light of day. Perhaps the courtier-poet was a little affected by the feelings of those in power, who loved to have contented, orderly, and not too irritable subjects, and disliked the fashion among the noble Romans of escaping in this manner from tyranny and persecution. At a later period suicide committed by criminals under accusation was made criminal by the Roman law. This was with a view to preserve the forfeiture of the criminal's property to the government. Suicide, as such, does not seem to have been the subject of legislation.

Although Christianity was not slow in effecting a reform in the feelings of mankind on this important subject, yet some relics of the ancient sentiments lingered awhile, even in the minds of enlightened believers. The fanatical Donatists were greatly addicted to suicide, and are justly condemned on this account among others by the early writers of the church. Nor did these latter ever esteem suicide lawful, even under the severe persecutions to which the church was subjected, except perhaps in one case — when committed by virgins to preserve their chastity. The cherished sentiments of the fathers of the church on this subject rendered them not only lenient to such victims of honour, but some of them have even gone so far as to commend them. Augustine, with his usual strong sense of moral right, only pities them; and expressly classes all suicide as homicide. (*De Civ. Dei*, l. i. c. 19.) There was, at an early period, no commemoration for the souls of suicides in the early church. And the council of Bracara, A. D. 563, refused them Christian burial; a measure which has been pretty generally adopted throughout Christendom.

There have been a few paradoxical writers who have contended in favour of the lawfulness of suicide, arguing on Christian premises. In *Hume's Essay on Suicide* this ground is taken, with the author's usual adroitness in pointing out supposed deficiencies in the scheme of Revelation. A more remarkable instance is Dr. Donne's "*βιαθανατος*; or, a declaration of that paradox or thesis, that self-homicide is not so naturally sin that it may never be otherwise." It is remarkable, however, less from the force of the argumentation, than the circumstance that a man of a religious, though eccentric turn of mind, should have defended such positions. Some of his arguments, those derived from the silence of Scripture on the specific subject, have been commonly repeated: others seem very puerile. Those who wish it will find them seriously refuted, at much length, by the painstaking Dr. Moore, in his *Essay on Suicide*, already quoted, from which we have taken most of this historical sketch. To say the truth, his refutation is in some instances as weak as any part of Donne's paradox.

Among the writings of another class of thinkers, the reasonings *pro* and *con* urged by Rousseau in the *Nouvelle Heloise* are well known. Though there is little convincing in the logic of the antagonist of suicide, yet the side he takes is made to appear the generous and noble one; and in this case, as in several others, Rousseau must be owned to have done service to the cause of morality, considering the incredible influence which he exercised on the fervid heads and hearts of his time. It is remarkable that Lord Edward, in the work above

alluded to, is made to admit one exception in favour of suicide, in the case of acute and irremediable pain. Madame de Staël, in her *Essay on the Influence of the Passions*, advanced a sort of defence of suicide; in her later work (*Reflexions sur le Suicide*, published in 1810) she has enforced the more customary doctrine with much eloquence and feeling. We are not acquainted with the work of the Swedish professor Robeck in defence of suicide (who killed himself after writing it), except through the mention made of it by Dr. Moore and Madame de Staël.

In discussions on the subject of proneness to suicide in particular classes or nations, it is impossible to disconnect it from that of insanity; because the miserable delusions of that disease constantly impel their victim to its commission. In societies, therefore, where insanity is most common, the number of suicides will be greatest. It does not follow that the number of suicides committed by persons not insane will also be greatest in such societies; that is, when we disregard the refinements of those who profess to consider suicide itself as a proof of greater or less derangement of the mental functions. What we mean by the suicide of a sane person is, the suicide of one of whose insanity there is no evidence except such as may be considered to arise from the act itself. Considered in this light, the tendency to deliberate suicide has been almost epidemic in many communities. Nor does it arise from similar causes, or in similar states of society. Among the old Scandinavians, as at this day with some tribes of savages, it was the offspring of the intolerance of fierce dispositions of the helplessness of age and disease. It prevails, too, sometimes in effeminate communities, where there is little zest or excitement in life, with mean habits, little self-respect, and much apathy: thus it is extremely common in China, even, it is said, among the lower classes, notwithstanding the proclamations, full of ethical saws, which the magistrates issue against its commission. Among people of minds thus disposed, the act is generally deliberate, and unconnected with insanity; so, again, where it results from a cold temperament, and a sarcastic and contemptuous view of life, which was the notion formerly entertained by foreigners of the English mania for suicide; a notion which probably had not much foundation in truth at any time. Sixty years ago, Mercier (*Tableau de Paris*, vol. iv.) thought it prevailed less in England than France. At present, in communities civilized on the European model, it would probably be found that the number of suicides was pretty nearly in proportion to that of insane persons, and that the same causes which produce mental disturbance lead likewise to self-murder. Perhaps the principal predisposing influences, as they affect society in the mass, may be reduced to four: — the spirit of mercantile speculation, leading to sudden and overpowering vicissitude of prosperity and want; mental excitement, produced chiefly by misdirected education, literature, and philosophy; absence of self-restraint, especially on religious principles; and intemperance in spirituous liquors. Either of these causes alone may be sufficient: for example, in various parts of northern Germany, and in Geneva, where there is little of commercial movement, and where the body of the people are orderly and well-conducted, suicide is nevertheless extremely common among the educated classes, and may be referred almost wholly to mental excitement. But where they all combine, the effect is fearful; as may be witnessed in the great cities of France and the United States. On the other hand, suicide is rare in nations where fatalism prevails, as among the Turks and Spaniards; in nations in which a love of order is joined with an unrefined mental organization and great love of physical enjoyment, such as the south Germans, and to a certain extent the Italians. The following table exhibits some of the results given by M. Quetelet, from researches extending over a number of years, from 1820 downwards; but we give them, premising our doubt as to the possibility of obtaining accurate returns in many countries.

Number of Suicides annually, compared with the Population.

Russia	1 in 49,182
Austria	— 20,900
France	— 18,000
Pennsylvania	— 15,875
Prussia	— 14,404
New York (State)	— 7,797
City of London	— 5,000
City of Berlin	— 2,941
City of Geneva	— 2,941
City of Paris	— 2,400

With regard to classes, the number of suicides is probably distributed in a pretty equally diminishing proportion from the highest to the lowest: with the exception, however, of crowned heads; for it has been observed that no sovereign, at least in modern times, was ever known to commit self-murder. There is a remarkable paper in the first volume of the *Journal of the London Statistical Society*, showing its prevalence among the military in this city. The suicides in the Dragoon Guards and Dragoons are said to amount to one twentieth of all the deaths; while among the members of the Equitable (to make the comparison with a body of grown-up persons) they are only 1 in 110.

With respect to the causes of suicide, some curious results have been obtained by statisticians; but, in giving them, we must profess our doubts concerning the value of such statements, from the very vague data on which they must necessarily be founded. It appears from a classification of 134 suicides committed in ten years at Geneva (by M. Prevost, in the 15th vol. of the *Annales de Hygiène*), that the following causes produced them: —

Disease	34
Mental alienation	24
Pecuniary misfortunes	19
Domestic "chagrins"	15
Melancholy, cause unknown	13
Misconduct, drunkenness	10
Fear of punishment, remorse	6
"Chagrins" of love	6
Gambling and lotteries	4
Mysticism	2

Comparing these with other accounts, it would seem that love produces at Paris $\frac{1}{26}$ of the suicides committed, at Geneva $\frac{1}{22}$, at Petersburg $\frac{1}{5}$, if Mr. Schön is to be believed; a singular contrast to the commonly supposed effects of climate. Domestic griefs at Paris (from 1794 to 1823), $\frac{1}{9}$; at Geneva the same. Misconduct at Paris $\frac{1}{23}$, at Geneva $\frac{1}{13}$, at Petersburg $\frac{1}{4}$. Gambling at Paris $\frac{1}{43}$, at Geneva $\frac{1}{14}$. Some of these results, in Paris and Geneva, are certainly remarkable for their correspondence. (See an Essay of M. Brouc, in the 16th vol. of the *Annales de Hygiène*, already cited. The reader may consult also M. de Villeneuve Bargemont, *Econ. Politique Chrétienne.*)

The following statement is extracted from the official tables of revenue, trade, and population for 1839: —

Number of suicides in England and Wales during the year ended 30th of June, 1839...Males, 751; Females, 307.

The Ages of 1044 Suicides.

Between the ages of 10 and 15	8
— 15 — 20	73
— 20 — 30	151
— 30 — 40	172
— 40 — 50	217
— 50 — 60	221
— 60 — 70	141
— 70 — 80	54
— 80 — 90	14
— 90	2

From this it appears that the greatest number of suicides (relatively to the numbers living) are between the ages of fifty and sixty (which appears from M. Prevost's calculation to be also the case at Geneva); the tendency to suicide regularly increasing up to the latter age. Between seventy and eighty the number is still very considerable.

The Season of the Year.	Males.	Females.
January, February, March	163	66
April, May, June	210	94
July, August, September	214	73
October, November, December	164	74
	751	308

Thus the proportion of male to female suicides is $2\frac{1}{4}$ to 1; at Geneva exactly the same (95 to 38). The subject must not be dismissed without noticing the great increase of suicide which most observers represent to have taken place in the last twenty years, especially in the large towns of northern Europe. But there must be a certain degree of doubt how much of the apparent increase is owing to more accurate observations.

Suicide is ranked by the English law as a peculiar species of felony; and, like other felonies, cannot be committed by persons under the age of discretion, or insane. From very ancient times (see *Bracton*) the law imposed the forfeiture of personal property as a consequence of it; and a felo de se (as a wilful suicide is termed) forfeits all chattels, real and personal. But the offence was never attended with corruption of blood, or the forfeiture of lands of inheritance; so that the will of a felo de se stands good as to realty. In order to vest these chattels in the crown, the fact of self-murder must be proved by an inquisition, which the coroner is the proper officer to hold. In addition, the law formerly required that a self-murderer should be buried in a highway, with a stake driven through his body. Now, by 4 G. 4. c. 52. his remains are to be privately buried at night in the churchyard. But the canon law (confirmed by the rubric in the Common Prayer Book) forbids the performance of Christian rites over them.

SUIT. In Law, the same as *action;* which see.

SULCATE. (Lat. sulcus, *a furrow.*) In Zoology, when a surface is deeply impressed with longitudinal parallel lines.

SU'LPHATES. Salts containing sulphuric acid; green vitriol is a *sulphate* of the protoxide of iron. Glauber's salt is a *sulphate* of soda.

SU'LPHITES. Salts of the sulphurous acid.

SU'LPHOCYA'NIC ACID. This acid was discovered in 1808, by Mr. Porrett, who ascertained it to be a compound of sulphur, carbon, hydrogen, and nitrogen; he called it *sulphuretted chyazic acid*, the term chyazic being composed of the initials of carbon, hydrogen, and azote. It is best formed by distilling a strong solution of sulphocyanuret of potassium with phosphoric acid, when sulphocyanic, or more properly *hydro-sulphocyanic*, passes over into the recipient, and phosphate of potassa remains in the retort. So obtained, it is a liquid of a slight pink hue, and smells somewhat like vinegar. The strongest solution has a specific gravity of 1·022; boils at 217°, and crystallizes at 55° in six-sided prisms. It gives a very characteristic deep red solution with persalts of iron; with a salt of copper it gives a white precipitate. It is composed of

	Atoms.	Equiv.
Sulphur - - -	2	32
Cyanogen - - -	1	26
Hydrogen - - - -	1	1
	1	59

Sulphocyanuret of potassium is obtained by mixing equal weights of powdered sulphur and ferrocyanate of potassa, and keeping them in fusion for half an hour in a flask; when cold, reduce the mass to powder, and digest it in water; filter the solution, and add a sufficiency of liquid potassa to throw down the iron.

SU'LPHONAPHTHA'LIC ACID. A compound of sulphuric acid and naphthaline, discovered by Mr. Faraday. (*Phil. Trans.* 1826.)

SU'LPHOSINA'PISIN. (Lat. sulphur, and sinape, *mustard.*) A crystallizable substance obtained from mustard seed; it appears to contain sulphur, carbon, hydrogen, and nitrogen.

SULPHOVI'NIC ACID, *Œnothionic Acid.* An acid formed by the action of sulphuric acid upon alcohol. From Mr. Hennel's experiments (*Phil. Trans.* 1826 and 1828) it appears to be a compound of

	Atoms.	Equiv.
Sulphuric acid - - - -	2	80
Quadri-hydrocarbon - - -	1	28
	1	108

SU'LPHUR, *Brimstone.* A yellow brittle mineral product, found in various parts of the world; but apparently most abundant in volcanic regions. Europe is chiefly supplied with it from the south of Italy and from Sicily. It most commonly occurs massive; but it is sometimes met with crystallized in the form of an oblique rhombic octoedron. Fine specimens of this description are seen in our mineral cabinets, and bear a high price. A considerable quantity of sulphur is also obtained from some of its metallic combinations, such as the sulphurets of copper and of iron. These ores are heated, or roasted, as it is termed, in furnaces so constructed that the sulphur vapour may be condensed, and from time to time collected; this, when purified by fusion, is cast into moulds, and forms common or *roll brimstone.* Small quantities of sulphur also occur in several animal and vegetable products, and are frequently recognized by the odour of sulphuretted hydrogen which they evolve during putrefaction. Sulphur is a non-conductor of electricity, insipid, and inodorous, unless rubbed or heated, when it evolves a sulphurous smell. Its specific gravity is 1·99. It melts at about 216°; and when heated to about 250° it becomes a limpid, amber-coloured liquid; if the heat be raised to about 450°, it again becomes viscid and deeper coloured; at 480° up to its boiling point it acquires rather more fluidity; at about 600° it rises rapidly in vapour, and in close vessels condenses in the form of a fine yellow powder, composed of crystalline grains: in this state it is called *flowers of sulphur.* The earthy and metallic impurities which, with a portion of sulphur, remain in the subliming vessel, were formerly called *sulphur vivum.* When sulphur in its viscid state of fusion is poured into water it becomes a ductile mass, which slowly hardens, and which is often used for taking impressions of seals and medals. When sulphur is in the form of vapour it is of a dense orange colour; its specific gravity in that state is about 6·6, and 100 cubic inches of it should therefore weigh about 206 grains.

There is another form of sulphur which is sometimes called *milk of sulphur* (lac sulphuris), and which is a *hydrate of sulphur;* it is obtained by precipitating sulphur by muriatic acid from certain of its alkaline solutions. When sulphur which has been melted is suffered to cool slowly, its interior often exhibits prismatic crystals, and very beautiful specimens of this artificial crystallization of sulphur may be obtained by melting a few pounds of it in a crucible or ladle, and when partially cooled piercing the outer crust and inverting the vessel, so that the interior liquid part may run out; on breaking the mass when cold, the cavity will be found lined with prismatic crystals.

The results of the combustion of sulphur, its equivalent number (16), and several other details respecting its combinations and uses, are given under the heads of SULPHURETTED HYDROGEN, and of SULPHURIC and SULPHUROUS ACIDS.

Sulphur is insoluble in water; it dissolves in boiling oil of turpentine, and is deposited often in crystals as the solution cools. It is also soluble in alcohol, if both substances be brought together in the state of vapour. It combines also with chlorine, bromine, and iodine. Its native combinations with the metals form some of the most important ores. It is from the sulphurets of lead and of copper that the commercial demands for these valuable metals are almost exclusively supplied.

Sulphur is of great importance in the arts. It is used extensively in the manufacture of gunpowder, and in the formation of sulphuric acid, or oil of vitriol. It is also used in medicine, and for other purposes of the arts. The entries for home consumption in 1838 and 1839 amounted, at an average, to 695,056 cwt. a year. The duty on refined or roll brimstone varies from 6*s.* to 9*s.* 9*d.* a cwt., whereas on rough it is only 6*d.*; so that the imports consist almost wholly of the latter. The largest portion by far of the imports come from Italy, or rather Sicily. The price of rough brimstone in bond in the London market usually varies from 6*l.* 10*s.* to 7*l.* 10*s.* a ton.

SU'LPHURETS. Compounds of sulphur with electropositive or inflammable bodies. The most common ores of copper and of lead are *sulphurets* of those metals.

SULPHURETTED HYDROGEN, *Hydro-sulphuric Acid.* A gaseous compound of 1 atom of sulphur = 16 + 1 atom of hydrogen = 1. The equivalent, therefore, of sulphuretted hydrogen is 17. This gas was first examined by Scheele in 1777. It may be obtained by acting upon sulphuret of antimony by muriatic acid, or upon protosulphuret of iron by diluted sulphuric acid, and is immediately recognized by its peculiar fetid odour, which is so diffusible that a single cubic inch of it escaping into the atmosphere of a large room is soon every where perceptible by its smell. It is very deleterious to respiration. 100 cubic inches weigh about 36 grains, its specific gravity compared with air being as 1180 to 1000, or, compared with hydrogen, as 17 to 1. It is liquefied by a pressure of 17 atmospheres at 50°. Water agitated with this gas takes up its own volume, and acquires a bitterish nauseous flavour, and the odour which characterizes Harrowgate and Aix-la-Chapelle waters, and which derive their chief peculiarities from the presence of this gas. Sulphuretted hydrogen extinguishes flame; but is itself inflammable in the contact of air, burning with a blue flame, and depositing during its slow combustion a portion of its sulphur. When mixed with excess of oxygen and inflamed, it explodes, and the mixture is converted into sulphurous acid and water. One volume of the gas requires one volume and a half of oxygen for its entire combustion, and the results are water, and 1 volume of gaseous sulphurous acid. This gas is immediately decomposed by chlorine and by iodine, which, if not added in excess, throw down its sulphur and combine with its hydrogen. It is unequivocally recognized by its peculiar odour, and by its blackening the salts of lead. Sulphuretted hydrogen, diluted with 20,000 measures of pure hydrogen, sensibly blackens a piece of paper which has been dipped into a solution of acetate of lead: white lead is also immediately discoloured by it; hence the mischief which it does to white paint, and to pictures. The aqueous solution of sulphuretted hydrogen reddens litmus; and inasmuch as it combines with certain bases, it is properly considered as a weak acid.

SULPHURIC ACID, *Oil of Vitriol.* This most important acid was discovered by Basil Valentine towards the end of the 15th century. It was formerly obtained by the distillation of green vitriol, and from its oily appearance it acquired the name, which it still bears, of *oil of vitriol.* In this country it is procured by burning a mixture of 7 or 8 parts of sulphur with 1 of nitrate of soda or of potash. The mixture is burned in a furnace so contrived that a current of air carries the products of the combustion into a large leaden chamber, the bottom of which is covered to the depth of a few inches with water. The principal products of the combustion of the above-mentioned mixture of nitre and sulphur are sulphurous and nitrous acids; and these, together with atmospheric air and aqueous vapour, form the contents of the chamber.

The sulphurous and nitrous acids, with a portion of water, combine to form a white crystalline substance, which, upon falling into the water of the chamber, is instantly decomposed. The nitrous acid imparts oxygen to the humid sulphurous acid, and so converts it into sulphuric

acid; whilst the nitrous acid, having lost oxygen, reverts to the state of *nitric oxide*, which is given out into the air of the chamber, from which it immediately again abstracts oxygen, and becoming nitrous acid, is again ready to acidify a new portion of sulphurous acid. The oxygen, therefore, is thus indirectly transferred to the sulphur, or to the sulphurous acid, from the atmosphere, through the medium of the attractive power of the nitric oxide for that element; and the circumstance of this process being repeated over and over again by the same portion of nitrous gas, accounts for the small quantity of nitre required in this curious process.

When the water in the chambers is rendered sufficiently acid, which is judged of by its specific gravity, it is drawn off into leaden boilers, where it is evaporated down to a certain density; after which, as it would then act upon the lead, it is transferred to platinum boilers supplied with still-heads, and there is brought to its proper degree of concentration by further distilling off a portion of the residuary water. This last process was formerly conducted, at great risk and inconvenience, in glass retorts: its present improvement shows a most important application of platinum, which is not acted upon by the boiling acid. Of late, sulphuric acid has been largely manufactured from the sulphur obtained by roasting common pyrites (sulphuret of iron); one of the objections to which is, that it almost always contains more or less arsenic, by which the resulting acid is therefore contaminated. The acid made from Sicilian sulphur is indeed not always free from this mischievous impurity.

Sulphuric acid is a limpid colourless fluid, of a specific gravity of 1·8. It boils at 620°; it freezes at 15°. But the temperature at which the diluted acid congeals is singularly modified by the quantity of water which it contains. When of the specific gravity of 1·78 (which may be regarded as a compound of 1 atom of dry acid and 2 of water), it freezes at 40°, and remains solid for a long time at several degrees above that point: if the density be either diminished or increased, a greater cold is required to congeal it.

It is acrid and caustic, and intensely acid in all its characters, even when largely diluted. Its attractions for bases is such that it separates or expels all other acids more or less perfectly from their combinations. Its affinity for water is such that it rapidly absorbs it from the atmosphere, and when mixed with water much heat is evolved: thus by suddenly mixing 4 parts of the acid and 1 of water at 60°, the temperature rises to 300°. Its attraction for water also causes the sudden liquefaction of snow; and if mixed with it in due proportion, an intense cold is the consequence. It acts energetically upon animal and vegetable substances, generally charring them, and often, as in the case of *sugar*, with singular rapidity.

This acid, as it usually occurs in commerce, under the name of *concentrated sulphuric acid*, is a compound of 1 atom of anhydrous acid and 1 of water. The anhydrous sulphuric acid is constituted of 16 sulphur (1 atom), and 24 oxygen (3 atoms); its equivalent, therefore, is $16 + 24 = 40$: this is the composition of the acid as it exists in the *anhydrous sulphates*. The strongest liquid acid consists of 40 of the dry or anhydrous acid (1 atom), and 9 water (1 atom), and is therefore represented by the equivalent $40 + 9 = 49$.

Sulphuric acid is an article of great commercial consumption; its purity and value are judged of by its specific gravity. Upon this subject Dr. Ure's tables may be consulted, which show the quantity of real or *dry*, and of commercial acid, in diluted acid of all densities.

By the term real, dry, or anhydrous sulphuric acid, we mean that which exists in the sulphates, and which may be obtained in a separate state by distilling protosulphate of iron, or green vitriol, at a high temperature: there comes over a dense brownish liquid, which emits vapour when exposed to air, and has hence been termed *fuming sulphuric acid*. On putting this into a retort to which a receiver surrounded by ice or snow is carefully adapted, and heating it gently, a vapour passes over, which condenses into a white crystalline solid; this, which is *anhydrous* or *glacial* sulphuric acid, liquefies at about 70°, and evaporates at about 112°. Yet, when combined with such portion of water as constitutes the above described liquid acid, it is one of the most fixed of fluids. It hisses when dropped into water in consequence of the great heat evolved.

The ready test of sulphuric acid is a soluble salt of baryta; the solution of chloride of barium is generally used, which, when dropped into any solution of free or combined sulphuric acid, announces its presence by a white cloud, or precipitate of *sulphate of baryta*, which is insoluble in nitric acid: this precipitate, when collected, and well washed and dried, consists of 77 baryta and 40 sulphuric acid; so that 117 is its equivalent, and this weight indicates 40 of the dry acid. In the same way sulphuric acid, and the sulphates, are tests of baryta.

SULPHURIC ETHER. *See* ETHER.

SULPHUROUS ACID. This acid consists of 16 sulphur + 16 oxygen; its equivalent being 32. It is obtained by heating sulphuric acid in contact with certain metals, which abstract an atom of its oxygen; such, for instance, as silver or mercury. It is also formed by burning sulphur in oxygen gas. One volume of water takes up about 30 volumes of sulphurous acid gas; so that it requires to be collected and preserved over mercury, or in dry stoppered phials. It has the well-known suffocating odour of burning sulphur, and is possessed of considerable bleaching powers; so that the fumes of burning sulphur are often used to whiten straw, and certain silk and cotton goods; and when certain flowers, such as violets, dahlias, &c., are exposed to such fumes, or to sulphurous acid, their colours are mostly destroyed. Upon other colouring matters it has little effect. 100 cubic inches of sulphurous acid gas weigh between 67 and 68 grains; its specific gravity compared with atmospheric air being 2·22. It extinguishes flame, and kills animals. When subjected to the pressure of about two atmospheres, or when cooled down to 6°, it assumes a liquid form; and in this state it evaporates with such rapidity at common temperature as to produce a most intense degree of cold, so that by its aid chlorine may be liquefied and mercury frozen. It combines with bases, and produces a class of salts called *sulphites*; they are characterized by emitting sulphurous acid when acted upon by sulphuric acid, and by becoming converted into sulphates by oxidizing agents.

SU′LPHUR SALTS. Chemists have lately applied this term to the *double sulphurets*. The sulphurets of the most electro-positive metals have been termed *sulphur bases*, such as the protosulphuret of potassium, sodium, barium, &c.; whilst the sulphurets of arsenic, antimony, &c., the bisulphuret of carbon, and sulphuretted hydrogen, have been called *sulphur acids*; and the compounds resulting from the union of a sulphuret of the former with one of the latter class are *sulphur salts*.

SU′LTAN. (Sultaun.) In Arabic, *mighty*. Various Mohammedan princes are styled by this title besides the Ottoman emperor or grand sultan, to whom it is commonly given by Europeans, but whose peculiar title of Padishah is more dignified. The princes of the deposed family of the khan of the Crim Tartars are also styled sultan: so also the pacha of Egypt in that country, although not by the court of Constantinople.

SUMACH. (Eng. and Fr.) The powder of the leaves, peduncles, and young branches of the *Rhus coriaria* and *Rhus cotinus*, shrubs which grow in Hungary, the Bannat, and the Illyrian provinces. Both kinds contain tannin, with a little yellow colouring matter, and are a good deal employed for tanning light-coloured leathers; but the first is the best. With mordants, it dyes nearly the same colours as galls. In calico-printing, sumach affords, with a mordant of tin, a yellow colour; with acetate of iron, weak or strong, a gray or black; and with sulphate of zinc, a brownish yellow. A decoction of sumach reddens litmus paper strongly; gives white flocks with the proto-muriate of tin; pale yellow flocks with alum; dark blue flocks with red sulphate of iron, with an abundant precipitate. In the south of France, the twigs and leaves of the *Coriaria myrtifolia* are used for dyeing, under the name of *rédoul* or *rodou*. The imports for home consumption amount to about 200,000 cwt. a year.

SU′MMER. One of the four seasons of the year. The summer season, for the northern hemisphere, begins when the sun reaches the tropic of Cancer, and ends at the following equinox.

SUMMER. (Quasi trabs summaria, *an upper beam.*) In Architecture, any large piece of timber supported on two strong piers or posts, and serving as a lintel to a door, window, &c.

SU′MMONS, WRIT OF. In Law. By the Uniformity of Process Act, 2 W. 4. c. 39. s. 1., it is provided that wherever (in personal actions) it is not intended to hold the defendant to special bail, or to proceed against a member of parliament under 6 G. 4. c. 16., this writ, or process, shall be the commencement of the action. It may issue from either of the four superior courts of common law; and a copy of the writ must be personally served on the defendant against whom it is intended to proceed. The duration of a writ of summons is four calendar months, inclusive, from the day of issuing; but it may be continued by renewals, termed *alias* and *pluries* writ of summons. The amount of the debt claimed (if the action be to recover a debt), with other requisite particulars, must be indorsed on the writ of summons. If the defendant do not appear either personally or by his attorney in answer to the writ, the plaintiff may enter an appearance for him in the proper court, and proceed to declare as if he had appeared.

SU′MPTUARY LAWS. (Lat. sumptus, *expense.*) Laws intended to restrain the expenditure of citizens. Ancient legislation abounded in them. Thus, among the Romans, the Lex Orchia limited the number of guests at a feast; the Lex Fannia restricted the cost of an ordinary entertainment to ten *asses*, and so forth. There were anciently many laws in England to restrain excess

in apparel; but they were all repealed by 1 J. 1. c. 25. It is said, however, that one ancient statute, 10 E. 3. st. 3., which orders that no man shall be served at dinner or supper with more than two courses, remains unrepealed. It is truly said by Montesquieu, that sumptuary laws are of all laws the most inefficacious and most constantly violated.

SUN. (Ger. sonne.) In Astronomy, the central body of our system, about which all the planets and comets revolve, and by which their motions are regulated and controlled. In Physics, the sun is the source of light and heat; and therefore the primary cause of all the motions and changes effected on the surface of the earth by those great agents of nature.

Apparent Magnitude of the Sun. — The sun presents to the naked eye the appearance of a luminous circular disc, subtending an angle of rather more than half a degree. But on measuring accurately the diameter of the disc by means of a micrometer, it is found to be not always the same, but subject to an annual variation. In fact, as the earth describes an ellipse, of which the sun occupies one of the foci, its distance from the sun is constantly changing, and the variation of the sun's apparent diameter is a necessary consequence of the change of distance. When the earth is in its perihelion, or point of its orbit nearest to the sun, the sun's apparent diameter is 32′ 35·6″; and when the earth is at its aphelion, or most distant point, the apparent diameter is 31′ 31·0″. The mean apparent diameter, or diameter at the sun's mean distance, is 32′ 2·9″.

Distance of the Sun. — The sun's true distance is found from his horizontal parallax. This is so small a quantity that it would scarcely be possible to determine it in the usual way by observations made on opposite sides of the earth; but the astronomical phenomena of the transits of the planet Venus over the sun's disc afford the means of determining it with the utmost precision. From such phenomena the parallax has been found to be only 8·6″; that is to say, if an observer could be placed at the centre of the sun, the earth's semidiameter would be seen by him under an angle of 8·6″. From this it follows that the mean distance of the sun from the earth must be at least equal to 24,047 times the earth's radius; and as the radius of the earth is nearly 4000 miles, it follows that the sun's true distance from the earth must be about 96,000,000 miles. *See* PLANET.

In order to obtain a more distinct idea of this enormous distance, we may compute the time in which it would be passed by some of the swiftest motions with which we are acquainted. A 24 lb. cannon ball, fired with a charge of 8 lbs. of gunpowder, is projected with a velocity of about 1600 feet in a second. Supposing it were to continue to move towards the sun with the same uniform velocity, it would require ten years to reach his surface. A body travelling with the velocity of sound would require about five years to pass from the sun to the earth. Light itself, which travels with the astonishing velocity of 192,500 miles in a second, only reaches the earth eight minutes and eighteen seconds after leaving the sun's surface.

Knowing the distance and apparent diameter of the sun, it is easy to compute its real dimensions. A body which subtends an arc of 32′ 3″ of a circle, whose radius is 96,000,000 miles, must have a real diameter of 892,000 miles; which, therefore, is the diameter of the sun. Or, since the true diameter of the sun must have to the diameter of the earth the same ratio which the sun's apparent diameter as seen from the earth has to the earth's apparent diameter as seen from the sun, that is, a ratio of 32′ 3″ to 8·6″, or of 111·8 to 1, it follows that the sun's diameter must be nearly 112 times the diameter of the earth. Hence the volume of the sun must be 1,397,415 (the cube of 111·8) times, or, in round numbers, 1,400,000 times the volume of the earth. The mean distance of the moon being rather less than 60 times the earth's radius, if the sun's centre were placed at the centre of the earth its surface would be at twice the distance of the moon's orbit; and the volume of a sphere whose radius is equal to that of the moon's orbit would only be an eighth part of the volume of the sun. The sun's volume is 500 times greater than the volumes of all the planets taken together.

Mass and Density of the Sun. — The magnitude and distance of the sun are determined by direct observation; his mass as compared with that of the earth is deduced from the law of universal gravitation, and the theory of central forces. The earth revolves round the sun at a given distance, and in a given time; and from these data the centrifugal force becomes known. But the force which counteracts this centrifugal force, and compels the earth to move in its elliptic orbit, and prevents it from flying off in a tangent to that orbit, is the sun's attraction. Hence the solar attraction is equal to the centrifugal force. But the earth's attraction at its surface is a known force, being that which causes a heavy body to fall through $16\frac{1}{10}$ feet in a second of time; and consequently, from the known law of diminution proportionally to the inverse square of the distance, the earth's attractive force at any distance from the surface also becomes known. Now, on comparing the centrifugal force due to the earth's motion in its orbit with the force of terrestrial gravity on a body at the distance of the sun, it is found that the former exceeds the latter in the ratio of 354936 to 1. But when the distance is the same, the attractive forces of two bodies are directly as their masses or quantities of ponderable matter; and hence the sun's mass is 354936 times greater than that of the earth. It is also found to be about 800 times greater than the aggregate of the masses of all the planets and satellites.

The density of a body is directly as its mass, and inversely as its volume. If, therefore, we call the density of the earth 1, the ratio of the density of the sun to that of the earth will be as 354936 ÷ 1397415 to 1, or as ·0254 to 1; whence the sun's density is about one fourth of that of the earth.

In order to compare the force of solar gravity at the sun's surface with that of terrestrial gravity at the earth's surface, we must recollect that the attraction of a body on an exterior point is directly as the mass of the attracting body, and inversely as the square of the distance of the point from its centre. Hence, since the sun's mass is 354936 times that of the earth, and the radius (or distance of the surface from the centre) 111·8 times that of the earth, if A denote the force of solar gravity at the sun's surface, and B that of terrestrial gravity at the earth's surface, then

$$A:B::\frac{354936}{(111\cdot 8)^2}:\frac{1}{(1)^2};$$

or A is to B as 27·9 (nearly) to 1. A body, therefore, which at the earth's surface weighs one pound, would weigh 27·9 pounds if carried to the surface of the sun. "An ordinary man would not only be unable to sustain his own weight on the sun, but would be literally crushed to atoms under the load." (*Herschel's Astronomy.*)

Rotation of the Sun. — The sun's surface, when viewed through the telescope, is frequently diversified with a number of dark patches or *spots*, which being observed from day to day are found not to remain in the same place, but to move across the surface, without, however, changing their relative positions. These phenomena are accounted for by supposing the sun to have a rotatory motion about an axis from west to east. From a comparison of the best observations Delambre found the period of rotation to be about 25 days; and that the sun's equator is inclined to the ecliptic in an angle of about 7° 20′, and intersects it in a line which makes an angle of 80° 21′ with the line of the equinoxes. The observations of the spots are, however, subject to great uncertainty; but the *fact* of rotation from west to east, or in the same direction as the earth and all the other planets, is established.

Spots of the Sun. — The solar spots, to which allusion has just been made as furnishing the elements of the sun's rotation, present very remarkable appearances, and have been the subject of numerous theories respecting the nature and physical constitution of the sun. They began to attract attention soon after the discovery of the telescope, and their phenomena are described with sufficient accuracy by Hevelius and Scheiner. In form they are exceedingly irregular; and, when watched attentively for some time, are observed to enlarge and contract, and to change perpetually their form and outline. Frequently they disappear without approaching the edge of the disc, and break out suddenly in places where none were seen before. Sometimes a spot has been seen to break up into several parts, and the fragments to separate from each other, as if acted upon by an explosive force. The *nucleus* of a spot is perfectly black, and sharply defined; and is surrounded by an *umbra*, or border of a fainter shade. In the neighbourhood of large spots, or in places where they are numerous, bright streaks, or portions more luminous than the general surface of the sun, called *faculæ*, are frequently seen. Among these faculæ spots are often observed to break out; and when this does not happen they are generally succeeded by spots, larger in proportion to the brightness of the antecedent faculæ. The region of the spots is generally confined to the equatorial parts of the sun, within about 30° of the equator; but occasionally they are observed over the whole disc.

The magnitude of the spots, and the scale on which their movements are performed, are not the least remarkable circumstances connected with the phenomena. At the distance of the sun, a line which subtends an angle of one second is equal to about 460 miles, and a circle of that diameter has an area of about 166,000 miles; and this is the smallest space which can be distinctly discerned on the sun's disc. But a spot was observed by Mayer having a diameter equal to 1-20th of the diameter of the sun, or upwards of 96″, and consequently (supposing it to be circular) covering an area of 1520 millions of square miles, — upwards of 30 times the whole surface of the earth.

Numerous hypotheses have been formed respecting

the solar spots. Scheiner supposed them to be planets revolving at no great distance from the sun's surface. Galileo and Hevelius conceived them to be a sort of *scoriæ* or *scum* formed at the surface of the sun, and floating in an ocean of liquid matter. Lahire supposed them to be protuberant parts of solid, opake, and irregular masses, floating in the fluid matter of the sun. Dr. Wilson, of Glasgow, accounted for the spots by supposing the sun to consist of a dark nucleus, covered to a certain depth by luminous matter, through which cavities or gulfs are made by volcanic or other actions, and permit the dark nucleus to be seen. Lalande suggests that the spots or opake bodies may be merely the summits of mountains, usually covered by the igneous fluid, but which, by the flux and reflux of the fluid, sometimes protrude beyond its surface, and thus become visible. (*Astronomie*, art. 3240.) The most probable view, however, is that taken by Sir William Herschel, who considers "the luminous strata of the atmosphere to be sustained far above the level of the solid body by a transparent elastic medium, carrying on its upper surface (or rather at some considerably lower level within its depth) a cloudy stratum, which, being strongly illuminated from above, reflects a considerable portion of the light to our eyes, and forms a penumbra, while the solid body shaded by the clouds reflects none. The temporary removal of both the strata, but more of the upper than the lower, he supposes effected by powerful upward currents of the atmosphere, arising, perhaps, from spiracles in the body, or from local agitations." (*Sir J. Herschel's Astronomy*, p. 209.)

Physical Constitution of the Sun. — Respecting the physical nature of the enormous mass of matter which controls the motions of all the bodies of the solar system, and supplies them with light and heat, we can only form conjectures, guided in a feeble degree by the phenomena of the spots. According to the hypothesis broached by Sir William Herschel, as stated in the above quotation, there are two regions of solar clouds; the inferior stratum being opake, and probably resembling our own atmosphere; while the upper stratum is the repository of light and heat, which emanate from it in all directions. This upper luminous stratum he supposed to have an altitude of between 1840 and 2765 miles above the surface of the sun. The lower stratum, by reflecting a considerable portion of the rays which fall upon it from the luminous clouds above, not only increases the quantity of light which the latter send forth into space, but serves as a canopy to screen the surface of the solid body of the sun from the scorching effects of the surrounding regions of light and heat; and he supposed its density might even be such as to maintain a temperature at the actual surface of no greater elevation than is consistent with the support of animal life. But whatever may be the state of the temperature at the actual surface, of which only casual glimpses are obtained through openings in the luminous clouds, it is difficult to conceive that the luminous matter can be otherwise than in a state of the most intense ignition. "That the temperature," says Sir John Herschel, "at the visible surface of the sun cannot be otherwise than very elevated, much more so than any artificial heat produced in our furnaces, or by chemical or galvanic processes, we have indications of several kinds. 1st, From the law of decrease of radiant heat and light, which being inversely as the squares of the distances, it follows that the heat received on a given area exposed at the distance of the earth, and on an equal area at the visible surface of the sun, must be in proportion to the area of the sky occupied by the sun's disc to the whole hemisphere, or as 1 to about 300,000. A far less intensity of solar radiation, collected in the focus of a burning-glass, suffices to dissipate gold and platina in vapour. 2dly, From the facility with which the calorific rays of the sun traverse glass, — a property which is found to belong to the heat of artificial fires in the direct proportion of their intensity. 3dly, From the fact that the most vivid flames disappear, and the most intensely ignited solids appear only as black spots upon the disc of the sun when held between it and the eye." (*Astronomy*, p. 210.)

These circumstances give great probability to the supposition that luminous matter which surrounds the body of the sun has a temperature far exceeding any which can be produced by artificial means; but the sciences of light and heat are not yet sufficiently advanced to enable us to arrive at any certain conclusions on the subject, or to form other than purely conjectural hypotheses respecting the nature and constitution of the sun. "The great mystery," continues Sir John Herschel, "is to conceive how so enormous a conflagration (if such it be) can be kept up. Every discovery in chemical science here leaves us completely at a loss, or rather seems to remove farther the prospect of probable explanation. If conjecture might be hazarded, we should look rather to the known possibility of an indefinite generation of heat by friction, or to its excitement by the electric discharge, than to any actual combustion of ponderable fuel, whether solid or gaseous, for the origin of the solar radiation." (P. 212.)

Considering the enormous and incessant emanation of light and heat from the sun, the question has often arisen whether the volume of the sun undergoes any diminution. If the high temperature is kept up either by electric currents, or by friction, as above suggested, no loss of volume would be sustained; but if, according to the hypothesis of Newton, light is produced by the actual emission of luminous particles, a diminution of volume would appear to be a necessary consequence. Observation, however, can afford us no information on this head; for, supposing an actual diminution to be going on at such a rate as to lessen the diameter by two feet in 24 hours (which, having regard to the sun's magnitude, may be considered as enormous), 3000 years would elapse before the diminution of the apparent diameter would amount to a single second. Buffon supposed the sun to be an immense furnace, alimented by comets precipitating themselves into it from time to time.

Atmosphere of the Sun. — The existence of a solar atmosphere was inferred by Bouguer from a comparison of the intensity of radiation at different points of the disc. By reason of the globular figure of the sun, a much larger portion of the surface towards the border is comprehended under a given visual angle than at the centre; and, as every point of the surface must be supposed to radiate equally in all directions, it follows that the intensity of light near the border should be greater than at the centre in proportion to the greater extent of surface comprised under the same angle. Bouguer's observations, however, led him to infer that the light from the centre of the disc had a greater intensity than that which proceeded from the borders, — a circumstance which would be explained on the supposition of its being absorbed in a greater proportion by having to traverse a greater extent of atmosphere. But the more delicate experiments of Arago have shown that all the points of the disc are equally luminous; so that the hypothesis of an atmosphere, however probable on other grounds, is not supported by such observations. The existence of a solar atmosphere is, however, indicated by the faint light observed round the sun's limb in a total eclipse; and, perhaps, still more unequivocally by the phenomenon of the zodiacal light. *See* ZODIACAL LIGHT.

Sun's Position and proper Motion in the Heavens. — The discoveries in sidereal astronomy which have been made in modern times, all tend to establish the hypothesis of a similarity of condition and a community of nature between the sun and the fixed stars. The prevalence of gravitation among these remote bodies, following the same law as is observed in the solar system, is no longer a matter of speculation; the proof being afforded by the elliptic orbits described by so many of the double stars about their common centre of gravity. With respect to the place which the sun occupies in the heavens, we have, says Sir J. Herschel (*Mem. Royal Astron. Society*, vol. xi.), almost ocular evidence that our system is excentrically situated within the nebula of the *Milky Way*, and nearer to its southern than to its northern portion. It was also an opinion of Sir William Herschel, that the sun, like many of the fixed stars, has a proper motion in space, in consequence of which it is at present advancing towards a point of the heavens within the constellation *Hercules*. That the sun does not remain absolutely at rest in space, but has a proper motion in *some* direction, may be regarded as not only highly probable, but almost certain; but many centuries of observation may be required to enable astronomers to detect its laws, or even to arrive at any definite conclusions respecting its direction or the remote centre about which it is performed. (*Sir J. Herschel's Astronomy*; Lalande, tom. iii.; Biot, *Astronomie Physique*; Laplace, *Système du Monde*; Delambre, *Astronomie*, &c.) *See* STAR.

SUNDAY, the first day of the week, is said to derive its name from the Saxons, who consecrated it to the sun in heathen times. The solemnization of this day dates from the earliest age of the Christian church, in memory of the death of Christ, and of the descent of the Holy Ghost, both of which events took place upon it. The Jewish Christians retained at the same time their Sabbath, the last day of the week; but this practice became obsolete early, at least in the Western church. The Sunday was at first distinguished merely by peculiar prayers and passages of the Scriptures. It does not appear to have been strictly observed as a day of cessation from labour before the reign of Constantine. By the decree of that emperor (A. D. 321) public business, and military exercises, were suspended. The council of Laodicea (A. D. 360) forbade labour in general terms; and the laws of Theodosius (circ. A. D. 420) sanctioned this interdiction by civil penalties. *See* SABBATH.

SUNDAY LETTER. *See* DOMINICAL LETTER.

SUNNIAH. (Arab. *a troop*, or *band*.) The name given to the sect commonly considered as orthodox among the Mussulmans by the followers of Ali. The

latter believe that the sovereign imâmship, or imaginary dignity which conveys supremacy over all the faithful, belongs of right to the descendants of Ali, son-in-law of Mohammed. The schism between these two sects has subsisted from the earliest times of Mohammedanism; when Ali, having become fourth caliph after the death of Othman, a rebellion was raised against him by Maaniah, founder of the Ommiad race of caliphs, about the year 1000 of the Christian era. The division took place between the two parties in the court of the caliph Moli l' Mah, which resulted in the Schiite party becoming pre-eminent in Persia, the Sunniahites in Turkey and most other Mohammedan countries.

SUO'VETAURILIA. (Lat. sus, *a swine*, ovis, *a sheep*, and taurus, *a bull*.) In Roman History, a quinquennial sacrifice, which consisted of the immolation of a sow, a sheep, and a bull; hence the name. *See* LUSTRATION.

SUPERCARGO. The person in a merchant ship appointed to superintend all the commercial transactions of the voyage is so called.

SUPERDO'MINANT. (Lat. super, *above*, and dominans, *governing*.) In Music. In the descending scale, the sixth of the key.

SU'PEREROGA'TION, WORKS OF. In Theology. It is a belief countenanced by many tenets of the church of Rome, that men may acquire merit in the eyes of God by good works beyond what are necessary for salvation. This notion is said by Protestants to have been first known about the 12th or 13th century, and to have been founded upon what the Roman Catholics call "counsels of perfection;" that is, rules which do not bind under the penalty of sin, but are only useful in carrying men to a higher degree of perfection than is requisite for Christians. This doctrine is condemned by the church of England in her 14th article.

SUPERFI'CIAL MEASURE. The measure of surfaces or areas; also called square measure. *See* MEASURE.

SUPERFI'CIES. The exterior face of any body. *See* SURFACE.

SUPE'RIOR. In Scottish Law, one who has made an original part of heritable property with reservation of rent and service. The grantee is termed *vassal*: the interest of the grantor is *dominium directum*, that of the grantee *dominium utile*; or, the former superiority, the latter property. The reunion of these two rights in the same person is termed *consolidation*.

SUPE'RLATIVE. In Grammar, the name vulgarly given to the third degree in comparison, formed in the Teutonic languages by the additional syllable "est."

SUPERSE'DEAS. In Law, a writ that lies to stay various ordinary proceedings; as to stay an execution after a writ of error has been allowed and bail put in; to set aside erroneous judicial processes; and, in certain cases, to discharge prisoners.

SUPERSTI'TION. (Lat. superstitio, from super, *above*, sto, *I stand*: the steps of the derivation are extremely obscure.) This word, like many others, has, in common language, both a subjective and objective sense; that is, we speak of superstition as a habit in the mind; and we also speak of a particular tenet, or a particular observance, as "a superstition." Every belief, 1. in the existence of particular facts or phenomena, produced by supernatural agency, which existence is not demonstrated by experience nor asserted in Revelation; 2. in causation not demonstrated by experience or asserted by Revelation, *i. e.* of the *direct* agency of supernatural power in producing results which can either be proved to proceed from secondary causes, or by reasonable analogy must be inferred so to proceed, — is, in common language, superstition. An instance of the first species is the belief in the existence of imaginary beings, ghosts, spectres, &c.; of the second, the belief that epileptic fits are produced by witchcraft, — that meteorological phenomena hitherto imperfectly explained, such as wind or lightning, are produced without the intervention of regular physical causes by the immediate act of the divinity, &c. The word is almost always used in a religious sense, like the Greek δεισιδαιμονια; that is, the belief which we regard as *superstitious* concerns the agency of the Deity, or inferior supernatural agents. For example, we do not generally term the belief in animal magnetism, tellurism, the divining rod, &c. superstitions; these are persuasions respecting certain occult powers of nature undemonstrated (that is, in the case of most believers) by experience; they are *superstitions* in the mode in which they are generated and affect the mind, but not in point of subject matter. On the other hand, there is much carelessness in the application of the word to religious tenets, where these flow necessarily from the belief in certain other truths as revealed: for example, no Christian esteems it superstition to believe that a dead man was, in a certain instance, restored to life, although nothing can be in itself more incredible; because it is asserted in writings which he considers as revealed, and the power of working miracles is expressly claimed in that revelation. But some Christians place faith in the declaration of their church, just as all Christians do in Scripture; and justify that faith by argument addressed to the reason. How, then, can they be accused of superstition in believing the truth of narratives, however incredible in themselves, which that church sanctions and approves; for example, many of the miraculous legends commonly received in the Romish church? Those who do not adhere to that church may stigmatize it as superstitious; but they can hardly call the belief which leads the Roman Catholic to address his prayer to Saints, or the Virgin, a superstition *in him*.

SUPERTONIC. (Lat. super, *above*, and tonus, *a tone*.) In Music, the second above the key note. From its being a comma higher in the major scale than in the relative minor, it is, in theory, considered a variable sound.

SUPINA'TION. The art of turning the palm of the hand upwards by rotating the radius upon the ulna.

SU'PINES. In Grammar, certain forms of the Latin verbs. The supine in *um* (of which the form is the same as the neuter of the past participle, as *amatum* in the verb *amo*) serves generally, in conjunction with another verb, to express an *intended* action; as "Lusum it Mæcenas," "Neque vos ultum injurias hortor;" in both which cases it would be expressed by the infinitive in modern languages; in the Greek, either by the infinitive, or more accurately by the infinitive used as a noun with a preposition. The existence of the other supine (in *u*) is doubted by some grammarians. The name is said to have been given to signify their character, neither passive nor active.

SU'PPLEMENT. In Geometry and Trigonometry, the supplement of an arc or angle is what must be added to it in order to make a semicircle, or 180°.

SUPPLEMENT. In Literature, an addition made to any work or treatise, in the view of rendering it more complete.

SUPPLY. In Parliamentary language, the sum granted to the sovereign by parliament for defraying the expenses of the current year. The known or probable amount of the different branches of the year's expenses is stated to the House of Commons in a committee of supply by the chancellor of the exchequer, and, after these have been voted by the committee, they are formally granted by an act of parliament, called the Appropriation Bill. The granting of the annual supplies is a peculiar privilege of the House of Commons, which never permits any alteration or amendment (except merely verbal) to be made by the House of Lords in the bills passed for this purpose.

SUPPLY. In Political Economy. *See* POLITICAL ECONOMY.

SUPPORT. In Architecture. *See* POINTS OF SUPPORT.

SUPPORTERS. In Heraldry, the figures placed on each side of a shield. The device of supporters probably originated from the practice of knights at tournaments having their armorial shields fixed or hung near the place of justing, and guarded by pages or other retainers standing on the side of them dressed in various fanciful accoutrements; although some consider it as entirely a modern invention, or ornamental addition by painters and limners, who found a vacant space on each side of the escutcheon which they filled up by imaginary figures. It does not appear that supporters were at first exclusively borne by individuals of a particular rank; and some private families are supposed to be still entitled to them by prescription. But, in modern English heraldry, the grant of supporters is limited to sovereigns and princes of the blood royal, peers of the realm, knights of the Bath, knights banneret, baronets of Nova Scotia (by their patents of creation), and to such persons as receive them by special license from the king. It is said by heraldic writers that females cannot assume supporters; but this prohibition seems to be habitually infringed in practice.

SUPPO'SED BASS. In Music, the bass of a chord when it is not the root of the common chord or harmonic triad. It is also sometimes called the inversion of the accompanying chord.

SUPPOSI'TION. (Lat. suppositum.) In Music, the use of two successive notes of equal value as to time, one of which being a discord supposes the other a concord. The harmony, though by rule falling on the accented part of the bar, and free from discords, requires their proper preparation and resolution; and they are called *passing notes*. Discords on the unaccented part of the measure are allowable by conjoint degrees, and it is then not required that the harmony should be so complete on the accented part. This transient use of discords followed by concords is what we, after the French, call *supposition*, whereof there are several kinds.

SUPPO'SITORY. A pill or bolus introduced into the rectum, where it gradually dissolves. Opium is sometimes usefully applied in this way to allay irritation of the bladder and neighbouring parts.

SUPPRESSION. A figure in Grammar is sometimes so called by which words are omitted in a sentence, which are nevertheless to be understood as necessary to a perfect construction: as, for instance, in most languages, the repetition of a noun is avoided where it is coupled with a pronoun in one branch of the proposition; *e.g.*

"this (horse) is my horse," or "this horse is mine" (horse). *See* ELLIPSIS.

SUPPURA'TION. The process by which pus or matter is formed in inflammatory tumours.

SUPRACRETACEOUS ROCKS. A Geological term applied to certain rocks or strata lying above the chalk; they have also been called *tertiary strata*. *See* GEOLOGY.

SUPRALAPSA'RIANS. Those who assert that the fall of Adam, with all its pernicious consequences, was predestinated from all eternity, and that our first parents had no liberty in the beginning. *See* CALVINIST.

SUPRANA'TURALISTS. A name given of late years to the middle party among the divines of Germany, to distinguish them from the *Rationalists*, who exclude all supernatural manifestations from religion; and from the Evangelical party, whose tenets are of a more strict description. Thus many of the supranaturalists appear to have given way to the system of accommodation (as it is termed) in religious matters, so far as to explain away the doctrine of original sin, and other tenets which we are accustomed to consider as fundamental: others approximate to what are regarded as orthodox Protestant opinions among ourselves.

SUPRE'MACY, OATH OF. An oath denying the supremacy of the pope in ecclesiastical or temporal affairs in England, which by many statutes was required to be taken, along with the oath of allegiance, by persons in order to qualify themselves for office, &c. By 10 G. 4. c. 7. s. 10. Roman Catholics are qualified for all offices (with the exception named in the act), on taking a declaration, which is substituted for the former oaths.

SURAES. A name given in Persia to buildings constructed for the accommodation of travellers. They are synonymous with *khans* or *caravanseras*, which see.

SU'RBASE. (Fr.) In Architecture, the upper base of a room, or rather the cornice of the dado.

SURD. In Arithmetic and Algebra, a magnitude which is inexpressible by rational numbers. Thus the square root of 2, the cube root of 3, &c. are numbers which cannot be expressed exactly in the ordinary notation, and are represented by prefixing the radical signs indicating the operation, viz. $\sqrt{2}$, $\sqrt[3]{3}$. Such quantities are otherwise called *irrational* or *incommensurable*.

SURFACE. A mathematical surface or superficies is defined by Euclid to be that which has only length and breadth. This definition excludes a *line*, which has length only; and a solid, which has length, breadth, and thickness. As a line is generated by the motion of a point, so a surface is generated by the motion of a line. If the generating line be a straight line, and move subject to the condition of having always two consecutive positions in the same plane, the surface generated is *developable*, and can be stretched out on a plane, as the surface of a cone, a cylinder, &c. But if the generating straight line is constrained to move so that no two of its consecutive positions are in the same plane, the surface cannot be developed on a plane. Such a surface is called by the French geometers *surface gauche*.

SURMOUNTED. In Architecture, a term used to denote an arch or dome which rises higher than a semicircle.

SURMOUNTED. In Heraldry, a term used when one figure is laid over another: *e.g.* a pile surmounted of a chevron.

SURNAME. In modern European usage, the family name of an individual; but often used for any distinguishing name. (*See* NAME.) According to Ducange, the use of surnames in France began about the year 987, when the barons adopted the practice of designating themselves by the names of their estates. And this has been the general, though by no means the uniform origin, of family names in the nobility of Europe; some having been derived from badges, cognizances, the nicknames applied to individuals, &c. Among the commonalty of this country, surnames are said not to have been general before the reign of Edward II. It will be found on examination that a great number of them originate in the still older custom of adding to the son's Christian name that of the father by way of distinction; many more from the names of trade; and many more from accidental distinctions, as of size or colour, probably applied in the first instance to the founder of the family.

SU'RPLICE. (Lat. superpelliceum, apparently from pellis, *skin*.) This ecclesiastical vestment is thought by Mr. Palmer (*Orig. Liturg.* ii. 320.) to have been at one time not different from the alb. It now has wider sleeves, a difference which is thought to have originated in some distinction between the dress of a superior and inferior order of clergy. It dates from the 12th century. The vehement objections entertained by the Puritans of the 16th century to its use are well known. *See* VESTMENTS.

SURRE'NDER. In Law. 1. A deed by which the tenant of a particular estate conveys his interest to tenant in remainder, a reversion immediately expectant on the determination of that estate. 2. A surrender of copyhold or customary estates is the yielding up of such estates by the tenant into the hands of the lord for purposes expressed in the surrender. By this means are accomplished conveyances of copyhold lands, the lord being in general bound to admit the party in whose favour the surrender is made. *See* COPYHOLD.

SU'RROGATE. (Lat. surrogatus.) In Law, one substituted for or appointed in the room of another. It is commonly used in the ecclesiastical courts as the description of an officer who acts as deputy for the bishop's chancellor.

SURSO'LID. In Arithmetic, the fifth power of a number. If 2 be the root, the sursolid is $2 \times 2 \times 2 \times 2 \times 2 = 32$.

SU'RTURBRAND. A species of peaty bituminous coal found in Iceland. It resembles Bovey coal.

SURVEYING. (Fr. survoir, *to overlook*.) In Practical Mathematics, the art of determining the boundaries and superficial extent of a portion of the earth's surface. The object of a survey may be either to ascertain the contents of a field or portion of land, or to determine the relative distances and bearings of the most prominent objects of a country for the purpose of constructing a map, or to determine the form and dimensions of a portion of the earth's surface with a view to deduce the magnitude and figure of the earth by comparing the geodetical distances between given points with their astronomical positions. In all cases the operation is conducted on the same principles; but while the first requires only the application of the merest elements of arithmetic and trigonometry, the last can only be accomplished with the aid of instruments of the most refined description, and processes of calculation deduced from mathematics of the highest order.

In measuring land all the lines and the surfaces whose contents are to be found are reduced to the same horizontal plane, on the principle that as plants shoot up vertically no greater number can be produced on the slant side of a hill than would grow on the area covered by its horizontal base. When the lines actually measured are not horizontal, they are therefore multiplied by the cosines of their respective inclinations to the horizon.

The English standard unit of land measure is the acre, which contains four roods; and a rood is subdivided into 40 poles or perches, each pole containing $30\frac{1}{4}$ square yards. (*See* MEASURE.) But though roods and poles are the legal subdivisions of the acre, and the terms continually occur in all descriptions of the contents of land, in practice a decimal division is followed, which is greatly more convenient for calculation. For the linear measurements a chain is employed consisting of 100 links, and its whole length is such that one *square chain* is equal to the tenth part of an acre. But the acre containing 4840 square yards, the square chain consequently contains 484 square yards, and the length of the chain is the square root of 484, that is, 22 yards; whence its 100th part, or one link, is 7·92 inches. In order to avoid decimal fractions, surveyors usually set down all the measures in links; and when the contents of a field are cast up in square links, it is only necessary to mark off the five last figures as decimals in order to have the contents in acres, the number of square links in an acre being $100 \times 100 \times 10 = 100{,}000$.

The measurement of angles being in general an operation much less liable to error than the measurement of linear distances, when the surface to be measured is of considerable extent the skilful surveyor will avoid making further use of the chain than is necessary for obtaining the data requisite for a trigonometrical computation. The most convenient instrument, and that which is almost universally employed in land surveying for the measurement of angles, is the theodolite, which, from the nature of its construction, gives the angles reduced to the plane of the horizon, and consequently renders a computation for that purpose unnecessary. (*See* THEODOLITE.) As auxiliary to the theodolite, and for the purposes of sketching and filling in the details of a map, the *plane table* and the *prismatic compass* (see the terms) are used; and in order to determine the bearings of the several objects observed from any station with reference to the cardinal points of the horizon, a compass and needle accompany the theodolite.

It frequently happens in surveying that triangles are to be measured whose sides contain very acute or obtuse angles. In such cases a small error in the angular measurement would lead to very erroneous results; and the practice usually adopted for finding the area is to measure the longest side of the triangle and the perpendicular let fall upon it from the opposite angle, the area being half the product of the side into the perpendicular. For the purpose of tracing the perpendicular, the simple cross-staff may be employed; but the instrument called the *optical square* (which is merely a small shallow circular box containing the two principal glasses of the sextant fixed at an angle of 45°) will effect the purpose with greater accuracy. The method of using it is obvious. If the observer moves forward or backward in the straight line A B until the object B seen by direct vision coincides with another object C seen by reflexion, then a straight

line drawn to C from the point at which he stands when the coincidence takes place will be perpendicular to A B. The box sextant might evidently be employed for the same purpose.

Since every plane figure may be regarded as composed of a certain number of triangles, the whole theory of land surveying resolves itself into the measurement of the areas of plane triangles. For computing the area of a triangle it is necessary to know the length of at least one side; and when this is known, together with any two of its other parts, the remaining parts and the area are computed by the rules of trigonometry. As usual, let the sides of a triangle be denoted by a, b, c, and the angles respectively opposite by A, B, C, and let $s = \frac{1}{2}(a + b + c)$; then the area is found by either of the three following formulæ: $\sqrt{\{s(s-a)(s-b)(s-c)\}}$, $\frac{1}{2}ab$ sin. C, $\frac{a^2 \text{ sin. B sin. C}}{2 \text{ sin. A}}$. (*See* TRIGONOMETRY.)

In surveying an estate, the usual practice is to measure round it with a chain, and observe the several angles with the theodolite; and if the boundaries are very irregular, a straight line is run between two points so as to cut off one or more of the bendings and the perpendiculars or *offsets* from the straight line to each bending measured with a rod or offset staff, the most convenient length of which is 10 links. By this means the spaces included between the actual boundaries and the assumed straight lines are computed; and the sides and angles of the interior polygon being known, its area may be formed without resolving it into triangles. *See* POLYGON.

Trigonometrical Survey. — When a survey is to be effected on a large scale, as for making a geometrical map of a country, or for measuring an arc of the terrestrial meridian, not only is minute accuracy required in all the practical parts of the operation, but it becomes necessary to have regard to the curvature of the earth's surface, the effects of temperature, refraction, altitude above the sea, and a host of circumstances of which the influence is wholly unappreciable in the practice of ordinary surveying. Geodetical measurements of this kind have been executed in various countries. (*See* DEGREE.) The first which was undertaken in our own country was that of General Roy, begun in 1783, for the purpose of connecting the Greenwich observatory with the French triangulation, which had been carried on from Paris to the coast opposite Dover, and consequently for determining the difference of the meridians of the two observatories by actual measurement. This gave rise to a more important operation; namely, a general survey of the kingdom, which was begun in 1791 under the direction of the Board of Ordnance, and has been carrying on up to the present time. A brief description of the methods employed in conducting the different parts of this splendid national undertaking will probably be the best means we could adopt to explain the nature and objects of an accurate trigonometrical survey.

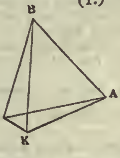
Measurement of Base. — This is the fundamental, and probably the most difficult part of the whole operation, and requires to be executed with the most minute accuracy, as any error committed in its determination will affect all the distances deduced from it, and be multiplied in the ratio of these distances to the length of the base. First of all, a suitable piece of ground, on which a straight line of not less than 5 or 6 miles can be laid down, must be selected and carefully levelled; and a measuring apparatus employed of which the length is exactly known in units of a standard scale. General Roy's base on Hounslow Heath was first measured with deal rods; but as these were found to be affected by the hygrometrical changes of the atmosphere, it was again measured with glass tubes 20 feet in length, furnished with a peculiar apparatus for making the contacts. In the subsequent measurement of the same line for the ordnance survey, two steel chains of 100 feet in length, made by the celebrated Ramsden, were made use of. One of these was used as a measuring chain; the other was kept for the purpose of the measuring chain being compared with it before and after the operation. In the act of measuring, the chain was laid in a trough supported on trestles, and stretched with a weight of 56 lbs. The same apparatus was employed in measuring five other bases in different parts of the country, for the purpose of verifying the accuracy of the work. For the measurement of a base in the survey of Ireland, Colonel Colby employed a compensating apparatus formed of bars of different metals, so arranged that the distance between two points viewed by microscopes remains constant under all changes of temperature. The length of the Hounslow Heath base was nearly 5·2 miles; that of the Irish base about 8 miles.

Selection of Stations. — The next step in the operation is to divide the country to be surveyed into a series of connected triangles. The choice of the stations which form the angular points must depend in some measure on the nature of the country; but where circumstances admit of a selection being made, it is very important to form the triangles so that the small unavoidable errors of observation shall produce the least errors possible in the resulting sides. The conditions required for this purpose are most nearly fulfilled by making the triangles as nearly as possible equilateral.

Signals. — Various plans have been adopted in the course of the survey for marking and rendering visible the stations at which the instrument is successively set up. At first flag-staffs were chiefly used, carrying lamps and concave reflectors for night observations. Such signals could be seen in the telescope of the great theodolite at distances of 20 or even 24 miles. Bengal lights, fixed in small sockets, were used for more distant stations. But night observations having been found by experience to be attended with much uncertainty as well as inconvenience, they have of late years been abandoned. In the mountainous countries of Scotland and Ireland, and where the sides of the triangles generally exceeded 50 and sometimes even 100 miles in length, conical piles of stone were erected on the tops of hills; and although these signals are attended with this disadvantage, that they can only be seen when the atmosphere is clear (and the surveying parties have been frequently compelled to remain weeks and even months encamped on the summits of the mountains before a single observation could be made), yet from the steadiness of the object observed they are found on the whole to be preferable to any night signals that have hitherto been tried. When the theodolite is to be set up at a station which has been already observed from another, the pile is thrown down, and the instrument placed exactly over its centre. The heliotrope, and small plane mirrors, have likewise been occasionally employed with success. (On this subject, see Mr. Drummond's paper in the *Phil. Trans.* for 1826.)

Reduction to Centre of Station.—In observing the angles at any station, it is supposed that the centre of the instrument is placed exactly at the centre of the station. This condition was rigidly adhered to in the ordnance survey of Britain by erecting signals on purpose; but where the saving of expense is an object, it will often be convenient to take advantage of spires, towers, &c., in which case the instrument cannot always be placed in the required position. In such circumstances, the observation is made at a point near the station, and the angle at that point subtended by two remote objects is reduced to that which would have been observed if the instrument had been placed exactly at the centre of the station. The reduction is made as follows: — Let C (fig. 1.) be the centre of the station, A, B the two remote objects observed; and suppose the instrument to be set up at a point K near to C; then the angle actually measured is A K B, while that which is to be determined is A C B. Put C A = b, C K = d, the angle B A C = A, A C B = C, A K B = K, B K C = k; then the difference between C and K expressed in seconds of a degree is

(1.)



$$C - K = \frac{d \text{ sin. } (A - k) \text{ sin. K}}{b \text{ sin. A sin. } 1''}.$$

The distance C K or d is measured; C A or b is found approximately by computing the triangle A C B with the approximate value of C observed at K; and the angles A, K, k are given by observation. The formula is not quite exact, but sufficiently so for all ordinary cases.

Reduction to the Horizon. — Another indispensable condition is, that the angles observed at each station be reduced to the plane of the horizon. When the theodolite is employed for measuring the angles this reduction is effected by the instrument itself, and hence the great advantage of the theodolite as a surveying instrument; but when the angles are measured with a repeating circle or sextant, a reduction is necessary, unless the two distant objects observed be in the same horizontal plane with the instrument, which will rarely happen. Suppose the observer stationed at A, and let B and C be the distant objects. Let the angular elevation of B above the horizontal plane (which is found by measuring its zenith distance) be β seconds, and the elevation of C be γ seconds; also let A′ be the horizontal projection of the angle A, and suppose A − A′ = x seconds; then

$$x = \left\{\left(\frac{\beta + \gamma}{2}\right)^2 \text{tan.}\left(\frac{A}{2}\right) - \left(\frac{\beta - \gamma}{2}\right)^2 \text{cot.}\left(\frac{A}{2}\right)\right\} \text{sin. } 1'',$$

which gives the correction to be subtracted from the observed angle A in order to have the corresponding angle A′. If one of the objects B or C be depressed, the arc of depression, β or γ, must be regarded as a negative quantity.

Spherical Excess. — The sum of the three angles of any spherical triangle exceeds 180° by a quantity which is called the spherical excess, and which we shall denote by E. If the observations could be made with absolute accuracy, the sum of the three observed angles of any triangle on the ground would be 180° + E; the difference of their sum from this quantity is the aggregate error of the three

observed angles, and must be distributed among those angles so as to render the sum precisely $180^\circ + E$ before the sides are computed. It is therefore necessary to determine E. Let S denote the area of the triangle in square feet, r the number of feet in the radius of the earth, and $\pi = 3{\cdot}14159$; then E is given in seconds by this formula (*see* SPHERICAL EXCESS),

$$E = \frac{S \times 648000''}{\pi r^2}$$

(648000 being the number of seconds in 180°). In order, therefore, to compute E, we must previously know the values of S and r. Now with respect to S, it is to be observed that in every case which can arise in practice the area of the triangle must be a very small quantity in comparison of r^2, so that in order to find E it is not necessary to compute S with great precision. A sufficiently near value will be obtained by calculating one of the unknown sides as if the triangle were a plane one, and computing the area from the formula $S = \frac{1}{2} a b \sin. C$.

With respect to r, which is here taken to represent the radius of curvature of the surface of the triangle in question, it is to be remarked that by reason of the ellipticity of the earth, the radius of curvature of any arc on the earth's surface varies not only with the latitude of the place of observation, but also with the direction of the arc in respect of the meridian. For the present purpose it would be sufficiently accurate to assume r as the radius of the meridian; but as the radius of the perpendicular and oblique arcs is required in other parts of the computation, we shall here state the formulæ from which they are computed. Let R be the radius of curvature of the meridian at latitude l, R′ the radius of the circle pependicular to the meridian, and r the radius of a great circle making an angle $= \theta$ with the meridian; also let p denote half the polar axis of the earth $= 20{,}852{,}394$ feet (*see* DEGREE), and e the ellipticity, or the difference between the equatorial and polar axes divided by the polar axis $(= 1 \div 301{\cdot}026 = {\cdot}003322)$; then

$$R = p\,(1 - e + 3e \sin.^2 l)$$
$$R' = p\,(1 + e + e \sin.^2 l)$$
$$r = R\,(1 + \frac{R' - R}{R'} \sin.^2 \theta)$$

Since the inclination θ is different for each of the sides of the triangle, a mean value of r may be found by making $\theta = 45^\circ$, in which case $\sin.^2 \theta = \frac{1}{2}$; and as the curvature varies very little through a considerable extent of country, the same value of r may be used for all the triangles within a zone of two or three degrees of latitude. Suppose, then, the value to be computed for the mean latitude of a chain of triangles, the formula for the spherical excess will be $E = \dfrac{a b \sin. C \times 648000}{2 \pi r^2}$; and on assuming the constant $648000 \div 2\pi r^2 = m$, the formula for computation will be

$$\log. E = \log. a + \log. b + \log. \sin. C + \log. m.$$

It is proper to remark that in general E is a very small quantity. When the sides of the triangles are about 20 or 30 miles, it will seldom exceed 4 or 5 seconds of a degree; but in some of the great triangles connecting Ireland with the west coast of Scotland its value was found to exceed 30 seconds.

Having computed the spherical excess E, make $e = A + B + C - (180^\circ + E)$, (A, B, C being the observed horizontal angles), then e is the error of the sum of the observed angles; and if there be no reason for supposing that any one of the angles has been less accurately determined than the others, the error e must be equally divided among them, or a third of e must be added to or subtracted from each angle, according as the error is in excess or defect, and the results will give the angles from which the sides are to be computed. Thus, if the angles for computation be A′, B′ C′, we have

$$A' = A + \tfrac{1}{3}e,\ B' = B + \tfrac{1}{3}e,\ C' = C + \tfrac{1}{3}e.$$

Calculation of the Sides. — The angles being thus corrected for errors of observation, it now remains to compute the two unknown sides of the triangles. The computation may be made by the ordinary rules of spherical trigonometry; but this method is seldom practised on account of the length of the calculations. A second method, which was practised by Delambre, and has been adopted in the ordnance surveys of Britain and Ireland, consists in first computing from the observed horizontal angles the corresponding angles formed by the chords of the terrestrial arcs, and then calculating the triangle as a plane one. In this manner the chords of the spherical arcs are found, whence the arcs themselves are easily obtained. The reduction of a horizontal or spherical angle to the corresponding chord angle is made as follows: — Let A be the observed spherical angle, b and c the lengths of the containing sides computed approximately as above explained, r the radius of curvature at the place of observation, and $A - x$ the plane angle contained by the chords of the sides b, c; then

$$x = \frac{1}{16}\left(\frac{b+c}{r}\right)^2 \frac{\tan.\frac{1}{2}A}{\sin. 1''} - \frac{1}{16}\left(\frac{b-c}{r}\right)^2 \frac{\cot.\frac{1}{2}A}{\sin. 1''}.$$

This formula gives the reduction x expressed in seconds, and consequently the chord angle $A - x$. If we now denote by x' and x'' the corresponding corrections for the other angles B and C, the sum of the three corrections will evidently be the difference between the sum of the three spherical angles of the triangle and the sum of the angles of the plane triangle formed by the chords, or 180°, and consequently

$$x + x' + x'' = E;$$

so that the spherical excess is obtained from the reduction, and does not require to be previously computed.

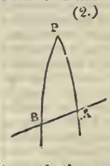
The three chord angles $A - x$, $B - x'$, $C - x''$, being computed from the above formula, the difference between their sum and 180° gives the error of the three observed angles, and must be apportioned among the three chord angles, so that their sum shall be precisely 180°. With these corrected angles the chords of the spherical sides are computed as in plane trigonometry; and the arcs are then found from the chords from the following formulæ, where a', b', c' are the chords of the three terrestrial arcs a, b, c; namely,

$$a = a' + \frac{a'^3}{24 r^2},\ b = b' + \frac{b'^3}{24 r^2},\ c = c' + \frac{c'^3}{24 r^2}.$$

Legendre's Theorem.—A third method of computing the sides, which has been generally adopted in the recent surveys on the Continent, is derived from a theorem which was discovered by Legendre, and is demonstrated in his *Elémens de Géométrie.* "If from each of the angles of any small triangle on the surface of a sphere or spheroid one third of the spherical excess be deducted, the sines of the angles thus diminished will be proportional to the lengths of the opposite sides, and consequently the sides may be computed as if the triangle were rectilineal." This is the easiest method of any; and in fact, if the three angles are assumed to have been equally well determined, the previous computation of the spherical excess is not necessary for the calculation of the sides, though it will be required for estimating the relative accuracy of the observations. The method of proceeding is this: — Let A, B, C be the three observed angles; and let $\delta = A + B + C - 180^\circ$; then, from each of the three observed angles subtract $\frac{1}{3}\delta$, and with the angles thus reduced compute the sides as in a plane triangle from the formula $b = a \sin. (B - \frac{1}{3}\delta) \div \sin. (A - \frac{1}{3}\delta)$. The sides thus determined are equal to the geodetical lines, or the spherical arcs on the ground.

Latitudes, Longitudes, and Azimuths.—When the sides of all the triangles have been computed the distances between the stations become known; but in order to complete the survey, it is still necessary to determine the astronomical positions of the principal stations, and the bearings of the sides of the triangles with respect to the terrestrial meridians. For this purpose the latitude and longitude of one of the stations, and the azimuth of another as seen from it, must be found by astronomical methods (*see* LATITUDE, LONGITUDE, AZIMUTH); but when this has been done these elements may be computed for each of the other stations in the chain of triangles, provided the dimensions and ellipticity of the spheroid are assumed to be known. The formulæ for computation are the following: —

(2.)



Let A and B (fig. 2.) be two stations, A P and B P the meridians passing through A and B and meeting in the pole P; and let the azimuths at each station be counted from the south towards the west. Assume

$l = 90^\circ - A P =$ latitude of A,
$l' = 90^\circ - B P =$ latitude of B,
$A = 180^\circ - P A B$ the azimuth of B as seen from A,
$B = 180^\circ + P B A$ the azimuth of A as seen from B,
$P = A P B$ the difference of the longitudes of A and B,
$d =$ length of the geodetical line A B in feet,
$R' =$ radius of the circle perpendicular to the meridian at A in feet,
$e =$ the ellipticity as above defined $= {\cdot}003322$;
then,

$$l' = l - \left\{\frac{d \cos. A}{R' \sin. 1''} + \frac{d^2 \sin.^2 A \tan. l}{2 R'^2 \sin. 1''}\right\} (1 + 2e \cos.^2 l)$$

$$P = \frac{d \sin. A}{R' \cos. l' \sin. 1''}$$

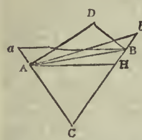
$$B = 180^\circ + A - P\frac{\sin. \frac{1}{2}(l + l')}{\cos. \frac{1}{2}(l - l')}.$$

These formulæ are theoretically sufficient to give the elements in question; but as some uncertainty must exist as to the ellipticity of the earth, and a small error in this respect will affect the convergency of the meridians, and produce a considerable error in the computed longitudes

and azimuths, it is necessary, in carrying a survey over a considerable tract of country, to check the azimuths by determining the direction of the meridian at different stations by astronomical observations.

Calculation of Altitudes. — The only element which remains to be determined, in order to complete the survey, is the relative altitudes of the different stations or principal points. At every station the elevation or depression of each of the others observed from it is measured with the theodolite; but owing to the curvature of the earth, and the refraction of light, a calculation is necessary in order to determine their true differences of level, or of distance from the centre of the earth.

(3.)



Let A and B (fig. 3.) be two stations, C the centre of the earth; and let b be the position of B as seen from A elevated by refraction, and a that of A as seen from B. Make C H = C A; then H B is the true difference of altitude of A and B, or the quantity to be determined from observation. Join A H, A B, A b, and draw the horizontal lines A D and B D, which will be respectively perpendicular to C A and C B. Assume in seconds,

d = D A b the observed depression of B,
d' = D B a the observed depression of A,
C = A C B the angle measured by the arc A B,
ϱ = the mean refraction,
ϕ = B A H the angular difference of altitudes;

then B H will be found by the following formulæ: —

$$\varrho = \tfrac{1}{2}\left\{C - (d + d')\right\} \quad \phi = \tfrac{1}{2}C - (d + \varrho)$$
$$BH = AB \times \phi \sin. 1''.$$

Thus B H is found in terms of A B, and the reciprocal observations at A and B. The mean refraction ϱ is also determined at the same time; but if this be assumed to be known, the observation of depression at one of the stations would be sufficient to give the difference of elevations. The two quantities d and d' have been both assumed to be depressions; if one of them is an elevation, it must be taken with the negative sign.

See the *Trigonometrical Survey of England and Wales;* Delambre, *Base du Système Metrique;* Puissant, *Traité de Geodesie;* Id. *Nouvelle Description Géometrique de la France; Encyc. Brit.* art. "Trigonometrical Survey."

SURVI'VORSHIP, in the doctrine of Life Annuities, is a reversionary benefit contingent upon the circumstance of some life or lives *surviving* some other life or lives, or of the lives falling according to some assigned order. For the solution of the different questions which can be put relative to the values of annuities and assurances in every order of survivorship, where there are only three lives, see the treatises of Baily and Milne; or the *Essay on Probabilities* by Professor De Morgan, in the *Cabinet Cyclopædia.*

SUSPE'NSION BRIDGE. In Architecture, a bridge in which the roadway, instead of being carried over the supporting points, is suspended from them, the supporting points being chains or other flexible materials. The principle has recently been carried to a great extent in this country, as in the case of the Menai bridge; but its application is old, and has long been practised among people who have attained very little if any skill in the arts. *See* BRIDGE.

SUSSEX MARBLE. A variety of limestone which constitutes one of the fresh-water deposits of the Wealdon group; it abounds in shells of *Paludinæ*, a genus of fresh-water Univalves. It occurs in layers varying from a few inches to upwards of a foot in thickness, the layers being separated by seams of clay or of friable limestone.

SU'TTEE. (More correctly written Sati or Satee; in Sanscrit, *pure.*) A word applied by the Brahmins to various rites of religious purification; but more especially, by usage, to the voluntary self-immolation of widows on the funeral pile of their husbands. This is nowhere commanded in the religious books of Hindoostan, although it is spoken of, in common with many other acts of similar fanaticism, as highly meritorious. The English government, up to a late period, had only interfered to ensure, as far as possible, that the sacrifice should be voluntary on the part of the sufferer, which was done by the presence of a government officer. Thus legalized, suttees became frightfully common in Bengal and the adjoining provinces in the present century. At length, in December, 1829, they were abolished in the British dominions by Lord W. Bentinck. (See *Forbes's Oriental Memoirs*, ii. 26.; *Heber's Journal*, i. 70.; and many other authorities.) There is a curious account of a suttee in Bali, an island in which the Hindoo religion now prevails, in *Crawford's Ind. Archipelago*, book vi. ch. 2.

SUTURE, in Mammalogy, is the line formed by the incumbent series of converging series of hairs of the integument. In Entomology, it is the line at which the elytra meet, and are sometimes confluent.

SUTURE, in Anatomy, means the junction of bones by their serrated or teethed margins: the bones of the skull are so united.

SWAB. A large bundle of old yarns hung by the middle, and swung right and left to dry the decks.

SWA'LLOW. A name equivalent to the subgeneric term *Hirundo*, appropriated in modern Ornithology to the British species called bank, chimney, and window swallow, and to foreign allied forms dismembered from the swifts.

SWAMP. Ground habitually so moist and soft as not to admit of being trod on by cattle, but, at the same time, producing particular kinds of trees, bushes, and plants. A swamp differs from a bog and a marsh in producing trees and shrubs, while the latter produce only herbage plants and mosses.

SWAN. Of the noble web-footed birds so called there are three British species, — the Hooper or Bewick's, the wild and the tame swan. These form the type of the subgenus *Cygnus.* The wild swan and Hooper ought perhaps to be regarded as the only true native species. The tame swan (*Cygnus olor*) is superior in bulk to either of the wild species, and is at once distinguished by a large black callous knob on the base of the bill. Both the wild species are peculiarly characterized by convolutions of the windpipe, extending in the mature bird through the whole length of the keel of the sternum. These convolutions are horizontal in the *Cygnus Bewickii*, and vertical in the *Cygnus ferus.*

SWARD. Green turf; that is, the surface of land under pasture grasses. A fine sward may be called the characteristic feature of British landscape, not being found in the same degree of perfection in any other country, not even in Ireland.

SWEDENBO'RGIANS. The followers of Emanuel Swedenborg, a Swedish nobleman, who died in 1772. He conceived the society which he founded to be the New Jerusalem spoken of in Revelations, and its members to be gifted with peculiar insight into spiritual things. The Swedenborgians imagine that they can see mentally, and hold conversation with spirits. They interpret Scripture by a system of correspondences, supposing it to have three distinct senses, accommodated respectively to particular classes both of men and angels. They date the last judgment of the spiritual world and the second advent of Christ from the year 1757. They abound principally in England, where they have at the present day several chapels in London and other large towns.

SWELL. The term for a succession of waves in a particular direction, and named after the point of the compass *from* which the waves move.

SWELL. In Music, a set of pipes in an organ acted upon by a key board, and capable of being increased in intensity of sound by the action of a pedal, which allows of its being thereby gradually augmented. *See* ORGAN.

SWIFT. The name of the largest and most powerful flier of the swallow tribe which visits this country. It is the type of the subgenus *Cypselus* of Temminck; the *Hirundo apus* of Linnæus. *See* HIRUNDO.

SWIFTER. The name given to the foremost and aftermost shrouds, which are not rattled with the rest. The term *swifter* is also applied in many cases to a rope used for the temporary purpose of tightening or keeping a thing in its place.

SWIMMERS. The web-footed or aquatic birds (*Natatores*, Ill.; *Palmipedes*, Cuv.) are so called; also a tribe of spiders (*Araneidæ natantes*) which live in water, and there spin and spread abroad filaments to entrap their prey.

SWINE POX. The *chicken pox*, which see.

SWINE STONE. Fetid or bituminous limestone, which exhales a disagreeable odour on friction.

SWING. The ship at anchor is said to swing when she changes her position at the turn of the tide.

SWIVEL. In Gunnery, a small cannon; so called from its being fixed in a *swivel*, by means of which it may be directed to any object. Swivels are chiefly used at sea, and are placed on the ship's side, stern, or bow, and also in the tops.

SWORD OF STATE. Four swords are used at the coronation of a British sovereign: 1. The sword of state properly so called. 2. The curtana (curtus, *shortened*), the sword of mercy, which is pointless: it is mentioned by Matthew Paris. 3. The sword of spiritual justice. 4. The sword of temporal justice. These three are carried before the sovereign: he is girt with the first.

SWORD, ORDER OF THE. A Swedish military order of knighthood, instituted by Gustavus Vasa.

SY'BARITE. A term used metaphorically to designate an effeminate voluptuary; so called from the inhabitants of Sybaris, formerly a town of Italy on the gulf of Tarentum, whom a devotion to sensual pleasures had so enfeebled that they became an easy prey to the Crotonians,

a people comparatively insignificant in point of numbers, by whom their city was levelled to the ground, B. C. 310.

SYCEE SILVER. The only approach to a silver currency among the Chinese. In it the government taxes and duties and the salaries of the officers are paid; and it is also current among the merchants in general. The term *sycee* is derived from two Chinese words *se sze*, "fine gloss silk;" which expression is synonymous with the signification of the term *wan*. This silver is formed into ingots (by the Chinese called shoes), which are stamped with the mark of the *office* that issues them and the dates of their issue. The ingots are of various weights, but most commonly of ten taels each.

Sycee silver is divided into several classes, according to its fineness and freedom from alloy. The kinds most current at Canton are the following: —

1. Kwan heang: The hoppos duties, or the silver which is forwarded to the imperial treasury at Pekin. This is of 97 to 99 tonch. On all the imperial duties a certain per-centage is levied for the purpose of turning them into Sycee of this high standard, and of conveying them to Pekin without any loss in the full amount. The hoppo, however, in all probability, increases the per-centage far above what is requisite, that he may be enabled to retain the remainder for himself and his dependants.

2. Fan hoo, or fan foo: the treasurer's receipts, or that in which the land tax is paid. This is also of high standard, but inferior to the hoppos duties; and being intended for use in the province. and not for conveyance to Pekin, no per-centage is levied on the taxes for it.

3. Yuen paon, literally "chief in value." This kind is usually imported from Soochan in large pieces of 50 taels each. It does not appear to belong to any particular government tax.

4. Yen, or een hearg, "salt duties." It is difficult to account for these being of so low a standard, the salt trade being entirely a government monopoly.

5. Muh tue; or wuh tue, the name of which signifying "uncleansed or unpurified," designates it as the worst of all. It is seldom used except for the purpose of plating. (Prinsep's "Useful Tables," *Appendix to Journal of Asiatic Society*, 8vo. Calcutta, 1834.)

SYCO'MA. (Gr. *συκον*, *a fig.*) A fig-shaped tumour.

SY'COPHANT. (Gr. *συκοφάντης*, from *συκον*, *a fig*, *φαίνω*, *I disclose.*) It was forbidden by the laws of Athens at one period to export figs. The public informers who gave notice of delinquencies against this fiscal law were extremely unpopular, and hence the word came into use to signify an informer or false accuser generally; in which sense it is constantly used by Aristophanes and the orators. In modern languages it has acquired the sense of a mean flatterer.

SYCO'SIS. A tubercular eruption upon the scalp, or bearded part of the face: it sometimes forms a very troublesome impediment to shaving.

SY'ENITE. A granitic rock from *Syene*, or *Siena*, in Egypt. It often has the appearance of a variety of granite. *See* GEOLOGY.

SY'LLABLE (Gr. *συλλαβη*, from *συλλαμβανω*, *I collect*), is defined by Girard, the celebrated French grammarian, "a simple or compound sound, pronounced with all its articulations by a single impulsion of the voice." The principal difficulty in arranging the syllabic construction of language is to ascertain in what cases two or more consonants following each other may be joined in a syllable; which can only be done by investigation of the mechanism of speech. (See a learned article on this subject in the *Encyclopédie.*)

SY'LLABUS. (Gr. *συν* and *λαμβανω.*) A compendium or abridgment, or a table of contents; as a syllabus of lectures, &c.

SYLLE'PSIS. (Gr. *συλληψις*, *connection or taking together.*) In Grammar, sometimes called substitution. A name given by some writers to that idiom of the Greek and Latin languages whereby an adjective predicated of a masculine and feminine substantive is made to accord in gender with the former: *e.g.* "rex et regina beati."

SY'LLOGISM. (Gr. *συλλέγω*, *I collect.*) In Logic, an argument stated in the correct logical form, consisting of three propositions, and having the property that the conclusion necessarily follows from the two premises; so that if the premises be true, the conclusion must be true also. (*See* PROPOSITION, LOGIC.) As often as the mind observes any two notions to agree with a third, it immediately concludes that they agree with each other: as, A is equal to B; B is equal to C; therefore A is equal to C. Or, if it finds that one of them agrees and the other disagrees with the third, it pronounces that they disagree with each other. In the first of these processes it produces a syllogism with an affirmative conclusion in the latter, a syllogism with a negative conclusion.

Syllogisms are variously divided: by some into single, complex, and conjunctive, &c.; by others (according to the Oxford system of logic) into categorical, hypothetical, conditional, &c. But the categorical syllogism, consisting of three categorical propositions, is the simplest form of reasoning, and that to which all other forms can be reduced.

The following are the two canons by which the validity of a categorical syllogism is explained: — 1. If two terms, *i.e.* notions expressed in language (*see* TERM), agree with one and the same third, they agree with each other. 2. If one term agrees and another disagrees with a third, the two first disagree with one another. Hence are deduced the six following rules.

1. Every syllogism has three terms only; viz. the middle term, and the two extremes. The subject of the conclusion is called the minor term; its predicate the major term: the middle term is that with which they are respectively compared. 2. Every syllogism has three propositions only: the major premiss, in which the major term is compared with the middle; the minor premiss, in which the minor term is compared with the middle; the conclusion, in which the major and minor terms are compared together. 3. The middle term must be, in logical language, distributed once at least in the premises; *i.e.* it must be the subject of a universal, or the predicate of a negative (*see* PROPOSITION); otherwise it may happen that one of the extremes is compared with one part of it, and the other with another part. 4. No term must be distributed in the conclusion which is not distributed in one of the premises; otherwise the whole term would be employed in the conclusion, where part only are employed in the premiss: this error is called an illicit process of the major or minor premiss. 5. From negative premises you can infer nothing; *i.e.* if two terms disagree with a third, you cannot conclude either their mutual agreement or disagreement. 6. If one premiss be negative, the conclusion must be negative; for if one term disagree with the middle, it must of necessity also disagree with the other. The other rules are corollaries deducible from these six.

The *mood* of a syllogism is the designation of its three propositions in their order, according to their respective quantity and quality. By reference to the head PROPOSITION, it will be seen that arbitrary symbols are adopted in logic to mark the quality and quantity of propositions: thus A stands for a universal affirmative; E represents a universal negative; I a particular affirmative; O a particular negative. These four letters will afford sixty-four different combinations of three letters; but of these the greater part will afford syllogisms erring against some one or more of the rules previously laid down: thus E E E would be at once inadmissible, as exhibiting two negative premises, — against rule 5. By an accurate examination, it is found that eleven moods only will afford correct syllogisms: A A A, A A I, A E E, A E O, A I I, A O O, E A E, E A O, E I O, I A I, O A O.

The figure of a syllogism consists in the situation of the middle term with reference to the major and minor terms. 1. The first figure is where the middle term is the subject of the major premiss, and predicate of the minor. 2. Where the middle term is the predicate of both premises. 3. Where it is the subject of both. 4. Where it is the predicate of the major, and subject of the minor. Multiplying the moods by the figures, we should have forty-four different syllogisms. But it will be found, on examination, that five moods in each figure (twenty in all) would err against some one or other of the rules before laid down: *e.g.* I A I is an allowable mood in the third figure; but, in the first, it would have an undistributed middle. Of the twenty-four remaining, five are unnecessary; *i.e.* they are moods in which a particular conclusion only is inferred from premises which would warrant a universal. The nineteen remaining are expressed in the following mnemonic lines:—

Fig. 1. 4 moods: B*A*r*b*A*r*A, c*E*l*A*r*E*n*t*, d*A*r*I*I, f*E*r*I*O-*que*, prioris.
Fig. 2. 4 moods: C*E*s*A*r*E, c*A*m*E*s*t*r*E*s, f*E*s*t*I*n*O, b*A*-r*O*k*O, secundæ.
Fig. 3. 6 moods: Tertia d*A*r*A*p*t*I, d*I*s*A*m*I*s, d*A*t*I*s*I, f*E*l*A*p*t*O*n*, B*O*k*A*r*d*O, f*E*r*I*s*O*n*, habet: quarta insuper addit.
Fig. 4. 5 moods: B*r*A*m*A*n*t*I*p*, c*A*m*E*n*E*s, d*I*m*A*r*I*s, f*E*s*A*p*O, f*r*E*s*I*s*O*n*.

One mood in each figure may be given by way of example. The letter M designates the middle term; the letter preceding the proposition its quantity and quality.

1. A. All excess (M) is sinful.
   A. All gluttony is excess (M): therefore
   A. All excess is sinful. (A syllogism in Barbara.)
2. A. Every thing expedient is lawful (M).
   E. Nothing unjust is lawful (M): therefore
   E. Nothing unjust is expedient. (A syllogism in Camestres.)
3. A. All conquerors (M) are cruel.
   I. Some conquerors (M) are just: therefore
   I. Some just men are cruel. (A syllogism in Datisi.)

4. A. Whatever is expedient is conformable to nature (M).
   E. Whatever is conformable to nature (M) is not hurtful: therefore
   E. What is hurtful is not expedient. (A syllogism in Camenes.)

It will be observed that in all these instances the major premiss is presumed to precede the minor; but although this is the most convenient form of reasoning, the minor premiss is, with equal validity, made the first in the series: *e.g.*

Brutus is an honourable man:
Honourable men affirm the truth; therefore
Brutus affirms the truth.

This is a syllogism in Barbara, with the minor premiss placed before the major.

The fourth figure is considered to be inverted and unnatural; and the first three figures, with their fourteen moods, furnish almost every argument which is employed, however far it may be removed in appearance, through the intricacy of language, from the syllogistic form. But all arguments may be brought, by an ingenious process termed *reduction*, into one or other of the four moods of the first figure.

In reducing a syllogism, the premises may be illatively converted (*see* ILLATIVE CONVERSION), or transposed; since the force of the argument can be altered by neither of these processes. By employing this liberty, we deduce either the same conclusion with the original, or another conclusion from which the original conclusion follows by illative conversion. We have not space to explain, by examples, these various processes. The letters which compose the names of the syllogistic moods are framed to express the manner in which those of the three last figures are reduced into those of the first. The first letter indicates the mood into which those beginning with the same letter are to be reduced: *e.g.* Bramantip is reducible into Barbara; *m* indicates that the premises are to be transposed; *s* and *p* that the proposition denoted by the vowel immediately preceding is to be converted, — *s* simply, *p* per accidens; *k*, which occurs only in Baroko and Bokardo, indicates that the proposition denoted by the vowel immediately before it must be left out, and the contradictory of the conclusion (*see* CONTRADICTORY) substituted, which is termed the *reductio ad impossibile*.

A hypothetical syllogism is one in which the conclusion is deduced from an hypothetical premiss (called the major) and a categorical premiss (called the minor). It is of two kinds, — conditional and disjunctive: the first subdivided into constructive and destructive.

1. Conditional constructive. { If the demand increases, the supply will increase:
But the demand increases;
Therefore the supply will increase.

2. Conditional destructive. { If the country is flourishing, agriculture is flourishing:
But agriculture is not flourishing;
Therefore the country is not flourishing.

3. Disjunctive. { Either A is B, or C is D:
But A is not B;
Therefore C is D.

It is evident that a disjunctive syllogism may easily be reduced to a conditional. (See the *Compendium of Logic* by Dean Aldrich, commonly used at Oxford; and the Treatise of Archbishop Whately.)

SYLPH. (Gr. σιλφη, *a kind of insect.*) The name given to the spirits of air in the fantastic nomenclature of the Rosicrucians and Cabalists. (See those articles.) The use which Pope has made of this fancy in his *Rape of the Lock* is well known. He seems to have borrowed it from the enigmatical romance called the *Count de Gabalis*.

SY'MBOL. (Gr. σύμβολον; from συν, *together*, and βαλλω, *I throw.*) A word of many meanings, although now commonly used in one only. 1. The primary meaning of the verb συμβαλλειν expresses the act of several in constituting or throwing together portions to form a whole. Hence συμβολον signified a treaty or agreement. (*Arist. Polit.*) And it seems to be in this sense that the creeds are termed by early ecclesiastical writers symbols: either because (as Augustine says) all the fundamental doctrines of Christianity are *collected* in them; or from the old traditionary story, related by Rufinus, that the creed called the Apostles' was formed by each of them contributing a sentence. (*See* CREED.) 2. The mind may be said to put together (συμβαλλειν) outward appearances, and collect from them the notion of a thing signified by them; and hence the outward appearances themselves derive the appellation of *symbols*, signs, or emblems; while the act of the mind is termed *conjecture* (Lat. conjicio). Thus, the standards of military bodies were called by the Greeks symbols; as likewise omens and portents; and expressions or figures denoting a received meaning, as the Pythagorean symbols. In this sense, the early Christian church called all rites, ceremonies, and outward forms bearing a religious meaning, by the general name of symbols; the sacraments themselves, and the sacramental elements, the Cross, and, in later times, images and pictures. Symbols, properly so called, must be distinguished from types, *i.e.* phenomena, manifestations recorded in the Old Testament, of which the full meaning is developed by correlative manifestations in the New; and from mere symbolical attributes, such as the figures usually introduced in company of the four Evangelists. *Symbolical books* are such as contain the creeds and confessions of different churches; such as the three creeds, received by all; the Confession of Augsburg, received by the Lutherans; the articles of the Church of England, &c. The Germans call the study of the symbols and mysterious rites of antiquity, and also the study of the history and contents of Christian creeds and confessions of faith, by the name of Symbolics (mythological or theological). *Marheineke's Institutiones Symbolicæ*, of which the first edition appeared in 1812, is one of their most distinguished works in the latter class.

SYMME'TRICAL SOLIDS. In Geometry, a name given by Legendre to solids which, though equal and similar, cannot be brought to coincide with each other, or to occupy the same portion of space. A man's two hands afford an example of symmetrical solids. The equality of plane figures is proved by showing that they may be made to coincide, but it is evident that this mode of proof cannot be extended to all solids.

SY'MMETRY. In the Fine Arts. *See* PROPORTION.

SY'MPATHY. (Gr. συμπασχω, *I suffer with.*) In Moral Philosophy, the quality of being affected by feelings common to our fellow-men. In his *Theory of Moral Sentiments*, Dr. Smith maintains that sympathy is the real foundation of morals. (*See* VIRTUE.) For a succinct statement of this theory, see "The Life of Dr. Smith," prefixed to M'Culloch's edition of the *Wealth of Nations*, p. iv. In the Fine Arts, the term signifies conformity of the parts to each other; but in Painting it is more usually applied to the effective union of colours.

SY'MPHONY. (Gr. σὺν, *with*, and φωνη, *voice.*) In Music, a composition which, from the etymology of the term, evidently implies that the voice anciently formed an essential part of its construction. In the present day, however, the term is otherwise applied, and is exclusively used for a piece in which instruments only are engaged. It is, in fact, a composition for a perfect instrumental orchestra, which, until the beginning of the eighteenth century, was unknown. The *Concerti grossi* of Corelli were the first of the species, which was carried out to a greater extent in the works of Geminiani and Vivaldi; but it does not seem to us that before the time of Haydn it can be said to have assumed the form which the name now imports. There is, perhaps, no musical composition in which the power of the author is so completely developed as in a symphony. The musician in it becomes a poet, or perhaps rather a painter. Scenes and the passions are represented therein by a combination of musical sounds; in illustration of which we need only cite that splendid work of Beethoven, known to all under the name of *Il Pastorale*. The general form of the symphony may be thus described: — It opens with a short, serious, slow movement; this is followed by and forms a contrast to one of spirit and of a lively nature; then comes an andante varied, or an adagio or slow movement; a minuet with its trio follows; and the symphony usually closes with a lively rondo, or a finale of rapid motion.

SY'MPHYSIS. (Gr. συμφυειν, *to grow together.*) A term applied to the junction of certain bones, or to joints not admitting of motion; as the *symphysis of the pubes*.

SYMPIESO'METER. (Gr. συμπιεζω, *I compress*; μετρον, *measure.*) An instrument contrived by Mr. Adie of Edinburgh for measuring the weight of the atmosphere by the compression of a column of gas. It consists of a glass tube ABC of about 18 inches in length, bent as represented in the annexed figure, and having an enlarged portion or bulb of about 2 inches in length and half an inch in diameter at each end. The top at A is hermetically sealed, and the other extremity C can be stopt by a cork. The upper part of the tube A *m* is filled with some permanently elastic gas different from common air (hydrogen gas is found to answer best), and the lower *m* B *n* with a fixed oil, or some fluid which does not act upon the gas and is not acted upon by air.

The tube being opened at C, the oil is exposed to the pressure of the atmosphere, and stands at a height *m*, corresponding to the difference of the pressures of the atmosphere and of the column of enclosed gas. Consequently as the atmospheric pressure becomes greater the gas will be compressed, and the column of oil will rise. The change in the bulk of the gas occasioned by a change of pressure is measured by a scale, which is formed experimentally, and of which the divisions are entirely arbitrary.

But as the bulk of the enclosed gas is altered by any change of temperature as well as of pressure, it is necessary to apply a correction on this account. For this purpose a common thermometer is attached to the instrument to indicate the temperature; and the principal or barometric scale, which measures the compression of the gas, is made to slide upon another scale divided so as to represent the change of bulk in the gas produced by a change of temperature under the same pressure, and corresponding to the graduation of the thermometer. In making an observation, the temperature is first observed by the thermometer; an index or pointer, which is fixed to the top of the sliding scale, is then set opposite to the degree of temperature on the fixed scale, and the number on the sliding scale opposite the top of the column of oil gives the pressure of the air in inches of the mercurial barometer.

The principle of the sympiesometer is the same as that of the *manometer*, or air barometer, which was long ago proposed by Hooke; and Mr. Adie's great improvement consists in the substitution of a gas for common air, which has the defect of being absorbed by the enclosing fluid. It is a valuable instrument at sea, as it is not affected in any degree by the motion of the ship; and it possesses several advantages over the barometer in its convenient size, its greater portability, and in being less liable to accident. (See the *Edinburgh Encyclopedia*, art. "Meteorology;" *Edin. Phil. Journal*, No. 1.; *Edin. Journal of Science*, No. 20.)

SYMPO'SIARCH. (Gr. συμποσιον, *feast*, and αρχω, *I rule*.) The ruler or master of a feast; one selected by the consent of the party to be their president for the occasion, whom the Greeks sometimes called βασιλευς. The word rendered "governor of the feast," in John, ii. 8., is αρχιτρίκλινος. Some think that a priest or Levite was chosen to fill this office in Jewish feasts.

SYNÆ'RESIS. (Gr. συναιρεω, *I contract*.) Otherwise called *Crasis*. (Gr. κρασις, *mixture*.) In Grammar, the contraction of two syllables into one by the formation of a diphthong, or by rendering one of them mute: as, Atreides for Atreïdes. *See* METAPLASM.

SY'NAGOGUE. (Gr. συναγω, *I assemble*.) The religious assemblies of the Jews are so called by Hellenic writers. The Jews had no synagogues, it is thought, before the Babylonish captivity. They were first formed after the return of the Jews to the Holy Land. The rule was, that a synagogue was to be erected in any place where there were ten persons of full age and free condition ready to attend the service of it. Others, however, consider the ten *batelnim*, to use the Hebrew word, to have been ten elders, or stationary men of the synagogue. (See *Lightfoot*.) The service performed in the synagogues consisted, and still consists, of prayers, reading the scriptures, and preaching and expounding of them. The prayers are contained in liturgies. The reading of the scripture consists of three portions: the "Shema," certain selected passages from Deuteronomy and Numbers; the law and the prophets. The third part of the service is mentioned in several places in the narratives of the life of our Saviour, and the Acts: Luke, iv. 16. Acts xiii. 5. The times of the synagogue service were three days a week (Monday, Thursday, and Saturday), besides the holydays. The ministration of the synagogue was not confined to the order of priests; the elders, or "rulers of the synagogue," were persons qualified, and duly admitted, of all tribes. (Prideaux, *Connection*, vol. i.)

SYNALÆ'PHA. (Gr. συν, *together*, αλειφω, *I anoint*; from the melting together of two sounds.) In Classical Prosody, the usage by which, when a word ends with a vowel, with the letter *m*, and the next begins with a vowel, the final syllable of the one runs into the first of the other. This, in Latin verse, also takes place when the last letter is *m*; but the usage in this instance is called *ecthlipsis*, or elision. The synalæpha is commonly, though not with equal regularity, adopted in Italian and Spanish poetry, and is not unfrequently attempted, especially by Milton, in our own; in French it extends only to the *e* mute at the end of words.

SYNARTHRO'SIS. (Gr. συν, *with*, and αρθρον, *a joint*.) The immoveable connection of one bone with another.

SYNCA'RPOUS. (Gr. συν, and καρπος, *fruit*.) In Botany, a term applied to the carpels of a compound pistil when they are completely united into an undivided body; as in the orange.

SY'NCATEGOREMA'TIC. (Gr. συν, and κατηγορημα; a word employed together with categorematics or terms.) In Logic, a word which cannot be employed by itself as a term, but requires to be conjoined with another or others for that purpose. Such are adverbs, prepositions, nouns in other cases besides the nominative, &c. *See* TERM.

SY'NCHONDRO'SIS. (Gr. συν, and χονδρος, *a cartilage*.) The junction of one bone with another by an intervening cartilage.

SY'NCHRONISM. (Gr. συν, and χρονος, *time*.) The tabular arrangement of history according to dates, by which contemporary persons and things in different countries are brought together.

SYNCLI'NAL. *See* ANTICLINAL.

SYNCOPA'TION. In Music. *See* DRIVING NOTES.

SY'NCOPE. (Gr. συν, and κοπτω, *I cut*.) A figure of Grammar, by which one or more letters are omitted in the middle of a word; as in the Latin *litus* for *littus*. *See* METAPLASM.

SYNCOPE. In Pathology, fainting. A disease in which the circulation and respiration temporarily cease, or become extremely feeble.

SYNCOPE. In Music. *See* LEGATO.

SY'NCRETISM. (Gr. συν, and κρασις, *mixture*.) In Philosophy, the blending of the tenets of different schools into a system. A party among the Platonists at the revival of letters, to which belonged Ammonius, Pico della Mirandola, Bessarion, and other distinguished men, have received the name of Syncretists.

SY'NCRETISTS. In Ecclesiastical History, the partisans of Calixtus, a Lutheran divine of the 16th century, who endeavoured to form a comprehensive scheme which should unite the different professors of Christianity. The opinions of Calixtus raised a strong controversy in the Lutheran church. A new confession of faith was drawn up in Saxony for the purpose of excluding his partisans. As doctrines, however, they did not long survive his death, although not without effect on the spirit of the age. (*Mosheim*, cent. xvii. sect. 2.)

SYNDA'CTYLES, *Syndactyli*. The name of a tribe of Perchers, including those which have the external and middle toe united as far as the second joint.

SYNDESMO'SIS. (Gr. συνδεσμος, *a ligament*.) The union of one bone with another by means of ligament.

SY'NDIC. (Gr. συν, *with*, δικη, *justice*.) A title given at different times to various municipal and other officers. The syndics of cities in Provence and Languedoc, under the old French government, were officers delegated by the municipality as agents or mandatories. Such were also the syndics of trading companies. The creditors of a bankrupt, under the law of France, appoint syndics or directors from among their number.

SYNE'CDOCHE. (Gr. συν, *with*, εκ, *out*, and δεχομαι, *I receive*.) In Rhetoric, a figure by which the whole is put for a part, or part for the whole. It is a species of trope. (*See* TROPE.) There are six ordinary instances of synecdoche: 1. When genus is put for species (as "being" in the sense of "man"). 2. When species is put for genus. 3. When the essential whole is put for one of its parts. 4. When the matter, or form, is put for the whole being. 5. The whole for a part. 6. The part for the whole.

SYNE'CHIA. (Gr. συνεχω, *I adhere*.) A disease of the eye in which the iris adheres to the cornea, or to the capsule of the crystalline lens.

SYNE'RGISTS. (Gr. συνεργιζω, *I co-operate*.) A name given to a party in the Lutheran church in the latter end of the 16th century. Those who were thus called appear to have held the doctrine that the divine grace requires a correspondent action of the human will in order to become effectual; which, or something resembling it, is termed semi-pelagian in early ecclesiastical history. Some sentiments expressed by Melanchthon, towards the close of his life, seem to have introduced it into that church.

SYNEURO'SIS. (Gr. συν, and νευρον, *a nerve*, or *ligament*, or *membrane*.) The union of one bone with another by means of an intervening membrane.

SYNGNA'THIANS, *Syngnathii*. (Gr. συν, *with*, γναθος, *a jaw*.) The name of a family of Lophobranchiate fishes, including those in which the lengthened jaws are united by a surrounding integument, so as to form a tubular mouth: the genus *Syngnathus*, or pipe fish, is the type. *Syngnathæ* is a name given by Dr. Leach to an order of Myriapodous insects.

SY'NGRAPHA. (Gr. συν, and γραφω, *I write*.) In Diplomatics, contracts signed by the creditor and debtor, and of which a duplicate original was kept by each.

SYNIZE'SIS. (Gr. συνιζω, *I meet*.) An obliteration of the pupil of the eye; a closed pupil.

SY'NOCHA. (Gr. συνεχω, *I continue*.) A continued inflammatory fever. The term *synochus* is applied to continued fevers, which are in their symptoms intermediate between *synocha* and *typhus*. They are also called *mixed fevers*.

SY'NOD. (Gr. συνοδος, employed in that language to signify a council or ecclesiastical assembly.) Among the moderns a distinction is sometimes made between a council and a synod; the former term representing a general assembly of the episcopal, provincial, or national order; the latter the convention of the inferior clergy of a diocese under its bishop or archdeacon. *See* COUNCIL.

SYNOD. In the Scottish Kirk, an assembly composed of two or more presbyteries. It consists of every parish minister within its limits, and of the elders who have last represented the different sessions in the presbytery. There are sixteen synods in Scotland. *See* PRESBYTERY.

SY'NOD OF DORT. *See* DORT, SYNOD OF.

SYNO'DIC. (Gr. *συν, together, οδος, pathway.*) In Astronomy, the synodic revolution of a planet (or the moon), with respect to the sun, is the time between two consecutive conjunctions or oppositions. The duration of this period is easily found when the difference between the mean motion of the planet and sun in a given interval of time is known; for this difference is to 360° as the given interval to the synodic revolution. The *synodical month* is the period of the moon's synodic revolution, and is the same with *lunar month* or *lunation*. *See* MOON.

SY'NONYMS. (Gr. *συν*, and *ονομα, a name.*) Words of the same language which have a similar signification. Strictly speaking, words having exactly the same signification are not to be found in any language, unless one of them has been borrowed from another language; but in this case the shades of difference are often so slight that words may be frequently used for one another, and this interchange produces a pleasing variety in composition, necessary in poetry. Synonyms form an important object of philological study, demanding, on the part of the inquirer, great knowledge of the principles of language. The chief works on this subject are the *Onomasticon* on Greek, Dumesnil on Latin, Blair, Booth, and Crabbe on English, Stosch and Eberhard on German, and Girard, Beauzée, and Roubaud on French synonyms.

SYNO'PSIS. (Gr. *συν, together, οψις, view.*) A collective view of any subject; as a synopsis of astronomy, theology, &c.

SYNO'VIA. (Gr. *συν*, and *ωον, an egg.*) The fluid which lubricates the cartilaginous surfaces of the joints: it is glairy, and resembles the white of egg.

SY'NTAX. (Gr. *συντασσω, I arrange together.*) In Grammar and Rhetoric, the disposition of the words and members of a sentence in the grammatical arrangements proper to the language. *See* GRAMMAR.

SY'NTHESIS. (Gr. *συν, with; τιθημι, I place.*) In Geometry and Logic, the method of demonstration which sets out from some principle established or assumed, or proposition already demonstrated, and ascends through a series of propositions to that which is enunciated. Synthesis is also called the direct method or *composition*, and is the reverse of analysis or resolution. It is the method followed in *Euclid's Elements*. For the sense in which analysis and synthesis were understood by the ancient geometricians, see ANALYSIS.

SYNTHESIS. In Chemistry, those chemical operations by which compounds are obtained by the union of the separate component parts are called *synthetic*. The term is especially used as opposed to *analysis*. Thus I demonstrate the composition of water *analytically* by resolving it into oxygen and hydrogen gases; and *synthetically*, by recombining those gases so as again to produce the water which had previously been decomposed; the terms *synthesis* and *analysis* being, in fact, synonymous with *composition* and *decomposition*.

SY'PHILIS. (Probably from Gr. *σιφλος, unclean.*) The venereal disease.

SY'RINGE. In Hydraulics, a machine consisting of a small cylinder with an air-tight piston or sucker, which is moved up and down in it by means of a handle. The lower end of the cylinder terminates in a small tube, through which a fluid is forced into the body of the cylinder by the atmospheric pressure when the handle is drawn up, and then expelled in a small jet by pushing the handle in the opposite direction. The syringe acts on the principle of the sucking pump. The syringe is also used as a pneumatic machine for condensing or exhausting the air in a close vessel, but for this purpose it must be furnished with two valves. In the condensing syringe, the valves open downwards and close upwards; in the exhausting syringe they are closed downwards and opened upwards. *See* AIR GUN and AIR PUMP.

SY'RMA. (Gr. *συρμα*, from *συρω, I draw.*) A long garment; so called from its train reaching the ground. It was the proper dress of actors in the classical tragedy.

SYSSARCO'SIS. (Gr. *συν, with*, and *σαρξ, flesh.*) The junction of bones by intervening muscles.

SYSSI'TIA. (Gr. *συσσίτια, common messes.*) An institution of some ancient states, particularly Lacedæmon and Crete, by which the male freemen had their meals together in common messes, instead of eating with their families in private.

SYSTEM. (Gr. *συν, together*, and *ιστημι, I stand.*) In Astronomy, an hypothesis of a certain order and arrangement of the celestial bodies by which their apparent motions are explained. For an account of the systems of Ptolemy, Copernicus, and Tycho Brahe, see ASTRONOMY.

SYSTEM. In the Fine Arts, a collection of the rules and principles upon which an artist works.

SYSTEM. In Music, an interval composed, or supposed to be composed, of several lesser ones; as an octave, which is a system. *See* DIASTEM.

SY'STOLE. (Gr. *συστελλω, I contract.*) In Greek and Latin prosody, a licence by which a long syllable is used as short: *e.g.*

Matri longa decem tulĕrunt fastidia Menses.

SYSTOLE. The contraction of the heart

SY'STYLE. (Gr. *συν, with*, and *στυλος, a column.*) In Architecture, the arrangement of columns in such a manner that they are two diameters apart.

SY'ZYGIES. (Gr. *συζυγια, union, conjunction.*) In Astronomy, the places of the moon or planets when in conjunction or opposition with the sun.

T.

T, the nineteenth letter in the English alphabet, belongs to that order of consonants called *dentals*, or *palato-dentals*, and is susceptible of numerous interchanges, both in the ancient and modern languages. As an abbreviation, T was used for Titus, Tilius, and Tullius. The Roman tribunes indicated their assent to the decrees of the senate by subscribing a T. The sound of *th* is peculiar to the English language.

T BANDAGE. A bandage so named from its shape; it is used to support the dressings after certain surgical operations. (See *Cooper's Surgical Dictionary*.)

TABA'RD. A sort of tunic, or mantle, covering the body before and behind, reaching below the loins, but open at the sides from the shoulders downwards: an ordinary article of dress in England and France in the middle ages. It was at first chiefly used by the military, afterwards by other classes. The tabard, with coats of arms blazoned before and behind, is the state-dress of heralds to this day. It is the dress worn by the knaves in cards. Long tabards, reaching to the mid-leg, were a peculiarly English fashion.

TABASHE'ER. A Persian word signifying a light white porous substance found in the joints of the bamboo: it consists almost entirely of silica. It is said to be used medicinally in the East Indies; but its virtues must be merely imaginary.

TA'BBY. (Ital. tabino.) A term formerly applied to certain figured silks and other goods upon which an irregular pattern had been stamped, either by the pressure of engraved rollers, or by folding the stuffs in such a way as to produce, by the mutual pressure of their fibres, an inequality of surface, which, by reflected light, gives rise to the appearance called *watering*.

TABE'LLION. (Lat. tabula, from the tablets on which they wrote.) In the Roman empire, officers who had charge of public documents were so called; they were also secretaries, or registrars, and in some cases judges. (See Savigny, *Hist. of the Roman Law*, vol. i.) The notaries were their assistants. In France, the titles of "Tabellion" and "Greffier" were confounded, and Henry IV. united the functions of tabellion with those of notary; but the old title seems still to be retained (or was until the Revolution) in some few places.

TA'BERNACLE. (Lat. tabernaculum.) A Latin word signifying a *tent* or *cabin*. The tabernacle which was carried from station to station by the Jews during their wanderings in the desert, was a tent of sails and skins stretched upon a framework of wood, and divided into two compartments; the outer, named *the Holy*, being that in which incense was burned, and the shew bread exhibited; and the inner, or *Holy of Holies*, in which was deposited the ark of the covenant. (Exod. xxvi. xxvii. See *Archæologia*, vol. i.)

The Feast of Tabernacles was one of the three principal festivals among the Jews. It commenced on the 15th of the month Tisri, corresponding with the 30th of September, and lasted seven days, during which the people dwelt in booths formed of the boughs of trees. It was instituted in commemoration of the habitation of their ancestors in similar dwellings during the forty years of their pilgrimage in the wilderness. (See Leviticus, xxiii.)

TA'BES. (Lat.) A wasting away of the body; emaciation; atrophy.

TA'BLATURE. (Lat. tabula, *a table.*) In Music, the use of the letters of the alphabet, or any other character, for expressing the notes or sounds of a composition. It is not now a usual mode of writing. In its stricter and more original sense it is a mode of writing music for a particular instrument on parallel lines (of which each represents a string of the instrument) by means of certain letters of the alphabet. Thus A denotes that the string is to be struck open, B that one of the fingers is to be put on the first stop, C on the second, D on the third, and so on through the octave.

TA'BLE. (Lat. tabula.) In Physics, Astronomy, &c. This term has two different significations. In the first place, it is used to denote merely a collection of numbers, exhibiting the measures or values of some property common to a number of different bodies in reference to some common standard. Thus we have tables of specific gravity, of refractive powers, of the expansion of substances by heat, &c. In its second signification, it denotes a series of numbers which proceed according to

some given law expressed by a mathematical formula. Of this kind are the logarithmic tables; tables of the powers or roots of the different numbers; of the sines, cosines, and other angular functions; of astronomical refractions; of the equations of the planetary orbits, &c. Tables of this sort, by exhibiting at once to the eye all the different values which a given formula can have, save endless labour in calculation, and are of the utmost importance in every branch of natural philosophy. The logarithmic tables, for example, form the universal instrument of astronomical calculation; and it may be safely affirmed that without them the computations necessary for determining the places of the different bodies of the solar system, and rendering astronomy a science of practical utility, would be altogether impossible.

Table is also used in a popular sense to denote a collection of particulars brought under one view. Thus, in history, we have chronological tables; in statistics, tables of mortality at different ages, &c. The mere titles of the useful tables which have been formed in the various departments of knowledge would fill a large volume.

TABLEAUX VIVANTS. (Fr. *living pictures.*) The name given to an amusement in which groups of persons dressed in appropriate costume are made to represent some interesting scene in the works of distinguished painters or authors. It is thus managed:—The room in which the spectators are placed being darkened, the group assume their respective attitudes behind a frame (or some other contrivance intended to represent it) covered with gauze; and candles being so placed as to reflect light upon the group from above, the illusion is complete. These representations are not unfrequently resorted to in England; but their home is chiefly in France and Germany, where they form an important feature on all festive occasions. They owe their present popularity to the celebrated M. Händel-Schutz, whose genius for imitation and declamation was unrivalled in Germany. (See the *Damen-Lexicon.*) Tableaux are often employed to represent some scene in which a riddle is concealed.

TA'BLE LANDS. In Physical Geography, the name given to an extensive system of plains with steep acclivities on every side, and differing from other plains, which are either not much elevated above the sea, or rise by imperceptible degrees. Some of these are very extensive, and retain a general level of several thousand feet above the sea. Sometimes they are bordered with chains of mountains much less elevated on the side towards the table land than in the opposite direction: and sometimes they have surfaces much undulated or broken. The chief table lands are in Central Spain, Southern Africa, Central Asia, Persia, Southern India, Mexico, and the Southern Andes. (See *Traill's Physical Geography*, p. 25. *et seq.*)

TABLE SPAR, TABULAR SPAR. *Schaalstein* of Werner. A greyish white mineral, which occurs in masses and in granular concretions: it is a silicate of lime.

TABLETS. In Roman Antiquities, pieces of ivory, metal, stone, or other substance, used in judiciary proceedings, or in the passing of laws.

TA'BOR. (Fr. tabourine.) A small drum.

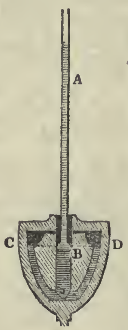
TA'BORITES, or THABORITES. The denomination of one of the parties into which the followers of Huss, in Bohemia, separated after the death of their leader. They were so called from Tabor, a hill or fortress of Bohemia, upon which they encamped during the struggle which they maintained against the civil and ecclesiastical power. At their head stood John Ziska von Brockznow, who was distinguished at once for his indomitable courage and his remorseless cruelty. After various fanatical exhibitions, which were met by their adversaries with determined hostility, the better and more quietly disposed portion of the Taborites formed themselves into a religious society under the denomination of the Bohemian Brethren. They established several Christian communities, elected their own bishops, priests, and elders; drew up a rigorous plan of ecclesiastical discipline; and sent forth missionaries to various parts, though with little success. Though harassed by persecutions, they continued to augment their numbers, and at the end of the 15th century they counted about 200 communities of adherents. At the end of this period the distinctive name and opinions of the Taborites were lost among the various assailants of the Romish corruptions, who formed the vanguard of the Reformation in Germany. (*See* CALIXTINES, HUSSITES.) An interesting picture of the horrors of the bloody religious war in which this sect was engaged at the period of its institution is to be found in the historical romance of Herlosssohn, called *The Last Taborite* (*Der Letzte Taborit*)—a work well worthy of being translated into English.

TABULA'TUM. (Lat.) In Ancient Architecture, a term used to denote the floors, ceilings, and other wood work in a house: occasionally also it was applied to balconies and projections of that nature.

TA'CAMAHA'C. (An Indian word.) A brownish aromatic resin formerly used in medicine, supposed to be the produce of the *Populus balsamifera.*

TACET. (Lat. taceo, *silent.*) In Music, a term denoting that through the movement to which it is affixed in any part that part is to lie still or be silent during its performance.

TACHO'METER. (Gr. ταχος, *speed*, and μετρον, *measure.*) A contrivance invented for the purpose of indicating minute variations in the velocity of machines. When a vessel containing a fluid is whirled rapidly round a vertical axis, the centrifugal force produced by the whirling motion causes the fluid to recede from the axis, and to rise on the sides of the vessel, so that the surface of the fluid assumes a concave parabolic form; and the distance to which the centre of the surface falls below its original level is proportionate to the velocity of rotation, and subject to corresponding variations. Any method, therefore, of measuring or rendering visible the depression of the central surface will indicate the variations of velocity. The method usually adopted is the following:—A glass tube A, open at both ends, and expanding at one extremity into a bell B, is immersed with its wider end in mercury contained in a cup C D. The tube is so suspended as to be unconnected with the cup. This tube is then filled to a certain height, A, with spirits tinged with some colouring matter, to render it easily observable. The cup is attached to a spindle turned by the machine. Now as the cup is whirled round by the spindle, the level of the mercury in the bell falls, and the spirit therefore descends in the tube. As the motion is continued, every change of velocity causes a corresponding change in the level of the mercury, and consequently also in the height of the spirits in the tube at A; and as the capacity of the bell B is much greater than that of the tube A, a very small change in the level of the mercury causes a considerable change of the height of the spirits in the tube. (*Cabinet Cyclopedia*, art. "Mechanics," p. 235.)



TACHYDRO'MIANS, *Tachydromii.* (Gr. ταχυς, *swift*, and δρομος, *a course.*) The name of a family of wading birds, of which the genus *Tachydromus* is the type. The term is also applied to a family of Saurian reptiles by Fitzinger, and to a family of Dipterous insects by Mirgen.

TACHY'DROMUS. (Gr. ταχυς, and δρομος, *a course.*) A subgenus of *Lacertidæ*, differing from the true lizards in having a very long body and tail, with their fore legs very distant from the hind legs, and the back covered with scales similar to those on the belly. They are found in the Indian islands and China, and run with great velocity; whence their name of swift lizards.

TACHY'GRAPHY, or TACHE'OGRAPHY. (Gr. ταχος, *quick*, and γραφω, *I write.*) One of the many names of Greek derivation which have been given to the art of short hand.

TACK. The weather clue or corner of a course, as also of any sail set with a boom or gaff, and of a flag. Also, the rope by which such clue is extended: thus, the *main tack* is the rope by which the tack or weather clue of the mainsail is drawn down to the ship's side.

A ship is said to be on the *starboard tack* when she is close-hauled, having the wind on the starboard side; and on the *larboard tack*, when the wind is on the larboard side. *To tack* is to change from one tack to the other by turning the vessel round with her head to the wind.

TA'CKLE. The Sea term for a pulley composed of two or more blocks. The rope is called the *fall.* The term appears to have been derived thus:—Gr. τροχαλια; Lat. trochlea; Ital. taglia; Dutch taakel. (See *Willis's Principles of Mechanics*, p. 198.)

TA'CTICS. In a general sense, the evolutions, manœuvres, and positions which constitute the main spring of military and naval finesse.

The expression *naval tactics* is commonly understood to relate to the attack or defence of fleets or single ships; but as tactical manœuvres are necessarily practised also in keeping any number of ships together, and in the communication of single ships, whether for hostile purposes or not, the subject, in fact, includes all considerations relative to the closing or separating of vessels at sea. We can of course here merely attempt to convey such general notions on the subject as may assist the reader in the study of it.

The subject of tactics, as applied in war, naturally divides itself into two parts; viz. disposing the fleet for closing with or avoiding the enemy while distant, and bringing on the engagement. The former alone of these

can be made the subject of fixed rules; but the manner of bringing on the action with the whole or part of the enemy's fleet, the choice of the weather or lee *gage* (as the windward or leeward position is called), under given circumstances of weather, locality, armament, relative numbers, discipline, &c., must depend on the experience, skill, and *coup d'œil* of the commander-in-chief.

The evolutions by which the ships of the fleet pass from one position to another are given in all works on naval tactics; and those in most common use are often contained in Signal Books, both English and foreign. The elementary evolutions really necessary are but few, though, especially in foreign works, they are multiplied to an inconvenient, if not impracticable extent. The opinions of officers and writers have differed on many points of great importance; such as the position of the commander-in-chief, the tacking or wearing of the fleet together, or in succession, and also in the general disposition of the fleet.

In regard to the action itself, it appears it was the custom formerly to endeavour to engage the enemy's whole fleet, ship to ship. This, however, was, in most cases, easily avoided, and actions were consequently often indecisive. The circumstance of Lord Rodney's passing through the French fleet on the 12th of April, 1782, seems to have drawn attention strongly to the principle of separating the enemy's fleet into portions which might be attacked in detail. The merit of suggesting the breaking of the enemy's line on this occasion having been attributed to Mr. Clerk of Eldin, author of a work on Tactics which appeared at the time, has become the occasion of much controversy; but the manœuvre had been already treated in French and Spanish works on Tactics. One of the most striking applications of the principle was exhibited in Lord Nelson's attack at the battle of the Nile. Among the works on Tactics may be noticed here, *Tactique Navale*, by the Count Morogues, which was considered an improvement on Le Pere Hoste's work; *Tactica Naval*, by Salazar; and Mr. Clerk of Eldin's *Naval Tactics*, above quoted. Much information is contained in Admiral Ekins's *Naval Battles;* and remarks on the tactics of single actions are found in Sir Howard Douglas's *Naval Gunnery*. Some other works on the subject will be found in any good catalogue of naval books.

TA'CTION. (Lat. tango, *I touch.*) In Geometry, the same as tangency or touching. *See* TANGENT.

TÆ'NIA. (Gr. ταινια, *a fillet.*) An intestinal worm, commonly called the *tape worm*. When this worm infests the bowels, it often produces a variety of anomalous symptoms, and is very difficult to get rid of. The most effective remedies are purges, and especially oil of turpentine, half an ounce of which is taken in the morning, fasting, mixed with a little barley water. If it does not purge briskly, a dose of castor oil may be taken after it, or the oil of turpentine repeated. If any portion of the tape worm remains in the intestines, the symptoms are apt to recur, so that much attention is requisite to ensure its total evacuation.

TÆNIA. In Architecture, the listel above the architrave which separates it from the frieze in the Doric order.

TÆ'NIOIDS, *Tænioides*. (Gr. ταινια, *a riband;* εἶδος, *form.*) The name given by Cuvier to a family of Acanthopterygious fishes, comprehending those which have a flattened riband-shaped body; also the name of a family of Sterelminthoid intestinal worms, of which the tape worm (*Tænia*) is the type.

TA'FFETY. A thin glossy silken fabric, formerly much used in England. It is extensively used on the Continent for window curtains.

TA'FFRAIL. The uppermost rail of a ship's stern.

TA'GES. An old Italian divinity, who is represented to have sprung as a beautiful boy from the earth, which a Tuscan ploughman had furrowed too deep. The first act of this earth-born god was to foretel from the wings of birds what was to happen to the peasants by whom he was quickly surrounded; and hence he was worshipped as the inventor of augury. (*See* AUGURS.) A collection of his prophecies was made and preserved in the sacred records of Etruria.

TA'GLIA. (Ital.) In Mechanics, the name given to a particular combination of pulleys. "The taglia consists of a system of fixed pulleys collected in one common block, and also of a system of moveable pulleys in a separate block, to which the weight is attached, with one string going round all the pulleys, and having one of its ends fixed to a point in the system, and the other end going from one of the fixed pulleys drawn by the power." (*Venturoli's Mechanics*, by Cresswell.) Sometimes several taglias are combined, so that one acts upon the other; the system is then a *compound taglia*. *See* PULLEY.

TAGLIACO'TIAN OPERATION. The operation for the restoration of the nose. *Rhinoplastie* of the French. The merit of inventing this operation is usually given to Tagliacotius, a Venetian surgeon, who wrote upon the subject in 1598, and proposed the replacement of the deficient organ by an artificial nose cut out of the skin of the shoulder or arm. A supposed modern improvement consists in having recourse for the new materials to the skin of the forehead, out of which a triangular piece is so cut that it may retain connection at its apex, which is downwards, and so admit of being twisted or turned down to form the artificial nose by adhesion to the recently cut surfaces of the truncated organ. It appears that this operation was practised in India from time immemorial, and that it was also not uncommonly resorted to by the Italians, and especially the Romans, among whom the loss of the nose was a punishment of not unfrequent infliction. (See *An Account of Two Successful Operations for restoring a lost Nose*, by J. C. Carpue, Lond. 1816; *Liston's Practical Surgery*, Lond. 1837; and *Cooper's Surgical Dictionary*.)

TA'GUS. (Gr. ταγός.) In ancient Greek History, the title of the president of the Thessalian confederacy.

TAIL. In Architecture, the bottom or lower end of any member, as of a slate or tile. A *tail trimmer* is that next the wall into which the ends of joists are fastened to avoid the flues. Used as a verb, *to tail in* any thing is to fasten it by one of its ends into a wall.

TAILLE. In ancient French Jurisprudence, any imposition levied by the king or any other lord on his subjects. There is some obscurity about the derivation of this word. It is commonly deduced from talcæ, *tallies*, little pieces of wood with which reckonings were made. But whether these were not so called from their use in *telling* or counting (Germ. zahlen), does not appear. Again, it is apparently connected with the Germ. zoll, Engl. *toll;* but these words are derived by some, through the Ital. tolta, from the Lat. tollere, *to raise*. Perhaps the whole series of words is from the same original root; but it is not easy to trace the affinities. The *Royal Taille*, in old France, which was the impost commonly understood under the general name, was a personal or rather mixed constitution, from persons not noble or ecclesiastical, or enjoying certain other exemptions imposed according to their supposed ability, measured by their goods. In the respect in which it fell on the agricultural class, from which it was chiefly levied, it is described by Adam Smith as "a tax on the supposed profits of the farmer, which they estimate by the stock which he has upon the farm." (Book iii. ch. 2.) In Languedoc, and one or two other districts, the taille was real; *i. e.* imposed on land and goods. This tax was rendered annual and permanent in 1445. The "real" taille is now replaced by the "contribution foncière," and the personal by the "contribution personnelle et mobiliaire."

TAILLOIR. (Fr.) In Architecture, the same as *abacus;* which see.

TAI'LZIE, or ENTAIL (Fr. tailler, *to cut off*), in Scottish Law, signifies, in general, any deed whereby the legal course of succession is cut off, and an arbitrary one substituted. But, more strictly, a deed of tailzie is one framed in terms of the statute 1685, c. 22., and intended for the purpose of securing the descent of an heritable estate to the series of heirs and substitutes called to the succession by the maker of the tailzie. The principal difference between Scottish and English entails lies in the absence of any provision, in the law of the former country, similar to the fictions of fines or recoveries in the latter, whereby parties in possession were enabled to cut off the entail. Several statutes have been passed since that of 1685 to give heirs of entail in possession certain liberties which they could not otherwise possess; as, to sell superiorities (2 G. 2. c. 50, 51.); to grant leases for 31 years, 14 years, and a life or two lives, and building leases for 99 years; and to exchange lands (10 G. 3. c. 51.), redeem the land tax (42 G. 3. c. 46.), make provisions for wives and children (5 G. 4. c. 87.).

TALAPO'INS. The title, in Siam, of the priests of Fo; who are called in China, Seng; in Tartary, Lamas; and by Europeans, Bonzes.

TALC. A foliated magnesian mineral of an unctuous feel, often used for tracing lines on wood, cloth, &c., which are not so easily effaced as those of chalk. Talc is employed in the composition of *rouge végétal*. The Romans prepared with it a beautiful blue, by combining it with the colouring fluid of particular kinds of testaceous animals. Talc is met with in Aberdeenshire, Perthshire, and Banffshire in Scotland, and in various parts of the Continent, where rocks of serpentine and porphyry occur. The talc brought from the Tyrolese mountains is called in commerce Venetian talc. Several varieties are found in India and Ceylon.

TA'LCITE. In Mineralogy, a synonym of *nacrite;* which see.

TA'LENT. (Gr. ταλαντον.) A Grecian weight, which was much used in the computation of money. It contained 60 minæ; but its value varied in different states. The Attic talent was equivalent to about 198*l.* of English money; the Æginetan to 331*l.* (See as to the Attic talent, *Boeckh*, i. 25.; *Gibbon's Miscellan. Works* iii. 410.)

TA'LES. In Law. If by reason of challenges or other causes a sufficient number of jurors do not appear at a trial, either party may pray a tales; that is, may pray the sheriff (since 6 G. 4. c. 50. the judge at the trial) to allow a sufficient number of qualified men who happen to be present (tales circumstantibus) to be joined with the other jurors to make up the twelve. In practice this seldom arises, except in the case of special jury trials, when the talesmen are taken from the common jury panel in the same court. *See* JURY.

TALIO'NIS LEX. (Lat.) A punishment in which a person convicted of a crime suffered exactly in the same manner as he had offended: thus an eye was required for an eye and a tooth for a tooth. This mode of punishment was established by the Mosaic law, and was in some cases imitated by the Romans.

TA'LISMAN. (From the Arabic, dual of the noun telesm; Gr. τελεσμα, in the sense of an astrological wonder, or effect of the stars.) Among the Eastern nations, a figure cut in metal, stone, &c., supposed to have been made with particular ceremonies, and under particular astrological circumstances, and to possess various virtues, but chiefly that of averting disease or violent death from the wearer. In a more general sense, any portable object endowed with imaginary influence in controlling evil spirits, &c. has been so designated. The term is frequently used as synonymous with amulet (which see); but, strictly speaking, the latter is not believed to possess such extensive powers as the talisman. (See a curious article in the *Enc. Metropolitana*.)

TA'LLAGE (from the Fr. taille), in the language of the old English law, is said to be a general name for all taxes by Sir E. Coke. *See* TOLL, TAILLE.

TA'LLOW. (Germ. talg.) The fat obtained by melting the suet of the ox and sheep, and straining it so as to free it from membrane.

Tallow is an article of great importance. It is manufactured into candles and soap; and is extensively used in the dressing of leather, and in various processes of the arts. Besides our extensive supplies of native tallow, we annually import a very large quantity, principally from Russia. The exports of tallow from Petersburgh amount, at an average, to between 3,500,000 and 4,000,000 poods, of which the largest portion by far is brought to England; the remainder being exported to Prussia, France, the Hanse Towns, Turkey, &c.

TALMUD. The traditionary or unwritten laws of the Jews. It is called *unwritten*, to distinguish it from the textual or *written* law; and, is in fact, the interpretation which the rabbins affix to the law of Moses, which embodies their doctrine, polity, and ceremonies, and to which many of them adhere more than to the law itself.

The word is derived from Heb. lamad, *he taught*. The Talmud, therefore, is a book or volume, which contains such doctrines and duties as are *taught* to the Jews by their own authorized *teachers*, the ancient rabbins.

There are two Talmuds, that of Jerusalem and that of Babylon; not to mention those of Onkelos and Jonathan, which are rather paraphrases than volumes of traditionary doctrines.

The Talmud of Jerusalem consists of two parts — the *Gemara*, and the *Mishna*. The *Mishna* signifies a doubling or reiteration; the *Gemara*, a work brought to perfection or completed, — from the Chaldee *gamar*, to finish or complete. The Gemara and the Mishna together, strictly speaking, form the Talmud; but the rabbins are wont to designate the Pentateuch of Moses the *first* part of the Talmud, and which is simply the law. The *second* part is the *Mishna*, which is a more extensive explication or amplification of the law; and the *third* part, the *Gemara*, as finishing and completing it.

The Mishna is the work of Rabbi Judah Hakkadosh, 120 years after the destruction of the temple of Jerusalem. It is written in a tolerably pure style, and its reasonings are much more solid than those of the Gemara, which the Jewish doctors, it is stated, have stuffed with dreams and chimeras, and many ignorant and impertinent questions and disputations. The Gemara was written about 100 years afterwards by Rabbi Jochanan, the rector of the school at Tiberias. These two works form the Jerusalem Talmud.

But the Talmud of Jerusalem is less esteemed than the Talmud of Babylon formed by Rabbi Asa or Aser, who had an academy for forty years at a place called Sara, near Babylon, whence it was denominated the Babylonish Talmud. It is this Talmud which the Jews more frequently consult; and it is especially esteemed by those Jews who live beyond the Euphrates, from the circumstance that it was compiled at Babylon. Rabbi Asa was called to his fathers before this celebrated commentary on the Mishna was completed; but it was finished by his disciples (some say his children) about 500 years after Christ. With the exception of the sacred authors, these Talmuds, after the Chaldee paraphrases, are the most ancient books of doctrine possessed by the Jews.

A converted Jew in the year 1238 detected several errors in the Talmud, which he laid before Pope Gregory IX., who required the archbishops of France and the kings of Spain and Portugal to seize and burn all such books of the Jews, and twenty cartloads of Hebrew books were accordingly burnt in France alone.

Pope Paul IV. and Clement VIII. also signalized themselves in destroying all the Talmudic books that could be found, and many thousand volumes of the Talmud were by their orders juridically condemned to the flames. These acts, worthy of Roman pontiffs, might have suggested that famous list, entitled *Libri Prohibitorum*, which afterwards received much augmentation; and among the many *heretical* works enumerated might be found Addison's *Spectator*.

The Talmud of Jerusalem was printed in one vol. folio, and that of Babylon in twelve and fourteen vols. folio, which we find in a bookseller's catalogue thus described, "Talmud Babylonicum Hebraicum integrum ex Sapientum Scriptis et Responsis compositum a Rab. Aser, additis Comment. Rab. Sal. Iarchi, et Rab. Mosis Maimonidis, Hebraice, 14 tom. folio, Amstelodami, 1644."

Two curious works on the traditions and doctrines of the Jews, and selections from the Talmud, were written by Peter Stehelin and W. Wotton; the former entitled *Traditions of the Jews, with the Expositions and Doctrines of the Rabbins contained in the Talmud and other Rabbinical Writings*, 2 vols. 8vo. 1742; the latter, *Miscellaneous Discourses relating to the Traditions and Usages of the Scribes and Pharisees in our Saviour's Time*, 2 vols. 8vo. 1718. (See the *Enc. Metropolitana*; Wolff, *Bibl.* ii. 658.; Eisenmenger, *Das Entdeckte Judenthum*; Remarks on the study of it in *Quart. Rev.* vol. xliii.)

TA'LON. (Fr.) In Architecture, the same as *ogee*; which see.

TA'LPA. In Surgery, a tumour under the skin or cuticle, commonly called a *mole*.

TA'LUS. The sloping heap of fragments accumulated at the foot of a steep rock. The term talus has also been applied to the *astragalus*, one of the bones of the ankle.

TA'MARIND. (Arab. tamor-hindy, *Indian date*.) A large tree of the Leguminous order, whose pods supply the subacid preserve commonly sold in the shops under this name. The pods in their natural state are acid, and acquire their sweetness by the sugar in which they are packed after their hard brittle shell has been taken off. The tree itself is a native of both the East and West Indies.

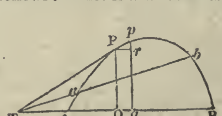
TA'MARIX (Tamarisia, the people among whom it grows), is a name given by botanists to some shrubs of slender growth, clothed with very small green leaves and long spikes of pink flowers, the natural country of which seems to extend from Spain to Delhi, occupying a band of ten or twelve degrees of latitude. They are in this country merely ornamental plants; but in Syria and the adjoining countries they secrete a kind of manna, which some authors have asserted was the manna of scripture; but this opinion is not regarded as well founded.

TAMBOURI'NE. (Fr. tambour.) A musical instrument of procession of the drum species, being a cylinder of about 6 inches wide, in which bells are suspended. It is covered at one end with parchment, after the fashion of a drum.

TA'MPING. A term used by miners to express the filling up of a hole bored in a rock for the purpose of blasting.

TA'NGENCIES. (Lat. tango, *I touch*.) In the ancient Geometry, the *problem of tangencies* was one of the six branches of the geometrical analysis created by Apollonius of Perga. Its general object was to describe a circle passing through given points, and touching straight lines or circles given in position, the number of data in each case being, of course, limited to three. Of the treatise of Apollonius some lemmas only were preserved in the mathematical collections of Pappus; from which the treatise was restored by Vieta, of whose restoration there is an English translation by Lawson, with the addition of a supplement by Fermat, on Spherical Tangencies. The principal cases of the problem of plane tangencies are given, and neatly demonstrated, in *Leslie's Geometrical Analysis*.

TA'NGENT. (Lat. tangens; from tango, *I touch*.) In Geometry, the tangent to a curve is a straight line which meets or touches the curve without intersecting it. The nature of the tangent may be explained as follows: — Let A P B be an arc of a curve, and let the straight line T A B intersect it in two points, A and B. Conceive the straight line to revolve about the point T. When it comes into the position T *a b* the intercepted arc *a* P *b* is shorter than A P B, or the points *a* and *b* have approximated. Let the motion of the line about T still be continued, and the length of the intercepted



arc of the curve will become less and less, until the straight line comes into the position T P, when the two points a and b coalesce, or rather their distance becomes smaller than any assignable quantity. In this ultimate position, the direction of the vanishing arc is that of the tangent, or the element of the arc coincides with the tangent.

From this it is easy to deduce an expression which determines the direction of the tangent at the point P. Let A be the origin of the rectangular co-ordinates, the abscissa being measured on A B. Through P draw the ordinate P Q; and taking P p an indefinitely small element of the curve, draw $p\ q$ the ordinate through p, and P r parallel to A B; also let the tangent meet A B produced in T. The line Q T is called the subtangent; and the point P being assumed, it is only necessary to determine T, or the distance Q T, in order to have the tangent P T. Now the triangles P $p\ r$ and P Q T are similar, whence $p\,r : r\,\mathrm{P} : \mathrm{P\,Q} : \mathrm{Q\,T}$; but by the principles of the infinitesimal calculus $p\,r = d\,y$, $r\,\mathrm{P} = d\,x$; and we have also $\mathrm{P\,Q} = y$, therefore $d\,y : d\,x : : y : \mathrm{Q\,T}$; that is, the subtangent $\mathrm{Q\,T} = y\dfrac{d\,x}{d\,y}$.

See Differential Calculus, p. 343.

This is the general formula for the subtangent of any curve at the point whose co-ordinates are x and y; and therefore the position of the tangent can always be determined when the relation between x and y is defined by an equation, by differentiating that equation.

One of the earliest uses which was made of the differential calculus was to find the positions of tangents to curve lines; and hence the calculus itself, in its early period, was often denominated the *method of tangents*. When the equation of the curve is given, it is easy to find the tangent at any point, as only a simple differentiation is required in addition to the ordinary operations of algebra; but the inverse problem, to determine the equation of the curve when its subtangent at any point is given, requires an integration, and is consequently, in general, attended with much greater difficulty. The first problem was called the *direct*, and the second the *inverse* method of tangents. The terms are synonymous with differential and integral calculus.

Euclid has shown that no straight line can be drawn between a circle and its tangent which does not cut the circle. This property is true of all other curves, and the contact of a curve with its tangent is called a contact of the first order. *See* Contact, Angle of.

Tangent, in Trigonometry, is the straight line which touches a circular arc at one of its extremities, and is terminated by the production of the radius passing through the other extremity. The arc and its tangent have always a certain relation to each other; and when the one is given in parts of the radius, the other can always be computed by means of an infinite series. Let ϕ denote an arc, and tan. ϕ the tangent of the arc ϕ; we have the following series:—

$$\phi = \tan\phi - \tfrac{1}{3}\tan^3\phi + \tfrac{1}{5}\tan^5\phi - \tfrac{1}{7}\tan^7\phi + \&c.$$

$$\tan\phi = \phi + \frac{\phi^3}{3} + \frac{2\,\phi^5}{3\cdot 5} + \frac{17\,\phi^7}{3^2\cdot 5\cdot 7} + \frac{62\,\phi^9}{3^2\cdot 5\cdot 7\cdot 9} + \&c.$$

The tangents were introduced into trigonometry by the Arabians, and the introduction has been of the most important use in simplifying calculations. For the manner of using the sines, cosines, tangents, and other angular functions, see Trigonometry.

TA'NISTRY. An ancient Irish custom of descent, defined as "descent from the oldest and worthiest of the blood." (See *Sir J. Davies's Cases before the Irish Judges*, 1762.) Some have derived it from thane or thegn; but this seems to be a word of Teutonic origin. (See also *Quart. Rev.* vol. lvi. p. 223.)

TANK. In the Navy, a case of sheet iron about 4 feet square, and containing about 2 tons. Bilge tanks are of various forms, in order to employ the vacant spaces near the sides in small vessels. Iron tanks have for many years been used in the navy from their incomparable superiority over casks in keeping the water sweet.

Tank. In Gardening, a cistern or reservoir, made of stone or timber or some other material, used in collecting and preserving water during a scarcity or drought. Tanks are sometimes built in the ground, and lined with lead or cement. (*Loudon's Encyc. of Gardening*, p. 603.)

TA'NNER'S BARK. The bark of oak, chestnut, willow, larch, and other trees, which abounds in tannin, and is used by tanners for preparing leather. After being exhausted of the tanning principle by being chopped into small pieces, or bruised, and steeped in water, it is laid up in heaps to dry, and sold to gardeners for the purpose of producing artificial heat by fermentation in pits or beds, in bark-stoves or other out-houses, or pits. *See* Stove.

TANNIC ACID. This term has been especially applied to a substance obtained by Pelouze by acting upon bruised galls by common ether; it is a white uncrystalline powder, very astringent, little soluble in water, and reddening litmus. When moistened and exposed to air it becomes converted into gallic acid. It is extremely astringent, and appears to be the active principle of tanning substances (tannin) in general. Its equivalent, deduced from the analysis of the neutral *tannates*, appears to be 426. Its ultimate elements are 30 atoms of carbon, 18 of hydrogen, and 24 of oxygen.

TA'NNIN. The pure astringent principle of vegetables, upon which their power of converting skin into leather depends. Its leading character is its property of producing a dense whitish precipitate in a strong solution of animal jelly, such, for instance, as isinglass. It may be obtained tolerably pure by infusing bruised grape seeds in cold water; or more circuitously by adding acetate of copper to filtered infusion of galls, washing the precipitate, and decomposing it (diffused through water) by sulphuretted hydrogen. On evaporating its solution, it is obtained as a pale yellow extract of a strong astringent taste. The action of astringents upon persalts of iron has given rise to its distinction into two varieties; the first changing them to deep blue or black, the second to green. The tan of galls, oak bark, grape seeds, &c., possesses the former property; that of catechu and tea the latter.

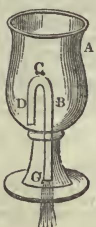
By digesting powdered charcoal in nitric acid, and carefully evaporating the solution so obtained, Mr. Hatchett succeeded in procuring a brown substance of an astringent taste, and precipitating solution of gelatine, which he terms, therefore, *artificial tan*.

TANTALITE, or COLUMBITE. The ferruginous oxide of columbium. It occurs in small masses, and in octoedral crystals. It has been found in Finland and in the United States of America.

TANTA'LIUM. *See* Columbium.

TA'NTALUS. In Greek Mythology, a king of Lydia, Phrygia, or Paphlagonia, according to different authors, whose punishment in the infernal regions is well known to classical readers. He was condemned to be plunged in water, and have delicious fruits hanging continually over his head, without the power of satisfying either thirst or hunger. His crime is differently represented. According to some, he served to the gods at a feast the limbs of his own son Pelops; according to others, he revealed the mystery of the gods, of whom he was high-priest; while others attribute to him the vices of pride and too great wealth. (For a learned interpretation of the myth, see *Bryant's Ancient Mythology*, i. 364.)

TANTALUS'S CUP. A philosophical toy which amusingly exhibits the principle of the siphon. Into a



hole in the bottom of a cup A the longer leg of a siphon B C D is cemented, so that the end D of the shorter leg nearly touches the bottom of the cup within. When water is poured into the cup, it rises in the shorter leg of the siphon until it reaches the level of the top of the bend at C, when it flows over into the larger leg, and is carried off at G; so that if water is not supplied to the cup faster than it is drawn off by the siphon, the cup will be emptied. To form the toy, the legs of the siphon are concealed by the hollow figure of a man whose chin is on a level with the bend of the siphon; so that the figure stands like Tantalus in the fable,—up to the chin in water, but unable to quench his thirst.

TA'NYSTOMES, *Tanystoma*. (Gr. *τεινω, I stretch*, and *στομα, a mouth*.) The name of a family of Dipterous insects, comprehending those which have a projecting proboscis, with the last joint of the antennæ undivided.

TA'PESTRY. (Fr. tapisserie.) An ornamental figured textile fabric of worsted or silk for lining the walls of apartments. The most celebrated manufacture of this kind is produced at the Gobelins royal manufactory, near Paris. In Painting, *tapestry* is applied to a representation of a subject in wool or silk, or both, worked on a woven ground of hemp or flax.

TAPE WORM. *See* Tænia.

TAPIO'CA. The prepared starch of the root of the *Jatropha manihot*. The root abounds with a milky juice, which is poisonous, but which deposits an inert starch when diffused through water. The root is called *cassava*, and is rendered harmless by boiling.

TA'PIR. (Lat. tapirus.) The name of a genus of Pachydermatous Mammals, of which three existing and several extinct species have been determined. Of the existing species one is a native of Sumatra, the other two of South America. They have a short proboscis; four toes on the fore foot, and three toes on the hind foot.

TAR. A dark-brown viscid liquid, obtained by heating the wood of the fir tree: it consists of resin, empyreumatic oil, and acetic acid. When inspissated by boiling, it is converted into *pitch*. The varieties of tar have lately been the subject of an elaborate investigation by Dr.

Reichenbach, who has obtained from it six distinct substances, which he terms *paraffine*, *eupion*, *kreasote*, *picamar*, *capnomar*, and *pittacal*.

TAR, MINERAL. A variety of bitumen, much resembling petroleum.

TA'RANIS. In Mythology, a Celtic divinity, confounded by Latin writers with their Jupiter. He was regarded as the evil principle, and worshipped with human sacrifices; whence the verse of Lucan,—

Et Taranis Scythicæ non mitior ara Dianæ.

(See *Mem. de l'Acad. des Inscr.* vol. xxiv.)

TARA'NTULA. (So called from Taranto in Sicily.) The name of a Fabrician genus of Pedipalpous Pulmonary Arachnidans, infesting the torrid regions of Asia and America. The group is now divided into the genera *Phrynus* and *Thelyphonus*. The term is also applied to a genus of spiders found in some parts of Sicily, whose bite produces a train of symptoms long believed to be curable only by music. From this word is derived the term *tarantella*, the national dance of the Sicilians.

TA'RDIGRADES, *Tardigrada*. (Lat. tardus, *slow*; gradior, *I march*.) A family of Edentate Mammals, comprising those which are remarkable for the slowness of their motions when upon the ground, as the sloths.

TA'RDO. (It. *slow*.) In Music, a term denoting that the movement to which it is affixed is to be performed slowly. It is nearly the same in signification as *largo*.

TARE. In Commerce, an abatement or deduction made from the weight of a parcel of goods on account of the weight of the chest, cask, bag, &c. in which they are contained. Tare is distinguished into *real tare*, *customary tare*, and *average tare*. The first is the actual weight of the package; the second its supposed weight according to the practice among merchants; and the third is the medium tare, deduced from weighing a few packages and taking it as the stnadard for the whole. In Amsterdam, and some other commercial cities, tares are generally fixed by custom; but in this country the prevailing practice, as to all goods that can be unpacked without injury, both at the custom-house and among merchants, is to ascertain the real tare. Sometimes, however, the buyer and seller make a particular agreement about it.

TARE. In Agriculture. *See* VETCH.

TA'RGUM. A Hebrew word, denoting a paraphrase of some portion of scripture in the Chaldean language, of which there are ten in existence: the two principal ones being those of Jonathan (or rather the Pseudo-Jonathan), an author who wrote a paraphrase, or rather a commentary, upon the Greater and Lesser Prophets, about thirty years B. C.; and of Onkelos, upon the Pentateuch, which is considered the most valuable of all, and is referred to the first century of our era. Two others are supposed to be of considerable antiquity. The remaining six are comparatively modern. (See *Enc. Metr.*)

TA'RIFF. A table alphabetically arranged, specifying the various duties, drawbacks, bounties, &c. charged and allowed on the importation and exportation of articles of foreign and domestic produce.

TARPAW'LING. A painted or tarred canvass cover generally.

TARRAS, or TERRAS. A volcanic product, which, mixed with mortar, gives it the property of hardening under water. Several argillo-ferruginous minerals possess this property, and are often indiscriminately used under this term.

TARSE, *Tarsus*. (Gr. ταρσος, *sole of foot*.) In Mammalia, signifies the collection of small bones between the tibia and metatarsus, or those which constitute the first part of the foot. In Birds, it is sometimes applied to the third segment of the leg, which is rarely fleshy or feathered; and corresponds with the tarsus and metatarsus conjoined. In Insects, it signifies the aggregate of minute joints which constitute the fifth principal segment of the leg or the foot.

TA'RTAR. (Gr. ταρταρος, *infernal*; because it is the sediment or dregs of wine.) The substance which concretes upon the inside of wine casks. It is called red and white *argol*, according to the wine from which it is obtained. When purified it is often called *cream of tartar*: it is a bitartrate of potash.

TARTAR EMETIC. A double salt, consisting of tartaric acid in combination with potassa and protoxide of antimony. *See* ANTIMONY.

TARTA'RIC ACID. The acid of tartar. This acid is contained in grape juice, and in tamarinds and several other fruits. It is usually obtained from purified tartar: 4 parts of powdered tartar and 1 of chalk are mixed in hot water, and the white powder which subsides (tartrate of lime) is decomposed by dilute sulphuric acid, which combines with the lime to form sulphate of lime, and the tartaric acid being liberated is obtained by evaporation. When pure it forms white crystals, composed of one equivalent of dry acid and one of water ($66 + 9 = 75$). The anhydrous tartaric acid, as it exists in the dry tartrates (tartrate of lead, for instance), is composed of

	Atoms.	Equiv.	
Carbon	4	24	36.36
Hydrogen	2	2	3·03
Oxygen	5	40	60·61
	1	66	100·00

TARTAR OF THE TEETH. This substance, which occasionally concretes upon the teeth, consists, according to Berzelius, of

Salivary mucus	13·5
Animal matter soluble in muriatic acid	7·5
Phosphate of lime (earthy phosphates)	7·9
	100·0

TA'RTARUS (Τάρταρος; called also the house of Hades by the Greeks, and Orcus by the Latins), was the name of the infernal regions, over which Pluto or Hades had dominion.

TARTRA'TES. Salts in which the tartaric acid is combined with bases.

TARTROVI'NIC ACID. An acid composed of tartaric acid in combination with the elements of ether.

TARTU'FFE. A common French nickname for hypocritical pretenders to devotion. It is derived from the celebrated comedy of Molière, of which the hero is so called. Whether Molière invented, or took it from the popular language of the time, does not appear: some say that he intended to attack Louis XIV.'s confessor, Père la Chaise, whom he had once seen eating truffles with peculiar *goût;* and thence the name. The play was written in 1664, but not acted till 1669; great difficulties being thrown in the way of the author by the clergy and the papal legate. On one occasion it was prohibited when the curtain was on the point of rising, and Molière announced to the public its disappointment in the well-known equivocal words, "Monsieur le président ne veut pas qu'on le joue." When at last licensed (through the influence, it is said, of the king himself), it had a run of three months with unparalleled success; and the eager attention and applause which it still excites bear testimony at once to the keenness of the wit, and the peculiar relish of the public for the exposure of the frailties of those who profess a religious character. In England, this play has been made more than once to serve the popular passions of the day. Cibber translated it, and made the hero a nonjuring churchman; and the play is still acted under the name of *The Hypocrite*, in which the Tartuffe is a methodistical divine.

TASTE. That power of the mind which is conversant about the beautiful, both of nature and of art. In the Latin language, the same metaphor obtained a very wide application, and the term sapientia was employed to signify quickness and correctness of judgment generally. Shaftesbury's use of the term is nearly as extensive, being applied by him to manners, morals, and government, and to wit, ingenuity, and beauty. In its modern use it is restricted to those objects which fall within the province of imagination. Now, although imagination derives its objects pre-eminently from those of the sight and hearing, and although the epithet *beautiful* is, for the most part, confined to these; yet the mental power which judges of them borrows its name from a third sense. The reason of this is satisfactorily shown by Coleridge. (*Literary Remains*, vol. i.) The senses, he observes, are either purely organic, or mixed. The former present their objects to the mind distinct from its perception of them, while the latter invariably blend the perception of the object with a certain consciousness of the percipient subject. To the latter class belong the touch, the smell, and the taste. Of these taste and smell differ from the touch, as adding to that reference to our vital being which is common to the three a degree of enjoyment or otherwise; while the taste is distinguished from the smell only by its more frequent and dignified use in human nature. By taste then, as applied to the fine arts, we must be supposed to mean an intellectual perception of any object, blended with a distinct reference to our sensibility of enjoyment or dislike.

In the same essay Coleridge gives another and a wider definition of taste: as "a metaphor taken from one of the mixed senses, and applied to objects of the more purely organic, and of *our moral sense*, when we would imply the coexistence of an immediate personal dislike or complacency." Now, by the constitution of man's nature, every exertion of human activity in the pursuit of the good, the beautiful, and the true, combines a sense of pleasure, or the contrary, with the perception of their respective objects; and this fact would justify the widest application of the metaphor. While, however, in the case of the true, this coexistent pleasure has not received any distinctive appellation, and while conscience, as comprehending the sense of approbation and disapprobation, is characteristically applied to the moral energy, that of taste has been confined to the perception of beauty and the accompanying gratification.

But taste, like all other metaphorical terms, is extremely inaccurate; and by directing attention exclusively to this element of pleasure, it has led to a very inadequate conception of the true nature of the faculty which it designates. Thus Hutcheson (*Inquiry into the Idea of Beauty and Virtue*) maintains that the faculty is peculiar, and a sense which, similarly to the other senses, procures a pleasure totally distinct from a cognition of principles, or of the causes, relations, and usages of an object; that beauty strikes at first sight, and that knowledge the most perfect will not increase the pleasure which it gives rise to; and lastly, that all the diversity of sentiments excited in different minds by the beautiful arise solely from the modifications of the sense by association, custom, example, and education. Among the advocates of the theory of a moral taste we may reckon Hume, Akenside, Blair, Lord Kames, and Beattie.

Blair accordingly defines taste to be the power of receiving pleasure from the beauties of nature and art; while Akenside describes it as "certain internal powers feelingly alive to each finer impulse." Dr. Beattie (*Essay on Poetry and Music*) supposes taste to have its origin in a mutual harmony and sympathy between the soul in its first formation and the rest of nature, which experience may confirm, but no perverse habits subdue. In the *Essay on the Delicacy of Taste*, Mr. Hume talks of it as a natural sensibility; while in the *Essay on the Standard of Taste*, he seems to admit of no other criterion than the decisions of a due and sufficiently extensive experience. Lastly, Lord Kames declares a taste in the fine arts to be nearly allied to the moral sense; but yet, like morals, capable of being raised to a rational science by an examination of the sensitive branch of the human constitution, and an enumeration of the objects which are either agreeable or disagreeable by nature.

But taste is not only a sensitive, but also a cognitive faculty. When a beautiful object is presented to the mind, not only does it make on it a delicious impression of pleasure, but the mind in the first place passes judgment upon it, and declares it to be beautiful; that is, conformable to a standard called the beautiful. In this complex operation of taste, the judgment is the antecedent, and the pleasure the consequent. When the impassible judgment has passed sentence upon the object, then the sensibility is awakened to certain sentiments, which are, as it were, the echo of the reason. (Cousin, *Sur le Vrai, le Bien, et le Beau.*)

Thus, too, Ancillon (*Melanges Literaires, &c.*):—"The impression which an object makes on the senses is insufficient to give rise to the sentiment of the beautiful. The impression on the senses is but the occasion on which the taste declares that the idea which it impressed on the sensible object, and which that object expresses, is the idea of beauty." To this view of taste we may refer the opinions of Addison and Burke. According to the latter, taste is that faculty or those faculties of the mind which are affected with, or form a judgment of, the works of imagination and the elegant arts; while Addison connects the emotion of pleasure with the power of distinguishing the beauties and imperfections of an author. To this class also we must refer the views of Sir Joshua Reynolds, Dr. Gerard, and Mr. Alison. According to the latter, taste is that faculty of the human mind by which we both perceive and enjoy whatever is beautiful and sublime in the works of nature and art, the perception of these two qualities being attended with an emotion of pleasure distinguishable from every other pleasure of our nature. In the sketch of his proposed work, which unfortunately he has never completed, he intended to show the nature of the faculty, and, in refutation of the theory of Hutcheson, to prove that it has no resemblance to a sense; and that it is not even a separate and peculiar faculty, but admits of being ultimately resolved into more general principles of our mental constitution. If taste were only a sense, it would be difficult to explain the fact, that amidst the inexhaustible variety of sensations which different minds experience from the beautiful, there nevertheless reigns a certain unanimity in men's judgments with respect to it, which cannot have any other source than the identity of reason in the human species. The sense of pleasure, however, is still a necessary and essential element of the faculty of taste. Without it we should be condemned to a perfect uniformity of sentiment in the presence of the beautiful, in the same manner as the absence of judgment would reduce us to an endless diversity.

The same conclusion will follow from an examination of some of the principal definitions of beauty. According to St. Austin (Ep. 18.), "unity is the universal form of beauty;" and to Malespina (*Delle Leggi del Bello*), "beauty consists in unity, multiplicity, and propriety." De Crousaz (*Traité du Beau*) makes beauty to consist in variety, unity, regularity, order, and proportion. Winckelmann and Sulzer agree also in making unity and multiplicity to be essential constituents of the beautiful. And lastly, the definition of beauty in the Italian schools of painting, was, "il più nell' uno,"—variety in unity; which is nearly identical with Hutcheson's explanation of it,—uniformity in variety. The justness of these views will readily appear, if we consider that while variety satisfies the demands of the imagination by affording the gratification most conformable to its nature and laws, unity is necessary for its being apprehended by the judgment, and in order to its appreciation as a work of art.

A few definitions of beauty remain to be noticed, which apparently favour the theory of Hutcheson. According to Burke (*On the Sublime and Beautiful*), and Price (*Essay on Beauty*), beauty consists in such qualities as induce in us a sense of tenderness and affection. Alison declares that the qualities of matter are neither beautiful nor sublime in themselves, but only such so far as they are signs or expressions of qualities capable of producing emotion. Wieland makes beauty to consist in the unity of an *agreeable* variety; and Kant teaches that the beautiful pleases irrespectively of any idea of utility, or of any conception of design, simply by the correspondence of the object and and the sensitive organ.

The emotions of taste are usually distinguished into those of the sublime and beautiful; but Dugald Stewart seems with justice to have denied the existence of any intrinsic difference between them. According to Burke, indeed, the terrible is a fruitful source of the sublime; and this idea does not seem capable of being made an ingredient of the beautiful. In the same way, on the other hand, there are ideas eminently beautiful which can never give rise to an emotion of sublimity. Nevertheless, this does not constitute an essential difference between the two. It is with reference to their several effects upon the imagination that they may perhaps be most correctly distinguished. Considered in itself, a beautiful object ought to present the greatest possible unity combined with the greatest possible variety; and considered in the effect it produces on the mind, its beauty consists in the free, facile, and harmonious play of the imagination. On the other hand, the imagination is lost and overpowered in the contemplation of the sublime, which in its infinity presents at once unity and variety.

TASTO. (It. *the touch.*) In Music, a term used in conjunction with *solo*, to signify that the instruments that can accompany by chords are only to play single sounds till the direction is contradicted by the word *accordo*, or *accompanimento*.

TA'TTA. (Indian.) A bamboo frame or trellis, over which water is suffered to trickle with a view of cooling the air as it enters the windows or doors.

TATTOO'ING. The name given to a practice common to several uncivilized nations, which consists in puncturing the skin and rubbing a dye or gunpowder into the wounds, by means of which certain figures are represented on the face and other parts of the body on which the operation has been performed.

TAU'RUS. (Lat. *the Bull.*) In Astronomy, the second in order of the twelve zodiacal constellations. There are several remarkable stars in this constellation: Aldebaran, of the first magnitude, in the eye; the well-known cluster called the Pleiades, in the neck; and the Hyades, in the face. *See* CONSTELLATION, ZODIAC.

TAU'TOCHRONE (Gr. ταυτος, *the same*, and χρονος, *time*), in Mechanics, is a curve line having this property, that a heavy body descending along it by the action of gravity will always arrive at the lowest point in the same time, wherever the point from which the body begins to fall be taken in the curve. Huygens first showed that this is a property of the common cycloid when the motion takes place in a vacuum, and gravity is supposed to act in parallel straight lines. (*See* CYCLOID.) Newton and Hermann also determined the tautochrone in a vacuum, when gravity is supposed to be directed towards a given centre. Newton likewise showed that the cycloid is also the tautochrone in a resisting medium, when the resistance is proportional to the velocity (*Principia*, b. ii. prop. 26.); and Euler first determined the nature of the curve when the resistance is proportional to the square of the velocity (*Mechanica*, vol. ii.) See also Joh. Bernoulli, *Opera*, vol. iii.

TAUTO'LOGY. (Gr. ταυτὸ, *the same thing*, and λογος, *discourse.*) In Rhetoric, a vicious diction, by which the same idea is expressed in two or more different words or phrases, apparently intended to convey different meanings.

TAWING. The art of preparing certain kinds of leather by imbuing the skins with saline, oily, and other matters. *See* LEATHER.

TAXATIO ECCLESIASTICA. A name given to several public records. The oldest is that of Norwich, made in 1253, for the purpose of assessing the first fruits and tenths of ecclesiastical benefices; sometimes called Pope Innocent's valor, that pontiff having made a present of them for three years to Henry III. All taxation was regulated by this assessment until the reign of Henry VIII., when the *Valor Ecclesiasticus*, sometimes called the *King's Books*, was compiled by his commissioners.

TAXATION. A tax is a rate or duty laid by government on the incomes or property of individuals, or on the

products consumed by them; the produce of such duty or rate being placed at the disposal of government.

A tax may be either general or particular; that is, it may either affect all classes indiscriminately, or only one or more classes.

Taxation (Lat. taxatio) is the general term used to express the aggregate of particular taxes. It is also the name given to that branch of the science of political economy which explains the mode in which the revenue required for the public service may be most advantageously raised.

It would be quite superfluous to enter into any lengthened arguments to show the utility, or rather necessity, of raising a revenue for the use of the public. *Neque quies gentium, sine armis; neque arma, sine stipendiis; neque stipendia, sine tributis habere queunt.* (*Tacit. Hist.* iv. cap. 74.) It is admitted on all hands that security from foreign invasion, the speedy and impartial administration of justice, and the maintenance of good order and tranquillity, are absolutely indispensable to the successful exertion of industry, and to the advancement of society. And when such is the case, no individual can justly complain that he is made to contribute, in the same proportion to his means as others, for the attainment of such objects; or, which is the same thing, that he is made to pay his fair share of the sum required to procure the services of the soldiers and sailors necessary to repel hostile aggression, and to support the various institutions and public functionaries required to maintain internal peace, to promote prosperity, and to protect every citizen in the undisturbed enjoyment of his property and rights. In most countries the public has frequently had to contribute larger sums than have been required for the ends of good government. But abuses of this kind obviously originate either in the misconduct of administration, or in the defective political organization of the states in which they occur, and do not, therefore, properly come within the scope of our inquiries. In treating of taxation, the object of the political economist is, not to inquire whether the revenue raised by the state exceed its necessary wants, or whether it be judiciously expended; but to point out the effect of taxation on individual and public wealth, and, by analyzing the various methods in which a revenue may be raised, and comparing them together, to show which is most advantageous, or rather which is least injurious. But as such inquiries, were they prosecuted at any considerable length, would involve discussions nowise suited for a work of this kind, and far exceed its limits, we must confine ourselves to a few observations illustrative of the principles that should be especially kept in view in the imposition of taxes.

Taxes may be either direct or indirect; that is, they may be either imposed on the incomes or property of individuals, or on the articles on which these incomes or property are expended. But before proceeding to inquire into the nature and influence of different taxes, it may be proper to premise the maxims laid down by Adam Smith with respect to taxes in general, inasmuch as they are drawn up with singular judgment and comprehensiveness.

First Maxim — "The subjects of every state ought to contribute towards the support of the government, as nearly as possible in proportion to their respective abilities; that is, in proportion to the revenue which they respectively enjoy under the protection of the state. The expense of government to the individuals of a great nation is like the expense of management to the joint tenants of a great estate. In the observation or neglect of this maxim consists what is called the equality or inequality of taxation."

Second — "The tax which each individual is bound to pay ought to be certain, and not arbitrary. The time of payment, the manner of payment, the quantity to be paid, ought all to be clear and plain to the contributor and to every other person. When it is otherwise, every person subject to the tax is put, more or less, in the power of the tax-gatherer, who can either aggravate the tax upon any obnoxious contributor, or extort, by the terror of such aggravation, some present or perquisite to himself. The uncertainty of taxation encourages the insolence and favours the corruption of an order of men who are naturally unpopular, even where they are neither insolent nor corrupt. The certainty of what each individual ought to pay is, in taxation, of so great importance, that a very considerable degree of inequality, it appears, I believe from the experience of all nations, is not so great an evil as a very small degree of uncertainty."

Third — "Every tax ought to be levied at the time and in the manner in which it is most likely to be convenient for the contributor to pay it. A tax upon the rent of land or of houses, payable at the same term at which rents are usually paid, is levied at the time when it is most likely to be convenient for the contributor to pay, or when he is most likely to have wherewithal to pay. Taxes upon such consumable goods as are articles of luxury are all finally paid by the consumer, and generally in a manner that is very convenient for him. He pays them by little and little as he has occasion to buy the goods; and as he is at liberty, too, either to buy or not to buy as he pleases, it must be his own fault if he ever suffers any considerable inconveniences from such taxes."

Fourth — "Every tax ought to be so contrived as both to take out and to keep out of the pockets of the people as little as possible, over and above what it brings into the public treasury of the state." (*Wealth of Nations*, M'Culloch's ed. 1 vol. 8vo. p. 371.)

It may be, and in fact often has been supposed, that direct taxes, or taxes laid on property or income, or both, would have the advantage of corresponding better with the first of Smith's maxims than any other description of taxes, by making individuals contribute to the wants of the state proportionally to the revenue which they enjoy under its protection; and so, no doubt, were it possible to assess them fairly, such would be the case. But the obstacles in the way of their fair and equal assessment are such as can never be overcome; and the truth is, that taxes on either income or property, though theoretically equal, are practically the most unequal that can be imagined. We may get a pretty accurate notion of the income derived from lands, houses, funded property, and mortgages; but all beyond this is mere guess-work. There are no means by which to ascertain the amount of farming capital, stock in trade, the profits derived from them, or the incomes of professional men. No inquisition into the private affairs of individuals can ever discover these particulars. There is nothing, in fact, to depend upon in such cases but the declarations of the parties; and we need not dwell on the impolicy of any system of finance that sets the duty and the interests of the contributors in opposition, and makes them profit by concealing or perverting the truth. Besides, although these preliminary and insuperable difficulties were overcome, and we learned the capital and incomes of different parties, we should have other and greater difficulties to surmount before the tax could be fairly assessed. The same deduction should not be made from incomes derived from sources that are not equally lasting. To assess them on a just principle, the present value of different incomes, or their value reduced to a perpetuity, would have, in the first place, to be determined.

But it may be unhesitatingly affirmed that to do this upon a large scale would be quite impracticable. It is clear, therefore, that taxes on income or property should not be introduced, except as a *dernier resort*, as a means of filling the coffers of the treasury when the other and more legitimate sources of revenue are insufficient, and when, as in the late war, money must be had at all hazards.

It is besides absurd to suppose, as has been done, that the burdens that at present fall on the labouring classes could be sensibly reduced by repealing the duties on tea, sugar, soap, &c., and imposing in their stead taxes on property. Suppose that the attempt were made, and observe what the result must be. A manufacturer employs a certain number of men, who pay 1000*l.* a year in taxes on commodities. Now, if the taxes that are at present paid by the labourers be repealed, those that fall on their employers must be equally increased; so that the manufacturer in question will have 1000*l.* more to pay in taxes after the change takes place, and will of course have 1000*l.* less to lay out on wages. It is consequently contradictory and absurd to suppose that you can improve the condition of the labouring classes by repealing the taxes that fall on them to lay them on capitalists.

Direct taxes on property have been the curse of every country into which they have been introduced, and are at once a consequence and a cause of a low and impoverished state of society. To evade them, people that are not poor counterfeit poverty; some of the most powerful incentives to industry and economy are in consequence destroyed, at the same time that inferior stock, machinery, &c. are made use of. Such taxes are besides most unpopular, as well from their requiring an odious though ineffectual inquisition into the affairs of individuals, as from their being direct. So much is this the case, that we are well convinced that the raising of eighteen or twenty millions by taxes on income would be felt to be a much greater burden, and would really be far more injurious, than the raising of fifty or sixty millions by well-devised indirect taxes, such as the greater number of those that now exist in England.

Luckily, however, indirect taxes have almost invariably been the greatest favourites both of princes and subjects; and there are many solid reasons why this should be the case. The burden of direct taxation is palpable and obvious. It admits of no species of disguise or concealment, but makes every one fully sensible of the exact amount of income taken from him by government. Every one, however, is extremely averse from parting with property, unless he obtain some more acceptable equivalent in its

stead; and as the benefits derived from the institution of government are neither so very obvious nor striking as to be easily and readily felt and appreciated by the bulk of the people, there is, in the great majority of cases, a a decided disinclination to pay a large amount of direct taxes. Hence it is that governments have so generally had recourse to indirect taxes. Instead of exciting the prejudices of their subjects by openly demanding a specific portion of their incomes, they have taxed the articles on which these incomes are usually expended. This ingenious plan conçeals the amount of taxation, and makes its payment appear in some measure voluntary. The tax being generally paid, in the first instance, by the producers, the purchasers confound it with the natural price of the commodity. No separate demand being made upon them for the tax, it escapes their recollection, and the article which they receive seems the fair equivalent of the sacrifice made in acquiring it. Such taxes have also the advantage of being paid by degrees, in small portions, and at the time when the commodities are wanted for consumption, or when it is most convenient for the consumers to pay them.

That indirect taxes labour under some considerable disadvantages is most true, though these have been much exaggerated. It is alleged, in the first place, that taxes on commodities necessarily alter the natural distribution of the capital and industry of a country, and force them into less advantageous channels; because, where a tax is laid on a particular class of commodities, the producers, in order to raise the price proportionally to the tax, diminish the supply in the market by transferring a portion of the capital employed in the production of the taxed commodities to some other business. But it is to be observed that this effect, if it be sensible at all, is experienced only when a duty is first imposed, and that after a short while the duty is blended with the cost of production, and has no further influence over the distribution of capital. It is also true, that, provided the tax be not oppressive, or so high as to drive capital wholly from the business, it acts as a stimulus to invention, and makes those engaged in the business exert themselves, by new efforts of ingenuity and economy, to find out means of paying the tax without adding to the price of the articles produced, or withdrawing any portion of their capital from the business. In many instances these efforts have been completely successful; and in some instances the influence of the tax has been more than neutralized by the exertions made to defeat it.

Taxes on commodities being almost always paid by the producers before they are sold to the consumers, they not only, it is said, increase prices by the whole amount of the duties, but also by the profits due to the manufacturers by whom they have been advanced. But though this circumstance undoubtedly operates to increase prices, its influence in this respect has been greatly over-rated by M. Say, M. Sismondi, and others. The latter has calculated that a tax of 4000 francs, paid originally by a manufacturer whose profits were 10 per cent., would, if the manufactured commodity only passed through the hands of five different persons before reaching the consumer, cost the latter the sum of 6734 francs. This calculation proceeds on the supposition that he who first advanced the tax would receive from the next manufacturer 4400 francs, and he, again, from the next, 4840 francs; so that at each step 10 per cent. on its value should be added to it. "But," as Mr. Ricardo has justly observed, "this is to suppose that the value of the tax would be accumulating at compound interest; not at the rate of 10 per cent. per annum, but at an absolute rate of 10 per cent. at every step of its progress. M. Sismondi's statement would be correct if five years elapsed between the first advance of the tax and the sale of the taxed commodity to the consumer; but if one year only elapsed, a remuneration of 400 francs, instead of 2734, would give a profit at the rate of 10 per cent. per annum to all who had contributed to the advance of the tax, whether the commodity had passed through the hands of five manufacturers or fifty." (*Principles, &c.* 3d edit. p. 459.)

It is certainly true that duties on commodities encourage smuggling. "They tempt," says Dr. Smith, "persons to violate the laws of their country who are frequently incapable of violating those of natural justice, and who would have been in every respect excellent citizens, had not the laws of their country made that a crime which nature never meant to be so." (P. 378.) In consequence of this tendency, duties on commodities require the employment of a number of revenue officers; and as they expose the producers of the taxed articles to considerable inconvenience and hardship from domiciliary visits, they force them to indemnify themselves by making a corresponding addition to the price of their goods. But this, after all, is not so much a consequence of duties on commodities, as of their abuse, or of their being carried to an oppressive extent. So long as they are confined within reasonable limits, the temptation which they create to engage in smuggling transactions may be very easily obviated; and it has been shown over and over again, that duties so restricted are uniformly more productive than those which are carried to such a height as to hold out any great encouragement to smuggling.

It may also be said that duties on commodities do not fall on individuals in proportion to their means of paying them; and that while they press with undue severity on persons with large families, or who occupy prominent stations, they may be almost wholly avoided by rich misers and those in the more obscure walks of life. But in taxation we have only a choice of difficulties. However desirable, it is, as already seen, quite impossible to tax individuals in proportion to their incomes; and as any attempt to impose an equal income tax would not only be sure to fail, but would be attended with the most disastrous effects, resort must necessarily be had to the best practicable taxes, that is, to duties on commodities. And it does not really appear that such duties can be considered as unequal. If duties be laid on sugar or wine, those who abstain from their use will, of course, escape them; but those who use such articles have no good right to complain of this, seeing that they may also, by exercising the same self-denial as the others, exempt themselves from the duties.

Taxes on commodities are most commonly divided into two great classes; the one consisting of external or frontier, and the other of internal duties. The first class, called in England customs duties, are principally charged on commodities brought from foreign parts on their importation into a country, and sometimes also on native commodities when exported. The second class, which are here called excise duties, are charged on certain articles produced within a country, and intended for home consumption. In addition to these great sources of indirect taxation, duties are sometimes laid on the paper or other materials necessary to the completion of deeds and other contracts, on the liberty to use certain articles and to exercise certain privileges, &c.

Customs duties formed an important branch of the public revenue of most ancient states, and in modern times they have been very extensively imposed. In England they have been charged from a very remote period; and though inconsiderable at first, they have increased with the increase of civilization and commerce, till they have long formed one of the most copious sources of the public revenue. The various duties were collected, for the first time, in a book of rates, or tariff, published in the reign of Charles II.; but there is hardly a year in which the customs duties do not undergo considerable modifications. It is now the practice to consolidate the different acts imposing or varying the customs duties before they become inconveniently numerous; and tariffs, or tables of duties, drawbacks, &c., are annually published for the convenience of merchants and others.

Owing principally to the vast increase of the commerce, wealth, and population of the country, but partly also to the increase of the rates, the progress of the customs duties has been quite extraordinary. The revenue derived from the customs duties in 1596, in the reign of Elizabeth, amounted to no more than 50,000*l*. In 1613, it had increased to 148,075*l*., of which no less than 109,572*l*. was collected in London. In 1660, at the Restoration, the customs produced 421,582*l*.; and at the Revolution, in 1689, they produced 781,987*l*. During the reigns of William III. and Anne, the customs revenues were considerably augmented, the nett payments into the exchequer in 1712 being 1,315,422*l*. During the war terminated by the peace of Paris in 1763, the nett produce of the customs revenue of Great Britain amounted to nearly 2,000,000*l*. In 1792, it amounted to 4,407,000*l*. In 1815, at the close of the war with revolutionary France, it amounted to 11,360,000*l*.; and in 1840, the customs revenue of the United Kingdom amounted to 23,341,813*l*., of which Great Britain furnished 21,209,082*l*., and Ireland 2,132,731*l*.

For a lengthened period customs duties were charged indifferently on all sorts of commodities, whether exported or imported; the duty on wool sent to the Netherlands, France, &c. being formerly, in fact, the principal item in the customs revenue. But for a long time past customs duties have been almost exclusively laid on imported articles; those laid on exports being, in most instances, imposed rather to check or prevent the exportation of the articles, than in the view of raising revenue.

Customs duties, when judiciously imposed, and confined within reasonable limits, are perhaps the least exceptionable of all taxes. (*See* CUSTOMS.) But if they be carried to such a height as to give any overpowering stimulus to smuggling, they contradict and defeat the very purpose for which they are intended. Our finance ministers have not, however, been sufficiently alive to this obvious consideration. There can be no articles better fitted to bear customs duties than tobacco and spirits; but the duties with which they are loaded are so extravagantly high that they occasion a great deal of smuggling, with its accompanying crime and demoralization, and would certainly be a good deal more productive were they effectually reduced. The existing duties on brandy and geneva are, perhaps, the very worst in our tariff; but

they would be about the very best were they reduced from 22*s*. 6*d*. to 8*s*. or 10*s*. a gallon.

As already stated, the customs revenue of 1840 amounted to 23,341,813*l*.; and we hesitate not to affirm that no equal amount of revenue was ever raised in any country, or in any period of time, with so little difficulty and inconvenience. The assessed taxes, exclusive of the land-tax, produced, in 1840, 2,971,005*l*.; and no one familiar with the facts can doubt that their payment produced more irritation, and was regarded as a greater burden by the public, than the payment of the customs duties, though the latter brought between six and seven times as great an amount of income into the coffers of the treasury.

The customs revenue of 1840 was collected in Great Britain at a charge of 4*l*. 18*s*. 10*d*. per cent. on its gross produce; and in Ireland, at a charge of 10*l*. 8*s*. 3*d*. on ditto.

Excise Duties. — The next great branch of the public revenue consists of inland or excise duties; that is, as already seen, of duties charged on certain commodities produced or manufactured at home.

Excise duties were introduced into England by the Long Parliament in 1643; being then laid on the makers and venders of ale, beer, cider, and perry. The Royalists soon after followed the example of the Republicans, both parties declaring that the excise should be continued no longer than the termination of the war. But it was found too productive a source of revenue to be again relinquished; and when the nation had been accustomed to it for a few years, the parliament declared, in 1649, that the "impost of excise was the most easy and indifferent levy that could be laid upon the people." It was placed on a new footing at the Restoration; and notwithstanding Mr. Justice Blackstone says, that "from its first original to the present time its very name has been odious to the people of England" (*Com.* book i. c. 8.), it has continued progressively to gain ground; and it is at this moment imposed on several most important articles, and furnishes nearly a third part of the entire public revenue of the kingdom. *See* EXCISE DUTIES.

Some excise duties that were justly objected to have been repealed within these few years; and with the exception of the duty on glass, which interferes injuriously with the manufacture, we are not sure that there is one of the existing duties that can be fairly objected to on principle, though the rate of duty might, in some instances, be advantageously reduced. We subjoin an account of the articles subject to excise duties in Great Britain in 1840, with the nett produce of the duties in the same year.

Articles.	Nett Revenue.		
	L.	s.	d.
Auctions - - -	302,948	14	9¼
Bricks - - - -	5[illegible]3,379	14	6
Glass - - -	704,540	7	3½
Hops - - - -	341,439	17	2¼
Licences - - -	947,680	19	1¾
Malt - - - -	4,788,402	14	10¾
Paper - - . -	558,716	0	9¼
Post Horse Duty - - -	212,634	18	0¾
Post Horse Licences - -	4,001	10	0
Soap - - -	806,704	15	0¼
Spirits - - -	4,169,554	11	11½
Sugar - - -	73	3	9
Vinegar - - - -	26,470	8	8¼
Total - -	13,386,847	16	0¾

It has been said that the excise duties "greatly raise the cost of subsistence to the labouring classes." But this assertion has really no solid foundation. We have seen above that, in 1840, the excise duties in Great Britain produced 13,386,774*l*. Now of this sum the duties on spirits, malt, and licences, produced 9,905,937*l*. In fact, the only excise duty that can be said to fall on a necessary of life is that on soap, which produced in 1840 (in Great Britain) 806,705*l*.; and as the population of Great Britain amounts at present to above 18,500,000, the soap tax, at an average, does not impose a burden of above 10*d*. a year on each individual! If we estimate its annual pressure on a labouring family of five persons at 2*s*. 6*d*., we shall not be within, but considerably beyond the mark. In Ireland there is no tax on soap.

Latterly some reductions have been made in the duties on glass. Still, however, they are most objectionable, inasmuch as they interfere most materially with the processes carried on in the manufacture, and, by obstructing the introduction of new discoveries and improved methods, enhance the prices of the article in a much greater degree than might be inferred from the amount of the duty.

The only taxes in the departments of customs and excise, or of the revenue generally, that can be truly said to fall on articles necessary to the labourer are, besides soap, those on tea, sugar, and one or two more. It is pretty certain that the duties on tea and sugar, which are by far the most important, might be materially reduced without affecting the revenue; and the presumption is, that the duty on sugar, which enters so largely into most descriptions of food, will be speedily reduced, and the trade in it placed on an entirely new footing.

Even though they were not required by the public exigencies, the duties on spirits obstruct a pernicious habit, and should not be given up. They are the best of all possible duties; and the only thing to be attended to in their imposition is, not to carry them to such a height as to defeat their operation by encouraging smuggling. We have yet to learn, supposing they are not carried beyond this limit, that a single good objection can be made to these duties.

The obscurity and complexity of the excise laws have been justly complained of; in this respect, however, they have been materially improved of late years; and the statutes under which they are collected are now, for the most part, sufficiently perspicuous, and easily understood.

The capacity of a tax on a commodity to raise a revenue depends partly on the nature and extent of the demand for the taxed article, and partly on the means of preventing its being smuggled or the duty evaded. Every tax, by raising the price of the article on which it is laid, has a tendency to bring it within the command of a smaller number of purchasers, and to lessen its consumption. An individual who might be able and disposed to pay 1*s*. a bottle of duty on wine might neither have the means nor the inclination to pay 2*s*. or 3*s*.; and instead of being augmented, the revenue might be diminished by such an increase of duty. And hence, whenever the duties on commodities are raised beyond certain limits, — which, however, it is impossible to define *à priori*, seeing that they necessarily vary according to the description of commodities charged with duties, the varying tastes and circumstances of society, and the means of counteracting smuggling, — they depress consumption to such an extent as to become less productive than if they had been lower.

Variations in the amount of the duties affecting commodities have exactly the same effect on their price, and consequently on their consumption, as corresponding variations in the cost of production. But it is clear that any reduction in the price of articles the necessary cost of which is very considerable, and can therefore be used only by the rich, would not so powerfully increase their consumption as an equal reduction in the price of cheaply produced commodities in general demand. Thus, a reduction of 25 or even 50 per cent. in the price of coaches, would not add greatly to the demand for them; for, notwithstanding this reduction, they would still be luxuries for which none but the rich could afford to pay. But a reduction of 25 or 50 per cent. in the price of tea, sugar, beer, gin, or any article in general demand, would extend its consumption in a much greater ratio. The reason is plain. The lower classes form by far the most numerous portion of society; the articles referred to, and others of the same description, are highly esteemed by them, and are, even at their present prices, extensively consumed. But a reduction of a half, or even a fourth from their price, would add prodigiously to the demand for them. It would enable their present consumers to use them in larger quantities; while it would at the same time bring many of them fully under the command of a very large class, by whom they are now used as luxuries only on rare occasions. The history of taxation in this and other countries fully confirms this statement. When carried beyond due limits, taxes on commodities cease to be productive, and recover that quality when they are reduced. There is much truth in the shrewd remark of Dr. Swift, that in the arithmetic of the customs two and two do not always make four, but sometimes only one. In 1808, the duty on coffee was 1*s*. 7½*d*. per lb.; the quantity entered for consumption that year being 1,069,691 lbs., producing a nett revenue of 161,246*l*. In the course of the year the duty was reduced to 7*d*. per lb.; and next year no fewer than 9,251,837 lbs. were entered for home consumption, producing a nett revenue of 245,886*l*. The coffee duty has since been lowered to 6*d*.; and the quantity entered for consumption is now (1842) about 28,500,000 lbs., and the revenue about 850,000*l*. a year.

The history of the duties on tea, spirits, wine, sugar, and indeed of every other article in extensive demand, is precisely similar. When carried to an oppressive height, the duty either occasions the use of the article to be given up; or, which is the most common case, it makes it be supplied through clandestine channels in defiance of the law. But when the duty is moderate, a taste for the article is diffused; and the profits to be made by trampling on the law not being sufficient to remunerate the smuggler, he is forced to abandon his hazardous occupation, and the article is wholly supplied through legitimate channels. After the various disastrous consequences entailed on the country by the exorbitant height to which many duties were carried previously to 1825, and the signal advantages that have resulted to the revenue and the public from their subsequent modification, it may be hoped that the principle now stated will meet with more attention in future.

The attempts that have been made in Great Britain and elsewhere to suppress smuggling, and at the same time to maintain exorbitant duties, have all signally failed. It has been invariably found that no severity of the law, nor vigilance on the part of the officers, can prevent the smuggling of commodities loaded with excessive duties. At this moment it is supposed that from 500,000 to 600,000 gallons of foreign brandy and geneva find their way into our market without paying any duty, in defiance of the coast guard, and of all the other machinery for keeping them out. Large quantities of tobacco are also smuggled. In fact, there are no means of effectually putting down smuggling other than a reduction of duty. The very severity of the laws prevents their execution. It creates a sympathy in favour of the smuggler; it stimulates the trader to corrupt the officer to conceal a fraud; and it makes the officer overlook what he might otherwise discover.

Stamp Duties.—These duties form the next most important branch of the public revenue, after the customs and excise. They are mostly laid on the parchment or paper on which certain deeds, contracts, receipts, acquittances, bills of exchange, newspapers, policies of insurance, indentures of apprenticeship, &c. are written or printed; and derive their name from the parchment or paper being impressed with a stamp stating the amount of the duty. When imposed on fair principles, and not carried to too great a height, stamp duties seem to be one of the most legitimate sources of revenue. They assist in authenticating legal instruments, and render it much more difficult than formerly to forge deeds of any standing. It is needless, perhaps, to say, that if stamp duties be carried to such a height as to oppose any serious obstacle to the free circulation of property, or to the execution of necessary deeds, they become exceedingly injurious. Perhaps the duty on fire insurance is the most objectionable of the existing stamp duties. It amounts to 3*s.* per cent. on all property insured; whereas the premium paid to insurance offices, for common risks, is no more than 1*s.* 6*d.* per cent., or only half the duty. Thus, if a person wish to insure 1000*l.* on a dwelling-house, a shop, warehouse, or other commonly hazardous property, he pays 15*s.* to an insurance office as an indemnification for the risk, and 30*s.* to government for leave to enter into the transaction. So exorbitant a duty cannot be too severely condemned. It discourages that providence and foresight the encouragement of which ought to be an object with all prudent governments; and it is the principal cause that much property is not insured at all, and that what is insured is seldom sufficiently covered. Every individual, in fact, who insures any commonly hazardous property, is obliged to pay three times as much as the risk is really worth. Under such circumstances, the wonder certainly is, not that a great deal of property is uninsured, but that such is not the case with a great deal more. Seeing the vast importance of insurance, it may well be doubted whether it ought to be charged with any duty, however slight. But were the duty fixed at 9*d.* per cent., or at half the premium, its influence in repressing insurance would not be very sensible; and the increase of business to which such a reduction of the duty would lead would be so very great, that we have little doubt that in a few years the reduced duty would yield nearly as large a revenue as is derived from the present exorbitant duty.

The duties on legacies, and on the probates of wills, are included under the head of STAMP DUTIES, of which they are very important items. These duties affect only personal or moveable property. The first, or legacy duty, varies according to the propinquity of the successor; being 1 per cent. on property devolving on children and lineal heirs, 3 per cent. on property devolving on brothers and sisters, 4 per cent. on property devolving on cousins, and 10 per cent. on property devolving on strangers. The probate duty varies according to the amount of property in the will. The duties on stage and hackney coaches, gold and silver plate, &c., come under the head of STAMPS.

Land Tax.—The existing land tax originated in 1692, being intended to replace the subsidies and such like grants previously made to the crown. According to the valuation at which it was assessed, it was found that a charge of 1*s.* per pound on the rental of the country produced 500,000*l.* No subsequent change has been made in this valuation. The tax, which was annually voted, usually amounted to 4*s.* per pound of the valued rent. In 1798, it was made perpetual at that rate, leave being at the same time given to the proprietors to reduce it.

The land tax has always been very unequal. When imposed, the proprietors friendly to the Revolution returned their estates at a much higher value than those attached to the House of Stuart. The different degrees of improvement that have since taken place in the various districts of the country have, in some instances, tended to correct the inequalities in the original imposition of the tax; but their more common effect has been to increase them.

Assessed Taxes.—These form the fourth great head of revenue. They include the duties on windows, servants, horses, carriages, armorial bearings, game, &c. The house duty, that used to be one of the principal items in the assessed taxes, has been recently repealed. A hearth tax, or duty proportioned to the number of fireplaces in a house, was established in this country at a very early period; but owing to its being necessary to the assessing of the tax that the government officers should be admitted to view the inside of each house, the hearth tax became exceedingly unpopular, and was repealed by the stat. 1 Will. & Mary, c. 10. This statute declares hearth money "not only a great oppression to the poorer sort, but a badge of slavery upon the whole people, exposing every man's house to be entered into and searched at pleasure by persons unknown to him; and therefore to erect a lasting monument of their majesties' goodness in every house in the kingdom, the duty of hearth money was taken away and abolished."

But six years afterwards "the prospect of this monument of goodness was," to use Blackstone's words, "somewhat darkened," by the passing of an act (7 Will. III. c. 18.) laying a duty on all inhabited houses except cottages, and also on windows. These duties were afterwards considerably increased: they were, however, materially modified within the last few years; and neither the existing window tax, nor the house tax previously to its repeal, could be said to be oppressive. Indeed, out of 2,850,937 inhabited houses in Great Britain in 1831, only 442,482, or not a sixth part of the entire number, paid duty in 1833. All houses below 10*l.* a year of rent were exempted from the duty; the rate of charge on those that were assessed being 1*s.* 6*d.* per pound on houses worth from 10*l.* to 20*l.* a year, 1*s.* 3*d.* per pound on those worth from 20*l.* to 40*l.*, and 2*s.* 10*d.* per pound on those worth 40*l.* and upwards. The assessed taxes do not extend to Ireland. The cost of their collection amounted, in 1840, to 4*l.* 11*s.* 10*d.* per cent. of the gross produce.

The house tax being assessed according to the rent, it frequently happened that private houses, shops, and taverns in towns, were assessed in a larger sum than the finest houses of the nobility and gentry in the country. There was not, however, any injustice in this; for, in point of fact, had any attempt been made to let the latter, they would rarely have found a tenant or brought any rent. This apparent inequality afforded, however, a convenient topic for declamation, and for raising an outcry against the tax, which was, in consequence, repealed in 1835.

With the exception of the duties on the postage of letters, which have been noticed elsewhere (*see* POST OFFICE), the observations now made will probably suffice to give the reader a general idea of the principles on which taxes should be imposed, and of the leading characteristics of the principal taxes now in force in this country.

Collection of Taxes.—Taxes in Great Britain are almost wholly collected by government officers, paid by salaries. The customs duties, the excise duties, and the duties on stamps, with the assessed taxes, are each under the management of a particular department, having at its head a board of commissioners, with various classes of inferior officers. The post office revenue is managed by a postmaster-general and a principal secretary. The heads of the different revenue departments correspond with and receive their instructions from the treasury, to which is committed the charge of supervising, controlling, and regulating all matters connected with the assessment and collection of taxes. The number of commissioners in the different revenue boards was formerly much greater than at present; and it is contended by some very high authorities that their number might still be advantageously reduced, and that the whole responsibility should rest with the head of each department. Various reforms and retrenchments have been also introduced into the subordinate departments, and not a few abuses have been rectified in the assessment and collection of most duties. Perhaps the only very material reforms that need now be looked for in this department, must arise rather from changes and modifications of duties than from any changes in the way in which they are charged and collected. The reduction of the present exorbitant duties on brandy, geneva, and tobacco, by taking away an overwhelming temptation to their clandestine importation, would enable a large saving to be effected in the customs departments, at the same time that it would be productive of various other beneficial consequences. In the excise there remains little to be amended; and were the glass duties repealed, and the regulations as to some of the other duties simplified, the system would have received all the perfection of which it seems capable.

Those who wish for further information on the subjects treated of in this article may consult the article on Taxation in the new edition of the *Encyclopædia Britannica; Ricardo's Principles of Political Economy;* M'Culloch's edition of the *Wealth of Nations*, &c.

ACCOUNT of the Public Income of the United Kingdom; specifying its different Sources, and the Amount derived from each, during 1838, 1839, and 1840.

INCOME.	1838.		1839.		1840.	
CUSTOMS AND EXCISE.	L.	L.	L.	L.	L.	L.
Spirits { Foreign	1,389,371	- -	1,341,821	- -	1,290,581	
Spirits { Rum	1,411,067	- -	1,273,630	- -	1,155,613	
Spirits { British	5,467,201	- -	5,442,478	- -	5,201,664	
Malt	4,932,080	- -	4,845,949	- -	4,983,602	
Hops	302,906	- -	280,079	- -	341,440	
Wine	1,846,057	- -	1,849,710	- -	1,791,646	
Sugar and Molasses	4,893,684	- -	4,827,019	- -	4,650,017	
Tea	3,362,035	- -	3,658,800	- -	3,472,864	
Coffee	684,979	- -	779,115	- -	921,552	
Tobacco and Snuff	3,561,812	27,851,192	3,495,687	27,794,288	3,588,192	27,397,171
Butter	251,665	- -	213,078	- -	257,577	
Cheese	115,907	- -	105,219	- -	117,679	
Currants and Raisins	300,828	- -	323,882	- -	339,880	
Corn	186,760	- -	1,098,778	- -	1,156,640	
Cotton Wool and Sheep's Imported	725,445	- -	559,679	- -	785,491	
Silk	254,874	- -	262,304	- -	240,628	
Hides and Skins	61,478	- -	62,822	- -	50,504	
Paper	541,788	- -	629,817	- -	583,982	
Soap	810,813	- -	784,168	- -	808,201	
Candles and Tallow	183,669	- -	182,000	- -	186,283	
Coals, sea-borne	7,632	- -	8,447	- -	6,827	
Glass	688,837	- -	718,348	- -	738,553	
Bricks, Tiles, and Slates	418,335	- -	463,426	- -	523,380	
Timber	1,572,618	- -	1,603,194	- -	1,730,551	
Auctions	285,186	- -	298,404	- -	316,246	
Excise Licences	1,023,202	- -	1,028,685	- -	1,054,115	
Post Horse Duties	241,266	- -	228,251	- -	216,636	
Miscellaneous of Customs and Excise	1,596,366	9,264,669	1,546,716	10,117,218	1,617,064	10,730,237
TOTAL CUSTOMS AND EXCISE	- -	37,115,861	- -	37,911,506	- -	38,127,408
STAMPS.						
Deeds and other Instruments	1,663,720	- -	1,699,283	- -	1,710,533	
Probates and Legacies	2,192,231	- -	2,017,686	- -	2,098,078	
Insurance { Marine	251,856	- -	292,978	- -	299,398	
Insurance { Fire	891,704	- -	923,005	- -	944,321	
Bills of Exchange, Bankers' Notes	734,109	- -	781,629	- -	773,114	
Newspapers and Advertisements	341,974	- -	363,420	- -	376,006	
Stage Coaches	494,284	- -	497,216	- -	438,047	
Receipts	173,825	- -	173,047	- -	175,070	
Other Stamp Duties	468,784	7,212,487	469,001	7,217,265	473,256	7,287,823
ASSESSED AND LAND TAXES.						
Land Taxes	1,184,830	- -	1,174,100	- -	1,181,283	
Windows	1,262,561	-	1,298,622	- -	1,404,642	
Servants	201,018	- -	201,482	- -	216,823	
Horses	377,477	- -	384,286	- -	416,170	
Carriages	442,757	- -	447,467	- -	481,499	
Dogs	156,200	- -	159,852	- -	170,951	
Other Assessed Taxes	278,242	3,903,085	266,880	3,932,689	280,919	4,152,287
POST OFFICE	- -	2,346,278	- -	2,390,764	- -	1,342,604
CROWN LANDS	- -	388,642	- -	357,815	- -	482,429
Other Ordinary Revenues, and other Resources	- -	312,575	- -	248,310	- -	300,966
TOTAL INCOME	- -	51,278,928	- -	52,058,349	- -	51,693,510
Excess of Expenditure over Income	- -	441,819	- -	1,381,938	- -	1,750,543
		51,720,747	- -	53,440,287	- -	53,444,053

ACCOUNT of the Expenditure of the United Kingdom during 1838, 1839, and 1840; specifying the different Items, and the Amount of each.

EXPENDITURE.	1838.		1839.		1840.	
	L.	L.	L.	L.	L.	L.
REVENUE: — *Charges of Collection.*						
Civil Departments { Customs	636,847	- -	638,824	- -	623,733	
Civil Departments { Excise	851,494	- -	855,424	- -	840,700	
		1,488,341		1,494,248		1,464,433
Preventive Service, Land Guard, Revenue Police Cruizers, and Harbour Vessels	- -	570,129	- -	567,636	- -	577,088
		2,058,470		2,061,884		2,041,521
Stamps	- -	154,213	- -	158,709	- -	150,133
Assessed Taxes	- -	209,203	- -	169,578	- -	168,772
Other Ordinary Revenues	- -	52,213	- -	64,223	- -	54,678
Superannuation and other Allowances	- -	374,401	- -	369,101	- -	357,736
TOTAL REVENUE	- -	2,848,500	- -	2,823,495	- -	2,772,840
PUBLIC DEBT.						
Interest of Permanent Debt	24,212,580	- -	24,183,865	- -	24,352,269	
Terminable Annuities	4,183,966	- -	4,271,458	- -	4,244,444	
Management	133,566	- -	133,866	- -	134,241	
	28,530,112		28,589,189		28,730,954	
Interest on Exchequer Bills	720,928	- -	856,701	- -	642,997	
TOTAL DEBT		29,251,040		29,445,890		29,373,951
CIVIL GOVERNMENT: — *Civil List — Privy Purse.*						
Salaries of the Household, Tradesmen's Bills	371,800	- -	371,800	- -	371,800	
The Allowances to the several Branches of the Royal Family, and to his Royal Highness Leopold Prince of Cobourg (now King of the Belgians) *	308,000	- -	308,000	- -	323,928	
The Lord Lieutenant of Ireland's Establishment	33,869	- -	35,163	- -	32,359	
The Salaries and Expenses of the Houses of Parliament, including Printing	142,195	- -	139,358	- -	122,410	
Civil Departments, including Superannuation Allowances	458,258	- -	411,783	- -	518,940	
Other Annuities, Pensions, and Superannuation Allowances on the Consolidated Fund and on the Gross Revenue	357,576	- -	367,033	-	349,397	
Pensions, Civil List	621	- -	1,546	- -	2,743	
TOTAL CIVIL GOVERNMENT		1,672,319		1,634,683		1,721,577
JUSTICE.						
Courts of Justice	552,181	- -	525,501	- -	534,945	
Police and Criminal Prosecutions	562,191	- -	510,201	- -	577,363	
Correction	417,966	- -	403,274	- -	285,295	
TOTAL JUSTICE		1,532,338		1,438,976		1,397,603
DIPLOMATIC.						
Foreign Ministers' Salaries and Pensions	182,028	- -	186,934	- -	188,765	
Consuls' Salaries and Superannuation Allowances	148,606	- -	115,929	- -	124,782	
Disbursements, Outfit, &c.	62,198	- -	48,100	- -	51,998	
TOTAL DIPLOMATIC		392,832		350,963		365,545
FORCES.						
Army. { Effective { Number of Men	(82,746)	- -	(88,481)	- -	(91,901)	
Army. { Effective { Charge	4,263,541	- -	3,952,881	- -	4,400,595	
Army. { Non-effective { Number of Men	(90,914)	- -	(89,383)	- -	(88,006)	
Army. { Non-effective { Charge	2,552,100	- -	2,589,781	-	2,489,672	
TOTAL ARMY	6,815,641	- -	6,542,662	- -	6,890,267	
Navy. { Effective { Number of Men	(30,399)	- -	(34,137)	- -	(36,501)	
Navy. { Effective { Charge	3,046,867	- -	3,993,225	- -	4,152,666	
Navy. { Non-effective { Number of Men	(24,530)	- -	(23,732)	- -	(22,958)	
Navy. { Non-effective { Charge	1,473,561	- -	1,496,979	- -	1,444,845	
TOTAL NAVY	4,520,428	- -	5,490,204	- -	5,597,511	
Ordnance. { Effective { Number of Men	(9,012)	- -	(9,235)	- -	(9,395)	
Ordnance. { Effective { Charge	1,219,633	- -	1,790,464	- -	1,474,577	
Ordnance. { Non-effective { Number of Men	(622)	- -	(614)	- -	(614)	
Ordnance. { Non-effective { Charge	165,058	- -	160,746	- -	157,063	
TOTAL ORDNANCE	1,384,681	- -	1,951,210		1,631,640	
TOTAL FORCES		12,720,750		13,984,076		14,119,418
Army and Ordnance, Insurrection in Canada	- -	500,000	- -	647,000	- -	553,249
China Expedition	- -	- -	- -	- -	- -	150,000
Bounties, &c. for promoting Fisheries	- -	13,454	- -	14,553	- -	14,607
Public Works	- -	299,864	- -	321,702	- -	351,837
Payments out of the Revenue of Crown Lands, for Improvements and various Public Services	- -	144,731	- -	146,466	- -	244,741
Post Office: Charges of Collection and other Payments	- -	676,835	- -	746,879	- -	848,368
Quarantine and Warehousing Establishments	- -	134,534	- -	118,594	- -	119,477
Miscellaneous Services not classed under the foregoing Heads	- -	1,533,550	- -	1,767,010	- -	1,410,840
		51,720,747		53,440,287		53,444,053
Memorandum: The Amount of Terminable Annuities on 5th January was		4,292,173	- -	4,298,720	- -	4,114,021
In corresponding Perpetuities, as estimated by Mr. Finlaison		1,830,654	- -	1,771,430	- -	1,710,761
DIFFERENCE		2,461,519	- -	2,527,290	- -	2,403,260

* No part of this income is at present paid for the use of King Leopold. The trustees, after discharging certain annuities and pensions to the servants and establishment of the late Princess Charlotte, repay the balance of the annuity to the Exchequer: the sum so repaid in the last year was 34,000*l.*

TA'XICORNS, *Taxicornes*. (Lat. taxus, *a yew tree*; cornu, *a horn*.) The name of a family of Coleopterous insects, including those in which the antennæ gradually augment in size as they extend from the head, or terminate in an enlargement.

TA'XIDERMY. (Gr. *ταξις*, *arrangement*, and *δερμα*, *skin*.) The art of arranging and preserving the skins of animals. The most popular treatise on taxidermy is Mr. Swainson's volume in *Lardner's Cyclopedia*.

TA'XIS. In Surgery, the replacement of parts which have quitted their natural situation by the hand, and without instrument or operation; as in reducing hernia or rupture.

TAXIS. In Architecture, the fitness of the parts to the end for which a building is erected.

TA'XUS (Lat.), is the botanical name of the yew tree, celebrated for the hardness and elasticity of its wood. Its berries are harmless; but its leaves are poisonous, partaking of the property of foxglove. It is the most simple form of the Coniferous alliance, and is usually taken as the best illustration of the gymnospermous structure among Exogens; because its female flower is quite solitary, and readily examined. What travellers in New Zealand call yews appear to be species of *Dacrydium*.

TAYLOR'S THEOREM. In Mathematics, a very general and remarkable formula of most extensive application in analysis, discovered by Dr. Brook Taylor, and given in his *Methodus Incrementorum*, published in 1715. The formula is this:— Let u be any function whatever of a variable x, and let u' be what u becomes when x receives an increment $= h$; then

$$u' = u + \frac{du}{dx}\cdot\frac{h}{1} + \frac{d^2u}{dx^2}\cdot\frac{h^2}{1\cdot 2} + \frac{d^3u}{dx^3}\cdot\frac{h^3}{1\cdot 2\cdot 3} + \&c.$$

Demonstrations of this important theorem are given in every treatise on the differential calculus; and it is made by Lagrange the foundation of the calculus itself. (See Lagrange, *Théorie des Fonctions Analytique*.)

TEA. The dried leaves of the tea tree, of which there are two varieties. 1. The *Thea nigra*; black or bohea tea. 2. *Thea viridis*; green tea. The boheas include souchong, pekoe, and congou; and the greens are hyson, singlo, and imperial or bloom tea. The leaves are collected and dried on iron plates by a gentle heat. Tea taken in moderation, especially as we use the infusion, with sugar and milk, is strengthening and invigorating; it also appears to possess certain stimulating and narcotic properties, of which some individuals are peculiarly susceptible, and which renders it improper in hypochondriacal and hysterical patients. We know little of the chemical properties of the varieties of tea; but the following table shows that, in regard to its more obvious constituents, the different varieties are not widely dissimilar. The column showing the weight of the precipitate by jelly may be taken as indicating the relative proportion of the astringent matter.

100 Parts of Tea.	Soluble in Water.	Soluble in Alcohol.	Precipitate with Jelly.	Inert Residue.
Green: hyson - 14*s*. per lb.	41	44	31	56
— 12*s*. —	34	43	29	57
— 10*s*. —	36	43	26	57
— 8*s*. —	36	42	25	58
— 7*s*. —	31	41	24	59
Black: souchong, 12*s*. —	35	36	28	64
— 10*s*. —	34	37	28	63
— 8*s*. —	37	35	28	63
— 7*s*. —	36	35	24	64
— 6*s*. —	35	31	23	65

Of the above precipitate by jelly, about 40 per cent. may be regarded as *tannin*; and the difference between the second and the first column shows the quantity of resin contained in the above teas: the resin has an agreeable flavour of the tea. Water distilled off tea has an agreeable flavour, and is said to be narcotic: it contains a trace of volatile oil. Oudry's statement of the existence of a peculiar principle in tea (*thein*) requires confirmation.

The late rise and present magnitude of the British tea trade are among the most extraordinary phenomena in the history of commerce. Tea was wholly unknown to the Greeks and Romans, and even to our ancestors, previously to the end of the 16th or the beginning of the 17th century. It seems to have been originally imported in small quantities by the Dutch; but was hardly known in this country till after 1650. In 1660, however, it began to be used in coffee houses; for, in an act passed in that year, a duty of 8*d*. is laid on every gallon of "coffee, chocolate, sherbet, and tea," made and sold. But it is abundantly evident that it was then only beginning to be in[illegible]red. The following entry appears in the Diary of [illegible] Pepys, secretary to the Admiralty:— "September 26. 1661. I sent for a cup of tea (a China drink), of which I had never drunk before." In 1664, the East India Company bought 2 lbs. 2 oz. of tea as a present for his Majesty. In 1667, they issued the first order to import tea, directed to their agent at Bantam, to the effect that he should send home 100 lbs. of the best tea he could get! (See the references in *Milburne's Orient. Com.* vol. ii. p. 530.; *Macpherson's Hist. of Com. with India*, pp. 130—132.) Since then the consumption seems to have gone on regularly, though slowly, increasing. In 1689, instead of charging a duty on the decoction made from the leaves, an excise duty of 5*s*. per lb. was laid on the tea itself.

The great increase that took place in the consumption of duty paid on tea in 1784 and 1785, over its consumption in the preceding years, is to be ascribed to the reduction that was then effected in the duties. In the *nine* years preceding 1780, above 180,000,000 lbs. of tea were exported from China to Europe in ships belonging to the Continent, and about 50,000,000 lbs. in ships belonging to England. But, from the best information attainable, it appears that the real consumption was almost exactly the reverse of the quantities imported; and that while the consumption of the British dominions amounted to above 13,000,000 lbs., the consumption of the Continent did not exceed 5,500,000 lbs. If this statement be nearly correct, it follows that an annual supply of above 8,000,000 lbs. was clandestinely imported. It was well known, indeed, that smuggling was carried on to an enormous extent; and after every other means of checking it had been tried to no purpose, Mr. Pitt proposed, in 1784, to reduce the duties from 119 to $12\frac{1}{2}$ per cent. This measure was signally successful. Smuggling and the practice of adulteration were immediately put an end to, and the legal imports of tea were about trebled. In 1795, however, the duty was raised to 25 per cent.; and after successive augmentations in 1797, 1800, and 1803, it was raised, in 1806, to 96 per cent. *ad valorem*, at which it continued till 1819, when it was raised to 100 per cent. on all teas that brought above 2*s*. per lb. at the Company's sales.

Down to the 22d of April, 1834, the duty on tea was an *ad valorem* one, being 96 per cent. on all teas sold under 2*s*. a pound, and 100 per cent. on all that were sold at or above 2*s*. Seeing that tea may now be considered almost as a necessary of life, this was certainly a high duty; though, as a large amount of revenue must be raised, we do not know that it could be fairly objected to on that ground. But under the monopoly system the duty was, in fact, about 200 per cent. *ad valorem!* For, the price of the tea sold by the Company being forced up to nearly double what it would have been had the trade been free, it followed, inasmuch as the duty varied directly as the price, that it also was doubled when the latter was doubled. The price of congou at Hamburgh, for example, varies from 1*s*. 2*d*. to 1*s*. 4*d*. per lb.; and had the Company supplied our markets with congou at the same rate, it would have cost us, duty included, from 2*s*. 2*d*. to 2*s*. 8*d*. per lb. But instead of this, the congou sold by the Company has been, at an average, a good deal above 2*s*. per lb.; and the duty being as much, it has invariably cost us from 4*s*. to 5*s*. per lb. Hence, though the duty was only 100 per cent. on the Company's price, it was really above 200 per cent. on the price of tea in an open market! The mischief of the monopoly was thus aggravated almost beyond endurance, inasmuch as every addition made by it to the cost of the article made an equal addition to the duty on it.

But this system is now happily at an end. The *ad valorem* duties ceased on the 22d of April, 1834; and all tea imported into the United Kingdom for home consumption is now charged with a customs duty as follows:—

Bohea - - - - -	1*s*. 6*d*. per lb.
Congou, twankay, hyson skin, orange pekoe, and campoi - - -	2*s*. 2*d*. —
Souchong, flowery pekoe, hyson, young hyson, gunpowder, imperial, and other teas not enumerated - -	3*s*. 0*d*. —

We subjoin an account of the quantities of tea entered for home consumption in the United Kingdom in 1840 and 1841, with the gross amount of duty received on the same:—

	Quantities. *lbs.*	Revenue. *L.*
1840 -	32,262,892	3,473,964
1841 -	36,396,078	3,978,198

TEAK WOOD, or INDIAN OAK. The produce of the *Tectona grandis*, a large forest tree, that grows in dry and elevated districts in the south of India, the Burman empire, Pegu, Ava, Siam, Java, &c. Teak timber is by far the best in the East; it works easily, and, though porous, is strong and durable; it is easily seasoned, and shrinks very little; it is of an oily nature, and therefore does not injure iron. Mr. Crawfurd says that, in comparing teak and oak together, the useful qualities of the former will be found to preponderate. "It is equally strong, and somewhat more buoyant. Its durability is more uniform and decided; and to insure

that durability it demands less care and preparation; for it may be put in use almost green from the forest, without danger of dry or wet rot. It is fit to endure all climates and alternations of climate." (See *Tredgold's Principles of Carpentry*, p. 206.; *Crawfurd's East. Archip.* vol. i. p. 451.)

The teak of Malabar, produced on the high table land of the south of India, is deemed the best of any. It is the closest in its fibre, and contains the largest quantity of oil, being at once the heaviest and the most durable. This species of teak is used for the keel, timbers, and such parts of a ship as are under water: owing to its great weight, it is less suitable for the upper works, and is not at all fit for spars. The teak of Java ranks next to that of Malabar, and is especially suitable for planking. The Rangoon or Burman teak, and that of Siam, is not so close-grained or durable as the others; it is, however, the most buoyant, and is therefore best fitted for masts and spars. Malabar teak is extensively used in the building yards of Bombay. Ships built wholly of it are almost wholly indestructible by ordinary wear and tear; and instances are not rare of their having lasted from 80 to 100 years; they are said to sail indifferently; but this is probably owing as much to some defect in their construction as to the weight of the timber. Calcutta ships are never wholly built of teak; the timbers and framework are always of native wood, and the planking and deck only of teak. The teak of Burma, being conveyed with comparatively little difficulty to the ports of Rangoon and Martaban, is the cheapest and most abundant of any. It is largely exported to Calcutta and Madras.

A species of timber called African teak is pretty largely imported into England, from the west coast of Africa. But, in point of fact, it is not teak, and it is destitute of several of its most valuable properties. It is, however, for some purposes, a useful species of timber.

TEANY, TAWNY, or BRUSK. In Heraldry, a colour compounded of red and yellow, employed in blazonry, but rarely met with in English coats of arms, and reckoned one of the dishonourable colours. In engraving, it is represented by diagonal and horizontal lines crossing each other.

TEARS. The fluid which lubricates the cornea of the eye, when secreted in excess, forms *tears;* they are limpid, saline, perfectly miscible with water, and have a slight alkaline reagency, owing to the presence of free soda: their principal saline contents are common salt and a trace of phosphate of soda, and they contain traces of albumen; but the whole solid matter scarcely amounts to 1 *per cent.* When the lachrymal duct by which the tears are conveyed into the nostrils is obliterated, and they flow over the angle of the eye, they become concentrated by evaporation, and leave an irritating muco-saline crust. The exact nature, however, of the animal matter contained in the tears has not been determined.

TECHNO'LOGY. (Gr. τεχνη, *art*, and λογος, *a discourse.*) A term invented to express a treatise on art or the arts.

TECTIBRA'NCHIATES. (Lat. tego, *I cover*, and branchia, *gills.*) A name given by Cuvier to an order of Hermaphrodite Gastropods, comprehending those species in which the gills are covered by a process of the mantle, containing a shell, or enveloped in a reflected margin of the foot: for this name that of *Monopleurobranchiata* has been substituted by M. De Blainville.

TECTO'RIUM OPUS. (Lat. tector, *a plasterer.*) In Architecture, the plasterers' work used on ceilings and interior walls: it was a composition of lime and sand, and differed from stucco, which was called albarium opus. Great pains were taken to prevent its cracking, by crossing layers of reed upon it coated with argillaceous earth previous to coating it with paint.

TECTRI'CES, *Coverts.* (Lat. tego, *I cover.*) The name of the feathers which cover the quill feathers and other parts of the wing. *See* COVERTS.

TE DEUM. (From the first words of the original Latin, "Te Deum laudamus;" *We praise thee, O God.*) The authorship of this sublime hymn has been ascribed by some to Ambrose and Augustine; by others to Ambrose alone, to Hilary, and other less distinguished persons. It is, however, generally thought to have been composed in the Gallican church: the most ancient mention of it being in the rule of Cæsarius, bishop of Arles in the fifth century. The Te Deum, in the office of matins, is always sung after the reading of scripture; in the English morning service, between the two lessons. (Palmer, *Origines Liturgicæ*, ch. i. part 1. sec. 2.)

TEETH. *See* DENTES.

TEETH OF WHEELS, are generally the means by which the power of the first mover is conveyed to the working point of a machine; and it is obviously of great importance that they should be of such a form that as little as possible of the original power may be lost in transmission, and that the impulse should be conveyed through the train of wheels with a uniform force.

In the formation of the teeth of wheels, the object aimed at is to give them such a curvature that the angular velocities of the two pieces working together shall maintain the same constant ratio in all positions of contact. In order to preserve the constancy of the angular velocity ratio, it is only necessary that the acting faces of the teeth shall have such a form that the normal common to the two surfaces in contact shall always divide the *line of centres* (that is, the line joining the centres of the wheel and pinion) in a fixed point. Now, the teeth of one wheel being assumed to have any form whatever, it is always *geometrically* possible to assign the form of those of another so that they shall fulfil this condition, and, consequently, work together correctly; but the forms which are found to answer in practice are limited to a comparatively small number. We subjoin the following cases from Brewster's edition of *Ferguson's Mechanics:* —

Case 1. — If the acting faces of the teeth of a wheel are epicycloids whose generating circle has the same radius as the primitive radius of the pinion, and whose base has the same radius as the primitive radius of the wheel; and if these teeth drive the pinion by acting upon infinitely small pins in its circumference, — the motion of the wheel and pinion will be uniform.

Case 2. — If the acting faces of the teeth of a wheel are epicycloids whose generating circle is of any magnitude whatever, and whose base is the convex circumference of the wheel; and if the acting faces of the leaves of the pinion are epicycloids described by the same generating circle, and whose base is the concave circumference of the pinion, — the motion of the wheel and pinion will be uniform.

Case 3. — If the acting faces of the teeth of a wheel are epicycloids whose generating circle has a radius equal to half the radius of the pinion, and a base of the same radius as the wheel; and if the acting faces of the leaves of the pinion are straight lines directed to the centre of the pinion, — the motion of the wheel and pinion will be uniform.

Case 4. — If the teeth of a rack drive a pinion; then, when the acting faces of the teeth of the rack are cycloids whose generating circle has the same radius as the pinion, and when their teeth drive the pinion by acting upon infinitely small pins placed in its circumference, the motion of both will be uniform.

Case 5. — If the acting faces of the teeth of the rack are cycloids whose generating circle has a radius equal to half the radius of the wheel; and if they drive the wheel by acting upon rectilinear teeth which are a continuation of the radii, — the motion of both will be uniform.

Case 6. — When the teeth of a wheel driving a rack have their acting faces formed of the involutes of a circle having the same radius as the pinion, and drive the rack by acting upon infinitely small pins fixed in its rectilinear edge, the motion will be uniform.

For detailed information connected with this subject, the reader may be referred to the following works: — Camus, *On the Teeth of Wheels; Buchanan's Treatise on Mill Work*, by Rennie; Airy, *On the Teeth of Wheels* (*Cambridge Phil. Trans.* vol. ii.); and particularly to *Willis's Principles of Mechanism*, 1841. *See* WHEEL.

TEGME'NTA. (Lat. tego, *I cover.*) In Botany, the scales covering the leaf-buds of the deciduous trees of cold climates.

TE'GUMENT, or TEGMEN. In Anatomy, the general covering of the body. In Entomology, the term is applied to the coverings of the wings of the order *Orthoptera*, or straight-winged insects.

TEINDS. In Scottish Law, tithes. By the course of various usurpations, the whole teinds of Scotland had become vested after the Reformation in the crown; or in private individuals, termed *titulars*, to whom they had been granted by the crown, or to the *feuars* or renters from the church. By a succession of decrees and enactments these tithes were generally rendered redeemable at a fixed valuation; and the clergy are provided for by stipends, paid by the commissioners of tithes (when these are vested in the crown) or by the titular. The minister can seek the increase of these stipends by process of augmentation and modification; and, if augmented, every heritor becomes liable in proportion to the amount of his teinds.

TEI'NOSCOPE. The name given by Sir David Brewster to an instrument otherwise called the *prism telescope*, formed by combining prisms in a particular manner, so that the chromatic aberration of the light is corrected, and the linear dimensions of objects seen through them increased or diminished.

"If we take a prism, and hold its refracting edge downwards and horizontal, so as to see through it one of the panes of glass in a window, there will be found a position, viz. that in which the rays enter the prism and emerge from it at equal angles, when the square pane of glass is of the natural size. If we turn the refracting edge towards the window, the pane will be extended or magnified in its length or vertical direction, while its breadth

remains the same. If we now take the prism, and hold its refracting edge vertically, we shall find, by the same process, that the pane of glass is extended or magnified in breadth. If two such prisms, therefore, are combined in these positions, so as to magnify the same both in length and breadth, we have a telescope composed of two prisms; but unfortunately the objects are all highly fringed by the prismatic colours. We may correct these colours in three ways: — 1st, We may make the prisms of a kind of glass which obstructs all the rays but those of one homogeneous colour; or we may use a piece of the same glass to absorb the other rays when two common glass prisms are used. 2d, We may use achromatic prisms in place of common prisms. Or, 3d, what is best of all for common purposes, we may place other two prisms exactly similar in reverse positions." (*Brewster's Optics, Cabinet Cyc.* p. 363.)

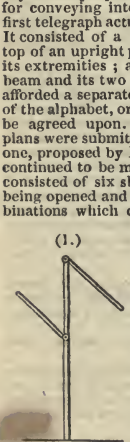
Professor Amici, of Modena, has recently constructed a combination of prisms of the same glass, in which the chromatic aberration is corrected, and a power of about three times obtained. The plan is well suited for opera glasses. Amici's teinoscope consists of four rectangular prisms, having their refractive angles different, and connected by pairs; the two pairs being similar, those next the eye or the first pair are vertical, and the second pair horizontal, so that equal refraction is produced in every direction. The distance between each pair is about an inch and a half. (*Library of Useful Knowledge*, "Optical Instruments," p. 55.) Sir D. Brewster (*Optics*, p. 364.) states that this instrument had been made by Dr. Blair as well as by himself, before it was proposed or executed by Amici.

TELAMO'NES. (Gr. τλαω, *I bear up.*) In Architecture, figures of men used for supporting entablatures, similar to Caryatides: see that word.

TE'LEGRAPH. (Gr. τηλη, *afar off*, and γραφω, *I write.*) The name given to a mechanical contrivance for the rapid communication of intelligence by signals. Of late years, the term *semaphore* (Gr. σημα, *sign;* φερω, *I bear*) has been introduced by the French, and frequently adopted by English writers.

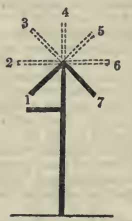
Although the art of conveying intelligence by signals was practised in the earliest ages, and is known even to the rudest savages; and although its importance is not only obvious, but continually felt wherever government is established, it has been allowed to remain in its original state of imperfection down almost to our times. The first description of a telegraph universally applicable was given by Dr. Hooke, in the *Philosophical Transactions* for 1684. The method which he proposed, for it was not carried into practice, consisted in preparing as many differently shaped figures, formed of deal, — for example, squares, triangles, circles, &c.,—as there are letters in the alphabet, and exhibiting them successively, in the required order, from behind a screen; and he proposed that torches or other lights, combined in different arrangements, should supply their place by night. About twenty years later, Amontons exhibited some experiments before the royal family of France, and the members of the Academy of Sciences, by which the practicability of the art was demonstrated. But although both the proposal of Hooke and the experiments of Amontons were made public, telegraphic communication was not applied to any useful purpose until 1794, when the plan was adopted for conveying intelligence to the French armies. The first telegraph actually used was the invention of Chappe. It consisted of a beam which turned on a pivot in the top of an upright post, having a moveable arm at each of its extremities; and each different position in which the beam and its two arms could be placed at angles of 45° afforded a separate signal, which might represent a letter of the alphabet, or have any other signification that might be agreed upon. In the following year, 1795, several plans were submitted to the English admiralty; of which one, proposed by Lord George Murray, was adopted, and continued to be made use of down to the year 1816. It consisted of six shutters, arranged in two frames, which being opened and shut according to all the different combinations which can be formed, afforded the means of giving sixty-three separate and distinct signals. In 1803, the French erected *semaphores* along their whole line of coast, formed of an upright post, carrying two, or sometimes three beams of wood, each turning on its own pivot, one above the other. In 1807, Captain (now General) Pasley, of the Royal Engineers, published his *Polygrammatic Telegraph*, differing from the French semaphores by having beams turning on the same pivot; and, in order to obtain a sufficient number of different signals, he proposed to erect two or three posts at each station. In 1816, Sir Home Popham considerably simplified this construction. His telegraph, which was adopted in that year by the Admiralty instead of the shutter telegraph, and has continued in use ever since, consists of merely two arms, moveable on different pivots on the same mast, as represented in the annexed figure (1.). It is capable of giving forty-eight independent signals. Lastly, in 1822, General Pasley still further simplified the construction, by placing the two arms on the same axis. As this form of the instrument appears to be the most perfect at present in use, we shall give a few details repecting its construction, and the mode of using it.

(1.)



For day signals, the telegraph consists of an upright post of sufficient height, with two arms moveable on the same pivot on the top of it, and a short arm, called the *indicator*, on one side; as in the annexed figure (2.). Each arm can exhibit the seven positions, 1, 2, 3, 4, 5, 6, 7, besides the position called the *stop*, which points vertically downwards, and is hid by the post. In order to show the number of signals that may be made with this machine, we may suppose the arm nearest the indicator, reckoning in the order of the numbers as shown in the figure, to indicate tens, and the other units; then the signal represented in the figure will be 17, which may be taken to denote a letter of the alphabet. If the arm on the left had the position indicated by 3, and that on the right the position indicated by 6, the signal would be 36. In this manner, the number of separate and independent signals, with their signification, will be as in the following table: —

(2.)



No. of Signal.	Signification.	No. of Signal.	Signification.	No. of Signal.	Signification.
1	A	15	L	36	V
2	B	16	M	37	W
3	C	17	N	45	X
4	D	23	O	46	Y
5	E	24	P	47	Z
6	F	25	Q u	56	
7	G	26	R	57	
12	H	27	S	67	
13	I	34	T		
14	K	35	U		

There are thus, as already stated, 28 independent signals, which are more than sufficient for spelling any message, though not enough for indicating both the letters of the alphabet, and also the numeral digits; and it may be remarked that No. 4. is a bad signal, when used by itself, because it appears in the telescope as a prolongation of the post. Advantage may, however, be taken of the indicator, if made moveable, to increase the number of combinations.

The use of the indicator is to show the order or direction in which the signals are to be reckoned; that is, whether from right to left, or from left to right. This is indispensable at sea, or wherever it is required to convey intelligence in different directions at the same time.

In order to adapt the telegraph to the purpose of making night signals, a lantern, called the central light, is fixed to the pivot on which the arms move, and one is also attached to the extremity of each arm. A fourth lantern, used as an indicator, is fixed in the same horizontal line with the central light, at a distance from it equal to twice the length of one arm, and as nearly as may be in the plane in which the lights revolve.

The arms and the indicator are made of wood, framed and panelled for the sake of lightness. The arms are fixed one on each side of the post, and counterpoised by weights, or by light frames of iron-work, which at a little distance are quite invisible. The precaution of counterpoising is necessary, as the arms would not otherwise remain in any given position unless held by the hand, or stopped by some mechanical contrivance, which would be attended with inconvenience. Motion is communicated to the arms by means of an endless chain passing over two pulleys; one fixed to the arm itself, and turning on the same pivot; and the other on a pivot fixed to the lower part of the post, within the reach of the signalman. The pulleys are of the same size, and worked with great care, so that the arms can be set with the greatest exactness; and the required positions are pointed out by a dial-plate, the index of which is moved by a lever attached to the lower pulley.

It is found from experience that the length of the arm should be about one foot for each mile of distance, and the width of the arm should be from one sixth to one eighth of its length. The indicator should be of the same width, but only about four fifths of the length of the arm.

Instead of employing the different telegraphic signals to represent the letters of the alphabet, each may have

a signification entirely arbitrary, but settled by previous agreement; and thus a message may be communicated by a single sign. When this plan is adopted, a much greater number of signals is required; but this is obtained by successively exhibiting two or more of the different single signs. Thus, supposing the telegraph capable of exhibiting 20 independent signs; then by two successive changes 400 signals may be made, and 8000 by three successive changes. Every system of telegraphic signals according to this plan is of necessity accompanied with a telegraphic dictionary, containing the signification of the different combinations of signs. Several works of this kind have been compiled. One by Sir Home Popham, at present used in the English navy, contains about 13,000 words or sentences, which is probably more than is necessary for any practical purpose, though there are others much more extensive. The Admiralty adheres to the safer, though somewhat less rapid practice, of spelling all the sentences.

In the management of a fleet at sea, telegraphic communication is indispensable. In the English navy, the signals are generally made by flags; though, from the difficulty of making out their figures and colours in calm weather, or when the wind blows in the direction in which the signal is to be communicated, the communication, it might be supposed, would be made with greater certainty by means of the semaphore.

Various attempts have been made at different times, particularly on the Continent, to supersede the optical telegraph, which is always useless in hazy weather, by applying the agency of electricity or galvanism to the rapid communication of intelligence. An apparatus for accomplishing this purpose by means of galvanism has recently been contrived by Professor Wheatstone, of King's College, London, which, if experiments on a relatively small scale may be trusted to, appears to be completely successful. It has been adopted on some of the principal lines of railway in this country.

TELEO'LOGY. (Gr. τελος, *an end*, and λογος, *a discourse.*) The doctrine of final causes is so called. The *teleological argument* for the existence of a Deity is derived from the marks of design apparent in the universe, which not only imply an intelligent Creator, but demonstrate at the same time his benevolence and other moral attributes. When these are derived from material nature, the argument is styled the *physico-theological*. The reader will find in *Whewell's Bridgewater Treatise* an explanation of Bacon's meaning in banishing final causes from the domain of physical science.

TE'LEOSAUR, *Teleosaurus*. (Gr. τελειος, *perfect;* σαυρος, *a lizard.*) The name of a genus of fossil Saurian reptiles, resembling the *Gavials;* but having the vertebræ united by flat surfaces, instead of ball-and-socket joints.

TE'LESCOPE. (Gr. τηλη, *distant;* σκοπεω, *I look at.*) An optical instrument for viewing distant objects.

For several reasons a distant object is seen less distinctly than a similar near one. The angle which an object subtends diminishes as the distance increases; the density of the light which renders it visible also diminishes with the distance, but in a much faster ratio; and a considerable portion of light is always lost in its passage through the atmosphere.

It is found by experience that to be discernible at all in ordinary daylight, a detached object must subtend at the eye an angle of not less than 30″, and that the least angle under which contiguous objects can be satisfactorily distinguished is about one minute. By the aid of a telescope a magnified image of the object is obtained; and within certain limits the object is not only apparently enlarged, but rendered brighter than it appears to the unassisted eye.

The invention of the telescope, to which practical astronomy is indebted for its most important discoveries, has been ascribed to various persons. Sir David Brewster (*Encyc. Brit.*, art. "Optics") says, "We have no doubt that this invaluable instrument was invented by Roger Bacon or Baptista Porta, in the form of an experiment; though it had not, perhaps, in their hands assumed the maturity of an instrument made for sale, and applied to useful purposes, both terrestrial and celestial. If a telescope is an instrument by means of which things at a distance can be seen better than by the naked eye, then Baptista Porta's concave lens was a real telescope; but if we give the name to a tube having a convex object-glass at one end, and a convex or concave lens at the other, placed at the distance of the sum or difference of their focal lengths, then we have no distinct evidence that such an instrument was used before the beginning of the 17th century." Descartes ascribes the invention to James Metius, a citizen of Alkmaer in Holland; Huygens to John Lippersey, or Zacharias Jansen; Borellus also to Jansen. Professor Moll, who has discussed these rival claims, after examining the official papers preserved in the archives at the Hague, comes to the conclusion that Metius (whose proper name was Jacob Adriaansy), on the 17th of October, 1608, was in possession of the art of making telescopes; but that from some unexplained reason he concealed his invention, and thus gave up every claim to the honour he would have derived from it; that on the 21st of October in the same year, 1608, John or Hans Lippersey, a spectacle-maker of Middleburg, was actually in possession of the invention; and that there is little reason to believe that either Hans or Zacharias Zanz (or Jansen, father and son) were inventors of the telescope, though one of them invented a compound microscope about 1590. (*Journal of the Royal Institution*, vol. i.)

The telescope soon made its way into other countries. In April or May, 1609, the illustrious Galileo, having heard a rumour of the invention, set about considering the means whereby distant objects could be seen distinctly, and was soon in possession of a telescope which magnified three times. In subsequent trials he succeeded in increasing the magnifying power; and before the beginning of 1610, he had observed the satellites of Jupiter. Our countryman Harriot also, in 1609, began to use the telescope for examining the disc of the moon, and before he had heard of the discoveries of Galileo. (*Priestly's History of Discoveries relating to Vision, Light, and Colours.*)

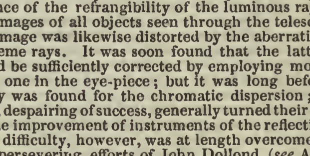
Telescopes are of two kinds, *refracting* and *reflecting* telescopes: the former depending on the use of properly figured lenses, through which the rays of light pass; and the latter on the use of specula, or polished metallic mirrors, which reflect the rays; an inverted image of the object being formed in both cases in the focus of the lens or mirror.

Refracting telescopes were those which were first constructed. They were of the most simple character, consisting merely of an object-glass of one lens, and an eye-glass of one lens, but of a shorter focus. But in this construction the prismatic colours produced by the difference of the refrangibility of the luminous rays tinged the images of all objects seen through the telescope, and the image was likewise distorted by the aberration of the extreme rays. It was soon found that the latter defect could be sufficiently corrected by employing more lenses than one in the eye-piece; but it was long before a remedy was found for the chromatic dispersion; and artists, despairing of success, generally turned their attention to the improvement of instruments of the reflecting class. The difficulty, however, was at length overcome through the persevering efforts of John Dollond (*see* ACHROMATISM); and the *achromatic refracting telescope* may now be regarded as an instrument all but perfect.

The principles on which telescopes depend having been explained under the terms REFLEXION and REFRACTION, and the properties and construction of their principal parts under ACHROMATISM, LENS, MIRROR, we shall here describe some of the principal forms which the instrument has assumed. It will be borne in mind that the general aim in the construction of a telescope is to form, by means of lenses or mirrors, as large, bright, and distinct an image of a distant object as possible, and then to view the image with a magnifying glass in any convenient manner. We shall first describe those of the refracting class.

Galilean Telescope. — This is the most ancient form of the telescope, and is that which was used by Galileo. It consists of a converging object-glass A B (fig. 1.), and

(1.)



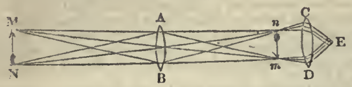
a concave diverging eye-glass C D. On passing through the object-glass A B, the rays of light coming from the different points of a distant object in parallel pencils are rendered convergent, and proceed towards the principal focus, where they would form an inverted image; but before they arrive at this point they fall upon the concave lens C D, by which they are again rendered parallel, or at least their convergence is corrected so as to give distinct vision of the object to the eye at E. The lens C D is therefore placed between the object-glass and the image, and at a distance from the image equal to its principal focal distance. The magnifying power is equal to the principal focal distance of the object-glass divided by the principal focal distance of the eye-glass. *See* LENS.

In this telescope the object is seen erect, and the length of the tube is only the difference between the focal lengths of the two lenses. These properties render it preferable to any other telescope for many ordinary purposes; as, for example, an *opera-glass*. When used for this purpose, the magnifying power is hardly ever greater than 4; and it is often as low as 2.

Astronomical Telescope. — This is composed of a converging object-glass A B (fig. 2.), and of a converging eye-glass C D. Rays of light proceeding from any point

M of a distant object M N, and falling on the different points of the object-glass, are refracted into a point m in

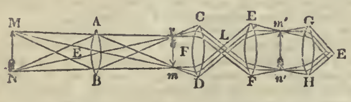
(2.)



the principal focus. In like manner, those proceeding from the point N are refracted into the point n; and thus an inverted image $m\ n$ is formed at the focus of the object-glass. The eye-glass is placed so that its focus shall coincide with the place of the image; consequently rays diverging from any point of the image, and falling on the lens C D, are refracted into a parallel direction before they enter the eye at E, and are thereby rendered fit to produce distinct vision. The length of the telescope is equal to the sum of the focal distances of the two lenses; and the magnifying power is equal to the focal distance of the object-glass divided by the focal distance of the eye-glass. This telescope was first described by Kepler in his *Dioptrice* (1611); but it does not appear to have been executed until about twenty or thirty years later.

Terrestrial Telescope. — This differs from the astronomical telescope only in having two additional lenses E F, G H (fig. 3.), placed in the tube of the eye-glass for the purpose of restoring the inverted image to its erect position, and thereby accommodating the telescope to terrestrial objects. The focal lengths of these additional lenses are usually the same as that of the eye-glass. The two pencils of rays proceeding from the points M and N cross each other in the anterior focus of the second lens E F, and falling parallel on E F form in its principal focus an inverted image of mn, and consequently an erect image of the object M N. This image $m'\ n'$ is seen by the eye at E through the lens G H, as the rays diverging from m' and n' in the focus of G H enter the eye in parallel pencils. When the three first lenses are equal, the magnifying power is the same as that of the astronomical telescope, whose object and eye glasses are the same as A B and C D.

(3.)

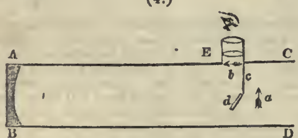


The performance of refracting telescopes depends most essentially on the goodness of the object-glass; for if the first image is bright and distinct, and perfectly achromatic, there is little difficulty in constructing eye-pieces to magnify it, without causing it to undergo any sensible alteration.

Reflecting Telescopes. — In reflecting telescopes the speculum, or mirror, performs the same office that the object-glass does in those of the refracting kind, and is therefore called the *object-mirror*. The instrument is constructed in various forms; but these differ from one another chiefly in reference to the contrivances which have been adopted for bringing the focal image into a convenient situation for being viewed by the eye-piece. The principal forms are the Newtonian, the Gregorian, the Cassegrainian, and the Herschelian.

Newtonian Telescope. — Let A B C D (fig. 4.) represent

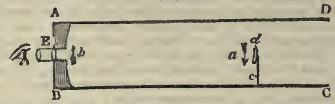
(4.)



a section of the tube of the telescope; A B the object-mirror, which would form at its focus the image a of any distant object. Now if a person attempted to view the image in its place at a by placing himself directly before the mirror, he would necessarily intercept the rays of light from the object passing down the tube to the mirror, and consequently there would be no image to view. Sir Isaac Newton overcame this difficulty by introducing a small diagonal plane speculum d between A B and a, which intercepting itself but a small portion of the light, reflects towards the side of the tube the rays converging from A B, and causes the image which would have been formed at a to be formed at b, where it can be conveniently viewed by the eye-piece E attached to the side of the tube. The small mirror is of an oval form, and is fixed on a slender arm c connected with a slide, by means of which it may be made to approach or recede from the large speculum A B, according as the image approaches to or recedes from it. In this telescope the magnifying power is equal to the focal length of the object-mirror A B divided by that of the eye-glass.

Gregorian Telescope. — In this construction the object-mirror A B (fig. 5.) is perforated in the middle, and the

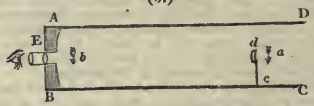
(5.)



rays of light from a distant object being reflected from the surface of A B cross each other in the focus, where they form an inverted image a, and are then intercepted by a small concave mirror d, which causes them again to converge to a focus at b, near the perforation of the object-mirror, where they form a reinverted or direct image, which is viewed by an eye-piece E screwed into the tube behind A B. The curvature of the small speculum should be elliptical, having the foci at a and b; but it is generally made spherical. In this case the great speculum should be slightly hyperbolic, to counteract the aberration of the small mirror.

Cassegrainian Telescope. — The great speculum of this instrument is perforated like the Gregorian; but the rays converging from the surface of the mirror A B (fig. 6.)

(6.)

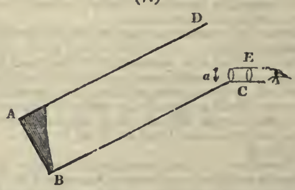


towards the focus a are intercepted before they reach that point by a small convex mirror d, not sufficiently convex to make the rays divergent, but of such a curvature as to prevent them from coming to a focus till they are thrown back to b, near the aperture in A B, where they form an inverted image which is viewed by the eye-piece E. This construction has the advantage of requiring a shorter tube than the Gregorian; but the inversion of the image is not corrected, and for this reason probably it has not been much used.

In the two last constructions the small mirror d is adjusted by means of a rod turning on a shoulder near the eye end of the tube, and connected by a screw with the apparatus which carries the arm c to which the mirror is attached.

Herschelian Telescope. — This construction differs from the others in having no second mirror. The large speculum A B (fig. 7.) is placed at the bottom of the tube

(7.)



in an inclined position, so as to bring the focal image a near the edge of the tube, where it is viewed directly by the eye-piece E without interfering with the light entering the telescope from the object observed. The magnifying power is the same as in the Newtonian.

The reflecting telescope was invented by James Gregory, and is described by him in his *Optica Promota* (1663); but the first telescope of the kind was executed by Newton. Reflecting telescopes have been made on a very large scale. The celebrated intrument of Sir William Herschel, erected at Slough in 1789, was 40 feet in length. Its great speculum had a diameter of 49½ inches; its thickness was about 3½ inches, and its weight when cast was 2118 lbs. Its focal length was 40 feet, and it admitted of a power of 6450 being applied to it. The essential advantage of large telescopes of this kind consists in the immense quantity of light which they collect, whereby the observer is enabled to perceive faint nebulæ and stars which are altogether invisible in ordinary instruments.

Reflecting telescopes are used only for observing *phenomena*, and are not, like refracting telescopes, attached to circular instruments for the purpose of measuring angles with greater precision. In order to derive full

benefit from them, they must be used in the open air; and must either be mounted equatorially (*see* EQUATORIAL), or else in such a manner as to be capable of a smooth motion both in a vertical and horizontal direction. Telescopes of this kind being generally used with a high magnifying power, and consequently having a small field of view, are always accompanied with a smaller telescope or *finder* fixed to the tube, so that the axes of the two instruments are exactly parallel.

Eye-pieces of Telescopes. — When the image formed by the object-glass or mirror is viewed with a single lens or eye-glass, whether concave or convex, it is only in the centre of the field that distinct vision is obtained, all towards the margin being hazy and distorted. To remedy this defect, Boscovich and Huygens separately proposed the construction of an eye-piece formed of two lenses, placed at a distance from each other equal to half their focal distances. Boscovich recommended two similar lenses; Huygens, that the focal length of the one should be twice that of the other; and as this construction is found to answer best in practice, it is that which is most commonly used.

The two lenses are usually plano-convex, with the convex faces towards the object-glass: the larger lens, called the field glass, is innermost, or nearest the object-glass; and a diaphragm cutting off the marginal rays is usually placed between them near the focus of the eye lens, where the image is formed. This eye-piece is usually called the *negative* eye-piece, from its having the image seen by the eye behind the field glass; and is that which is commonly supplied with telescopes intended only for the purpose of *seeing* objects, without reference to measurement.

Another modification of the two-lens eye-piece was proposed by Ramsden, and is called the *positive* eye-piece, because the image observed is before both lenses. The lenses are plano-convex, and nearly of the same focal length; but their distance from each other is less than the focal distance of the lens nearest the eye, two lenses thus placed acting as a compound simple lens. This eye-piece is the most convenient when micrometer wires are placed in the focus, because it can be taken out without injuring the wires; and it has also this advantage, that the measure of an object given by one eye-piece is not altered when it is changed for another of a different magnifying power.

In both the eye-pieces now described the image is seen inverted; and though this is of no importance in astronomical observations, it is inconvenient when the telescope is used for looking at terrestrial objects. By placing an additional pair of lenses in the tube of the eye-piece, the image is repeated and reinverted, and consequently seen erect. By this means, as explained above, the terrestrial telescope is obtained.

The name of *diagonal eye-piece* has been given to eye-pieces furnished with a diagonal reflecting mirror, the object of which is to give a more convenient direction to the rays emerging from the eye-piece when the telescope is pointed high.

Telescopes are generally supplied with eye-pieces of different powers, which are all fitted to enter the same tube; and the focal adjustment is commonly effected by a rack and pinion motion acting on the tube which carries the eye-piece.

For full information respecting the construction of telescopes, and the best modes of mounting them on stands or otherwise, to secure steadiness and allow of the requisite motion, the reader is referred to *Pearson's Practical Astronomy*, vol. ii. (See also *Smith's Optics; Coddington's Optics*.)

TELLINA. (Gr. τελλινη, *a species of muscle.*) A genus of cockles (Cardiaceous Bivalves in the Cuvierian system), characterized by the hinge of the shell having one tooth on the left and two teeth on the right valve, often bifid; in the right valve there is a plate which does not enter a cavity in the opposite valve. There is a slight fold near the posterior extremity of both valves which renders them unequal at that part, where they gape a little. The soft parts, or animal of the *Tellina*, called *peronæa* by Poli, has two long tubes for respiration and excretion, which can be withdrawn into the shell, and are concealed in a fold of the mantle.

Cuvier separated from the Linnæan *Tellinæ* the genus *Loripes*, distinguished by the feebly developed cardinal teeth, and by a long cylindrical foot. Other genera have since been detached from the Cuvierian *Tellinæ*, which now form a family, *Tellinidæ*, in the system of Lamarck.

TELL TALE. The dial plate at the wheel, showing the position of the tiller.

TELLU'RIUM. (Lat. tellus, *the earth.*) This rare metal has only been found in small quantities in the gold mines of Transylvania: it occurs in the metallic state, combined with gold or silver. It is white, brilliant, brittle, and easily fusible. Its specific gravity is about 6·25. It is combustible, and often exhales a peculiar odour, like horse-radish, which Berzelius ascribes to the presence of minute portions of selenium. It forms a protoxide and a peroxide, often called *tellurous* and *telluric acids*. Its equivalent is either 32 or 64. In the former case, the protoxide consists of 1 atom of tellurium and 1 of oxygen (32 + 8), and the peroxide of 1 atom of tellurium and 1½ of oxygen (32 + 12); in the latter the numbers are doubled. Tellurium forms a gaseous compound with hydrogen, which has been called *hydrotelluric acid.*

TE'MPERAMENT. (Lat. temperare, *to moderate.*) In Music, the adjustment of the imperfect concords, in musical instruments whose sounds are fixed, such as organs, piano-fortes, &c., so as to transfer to them part of the beauty of the perfect concords. The defect to be remedied arises from the single short keys between the two larger ones serving for flats as well as sharps. It is necessary to observe, that in the theory of harmonies the interval of a tone is not always the same; for instance, that lying between the fourth and fifth of the scale contains nine small parts, called commas, whereas that between the fifth and sixth of the major scale contains only eight commas. Again, the diatonic semitone contains five commas, and the chromatic semitone three or four, according to the magnitude of the tone. Hence it is that the different situation of these elements with regard to each other, causes intervals of the same names to consist of different degrees or elements. To improve them, therefore, musicians *temper* them so as to reduce the whole more to mean distances from each other, necessarily producing a new division of the octave.

TEMPERAMENT, in Physiology, has been defined as that peculiarity of organization which to a certain extent influences our thoughts and actions. The ancient physicians enumerated four temperaments; namely, the bilious, the choleric, the phlegmatic, the sanguine, the melancholic. To these some have added the nervous; and these terms are still in use among medical writers.

TEMPERATE ZONES, in Geography, are two of the five zones into which the terrestrial globe is divided. The *north temperate zone* is included between the tropic of Cancer and the arctic circle; and the *south temperate zone* between the tropic of Capricorn and the antarctic circle.

TE'MPERATURE. A definite degree of sensible heat, as measured by the thermometer.

TE'MPLARS, or KNIGHTS OF THE TEMPLE. A military order of religious persons. It was founded by an association of knights, in the beginning of the 12th century, for the protection of pilgrims on the roads in Palestine: afterwards, it took for its chief object the protection of the Holy Sepulchre at Jerusalem against the Saracens. Knights were fixed at Jerusalem by King Baldwin II., who gave them the ground on the east of the Temple. Their rules were taken from those of the Benedictine monks: they took the vows of chastity, obedience, and poverty. The classes of the order were, knights, esquires, servitors, and chaplains; the universal badge of the order was a girdle of linen thread. The officers of the order were chosen by the chapter from among the knights: they were, for military affairs, marshals and bannerets; for purposes of government, priors, who superintended single priories or preceptories; abbots, commanders, and grand priors, who governed the possessions of the order within separate provinces; and the grand master, who, in some respects, assumed the dignity of a sovereign prince, being independent in secular matters, and depending solely on the pope in spiritual. The chief part of the 9000 estates, lordships, &c. which the society possessed in the 13th century, was situated in France; and the grand master was usually of that nation. The Templars were driven from Palestine by the Saracens, with the rest of the Christians, and then fixed the chief seat of their order in Cyprus. Their exorbitant power and wealth, and the haughty manner in which they endeavoured to keep aloof from the control of European sovereigns, and act as a military republic independent of their authority, were probably the principal reasons which induced Pope Clement V. and Philip the Fair of France to concert their overthrow. The charges of heresy and idolatry, which were preferred against them, were at least unsupported by evidence. In 1307, Jacques de Molay, the grand master, having been enticed into France, was arrested by Philip; the Templars' estates were seized; many of them burnt alive, after the mockery of a trial; and, in 1312, the order was abolished by a bull of Clement V. Its vast estates fell partly into the hands of the sovereigns of the countries in which they were situated, partly into those of the Hospitallers and other military orders. Detached bodies of the order, however, continued to subsist for some time in different countries. See, among numerous authorities, Raynouard's tragedy of *Les Templiers*, with the notes; *Turner's England in the Middle Ages*, vol. ii.; *Mem. de l'Ac. des Inscr.* vol. xxxvii.; *Addison's History of the Knights Templars and the Temple Church*, 1842. For a notice of the strange irreligious doctrines attributed to them, see the article BAPHOMET.

TE'MPLE. A building dedicated to the service o

some deity. Derived from the Lat. templum, Gr. τέμενος, signifying *separation* and *consecration*. The term is generally confined to heathen edifices; excepting in the case of the building erected for the worship of God by Solomon at Jerusalem, which is emphatically denominated *the Temple*. This edifice was similar in its plan to the Tabernacle, consisting of the holy of holies, the sanctuary, and a portico. It is minutely described in 1 Kings, vi.

The Temple of Solomon was begun B. C. 1012, and destroyed by Nebuchadnezzar B. C. 586. It was rebuilt after the return of the Jews from captivity, and after a period of nearly 500 years repaired and beautified by Herod the Great. The restoration contemplated by this prince must have been extensive. When the Jews say to Christ, "Forty years was this temple in building," they are generally supposed to allude to the time during which the repairs had been in progress; nor, according to Josephus, were they brought to a completion when the temple itself, together with the entire city, were demolished by the army of Titus, A. D. 70.

The structure to which this term is applied is of comparatively modern date, for the earliest temples were an open spot with a rude altar of earth and stones; indeed, the Persian religion forbade the worship of the Deity except in the open air, and the earliest Greek temples give us some notion of the same sort of practice. The oracle at Delphi, according to Pausanias, was merely an arbour of laurels; and from Herodotus we learn that the oracles at Dodona were delivered from an old oak. The remarkable features of the Egyptian temple are the massive dimensions, and the number and arrangement of the columns; the cell being always of diminutive size. In Greece, at the period when they had advanced in art, every city exhibited structures of the most elaborate and splendid description dedicated to the service of their divinities; and the Romans long after emulated their masters in the care and riches bestowed upon these edifices. Some of the most celebrated were those of the Parthenon (to Minerva) at Athens, of Diana at Ephesus, of Apollo at Delphi, of Jupiter at Olympia, of Venus at Paphos and Cythera, and that of the Capitoline Jupiter at Rome. Asia Minor abounded with them; and in the other direction we find them as far west as Nismes. Vitruvius has classed temples under seven heads; viz. those *in antis*, the *prostyle*, the *amphiprostyle*, the *peripteral*, the *dipteral*, the *pseudodipteral*, and the *hypæthral*, all of which are defined under these names in this work.

TE'MPLET. (Etym. doubtful.) In Architecture, a short piece of timber laid under a girder or beam to distribute the weight. Also a mould used by bricklayers for cutting or setting out work, and by millwrights for shaping the teeth of wheels.

TEMPO. (It. *time*.) In Music, the Italian word constantly used to express time.

TE'MPO D'IMBROGLIO. (It. *time of trouble*.) In Music, a term applied to a composition written in one measure, but really performed in another.

TE'MPORAL or TEMPLE BONES. Two irregular bones, one on each side of the head. They are connected with the occipital, parietal, and sphenoid bones, and are articulated with the lower jaw. Comparative anatomy shows that the so-called "temporal bone," in man, is essentially an assemblage of five bones, called squamous, zygomatic, tympanic, petrous, and mastoid; having distinct functions developed in different proportions, and continuing permanently detached in the cold-blooded classes, but soon coalescing in the warm-blooded classes. The tympanic element, however, continues permanently detached in birds.

TENA'CITY OF THE METALS. The power which metallic wires possess of sustaining, without breaking, the action of a suspended weight. *See* COHESION, STRENGTH OF MATERIALS.

TENA'CULUM. A surgical instrument, consisting of a fine sharp-pointed hook, by which the mouths of bleeding arteries are seized and drawn out, so that in operations they may be secured by ligaments.

TENAILLON. In Fortification, a kind of outwork made on each side of a small ravelin to increase its strength, and to cover the shoulders of the bastion. Works of this kind are, however, so decidedly inferior to large ravelins, that they are seldom adopted.

TENANT, TENEMENT. In Law. These words are derived from the principles of the feudal system, according to which (as it prevailed in England) no land was without a lord; and every one who enjoyed land *held* it either of a mesne tenant, or of the crown. The party holding the land is called *tenant*, the thing holden *tenement*, the mode of holding *tenure*. Thus tenants are said to be in fee-simple, in tail, for life, for years, &c. Tenement, in the largest sense of the word, is every thing which may be holden; viz. all corporeal hereditaments, and incorporeal hereditaments of a permanent nature issuing out of the same. Thus lands, houses, rights of common, &c., franchises, offices, are all tenements in the larger sense. In the more narrow acceptation in which the word is popularly applied, it describes a house with the homestall or immediate appurtenances.

TENCH. The name of a species of Cyprinoid fishes (*Tinca vulgaris*, Cuv.), and the type of a subgenus of that family. It is generally more or less abundant in ornamental waters and ponds, but is seldom found in rivers in this country. It is common in most of the lakes of the European continent, whence it is supposed to have been imported into England. The tench is remarkable for its tenacity of life; it spawns about the middle of June, at which time the female is attended by two males. Their food consists of the smaller soft-bodied aquatic animals, and vegetable matter. In stocking a pond with tench, the large-sized fish should be selected, and two males to one female should be the proportion of the sexes. *See* TINCA.

TE'NDER. In Law, the legal tender of a debt is by the actual production and offer of the sum due, unless the creditor dispense with it by a declaration that he will not accept it. The tender must be of money: if beyond the sum of 40*s*., in gold, or in what has been rendered by act of parliament equivalent for that purpose, viz. Bank of England notes, which are a legal tender for every sum above 5*l*., except at the Bank of England or its branches. A tender of country bank notes, if not objected to on that ground, is sufficient. The tender of a larger sum than that due is legal, unless it be of a sum requiring change.

TENDO ACHILLIS. The large tendon which passes from the muscles of the calf of the leg to the heel. Its name has reference to the fable of the dipping of Achilles in the Styx; his mother, Thetis, having, as it is said, held him by that part.

TE'NDRIL, is any slender twining part by which one plant attaches itself to another. It is often a transformation of a leaf which has no lamina, or which has the midrib elongated beyond it, retaining its usual tapering figure, and becoming long and twisted spirally. In the vine it is an abortive bunch of flowers; in the passion flower, a metamorphosed branch; in some petals a thin extended point, as in *Strophanthus*.

TENE'SMUS. (Gr. τειν, *I stretch or constringe*.) A straining and ineffectual inclination to void the contents of the bowels.

TE'NNANTITE. A mineral named in honour of the late Mr. Tennant. It is an arsenical sulphuret of copper and iron. It occurs in the copper veins of some of the Cornish mines, both massive and crystallized.

TE'NON. (Lat. teneo, *I hold*.) In Architecture, the end of a piece of wood or timber, diminished usually by one third of its thickness, which is received into a hole corresponding to it in size, called a mortise, by which expedient the two are held jointed or fastened together.

TENO'RE, or TENOR. (It.) In Music, the mean or middle part of a composition, being the ordinary compass of the human voice when neither raised to a treble or lowered to a bass. What is called counter-tenor is only a higher tenor.

TE'NREC. The name of a small Insectivorous quadruped of Madagascar, allied to the hedgehog: it forms the type of the genus *Centetes*.

TENSE. (Lat. tempus, *time*.) In Grammar, that modification of the verb which defines the time at which the action is conceived as taking place. *See* GRAMMAR.

TENSOR MUSCLES, in Anatomy, are those which tighten the part to which they are fixed; as the tensor vaginæ femoris, tensor palati, &c.

TENT, *Tinta*. A Spanish red wine, chiefly from Malaga and Gallicia.

TENT, in Surgery, is a plug of lint used for dilating wounds: a piece of sponge which has been imbued with wax is termed *sponge-tent*.

TE'NTACLE. (Lat. tentaculum, *a holder*.) This term is used by Savigny in a restricted sense to signify the elongated, filiform, inarticulate appendages of the mouth of Annellides; but is also applied to all appendages, whether jointed or not, which are used as instruments of exploration and prehension. Thus the oral arms of the Polyps, the prehensile processes of Cirripeds and Annellides, the cephalic feet of the Cephalopods, the barbs of fishes, are termed tentacles.

TENTH. In Music, an interval containing nine degrees and five spaces.

TENTHS. The tenth part of the yearly value of al benefices, which was anciently paid, with the first fruits, to the pope. *See* FIRST FRUITS.

TENTO'RIUM. The process of the *dura mater* which separates the cerebrum from the cerebellum.

TE'NUES. (Lat. *thin*; Gr. ψιλαι.) The three letters *k*, *p*, *t* in the Greek alphabet are so called, in relation to their respective middle letters *g*, *b*, and *d*, and their aspirates *ch*, *ph*, and *th*.

TE'NUIRO'STERS, *Tenuirostres*. (Lat. tenuis, *slender*, and rostrum, *a beak*.) The name of a tribe of Insessorial birds, including those which have a long and slender bill.

TE'NURE. The feudal relation between lord and vassal in respect of lands. Tenures in capite, or in chief,

were those by which land was held immediately of the crown; mesne tenures, of mesne or inferior lords. English tenures under the feudal system are reduced by Blackstone to four: knight-service, or chivalry; free socage; pure villenage; and villein-socage. *See* FEUDAL SYSTEM, SOCAGE, VILLENAGE.

TENURES, SCOTTISH, were five: viz. 1. Military, or *ward-holding;* abolished, with all its *casualties* or incidents, by 20 G. 2. c. 50. 2. By *mortification*, or *mortmain;* which now only applies to manses and glebes, retained by the act of 1587 as mortified to the church. 3. *Burgage holding*, by which the burgesses of royal burghs hold lands and houses within the burgh of the sovereign by service of watching and warding, &c. 4. *Blanch tenures*, by which the grantee or vassal is bound to pay to the superior annually a species of quit-rent or acknowledgment. 5. *Feu-holding*, by grant, with reservation of pecuniary services. *See* FEU.

TEPHROMANTI'A. (Gr. τεφρα, *ashes*, and μαντεια, *prophecy*.) Divination from the figures assumed by red-hot embers. (See Potter, *Arch. Gr.* i. 353.)

TE'RAPHIM. A word used thirteen or fourteen times in the Old Testament, and commonly rendered by our translators "idols." Bryant explains them as "lunar amulets, or types of the ark in the form of crescents, supposed to have been invented by the patriarch Terah." (*Antiq.* iii. 321.) In later times, strange and horrible practices of witchcraft are described by Rabbinical writers in explaining this word. The teraph, according to Rabbi Eliezer, was made by killing a first-born child, opening the head, putting a gold plate with the name of the impure spirit under the tongue, &c. (See also the notes to *Southey's Thalaba*, book i.)

TERATO'LOGY. (Gr. τερας, *a monster*, and λογος, *a discourse*.) That branch of physiological science which treats of the various malformations and monstrosities of the organic kingdoms of nature.

TEREBE'LLUM. (Lat. terebro, *I bore*.) The name of a genus of Buccinoid Pectinibranchiate Gastropods, having an oblong shell with a narrow aperture, destitute of folds and ridges, and gradually enlarging to the extremity opposite to the spire.

TEREBRA'NTIA. (Lat. terebro, *I bore*.) The name of a section of Hymenopterous insects, characterized by the possession of an anal instrument organized for the perforation of the bodies of animals, or the substance of plants. The borer (*terebra*) is peculiar to the female, and is composed of three long and slender pieces, of which two serve as a sheath for the third; it is placed at the anal extremity of the abdomen, and the oviduct is continued into it. The females instinctively use this weapon to prepare a place for the deposition of their eggs, where the maggot may be incubated in safety, and upon its exclusion be surrounded by already organized matter adapted for its sustenance. Some genera select vegetables for the parasitic support of their young, as *Sirex* (Linn.), which infests the pine-tree; and *Cephus* (Latr.), which perforates the stalks of corn for the purpose of oviposition. Others, as the ichneumons, pierce the skins of insects, and deposit their eggs in the subcutaneous fatty and nutrient material. Some ichneumons are provided with long and extensible anal borers, which they insinuate beneath the bark of trees, and into crevices and fissures, where their instinct and peculiar antennal organs of sensation teach them that the insect resides that may form a fitting nidus for the parasitic and carnivorous larvæ. Other ichneumons, with short terebræ, place their ova in the bodies of Lepidopterous larvæ, or in those pupæ which are readily accessible to their attacks.

The female ichneumons manifest a wonderful instinct at the season of oviposition in discovering the insects, as well mature as in their different stages of egg, maggot, caterpillar, and chrysalis, which are obnoxious to the wounds, with all the fatal consequences, of the instrument from which the present section of *Hymenoptera* takes its name.

TEREBRA'TULA. (Lat. terebro, *I bore*.) The name of a genus of Palliobranchiate Acephalous Bivalve Mollusks, in which one of the valves is perforated for the transmission of a peduncle: the hole through which the peduncle passes is completed by a small detached calcareous piece.

TERE'DO. (Lat. teredo, *the ship-worm*.) The name of a genus of Acephalous Mollusks which bore their habitations in submerged timber, and occasion destructive ravages in sunken piles, ships' bottoms, &c.

TE'RGUM (Lat. tergum, *the back*), in Entomology, signifies the upper or supine surface of the abdomen.

TERM (Lat. terminus, *a boundary*), in Logic, is the expression in language of the notion obtained in an act of apprehension. (*See* APPREHENSION.) A term may consist of one word, or of several; but every word is not capable of being employed by itself as a term, or, in logical language, *categorematic*. Adverbs, prepositions, &c., and also nouns in any other case besides the nominative, are syncategorematic, *i.e.* can only form part of a term; while a verb is a mixed word, being resolvable into the copula (or auxiliary verb) and the term, to which the copula gives tense, mood, and position; but an infinitive mood is a term by itself. Simple terms, or categorematics, are divided into *singular* and *common*. A singular term stands for one individual; as "Cæsar," "the king." It is obvious that these terms cannot be affirmed or denied (in logical phrase, predicated affirmatively or negatively) of any thing but themselves. A common term stands for many individuals (which are called its significates), as "man," "king." These, it is evident, can be said (or predicated) of others; *e.g.* "Cæsar is a man," "Frederick is a king." The subject of a proposition, therefore (*see* PROPOSITION), may be either a singular or a common term; the predicate must be a common term. Terms are said to be univocal, equivocal, analogous, &c.; but these are rather distinctions of language than of logic. They are also said to be "of the first intention," and "of the second intention;" the first appearing to be words used in a vague and general sense; the latter words used in a limited and specific sense, which they bear in some particular art or science.

TERMI'NALIA. Annual festivals celebrated by the Romans in the month of February, in honour of Terminus, the god of boundaries. On such occasions the peasants assembled at the different landmarks or *termini* that divided their property, and offered up libations of milk and wine. *See* TERMINUS.

The word *terminus* is now employed chiefly to designate the extreme points of a railroad.

TE'RMINISTS. In Ecclesiastical History, a name given to a class among the Calvinists, whose tenet it is (or was, for such opinions hardly exist at the present day), that there are persons to whom God has fixed, by a secret decree, a certain *term* before their death, after which he no longer wills their salvation, however long they may live. They instanced the cases of Pharaoh, Saul, and Judas, among others.

TERMINO'LOGY. (Lat. terminus.) In every science or art, that preliminary knowledge which teaches us to define the words and phrases peculiarly employed in it (in other words, its technical terms) is called its terminology.

TERMINTHUS. A black pustule chiefly attacking the legs. It is not, however, clear what the disease was which the Greek writers describe under this name. (*Med. Dict.*)

TE'RMINUS. (Lat.) In Ancient Architecture, a stone raised for the purpose of marking the boundary of a property. Also a pedestal increasing in size as it rises, or a parallelopiped for the reception of a bust. Terminus was the name of the god of boundaries among the Romans. Terminus, in more recent times, is applied to the beginning or the end; *i.e.* to the first and last station of a railroad.

TERMITES. (Lat. termes, *the branch of a tree*.) These insects constitute an extensive and important tribe of the Neuropterous order, confined to the warmer latitudes of the globe, and performing a considerable share in the essential labour of completing the comminution and destruction of dead and decomposing organized matter. The termites are all social, terrestrial; and are active, carnivorous or omnivorous, in all the stages of their existence, save that of the ovum, after which they undergo only a semimetamorphosis. The mandibles are always strong and hard, but differ in relative size in different classes of individuals of the same community.

The tribe *Termetinæ* includes the genera *Mantispa*, *Raphidia*, *Psocus*, *Perla*, and *Termes* proper (now the type also of a family, *Termitidæ*, or white ants, as they are commonly called). These are characterized by four-jointed tarsi; but the wings are carried horizontally on the body, and very long: the head rounded, and the prothorax short and square. The body is depressed, with the antennæ short; the mouth very similar to that of the *Orthoptera*, with the four-cleft lower lip; three occelli, one rather indistinct; the wings generally but slightly transparent, coloured, with the nervures not forming a close network; and the legs short.

The termites peculiar to the tropical and adjacent countries are known under the name of white ants, and commit most extraordinary ravages, especially in the larva state, in which they are called *workers;* these are like the perfect insect, but with the body softer, and without wings, and the head generally larger and destitute of eyes, or nearly so. They are united into colonies of incalculable numbers, and live concealed in the interior of the earth, trees, and other wooden matters, such as furniture, shelves, &c., in which they form galleries, forming routes conducting to the centre of their nests; so that these objects, of which the outer surface is (with surprising instinct) left untouched, fall to pieces on the slightest touch. The nests of some species are external, but without any evident exit. Sometimes they are elevated to a great height above the surface, like pyramids, occasionally surmounted by a solid roof, which,

by their height and number, appear at a distance like a small village. Sometimes these insects affix their nests to the branches of trees. Another sort of individual, termed *neuters* or *soldiers*, and which Fabricius mistook for pupæ, defend the nest. They have a head much larger and longer; and the mandibles are very long, and cross over each other. They are far less numerous than the larvæ, and live near the outer surface of the nest, so that they make their appearance just when it is attacked: they are also stated to compel the workers to labour. The demi-nymphs have the rudiments of wings, and in other respects resemble the larvæ.

When arrived at the perfect state the termites quit their habitation; fly abroad during the evening and night in great numbers: they lose their wings before morning, which dry; and falling to the earth, they become the prey of birds, lizards, &c. The couples are then collected by the larvæ, which inclose each of them in a large cell; but Latreille conjectures that the act of coupling takes place in the air, as in the ants, and that the females alone occupy the attention of the larvæ in order to the establishment of fresh colonies. The abdomen of the female subsequently acquires an enormous size, from the innumerable eggs which it contains. The royal chamber occupies the centre of the habitation, and around it are distributed those which contain the eggs and provisions.

Some larvæ of *Termes varium* have eyes, and appear to have habits somewhat different to the rest, and to approach our ants.

Negroes and Hottentots are very fond of these insects.

TERMS, in Law, are four sections of the year appropriated to the transaction of particular business in the superior courts of common law and equity. They are now regulated by 11 G. 4. and 1 W. 4. c. 70.

Hilary Term begins the 11th, and ends the 31st of January.

Easter Term begins 15th of April, and ends the 8th of May.

Trinity Term begins 22d of May, and ends the 12th of June.

Michaelmas Term begins the 2d, and ends the 25th of November.

Whenever any one of these days falls on a Sunday, the following Monday is substituted for it; and if the days from Thursday before to Wednesday after Easter Sunday inclusive, or any part of them, fall within Easter term, such days are regarded as holydays, and the term is increased by an additional number of days at the end, and Trinity term proportionably postponed. During term the three superior common law courts sit *in banc;* and all their business, with the exception of the trial of issues in fact, and such preliminary or other matters of minor importance as can be transacted before a judge at chambers, is performed. The power of the courts has, however, been increased by a recent statute, enabling them to transact certain term business in vacation time. The rest of the year is termed Vacation. During the vacation, one judge of each court sits at Nisi Prius for the trial of causes in London and Middlesex, through the periods called Sittings; which are fixed by the same act to last not more than twenty-four days after Hilary, Trinity, and Michaelmas terms respectively, nor more than six days after Easter term. During the vacation also the circuits are held, in which causes are tried and the gaols delivered in other parts of England and Wales.

TERMS OF EQUATIONS, are the several parts of which they are composed, connected by the signs of addition or subtraction. Thus, $2ax-bc$, has for its terms $2ax$ and bc. Generally all terms containing the same power of the unknown quantity are considered as one compound term; the coefficients, with their proper signs, being connected with that power of the unknown quantity.

TERPSI'CHORE. (Gr. τερπω, *I delight*, and χορος, *a dance*.) The muse who presided over dancing, usually represented with a seven-stringed lyre or a plectrum in the hand, and in the act of dancing.

TERRACE. (Fr. terrasse.) In Architecture, a raised natural or artificial bank for the purpose of affording a promenade.

TERRA COTTA, literally baked clay, is the name given to statues, architectural decorations, figures, vases, &c., modelled or cast in a paste made of pipe or potter's clay and a fine-grained colourless sand from Ryegate, with pulverized potsherds, slowly dried in the air, and afterwards fired to a stony hardness in a proper kiln.

TERRÆ FILIUS. In Classical Latinity, a humorous designation of persons of low origin or obscure birth: terræ filii, *sons of the earth*. (See *Persius*, Satire 6.) In the university of Oxford, by an ancient custom, abolished a century ago, a satirical Latin oration was read at the commemoration annually by an undergraduate, who assumed the title of Terræ Filius, and often indulged in considerable license in his treatment of the authorities of the place.

TERRA JAPONICA. The old pharmaceutical designation of the substance now called *catechu*. It was formerly regarded as an earthy mineral.

TERRA PONDEROSA. The old mineralogical name of carbonate and sulphate of baryta.

TERRA SIENNA. A brown ochreous clay brought from Sienna, and sometimes used as a pigment.

TERRE-PLEIN. In Fortification, the horizontal surface of the rampart where the guns are placed and worked. Its breadth may be from 24 to 40 feet; and it is bounded outside by the parapet, and inside by the inner slope of the rampart. *See* FORTIFICATION.

TERRE'STRIALS, *Terrestres.* (Lat. terra, *the earth.*) The name of a section of the class *Aves*, corresponding to the orders *Rasores* and *Cursores;* also of a family of Pulmonated Gastropods, and of a division of Isopodous Crustaceans.

TERRE-VERTE. Green earth. A species of chlorite of a green or olive colour, found in Germany, France, Italy, and North America. According to Klaproth, it is a hydrated silicate of oxide of iron and potash, with a little magnesia and alumina. The green earth of Verona, once used as a pigment, is a sub-species of this mineral.

TE'RROR, REIGN OF. In the History of the French Revolution. This term has been generally applied to the period during which the executions were most numerous, and the country under the sway of the actual terror inspired by the ferocious measures of its governors, who had established it avowedly as the principle of their authority. It seems to be most properly confined to the period between October, 1793, when the revolutionary tribunal, although constituted at an earlier time, was first put in permanent action on the fall of the party of the Gironde, and the overthrow of Robespierre and his accomplices in Thermidor (July), 1794. The agents and partisans of the system have been termed Terrorists.

TE'RTIALS, *Tertiariæ*. (Lat. tres, *three.*) These are the large feathers which take their rise from the proximal extremity of the bones of the wing, corresponding to those of the forearm near the elbow joint, forming a continuation of the secondaries. They are so long in some birds of the snipe and lapwing kind, that when the bird is flying they give it the appearance of having four wings.

TERTIAN FEVER. An intermittent fever or ague, the paroxysms of which return every other day. *See* AGUE.

TE'RTIARIES. In Ecclesiastical History, a religious body, a kind of associates of the Franciscans, who acknowledged the *third* rule of Saint Francis, and seem connected with the Fraticelli and Beghardi of the 13th century. (See *Mosheim*, 13th cent. part ii. chap. ii.)

TE'RTIARY STRATA. A series of sedimentary rocks which lie above the primary and secondary strata, and are distinguished from them by their *organic remains*. *See* GEOLOGY.

TERTIUM SAL. An obsolete chemical term formerly applied to neutral salts, as being a third substance, or *tertium quod*, resulting from the union of an acid and alkali.

TERTU'LLIANISTS. In Ecclesiastical History, a branch of the African Montanists; so named from the father Tertullian, who embraced Montanist opinions. (See *Burton's Lectures*, vol. ii. p. 234.)

TERU'NCIUS. A coin of ancient Rome, the same as the quadrans or triuncis, being the 4th part of the *as*, and consequently containing three ounces before the value was diminished.

TE'RZA RI'MA (*third or triple rhyme*). A peculiar and complicated system of versification, borrowed by the early Italian poets from the Troubadours. The verses are the ordinary Italian heroic lines of eleven syllables (interspersed very rarely with ten-syllable lines). The rhyme is thus arranged: — At the commencement of a poem or portion of a poem, verses 1 and 3 rhyme together; as do verses 2, 4, and 6; the third rhyme begins with verse 5, which rhymes to 7 and 9; the fourth is formed by 8, 10, and 12, and so on; and the poem or canto ends abruptly, the last rhyme, like the first, being on a couplet instead of a triplet. It is obvious that the rhyme is interlaced throughout, and continually in suspense, so that no pause can be found until the end of the poem or canto; as, at the end of every line, there must still be a rhyme incomplete. This continuity gives a very peculiar character to the metre, and renders it highly expressive of sustained narrative or passion, and the abruptness of the conclusion is often turned to good effect by masters of versification. This metre has been rendered celebrated by Dante, who wrote in it his *Divina Commedia*. It has been adopted by his imitators, of whom the latest, Vincenzo Monti, has used it to much advantage; and by Ariosto and other poets for their satires. Byron has adopted it in English, with indifferent success, in his *Prophecy of Dante;* and it has been attempted by various translators.

TERZE'TTO. (It.) In Music, a composition in three parts.

TE'SSELATED PAVEMENT. (Lat. tessela, di-

min. of tessera.) In ancient Architecture, a pavement formed of small square pieces of stone called *tesseræ* or *dies*. They are frequently, indeed mostly, found inlaid in different colours and patterns, and with a central subject. They are embedded in cement, and rest on prepared hard strata.

TE'SSERA. In Roman Antiquities, a die six-sided, like the modern dice; and thus to be distinguished from the talus, which had only three sides. Tickets or tallies used for various purposes were called tesseræ. Thus guards were set at night in their camps by means of a tessera with a particular inscription, given from one centurion to another through the army; and in this way the word tessera seems to have come to signify the watchword or password delivered to the guard. (See *Mém. de l'Acad. des Inscr.* vol. xxxvii.)

TESSERA. In Architecture. *See* TESSELATED PAVEMENT.

TE'SSERACONTE'RIS. (Gr. τεσσεϱακοντα, *forty*, and εϱεσσω, *I row*.) A galley with forty banks of oars; one of the largest of monstrous vessels mentioned by ancient writers. Great doubts have been entertained as to the possibility of the construction of a vessel which, according to the received notions respecting classical shipbuilding, must have required about *four thousand* rowers; but it is seriously recorded that one was built for Ptolemy Philopater, probably for purposes of show only. *See* TRIREME, GALLEY.

TESSULAR. A term applied in Crystallography to a system of crystals, including the cube, tetraedron, &c.

TEST. In Chemistry, any thing by which we distinguish the chemical nature of substances from each other: thus infusion of galls is a *test* of the presence of iron, which it renders evident by the production of a black colour in water and other liquids containing that metal; in the same way sulphuretted hydrogen is a test of the presence of lead, and nitrate of baryta of sulphuric acid. In Metallurgy and Assaying, the porous crucible which absorbs the liquid vitrifiable oxide of lead and other metals combined with it is sometimes called the *test*.

TE'STA. In Botany, the integuments of a seed.

TESTA'CEANS, *Testacea*. (Lat. testa, *a shell*.) This term was employed by Linné to signify an order of the class *Vermes*. It is applied by Cuvier to an order of his class *Acephala*, comprehending those which are provided with a calcareous shell.

TESTACE'LLUS. (Lat. testa.) A genus of slugs; so called from their being furnished with a diminutive shell, which forms a shield or protection to the heart. Of this destructive genus the following species are British, and occasionally infest our gardens and nursery grounds: — *Test. scutellum*, Sowerby; *Test. halyotideus; Test. maugei*.

TESTAMENT, OLD AND NEW. *See* BIBLE.

TEST AND CORPORATION ACT. The popular names of the statutes 13 Car. 2. st. 2. c. 1. and 25 Car. 2. ch. 2.: by the first of which it was provided that all magistrates in corporations should take the oaths of allegiance and supremacy, and another renouncing the doctrine that it is lawful to take arms against the king; and should have received the sacrament within a year before their election, according to the rites of the church of England. The latter extended these provisions to "all persons that shall bear any office or offices, civil or military," &c.; and introduced a new declaration against transubstantiation. These acts, long esteemed the great bulwarks of the Protestant church, were nevertheless evaded by means of acts of indemnity annually passed for the relief of those who had neglected to take the oaths. They were finally repealed 1828 (9 G. 4. c. 17.), as far as regarded the administration of the sacrament, and a declaration set forth in the act substituted. Locke, as well as many other eminent men, has strongly objected to the principle of making a religious solemnity a test of conformity: it is defended by Dean Swift.

TESTIMONY. *See* EVIDENCE.

TE'STING. In Metallurgy, the operation of refining gold and silver by means of lead upon a vessel called a *test* or cupel. *See* CUPELLATION.

TESTUDINA'TA. (Lat. testa.) The name of a tribe of Chelonian reptiles, of which the tortoise (*Testudo*) is the type. It has been sometimes used as synonymous with *Chelonia*, and as a name for the whole order.

TESTU'DO. A military contrivance adopted by the Greeks and Romans principally in attacking walls and fortified places. It was formed by a body of troops holding their shields above their heads, so as to overlap one another and form a kind of penthouse, which threw off the missiles of the enemy while the assailants were approaching the walls. The word properly means a tortoise, from the similitude of whose shell to this contrivance the name was borrowed.

TE'TANUS. (Gr. τεινω, *I stretch*.) A spasm of the whole of the muscles. It is frequently caused by lacerated wounds, and affecting the jaw is termed *lockjaw*. In hot climates this disease is sometimes produced by exposure to cold, or by suppressed perspiration, and it then often admits of relief and cure; but when it is the consequence of a wound it is usually fatal.

TETHY'DANS, *Tethydes*. The name of a tribe of Tunicated Acephalous Mollusks, of which the genus *Ascidia* (*Tethys* of the ancients) is the type.

TE'THYS. (Gr. τηθυον, *an ascidian*.) A name applied by Linnæus to a genus of Vermes Testacea; and by Cuvier to a genus of Nudibranchiate Gastropods, characterized by having two rows of branchiæ along the back in the form of tufts.

TETHYS. In Greek Mythology, the daughter of Uranus and Gaia, and wife of her brother Oceanus. The symbol of the sea, and of the element of water; in which character she is sometimes confounded with Thetis, unless indeed the name of the latter goddess be only another form of hers.

TETRA'CERAS. (Gr. τετταϱες, *four*, and κεϱας, *a horn*.) The generic name proposed by Dr. Leach for the four-horned antelope.

TE'TRACHORD. (Gr. τετταϱες, and χοϱδη, *a string*.) In Music, a concord consisting of, three degrees or intervals, and four terms or sounds; in modern music it is commonly called *a fourth*. The word, in its strictly literal sense, signifies any instrument with four strings, and was applied to the lyre in its primitive state.

TE'TRADITES. A word used in several senses, all of them, however, bearing upon its original derivation from Gr. τετταϱες, *four*. 1. Among the ancients children were so called who were born in the fourth month; and such were believed to be unlucky. 2. The Manichees and others, who believed the Godhead to consist of four instead of three persons, bore this name. And 3. In Ecclesiastical History different sects of heretics were so called, in consequence of the respect with which they regarded the number four.

TETRA'DORON. (Gr.) In ancient Architecture, a species of brick used by Greek builders in the private dwellings, four palms in length.

TE'TRADRACHM. A common silver coin of the ancient Greeks, of the value of four drachms.

TETRADY'NAMOUS. (Gr. τετταϱες, and δυναμις, *power*.) A flower having six stamens, of which two are short, and separated by two pairs of longer ones.

TETRAE'DRON, or TETRAHEDRON. (Gr. τετταϱες, and εδϱον, *side*.) In Geometry, one of the five Platonic bodies, or regular solids. It is bounded by four equilateral and equal triangles, or it is a triangular pyramid having four equal and equilateral faces. If we assume $a =$ the linear edge, $b =$ the whole superficies, $c =$ the solid content, $r =$ the radius of the inscribed sphere, $R =$ the radius of the circumscribed sphere, then the following relations hold true: —

$$a = 2r\sqrt{6},\ b = 24r^2\sqrt{3},\ c = 8r^3\sqrt{3},\ R = 3r.$$

See PLATONIC BODIES.

TETRAETE'RIS. (Gr. τετταϱες, and ετος, *a year*.) In Grecian Chronology, a cycle of four years, invented by Solon, to make the lunar year equal to the solar. This he effected by intercalating a month of twenty-two days at the end of two years, and at the lapse of other two years another month of twenty-three days, making in all forty-five days, which will be found to be the difference between the lunar and solar year after an interval of four years.

TE'TRAGON. (Gr. τετταϱες, and γωνια, *angle*.) In Geometry, a figure having four angles.

TE'TRAGO'NIA (Gr. τετταϱες, and γωνια), is a genus of herbaceous plants of the Portulacaceous order, with four-cornered fruit; one species of which, native of New Zealand, is cultivated as an esculent under the name of New Zealand spinach. Although inferior to genuine spinach, it is valuable on account of its resistance to drought and the great quantity of foliage that may be gathered from a single plant. It is an annual of the easiest culture.

TETRAGRA'MMATION. Among several ancient nations, the name of the mystic number four, which was often symbolised to represent the Deity, whose name was expressed in several languages by four letters: thus the Heb. יהוה; the Assyrian Adad; the Egyptian Amon; the Persian Syre; the Greek Θεος; the Lat. Deus. By a curious coincidence, the same peculiarity prevails in many modern languages, as will be seen in the Germ. *Gott*, the French *Dieu*, &c.

TETRA'LOGY. (Gr. τετταϱες, and λογος, *discourse*.) The name given to the collection of four dramatic compositions which was brought forward for exhibition at Athens by competitors for scenic honour. It consisted of three tragedies and a "satyrus" (*see* SATIRE), of which the only example left is the *Cyclops* of Euripides.

TETRA'METER. (Gr. τετταϱες, and μετϱον, *measure*.) A verse consisting of four measures; that is, according to the Greek prosody, of eight iambic, trochaic, or anapæstic feet, or four feet exceeding three times.

TETRA'NDROUS. (Gr. τετταϱες, *four*, and ανηϱ, *a man*.) A flower having four stamens.

TE'TRAO. (Lat. tetrao, *a bustard*.) A name selected

by Linnæus for an extensive genus of gallinaceous birds, characterised by a naked and generally red band, which occupies the place of the eyebrow. This genus comprehended all the various species of grouse, partridges, francolins, quails, and tinamous; and the necessity for subdividing it was consequently soon recognised. Latham restricts the genus *Tetrao* to those species of which the feet are covered by feathers, and are without spurs, with naked toes, and a round or forked tail: these are the true grouse. The species in which the toes are feathered as well as the legs, called ptarmigan, form the genus *Lagopus*. Brisson separated from the Linnæan *Tetraones*, the partridges, francolins, and quails, under the generic title *Perdix;* and the obvious characters indicated by the common names of these tribes, have been made by later zoologists the grounds for as many distinct genera. The quails of the New World form the distinct genus *Ortyx*, The long-necked tinamous of America, constitute the last genus (*Tinamus*, Latham) of the family *Tetraonidæ*.

TETRAPHA'RMACON. An ointment composed of four remedies; namely, wax, resin, lard, and pitch.

TE'TRAPLA. (Gr. *τετταρες*.) In Ecclesiastical History, the name of a Bible arranged by Origen in four columns, consisting of four different Greek versions; viz. that of the Septuagint, that of Aquila, that of Symmachus, and that of Theodosian. This work must not be confounded with the *Hexapla*, which see.

TETRAPNEUMO'NIANS, *Tetrapneumones*. (Gr. *τετταρες*, and *πνευμων*, *a lung*.) The name of a section of spiders (*Araneidæ*), comprehending those which have four pulmonary sacs.

TETRA'PTERANS, *Tetraptera*. (Gr. *τετταρες*, and *πτερον*, *a wing*.) A name applied by some entomologists to the insects which have four wings, and which thus constitute an extensive primary division of the class.

TE'TRARCH. (Gr. *τετράρχης*.) The governor of a fourth part of a country. This was a title granted by the Romans to some tributary princes, whom they did not dignify with the style of king. It seems to have originated among the Galatians. Such were the sons of Herod the Great, amongst whom his dominions were divided after his death. (See *Mém. de l'Acad. des Inscr.* vol. xxviii.)

TETRASPASTON. (Gr. *τετταρες*, and *σπαω*, *I pull*.) In Mechanics, a machine in which four pulleys all act together.

TETRA'STICH. (Gr. *τετταρες*, and *στιχος*, *verse*.) In Poetry, a stanza of four verses.

TE'TRASTYLE. (Gr. *τετταρες*, and *στυλος*, *a column*.) In Architecture, a building having four columns in front.

TE'TTER. An eruptive disease of the cuticle. *See* PSORIASIS.

TETTI'GES. (Gr. *grasshoppers*.) An appellation assumed by the ancient Athenians in allusion to the boast that they were produced from the soil which they inhabited. In conformity with this belief they were often styled *αυτοχθονες*, or earthborn, and wore golden grasshoppers in their hair.

TETTIGO'NIANS, *Tettigonides*. (Lat. tettigonia, *a kind of grasshopper*.) A section of Hemipterous insects, of which the genus *Tettigonia* is the type. It is synonymous with Cicadarians. *See* CICADA.

TEUTA'TES. In Mythology, a Celtic divinity, to whom Roman writers have given some of the attributes of their Mercury (*Mem. de l'Ac. des Inscr.* xxiv. 349.), enumerated by Lucan among the gods of the Gauls: Quibus immitis placatur sanguine diro Teutates.

TEUTHIDANS, *Teuthidæ*. (Gr. *τευθος*, *a calamary*.) The family of Dibranchiate Cephalods of which the calamary (*Loligo vulgaris*) is the type.

TEUTO'NIC ORDER. One of the principal military orders of religious persons. It was founded in 1190, by Frederic duke of Swabia, and intended for Germans of noble rank only: its rules were the same with those of the Templars. Like the other orders (*see* SAINT JOHN, TEMPLARS), its original object was the performance of service against the infidels in Palestine. It was dedicated to the Virgin Mary. After the conquest of Jerusalem by the Saracens, the grand master removed to Venice, and afterwards to Marburg. By degrees it made extensive conquests from the various heathen nations on the southern shores of the Baltic. The Prussians were subdued by it, and forced to embrace Christianity, after a struggle of more than half a century. In 1237, it was united with the order of the Brethren of the Sword in Livonia. Its conquests elevated it to the rank of a sovereign power in Europe. The grand master, during the epoch of its domination, had his seat at Marienburg, in Prussia. Its territory extended from the Oder to the Gulf of Finland, and the population under its government is supposed to have amounted in the 15th century to two millions and a half of souls. Its dominions, however, were gradually lost by revolt or foreign conquest. West Prussia fell to Poland, East Prussia to the house of Brandenburg. Afterwards the seat of the grand master was at Mergentheim in Swabia; and he became a spiritual prince of the empire. By the peace of Presburg, in 1805, the rights and revenue of the grand mastership was obtained by the emperor of Austria: but the order was abolished by Napoleon in 1809; and its lands having passed to the sovereigns of the various districts in which they were situate, it now retains a titular existence only in Austria.

TE'XTUARIES. Among the Jews, the sect of Caraites, or Karaites, has been so called (see that word), from its adherence to the text of the Jewish scriptures.

THABORITES. *See* TABORITES.

THALAMUS. (Gr. *θαλαμος*, *a bed*.) In Anatomy, the part of the brain from which the optic nerves have part of their origin.

THALAMUS, in Botany, is the part on which the ovary is seated. The succulent red centre of a strawberry, the core in the fruit of a raspberry, are the thalami of these plants. Some botanists call it the receptacle of the fruit.

THALI'A. (Gr. *θαλεια*, *the blooming one*.) The muse who is generally regarded as the patroness of pastoral and comic poetry. She is also supposed to preside over husbandry and planting. She is represented leaning on a column with a mask in her right hand and a shepherd's crook in her left.

THALI'DANS, *Thalides*. (Gr. Θαλεια, one of the Muses.) The name of a tribe of Tunicaries, of which the genus *Salpa* or *Thalia* is the type. *See* SALPA.

THA'LLUS. In Botany, a term given to the organs of vegetation of liverworts, lichens, and seaweed, and to the bed of fibres from which many species of fungi arise. It is regarded as a fusion or blending together of leaf and stem. Hence plants consisting of thalli only are called Thallophytes or Thallogens. The spawn of the mushroom shows the appearance of the thallus in fungi.

THAMMUZ. The tenth month of the Jewish civil year, answering to part of June and July, and including twenty-nine days. In Mythology, the name under which the Phœnicians worshipped Osiris or Adonis. *See* ADONIS.

THANE. (Sax. thegn.) In early English History, a title of honour among the Anglo-Saxons. In its original meaning it signified a minister or servant, and was applied to the followers of kings and chieftains. Thus the king's thanes were at an early period a distinct and elevated class. In a later age of the Anglo-Saxon power, the term had become more extensive in its signification, and seems to have been appropriated to all landed proprietors who were below the rank of earl and above that of alderman, and had the privilege of assisting in framing the laws. In Latin charters the word *miles* is the equivalent of thane. There were superior and subordinate thanes, standing in the same relative situation as mesne lords and vassals under the feudal system of France and Normandy. (See *Turner's Anglo-Saxons; Palgrave's Commonwealth*.)

THA'TCHING. Covering houses, stacks, or ricks with straw or reeds, in such a manner as to throw off the rain, and exclude excessive heat, or prevent its escape from within. The straw generally used in thatching is that of the wheat, as being the longest and thickest, and the most durable. Next to wheat, rye straw is preferred, or, in default of that, the straw of oats; but the most durable of all thatch in cold countries is that formed of the reed (*Arundo donax*, Linn.), or of the common heath or ling (*Calluna vulgaris*, Sal.). A very durable covering of the thatch kind is also formed of the spray of birch, of the bark of that tree, or of oak or pine, and of the chips and shavings made by hurdle-makers from the poles and shoots supplied by copse woods. Thatched roofs were formerly almost universal in cottage architecture; but they are now being supplanted by roofs covered with tiles or slates, which are much more durable, and not subject to catch fire; while the straw formerly used for roofs is much more profitably employed as litter for cattle, and thus turned into manure, and employed in reproduction, — a process which, in agriculture at least, ought not to be deprived of any material contributing so essentially to its aid as manure.

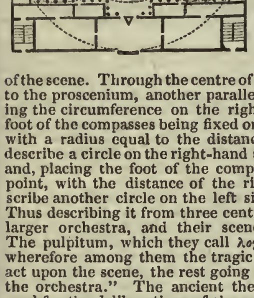
THAU'MATROPE. (Gr. *θαῦμα*, *a wonder; τρεπω*, *I turn*.) The name given by Dr. Paris to an optical toy, the principle of which depends on the *persistence* of vision. A circle is cut out of a piece of card, to opposite edges of which two silk strings are fixed, by twisting which between the finger and thumb of each hand the disc is turned round with considerable velocity. On one side of the disc is drawn any object, as a chariot; on the other side, the charioteer in the attitude of driving; so that when the card is twirled round, we see the charioteer driving the chariot; or, in consequence of the duration of the impressions of light on the retina, we see at once what is drawn on both sides of the card. (*Library of Useful Knowledge*, "Optics.")

THEA (Chinese tcha), is the botanical name of the genus which includes the plants yielding tea. They are found in China and the bordering countries in various situations, either in warm and damp valleys by the sides

of rivers, as in Assam, or on mountain sides, and on cool hills; occurring in the latter situations as far northward as Chusan. Some botanists assert that there is but one kind of tea tree, the difference in the samples of commerce depending upon the mode of preparation; others say that genuine black and green teas are the produce of different species, but that both kinds may be made artificially from the former sort. The latter appears to be the truth. The cultivation of tea for commercial purposes has been attempted successfully in the Himalayas, Java, Brazil, and Madeira; but unprofitably in the two latter countries, on account of the high price of labour. *See* TEA.

THE'ATINES. A religious order in the Roman Catholic church, the earliest in point of date of the communities of "regular clerks:" it was founded in 1524 by St. Cajetan of Thiene. The members, besides the ordinary monastic vows, bound themselves to the duties of the cure of souls, preaching against heresies, tending the sick and convicts, and to abstain from possessing property or asking for alms. This order does not appear to have met with much success, except in Italy, where (it is said in the *Conv. Lexicon*) the bishops are very generally chosen from it. (See *Mosheim*, cent. xvi.)

THE'ATRE. (Gr. θεατρον, from θεαομαι, *I behold.*) In Architecture, a building appropriated to the representation of dramatic spectacles. The theatres of the Greeks and Romans display some of the most extraordinary specimens of their power in the arts. Bacchus has the reputation of being the inventor of them, which, after their temples, appear to have been the most important public edifices of those people. They seem to have been carried to perfection in the Grecian colonies at an earlier period than they were in the mother country. The first theatre of *stone* at Athens, called the theatre of Bacchus, was built in the time of Themistocles; and as there seems little doubt that the Athenians were the inventors of the drama as a regular scenic action, it is fair to presume that they were the first to regulate the form and proportions which necessity and pleasure dictated in their arrangement. The subjoined diagram shows the general form of the Greek theatre, which differed but little from that of the Romans; and the instructions given by Vitruvius in the eighth chapter of his fifth book, as to the general outline of the plan, are as follows: — "Whereas in the Latin theatre the points of four triangles touch the circumference, in the theatres of the Greeks the angles of three squares are substituted; and the side of that square which is nearest to the place of the scene, at the points where it touches the circumference of the circle, is the boundary of the proscenium. A line drawn parallel to this, at the extremity of the circle, will give the front of the scene. Through the centre of the orchestra, opposite to the proscenium, another parallel line is drawn touching the circumference on the right and left; then, one foot of the compasses being fixed on the right-hand point, with a radius equal to the distance from the left point describe a circle on the right-hand side of the proscenium, and, placing the foot of the compasses on the left-hand point, with the distance of the right-hand interval describe another circle on the left side of the proscenium. Thus describing it from three centres, the Greeks have a larger orchestra, and their scene is further recessed. The pulpitum, which they call λογειον, is less in width; wherefore among them the tragic and comic performers act upon the scene, the rest going through their parts in the orchestra." The ancient theatres were frequently used for the deliberations of the general assembly of the people on political matters, as we find from Tacitus and Ausonius in respect of the theatres at Antioch and Athens. Notwithstanding the use of those buildings in later times as quarries freely used by the inhabitants of the cities in which they stood, there are still considerable ruins at Ephesus, Alabanda, Teos, Smyrna, Hierapolis, Cyzicus, Alinda, Magnesia, Laodicea, Mylassa, Sardis, Miletus, Stratonicea, Telmessus, Jasus, and Patara, all in Asia Minor; in Sicily, at Catana, Taurominium, Syracuse, Argyrium, and Segesta. In Greece, ruins are still extant at Athens, Sparta, in the island of Egina, at Epidaurus, and Megalopolis. According to Pausanias, that at Epidaurus, built by Polycletus, surpassed all the other theatres of Greece in its beauty and proportions; but in grandeur and magnificence the Roman theatres far surpassed those of the Greeks; nor is this surprising, considering the population the former had to accommodate compared with that of the latter. For a very considerable period the theatres of Rome, like those of the Etruscans, were of wood; and Pompey, on his return from the war against Mithridates, was the first who constructed one of stone. This must have been of large dimensions, inasmuch as it would contain 40,000 spectators. The remains of it at some stables of a palace are still visible. There were two other considerable theatres in Rome; the first built in the year 741 of the city, by Cornelius Balbus; and the second, which was begun by Julius Cæsar, but not finished till the time of Augustus, who dedicated it to his friend Marcellus. From the remains it appears that it was a specimen of great beauty and purity, as far as relates to the profiles of two of its orders, there being no vestiges of the upper order. The only other remains of Roman theatres are at Saguntum and Oranges, though the Romans usually erected theatres in their newly conquered cities, or at least embellished and improved those they found on the spot.



The modern theatres of Rome are, perhaps, the worst in Europe. Italy, however, boasts some beautiful examples; the principal whereof are those at Parma, now in a very dilapidated state, Milan, Verona, Turin, Naples, and Bologna. In France, a very fine theatre at Bourdeaux; the theatre at Versailles; and some elegant theatres in Paris. Till recently this country has been unsuccessful in the design of theatres; but a taste seems rising, which we doubt not, if opportunity occurred, would tend to raise its character in that respect in the eyes of foreigners. We subjoin a short table of the width of the stage in a few European theatres: —

Milan	40 feet.
San Benedetto, Venice	40
Theatre Français, Paris	40
Parma	40
Bourdeaux	39
Turin	39
Covent Garden	37
Argentino at Rome	36
Theatre Italien, Paris	33

THE'BAID. The name given to the heroic poem of Statius, which celebrates the civil war of Thebes waged between the two brothers Eteocles and Polynices. It consists of twelve books. The poet Gray has translated book ii.

THEBAN YEAR. In Chronology, the Egyptian year of 365 days 6 hours was so called. (See Bryant, *Ancient Mythology*, iv. 437.)

THE'CA. (Gr. θηκη, *a case or receptacle.*) This term is used in Botany in various senses. It is applied to one of the lobes of an anther; to the case or urn containing the spores of mosses; to delicate tubes sunk in the shields of some lichens; and to certain simple kinds of fruit. In all cases it expresses a hollow case. It is now seldom used, except for the spore-vessel of a moss.

THE'CAPHONE. The long stalk upon which the ovarium of some plants is seated; as in *Cleome*, and the caper bush.

THECODA'CTYLUS. (Gr. θηκη, and δακτυλος, *a digit.*) A subgenus of night-lizards or geckoes, distinguished by having the subdigital scales divided by a median groove into which the claw can be retracted.

THE'CODONTS. (Gr. θηκη, and οδους, *a tooth.*) A tribe of extinct Lacertian reptiles, distinguished by having their teeth implanted in distinct sockets. One of the genera of this tribe, from the magnesian conglomerate near Bristol, has been called *Thecodontosaurus*.

THE'COSTOMES, *Thecostoma*. (Gr. θηκη, and στομα, *a mouth.*) The name given by Latreille to those insects which have a suctorious mouth enveloped in a sheath.

THEFT. In Jurisprudence, the general name for the most ordinary class of offences against property; for which English law uses the peculiar designation of larceny. The difficulty of distinguishing between theft, those other species of fraudulent appropriation which are regarded by the laws of most countries as criminal offences, and, finally, that class which is only the subject of civil action, has given rise to a variety of definitions. By the French Code, art. 379., "Whoever has fraudulently abstracted a thing which does not belong to him is guilty of theft." By that of Bavaria, art. 209., "Whoever knowingly of his own accord takes possession of moveables not his, without consent of the person entitled thereto, but without violence to any one, with intent unlawfully to hold the same as his property, is a thief." The principal characteristics of English law on the subject are, that it requires an actual taking, and an actual carrying away for some distance, however small, to constitute the offence. The Commissioners of Criminal Law, in their Third Report (1839), recommend the following definition: "Whosoever shall, without such consent as is hereinafter specified, take and remove anything, being the property of any other person, and, unless when it shall be otherwise provided, of some value, with intent to despoil the owner, and fraudulently appropriate the same, shall be guilty of theft."

THEISM. *See* Deism.

THEME. (Gr. θεμα.) A subject proposed for discussion, whether orally or in writing.

THE'MIS. (Gr. Θεμις.) In Grecian Mythology, the goddess of law. She was one of the Titans, and bore to Jupiter Peace, Order, Justice, the Fates, and Seasons.

THEO'CRACY. (Gr. Θεος, *God*; κρατεω, *I rule*.) A term expressing the government of a state immediately by God. The constitution of the Israelites, previous to the appointment of kings, was emphatically a theocracy; their chief magistrates or judges being for the most part occasional officers appointed by the express direction of God. The kingly government may still be considered in a secondary sense as a theocracy, from the general superintendence which Jehovah continued to exercise over it. All polities may in this sense be called theocratic in which the final appeal in matters of moment is made to the will of God, as expressed in oracles, by auguries, or the mouth of the priesthood.

THEOCRA'SY. (Gr. Θεος, and κρασις, *mixture*.) In ancient Philosophy, a term invented to signify the intimate union of the soul with God in contemplation, which was considered attainable by the newer Platonists. Similar ideas are entertained by the philosophers of India, and by many religious sects. *See* Quietism.

THEODICÆ'A. (Gr. Θεος, *God*; δικαιος, *just*.) A justification of the dealings of Divine Providence with man. A work under this title was published by Leibnitz in the year 1710, in which he endeavours to prove that of all the possible schemes of government which God might have adopted, the one which actually exists in the world is the best. This is commonly known under the name of Optimism.

THEO'DOLITE. (Gr. θεαομαι, *I view*, and δολος, *stratagem*.) A surveying instrument for measuring the angular distances between objects projected on the plane of the horizon.

In accurate surveying, when the instrument used for observing the angles is a sextant or reflecting circle, or such that its plane must be brought into the plane of the three objects which form the angular points of the triangle to be measured, the altitudes of the two distant objects above the horizon of the observer must be determined, and a calculation is then necessary to reduce the observed angles to the plane of the horizon. The object of the theodolite is to measure the horizontal angles at once, and thereby render the previous calculation, and even the observation of the altitudes, unnecessary.

It is easy to conceive, in a general way, how this object may be effected. A telescope with cross wires in its focus must be mounted so as to be moveable both about a vertical and horizontal axis, in order that it may be brought to bear upon any object, whether in the horizon, or above or below it; and the proper means applied for measuring, with the utmost accuracy, the angle described about the vertical axis (which is the horizontal angle) in turning the telescope round from one object to another. It is consequently necessary to fix a graduated circle to the vertical axis, so that its plane may be exactly horizontal, and its centre coincident with the vertical axis; and about the same axis a radial bar, firmly connected with the telescope, must revolve parallel to the plane of the circle, for the purpose of indicating the divisions passed over on the limb of the circle when the telescope is turned from the first object to the second. And in order to render the instrument subservient to the purpose of measuring altitudes, a graduated vertical arch is attached to the telescope; but as it seldom happens, in the practice of surveying, that the objects observed are very much elevated above or depressed below the horizon, or that the vertical angles are required to be taken with the same degree of accuracy as the horizontal angles, the vertical arch is generally only a portion of a circle of smaller radius, and less minutely divided than the horizontal circle.

The theodolite, as now generally constructed for the purposes of ordinary surveying, may be described as follows: —The horizontal limb or circle consists of two circular plates, which turn freely on each other. The lower or graduated plate receives the divisions of the circle, and the upper or vernier plate has two vernier divisions diametrically opposite. The vertical axis consists of two conical parts, one working within the other. The external part is attached to the graduated plate, and the internal to the vernier plate. The diameter of the under plate is somewhat larger than that of the vernier plate, and its edge is sloped off to receive the graduation; and portions of the opposite edges of the vernier plate are sloped off in like manner to receive the vernier divisions. The graduation is usually to thirty minutes of a degree, but is subdivided by the verniers into single minutes; and in a well-made instrument quarter minutes may be estimated by the eye. For the purpose of adjusting the plane of the circle to the horizon, the external axis is fitted into a ball, which works in a socket between two parallel plates held firmly together by the ball and socket, the under plate being connected with the staff-head supporting the instrument. But this adjustment may also be made (and in larger instruments is usually made) by a tripod support, having a foot screw at each extremity acting against a plate of metal supported by the staff. Upon the plane of the vernier plate are placed two spirit levels at right angles to each other, with their proper adjusting screws, by which the circle is brought accurately into the horizontal plane indicated by the levels. The centre of the circle is adjusted over the point which forms the centre of the station from which the observation is to be made by means of a plummet.

Instead of the vernier plate described above, the index is sometimes formed by three radial bars connected with the internal vertical axis, each carrying a vernier at its extremity; and a fourth bar carries the clamp, by which the system is secured to the graduated limb.

The horizontal axis of the vertical limb (which is usually a semicircle) is supported by a frame firmly imbedded in the vernier plate, and turning along with it about the vertical axis. The telescope has two collars or rings of bell metal, ground truly cylindrical, on which it rests in supports permanently attached to the vertical limb, so that both move together in the vertical plane. The divisions on this limb are read off to single minutes by means of a fixed vernier connected with the frame, and so adjusted that the index points to the zero of the graduated arc when the optical axis of the telescope is truly horizontal. For effecting this adjustment, or determining its index error, a spirit level is attached to the telescope, at one end by a joint, and at the other by a screw, whereby the end is raised or depressed until the air bubble stands at the middle of the glass tube. The telescope is then reversed; and if the air bubble of the level still stands at zero, the adjustment is perfect; if not, the index error becomes known by bringing the level to the proper position, and may either be corrected or allowed for in the observations.

In some theodolites the telescope is supported in the manner of a transit instrument; that is to say, the telescope and the horizontal axis on which it turns form one piece, and the vertical limb is a complete circle. By this construction the instrument becomes better adapted for determining the altitudes of stars, and consequently for finding the direction of the meridian and the azimuths of objects, or for other astronomical purposes. In fact, it becomes an altitude and azimuth instrument.

In theodolites for common topographical purposes the horizontal circle is seldom more than five inches in diameter; but as the double vertical axis gives the means of carrying round the telescope from the first object to the second without disturbing the graduated circle, and then, by clamping the vernier and graduated plates, of bringing it back, and the graduated circle along with it, to the first object, the measure of the angle may be repeated any number of times, exactly as with the repeating circle, and a very considerable degree of accuracy obtained even with a circle of this small size. (*See* Repeating Circle.) But the principle of repetition is better carried into effect by means of a particular kind of stand or tripod, called a *repeating stand*, which turns round concentrically with the vertical axis of the theodolite; and this apparatus is usually had recourse to when the instrument is on a large scale.

As the accuracy of the observation must depend on the horizontal circle remaining perfectly fixed while the telescope and verniers are turned round, a second telescope, called a watch telescope, is sometimes attached to the horizontal circle beneath the limb, which, being directed to a fixed object, serves to detect any disturbance of the circle clamp, or accidental shifting of position while the upper telescope with the verniers is turned from the first object to the second. But this can scarcely be applied to the repeating theodolite.

The principal adjustments of the theodolite are, first, to rectify the line of collimation of the telescope; secondly, to make the axis of the horizontal limb truly vertical; and, thirdly, to adjust the zero of altitude. For the practical methods of making these adjustments in the case of the common surveying theodolite, and instructions as to the mode of observing, the reader may be referred to *Simms's Treatise on Mathematical Instruments*, 1834.

In geodetical operations, where very great accuracy is indispensable, as, for example, in measuring an arc of the meridian, the instrument is constructed on a much larger scale. The great theodolite by Ramsden, belonging to the Board of Ordnance, which has been used for measuring most of the principal angles of the British Trigonometrical Survey, has a horizontal circle of three feet in diameter, and two telescopes of thirty-six inches focal length. A similar one of equal dimensions had formerly been constructed by the same excellent artist for the Royal Society, and was used by General Roy in his operations for connecting the observations of Greenwich and Paris towards the end of the last century, and also by Colonel Colby and Captain Kater for the same purpose in 1821. A full description of this superb instrument is given in the *Phil. Trans.* vol. lxxx., and in the

first volume of the *Trigonometrical Survey of England and Wales*. A theodolite of equal dimensions, by Cary, has been employed in the measurement of the great meridional arc of India by Colonel Lambton and Colonel Everest. The French astronomers, in measuring their arc of meridian, used only the repeating circle; but in the more recent operations of the same kind in Germany and Russia, the geodetical angles were determined with the theodolite.

THEO'GONY. (Gr. Θεος, *God*; γονος, *birth*.) In the Religion and Literature of ancient Greece and Rome, the history of the descent and relationships of the various gods who were the objects of popular worship. These genealogies were very variously related by different writers, and originated in some instances from national superstition; while in others they had an allegorical sense, and were invented by the learned men or poets of those countries.

Theogony is also the title of a poem attributed to Hesiod, giving an account of the birth and parentage of most of the Grecian divinities.

THEOLOGIUM. A small upper stage in the ancient theatre upon which the machinery of the gods was arranged.

THEO'LOGY. (Gr. Θεος, and λογος, *discourse*.) The science which treats of the nature and attributes of God, of his relations to man, and of the manner in which they may be discovered. Lord Bacon divides the science under the following heads: — 1. Inspired. 2. Natural, which he calls the first part of philosophy. 3. Appendices Theologiæ Inspiratæ: sc. Doctrina de legitimo usu rationis humanæ in divinis; doctrina de gradibus unitatis in civitate Dei; emanationes scripturarum. 4. Theologiæ tam inspiratæ quam naturalis appendix: Doctrina de angelis et spiritibus. (*De Augm. Sci.* l. ii. ch. 1.)

Natural Theology is the inquiry into these subjects prior to the idea of revelation, and conjectures concerning them from data furnished by the constitution of nature alone. It is only by the conclusions arrived at by this process that we are put in a proper condition to examine the evidence of *revealed religion*, the basis of which is the satisfaction it affords to the demands of the human reason and affections.

A pure system of natural theology, looking no farther for the evidence of divinity than the marks of it displayed in the creation, is deism, — the belief in God as a superintending Providence, which seems to require as a corollary the idea of a future retribution. Those who can discover no design in the constitution of the world, *i. e.* no trace of God's hand therein, are atheists, or deniers of a Deity. Again, the most common form of religion deduced by the heathens from their researches in natural theology is the supposition of numerous gods, each manifesting himself to us in the various functions and qualities of the animate and inanimate world, and sometimes, according to ancient legends and traditions, by direct communication in various ways. Opposed to this is monotheism, which recognizes more distinctly than deism the unity of the godhead, and gathers up under one volition and agency the attributes which the polytheist dispersed among a vast number of divinities. Of monotheist religions the Jewish, Christian, and Mohammedan lay claim to express revelation by the word of God.

THE'OMANCY. (Gr. Θεος, and μαντεια, *prophecy*.) A name which has been given to that species of divination which was drawn from the responses of oracles among heathen nations, in which a god himself was supposed to answer the inquirer; or from the predictions of sibyls and others supposed to be immediately inspired by some divinity.

THEOPA'SCHITES. (Gr. Θεος, and πασχω, *I suffer*.) In Ecclesiastical History, a name given by the orthodox to certain heretics of the 5th century, followers of Peter the Fuller, an usurping bishop of Antioch. Being strongly attached to the Monophysite opinions, his enemies charged him and his disciples with holding that all the three persons of the Godhead were crucified. (*Mosheim*, 5th cent. part ii. ch. 51.)

THEO'PHANY. (Gr. Θεος, and φαινομαι, *I appear*.) A word invented to signify the manifestations of God to man by actual appearance. These have formed a striking feature in most systems of religion. (See, on Pagan Theophanies, the 5th Dissertation of M. Foucher on the Hellenic Religion, *Mém. de l'Acad. des Inscr.* vol. xxxvi. p. 292.)

THEOPHILA'NTHROPISTS. (Gr. Θεος, *God*, and φιλανθρωπος, *a lover of men*.) A title assumed by a society formed at Paris during the first French revolution. The object of its founders was to establish a new religion in the place of Christianity, which had been formally abolished in France by the Convention, and had lost its power over the minds of large classes of the people. The Directory granted these philosophical sectarians the use of ten parish churches in Paris, where they held meetings for religious service; at first on the Decadi, or revolutionary holyday, afterwards on the Sunday. Their system of belief was a pure deism; their service a simple liturgy, with some emblematic mummeries. The attempt to found a new sect was, however, wholly unsuccessful. In 1802 they were forbidden the use of the churches by the consuls, and then ceased to exist.

THEO'RBO. (It. tiorba.) A lute of large dimensions, sometimes called the arch-lute, and formerly used for striking the chords of the thorough bass in accompaniments.

THE'OREM. (Gr. θεωρημα, from θεαομαι, *I observe*.) In Geometry, a truth proposed to be proved; in contradistinction to a *problem*, which proposes something to be done. A theorem wants demonstration; a problem requires solution. In algebra, the term is applied to various formulæ, as the *binomial theorem*, *Taylor's theorem*, and others; for which see the respective terms.

THEO'RICON. In ancient Attic History, the name given to that portion of the revenue of the state which was exclusively reserved for the purpose of theatrical representations. (See *Boeckh's Public Economy of Athens*, i. 289. 299. &c.)

THE'ORY (Gr. θεωρια), in Science, properly expresses a connected arrangement of facts, according to their bearing on some real or hypothetical law. A *hypothesis* has been distinguished from a theory as an assumption which is conceived to afford a *support* to the discovered law. Thus some have imagined that the facts of gravitation are explained on the supposition of a subtle and all-pervading ether. Here it is evident that the *facts*, and therefore the *theory* or connected survey of them, are unaffected by the *supposition* in question.

Theory. The abstract principles of any science or art, considered without reference to practice.

THEO'SOPHISTS. (Gr. Θεος, and σοφια, *wisdom*.) The name commonly given to a sect of philosophers who pretended to derive their knowledge of God and divine matters from direct inspiration. One of the most distinguished of this class in modern times was Jacob Böhme.

THERAPE'UTÆ. (Gr. *worshippers*.) A Jewish sect of the first century after Christ, concerning whom some doubt is entertained whether or not they had embraced Christianity. They are mentioned by Philo Judæus. (See *Burton's Lecture on the Ecclesiastical History of the First Three Centuries*, vol. i. p. 300.)

THERAPEU'TICS. (Gr. θεραπευειν, *to heal*.) A branch of pathology relating to the application of remedies, and the curative treatment of disease.

THERAPHIM. *See* Teraphim.

THERI'ACA. (Gr. θηρ, *a venomous animal*.) A name given in ancient Pharmacy to certain complex remedies supposed to be antidotes to poisons: they were usually in the form of confections. Some of the more celebrated have been transferred to comparatively modern pharmacopœiæ; such as the *Theriaca* of Andromachus; *Theriaca Veneta*; *Confectio Mithridati*, &c.

THERMÆ. (Lat.) In Ancient Architecture. *See* Bath.

THE'RMIDOR. In the French Calendar, the name of the 11th month of the year in the French Republic. It commenced on the 19th of July, and ended on the 17th of August. The name is derived from the Gr. θερμος, *warm*, and was borrowed from the great heat which characterizes that period of the year. It was the month signalized by the overthrow of Robespierre and the Reign of Terror; thence commonly called the Revolution of Thermidor, and those who boasted of having participated in it called themselves Thermidorians.

THERMO-ELECTRICITY. When one part of a metallic bar is heated and another cooled an electric current is generated in its substance, which may be rendered evident and its direction ascertained by the galvanometer. When two metals of different temperatures are brought into contact similar electric currents are generated, the quantity and direction of the electricity varying with the nature of the metals and their respective temperatures. The best apparatus for exhibiting these thermo-electric currents consists of alternate bars of antimony and bismuth soldered together at their ends, so as to form a compound bar or parallelogram, the junctions of which may be alternately heated and cooled: in this case the direction of the current is from the antimony to the bismuth; so that these metals bear the same relation to each other in the thermo-electric series, as the zinc and silver in the simple voltaic circuit. The term *stereo-electric* has also been applied to these currents, implying their production in solid bodies independent of a fluid, and as opposed to the hydro-electric or voltaic current. *See* Voltaic Battery.

THERMO'METER. (Gr. θερμος, *warm*, and μετρον, *measure*.) An instrument for measuring variations of heat or temperature.

The principle upon which thermometers are constructed is the change of volume which takes place in bodies when their temperature undergoes an alteration. Generally speaking, all bodies expand when heated and contract when cooled, and in such a manner that, under

the same circumstances of temperature, they return to the same dimensions; so that the change of volume becomes the exponent of the temperature which produces it. But as it is necessary not merely that expansion and contraction take place, but that they be capable of being conveniently observed and measured, only a small number of bodies are adapted for thermometrical purposes. Solid bodies, for example, undergo so small a change of volume with moderate variations of temperature, that they are in general only used for measuring very high temperatures, as the heat of furnaces, of melting metals, &c. Instruments for such purposes are called pyrometers. (*See* PYROMETER.) The gaseous fluids, on the other hand, are extremely susceptible of the impressions of heat and cold; and as their changes of volume are great even with moderate accessions of heat, they are only adapted for indicating very minute variations, or for forming *differential* thermometers. (*See* DIFFERENTIAL THERMOMETER.) Liquids hold an intermediate place; and, by reason of their moderate but sensible expansion through the ranges of temperature within which observations have to be made for by far the greater number of purposes, are commonly used for the construction of thermometers. Various liquids have been proposed, as oils, ether, spirits of wine, and mercury; but scarcely any other than the two last are now ever used, and mercury by far the most generally.

The properties which render mercury preferable to all other liquids (unless for particular purposes) are these:—1. It supports, before it boils and is reduced to vapour, more heat than any other fluid, excepting certain oils, and endures a greater cold than would congeal most other liquids, excepting certain spirituous liquors. 2. It takes the temperature of the medium in which it is placed more quickly than any other fluid. Count Rumford found that mercury was heated from the freezing to the boiling point of water in 58 seconds, while water took 133 seconds, and air 617 seconds; the heat applied being the same in all the three cases. 3. The variations of its volume within limits which include the temperatures most frequently required to be observed are found to be perfectly regular, and proportional to the variations of temperature. The spirit thermometer is now little used excepting for observations of very low temperatures, or as a self-registering instrument for meteorological observations.

Construction of the Mercurial Thermometer.—In order to render small changes of volume sensible, a glass bulb, having a slender hollow tube attached to it, is filled with mercury, so that expansion or contraction can only take place by the rise or fall of the liquid in the tube. The diameter of the tube may be of any convenient size; but the smaller it is the larger will be the scale of the variations; and capillary tubes are usually employed. It is essential that the diameter of the bore be of a uniform width throughout; a quality which is tested by drawing up into the tube a short column of mercury, and measuring its length at the different parts with a pair of compasses. Not more than a sixth part of the tubes which come from the glass-house are found to be fit for the purpose.

Having selected a tube, the workman begins by blowing a hollow ball A upon one extremity of it, by means of an air-bag of caoutchouc (in order to avoid the introduction of watery vapour by blowing from the mouth). The length which the thermometer is to have is then marked, and above this point the tube is expanded into a second bulb B, rather larger than the first. When the tube has acquired its natural temperature one of the bulbs is warmed, in order to expel the air from it, and the open end of the tube is plunged into distilled and well-boiled mercury. During the cooling the mercury rises into the second bulb B, whence it is made to pass into A by placing this undermost, and expelling the air from it by heat, after which the mercury descends from the effect of cooling. When the bulb A has been completely filled, and also a part of B, the tube is suspended horizontally over a charcoal fire, so as to be equally heated throughout, and the enclosed mercury boiled, in order to expel every remaining particle of air or humidity. The open end is then touched with sealing-wax, and the tube withdrawn from the fire, and placed in an upright position until it is cooled, when the bulb A and the portion of the tube under B will be filled with mercury. A portion of mercury is then expelled by heat, so that the column may stand at the proper height in the tube. The tube is then carefully softened with the blow-pipe, and hermetically sealed under the bulb B, which is thus cut off.

Graduation of the Scale.—The instrument prepared in the manner now described is admirably adapted for rendering evident the expansions and contractions of the enclosed fluid, and it only remains to adapt a scale to it in order to have a complete thermometer. The graduation of the scale is in some measure arbitrary; nevertheless, in order that different thermometers may be comparable with each other, it is necessary that two points at least be taken on the scale corresponding to fixed and determinate temperatures, the distance between which will determine the graduation. The two points which are now universally chosen for this purpose are those which correspond to the temperatures of freezing and boiling water. With respect to the first of these there is no difficulty; it is only necessary to surround the bulb with ice, and to mark on the stem the point at which the mercury stands when the ice begins to melt. The boiling point is not so readily determined. As the temperature at which water boils varies to a small extent with the barometric pressure, it is necessary, in order to have instruments comparable with each other, either that the boiling point on the scale be determined when the barometer stands at a certain height which is arbitrarily assumed for the standard, or else to apply a correction when the actual height of the barometer is above or below the assumed standard. De Luc made a number of experiments on this subject, and gave a formula for the correction, which was adapted to Fahrenheit's scale and English inches by Horsley. (*Phil. Trans.* vol. lxiv.) A committee of the Royal Society, who undertook to investigate the best method of adjusting the fixed points, and whose report is contained in vol. lxvii. of the *Transactions*, laid down a set of rules which have been generally followed by English instrument makers. They recommended the adoption of 29·8 inches for the standard barometric pressure, and gave a table of the corrections for all ordinary pressures above or below this standard. Their table is very nearly represented by the following simple rule, which will be quite sufficient for the guidance of the artist in all ordinary cases:—

Supposing the thermometer placed in an atmosphere of steam immediately over the surface of boiling water, then for every tenth of an inch by which the barometer is above or below 29·8, the correction for the boiling point of the scale of the thermometer is one thousandth part of the interval between the freezing and boiling points. The corrected must be placed lower than the observed boiling point by this quantity when the pressure exceeds 29·8 inches, and higher when the pressure is less than the standard.

Several other minute circumstances must be attended to in the construction of delicate instruments. As the temperature of boiling water is different at the top and near the bottom of the vessel in which it boils, the thermometer should not be plunged into the water itself, but into the vapour which rises above it, in a close vessel with an aperture for the escape of the steam. The vessel should be of metal, because water boils at a different temperature in vessels of different substances, as metal and glass. Distilled water, or clear soft water, should be used; if mixed with saline ingredients, the temperature at which it boils would be affected, and the instrument rendered inaccurate.

The interval between the two fixed points on the stem may be divided into any number of degrees at pleasure, and the graduation continued above and below as far as may be thought requisite: the numeration may also be begun at any point whatever on the scale; but there are only three methods of division so generally adopted as to require particular notice. The first is Fahrenheit's, which is used in this country, in Holland, and North America; the second Reaumer's, which was formerly in general use in France, and is still followed in Spain and some parts of Germany; and the third that of Celsius, or the centigrade scale, now used in France, Germany, and Sweden.

Fahrenheit's Scale.—In this scale the interval between the freezing and boiling points of water is divided into 180 equal parts, or degrees, which number was chosen by Fahrenheit (or probably Röemer), from some theoretical considerations respecting the expansion of mercury; it being computed that the thermometer when plunged into melting snow contained 11,156 parts of mercury, which, at the temperature of boiling water, were expanded into 11,336 parts, being an increase of 180 parts. The zero point of the scale is placed at 32° below the freezing point of water. It has been frequently stated that this point was selected as indicating the temperature of a freezing mixture of snow and salt; but it appears from Boerhaave that it was adopted from a still more precarious supposition, namely, the greatest cold observed in Iceland, which was probably assumed to be the lowest natural temperature. The freezing point is thus marked 32°, and consequently the boiling point at $32 + 180 = 212$. It must be admitted that this scale, though it possesses some advantages in the lowness of the zero point and the smallness of the divisions, is not well adapted to philosophical purposes.

Reaumer's Scale.—Reaumer, in 1730, proposed the adoption of the temperature of melting ice as the zero of the scale, and to divide the distance between this and the boiling point of water into 80°, having observed that between those temperatures spirits of wine (which he used

for the thermometric fluid) expanded from 1000 parts to 1080. This division soon became general in France and other countries, and a great multitude of valuable observations have been recorded in terms of it; but it is now seldom used in works of science.

Centigrade Scale.—In 1742, Celsius, professor at Upsal in Sweden, proposed to divide the space between the freezing and boiling points of water into 100 equal parts, the zero point being placed (as in Reaumer's) at freezing. This division being in harmony with our decimal arithmetic, is better adapted than the two former to scientific purposes. It has been adopted by all the French writers since the Revolution, and is the best known in most parts of the north and middle of Europe.

It has been sometimes objected to this scale (and the objection applies equally to Reaumer's), that on account of the comparatively high point at which the zero is placed, meteorological observations are embarrassed with the algebraic signs of *plus* and *minus*. The inconvenience (if any) is a very trifling one, and is much more than compensated by the facilities for calculation which the scale affords.

Conversion of Degrees of one Scale into Degrees of another. — From the manner in which the three scales are graduated, it is easy to deduce formulæ expressing any temperature given according to one scale in terms of either of the others. The interval which in Fahrenheit's scale is divided into 180 parts is divided into only 100 parts in the centigrade scale, and into 80 in Reaumer's. Hence one degree of Fahrenheit's is equal to 5-9ths of a degree of the centigrade, and to 4-9ths of a degree of Reaumer. But some attention is required on account of the difference of the zero points. For the sake of perspicuity, it is convenient to adapt the expressions to three distinct cases. Let F denote degrees of Fahrenheit's scale, C degrees of the centigrade, and R degrees of Reaumer; then,

Case 1. For all temperatures above the freezing point,

$$F - 32 = \tfrac{9}{5}C = \tfrac{9}{4}R.$$

Case 2. For all temperatures between the freezing point and the zero of Fahrenheit's scale,

$$32 - F = -\tfrac{9}{5}C = -\tfrac{9}{4}R.$$

Case 3. For all temperatures below the zero of Fahrenheit,

$$-32 - F = -\tfrac{9}{5}C = -\tfrac{9}{4}R.$$

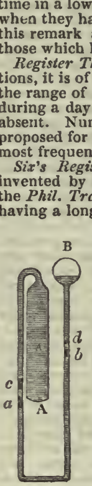
By substituting numbers in these formulæ for F, C, or R, as the case may require, the corresponding values on the other scales is immediately obtained; but if many reductions are required to be made, it is more convenient to have comparative tables, by which the correspondence of the scales is seen at a glance. Such tables are given in most treatises on chemistry.

Theory of the Graduation. — It will be evident from what has now been said that, whatever scale be adopted, the division is founded on the assumed principle that equal increments of heat produce equal expansions. This assumption may be put to the test of experiment by the mixture of fluids at different temperatures. For example, if a pound of water at 212° Fahr. be mixed with another pound of water at 32°, and the requisite precautions be used, then the temperature of the mixture will be 122°, which is the arithmetical mean between the two temperatures; and if the assumed principle be correct, a thermometer plunged into the mixture will stand at 122°. This is found to be the case with the mercurial, but not with the spirit thermometer; and, in general, thermometers formed of different fluids, when exposed to the same temperatures, do not give the same indications throughout the whole extent of the scale. An important question hence arises: what substance ought to be adopted as the standard to which, in comparing observations, all others should be reduced? It is, perhaps, not possible to determine this question with absolute certainty; but the experiments of the French chemists Dulong and Petit on the dilatation of various substances, render it probable that air and the other permanent gases (which all expand equally) afford the most accurate indications of the true variations of temperature. As compared with the air thermometer, the expansion of mercury is proportional to the increase of temperature from — 36° to + 100° of the centigrade scale. From this point to 360° (the boiling point of mercury), mercury expands more rapidly than air, and consequently the mercurial thermometer stands higher than the air thermometer in the same temperature. When the former indicates 200° and 300°, the latter indicates 197° and 292·7° respectively; and it seems to be a general law that all fluids with the same increase of heat expand more rapidly as the temperature approaches their boiling point. The more rapid expansion of the mercury at high temperatures is, however, in some measure corrected by the expansion of the bulb.

Change of the Zero Point. — There is a circumstance connected with the mercurial thermometer which requires to be attended to when very exact determinations of temperature are to be made. Bellani in Italy, and Flaugergues in France, observed that when thermometers which have been constructed for several years are placed in melting ice, the mercury stands in general higher than the zero point of the scale; and this circumstance, which renders the scale inaccurate, has been usually ascribed to the slowness with which the glass of the bulb acquires its permanent arrangement, after having been heated to a high degree in boiling the mercury. Despretz (*Traité de Physique*) observes, that in very nice experiments it is always necessary to verify the zero point; for he found that when thermometers have been kept during a certain time in a low temperature, the zero point rises, but falls when they have been kept in a high temperature: and this remark applies equally to old thermometers and to those which have been recently constructed.

Register Thermometers. — In meteorological observations, it is of great importance to ascertain the limits of the range of the thermometer in a given period of time, during a day or night, for example, while the observer is absent. Numerous contrivances have accordingly been proposed for this purpose, but the two following are those most frequently used.

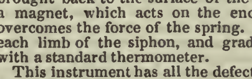
Six's Register Thermometer. — This instrument was invented by Mr. Six of Colchester, and is described in the *Phil. Trans.* vol. lxxii. It is a spirit thermometer, having a long cylindrical bulb A, with a tube bent in the form of a siphon, and terminating in a small cavity B. A part of the tube, from a to b, is filled with mercury; but the bulb A, and the remaining portion of the tube, and a small part of the cavity B, with highly rectified alcohol. The use of the mercury in the middle of the tube is to give motion to two indices, c and d, which consist each of a glass tube in which a small bit of iron wire is enclosed, the ends being capped with enamel. The indices are of such a size that they move freely within the barometric tube, and allow the spirit to pass; but a slender spring is attached to each, which presses against the side of the tube, and is just strong enough to prevent the index from falling down when it has been raised to any point and the mercury recedes. The action of the instrument will be readily apprehended from the figure.



An increase of heat expands the alcohol in the bulb A, depresses the mercury at a, and consequently raises it in the other branch of the siphon at b. The mercury while rising drives the index d before it; and when the temperature diminishes, the mercury recedes from the index, which is retained in its place by the action of the spring, and consequently marks the highest point at which the mercury has stood. In like manner, when the spirit in the bulb A is contracted by a diminution of heat, the mercury is pressed towards A by the elastic force of a portion of air purposely left in the cavity B, and drives before it the index c, which is prevented from falling back by the spring, and consequently remains at the highest point at which the mercury has stood in that branch of the siphon. When the observation has been made, the indices are brought back to the surface of the mercury by means of a magnet, which acts on the enclosed iron wire and overcomes the force of the spring. A scale is applied to each limb of the siphon, and graduated by comparison with a standard thermometer.

This instrument has all the defects which belong to the spirit thermometer, and the indications are besides in some degree deranged by the expansion and contraction of the enclosed column of mercury; probably, also, by the friction of the indices. Nevertheless, it is the best instrument we possess for determining the temperature of the sea at great depths.

Rutherford's Thermometer. — Another register thermometer, simpler in its construction, and less expensive than the former, and consequently more generally used, is the *day and night thermometer* proposed by Dr. Rutherford in the *Edinburgh Transactions*, vol. iii. It consists simply of two thermometers; a mercurial thermometer A, and a spirit thermometer B, attached horizontally to the same frame, and each provided with its own scale.



The index of A is a bit of steel, which is pushed before the mercury; but, in consequence of its horizontal position, remains in its place when the mercury recedes, and consequently indicates the highest degree of the scale to which the mercury has risen. The index of B is of glass, with a small knob at each end. This lies in the spirit, which freely passes it when the thermometer rises; but when the spirit recedes, the cohesive attraction between the fluid and the glass overcomes the friction arising from the weight of the index, and the index is consequently carried back with the spirit towards the bulb. As there is no force to move it in the opposite direction, it remains

at the point nearest the bulb to which it has been brought, and thus indicates the lowest temperature which has occurred. By inclining the instrument, the indices are brought to the surfaces of their respective fluids, and prepared for a new observation.

History of the Thermometer. — The invention of the thermometer dates from about the beginning of the 17th century, but it is not certainly known when or by whom it was first brought into use. By the Dutch authors it is ascribed to Cornelius Drebbel, a peasant of Alkmaar, and by the Italians to Sanctorio. Libri (*Annales de Chimie*, Dec. 1830) maintains, on the authority of Castelli and Viviani, that the instrument was invented by Galileo prior to 1597. The thermometer of Drebbel and Sanctorio was a very imperfect instrument. It consisted of a glass tube, having a ball blown on one of its extremities, and the other end left open. A portion of air being expelled from the ball by heat, the open end was plunged into a cup containing any liquid, when, on the cooling of the ball, the liquid would rise in the tube, and the variations of its height indicate the increase or diminution of the temperature of the bulb. The instrument had no scale, and was therefore merely an indicator of changes of temperature, or a *thermoscope;* and it was defective even in this respect, inasmuch as it is affected not merely by heat and cold, but by the varying pressure of the atmosphere. The Florentine academicians first excluded the influence of atmospheric pressure by using a spirit instead of an air thermometer, and hermetically sealing the tube. The next step in improvement was the adoption of a fixed point in the scale. Boyle proposed the thawing oil of aniseeds, which he preferred to thawing ice, because it could be readily obtained at all times of the year. Halley proposed the uniform temperature of a deep pit, which he probably considered would be the mean temperature of the earth; but he also suggested the point at which spirit boils, as well as the boiling point of water. Newton appears to have been the first who saw the advantage of having two fixed points in the scale; and in order that the instrument might be applicable to a wider range of temperature, he used linseed oil as the thermometric fluid. This, however, has not been found to answer, on account of its sluggish motion and adhesion to the sides of the tube. The astronomer Röemer proposed the substitution of mercury, which is now generally used; and the knowledge of the fluctuation of the boiling point of water, owing to atmospheric pressure, is due to Fahrenheit, about 1724. Since that time no improvement has been made in the principle of the instrument.

For further information on this subject, the reader may be referred to Deluc, *Récherches sur les Modifications de l'Atmosphère*, Genève, 1772; Biot, *Traité de Physique*, tome I.; *Nicholson's Chemistry; Library of Useful Knowledge*, "Thermometer and Pyrometer;" Muncke, in *Gehler's Physicalisches Worterbuch.*

THE'RMOSCOPE. (Gr. θερμος, and σκοπεω, *I view.*) An instrument by which changes of temperature are indicated. The modification of the air thermometer, called by Leslie a *differential thermometer*, was claimed by Count Rumford as one of his own inventions, under the name of *thermoscope*. *See* Thermometer.

THE'RMOSTAT, or HEAT GOVERNOR. (Gr. θερμος, and ιστημι, *I stand.*) A self-acting physical apparatus for regulating temperature. A thermostat, the principle of which depends on the unequal expansion of metals by heat, was proposed by Dr. Ure for regulating the safety valves of steam engines with more certainty than the common expedients. (See *Proceedings of the Royal Society* for 1830 and 1831, p. 67.)

THE'SIS (Gr. θεσις, *a position*), in a general sense, is applied to any proposition, affirmative or negative, which is laid down or advanced to be supported by argument; but it is more particularly applied to those questions which are propounded in most of the Scotch and Continental universities to the students previously to their obtaining a degree.

Thesis. In Music, the depression of the hand in marking or beating time.

THESMOPHO'RIA. (Gr. θεσμοφορια.) A festival in honour of Ceres, surnamed *the lawgiver* (θεσμοφορος), because she first taught mankind the use of laws. It was celebrated by many cities of Greece, but with most observation and ceremony by the Athenians. The worshippers were free-born women, whose husbands defrayed the expenses of the solemnity, assisted by a priest and band of virgins. The women were clothed in white garments as emblematic of purity, and were strictly enjoined to preserve the strictest chastity some days previous to and during the whole of the festival, which lasted five days.

THESMO'THETÆ. The six inferior archons at Athens, who presided at the election of the lower magistrates, received criminal informations in various matters, decided civil causes on arbitration, took the votes at elections, and performed a variety of other offices. (See *Mém. de l'Acad. des Inscr.* vol. xxxix.)

THESPIAN ART. That of tragedy or tragic acting is so termed; from Thespis, an Athenian, who lived in the first half of the 6th century before Christ, and introduced the first rudiments of a tragic stage. *See* Drama.

THE'TA. (Gr. θ.) The unlucky letter of the Greek alphabet; so called because the judges in balloting on the prisoner used it to intimate their desire for his condemnation, from its being the first letter of θανατος, *death.* Hence the verse —

O multum ante alias infelix litera Theta.

THE'TES. (Gr. θῆτες.) In ancient Attica, originally bondsmen, who were excluded from holding the chief magistracies of the state. Under the constitution of Solon they formed the lowest class of free citizens who contributed nothing to the support of the state; but in the course of the subsequent innovations which brought the state to a complete democracy all the restrictions on the thetes were removed. They served generally as light-armed soldiers, but sometimes also as regular infantry upon an emergency. (See Boeckh, *Public Economy of Athens*, ii. 258.)

THE'TIS. In Greek Mythology, one of the Nereids, daughter of Nereus and Doris: was wedded under the auspices of the gods, among whom jealousy had arisen by reason of her beauty, to Peleus, king of Thessaly. By him she became the mother of Achilles. According to the ancient cosmogonies, Thetis was an emblem of the element of water. She is best known by the verses of Homer. Her marriage with Peleus is the subject of some exquisite lines by Catullus.

THE'URGY. (Gr. Θεος, *God*, and εργον, *work.*) A name given by the ancients to their imaginary art of magic, which was, like the whole magic of the middle ages, the result of an intercourse with and influence over spiritual beings of the more exalted class, — gods, dæmons, &c. In the modern art magic, it was that species of magic which operated by celestial means: opposed to natural magic, which was effected by knowledge of the occult powers of nature; and necromancy, or magic effected by the aid of evil spirits. (See *Mém. de l'Acad. des Inscr.* vol. xxvii.)

THI'CKET. Trees or shrubs crowded together in such a manner as to form a mass not easily penetrated by men or cattle.

THI'NNING. Reducing the number of plants or trees which have been sown or planted, with a view to those which remain attaining a more mature growth. Natural woods are also thinned for the same purpose. The operation ought to be commenced as soon as the extreme leaves or branches are nearly touching one another, and continue till the plants have attained their full growth, or the required dimensions or age. On no account should the branches of any one tree in a plantation be allowed to touch the branches of any other tree; because in that case the foliage is deprived of its due proportion of sun, air, and rain, and the tree is drawn up in height at the expense of its thickness and vigour to resist storms; while the timber or fruit produced will be diminished both in quantity and quality. There is no department of planting less understood than the subject of sheltering young plantations; and it may with truth be said that in by far the greater number of cases nothing is ultimately gained by drawing up trees in masses, and afterwards thinning them out. The trees left being unprepared both by their bark and roots for the new atmospherical circumstances in which they are placed, receive a greater check than if they had been originally planted so thin as at no period of their growth to touch one another.

THIN OUT. Geologists say that strata *thin out* when they gradually diminish in thickness and disappear.

THIRD. In Music, an imperfect concord, containing two degrees or intervals, and three terms or sounds.

THIRD COAT. In Architecture, the stucco when painting is to be used, or the setting for the reception of paper.

THIRD ORDER. In Ecclesiastical History, most of the chief religious orders (Premonstrants, Carmelites, Franciscans, Augustines, &c.) have or had bodies of secular associates, not bound by vows, but conforming to a certain extent to the general designs of the order; a custom thought to have originated about A. D. 1476, when Sixtus IV. gave permission to the Carmelites to attach such persons to their body. In course of time the third order contained a mixture of secular and religious persons.

THIRST. (Germ. durst.) The sensation of a desire to drink, consisting in a sense of dryness and heat of the mouth, sometimes extending along the œsophagus to the stomach: the posterior fauces become red, and the usual mucous secretion thick and viscid, as also the saliva. A vague inquietude, troubled mind, and quick pulse ensue; and if not relieved, respiration becomes laborious, and the mouth is opened wide to admit the cool air. Some people soon suffer from thirst, and are in the habit of drinking to an excessive extent; while others hardly ever experience its sensation, and scarcely require to drink the diluting liquids or water. Thirst is a common symp-

tom of febrile and other diseases, and is most effectively relieved in such cases by mild acid and mucilaginous drinks; milk and emulsions are, however, sometimes more efficient and agreeable. Excessive exercise or perspiration are common causes of thirst, in which case the sensation seems merely to announce the deficiency of water in the system. Habitual thirst is often acquired by indulgence in drinking, especially among labourers and others who take excessive quantities of beer, and who at length can scarcely exist without unnecessary and prejudicial quantities of that or similar beverages. The thirst induced by excessive exercise in warm weather is in ordinary cases most effectually relieved by milk and water, or warm tea. In these cases indulgence in beer, cider, wine, or spirits and water, invariably induces febrile reaction, and should therefore be generally avoided.

THIRTY YEARS' WAR. In History, properly a series of wars carried on between the Protestant and Roman Catholic leagues in Germany, in the first half of the 17th century. The house of Austria was throughout at the head of the latter party. The Protestant princes of Germany were assisted by various foreign powers; in the earlier part of the war by Denmark and Sweden, and afterwards by France. It is considered to have commenced with the insurrection of the Bohemians in 1618, and ended with the peace of Westphalia in 1648. The celebrated history (incomplete) of this war, by Schiller, is rather a spirited historical essay than an accurate narrative.

THISTLE, or SAINT ANDREW. A Scottish order of knighthood, said to be of great antiquity, but revived by James V. in 1540; again by James II. of England, VII. of Scotland, in 1687; and a third time in 1703, by Queen Anne, who increased the number of knights to twelve, and placed the order on a permanent footing. The thistle as is well-known is the national emblem of Scotland; and the national motto is very appropriate, being "Nemo me impune lacesset," *nobody shall provoke me with impunity*. This is also the motto of the order of the thistle.

THMEI. The Egyptian goddess of justice, or of truth. Her figure is frequently represented in Egyptian sculptures in the hands of the kings. The Hebrew Thummim (the well-known and mysterious Urim and Thummim, Exod. xxxix. 8. 10.) is the plural or dual of the same word. (*Wilkinson's Manners and Customs of the Ancient Egyptians*, vol. v. p. 58.)

THO'LUS. (Gr. θολος.) In Architecture, a building of a circular form, but used by Vitruvius for expressing the roof of a circular building. The term was also employed to denote the laconicum of a bath, which was circular in form.

THOMÆANS, or THOMITES. In Ecclesiastical History, a name given in Europe to the ancient church of Christians established on the Malabar coast of India, and thought to have been originally founded by St. Thomas; although whether this was the apostle of that name is doubtful. The language used by them in their sacred rites, when they were first discovered by Europeans, was the Chaldee or Syriac. The Portuguese have effected a partial conversion of them to Romanism.

THO'MISTS. The followers of Thomas Aquinas, the Angelic Doctor, one of the most distinguished of the schoolmen of the 13th century. They differed from the rival sect of Scotists chiefly in the milder form under which they adopted the doctrines of realism. The Scotists regarded the universal as objectively and independently real; the Thomists sought rather to ground the objective in a spiritual or rational principle, in some degree approximating to the Platonic doctrine of ideas. The Thomists continued as a sect to the commencement of the 17th century, and numbered several eminent men in their ranks, among whom may be mentioned Algidius of Colonna and Francis Suarez.

THOMSONITE. (So called from the discoverer.) A variety of zeolite from Dumbarton: it generally occurs in radiated masses of small prismatic crystals.

THOR. In Scandinavian Mythology, the son of Odin and Freya, and the divinity who presided over all mischievous spirits that inhabited the elements. His power is represented as irresistible. Many of his deeds are preserved in the *Edda* (which see); but it is probable that the worship of this divinity under the name of Donan, or god of thunder, spread also into Germany, where traces of him are still to be found in numerous local appellations, as Donnersberg, Thorstein, &c. As the worship of this god extended, nothing was more likely than that the Germans should confound him with the Jupiter of the Romans, who were then invading their country; and hence in Germany the day sacred to Jupiter was denominated Donnerstag, while the Scandinavian equivalent of the same deity has been retained by the English in Thursday (Thor's day).

THORA'CIC DUCT. The great trunk which conveys the contents of the lacteals and absorbents into the blood. In the human body it is about the diameter of a crow-quill, and lies upon the dorsal vertebræ between the aorta and azygos vein, extending from the posterior opening of the diaphragm, in a somewhat serpentine course, to the angle formed by the union of the left subclavian and jugular veins, into which it pours its contents. *See* CHYLE and LYMPH.

THORA'CICS, *Thoracici*. (Gr. θωραξ, *the chest*.) The name given by Linnæus to those fishes which have the ventral fins placed beneath the pectorals.

THO'RAX. (Gr. θωραξ, *a shield*.) The second segment of insects is so called by Latreille and Andouin; the term is restricted to the upper surface of the trunk by Linné and Fabricius. In Arachnidans the thorax and head are confluent, and form but one segment, which is termed the cephalothorax. As a cavity appropriated to the reception of the circulating and respiratory organs, the thorax is only distinct in Mammals.

THORAX. The chest; the part of the body between the neck and the abdomen. It contains the heart and lungs, the œsophagus, the thymus gland, the thoracic duct, part of the aorta and vena cava, the vena azygos, the eighth pair of nerves, and a part of the great intercostal nerve.

THORAX. In Grecian Antiquities, a piece of defensive armour consisting of two parts, one defending the back, and the other the belly; called *lorica* by the Romans. The more ancient were made of padded linen; but they were also made of leather, brass, iron, and other metals.

THORI'NA. (From Thor, the Scandinavian deity.) An earthy substance discovered, in 1828, by Berzelius in a rare Norwegian mineral called *thorite*, which is a hydrated silicate of thorina. Like the other earths, thorina is the oxide of a heavy grey metal, which has been termed *thorium*, and which is not acted upon by water; but when heated in the air it burns with great brilliancy into a white oxide. Thorina obtained in this way is white, infusible, and very heavy, its specific gravity being 9·4. It is insoluble in all acids except sulphuric, and in that with difficulty. Its equivalent is about 68. Thorina is distinguished from alumina and glucina by its insolubility in caustic potash, and from zirconia by being precipitated by ferrocyanuret of potassium.

THO'RN APPLE. *See* STRAMMONY AND DATURIA.

THO'RNBACK. The name of a species of ray (*Raia clavata*, Linn.), distinguished by the short and strong recurved spines, rising from a broad osseous tubercular base, which are scattered over the back and tail. Two of these broad-based spines occupy the central ridge of the nose.

THOROUGH BASS. *See* BASS.

THOTH, THOUTH, TAOUT. An Egyptian divinity, considered by the Greeks as identical with Mercury. His hieroglyphic represents the beginning of the astronomical year. He was regarded as the inventor of writing and Egyptian philosophy; and is hence paralleled with Mercury by Cicero. He is represented as a human figure with the head of a lamb or ibis. (Plato, *Phædrus;* Plutarch, *De Is. et Osir.;* Wilkinson, *Ancient Egyptians*, vol. v.) Bryant says the same with Θεος (*Mythol.* i. 13.)

THOUSAND AND ONE NIGHTS; more commonly called among ourselves the *Arabian Nights' Entertainments*, from the title adopted in our first translation from Galland's version. A well-known collection of oriental tales, which has acquired in the west a popularity never attained by any other eastern composition. The history of the work has been the subject of much investigation, especially by De Sacy, Von Hammer, and our last learned translator Mr. Lane, from whom we borrow most of this article. It is the opinion of Mr. Lane that the work, in its present form, is the composition of a single author living in Egypt; and that it was most probably "not commenced earlier than the last quarter of the 15th century of our era, and completed before the termination of the first quarter of the next century, soon after the conquest of Egypt by the Osmanlee Turks in 1517." But the origin of the tales is a much more difficult subject of inquiry. It seems to be now established (from the discoveries of De Sacy and Von Hammer) that there was an ancient Persian collection of stories, known by the name of the *Hezar Afzáneh* (the "Thousand Fanciful Tales"), of unknown antiquity, but certainly older than the 9th century of our era; that the framework of this collection was the same with that of the modern, namely, the story of the cruel king Shakryar and his ingenious queen Chehrazád; and that this was very early translated into Arabic by the name of the *Thousand Nights*. But Mr. Lane differs from these learned orientalists in still believing that the early work was only a model; that the greater proportion of the modern tales are really Arabian, especially all those founded on the supposed adventures of the Khalif Haroun and his queen Zobeyde, a few only being distinctly of Persian or Indian original; *e.g.* the *Magic Horse*, the *Damsel and the Seven Wezeers*. The difference seems to reduce itself to this, whether the present work is the last of several successive editions of the old *One Thousand Nights*, or has pretensions to be considered as a new construction on an old groundwork; the latter being Mr. Lane's opinion. (See De

Sacy's Dissertation, prefixed to a late edition of Galland's version; Von Hammer's preface to that of Trébutien; Mr. Lane's Preface, and "Review" at the conclusion of his third volume; the *Athenæum*, No. 622.)

But whatever the history of the work, many of the main features of the stories are of primeval antiquity, and form, in fact, part of the popular literature of all countries. The original Persian or Arab writers were connected by habits of travelling and merchandise through India with the far East, and through Greece with the extreme West; and the superstitions, anecdotes, and pregnant sayings of all times and ages, repeated in various forms to the tired listeners of the caravan at its evening's halt, have contributed to enrich this singular collection. The *Adventures of Sindbad* have been curiously illustrated with antiquarian learning by Mr. Hole, and form one of the most singular examples of the ubiquity of good stories.

It appears that the learned Arabs hold the *Thousand and One Nights* in small esteem, as an incorrect and unclassical composition; but it is a great mistake (a very natural one for distinguished orientalists, like Mr. Lane, to fall into unconsciously) to imagine that their great charm to the people of the West consists in their faithful representation of Asiatic manners. A far greater attraction lies in the fancy which dictated the narratives — a quality belonging to all times and places. And hence it is that we are convinced Mr. Lane is wrong in his low appreciation of Galland's version. That it is very incorrect in point of costume is doubtless true; but the peculiar genius of Galland led him to detect the poetical fancy, the humour, the oddity, the picturesqueness of the composition, under the cumbrous prolixity of Arab story-telling, and to bring it out in a manner by no means strictly faithful, but sufficiently so to give an oriental quaintness to his work, without the languor of the original, — an odd but agreeable mixture of Arab simplicity with the artificial naïveté of polished France. We believe that while the versions of Mr. Lane and other learned men will always be consulted with interest, that of Galland will still be the cherished companion of all ages, but especially of youth. The numerous European imitations of the *Thousand and One Nights* are well known, and may for the most part be characterized as very unsuccessful: perhaps the best is the French *Additional Arabian Nights*, containing the history of Mangraby the Magician, &c.

THRA'NITE. The uppermost (or, according to some arrangements of the classical galley, the foremost) of the three classes of rowers in an Athenian trireme; the middle being called the zeugitæ, the lowest thalamitæ. *See* GALLEY, TRIREME.

THRA'SHING. Separating grain or seeds from the straw or haum by means of a flail or thrashing machine, or by treading with cattle. The latter was the mode employed in the ages of antiquity; and it is still practised in the south of Europe, and in Persia and India: The Romans employed oxen for this purpose; sometimes alone, and sometimes with the addition of a kind of roller studded with iron knots, which they dragged over the corn, and which was spread on a circular floor, the driver standing in the centre, and guiding the oxen around him by means of reins. It was customary to allow the oxen occasionally to breathe and take a bite of the corn, agreeably to the scripture precept. A kind of flail or rod was also sometimes used by the Romans, and is doubtless the origin of the present implement of that name. In colder and moister climates, such as that of Britain, where a floor sufficiently hard for threshing out corn could not be maintained in the open air, threshing appears to have been always performed under cover, and with the flail, till the latter end of the 18th century, when thrashing machines were introduced.

THRA'SHING MACHINE. A machine for separating corn or other seeds from the straw or haum; and either impelled by horse or cattle, wind, water, or steam. The modern thrashing machine was invented in Scotland about the year 1758 by a farmer in the parish of Dumblaine, Perthshire, and afterwards brought to nearly its present state of perfection by Mr. Meikle, a millwright of Haddingtonshire, about the year 1786. Meikle's thrashing machine consists of a cylinder furnished with beaters fixed on its circumference, to which the corn being presented by rollers the ears are beat in pieces; and while the grain drops through a grating into a winnowing machine the straw is carried forward, and delivered by itself ready to be made up into bundles. Some thrashing machines only beat out the corn, and separate it from the straw; while others beat it out, winnow it, and sift it. One of the most complete thrashing machines in Britain is that at Winstay, in Denbighshire, which not only thrashes and winnows, but measures the corn in bushels, and transports it to the granary in a fit state for being carried to market. (See *Encyc. of Agr.* p. 1311.)

The employment of thrashing machines relieves the labourers from the severest drudgery incident to agriculture; they enable the work to be done at the time there is a demand for corn; and, by doing it better, or separating the corn (particularly wheat) more completely from the straw, they add both to the wealth of the farmer and the produce of the country; enabling the former to employ, and the latter to feed, more labourers. This latter is, indeed, a most important consideration. It is calculated, by the best informed agriculturists, that 5 per cent., or one twentieth part, more produce is afforded by a crop thrashed by machinery than by the old method; and, estimating the total produce of the corn crops of Great Britain and Ireland at 50,000,000 quarters, we should, on this hypothesis, have an additional annual supply of no less than 2,500,000 quarters, were thrashing machines universally substituted for flails! So great an increase of produce in the hands of the farmers would obviously enable them to employ far more labourers than would be superseded by the use of the machine. (*Brown on Rural Affairs*, vol. i. p. 332.)

As we remarked above, thrashing machines may be driven either by horse, water, or steam power; but in all the great farms in the Lothians in Scotland, and in some parts of England, all other methods have merged in the last.

THREE-COAT WORK. In Architecture, plastering which consists of pricking-up or roughing-in, floating, and a finishing coat.

THRE'NODY. (Gr. θρῆνος, *a dirge*; ᾠδή, *song*.) A short species of occasional poem, composed on the occasion of the funeral of some distinguished personage. *See* EPICEDIUM.

THRO'MBUS. A small tumour, which sometimes ensues in consequence of the escape of blood into the cellular membrane in the operation of bleeding.

THRONE. (Gr. θρονος.) In Architecture, a chair of state raised above the level of the floor whereon it stands, usually richly ornamented and covered with a canopy.

THRUSH. In Medicine. This disease consists in small white ulcers upon the tongue, palate, and gums, and is common in infants who are ill-fed or brought up by hand. It is apt to extend through the whole course of the mucous membrane lining the alimentary canal, exciting fetid eructations and flatulency, with a troublesome diarrhœa, and sometimes proves fatal. The treatment consists in giving a gentle emetic of ipecacuanha, and keeping the bowels clear and open with castor oil, or rhubarb and magnesia. The strictest attention should be paid to the diet, which should consist of milk and light farinaceous food.

THRUSH. In Ornithology, one of the largest and most melodious of our native song birds; the type of the genus *Turdus*, Linnæus. It is not migratory, but is supposed to quit the more northern parts of England in winter for the southern provinces. It makes its nest in March; lays four or five blue eggs, spotted with black at the larger end. It feeds on berries, insects, and shell-snails; and often selects a particular kind of stone against which it breaks the shell of the snail, and near which a great quantity of fragments of the shells may be found.

THRUST. (Lat. trudo, *I push*.) In Architecture, the horizontal force of an arch, by which it acts against the piers from which it springs. Also a similar action of rafters or of a beam against the walls which bear them.

THUG. (From the Hindee verb thugna, *to deceive*.) A member of a singular association of robbers and murderers, which has excited of late years much attention in India. It appears that the existence of the system of *thuggee*, as it is called, was hardly known before the year 1810, and that no combined measures were taken to put a stop to it until about 1830. Since that time it has been fully detected, and greatly checked, chiefly through the admission of approvers from all the gangs. Capt. Meadows Taylor informs us that, between 1831 and 1837, 3266 Thugs were brought to justice, of whom 412 were hanged, 1059 transported, and 483 turned approvers. Still it is by no means supposed to be extinct. Its origin is unknown; and both Mohammedans and Hindoos belong to the society indifferently, although its tutelary goddess, Bhowanee, belongs to the latter faith. The Thugs are peculiarly superstitious in their observances. They are directed, in all their proceedings, by auguries supposed to be vouchsafed by their goddess; and particular classes are altogether exempt from their attacks: among whom are dancing girls, minstrels, sikhs, some religious mendicants, tailors, oilmen, blacksmiths, carpenters. It is stated also that they seldom destroy women unless for their own safety; and they have very seldom ventured to attack Englishmen. They usually move in large gangs, and attach themselves to travelling parties; they will journey with them for days, to find at last an opportunity to master them. When all is ready, one division of the murderers strangles the victim, while another body prepares their graves; and by means of this division of labour the fearful work is accomplished with wonderful celerity. It appears that numbers of Thugs resided together in villages, when they were prohibited by the landowners, sometimes by rajahs, to whom they paid tribute. The common

destruction of life occasioned by them may be conjectured by the fact that one Thug, admitted an approver at Saugor, confessed to Col. Taylor, who does not seem to suspect him of exaggeration, that he had been concerned in the murder of 719 persons! The existence of so strange and monstrous a system can only be explained by the condition of India; the extreme timidity and apathy of its inhabitants, and their division into castes; the number of small native governments; the habit of dwelling in villages, divided by extensive uninhabited tracts; the quantity of travelling that takes place in that commercial country, without navigable rivers or secure conveyances; and the murderous spirit of Hindoo fanaticism. (See *Col. Sleeman's Ramasccana, Vocabulary of the Thugs*, and an article on it in the *Ed. Rev.* vol. lxiv.; and *Col. Meadows Taylor's Adventures of a Thug*, 2 vols. Lond. 1839, from the Introduction to which these details are chiefly taken.)

THU'LE. The name given by the ancients to the most northern part of the habitable world; but it is almost impossible to say, from the variety of opinions entertained respecting it, whether any definite country was meant by this appellation. Some have thought that Norway, but most geographers are of opinion that Iceland, was the place alluded to. But be this as it may, it is long since the prophecy of Seneca in the following lines has been fulfilled:—

> —— Venient annis
> Sæcula seris, quibus Oceanus
> Vincula rerum laxet, et ingens
> Pateat tellus, Typhisque novos
> Deteget Orbes, nec sit terris
> Ultima Thule.

THULITE. A rare mineral of a peach-blossom colour from Norway. Its composition has not been ascertained.

THU'MERSTONE. A variety of axinite from Thum, in Saxony.

THUMMIM. *See* URIM.

THU'NDER. (Germ. donner, Lat. tonitru.) The noise produced by an explosion of lightning, or by the passage of lightning through the air from one cloud to another, or from a cloud to the ground.

The character of the sound of thunder varies with the force and the distance of the explosion, the situation of the observer, the nature of the surrounding country; and it is probably influenced also by the relative situations of the clouds.

When lightning strikes an object near us on the earth, it produces a noise resembling that of a violent crash, which is not repeated or prolonged by reflection. When the explosion is more distant, a rumbling, irregular, and recurring noise is heard, which gradually dies away in the distance, like the prolonged echo of the sound of ordnance discharged in a mountainous district.

Thunder frequently commences with an astounding rattle, which is probably occasioned by a series of explosions or discharges of electric matter in rapid succession from a highly charged thunder cloud.

We have a familiar example of this *species* of noise in the cracking which accompanies the sparks discharged from the conductor of a well-supplied electrical machine towards any adjacent conducting body; the loudness of the snaps, as well as their frequency, increasing with the electric intensity. And when we consider how trifling a portion of electric matter can be put in action by the most powerful means of artificial excitement, compared with the quantity stored up in a full-charged thunder cloud, the discrepancy between the appalling crash of the one and the insignificant snap of the other will not appear surprising, though both originate in the same cause. This cause is the vibration of the air agitated by the passage of the electric discharge with a greater or less degree of intensity; and two explanations may be given of the manner in which the vibration is produced.

The first explanation proceeds on the supposition that the electric fluid opens a passage to itself through air or other matter, in the manner of a projectile, and that the sound is caused by the rush of the air into the vacuum produced by the instantaneous passage of the fluid. But it is objected that if this explanation holds good, the passage of a cannon ball through the air ought to produce a similar sound; whereas it only produces a sort of whistling noise, which even the most timid have never thought of comparing with thunder. Another still stronger objection is, that all the experiments seem to indicate that the electric fluid is not transferred from point to point like a projectile of ponderable matter, but is conveyed along by the vibration of an elastic medium, as sound is conveyed through the atmosphere.

The second explanation, which appears more in harmony with all the facts, is founded on this vibratory propagation of the electric fluid. When the electric spark passes between two points, there is a decomposition and recomposition of electricity in all the media in which it appears, and consequently a vibration more or less violent is produced, which vibration gives rise to the sound. On this hypothesis, the continued roll is the effect of the comparatively slow propagation of sound through the air. For the sake of illustration, suppose a flash of lightning of 11250 feet in length, or that the spark is instantaneously seen from one end to the other of this line. At the same instant the flash is visible the vibration is communicated to the atmosphere through the whole extent of the line. Now suppose an observer placed in the direction of the line of the flash, and at the distance of 1125 feet from one end; then, since sound travels at the rate of about 1125 feet in a second (*see* SOUND), one second will elapse after the flash has been seen before any sound is heard. When the sound begins, the vibration communicated to the nearest stratum of air has reached his ear; and since we have supposed the line of disturbance to be 11250 in length, the vibrations of the more distant strata will continue to reach his ear in succession during the space of ten seconds. Hence the length of the flash determines the duration of the sound; and it follows that the same flash will give rise to a sound of greater or less duration, according to the position of the observer with respect to its direction. Thus, in the above instance, suppose a second observer to be placed under the line, and towards its middle, he would only hear the sound during half the time it was heard by the first observer; and if we suppose the line to be circular, and the observer to be placed near its centre, the sound would arrive from every point at the same instant in a violent crash.

Although the vibratory motion is communicated to all the strata of air along the whole length of the flash, they will not all receive the same impulsion, unless they are all at the same temperature and in the same hygrometric state, which can rarely happen. Hence the first impression of the sound is not always the most intense, although it proceeds from the nearest point.

During a thunder storm shelter should not be taken under trees or hedges, which are likely to act as conductors; but, at the same time, a person is safer when at the distance of about 30 or 40 feet from such objects than on an open plain. Water should also be carefully avoided, because it is a good conductor, and the height of a man above it may determine the course of the lightning. In a house, the safest position is near the middle of a room; and the security may be increased by sitting on a feather bed or hair mattrass, or thick woollen rug, all of which are bad conductors. It is injudicious to take refuge in a cellar, because the discharge is often from the earth to a cloud, and buildings frequently sustain the greatest injury in the basement stories. It is dangerous to be near the fireplace, because the chimney is the part most likely to be struck, and the soot is a powerful conductor. Gilt furniture, bell wires, and all large metallic surfaces, are to be avoided for the same reason. (See on this subject a highly interesting *Notice sur le Tonnerre*, by Arago, in the *Annuaire*, for 1838, translated in the *Edinburgh Philosophical Journal*.

THURLS. Short communications between the adits in mines.

THU'RSDAY. The fifth day of the week, which derives its name from Thor, the old Scandinavian god of thunder; equivalent to the Jupiter of the ancients, to whom this day was also consecrated.

THUS. (Gr. *θυω, I sacrifice*; from its use in sacrifices.) The resin of the spruce fir. The term frankincense is also applied to it, and to *olibanum*, which is the gum resin of the *Juniperus lycia*.

THWART. In Naval Affairs, used for athwart or across; also a bench for rowers.

THYMELA'CEÆ. (Thymelea, one of the genera.) A natural order of shrubby Exogens, having a calyx only, and no corolla, although the flowers of many are coloured very gaily. *Daphnes*, valued for their fragrance, *Mezereung*, the various species of the Australian genus *Pimelea*, and the *Gnidias* and *Struthiolas* of the Cape of Good Hope, are favourite subjects of cultivation. One feature of the order is the causticity of the bark, which acts upon the skin as a vesicatory, and causes excessive pain in the mouth if chewed. The berries of *Daphne laureola* (the spurge laurel) are poisonous to all animals except birds.

THY'MUS GLAND. A gland situated under the upper part of the sternum, in the anterior mediastinum. Its excretory duct has not been detected, nor is its use known. It is of great comparative size in the fœtus.

THY'NNUS. (Gr. *θυννος, a tunny*.) A genus of Scomberoid fishes, of which the highly valuable fish the tunny (*Thynnus vulgaris*, Cuv.) is the type. The form of the body in this genus of fishes is like that of the mackerel, but is less compressed; the first dorsal fin extends nearly to the second; the second dorsal and the anal fins are divided into numerous finlets; the sides of the tail are decidedly carinated; there is a single row of small pointed teeth in each jaw. The tunny is remarkable among fishes for its high temperature, its perfect respiratory organs, the quantity of nerves supplying the gills, and the general abundance of rich red blood throughout the body. It is the object of the most important fisheries in the Mediterranean sea, and when salted and dried serves the inhabitants of most Catholic countries with the fast

days' meat. The *bonito* (*Thynnus pelamys*) is a species of the present genus of fishes.

THY'RIS. (Gr. θυρις, *a window.*) A genus of butterflies.

THY'ROID. (Gr. θυρεος, *a shield*, and ειδος, *form.*) The thyroid or scutiform cartilage is placed perpendicular to the cricoid cartilage of the larynx, of which it forms the upper and anterior part. In men it is harder and more prominent than in women; it is sometimes called *Adam's apple.* The thyroid gland is situated upon the thyroid and cricoid cartilages of the trachea; its duct has not been seen, and its use is unknown. When enlarged it forms the bronchocele.

THY'RSUS. (Gr. θυρσος.) A staff entwined with ivy, which formed part of the accoutrement of a Bacchanal, or performer in the orgies of Bacchus.

THYRSUS. In Botany, a form of inflorescence, consisting of a compact panicle, the lower branches of which are shorter than those of the middle; in other words, it is composed of a primary axis developing secondary axes from its sides, which in their turn develop tertiary axes, the upper and lower branches being shorter than those of the middle, as in the common lilac.

THY'SANURANS, *Thysanura.* (Gr. θυσανοι, *fringes*, ουρα, *a tail.*) The name of an order of Ametabolian insects, comprehending those in which the abdomen is terminated by filaments, or by a forked tail adapted for leaping.

TIA'RA. The well-known ornament with which the ancient Persians adorned their heads. It was in the form of a tower, and adorned with peacocks' feathers. Xenophon says that it was sometimes encompassed with the diadem, at least in ceremonies, and had frequently the figure of a half moon embroidered upon it. This was the name also originally given to the mitre of the popes. It was nothing more than a round high cap, at first single instead of double, like that of the other bishops. Nicholas the First added the first gold circle, as the sign of the civil power. The second was added by Boniface about 1300; the third by Urban V. about 1365. (Bowden, *Life of Gregory VII.* i. 60.)

TI'BIA. (Lat.) In Anatomy, the largest of the two bones which form the second segment of the leg, or sacral extremity. In Entomology, it is the fourth joint of the leg, is very long, and usually triquetrous. Its name is said to have reference to its resemblance to the ancient pipe or flute.

TIC DOULOUREUX. A very painful affection of a nerve, coming on in sudden and excruciating attacks: it is perhaps most common in that branch of the fifth pair which comes out of the infra-orbitary foramen. Nothing is known of the cause of tic douloureux, except in one or two very rare cases, where a small spicula of bone has been found pressing on the nerves. The treatment is equally uncertain, except where it assumes an intermittent form, and then large doses of tonics, and especially carbonate of iron have proved useful.

TI'CHORRHINE. (Gr. τειχος, *a wall*; ῥιν, *a nose.*) The name of a fossil species of rhinoceros (*Rhinoceros tichorrinus*), which is so called on account of the middle vertical bony septum or wall which supports the nose.

TIDE MILLS, are such as have the ebb and flow of the tide for their first movers. As the tide rises, the water is admitted into a reservoir through a sluice, over which the mill is built, turning the water-wheel in its passage through the sluice. At high tide the sluice gates are shut till the water has fallen sufficiently outside, when they are opened, so as to allow the water to flow out again from the reservoir, and turn the wheel as it escapes through the sluice.

In some tide mills the water-wheel turns one way as the tide rises, and the contrary as it falls; but in others an arrangement is adopted by which the wheel is made to turn always in the same direction. In some, the water-wheel rises and falls with the tide; and in others, the axis is fixed, so that it can neither rise nor fall. In the latter case, the power is applied at an obvious disadvantage, though rotatory motion to a certain extent may be given even when the wheel is wholly immersed in the water, from the *difference* of the velocity of the water at the top and bottom of the sluice. (See *Gregory's Mechanics*, vol. ii.)

TIDES. The alternate rise and fall of the waters of the ocean. The moon is the principal agent in the production of the tides; but they are modified, both with respect to their height and the times at which they happen, by the action of the sun. The effect of the planets is inappreciable.

The attractive force of a body on a distant particle of matter varying inversely as the square of the distance, the particles of the earth on the side next the moon will be attracted with a greater, and those on the opposite side with a smaller force, than those which are situated intermediately. The gravitation towards the earth's centre of the particles nearest the moon will therefore be diminished, and consequently, if at liberty to move among themselves, they will rise above the general level. In like manner, the moon's attraction on the most distant particles being less than on the central ones, their relative gravitation towards the centre will also be diminished, and the waters will consequently be heaped up on the side of the earth which is turned away from the moon. Hence if the earth were at rest, the ocean would take the form of an oblong spheroid, with its longer axis passing through the attracting body; and it may be shown from theory that the spheroid would be in equilibrium under the influence of the moon's attraction, if the longer semi-axis exceeded the shorter by about 58 inches. But in consequence of the rapid rotation of the earth about its axis, the spheroid of equilibrium is never fully formed; for before the waters can take their level, the vertex of the spheroid has shifted its position on the earth's surface, in consequence of which an immensely broad and very flat wave is formed, which follows the motions of the moon at some interval of time. In the open sea the time of high water is, in general, from two to three hours after the moon's transit over the meridian either above or below the horizon. The tidal wave, it is to be observed, is entirely different from a current: the particles of water merely rise and fall; but except when the wave passes over shallows, or approaches the shore, there is little or no progressive motion.

The waters of the ocean are affected in a similar manner by the action of the sun, under the influence of which they have a tendency to assume at every instant the form of an elongated spheroid; but although the attractive force of the sun is immensely greater than that of the moon, yet, by reason of the greater distance of the sun, the *difference* of the effect on particles situated on opposite sides of the earth (on which difference the phenomena depend) is very much less. The solar tides are therefore comparatively small with respect to the lunar tides, and, in fact, are never perceived as distinct phenomena, but become sensible only from the modifications which they produce in the heights and times of those which primarily depend on the moon. At the syzygies, when the sun and moon come to the meridian together, the tides are, *ceteris paribus*, the highest; at the quadratures, or when the sun and moon are 90° distant, the tides are least. The former are called *spring tides*, the latter *neap tides.* Although we are not in possession of data to enable us to compute the exact height either of the spring or neap tides, yet their relative heights in the open ocean probably correspond very nearly to the ellipticities of the spheroids of equilibrium that would be formed under the action of the two bodies exerted separately. Now the ellipticity of the aqueous spheroid formed by the moon's action is about five feet, and the ellipticity of that formed by the sun's action about two feet; therefore, the spring and neap tides being the sum and difference of the separate effects, the average spring tide will be to the average neap in the ratio of about 7 to 3. *See* GRAVITATION.

By reason of the ellipticity of the orbits the distances of the sun and moon from the earth are continually changing; and the theory of attraction proves that the efficacy of either body in disturbing the waters of the ocean is inversely proportional to the cube of its distance. Hence it is found that if the mean efficacy of the sun be represented by 20, the influence of the sun's action will vary between the extremes of 19 and 21, and and that of the moon's between 43 and 59. The highest spring tide will therefore be to the lowest neap as $59+21$ to $43-19$; that is, as 80 to 24, or as 10 to 3.

Another effect of the solar action is observed in the times at which high water takes place from day to day. In the spring and neap tides the time of high water is not altered by the sun's action, the solar and lunar tides being synchronous in the former case, and the time of actual low water being that of solar high water in the latter; but in the intermediate tides the time of actual high water is accelerated or retarded. In the first and third quarters of the moon, the solar wave is to the westward of the lunar one; and consequently the observed tide, which is the result of the combination of the two waves, will be to the westward of the place it would occupy if the moon acted alone, and the time of high water will therefore be accelerated. In the second and fourth quarters, the general effect of the sun is to produce, for a like reason, a retardation in the time of high water. This result of the combined action of the two attracting bodies is what is usually termed the *priming and lagging* of the tides, and it is most remarkable about the time of new and full moon.

It is to be observed, however, that the effect now described is modified to some extent by the inertia of the water. The greatest and least tides do not happen exactly at the times of new and full moon; but at least two, and commonly three tides after, even at places directly exposed to the general tide of the ocean. In consequence of the greater amount of impressed force, the acceleration of the lunar tide is greater than that of the solar; whence it may happen that when the lunar tide occurs two or three hours after the transit of the moon,

the solar tide may be three or four hours after that of the sun, so as to be about an hour later at the times of conjunction and opposition. The highest spring tides will thus occur when the moon passes the meridian about an hour after the sun; while at the precise time of new and full moon the lunar tide will be retarded about a quarter of an hour by the solar tide. But the time of high water does not follow the moon's transit at the same interval at every period of the lunation. When the sun and moon are in conjunction the interval is called the *mean interval;* at other periods of the lunation the lunitidal interval is sometimes greater and sometimes less than the mean, and the difference is called the half-monthly or *semimenstrual inequality*.

The apparent time of high water at any port, in the afternoon of the day of new or full moon, is what is usually called the *establishment of the port*. Mr. Whewell calls this the *vulgar* establishment, and the mean of all the intervals of tide and transit for a half lunation he terms the *corrected* establishment. This corrected establishment is consequently the lunitidal interval corresponding to the day on which the moon passes the meridian exactly at noon or midnight.

The two tides immediately following one another, or the tides of the day and night, vary, both in height and time of high water, at any particular place with the distance of the sun and moon from the equator. As the vertex of the tide wave always tends to place itself vertically under the luminary which produces it, it is evident that, of two consecutive tides, that which happens when the moon is nearest the zenith or nadir will be greater than the other; and consequently when the moon's declination is of the same denomination as the latitude of the place, the tide which corresponds to the upper transit will be greater than the opposite one, and *vice versâ*, the differences being greatest when the sun and moon are in opposition and in opposite tropics. This is called the *diurnal inequality*, because its cycle is one day; but it varies greatly at different places, and its laws, which appear to be governed by local circumstances, are very imperfectly known.

We have now described the principal phenomena that would take place, were the earth a sphere and covered entirely with a fluid of uniform depth. But the actual phenomena of the tides are infinitely more complicated. From the interruption of the land, and the irregular form and depth of the ocean, combined with many other disturbing circumstances, among which are the inertia of the waters, the friction on the bottom and sides, the narrowness and length of the channels, the action of the wind, currents, difference of atmospheric pressure, &c. &c., great variation takes place in the mean times and height of high water at places differently situated; and the inequalities above alluded to, as depending on the parallax of the moon, her position with respect to the sun, and the declination of the two bodies, are, in many cases, altogether obliterated by the effects of the disturbing influences, or can only be detected by the calculation and comparison of long series of observations.

By reason of these disturbing causes, it becomes a matter of great difficulty to trace the propagation of the tide wave, and the connection of the tides in different parts of the world. In the *Philosophical Transactions* for 1832, Sir John Lubbock published a map of the world, in which he inserted the times of high water at new and full moon at a great number of places on the globe, collected from various sources, as works on navigation, voyages, sailing directions, &c.; and in order that the march of the tide wave might be traced more readily, the times were expressed in Greenwich time as well as the time of the place. In the same *Transactions* for 1833, Mr. Whewell prosecuted this subject at greater length; and availing himself of *à priori* considerations, as well as of a mass of information collected in the Hydrographer's office at the Admiralty, inserted in the map a series of *cotidal lines*, or lines along which high water takes place at the same instant of time. But these cotidal lines, as Sir J. Lubbock remarks, are entirely hypothetical; for we have few opportunities of determining the time of high water at a distance from the coast, though this is sometimes possible by means of a solitary island, as St. Helena. (*Lubbock's Elementary Treatise on the Tides*, 1839.)

According to Mr. Whewell's deductions, the general progress of the great tide wave may be thus described:— It is only in the Southern Ocean, between the latitudes of 30 and 70 degrees, that a zone of water exists of sufficient extent to allow of the tide wave being fully formed. Suppose, then, a line of contemporary tides, or *cotidal line*, to be formed in the Indian Ocean, as the theory supposes, that is to say, in the direction of the meridian, and at a certain distance to the eastward of the meridian in which the moon is. As this tide wave passes the Cape of Good Hope, it sends off a derivative undulation, which advances northward up the Atlantic Ocean, preserving always a certain proportion of its original magnitude and velocity. In travelling along this ocean the wave assumes a curved form, the convex part keeping near the middle of the ocean, and ahead of the branches, which, owing to the shallower water, lag behind on the American and African coasts; so that the cotidal lines have always a tendency to make very oblique angles with the shore, and, in fact, run nearly parallel to it for great distances. The main tide, Mr. Whewell conceives, after reaching the Orkneys, will move forward in the sea bounded by the shores of Norway and Siberia on the one side, and those of Greenland and America on the other, will pass the pole of the earth, and finally end its course on the shores in the neighbourhood of Behring's Straits. It may even propagate its influence through the straits, and modify the tides of the North Pacific. But a branch tide is sent off from this main tide into the German Ocean; and this, entering between the Orkneys and the coast of Norway, brings the tide to the east coast of England, and to the coasts of Holland, Denmark, and Germany. Continuing its course, part of it at least passes through the strait of Dover, and meets in the British Channel the tide from the Atlantic, which arrives on the coast of Europe twelve hours later: but in passing along the English coast another part of it is reflected from the projecting land of Norfolk upon the north coast of Germany, and again meets the tide wave on the shores of Denmark. Owing to this interference of different tide waves, the tides are almost entirely obliterated on the coast of Jutland, where their place is supplied by continual high water.

In the Pacific Ocean the tides are very small; but there are not sufficient observations to determine the forms and progress of the cotidal lines. Off Cape Horn, and round the whole shore of Terra del Fuego, from the western extremity of the Strait of Magalhaens to Staten Island, it is very remarkable that the tidal wave, instead of following the moon in its diurnal course, travels to the *eastward*. This, however, is a partial phenomenon; and a little farther to the north of the last-named places the tides set to the north and west. In the Mediterranean and Baltic seas the tides are inconsiderable, but exhibit irregularities for which it is difficult to account. The Indian Ocean appears to have high water on all sides at once, though not in the central parts at the same time.

Since the tides on our coasts are derived from the oscillations produced under the direct agency of the sun and moon in the Southern Ocean, and require a certain interval of time for their transfer, it follows that, in general, the tide is not due to the moon's transit immediately preceding; but is regulated by the position which the sun and moon had when they determined the primary tide. The time elapsed between the original formation of the tide and its appearance at any place is called the *age* of the tide, and sometimes, after Bernoulli, the *retard*. On the shores of Spain and North America the tide is a day and a half old; in the port of London, it appears to be two days and a half old when it arrives.

Velocity of the Tide Wave.— In the open ocean the crest of the tide travels with enormous velocity. If the whole surface were uniformly covered with water, the summit of the tide wave, being mainly governed by the moon, would every where follow the moon's transit at the same interval of time, and consequently travel round the earth in a little more than 24 hours. But the circumference of the earth at the equator being about 25,000 miles, the velocity of propagation would therefore be about 1000 miles per hour. The actual velocity is perhaps nowhere equal to this, and is very different at different places. In latitude 60° south, where there is no interruption from land (excepting the narrow promontory of Patagonia), the tide wave will complete a revolution in a lunar day, and consequently travel at the rate of 670 miles an hour. On examining Mr. Whewell's map of cotidal lines, it will be seen that the great tide wave from the Southern Ocean travels from the Cape of Good Hope to the Azores in about 12 hours, and from the Azores to the southernmost point of Ireland in 3 hours more. In the Atlantic the hourly velocity in some cases appears to be 10° of latitude, or near 700 miles, which is almost equal to the velocity of sound through the air. From the south point of Ireland to the north point of Scotland the time is 8 hours, and the velocity about 160 miles an hour along the shore. On the eastern coast of Britain, and in shallower water, the velocity is less. From Buchanness to Sunderland it is about 60 miles an hour; from Scarborough to Cromer 35 miles; from the North Foreland to London 30 miles; from London to Richmond 13 miles an hour in that part of the river. (Whewell, *Phil. Trans.* 1833 and 1836.) It is scarcely necessary to remind the reader that the above velocities refer to the transmission of the undulation, and are entirely different from the velocity of the current to which the tide wave gives rise in shallow water.

Range of the Tide.— The difference of level between high and low water is affected by various causes, but chiefly by the configuration of the land; and is very different at different places. In deep in-bends of the shore, open in the direction of the tide wave, and gradually contracting like a funnel, the convergence of the water causes

a very great increase of the range. Hence the very high tides in the Bristol Channel, the Bay of St. Malo, and the Bay of Fundy, where the tide is said to rise sometimes to the height of 100 feet. Promontories, under certain circumstances, exert an opposite influence, and diminish the magnitude of the tide. The observed ranges are also very anomalous. At certain places on the southeast coast of Ireland the range is not more than 3 feet, while at a little distance on each side it becomes 12 or 13 feet; and it is remarkable that these low tides occur directly opposite to the Bristol Channel, where (at Chepstow) the difference between high and low water amounts to 60 feet. In the middle of the Pacific it amounts only to 2 or 3 feet. At the London Docks the average range is about 22 feet; at Liverpool 15·5 feet; at Portsmouth 12·5 feet; at Plymouth also 12·5 feet; at Bristol 33 feet.

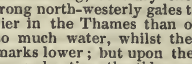
Theory of the Tides. — The theory of the tides, considered as a consequence of solar and lunar attraction, was first sketched by Newton in the *Principia*. In the 36th and 37th propositions of the third book, he determines the forces of the sun and moon to elevate the waters of the ocean, on the supposition that the sea is a fluid of the same density as the earth, covering the whole terrestrial surface, and which takes at every instant the figure of equilibrium. He assumes, without demonstration, that this figure is an elongated spheroid. One spheroid he supposes to be formed under the action of the sun, another under the action of the moon; and by reason of the smallness of their eccentricities they may be conceived as superposed the one on the other. From these suppositions he deduced the general phenomena of the ebb and flow of the sea; and by comparing his theory with observations of the heights of the spring tides made at the mouth of the Avon, near Bristol, he determined the ratio of the attraction of the moon to that of the sun to be nearly 4·48 to 1; whence he deduced the mass of the earth to be to that of the moon as 39·788 to 1, the density of the sun to that of the earth as 1 to 4, and the density of the moon to that of the earth as 11 to 9. Newton's theory was defective in many points of view; but fifty years elapsed before it received any improvement. In 1738, the subject of the tides was proposed as a prize question by the French Academy of Sciences, which gave occasion to the celebrated treatises of Daniel Bernoulli, Maclaurin, and Euler. Maclaurin's Essay is remarkable, as containing a demonstration of the theorem assumed by Newton, that the elliptic spheroid affords an equilibrium under the action of the disturbing forces: those of Bernoulli and Euler, though they furnish no new principle of equal or similar importance in point of theory, enter more into details, and contain many useful illustrations. That of Bernoulli, indeed, contains a table which has served as the model for all those (not purely empirical) which have since been formed. The next important step in the theory of the tides was taken by Laplace, who first treated the subject as a general question of hydrodynamics, and attempted to deduce the principal phenomena from the equations of the motions of fluids. But in order to simplify the equations, which are of a very complicated nature, he was forced to have recourse to the hypothesis of a fluid covering entirely a spheroid of a regular surface, and consequently the results were far from representing the actual observations of the tides at any port. The late Dr. Thomas Young (*Ency. Brit.*, art. "Tides") extended Laplace's method to the more general case of an ocean covering a part only of the earth's surface, and more or less irregular in its form; and attempted also to include in his calculation the effects of hydraulic friction on the times and magnitudes of the tides. It is, however, quite impossible to embrace in any calculation the whole of the accessory circumstances which influence the times and magnitudes of the tides, the greater part of which are, in fact, entirely unknown; and therefore, says Laplace, all we can do is to analyze the general phenomena which should result from the joint action of the sun and moon, and deduce from observations the data which are indispensable for completing the theory of the tides for each particular port.

A great number of observations of the tides at the port of Brest, during the last century, were discussed by Laplace in the *Mécanique Céleste;* but in order to determine the motion of the tide wave, and separate the general laws of the phenomena from local irregularities, it is necessary to have regular series of observations made at different parts of the ocean. Until very recently the theory may be said to have been in advance of the observations; but of late years the subject has received great attention, and at the present time a more perfect theory of hydrodynamics appears to be necessary for the physical explanation of the phenomena. In 1829, Sir John Lubbock undertook the discussion of the tide observations which are made at the London Docks, with the view of obtaining correct tables for predicting the time and height of the tides for the *British Almanac*. The results, which were published in the *Philosophical Transactions* for 1831, are deduced from a series of upwards of 13,000 observations, during a period of nineteen years, and are of great importance, both as affording materials for the construction of tide tables, and as pointing out the defects of the equilibrium theory, with which they were accurately compared. In some of the subsequent volumes of the *Transactions* the author has continued his investigations, and has also published, separately, an account of Bernoulli's *Traité sur le Flux et Reflux*, and an elementary treatise, which appeared in 1839. In the *Phil. Trans.* for 1833, M. Whewell gave an *Essay towards a first Aproximation to a Map of Cotidal Lines*, which has been followed by a series of interesting papers in the subsequent volumes to the present time (1842). Mr. Whewell's researches have been chiefly directed to the determination of the following points: — First, the motion of the tide wave at different parts of the ocean; secondly, the comparison of the observed laws at different places with theory; and, lastly, the laws of the diurnal inequality. In 1834, the British Association procured an extensive series of observations to be made on the coasts of Britain and Ireland at 537 stations of the coast-guard. These were repeated at the same places in June, 1835; and, at the request of our government, simultaneous observations were made by the other maritime powers of Europe and the United States. The number of stations in America was 28, extending from the mouth of the Mississippi to Nova Scotia; and the number on the continent of Europe 101, between the straits of Gibraltar and the north Cape of Norway. The results of these observations, reduced under Mr. Whewell's superintendence, were published in the *Phil. Trans.* for 1836; and they are of great importance, not only as affording a far more precise determination of the progress of the tide wave and the forms of the cotidal line on the coasts of Europe and North America than previously existed, but as furnishing more correct data for the construction of the tide tables.

Influence of Atmospheric Pressure and Winds.—Besides the numerous causes of irregularity depending on the local circumstances, the tides are also affected by the state of the atmosphere. At Brest, the height of high water varies inversely as the height of the barometer, and rises more than eight inches for a fall of about half an inch of the barometer. At Liverpool, a fall of one tenth of an inch in the barometer corresponds to a rise in the river Mersey of about an inch; and at the London Docks, a fall of one tenth of an inch corresponds to a rise in the Thames of about seven tenths of an inch. With a low barometer, the tides may therefore be expected to be high, and *vice versâ.* The tide is also liable to be disturbed by winds. Sir J. Lubbock states that, in the violent hurricane of Jan. 8. 1839, "there was no tide at Gainsborough, which is twenty-five miles up the Trent, — a circumstance unknown before. At Saltmarsh, only five miles up the Ouse, from the Humber, the tide went on ebbing, and never flowed till the river was dry in some places; while at Ostend, towards which the wind was blowing, contrary effects were observed. During strong north-westerly gales the tide marks high water earlier in the Thames than otherwise, and does not give so much water, whilst the ebb tide runs out late, and marks lower; but upon the gales abating, and the weather moderating, the tides put in, and rise much higher; whilst they also run longer before high water is marked, and with more velocity of current; nor do they run out so long or so low." (*Elementary Treatise on the Tides.*)

TIDE GAUGE. A mechanical contrivance for registering the state of the tide continuously at every instant of time. In the *Phil. Trans.* for 1838, there is a description of a very complete self-registering machine for this purpose, erected at Bristol by Mr. Bunt. The principal parts are an eight-day clock, which turns a vertical cylinder revolving once in twenty-four hours; a wheel, to which an alternate motion is communicated by a float rising and falling with the tide, and connected with the wheel by a wire passing over a pulley, and kept constantly strained by a counterpoise; and a small drum on the same axis with the wheel, which, by a suspending wire, communicates one eighteenth of the vertical motion of the float to a bar carrying a pencil, which describes a curve on the cylinder, and thereby marks the fluctuations and the time and height of high water. Various tide gauges, on similar principles, have been constructed by others, particularly by Captain Lloyd, Mr. Mitchell, and Mr. Palmer. (See the *Nautical Magazine* for October, 1832.)

TIE. In Architecture, a piece of timber or metal placed in any direction, whose office is to bind two bodies together which have a tendency to separate or diverge. *See* Roof.

Tie. In Music, a character ⌣ used in ancient music to connect syncopated notes, which were divided by a bar; thus .

TIER. A row or range of guns, casks, &c. Also the place on the orlop deck on which the cables are stowed.

TIERCE. In Heraldry, a term used for the field when divided into three parts.

TIERS E'TAT. The third branch, or commonalty, in the French estates. The origin and meaning of the word are illustrated by M. Gautier. (*Mém. de l'Acad. des Inscr.* vol. xxxvii.) The important part which the representation of the tiers état played at the commencement of the French revolution is known to all. Previously to the great French revolution, the French were divided into three distinct classes, the nobles, the clergy, and the commonalty, forming in their united capacity the states general of the kingdom; and their deliberations were separately conducted by individual vote in different chambers, in which the three classes above mentioned respectively assembled. They then met in common to deliberate together, and vote collectively. Now, as the number of the deputies was nearly equal in each order, the result of the votes taken collectively was always necessarily favourable to the privileged orders. Hence it was loudly demanded that the number of the third or tiers estate should be doubled, and the definitive resolutions decided by individual instead of collective votes. Every one knows that it was owing to the refusal of the nobles and the clergy to comply with this demand, that the crisis of the French revolution was accelerated; and to the consummation of this event a celebrated pamphlet of Siéyes, entitled *Qu'est ce que le Tiers Etat*, in a great degree contributed. *See* Assembly.

TI'GER. A species of the genus *Felis*, as large as the lion, but with a rounder head and longer body; of a bright reddish fawn colour above, a pure white below, irregularly crossed with black stripes. It is clothed with short hairs, and has no mane. The tiger is the most formidable and cruel of all quadrupeds, and the scourge of the less inhabited parts of India. It is limited to the Asiatic continent. *See* Felis.

TIGHT. The Sea term for the opposite of leaky.

TILIACEÆ (*Tilia*, the linden or lime tree), form a natural order of Exogenous plants, very nearly allied to the Malvaceous order, from which they differ in the stamens being distinct. In useful qualities they resemble that order, the bark being tough, their sap mucilaginous, and their timber light. Russia mats are made from the tough inner bark of the common lime tree; and a species of Corchorus, called *olitorius*, is employed in India as a potherb. A few have gay flowers, but the majority are plants of little interest.

TI'LLAGE LANDS. Lands kept under the plough, that is, cropped with annual or biennial plants, which require a continual change of the surface soil by stirring and turning with the plough or other agricultural implements, and by the addition of manure. The tillage plants of Britain and of analogous climates are chiefly the bread corn; leguminous or pea-flowered plants, such as the bean, pea, tares, clover, &c.; plants cultivated for their roots or tubers, such as the turnip, carrot, potato, &c.; or plants cultivated for their seeds, such as mustard, rape; or for the entire plant, such as wood, flax, hemp, and a variety of others.

TILLER. In Naval Language, the bar placed in the head of the rudder to turn it.

TI'LMUS. (Gr. τιλλω, *I pluck.*) Picking of the bed-clothes, or floccitation; a symptom of the fatal termination of some disorders.

TIMBER. In Carpentry, a word used to denote those pieces of wood that admit of being squared, or are capable of being employed in house and ship-building.

A considerable portion of the timber (oak) used in ship-building, and in the construction of machinery, is of home growth; but the greater portion of the timber (fir) used in house carpentry, and in the making of furniture, &c., is imported either from our colonial possessions or from foreign countries.

The trade in timber is one of great extent and importance. In fact, if there be one article more than another with which it is of paramount importance that a great maritime and manufacturing nation like England should be abundantly supplied on the lowest possible terms, that article is timber. But of late years, this sound principle has been most materially interfered with, partly for the sake of revenue, and partly to force a trade with our North American colonies. This forcing system has been carried to such an extreme extent, that from 1821 down to the present year (1842), a duty of 55*s.* a load has been laid on foreign timber, or timber from the N. of Europe, whereas timber from British America has been admitted at a duty of 10*s.* a load, making a discriminating or differential duty of no less than 45*s.* a load in favour of the latter! Such a preference would, under any circumstances, be most injurious; but it has been especially so from the fact of the timber of our North American possessions being, speaking generally, of very inferior quality; so that the practical operation of the system has been to compel the British public to pay a comparatively high price for a comparatively worthless article. We are glad, however, to be able to state that this pernicious system has recently been very materially modified; and that under the tariff introduced by Sir Robert Peel the duty on foreign timber is to be immediately reduced to 30*s.* a load, and that in 1843, it is to be reduced to 25*s.*, while the duty on timber from British America is to be reduced to 1*s.* the load. This reduces the differential duty or bounty in favour of Canadian timber from 45*s.* to 24*s.*, and is, in so far, a material improvement. But there neither is nor can be any good reason why the differential duty should not be still farther reduced, or rather why it should not be altogether abolished. The better plan would have been to have made the reduction only in foreign timber, and to have kept the duty on Canadian timber at its old level. Had this been done, the loss to the revenue would not have been nearly so great as it will be, at the same time that the differential duty in favour of colonial timber would have been reduced to 15*s.* a load, which, though an unpolitic, could not have been called an oppressive duty.

The consequence of this forcing system has been that of from 350 to 450 cargoes of timber annually imported into the United Kingdom, not more than from 60 to 100 are from the north of Europe. But under the new system, the proportions will be materially varied, and the balance of importation will be greatly in favour of the north of Europe. We subjoin,—

An Account of the Quantities of Timber Imported in 1838 and 1839; and of the Quantities retained for Home Consumption, and the Nett Amount of Duty derived therefrom in the same Two Years.

Timber.		Quantities Imported.		Quantities Exported.		Quantities returned for Consumption.		Net Revenue.	
		1838.	1839.	1838.	1839.	1838.	1839.	1838.	1839.
								L.	L.
Batten and batten ends	great hhds.	18,020	20,118	95	168	17,610	19,405	161,112	174,819
Deals and deal ends	ditto	72,737	80,647	1,306	1,072	70,878	77,536	622,261	631,839
Masts above 6, and under 8 ins. in diameter	numb.	11,240	17,188	303	209	10,969	15,374	3,331	4,781
— 8 — 12 —	ditto	3,943	5,263	121	320	3,690	4,723	2,635	3,304
— 12 inches and upwards	ditto	4,539	9,308	75	50	4,593	8,018	6,494	6,859
Oak planks	ditto	3,996	3,558	- -	- -	3,889	3,489	15,552	13,863
Staves	great hhds.	78,181	81,020	1,876	1,579	75,461	83,070	58,738	54,566
Fir, 8 ins. square and upwards	loads	647,061	623,265	545	310	633,899	629,251	572,595	550,999
Oak	ditto	34,890	50,752	- -	1	36,155	49,664	46,766	75,147
Unenumerated	ditto	43,415	51,676	45	58	43,523	51,336	10,976	12,961
Wainscot logs	ditto	5,737	2,644	- -	- -	4,518	4,072	12,353	11,862

TIMBERS. The general term for the upright pieces of wood in a ship's frame.

TIME. In Music, that affection of sound whereby shortness or length is denominated as regards its continuity on the same degree of tune. Time may be considered either with respect to the absolute duration of the notes themselves, measured by motion foreign to music, or with respect to the proportion or quantity of notes compared with each other. The signs or characters by which the time of notes is represented are given under the article Music.

Time. A limited portion of duration, measured by certain conventional or natural periods, and often marked by particular phenomena, — as the revolution of the celestial bodies, more especially of the sun, or the rotation of the earth on its axis.

Absolute Time is time considered in itself without reference to that portion of duration to which it belongs, however noted or marked.

Relative Time is time considered with reference to the termini of some specific interval of duration.

Apparent Time is time deduced from observations of the sun, and is the same as that shown by a properly adjusted sun-dial.

Mean Time is that shown by a well-regulated clock; and would be the same as that shown by the sun, if the sun were always in the equator, and his apparent diurnal motion in the heavens were uniform.

Sidereal Time is the portion of a sidereal day which has elapsed since the transit of the first point of Aries. It represents at any moment the right ascension of whatever object is then upon the meridian.

Astronomical Time of Day is the time past *mean noon* of that day, and is reckoned on to twenty-four hours in mean time.

Civil Time is mean time adapted to the purposes of civil life. The day commences at the midnight preceding the noon of the day, and is divided into parts of twelve hours each, the first twelve marked A.M. or *ante meridiem*, and the second P.M. or *post meridiem*.

TIMO'CRACY. (Gr. τιμοκρατία.) A term made use of by some Greek writers, especially Aristotle, to signify a peculiar form of constitution; but there are two different senses in which it is thus used, corresponding to the different meanings of the word τιμη, *a price* or *honour*, from which it is derived. According to the first it represents a state in which the qualification for office is a certain amount of property; in the latter it is a kind of mean between aristocracy and oligarchy, when the ruling class, who are still the best and noblest citizens, struggle for pre-eminence amongst themselves. (See *Quart. Rev.* vol. xlv.)

TIN. (Germ. zinn.) This metal was known to the ancients, who procured it from Spain and Britain. It appears to have been in use even in the time of Moses. (Numbers, xxxvi. 22.) It is rather a scarce metal, found in few parts of the world in any quantity. Cornwall is its most productive source; it also occurs in the mountains between Gallicia and Portugal, and in those between Saxony and Bohemia. Tin has also been brought from the peninsula of Malacca in India, and from Chili and Mexico. There are only two ores of tin; the native peroxide, and the double sulphuret of tin and copper: the latter, sometimes called *bell-metal ore*, is extremely rare; and it is exclusively from the former that the commercial demands are supplied. In Cornwall, the native peroxide, or *tin stone* (which is usually blended with oxides of iron and manganese), occurs in *veins*, and in loose grains and nodules in alluvial soil: the latter is called *stream tin*, and from it the purest metal is obtained. The ore is reduced by a very simple process; it is ground, washed, and roasted in a reverberatory furnace; it is then mixed with charcoal or Welsh culm and limestone, and strongly heated, so as to bring the whole into fusion, which is kept up for eight or ten hours: the lime combines with the earthy matters of the ore into a fusible slag, whilst the coal reduces the oxide to the metallic state, and the fused metal is drawn out at the bottom of the furnace into a clay mould. In this impure state it is exposed to a heat just sufficient to melt the pure tin, which runs off into a kettle, while the less fusible impurities remain behind: in the kettle, the tin is kept in fusion, and agitated by plunging pieces of wet charcoal into it, which causes a quantity of dross to rise to the surface, where it is skimmed off, and the purified metal is then cast into blocks of about 3 cwt. each.

The stream tin is smelted by charcoal; and the mass of grain tin obtained by such reduction is heated and let fall from a height, by which it splits into masses of a columnar fracture, which characterizes the pure metal.

Pure tin is a white brilliant metal. It has a slight taste and smell when rubbed, and its hardness is intermediate between that of gold and lead. Its specific gravity is 7·2. It is very malleable; and one of its most useful forms is that of foil, which is made by beating: it is about a thousandth of an inch in thickness. Its ductility and tenacity are inferior to most of the other malleable metals. A tin wire 78-thousandths of an inch in diameter will not support more than 38 pounds without breaking. It produces a peculiar crackling noise when beat. Exposed to air, it soon becomes superficially oxidized; and when melted successive films of a gray powder form upon its surface. The temperature at which it melts is about 442°. At a white heat it takes fire, and burns with a bright flame. The equivalent of tin is 58. It forms two oxides. The protoxide is thrown down by alkaline carbonates from an aqueous solution of protochloride of tin; and when dried and heated out of the contact of air its water is expelled, and it remains in the form of a dark substance, of the specific gravity 6·6. It burns like tinder, and becomes converted into the peroxide. It is soluble in sulphuric and hydrochloric, and in dilute nitric acid, and in the pure fixed alkalies. Its salts have a strong attraction for oxygen, and easily pass into persalts; so that it is a powerful deoxidizing agent, and is often used as such in some of the chemical arts. When a solution of protochloride of tin is dropped into a solution of perchloride of gold, a purple precipitate, called, from its inventor, *purple of Cassius*, is thrown down: it appears to be a compound of peroxide of tin with protoxide of gold, and its formation depends upon the deoxidizing power of the solution of tin. When tin foil is put into nitric acid there is violent action, attended by the decomposition of the acid and the peroxidizement of the tin, which is thus converted into a white powder: this, when edulcorated and dried at a red heat, acquires a yellow tint. It does not easily form permanent compounds with the acids; but it unites with the pure alkalies, and forms soluble compounds, which have sometimes been called *stannates*, and the peroxide itself *stannic acid*. The two oxides of tin are respectively composed of 58 tin and 8 oxygen, and 58 tin and 16 oxygen: their equivalents, therefore, are 66 and 74. Tin and chlorine also combine in two proportions: the *protochloride of tin* is formed by passing hydrochloric acid gas over metallic tin gently heated in a glass tube, or by heating a mixture of equal weights of tin filings and calomel, when it remains, after driving off the mercury, in the form of a gray solid, fusible at a red heat, and volatile at higher temperatures. Its aqueous solution is commonly termed *protomuriate of tin*. When tin foil is heated in excess of gaseous chlorine, or when 1 part of tin filings is mixed with 3 of corrosive sublimate and heated, a volatile liquid distils over, which is *perchloride of tin*, and its aqueous solution forms the *permuriate*. Exposed to air, it is decomposed by the aqueous vapour of the atmosphere, and exhales dense white fumes: hence it has been called, after its discoverer, *fuming liquor of Libavius*. Both the protomuriate and permuriate of tin are used by dyers and calico-printers. The former is prepared by heating granulated tin in strong hydrochloric acid, as long as hydrogen continues to be evolved; the latter, by gradually dissolving granulated tin in a mixture of two parts by measure of hydrochloric acid, one of nitric acid, and one of water. These chlorides of tin are respectively composed of 58 tin and 36 chlorine, and 58 tin and 72 chlorine, and are therefore represented by the equivalents 94 and 130.

When melted tin and sulphur are brought together, a black *protosulphuret of tin* is formed. The *bisulphuret of tin* is a yellow glistening substance, sometimes called *Mosaic gold* (*aurum musivum*), and used in ornamental japan work. It is prepared by heating in a glass retort 2 parts of peroxide of tin, 2 of sulphur, and 1 of sal ammoniac, and maintaining a low red heat till sulphurous acid ceases to be evolved. The sulphuret and bisulphuret of tin are constituted of 58 tin and 16 sulphur, and 58 tin and 32 sulphur; and have, therefore, the equivalents 74 and 80. The total produce of the tin mines and works of Cornwall may, at present (1842), be estimated at about 4000 tons a year, worth from 65*l.* to 80*l.* a ton.

TI'NCA. (Lat. tinca, *a tench*.) A subgenus of Cyprinoid fishes, characterized by having short anal and dorsal fins; very short barbules or tentacles about the mouth; no bony serrated ray at the commencement of either the dorsal or anal fins; small scales. Like the rest of the Linnæan *Cyprini*, the *Tinci*, or tenches, have no teeth except in the pharynx; whence the name of "leather-mouthed fishes" applied to this family of *Pisces Abdominales*.

TI'NCAL. The commercial name of rough borax as imported from India.

TI'NCTURE. A pharmaceutical preparation, generally consisting of active remedies dissolved in rectified or proof spirit. Tinctures are generally made by digesting bruised or pulverized vegetable substances in the spirit, either at common temperatures or aided by heat. The term *tincture* is sometimes applied to alcoholic solutions of resins, of which tincture of myrrh, of assafœtida, &c. furnish instances. Tinctures, from the quantity of alcohol which they contain, are necessarily exhibited in small doses: the most important of them are those which contain highly active ingredients, such as tincture of opium, &c.

TI'NCTURES, in Heraldry, are of three descriptions: metals, colours, and furs. The former are or, argent; the second gules, azure, sable, vert, purpure, sanguine, and tenny. The chief furs are ermine and vair; but there are several varieties of both, distinguished by different names. Each metal and colour, in blazonry (except the two last and least honourable, sanguine and tenny), is represented by a distinct precious stone and heavenly body; and when the arms of sovereign princes or high dignities are described by old heralds, the tinctures are frequently denoted by the names of these jewels or celestial bodies. *See* OR, ARGENT, &c.

TI'NEA. The scald head. *See* RINGWORM.

TIN PLATE. White iron. The art of tinning iron originated in Saxony, and was first made known here by Mr. Andrew Yarranton, about the year 1665; but it was not till nearly a century afterwards that works were established for its production upon a large scale at Pontypool. It is made by immersing for about one hour and a half very carefully cleaned plates of rolled iron in melted tin, by which they acquire a bright surface, and are applicable to a number of purposes for which iron plate, in consequence of the extreme facility with which it rusts, could not be used. The crystalline texture of the surface of these plates is beautifully shown by washing it over with a weak acid, and then cleaning it with an alkaline ley, and varnishing with a transparent varnish. Thus modified, it forms an ornamental article called *moirée métallique*. (On the manufacture of tin plate, see *Parkes's Chemical Essays*.)

TIRO'NIAN NOTES. The short-hand of Roman

antiquity. According to the received story, they were introduced into Rome by Tiro, the freedman and favourite of Cicero: he is supposed to have imported the art from Greece. MSS., written entirely in what are called the Tironian notes, are not unfrequently of the date of the 7th century and downwards; and they are still common in marginal notes. Kopp (*Tachygraphia Veterum Exposita*, p. 1817.) thinks that they are called from the word *tiro*, a learner. His second volume contains a dictionary of these notes, which he appears to have succeeded in deciphering. Some have thought that valuable lost classics may be recovered through this key; but as yet these hopes have been nugatory. (See *Ed. Rev.* vol. xlviii. p. 357. &c.)

TI'SRI. The first Hebrew month of the civil year, and the seventh of the ecclesiastical year. It corresponds to part of September and October.

TI'SSUE, in Plants, the thin membranous organization of which every part is composed, microscopical in size, and often appearing to the naked eye homogeneous, although it consists of a great variety of forms closely compacted. Vegetable anatomists regard its primitive form as spheroidal, and that the tubes and spiral vessels are mere extensions of that form. Tissue appears to be in all plants of the same nature originally, but it soon becomes altered by the deposition of various secretions upon its sides.

TI'TAN. In Grecian Mythology, according to the more modern account, the eldest son of Uranus and Gaia, who relinquished the sovereignty of gods and men to his younger brother Saturn, the latter undertaking to destroy all his children, so that the monarchy might revert to those of Titan. He afterwards recovered the sovereignty from Saturn; but Jupiter, the son of the latter, vanquished him, and restored it to his father. This, however, is a tale altogether unknown to the original mythologists. According to them, the Titans were many in number; children of Uranus and Gaia. Hesiod makes them six. The children of the Titans, Atlas for example, retained the same appellation. The war of these Titans with Jupiter was the subject of many different and contradictory legends. Its scene was laid in Thessaly; by Homer on the mountains Olympus, Pelion, and Ossa. By some writers Titan is identified with Hyperion; but this point is involved in great obscurity.

TITANITE. Native oxide of titanium.

TITA'NIUM. A rare metal, discovered by Gregor in a mineral from Cornwall called *menachanite*. Its characters were first ascertained by Klaproth, who gave it the above name. In the year 1822, Dr. Wollaston ascertained that the minute copper-coloured crystals occasionally found in the slag of the iron smelting furnaces at Merthyr and elsewhere were pure titanium; and it is to him that we are indebted for a precise account of its properties. In this state it has a copper colour, is extremely infusible, and of a specific gravity of 5·8; it is so hard as to scratch not only glass, but crystal. It resists the action of air and acids, but is oxidized by the action of nitre at a red heat. Titanium appears susceptible of two degrees of oxidizement. The protoxide of titanium is blue or purple, and appears to constitute the mineral called *anatase*. The peroxide, or *titanic acid*, exists nearly pure in *titanite*, or *rutilite*, and is combined with the oxides of iron and manganese in *menachanite*. The equivalent of titanium has not been very satisfactorily ascertained, but it is probably about 24 upon the hydrogen scale.

TITHES. In Ecclesiastical Law, the tenth part of the produce of the land, which, in this and other Christian countries, was anciently set apart for the endowment of the church. By the Mosaical law, the Levites, by whom the public worship of the Jewish state was performed, were supported, not as the other tribes, by the allotment of a certain district of Canaan, but by the appointment of divers cities in various parts of the country for their abode, and the payment of tithes from the whole community. This ordinance has frequently been appealed to under the Christian dispensation, as establishing the divine right of the clergy to the receipt of tithes for ever; but this ground of claim has been generally abandoned in modern times; nor does the practice of the early church, at its first establishment in connection with the state, give any reason to suppose that such an idea was then entertained. Nor, in this country, do the people and their rulers appear, upon their conversion, to have felt themselves under the obligation of any strict payment of tithes. It was first enjoined, apparently, in certain ecclesiastical canons, in the year 750; and the first civil decree upon the subject is discovered in the laws of Offa, king of Mercia, in 794. In France, a similar law was enforced by Charlemagne in 778, and from that time the payment has been continued without interruption to modern times.

Of tithes there are three kinds: — 1. *Predial*, of the vegetable productions of the land, as corn, hay, &c.; 2d, *Mixed*, as of wool, pigs, &c., which, though natural products, are nurtured and preserved by the care of man; 3rd, *Personal*, as of manual occupations, trades, fisheries, and the like. Another division of tithes is into great and small, or parsonage and vicarage tithes: of these the former are chiefly corn, hay, and wood; the latter are predial tithes of other kinds, together with mixed and personal tithes. The great tithes belong to the rector; whereas only the small tithes are due to the vicar. By the original law, all the land of the country was tithable, excepting the property of the crown, and of the church itself. But when at the Reformation the monasteries were dissolved, and their estates granted for the most part to laymen, these lands would have become tithable again, but for a particular statute which was enacted for the advantage of the new possessors. It was also allowable, up to the 13 Eliz., to effect compositions between the clergy and owners of the land, by which the parish was discharged of these payments for ever, in consideration of lands made over to the parson in exchange. This practice was, however, restrained by the statute above referred to, which limited all such compositions to a period of three lives or twenty-one years. From these causes, however, it is that we find a great deal of land in the hands of lay proprietors not subject to this charge. The monasteries, however, held one third of the benefices of the kingdom, from all of which they received tithes, and appointed members of their own body, as their vicars or curates, to discharge the ordinary functions of ministers in them. To these they either gave fixed stipends, or allotted the small tithes, taking, as their own share, the great or rectorial. This is called *appropriation* of tithes; but when these benefices fell into the hands of laymen, the same practice was continued, and is distinguished by the title of *impropriation*.

Tithes are either due *de jure* or by custom: to the latter class belong all personal tithes.

The subtraction of tithes from a parson, whether a clergyman or lay impropriator (*see* IMPROPRIATION), or from a vicar, is cognizable in the ecclesiastical courts. But these courts cannot try the right to tithes, except between spiritual persons; consequently, if the defendant pleads any matter involving a question of right, it must be tried by a jury. Suits for tithes are generally instituted in the Court of Exchequer. By the 53 G. 3. c. 127. justices of the peace have jurisdiction for the recovery of small tithes to the amount of 10*l*.

Lands and their occupiers may be discharged from the payment of tithes, either in part or totally, by a real composition, or by custom or prescription. The first is where an agreement is made between the owner and the parson or vicar, with consent of the ordinary and patron, that some land, or other real recompence, be given in satisfaction of tithes. By 13 Eliz. c. 10., as we have seen, no real composition, made since that statute, is good for any longer time than three lives or twenty-one years. Compositions between a tithe-owner and parishioner cease on the death of the incumbent with whom they were made.

A discharge by custom or prescription is either, 1. *De modo decimandi*, where a *modus*, or particular manner of tithing, is shown to exist by custom, which must have existed immemorially; *i. e.* is not good, if evidence be shown of its non-existence at any time since the reign of Richard I. Or, 2. *De non decimando*, where a total exemption from tithes is shown.

Such is a general view of the law of tithe previous to the great changes introduced by the Tithe Commutation Act, 6 & 7 W. 4. c. 71.; the object of which was to convert a tax, imposed on the gross produce of the soil, and varying annually in amount as well as money value along with it, into a rent-charge, perpetual as to the amount, but varying according to the money value.

By this act the money value of the tithes in each parish was to be calculated according to the average of the seven years ending at Christmas, 1835, *minus* the expences of collecting, &c.; but without deduction on account of parochial or county rates, &c. The commissioners appointed for that purpose under the act were then to award that sum (subject to some unimportant allowances), as the amount of the rent-charge to be paid in respect of the tithes. This rent-charge was to be apportioned among the lands of the parish, having regard to their average tithable produce and productive quality. The rent-charge, being thus valued in money, was to be taken as the price of such a quantity of wheat, barley, and oats as it would have purchased (each grain in equal quantities), according to the average price at the period of the confirmation of the apportionment. That quantity of grain was therefore to remain for ever as the annual charge upon the parish. In order to regulate the money amount of the tithes, the money payment each year was to be equal to the price of that quantity at the average of the seven years immediately preceding, to be ascertained by an advertisement of the comptroller of corn returns, published in the month of January every year. The rent-charge to be paid by the occupiers of the land on which it is respectively apportioned.

It will be apparent, from this brief outline of the provisions of the act, that a very great benefit was conferred by it, for all immediate purposes, upon the tithe-owner,

and for many upon both parties. The strifes and heart-burnings between the occupiers of the soil and the clergyman, which were occasioned by the old mode of collecting the impost, have been removed. The latter has been relieved alike from the consequences of indulgence towards his debtors, and the imputation of rapacity. In point of fact, the result of the valuation has been a considerable improvement in the incomes of the clergy, who comparatively seldom received their full due. The tenant and landowner gain by the removal of a most injurious tax on improvement; for the tithe, while it increased along with the produce of the land, acted as a great discouragement to increasing that produce.

But, looking to the future, its advantages are far more questionable. The tithe-owner will gain, no doubt, by any increase which may take place in the money price of corn. But he will be a loser by any fall in the price of corn; while any increase in the quantity of commodities produced in the country, the price of corn remaining the same, will leave his condition stationary, while other classes advance. It is thought that, in the last century, the agricultural produce of England has trebled. Tithe has nearly trebled along with it. If the same progression should continue for a century more, the produce of the country will again have trebled; rents and other incomes will have increased in proportion; population will have followed the same law of advance: — tithe will remain stationary; the income of the church will be no greater than what is now deemed sufficient for her support, while the exertions required of her will have greatly augmented.

And a permanent rise in the money price of corn, which might compensate this relative loss, is probably the last thing to be anticipated. Indeed, should that price fall materially, from the introduction of foreign grain, it will, probably, be necessary to commute anew, if the income of the tithe-owners is to be maintained at all.

To those who consider the sufficient temporal maintenance of the church a matter of high national interest, this prospect is a serious one; but even those who think otherwise cannot possibly regard it with indifference. Tithes are the property of the nation; and it cannot be for the advantage of any country that state property should not partake in the advance of individual wealth — that it should, relatively speaking, continually decrease.

The Tithe Commissioners report (1841), that they have received notices that voluntary commutations have been commenced in 9197 tithe districts; have received 5906 agreements, and confirmed 5136; 821 drafts of compulsory awards (such as they are empowered to cause to be made on the non-agreement of the parties), and confirmed 560. Taking the tithe districts of England and Wales at about 12,000, they appear to have finished about half the work of valuing and awarding. They have received 3688 apportionments, and confirmed 2632. According to the returns under the property tax (1810), it appeared that about 8,000,000 acres in England and Wales were tithe-free, and 21,000,000 tithable. See *M'Culloch's Statistics of the British Empire*. The same work contains the following analysis of appropriations and impropriations of tithes: —

Belonging to the crown - - -	38
Archbishops and bishops - - -	385
Ecclesiastical corporations aggregate -	702
Dignitaries and other eccl. corporations sole -	438
Universities, colleges, and hospitals -	281
Private owners - - - -	2552
Municipal corporations (since sold) - -	43
Vicarages partly endowed - - -	121
Ditto wholly endowed - - -	132

TITHING. A territorial division, of which the origin is pretty generally attributed to Alfred. It was a district supposed to contain ten freeborn men, of whom each was pledge for the others (*see* FRANKPLEDGE). One of these was annually appointed *tithingman*, *borsholder*, or *head-borough* (from borg, *a pledge*). Ten tithings constituted (as is supposed) a hundred.

TI'TULAR. Chiefly in Ecclesiastical usage, a person invested with the title to a benefice; generally used for one who has the title only, without possession or enjoyment.

TME'SIS. (Gr. τεμνω, *I cut.*) In Grammar, a figure by which a compound word is separated into two parts by the intervention of one or more words, as in the following line of Terence, "Quæ meo cunque animo lubitum est facere," for "quæcunque meo animo." This figure is a licence in the Latin language, frequent in Terence and Lucretius, rare in later writers; in the Greek it is more common; but of all Western languages, the German lends itself most readily to the division of compound words. In English the figure is unused.

TOADSTONE. A provincial term applied to certain igneous or basaltic rocks associated with the limestone formation of Derbyshire. *See* GEOLOGY.

TOBA'CCO. The dried leaves of the *Nicotiana tabacum*, a plant indigenous to America, but which succeeds very well, and is extensively cultivated, in most parts of the Old World. The recent leaves possess very little odour or taste; but when dried, their odour is strong, narcotic, and somewhat fœtid; their taste bitter, and extremely acrid. When well cured, they are of a yellowish green colour. When distilled, they yield an essential oil, on which their virtue depends, and which is said to be a virulent poison. The leaves are used in various ways; being chewed, smoked, and ground and manufactured into snuff. It is in the last-mentioned form that tobacco is principally used in Great Britain; and, though the contrary has often been asserted, its use does not seem to have been productive of any perceptible bad consequence.

The term *tobacco* is probably derived from Tabaco, a province of Yucatan, where it was first found by the Spaniards. To Sir Francis Drake and Sir Walter Raleigh has been ascribed the honour of having introduced it into England, nearly three centuries ago. For full particulars as to the history and statistics of this important article of commerce, see the *Com. Dict.*

TO'CSIN. An old French word, of which the derivation seems not to be ascertained (Gregory of Tours uses the word "seing" for the sound of a bell (see *Encycl. Méthodique*); signifying an alarum-bell (Germ. sturmglocke). The use of the terrible tocsin, during the troubles of the Revolution, to assemble the multitude, has rendered the word almost proverbial.

TOD. A weight used in weighing wool. It contains 28 lbs. avoirdupois.

TOFT, in old English, appears to signify the ground or enclosed space on which a messuage has formerly stood.

TO'GA. The gown or mantle peculiar to the Roman people; whence it was sometimes designated as the *gens togata*, or toga-clad nation. The toga was a loose flowing woollen garment covering the whole body round, and close below, but open at the top down to the girdle. The end was drawn up and thrown over the left shoulder, leaving the right arm at liberty, as it had no sleeves. The ordinary colour of the toga was white; but this was changed for a dark colour in mourning. The chief dignitaries of the state were distinguished by a purple band affixed to the edge of the toga, which was then called *prætexta*. An embroidered toga was worn by generals when they triumphed. (See *Chambers's Dictionary* for a concise account of the different species of toga.) It was the national characteristic of the Romans in the republican age; and when Augustus thought he perceived its disuse commencing among the crowds assembled at the theatre, and the substitution of the ordinary "lacerna;" he repeated with emphasis the line of Virgil —

Romanos rerum dominos, gentemque togatam.

Among women, the toga was only worn by the disreputable; the dress of the matron was the stola.

TOISE. A French measure of length, containing six French feet, or 1·949040 metres. The French toise is equivalent to 6·3945925 English feet.

TOKAY. A wine made at Tokay in Hungary; it is luscious, and yet has an agreeable quickness of flavour. It is usually more or less turbid, and is the only wine which is preferred in that state, and consequently agitated before it is poured into the glass.

TOLERA'TION (Lat. tolero, *I bear*), is used in a general sense to express impunity and safety in the state for all dissenters from the established church, who do not maintain any doctrines inconsistent with the peace and welfare of the state. Hence toleration implies a right of enjoying the benefit of the laws and of all social privileges, without any regard to difference of religion. The first toleration act in England passed in 1689; but it was not till 1829, when the Catholic Emancipation Bill was passed, that dissenters could be said to be on equality with churchmen in every respect. The Jews are now the only sect in England precluded from the full enjoyment of civil rights in consequence of their religion.

TOLL. (Germ. zoll.) The name usually given to the duties imposed on travellers and goods passing along public roads, bridges, &c. It is also used to indicate the payment to the corporation of a town, or to the lord or owner of a market or fair, upon sale of things tollable. The right, whether to take toll, or to be exempt from its payment, rests upon prescription or grant from the king. Toll is sometimes taken by a man for every beast driven across his ground, and is then called *toll-traverse;* also by a town for beasts going through it, or over a bridge or ferry maintained at its cost, and is then called *toll-thorough*. *See* TAILLE.

TO'LMEN, or DOLMEN. In Antiquities. Borlase, in his *History of Cornwall*, gives this name to large stones with passages apparently hollowed through them, which are commonly believed to be Druidical remains. There are many such in Britanny. See also *Archæologia*, vol. ii. and vol. viii. p. 210., where there is a description and representation of a celebrated one at Primham Rocks, in

Yorkshire. It has been supposed that they were acoustic contrivances, by means of which the Druids returned oracular answers.

TOLU BALSAM. The concrete balsam of *Myroxylon peruiferum*, a tree growing in the warmest parts of South America. This substance is pale brown; brittle in cold, but tenacious in hot weather; fragrant when heated, and entirely soluble in alcohol. It appears to contain that modification of the benzoic acid which has been called *cinnamic acid*.

TOMB. (Gr. τυμβος, Lat. tumulus.) Is used to express both the grave or sepulchre in which the body of a deceased person is interred, and a monument erected in his memory. In many countries it was customary to burn the bodies of the dead, and to collect the ashes into an urn (*see* URN) which was deposited in a tomb. The tombs of the Jews were generally hollow places hewn out of a rock. The Greeks constructed their tombs outside the walls of their cities, with the exception of those raised to distinguished personages. The same distinction was observed by the Romans; their sepulchres were in the country near the high roads, and none but emperors, vestals, and great personages had the privilege of burial within the walls. In Etruria, several tombs of the ancient inhabitants have been discovered containing beautiful vases, for full particulars respecting which, the reader may consult Mrs. H. Gray's interesting *Tour to the Sepulchres of Etruria*. See for the tombs of the Egyptians, Sir G. Wilkinson's *Manners of the Ancient Egyptians*, vol. iii. p. 183.

TO'MBAC. An alloy of copper and zinc, or a species of brass with excess of zinc. When arsenic is added, it forms *white tombac*.

TOMENTO'SE. (Lat. tomentum, *sheared wool*.) Covered with short inconspicuous interwoven hairs.

TON. A denomination of weight equal to 20 cwt., or 2240 lbs. avoirdupois. *Ton* is also the name of an English measure of capacity containing 252 gallons; but when used in the latter sense, the word is usually written *tun*.

TONDI'NO. (Ital.) In Architecture, the same as *astragal*, which see.

TONE. (Gr. τονος.) In Music, a property of sound which brings it under the relation of grave or acute, or the gravity or acuteness it may have from the number of vibrations of the sonorous body producing it. It is more particularly used for expressing that degree or interval of time by which sounds may be raised or lowered from one extreme of concord to another, so as still to produce melody.

TONES, ECCLESIASTICAL. In Music, the eight modes, now generally called the Gregorian Chant, in which the service of the Catholic church is performed; four whereof are authentic, and four of them plagal. Pope Gregory has been considered the inventor of them. They are the foundation of all music, and will ever be considered stupendous monuments of composition.

TONGUE. In Architecture. *See* GROOVE.

TONGUE. In Anatomy, the organ of taste; a soft fleshy viscus, moveable in all directions, composed of muscular fibres covered by a nervous membrane, upon which, especially at the tip and sides, are numerous nervous papillæ. The tongue is largely supplied by blood vessels, its arteries being branches of the ranine and labial, and its veins emptying into the great linguals which proceed to the external jugular; the nerves come from the fifth, and eighth, and ninth pairs. The tongue performs important functions, not only in tasting, but in articulating, and in eating or chewing or swallowing food, and in receiving drink.

TO'NIC. (From *Tone*.) In Music, the principal note of the key. It is the chief sound upon which all regular melodies depend, and in which they all terminate. Its octaves, both above and below, are equally called by the same name. It is, however, to be understood that the termination here alluded to has relation only to the chief melody, or to its bass, inasmuch as the inner or mean parts of the harmony conclude on the third or mediant, and the fifth or dominant.

TO'NICS. (Gr. τονοω, *I strengthen*.) Medicines which strengthen and increase muscular action. To this class belong vegetable bitters, stimulants, astringents, &c.

TO'NNAGE, implied originally the number of tons weight a vessel might safely carry. Prior to January, 1836, the rule established by act of parliament for the measurement of the tonnage of ships was founded on erroneous principles, and led to the most mischievous consequences.

By considering the breadth and depth nearly the same, the rule implied the square of the breadth; and hence increasing the breadth of a vessel increased her *nominal* tonnage for the payment of dues more than it increased her real capacity. Under this pernicious system vessels came to be built narrow and deep; and thus not only less efficient, but highly dangerous. In 1823 a committee, of which the celebrated Dr. T. Young was chairman, proposed to measure the internal capacity by taking the breadth and depth at each quarter of the length; but for some reason no step was taken. In 1832 another committee was appointed to consider the subject; and they concluded their labours in 1834 by recommending the method of Mr. Riddle, of the Royal Hospital, Greenwich. Mr. Riddle inferred that since a great number of direct measures for capacity would afford a result very near the truth, an approximation might be obtained by means of a smaller number of measures, provided additional weight was given in the calculation to those dimensions which extend through a greater part of the hull. He obtained the multipliers of these dimensions, the midship breadth and depth, by trial, from the vessels measured for the guidance of the committee; and the method is therefore founded on an arithmetical fact. The rule, briefly expressed, is as follows:—

Divide the upper deck, between the after part of the stem and the fore part of the sternpost, into six equal parts. At the foremost, middle, and aftermost points of division, measure, in feet and decimals, the depths from the under side of the upper deck to the ceiling at the limber strake. Divide each depth into five equal parts, and measure the inside breadths at 1-5th and 4-5ths (from the upper deck) at the two extreme depths, and at 2-5ths and 4-5ths of the midship depth. Measure the length, as above, at half the midship depth. To twice the midship depth add the extreme depths, for the sum of the depths. To the upper and lower breadths at the foremost division add three times the upper and lower breadths at the midship division, and the upper and twice the lower breadth at the aftermost division, for the sum of the breadths. Multiply the sum of the depths by the sum of the breadths, and the product by the length, and divide this product by 3500; the result is the tonnage for register.

In vessels with a poop or a break in the upper deck, measure the mean length, breadth, and height; multiply these together, and divide by 92·4, and add the result to the former quantity. In open vessels, the depth is measured from the upper edge of the upper strake. In steam vessels, the tonnage due to the content of the engine room (the depth being considered as the midship depth, and the breadth that at 2·5ths of this depth), divided by 92·4, is to be deducted.

The relative capacities of ships are determined very nearly by this method; that is, within little more than 4 or 5 per cent. generally, though, in extreme cases, the difference may amount to 10 or 12 per cent.: even this, however, is insignificant, as compared with the usual errors of the former method. The divisor by which cubic content is reduced to nominal tonnage was adopted, merely that while the reputed tonnage of most kinds of vessels would be corrected by the new rule, the total registered tonnage of the kingdom might remain unaltered. By the new method the dues paid on tonnage are proportioned to the capacities of the vessels; and as no advantage is gained in these respects by defective forms, a marked improvement in merchant vessels has followed the passing of the bill in 1835.

TONSILLI'TIS. Inflammation of the tonsils. *See* QUINSEY.

TONSILS. (Lat. tonsilla.) An oblong suboval gland on each side of the fauces, and opening into the cavity of the mouth by several large ducts.

TONTINE, a term derived from the name of the inventor Tonti, signifying a loan raised on life annuities with the benefit of survivorships. *See* ANNUITIES.

TOO'THING. In Architecture, bricks alternately projecting at the end of a wall, in order that they may be bonded into a continuation of it when the remainder is carried up.

TOP. In Naval Language, a small light platform near the lower mast-head.

TO'PARCHY (Gr. τοπος, *a place*, and αρχη, *government*), in Antiquity, signified a small state or lordship consisting only of a few cities or towns; or a petty country under the sway of a toparch. Thus Judæa was anciently divided into ten toparchies.

TO'PAZ. (Gr. τοπαζιον.) A crystallized mineral harder than quartz, of a yellow or wine colour, composed of 60 alumina, 35 silica, 5 fluoric acid. When heated, the Brazilian topaz becomes rose red, and is sometimes in this state passed off as a ruby; the Saxon topaz loses its colour by heat. When without flaws and of a good colour, it is much employed in jewellery. The Saxon is usually paler than the Brazilian, which often has a pinkish hue; the Siberian topaz is usually colourless, and the Scotch has a blue tinge.

TOPA'ZOLITE. (Gr. τοπαζιον, and λιθος, *a stone*.) A subvariety of garnet of a pale yellow colour, found in Piedmont. It is a silicate of alumina, lime, and iron, with traces of glucina and manganese.

TOPCHAINS. Chains used in action, by which the lower yard is hung in case of the slings being shot away.

TOPGALLANT. That which is above the topmast.

TO'PHET. A polluted unclean place near Jerusalem, into which the Jews used to throw the carcasses of beasts, or the bodies of men to whom they refused burial; and

where a fire was perpetually kept up to consume all that was brought. Hence Tophet is sometimes used metaphorically for hell. This place had also been defiled by human sacrifices which had been offered to Moloch. Hence Milton says of this hideous deity, that he

. . . . made his grove
The pleasant valley of Hinnom: Tophet thence
And black Gehenna called, the type of Hell.

The name is derived by some from Heb. toph, *a drum*, on account of the beating of drums and other instruments by which the cries of the children sacrificed to Moloch were stifled.

TO'PHUS. A soft tumour upon a bone. In Mineralogy, the term *tophus* has been applied to porous deposits of calcareous matter from water.

TO'PICS. (Gr. τοπος, *a place*.) In Rhetoric. By abstracting from a proposition which conveys a truth in the concrete (*i. e.* respecting certain circumstances expressed in the terms of the proposition) a portion of those circumstances denominated accidental, we arrive at the same truth in the abstract, or (in stricter language) more widely applicable, and accommodated to many different sets of accidental circumstances. Thus, for example, in jurisprudence, from an investigation of the truth in various insulated cases in which a too strict application of legal principles has been attended with evil effects, we deduce the general truth that such application is so attended; or, in the proverbial phrase, "summum jus summa injuria." Among the helps employed by the ancients in their favourite study of rhetoric was the collection and arrangement of a great variety of such general truths, according to the several sciences or subjects to which they belonged. These they termed *topoi*, or places; from which the modern term *topic* is derived. They considered it useful for the student in rhetoric to have at hand, by means of his memory, those compendious expressions of universal sentiment, and the general reasonings or declamations applicable to each of them, in order to employ them for particular use by performing the converse of that operation by which they were arrived at; viz. clothing them with the particular circumstances of the case. Thus the topos just cited might be useful to the forensic orator; it affords a subject for reasoning and declamation applicable to a great number of individual instances. Many of these topics answer to what in modern phrase we should term axioms; and, indeed, some of the axioms of pure mathematics are enumerated by Aristotle among the topics which are proper to every species of oratory.

TOPO'GRAPHY. (Gr. τοπος, *a place*, and γραφω, *I describe*.) Strictly the description of a place, or the science of describing places (distinguished from *chorography* or the description of a district, and from *geography*, the description of the earth.)

TOPPING LIFT. A rope for raising the end of any yard or boom.

TOP, SPINNING. A well-known toy. The steady motion which a well-spun top soon acquires suggested to Mr. Sisson, about eighty years ago, the employment of a mirror placed upon it at right angles to its axis, as an artificial horizon which might probably be used at sea; and on sending out the first of the late polar expeditions, the attention of Mr. Troughton was turned to the subject. But though useful observations might have been made on land with the instrument which he constructed, it was not found at sea to give results of any practical value; and we are not aware that any further attempts have been made to improve its construction, which is attended with considerable mechanical difficulties.

TOREU'MATO'LOGY (Gr. τορευμα, *sculpture*, and γραφω, *I describe*), signifies either the science or art of sculpture, or a description of ancient and modern sculpture and bas relief.

TOREU'TIC. (Gr. τορευτος, *polished*.) In Sculpture, a term applied to such objects as are executed with high finish, delicacy, and polish; but properly to all figures in hard wood, ivory, &c.

TO'RMENTIL ROOT. The root of the *Potentilla tormentilla*. It is occasionally used in medicine as an astringent.

TORNA'DO. (Spanish.) A violent hurricane or gust of wind, which, arising suddenly from the shore, veers round to all points of the compass, and indeed has been described as blowing from all points at once. Tornadoes are usually accompanied with thunder storms, and are generally of short duration. They are frequent in the Chinese seas and the West Indies. *See* STORMS.

TORNATE'LLA. A genus of oval marine Univales belonging to the *Plicaceæ*, found in the oolite and superjacent strata. Recent tornatellæ are found in shallow water, creeping upon and furrowing the sand.

TORPE'DO. (Lat. torpedo, *numbness*.) A genus of Cartilaginous fishes, separated from the *Raiæ* of Linnæus on account of the circular form of the body, and more especially from the presence of the electrical organs on which that form of the body mainly depends. Violent shocks are experienced on touching the living and active torpedo. It is probable that it exerts its electrifying or benumbing powers in order to secure its prey; and it is certain that the same power is employed in defending itself against assailants, to whose assaults it would be otherwise more exposed than are the ordinary rays; for the torpedo has a smooth skin, and is not defended by the spiny tubercles, or barbed and pointed bony weapons, with which the non-electric rays are provided.

TORQUES. In Antiquities, a chain or collar formed of a number of small ringlets interlaced with each other, framed of metal, and worn round the neck. No ornament perhaps was of more early or general use. It is mentioned in Genesis, xli. 42., as one of the ornaments conferred by Pharaoh on Joseph. It was in use among the Greeks and Romans, but peculiarly among the Celtic nations. The legends respecting the torques of the Gauls who invaded Rome are well known. It was from his victory over a Gaul that T. Mantius Torquatus derived his surname. (*Livy*, lib. vii. ch. 10.) And no relic is more commonly found in this country by antiquarian explorers. Boadicea wore a large golden torques. (*Dio. Cass.* lxii.) See the *Archæologia*, vol. xiv. p. 97. and *passim*, for descriptions of particular specimens.

TORREFA'CTION. (Lat.) The operation of roasting ores to deprive them of sulphur, arsenic, or other volatile ingredients. When drugs are highly dried, or partially toasted or roasted, they are also said to be torrefied.

TORRICE'LLIAN VACUUM. In Physics, the vacuum produced by inverting a tube of sufficient length, filled with mercury or any other fluid, in a vessel containing a portion of the same fluid, and allowing the fluid in the tube to descend until its weight is counterbalanced by that of the atmosphere. In this manner the first barometers were formed by Torricelli, and thence called *Torricellian tubes*. *See* BAROMETER.

TO'RRID ZONE. In Geography, the zone of the earth included between the tropics of Cancer and Capricorn. It extends from the equator, on both sides, to the parallel corresponding to the sun's greatest declination, about 23½ degrees. *See* ECLIPTIC, ZONE.

TO'RSION (Lat. torsio; from torqueo, *I twist*), in Mechanics, is the twisting or wrenching of a body by the exertion of a lateral force. If a slender rod of metal suspended vertically, and having its upper end fixed, be twisted through a certain angle by a force acting in a plane perpendicular to its axis, it will, on the removal of the force, untwist itself, or return in the opposite direction with a greater or less velocity, and, after a series of oscillations, will come to rest in its original position. The limits of torsion within which the body will return to its original state depend upon its elasticity. A fine wire of a few feet in length may be twisted through several revolutions without impairing its elasticity; and within those limits the force evolved is found to be perfectly regular, and directly proportional to the angular displacement from the position of rest. If the angular displacement exceeds a certain limit, the particles of the body will be wrenched asunder; or if the elasticity is not perfect (as in a wire of lead, for example) before disruption takes place, the particles will assume a new arrangement, or *take a set*, and will not return to their original position on the withdrawal of the disturbing force.

The resistance which cylinders or prisms formed of different substances oppose to torsion, furnishes one of the usual methods of determining the elasticity and strength of materials; and the property which a metallic wire or thread stretched by a small weight possesses of becoming twisted and untwisted in a series of isochronous and perfectly regular oscillations, has been ingeniously applied in the torsion balance to the measurement of very minute forces, and thereby to the establishment of the fundamental laws of electricity and magnetism, and to the determination of the mean density of the earth. *See* BALANCE OF TORSION.

The laws of torsion have been experimentally investigated by Coulomb in a variety of substances; as metallic wires, hairs, fibres of silk, &c. The method which he employed consisted in attaching a body of given form and dimensions to the extremity of the wire, and, after twisting it through a certain angle, to abandon it to the action of the force evolved, and observe the time of the oscillations. The following general laws were found to hold good:—

1. On loading a wire or thread with different weights, it will settle in different positions of stability; that is to say, an index attached to the weight will point in different directions if the weight be varied, and the angular deviation may amount even to a whole circumference.

2. The oscillations are isochronous.

3. The time of oscillation is proportional to the square root of the weight which stretches the wire.

4. The time of oscillation is as the square root of the length of the wire.

5. The time of oscillation is inversely as the square of the diameter of the wire.

From the second of these laws it follows that when the wire is twisted round from the position of rest, the force with which it tends to return to that position is proportional to the angle to be described in order to attain it. For it is a general result of mechanics, that all motions produced by forces acting according to this law have the property of tautochronism; that is to say, the oscillations are performed in equal times, whatever be the length of the arc. This fundamental property is usually enunciated by saying that the force of torsion is proportional to the angle of torsion.

Let F denote the force of torsion, measured by the weight which it would be necessary to apply by means of a pulley to a point p, situated at the unit of distance (one inch) from the axis of the wire, and invariably connected with it, to cause the point p to describe an arc of a circle equal in length to the unit of distance; then, by the property enunciated, the force which must be applied at p in order that the point may describe any arc ϕ is expressed by $F \cdot \phi$. If the arc of torsion is expressed in degrees instead of parts of the radius, we have $\phi = \pi \phi^{\circ} \div 180^{\circ}$ (π being the semicircumference to radius 1, or $= 3 \cdot 14159$); whence the expression of the force becomes $F \times \pi \phi^{\circ} \div 180^{\circ}$.

On this principle of the proportionality of the impelling force to the angle of deviation the problem of determining the time of an oscillation is solved. Suppose a body of any form attached to the extremity of a slender wire, whose weight in comparison of that of the body may be neglected, and let $d\,m$ be an element of the mass, r the distance of $d\,m$ from the axis of the wire, and T the time of an oscillation; the solution of the problem gives

$$T = \pi \sqrt{\left(\frac{\int r^2\,d\,m}{F}\right)}, \text{ or } T^2 = \pi^2 \frac{\int r^2\,d\,m}{F}.$$

The integral $\int r^2\,d\,m$ is the *moment of inertia* of the attached body. If the body be a cylinder whose axis coincides with that of the wire, and if a denote its radius and M its mass, then $\int r^2\,d\,m = \frac{1}{2} M a^2$; or, substituting the weight for the mass, and observing that if the weight be denoted by P, and the accelerating force of gravity by g ($= 32 \cdot 1908$ feet or $386 \cdot 2894$ inches in a second), we have $P = M g$, $\int r^2\,d\,m = P a^2 \div 2 g$. Hence the expression for the time becomes $T = \pi a \sqrt{\frac{P}{2 g F}}$.

If the attached body were a slender cylindrical needle suspended horizontally by its middle to the wire, we should, on denoting its length by l, have $\int r^2\,d\,m = \frac{1}{3} M l^2$; whence $T = \pi l \sqrt{\frac{P}{3 g F}}$.

The following results are deduced from the formula:— 1. The force of torsion is independent of the weight which stretches the wire, or F remains constant while P is varied. For suppose P to become P', and let T' be the corresponding time of oscillation, and F' the corresponding force; we have then

$$T^2 = \frac{\pi^2 a^2 P}{2 g F}, \quad T'^2 = \frac{\pi^2 a^2 P'}{2 g F'};$$

whence $T^2 : T'^2 :: P F' : P' F$. But, by the third experimental law, $T^2 : T'^2 :: P : P'$; therefore $F' = F$.

2. The force is inversely as the length of the wire. For, supposing P to remain constant, we have $T^2 : T'^2 :: F' : F$. But, by the fourth experimental law, $T^2 : T'^2 :: l : l'$; whence $F' : F :: l : l'$.

3. The force is proportional to the fourth power of the diameter of the wire. Let there be two wires of the same substance, but of different diameters, D and D', and stretched by the same weight P; and let T and T' be the corresponding times. By the fifth experimental law, we have $T : T' :: D'^2 : D^2$. But it has been shown that $T^2 : T'^2 :: F' : F$; therefore $F : F' :: D^4 : D'^4$.

To show the method of applying the formulæ, we shall compute one of the experiments of Coulomb. An iron wire was stretched by a vertical cylinder of ·8 of an inch radius, and weighing 2 lbs., and it was observed to make 20 oscillations in 242 seconds, or one in 12·1 seconds. It is proposed to determine the force F. From the formula for the time of an oscillation we have, by transposition, $F = \frac{\pi^2 a^2 P}{2 g T^2}$. Substituting numbers in this formula, we have $\pi^2 = 9 \cdot 8696$, $a^2 = \cdot 64$, $P = 2$, $g = 386 \cdot 2894$, $T^2 = (12 \cdot 1)^2 = 146 \cdot 41$; consequently $F = \frac{12 \cdot 633}{113113} = \cdot 0001117$ of a pound, or about ·78 of a grain. Hence the weight applied at the distance of one inch from the axis of the wire that would be required to twist the wire through a complete revolution, or 360°, is 6·283 times this quantity, or nearly five grains.

For the demonstration of the fundamental formula, namely, $T^2 F = \pi^2 \int r^2\,d\,m$, see Coulomb, *Théorie des Machines Simples*; or Biot, *Traité de Physique*, tom. i.

TORSO. (It.) In Sculpture, a statue of which nothing but the trunk of the human figure remains.

TORT. (Fr. wrong.) In Law, signifies injustice or injury.

TORTOISE. This name is usually applied to species of that division of the Linnæan genus *Testudo* including the terrestrial Chelonians, to which the generic name is now limited. *See* TESTUDO.

TORTOISE SHELL. The name given to the horny scutes or plates of the sea turtles; and in particular to those of the hawk's-bill turtle, *Chelone imbricata*.

TORTRI'CES. (Lat. torqueo, *I wreath.*) The name of a tribe of nocturnal Lepidopterous insects, comprising those the larvæ of which live concealed in leaves, which they roll around them for the purpose.

TO'RTURE. (Lat. torqueo, *I twist* or *torment.*) In a legal sense, the infliction of pain on an accused person in order to extort an avowal of guilt, or revelation of accomplices. Such a practice is sufficiently common among all half-civilized nations; but the Greeks and Romans were perhaps the first who introduced it as a part of their regular proceedings in criminal cases. Both at Athens and Rome torture was, however, considered as applicable only to extort evidence from slaves: towards them it was used profusely; and it was, in fact, a usual occurrence to order a whole family of slaves to the torture, in order to extract revelations where an atrocious crime had been committed, as, for instance, the murder of the master. Cicero, in several passages, condemns the use of torture; and Ulpian (Lex i. *De Quæstionibus*) says, "Res est fragilis et periculosa, et quæ veritatem fallit, nam plerique patientiâ sive duritiâ tormentorem ita et tormenta contemnunt, ut exprimi eis veritas nullo modo possit; alii tantâ sunt impatientiâ ut quid vis mentiri quam pati tormenta malint." (As to the torture at Rome, see *Gibbon*, vol. ii. p. 59. 4to ed.) Notwithstanding these recorded opinions of the highest luminaries of ancient jurisprudence, torture was adopted along with the rest of the process of the civil law in most European countries. (For its use in France, see QUESTION.) The general principle of the civilians was, that it could not be used unless *vehement suspicion* warranted its application. But no very definite meaning was attached in practice to these words; especially in Germany, where the abuse seems to have been carried to the greatest extent by the ignorant and cruel tribunals of her smaller states. When Howard visited the prisons of that country (about 1770), it was still in general use. (See his *Account of Prisons.*) The writings of various philosophical authors of the 18th century, especially Voltaire, Thomasius, and Beccaria (whose short treatise, *Dei Delitti e delle Pene*, obtained such singular notoriety), effected much towards bringing its employment into disrepute; but its general abolition can only be attributed to the superior regard for the rights of man introduced every where by the agitation of the French Revolution. In England, judicial torture was not recognized by the common law (for the peine forte et dure hardly falls within the same definition); and that it was also nearly unknown in practice, in the 14th century at least, may be inferred from the reluctance of Edward II. to submit the Templars to torture, which was overcome by the instances of Pope Clement V., and from a curious paper of questions addressed on that occasion by the archbishop of York to some divines, from which it appears that *no torturer could at that time be found in England.* (See Raynouard, *Mémoires sur les Templiers; Hallam's Constitutional History.*) The rack is said to have been introduced as an engine of state by the Duke of Exeter in the reign of Henry VI. However this may be, during the whole of the 16th century we find that the privy council assumed and exercised the right to direct torture-warrants to the lieutenant of the Tower and other officers, commanding them to submit to the torture persons accused not only of state offences, but of ordinary municipal crimes, when strong suspicion, but no sufficient evidence, existed. Torture-warrants were also issued, not by the council, but under the sign manual only. During this period the council seems, in fact, to have acted as a supplementary tribunal in aid of the regular courts, for the purpose of extorting discoveries of criminal offences. The instances of torture of seminary priests, &c., in Elizabeth's reign, have been often cited; but it is not so generally known that the practice was not confined to accusations of treason and sedition, but extended to other cases. (See *Jardine's Reading on the Use of Torture in England*, 1837.) Under James I. and Charles I. torture seems to have become less frequent, and to have been only employed in state offences; and this, perhaps, explains the well-known answer of the judges to Charles's question respecting Felton, the murderer of the Duke of Buckingham, that he ought not to be tortured, "for no such punishment is honour to our law." The last recorded case is that of William Archer, 1640; and as in that year the act for the abolition of the Star Chamber

granted a habeas corpus to all persons detained on warrants from the privy council, torture must then have been virtually abolished. In Scotland it was so in the 7th year of Anne.

TO'RUS. (Lat. *a rope.*) In Architecture, a large moulding used in the bases of columns, the profile whereof is semicircular. This term is also used in botany for the central part of the flower on which the carpels are placed.

TORY. A well-known party name in English history. (*See* WHIG.) The Irish malecontents, half robbers and half insurgents, who harassed the English in Ireland at the period of the massacre in 1640 and during the troubles which followed, were the first to whom this name was applied. It is said to have been transplanted into England about the time of the Popish Plot, when the public mind was agitated by chimerical fears respecting the apprehended employment of Irish Catholics to further that imaginary design; whence it was commonly applied by way of reproach to the court party, against which the popular hostility was then directed, as favouring and countenancing the supposed abettors of the plot. From the period of its introduction into England down to the present times the term Tory has been constantly employed to designate a large political party in this country. Down to the period when Hume wrote his *Essay on the Parties of Great Britain*, the conduct of the two great parties in the state (the Whigs and Tories) had been so vague and undetermined as to have led him to declare his utter inability to tell their nature, pretensions, and principles. Since that period, however, the conduct of the Tories has been more uniform; and it might now be easier to define the principles by which they have been guided during the last half century: but we shall not undertake the task. Within the last two or three years, the word Tory has been gradually displaced by *Conservative*, which seems likely to become the permanent designation of the Tory party. This term was originally assumed in contradistinction to *Destructives*, a name by which the more violent reformers came to be designated by their enemies; and it is now understood as referring to the whole Tory party, but more especially to what may be called the more liberal portion of that party.

TOTIPA'LMATES, *Totipalmati.* (Lat. totus, *entire*, and palma, *a palm.*) The name of a tribe of *Palmipedes*, or swimming birds, including those in which the hinder toe is enveloped in the same web with the three anterior toes.

TOUCH. In Medicine. The belief in the possibility of curing various maladies by the touch has produced a variety of singular superstitions. Plutarch attributes singular virtues to the touch of King Pyrrhus of Epirus. According to Suetonius, Adrian and Vespasian had the power of curing various diseases in the same manner. In what period the opinion respecting the virtue of the touch of the kings of France and England in curing epilepsy, scrophulas, &c. had its origin, it is difficult to ascertain. André Dulaurent, chief physician of Henry IV. of France, published a treatise on the subject. The ceremony of touching, by the kings of France, was practised at the four great feasts of the year; sometimes as many as 1500 were touched at a time. By an odd etiquette, the Spaniards had the first rank, then other foreigners, and the French last of all. The formula used at each imposition of the royal hand was, "Le roi te touche, et Dieu te guerit." Polydore Virgil attributes this virtue to Edward IV., and all our kings down to the end of the Stuart dynasty touched for the king's evil. Much efficacy has been attributed in different diseases, particularly tumours, &c., to the touch of the hand of a dead body; especially, according to Pliny and various modern authorities, of one who had died violently. We do not know whether the superstition is yet extinct under the influence of which scrophulous persons used to have themselves touched by the hands of criminals after execution. Boyle endeavours to explain away part of the miracle by attributing some virtue to the coldness of the application.

TOUCH. One of the five senses, resident in the nervous papillæ of the skin; it is also the sensibility diffused over the whole body. It is much more exquisite in some parts than others.

TOUCH. In Naval language, the sails are said to *touch* when the wind comes edgeways upon them.

TOUCH NEEDLES. Small bars, consisting of gold and silver alloyed with various definite proportions of copper, are thus termed by assayers, who use them to judge, by comparing their colour and streak upon a piece of hard black stone, such as basalt, with that of alloys of the precious metals, of the relative quantity of gold or silver in the latter. Hence also the term *touchstone*.

TOU'RMALINE. The more perfect forms of *schorl* go under this name. It is the *lyncurium* of the ancients. Its chief constituents are silica and alumina, with about 10 *per cent.* of soda, and a little oxide of manganese and of iron. The transparent coloured varieties are sometimes cut into ring-stones, and some of them are much valued for experiments on the polarization of light.

TOURN, in Law, was the turn or circuit anciently made thrice every year by the sheriff, for the purpose of holding in each hundred the great court leet of the county. The jurisdiction exercised by the sheriff on his tourn extended by the common law to the cognizance of all offences not capital; but sheriffs are prohibited by Magna Charta from holding any pleas of the crown in which they had a pecuniary interest in procuring a conviction; while a better tribunal was at the same time supplied by the establishment of annual circuits. The tourn, though never disallowed by law, has, with the curtailment of its jurisdiction, and the abandonment of the leet as a registry of pledges, long fallen into disuse; and the right of the jury or suitors at the tourn to present nuisances, or convict of minor offences, has, with other functions of courts leet, been transferred to the quarter sessions.

TOU'RNAMENT (in modern Latin torneamentum), or TOURNEY; originally derived from the Fr. tourner, modern Latin tornare, *to turn.* A well-known military sport of the middle ages, which without doubt arose from the exercises of military training. A joust or just is, properly speaking, the encounter of two knights in this species of exercise; the tournament, an assembly held for the purpose of exhibiting such justs, or the encounter of several knights on a side. The earlier tournaments were highly dangerous and sanguinary sports. They were performed with the ordinary weapons of warfare, the lance and the sword; and the combatants had only the strength of their armour to rely on for their defence. It was a recognized custom, according to Meyrick (*Hist. of Ancient Armour*), that whoever slew or disabled an adversary in the tournament was indemnified against all consequences. The account of the tournament given by the Count of Chablais in Savoy to Edward I. on his return from Palestine to England, as given by Thomas de Walsingham, represents a sort of violent mêlée, in which knights, squires, and archers were engaged on both sides, endeavouring to unhorse the riders and overthow the footmen by every possible means. But in the course of time this chivalric amusement became the subject of minute regulations, which in some degree diminished the danger and insured the fairness of the sport. The English *Statuta Armorum de Torneamentis* are assigned by Dr. Meyrick to the year 1295. (*See* SAINTE-PALAYE.) "Impartial taste," says Gibbon, "must prefer a Gothic tournament to the Olympic games of classic antiquity." (*Decl. and Fall*, ch. 50.)

In tournaments, when under the strict regulation of knightly usage, two sorts of arms were employed: those expressly made for the purpose, viz. lances with blunt heads of iron; and the ordinary arms of warfare, termed "armes a outrance," which were only employed by such champions as were desirous to signalize themselves in a more than ordinary degree, and frequently were not permitted by the judges of the tournament. Every knight attending was required to show his noble birth and rank, as a title to admission. These were at first proclaimed by the heralds with sound of trumpet; and hence the word blazonry, which signifies the correct deciphering of the heraldic symbols on a coat of arms, is derived by some from the German blasen, *to blow.* Afterwards, when armorial bearings became general, the shield of the knight gave token of his rank and family. The attendance of ladies at the tournaments, their distribution of prizes to those who had borne themselves best, arming and unarming the knights, &c., are various romantic circumstances well known to the reader of chivalric legends; but they must not be supposed to have been the necessary, or even usual accompaniments of these knightly sports, at least until a later age, when the taste for gallantry, combining with that for show and spectacle, turned these military exhibitions of skill into little more than gorgeous pageants. When we arrive at the reigns of Edward III. and Henry V., we find the justs usually held in honour of ladies, and every knight bound to possess in reality or in show a dame of his affections, for whose sake all his deeds of chivalry were performed. Dr. Meyrick quotes from a manuscript of the reign of Elizabeth the ordinances of justes, made by John Earl of Worcester, constable of England, in the sixth year of Edward IV.; from which it appears that the law of justs had become by that time the subject of very minute regulation. The prize belonged to him who broke most spears "as they ought to be broken;" *i. e.* on the head or body of the antagonist. From Stow we find that the lists erected in Smithfield in 1467, when the Bastard of Burgundy challenged Lord Scales, were 380 feet in length by 260 in breadth: these champions rode at each other two days with spears, and on the third encountered on foot with pole-axes. In the reign of Henry VIII., when the real spirit of chivalry was far advanced in its decline, the tournament was invested almost wholly with the character of a court pageant, but celebrated with a degree of splendour and costliness scarcely equalled in

former times. The famous volumes of woodcuts of the same period, styled the *Triumphs of Maximilian*, show that it was as favourite and almost as magnificent a spectacle at the court of Germany. The tragical death of Henry II. of France, in consequence of a blow received in a tournament, is well known, and was the cause of the final, although only gradual abolition, of this knightly amusement; which was revived at intervals in court solemnities in the seventeenth century, but rather as a memorial of past times than as a subsisting and popular custom.

The revival of the tournament was recently attempted in the west of Scotland by the Earl of Eglinton; but we scarcely suppose that the success of that attempt was either commensurate with its deserts, or was such as to induce any party to renew it. At the court of Wurtemburg tournaments are not unfrequently exhibited at this day.

See Sainte-Palaye, *Memoires sur la Chevalerie; Turner's History* (*Middle Ages*), vol. i. p. 472.; *Hist. de l'Ac. des Inscr.* vol. xix.; and Walter Scott's admirable delineation in *Ivanhoe*, which gives a more vivid idea of the tournament, with all its variety of martial exercises, than any serious work extant.

TOU'RNIQUET. (Fr.) A bandage which may be tightened to any extent by means of a screw, so as to exert pressure upon a cushion and compress the arterial trunks to which it is applied: it is chiefly used to prevent hæmorrhage in the operations of amputation.

TOW. To draw a vessel along by a rope. As the vessel towed affects the motions of the other, much attention is required on her part to second the intentions of the towing vessel.

TOWER. (Lat. turris.) In Architecture, a lofty building, square, polygonal, or circular on the plan, and often consisting of several stories. The tower of a church is that part which contains the bells, and from which the steeple rises.

TOWERS, ROUND. In Ireland, remarkable edifices of extreme antiquity, of which the origin has perplexed antiquaries to an unexampled degree. They are tall narrow edifices, varying in height from 80 to 120 feet. That at Kildare, we believe, is the highest; cylindrical in shape, with a door 8 or 10 feet from the ground, and narrow apertures at the top. There are sixty-two of these curious relics ascertained to exist in Ireland; and two in Scotland, at Abernethy and Brechin. They cannot have been watch-towers, their position being generally low; nor belfries, their shape and construction rendering such a supposition impossible, although some appear to have been used in that way in later times; and the notion that they were places of confinement for penitents or hermits seems extravagant. Common belief, however, attaches to them an ecclesiastical origin and use; and the well-known passage of Giraldus Cambrensis, a writer of the 12th century (who says that the fishermen of Lough Neagh reported that in clear weather remains of buildings, and among others round towers of the country fashion, were seen at the bottom), necessarily implies a greater antiquity. Irish antiquaries, however, as may be supposed, have luxuriated in hypotheses connecting them with ancient forms of pagan worship; such as the pyrolatry of the Persians, the Phallic rites, &c. (See *Moore's History of Ireland*, vol. i. ch. 2., for a variety of these opinions, and their authors.)

TOXICO'LOGY. (Gr. τοξικον, *poison*, and λογος, *a discourse*.) Poisons have been divided by Orfila and Christison into irritants, narcotics, and narcotico-acrids: the first class including those whose sole or predominating symptoms are those of irritation or inflammation; the second, those which produce stupor, delirium, and other affections of the brain and nervous system; and the third, those which are of a mixed character.

The chief effects of *irritants* are upon the alimentary canal, exciting inflammation, and sometimes ulceration of the tongue, fauces, and œsophagus, difficult deglutition, nausea, vomiting, and heat and pain of the stomach, with more or less tension of the abdomen, and pain on pressure. The sickness is generally accompanied by extreme anxiety and anguish, and the matters vomited consist, in the first instance, of any food that may have been in the stomach, with portions of the poison itself, and afterwards of viscid mucus, often streaked with blood and tinged with bile; the pain afterwards extends throughout the intestines, and mucous, bilious, and often bloody diarrhœa succeeds. The skin is cold and clammy, the pulse quick and feeble, the breathing often difficult, and the countenance expressive of extreme anxiety.

Narcotic poisons induce a train of symptoms of a very distinct character: headach, vertigo, confused vision, stupor, convulsions, paralysis, and coma, are their leading effects; but each particular poison is usually attended by certain peculiarities in the succession, violence, or generic character of the symptoms, which assist the experienced practitioner not only in determining the nature of the poison, but in discriminating between its effects and those of disease.

The symptoms of the *narcotico-acrid poisons* usually consist of those of the two former classes blended, and are often of a very complicated character; for the most part, however, their narcotic and irritant effects appear to be incompatible. In large doses, narcoticism predominates; in smaller, irritation: it is rarely that both are coexistent.

In the following tabular view of the principal poisons of the above classes, they are enumerated in the order in which they are described by Dr. Christison, to whose *Treatise on Poisons* the reader is referred for details which would be quite incompatible with the space which can be allotted to the subject in this work. Under the heads, however, of many of the individual substances mentioned in the following list, we have elsewhere given particulars respecting their composition and properties, and sometimes referred to their toxicological history.

I. Irritant Poisons.

Mineral acids.	Arsenic and its compounds.
Phosphorus.	Mercurial compounds.
Acetic acid.	Salts of copper.
Oxalic acid.	Antimonial poisons.
Fixed alkalies.	Salts of tin.
Nitre.	Salts of gold.
Alkaline and earthy chlorides.	Salts of silver.
Lime.	Salts of bismuth.
Ammonia and its salts.	Salts of chromium.
Alkaline sulphurets.	Salts of zinc.
Barytes.	Lead poisons.
Vegetable acrids.	Diseased and decayed animal matter.
Cantharides.	Mechanical irritants.
Venomous serpents.	

II. Narcotic Poisons.

Opium.	Hydrocyanic acid.
Hyoscyamus.	Carbazotic acid.
Lactuca.	Poisonous gases.
Solanum.	

III. Narcotico-acrid Poisons.

Nightshade.	Strychnia.
Thornapple.	Cocculus Indicus.
Tobacco.	Upas.
Hemlock.	Poisonous fungi.
Monkshood.	Poisonous grain.
Hellebore.	Alcohol.
Squill.	Ether.
Meadow saffron.	Empyreumatic oils.

The treatment of cases of poisoning must, of course, vary with the nature of the poison, the quantity taken, and the peculiarities of the individual. In almost all cases, copious vomiting should be excited as soon as possible by tickling the throat, and by emetics, such especially as sulphate of zinc, or ipecacuanha with emetic tartar; the former, however, in ten-grain doses dissolved in a little warm water, and repeated every ten or fifteen minutes till it freely operates, is generally most effectual. The use of the stomach-pump should also be resorted to. The vomiting should be kept up, and the stomach washed out with bland albuminous or mucilaginous fluids, such as milk, barley-water, flour and water, or thin paste, &c.; sometimes sugar and water.

The following is a short summary of the antidotes which may be resorted to, in reference to particular poisons. They should, of course, be administered as speedily as possible.

1. For *Mineral Acids*, or *Acetic and Oxalic Acid:* Chalk, or whiting and water; magnesia and water; soap and water; followed by albuminous diluents, such as milk, and white of egg mixed with water.

2. *Alkalies, Soda, Potash, Ammonia, &c.:* Vinegar, or any mild acid and water, or even very dilute mineral acids, such as water acidulated by them; olive oil, almond oil.

3. *Arsenic:* Emetics; and then milk, gruel, thick barley-water, and other similar diluents, in large quantities.

4. *Corrosive Sublimate:* White of egg and water; milk and cream; decoction of cinchona; infusion of galls.

5. *Sulphate of Copper* and other *Cupreous Poisons:* Sugar and water; white of egg and water.

6. *Antimonial Poisons:* Warm milk, gruel, or barley-water; infusion of galls; decoction of cinchona.

7. *Nitrate of Silver:* Copious draughts of warm salt and water.

8. *Sulphate of Zinc:* Solution of carbonate of soda in water, with milk, and mucilaginous or farinaceous liquids.

9. *Acetate of Lead:* Emetics; solution of sulphate of soda in water; milk; white of egg and water.

10. *Opium and its Preparations:* Emetics; strong

coffee; dashing cold water upon the face and breast; preventing torpor by forced exercise.

11. *Prussic Acid:* Ammoniacal stimulants cautiously applied to the nose; ammonia, or sal volatile, in repeated small doses; small doses of solution of chlorine in water; small doses of chloride of lime in water.

12. *Strychnia* and *Vegetable Alkaloids:* Infusion of gall nuts; decoction of cinchona; emetics.

TO'XODON. (Gr. *τοξον, a bow*, and *οδους, a tooth.*) An extinct genus of quadruped connecting the Pachydermal with the Rodent order, and distinguished by the curved form of all its teeth. The only known species, *Toxodon platensis*, Owen, was as large as the hippopotamus, and appears to have been restricted to the warmer parts of South America.

TO'XOTÆ. (Gr. *τοξον, a bow.*) In Greek Military History, bowmen. In the Plays of Aristophanes, the toxotæ mentioned, like the French "archers," are a kind of police, employed to keep order in the assemblies of the people and on other public occasions.

TRA'BEA. In Roman Antiquities, the robe used at first by the kings, but afterwards by consuls and augurs. The purple *trabea* was used only on the occasion of great sacrifices. The second sort, of purple and white, was commonly worn by consuls on state occasions. A third, of purple and scarlet, was the dress of the augurs.

TRABEA'TION. (Lat. trabes, *a beam.*) In Architecture, the same as *entablature;* which see.

TRA'CHEA. (Gr. *τραχεια*, from *τραχυς, rough.*) The windpipe. A cartilaginous and membranous tube through which the air passes into and out of the lungs. Its upper extremity is called the *larynx*, and consists of five cartilages. The uppermost forms a kind of valve at the mouth of the larynx or glottis, and is called the *epiglottis:* it closes the passage in the act of swallowing. The sides of the larynx are formed by the *aretenoid* cartilages, and the anterior part of the *thyroid* and *cricoid* or annular cartilages: these may be felt under the skin in the front of the neck. These cartilages are united by elastic ligaments, and are acted upon by appropriate muscles, so as to modify the dimensions and form of the aperture in the act of speaking: they are moistened by a mucous secretion. The canal from the larynx downwards is called *trachea*, till it divides into two *bronchiæ* opposite the fourth or fifth dorsal vertebra. They are kept open for the free passage of the air by their elastic cartilaginous texture, which consists of rings with intervening membrane and muscular fibres.

TRACHEÆ, in Botany, are what are now called spiral vessels, which received that name in consequence of their being considered the respiratory tubes of plants. *Trachenchyma* is a tissue composed of tracheæ.

TRA'CHEARIES, *Trachearia.* (Gr. *τραχεια, the windpipe.*) The name of an order of the class *Arachnida*, including those which breathe by means of tracheæ.

TRACHE'LIDANS, *Trachelidæ.* (Gr. *τραχηλος, a neck.*) The name of a family of Coleopterous insects, comprising those which have the head supported on a kind of pedicle or neck.

TRACHE'LIPODS, *Trachelipoda.* (Gr. *τραχηλος*, and *πους, a foot.*) The name given by Lamarck to an order of Mollusks, comprehending all those which have a free and flattened foot attached to the under side of the part of the body which he considers as analogous to a neck. The order corresponds nearly with the Pectinibranchiate Gasteropods of Cuvier.

TRA'CHEOCELE. (Gr. *τραχεια*, and *κηλη, a tumour.*) A tumour upon the trachea; an enlargement of the thyroid gland. *See* BRONCHOCELE.

TRACHEO'TOMY. (Gr. *τραχεια*, and *τεμνω, I cut.*) The operation of making an opening into the trachea in cases of threatened suffocation.

TRACHI'NUS. (Gr. *τραχυς, rough.*) A genus of spiny-finned fishes, characterized by their compressed body and approximated eyes: two dorsal fins; the first short, and with spinous rays; the second long, and with flexible rays. The anal fin is very long; the operculum is armed with a long spine directed backwards. By the wounds which the species of *Trachinus*, usually called "weevers," inflict with their opercular spine, they have become formidable to fishermen of all nations; and it is said that the French have a police regulation, by which the fishermen are directed to cut off the spines before they expose the fish for sale.

TRACH'ITIS. Inflammation of the trachea.

TRA'CHYTE. (Gr. *τραχυς, rough.*) A variety of lava which is often porphyritic, and when containing hornblende and augite passes into the varieties of trap called basalt, greenstone, dolerite, &c.

TRACT, TREATISE. In Literature, both originally from the same Latin word tractatus; the latter through the French. It would be difficult to assign any reason for the difference in signification between two words identical in origin and etymological meaning; but the first is now commonly used to describe short compositions, in which some particular subject is "treated," generally in the form of a pamphlet; the latter more extensive works.

TRA'CTION. (Lat. traho, *I draw.*) The act of drawing, or state of being drawn. In Mechanics, the *angle of traction* is the angle which the direction of the power makes with a given plane.

TRACTORS, METALLIC. Small bars of metal which were supposed to possess certain magnetic powers, and to cure painful affections and tumours by being drawn over the part. They bore the name of their inventor, Perkins, and were in considerable vogue about thirty years ago. A number of wonderful cures, however, having been attested, which were performed by means of spurious wooden tractors, the imaginary virtues of the magnetic or metallic fell into disrepute, and then into oblivion.

TRA'CTORY, or TRA'CTRIX (Lat. traho, *I draw*), in the geometry of curve lines, is the curve characterized by this property, that the tangent is always equal to a given line. It was called the tractory by Huygens, because it may be considered as described mechanically by a small weight attached to one extremity of a thread, while the other extremity is drawn along a given straight line. But in order that the curve may be described in this manner, it is necessary to suppose the friction of the plane of traction to be infinite, or at least to destroy at every instant the momentum which is generated by the motion of the small weight, otherwise the direction of the motion of the describing point would not be a tangent to the curve. The tractory has much analogy with the logarithmic whose *subtangent* is constant. The evolute of the curve is the common catenary. (D'Alembert, *Ency. Methodique; Peacock's Examples*, p. 174.)

TRADE. *See* COMMERCE.

TRADE WINDS, are winds which in the torrid zone, and often a little beyond it, blow generally from the same quarter, varying, according to circumstances, from N.E. to S.E.

The cause of this wind is to be ascribed principally to the high comparative temperature of the torrid zone, combined with the rotation of the earth from W. to E. The heated air at the surface ascending into the higher regions of the atmosphere, its place is supplied by the colder air rushing from the poles; which also becoming rarified, ascends in its turn, and is carried in the upper regions towards the poles to supply the stream of the under current: these under polar currents moving in progress towards the equator from the zones where the earth's motion is slower to others where it is more rapid, acquire an apparent relative motion in a westerly direction. The currents from the two hemispheres meeting near the equator, their meridional motions are there destroyed, and they therefore advance together with the remaining motion from the eastward round the globe. The regularity of the trade winds is disturbed in some places by local causes, and chiefly by the superior rarefaction of the air over land heated by the sun's rays. They extend farther to the northward or southward according as the sun's declination is north or south; and in some places they become periodical, blowing one half of the year in one direction, and the other half in the opposite one. (*See* MONSOON.) In the great Pacific ocean, however, the trade wind blows with a uniform and gentle breeze all the year round. The name of *trade winds* was given them from their important influence in navigation. *See* WINDS.

TRADI'TION. (Lat. trado, *I deliver.*) A truth of doctrine or fact, delivered or handed down to one from another, and received on the faith that the first to whom it was so delivered received it from an authentic source. In common language, the word is used to signify records of facts preserved in the memory of successive persons or generations only, and not committed to writing. In Theology, tradition means, generally, that body of doctrine and discipline supposed to have been put forth by our Saviour or his inspired Apostles, and not committed to writing; and thus the word is used in a contrary sense from "Scripture." And such traditions are of two sorts: tradition of doctrine (such as that of the Trinity), which is commonly said to be directly affirmed by tradition and proved by Scripture; and tradition of rites and ceremonies, called by Hooker "traditions ecclesiastical," or "ordinances made in the prime of Christian religion, established with that authority which Christ has left to his church in matters indifferent, and, on that consideration, requisite to be observed till like authority give just cause to alter them." (*Eccl. Pol.* v. 65.)

It is, of course, impossible to deny that Revelation may have been communicated to man in this manner, as well as in the form of Scripture. Therefore, when a Protestant asserts that Scripture is the *only* rule of faith, he must mean this only, that the evidence on which Scripture rests is solid, while no particular tradition has sufficient evidence to support it; for if any tradition had evidence to support it, there can be no *à priori* reason assigned why it should not be as binding as any Scripture. "I

make no scruple to grant," says the high church writer Hammond, "that apostolical traditions, such as are truly so, as well as apostolical writings, are equally the matter of that Christian's belief, who is equally secured by the fidelity of the conveyance that as the one is apostolical writing, so the other is apostolical tradition:" one of those unmeaning phrases which are of such common occurrence in this widely spread controversy; for the only real questions are, whether we *can* be "equally secured by the fidelity of the conveyance," in the case of tradition and of Scripture? and, secondly, who is to be the judge for us what is authentic tradition and what is not?

In the latter question lies the real difference, on this subject, between Romanist and Protestant. The former holds tradition of equal authority with Scripture; but then he also holds that the church, that is, the pope, with or without a council, is the authoritative declarer of tradition.

It is curious to observe that at the Council of Trent this fundamental difficulty, namely, who is to say what is tradition and what is not, struck the minds of the divines who were contending to fix the doctrine of the Catholic church. They were probably hardly agreed as to the form, rather than the substance, of its solution. "All agreed," says Paolo Sarpi, "that Christian faith is contained partly in Scripture and partly in tradition. Yea, some said more: that tradition was the only foundation of the Catholic doctrine; for the Scripture itself is not believed but by tradition." But Vicenzo Lanello, a Franciscan friar, thought "that they ought first to treat of the church, which is a more principal foundation;" since "Scripture itself is founded upon it," according to Saint Augustin's saying, and "that no use can be made of traditions, except by grounding them upon the same authority." But his opinion had no followers. "Some objected that the synagogues of the heretics would also arrogate the authority of a church." Others thought that the authority of the church was sufficiently declared already. (Book 2.) Perhaps some confusion would have been avoided if the father's suggestion had prevailed: but there is no doubt that the Romanist, by tradition, means tradition declared to be such by the church.

Protestants, on the other hand, without laying it down as a doctrine that tradition is equal to Scripture, have, in general, assented to the proposition that an authentic tradition of doctrine is binding; but on the question, what is the authority competent to pronounce a tradition authentic, they have wandered strangely indeed, from a reluctance to admit to its full extent that very right of private judgment on which they founded their dissent from Rome. And this is peculiarly the case with those reformed divines who dislike parting with the title "Catholic."

When the early Reformers, especially those of the Lutheran and Anglican schools, attacked a doctrine or practice of Rome, their first endeavour was generally to show that it was not scriptural; their second, that it was not *ancient*, *i. e.* did not rest on tradition. For this purpose, they opposed to the authority of the church, as it existed in their day, the authority of early fathers and councils, as expounding the belief of an earlier age. Thus they *recognised* the right of private judgment to try the authority of the existing church by comparing it with authorities of earlier times; they permitted each individual to apply for himself the historical test. But at the same time they denied, more or less directly, the right of private judgment to go further, and criticise the ancient authority itself; to examine, for instance, whether a doctrine acquiesced in, in the fourth century, might not have been altogether unknown to the first; whether corruption in the church may not have commenced at so very early a period as to invalidate greatly the testimony even of the oldest father; and, lastly, whether traditions, resting on high historical authority, are or are not consistent with Scripture. And even to the present day, the high church school of Anglican divinity does practically consider all these as points without the reach of private judgment.

Now this we cannot but think an untenable position. Either the church has and always had authority to declare to us what is tradition, or it has not. If it had, then the Reformation was an unlawful thing *ab initio;* and no church commencing in schism can be said to have a pure and real existence. If it had not, then each man, in the last resort, must judge for himself of the authenticity of what is propounded to him as tradition. He will be bound to judge with humility, respect, and submission; but the decision belongs ultimately to the *forum* of his proper conscience.

He will, therefore, feel it necessary to examine the value of the evidence for the doctrines or rules of discipline presented to him as traditional, by the same principles of criticism which he would apply to other testimony; not receiving all in the mass, on the faith of any alleged adoption of it by the church. For example, he finds that, scarcely two centuries after the lifetimes of the Apostles, several hundred bishops, convened from all parts of Christendom, at the Council of Nice, declared that the doctrine of the Trinity, as embodied in the creed of that council, had been "handed down" in their respective churches from the beginning. He accepts this as evidence of the highest authority to show that there was an oral teaching of that doctrine by the Apostles and their successors, corresponding with the indications afforded, but not expanded into the same explicit form, in Scripture. But when he is required to receive the doctrines, for instance, of the Apostolical succession as commonly understood, or of the sanctity of celibacy, or the use of language widely deviating from that of Scripture respecting the Sacraments, on the ground that these are "traditions," he holds himself at liberty to inquire, first, whether the language of fathers and councils respecting them is distinct and consistent, when freed from rhetorical exaggeration; next, whether it is not least strong in the age nearest the Apostles, and increases in force as we proceed lower; and, lastly, whether on all these subjects their testimony was not likely to be warped by the ordinary causes of error which throw discredit on witnesses, and from which we have no right whatever to imagine the Christian writers of the fourth, third, or second centuries exempt; such as the ambition of the clergy, the tendency to admit gnostic and heathen influences, and the deficiency in solid judgment and reasoning power which characterized the educated men of those ages. Again; he will not be influenced by the common Romish argument already alluded to, and frequently in use among high Anglican writers also, that "Scripture itself is found to be such by tradition." Because we receive the testimony of early Christian writers that such and such books were *canonical*, *i. e.* received in the church in their time, it by no means follows that we must receive their deductions from Scripture as having the form of tradition; not even when they style these the deductions of the church. Such reasoning would not pass for eminent in any but theological controversy. We receive the testimony of Xenophon and Plato as to the actions and sayings of Socrates; we do not, therefore, admit as authoritative their exposition of his philosophy, not even as an authoritative representation of what was regarded as his philosophy at Athens; and yet they were his cotemporaries. Irenæus, the earliest father on whom we depend for any thing like extensive testimony to tradition, lived a hundred years after the Apostles, and a hundred years of much corruption and dissention.

Lastly, he will know that if an overweening contempt of the authority of early uninspired writers, and of old ecclesiastical traditions, is most unbecoming a Christian inquirer, an exaggerated and superstitious veneration for them, if a more amiable error, is scarcely a less serious one. There could be no traditions more venerable, more sanctioned by the apparent "authority of the church," than those of the Jews at the time of our Saviour; yet our Saviour does not on that account in any degree mitigate his condemnation of them, or speak of them as entitled even to respect, when he denounces those who teach for doctrines the commandments of men.

(It would be impossible to refer to particular works on this subject of controversy. The extreme Protestant view of tradition is no where so fully argued as by Chillingworth, *passim.* For a concise and fair view, on high church principles, of the estimate of tradition by the English Reformers, see *Palmer's Church of Christ,* vol. i. p. 493. 504.)

TRA'GACANTH. A variety of gum: it is the produce of the *Astragalus Tragacantha*, a native of Africa, and imported in small twisted or flattened pieces, white or yellowish, and translucent or nearly opaque. When put into water they swell up, and gradually form a gelatinous or pasty mass; not dissolving into a clear solution, as is the case with gum arabic. An analogous kind of gum is found in other plants, and the generic name of *tragacanthin* is sometimes applied to it.

TRA'GEDY. (Gr. *τράγος, a goat,* and *ᾠδή, a song.*) A species of drama, in which the diction is elevated and the catastrophe melancholy. The name is usually derived from the ancient Greek custom of leading about a goat in procession at the festivals of Bacchus, in whose honour those choral odes were sung which were the groundwork of the Attic tragedy. Some recent writers, however, have given a new explanation of the word *τράγος*, considering it an ancient Greek adjective, and translating it "melancholy," or "lamentable." *See* DRAMA.

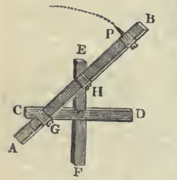
TRAGI-CO'MEDY. In Literature, a compound name, invented to express a class of the drama which should partake both of tragedy and comedy. If the mixture of serious with humorous portions in the piece alone entitles it to this name, then all the Plays of Shakespeare (with the single exception of the *Merry Wives of Windsor*, to which some add the *Twelfth Night*), as being pure comedies, belong to this class; as do, indeed, almost all the works of the old English dramatists. But *Troilus and Cressida* alone, of the Plays of Shakespeare, bears this title in old

editions: on what account we do not know. French critics define the distinction to be, that the *event* of the tragi-comedy is not unhappy or bloody. Dacier condemns them as illegitimate. Guarini, the Italian poet, wrote an essay on the subject.

TRA'GUS, in Anatomy, is the term applied to the small cartilaginous eminence at the entrance of the external ear: in the adult it is beset with small hairs.

TRAJE'CTORY. (Lat. trajectus.) The curve which a body describes in space; as a planet or a comet in its orbit, or a stone thrown obliquely upwards in the air. The form of the trajectory depends on the initial velocity with which the body is projected, the law and direction of the forces which act upon it, and the resistance of the medium in which it moves. The planetary orbits would be strictly elliptical, were it not for the disturbing forces which they exert on each other; and but for the resistance of the air, a body projected obliquely from the earth would describe a portion of a parabolic curve.

TRA'MMEL. (Old French, tramel.) An instrument for drawing ovals, much in use among joiners and other artificers. It consists of a cross, C D E F, in which are cut two grooves at right angles to each other; and a beam, A B, carrying two pins, G, H (which are clamped to A B, and slide in their grooves), as well as a pencil, P: these parts are called the cross and the beam. By turning A B round, the pins G, H slide along the grooves, and the pencil P describes an elliptic curve. A demonstration of the properties of this instrument may be seen at p. 700. vol. xiv. of *Hutton's Abridgment of the Philosophical Transactions*.



TRAMONTANE. See ULTRA-MONTANE.

TRANSCENDE'NTAL. In Algebra, a term applied to any quantity which cannot be represented by an algebraic equation of a finite number of terms with determinate indices. Such quantities include all exponential and logarithmic expressions and trigonometrical lines in terms of the arc. Thus a^x, x^x, log. x, tan. x, &c. are transcendental expressions; and any equation into which such expressions enter is called a *transcendental equation*, and any curve defined by such an equation is called a *transcendental curve*.

But by *transcendental equations* are sometimes meant such differential equations as can only be integrated by means of curves, logarithms, or series.

TRANSCENDENTAL. A word used by German philosophers to express that which *transcends* or *goes beyond* the limits of actual experience. This general meaning is somewhat restricted by Kant, who draws a distinction between the *transcendental* and the *transcendent*. The transcendental he defines to be that which, though it could never be derived from experience, yet is necessarily connected with experience, and which may be shortly expressed as the intellectual *form*, the *matter* of which is supplied by sense. "I call," says he, "all knowledge transcendental, which has regard in general not so much to *objects* as to our mode of knowing or apprehending objects (that is to say, to formal knowledge), so far as this is conceived to be possible *à priori*. A system of such conceptions would be named transcendental philosophy, as the system of all the principles of pure reason." The *transcendent*, on the contrary, is that which regards those principles as objectively real to which Kant assigns only a subjective or formal reality, and consequently is by him regarded as beyond the limits of the human reason altogether.

TRA'NSEPT. (Lat. trans and septum.) In Architecture, the cross part of a cathedral which extends on the north and south sides of the area between the nave and the choir, and forming, as it were, the short arms of the cross upon which the plan is laid out.

TRANSFIGURA'TION. The supernatural change which is described to have taken place in the appearance of Christ, when, as is recorded in Matth. xvii., Mark ix., Luk. ix., he took Peter, James, and John up into a high mountain with him, and was transfigured before them, his face shining as the sun, and his raiment showing white as light. There appeared in conversation with him Moses and Elias; and the apostles erected three tabernacles or tents to them. An ancient tradition assigns Mount Tabor as the scene of this event, upon which three contiguous grottoes have been fashioned to represent the three tabernacles.

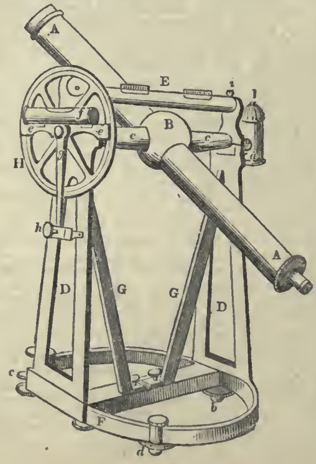
TRANSFU'SION. The injection of blood from one living animal into another. It was at one time supposed that this operation might be resorted to, to sustain life in cases of great loss of blood from accidental hæmorrhages and other causes; and that in certain cases of mental and bodily disease a cure might be effected by abstracting a large quantity of blood, and supplying its place by transfusion from another animal, such as a calf or sheep. Some of these experiments appeared at first to be attended with success, but bad consequences followed; and in two or three cases in which it was tried upon the human subject it proved fatal.

TRA'NSIT (Lat. transitus, *passage*), in Astronomy, is the culmination or passage of a celestial object across the meridian of any place. The determination of the exact times of such transits is one of the most important operations of practical astronomy, as it is by this means that the differences of right ascensions, and consequently the relative situations of the fixed stars, and the motions of the planets and comets in respect of the celestial meridians, become known; and it is most easily and accurately effected by the aid of the *transit instrument*, the nature and method of using which will be explained under that term.

Transit is also used to signify the passage of an inferior planet across the sun's disk. See MERCURY and VENUS.

TRANSIT INSTRUMENT. This important instrument, called by the French *instrument des passages*, *lunette méridienne*, consists essentially of a telescope firmly attached to a transverse horizontal axis, the ends of which are directed to the east and west points of the horizon. The extremities of the axis are formed into cylindrical pivots of exactly equal diameters, which rest in notches (technically called Y's, from their resemblance to that letter), formed in metallic supports, susceptible of nice adjustment both horizontally and vertically, so that the axis can be placed perfectly horizontal, and at right angles to the plane of the meridian in which the telescope moves. In the focus of the eye-piece is placed a system of three, five, or sometimes seven vertical and equidistant wires or spider lines, generally crossed by two horizontal ones, between which it is convenient that the passage of objects over the vertical wires should be observed. By means of adjusting screws the diaphragm, or plate to which the wires are attached, is brought into such a position that the middle vertical wire intersects the optical axis of the telescope, in which position it is permanently fixed.

When the system of wires is brought into this position, the middle one will be a visible representation of that part of the meridian to which the telescope is directed; and when a star is seen to pass this wire, it is in the act of culminating, or *transiting* the celestial meridian. The instant of the transit is noted on a clock or chronometer, which is an indispensable accompaniment of the instrument; and in order to render the observation more certain, the instant at which the star passes each of the vertical wires is noted, when practicable, and the mean taken as the true instant of passing the vertical wire. The times at which the sun and certain principal stars pass the meridian of Greenwich (and consequently the meridian of any other place whose longitude from Greenwich is known) being given in the *Nautical Almanac*, the comparison of the time indicated by the clock and the time in the almanac gives the *clock error;* and by observing the same stars from day to day the *clock rate* is determined. In this manner we are enabled to assign the exact interval of sidereal time between the transits of the different stars, and consequently the difference of their right ascensions. For determining the absolute place of a celestial body it is necessary to know also its polar distance, which is given by the mural circle; so that the



transit instrument and mural circle are the two essential instruments of an astronomical observatory.

The annexed diagram represents the *portable* transit instrument, as at present constructed by Troughton and Simms, when the telescope does not exceed twenty inches or two feet in focal length. The telescope tube A A is in two parts, connected together by a sphere B, which also receives the larger ends of the two cones C C placed at right angles to the telescope, and forming the horizontal axis. The axis terminates in two cylindrical pivots, which rest in Y's fixed at the top of the vertical standards D D. One of the Y's has a small motion in azimuth, by means of which the telescope can be adjusted exactly to the plane of the meridian. A spirit level E, which is made to stride across the telescope and rest on the two pivots, serves to show when the axis is horizontal. The standards D D are fixed by screws upon a brass circle F, which rests on three screws, *b*, *c*, *d*, forming the feet of the instrument, and by which the levelling is performed. G G are two oblique braces for the purpose of steadying the supports. On the extremity of one of the pivots, which extends beyond its Y, is fixed a divided circle H, which turns with the axis; while a double vernier remains stationary in a horizontal position, and shows the altitude to which the telescope is elevated. The verniers are set horizontal by means of a spirit level *f*, and are fixed in their position by a brass arm *g h*, clamped to the supports. The whole of this apparatus is moveable with the telescope, and when the axis is reversed can be attached in the same manner to the opposite standard. For the purpose of illuminating the wires when observations are made at night, one of the pivots is pierced, and admits the light of a lamp I, which is thrown upon the wires by a reflector placed diagonally in the sphere B. (*Simms's Treatise on Mathematical Instruments.*)

Adjustments. — In practice, the transit instrument is subject to three principal errors. 1st, The axis may not be perfectly horizontal, which is called the error of inclination. 2d, The optical axis of the telescope may not be quite perpendicular to the axis of the instrument, which is called the error of collimation. And 3d, The axis may not be exactly east and west, or the optical axis may not be exactly in the meridian, which is called the error of azimuth. To place the axis exactly horizontal, the level E is suspended in the proper manner from the pivots, and the air bubble brought to the middle by means of the foot screws. The level is then reversed, that is, the end which was turned to the west is now turned to the east; and if the air bubble still stands at the middle, the axis is horizontal; if not, the foot screws are adjusted until it stands at the middle in both positions of the level. The error of collimation is detected by pointing the telescope to a distant well-defined terrestrial object, and bisecting it by the middle vertical wire; the telescope is then lifted out of its supports and reversed (that is, the end of the axis which was turned to the west is now turned to the east), and brought again to bear on the same object. If the middle wire is found to be still bisected, the adjustment is perfect; if not, the diaphragm is moved a little to the right or left by means of the adjusting screws, until the middle wire bisects the object in both positions of the axis. To place the instrument exactly in the meridian some knowledge of practical astronomy is required. It is easy to place it *nearly* in the meridian by the transit of the sun at apparent noon, or of any star whose right ascension is known; and when in this approximate position to the meridian, the deviation may be discovered and corrected in various ways. One of the simplest is to observe two successive transits of Polaris (or any circumpolar star) above and below the pole. If the interval between the two transits is exactly twelve sidereal hours, the telescope is exactly in the meridian; and the difference of the interval from twelve hours shows both the amount and the direction of the azimuthal error. Another method consists in observing the transits of two stars differing considerably from each other (not less than 50°) in declination, and whose right ascensions (which should be nearly the same) are accurately known. The deviation from the meridian, in *seconds of time*, will then be given by this formula $(\Delta\ T - \Delta\ (A\ R.)$ $\times \dfrac{\cos.\ N \cos.\ S}{\sin.\ (N + S) \cos.\ L}$; where Δ T is the difference of the observed times of the two transits in sidereal seconds; Δ (A R) the observed difference of right ascensions, also in seconds of time; N the declination of one of the stars, supposed north; S the declination of the other, supposed south; and L the latitude of the place. If Δ T is greater than Δ (A R), the deviation will be to the east; and if less, to the west. A few repetitions of this process will suffice to place the instrument exactly in the meridian. In the case of fixed instruments, a meridian mark is usually made on some distant object, and permanently established for the convenience of ready reference.

The transit instrument appears to have been invented by the Danish astronomer Roemer, by whom it was first described in 1700, in the *Miscellanea Berolinensia*, tome iii. Dr. Halley placed a transit instrument in the Greenwich observatory in 1721, the telescope of which was about five feet in length; but it was little used until 1742, when Bradley commenced a regular series of meridional observations. The transit instrument at present in use in the Royal Observatory is the workmanship of Troughton, and was set up in 1816. The object-glass of the telescope is 5 inches in clear aperture, and the focal length 10 feet. Its horizontal axis, including the pivots, is 3 feet 10 inches. There are seven fixed vertical wires in the focus, and two horizontal axes; and the distance of the former from each other is such that an interval of about 18·3 seconds elapses while a star in the equator passes between each adjoining two.

For full details respecting the construction and adjustments of this important instrument, see *Pearson's Practical Astronomy; Memoirs R. Astr. Society*, vol. i.; and the article in the *Penny Cyclopedia.*

TRANSI'TION ROCKS. A Geological term, formerly applied to the older secondary series, under the idea that they were formed during the transition of the globe from the uninhabited to the inhabited state. *See* GEOLOGY.

TRA'NSITORY ACTIONS. In English Law, actions in which the *venue*, *i. e.* place alleged in the declaration, is immaterial, and consequently the trial may be had in any county; opposed to local actions, in which the trial can only be had in the county where the alleged injury was committed. To the former class belong actions of contract and quasi contract (assumpsit, debt, &c.). *See* ACTION, VENUE.

TRANSLA'TION. In Literature, the rendering of a literary work from the original language into another. The peculiar merits and peculiar difficulties of successful translation have often been pointed out by critics, but their judicious directions have been seldom realized by authors. In truth, those difficulties require a talent of so high an order to surmount them, that few writers are fit to undertake the office of translators (we mean of works of any high literary merit), except those whose genius has more congenial occupation in original composition; for notwithstanding Dryden's sarcastic remark, that "imitation of an author is the most advantageous way for a translator to show himself, but it is the greatest wrong which can be done to the memory and reputation of the dead," we are inclined to doubt whether, in reality, imitation be not the more advantageous method of the two. "Every author," says an able critic (*Edin. Review*, vol. xxxvi.), "is a mannerist. This manner constitutes, as it were, the identity of each author; it is what the translator ought to catch, and is nevertheless the very thing which is apt to evaporate in translation." Or, to borrow again the language of Dryden, the office of the translator is especially to render the "particular turn of thoughts and expression which are the characters that distinguish, and, as it were, individuate him from all writers." But nothing is so arduous as the attempt to catch this spirit, or manner, when the writer is also bound by the duty of rendering faithfully the sense. The imitator, freed from the necessity of exactly copying the sense, is far more at liberty to devote himself to seizing the evanescent qualities of the manner. This truth might, as it appears to us, be exemplified by many instances. Terence and Horace seem to have aimed at familiarizing Roman ears with the best poetry of Greece, not by translation, but by imitation. Indeed, much as the Romans borrowed from the Greeks, actual translation seems to have been uncommon; the only two examples which we at this moment recollect are Cicero's version of Aratus, and that by Catullus of a poem of Callimachus. Among modern authors, which of the English translators of Horace has approached half so near him as Pope in his *Satires?* Where, among all the translations of the Greek drama, shall we find any thing so thoroughly imbued with the spirit of that noble order of poetry as the *Sampson Agonistes* of Milton, and the *Bride of Messina* of Schiller? What translator of Lucan is nearly so Lucanic as Corneille? We do not mean to disparage the utility of translations, or the merits of some few among those which have passed into popularity; but as, with scarcely an exception, they are in relation to the originals, to use the well-known phrase of Cervantes, only the "wrong side of the tapestry turned outwards," so, in themselves, considered as literary works, they generally leave an impression of that peculiar stiffness which belongs to all copies.

These observations apply with greater force to poetical than prose translations; and, among the latter, more to works of taste and fancy than to scientific or historical treatises. In the latter, an easy style, clearness, and fidelity appear of greater importance in translation, than the more difficult feat of catching the manner and spirit of the author. In literary, and especially poetical translation, much controversy has been carried on between the advocates of literal and loose adherence to the sense of the author. Each has its advantages and merits; but

the last, approaching most nearly to the character of *imitation*, appears to us, on the whole, the better extreme of the two. *Three* distinct styles of translation are not ill characterized by a lively writer in the *Quarterly Review* (on "Mitchell's Aristophanes"), vol. xxiii. p. 482.

"It is the office of the translator to represent the forms of language according to the intention with which they are employed: he will therefore, in his translation, make use of the phrases in his own language to which use and custom have assigned a similar conventional import; taking care, however, to avoid those which from their form, or any other circumstances, are connnected with associations exclusively belonging to modern manners. He will likewise, if he is capable of executing his work upon a philosophic principle, endeavour to render the personal and local allusions into the *genera* of which the local or personal variety employed by the original author is merely the accidental type, and to reproduce them in one of those permanent forms which are connected with the universal and immutable habits of mankind. The *faithful translator* will not venture to take liberties of this sort; he renders into English all the conversational phrases according to their grammatical and logical form, without any reference to the current usage which has affixed to them an arbitrary sense, and appropriated them to a particular and definite purpose. The *spirited translator*, on the contrary, employs the corresponding modern phrases; but he is apt to imagine that a peculiar liveliness and vivacity may be imparted to his performance by the employment of such phrases as are particularly connected with modern manners; and if at any time he feels more than usually anxious to avoid the appearance of pedantry, he thinks he cannot escape from it in any way more effectually than by adopting the slang and jargon of the day. The peculiarities of ancient times he endeavours to represent by substituting in their place the peculiarities of his own time and nation."

He proceeds to exemplify these distinctions by an instance from Aristophanes: —

λοιδορεισθαι δ'οὐ πρεπει
ἀνδρας ποιητας ὡσπερ ἀρτοπωλιδας.

This, says he, the faithful translator will render literally, "scold each other like bakers' wives." The spirited translator will adopt the modern popular phrase most nearly analogous, — "like oyster wenches." The translator *par excellence* will choose a phrase rendering the particular and obsolete expression of the ancient by a general equivalent which must be equally appropriate in the idiom of all times and countries, — "like market-women," or "hucksters." Without cavilling at this ingenious piece of criticism, we must be permitted to doubt whether a translation of a highly idiomatic author conducted on this last principle would not preserve his general meaning with the serious sacrifice of his spirit.

In most modern languages there are some few translations which have attained celebrity. In English, Fairfax's *Tasso*, one of the earliest, has great beauty, but is rather enervate. The versions of Dryden are distinguished by their poetical power; though we agree with Mr. Hallam (*Introduction to the Literature of Europe*, iv. 536.), that he did not give the example as well as precept of rendering the "particular turn of thought and expression" of his authors. The utter want of individuality in his respective translations is plainly perceptible; for instance, in that from the fourth book of Lucretius. (It may be observed, in passing, that the remarks of Dryden on the art of translation, of which so much has been said, are chiefly to be found in his prefaces to *Ovid's Epistles*, and to his *Second Miscellany*.) Pope's *Homer* is a bad and careless version (critically speaking) of the Latin translation of the Greek poet: but it has one essential characteristic of the original, namely, his sustained energy; which renders it, even now, more popular than the cold, though not unfrequently dignified and elegant work of Cowper. Some portions of Cumberland's versions from *Aristophanes* deserve mention, although on the whole he is prosaic, and has not dared to follow the bold flight or imitate the metrical variety of his original. Mitchell's *Aristophanes* has been much admired; but it is wearisome from the continual striving after effect. Some of Elton's translations are very pleasing, especially of parts of *Hesiod*. Shelley has left two of the most beautiful essays in this line of composition which are to be found in our language: the *Hymn to Mercury* of Homer, and the *Walpurgis Night Scene* from Goethe's *Faust*. In the latter, indeed, he laboured under the disadvantage of an inadequate knowledge of the language; but none of Goëthe's more critical translators (not even Dr. Anster) has so powerfully seized his "turn of thought and expression." The same cannot be said of Byron's performance, — the first book of the *Morgante Maggiore*; which is, however, a remarkable feat of dexterity, from its extreme literalness: a feat in the same kind as Lord Brougham's recent version of the *De Coronâ* of Demosthenes. Mickle's *Lusiad*, though now little read, is one of the most poetical of English translations. Coleridge's *Wallenstein* is a truly wonderful work. So carelessly written that the poet has omitted whatever he found difficult, or thought unornamental, it is so exact and so spirited, that the reader is constantly impressed with the idea of Schiller himself rewriting his own drama in English, with here and there a variation as perfectly Schiller-like as the German original. Among prose translations, Philemon Holland's numerous ones, particularly that of *Pliny*, are still occasionally referred to by literary antiquaries, for their quaintness rather than their merit. Melmoth's *Epistles of Cicero and Pliny*, once much admired, are polished but cold. Gordon's *Tacitus* is a creditable attempt at rendering an extremely difficult author. Among our numerous translators from the German in the present times, none bears so high a reputation as Mrs. Austin. Mr. C. Lewis's translation of Boeckh's *Public Economy of Athens* is a work of great merit. French is a language affording so many advantages to the prose translator, from its condensation, its exactness, its rhetorical force, that it is, perhaps, rather to be wondered at that higher distinction has not been attained by individual French writers in that line. But few French translators are much remembered, except Amyot; and he chiefly for his vernacular language, possessed of great sweetness as well as quaintness, which formed a mode of style in the 16th century. The Chevalier Townley's translation of *Hudibras* is worth mentioning as a phenomenon, from its singular fidelity and spirit. Italian, on the other hand, seems to be an unfit language for the purposes of translation, from extreme diffuseness; yet it boasts of one translator of *Tacitus* (Davanzati), who made a point of rendering that affectedly concise historian in fewer words than the Latin. But of all modern languages, at least of those generally known in the literary world, German has by far the greatest capabilities for this purpose. This must be conceded, *à priori*, by those who are familiar with its peculiar powers and flexibility; and not less by those who are acquainted with this portion of its literature. Among the most highly esteemed poetical works of this description in Germany are Voss's *Homer* and *Virgil*; Streckfuss's *Dante*; Schlegel and Gries's *Calderon*; Schlegel's *Shakspeare*. In prose, the complicated syntax of the Germans, perhaps we may add the as yet unformed character of their prose style, detract from the natural powers of the language; still they have some excellent specimens of prose translation, among which Strombeck's *Tacitus* holds a high rank. (See also *Ed. Rev.* vol. xxxvi.)

TRANSLU'CENCY. (Lat. transluceo, *I shine through*.) Semitransparency. The term is chiefly used in descriptive mineralogy as applied to minerals which admit of a passage of the rays of light, but through which objects cannot be definitely distinguished.

TRANSMIGRATION OF SOULS. *See* METEMPSYCHOSIS, PYTHAGOREAN PHILOSOPHY.

TRANSMUTA'TION. In Alchemy, the operation of changing the imperfect metals (as they were termed) into the two precious, — gold and silver. This was the great object of that pretended science. *See* ALCHEMY.

TRANSMUTA'TION, in Geometry, the change of one figure or body into another of equal area or solidity; as a triangle into an equivalent square, a sphere into a cube, &c.

TRA'NSOM. (Lat. transenna, *a stretched cord*.) In Architecture, the horizontal piece framed across a double-light window: when a window has no transom it is called a *clere-story* window.

TRANSPA'RENCY, is that quality in certain bodies by which they give passage to the rays of light, and is generally supposed to be a consequence of the homogeneity of the matter of which they are composed.

TRANSPLA'NTING. The art of removing a plant or tree from one situation to another in such a manner as not to interrupt its growth. This operation is commonly performed in the winter season, or in autumn and spring, when vegetables are generally in a dormant state; and the great object of the transplanter is to lift as many of the roots as possible without injuring them, and to replace them in a new situation to which the tree is transplanted in such a manner as to facilitate their growth. With herbaceous plants and young trees this is comparatively a simple operation; but with large trees it is an operation of skill, care, and labour. The tree to be transplanted should be considerably under the normal age of the species; and to prepare it for the change which it is to undergo other trees, or objects of its own height, with which it is immediately surrounded, should be taken away a year or two previous to removal, in order to accustom the tree to the direct action of the light and air on every part of it which is above ground. The next part of the operation is to dig a trench round the tree, equidistant from the trunk, at the distance of three, six, nine, or twelve feet, according to its height, and to such a depth as to cut through all the horizontal roots. The tree may then be removed to its new situation, with or without the earth attached to that part of the roots which remain; or, which is a more certain mode, the trench may be left open during a year, in order that the sections

of the amputated roots may heal over, and be prepared to emit new fibrous roots after the tree is transplanted; or, and which is the more general mode, the trench may be filled up with finely pulverized soil, in order to encourage the production of fibrous roots; and at the end of a year, or of two years if the tree is very large, it may be removed to its final situation. Hitherto we have said nothing of the trunk and branches of the tree to be removed. In a moist climate, such as that of Ireland or the west of Scotland, all the branches may be retained; but in dry climates, such as that of England, the branches require to be thinned out in proportion to the roots cut off; and in dry and warm climates, such as that of central France, the greater number of the branches require to be removed. The proper season for transplanting all ligneous plants, whether small or large, is in autumn, after the leaves of deciduous trees have dropt, and when the sap of evergreen trees, in consequence of the decline of temperature, is comparatively in a dormant state.

TRA'NSPORT. A vessel hired by government to convey stores, troops, &c.

TRANSPORTA'TION. In Law, a species of punishment. It is not known to the common law of England, and was originally a commutation of punishment, pardon being granted to various descriptions of offenders on condition of undergoing transportation: generally for seven or fourteen years, or for life. It is now a statutable punishment for a great variety of offences. It is said to have been first inflicted as a punishment by 39 Eliz. c. 4., enacting that such rogues as were dangerous to the inferior people should be banished. At that time the English plantations in North America were the receptacles of transported convicts. Virginia, the Jerseys, Delaware, Maryland, &c. are the districts which received the greatest accession to their population from this cause. At the very commencement of the practice, the same arguments were employed against it by Lord Bacon which are urged at this day by many law reformers. "It is," he says, "a shameful and unblessed thing to take the scum of people, and wicked condemned men, to be those with whom you plant." It was not, however, brought into general use as a punishment until 1718, by 4 Geo. 1., which act gave the courts a discretionary power to banish felons entitled to clergy to the American plantations. After the loss of the greater part of our American colonies, several years elapsed before the government fixed on any place by way of substitute. At length, in 1787, Botany Bay, on the coast of New South Wales, was fixed upon: 760 convicts were despatched that year. But when the expedition arrived, it was discovered that Botany Bay (discovered by Cook in 1770) afforded no practicable site for the colony; which was consequently landed at Port Jackson, where the town of Sydney was founded. From that period to the present great numbers of convicts have been transported to Port Jackson, and to the later founded colony of Van Diemen's Land — our only two penal settlements. Much has been done of late years towards regulating the condition of the convicts in the colony, and subjecting the worse part of them to severe privations; in particular, by transporting some of them to particular depôts, where they are liable to close inspection and hard labour. Among the writers who have lately contended against the policy of continuing the punishment of transportation, we may particularly mention Archbishop Whately. (See his *Tracts on Secondary Punishments and Transportation.*)

Returning from transportation before the legal expiration of sentence was an offence formerly punishable with death; but by 4 & 5 W. 4. c. 67. those who commit the offence, or aid others in its commission, are punishable with transportation for life. A great mass of evidence on the effect of transportation as a punishment for crime in Great Britain, and its effect on the moral condition of the Australian colonies, will be found in the volumes published by the two committees of 1838 and 1839. It requires, however, to be read with much caution, on account of the evident bias of the committees themselves; for every one knows how effectually the inclinations of a committee give a colour to the evidence taken before it, from the mode in which the operation is performed. The views of that committee, resembling those of Archbishop Whately, of the inutility of the punishment here, and its mischievous effects in the colonies, have had some effect on the proceedings of government; so far, at least, as to produce the abolition of the practice of the immediate assignment of convicts as labourers on their arrival, and the detention of considerable numbers in the hulks in lieu of the full execution of their sentence.

Many of the vices ascribed to the system are undeniable; but it must never be forgotten that the truly philosophical or sensible mode of looking at it is by comparison with other secondary punishments. Take *any* mode of punishment in the abstract, and the eyes of the inquirer will soon detect so much of mischief caused to the sufferers, and so little visible good produced on the community, as to tempt him to regard it as detestable. In the first place, transportation must be considered without the bad practice of immediate and indiscriminate assignment, which was a mere abuse. Thus corrected, let it be compared with the best regulated system of imprisonment — 1. In respect of its effects on the convict himself; and it may be doubted whether in the Penitentiary, whether on the silent or separate system, the mind of the majority of sufferers goes through a more wholesome process than in the penal settlements, notwithstanding all we have heard even of the frightful condition of Norfolk Island, which is not an ordinary sample. 2. In respect of its effects on the ill-disposed population at home; and here, defective as transportation is commonly supposed to be, the experience of any one conversant with courts of justice will decide which sentence appears to produce the greatest impression when announced, — imprisonment, or banishment. And it must not be forgotten that it is not the real severity, but the action on the imagination, which deters from crime: the worst inflictions of the gaol are thought little of by any one except the sufferer, while the evils of expatriation are greater in idea than in reality. 3. In respect of the ultimate reform of the offender; and here transportation possesses an incalculable advantage over every other secondary punishment. The convict who has undergone it begins life afresh: he remains, indeed, under some disabilities, sufficient to mark the sense entertained by society of the difference between him and the man unstained by crime; but there is nothing to prevent his rising by regular and honest conduct, if he chooses, into a station of comfort, and even of respectability. The man who leaves a gaol is utterly ruined: society has devised, perhaps can devise, no means of extending to him a *jus postliminii*, and bringing him back within the pale of citizenship. His character is gone for ever; and if it could be really ascertained how many among relapsed offenders are actually driven into the recommission of crime by the hopelessness and infamy of their condition, if not by the actual want which results from it, we suspect that many who are now ready to give their suffrage for the abolition of transportation would be induced at least to pause until they can see their way through this difficulty.

TRANSPOSI'TION, in Algebra, is the transposing of a term from one side of an equation to the other, and is in effect the adding of equal quantities to or subtracting equal quantities from each side of the equation, the *sign* of the quantity being changed from + to —, or from — to +. For example, if $a + x = c - d$, by transposing a we have $x = c - d - a$; or if $a + b = c - x$, by transposing x and $a + b$ we get $x = c - a - b$. The object of transposition generally is to bring all the unknown terms to one side of the equation for more conveniently finding their value with respect to the known terms.

TRANSPOSITION. In Music, the change which takes place by performing the same melody in a higher or lower pitch, which may always be effected by altering the signature as the pitch of the new key note may require.

TRANSUBSTANTIATION. The doctrine held by the church of Rome, that in the Eucharist the bread and wine are annihilated and replaced by the body and blood of Christ. In one of its liturgical offices it says, "This *is not bread*, but God and Man, my Saviour." It is maintained by Protestants that this dogma, which was made the principal test of a true faith by the Papists at the Reformation, is not found in Scripture, which in the most literal acceptation only asserts of the elements that *they are Christ's body and blood;* i. e. that the substances coexist in some mysterious manner. Nor can they discover it in the writings of the fathers, or in the canons of the early church. They affirm that the first theologian who asserted even the consubstantiation, or union of substances, was Paschasius, in the ninth century, and that he was accused of making too gross an explanation of the mystery. It was in the course of these disputes, and in consequence of the formal and definite statement of their opinions to which controversialists were forced, that this idea of transubstantiation came into fashion among theologians; nor was it ever propounded as an article of faith by the authority of a council till the beginning of the 13th century in the papacy of Innocent III.

TRANSUDA'TION. (Lat. trans and sudo, *I transpire.*) The oozing of fluids through membranes, or through porous bodies.

TRANSVERSAL. In Geometry, the name applied to a line (whether straight or curved) which *traverses* or intersects any system of other lines; as when a straight line intersects the three sides of a triangle. The properties of straight and circular transversals are discussed by Carnot, in his *Géometrie de Position*, and *Essai sur la Théorie des Transversales.*

TRANSVERSE AXIS, in Conic Sections, is the diameter which passes through both foci. It is the longest diameter in the ellipse, the shortest in the hyperbola; and in the parabola it is infinite, as in that curve all diameters are. *See* CONIC SECTIONS.

TRAPE'ZIUM (Gr. τραπεζα, *table*), in Geometry, is the general name for a plane figure bounded by four straight lines. When two opposite sides are parallel, it is

called a trapezoid; when both pairs of opposite are parallel, it is called a parallelogram.

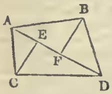
The following are a few of the most remarkable elementary properties of this figure.

1. The sum of any three sides is greater than the fourth side.

2. The sum of the squares of the diagonals is equal to the sum of the squares of the sides, and four times the square of the line joining the middle points of the diagonals.

3. The lines joining the middle points of the sides form a parallelogram.

4. If the figure can be inscribed in a circle, the sum of each pair of opposite angles is two right angles, and the sum of the rectangles of each pair of opposite sides, are equal to the rectangle of the diagonals.



To find the area of a trapezium, let A D be a diagonal, and C E, F B perpendiculars upon it; then A D × ½ (C E + B F) = the area.

TRAPEZIUS. In Anatomy, a muscle situated immediately below the integuments of the posterior part of the neck and back. Its principal action is upon the scapula; and it also acts upon the neck and head, drawing the latter backwards, and turning it on its axis.

TRAPEZO'ID. A trapezium which has one pair of opposite sides parallel. The area of a trapezoid is equal to half the sum of the parallel sides multiplied by the perpendicular distance between them.

In Anatomy, the *trapezoides* is the second bone of the second row of the carpus.

TRA'PPISTS. The name of a religious order which still exists in Normandy. It was founded in 1140 by a Count de Perche, in a deep valley called La Trappe, whence the name of the order, and has survived all the changes and revolutions of France. The rules of this order are of the strictest kind. It was, however, far less celebrated under its original foundation, than from the reform it underwent under the celebrated Abbé de Rancé, in the reign of Louis XIV. The history of this celebrated man is well known: he was a gallant and daring profligate, whose conversion was owing to the sudden death of a mistress. His character and reform were a favourite subject of discussion in the court of that king in its last and devout period; and he was himself the fashion, and much consulted and thought of by the fashionable devotees of the time. Perhaps the best appreciation of him will be found in the notices scattered through the *Memoirs* of Saint Simon, who reverenced him, but was too clear-sighted to idolize any one. His rule was of the austerest description; comprising, among other severities, absolute silence on the part of those admitted for a considerable period. At the Revolution the community of La Trappe was dispersed: many members escaped to England, and were received by Mr. Weld, the proprietor of Lulworth in Dorsetshire. There are now several congregations of Trappists. The famous Baron Geramb, so long the lion of the fashionable circles in London, ended his career by entering one of them. (See the *Encyl. Methodique*, "Théologie.") There is an account of the present state of the original convent in the *Revue de Paris*, vol. xxix. It is a melancholy picture. Many of the stories told of the austerities of La Trappe — *e.g.* that each of the monks is employed in digging every day a portion of his grave, &c. — are fables. But the main features of the discipline, the enforced silence, the complete seclusion from the world (insomuch that the superior alone receives news of the decease of a relation of any monk, and it is only announced to the community by a direction to pray for the soul of the kinsman of *one* of the brethren, without naming him), are as commonly reported.

TRAP ROCKS. (From the Swedish trappa, *a flight of steps*, because these rocks frequently occur in large tabular masses rising one above another like the successive steps of a staircase.) They are apparently of igneous or volcanic origin, and composed of felspar, augite, and hornblende, the predominance of one or other of these minerals giving rise to many varieties. See GEOLOGY.

TRAUMA'TIC. (Gr. τραυμα, *a wound.*) Relating to wounds; hence the traumatic balsams and ointments of old pharmacy.

TRAVELLER. In Naval affairs, a ring or hoop which slides along a rope or spar.

TRA'VERSE. In Law, a name given to a plea containing a denial of some matter of fact alleged on the other side, and offering to refer the matter to the decision of a jury.

In cases of misdemeanour, where the defendant postpones the trial of the indictment until the next sessions or assizes, he is said to traverse the indictment. The delays which this form formerly occasioned have been materially abridged by the act 60 G. 3. and 1 G. 4. c. 4.; under which persons in custody or held to bail twenty days before the sessions are bound to plead, unless a certiorari has been delivered before jury sworn.

TRAVERSE SAILING, in Navigation, is sailing on different courses in succession; and the method of reducing such compound courses and distances into an equivalent single course and distance is called *resolving a traverse.* The reduction may be effected either by geometrical projection or trigonometrical computation; but it is generally performed by inspection, with the aid of a *traverse table.*

TRAVERSE TABLE, in Navigation, is the tabulated form in which the northing, southing, easting, and westing are made on each individual course and distance in a traverse, for the purpose of finding readily the difference of latitude and departure made upon the whole; the difference between the sums of the northings and southings being the *diff. lat.*, and between the sums of the eastings and westings the *departure.*

The northing, southing, easting, and westing are generally taken by inspection from a table which contains the parts of a right-angled plane triangle corresponding to a given acute angle, and a hypothenusal line of every unit in length from 1 to 300, and sometimes to 500; an extent sufficient for the wants of the practical navigator. This table itself is also called a *traverse table*, from the facility which it affords in resolving a traverse; but it may be applied advantageously to many other purposes.

In the annexed figure A B C is a plane triangle right-angled at B; and if A B represent a portion of the meridian passing through A, and A C the distance from A to C, then the angle A is called the course, A B the difference of latitude, and B C the departure; and to a given angle A the corresponding values of A B and B C, being computed and entered in a table, form for the assumed value of A a portion of a traverse table.

The table is thus constructed to A C and angle A as *arguments*, the angle being taken to every degree and every quarter point of the compass, and the hypothenuse to every integer from unity to as high a number as may be thought requisite. But the table being formed, any two elements which geometrically determine the triangle may be assumed as the given one, and the other found by inspection from the table. But the use of the table is not limited to the solution of right-angled triangles only; for every case of oblique triangles may be solved by means of it.

TRA'VERTIN. (Ital. travertino.) A limestone, deposited from water holding carbonate of lime in solution. The word is a corruption of *tiburtinus*, this kind of stone being abundantly formed by the river Anio at Tibur near Rome. The species about Alba is usually called *peperino.* They are both of good quality, and were much used by the ancient Romans. Its Latin name was *lapis tiburtinus.*

TRAVE'STIE. (Fr. travestir, *to disguise.*) In Literature, a word used in the same signification as parody. *See* PARODY.

TREACLE. The viscid brown syrup which drains from the sugar in the refining moulds. Its specific gravity is generally 1·4, and it contains on the average 75 per cent. of solid matter. (*Ure's Dictionary.*)

TREAD. (Sax. tredan, *to set the feet on.*) In Architecture, the horizontal part of a step on which the foot is placed.

TREAD MILL. A recent invention for giving useful employment to persons imprisoned for crime.

Its usual form is that of a cylindrical wheel of about 5 feet diameter, and 16 feet long; and several of such wheels are sometimes coupled together. The circumference is furnished with twenty-four equidistant steps, on which the prisoners are made to work on the mill. Each individual treads in a separate compartment, boarded off so that no intercourse can take place between the parties at work at the same time.

All mounting the first step together, their weight sets the wheel in motion, bringing down the step trod upon; when they step up to the next one, which descends in the same manner, and so on, producing a continuous rotatory motion in the wheel, which may be applied as the moving force to a mill for grinding corn, or in turning any other machinery.

The prisoners at work on the wheel are assisted and supported by a hand-rail before them. The wheel makes about two rounds per minute, which is equivalent to a vertical ascent of about 32 feet per minute, and this is about the maximum of labour usually permitted on the wheel. These machines, which have now been introduced into all the great prisons in England and Wales, have been most efficacious in counteracting that feeling which disposes the worthless to balance the pleasures of idleness against the discomforts of confinement. The application of it to prisoners *before trial* was much denounced as an abuse. (See *Ed. Rev.* vol. xxxix. for a paper by the Rev. Sydney Smith on this subject.) The Court of King's Bench, however, refused a mandamus to compel the justices of Yorkshire to allow food, except bread and water, to prisoners committed for trial who refused to work.

TREASON, or HIGH TREASON. By the statute 35 E. 3. c. 2. the limits of this great offence were first accurately defined; and although subsequent enactments at different periods widely enlarged the range of actions which might be drawn within its penal character, yet most of these have been regarded as encroachments upon the principles of our jurisprudence. To compass the death of the king, queen, or king's eldest son and heir; to violate the king's wife or daughter, or the wife of the heir apparent; to levy war against the king in the realm; to assist the king's enemies in the realm or elsewhere; to counterfeit the king's privy seal; to clip or counterfeit the king's money; to slay the chancellor or other high judicial magistrates; — these are the seven species of treason constituted by this act. The many fresh species devised during the troubled periods which followed that reign, and by the arbitrary genius of Henry VIII., were repealed in the first year of the reign of Queen Mary. Of new treasons since created by analogy to those which were previously so considered, the principal are defined by 36 G. 3. c. 7.: such as conspiring to excite foreigners to invade the realm; levying war in order to compel the king to change his measures or counsels, or to overawe either house of parliament; and the expressions or declarations of such opinions by printing, writing, or any other overt act. Counterfeiting the king's money, or filing and clipping the king's coin, are still treasons; as well as having coining tools in possession, and importing false coin from abroad. Most other offences relating to the coin are of a lower description. In high treason all parties concerned are principals, no accessaries being recognised in this offence. (See the *Sixth Report of the Commissioners of Criminal Law.*)

TREA'SURER, LORD HIGH. Formerly the third great officer of the crown in England. The office is now executed by five persons, styled the lords commissioners of the treasury; one of whom holds also the office of chancellor of the exchequer. *See* TREASURY.

TREASURE TROVE. During the middle ages, *treasure trove*, or money dug from the ground, formed an important branch of the revenue of this and of most other European states. The security of property which we have enjoyed since the Revolution has, however, put, long ago, a complete stop to the practice of burying treasure in Great Britain. But down to a late period the practice was common in Ireland, and is, perhaps, not yet altogether abandoned in that country; and it is also common in some of the Continental states. Neckar mentions that in France, under the *ancien régime*, the vassals of many of the nobles, afraid of subjecting themselves to the violence of their masters, buried all the money they could scrape together; and during the anarchy and brigandage of the Revolution, vast sums were thrown into the earth. The well-informed Russian economist, M. Storch, mentions that the practice of burying treasure is still extremely prevalent in Germany, Italy, and Russia; and it must necessarily be more or less prevalent in every country exposed to the ravages of war, and where the rights of property are imperfectly protected. But it is chiefly in the despotical states of Asia, and in Turkey in Europe, that the burying of money is carried to the greatest extent. *There* every rich individual estimates his wealth, not by the stock or capital he has lent to others, or has employed in the great work of production, but principally by the amount of the treasure he has been able to conceal; and every poor man deposits in the earth whatever he can contrive to withdraw from the grasp of his avaricious masters. "The rajahs," says Mr. Luke Scrafton, in his valuable tract on Hindostan, "never let their subjects rise above mediocrity; and the Mohammedan governors look on the growing riches of a subject as a boy does on a bird's nest: he eyes their progress with impatience, then comes with a spoiler's hand and ravishes the fruit of their labour. To counteract this, the Hindoos bury their money under ground, often with such secrecy as not to trust even their own children with the knowledge of it; and it is amazing what they will suffer rather than betray it. When their tyrants have tried all manner of corporeal punishments on them, they threaten to defile them: but even that often fails; for resentment prevailing over the love of life, they frequently rip up their bowels, or poison themselves, and carry the secret to the grave." Mr. Scrafton considers that the universality of this practice, and the quantity of the precious metals which must in consequence have been lost, has been a principal cause of the long-continued drain of specie to the East. From the discovery of the American mines down to a very late period, the greatest portion of their produce has been directly or indirectly exported to Turkey, Hindostan, and other eastern countries; and yet it is said that the precious metals do not seem to have become more abundant in those countries, or the prices of commodities to be materially increased. But, without attempting to investigate the precise degree of credit that ought to be attached to this statement, it is abundantly certain that the want of security which has caused this locking up of so large a quantity of capital must be one of the main causes of the poverty and wretchedness in which the people of India, Persia, Turkey, &c. are involved.

TREA'SURY, BOARD OF. In England, the board to which is entrusted the management of all matters relating to the sovereign's civil list or other revenues. This office was formerly committed to the lord high treasurer, the third great officer of the crown; but in modern times a lord high treasurer has not been appointed, the duties of his office being executed by a board of five lords commissioners. The chief of these, or first lord of the treasury, is generally the prime minister for the time being; and, when a commoner, also chancellor of exchequer; though Sir Robert Peel has recently deviated from this practice. The salary of the first lord of the treasury is 5000*l.* per annum; that of the others 1200*l.* each. The other officers of the board are, two joint secretaries, a number of clerks (chief, senior, junior, minute, copying, &c.), a receiver of fees, a keeper of the papers, a solicitor, a chamber keeper, messengers, housekeepers, extra clerks and extra messengers.

TREA'TY. In Law, an agreement between two or more independent states. Grotius (*De Jure Belli et Pacis*, l. ii. ch. 15. s. 5.) divides treaties into two classes: those which turn on things to which the contracting parties are already bound by the law of nature, such as mutual amity, commerce, &c.; and those which contain stipulations for something more, such as treaties regulating boundaries, conceding particular powers, &c. The municipal constitution, in every state, determines in whom resides the authority to make and to ratify treaties. In most monarchies it is vested in the sovereign; in republics, in the chief magistrate, senate, or executive council; in federal states, sometimes exclusively in the federal authority, as in the United States; while in the Germanic federation the particular states retain the right of making treaties of alliance and commerce not inconsistent with the fundamental laws of the confederation. In order to enable a public minister or other diplomatic agent to conclude and sign a treaty, he must be furnished with a full power; and when so concluded the treaty is binding on the state, in the same manner as an agent is bound by the act of his principal. But the question how far, and in what cases, ratification is necessary, has been the subject of much debate among writers on international law. It is usual to reserve a power to ratify in the treaty itself. It is necessary also, in most constitutional governments, for the sanction of the legislative body to be subsequently given to treaties of commerce, or imposing taxes on the people, entered into by the executive. Thus the government of Great Britain, when making treaties, granting subsidies, &c. usually stipulates that the king will recommend to parliament to make the grant necessary for the purpose; but under the constitution of the United States, it has been thought that congress is bound to sanction treaties in general made by the president with the advice and consent of the senate. Treaties have been divided into real and personal: the former of which are said to bind the contracting parties, independently of any change of sovereignty or in the rulers of the state; the latter are made with express reference to the person of the actual ruler. But treaties properly so called, as of friendship and alliances, commerce and navigation, even if perpetual in terms, are said to expire — 1. In case either of the contracting parties cease to be an independent state; 2. When the internal constitution of government is so changed as to render the treaty no longer applicable. In this they differ from what are called transitory conventions, which pass from one government to another; such as treaties of cession, boundary, &c. (See *Wicquefort*, book ii.; *Vattel*, book ii.; Schoell, *Hist. des Traités de Paix*, 4 vols. Brussels, 1817.)

TREBLE. (Said to be the same as "threefold," sed quære?) In Music, the highest part in a concerted piece. Thus we say a treble violin, a treble hautboy, &c. In vocal music, this part is committed to boys or females. The treble is divided into first or highest treble, and second or low treble. Half treble, or, as it is sometimes called, *mezzo soprano*, is a high counter-tenor.

TRECKSCHUYT. (Dutch, *track ship or boat.*) The covered boats drawn by horses or cattle, and used for the conveyance of goods and passengers on the Dutch and Flemish canals, are so called. For an admirable description of the accommodations and management of the "treckschuyt," now so rapidly falling into disuse from the introduction of railways, see *Murray's Handbook for Northern Germany*.

TREENAILS. In Naval Language, wooden bolts by which the planks of a ship's bottom are secured to the timbers.

TREFOIL. (Lat. tres, *three*, and folia, *leaves*.) In Architecture, an ornament of three cusps in a circle; resembling three-leaved clover.

TREFOIL. A name given in English to different kinds

of three-leaved plants. White trefoil is *Trifolium repens;* yellow trefoil is *Trifolium minus;* black trefoil is *Medicago lupulina;* bird's-foot trefoil, *Lotus corniculatus.* All such plants are used for the food of cattle. The French word *trefle* has a similar application.

TREMA'NDO, *Tremolo.* (It. *trembling.*) In Music, a direction for one of the graces of harmony, which consists in a reiteration of one note of the chord: this, however, applies more directly to the word *tremolo,* whilst the *tremando* is a general shake of the whole chord.

TRE'MATODES, *Trematoda.* (Gr. τρημα, *a hole.*) The name of an order of Sterelminthans, or Parenchymatous Entozoa, comprising those which have organs of imbibition and adhesion in the form of suckers.

TREME'LLA. (Lat. tremo, *I tremble.*) A jelly-like plant of the lowest organization, found in damp walks and similar situations. It is composed of a thallus containing microscopical spores, and is closely allied to the plants called lavers.

TRE'MOLITE. A mineral, often of a fibrous texture, generally containing silica, magnesia, and carbonate of lime, originally found in the valley of Tremola on St. Gothard.

TRE'NCHES (Fr. tranché), in Fortification, are places cut out by besiegers to approach the place attacked in greater security. They are generally from 8 to 10 feet wide, and in depth something more than the height of a man, being commonly about 7 feet.

TRENT, COUNCIL OF, in Ecclesiastical History, was assembled by Paul III. in 1545; and continued, in twenty-five sessions, until 1563, under Julius III. and Pius IV. This celebrated council was convoked at a period when the Christian world was agitated by the early efforts of the reformers; and its most important decrees have therefore reference to the points on which the controversies of the Reformation chiefly turned: *e.g.* transubstantiation, image-worship, the authority of the pope. There is a certain degree of ambiguity in the expression of some of its decrees, owing to the uncertainty which the doctrines of the reformers caused in the minds of supporters of the Romish faith. But, on the whole, it cannot be denied that they express the general belief of Western Christians at the period when they were drawn up; and that they condemn, although with little decision and firmness, many of the more gross abuses of the church. The authority of these decrees (except so far as the more strictly doctrinal part of them is embodied in the creed of Pope Pius IV.) has been much debated among Romish ecclesiastics. In Germany, Poland, and Italy, they appear to have been adopted from the beginning without restriction; in Spain only with a reservation of the rights of the monarch; in France they have never been solemnly received. But as regards the more important portions of them which contain the rule of faith, they probably accurately express the belief of the Roman Catholic church at the present day. The famous history of Father Paul (*Paolo Sarpi*) is in many respects a noble model, but does not always contain a fair estimate of the subject. That of Cardinal Pallavicino represents the more Romanist view. (See *Mosheim,* vol. iii.; *Robertson's Charles V.; Hallam's Intr. to the Literature of Europe,* vol. ii.)

TREPA'N. (Gr. τρυπαω, *I perforate.*) A circular saw for perforating the skull. The term *trephine* is also applied to a similar but improved form of the instrument. (See the article "Trephine," in *Cooper's Surgical Dictionary.*)

TRE'SPASS, in Law, strictly is any transgression of the law less than felony, or misprision of felony; but is generally used to signify any wrong or damage which is done by one private person to another. *Trespass vi et armis* is where an act is done which is in itself an immediate injury to another's person or property; such as assault and battery, or breaking and entering a house or close. *Special trespass,* or *trespass on the case,* where an act is not immediately injurious, but only by consequence and collaterally. Trespass is a personal action of tort, and lies for injuries of a very miscellaneous character. Trespass on the case, as a form of action, arose originally out of a power given to the Court of Chancery to frame new writs for injuries which could not be redressed under the common forms of trespass or covenant. *Trover* and *assumpsit* are, in their origin, different forms of trespass on the case.

TRE'SSURE. In Heraldry, a border running parallel with the sides of the escutcheon, which should contain about one quarter of the bordure. It is generally either double or triple; and has usually fleur-de-lis, arranged in opposite directions alternately, perpendicular to the length of the tressure: it is then called *flory counter-flory.* The tressure forms part of the royal arms of Scotland, and of those of many noble Scottish houses.

TRESTLE TREE. *See* MAST.

TRET. In Commerce, an allowance of 4 lbs. for every 104 lbs. for the waste which certain kinds of goods are liable to from dust, &c.

TRIAD. (Gr. τρεις, *three.*) As to the mysterious triad of deities or dæmons, who are supposed by some to have been the basis of the dæmon-worship of the Greeks, according to a passage in Proceus on the *Timæus* of Plato (see *Bryant's Ancient Mythology,* vol. iii. p. 107.), "they could," he says, in accordance with his singular theory, "be no other than the three sons of Noah, who were the Baalim of the Scriptures, and the Δαιμονες and Αθανατοι of Greece." Others have imagined that the Triad of Plato and his followers was connected with the Christian Trinity. What are called by Cymric antiquaries the *Triads of the Welsh Bards* are poetical histories, in which the facts recorded are thrown into a kind of triplets. Thus, to take the commencement of the first Triad as an example,—"Three names have been given to the Isles of Britain since the beginning: Clas Merddin, Til Inys, and Inys Pridain." The Triads are supposed to be of no greater antiquity than the reign of Edward I., although they probably contain fragments of old history. (See *Turner's Anglo-Saxons,* vol. i.: "Britannia after the Romans.")

TRIAD. In Music, a compound of three sounds, which, from the extraordinary property it has of being naturally divisible into two thirds, one major and the other minor, constituting a fifth in the whole, has received the name of the *harmonic triad.* Its name is founded on its being formed of a third and a fifth, which, with the bass or fundamental sound, make three different terms.

TRIAL, in Common Law, is the examination and disposal of an issue of fact, either in criminal or civil proceedings. Trials are by *certificate.* by *inspection,* by the *record,* and *per pais,* or by a jury. The three first are of a peculiar character. Trial by certificate is where the evidence of the person certifying is the only proper test of the issue; as, the customs of the city of London are to be tried by the *certificate* of the mayor and aldermen, &c. Trial by inspection is said to be where the judges personally examine and decide the question in dispute; a practice long obsolete. Trial by the record is where the point at issue being whether or not a certain record exists, or certain averments in it, it is decided by the production of the record itself. But the ordinary trial of all facts, with these very rare exceptions, is by a jury, summoned to try the issue raised by the pleadings. Trials at bar of civil actions are those which take place before all the judges of the court of which the record is; the original, and, as it were, direct mode of trial, from which all others are variations, although it is now very rare in practice. In ordinary cases, it has been long superseded by trial at Nisi Prius (since 13 Ed. 1.). (*See* NISI PRIUS.) A trial at bar is now only granted on special grounds. Trials before the sheriff are when the demands do not exceed 20*l.*, by virtue of the stat. 3 & 4 W. 4. c. 42. s. 17. These are the only modes of disposing of issues raised on records in the superior courts; and trials of actions in courts of limited jurisdiction are governed by the same general rules. Criminal trials are had in like manner when an issue of fact, generally guilty or not guilty, is raised by the pleadings. *New trials,* in civil cases, are granted where the court of which the record is, sees reason to be dissatisfied with a verdict, either on the ground that evidence was improperly received or rejected; or that the judge misdirected the jury as to the law applicable to the facts; or that the verdict was against the weight of evidence; or that a party was unfairly surprised; or, lastly, that fresh evidence has since been discovered.

TRIA'NGLE. (Lat. triangulum.) A three-sided figure, which consequently has also three angles.

Triangles are rectilineal, spherical, or curvilineal. Rectilineal or plane triangles are bounded by straight lines; spherical triangles are formed on the surface of a sphere by the intersection of the planes of three great circles; curvilineal triangles are those which are bounded by three curves of any kind whatever.

Triangles receive other distinctive denominations from the relation of their sides and angles. Plane triangles are denominated *equilateral* when their three sides are all equal; *isosceles* when two only are equal; and *scalene* when all three are unequal. They are called *right-angled* when one of the angles is a right angle; *oblique-angled* when one of the angles is more than a right angle; and *acute-angled* when each of the angles is less than a right angle; and triangles are said to be *similar* when their angles are respectively equal each to each.

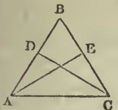
The following are some of the principal properties of plane triangles.

1. The greater side is opposite the greater angle, and *vice versâ.*

2. The sum of any two sides is greater, and the difference of any two less than the third side.

3. The sum of the three angles is equal to two right angles; and if one of the sides be produced, the exterior angle is equal to both the interior and opposite ones.

4. If A E and C D be perpendiculars from the angles A and C on the opposite sides A B and B C, then, generally, $AC^2 = AB \cdot AD + CB \cdot CE$; and, consequently, if the angle B is a right angle, $AC^2 = AB^2 + BC^2$.



5. Lines which bisect the angles of a plane triangle will pass through the centre of the inscribed circle; perpendiculars from the middle of the sides pass through the centre of the circumscribing circle; and lines drawn from the angles to the middle of the opposite sides pass through the centre of gravity.

6. Triangles are to each other in the compound ratio of their bases and altitudes.

The area of a plane triangle is found by multiplying the length of one of the sides into that of the perpendicular let fall upon it from the opposite angle; but there are various other expressions for the area, for which see TRIGONOMETRY.

TRIANGLE. In Astronomy, one of the forty-eight constellations of Hipparchus, situated in the northern hemisphere. The same name is also given to one of the twelve southern constellations formed by Bayer. There is also the *Little Triangle*, added by Hevelius, near the first named. *See* CONSTELLATION.

TRIANGLE. In Music, a small steel triangular musical instrument of percussion, open at one of its angles. It is set in vibration by being struck with a short bar of the same metal as that whereof the instrument is composed.

TRIANGLE, ARITHMETICAL. The name given by Pascal to a table of certain numbers disposed in the form of a triangle. The first vertical column of the table contains units only; the second contains the series of natural numbers; the third the series of triangular numbers; the fourth the series of pyramidal numbers; and so on. (*See* FIGURATE NUMBERS.) Thus —

1						
1	1					
1	2	1				
1	3	3	1			
1	4	6	4	1		
1	5	10	10	5	1	
1	6	15	20	15	6	1
&c.	&c.	&c.	&c.	&c.	&c.	&c.

Any number in the table is obtained by adding the number next above it, in the same column, to the number in the same line in the next preceding column; and it will be observed that the oblique diagonal rows, beginning at the left and descending towards the right, are the same as the vertical columns. One of the properties of the table is, that numbers taken on the horizontal lines are the coefficients of the different powers of a binomial. For the description and uses of the table, see the Introduction to *Hutton's Mathematical Tables*.

TRIANGULAR COMPASSES. Compasses having three legs; two opening in the usual manner, and the third turning round an extension of the central pin of the other two, besides having a motion on the central joint of its own. The instrument is useful in the construction of maps and charts, as three points may be taken off at once.

TRIANGULAR NUMBERS. The series of numbers formed by the successive sums of the terms of an arithmetical progression, of which the common difference is 1. Thus,

Arithmetical progression,	1, 2, 3, 4, 5, 6, &c.
Triangular numbers,	1, 3, 6, 10, 15, 21, &c.

The general term of the series is $\frac{1}{2}n(n+1)$. *See* FIGURATE NUMBERS.

TRIA'RII. The third, last, or veteran rank of infantry in the Roman legion. (*See* LEGION.) There is an essay on this particular rank, *Mem. de l'Ac. des Inscr.* vol. xxix.

TRIBE. (Lat. tribus.) A principal subdivision of the Roman people. The word signifies a division into three, which was the number of the patrician tribes; which were distinguished by the names Ramnes, Titienses, and Luceres. The first of these consisted of the original body of patricians; the next two were added at different times under the kings from the free citizens, who grew up round the first. The plebeian tribes, which finally included the whole people, were quite distinct from the above. They were instituted by Servius Tullius, who divided the city into four regions, and the rest of the Roman territory into twenty-six; most probably making in all thirty tribes, to correspond to the number of patrician *curiæ*. Ten of these are supposed to have been swept away by the cession of the territory on the Etruscan bank of the Tiber to Porsenna, as we hear of only twenty-one immediately after that event; the one having been most probably added. In later times, the number of tribes was increased to thirty-five, and they then included all the free citizens. In the mean time the patrician tribes became quite extinct; when all the difference of privileges enjoyed by their respective curiæ were abolished. (See *Niebuhr's Hist. of Rome*, 2d edit. p. 417.)

TRIBO'METER. (Gr. τριβω, *I rub*, and μετρον, *measure*.) In Mechanics, the name given by Musschenbroek and Coulomb to a sort of sledge, or apparatus for measuring the force of friction. *See* FRICTION.

TRIBU'NAL. A judgment seat in the forum of Rome, built by Romulus in the form of a half moon; hence any judgment seat: also a raised place in a camp, whence the general addressed his soldiers and issued orders.

TRI'BUNE. Properly, as the name denotes, the chief magistrate of a *tribe*. There were several kinds of officers in the Roman state that bore the title. 1. The plebeian tribunes, who were first created after the secession of the commonalty to the Mons Sacer (260 A. U.), as one of the conditions of its return to the city. They were especially the magistrates and protectors of the commonalty, and no patrician could be elected to the office. At their first appointment the power of the tribunes was very small, being confined to the assembling the plebeians, and the protection of any individual from patrician aggression; but their persons were sacred and inviolable, and this privilege consolidated their other powers, which, in the later ages of the republic, grew to an enormous height, and were finally incorporated with the functions of the other chief magistracies in the person of the emperor. The number of the tribunes varied from two to ten, and each of these might annul the proceedings of the rest by putting in his veto. (See *Niebuhr's Hist. of Rome*, 2d edit. i. 624.; Lableterie, *Mém. de l'Ac. des Inscr.* vol. xxxvii.) 2. Military tribunes were first elected in the year 310 A. U. in the place of the consuls, in consequence of the demands of the commonalty to be admitted to a share of the supreme power. This measure was not, however, a complete concession of their demands, but, in fact, evaded them in a great degree; for the tribunate was not vested with the full powers or honours of the consulate, not being a *curule* magistracy, and though it was open to all the people, patricians were almost invariably chosen. The number of the military tribunes was sometimes six, and sometimes three. For above seventy years sometimes consuls were elected and sometimes military tribunes; at last the old order was permanently restored, but the plebeians were admitted to a share of it. (See *Mem. de l'Ac. des Inscr.* vol. xxxvii.) 3. Legionary tribunes, or tribunes of the soldiers, were the chief officers of a legion, six in number, who commanded under the consul, each in his turn, usually about a month: in battle each led a cohort.

TRIBUNE. In Ancient Architecture, a raised seat or stand whence speeches were delivered to the people; the term is still used in this sense in the French chambers.

TRI'BUTE. (Lat. tribuo, *I give*.) A sum of money paid by inferior sovereign or state to a superior potentate, to secure the friendship or protection of the latter. The *black mail* formerly levied by the Scottish borderers on their less powerful neighbours, for protecting their property from the depredations of caterans, was a species of tribute.

TRI'CA. In Botany, one of the names of the shield or reproductive organ of a lichen.

TRICHE'CHUS. (Gr. θριξ, *hair*, and ιχθυς, *fish*.) A name invented by Artedi to designate the manatee, as being the only species of fish, or whale-fish, that was hairy: "quia solus inter pisces fere hirsutus sit." Linnæus, in his *System of Nature*, adopted the term *trichechus* as the generic appellation for the manatee (*Trichechus manatus*); but he added the walrus as a second species of the genus. Subsequent zoologists, in separating these very different animals, and placing them in distinct genera, have in this, as unfortunately in too many other cases, invented a new generic name for the animal so well designated by its original epithet, and have restricted the application of the term *trichechus* to the walrus, for which it was not originally designed.

TRICHI'ASIS. (Gr. θριξ, *a hair*.) A disease of the eyelids, in which the eyelashes grow inwards and irritate the bulb of the eye.

TRICHI'DIUM. (Gr. θριξ.) A netted filamentous organ, resembling a netted purse, in which the spores of some kinds of fungi are included.

TRICHI'NA. (Gr. diminutive of θριξ.) The name of a genus of microscopic encysted Entozoa, which infest the muscular tissue of the human subject.

TRICHIU'RUS. (Gr. θριξ, and ουρα, *a tail*.) The name of a genus of spiny-finned fishes, literally rendered in their popular English name of "hair-tails," significative of their most striking generic character, which is taken from the single elongated hair-like filament that terminates the rayless tail. The *Trichiuri* have no anal fin, and have neither ventral fins nor supplemental scales. But one species, viz. the silvery hair-tail (*Trichiurus lepturus*, Linn.), has been admitted into the catalogue of British fishes.

TRICHOCE'PHALUS. (Gr. θριξ, and κεφαλη, *a head.*) The name of a genus of Hematoid Entozoons, one species of which (*Trichocephalus dispar*, Rudolphi) infests the human intestinum cœcum.

TRICHOP'TERANS, *Trichoptera*. (Gr. θριξ, and πτερον, *a wing.*) The name of an order of insects founded by Kirby for the case-worm flies, which are characterized by four hairy membranous wings, resembling in their nervures those of the Lepidopterans; the under ones folding longitudinally.

TRICLI'NIUM. (Gr. τρεις, *three*, and κλινη, *a couch.*) In Ancient Architecture, a room furnished on three sides with couches, the fourth side being left open for facilitating the attendance of the servants, in which company was received and the repasts served. The winter triclinia were placed to the west, and those for summer to the east.

TRI'COLOR. The national French banner of three colours, blue, white, and red, adopted on the occasion of the first revolution. The immediate occasion for adopting them is said to have been that they were the colours worn by the servants of the Duke of Orleans; and they were first assumed by the people when the minister Neckar was dismissed in 1789. But these colours, in combination, appear to have formed a national emblem in France from a very early period. It is also said to have been formed by uniting the three colours successively used in the French standards at different periods; viz. the blue of the banner of St. Martin, the red of the oriflamme (*see* ORIFLAMME), and the white of the white cross, supposed to have been assumed under Philip of Valois. The three colours were given by Henry IV. to the Dutch on their desiring him to confer on them the national colours of his country; and they have since been borne successively by the Dutch republic and the kingdom of the Netherlands. The domestic livery of Louis XIV. was tricoloured, as were also the liveries of the Bourbon kings in Spain. At the Revolution, when the three colours were assumed on the national flag, they were borne in the same order as the Dutch, but in a different position, viz. the division of colours parallel to the flag staff; whereas in the Dutch flag it is at right angles with it. Tricoloured flags have been adopted in some of the German states, and in Belgium, &c.; and they are often employed as emblematical of liberty.

TRICU'SPID VALVE. The valve of the right ventricle of the heart.

TRI'DENT. (Lat. tres, *three*, and dens, *a tooth.*) The sceptre which the poets and painters of antiquity placed in the hand of Neptune is so called by way of eminence. It is in the form of a spear or fork with three prongs or teeth; hence the name. *See* NEPTUNE.

TRI'ENS. A small Roman copper coin, worth one third of the *as* (which see), as the derivation of the word implies. This was the piece of money usually placed in the hands of the deceased poor to pay Charon for their passage over the Styx.

TRIERA'RCHIA. (Gr. τριηραρχια.) An Athenian institution which imposed on a certain body of citizens the duty of fitting out triremes for the use of the state. About 1200 citizens were usually chosen for this purpose from the richest individuals, and these were subdivided into clubs of 12 or 16 to each ship. Demosthenes introduced a new regulation, by which the burden to be borne by each individual was made to bear a given proportion to his property. (See Boeckh, *Public Economy of Athens*, ii. 319. 360.)

TRIE'TERIS. (Gr. τρεις, *three*, and ετος, *a year.*) In Grecian Chronology, a cycle invented by Thales to connect his year, which consisted of 12 months of 30 days each, amounting to 360 days; this falling short of the true solar year, he inserted a month of 30 days at the end of every three years, by which means he made it exceed the true year by 13 days.

TRIFO'RIUM. (Lat.) In Gothic Architecture, an arched story between the lower arches and the clerestory in the aisles, choir, and transepts of a church. An example may be seen in Westminster Abbey, where the triforium affords a communicating gallery entirely round the church.

TRI'GAMOUS (Gr. τρεις, *three*, and γαμος, *marriage*), is a name applied by some botanists to plants containing three sorts of flowers in the same flower-head; that is to say, males, females, and hermaphrodites.

TRIGE'MINI. (Lat. tres, *three*, and geminus, *double.*) The fifth pair of nerves: they arise from the crura of the cerebellum, and are divided within the cranium into three branches; namely, the orbital, and the superior and inferior maxillary. The orbital branch is divided into the frontal, lachrymal, and nasal nerves; the superior maxillary into the spheno-palatine, posterior alveolar, and infra-orbital nerves; and the inferior maxillary into two branches, the internal lingual, and one more appropriately termed the infra-maxillary.

TRI'GLYPH. (Gr. τρεις, *three*, and γλυφω, *I carve.*) In Architecture, an ornament in the Doric frieze, consisting of two whole and two half channels, separated by flat spaces called *femora*.

TRI'GONALS, *Trigona*. (Gr. τρεις, *three*; γωνια, *an angle.*) The name of a family of Decapodous Crustaceans, the carapace of which is nearly triangular. *Trigonia* is also the name of a genus of Bivalves of a triangular form, and of which most of the species are fossil.

TRIGO'NIA. (Gr. τριγωνος, *having three corners.*) A name applied by Lamarck to a genus of Ostracean Bivalves, most of the species of which are found fossil; but which has a beautiful recent representative in the seas of the southern hemisphere, remarkable for the iridescent lining of the valves, *La Trigo nacrée* of Lamarck. It is also the name of a genus of South American plants.

TRIGONOCE'PHALUS. (Gr. τριγωνος, and κεφαλη, *a head.*) A genus of poisonous serpents, characterized by having the tail terminated by a horny conical process or spur. No species is known to inhabit Europe or Africa, in which continents the *Trigonocephali* are replaced by the vipers. The poisonous serpent of the island of Martinique, called by the French settlers "fer de lance," is a species of the present genus (*Trigonocephalus lanceolatus*).

TRIGONO'METRY. (Gr. τριγωνος, *triangle*, μετρον, *measure.*) This term, as its derivation implies, originally signified the measurement of triangles, or the branch of mathematics which treats of the relations between the sides and angles of triangles; but in its modern acceptance it includes all formulæ relative to angles or circular arcs, and the lines connected with them, these lines being expressed by numbers or ratios. In relation to its practical utility, it may be regarded as the most important of all the applications of mathematics.

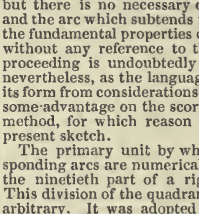
The magnitude of an angle is usually measured by the circular arc which has its centre at the angular point, and is intercepted by the straight lines forming the angle; but there is no necessary connection between an angle and the arc which subtends it, and in some modern works the fundamental properties of trigonometry are explained without any reference to the circle. This method of proceeding is undoubtedly more direct than the other; nevertheless, as the language of trigonometry has taken its form from considerations respecting the circle, there is some advantage on the score of perspicuity in the ancient method, for which reason we shall adhere to it in the present sketch.

The primary unit by which angles and their corresponding arcs are numerically expressed is the *degree*, or the ninetieth part of a right angle or of a quadrant. This division of the quadrant into ninety parts is entirely arbitrary. It was adopted by the ancient Greeks, and has been all but universally followed down to the present time; for although the French mathematicians attempted to introduce the decimal system, by dividing the quadrant into a hundred parts, their example has not been imitated, as the first effect of the alteration would be to derange and render useless the whole of the existing trigonometrical tables.

The degree is divided into 60 minutes, and the minute into 60 seconds. Anciently the seconds were subdivided into thirds; but the practice of writing down the parts of seconds as decimals is now universally followed. The expression $20^{\circ}\ 16'\ 43{\cdot}57''$ is read 20 degrees, 16 minutes, 43 seconds, 5 tenths and 7 hundredths of a second.

Let B A C (fig. 1.) be an angle contained by the two straight lines A B, A C; with A as a centre, and radius A B, describe a circle; let B A be produced to meet the circumference in E, and draw the diameter D F perpendicular to B E. From C draw C H and C K respectively perpendicular to B E and D F; and let B L and D M be also perpendicular to B E and D F, meeting A C produced in L and M. Now, since the angles at the centre of a circle are proportional to the arcs on which they stand, the arc B C may be taken as the geometrical measure of the angle B A C, and both will be expressed without distinction by the same number of degrees, minutes, &c. The following definitions are used.

(1.)



The arc D C, which is the defect of B C from the quadrant, is called the *complement* of B C; and C E, which is its defect from the semicircle, is called its *supplement*. C H is the *sine* of the arc B C, and C K or A H is the sine of its complement, or the *cosine* of B C; B L is the *tangent* of the arc B C, and D M is the tangent of its complement, or the *cotangent* of B C; A L is the *secant* of B C, and A M the secant of its complement, or its *cosecant*; B H is the *versed sine* of B C, and D K its

co-versed sine. These appellations are abridged as follows: — The arc being denoted by the single letter A, its sine is expressed by *sin* A; its cosine by *cos* A; its tangent by *tan* A; its cotangent by *cot* A; its secant by *sec* A; its cosecant by *cosec* A; its versed sine by *ver sin* A; and its co-versed sine by *co-ver sin* A.

Since the arc B C is assumed as the measure of the angle B A C, the above lines may be regarded respectively as the sine, cosine, tangent, &c. of the angle; and since all quantities used in trigonometry are to be expressed by numbers, we may take, instead of those lines, any numbers which are proportional to them; and thence we may assume the ratio of the arc B C to the radius A B, that is, B C÷A B, as the measure of the angle BAC. In like manner the sine of the angle B A C may be represented by C H ÷ A B, its cosine by A H ÷ A B, its tangent by B L ÷ A B, its secant by A L ÷ A B, its cotangent by D M ÷ A D, and its cosecant by A M ÷ A D. Adopting these definitions, the values of the trigonometrical functions of the angle B A C will evidently remain the same when the angle remains constant, whatever be the magnitude of the circle to which they are referred. It is usual to regard the radius A B as a unit, in which case the sines, cosines, tangents, &c. will be expressed in terms of that unit by the decimal notation. This is the way in which they are expressed in the trigonometrical tables.

From the right-angled triangles in the above diagram, we have $AH^2 + HC^2 = AC^2$, $AB^2 + BL^2 = AL^2$, $AD^2 + DM^2 = AM^2$; and because the three triangles A H C, A B L, A D M are similar, we have also

$$AH : HC :: AB : BL :: DM : DA;$$
$$HC : CA :: BL : LA :: DA : AM;$$
$$CA : AH :: LA : AB :: AM : DM.$$

Making the radius A B = A C = A D = 1, and denoting the angle B A C by A, these proportions give

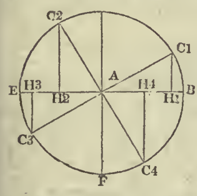
$$\cos A : \sin A :: 1 : \tan A :: \cot A : 1;$$
$$\sin A : 1 :: \tan A : \sec A :: 1 : \operatorname{cosec} A;$$
$$1 : \cos A :: \sec A : 1 :: \operatorname{cosec} A : \cot A;$$

from which, and the above equations, we obtain the following table of formulæ, exhibiting the relations among the trigonometrical lines: —

$$\cos^2 A + \sin^2 A = 1.$$
$$\sec^2 A - \tan^2 A = 1.$$
$$\operatorname{cosec}^2 A - \cot^2 A = 1.$$
$$\cos A \sec A = 1.$$
$$\sin A \operatorname{cosec} A = 1.$$
$$\tan A \cot A = 1.$$
$$\tan A \cos A = \sin A.$$
$$\cot A \sin A = \cos A.$$
$$\sin A \sec A = \tan A.$$
$$\cos A \operatorname{cosec} A = \cot A.$$
$$\tan A \operatorname{cosec} A = \sec A.$$
$$\cot A \sec A = \operatorname{cosec} A.$$

Of the Signs of the Trigonometrical Lines. — In the above definitions and formulæ the angle A was assumed to be less than a right angle, or less than 90°, and the sine, cosine, tangent, &c. were all regarded as positive. We have now to inquire what the expressions severally become as the arc increases through all its values from 0 to 360°. As before, let B E and D F (fig. 2.) be two diameters of the circle at right angles to each other; suppose the arc to begin at B; let BC_1 be less than a quadrant, and let the arc BC_1 or angle BAC_1 be denoted by A. Draw AC_2 at right angles to A C ; then, since C_1C_2 is 90°, the arc $BC_2 = 90 + A$. Let C_1A be produced to meet the circumference in C_3; then (reckoning always in the same direction) $BC_3 = 180° + A$. Lastly, let C_2A be produced to meet the circumference in C_4, and we have BC_4 (or $BDEC_4$) $= 270° + A$. Draw C_1H_1, C_2H_2, &c. perpendicular to E B. Now, according to the usual conventions of analytical geometry, if the point A be regarded as the origin of the co-ordinates, and distances measured in the direction A B be considered as positive, those measured in the direction A E will be negative; and of the lines perpendicular to E B, if those above E B be positive, those below it will be negative. Hence the sines and cosines of arcs in the different quadrants will be as follows: —

(2.)



In the first quadrant the arc BC_1 (= A) is less than 90°, and C_1H_1 and AH_1 are both positive; that is, sin A and cos A are positive. In the second quadrant we have $BC_2 = 90° + A$; its sine is C_2H_2 which is positive, and its cosine is AH_2, which is negative. But from similar triangles we have $C_2H_2 = AH_1$, and $AH_2 = C_1H_1$; therefore, $\sin(90° + A) = \cos A$, and $\cos(90 + A) = -\sin A$. In the third quadrant, we have $AC_3 = 180 + A$; the sine is C_3H_3 negative, and the cosine is AH_3 positive; but $C_3H_3 = C_1H_1$, and $AH_3 = AH_1$; therefore $\sin(180° + A) = -\sin A$, and $\cos(180 + A) = -\cos A$. In the fourth quadrant we have $AC_4 = 270° + A$; the sine is C_4H_4 negative, and the cosine is AH_4 positive. But $C_4H_4 = AH_1$, and $AH_4 = C_1H_1$; therefore $\sin(270° + A) = -\cos A$, and $\cos(270° + A) = \sin A$.

Having found the directions and values of the sine and cosine of an arc in each of the different quadrants, those of the tangent, cotangent, secant, and cosecant are also determined; for the above formulæ give

$$\tan A = \frac{\sin A}{\cos A},\ \cot A = \frac{\cos A}{\sin A},\ \sec A = \frac{1}{\cos A},$$
$$\operatorname{cosec} A = \frac{1}{\sin A}.$$

Whence it appears that the tangent and cotangent will be positive when the sine and cosine have both the same sign, that is, in the first and third quadrants; and negative when the sine and cosine have opposite signs, that is, in the second and fourth quadrants. It follows also that the secant has always the same sign as the cosine, and the cosecant the same as the sine.

On these principles the following table is constructed, which will very frequently be found useful in calculation, as it shows not only the sign to be prefixed to the several trigonometrical lines when the arcs to which they belong exceed 90°, but also how to find those lines in tables which contain them only for the first quadrant.

1st Quadrant.	2d Quadrant.
+ sin A	sin (90° + A) = + cos A
+ cosec A	cosec (90° + A) = + sec A
+ cos A	cos (90° + A) = — sin A
+ sec A	sec (90° + A) = — cosec A
+ tan A	tan (90° + A) = — cot A
+ cot A	cot (90° + A) = — tan A
3d Quadrant.	**4th Quadrant.**
sin (180° + A) = — sin A	sin (270° + A) = — cos A
cosec(180°+A)=—cosec A	cosec (270°+A) = — sec A
cos (180° + A) = — cos A	cos (270° + A) = + sin A
sec 180° + A) = — sec A	sec (270°+A) = + cosec A
tan (180° + A) = + tan A	tan (270° + A) = — cot A
cot (180° + A) = + cot A	cot (270° + A) = — tan A

Of the Trigonometrical Tables. — We now proceed to show how the different trigonometrical lines may be computed. The ordinary tables contain the logarithms of the sines, cosines, tangents, and cotangents for every ten seconds, and some of the better tables, as Taylor's, Baguay's, &c., for every second of the quadrant; but it is evident from the formulæ given above that if the values of any one of the four be computed for the different angles between 0 and 90°, the values of all the others will be obtained at the same time. Thus, since $\cos A = \sin(90° - A)$, a table of the values of the sine is also a table of the values of the cosine; and since $\tan A = \sin A \div \cos A$, the logarithm of the tangent of any angle is obtained by subtracting the logarithm of the cosine from the logarithm of the sine, and the logarithm of the cotangent by subtracting the logarithm of the sine from that of the cosine. The whole difficulty, therefore (or nearly the whole, for some peculiar artifices must be employed when the angles differ very little from 0, or from 90°), is reduced to the computation of the sine; and as this is expressed indefinitely in terms of the arc, it is necessary, first of all, to determine the length of the whole circumference in terms of the radius, from which the arc corresponding to any given number of degrees, minutes, and seconds, is found by proportion.

It is usual to designate the semicircumference of a circle whose radius is 1 by π. A great number of formulæ have been given for computing the value of π by means of infinite series. The following, which was discovered by Mechin, is the most rapidly convergent, and therefore the best adapted for computation: —

$$\pi = 16\left(\frac{1}{5} - \frac{1}{3 \cdot 5^3} + \frac{1}{5 \cdot 5^5} - \frac{1}{7 \cdot 5^7} + \frac{1}{9 \cdot 5^9} - \text{\&c.}\right)$$
$$-4\left(\frac{1}{239} - \frac{1}{3 \cdot 239^3} + \frac{1}{5 \cdot 239^5} - \frac{1}{7 \cdot 239^7} + \text{\&c.}\right).$$

By computing a few of the terms of this series, the value of π is readily obtained. The following is its value correct to 20 decimals: —

$$\pi = 3{\cdot}14159265358979323846, \text{ \&c.}$$

The series which give the trigonometrical lines in terms of the arc are as follows: — Let x be any arc less than 90°, then

$$\sin x = x - \frac{x^3}{1 \cdot 2 \cdot 3} + \frac{x^5}{1 \cdot 2 \cdot 3 \cdot 4 \cdot 5} - \frac{x^7}{1 \cdot 2 \cdot 3 \cdot 4 \cdot 5 \cdot 6 \cdot 7} + \text{\&c.}$$
$$\cos x = 1 - \frac{x^2}{1 \cdot 2} + \frac{x^4}{1 \cdot 2 \cdot 3 \cdot 4} - \frac{x^6}{1 \cdot 2 \cdot 3 \cdot 4 \cdot 5 \cdot 6} + \text{\&c.}$$

$$\tan x = x + \frac{x^3}{3} + \frac{2x^5}{3\cdot 5} + \frac{17x^7}{3^2\cdot 5\cdot 7} + \frac{62x^9}{3^2\cdot 5\cdot 7\cdot 9} + \text{\&c.}$$

$$\cot x = \frac{1}{x} - \frac{x}{3} - \frac{x^3}{3^2\cdot 5} - \frac{2x^5}{3^3\cdot 5\cdot 7} - \frac{x^7}{3^3\cdot 5^2\cdot 7} - \text{\&c.}$$

$$\sec x = 1 + \frac{x^2}{1\cdot 2} + \frac{5x^4}{1\cdot 2\cdot 3\cdot 4} + \frac{61a^6}{1\cdot 2\cdot 3\cdot 4\cdot 5\cdot 6} + \text{\&c.}$$

$$\operatorname{cosec} x = \frac{1}{x} + \frac{x}{1\cdot 2\cdot 3} + \frac{7x^3}{3\cdot 4\cdot 5\cdot 6} + \frac{31x^5}{3\cdot 4\cdot 5\cdot 6^2\cdot 7} + \text{\&c.}$$

For other and more expeditious methods of computing the trigonometrical lines, or deriving them from one another, the reader is referred to the Preface to the *Tables Trigonometriques Decimales*, by Delambre; or to *Callet's* or *Hutton's Tables*.

The following expressions for the sine and cosine of an angle, found by John Bernoulli, are of frequent use in analytical trigonometry:—Let $e = 2{\cdot}7182818$ (the base of the Napierean logarithms), then

$$\sin x = \frac{e^{x\sqrt{-1}} - e^{-x\sqrt{-1}}}{2\sqrt{-1}};$$

$$\cos x = \frac{e^{x\sqrt{-1}} + e^{-x\sqrt{-1}}}{2}.$$

To these we may add the following formula for a multiple angle, discovered by Demoivre, which is readily deduced from them (m is any number whatever):—

$$\left(\cos x + \sin x\sqrt{-1}\right)^m = \cos mx + \sin mx\sqrt{-1}.$$

Formulæ relative to Two Arcs.— In trigonometrical calculations, it is very frequently necessary to express the sines, cosines, &c. of the sum or difference of two angles in terms of the sines, cosines, &c. of the single angles. The following table contains a synopsis of the most useful formulæ; the first four are easily demonstrated by means of a simple geometrical construction, and all the others are deduced from these four by the ordinary algebraic transformations:—

$$\cos(A + B) = \cos A \cos B - \sin A \sin B.$$
$$\cos(A - B) = \cos A \cos B + \sin A \sin B.$$
$$\sin(A + B) = \sin A \cos B + \cos A \sin B.$$
$$\sin(A - B) = \sin A \cos B - \cos A \sin B.$$
$$\cos B + \cos A = 2\cos\tfrac{1}{2}(A + B)\cos\tfrac{1}{2}(A - B).$$
$$\cos B - \cos A = 2\sin\tfrac{1}{2}(A + B)\sin\tfrac{1}{2}(A - B).$$
$$\sin A + \sin B = 2\sin\tfrac{1}{2}(A + B)\cos\tfrac{1}{2}(A - B).$$
$$\sin A - \sin B = 2\cos\tfrac{1}{2}(A + B)\sin\tfrac{1}{2}(A - B).$$

$$\tan(A + B) = \frac{\tan A + \tan B}{1 - \tan A\tan B}.$$

$$\tan(A - B) = \frac{\tan A - \tan B}{1 + \tan A\tan B}.$$

$$\cot(A + B) = \frac{1 - \tan A\tan B}{\tan A + \tan B}.$$

$$\cot(A - B) = \frac{1 + \tan A\tan B}{\tan A - \tan B}.$$

$$\tan A + \tan B = \frac{\sin(A + B)}{\cos A\cos B}.$$

$$\tan A - \tan B = \frac{\sin(A - B)}{\cos A\cos B}.$$

$$\cot A + \cot B = \frac{\sin(A + B)}{\sin A\sin B}.$$

$$\cot B - \cot A = \frac{\sin(A - B)}{\sin A\sin B}.$$

$$\tan A + \cot B = \frac{\cos(A - B)}{\cos A\sin B}.$$

$$\cot A - \tan B = \frac{\cos(A + B)}{\sin A\cos B}.$$

$$\cos 2A = 1 - 2\sin^2 A,\quad \sin 2A = 2\sin A\cos A.$$

$$\tan 2A = \frac{2}{\cot A - \tan A},\quad \cot 2A = \tfrac{1}{2}(\cot A - \tan A).$$

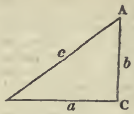
$$\cos\tfrac{1}{2}A = \sqrt{[\tfrac{1}{2}(1 + \cos A)]},\quad \sin\tfrac{1}{2}A = \sqrt{[\tfrac{1}{2}(1 - \cos A)]}.$$

$$\tan\tfrac{1}{2}A = \frac{\sin A}{1 + \cos A},\quad \cot\tfrac{1}{2}A = \frac{\sin A}{1 - \cos A}.$$

Solution of Plane Triangles.— Having explained the nature of the trigonometrical quantities, and exhibited some of their most useful relations, we come next to apply them to the solution of triangles, which forms the proper object of trigonometry. Of the six parts of which a triangle consists, namely, the three sides and the three angles, it is known from geometry that when any three (excepting the three angles) are given, all the rest are determined; accordingly, we have to find expressions for each part in terms of three others, and so arranged that they can be immediately calculated from a table which contains the logarithms of the sines, cosines, tangents, and cotangents to every minute or smaller division of the quadrant. The solution of triangles may therefore be regarded as the art of applying such a table to each particular case. It is convenient to consider the cases of the right-angled triangles separately.

Right-angled Plane Triangles.— In all the solutions which follow, the sides of the triangle will be denoted by a, b, c; and the angles respectively opposite by A, B, C. In the right-angled triangle A B C (fig. 3.), let C be the right angle, and consequently c the hypothenuse. There are four distinct cases, and in each case the solution follows immediately from the definition of the sine, cosine, tangent, and cotangent.

(3.)



Case 1. Given the two sides a and b to find the angles A and B, and the hypothenuse c. Here we have from the definition

$$\tan A = \frac{a}{b};\ \tan B = \frac{b}{a};\ \cos A = \frac{b}{c};\ \text{whence } c = \frac{b}{\cos A},$$

or in like manner $c = a \div \cos B$.

Case 2. Given the hypothenuse c and a side a, to find the angles A and B and the side b. Here

$$\sin A = \cos B = \frac{a}{c};\ \sin B = \frac{b}{c};\ b = c\sin B = c\cos A.$$

The side b may be found independently of the angles; for since $b^2 = c^2 - a^2$, we have $b = \sqrt{[(c + a)(c - a)]}$.

Case 3. Given a side a and one of the acute angles A, to find the other side b, the hypothenuse c, and the angle B.

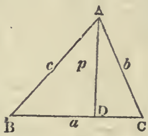
$$\text{Here } \cot A = \frac{b}{a};\ \sin A = \frac{a}{c};\ b = a\cot A;\ c = \frac{a}{\sin A}.$$

For the angle we have $B = 90^\circ - A$.

Case 4. Given the hypothenuse c and an angle A, to find the sides a and b and the other angle B. Here $a = c\sin A$; $b = c\cos A$; $B = 90 - A$.

Oblique-angled Plane Triangles.— The solutions of the different cases are all derived from the three following propositions: First, the sum of the three interior angles of any triangle is equal to two right angles; that is, $A + B + C = 180^\circ$ . . . . (1.) Secondly, in any triangle, the sides are to each other as the sines of the opposite angles. For, draw A D (fig. 4.) perpendicular to B C, and let A D $= p$; we then have $\sin B = \frac{p}{c}$, $\sin C = \frac{p}{b}$;

(4.)



whence $\frac{\sin B}{\sin C} = \frac{b}{c}$. The same property must evidently hold true of sides a and c, and a and b; whence

$$\frac{\sin A}{\sin B} = \frac{a}{b};\ \frac{\sin B}{\sin C} = \frac{b}{c};\ \frac{\sin C}{\sin A} = \frac{c}{a}\ \ldots\ (2.)$$

The third general property may be derived from the second, but is more readily found as follows:—In the last figure let B D $= m$, D C $= n$; we have then $m = a - n$, whence $m^2 = a^2 + n^2 - 2an$. Adding p^2 to both sides, and observing that $m^2 + p^2 = c^2$, $n^2 + p^2 = b^2$, and $n = b\cos C$, we have $c^2 = a^2 + b^2 - 2ab\cos C$, and consequently

$$\cos C = \frac{a^2 + b^2 - c^2}{2ab}\ \ldots\ (3.)$$

We now proceed to give the solutions of the different cases, of which there are four.

Case 1. Given the three sides, a, b, c, to find the three angles A, B, C.

$$\text{Put } s = \tfrac{1}{2}(a + b + c),\ M = \sqrt{\left\{\frac{(s-a)(s-b)(s-c)}{s}\right\}};$$

$$\text{then } \tan\tfrac{1}{2}A = \frac{M}{s - a},\ \tan\tfrac{1}{2}B = \frac{M}{s - b},\ \tan\tfrac{1}{2}C = \frac{M}{s - c}.$$

Case 2. Given two sides, a, b, and the included angle C, to find the other side c, and the other angles A, B.

Find first the sum and difference of A and B from these two formulæ, $A + B = 180^\circ - C$, $\tan\tfrac{1}{2}(A - B) = \frac{a - b}{a + b}\tan\tfrac{1}{2}(A + B)$; then

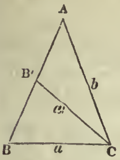
$$A = \tfrac{1}{2}(A + B) + \tfrac{1}{2}(A - B).$$
$$B = \tfrac{1}{2}(A + B) - \tfrac{1}{2}(A - B).$$
$$c = a\frac{\sin C}{\sin A} = b\frac{\sin C}{\sin B}.$$

Case 3. Given two sides a, b, and the angle opposite one of them, A, to find the third side c, and the other angles B, C.

Here we have $\sin B = \frac{b}{a}\sin A$; $C = 180^\circ - (A + B)$;

$c = a \dfrac{\sin C}{\sin A} = b \dfrac{\sin C}{\sin B}$. In this scae, however, it is necessary to remark, that if the side which is adjacent to the given angle be greater than the side opposite to it (that is, if b be greater than a), then there are two triangles which furnish the same data, and consequently the solution is ambiguous. For with C (fig. 5.) as a centre, and radius equal to C B, describe an arc of a circle intersecting A B in B′, and join C B′; it is obvious that the data a, b, A belong to both triangles A C B and A C B′, and the solution gives alike $c =$ A B, and $c =$ A B′. The solution is therefore said to be ambiguous.

(5.)



Case 4. Given two angles, A, B, and the side between them c.

In this case the third angle is likewise given by reason of $C = 180^\circ - (A + B)$, and consequently the sides are found from the formulæ

$$a = c \frac{\sin A}{\sin C},\ b = c \frac{\sin B}{\sin C}.$$

Area of a Plane Triangle.—Euclid has shown that the area of any plane triangle is equal to the rectangle contained under half the base and the perpendicular let fall on it from the opposite angle; that is, area $= \frac{1}{2} a p$ (fig. 4.) But for p we may substitute $b \sin C$ (or $c \sin B$), and we have area $= \frac{1}{2} a b \sin C$. If from this expression we eliminate b by the first of the equations (2.), we shall have the area in terms of a side and the three angles; or, if we eliminate sin C by means of the formula (3.) and the equation $\cos^2 C = 1 - \sin^2 C$, we shall have an expression for the area in terms of the three sides. Assume $s = \frac{1}{2}(a + b + c)$; then the area is expressed by any of the following formulæ:—

$$\text{area} = \frac{a b \sin C}{2} = \frac{a^2 \sin B \sin C}{2 \sin A} = \sqrt{[s(s-a)(s-b)(s-c)]}.$$

Spherical Trigonometry.—This branch of trigonometry considers the relations between the sides and angles of triangles formed on a sphere. Before giving the formulæ for the solutions of the different cases, it will be useful to state a few elementary properties of spherical triangles, depending on principles purely geometrical.

The following definitions must be premised:—1. The common section of the spherical surface and any plane passing through the centre of the sphere is called a *great circle* of the sphere. 2. The *pole* of a great circle is a point on the surface of the sphere from which all straight lines drawn to that great circle are equal. 3. A *spherical angle* is the angle on the surface of the sphere made by two great circles at their intersection. It is identical with the angle made by the planes of the circles, and is measured by an arc of the great circle whose pole is at the angular point. 4. A *spherical triangle* is a figure on the surface of the sphere bounded by three arcs of great circles, each of which is less than a semicircle. 5. Any arc of a great circle is the measure of the plane angle formed at the centre of the sphere by the two radii passing through the extremities of the arc.

From these definitions the following properties are easily derived:—

1. The distance of a great circle from its pole is a quadrant.

2. If two great circles cut one another at right angles, each passes through the pole of the other; and, consequently, if two great circles cut a third at right angles, they will meet in its pole.

3. A spherical triangle which has two equal sides has the angles opposite to those sides equal, and the greater side has the greater angle opposite to it.

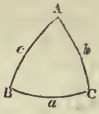
4. The sum of any two sides is greater than the third, the difference of any two less than the third; and the sum of all the three sides is less than the circumference of a great circle.

5. If about the angular points of a spherical triangle as poles there be described three great circles on the sphere, these, by their intersections, will form a triangle which is said to be *supplemental* to the former; and the two triangles are such that the sides of the one are the supplements of the arcs which measure the angles of the other.

6. The sum of the three angles of any spherical triangle is greater than two right angles, but less than six right angles.

Solution of Spherical Triangles.—The solutions of all the different cases of spherical triangles are comprehended in the four following sets of formulæ; and it will be remarked that the different formulæ in each set express all the same property, and are formed by merely interchanging the letters. Those of the first set are readily demonstrated from the properties of the triangular pyramid, or *tetraedron*, and the others may be all deduced analytically from the first; so that, in fact, the whole of spherical trigonometry is comprehended in the first of the underwritten equations. The radius of the sphere is supposed to be unity; the three sides or arcs are respectively denoted by a, b, c (fig. 6.), and the measures of the angles respectively opposite by A, B, C. It is to be observed that the sides a, b, c (as well as the angles A, B, C), are expressed in degrees, minutes, &c.; and not, as in plane trigonometry, in absolute measures, as feet, yards, &c.

(6.)



I.

$$\cos a = \cos b \cos c + \sin b \sin c \cos A.$$
$$\cos b = \cos a \cos c + \sin a \sin c \cos B.$$
$$\cos c = \cos a \cos b + \sin a \sin b \cos C.$$

II.

$$\frac{\sin b}{\sin a} = \frac{\sin B}{\sin A},\ \frac{\sin c}{\sin a} = \frac{\sin C}{\sin A},\ \frac{\sin b}{\sin c} = \frac{\sin B}{\sin C}.$$

III.

$$\cot a \sin b = \cot A \sin C + \cos b \cos C.$$
$$\cot a \sin c = \cot A \sin B + \cos c \cos B.$$
$$\cot b \sin a = \cot B \sin C + \cos a \cos C.$$
$$\cot b \sin c = \cot B \sin A + \cos c \cos A.$$
$$\cot c \sin a = \cot C \sin B + \cos a \cos B.$$
$$\cot c \sin b = \cot C \sin A + \cos b \cos A.$$

IV.

$$\cos A = -\cos B \cos C + \sin B \sin C \cos a.$$
$$\cos B = -\cos A \cos C + \sin A \sin C \cos b.$$
$$\cos C = -\cos A \cos B + \sin A \sin B \cos c.$$

The above general formulæ apply to every case of spherical triangles; but when one of the angles is a right angle, they become considerably more simple; and, in the case of oblique-angled triangles, they admit of transformations, by which they are rendered more convenient for logarithmic calculation.

Right-angled Spherical Triangles.—As before, let C be the right angle and c the hypothenuse.

(7.)

Case 1. Given the two sides a, b, to find the hypothenuse c, and the two oblique angles A, B. Here

$$\cos c = \cos a \cos b;\ \tan A = \frac{\tan a}{\sin b};\ \tan B = \frac{\tan b}{\sin a}.$$

Case 2. Given the hypothenuse c and a side b, to find the other side a and the two oblique angles.

$$\cos a = \frac{\cos c}{\cos b};\ \cos A = \frac{\tan b}{\tan c};\ \sin B = \frac{\sin b}{\sin c}.$$

Case 3. Given a side a and the opposite angle A, to find the other side b, the hypothenuse c, and the angle B.

$$\sin b = \frac{\tan a}{\tan A};\ \sin c = \frac{\sin a}{\sin A};\ \sin B = \frac{\cos A}{\cos a}.$$

In this case it is necessary to observe, that as a sine belongs to the supplement of the angle as well as to the angle itself, each of the things to be found has two values; and consequently the solution is ambiguous, as two distinct triangles may be formed of the same data.

Case 4. Given a side a, and the adjacent angle B; to find b, c, and A.

$$\tan b = \sin a \tan B;\ \cot c = \cot a \cos B;\ \cos A = \cos a \sin B.$$

Case 5. Given the hypothenuse c, and an angle A, to find the sides a, b, and the angle B.

$$\sin a = \sin c \sin A;\ \tan b = \tan c \cos A;\ \cot B = \cos c \tan A.$$

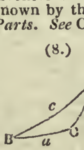
Case 6. Given the two oblique angles A, B, to find the two sides a, b, and the hypothenuse c.

$$\cos a = \frac{\cos A}{\sin B};\ \cos b = \frac{\cos B}{\sin A};\ \cos c = \cot A \cot B.$$

All the six cases of right-angled spherical triangles, it is proper to remark, were reduced by Lord Napier, the inventor of the logarithms, to two rules, which are known by the name of *Napier's Rules of the Circular Parts*. *See* CIRCULAR PARTS.

Oblique-angled Spherical Triangles.

(8.)



Case 1. Given the three sides a, b, c, to find the three angles A, B, C.

Find $s = \frac{1}{2}(a + b + c)$, and put M =

$$\sqrt{\left\{\frac{\sin(s-a)\sin(s-b)\sin(s-c)}{\sin s}\right\}};$$

then $\tan \frac{1}{2} A = \dfrac{M}{\sin (s-a)}$, $\tan \frac{1}{2} B = \dfrac{M}{\sin (s-b)}$,

$$\tan \tfrac{1}{2} C = \frac{M}{\sin (s-c)}.$$

Case 2. Given two sides a, b, and the included angle C, to find c, A, and B.

$$\tan \tfrac{1}{2}(A+B) = \frac{\cos \frac{1}{2}(a-b)}{\cos \frac{1}{2}(a+b)} \cot \tfrac{1}{2} C;$$

$$\tan \tfrac{1}{2}(A-B) = \frac{\sin \frac{1}{2}(a-b)}{\sin \frac{1}{2}(a+b)} \cot \tfrac{1}{2} C;$$

$$A = \tfrac{1}{2}(A+B) + \tfrac{1}{2}(A-B);\ B = \tfrac{1}{2}(A+B) - \tfrac{1}{2}(A-B);$$

$$\sin c = \sin a \frac{\sin C}{\sin A} = \sin b \frac{\sin C}{\sin B}.$$

The side c may be otherwise found without finding the angles A and B. Thus, find an auxiliary angle ϕ, such that $\cot \phi = \tan a \cos C$; then

$$\cos c = \frac{\cos a \sin (b+\phi)}{\sin \phi}.$$

Case 3. Given two sides a, b, and the angle opposite one of them A, to find the third side c, and the angles B, C.

Find two subsidiary angles ϕ and ψ, such that $\cot \phi = \tan b \cos A$, $\tan \psi = \cos b \tan A$; then

$$\sin (c+\phi) = \frac{\cos a \sin \phi}{\cos b},\ \sin B = \sin A \frac{\sin b}{\sin a},$$

$$\sin (C+\psi) = \cot a \tan b \sin \psi.$$

This case is ambiguous for the same reason as the corresponding case of plane triangles.

Case 4. Given two angles A, B, and the side between them c, to find the other sides a, b, and the remaining angle C.

Find two angles ϕ and ψ, such that $\tan \phi = \cos c \tan A$, $\tan \psi = \cos c \tan B$; then

$$\tan a = \frac{\tan c \sin \phi}{\sin (B+\phi)},\ \tan b = \frac{\tan c \sin \psi}{\sin (A+\psi)},$$

$$\cos C = \frac{\cos A \cos (B+\phi)}{\cos \phi} = \frac{\cos B \cos (A+\psi)}{\cos \psi}.$$

Case 5. Given two angles A, B, and the side opposite one of them a, to find the other sides b, c, and the remaining angle C.

Find two angles ϕ and ψ, such that $\tan \phi = \tan a \cos B$, $\cot \psi = \cos a \tan B$; then

$$\sin b = \sin a \frac{\sin B}{\sin A},\ \sin (c-\phi) = \cot A \tan B \sin \phi,$$

$$\sin (C-\psi) = \frac{\cos A \sin \psi}{\cos B}.$$

This case is also ambiguous.

Case 6. Given the three angles A, B, C, to find the sides a, b, c.

Find $S = \frac{1}{2}(A+B+C)$, and assume

$$N = \sqrt{\left(\frac{-\cos S}{\cos (S-A) \cos (S-B) \cos (S-C)}\right)};\ \text{then}$$

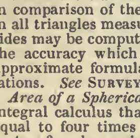
$$\tan \tfrac{1}{2} a = N \cos (S-A);$$
$$\tan \tfrac{1}{2} b = N \cos (S-B);$$
$$\tan \tfrac{1}{2} c = N \cos (S-C).$$

When the sides of a spherical triangle are very small in comparison of the radius of the sphere, as is the case in all triangles measured on the surface of the earth, the sides may be computed from the observed angles with all the accuracy which the observations will admit of by approximate formulæ, which greatly abridge the calculations. *See* SURVEYING.

Area of a Spherical Triangle.—It is known from the integral calculus that the area or surface of a sphere is equal to four times that of one of its great circles, or $= 4 \pi r^2$; where r is the radius of the sphere, and $\pi = 3{\cdot}14159$. Hence, surface of hemisphere $= 2 \pi r^2$.

Now it is manifest that the portion of the spherical surface included between two great semicircles, and which is called a *lune*, will have the same ratio to the surface of the hemisphere as the angle of the lune has to 180°; therefore if the angle of the lune be A°, its surface will be $2 \pi r^2 (A \div 180)$.

(9.)



Let A B C (fig. 9.) be a triangle upon the hemisphere A B H E, and let the sides B C and A C be produced till they meet again in F on the opposite hemisphere; then, since C D F and C E F are semicircles, they are equal to A C D and B C E; whence A C = D F and B C = F E, and the two triangles A B C and D E F are every way equal.

Let S = surface of the triangle A B C; then S = surface of hemisphere − B H D C − A G E C − D C E = $2 \pi r^2$ − (lune A H D − S) − (lune B G E − S) − (lune C D F E − S) $= 2 \pi r^2 \left(1 - \dfrac{A}{180} - \dfrac{B}{180} - \dfrac{C}{180}\right) + 3$ S; therefore $S = \dfrac{A+B+C-180}{180} \pi r^2 = \dfrac{E}{180} \pi r^2$, where $E = A + B + C - 180°$.

From this it follows that the area of a spherical triangle is proportional to the excess of the sum of its three angles above 180°; and hence this quantity, which is called the *spherical excess*, is sometimes taken as the measure of the area of the triangle. The spherical excess and the area are immediately deducible from each other. *See* SPHERICAL EXCESS.

In the above formula the area is given in terms of the three angles. The following elegant formula, which gives the spherical excess in terms of the three sides, is due to L'Huillier:—Let $s = \frac{1}{2}(a+b+c)$; then

$$\tan \tfrac{1}{4} E = \sqrt{[\tan \tfrac{1}{2} s \tan \tfrac{1}{2}(s-a) \tan \tfrac{1}{2}(s-b) \tan \tfrac{1}{2}(s-c)]}.$$

Trigonometry owes its origin to the Greek astronomers of Alexandria. The solutions of the most useful cases of spherical triangles have been known from the time of Hipparchus, and the fundamental formulæ appear in the *Analemma* of Ptolemy. The Greeks, however, instead of the *sines*, employed the *chords* of the double arcs. The sines were introduced by the Arabians, to whom the science is indebted for some other improvements. Regiomontanus introduced the *tangents*, which have greatly simplified the calculations. But the present elegant and compact form in which the solutions now appear is the result of improvements in modern analysis. The treatises on trigonometry are extremely numerous. For the history the reader may be referred to Montucla, *Histoire des Mathématiques;* Delambre, *Histoire de l'Astronomie;* and the Introduction to *Dr. Hutton's Mathematical Tables*.

TRILA'TERAL. (Lat. tres, *three*, and latus, *side*.) Three-sided; a term applied to all triangular figures.

TRI'LLION. In Arithmetic, a million of billions, or a million of million of millions. The term is said by Dr. Johnson to have been invented by Locke.

TRI'LLO. (It.) In Music, a term by which it is intimated that the performer is to beat quickly on two notes in conjoint degrees alternately one after another, beginning with the highest and ending with the lowest. It is marked with a single T as well in a vocal as in an instrumental part.

TRI'LOBITES. (Lat. tres, *three*, and lobus, *a lobe*.) The name given by Cuvier to an order of Crustaceans, comprehending those remarkable fossil species in which the body is divided into three lobes by two fissures which run parallel to its axis.

TRI'LOGY. (Gr. τρεις, *three*, and λογος, *a discourse*.) The word applied to a series of three dramas, which, although each of them is in one sense complete, yet bear a mutual relation, and form but parts of one historical and poetical picture. All the plays of Æschylus, and the *Henry VI.* of Shakspeare, are examples of a *trilogy*.

TRIM. The position of the keel of a ship with respect to a horizontal line. Also the disposition of the weights or stowage, as favourable or otherwise for sailing, which are expressed by *in trim*, and *out of trim*.

TRI'MERANS, *Trimera*. (Gr. τρεις, *three*, and μερος, *a part*.) The name of a section of Coleopterous insects, including those which have each tarsus composed of three articulations.

TRI'MMER. In Architecture, a piece of timber framed at right angles to the joists opposite chimneys or the well holes of stairs, which receives the ends of the joists intercepted by the opening.

TRIMMING JOIST. In Architecture, a joist into which a trimmer is framed.

TRI'MYARIES, *Trimyaria*. (Gr. τρεις, *three*, and μυων, *a muscle*.) The name by which those Bivalves are distinguished which present three muscular impressions on each valve.

TRINE. (Lat. trinus, *threefold*.) Of threefold dimensions,—length, breadth, and thickness. In Astrology, the trine is one of the five aspects of the influential bodies, the angle subtended by the two planets as seen from the earth being 120°, or the third of the zodiac. The trine was supposed to be a benign aspect. *See* ASTROLOGY.

TRI'NGA. (Lat. *a wading bird*.) A genus of wading birds (*Grallæ*), characterized by a compressed bill of moderate length, enlarged at the point; and a hind toe, too short to reach the ground. It is by the latter character that the lapwings (*Tringæ*) are distinguished from the plovers (*Charadeii*), in which the hind toe is wanting.

TRINITA'RIANS. A religious order, founded in 1198 under the pontificate of Innocent III. Its members devoted themselves especially to the duty of ransoming captives taken by the Moors and other infidels. Another body of Trinitarians was formed in consequence of a reformation of the order in 1578. There was also a female

order of the same name, and dedicated to the same objects.

TRI'NITY. The three persons comprised in the Godhead, and distinguished as the Father, the Son, and the Holy Ghost. The term is not found in the Scriptures, and its introduction is referred at the earliest to the 2d century. All denominations of Christians that believe in the Trinity, or Triune Deity, are comprised under the general name of Trinitarians. Several theories have been framed as to the existence of supposed doctrines of a Trinity in Pagan systems. (See, as to the Orphic, Platonic, Egyptian, Greek and Latin, Magian, and Indian Trinities, *Dale's Chronology*, vol. iv.)

TRINITY SUNDAY. The Sunday next after Whit Sunday; so called on account of a feast which was anciently and still continues to be held on that day, in the Romish church, in honour of the Holy Trinity. This feast does not appear to have been fully established in the Western Church until the year 1334, under Pope John XXIII.

TRINO'MIAL. (Lat. tres, *three*, and nomen, *name*.) In Algebra, a quantity consisting of three terms connected by the signs + or —; as $a + b\,c^2 - d^3$.

TRI'O. (It.) In Music, a composition consisting of three parts. Besides those general rules of counterpoint which forbid that two octaves or fifths follow one another either to the bass or any other part in trios, the third must be heard in every time of the bar, either with the bass or between the other two upper parts; or in other words, one of the parts must make a third with the bass, and the other a fifth or octave.

TRIOLET. A stanza of eight lines, in which the first line is thrice repeated.

TRIO'NES. In Astronomy, the seven principal stars in the constellation Ursa Major, popularly called Charles's Wain; four of the stars being fancied to represent a wain or waggon, and the three others the horses by which it is drawn.

TRIPHA'NE. A synonym of the mineral called also *spodumene*.

TRI'PHTHONG. (Gr. τρεις, *three*, and φθογγη, *sound*.) In Grammar, a composite sound of three vowels, as a diphthong is of two; such as the German "aeu." There is no such sound in English, nor, strictly speaking, in French, unless the combinations "ieu" in that language be so considered.

TRI'PLE. (Gr. τριπλους, *threefold*.) In Music, one of the kinds or measures of time, of which there are many different subdivisions. There are, however, only four principal ones, whereof the others are varieties. See art. MUSIC.

TRIPLE SALTS. A term by which, in Chemistry, certain salts are sometimes designated, in which two bases are combined with one acid. Thus, emetic tartar, which is composed of oxide of antimony and of potassa with tartaric acid, and Rochelle salts in which soda and potassa are combined with the same acid, are *triple tartrates*. These salts, however, are more properly regarded as *double salts*; that is, as consisting of tartrate of antimony and of tartrate of potassa, or of single equivalents of tartrate of potassa and tartrate of soda.

TRI'PLETS. In Poetry, three verses rhyming together. Thus, in the famous lines of Pope.

> "Waller was smooth, but Dryden taught to join
> The varying verse, the full resounding line,
> The long majestic march and energy divine."

In Music, notes grouped together by threes; thus,

. In common time, where three of the quavers are intended to be equal in duration to a crotchet, a 3 is sometimes placed over them; but they are generally known by being grouped together, and thus form one of the single parts of the whole measure.

TRIPLICATE RATIO. In Arithmetic and Geometry, the ratio of the cubes is the cube of the simple ratio. Thus the triplicate ratio of 2 to 3 is the same as that of 8 to 27. Similar solids are to each other as the triplicate ratio of their like dimensions.

TRI'POD. (Gr. τρεις, *three*, and πους, *a foot*.) In Architecture, a vessel, table, seat, or instrument having three feet. It was from such a seat that the Pythian goddess rendered oracular answers at Delphi.

TRI'POLI. A mineral used for polishing, originally from Tripoli in Barbary. It occurs in friable earthy masses of a dull clay colour. Its essential components are silica, alumina, and oxide of iron; but the varieties of tripoli appear to vary extremely in composition. Ehrenberg has found the different tripolis to be aggregates of silicified animalcules.

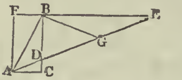
TRI'REME. (Lat. tres, and remus, *oar*; Gr. τριήρης, *a galley with three rows of oars*.) The usual war vessel of the Greeks at the time of the Persian and Peloponnesian wars, and nearly down to the period of the first Punic, when we find quinqueremes pretty generally substituted. With respect to the construction, and the difficulties attending its explanation, see GALLEY. Some light has been thrown on Athenian naval matters by the recent discovery of some inscriptions at the Piræus, which have been commented on by Boeckh. (See *Foreign Quart. Rev.* Jan. 1841. See also his *Public Economy of Athens*, transl. i. 372 &c.).

TRISA'GION. (Gr. τρις, *thrice*, and ἅγιον, *holy*.) In the Greek Church, the threefold invocation of the Deity as "Holy." (Lat. tersanctus.) This invocation takes its origin from Isaiah, vi. 3.; Revelations, iv. 8. The ordinary form is that in Isaiah, "Holy, Holy, Holy Lord God of Hosts, all the earth is full of thy glory." A different form of the trisagion is repeated daily in the service of the Greek church, and is attributed to Saint Proclus. Concerning the war which was raised A.D. 508-518, by the addition of the words "who was crucified for us," see *Gibbon*, chap. xlvii.

TRISE'CTION. (Lat. trisectio.) The dividing of any thing into three equal parts.

TRISECTION OF AN ANGLE. In Geometry, a problem of great celebrity among the ancient Greek mathematicians. The indefinite trisection of an angle cannot be effected by plane geometry, that is to say, by means of the straight line and circle, inasmuch as the analytical equation on which it depends rises to the third degree; but it may be accomplished by means of the conic sections and some other curves, as the quadratrix. The geometrical conditions on which the solution of the problem depends may be explained as follows:—

Let B A C be the angle, and suppose D A C to be its third part. Through any point B in A B draw B C perpendicular to A C, and B E parallel to A C; produce A D to meet B E in E, and complete the rectangle A F B C. Now since D A C is the third of B A C, therefore B A D is equal to twice D A C, or twice B E A. Draw B G, making the angle E B G equal to B E G; then B G A, being equal to G B E and G E B together, is equal to twice B E A, and consequently equal to B A G. Hence the two triangles E G B and G B A are isosceles, or G E = G B = B A. Again, the angle G B D is the difference between a right angle and E B G, and G D B or its equal A D C is the difference between a right angle and D A C, which is equal to E B G; therefore G B D is equal to G D B, whence G D is equal to G B or A B. It thus appears that D G and G E are each equal to A B, or that D E is equal to twice A B, which is a given line. If, therefore, in a rectangle A F B C, a straight line A D could be drawn from the angular point A, so that on producing it to meet the opposite side F B the produced part should be equal to a given straight line, the problem would be solved. This is the condition to which the trisection of the angle is reduced by Pappus of Alexandria, in the 4th book of his *Mathematical Collections*, where he shows how it may be constructed by means of an hyperbola. When, however, the rectangle A F B C becomes a square, that is, when the given angle B A C is half a right angle, the construction is easily effected by elementary geometry. (See *Leslie's Geometrical Analysis*.)



TRI'SMUS. (Gr. τριζω, *I gnash*.) Lockjaw; tetanus affecting the jaw. There are two species of this malady: the one caused by wounds, or, under certain circumstances, by exposure to cold; the other attacking infants during the two first weeks from their birth.

TRI'SPAST, or TRISPASTON. (Gr. τρεις, *three*, and σπαω, *I draw*.) A machine with three pulleys acting in connection with each other for raising heavy weights.

TRI'THEISM. (Gr. τρεις, *three*, and Θεος, *God*.) In Controversial Theology, an error into which some divines appear to have unconsciously fallen in their zeal to support the honour due to each of the three persons of the Trinity. Sherlock in his controversy with South, whose views seemed to tend to confound the separate natures of the Father, Son, and Spirit, and were generally characterized as Sabellian, is accused of having been betrayed into the opposite dogma of Tritheism.

TRI'TICUM. *See* WHEAT.

TRI'TON. In Mythology, a marine deity, son of Neptune. Tritons are sometimes mentioned in the plural number. They were represented as half fish in form. In Zoology, the name *Tritonia* has been given to a genus of marine, naked, gastropodous Mollusks, or sea-slugs.

TRI'TONE, or TRITONUS. (Gr. τρεις, *three*, and τονος, *tone*.) In Music, an interval, now generally called a sharp fourth, consisting of four degrees, and containing three tones between the extremes, on which account the ancients gave it its name. It is moreover divisible into six semitones, three diatonic and three chromatic. In dividing the octave, we find on one side the tritone and on the other the false fifth.

TRITO'XIDE. In Chemistry, such oxides as contain one atom of base united to three atoms of oxygen.

TRI'UMPH. (Lat. triumphus.) The highest military

honour that could be obtained by a Roman general. It was a solemn procession, with which the victorious leader and his army advanced through the city to the capitol, accompanied by the captives taken in war, and vehicles bearing the spoils, and all the furniture that could add magnificence to the spectacle. On arriving at the capitol the general offered up a prayer of thanksgiving to Jupiter and the other gods, and sacrificed white bulls. A triumph was decreed by the senate, and sometimes by the people against the will of the senate, to the general who in a just war with foreigners, and in one battle, had slain above 5000 enemies of the state, and enlarged the limits of the empire. *See* OVATION.

TRIUMPHAL ARCH. In Architecture, an arch erected to perpetuate the memory of a conqueror, or of some remarkable victory or important event. At first it consisted of a single arch, decorated merely with a statue and spoils of the victorious commander; but arches were afterwards erected with two, and then with three passages. Those on the Via Triumphalis in Rome were the most magnificent; and in cases where they served as gates, they were usually constructed with two openings, so that one was appropriated for carriages passing into, and the other for carriages passing out of the city. The following is a list of some of the principal triumphal arches of antiquity: — The arch at Rimini, erected in honour of Augustus on the completion of the repairs of the Flaminian Way from Rome to that city. It was one of the noblest as well as most ancient of the arches of the ancients, having a single passage about thirty-three feet wide, and was, contrary to the usual practice, crowned with a pediment. The lesser arch of Septimus Severus at Rome, commonly called the *Arch of the Goldsmiths*, is a curious example, being of a single opening, and crowned with a flat lintel. An extremely elegant arch at Susa, on the Italian side of Mont Cenis, in honour of Augustus. The arches of Aurelian and Janus, which possess more singularity than beauty. The arch of Pola, in Istria, which is curious from the use of coupled columns which it exhibits, and was erected by Salvia Posthuma, in honour of Sergius Lepidus and his two brothers. The arch of Trajan at Ancona, which, though it has been stripped of its bronze ornaments, retains the beauty of its effect and proportions, and is still in tolerable preservation. It stands at the entrance of the mole of the port, and has four Corinthian columns on pedestals. The arch of Titus at Rome, in which the order used is Composite, and was probably erected after the emperor's death. An arch at Benevento, in honour of Trajan, somewhat resembling that of Titus at Rome, also of the Composite order. An arch of Gavius at Verona, called *del Castel Verchio*, but no longer in existence. The arch of Septimus Severus at Rome, at the foot of the capitol, and that of Constantine in the same city. All these are each with three openings. For the latter the arch of Trajan was despoiled of its ornaments, as the greater part of the bassi-relievi upon it represent the victories of that emperor. It is in better preservation than any of the other arches that we have mentioned, and was indebted for its state to the care of Pope Clement XII.

TRIU'MVIRATE. In Ancient History, this term was applied to two great coalitions of the three most powerful individuals in the Roman empire for the time being. The first of these was effected in the year 60 B.C. between Julius Cæsar, Pompey, and Crassus, who pledged themselves to support each other with all their influence. This coalition was broken by the fall of Crassus at Carrhæ in Mesopotamia; soon after which the civil war broke out, which ended in the death of Pompey, and establishment of Julius Cæsar as perpetual dictator. After his murder, 44 B.C., the civil war again broke out between Antony, who wished to avenge the death and succeed to the fortunes of Cæsar, and the republic, on whose side were ranged Octavius and Brutus. Lepidus with a large army remained in suspense which side to take. But after the battle of Mutina, in which both consuls fell, 43 B.C., Antony, Octavius, and Lepidus coalesced; thus forming the second triumvirate, each party confirming the bond of union by the sacrifice of some of his own friends to the hatred of the others, — in which case was Cicero, who was delivered up by Octavius to the vengeance of Antony. Against this confederation Brutus still held out, with the rest of the conspirators against Cæsar, till their destruction at the battle of Philippi. The triumvirates divided the provinces of the empire, Octavius taking the west, Lepidus Italy, and Antony the east; but the iniquitous union was soon broken by the passion of Antony for Cleopatra, which induced him to repudiate Octavia, the sister of Octavius. War ensued, which was terminated by the defeat and death of Antony at Actium, in 32 B.C.; after which every thing fell into the hands of Octavius, Lepidus offering no obstacle.

TRI'VIUM. (Lat. *three ways.*) The name given in the schools of the middle ages to the three first liberal arts (grammar, rhetoric, and logic), which were studied together. The other four (arithmetic, music, geometry, and astronomy) formed what was termed the quadrivium; and the two following mnemonic lines comprehend the whole: —

Gram. loquitur; Dia. verba docet; Rhe. verba ministrat;
Mus. canit; Ar. numerat; Ge. ponderat; As. colit astra.

TRO'CAR. An instrument used in tapping for the dropsy. The name is said to be corrupted from the French *trois-quarts*, from the three sides of its point.

TROCHA'NTER. (Gr. τρεχω, *I run;* because the muscles inserted into it are those chiefly concerned in the act of running.) A name given to two processes (greater and less trochanter) at the upper end of the thigh-bone.

TRO'CHE. (Lat. trochus, or trochescus, dim. of *wheel.*) A small round lozenge or cake, generally composed of sugar and mucilage, united with small portions of more active remedies, intended to be allowed gradually to dissolve in the mouth.

TRO'CHEE. (Gr. τροχαιος.) A rhythmical measure consisting of two syllables, a long and a short; thus, — ◡.

TRO'CHILUS. (Gr. τροχιλος, *a small bird.*) This term was applied by Linnæus to the genus of small and brilliantly coloured birds which, from the energy and rapidity of the vibrations of their wings during flight, are called humming-birds. This genus includes the smallest of the feathered tribe, and, if we except a few fishes, the most diminutive of vertebrated animals: some humming-birds scarcely exceed a humble-bee in size; they are unable to escape from the strong webs of the large spiders of the American tropics, and thus sometimes become their prey.

The humming-birds are characterized by a long and slender bill, inclosing an extensile bifid tongue, by which they extract the nectar and the small insects which may lurk in the recesses of flowers. They have very small feet, long and narrow wings, a broad and entire sternum with an unusually deep keel and a short and strong humerus; all combining to form a mechanism for rapid and powerful flight, like that of the swift. Humming-birds live in pairs: they have the character of being very quarrelsome, the males fighting desperately with each other: both sexes combine to defend their nests with courage.

TRO'CHLEA. (Gr. τροχαλια, Lat. trochlea.) In Mechanics, the same as pulley or tackle. *See* PULLEY.

In Anatomy, the term *trochlea* is applied to the cartilage through which the tendon of the *trochlearis muscle* passes. It is the superior oblique muscle of the eyeball, and is accompanied by the *trochlearis nerve*.

TRO'CHOID. (Gr. τροχος, *a wheel*, and ειδος, *form.*) The curve described by any point in a wheel rolling straight forward on a level. It is the same as the cycloid; and for an account of its principal properties, see CYCLOID. The same name is also given to another curve, sometimes called the companion of the cycloid, or *curve of arcs*.

TRO'CHUS. (Gr. τροχος.) The name given by Linnæus to a genus of the *Vermes Testacea*, characterized by a subconical spiral shell, with the margin entire, without a fissure or canal for the siphon of the mantle, the animal not possessing any respiratory tube. The mouth of the shell is closed by an operculum, or some analogous part. The species to which the characters of the Linnæan genus are applicable constitute a family of Pectinibranchiate Gastropods in the system of Cuvier, called *Trochoida*, which includes the following genera: — *Tectaria*, Montfort; *Calcar*, Montf.; *Rotella*, Lam.; *Cantharis*, Montf.; *Infundibilum*, Montf.; *Telescopium*, Montf.; *Solarium*, Montf.; *Euomphalus*, Sowerby. The Gastropod called *Turbo pica* by Linnæus, having been ascertained to have an operculum, is now referred to the genus *Trochus*.

TRO'GLODYTES. (Gr. τρωγλη, *cave*, and δυνω, *I enter.*) Tribes of men who have their dwellings in subterraneous caverns. Several such tribes are mentioned by ancient authors, and the remains of their dwellings still attest their existence; especially along the banks of the Nile, in Upper Egypt and Nubia, and in parts of Syria and Arabia. (See *Bryant's Mythology*, iv. 381.)

The chimpanzee has been called by Blumenbach *Simia troglodytes*.

TROMBO'NE. (It.) A brass musical wind instrument serving as the bass to the trumpet, to which in general form it is similar, but of much larger dimensions.

TRO'NA. A native sesquicarbonate of soda found on the banks of the soda lakes of Sukena in Africa.

TRON WEIGHT. The most ancient of the weights used in Scotland; and though its use is now prohibited by law, it is still occasionally employed in some of the rural districts in weighing wool, cheese, butter, &c. The tron pound was not a well-defined weight, but varied from 21 to 28 ounces avoirdupois.

TROOP. A body of mounted soldiers, equivalent to *company* in foot regiments. The term *troops* is not limited to cavalry, but extends to all kinds of soldiers, whether mounted or not.

TROPÆ'OLUM. (Lat. tropæum, *a trophy;* the leaves

resembling a buckler, and the flowers an empty helmet.) A genus of handsome trailing plants, some of whose species have pungent fruits, which have rendered them useful as condiments. Indian cress, the name given to *Tropæolum majus*, expresses their quality. They form a small group nearly allied to the Geraniaceous order, if not forming a part of it.

TROPE. (Gr. τρεπω, *I turn.*) In Rhetoric, literally any expression *turned* from its primary signification, and employed in a sense derived in some manner from that primary signification. In this sense, the general term trope comprises the various figures termed metaphor, allegory, metonymy, synecdoche (which see), and perhaps several others. By the natural progress of language, words or phrases at first employed as tropes become impressed so strongly with their new or derivative signification, that it finally supersedes the original; its *tropical* or *figurative* being lost in its *simply indicative* character.

TRO'PHI. (Gr. τρεφω, *I nourish.*) A name given by Kirby to the different instruments of, or organs contained in the mouth, or closing it, and employed in manducation or deglutition. They include the *labrum*, *labium*, *mandibulæ*, *maxillæ*, *lingua*, and *pharynx*.

TROPHO'NIUS, in Greek Mythology, son of Erginus, king of Orchomenos, together with his brother Agamedes, built the temple of Apollo at Delphi; and having prayed for a reward from the god, it was promised him on the seventh day, on which he and his brother were both found dead. The story is told in other ways. He had a temple at Lebadea, as Jupiter Trophonius. In this temple was the celebrated cave into which those who descended spoke oracularly on their return; and in this way responses were made. But the impressions produced by the descent were thought so to work upon the spirit of a visitor, that he remained a victim to melancholy the remainder of his life. Hence arose the proverb applied to a serious man,—that he looked as if he came out of the cave of Trophonius. Some thought that the priests had secret access to the cavern, and that those whose minds did not give way under the terror of the scene which they encountered were murdered by them. (See Bryant, *Anc. Myth.* vol. ii. p. 361.)

TRO'PHSPERM. (Gr. τρεφω, *I nourish*, and σπερμα, *a seed.*) A name given by some French botanists to the placenta of a plant.

TRO'PHY. (Gr. τροπαιον, from τρεπω, *I turn.*) A monument consisting of some of the arms of slain enemies, hung upon the trunk of a tree, or a stone pillar, by a victorious army in token of its victory and the flight of the enemy; whence its name. Trophies were always dedicated to some deity, and especially to Jupiter, whence it was deemed sacrilegious for any one to injure or demolish them; while at the same time it was esteemed an equal crime to repair them when decayed. This custom was common to all the Greeks, except the Macedonians, who were forbidden to raise trophies by a law of one of their ancient kings. Perhaps the most celebrated trophies of ancient times were those of Marius at Rome, which were of marble, and were restored by Cæsar after their destruction by Sylla, contrary to all the usages of the times. (See as to Roman trophies, *Mém. de l'Ac. des Inscr.* xxiv. 32.)

TROPICAL HIEROGLYPHICS. *See* HIEROGLYPHICS.

TRO'PICAL YEAR. (Gr. τροπη, *return.*) The time between the sun's leaving a tropic and returning to it; popularly it means the time from the longest day in one year till the longest in the next. *See* YEAR.

TRO'PICS, in Astronomy, are the parallels of declination, between which the sun's annual path in the heavens is contained, their distance from the equator being equal to the sun's greatest declination. The northern tropic is called the tropic of Cancer, and the southern one that of Capricorn, from their touching the ecliptic in the first points of those signs.

The distance of the tropics from each other is equal to the difference between the greatest and least meridian altitudes of the sun, observed at any place whose latitude is greater than the obliquity of the ecliptic. *See* ECLIPTIC.

TROPICS, in Geography, are the two parallels of latitude on the earth, over which the sun is vertical when his declination is greatest, or when it is the longest day in the hemisphere in which the tropical circle is situated over which the sun is, and the shortest in the other hemisphere.

TRO'PIDONO'TUS. (Gr. τροπις, *a keel*, and νωτος, *the back.*) A genus of non-venomous serpents, nearly allied to the true Colubers; but with bodies thicker in proportion to their length, the back more keel-shaped, and the abdomen more expanded and convex; the head is large and conical, with a slender and short muzzle. The species seldom exceed three or four feet in length; they live near fresh-water streams, and are good swimmers: they are confined to the old world continents, and are replaced in South America by the genus *Homalopsis*. The *Coluber scaber*, Linn., a serpent of the Cape of Good Hope, remarkable for the presence of teeth in the œsophagus, and their absence from the mouth, is referred to the genus *Tropidonotus* by Schlegel.

TROU'BADOURS, *i. e.* Inventors. (Ital. trovar; Fr. trouver, *to find.*) A school of poets who flourished from the 11th to the latter end of the 13th century, principally in the south of France, but also in Catalonia, Arragon, and the north of Italy. They wrote in varieties of the Provençal or Romance language, also called in the middle ages Langue d'oc. They flourished under the lines of the Counts of Toulouse, Barcelona, and Provence; and their minstrelsy and peculiar spirit declined from the time of the crusade against the Albigenses, when the former of these noble houses was vanquished and humiliated, and their land overrun by the sterner adventurers of the north. The most renowned among the Troubadours were knights, who cultivated poetry as an honourable accomplishment; but their art declined in its later days, when it was chiefly cultivated by minstrels of a lower class. The names and some of the productions of more than 200 Troubadours have been preserved, and among their numbers are to be found kings, dukes, counts, and warriors of historical celebrity. The most remarkable characteristics of the Provençal poetry were its almost entire devotion to the subject of romantic gallantry, and the very complicated character, in general, of its metre and rhymes. The principal species of composition cultivated by the Troubadours were *tenzones*, or poetical contests between two minstrels; sometimes breathing satire or defiance, sometimes rivalling each other in the praise of their ladies, sometimes aiming at mere exertions of verbal ingenuity; *sirventes*, pieces devoted to martial and other serious subjects; short songs, or *chanros;* and a variety of other lyrical strains, *soulas*, *lais*, *pastourelles*, *arbades*, *serenades*, *retronage*, and *redondes*. The earliest Italian poets framed their style of thought and versification closely after the model afforded them by the troubadours. (See Sismondi, *Literature du Midi de l'Europe*, vol. i.; the works of M. Raynouard; *Mr. Lewis's Researches into the Romance Language;* Schlegel, *Obs. sur la Langue et Lit. Provençale.*)

TROUGH OF THE SEA. The ship is said to be in the trough, when she lies parallel to the hollows between the waves.

TROUT. (Lat. trutta.) This name is restricted properly and specifically to the *Salmo fario* of Linnæus; but is applied in a generic sense to other native species of *Salmo*, the *S. eriox* of Linnæus, which is the *S. salar* of Rondeletius, being called the bull-trout and grey trout; the *Salmo ferox*, the great grey trout, or lake-trout; the *S. trutta*, the salmon-trout, &c. The common trout inhabits most of our lakes and rivers, and is subject to many varieties of colour, proportions, and even of internal structure, as in the stomach of the gillaroo-trout, according to the variations of soil and food. The season of spawning with the trout is generally in the month of October, at which period the gravid fish make their way up the stream to the shallows. Trouts are in finest condition from the end of May to September.

TRO'VER. In Law, is an action of tort. It is a species of action on the case (*see* ACTION), which is employed to try a disputed question of property in goods and chattels. The declaration in trover assumes (by a fiction) that the plaintiff lost, and the defendant found and converted to his own use, the goods in question.

TROWELLED STUCCO. In Architecture, stucco left ready for the reception of paint.

TROY WEIGHT. An English weight chiefly used in weighing gold, silver, diamonds, and other articles of jewellery. The pound troy contains 12 ounces or 5760 grains, the pound avoirdupoise containing 7000 of such grains. The name is supposed to have reference to the monkish name given to London, of Troy Novant. *See* WEIGHTS.

TRUCE. (Mod. Lat. treuga, from the Teutonic treue, *truth.*) An agreement between states, or those representing them, for the suspension of hostilities. Such an agreement, when made by officers of the state in the general exercise of their duty, and not authorized for the purpose expressly, or by necessary implification, ranks among that class of conventions which jurists term sponsions, and which are binding only if ratified. (*See* SPONSION.) A general armistice or truce differs from a partial, which is limited to particular places; as between two armies, or between a besieged fortress and the besieging army. The former, in general, requires ratification: power to include the latter is held to be implied in the general authority of military and naval officers. (See *Vattel*, book iii. ch. 16.; *Wheaton on International Law*, vol. ii.)

TRUCE OF GOD, *Treuga Dei*. A suspension of arms, which occasionally took place in the middle ages, putting a stop to private hostilities. The right to engage in these hostilities was jealously maintained by the inferior feudatories of the several monarchies of Europe. But it was restrained by the repeated promulgation of these truces, under the authority of the church. Thus, in the

county of Roussillon, A. D. 1027, it was determined in a synod of the clergy, that no man should attack his enemy from the hour of nones on Saturday to the hour of prime on Monday. In 1041, a general " truce of God " was accepted by the barons, first of Aquitain, and then of all France, to last from the Wednesday evening of every week to the Monday morning following. This regulation was admitted by Edward the Confessor in England, in 1042, with some additions of great festivals and other days. It was confirmed by many councils, especially the Lateran council of 1179. The observation of it was sworn by knights, burgesses, and peasants, of the age of fourteen and upwards; and the penalty of its infringement was excommunication, which, however, was quite insufficient to maintain it. Philippe Auguste introduced a new species of truce, termed the quarantine, by one of his ordinances. It restrained the family of an injured or murdered person from the commencement of hostilities until forty days after the act done, under penalty of high treason.

TRUCK. The small wooden cap at the extremity of a flag staff, or at the mast head. Also a small circular piece of wood with a hole bored through it for a rope to run through.

TRUCK SYSTEM. A name given to a practice that has prevailed, particularly in the mining and manufacturing districts, of paying the wages of workmen in goods instead of money. The plan has been for the masters to establish warehouses or shops; and the workmen in their employment have either got their wages accounted for to them by supplies of goods from such *depôts*, without receiving any money; or they have got the money, with a tacit or express understanding that they were to resort to the warehouses or shops of their masters for such articles as they were furnished with. (For the advantages and disadvantages of this system, see *Com. Dict.*)

TRU'FFLE. A subterranean fungus, of a roundish oblong form, and a blackish brown colour, much employed in cookery. It is found by dogs and pigs, trained for the purpose, in soil beneath trees, especially beeches and oaks; it is, however, very local. It is propagated by spores included in sinuous chambers in the interior; but has never yet been cultivated with success, notwithstanding many attempts that have been made. Botanists recognize several kinds of truffles, the commonest being the *Tuber cibarium*.

TRU'MPET. In Acoustics, an instrument used for the purpose either of conveying articulate sounds to a great distance, or for applying to the ear, in order to collect the sonorous rays, and render sounds more distinct. In the former case, the instrument is a *speaking-trumpet;* in the latter, a *hearing-trumpet.*

Speaking-trumpet. — The object of the speaking-trumpet is to increase the intensity of speech, and transmit it to considerable distances in a particular direction. In order to obtain this effect, it is necessary that the aërial undulations which would disperse themselves in all directions be confined by the sides of the trumpet, and reflected so as to take, as nearly as possible, a direction parallel to the axis. This is accomplished by giving the trumpet such a form that its diameter becomes greater towards the extremity furthest from the mouth. A cylindrical or prismatic tube, of equal diameter throughout, assists powerfully in conveying sound from one extremity to the other, but contributes in no degree to give a direction to sound, or transmit it through free air.

The theoretical explanation of the effects of the speaking-trumpet is attended with considerable difficulty. Assuming that the reflexion of sound takes place according to the laws of catoptrics, Lambert (*Berlin Memoirs for* 1763) shows the best form of the instrument is a truncated cone, for the rays successively reflected from the interior surface of this figure make smaller angles with the axis after each successive reflexion. Cassegrain (*Journal des Savans*, tom. iii.) recommends the surface formed by the revolution of a hyperbola about its asymptote; and Kircher had previously proposed a truncated parabolic conoid, the mouth-piece occupying the focus. Some authors suppose that the trumpet should be formed of a very elastic material, in order to strengthen the sound by its vibrations. Others are of opinion that it should be without elasticity, to avoid the confusion that might be caused by the vibrations of the tube. Hassenfratz (*Journal de Physique*, tom. lvi.), who made a number of experiments on the power of the trumpet, by fixing a small watch in the mouth-piece, and observing the distance at which the beats ceased to be audible, found that the effects were precisely the same with a trumpet of tinned iron, whether used in its naked form, or tightly bound round with linen to prevent vibration, or when lined with woollen cloth, whereby reflexion was entirely prevented. It would appear, therefore, that neither the shape of the instrument, nor the material of which it is formed, is of much consequence. Leslie (*Experimental Inquiry into the Nature and Propagation of Heat*) supposes the effect of the trumpet to be owing to the more condensed and vigorous impulsion given to the air from its lateral flow being checked. " The tube," he observes, " by its length and narrowness, detains the efflux of air, and has the same effect as if it diminished the volubility of that fluid, or increased its density. The organs of articulation strike with concentrated force; and the pulses, so vigorously thus excited, are, from the reflected form of the aperture, finally enabled to escape, and to spread themselves along the atmosphere." p. 225.

The invention of the speaking-trumpet is commonly ascribed to Sir Samuel Moreland, who, about the year 1670, proposed the best form of the speaking-trumpet as a question to the Royal Society, and exhibited some instruments, constructed according to his own views. These were, in general, large conical tubes, spreading suddenly, at the extremity, to a greater width. They were tried in St. James's Park; and it is stated that their effects were such that the king (Charles II.), speaking in his ordinary colloquial pitch of voice, through a trumpet of only five feet and a half long, was distinctly heard at the distance of 1000 yards. Another person was perfectly understood at the distance of four miles and a half. Kircher claims the credit of having made such experiments previously; but his remarks apply rather to hearing than to speaking trumpets.

Hearing-trumpet. — The hearing-trumpet, or ear-trumpet, may be considered as a reversed speaking-trumpet, with which it generally corresponds in form, though, for the sake of portability, it is often made curved or spiral. Lambert recommends the parabolic figure as the most advantageous; but, in order to give the greatest effect, the apex of the paraboloid must be cut off, and the mouth of a small tube inserted in the focus, to convey the sound concentrated at that point to the auditory organ. Various other forms are adopted in practice; and, of late years, flexible India rubber tubes have been brought into use, having a conical mouth-piece of ivory or silver at one extremity, and a small tube of like material, to be applied to the ear. A trumpet of this kind may be used advantageously, not only for remedying the defects of the organ of hearing, but for assisting the observer to collect feeble and distant sounds. (See *Moreland on the Speaking-Trumpet*, 1671; Chladni, *Traité des Sons;* Gehler, *Physikalisches Worterbuch*, art. " Hörrohr.")

TRUMPET. A musical wind instrument usually made of brass, but sometimes of silver. This instrument formerly possessed but few notes; but in later times it has, by means of slides and keys, been vastly extended in its inflexions. Its compass will be seen by referring to the synoptical view of the different instruments at the end of the article MUSIC.

TRU'NDLE. In Mechanics, a pinion having its teeth formed of thick cylinders or spindles; otherwise called a *lantern wheel*, or *wallower*.

TRUNK. (Lat. truncus.) In Architecture, the same as *shaft*. In the application of this word to a pedestal, it signifies the die, dado, or body of the pedestal.

TRUNK, in Entomology, signifies the intermediate section of the body which lies between the head and the abdomen.

TRU'NNIONS. The pivots or short cylinders projecting from the sides of a piece of ordnance, by which it rests on the cheeks of the carriage. The *trunnion ring* is the ring on a cannon next before the trunnions.

TRUSS. (Fr. trousser.) In Architecture, a framed assemblage of pieces of timber for the purpose of tying up or suspending a principal beam or piece. *See* ROOF.

TRUSS. A rope confining the middle of a lower yard to the mast.

TRUSS, in Surgery, is an apparatus by which in cases of rupture the intestine is retained in the abdominal cavity. This is usually effected by the aid of a steel spring resting upon a small pad or cushion, which is kept in its place by a proper bandage.

TRUSSED ROOF. In Architecture, one so constructed as to support the principal rafters and tie beam at certain points where bending of the timber is likely to occur. *See* ROOF.

TRUST. In Law, is a term commonly used to designate any equitable right or interest, as distinguished from a legal one: properly, that class of equitable rights supposed to be founded in the confidence placed by one party in another; the name *trustee* denoting the person in whom confidence is placed; *cestuy que trust*, the person who trusts, — in other words, the party who enjoys a beneficial interest in the objects of which the trustee has the legal property.

The origin of conveyances in trust may be traced to the *fidei commissum* of the Romans, which was a gift by will to a person capable of taking in trust for another incapable by the Roman law of taking such benefit, whose claim under such gifts was for a long time precarious, and merely fiduciary, but came at length to be recognized and enforced by law. With us in the same manner, the original motive for the introduction of the fiduciary right, which was certainly borrowed from the Romans,

was the wish to escape from the disabilities affecting certain persons, or bodies, or the liabilities attached to property in its direct and simple shape. Such was, in particular, the disability of corporations to purchase land at common law; and on this account, as it is commonly said, the ecclesiastics, who were chiefly interested in this matter, introduced this new species of property, which was willingly recognized by the chancellors, then usually ecclesiastics, and in other respects inclined to adopt the principles of the civil law. The clergy were, however, soon themselves deprived of the benefit of the invention, the disability of corporations to take land being extended by statute to the new right so created. But there still remained many liabilities arising from feudal tenure, incident to property at common law; such as, for instance, dower, escheat, wardship, restraint upon alienation by will, which it was desirable and possible either to evade by this mode of conveyance in trust, or to transfer to a quarter less likely to be affected by them: and there were also many modifications of property for the benefit of families, which could only be given to it in this manner. It must be admitted, further, that there were less honest purposes, such as the defrauding *bonâ fide* purchasers by secret alienation, sought to be attained by the same means. For these, among other reasons, conveyances in trust were still resorted to; and the Court of Chancery, which had once, for whatever reason, originally recognized, continued to enforce them.

There were also two other means of creating a trust, or rather raising a use, not by actual conveyance: the one by agreement for money; the other by covenant under seal in consideration of near *relationship*.

The right so created was called indifferently a *trust* or *an use*; more commonly the latter, from the actual enjoyment of the rents and profits annexed to it in equity. Indeed, the benefit of the use or trust was in the first instance confined to this; but the cestuis que use, or parties beneficially interested, soon acquired the right of directing a conveyance by the holders of the legal estate, legally termed the feoffees to uses, and also of calling upon them to use the legal title in their defence in a court of common law.

Several statutes were passed at different times, giving to the owner of the use or trust partial legal rights, and partially also subjecting interests of that sort to legal liabilities, before the celebrated statute, commonly called the Statute of Uses, which was passed in the 27th year of Henry VIII. The general object of this statute, as stated in the preamble, was to prevent those secret and fraudulent transfers occasioned by the separation of the real from the apparent ownership, and to restore those rights of the feudal lord, and of the crown, which had been in a great measure evaded, by keeping the legal title to which alone they attached in a course of succession; where it was likely to be forfeited by treason, and where it was less frequently subject by descent to an infant heir to the burden of wardship and relief. The general effect of the statute, as stated in the title, was the transferring or changing the use into possession, that is, annexing to the use the legal right of possession, whereby the real owner would be made manifest to all, and the real ownership would become subject to all the liabilities incident to the legal title: in short, the distinction between equitable and legal rights would be abolished, and the adjudication on all questions of property, except in particular cases of fraud or accident, would be restored to the courts of common law.

The statute, however, was so worded as not to apply either to copyholds or leaseholds, nor indeed to personal property of any description, which at that time was little thought of; so that equitable rights in copyholds and personalty remained as before, merely equitable; and they arose again, very shortly afterwards, in every species of real property, it being held by the courts of common law that such uses or trusts only were executed and transferred into possession by the statute, as were raised or declared upon what was *before* the statute the legal seisin or estate; so that where a new legal estate taking effect as such by virtue of the statute was created or conveyed in trust, such trust right not being within the purview of the statute, and not being recognized by the courts of common law, was adopted and enforced in equity, for reasons altogether similar in kind to those which originally led to the introduction of uses. Hence a new system of equitable rights grew up under the name of trusts, commensurate with the new system of legal rights or uses (for the use henceforth denoted the legal estate), created by the statute; and though some of the peculiar advantages of the old trust were, by the effect of the statute, transferred to the new legal ownership, such as the capability of modification for the benefit of different parties upon different events, and though the right of disposition by will was shortly afterwards extended to it by special statute, and though whatever advantages were still possessed by the *trust*, as a means of evading the burdens of tenure or other liabilities now attached to the use, were gradually removed either by the abolition of those burdens or the extension of those liabilities, trusts still continued and continue to be habitually resorted to for various purposes. These are, generally, either to protect the interests of married women and children, by placing in the hands of trustees for them the legal rights which they would be incapable of exercising; or to secure the rights of those in remainder, by severing from the usufruct of property for a life the power of disposing of the whole; or, lastly, the convenience of management, where many parties are interested in the same subject. These observations can apply only, at least with one or two exceptions, to express trusts. An express trust supposes a legal transfer of the property actually completed, and a declaration in the same instrument, or having reference to the same instrument (as an appointment under a power thereby created) of the trust upon which the property so transferred is to be held. Such trusts may be declared in or by a reference to any instrument, either deed or will, that is sufficient to pass property at law; the ground upon which they rest is the express confidence that is placed in the trustee, by the person who transfers the property to him, no consideration of money or blood between the trustee and those for whom he holds being required as an inducement for the interference of equity. Trusts are most commonly raised by marriage-settlements, or by will. The usual trusts in the former case, as to real estate, are upon legal estates in terms of years, to arise upon certain events, to be held in trust, in the first place, for securing to the wife payment of her pin-money during marriage, and of her jointure after the husband's death; then for the raising, by sale or mortgage of the term, the stipulated provisions for younger children, and also for providing for their maintenance during minority. The ultimate trust of such terms, whether expressed or not, is for the person entitled to the corpus of the estate, subject to those charges which the terms are created to secure. Similar trusts, also, are commonly raised in wills, for the maintenance or advancement and portioning of younger children. In all such cases, the legal rights vested in the trustees most commonly remain in their hands, as a means only of compelling the person actually in possession to discharge those claims subject to which he holds his estate. But there are other trusts of frequent occurrence, both in marriage-settlements and in wills, which require a more active interference on the part of the trustees, and which, therefore, carry with them a greater degree of responsibility. These are trusts for the sale of land and investment of the proceeds upon security, or in the purchase of other land, or trusts for the investment of what was originally personalty; in which cases, it is important for the trustees to consider, in the first place, how far the trust for sale or conversion is imperative and immediate, lest by delay they become liable for any loss that may ensue from the alteration in the value or price of land securities; in the next place, what are the securities in which they are directed to invest, as they will be answerable for the failure of any security a resort to which has not been authorized by the terms of the trust. Where these securities are private, or where a purchase of land is made with trust moneys, they are further bound to see that the usual professional inquiries are in either case instituted into the validity of the title. It is obviously their duty, also, to look to the due appropriation or distribution of the proceeds. Where there is a conversion absolute, or, as it is called, *out and out*, of realty into personalty, or of personalty into realty, either agreed to or directed by deed or will, land is in equity considered as money, and money as land, for all the purposes of succession or transmission; but it rarely happens that a conversion by will is in terms sufficiently absolute to exclude the right of the heirs, or, where it is personalty, the rights of the personal representative, to such part of the real or personal estate, whether actually converted or not, as shall not be required to fulfil the purposes for which the conversion was directed.

The system of trusts is still more generally prevalent in limitations of copyhold and personal property, particularly personal chattels, as money or stock in the funds, to neither of which classes of property the Statute of Uses applied, and in which, therefore, the legal interest remained, at least for a time, subject to the narrow rules of the common law; and copyhold property is therefore, for this as well as for other reasons, more commonly settled upon trust than is property of freehold tenure. Personal property, though once held incapable at common law of partial or shifting limitations, has long, by a somewhat forced though ingenious rule of construction, been released from that restriction; and therefore in the settlement of chattels real, of which the title is distinct from the possession, the creation of a distinct equitable title is not more often resorted to than in the settlement of real property of freehold tenure. But it is in regard to that sort of personal property, the title to which, or rather the power of conferring a title to which, is annexed to the possession, either from the nature of the thing itself, as in the case of money, or for reasons of

public convenience, as in the case of bills of exchange, and in regard also to stock in the funds (a class of property over which the holder, whether it be in trust or not, has by the regulations of the bank absolute power of alienation), that the utility of trusts is more particularly conspicuous. Whenever it is sought to create in any such property shifting or partial interests, nothing in such cases can secure future or contingent rights from the dishonesty of the tenant for life or partial owner but the intervention of trustees, in whose hands the whole legal interest, that is to say, the whole power of alienation, resides; and though a similar danger is sometimes to be apprehended even at their hands, yet their number itself, and the discretion that may be exercised in their appointment, afford a greater security than is to be found in the integrity of a single individual.

Duties of Trustees.—It is only in cases of express trusts, whether such in the origin, or become such by the acceptance and acknowledgment of the legal owner undertaking to act as trustee, that the rules respecting the duties, liabilities, and rights of trustees are applicable. As to their liabilities, they are liable not only for such sums as they actually have received, but for such also as they might, but for their wilful neglect or default have received. Where there are several trustees, each is generally liable for his own acts and receipts only; but where all concur in empowering either one of themselves, or a third party, to do or receive that which he could not do or receive but by virtue of such authorization, all are responsible for his acts and receipts under such joint authority. It is the duty of trustees, besides being faithful accountants, to apply and distribute rightly the property they are entrusted with according to the various rights of the parties entitled to it; and they are liable for any misapplication, arising either from ignorance of facts which they ought to have known, *i.e.* might by common diligence have known, or from ignorance of the law in any case. It is their business, then, as to the first, to inquire diligently into all the circumstances of the trust; and as to the second, where upon consulting professional advisers there appears to be any reasonable doubt, to refer it to the opinion of the court by instituting a suit for the fulfilment of the trust. The rights of trustees are confined to the reimbursement of their proper expenses out of the trust property. An express trust will not fail for the want of trustees; where none are nominated, the court will take upon itself the appointment. To the same class of trusts proper, that is to say, equitable rights arising from confidence reposed, may be assigned implied or resulting trusts, in which the confidence is not expressed, but implied by courts of equity from the want of consideration or motive apparent in such cases, to give away the whole, or, as it may be, any part of the beneficial interest. Such trusts arise, in the first place, upon the conveyance or transfer, by deed or will, of property real or personal upon some trust expressly declared, which does not exhaust the whole beneficial interest, or expressly upon trust, though no trust be declared; in the first of which cases, the surplus of the beneficial ownership, after satisfaction of the express purpose or trust, and in the second case, the whole of the ownership, results to the party making such conveyance or transfer. To the former class of partial resulting trusts belongs the equity of redemption upon a mortgage, which is an equitable right resulting to the mortgagor after all right of redemption is forfeited at law, to recover back the thing mortgaged upon payment of the capital and interest of the money borrowed upon the security of such pledge. This equity of redemption subsists in favour of the real or personal representatives of the mortgagor against the real or personal representative mortgagee, till it is destroyed either by twenty years of the adverse possession, *i.e.* possession without any acknowledgment whatever of any rights in the mortgagor, or, which is the most common case, by decree of foreclosure in equity, by which a peremptory day is fixed.

Trusts of a similar nature frequently arise upon devises of real property for payment of debts, in which cases a trust results in the surplus, either for the heir, or the residuary devisee, where there is one; but it should be observed, that where any specific purpose for which a trust is created by devise in the produce of land fails of taking effect, such as a legacy charged upon land by predecease of the legatee, or a similar legacy void under the Statute of Mortmain, the benefit of the lapse results to the heir, and not to the residuary devisee, who takes by such devise not that which ultimately is not applicable to the purposes of the will, but that only which the testator expresses no intention of otherwise disposing of. But where a legacy, payable out of the personalty, fails of taking effect, the lapse shall enure for the benefit of the residuary legatee, where there is one, in preference to the next of kin; the reason of the difference being that previous to the late Wills Act a devise of land spoke from the time of the will, a bequest of personalty from the death of the testator.

A trust is implied in the *whole* beneficial ownership upon the conveyance or transfer by deed of the legal interest in real or personal property; *i. e.* where it is either chattels real or stock, or where the corpus of the property is not actually delivered to a person from whom no motive or consideration moves, and in whose favour no declaration of trust is contained in such deed or instrument; in which case a trust is implied, either for the party making such conveyance or transfer, or for the person from whom it is shown aliunde that the consideration for such conveyance or transfer, as, for instance, the money with which the purchase was made, actually moved. The implication of resulting trusts has, perhaps, arisen through an unwise departure from the Statute of Frauds, as it is a reliance upon parol evidence in opposition to the legal title. It should, however, be observed, that the parol evidence, upon which such trusts may be *raised*, must be evidence, not of declarations or intention, but parol evidence of facts; as, for instance, of the payment of money by a person not the nominal purchaser; but to repel a presumption of a trust parol evidence of a declaration of intention is admissible, because such evidence is corroborative of the legal import of the deed.

TRUTH. In the Fine Arts, a faithful adherence in representation to the models of nature, or the prototypes on which the principles of art are founded.

TRY'ING, or A-TRY. In Naval Language, a word somewhat obsolete for *heaving* or *hove to*.

TRY'SAIL. A small gaff sail of strong or storm canvass, set in bad weather.

TUBE. (Lat. tubus.) A pipe or long hollow body. A tube is generally understood to signify a hollow cylinder, but the cylindrical form is not essential.

TUBER. In Botany, a kind of fleshy stem, formed underground, and filled with starch. It is commonly looked upon as a root, as in the potato. Also the systematical name of the truffle.

TU'BERCLE. In Morbid Anatomy, this term is applied to certain diseased structures, as *tubercles* of the lungs: small hard superficial tumours of the skin are also called tubercles.

TUBERCLE OF LOWER. An eminence in the right auricle of the heart where the two venæ cavæ meet; it was first described by Richard Lower, in 1665.

TUBE'RCULA QUADRIGEMINA. Four white oval tubercles in the brain, two of which are situated on each side, over the orifice of the third ventricle and the aqueduct of Silvius. The old anatomists called them *nates* and *testes*.

TU'BICOLES, *Tubicola*. (Lat. tubus, *a tube*, colo, *I inhabit*.) The name of an order of Anellidans, comprehending those which live in tubes, and which are Cephalobranchiate; also the name of a family of Lamellibranchiate Acephalous Mollusks, including those which have a tubular calcareous sheath in addition to the two shelly valves.

TU'BICORNS, *Tubicornia*. (Lat. tubus, cornu, *a horn*.) The name of a family of the order of Ruminants comprehending those in which the horns are composed of a horny axis covered with a horny sheath.

TU'BIFERS, *Tubifera*. (Lat. tubus; fero, *I carry*.) The name given by Lamarck to an order of the class *Polypi*, comprising those which are united upon a common substance fixed at its base, and whose surface is wholly or partially covered with retractile hollow tubes.

TUBIPORES, *Tubipora*. (Lat. tubus, porus, *a pore*.) The name of a family of Zoophytes, comprehending those in which the animals are isolated and contained in elongated cylindrical calcareous cells, attached by their base, and strengthened by cross bars at definite distances.

TUBULA'RIA. The name of a genus of Corallines, with simple or branched horny tubes, from the extremities of which the polypes are protruded; these have two rows of tantaces, of which the external is expanded in a radiated manner, the internal one raised into a tuft.

TUBULIBRA'NCHIANS, *Tubulibranchiata*. (Lat. tubus; branchiæ, *gills*.) The name of an order of Hermaphrodite Gastropodous Mollusks, comprehending those which have the shell in the form of a more or less irregular tube in which the branchia are lodged.

TUBU'LICOLES, *Tubulicola; Polypes à Tuyaux*. (Lat. tubus; colo, *I inhabit*.) A name applied by Cuvier to a family of Polypes, including those which inhabit tubes of which the axis is traversed by the gelatinous flesh, and which are open at the summits or sides to give passage to the digestive sacs and prehensile mouths of the polypes.

TU'ESDAY. In the Calendar, the third day of the week, named after Tuisco, the Saxon god of war; whence the astronomical symbol is the same as that for the planet Mars. As to the god Tuisco, or Tuisto, see *Mem. de l'Ac. des Inscr*. vol. xxiv.

TU'FA. (Italian.) A volcanic rock, composed of an agglutination of fragmented scoriæ.

TU'FO. In Architecture, a species of porous, light, sandy, calcareous stone, suited to the construction of vaults. The *travertino*, with which the cupola of St. Peter's is constructed, is of this species.

TU'GENDBUND. (Germ. *union of virtue.*) A patriotic association formed in Prussia after the treaty of Tilsit in 1807. Its object was to prepare the people of that country by moral instruction and discipline for better times. It was abolished at the instigation of the French; but its spirit survived, and it had great effect in promoting the national war against Napoleon in 1813.

TU'LIPA. (Turkish toliban.) A gay flower inhabiting the warmer parts of Europe and Asia Minor. It is well known for the gaudiness of its colours, which have made it a favourite with gardeners, who have converted its cultivation into a system of gambling, which the Dutch have been obliged to repress by sumptuary laws. It is a genus of the Liliaceous order.

TUMBLE HOME. The term describing the falling or bending inwards of the upper timbers of the ship's side.

TU'MBREL. (Old Fr. *tumerel.*) A low carriage with two wheels, occasionally used for the most ordinary purposes by farmers; but it is chiefly used for carrying the implements of the pioneers attached to trains of artillery.

TU'MULI. *See* BARROWS.

TUN. A measure of capacity. The English tun contains 252 gallons, or 4 hogsheads. *See* TON.

TUNE. (Gr. τονος.) In Music, the relation of notes to each other and the distances between them, wherefrom arises melody. In other words, it is a certain succession of different single sounds arranged according to art.

TU'NGSTATES. Compounds of the *tungstic acid. See* TUNGSTEN.

TU'NGSTEN. (Swedish tung sten, *heavy stone.*) The ores of this metal are the native tungstate of lime, and the tungstate of iron and manganese; the latter mineral is known under the name of *Wolfram.* Tungsten is a white, hard, and brittle metal, very difficult of fusion, and having the high specific gravity of 17·4. Heated to redness in the open air, it burns into the *peroxide*, or tungstic acid. The equivalent of tungsten is probably about 100; and the tungstic acid consists of 1 atom of metal and 3 atoms of oxygen ($8 \times 3 = 24$), and is represented by the equivalent 124. This metal was discovered by Messrs. Delhuyart. It is sometimes called *Wolframium*, and also *Scheelium*, in honour of Scheele, who first examined the nature of tungstate of lime.

TUNIC. (Lat. tunica.) A garment worn by the ancient Romans of both sexes, under the *toga* (which see), and next to the skin. It was generally of wool, of a white colour, and it reached below the knee. The senators wore their tunics with a broad stripe of purple sewed on the breast: the equites had narrow stripes; hence the epithets *lati*clavii and *angusti*clavii, applied respectively to these orders.

TU'NICARIES, *Tunicata.* (Lat. tunica, *a tunic.*) The name of an order of Acephalous Mollusks, comprehending those in which the exterior covering is uncalcified, soft, and elastic: it is equivalent to the *Ascidies* of Savigny, and the *Acephales sans Coquilles* of Cuvier.

TUNKERS, or DUNKERS. A religious sect, a subdivision of the Baptists: chiefly found in Pennsylvania. Their name is said to be derived from tunken, Germ., *to dip;* because in baptism they plunge the person head foremost into the water. They differ little in doctrine from other Baptists; but every brother is allowed to speak in their churches. This society was originally founded by one Conrad Beissel, in 1720; who founded a colony called "Ephrata," sixty miles from Philadelphia. They wear long beards.

TU'NNEL. (Sax. ꝑœnel.) In Engineering, a subterranean passage cut through a hill or under a river, for the purpose of carrying a canal, road, railway, &c.

In the construction of railways and canals, it is sometimes absolutely necessary, and very frequently expedient, to have recourse to tunnelling, either to preserve the requisite level, or shorten the distance, or to lessen the expense of open cutting. The circumstances on which the question of expediency depends are often of a very complicated nature; but generally speaking, it must be decided by considerations of economy, for in the present state of engineeering, a tunnel may be made of almost any length, and through materials of any description, from a granite rock to a quicksand. The nature of the ground can hardly be said to interpose any farther obstacle than what may be occasioned by the expense.

On account of the peculiar nature of the difficulties to be overcome, the tunnel which has recently been carried under the bed of the Thames, from Rotherhithe to Wapping, may perhaps be regarded as the most remarkable work of the kind which has ever been executed. A short account of this operation will probably be the best mode of conveying a notion of the extent and difficulty of such works generally.

Some previous attempts had been made to carry a tunnel under the river below London bridge. In 1799, one was projected at Gravesend; but the project was soon abandoned. In 1804, another was attempted from Rotherhithe to Limehouse. A shaft of 11 feet in diameter was sunk to the depth of 42 feet, and continued at a reduced diameter of 8 feet to the depth of 76 feet, whence a drift was carried 923 feet under the river, and to within 150 feet of the opposite shore, where difficulties of so formidable a nature arose that the engineer reported farther progress to be impossible. The scheme, however, continued to be agitated; and in 1823, Mr. Brunel proposed a plan which has at length been carried successfully into execution.

The act of parliament authorizing the operation was obtained in June, 1824, and shortly after the work was commenced at Rotherhithe. The shaft at this place is 150 feet from the river. It was formed by building a cylinder of brickwork 50 feet in diameter, 42 feet in height, and 3 feet in thickness, on the top of which a steam engine was erected for raising the water and earth. The cylinder was let down bodily into the ground, forcing its way through a bed of gravel and sand 26 feet deep, and full of land water. The shaft was sunk to the depth of 65 feet, and from this level another smaller shaft 25 feet in diameter was sunk, destined to be a well or reservoir for the drainage of water. The excavation for the body of the tunnel was commenced at a depth of 63 feet, and was carried on at a declivity of 2 feet and 3 inches per 100 feet, in order to have sufficient thickness of ground to pass safely under the river. The excavation is 38 feet in breadth, and 22½ feet in height, presenting a sectional area of 850 feet; and the base, at the deepest part of the river, is 76 feet below high-water mark. The body of the tunnel is of brickwork in Roman cement.

The means by which this extensive excavation was effected, consisted of a powerful apparatus of iron, which has been called a shield. It was formed of twelve great frames lying close to each other, and severally provided with the mechanism necessary to move them forward, and to secure them, when stationary, against the brickwork. The frames were 22 feet in height, and about 3 feet in breadth, and each divided into three stages or stories; the whole thus presenting thirty-six compartments or cells for the workmen. These compartments were open at the back; but in front small boards, which could be separately removed and replaced at pleasure, were pressed firmly against the ground to be excavated by screws. Each workman in his cell operated upon the surface opposed to him, taking out one of the small boards at a time, cutting the ground away to the depth of a few inches, and then replacing the board before he proceeded to the next; and when from 3 to 6 inches were thus removed over the whole surface of the shield, the frame was moved forward, and the work secured by immediately adding so much more of brickwork to the body of the tunnel. By this means, the excavation and the structure were carried forward simultaneously.

The tunnel consists of a double and capacious archway, one side being appropriated to carriages passing in one direction, and the other to those passing in the contrary, with paths for foot passengers by the sides of the carriage roads. The middle wall between the two archways was first built solid for greater strength, but openings were afterwards cut at short distances, so that each has a ready communication with the other. The two shafts at the extremities will contain easy flights of steps for foot passengers; and the access for carriages is intended to be by circular roadways 200 feet in diameter, the declivity of which will not exceed 4 feet in 100. The entire length of the tunnel is 1300 feet, and the expense is said to have been about 1200*l.* per yard.

In the course of the work, two irruptions of the river took place, the first on the 18th of May, 1827, after the excavation had been advanced to the distance of about 400 feet; and the second in January, 1828. These accidents were repaired by filling the chasms in the river with bags of clay; and on clearing the tunnel of water, the structure was found, on both occasions, to be in a perfectly sound state, and to have sustained, in fact, little or no injury. After the second irruption, however, the works, from want of funds, remained suspended for seven years; but assistance having at length been obtained from government, they were resumed in 1835, and proceeded without further interruption till the tunnel reached the termination on the Wapping side of the river, early in the present year, 1842. This extraordinary work, which during its progress was visited by multitudes of persons from all parts of the world, is, doubtless, destined to remain for ages a proud monument of the genius and perseverance of the engineer by whom it was contrived and successfully executed.

The establishment of railway communication in this country has given rise to some stupendous undertakings in the way of tunnelling. One of the most remarkable, perhaps the most remarkable of all, is the Box Tunnel, on the Great Western Railway, an account of which is given in the *Companion to the British Almanac* for 1842, and the *Railway Times* for July 10, 1841. This tunnel pierces through Box Hill, between Chippenham and Bath, part of which is 400 feet above the level of the railway. "It is 9680 feet long, 39 feet high, and 35 wide to the outside of the brickwork. The shafts for making

and ventilating it are thirteen in number, and vary in depth from 80 to 306 feet. The excavation amounted to 414,000 cubic yards, and the brickwork and masonry to more than 54,000 cubic yards. The number of bricks used was 30,000,000; a ton of gunpowder and a ton of candles were consumed every week for two years and a half, and 1100 men and 250 horses were kept constantly employed." For a considerable distance, the tunnel passes through freestone rock, from the fissures of which there was at times an immense influx of water, whereby on one occasion the works were interrupted for a period of nine months. On a subsequent occasion, after an irruption, water was for some time discharged by the engine at the rate of 32,000 hogsheads a day. This tunnel occurs on an inclined plane of 1 in 100.

The extent of brickwork or other structure which may be necessary to secure the excavation in works of the class now mentioned will depend, of course, on the nature of the materials through which the tunnel is driven; and in deciding this question, it is important to attend to the geological formation of the locality. In the unstratified rocks an excavation may be made with perfect safety and will require no support, while in those whose strata are nearly vertical, danger may he apprehended from slipping. In the chalk, oolite, marl, lias, and similar formations, the tunnel requires to be lined with brick-work throughout, as the materials cohere so imperfectly, that even the vibration arising from the passage of the carriages may cause the fall of parts of the roof.

The following table of the dimensions of a few railway tunnels will enable the reader to form an accurate notion of the gigantic scale on which such operations are conducted: —

	Length in Yards.	Height in Feet.	Width in Feet.
Box Tunnel, — Great Western - -	3,227	39	35
Wapping to Edge Hill, — Liverpool and Manchester - - -	2,200	16	22
Lime Street - - - -	1,760	19	25
Kilsby, — London and Birmingham -	2,420	27	23½
Primrose Hill, — Ditto - -	1,250	25	22
Canterbury and Whitstable - -	880	12	12
Leicester and Swannington -	1,760	13½	10¾

TU'NNY. *See* THYNNUS.

TU'RBAN. The usual head-dress of the Turks, Persians, and most other eastern nations. It varies in form in different nations, and in different classes of the same nation. It consists of two parts: a quilted cap, without brim, fitted to the head, and a sash, scarf, or shawl, usually of cotton or linen, artfully wound about the cap, and sometimes hanging down the neck. The Grand Signior's turban contains three heron's feathers, and is ornamented with diamonds.

TU'RBO. (Lat. turbo, *a whirling.*) The name of a Linnæan genus of the *Vermes Testacea*, characterized by having a shell of a regular turbinated form, with an entire and rounded mouth. The species grouped together by this specific character form a family of Pectinibranchiate Gastropods in the system of Cuvier, which is subdivided into the genera *Turbo* proper, Cuv.; *Delphinula*, Lam.; *Pleurotoma*, Defrance; *Scissurella*, D'Orb; *Tornatella*, Lam.; *Scalaria*, Lam.; *Cyclostoma*, Lam.; *Valvata*, Müll.; *Littorina*, Ferussac, &c.

TU'RBOT. The best, and, excepting the halibut, largest of our flat fishes; it is the type of the subgenus *Rhombus* of Cuvier. It is taken either by the troll-net, or, in deep water, by the many-hooked line baited with the common smelt, or small gar-fish. A preference is given in the London markets to the turbots caught by the Dutch, who are estimated to have drawn for this supply not less than 80,000*l.* a year.

TURF. The surface of grass lands, of a smooth and uniform texture, covered with pasture grass. The term is also sometimes applied to peat cut out of bog. *See* PEAT.

TU'RKEY RED. A fine and durable red dyed upon calico and woollen cloth; the colouring matter used in its production is madder, but the process for producing it in perfection is tedious and complicated. (See *Bancroft on Permanent Colours.*)

TU'RLUPINS. (A word of which no satisfactory derivation has been found. See *Du Cange's Glossary.*) In French Ecclesiastical History, one of the numerous popular by-names by which the sectaries of the 14th century, the precursors of the Reformation, were distinguished: called elsewhere Beghards, Picards, Beguins, Lollards, &c.

TU'RMA. In the Roman Legion, a company of horse, of which ten formed the whole complement of the legion. According to Varro, it consisted of thirty horsemen, ten answering to each of the three original equestrian tribes, the Tatienses, Ramnenses, and Luceres. But in addition to the ten, there seem to have been two file leaders; and as the word turma was sometimes indiscriminately used for the subdivision or third part of the full turma, the following lines of *Virgil's Æneid* seem to describe the arrangement: —

> Tres equitum numero turmæ, ternique vagantur
> Ductores: pueri bisseni quemque secuti.

(See M. Le Beau's 8th Dissertation on the Roman Legion, *Mém. de l'Ac. des Inscr.* vol. xxxii.)

TU'RMERIC. The root of the *Curcuma longa*. This root yields a fine yellow powder, which is occasionally used as a dye stuff in medicine; it also forms one of the ingredients of *curry powder*. Paper stained with turmeric is often used in the chemical laboratory as a test of the presence of free alkalies and their carbonates, by which its yellow colour is converted to brown.

TURN. In Music, a grace thus marked ∾; indicating that the note above it, one degree higher, must be struck before it shortly, then passed quickly through the note itself, and *turned* from the note a degree below into the note itself, over which the mark is placed.

TU'RNIP-FLY. As different insects prey, in the larva state, upon the leaves of the growing turnip, the most destructive, and consequently the most important and interesting of these, will be noticed under the present head. They are the turnip-flea, as it may be called from its power of agile leaping (*Haltica nemorum*), and the turnip-fly (*Athalia centifolia*). The turnip-flea belongs to a genus (*Haltica*) of minute Coleopterous insects, of the section *Tetramera*, and family *Galerucidæ*; in which genus the species are all remarkable for the large size of the femora or thighs of the hindmost pair of legs. The species in question does not exceed the twelfth of an inch in length; it is of an oval form, with the elytra of a greenish tinge, each ornamented with a broad longitudinal stripe of a pale brimstone colour; but there are other species of the same genus, perhaps equally destructive, and not characterized by the longitudinal elytral bands. The perfect insect shelters itself in the rough uncultivated margins of fields, feeding upon the hedge-weeds; and appears to be ready at any time, provided the weather be warm, to commence the work of destruction on the young turnip shoots. Late sowing of the turnip seed does not therefore obviate the attacks of the *Haltica*. The first precaution obviously is to clear away all the weeds in the neighbourhood of the turnip grounds that may afford food or shelter to the little enemy. When the turnip-flea has made its appearance in the crop, the ground should be dusted with quicklime, and this repeated as often as rain or wind beats it off, and the flea reappears. The other enemy to the turnip (*Athalia centifolia*) belongs to the order *Hymenoptera*, and family *Teuthredinidæ*, or saw-flies.

TU'RNSOL. *See* LITMUS.

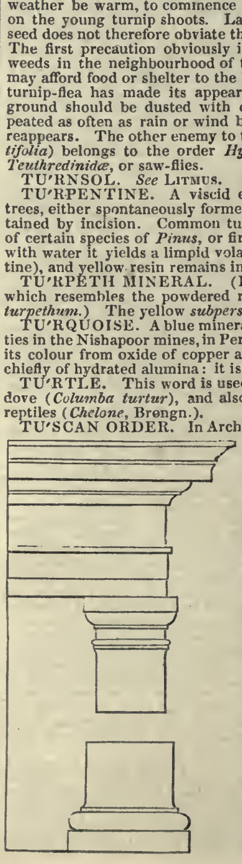
TU'RPENTINE. A viscid exudation from certain trees, either spontaneously formed upon the bark, or obtained by incision. Common turpentine is the produce of certain species of *Pinus*, or fir trees. When distilled with water it yields a limpid volatile oil (oil of turpentine), and yellow resin remains in the still.

TU'RPETH MINERAL. (From its yellow colour, which resembles the powdered root of the *Convolvulus turpethum.*) The yellow *subpersulphate of mercury*.

TU'RQUOISE. A blue mineral found in great quantities in the Nishapoor mines, in Persia. It appears to derive its colour from oxide of copper and of iron, and consists chiefly of hydrated alumina: it is admired in jewellery.

TU'RTLE. This word is used to signify a species of dove (*Columba turtur*), and also a genus of Chelonian reptiles (*Chelone*, Brongn.).

TU'SCAN ORDER. In Architecture, one of the five orders, and the simplest of them all. It is not found in any ancient example. Palladio has given two examples of this order, from one of which the profile here given is adopted, though by some that composed by Vignola has been preferred. The base, as will be seen on inspection, consists of a simple torus with its fillet, accompanied by a plinth. Sir William Chambers assigns to the column, with its base and capital, a height equal to seven of its diameters. Vitruvius speaks of this order with little praise, but Palladio commends it for its great utility. It does not allow the introduction of ornament; and it is to be



observed, that its columns are never fluted. By some architects it has been varied on the shaft with rustic cinctures; but such taste is perhaps very questionable. Though not suitable to every application of the order, the most perfect profile in this country to which we can refer is that of the portico of St. Paul's, Covent Garden, by Inigo Jones.

TU'TENAG. An alloy of copper, zinc, and nickel, made in China; the term is also sometimes applied to a pale brass, and to bell-metal. (*See* PACKFONG.) In India, zinc also sometimes goes under this name.

TUTORS. *See* UNIVERSITIES.

TU'TTI. (It. *all.*) In Music, a notice to the performer that, from the place to which it is affixed, all the parts are to play together. This word is generally used to contradict the word *soli*, or *solo*, which see.

TUTTY. An impure oxide of zinc collected from the chimneys of the smelting furnaces.

TWELF HINDI. In the old Saxon Commonwealth, the highest class of citizens were so called. They were valued at 12,000 shillings, and enjoyed many special prileges.

TWELFTH-DAY. The festival of the Epiphany, or Manifestation of Christ to the Gentiles; being the twelfth day, exclusive, from Christmas. (*See* EPIPHANY.) For the customs peculiar to this day in England, see *Brande's Popular Antiquities.*)

TWELVE TABLES, LAWS OF THE. The celebrated laws of the Roman republic, framed by the decemvirs appointed A. U. C. 303, on the return of three commissioners who had been sent to Greece to examine into foreign laws and institutions. The tables, as set up by the decemvirs, were originally ten in number; two were added in the second year of the decemvirate, and bore a more aristocratic stamp than the original ten (according to Cicero, the prohibition of marriages between patricians and plebeians was among the number). The text of the Twelve Tables were preserved down to the latest age of Roman literature, and formed the basis of the greater part of the Roman jurisprudence: they are called by Livy, "fons omnis publici, privatique juris." The authentic remains of them are given by Haubold (*Institutionum juris Romani privati Lineamenta*, Leipsig, 1826). There is a valuable chapter on the early Roman law, as founded on the Twelve Tables, in *Dr. Arnold's History of Rome*, vol. i.

TWI'LIGHT. (Germ. zwielicht.) In Astronomy, the faint light which is perceived for some time after sunset and before sunrise.

The twilight is produced by the reflexion of light from the atmosphere. When the sun descends below the horizon, the rays of light no longer reach the earth directly; but as they pass through the atmospheric strata a portion of them are reflected towards the earth, and illuminate its surface. At first the light, falling on the lowest and densest strata, is reflected in great abundance; but as the sun descends to a greater distance below the horizon, his rays fall on strata at a greater height, and consequently less dense. A smaller number of them, therefore, suffer reflexion; and as this number is constantly diminishing, the vivacity of the twilight diminishes in the same proportion, till at length the solar rays fall on strata so rare as to be incapable of reflecting light, and the twilight accordingly disappears. In the morning, the change from darkness to light takes place by the same gradations.

From this theory it is evident that twilight must begin and end when the sun's depression below the horizon attains a certain limit. The limit, however, cannot be fixed with any precision. It is usually estimated according the time which elapses from sunset till the smallest stars which are seen by the naked eye become visible. But this mode of estimating the duration of twilight is uncertain and arbitrary; and it will be reckoned greater or less according to the goodness of sight of the observer, and the temperature and pressure of the atmosphere. Accordingly, the sun's depression at the beginning and end of twilight has been fixed at various limits by different observers; by Alhazen, at 19°; by Tycho, at 17°; by Rothman, at 24°; by Stevinus, at 18°; by Cassini, at 15°; and by others at different quantities; but the limit usually assigned is 18°. Assuming this limit, the duration of twilight in different latitudes, and at the different seasons of the year, is computed as follows:—

In the spherical triangle Z P S, let P S = $90° - d$ be the distance of the sun from the pole, Z P = $90 - p$ the distance of the pole from the zenith of the observer, and Z S = $90° + 18°$; S being the place of the sun when he reaches the circle parallel to and 18° below the horizon. Now as d, the sun's declination, is known, and also p, the latitude of the place, the three sides of the triangle are given; whence the hour angle Z P S is found (*see* TRIGONOMETRY) by the formula.

$$\cos Z P S = \frac{-\sin 18° - \sin p \sin d}{\cos p \cos d}.$$

If, therefore, we make A = the semidiurnal arc of the sun, or the angle at the pole when the sun is in the horizon, and consequently his zenith distance = 90°, we shall have from the same formula

$$\cos A = -\tan p \tan d;$$

whence the angles Z P S and A are known, and their difference expressed in time gives the duration of the twilight.

At the equator $\sin p = 0$, $\cos p = 1$, and A = 90°. We have, therefore, $\cos Z P S = \frac{-\sin 18°}{\cos d}$. 1st, Suppose the sun to be in the equator; in this case we have also $d = 0$, and Z P S becomes equal to Z S = $90° + 18°$; whence the duration of twilight is equal to the time in which an arc of 18° on the equator passes over the meridian, or equal to 1 hour and 12 minutes. 2d, Suppose the sun to be at the tropic; in this case $d = 23\frac{1}{2}°$, and the duration of twilight is found by computing from the formula to be 1 h. 19 m.

By computing from the above formula, the duration of twilight, at the time of the equinox, is found to be 1 h. 55 m. at the latitude of 50°, and 2 h. 32 m. at the latitude of 60°. At the shortest day, its duration at different latitudes is as follows:—

1 h. 26 m. at latitude 25°,
2 h. 6 m. at latitude 50°,
2 h. 57 m. at latitude 60°;

and at 70°, when the sun no longer rises above the horizon, it continues about 5 h. 12 m. after the sun has passed the meridian of the place.

When the angle Z P S = 180°, we have $\cos Z P S = -1$. But in order that the hour angle may have this value, the sun must be on the lower semicircle of the meridian; and consequently, as his depression below the horizon is by hypothesis = 18°, the twilight will not entirely disappear, or will continue through the whole night. The formula in this case becomes

$$\cos p \cos d = \sin 18° + \sin p \sin d;$$

or $\cos (p + d) = \sin 18°$, whence $p + d = 72°$. When, therefore, the sun's declination $d = 72° - p$, the twilight will continue through the whole night at the place whose latitude is p. Hence, by giving different values to p, we find the declination, and consequently the day of the year on which twilight begins to continue through the whole night. Suppose $p = 50°$; then $d = 22$, which corresponds to the 1st of June. In the latitude of London (52°) perpetual twilight begins about the 20th of May. At 60° latitude it begins about the 22d of April; at 70° about the 26th of March; at 80° about the last of February; and at the pole itself about the 29th of January. It is scarcely necessary to remark, that as no account has been taken of the refraction, these expressions are only approximative.

One of the problems most frequently proposed respecting the twilight, is to find the day of the year when its duration is the least possible at a given latitude. This problem, which is the same as to determine the sun's declination when his zenith distance increases from 90° to 108° in the least time possible, was first solved by John Bernoulli (*Opera*, t. i. p. 64.). Solutions of it are given in most works on Practical Astronomy. (See Delambre, *Astronomie*, t. i.)

TWO-COAT WORK. In Architecture, plasterer's work that is either laid and set, or rendered and set.

TYMPANI'TIS, or TYMPANY. An elastic distension of the abdomen, arising from a morbid collection of gas in the intestines. The disease is sometimes termed *drum belly*, and arises occasionally from air secreted into the abdominal cavity, in which case it is usually fatal.

TY'MPANUM. (Lat. *a drum.*) The drum of the ear; the cavity behind the membrane of the tympanum, surrounded by the petrous portion of the temporal bone, and terminating at the cochlea of the labyrinth; it contains the four small auditory bones, and the Eustachian tube opens into it.

TYMPANUM, in Architecture, the space in a pediment enclosed by the cornice of the inclined sides and the horizontal fillet of the corona.

TYMPANUM, in Botany, is a membrane stretched across the mouth of the threa of a moss.

TYPE. (Gr. τυπος.) In the Fine Arts, the model or pattern in nature of an object used. Thus, in architecture, the types of columns are said to be trees, &c. &c.

TYPE. Properly, the figure stamped upon a coin: hence, a figure, sign, or symbol, especially those by which Christ was prefigured to the Jews, as the Brazen Serpent, the Lamb of the Passover, the Sacrifice of Isaac; or persons whose character and history are considered as embodying an anticipatory representation of the Saviour, as Moses, David, the prophet Jonah, &c.

Many types are referred to as such by the writers of the New Testament: and hence we learn to look for such intentional meaning in what we might otherwise,

in particular instances, pass over as mere coincidences and analogies. It is the great sum of such analogies, and the fulness with which they pervade the whole of Scripture, which seem most strikingly to evince the unity of design.

TYPE METAL. The alloy of lead and antimony used in casting printers' types. One part of antimony to three of lead are the usual proportions. This alloy takes a sharp impression from the mould or matrix, and is hard enough to stand the work of the press, without being brittle or liable to fracture.

TYPES. By this term is understood the letters, from the smallest size to the largest, with which books and other articles are printed. A single type consists of the shank, the beard, and the face. The shank is the body of the letter; the beard is that part between the shoulder of the shank and the face; the face is the shape of the letter, from which the impression is taken.

The following are the English names of the different sizes in their regular order; with the addition of the Dutch, French, German, and Italian names:—

1. Diamond, the smallest.
2. Pearl. (*Fr.* La Parisienne ou Sedanoise; *Ger.* Perl; *Ital.* Occhio di Mosca.)
3. Ruby.
4. Nonpareil. (*Dutch*, Nonpareil; *Fr.* La Nompareille; *Ger.* Nonpareille; *Ital.* Nompariglia.)
5. Emerald.
6. Minion. (*Fr.* La Mignione; *Ger.* Colonell; *Ital.* Minione.)
7. Brevier. (*Dutch*, Brevier; *Fr.* Le Petit Texte; *Ger.* Petit, or Jungfer; *Ital.* Piccolo Testo.)
8. Bourgeois. (*Dutch*, Bourgeois; *Fr.* La Gaillarde; *Ger.* Burgeois; *Ital.* Gagliarda.)
9. Long Primer. (*Dutch*, Garmond; *Fr.* Le Petit Romain; *Ger.* Corpus, or Garmond; *Ital.* Garamone.)
10. Small Pica. (*Dutch*, Dessendiaan; *Fr.* La Philosophie; *Ger.* Brevier, or Rheinlænder; *Ital.* Filosofia.)
11. Pica. (*Dutch*, Mediaan; *Fr.* Le Cicero; *Ger.* Cicero; *Ital.* Lettura.)
12. English. (*Dutch*, Augustyn; *Fr.* Le Saint Augustin; *Ger.* Mittel; *Ital.* Silvio.)
13. Great Primer. (*Dutch*, Text; *Fr.* Le Gros Romain: *Ger.* Tertia; *Ital.* Testo.)
14. Paragon. (*Dutch*, Paragon; *Fr.* Le Petit Parangon; *Ger.* Paragon; *Ital.* Parangone.)
15. Double Pica. (*Dutch*, Dubbelde Dessendiaan; *Fr.* Le Gros Parangon; *Ger.* Text, or Secunda; *Ital.* Due Linee Filosofia.)
16. Two Line Pica. (*Dutch*, Dubbelde Mediaan; *Fr.* Les Deux Points de Cicero; *Ger.* Doppelcicero.)
17. Two Line English. (*Dutch*, Dubbelde Augustyn; *Fr.* Palestine; *Ger.* Doppelmittel; *Ital.* Canoncino.)
18. Two Line Great Primer. (*Dutch*, Kanon; *Fr.* Petit Canon; *Ger.* Kleine Canon; *Ital.* Grosso Testo.)
19. Two Line Double Pica. (*Dutch*, Groote Kanon; *Fr.* Trismegiste; *Ger.* Grobe Canon.)
20. Trafalgar.
21. Canon. (*Dutch*, Parys Romeyn; *Fr.* Le Gros Canon; *Ger.* Kleine Missal; *Ital.* Canone.)

Canon is the largest size with a specific name; Pica then becomes the standard to distinguish them, and the next size to Canon is Four Line Pica, then Five Line Pica, and so on, to the largest size used in posting bills.

1. To enable the reader to form an opinion of the comparative sizes of
2. types, and the proportions they bear to each other, there is given
3. in this paragraph a line of each size, from Diamond, the
4. smallest type in general use in England, up to Great
5. Primer, inclusive, numbered to correspond with
6. the preceding list, in order to distinguish
7. them by their names. There is a smaller
8. type than Diamond lately introduced,
9. but it is as yet little used. The
10. French have one so small that
11. it cannot be read by the
12. naked eye, even by
13. young persons.

TYPHŌ'EUS. One of the Titans, said to have been overthrown in the war against Jupiter, and imprisoned under the weight of Ætna; a circumstance in mythological romance well known from the descriptions of Virgil, Pindar, and Æschylus. And see *Bryant's Anc. Mythol.* iv. 318.

TY'PHON. The Evil Genius of Egyptian Mythology. According to Sir G. Wilkinson (*Ancient Egyptians*, vol. iv. p. 417. &c.), they seem to have acknowledged two deities, who answered to the description given by the Greeks (especially Plutarch, *De Is. et Os.*) of Typho. "One, who was the brother of Netpe, and opposed to his brother Osiris, as the bad to the good principle; the other bearing the name of Typho, and answering to that part of his character which represents him as the opponent of Horus:" the true evil genius Ombte, whom the Greeks seem to confound with Typho. "He is figured under the human form, having the head of a quadruped, with square-topped ears, which some might have supposed to represent an ass with clipped ears, if the entire animal did not too frequently occur to prevent this erroneous conclusion." In his Egyptian names is "Ombte," in which Sir G. Wilkinson thinks he traces a connection with Antæus, the son of Earth. There appears to have been a general propensity to erase his figure and titles from the monuments at some remote epoch. (See also Bryant, *Anc. Myth.* vols. ii. and iii.)

TYPHOO'N. The name given to a violent tornado or hurricane in the Chinese seas. *See* STORMS.

TY'PHUS. This term (implying to burn with a concealed and smothered flame) is applied to certain continued fevers, attended by great debility and a tendency to putrefaction. It is contagious or infectious, and often epidemic, and is most prone to attack debilitated persons, especially where aided by want of cleanliness, good food, and fresh air; so that it often spreads in hospitals, jails, camps, and other situations where such causes assist its progress. This form of fever is liable to several modifications, commonly termed low fever, putrid fever, nervous fever, jail fever, &c. Its attack is generally characterized by inordinate muscular and nervous debility, and by great depression of spirits, weariness, flying pains, sighing, and a frequent, small, hard, and fluttering pulse; the tongue is foul and brown, and the taste impaired, and not unfrequently nausea and bilious vomiting prevail, constituting that variety of typhus which is sometimes called *bilious fever*. As the disease advances, the debility increases; the mouth becomes very foul, and the breath fetid; the urine deposits a brown sediment, and, together with the motions, is fetid, and rapidly putrefies; all these symptoms increase in intensity; the speech becomes inarticulate, muttering, and delirious; there is a tendency to bleeding from the nose, mouth, and bowels; petechiæ, or livid spots, appear upon the surface; the pulse sinks and intermits; the mind wanders; hiccup comes on; the hands and feet become cold; and, under these horrible symptoms, the patient dies. Such is an outline of the progress of a typhus fever to a fatal termination. In this climate it may endure for three weeks or a month; but in hot countries the symptoms follow each other more rapidly and violently, and it is not of more than eight or ten days' duration. When it does not terminate fatally, the symptoms begin to assume a more favourable aspect about the twelfth or fourteenth day; the pulse improves, the patient gets some tranquil sleep, perhaps perspires; the urine deposits a red sediment; bilious stools are passed; he becomes more tranquil in mind and body, and his symptoms gradually disappear till health is restored; but it is a disease the event of which must be anticipated with the utmost caution, for attacks apparently mild sometimes terminate fatally, and in other cases the constitution has rallied under the most alarming and malignant features. At the very commencement an emetic and a mild aperient are proper, followed up by aromatic opiates, with camphor and ether. It is possible that some particular symptom, indicative of local congestion, may call for bleeding or blistering: the former, except in some very rare cases, should be local only, and very limited as to quantity. Serpentaria, Peruvian bark, cascarilla, and colombo are the tonics which are most relied on; and, with these, camphor, aromatic confection, opiate confection, and ether; or, if agreeable to the stomach and bowels, sulphuric and muriatic acids, in small doses, and acidulous drinks. Wine and brandy, and, in some cases, bottled ale and porter, are requisite to keep up the general powers of the system; but care must be taken lest their use should be followed by over-excitement, and the quantity in some measure regulated by the previous habits of the patient. Broths, jellies, and the varieties of farinaceous food, may constitute the diet; and, in all cases, the utmost attention must be paid to extreme cleanliness, frequent change of linen, ventilation, and the due use of chlorine fumigation. On the first attack of typhus, the effusion of cold water, performed two or three times a day, often affords much relief; and afterwards, when the shock of such a remedy would be too great, sponging the head and body with cold or with slightly tepid water is productive of infinite comfort.

TYPO'GRAPHY. The art of printing. *See* PRINTING.

TY'RANNY. (Gr. τυραννος, *a tyrant*.) In the original sense of the word, a citizen who acquired sovereignty by violence or other usurpation is called, in the language of Greek political writers, a tyrant; and where the power thus acquired became hereditary, the title of

tyrant is still given to his descendants in the generations immediately following. A tyrant in this sense is opposed to basileus, a rightful king, with power either limited by the laws or sanctioned by ancient usage. (See, as to the Greek tyrannies, Wachsmuth, *Historical Antiquities*, vol. i. ch. 6.; and the explanation of the difference between the ancient and modern sense of the word given by Mitford, *Hist. of Greece*, i. 250. ed. 1829.)

TY'THING. A tything was a subdivision, *i.e.* a tenth part, as its name indicates, of the hundred, with which it was probably coeval in institution, as it was certainly identical in object, as far at least as regards the prevention of offences by the condition of liability for the production of offenders, or in default thereof reparation of the mischief, in the case of offences committed within the district. For this purpose, all free persons above the age of twelve years were required by the Saxon law to belong to some tything. No jurisdiction seems to have belonged to the tything; and the office of tythingman, or constable, seems always to have been confined, as it is now, to the preservation of the peace, and the apprehension of offenders. The limits of a tything were in most cases coextensive with those of a parish, with which it is now commonly, for practical purposes, identical.

U. and V.

U and V were long considered the same letter, and were used indiscriminately the one for the other; but at the beginning of the 16th century their peculiarities came to be marked, and *u* has since been used as a vowel and *v* as a consonant.

UBI'QUISTS, or UBIQUITA'RIANS. (Lat. ubique, *every where.*) In Ecclesiastical History, a school of Lutheran divines; so called from their tenet that the body of Christ was present in the Eucharist in virtue of his divine omnipresence. Luther is said to have maintained this argument, as a mode of reconciling the doctrine of transubstantiation with reason, for two years. Brentius, one of his diciples, passes for its principal supporter. Melanchthon opposed it; but it seems to have obtained great credit among the Lutherans of the sixteenth and seventeenth centuries.

U'CKEWALLISTS. In Ecclesiastical History, a sect of rigid Anabaptists; so called from one Uke Wallis, a native of Friesland. They appear to subsist still, independent of other Anabaptists and Mennonites, in Friesland and Groningen. (See *Mosheim*, vol. v.)

UKA'SE. An ordinance of the emperor of Russia, having the force of law in his dominions.

U'LCER. (Lat. ulcus.) A solution of continuity in any of the soft parts of the body, attended by a purulent or other discharge. The several kinds of ulcers are divided by surgeons into *local* and *constitutional*, but these often run into each other. They have been termed *simple* and *specific* sores or ulcers; the former resulting from accidental injuries, the latter from specific poisons or particular habits of body. (See *Cooper's Surgical Dictionary*.)

ULE'MA. (Turk. *learned men.*) The college or corporation composed of the three classes of the Turkish hierarchy: the imans, or ministers of religion; the muftis, or doctors of law; the cadis, or administrators of justice. This organization, according to D'Ohisson (*Tableau de l'Empire Ottoman*), was first framed by the caliphs, and adopted, along with the other principles of their government, by the Ottoman sultans. Candidates for admission into the Ulema are educated at the different colleges (medressés) of the empire. The *Sheikh ul Islam*, or mufti of Constantinople, is the president of the whole body. (See *Ed. Rev.* vol. 50.)

ULLAGE. In Gauging, what a cask wants of being full, is so called.

ULMA'CEÆ (Ulmus, the principal genus), are woody plants, usually timber trees, inhabiting temperate climates. They are apetalous Exogens, nearly allied to the Urticaceous order, from which they principally differ in having a two-celled fruit. The various kinds of elm trees are the best known species; but the thin papery fruit of these plants is by no means characteristic of the order; it is merely a character of the genus *Ulmus*.

U'LMIN. (Lat. ulmus, *the elm tree.*) A black or dark brown substance which exudes from the bark of the elm and several other trees, and which appears to be contained in most barks. It may be obtained by digesting elm-bark in boiling alcohol, and afterwards in cold water, by which various more soluble substances are removed; the residue is then digested in an aqueous solution of carbonate of potash: it acquires a brown colour, and yields a precipitate when neutralized by muriatic acid, which, after having been washed and dried, is *ulmin*. It is very sparingly soluble in water, but readily soluble in solutions of the alkaline carbonates. According to Boullay (*Annales de Chim. et Phys.* xliii. 273.), it is a compound of 567 carbon and 433 hydrogen and oxygen in the ratio to form water. He terms it *ulmic acid*, and considers it identical with the brown matter of vegetable mould and turf, and as contributing materially to the nutriment of growing plants.

U'LNA. The larger of the two bones of the forearm. It forms the point of the elbow, and is articulated by a species of hinge-joint to the humerus, and to the radius; and below to the radius, and to the bones of the wrist.

U'LTIMATE ANALYSIS. This term is applied in Chemistry to the resolution of substances into their absolute elements; and is opposed to the *proximate analysis*, by which they are merely resolved into secondary compounds. The ultimate analysis of crystallized blue vitriol, for instance, teaches us that its true elements are sulphur, copper, oxygen, and hydrogen; its proximate elements are sulphuric acid, oxide of copper, and water; the ultimate elements of sulphuric acid are sulphur and oxygen; of oxide of copper, copper and oxygen; and of water, hydrogen and oxygen. The terms *ultimate analysis* and *ultimate elements* are, however, most generally used in reference to organic products: gum resin, starch, and other compounds, are often found associated in a vegetable, and are called its *proximate* principles, and they are separated by proximate analysis; but all these are resolvable into carbon, hydrogen, and oxygen. These three elementary substances, therefore, are their *ultimate* components. The accurate determination of their relative proportions in the various products of vegetables is almost always a difficult chemical problem.

ULTIMATE RATIO. The ratio of evanescent quantities. *See* Prime and Ultimate Ratio.

ULTIMA'TUM. (Lat.) In Diplomacy, the final conditions offered by a government for the settlement of its dispute with another.

ULTRA. In Modern Politics, those who carry to their farthest point the opinions of the party to which they belong are so termed. The name was applied in 1793 to the more violent revolutionists; it has since been bestowed on the extreme section of all parties in turn.

ULTRAMARI'NE. (Lat. ultra, *beyond*, and marinus, *belonging to the sea.*) The blue colouring matter of the lapis lazuli. This substance is much valued by painters, on account of the beauty and permanence of its colour, both for oil and water painting. In its preparation the finest lapis lazuli is selected, heated to a dull red heat, and quenched in water; it is thus rendered friable, and is ground down into an impalpable powder. This is then mixed with a tenacious paste made of linseed oil, wax, resin, turpentine, and mastic; and the mixture being kneaded in warm water gives out the blue particles, which are afterwards collected by subsidence. Chemists have long in vain endeavoured to imitate this colour, but till lately its nature even had not been determined. It appears from the experiments of Gmelin that sulphuret of sodium is the principle to which the blue colour is owing, and he has succeeded in preparing an artificial ultramarine by heating sulphuret of sodium with a mixture of silica and alumina. (See the *Annales de Chimie et Physique*, vol. xxxvii. p. 409.)

U'LTRAMONTANE, or TRA'MONTANE. A name applied by Italian writers to theologians and jurists of other countries beyond the Alps, especially France. In ecclesiastical law, ultramontane tenets are those least favourable to the supremacy of the popes. As to ultramontane jurists, see Savigny, *Hist. of Roman Law*, vol. vi.

U'MBEL. In Botany, a form of inflorescence in which all the pedicels proceed from a single point, as in *Astrantia*. If there is no subdivision, the umbel is called simple; but if the pedicels produce other umbels, as in parsley, the umbel is compound.

UMBELLI'FEROUS PLANTS (Umbel), are a race of great frequency in all cool or temperate climates, and even occur in hot ones, though much more rarely. They are known in general by their flowers being disposed in an umbel. They have a herbaceous stem; leaves usually much divided, often inflated when they join the stem; and they have universally a dry fruit, which divides into two seed-like pieces. Some of them are poisonous, as hemlock and water dropwort; others are esculents, as celery, carrots, and parsnips; many yield aromatic fruits, as caraway, coriander, and anise; a few secrete a fœtid gum resin, of which assafœtida, ammoniacum, and galbanum are examples. The species are extremely numerous, and difficult to recognize with accuracy; and, unfortunately, no general rule has yet been discovered for distinguishing those poisonous from the harmless kinds.

U'MBER. Two distinct substances are used as pigments under this name: one is a variety of peat or brown coal, large beds of which are worked near Cologne; it is said to be largely used in the adulteration of snuff: the other, called *Turkish umber*, is a variety of ochraceous iron ore, composed, according to the analysis of Klaproth, of 48 peroxide of iron, 20 peroxide of manganese, 13 silica, 5 alumina, 14 water. The term umber

is said to be derived from Ombria, or Spoleto, in Italy, where it was first obtained.

UMBI'LICAL CORD, in Botany, is an elongation of the placenta in the form of a little cord, as in the hazel nut.

UMBI'LICATE. (Lat. umbilicus, *a navel.*) In Zoology, when a pit, tubercle, or granule has a depression in its centre.

UMBILI'CUS. (Lat.) Properly the navel; whence it was metaphorically applied to the two ends of the roller on which the manuscripts of the ancients were rolled, and which were usually adorned with ornamental knobs, while the ends of the parchment were filed with pumice-stone, in order that the folds might lie smooth and neat.

UMBILICUS. In Conchology, the aperture or depression in the centre, round which the shell is convoluted.

UMBILICUS. The scar by which a seed is attached to the placenta, frequently of a different colour from the rest of the seed, and not uncommonly very dark-coloured. It is more commonly called *hilum*.

UMBILICUS. In Geometry, used by the older geometers synonymously with *focus*.

UMBO. (Lat.) A protuberance or boss. In Conchology it is that point of a bivalve shell immediately above the hinge.

UMBRA. A shadow. In Astronomy, this term is applied to the dark cone projected from a planet or satellite on the side opposite to the sun. *See* ECLIPSE.

U'MPIRE. This word appears to be properly derived from the Fr. "impair," *uneven in number;* an umpire being a third party to whom a dispute is referred. An umpire is properly a person whom two referees, each chosen by his client, being unable to agree, jointly choose to determine between them.

UNBEND. In sea language, to take the cable from the anchor, a sail from its yard, &c.; to untie one rope from another.

UNCIÆ. The name given by the old writers on algebra to the coefficients of the letters in the expansion of any power of a binomial. Thus, the expansion of $(a+b)^4$ gives $a^4 + 4\,a^3\,b + 6\,a^2 b^2 + 4\,a b^3 + b^4$, in which the numbers 1, 4, 6, 4, 1, are the *unciæ*, or coefficients.

UNCIA'LES LITERÆ. (Lat.) Uncial letters or writing. In Diplomatics, a species of character compounded between the capital and the minuscule or small characters; some of the letters resembling the former, others the latter. It is supposed to have been employed in Latin MSS. as early as the third or fourth century, but was seldom used after the tenth.

U'NCIFORM BONE. (Lat. uncus, *a hook.*) The last bone of the second row of the wrist bones; so called from its hook-like process, which projects towards the palm of the hand, and gives origin to the great ligament which binds down the tendons of the wrist.

UNCOMMON CHORD. In Music, another term for the chord of the sixth; not so called, however, because it is unusual or improper, but to distinguish it from the *common chord*, wherein the lowest note is the root or fundamental bass. *See* MUSIC.

UNCONFORMABLE STRATA. A term applied by geologists to strata not lying parallel with the subjacent ones, or having a different line of direction or inclination.

UNCTION, EXTREME. *See* EXTREME UNCTION.

UNDE'CAGON. (Lat. undecim, *eleven*, and Gr. γωνια, *angle.*) In Geometry, a plane figure of eleven sides or angles. The area of a regular undecagon is found by multiplying its side into $\frac{11}{4}$ of the tangent of $73\frac{7}{11}$ degrees; hence if the side be 1, the area is 9·36564.

UNDERTOW. A current below different from that at the surface.

UNDERWOOD. The low woody growths produced among timber trees: sometimes called coppice wood; though the term *coppice wood* is more especially applied to woods in which low growths of shrubs, or the stools of trees, are more abundant than timber trees. *See* COPPICE WOOD and STOOL.

UNDI'NES, or ONDINES. (Lat. unda, *water.*) The name given by the Cabalists to one class of their spirits of the elements, namely, those residing in the waters. The ancient Greeks believed springs and lakes to be haunted by a peculiar race of supernatural nymphs (*see* NAIADS); and this belief passed down unimpaired to the middle ages. The ancient Saxons adored the female deity of the Elbe; and the belief in undines is still scarcely eradicated in that region. The Saxon peasants report that an undine is often met in the market-place of Magdeburg, dressed as a girl of their own class, but always to be known by having one corner of her apron wet. Near Toulouse many objects of value were once discovered on draining a large artificial lake, which are supposed to have been thrown in as offerings to the spirits of the water. The *nixe* of the northern countries is of the same family, and the Scottish *kelpies* are creatures of a similar superstition.

UNDULA'TION. (Lat. unda, *a wave.*) A waving motion; applied, in physics, to the vibratory motion of an elastic fluid, as the atmosphere.

UNDULATORY THEORY, in Optics, is the hypothesis according to which the impression of light is conveyed to the eye by the undulations of an elastic medium. This theory supposes the universe to be filled with an ether or medium of great elasticity, but so extremely rare as to offer no resistance to the motions of the planets. For an explanation of the phenomena of light and colours according to this theory, see LIGHT.

UNEVEN NUMBER. In Arithmetic, the same with *odd* number; a number not divisible by 2.

UNFORMED STARS, in Astronomy, are such as are not included in any of the constellations.

UNGUI'CULATES, *Unguiculata.* (Lat. unguis, *a claw.*) The name of a primary division of the class Mammalia, including those which have the digits armed with claws, but free for the exercise of touch upon their under surface. *See* MAMMALIA.

U'NGUIS, or CLAW. The narrow part of the base of a petal, taking the place of the footstalk of a leaf, of which it is a modification. The term is also used as a term of measure equal to a nail, or half an inch, or the length of the nail of the little finger.

U'NGULA. (Lat. *a hoof.*) In Geometry, a solid formed by cutting off a part from a cylinder, cone, or other solid of revolution, by a plane passing obliquely through the base. The ungula is, consequently, bounded by the plane of the base, the intersecting plane, and the portion of the surface of the cylinder, &c. included between them. The name is derived from its resemblance to the hoof (ungula) of a horse.

U'NGULATES, *Ungulata.* (Lat. ungula, *a hoof.*) The name of a primary division of the class Mammalia, including those species which have the digits inclosed in hoofs, the under surface not being left free for the exercise of touch. *See* MAMMALIA.

U'NICORN. (Lat. unus, *one;* cornu, *horn.*) The beast called unicorn, in our version of scripture (Heb. rem), is now commonly understood to be the rhinoceros. But the fabulous unicorn, which has passed into heraldry, is represented with the figure of a horse, and a single horn issuing from its forehead. The unicorn of Pliny, however, has the head of a hart, the feet of an elephant, the tail of a boar, and the rest of the body resembling a horse. Aristotle, Ælian, and all the classical writers on animals, mention the unicorn. The traveller Ludovicus Romanus asserts that he saw *two* unicorns, kept alive in the temple of Mecca. Altogether there is perhaps no fabulous beast for whose existence there is so much appearance of evidence, and some seem to imagine that it may yet be discovered in the interior of Thibet. Many strange virtues were attributed of old to the horn of the unicorn, particularly against poison; but the horns preserved in collections, and to which that name was given, were either of the rhinoceros, or of the narwal or sea-unicorn.

UNIFO'RMITY. (Fr. uniforme.) In the Fine Arts, resemblance in shape between the correspondent parts of a subject.

UNIFO'RMITY, ACT OF. In English History, the first act of uniformity is the 1 Eliz. c. 2.; that at present subsisting, 13 & 14 Car. 2. c. 4. It regulates the form of public prayers, administration of the sacraments, and other rites of the Church of England.

UNIGE'NITUS. The celebrated constitution, in the form of a bull, issued by Pope Clement XI. in 1713, in condemnation of Père Quesnel's *Réflexions Morales sur le N. Testament.* It is so called from its beginning, "Unigenitus Dei Filius." Father Quesnel was a friend of the celebrated Jansenist leader Arnauld, and became chief of that religious party after the death of the latter. He died in exile at Amsterdam, in 1679. The bull was procured by the Jesuits, especially Father le Tellier; it condemned 101 propositions selected from Quesnel's work. Its publication created great discord in France. Most of the bishops accepted it, but with explanations which they gave to the public. Cardinal de Noailles and others refused to accept it all. As soon as the Duke of Orleans became regent, Father le Tellier was banished, and the party opposed to the bull came into power; but the strength of Rome prevailed, and eventually the Duke of Orleans himself compelled de Noailles to accept the bull, in 1720. After that event the Jansenist party only survived in small fragments, especially among the commonalty of Paris. *See* JANSENISTS.

UNILO'CULAR. (Lat. unus, *one;* loculus, *partition.*) In Conchology, shells which are not divided into chambers. In Botany, seed vessels not separated into cells.

UNION. In British History. The union of the crowns of England and Scotland took place on the accession of James I. to the former. The scheme of uniting the kingdoms was afterwards several times taken up; and commissioners were appointed to consider it in the reigns of Charles II. and James II. But it was finally carried

into execution in 1706; the statute passed on that occasion being the 5 Anne, c. 8. By this enactment laws relating to trade, customs, and excise were to be the same in both countries; other laws to remain in force in each respectively. The parliament of the United Kingdom, called Great Britain, was to have 16 Scottish peers, and 45 members of the House of Commons. The mode of election of peers was subsequently regulated. (*See* PARLIAMENT.) Since the union, acts of parliament, in general language, are held to extend to Scotland; a proviso being inserted where it is to be excepted. The union of Great Britain and Ireland took place in 1800, by the statute 39 & 40 G. 3. c. 67. of the British, and 40 G. 3. c. 38. of the Irish statutes. It admitted 4 Irish lords spiritual, 28 temporal, and 100 commoners to the united legislature; the lords temporal elected for life, the lords spiritual sitting by a certain rotation. By article 5. the churches were united. For the changes which have since taken place in the number of Scottish and Irish members in the House of Commons, see PARLIAMENT.

UNIPE'LTATES, *Unipeltata*. (Lat. unus, *one*, and pelta, *a buckler*.) The name of a family of Stomapodous Crustaceans, comprehending those in which the carapace is composed of a single shield-like plate.

U'NISON. (Lat. unus, *one*, and sonus, *sound*.) In Music, a consonance of two sounds equal in gravity or acuteness, produced by two bodies of the same matter, length, thickness, tension, &c. equally struck at the same time, so that they yield the same tune or sound.

UNIT, UNITY. In Arithmetic, the number one; an individual of discrete quantity. Euclid defines number to be a multitude or collection of units.

UNITA'RIANS. Those who confine the Godhead to a single person; in which general sense the term may be taken to represent the Arians and Socinians, as well as the sect which is more strictly denominated Unitarian. These last are the descendants of the religious communities which adopted, in the 16th century, the opinions of Socinus; but in the course of years they have gone considerably further towards reducing Revelation to a mere ethical system. They have been supplied with an abundant stream of converts from the Presbyterians and Independents in this country, many congregations of whom became first Arian, and latterly Unitarian in sentiment. The principal Unitarian authorities are Drs. Priestley, Belsham, and Channing, who have either entirely rejected or neutralized the doctrine of the atonement, and represent the language of the apostles upon this and other mysterious points as either intentionally accommodated to the ideas current among their hearers, or derived from erroneous conceptions of their own. The revelation of the New Testament is thus reduced to the assertion of a mere historical fact— that of the existence of the man Jesus as a moral teacher. But with respect to what he taught, great latitude of interpretation is allowed to Unitarians, since it appears that in their view the exposition of the first disciples is not to be implicitly relied on; nor do they allow infallibility to the Author of the religion himself. The Unitarians were subjected to severe penalties, as deniers of the Trinity, long after other dissenters had been relieved by the Act of Toleration: the laws against them were not repealed by statute till the year 1813.

In this country they do not constitute a numerous body: the number of their congregations has been stated at something more than 200; but they are principally composed of persons of the educated classes. In Geneva the pulpits of the established church are mostly occupied by professors of these opinions; and in the northern states of America they form one of the most influential of Christian denominations.

UNITED BRETHREN. In Ecclesiastical History, a body of reformers in Bohemia, who separated themselves from the Catholics and Calixtines (according to some writers) about 1467. It is also said that they received episcopal ordination from the Vaudois. According to others (Bossuet, *Variations des Eglises Protestantes*, chap. ii.), they were an offshoot from the Taborites or Thaborites (see that article). At all events, it appears certain that there already existed a considerable body of persons professing the tenets of the Reformation in Bohemia at the period of Luther.

U'NITIES, in the Drama, are three,—of time, place, and action. The latter only is strictly adhered to in the dramatic compositions of classical antiquity; but what is termed by moderns the *classical* drama (in opposition to the *romantic*) requires all three. *See* DRAMA.

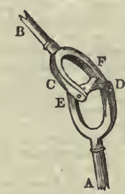
UNIT JAR. A small insulated Leyden jar placed between the electrical machine and a larger jar or battery, so as to announce by its repeated discharges, which may be counted, the number of them which have passed into the larger jar. This is among the many valuable additions made to electrical apparatus by Mr. Snow Harris.

U'NIVALVE. (Lat. unus, *one*; valva, *a valve*.) This term is applied to those Mollusks, the shell of which is composed of one piece, and which is generally convoluted spirally. Latreille also thus denominates a family of Lophyropodous Crustaceans.

UNIVE'RSAL. In Logic. A universal proposition is that which has the subject distributed, so that the predicate is declared concerning every thing comprehended in it; *e.g.* "All men (subject) are mortal (predicate)." In universal negative prepositions the predicate is distributed also; *e.g.* "No men are immortal."

UNIVE'RSALISTS. A name by which the Arminians are sometimes characterized, expressing the universality which they attribute to the operation of grace, conceiving it to be given to all men without favour or reserve. On the other hand, the Calvinists, or those who hold the particular election of individuals, are designated as Particularists.

UNIVERSAL JOINT, or HOOKE'S JOINT. In Machinery, an ingenious contrivance of Dr. Hooke for the purpose of communicating motion obliquely. It is single or double. In the single universal joint, the two



shafts or axles, A and B, between which the motion is to be communicated, terminate in semicircles, the diameters of which are fixed in the form of a cross, their extremities moving freely in bushes placed at the extremities of the semicircles. Thus, while the central cross remains unmoved, the shaft A and its semicircular end may revolve round C D as an axis; and in the same manner B, with its semicircular end, will revolve round E F. If the shaft A be made to revolve without changing its direction, the points C D will move in a circle whose centre is at the middle of the cross. The motion thus given to the cross will cause the points E F to move in another circle round the same centre, and hence the shaft B will be made to revolve. (*Mechanics*, *Cabinet Cycl.* p. 253.)

When the shafts are inclined to each other under an angle of 40°, it is necessary to employ a double universal joint, as represented in the annexed figure. In this

manner the motion may be transmitted from one shaft to another at right angles. Instead of employing a cross in the manner now described, the joints may be constructed with four pins, fastened at right angles upon the circumference of a hoop or ball. Universal joints are of great use in cotton mills, where the tumbling shafts are continued to a great distance from the moving power; for, by applying a universal joint, the shafts may be cut into convenient lengths, and so be enabled to overcome a greater resistance. (See *Gregory's Mechanics*, vol. ii. p. 9.; *Willis's Principles of Mechanism*, p. 272.)

UNIVE'RSITY. In the middle ages, the Latin term universitas signified the whole body of students, or of teachers and students, assembled in a place of education, with corporate rights, and under by-laws of their own; in later times, also, the name was held to imply that all branches of study were taught in a university. In the modern sense of the term, a university signifies an establishment for the purposes of instruction in all or some of the most important divisions of science and literature, and having the power of conferring certain honorary dignities, termed degrees. It is generally understood that the authorization of the sovereign power in the state is necessary to enable such an establishment to confer degrees; and, in most European countries, there are various offices and professional situations for which a person is qualified by having taken a certain degree at one of these establishments. Hence universities, although in many instances they are composed of private foundations, are justly regarded as national institutions. The University of Paris, the most celebrated of those of the middle ages, and which served in some degree as a model to the rest, was formed about 1200 by the union of the various schools of rhetoric, theology, and philosophy, with which that city abounded, under one head, styled the rector. That university was divided into four nations,—French, Picard, Norman, and English: the first comprehended students from Italy and Spain; the last from the north of Europe generally. The subjects taught were arranged under faculties; viz. theology, law, medicine, and that of the seven liberal arts,—rhetoric, logic, grammar, geometry, arithmetic, astronomy, music. (*See* TRIVIUM, QUADRIVIUM.) These faculties were corporate, and elected each a dean; and these last, with the procuratores of the nations, represented the university. The lowest degree was that of bachelor; the next licentiate; the third magister (this degree at Paris corresponded with that of doctor at Bologna). The colleges were royal or private foundations for the benefit of poor students, whose board was,

in some instances, found for them, and who received stipends or other emoluments. The faculty of theology at Paris was well known by the name of the Sorbonne (*q. v.*). This slight sketch of the constitution of the famous University of Paris may serve for similar establishments in other Continental countries during the middle ages, and down to a comparatively late period. In England, the two national universities have been established, from a period of considerable antiquity, at Oxford and Cambridge. The original constitution of these universities much resembled that of the Parisian, with the exception of the division into four nations, which was wanting. But their subsequent history was much modified by the growth of the colleges, or individual foundations, into a much higher degree of consequence. These were originally destined by their founders merely to entertain a certain number of junior students (generally termed scholars), and a higher body (named in most cases fellows), and furnish them with assistance in the prosecution of their studies; while the great body of independent students lodged in the numerous halls, and attended only on the public university lectures. But by degrees the colleges likewise became receptacles for independent students, under the tuition of the fellows; the halls were for the most part abandoned, and such as remained partook of the collegiate character; and, in the modern system (which has subsisted for more than two centuries), nó student is admitted to take a university degree unless he has completed his studies in a college, or collegiate hall, under the superintendence of its tutors. But the original division into independent and foundation students still subsists; although the fellowships in many instances, instead of being filled up from the junior foundation members in each college, are left open as prizes for the competition of the whole university. The degrees, in Oxford and Cambridge, are differently named, or arrived at in different succession, in the several faculties; but degrees in theology and medicine can only be obtained after the acquisition of certain degrees in arts. In Spain, the universities are arranged on a system somewhat resembling that which prevails in England, the students being entered of their respective college in each. In Germany, as in England, the earliest universities (Prague, founded in 1348, and Vienna, in 1365) were framed on the model of that of Paris. Germany has now a far more numerous list of universities than any other country. From the Bursæ (charitable establishments resembling our collegiate foundations for the benefit of poor students) was derived the term *Bursche*, by which the students of these universities are so generally known. But the collegiate system never prevailed in that country as among ourselves. On their present arrangement (which is pretty similar in all, Catholic as well as Protestant), the four faculties are retained. Professors in the various branches are appointed by government. These form the senate, at the head of which is the prorector, who is chosen annually or biennially. Besides these, there are extraordinary professors, who receive small salaries; and an inferior class of licensed teachers, or licentiates, who receive none. The professors are obliged to give public lectures in the branch of study to which they are appointed; but they, as well as the other two classes, may give also private lectures on whatever subject they please; and from the fees of attendance at these their principal income is derived. The student is for the most part left at liberty to attend what lectures he pleases; but licences to practise various professions, benefices in the various churches, &c., are only given, especially in Prussia, to those who have studied a certain number of years by attending lectures in the requisite branch of study. The constitution of the Scotch Universities has a great resemblance to those of Germany; and the same observation is applicable to the two universities established in the metropolis within the last few years, — London University and King's College. In France, the old university system may be said to have been entirely done away with by the Revolution. As to the universities of the middle ages, see Savigny, *Hist. of Roman Law*, vol. iii. For an elaborate defence of the English system, see *Quart. Rev.* vols. lii. lix. The history of the great change effected in it by the substitution of collegiate for professorial instruction, has been traced in a series of recent papers in the *Edin. Rev.*

UNI'VOCALS, or SYNONYMS. In the Aristotelian Logic (as used by the schoolmen), generic words; *i. e.* words of which both the genus and the difference are predicable of many different species: *e. g.* the genus "animal" is "univocum univocans" with respect to "man" and "brute," both of which are comprehended under any definition which can be given of the word "animal," and are called with reference to it "univoca univocata." Universal terms are also such as have only one signification; opposed to equivocal.

UNMOOR. To take up one of the two anchors by which the ship is moored.

UPAS TREE (Upas, the Javanese name), is a plant common in the forests of Java and some of the neighbouring islands, to which extraordinary stories, for the most part fabulous, have been attached. Upon the authority of Dutch writers, it has been asserted that it is a most deadly poison, employed in the execution of criminals; who are, however, pardoned if they succeed in reaching a tree and bringing back its venom. Birds were said to drop dead while flying over it, and the whole country round it was asserted to be desolated by its pestilent effluvia. The truth is, that the Upas tree is merely a tree with poisonous secretions, and nothing more; there is nothing deleterious in its atmosphere. It is an Urticaceous plant, called *Antiaris toxicaria*, and is very nearly related to the fig, some of whose species are also deadly poisons.

UPHERS. In Architecture, fir poles chiefly used in scaffolding; they run from twenty to forty feet in length, and from four to seven inches in diameter.

U'PLANDS. Lands on hills or steep declivities, which in general require a different kind of management from lands in plains or comparatively flat surfaces. Uplands are generally kept in pasture or underwood.

U'PUPA. (Lat. upupa, *a hoopoe.*) A genus of Tenuirostral Passerine birds, distinguished by an ornamental head-crest formed of a double range of feathers, which can be erected at will. The common hoopoe (*Upupa epops*) is an occasional but rare visitant of England.

U'RACHUS. The ligamentous chord which arises from the base of the urinary bladder, and terminates in the umbilical cord.

URA'NIA. In Mythology, the muse of Astronomy. She is generally represented with a crown of stars, in a garment spotted with stars, and holding in her left hand a celestial globe or a lyre.

URA'NIUM. A metal discovered by Klaproth in 1789, who named it after the planet Uranus, discovered about that time. It occurs only in two native combinations, — the *pechblende* of Saxony, and the *uranite;* of the latter, fine specimens have been found in Cornwall. Little is known of the properties of metallic uranium: it appears to be a brittle gray metal, of the specific gravity about 9. From the experiments of Berzelius and Arfwedson we deduce the number 217 for its equivalent; that of its protoxide being 225, and of its peroxide (sesquioxide) 229. The salts of the oxides of uranium are of a fine grass green or yellow colour: the persalts have been most examined. Ferrocyanate of potassa produces in them a very characteristic rich brown precipitate, not unlike that formed by the persalts of copper. They are also precipitated brown by infusion of galls.

U'RANOSCOPUS. (Gr. οὐρανος, *heaven;* σκοπεω, *I explore.*) A genus of fishes was so called by Linnæus, because both eyes were placed on the superior surface of the head, which presents a nearly cubical form. The mouth is cleft vertically at the anterior part of the head, and, like the eyes, is directed upwards. The species of of this genus, commonly called "star-gazers," belong to the *Percoid* family of Acanthopterygian fishes in the Ichthyological system of Cuvier.

U'RANUS. (Gr. οὐρανος, *heaven.*) In Mythology, a divinity, the first king of the Atlantic nation, and the father of Saturn.

URANUS. In Astronomy, the remotest known planet belonging to our solar system. The mean distance of Uranus from the sun is 19·18239, that of the earth being considered as unity, whence its real distance is upwards of 1800 millions of miles. Its sidereal revolution is performed in about 84 Julian years. The orbit is inclined to the ecliptic in an angle of only 46′ 28·44″; and the eccentricity of the orbit is 0·046679, half the major axis being taken as unity. The apparent diameter of Uranus (which, on account of the great magnitude of its orbit in comparison of that of the earth, undergoes very little variation) is about 4″; whence the real diameter of the planet must be about 35,000 miles, or nearly four and a half times that of the earth; and its bulk about eighty times that of the earth. Uranus presents the appearance of a small round and uniformly illuminated disk, without rings, belts, or discernible spots. From analogy we infer that it revolves about its axis; but of this there is no direct proof: the great distance of the planet, indeed, precludes our obtaining much knowledge of its physical state. Two satellites at least are known to attend Uranus. Sir William Herschel thought he could discern six; but the existence of more than two has not been clearly made out. In fact, with the exception of the two inferior satellites of Saturn, those of Uranus are the most difficult objects to obtain a sight of in the solar system. The two satellites which are in some degree known have this remarkable peculiarity, that, instead of advancing from west to east round the centre of the primary, the planes of their orbits are nearly perpendicular to the ecliptic, and their motion is retrograde.

Uranus was discovered by Sir William Herschel, at Bath, on the 13th of March, 1781. It had been previously observed by Flamsteed, Bradley, Mayer, and Lemonnier; but, owing to the inferiority of their telescopes, not one

of these astronomers suspected it to be a planet. Sir W. Herschel called it the *Georgium Sidus*, in honour of George III. Foreigners for some time called it the *Herschel;* and it is now, in some English works, called the *Georgian.* *See* PLANET.

URE'A. A peculiar crystallizable substance held in solution in the urine. When dried in vacuo it consists, according to Dr. Prout, of

	Atoms.	Equiv.	Theory.	Experiment.
Nitrogen -	2	28	46·67	46·65
Carbon -	2	12	20.00	20·07
Hydrogen -	1	4	6·67	6·65
Oxygen -	4	16	26·66	26·63
	1	60	100·00	100·00

Urea is readily soluble in water, tasteless, inodorous; and when mixed with the other contents of the urine very prone to putrefaction, the principal result of which is carbonate of ammonia. Urea has been artificially obtained by the action of ammonia on cyanate of lead; oxide of lead is precipitated, and colourless crystals of urea obtained by carefully evaporating the solution.

URE'DO. (Lat. uro, *I burn.*) A genus of microscopical Fungi, whose presence is known by the burnt appearance of the part they infest. They consist of extremely minute brown spores, which multiply with great rapidity, and appear to injure plants by absorbing their juices. Smut and brand, diseases too well known to the farmer, are caused by their ravages. Steeping corn in lime-water is the best means of repelling their attacks.

U'RETER. The membranous tube which conveys the urine from the kidney to the urinary bladder.

U'RE'THRA. The membranous tube or canal by which the urine is voided.

U'RIA. A genus of web-footed birds, belonging to the short-winged family *Brachypteres* of Cuvier, and, like the rest of that family, admirable divers. The species of *Uria* are all marine, and generally known by the name of "Guillemots." They resort in vast numbers to breed among the rocks of the Orkney and Shetland Isles, and are a source of profit to the adventurous inhabitants.

URIC ACID. An acid peculiar to the urine of certain animals; it is always present in human urine, and in the excrements of many birds of prey and of serpents, especially of the *Boa constrictor*, which is voided in white nodules, consisting of little else than urate of ammonia. Uric acid also forms one of the commonest varieties of urinary calculi, and of the red gravel or sand which is voided in certain morbid states of the urine. Pure uric acid is obtained in the state of a very insoluble white powder by digesting powdered uric calculus, or the excrement of the boa, in potash, and dropping the solution into weak muriatic acid: the precipitate which falls is to be well washed, and dried at 212°. Its most distinctive chemical character, by which it is at once easily recognized, is, that when moistened with nitric acid and heated it dissolves, and upon evaporation to dryness leaves a red compound, which, upon the addition of a drop or two of a solution of caustic ammonia, becomes of a fine crimson (*purpurate of ammonia*). The following is the composition of uric acid: —

	Atoms.	Equiv.	Theory.	Experiment.
Nitrogen -	2	28	31·11	31·125
Carbon -	6	36	40·00	39·875
Hydrogen -	2	2	2·22	2·225
Oxygen -	3	24	26·67	26·775
	1	90	100·00	100·000

U'RIM. A word connected in its signification with the word *thummim*, being the plural of the Hebrew aur, *a light, a luminary;* whence it has come to signify fire. *Thummim*, which is the plural of thom or tam, means *fulness* or *perfection*. See *Wilkinson's Ancient Egyptians*, as to the connection of this word with the title of the Egyptian god Thauth, or Thoth.

The two words, conjointly, signify light and perfection; but the Septuagint render it literally δήλωσις και αλήθεια, *manifestation and truth*. The urim and thummim were the precious stones on the high priest's breastplate, which made known the will of God by casting an extraordinary lustre, and thereby *manifested* the success of events to those who consulted them.

The high priest alone could officiate at this solemn ceremony; and the urim was to be consulted only at the instance of public persons, such as the king, the president of the sanhedrim, and the general of the Israelitish army; and only on such public matters as related to the common interest of the twelve tribes.

The manner in which the high priest consulted the urim was as follows: — Having entered into the sanctuary or holy place, being fully invested with his robes and breastplate, and with his face turned towards the ark of the covenant, upon which the divine presence reposed, he brought the matter to be consulted; the person for whom he consulted standing behind him, and in humility and reverence awaiting the answer. The high priest then fixed his eyes on the pectoral, and those letters which formed the answer shone with more than ordinary lustre, and were significantly raised out of their places. So when David inquired of God, by means of the urim, whether he should go up to one of the cities of Judah, three letters came out of their places as it were, and gave the answer.

While the Hebrews were under a theocracy, or immediately governed by Jehovah, it was necessary there should always be means at hand to consult him; but when this theocracy ceased, and the kingdom became hereditary in the person and family of Solomon, and Israel became divided into two monarchies, under Rehoboam and Jeroboam, the consulting of the urim and thummim appears to have ceased.

URINE. (Gr. *οgουειν, to rush out.*) The fluid secreted by the kidneys, whence it passes by the ureters into the bladder. The variable appearance of the urine announces, even to the casual observer, corresponding fluctuations in its composition; these have long been studied by physicians and medical chemists, as furnishing useful prognostics in disease. The chemical analysis, however, of the urine is attended by many difficulties, chiefly arising out of the great number of different substances which are found in it, the variations in quantity and quality to which they are liable, and the facility with which they are modified by the analytical reagents which it is necessary to employ. The substances always found in healthy urine are water; carbonic acid; phosphoric acid, or superphosphate of lime; uric acid, or superurate of ammonia; phosphates of lime, soda, magnesia, and ammonia; sulphate of soda; chloride of sodium (common salt); urea, albumen, and mucus; colouring and odorous matter. To these may probably be added fluoric, benzoic, and lactic or acetic acids; gelatine; acetate of ammonia; sulphate of potassa; fluoride of calcium; muriate of ammonia; sulphur; silica. In certain diseases other products make their appearance, which are not discoverable in healthy urine; such as oxalic acid, or oxalate of lime; nitric acid; sugar; carbonate of lime; cystic oxide; and occasionally some anomalous organic compounds, the nature of which has not been very satisfactorily ascertained.

It is almost impossible, in consequence of the circumstances above mentioned, to give a correct notion of the relative proportions of the component parts of healthy urine; but the following statement, from Berzelius, will serve to give an idea of the average composition of this complicated fluid.

Water - - - - - -	933·00
Urea - - - - - -	30·10
Sulphates of potash and soda - -	6·87
Phosphate of soda and of ammonia - -	4·59
Chloride of sodium - - - -	4·45
Muriate of ammonia - - - -	1·50
Free lactic acid (acetic?) } Lactate of ammonia } Animal matter } - - -	17·14
Earthy phosphate and a trace of fluoride of calcium - - - - - -	1·00
Uric acid - - - - - -	1·00
Mucus and albumen - - - -	0·32
Silica - - - - - -	0·03
	1000·00

When the urine is in a healthy state, there are many circumstances of mind and body which materially influence its appearance and quantity. It is often little else than water, as after very copious draughts of diluting and diuretic liquids; at other times it is saturated with its solid contents, and even deposits part of them as it cools. If turbid at the time it is voided, it may always be considered as in a morbid state. Sometimes it contains foreign matters which have been taken as medicine or food. The peculiar odour imparted to it by asparagus, the colour by spinach, rhubarb, &c., and the passage of certain saline substances by the kidneys, are familiar cases of these modifications to which the urine is subject. The daily average voided under ordinary circumstances, by healthy individuals, is not less than 30 nor more than 40 ounces; and its specific gravity should not exceed 1030; though in some cases of disease, as in diabetes, and occasionally in some diseases of the liver and of the kidneys (as in cases of albuminous urine described by Dr. Bright) it rises to 1040. The usual average is 1020. It always reddens the vegetable blues which indicate free acid. In cases of suppressed perspiration its quantity is usually increased; and in hot weather, and when the perspiration is copious, it is diminished, for it is one of the great outlets of mere water from the system. We may also observe, that a large quantity of nitrogen is thrown off by the same channel, for that element constitutes 20 *per cent.* of urea.

Urinary Calculi.—When the uric acid of the urine, which we have already stated to be one of its most insoluble contents, is secreted in any extraordinary proportion, it is passed in a solid state, generally in minute red crystals, or *red sand;* and these not unfrequently agglutinate, so as to form small *calculi* from the size of a pin's head upwards. These, passing with more or less pain from the kidney along the ureter into the bladder, produce what is termed a *fit of gravel;* and if one or more of them remain in the bladder, it then increases in size, and becoming too large to be passed with the urine, gives rise to symptoms of *stone in the bladder*. The increase of this nucleus will be more or less rapid, according to the state of the urine; but if the inordinate formation of uric acid continues, that substance will frequently be deposited upon it in successive layers, and it will sometimes thus attain a considerable size, and consist almost entirely of uric acid. But if the uric attack in the kidney is transient, the small uric calculus in the bladder usually becomes encrusted with a white deposit, composed of *ammonio-magnesian phosphate*, perhaps with more or less *phosphate of lime*, this mixture forming what has been termed the fusible calculus; and this gives rise to a second and frequent species of urinary calculus, namely, that in which a uric nucleus is enveloped in the phosphates. The natural tendency of the urine is to deposit the above-mentioned difficultly soluble phosphates upon any extraneous matter or nucleus which may chance to be in the bladder; but the rapidity with which it is deposited is very different in different individuals, and accordingly the increase in size of such a calculus is sometimes very slow, and sometimes extremely rapid; and as the violence of the symptoms generally depends (but not always) upon the size of the concretion, they will be subject to great consequent irregularity. It does occasionally happen that calculi are formed in the bladder independent of any morbid state of the urine itself, or of any uric nucleus sent down from the kidneys; but these cases are rare, and appear to depend upon the accumulation of sand and mucus in certain disordered states of the bladder, which is gradually indurated into a nucleus, and which then goes on to increase in the phosphates; so that, on cutting such a calculus through the centre, we do not, as in the majority of cases, observe a uric nucleus, but the whole concretion is white and more or less crystalline, and usually consists of little else than ammonio-magnesian phosphate. This outline of the formation of calculi includes by far the greater number of cases; but it occasionally happens that not only the nucleus, but the bulk of the stone, is made up of *oxalate of lime*, a substance which we have above alluded to as not belonging to healthy urine. When these calculi come direct from the kidney, they often are grey and smooth, and look almost like a hempseed; or, when more carefully examined, are found to be a congeries of little rounded particles; but when they have increased in the bladder, they are then generally rough and dark brown on the exterior, whence they have acquired the name of *mulberry calculi*. Another, and more rare substance, which forms gravel and calculi, is the *cystic oxide;* and in some very rare cases small concretions of *carbonate of lime* have been voided, most probably originating in the prostate gland. Lastly, minute grains of *silica* are said to have been detected in the urine, and this substance has also been found in calculi; but it is rare, and in small quantity. In concluding this sketch of the history of the urine and urinary calculi, we cannot too strongly insist upon the importance of attending to the early symptoms of the disease, and to its first announcement, which *generally* consists in habitual turbidness and deposits in the urine. All persons are subject to occasional appearances of this kind; but when they are *constant*, they ought to be considered as alarming indications of further mischief. These, in their early stages, are almost always curable, either by diet, medicine, or both; but when once a stone has formed in the kidney or bladder, all hope of its removal, except by an operation (and even that not admissible in the case of kidney calculi), is vain, nothing having been yet discovered to which the term *solvent* is properly applicable. The removal of the stone from the bladder is effected by operation in two ways: either by an incision into the bladder, and the removal of the stone by a forceps,—this constitutes *lithotomy;* or by *lithotrity*, in which certain instruments are introduced by the urethra, so as to grasp the stone, and enable the operator to reduce it to fragments sufficiently small to allow of being voided by the usual passage.

URN, in Mosses, is the hollow urn in which the spores or false seeds are lodged.

URN, CINERARY or SEPULCHRAL. (Lat. uro, *I burn.*) A species of vase used among the ancients to receive and preserve the ashes of the dead. The form of the urn was derived by the Romans from Greece; but the Greeks did not employ their urns for sepulchral purposes. Among the Romans these vessels were especially consecrated to retaining the ashes of the dead. Similar vessels were used by the ancient Teutonic and Slavonic tribes, who likewise burnt their dead. Sir T. Brown's celebrated work, *Hydriolaphia, or Urn Burial*, contains a strange collection of learned fragments and philosophical reflections on this subject. Numerous descriptions of cinerary urns, both Roman and British, discovered at different periods in this country, will be found in the *Archæologia*.

UROCE'RATA. (Gr. ουρα, *a tail*, and κερας, *a horn.*) The name of a tribe of *Terebrantia*, or boring Hymenopterous insects, in which the *terebra* or borer of the females is sometimes very long and prominent, and composed of three filamentary processes, sometimes capillary, and coiled in a spiral form in the interior of the abdomen.

U'RODELES, *Urodelæ*. (Gr. ουρα, and δηλος, *manifest.*) The name of that tribe of Caducibranchiate Batrachian reptiles which preserve the tail through all the stages of their existence.

URO'PTERANS, *Uroptera*. (Gr. ουρα, and πτερον, *a wing.*) The name of a family of Amphipodous Crustaceans, including those in which the tail is terminated by enlarged appendages in the shape of fins.

UROPY'GIUM. (Gr. ουρα, *a tail*, and πυγη, *behind.*) The base of the tail in mammals and birds.

URO'SCOPY. The judgment of diseases founded upon an inspection of the urine.

U'RSA MA'JOR. The Great Bear; one of the forty-eight constellations of Ptolemy, in the northern hemisphere, and near the pole. It is often alluded to in the most ancient histories, sacred and profane, under the various denominations of Arctos, Bootes, Helix, Callisto, Megisto, the Waggon, the Plough. It contains seven very conspicuous stars, called *septemtriones;* whence *septemtrio*, the north.

URSA MINOR. The Lesser Bear; also one of the forty-eight constellations of Ptolemy. It was called by the Greeks *Cynosura;* that is, the *Dog's Tail*. The pole star is in this constellation.

U'RSULINES. In Ecclesiastical History, an order of nuns, of which the origin is ascribed to Angela di Brescia, about 1537; but which derived its name from St. Ursula (a lady of the family of Benincasa at Naples). The Ursulines were bound to perform charitable offices to the sick, poor, and penitent. They were erected into an order by Gregory XIII., in 1577, at the solicitation of St. Charles Borromeo. They take, in addition to the three ordinary vows, a fourth,—to devote themselves to education. (See Waddington, *History of the Church*, p. 401.)

U'RSUS. (Lat. ursus, *a bear.*) A genus of Plantigrade Carnivora in the system of Cuvier, restricted to those species which have three large tuberculate molars on each side of both jaws, the anterior lower and the posterior upper one being the largest. They are preceded by a tooth a little more trenchant, representing the carnassial tooth, and by a variable number of small premolars. In accordance with this dentition, the bears are omnivorous or frugivorous. They are heavy, stout-bodied animals, with thick limbs, and a very short tail: the cartilage of the nose is moveable, and sometimes very long, as in the labiated bear, commonly called the ursine sloth. The bears of the northern regions pass the winter in a state of somnolency in dens or other hiding places, and it is in these retreats that the female brings forth her young. The species best known are the common brown bear (*Ursus arctos*), the black bear (*Ursus Americanus*), the grisly bear (*Ursus ferox*), the polar bear (*Ursus maritimus*), the *Ursus labiatus*, *Ursus Thibetanus*, *Ursus Malayanus*, and *Ursus Syriacus*.

URTICA'CEÆ (Lat. urtica, *the nettle*), form a very large and natural order of plants, with apetalous flowers, a lenticular simple fruit, and a seed whose embryo always directs its radicle towards the top of the cavity. The stinging properties of the common nettle are participated in by many others whose acridity is intense. Others are provided with a poisonous juice, which in its most concentrated form gives the upas tree of Java its formidable qualities. A narcotic principle is highly developed in hemp, and the toughness of the fibre of that plant occurs in many others of the order. Nevertheless the fig, the bread-fruit, the mulberry, and hops, in which nothing deleterious is remarked, are the produce of some species; and even the milk tree of the Caraccas, whose bland juice feeds the natives of the country, is an Urticaceous plant. Many species furnish caoutchouc, which, in *Ficus elastica*, is of the finest quality.

URTICARIA. *See* NETTLE RASH.

U'SANCE. In Commercial Law. A foreign bill is often drawn at one, two, or more "usances," meaning thereby certain periods of time which it is the usage of the countries between which the bills are drawn to allow for payment thereof. Thus, the "usance" between London and Paris is one calendar month; a bill drawn here "at one usance," on the 2d January, is payable there on the 5th February, allowing three days of grace.

USE, in its original sense, signified the equitable right one had to take the rents and profits of land whereof the

legal ownership was in another. It was very nearly the same as the trust of the present day, and created in the following manner: — The owner of land conveyed it by feoffment to some friend, on the understanding that the feoffee should hold it for the sole use and benefit of the feoffor, or such persons as he might nominate. In this way the seisin or legal property of the land became vested in the feoffee to uses as trustee; while the feoffor, or other person nominated by him, who was called the cestui que use, had the substantial use and enjoyment of it. The simplicity of the common law, however, recognized but one person in connection with the soil, namely, its real owner, and repudiated the idea of any use as separated from the seisin; so that if the trustee, abusing the confidence placed in him, refused to let cestui que use take the rents and profits, there was no redress for the grievance. But the Court of Chancery, as a court of equity, considered the agreement entered into by the trustee as binding on his conscience; and after calling on him by writ of subpœna to appear and make a disclosure on oath of the particulars of his trust, compelled him to perform it.

The system of uses was transplanted from the civil law, and introduced into this country about the time of Edward III. by the ecclesiastics, who procured conveyances to be made, not directly to themselves, but to lay persons as trustees for them, in order to evade the statutes of mortmain. Once known, it was generally adopted; and though crushed in its infancy, so far as regarded religious houses, continued to flourish without disturbance in other respects, and was found admirably adapted to the wants and convenience of the people at large in softening the rigours of feudal tenure, and facilitating the alienation and settlement of property. The laws and policy of feudal tenure required the vassal to render certain fruits and services to his lord; and if these were not duly rendered, or any act were done in derogation of the lord's title, the estate was forfeited. The tenancy of the freehold could not be interrupted or suspended for an instant; and to every transfer of it actual and public delivery of possession, in the presence of witnesses, and accompanied by much solemn ceremonial, was absolutely indispensable; so that the lord might always have some person to perform the services due to him, and always know with certainty who that person was. The lord was entitled to sell his ward in marriage, to take the profits of the land during the wardship, and on the descent or alienation of the land heavy fines were payable to him. The tenant had no power of directing the destination of the land by will; such a mode of disposition would at once have been wanting in notoriety, and have deprived the lord of his fruits upon a descent.

When, however, the equitable interest in land, as distinguished from the legal property in it, became recognized and enforced in the Court of Chancery, the principal hardships of tenure were easily avoided. A. conveyed land to B. to A.'s own use; the terms upon which B. took the land were said, in equity, to affect his conscience, and to impose upon him a moral obligation to fulfil them honestly. But it was in equity only that A. had any claim: there he might call upon B. to allow him to take the profits of the land, and to make such conveyances of it as he might from time to time direct. At law A. had no control over or connection with the land any longer remaining to him. His use, therefore, altogether evaded the grasp of tenure, which rested entirely upon the common law. It was held of no one; it was the creature of his own declaration, operating upon the conscience of the person in whom he confided. It might be transferred at any time without any public solemnities by a secret declaration. At law A. could not carve out for himself a portion of the whole fee, and limit the residue of it to others, without first of all going through all the formalities of a conveyance to B., and then taking back a reconveyance, with the same formalities, of that portion of the fee which he might wish to retain to himself. Husband and wife being one person in law, he could not carve out a portion for her without conveying to B., in order that B. might afterwards convey to her. He could not convey the fee, or any portion of it, to B.; so that it should, on the happening of any named event, or the expiration of any named period, shift either wholly or in part from him to any other person. He could not even convey to B. at all without giving him immediate possession: a conveyance to him in futuro, as from Christmas next, would have been altogether void. He might, however, resorting to equity, and making a declaration of the uses to which he wished his property to be applied, effect all these and innumerable other arrangements by a single stroke of the pen, or a mere breath. The use, emancipated from the common law, had such a suppleness and pliability as almost to accommodate itself to his very whims. He might dispose of it by will, or it would descend to his heirs in the course of the common law; but no fine was payable upon its descent. It was not liable either to dower or to curtesy; it was not extendible for debts, nor forfeited for treason. Lord Bacon accordingly complains, that it "deceived many of their just and reasonable rights. A man that had cause to sue for land knew not against whom to bring his action, or who was the owner of it. The wife was defrauded of her thirds; the husband of his curtesy; the lord of his wardship, relief, heriot, and escheat; the creditor of his extent for debt; and the poor tenant of his lease." To remedy these and other inconveniences, the statute 27 Henry 8. c. 10. was passed, usually called the Statute of Uses; which enacts, that when any person shall be seised of lands to the use, confidence, or trust of any person, he shall thenceforth be seised and possessed of the land of and in the like estate as he had in the use, trust, or confidence.

The statute thus executed the use, as it is called, by transferring it into possession, and doing away with the distinction between the beneficial interest and legal property in land. Whoever had the use had now also the legal estate. Thus the use was not abolished, according to the probable intention of the legislature, but merely annexed to and incorporated with the legal estate; to which, therefore, it now superadded all the convenient ductility of its own nature. It had no longer a merely precarious existence in equity, but a firm locus standi in courts of law. It was shorn, indeed, of many of its old privileges, such as exemption from dower, curtesy, and forfeiture; but for this loss there was soon contrived a remedy. The judges, in their narrow construction of the statute, decided that its provisions did not extend to a use limited upon a use, as their phrase was. Accordingly, on a feoffment to A. and his heirs, to the use of B. and his heirs, to the use of (or in trust for) C. and his heirs; they held that the statute clothed the first use with the legal ownership, and that the second was a nullity. But as it was quite clear that C., and not B., was the person intended to enjoy the estate, this verbal pedantry of the common law judges drove C. into the Court of Chancery for relief, where he was immediately received as the substantial cestui que use; and the *use* which the statute had been in law held not to execute was considered a valid *trust* in equity. Thus by limiting two uses successively instead of one only as before the statute,—by making, in fact, the conveyance only three words longer than had been customary, the equitable interest and the legal estate were again disunited, and the use under its new name of trust was as popular and available as ever. In this manner the destructive qualities of the statute are virtually repealed, while its creative qualities are to this day in full operation; and the legislature, instead of paralyzing the use, has only given new form and flexibility to the legal estate.

Uses are of various kinds.

An *executed use* is one to which the statute applies by annexing to it the legal ownership. That to which the statute does not apply is called, as has been already mentioned, a *trust*.

Secondary or *shifting use* is one which takes effect in derogation of a use previously limited, as in a conveyance to A. to the use of B.; and if C. shall return from Rome or pay B. a certain sum of money, then to the use of C.

Springing use is one limited to arise on a future event, where no preceding use is limited.

Future or *contingent use* is one limited to a person not ascertained, or upon an uncertain event, but without derogation of an use previously limited, as to A. for life, and afterwards to his unborn son.

Resulting use. When the use limited expires or cannot vest, it is said, either after such expiration or during such impossibility, to result back to the grantor; as on a conveyance by A. to the use of his intended wife for life, then to her eldest son in tail: here, until the marriage, the use results back to A.; or results to him in fee in the event of his wife dying without issue.

U'SHER. (Probably from the Fr. huissier.) An officer who has the care of the door of a court or hall, &c. In the court of England, he is an officer of considerable rank, whose business it is to introduce foreign ambassadors or other high strangers to the sovereign.

USQUEBAUGH. A strong compound liquor, made in greatest perfection at Drogheda in Ireland. Brandy or other spirits, raisins, cinnamon, cloves, and various other spices are its ingredients.

USTRI'NUM, or USTRI'NA. (Lat. uro, *I burn.*) In Roman Antiquities, a public burning-place, enclosed by walls, in which bodies, mostly of the poorer sort of people, were consumed. An ustrinum, according to Montfaucon, was square, and in compass about 300 feet. In the *Archæologia* (vol. xxvi.) will be found a detailed account of the site of one recently discovered in Cambridgeshire, which appears to have been of rather large dimensions.

USTULATION. (Lat.) A term of old Pharmacy, implying the gradual desiccation and torrefaction of substances.

USUCA'PTION. In Civil Law, the acquisition of property in any thing by possession and enjoyment for a certain term of years; commonly considered as synony-

mous with prescription, although some have restrained the use of the former term to moveables only.

U'SUFRUCT, in the Civil Law, is defined to be the right of enjoying indefinitely something belonging to another without diminishing its substance. *Usufruct* differs from *use*; because he who has the use of a thing can only enjoy it personally, whereas the right of him who has the usufruct is alienable, and may be granted, sold, or hired to another. Usufruct may be constituted in four ways: by contract, by will, by judgment of a court (as where the judge, in effecting a division of common property, may, under certain circumstances, instead of dividing the inheritance, allot the usufruct to one, and the thing to another), and by operation of law. Usufruct is, properly speaking, confined to things real, and to incorporeal rights (whether they would be termed real or personal, according to the division of our law), such as debts; but a sort of usufruct (quasi usufruct) may exist in things liable to be consumed by use. The division between the fruit (which belongs to the usufructuary), and the thing itself (which belongs to the proprietor), affords room for a great variety of legal distinctions. Usufruct may be extinguished in several ways: by the death, natural or civil, of the usufructuary; by loss; by prescription, the right being extinguished if disused for a certain period; by forfeiture, where the usufructuary abuses his right; by expiration of time, if the usufruct have been granted for a term; and by the union of the usufruct with the property in the same hands.

U'SURY. The taking of interest for money: from the Latin word usura. The Jews were forbidden by the law of Moses to exact interest from one another. By the old Roman law of the twelve tables, the rate of interest allowed as legitimate was the usura centesima, which was strictly one per cent. a month; and has been supposed by some to have amounted to twelve, by others to ten per cent. in the year. Interest was also computed in the following manner: — Usura unciaria, being the lowest term, one per cent., or one twelfth of the usura centesima; usura semis, or semis, half the centesima (six per cent.); bes, quadrans, quincunx, &c., two third parts, a quarter, a fifth of the centesima (eight, three, two per cent.). The Roman laws against excessive usury were frequently renewed, and constantly evaded; but the same principle, additionally sanctioned by mistaken religious opinions, pervaded the laws of all countries in which the civil jurisprudence prevailed. The amount of legal interest has been fixed by various statutes in England. In the reign of Henry VIII. ten per cent. was allowed; by 21 J. 1., 8 per cent.; by 12 C. 2., 6 per cent.; by 12 Ann. 5 per cent. All contracts made for the payment of any principal to be lent on usury above this rate were utterly void. The question of usury, *i. e.* whether a contract is *bonâ fide*, or a colour for a usurious loan, was determined by the verdict of a jury. But the usury laws have been relaxed by several recent statutes. By the last, 2 & 3 Vict. c. 37., bills of exchange not having more than 12 months to run, and contracts for loans or forbearance of money above 10*l.*, are no longer affected by those laws. But 5 per cent. remains the legal interest recoverable on all contracts, unless otherwise specified.

UT. In Music, the name of the first of the musical syllables. The Italians, for the sake of softening the sound, use the syllable Do instead of Ut in the modern solfeggi.

U'TERINE. (Lat. uterus, *belly*.) In the Civil Law, an uterine brother or sister is one issued from the same mother.

UTILITA'RIANS. A name which has been given to a particular sect of modern politicians; those, namely, who profess to try the excellence of modes of government and usages simply by their utility. The celebrated Jeremy Bentham, regarded as the founder of this sect, introduced into the critical department of politics a closer logic than had been commonly applied to it; and aimed at applying his famous principle, "the greatest happiness of the greatest number," as an immediate test by which to affirm or deny the value of institutions. It is evident that all political sects, both of writers and statesmen, profess ultimately the same object. The real characteristic of the Utilitarians consists in the peculiar sense in which they understand it. They confine for the most part the proposed utility, so as to restrict it to that which is useful for the material and economical well-being of the multitude. Their tenets have been attacked in two celebrated articles in the *Edin. Review* (vols. 49 and 50.): *Mill's Essay on Government*, and *Austin on Jurisprudence*, may be referred to as containing the most intelligible summaries of them.

UTI POSSIDE'TIS. In Politics, a treaty which leaves belligerent parties mutually in possession of what they have acquired by their arms during the war is said to be based on the principle of *uti possidetis* — "as you possess."

UTO'PIA. A term invented by Sir T. More (from Gr. *ουτοπος*, *no place*), and applied in his celebrated work called *Utopia* to an imaginary island, which he represents to have been discovered by a companion of Amerigo Vespucci, and as enjoying the utmost perfection in laws, politics, &c., in contradistinction to the defects of those which then existed. The work was first printed in 1516, but Froben's edition, of 1518, is more correct. The word *Utopia* has now passed into all the languages of Europe, to signify a state of ideal perfection; and *Utopian* is used synonymously with *fanciful* or *chimerical*.

UTRI'CULUS. (Lat. uter, *a bladder*.) A term in Botany applied to a one-celled, one or few-seeded, superior membranous fruit, frequently dehiscing by a transverse suture, as in *Chenopodium*. It is also used to indicate a fruit with a thin skin and a single seed. Sometimes this word is employed to express a separate cell of the cellular tissue of a plant, which is usually a little vegetable bladder.

UVA URSI. The *Arbutus uva ursi*, *bear's berry*, or *whortleberry*. The leaves of this small shrub have a highly astringent and sweetish taste; their decoction or infusion is occasionally used in medicine, especially in certain disorders of the kidney and bladder.

U'VULA. (Lat. dim. of uva, *a grape*.) A small fleshy protuberance attached to the soft palate, and hanging over the tongue. It consists of the common integuments of the mouth, and a small vermicular muscle by the contraction of which the uvula is elevated. In some cases of enlarged or relaxed uvula which will not yield to local or other remedies, it becomes necessary to amputate a part of it, in consequence of the impediment to deglutition which then ensues, and the tickling cough and retching which it induces.

VACCINA'CEÆ. (Vaccinium, one of the genera.) A natural order of shrubby Exogens, chiefly inhabiting North America. Formerly combined with the Ericaceous order, from which they differ in their inferior ovary and succulent fruit. The berries of many are eaten, under the names of cranberry, bilberry, whortleberry, &c.; and some of the species are cultivated as objects of ornament.

VACCINATION. *See* Cow Pox.

VACU'NA, or VACI'NA. The ancient Italian goddess of leisure, to whom the husbandmen sacrificed at the close of harvest, or "harvest-home;" to which rustic festival Horace alludes in the words "fanum putre vacunæ." (See also *Ov. Fasti*, vi.)

VA'CUUM (Lat. vacuus, *empty*,) in Physics, is a portion of space void of matter. The possibility of the existence of a perfect vacuum has been a favourite subject of dispute with the schoolmen and metaphysicians. Its existence was maintained by the Pythagoreans, Epicureans, and Atomists; and denied by the Peripatetics, who ascribed the rise of water in a sucking-pump, and some other phenomena of the same kind produced by atmospheric pressure, to nature's abhorrence of a vacuum. Descartes made the essence of matter to consist in extension, and therefore denied the possibility of a vacuum; for if extension be the essence of matter, wherever extension is there matter must be. Those, again, who suppose all material bodies to be formed of the agglomeration of elementary particles, are compelled, by the phenomena of motion, to admit at least the existence of what was called by the schoolmen a *vacuum interspersum*, or of intervals devoid of all matter among the interstices or pores of bodies; for if there were no interstices, all space would be full of matter, in which case no body could be moved out of its place, inasmuch as there would be no unoccupied place into which it could move. For the arguments on this subject, see *Newton's Optics*.

The most perfect vacuum that can be produced artificially is the *torricellian vacuum*, or the space above the mercury in the barometric tube. But in this sense vacuum merely signifies the exclusion of atmospheric air; for this space in the barometer may be filled with the vapour of mercury, or with some other medium infinitely more rare than air, and inappreciable to our senses. It is obvious, from the nature of the pneumatic machine, that the vacuum produced by an air-pump, or the Boylean vacuum, as it has been called, can never be perfect, as some air must always remain in the receiver, however long the exhausting process may be continued.

The question of the abstract existence of a vacuum is not worth discussing; but there is another question of great interest with reference to physical astronomy connected with the subject, — namely, whether the spaces in which the planets move are so far void of matter as to offer no resistance to their motions, or are occupied by a medium of sufficient density to impede their motions in the long run in a sensible degree. Recent observations appear to give some countenance to the supposition that this is actually the case. It has been observed that after the most careful allowance has been made for the attractions of the planets, and all other known causes of disturbance, on Encke's comet, the successive returns of that body to its perihelion are accomplished in periods which are constantly diminishing. (*See* COMET.) Now this is precisely the effect that would be produced if the body moved in a medium which offered a small resistance to its motion;

and as this is the only obvious mode of explaining the phenomenon, it has been generally adopted. Nevertheless, it is extremely difficult to reconcile the supposition of an existing medium with the astronomical fact, that, during the last two thousand years of observation, it has produced no effect on the motions of the large planets capable of being appreciated by the most delicate instruments. This fact, however, though it proves the extreme feebleness of the resistance, does not furnish an absolute proof that such a medium may not exist, and that its effects may not ultimately become sensible even on the densest planets. If it does exist, the consequence seems inevitable that all the planets and satellites, as well as the comets, must be ultimately precipitated into the sun.

Another argument against the existence of a vacuum is furnished by the undulatory theory of light. If this hypothesis be true, and it is rendered probable by numerous phenomena, a medium of great elasticity must pervade all the parts of space through which light penetrates. There could in this case be no vacuum; unless, indeed, the term be understood to denote merely the absence of ponderable matter. *See* LIGHT.

VA'DE IN PACE. (Lat. *go in peace.*) In monastic communities offences were sometimes punished by the dreadful infliction of starving to death in prison; and bones have occasionally been found among the ruins of convents of victims who appear to have perished in this manner. The punishment acquired this name from the words in which the sentence was pronounced. The use which Walter Scott has made of this custom in his poem of *Marmion* is well known. But it is no romantic fiction. (See Fleury, *Hist. Eccles.* vol. xx. p. 102.; where, however, the *vade in pace* is described as perpetual solitary imprisonment. *Dict. de Trévaux.*)

VAGA'NTES. (Lat. vago, *I wander.*) The name of a tribe of spiders (*Araneidæ*), comprehending those which watch their prey concealed in a web; but also frequently run with agility, and chase and seize their prey.

VAGI'NA (Latin term for *sheath*), is applied by botanists to the leafstalk of those plants in which it becomes thin and rolls round the stem, to which it then forms a sheath: this is the case in grasses.

VAGI'NATES, *Vaginati.* (Lat. vagina, *a sheath.*) Sheathed Polypes. The name of an order of Polypes, comprehending those which are constantly surrounded by and attached to a calcareous or horny polypiary.

VA'GRANCY. (Lat. vagro, *I wander.*) In Law, a very miscellaneous class of offences against public police and order is comprehended under this title in English Law. Vagrants, under the present act of parliament in force on the subject (5 G. 4. c. 83.) are of three descriptions:—1. Idle and disorderly persons; including persons neglecting to maintain their families; paupers returning without certificate to parishes whence they have been legally removed; beggars, common prostitutes, pedlars without licence, &c.; all of whom may be summarily convicted and committed to gaol for a month by any single justice, subject to an appeal to the sessions. 2. Rogues and vagabonds including persons guilty of the former offences, who have been once already convicted of being idle and disorderly; fortune-tellers and other impostors; persons guilty of indecent exhibitions; procurers of charitable contributions under false pretences; playing at games of chance in public places; having in their possession housebreakers' implements, or offensive weapons, with intent to use them; reputed thieves frequenting public places to commit felony, and others; all of whom may be committed for three months. 3. Incorrigible rogues, viz. persons guilty of the last class of offences, having been already convicted; persons breaking out of legal confinement, &c., who may be committed to the next sessions, and there sentenced to a year's imprisonment. Under this act justices possess very extensive powers, such as to issue warrants to bring before them persons suspected of vagrancy, to search lodging houses reasonably suspected of harbouring vagrants, &c.

VAIR. In Heraldry, one of the furs employed in blazonry. It is supposed to represent the skin of a small squirrel. It is always white and blue, unless otherwise specified in the blazon; as vair of *or* and azure, vair of ermine and gules, &c. Vair appears to be derived from varius. *Vairy* is the pattern of vair with more than two colours.

VA'LENTINE. Feb. 14. is the day sacred to St. Valentine, a presbyter, who, according to the legend, was beheaded at Rome under Claudius. Mr. Brand (*Popular Antiquities*, vol. i. p. 47.) says that he cannot find in the life of the saint any circumstances likely to have given origin to the peculiar ceremonies of the day. It appears to have been a very old notion, however (for it is alluded to by Chaucer, as well as by Shakspeare in the *Two Gentlemen of Verona*), that on this day birds begin to couple. And the custom of "choosing Valentines" is of great antiquity in this country, as well as in France, where, however, it has been long disused. Lydgate mentions it (1476); Grose explains Valentine to mean "the first woman seen by a man, or man by a woman," on that day; but it does not appear where he picked up this explanation. There is also a curious French Valentine, composed by the poet Gower, in *Warton's History of English Poetry* (Additions to vol. ii. p. 31.). Herrick mentions the notion and the custom:—

> Oft have I heard both youths and virgins say,
> Birds choose their mates, and couple too, this day.

It appears that the Reformers attacked this as well as other legendary customs of their time; and that the Romanists themselves were so scandalized at it that devices were invented for turning the day to profitable use. St. Francis de Sales introduced the practice of drawing lots for patron saints on it, by way of substitute. According to others, this latter practice was of much older date, and substituted for a pagan custom by which boys and girls drew each other's names on the 15th February (day of Februata Juno). However this may be, it is certainly one of the few saints' days in the calendar popularly remembered in England, as the returns of the post office invariably testify.

VALENTI'NIANS. In Ecclesiastical History, a sect of the second century; so called from Valentinus, their founder. They were a branch of the Gnostics. *See* GNOSTICS.

VALE'RIAN. The root of this plant, the *Valeriana officinalis*, is used in the form of infusion, decoction, or tincture, as a nervous stimulant and antispasmodic.

VALERIANA'CEÆ. (Valeriana, one of the genera.) A natural order of herbaceous Exogens inhabiting temperate climates. They are distinguished from the Dipsaceous order by their flowers not being in heads, by the want of albumen, and the absence of an involucel. The roots of *Valeriana officinalis* are aromatic and antispasmodic; and the young leaves of the species of *Valerianella* are eaten as salad, under the French name of mâche, or the English one of lamb's lettuce and corn salad.

VALE'SIANS. An ancient sect of heretics mentioned by Epiphanius, and supposed to have become known about A. D. 240; said to have adopted the practice of eunuchism.

VA'LET, VARLET. Originally, the sons of knights, and afterwards those of the nobility before they had attained the age of chivalry. The name is sometimes written *vasletus*, and seems to be derived from the same root with vassal; probably the Celtic gwâs. (*See* VASSAL.) Valet in French, and varlet in English, degenerated in later times into the signification of servant.

VALHA'LLA, or WALHALLA. The palace of immortality, in the Scandinavian mythology, inhabited by the souls of heroes slain in battle.

VALKY'RIUR, or DISAS. The Fates of the Scandinavian mythology: the "choosers of the slain," who conduct heroes killed in battle to Valhalla.

VALLEY. (Lat. vallis.) In Architecture, the internal angle formed by two inclined sides of a roof. It is supported by a rafter called the *valley rafter*, or *valley piece*; on which lies a board for the reception of the lead gutter, called the *valley board*.

VA'LLUM. (Lat.) The rampart with which Roman armies enclosed their camps, and which was crowned with a breastwork of stakes.

VALVA'TA. (Lat. valvæ, *folding doors.*) A genus of fresh-water snails or Gastropods; so called from the valve-like form of the operculum or lid which covers the aperture of the depressed spiral shell. Of this genus several species are British; as *Valvata obtusa*, common in the ditches at Battersea; *Valv. spirorbis*, *Valv. planorbis*, *Valv. minuta*, &c.

VALVE. In Mechanics, a close lid affixed to a tube, or hollow piston, or opening in a vessel, by means of a hinge or other sort of moveable joint, in such a manner that it can be opened only in one direction. A spherical ball of metal laid on the end of a tube properly formed, and retained in its place by its weight alone, is sometimes used advantageously instead of a valve, as in the *hydraulic ram*. The *safety valve* of the steam engine is a valve attached to the boiler, to obviate the danger of its bursting in case the steam should become too strong. The valve is so loaded that its weight, added to that of the atmosphere, exceeds the pressure of the steam, when of a sufficient force. When the expansive force increases so far that its pressure preponderates over the pressure of the atmosphere and the weight of the safety valve, the valve opens, and the steam escapes from the boiler till its elastic force is sufficiently diminished, and the valve shuts by its own weight. By opening the safety valve the engine may be stopped at pleasure, for which purpose a particular apparatus is attached to the valve. As any accidental derangement of the safety valve might be attended with the most disastrous consequences, it has been proposed to make the valve of a metal which melts at a particular temperature, by which means the elastic force of the steam could never exceed that which corresponds to the temperature at which the valve would melt. This method has been adopted in France.

VALVES. In Botany, the pieces into which the fruit of a plant naturally separates when it bursts. The name is also applied to similar parts in any other organ, as the anther.

VA'MBRACE. (Fr. avant-bras.) In Plate Armour, the piece which served as a protection to the arm below the elbow.

VA'MPIRE. A blood-sucking spectre, the object of superstitious dread among various nations of Europe. The belief in vampires, *i.e.* in persons returning to the earth after death and burial, not as ghosts, but in actual corporeal substance, and sucking the blood of living men, appears to have prevailed in classical times. The Empusæ, Lamiæ, and Lemures were species of vampires. One of the most detailed stories of vampires is the tale of *Machates and Philinnion*, which Goëthe has made the foundation of his poem of the *Bride of Corinth:* in which the dead bride of a young man visits him at night, and withers him by her embrace. But in modern Europe, the populations among which vampire superstitions have prevailed appear to be of Sclavonic descent. The word vampire is said by Adelung to be of Servian origin; and although the modern Greeks have also their vampires, yet the barbaric names by which they call them (Vroucolachas, Vuroulachas, Vardoulachas) seem rather to indicate the Sclavonic, or perhaps Albanian source, from which they derived both the tradition and the word. In Crete they are called Katakhanâs, and firmly believed in. (See *Pashley's Travels.*) About a century ago, there prevailed in several districts of Hungary an epidemic dread of vampires, which lasted some years, and gave birth to many extraordinary stories. It was believed that in several places those among the dead who belonged to the class of vampires arose nightly from their graves and sucked the blood of the living, who fell into consumptions and perished; that those who had died in this manner became infected with vampirism; and that the only way of exterminating the plague was by disinterring all the suspected vampires, and, if it were discovered that they exhibited the tokens of their hideous character, burning them to ashes, or driving a stake through their middle. The attestations which these grotesquely fearful tales received, are among the most singular instances of human credulity recorded in all the annals of superstition. They are, in many instances, related on the authority of the pastors and other most credible persons of villages and towns, who depose to having been themselves witnesses of the scenes beheld on opening the vampires' graves. Some, indeed, had actually seen the spectres themselves on their nightly excursions; but more generally the subscriptions are by persons present at the inspection of the dead bodies; when, if the subject was a true vampire, he was generally found of a florid and hale complexion; his hair, beard, and nails had grown; his mouth, hands, &c. were stained with fresh blood; his eyes open and brilliant. Sometimes, when the stake was driven through him, he was heard to utter cries like those of a living person. It was believed that the consumption produced by the sucking of the vampire could be cured by eating earth from his grave. The popular name of the vampire-bat (*Vespertilio spectrum*), a small animal of South America which sucks the blood of persons asleep, is derived from these imaginary monsters.

VAN. In Naval language, the foremost division of the line of battle, which is also the weather division when the fleet is on a wind.

VANA'DIUM. (Lat. Vanadis, *a Scandinavian deity.*) A metal discovered in 1830, by Professor Seftström of Fahlun, in iron prepared from the iron ore of Taberg in Sweden. Vanadium has also been found in a lead ore from Wanlockhead in Scotland, and in a similar mineral from Zimapan in Mexico. Vanadium is a white brittle metal, very difficult of reduction; not oxidized by air or water; and insoluble in sulphuric, muriatic, and hydrofluoric acids, but soluble in nitric and nitromuriatic acids, with which it yields solutions of a fine dark blue colour. It is not acted upon by boiling caustic potash, nor by the carbonated alkalies at a red heat. The peroxide of vanadium is of an orange colour, and very slightly soluble in water; it unites with the salifiable bases; with the alkalis its salts are soluble, with the other bases sparingly soluble. These salts are orange or yellow coloured; in these and other respects there is a close resemblance between vanadium and chromium. Peroxide of vanadium, or vanadic acid, is distinguished from chromic acid by the action of deoxidizing substances, which give a blue solution with vanadium, but a green one with chromium. When heated with borax in the reducing flame of the blowpipe, both of the acids yield a green glass; but in the oxidizing flame the bead becomes *yellow* if vanadium is present, but the green colour is permanent if produced by chromium. According to the experiments of Berzelius, the equivalent of vanadium is about 68; and the protoxide, the deutoxide, and the vanadic acid, are composed respectively of 1 atom of vanadium, and 1, 2, and 3 of oxygen.

VANE. A contrivance for showing the direction of the wind. It consists usually of a thin slip of wood or metal, attached to a perpendicular axis, round which it moves freely; and is so shaped that it presents always the same extremity to the point of the horizon from which the wind blows.

VANE'LLUS. (Lat. *a lapwing.*) A name applied by Bechstein to a subgenus of the Linnæan *Tringæ*, including the true lapwings, which are distinguished from the *Squatarolæ* of Cuvier by their more distinct, though small, hinder toe, and their partially scutellated tarsi.

VANE'SSA. (Or better *Phanessa;* from φανης, one of the names of Venus or Love in the Greek as well as Egyptian mythology.) The term is applied to a genus of butterflies.

VANG. A rope for steadying the extremity or peak of a gaff to the ship's side.

VANGUARD. That part of an army which precedes the main body on the march, as a security against surprise.

VANI'LLA (Span. baynilla, *a small pod*), is the succulent fruit of a plant of the Orchidaceous order, climbing over trees in the tropical parts of America after the manner of ivy. Its fragrance is owing to the presence of benzoic acid, crystals of which form upon the pod if allowed to be undisturbed. It is an aromatic, employed in confectionary and the preparation of liqueurs, and in flavouring some kinds of chocolate, &c.

VA'POUR. (Lat. vapor.) When liquids and certain solids are heated they become converted into elastic fluids or *vapours*, which differ from *gases* in this respect, that they are not under common circumstances permanently elastic, but resume the liquid or solid form when cooled down to ordinary temperatures. The term *vapour* is frequently limited to water in the state in which it exists in our atmosphere and in other humid aëriform bodies; that is, in a perfectly invisible state. When very moist air is duly cooled, the vapour, previous to assuming the liquid state, becomes visible, as seen in mist and fog; it is observed in the same state when steam issues rapidly from the spout of a tea-kettle, when it escapes into the air from the surface of hot water. In this case it is sometimes called *vesicular vapour;* for, from its action on light, it seems in that *visible* state to exist in the form of minute vesicles. Different substances yield vapours with very different degrees of facility, or, in other words, are more or less volatile; a circumstance dependent, probably, upon the less or greater cohesion with which their particles adhere. Hence fluids are generally more volatile than solids, and hence solids generally pass into the liquid state before they assume the form of vapour. To both these statements there are, however, many exceptions; thus most of the expressed oils are very differently vaporizable, and are hence termed *fixed oils*. Common concentrated sulphuric acid is also a very fixed liquid, requiring a high temperature for its vaporization; and camphor and some other solids evaporate at common temperatures, and arsenic and sal ammoniac at high temperatures, without previously assuming the liquid state. The space which vapours occupy always exceeds that of the substances from which they arise. Thus, at the temperature of 212°, and under a pressure of 30 inches of mercury, a cubic foot of water produces 1696 cubic feet of vapour, of alcohol 660, and of ether 443. Hence it is obvious that different vapours differ very considerably in density, and that this property is not directly as that of the liquids which furnish them. Thus, if we assume the density of air as 1000, that of aqueous vapour or steam is only 625; the density of aqueous vapour to that of atmospheric air being as 1000 to 1694. Again, assuming the density of air as = 1000, that of alcohol vapour is 1613, and of ether no less than 2586; though alcohol and ether are both, in the liquid state, lighter than water. As water boils at a higher temperature than alcohol, and alcohol at a higher temperature than ether, it was supposed that the density of vapours was probably directly as the volatility of their respective liquids: but this law has exceptions; for bisulphuret of carbon yields a heavier vapour than ether, but its boiling point is higher. All pure vapours follow the same law of expansion, when heated, as gases; that is, for every degree of Fahrenheit's thermometer they increase by $\frac{1}{480}$th of the volume which they occupied at 32°.

VAPOUR, in Physics, denotes the condition of a body, when by the accession of heat its particles acquire a repulsive force, and it is reduced to the state of an elastic fluid. Every liquid possesses the property of boiling at a certain determinate temperature, under the mean pressure of the atmosphere. Water, for example, boils at the temperature of 212° of Fahrenheit's scale, when the pressure of the atmosphere is equal to a column of mercury 30 inches in height; but under a diminished pressure it boils at a lower temperature; and by increasing the pressure, the temperature of the boiling point is increased. In the course of ebullition an elastic fluid, or vapour, is generated; and it is only when the tension of the vapour becomes equal to the pressure that the action of boiling begins. But though ebullition and the

consequent rapid formation of vapour only take place at a given temperature under a given pressure, vapour will rise from the surfaces of all liquids in free contact with the atmosphere at much lower temperatures. Water, for example, exposed in an open vessel, undergoes a gradual diminution of bulk, and is dissipated at temperatures far below the boiling point; and ice itself soon wastes away in the same insensible manner. This dissipation has been shown by Dalton to be occasioned by the formation of vapour of the same temperature as that of the water from which it proceeds, and having an elastic force equal to that of the vapour of water boiling at that temperature under a diminished pressure. Some liquids, ether for instance, require to be carefully secluded from the atmosphere to prevent their rapid evaporation.

Tension of Vapour at different Temperatures.—Dr. Dalton of Manchester was the first who ascertained by accurate experiments the elastic force of vapours at different temperatures below that of the point of ebullition. (*Manchester Memoirs*, vol. v. 1802.) The method which he employed consisted in introducing a portion of liquid into the vacuum of a barometer, where it floats on the surface of the mercury, and part of it is immediately converted into vapour. The tension of the vapour causes the mercury to descend; and the force of the tension is measured by the space through which the mercury falls, or by the difference of the height of the mercury in the tube in which the experiment is performed and its height in the common barometer. Dr. Dalton employed two barometric tubes plunged in the same cistern of mercury; into one of these the liquid furnishing the vapour was introduced, the other serving the purpose of comparison; and in order that the experiment might be made at any determinate temperature, the two tubes were surrounded by another wider tube, into which water was poured of the temperature required. When the liquid on which the experiment was made was water, and the water surrounding the two barometric tubes was at the temperature of ebullition, the vapour formed in the tube caused the mercury to descend to the level of that in the cistern; whence it was inferred that at the temperature of ebullition the elastic force of aqueous vapour is precisely equal to the atmospheric pressure. A similar result was obtained when the experiment was performed with other liquids.

If the tube containing the portion of liquid be of considerable length, and the basin in which it is inverted of considerable depth, the pressure on the vapour above the mercury may be varied by raising or lowering the inverted tube. When the pressure is diminished in this way, it is found that so long as any liquid remains, new vapour of the same degree of tension will be generated, and the altitude of the mercury in the tube remain constant. On the other hand, an increase of pressure causes the condensation of a part of the vapour, and the mercury in the tube stands at the same height above that in the cistern. If the quantity of liquid in the barometric tube be so small that the whole is converted into vapour, it will be found that on raising the tube and increasing the space in which the vapour is contained, the elastic force diminishes in proportion as the space is increased. The law of Mariotte, therefore, applies to vapours as well as to the permanent gases (*see* PNEUMATICS); but with this distinction, that the vapours of all liquids, at a certain determinate temperature, have a maximum of density and tension which cannot be exceeded, and on attaining which they are condensed into the liquid form by any attempt to compress them further. It follows, therefore, that at a given temperature no more than a limited quantity of vapour can exist in a given space. This forms the criterion which distinguishes vapours from the permanent gases.

The results obtained by Dalton, in his experiments on the tension of aqueous vapour, are exhibited in the following table (*Manchester Memoirs*, 1802):—

Table showing the Maximum Tension of Aqueous Vapour at Temperatures below 212°, estimated in the Height of the Column of Mercury they are capable of supporting

Temperature.	Tension in Inches of Mercury.	Temperature.	Tension in Inches of Mercury.	Temperature.	Tension in Inches of Mercury.
2°	0·068	77°	0·910	152°	7·81
7	0·082	82	1·07	157	8·81
12	0·096	87	1·24	162	9·91
17	0·116	92	1·44	167	11·25
22	0·139	97	1·68	172	12·72
27	0·168	102	1·98	177	14·22
32	0·200	107	2·32	182	15·86
37	0·237	112	2·68	187	17·80
42	0·283	117	3·08	192	19·86
47	0·339	122	3·50	197	22·13
52	0·401	127	4·00	202	24·61
57	0·474	132	4·60	207	27·20
62	0·560	137	5·29	212	30·00
67	0·655	142	6·05		
72	0·770	147	6·87		

From this table the following formula for the elastic force or tension (which is measured by the pressure p), in terms of the degrees of temperature t, reckoned from 32°, has been deduced, which nearly represents the table; namely,

$$p = \cdot 1718\,(1 + \cdot 006\,t)^7.$$

In order to determine the tension of vapour at a temperature above the boiling point, it is necessary to have recourse to a different method of experimenting. By far the most satisfactory experiments hitherto made on this subject are those of Dulong and Arago, which were undertaken at the instance of the French government, for the purpose of ascertaining the exact temperatures at which aqueous vapour acquires a given tension, with a view to establish such legislative regulations as might appear necessary to prevent accidents from the bursting of steam-boilers. As an account of these experiments, and a table of the results, have already been given under the term STEAM, (p. 1157.) it is here only necessary to remark, that the pressures or tensions were ascertained by direct experiment at different temperatures from 212° to 436° of Fahrenheit, between which they were found to vary from 1 to 24 atmospheres; and that the relation between the pressure and temperature (at least for all pressures exceeding four atmospheres) was found to be represented very nearly by the following empirical formula, viz.

$$p = (1 + 0\cdot 003974\,t)^5,$$

in which p denotes the tension or elasticity expressed in atmospheres, and t the degrees of temperature of Fahrenheit, counting from 212°.

It is evident from this empirical formula, as well as the numbers in the table, that the tension of aqueous vapour increases in a much faster ratio than the temperature. This result appears to be general, and applicable to the elastic force of the vapours of all liquids, at least so far as may be judged from the imperfect experiments which have hitherto been made on the vapours of mercury, alcohol, and ether. Dalton thought that he had discovered a law which would establish a very simple relation among the tensions of the vapours of different liquids. It consists in this, that at an equal number of degrees above or below the point of ebullition corresponding to each liquid the elastic force of their vapours is equal. Thus, water boils at 212°, alcohol at 175°, and ether at 100°, the tension of the vapour at the boiling point being in all cases the same, and equal to the pressure of the atmosphere. Now, from the experiments of Dulong it appears that the tension of aqueous vapour is doubled when heated under pressure to 251°; that is, by an increase of temperature of 39° above the boiling point. Hence, by the law of Dalton, the tension of the vapour of alcohol is equal to two atmospheres when its temperature is $175° + 39° = 214°$; and that of ether equal to two atmospheres when the temperature is $100° + 39° = 139°$. Dalton himself afterwards discovered that this law fails when the distances from the point of ebullition are considerable.

Density of Vapour.—The density of vapour may be determined by introducing a known weight of the liquid which yields it into a receiver containing mercury, and inverting the receiver in a vessel also containing mercury, and tall enough to contain, above the mercury, a sufficient depth of water to cover the receiver. The whole apparatus is then heated; and when the whole of the liquid in the inverted receiver has been evaporated, the space the vapour occupies and its temperature are noted. We have then a given bulk of vapour, the weight of which is the same as that of the liquid from which it has been produced, and consequently known. The temperature is also known; and the pressure given in terms of the column of mercury in the receiver, and the height of the surrounding fluid compared with the indication of barometer. In this manner the density is found; and when the density of a vapour at a given temperature and under a given pressure has been found, its density under any other pressure, and at its corresponding temperature, may be calculated in the following manner:—Let a = the constant coefficient of dilation = ·00208 (it being found by experiment that vapour out of contact with liquid expands or contracts at the same rate as permanently elastic fluids by variations of temperature, that is to say, by 1-480th part of its volume for each degree of Fahrenheit's scale), t = the number of degrees of Fahrenheit's thermometer above 32°, v = the volume, p = the pressure, and d = the density of a vapour at the temperature of 32°; and let v', p', and d' be respectively the volume, pressure, and density at another temperature, $32° + t$. We have then $v' = (1 + a\,t)\,v$. Now, when the pressure is constant, the density is inversely as its volume; and, by the law of Mariotte, the density of a gas or vapour is directly as the pressure; whence $\frac{d'}{d} = \frac{p'}{p} \times \frac{v}{v'}$, and consequently $\frac{d'}{d} = \frac{p'}{p\,(1 + a\,t)}$, or $d' = \frac{d\,p'}{p\,(1 + a\,t)}$.

If we compare the density of aqueous vapour at any temperature with its density at the boiling point of water, which is 180° above the freezing point, and put d'' = the density, and p'' = the pressure at the boiling point, the formula becomes $d' = \frac{d''\,p'\,(1+180\,a)}{p''\,(1+a\,t)}$. The following table, computed from this formula, with Dalton's values of the pressures, shows the density and volume of aqueous vapour, at its maximum tension, for every ninth degree of temperature from the freezing to the boiling point. The unit of density is water at the temperature of 32°; and the unit of volume the volume of an equal weight of water also at 32°. As the density is inversely proportional to the volume, the numbers in the two last columns are the reciprocals of each other. They differ slightly from the numbers given by Gay Lussac.

Temperature.	Density.	Volume.
32°	·0000053	188600
41	·0000073	137000
50	·0000097	103000
59	·0000131	76330
68	·0000173	57800
77	·0000227	44050
86	·0000297	33670
95	·0000390	25640
104	·0000499	20030
113	·0000637	15690
122	·0000710	14080
131	·0001022	9784
140	·0001261	7930
149	·0001592	6281
158	·0001964	5091
167	·0002388	4187
176	·0002936	3406
185	·0003557	2811
194	·0004261	2346
203	·0005074	1971
212	·0005896	1696

By means of this table the weight of water may be calculated that would be contained in the form of vapour of the maxium tension in any given volume,—a calculation which is frequently required in meteorological inquiries.

The phenomena of vapour have been studied with reference to two objects; the condition of the atmosphere as to moisture, and the properties of steam as a moving power in machinery. On the subject of vapour in connection with the first of these objects, see *Daniell's Meteorological Essays; Davy's Elements of Agricul. Chemistry:* also the terms Dew, Evaporation, Hygrometry. For experiments on the elasticity and density of aqueous vapour, see, in addition to the Memoirs of Dalton and of Arago and Dulong, already cited, *Robison's Mechanical Philosophy;* Ure, in the *Phil. Trans.* for 1818; Pouillet, *Traité de Physique;* Despretz, *Traité de Physique; Gehler's Physikalisches Worterbuch*, art. "Dampf," by Prof. Muncke; and the various recent works which treat of the steam engine. *See* Steam.

VARIABLE QUANTITY, in Analysis, is a quantity conceived to be in a state of increase or diminution, or or to have different values in the same equation. Thus, the abscissa and ordinates of a curve are variable quantities; because they have different values for every different point in the curve, and in passing from one point to another their values increase or diminish according to the law of the curve. In the equation of the circle $y = \sqrt{(2\,a\,x - x^2)}$, x and y are variables; for x may have any value whatever between 0 and 2 a, and there will be a corresponding value of y, which satisfies the equation. The quantity a is a *constant* quantity, and remains the same, whatever be the values of x and y. It represents, in fact, the radius of the circle. In mechanics, a *variable motion* is that which is produced by the action of a force which varies in intensity, or which continues to act after motion has been communicated.

VA'RIANCE. In Law, a difference of statement between two material documents in a cause; as where the plaintiff's declaration differed (formerly) from the writ, or where it differs from a deed on which it is grounded. And, in ordinary language, a departure in the oral evidence from the statement in the pleadings is termed a variance. This variance may be either immaterial or material; and, in the latter case, amendable or not, according to a great variety of distinctions. The powers of amendment given to courts and judges are greatly extended by 3 & 4 W. 4. c. 42. s. 23, 24.

VARIA'TION. (Lat. varius, *changing.*) In Music, a difference in performing the same air or melody, either by subdivision of its notes into several others of less duration, or by adding graces; but, nevertheless, in such a manner that the original melody is not lost in the decorations or alterations which it is thus made to undergo.

VARIATION OF CURVATURE, in Analytical Geometry, is the change which takes place in the curvature in passing from one point of a curve to another. The circle is the only curve in which the curvature is uniform at every point. The curvature of a curve line at any point is the same as that of the osculating circle at that point. But the curvature of a circle is inversely as its radius: hence the curvature of any curve is inversely proportional to the radius of curvature; and, consequently, the differential of the curvature is proportional directly to the differential of the radius, and inversely to the square of the radius of curvature. In the conic sections, the variation of curvature at any point is proportional to the tangent of the angle included between the diameter and normal, both passing through that point.

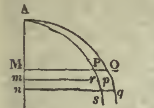
VARIATION OF THE COMPASS. The angle which the magnetic needle makes with the plane of the true meridian. It is otherwise called the *declination.* (*See* Declination of the Magnetic Needle.) For tables showing the variation of a great number of places, and its progressive, annual, and diurnal changes, see *Brewster's Treatise on Magnetism*, 1837, reprinted from the *Encyclopædia Britannica*.

VARIATION OF THE MOON. In Astronomy, an inequality of the moon's motion, depending on the angular distance of the moon from the sun. It arises from that part of the sun's disturbing force which is at right angles to the radius vector, and which accelerates the motion of the moon from the quadratures to the syzygies, and retards it from the syzygies to the quadratures. It is proportional to the sine of twice the angular distance between the sun and moon; and its maximum value, or the coefficient of its argument, is 35′ 41·9″. Hence it is represented by the formula (35′ 41·9″) sin. 2 A, A being the angular distance of the moon from the sun. The variation was discovered by Tycho Brahé. It had escaped the observation of Hipparchus and the ancient astronomers, though of sufficient magnitude to have been sensible to them; probably because they chiefly observed the moon in the syzygies and quadratures, and at these points of the orbit its value is nothing.

VARIATIONS, CALCULUS OF. An important branch of the modern mathematics, invented by Lagrange, the principal object of which is to resolve in a general manner certain classes of questions respecting *maxima* and *minima*, the solution of which cannot be obtained by the ordinary processes of the differential calculus. In solving problems of maxima and minima by the differential calculus, it is necessary to find the determinate values of the different variables which enter into a proposed finite function of those variables, in order that the proposed function may have the greatest or least value possible. Many problems of this nature are met with in the writings of the ancient geometers, particularly in the Conics of Apollonius; and the application of algebra to geometry gave rise, about the middle of the 17th century, to numerous others, proposed and solved chiefly by Fermat, Slusius, Hudde, &c. As no general method of solving such questions was known previous to the invention of the differential calculus, their solution was accomplished by particular artifices, and was frequently attained with very considerable difficulty. This difficulty was removed in respect of the class of questions now mentioned by the invention of the calculus; but as the instrument of investigation was improved, new views were opened up, and a more difficult class of questions was proposed, to which the known methods seemed inapplicable. It was proposed to find, among all curves subjected to a given law, that which best fulfilled a given condition: for example, to find the curve which, relatively to co-ordinates given in magnitude and position, encloses the greatest space; to find the curve along which a heavy body must descend in order to pass from one given point to another given point in the least time possible, &c. In such questions the relations between the variables is not given, as in the ordinary cases of maxima and minima; the object proposed is to find that relation, or to find the equation which must subsist between the variables in order that the condition of maximum or minimum may be fulfilled.

The first problem of this kind which was solved appears to have been that of the solid of least resistance. In the first edition of the *Principia*, published in 1687, Newton gave the equation of the curve by the rotation of which about its axis the solid is formed which, when moved through a fluid in the direction of the axis, is less resisted than any other body of the same specific gravity and bulk; but without demonstration or indication of the views by which he had been guided. About ten years later the famous question of the *brachystocrone*, or curve of quickest descent, was agitated between the two brothers James and John Bernoulli, in which Leibnitz and some of the other most illustrious mathematicians of the day took a part. The more general problem of *isoperimeters* was solved by James Bernoulli in 1701; and it was in the analysis which he gave on this occasion that the principle on which the solution of similar questions depends was first distinctly unfolded. Euler treated the whole subject in his peculiarly luminous manner in a treatise published in 1744, under the title *Methodus Inveniendi Lineas Curvas Maximi Minimive Proprietate Gaudentes.* And, lastly, the method was reduced to its utmost sim-

plicity by Lagrange, who supplied the algorithm and gave it the form under which it is now exhibited as the calculus of variations.



In order to give an idea of the nature and objects of this calculus, let us suppose a parabola A P referred to its rectangular co-ordinates A M $= x$, M P $= y$, and of which the parameter is a. The equation of this parabola is $y^2 = a\,x$. Now if $m\,p$ be drawn infinitely near M P, and P r parallel to the axis, the line M m or P r will represent $d\,x$, the differential of the axis x; and $r\,p$ will represent $d\,y$, the differential of the ordinate y; also the relation between those differentials is found by differentiating the equation $y^2 = a\,x$, which gives $2\,y\,d\,y = a\,d\,x$, whence $d\,y = \frac{a\,d\,x}{2\,y}$, or $d\,y = \frac{a\,d\,x}{2\sqrt{ax}}$.

Let us now suppose the parameter of the parabola also to vary, and to become $a + \delta\,a$ (the Greek letter δ being used to indicate the variation of a quantity, in the same manner as d is used to denote the ordinary differential). On constructing another parabola A Q, the parameter of which is $a + \delta\,a$, the variations which the co-ordinates undergo in consequence of this variation of the parameter will be represented as follows: — 1. Suppose the absciss A M to be the same in both parabolas. The ordinate M Q of the new parabola A Q will be equal to the ordinate M P augmented by the small quantity P Q, which, therefore, is the variation of y, and according to the notation of the calculus denoted by $\delta\,y$. In order to find the value of this variation, we must substitute $y + \delta\,y$ for y, and $a + \delta\,a$ for a in the equation $y^2 = a\,x$. This gives $(y + \delta\,y)^2 = (a + \delta\,a)x$, from which subtracting the original equation $y^2 = a\,x$, and neglecting quantities of the second order, as in the differential calculus, we get $2\,y\,\delta\,y = x\,\delta\,a$, whence $\delta\,y = \frac{x\,\delta\,a}{2\,y} = \frac{x\,\delta\,a}{2\sqrt{a\,x}}$.

2. Suppose the absciss also to vary, and to become A n. We have then M $n = \delta\,x$, and $s\,q = \delta\,y$. By substituting $x + \delta\,x$ for x, $y + \delta\,y$ for y, and $a + \delta\,a$ for a, in the original equation, it becomes $(y + \delta\,y)^2 = (a + \delta\,a)(x + \delta\,x)$; whence, by performing the multiplications indicated, subtracting the equation $y^2 = a\,x$, and neglecting quantities of the second order, we get $2\,y\,\delta\,y = a\,\delta\,x + x\,\delta\,a$, and consequently $\delta\,y = \frac{a\,\delta\,x + x\,\delta\,a}{2\,y} = \frac{a\,\delta\,x + x\,\delta\,a}{2\sqrt{a\,x}}$, for the value of the variation of y.

From this example we may see clearly the distinction between differentials and variations. The changes of the co-ordinates relative to the same curve are made by differentials; those which take place in passing from one curve to another of the same kind are made by variations. Each of the small quantities $\delta\,x$, $\delta\,y$, $\delta\,a$, is arbitrary, and we may make $\delta\,x = d\,x$; but this equality being established, we are no longer at liberty to suppose $\delta\,y = d\,y$, or $\delta\,a = d\,a$. It is also obvious that the variations of algebraic quantities are found exactly in the same manner as the differentials of those quantities; in fact, it is only necessary to substitute the characteristic δ for d, and to follow the rules of the differential calculus. This remark extends to variations of all orders, and to circular and exponential quantities.

The rules being entirely the same in both methods, it is evident that the variation of $d\,x$ is $\delta\,d\,x$, and reciprocally that the differential of $\delta\,x$ is $d\,\delta\,x$. These two quantities are also identical; for if we suppose x and x' to be two consecutive values of x, we have, by the principles of the differential calculus, $d\,x = x' - x$, whence $\delta\,d\,x = \delta\,x' - \delta\,x$. But in the same manner as x and x' are two consecutive quantities in the series of values of the variable x, so $\delta\,x$ and $\delta\,x'$ may be regarded as two consecutive values of the variable $\delta\,x$; whence $d\,\delta\,x = \delta\,x' - \delta\,x$, and consequently $\delta\,d\,x = d\,\delta\,x$.

Another principle of equal importance is, that the variation of the integral of any differential quantity is equal to the integral of the variation; that is to say, in any function P of different variables, as x, y, z, &c., and their differentials, we have $\delta\int \mathrm{P} = \int\delta\,\mathrm{P}$. To prove this let $\int \mathrm{P} = \mathrm{U}$. We have then $\mathrm{P} = d\,\mathrm{U}$ by taking the differentials; whence $\delta\,\mathrm{P} = \delta\,d\,\mathrm{U}$, and therefore, by what has been shown, $\delta\,\mathrm{P} = d\,\delta\,\mathrm{U}$. Integrating this last equation, we get $\int\delta\,\mathrm{P} = \delta\,\mathrm{U}$; whence, by restoring the value of U, $\int\delta\,\mathrm{P} = \delta\int\mathrm{P}$.

By means of these two principles we are enabled to find the variation of an indefinite integral expression $\int \mathrm{V}\,d\,x$, which, in fact, is the principal object of the method of variations. If this integral is a maximum or minimum, its variation must be made equal to nothing; and in this manner an equation is obtained which gives the required relations between the variable co-ordinates.

Lagrange, in his *Mécanique Analytique*, has founded a complete system of rational mechanics on the method of variations. The object of this important application may be understood from considering that the co-ordinates of the different points of a moving body may be used either for the purpose of comparing the positions of two different points at the same instant, or of two consecutive positions of the same point. In the former case, the only relation between the co-ordinates is that which results from the form of the surface of the body; in the latter the change of the co-ordinates is determined by the conditions of the motion, and a new variable is introduced which is the measure of the time. The co-ordinates, therefore, vary in two totally distinct modes, which it is necessary to indicate by different symbols. One of these modes becomes, in reference to the other, the calculus of variations, which, according to this view of the subject, may be described as a method of differentiating quantities conceived to vary in a particular manner, after having been already differentiated on the supposition that they vary in a different manner. See Lagrange, *Mécanique Analytique*; Id. *Leçons du Calcul.*; Lacroix, *Traité du Calcul. Diff. et Intégral*, tome ii.; Bossut, *Traité du Cal. Diff. et Integ.*; *Woodhouse on Isoperimetrical Problems*; *Airy's Mathematical Tracts*.

VARICE'LLA. *See* Chicken Pox.

VARICOCE'LE. (Lat. varix, *a distended vein*, and κήλη, *a tumour*.) A swelling of the veins of the spermatic cord.

VARI'ETY. (Lat. varietas.) In Zoology, this term is applied to individuals of the same species, which, from the operation of different causes, as age, climate, food, locality, domestication, &c., present deviations from the specific type in size, colour, form, and relative proportion of parts of the body; but have the capacity of reverting to the original typical form in successive generations, on the cessation of the influences under which the variety originated.

VARI'OLA. *See* Small Pox.

VA'RIOLITE. A porphyritic rock consisting of an imperfectly crystallized aggregate of felspar and quartz.

VARI'OLOUS. (Lat. variola, *small pox.*) In Zoology, when a part is beset with many shallow impressions like marks of the small pox.

VARIO'RUM EDITIONS. In bibliography, certain editions of the classic authors of antiquity, published chiefly in Holland, in the 17th and 18th centuries, and containing the notes of numerous commentators, are so called. These editions are chiefly valued by collectors.

VA'RIX. (Lat.) A dilatation or swelling of a vein.

VA'RNISH. (Fr. vernis.) A fluid which when spread thin upon a solid surface becomes dry, and forms a coating impervious to air and moisture. There are two kinds of varnish; namely, *spirit* and *oil varnishes:* rectified alcohol is used for the former; and for the latter fixed and volatile oils, or mixtures of the two. The solid substances dissolved in the above menstrua, and which constitute what is termed the body of the varnish, are almost exclusively resinous, and are chiefly the following: — 1. *Turpentine*, all the varieties of which are employed by the varnisher: they form an excellent body, and give strength and glossiness at a small expense; but they do not dry without other additions. 2. *Copal*, a peculiar resin, very difficult to dissolve, but forming a hard and durable ingredient. It is generally melted over a gentle fire previous to use. 3. *Lac*, which gives great toughness and hardness; but is often inadmissible, on account of its reddish brown colour. 4. *Mastic*, which yields a tough, hard, brilliant, and colourless varnish. 5. *Elemi*, a resin of a pale yellow green tint, and a valuable ingredient, on account of its toughness and durability. 6. *Sandarach*, a resin which imparts splendour, but which alone is not durable. 7. *Amber*, a valuable ingredient, on account of its hardness and durability; but difficult of transparent solution, and hence chiefly used in opaque varnishes. 8. *Benzoin*, added on account of its fragrancy. 9. *Anime*, which gives brilliancy and some scent. 10. *Gamboge*, for yellow varnishes. 11. *Dragon's blood*, for red varnish. These, together with turmeric, saffron, and annotta, are chiefly used on account of their colour, and to cover brass and copper under the name of *lacquers*. 12. *Caoutchouc*. This extraordinary vegetable product has of late been much employed in a variety of preparations used as varnishes. It is invaluable where materials are to be rendered air-tight, as balloons, for example, and where at the same time flexibility, and even elasticity, are required; but its principal application in this way is in the manufacture of various *water-proof* articles. 13. *Asphaltum*, the varieties of which are indispensable in black oil varnishes. In making spirit varnishes, the strongest alcohol of commerce should be used (of a specific gravity not exceeding 820), and its solvent power over some of the more intractable resins is sometimes improved by the addition of a little camphor; in order to prevent the agglutination of the resin, it is often requisite to mix it

with sand or pounded glass, by which the surface is much increased, and the solvent energy of the spirit facilitated. The proportions in which the several ingredients are used, and the selections for particular purposes, are infinitely various. The following are a few good varnishes, in illustration of their varieties: — 1. *Spirit varnish.* Sandarach 4 oz., seed lac 2 oz., elemi 1 oz.; digest the whole in a quart of moderately warm alcohol, and when dissolved add Venice turpentine 2 ozs. 2. *Lac varnish.* Seed lac 8 oz.; digest for four days in a warm place with a quart of alcohol, and then strain through flannel. 3. *Turpentine varnish.* Mastic 12 oz., mixed with 5 oz. of pounded glass, and digested in a quart of oil of turpentine, adding at intervals about half an ounce of camphor in small pieces. When the mastic is dissolved add to the warm fluid an ounce and a half of previously liquefied Venice turpentine, and stir the whole together. 4. *Copal varnish.* Copal which has been previously melted by a gentle heat 3 oz., oil of turpentine 20 oz. (measure): put the oil into a flask placed in boiling water, and add the powdered copal in small portions at a time, so that it may be gradually dissolved; let it stand a few days to clear, and then pour it off, and if too thick for use add to it a little warm oil of turpentine. This varnish dries slowly, but is very durable. 5. *Linseed varnish.* Melt 16 oz. of copal in an iron pot with as gentle a fire as possible, and when fused pour in 3 oz. of hot linseed oil; stir the mixture, remove it from the fire, and while yet warm gradually add a pint of warm oil of turpentine: when the whole is incorporated, strain it through a piece of linen into phials. This is a hard and durable, but also a coloured varnish. 6. *Amber varnish.* Melt 16 oz. of amber in an iron pot, then add 2 oz. of melted lac and 10 oz. of hot drying linseed oil; incorporate the whole by stirring; remove it from the fire, and before it cools add a pint of warm oil of turpentine. 7. *Black varnish.* Melt 16 oz. of amber in an iron pot, and add half a pint of hot drying linseed oil, 3 oz. of powdered rosin, and 3 oz. of powdered asphaltum; stir all together, and when removed from the fire and sufficiently cool add a pint of warm oil of turpentine. 8. *Lacquer.* Digest 3 oz. of seed lac, 1 oz. of turmeric, and 2 drs. of dragon's blood for six days in a pint of alcohol, frequently shaking the bottle, which should be kept in a warm place; strain the lacquer through linen. The above are samples of each of the principal varnishes; but every maker varies the proportions, and often the nature of the ingredients. In the preparation of varnishes, in consequence of the highly combustible nature of all the materials, the utmost care is requisite to avoid accidents by fire.

VA'RVICITE. An ore of manganese found at Hartshill in Warwickshire. It appears to be a compound of 2 equivalents of peroxide and 1 of sesquioxide of manganese with 1 of water.

VA'SCULAR SYSTEM, in Botany, is that portion of the tissue of plants which is destined for the conveyance of air. Vascular plants are those in which the vascular system occurs, or forms a principal feature. The air vessels are the tracheæ or spirals.

VASE. (Lat. vas.) In Sculpture, a vessel usually ornamented with sculpture of fruits, flowers, bassi-rilievi, &c.

VA'SES, ETRUSCAN. In Antiquities. These well-known and beautiful objects of ancient art have been discovered in great numbers, chiefly in the sepulchres of ancient Italian cities. Their material is terra cotta, and they are painted with figures and scenes. The most beautiful, and indeed the most numerous, were formerly obtained from Campania and Magna Græcia; and it was much controverted among antiquarians whether the workmanship was not originally Greek, which is maintained by Sir W. Gell. (*Topography of Rome*, vol. i.) Of late years, the great sources have been the sepulchres of Etruria Proper. Five thousand have been taken in twenty-five years from the ruins of Tarquinia alone; and it seems to be now generally admitted that the manufacture is rightly called Etruscan; that it is of extreme antiquity; that in its origin it is connected, in some way not easily explicable, with early Egyptian art; that in its progress Greek taste and style were introduced; that the art had fallen into disuse in the flourishing period of the Roman empire, which is evinced by this fact, among others, that none have been found in Pompeii or Herculaneum. "The most ancient vases are those called of the Egyptian style. They are particoloured, of red and black upon a pale yellow ground. *Black* vases, with friezes of animals and ornaments in bassi-rilievo, are also of very high antiquity. Those with *black* figures on a *red* ground come next in order; while the most modern are *black* with *red* figures: such of them, at least, as depart from the old stiff Etruscan style, and have the more natural shapes of Greek art; for example those of Magna Græcia in general, and Nola in particular." (Mrs. H. Gray, *Sepulchres of Etruria*, p. 45.)

VA'SSAL. (Derived, according to Sir F. Palgrave *on the English Commonwealth*, from the Welsh gwâs, *a young man or page;* gwasâeth, *the state of pagehood*, being rendered in Latin vassaticum.) The holder of a fief, by fealty and service, of a feudal superior or lord. (*See* FEUDAL SYSTEM.) From the Celtic origin of this word, it has been inferred that some portion of the feudal usages were derived from those of the tribes which possessed Gaul and Britain before their annexation to the Roman empire. In the ancient documents of the Carlovingian kings, the vassal is termed "vassus," or "homo fidelis;" the lord generally "senior." The term vassal was also more generally used, in common language, to signify all who were dependent on a superior lord, from those who held fiefs of him down to his serfs or villeins. (See Guizot, *Civilization en France*, vol. iv.)

VASTUS. A term applied by anatomists to two muscles of the thigh, the *external* and *internal vasti.*

VA'TICAN, the ancient palace of the popes, and the most magnificent in the world, stands at Rome on the right bank of the Tiber, and on the hill anciently called by the same name; derived, according to Aulus Gellius, from Vaticinium, or rather from an ancient oracular deity of the Latins, called by the Romans Jupiter Vaticanus, who was worshipped there. Some say that Pope Symmachus began the construction of the palace. It was inhabited by Charlemagne in 800; and the present irregular edifice has been raised by the gradual additions of a long series of pontiffs. Its extent is enormous, the number of rooms, at the lowest computation, amounting to 4422; and its riches in marbles, bronzes, and frescoes, in ancient statues and gems, and in paintings, are unequalled in the world; not to mention its library, the richest in Europe in manuscripts. The length of the museum of statues alone is computed to be a mile: here are the Sistine Chapel; the Camere of Raphael, painted by himself and his pupils; the museum of Pius VI., peculiarly rich in objects of ancient Italian workmanship; and other deposits of art and antiquity, each of which by itself would suffice to render a city illustrious.

VAU'DEVILLE. In French Poetry, a species of light song, frequently of a satirical turn, consisting of several couplets and a refrain or burden, introduced into theatrical pieces. The origin of the word is disputed; some derive it from Vau-de-Vire, a village in Normandy. Short comic pieces interspersed with such songs are also termed Vaudevilles.

VAU'DOIS. (Lat. Waldenses.) The inhabitants of some valleys in the Alps between Italy and Provence, from whence they derive their name; and who must be distinguished from the Waldenses, or followers of Peter Waldo, who acquired celebrity in the 12th century, and from whom some writers have deduced both their religious tenets and their appellation also. The Vaudois are celebrated for having maintained the purity of their doctrine for many ages before the Reformation; and it has been asserted by some theologians that the true spirit of the primitive Christianity was kept alive among them throughout the whole period of Romish corruption. This position, however, does not seem susceptible of proof. Another claim that they possess to a place in ecclesiastical history, is derived from the numerous persecutions to which they have been exposed on account of the witness they have so long borne against the erroneous doctrines of the nations by whom they are surrounded. Their extreme antiquity is certain at all events; and the numerous attempts which have been made by Romanist writers to fix on them the stigma of Manicheism seem unsupported by the evidence. For the last three centuries they have been viewed with displeasure by the dukes of Savoy and kings of Sardinia, their masters, and repeatedly visited with military execution, or more legal forms of violence. One great persecution, in the 17th century, is known to us by Milton's noble sonnet. Not long after it they were altogether expelled, and retreated into Switzerland, whence they returned by a celebrated march, and recovered their valleys by force; an event commemorated in the work of Arnaud, one of their pastors, *La Glorieuse Rentrée des Vaudois dans leurs Vallées.* At present they are by no means free from occasional vexations. Their number is about 30,000. (See *Faber on the Waldenses and Albigenses*, as to their tenets.)

VAULT. (Fr. voute; It. volta.) In Architecture, an arched roof, so contrived that the stones, bricks, or other materials whereof it is constructed, sustain and keep each other in their places. Vaults are circular and elliptical. When their section rises higher than a semicircle, they are said to be *surmounted;* when less, *surbased.*

VA'VASSOR. A word of uncertain derivation, although probably derived from the same root with vassal (gwâs, *a youth or page*, in some Celtic dialects). The vassals who held immediately of the higher nobility, under the feudal system in France, were frequently comprehended under this general name; the châtelains being such vavassaors as possessed castles or fortified houses. (See Hallam, *Middle Ages*, vol. i. p. 149.) The word, however, seems to have been of very loose application. Poor gentlemen are termed vavassors in old French romances. In England the title was not usual, although it

is mentioned in Bracton in contradistinction to baron, and sometimes appears to have designated persons who held land by military tenure of others than the king. (See *Archæologia*, vol. ii.)

VE'CTIS. (Lat. *the lever.*) In Mechanics, the same with *lever. See* LEVER.

VE'CTOR (Lat. vehere, *to carry*), or RADIUS VECTOR. In Astronomy, a straight line conceived to be drawn from the centre of a planet to the centre of the sun, by which the planet appears to be *carried* round the sun in its orbit. In geometry, the radius vector of a conic section is a straight line drawn from one of the foci to any point in the curve.

VE'DA. The name by which the Hindoos designate the collective body of their scriptures; sometimes called Vedam, Bedam, &c., according to various provincial pronunciations, by European writers. The four Vedas (Rig, Yajust, Saman, and Atharvan) are believed, according to the orthodox creed, to have been revealed by Brahma. But the subdivisions are infinite, as are also the connected works, — Upavedas, Angas, Upangas, &c.; some of which are considered by Mr. Colebrooke to constitute, according to received opinion, a fifth Veda. The arrangement is ascribed to one Vyasa, a sage of whom nothing positive can be ascertained. The Vedas chiefly consist of prayers, precepts or maxims, and stories; called respectively by different titles Thus a portion of the mythological histories are called Puranas; but these are not to be confounded with the poems of romantic mythology called by the same name. (*See* PURANAS.) The genuineness and antiquity of the Vedas have been matter of much dispute among western antiquaries. The chief chronological data are, that they were compiled before the supposed incarnation of Vishnu, as Rama and Krishna, under which titles he is now so commonly worshipped among the Hindoos; and also before the appearance of Buddha. Sir William Jones (*Asiat. Researches*, vol. ii.) gave them a conjectural antiquity of about 3000 years; and Mr. Colebrooke (Ib. vol. viii.) arrives at about the same conclusion.

VEDA'NTA. A sect among the Hindoos, whose theory of philosophy is professedly founded on the revelations contained in the Vedas. Its fundamental tenets appear to have a near connection with the opinions of Epicharmus, Plato, Pyrrho, and what is termed the Berkelian philosophy among ourselves; namely, that matter has no existence independent of mental perception; with the ordinary consequences of that doctrine, of which those practically most important are the maxims of Quietism. See, on the philosophy of the Vedas, *Ritter's History of Ancient Philosophy* (translation), vol. i. p. 66, &c.

VEER. In Naval Language, to give the ship more scope of cable. Also to let any thing drop astern by a rope. Also the old term for *to wear.*

VE'GETABLE EARTH. Soil in which decayed vegetable matter is in a much larger proportion than the primitive earths. In Horticulture, vegetable earth is called mould; and in Agriculture the term is applied to the surface soil of hollows, which contain alluvial soil beneath, and vegetable matter, generally of a black colour, on the surface.

VEGETA'TION. *See* BOTANY.

VEGETA'TION, CHEMISTRY OF. From the moment a seed begins to grow a series of chemical changes are induced, essential to the development of its germ. The process has been chiefly studied in regard to bicotyledonous plants, and a general outline of it is given under the word GERMINATION.

VE'HMIC COURTS. (Germ. vehm, or femgerichte.) Criminal courts of justice, established in Germany during the middle ages. These courts are commonly said to have originated in those held by the Missi Dominici, or imperial legates, sent by Charlemagne into the provinces of his empire; but many circumstances denote their descent from the more ancient tribunals of the German tribes, held in the open air in the primitive periods of their history. (See a curious account of the free field courts of the Germans in Sir F. Palgrave's work on the *English Commonwealth; Wigand's Femgericht Westphalens.*) But the character under which these institutions became formidable and important, about the beginning of the 13th century, arose from the disordered state of northern Germany after the dissolution of the duchy of Saxony. The Vehmic, or, as they were called, free courts, were then modelled on a secret system of organization. The president was usually a prince or count of the empire; his assistants (styled Freischöffen) were persons affiliated to the society by secret initiation, to the number, it is said, at one time of 100,000. All these were bound to attend the secret meetings of the courts when summoned, and to execute their decrees, if necessary, by taking the life of persons condemned. Westphalia, styled, in the language of the free courts, the Red Land, was the district in which their central authority was seated. These courts exercised a great power, which was occasionally serviceable in repressing the lawless violence of the nobles of that period, but which was also liable to be perverted to the gratification of private malice and tyranny. Various leagues were formed in the 15th century, by the nobles of the empire, for the purpose of destroying their influence; which was at last effected, chiefly by the introduction of a better system of public judicature and police in the several states. See also the publication of the Library of Entertaining Knowledge Society, *Secret Societies of the Middle Ages.* The romantic use of this history made by Goethe in his *Goetz von Berlichingen* is well known.

VEIL. A term used in describing fungi to denote the horizontal membrane connecting the margin of the pileus with the stipes.

VEINS. (Lat. vena.) In Anatomy, elastic tubes which convey the blood from the arteries back to the heart. *See* HEART.

VEINS, MINERAL. Cracks or fissures in rocks filled up with substances differing from the rock itself. When these are of a metallic nature, they form the chief repositories of the most useful metals, and are termed *metallic* veins: they often contain cavities lined with some of the most beautiful mineral products. Some veins are several yards wide; and they often branch off into smaller ramifications, which are gradually lost in the surrounding rock. *See* GEOLOGY.

VELE'LLA. (Diminutive of velum, *a sail.*) The name of a genus of Acalephes, characterized by a vertical crest or sail, by means of which they are wafted along the surface of the ocean.

VE'LITES. The light-armed infantry attached to a Roman legion were so called. (See *Mém de l'Ac. des Inscr.* vol. xxix.) They were equipped with bows, slings, and javelins, a light wooden buckler covered with leather, and a head-piece.

VE'LLUM. (Lat. velamen, or vitulinum.) A fine kind of parchment made of calfskin. The skins are limed, shaved, washed, and stretched in proper frames, where they are scraped with the currier's fleshing-tool, and ultimately rubbed down to a proper thickness with pumice-stone.

VELO'CE. (It. *swift.*) In Music, a term which, prefixed to a movement, indicates that it is to be performed in a rapid manner.

VELO'CIPEDE. (Lat. velox, *swift*, and pes, *foot.*) A vehicle invented at Mannheim in 1817, by M. Drais, consisting of a piece of wood about five feet long, and half a foot wide, resting on two wheels, one behind the other. On this an individual sits, as on horseback, his feet touching the ground, and thus propelling the machine. The front wheel may be turned at pleasure, so that the rider may give any direction to the machine. This species of vehicle never came into general use; but it was improved by Knight in this country, and a patent received for it.

VELO'CITY (Lat. velox, *swift*), is measured by the space which a moving body passes through in a given time. The velocity of a body is uniform when it passes through equal spaces in equal times; and variable when the spaces passed through in equal times are unequal. It is accelerated when the force by which a body is put into a state of motion continues to act after the motion has commenced; and retarded when the moving body encounters obstacles which tend to destroy the motion. Velocity is merely a relative term; for there is nothing, as Biot remarks (*Traité de Physique*, l. iii. p. 148.), which in itself is either swift or slow, any more than great or small. The velocity of a cannon ball appears very great, as it can scarcely be followed by the eye; yet it is slow in comparison of the motion of a point on the earth's equator carried round by the diurnal motion; and this, in its turn, is far inferior to the velocity of the earth in its orbit, which again is greatly exceeded by the velocity of light. (For the velocity of falling bodies, see ACCELERATION; for the velocity of a body moving in curve about a centre of force, see CENTRAL FORCES. *See also* GUNNERY, VIRTUAL VELOCITY, &c.

VELVET. A rich kind of stuff, extensively used for ladies' dresses and a variety of other purposes. Of velvet there are properly only two kinds, that with a plain, and that with a tweeled, or, as it is also called, a Genoa ground or back. When the material is silk, it is called velvet; when cotton, velveteen. The latter is a species of *fustian*, which, under a variety of names, is largely used for men's wearing apparel.

VENA CAVA. *See* HEART.

VENEE'R. In Architecture, a thin piece of material of a more valuable kind laid on another of a more common sort, by which the whole substance appears to be of the more valuable sort. Veneering is more usually applied to furniture than to strictly architectural purposes.

VENE'TIAN SCHOOL. In Painting. The distinguishing character of this school is colouring, and a consummate intellectual knowledge of chiaro-scuro; in both which all is grace, spirit, and faithful adherence to nature, so seductive as to lead the spectator away from any consideration of its defects. It is an exquisite bouquet of

well-arranged flowers; or a collection of pulpy, juicy, saccharine fruits. But it is not to be inferred that it is altogether wanting in still higher accomplishments; for the head of it was Tiziano de Vecelli; and in its ranks are to be found Tintoretto, Paul Veronese, Giorgione, and many other illustrious masters. *See* PAINTING.

VE'NIAL SIN. (Lat. venia. *forgiveness.*) In Theology, is defined, by Roman Catholic theologians, a sin which weakens sanctifying grace, but does not take it away: It is not necessary, although commendable, to mention such sin in confession. Reformed theologians altogether reject the formal distinction between venial and mortal sin.

VENI'RE FA'CIAS. In Law, a judicial writ, directed to the sheriff, to cause a jury to *come* or appear in the neighbourhood where a cause is brought to issue, to try the same. (*See* JURY.) A *venire facias de novo*, being a writ directing the sheriff to cause a jury to come and try a cause a second time, is granted where there has been a mis-trial; on the ground of irregularity, as, for instance, in summoning the jury; on the ground of misconduct by the jury; and also in certain cases where the verdict given is imperfect by reason of some ambiguity and uncertainty. The great rule of difference between a venire de novo in the latter case and a new trial is, that the former is only granted on matter appearing on the record.

VENI, SANCTE SPIRITUS. (Lat. *Come, Holy Ghost.*) The name given to a mass in the Roman Catholic church to invoke the assistance of the Holy Spirit.

VENTA'YLE, or AVENTAYLE. The visor of a helmet. *See* HELMET.

VE'NTER, (Lat.) in Entomology, signifies the lower part of the abdomen.

VENTILA'TION (Lat. ventus, *wind*) literally signifies fanning or blowing. In Domestic Economy, it is the art of conveying currents of fresh air through close apartments or confined places, so as to maintain the atmosphere in a state of purity.

Atmospheric air consists of two ingredients, oxygen and azote, blended together in the proportion of one part by measure of the former to four of the latter. When these proportions are altered, air becomes unfit for respiration; and when the oxygen is withdrawn or consumed, it is rendered altogether incapable of supporting animal life or combustion. But there are operations both of nature and art continually going forward in which the oxygen of the atmosphere is consumed, and gaseous products evolved which are destructive of life. Thus, in the act of respiration, a certain portion of the oxygen contained in the air inhaled into the lungs is converted into carbonic acid, a substance which acts as a narcotic poison; and hence, in a confined apartment, air is soon rendered, by breathing alone, not merely incapable of maintaining life, but highly destructive of it, in consequence of the evolution of a deleterious gas. In like manner, oxygen is consumed, and carbonic acid evolved, in the process of combustion; and the burning of a pan of charcoal in a close room is known to be a certain means of extinguishing life.

Although a decomposition and deterioration of air is thus continually going forward, nature has by various means provided so effectually for the restoration of the two constituent gases, that in whatever part of the world, and at whatever height in the atmosphere, air is taken, it is found, when chemically examined, to contain azote and oxygen in exactly the same proportions. *See* AIR.

Quantity of air required for Ventilation.— If the question were solely how to command a sufficient supply of fresh air, it would be easily solved; but as in our climates the temperature of the external atmosphere is in winter generally very much lower than is necessary for comfort, we have at the same time to provide for the maintenance of an artificial temperature in our apartments, by allowing the air to enter no faster than it can be warmed. One of the first points, therefore, to be considered, is the amount of the supply of fresh air which an individual requires for comfort and health. This, however, is a point on which, by reason of the great variety of circumstances concerned, it is extremely difficult to arrive at any satisfactory conclusion.

Dr. Henry estimates that an adult person makes, on the average, 20 inspirations per minute, and draws into his lungs at each inspiration 20 cubic inches of air. Peclet allows 40 cubic inches for each inspiration. Taking the mean of the two estimates, we have 600 cubic inches expired per minute. But, according to Dr. Arnott, air expelled from the lungs is found to vitiate, so as to render unfit for respiration, twelve times its own bulk of pure air; hence, the quantity of air spoiled every minute by the respiration of an adult, is 7200 cubic inches, or rather more than 4 cubic feet. Dr. Arnott, however, supposes the waste to be only half of this quantity. But there are several other causes of deterioration besides the production of carbonic acid from the lungs: the effluvia and vapour of animal matter exuded from the whole surface of the body is not less injurious than carbonic acid; and, according to M. Seguin, in a temperature of 60°, about 3½ cubic feet of air per minute is charged with animal vapour transmitted through the skin of an adult, and rendered unfit for respiration. When artificial lights are used, a further allowance must be made for the waste by combustion. Besides, air is required for various other purposes than those which have now been mentioned. It acts as a cooling power, and hence the supply requisite for comfort depends on its temperature. It likewise serves to carry off moisture from the skin, and therefore its state as to dryness or humidity must be considered. Dr. D. B. Reid found, from observations on a number of persons assembled in an experimental room, that not less than 10 cubic feet per minute should be allowed to each individual on the average, at an agreeable temperature; but that, to maintain the atmosphere in all its purity, a much larger supply would at times be desirable. On the whole, therefore, we may conclude that 10 cubic feet of fresh air per minute, for each individual, is the smallest allowance that should be made in order to ensure healthful ventilation.

Sources of Ærial Movement.—One of the most efficient means of ventilation is afforded by the action of heat. At ordinary temperatures, air suffers an expansion of about 1-500th part for each degree of Fahrenheit's thermometer by which the temperature is raised; and being rendered specifically lighter in the same proportion, the pressure of the surrounding atmosphere predominates, and the heated air is forced upwards. This principle is exemplified in the action of the ordinary chimney, which may be regarded as a tube open at both ends, and placed in any position except the horizontal. The air in the lower end of the tube, being heated by the fire, rises and passes out at the upper end, while its place is supplied by the pressure of the fluid surrounding the lower opening; and the circumstances of motion are the same as if another tube, filled with air of the original temperature, were adapted to the lower end of the chimney, which is filled with heated air, so that the current is established in the same manner as in an inverted siphon, in which two columns of air of different densities, but equal altitudes, press against each other. At the lower opening of the chimney, the draught or velocity of the current is expressed by this formula,

$$v = \sqrt{[2\,g\,h\,a\,(t' - t)]},$$

where v denotes the velocity in feet per second, g the accelerating force of gravity (= 32·2 feet per second), a the rate of expansion for one degree of increased temperature, t' the temperature of the heated air as it enters the chimney, and t that of the external air. It appears from this that the velocity of draught is as the square root of the height of the chimney, and the square root of the excess of temperature at the lower opening. But as the same quantity of air must be supposed to pass through every different section of the chimney in the same time, it follows that the velocity at every part must be inversely as the density, and, therefore, decreases from the bottom to the summit.

As the draught of a chimney depends on the difference of the temperature of the air at its lower and upper ends, it will afford a considerable power of ventilation, even when there is no fire, if the room be heated by any means (as by an assemblage of persons) above the temperature of the external atmosphere. In warm weather this may, however, be insufficient; but in this case a large shaft, communicating with the apartment at some distance, will afford, by means of a good fire, an exhausting power to any extent. This is the method by which the Houses of Parliament are at present ventilated, and the principle has been frequently applied in mines and manufactories. The impulsion of air into a chamber by mechanical means is often had recourse to in particular circumstances. In the printing-office of the Bank of England there is a ventilating apparatus consisting of a square box for a pump body, with a loose piston, and furnished with large valved openings, by means of which 1100 cubic feet of air per minute are driven through the apartments. For ventilating the holds of ships, cellars, &c., the windsail is usually applied, though sometimes a fanner is introduced for the same purpose.

The subject of ventilating is intimately connected with that of warming apartments; and the great difficulty to be overcome is, to provide for both objects at the same time. The open fire-place, so generally used for private buildings in this country, affords, beyond question, the purest and wholesomest source of heat; but it is attended with many serious defects. By far the greater part of the heat produced by the combustion passes through the chimney without contributing to warm the apartment, thus occasioning a great waste of fuel; while the air admitted into the room to supply the place of that which sustains the combustion is allowed to find its way through the imperfect fittings of the doors and windows, wherever accident leaves an aperture, under no regulation, and accordingly passes through the apartment to the fire-place, in offensive and injurious currents. Nor,

after all, is the ventilation by any means complete; for while currents of cold air are passing along a few inches or feet above the floor, they seldom rise above the level of the chimney-piece, and the air in the upper part of the room may exist in a greatly vitiated state by the products of respiration and the combustion of the lamps or candles. These evils might, indeed, be obviated to a considerable extent, and the currents in the room much diminished, by bringing an independent supply of air through tubes leading directly from the outer air to the fire-place, and provided with valves to regulate the quantity. Count Rumford recommended that the air should be conducted from the roof of the building through a pipe or canal placed in the interior of the chimney, and admitted into the apartment through a regulated ventilator in the chimney-piece. The object of placing the tube within the chimney was, that the air, in its passage through it into the room, should be warmed by the contrary current of air from the fire-place; thus economising the heat which in the ordinary arrangement is entirely lost. This suggestion has been improved upon in a great variety of ways, and the principle applied to close as well as to open stoves.

When apartments are warmed by other means than open fires, as close stoves, the circulation of hot water in tubes, heated air, &c., means should be applied to obtain ventilation entirely independent of the heating, and controlled by valves. If stoves are used, the chimney to carry off the products of combustion, and the tubes which supply the air necessary to maintain it, should have no communication with the chamber in which the stove is placed. Stoves of low combustion, like Arnott's stove, or the porcelain stoves used in the north of Europe, are the best: iron, heated to a high temperature, causes an offensive smell, and decomposes the air; besides, the air which comes in contact with it, in consequence of the temperature it acquires, rushes rapidly to the highest part of the room, and renders regulated ventilation impossible. The mild hot-water apparatus, when the pipes are suitably disposed, affords an agreeable warmth, and has this advantage — that the sources of heat not being confined to a particular part of the room, equable ventilation is rendered more easy. In rooms for public assemblies, where the air requires to be changed rapidly, greater difficulty is encountered: the best method undoubtedly is, to admit the pure air from a chamber in which it is previously heated (or cooled, as the case may require,) to the suitable temperature, and to carry off the respired and vitiated air by the shaft of a furnace.

Of late years the subject of ventilation, as connected with the public health, has engaged much attention; and a mass of useful information respecting it will be found in the recent *Parliamentary Reports*, particularly on the ventilating and acoustic arrangements of the present House of Commons, on education and manufactures, and the means of improving the health of large towns. (See *Tredgold's Principles of Warming and Ventilating Public Buildings, &c.; Arnott on Warming and Ventilation; the Monthly Chronicle*, vol. i. p. 220; *Dr. Reid's Chemistry of the Atmosphere; Encyc. Brit.* art. "Ventiation;" Peclet, *Traité de la Chaleur*.)

VENTILATOR. Any machine or contrivance for promoting or regulating ventilation. The commen ventilator placed in windows, which revolves in the same manner as a smoke-jack, in consequence of the impulsion of a current of air, serves only to retard in some degree the entrance of the current, to disperse it in different directions, and to prevent any sudden increase in the intensity of the draught. It has no power of acting so as to create a current, or keep up its intensity when it has been established.

VE'NTRICLE. (Lat. venter, *the belly*.) A term in Anatomy, applied to cavities of the brain and of the heart.

VE'NTRICOSE. In Zoology, a part is so termed when it bellies out as if filled with air.

VENTRI'LOQUIST. (Lat. venter, *the belly;* loquor, *I speak*.) One whose voice appears to come from his belly. Ventriloquists are generally supposed to have the power of making the voice appear to come from distant objects or quarters; but this is a deception, arising out of the manner in which the ventriloquist manages his voice. The art appears to consist in filling the lungs with air, and employing, during expiration, such organs of voice as can be used without the aid of the lips; or at least with as little movement of the lips, mouth, or cheeks, as is compatible with the pronunciation of certain words. By practice many individuals have acquired considerable dexterity in this art; and when certain words can be distinctly pronounced in different tones, in the way described, the imagination of the hearers easily leads them to suppose that they come from a person in a box, or up the chimney, or from inanimate objects, especially if adventitious means be resorted to to aid the illusion, as is generally the case in such exhibitions.

VENU'E. (Norm. Fr. visne; Lat. vicinetum, *neighbourhood*.) In Law. By the original institution of trial by jury, jurors were summoned from the immediate neighbourhood where a fact happened, to try it by their own knowledge. Hence, long after the institution had been altered in character, juries were still summoned in point of form from the parish, village, &c., until by 4 Ann. c. 16. they became summonable as they still are, from the body of the county. The venue, therefore, was the neighbourhood named in the venue facias, or writ summoning the jury; and the last relics of the old practice, in criminal proceedings, were abolished by 5 G. 4. c. 50. (*See* JURY.) The venue, therefore, is the county in which the action is to be tried, which is specified in all material allegations in the pleadings; and it need not be the county in which the fact took place except in what are called local actions. *See* PLEADING.

VE'NUS. In Astronomy, one of the principal planets, the second in the order of distance from the sun, and the most brilliant of all the planetary bodies. From her alternate appearance in the morning and evening, Venus was called by the Greeks *Hesperus* and *Phosphorus*, the *evening* and *morning star;* sometimes also she is called the shepherd's star.

The distance of Venus from the sun is ·7233316, that of the earth being unity; whence her true distance is about 68 millions of miles. Her sidereal revolution is performed in 224·7007869 mean solar days; and her synodical period, or the interval between her successive conjunctions with the sun, is 583·920 mean solar days. The inclination of the orbit to the ecliptic was 3° 23′ 28·6″ at the commencement of the present century, and is subject to a decrease of about 0·0455″ in a year. The eccentricity of the orbit is ·00686074, half the major axis being unity; and the longitude of the ascending node at the commencement of the present century was 74° 54′ 12·9″, having a motion westward, when referred to the fixed stars, amounting to 17·6″ in a year.

The mean apparent diameter of Venus, or her apparent diameter when at her mean distance, is 16·9″; but it is subject to great variations, being only 9·6″ at the time of her superior conjunction, and at the time of the inferior conjunction sometimes so much as 61·2″. Comparing this with her mean distance, her true diameter is ·975, that of the earth being unity; and is consequently about 7700 English miles. Her volume is therefore ·927 of that of the earth. Her mass, as compared with that of the sun, is ·0000024638.

Venus, being an inferior planet, is never seen in opposition to the sun. Her greatest elongation, or angular distance from the sun, varies from 45° to 47° 12′. According to her various positions relatively to the sun and earth, she changes her phases like the moon, appearing when she first emerges from the sun's rays and becomes visible in the morning as a fine luminous crescent, the horns of which are turned away from the sun. As the planet recedes from the sun, the breadth of the crescent increases: at the greatest elongation it becomes a semicircle; after this the breadth of the disk goes on increasing till the planet arrives at its superior conjunction, where it appears as a full orb, the illuminated side being turned towards the earth. These appearances, on account of the irradiation, are not appreciable by the naked eye, but they become visible in an ordinary telescope.

Venus is supposed to revolve about an axis; and the time of rotation is stated, from observations made by Schroeter, to be 23 h. 21 m. 7·2 sec., the axis of rotation being inclined to the ecliptic in an angle of about 75°. There is, however, considerable doubt as to the accuracy of these conclusions. On this subject Sir John Herschel remarks, that Venus, "although it attains occasionally the considerable apparent diameter of 61″, which is larger than that of any other planet, is yet the most difficult of them all to define with telescopes. The intense lustre of its illuminated part dazzles the sight, and exaggerates every imperfection of the telescope; yet we see clearly that its surface is not mottled over with permanent spots like the moon: we perceive in it neither mountains nor shadows, but a uniform brightness, in which we may, indeed, fancy obscurer portions, but can seldom or never rest fully satisfied of the fact. It is from some observations of this kind that both Venus and Mercury have been concluded to revolve on their axes in about the same time as the earth. The most natural conclusion, from the very rare appearance and want of permanence in the spots, is, that we do not see, as in the moon, the real surface of these planets, but only their atmospheres, much loaded with clouds, and which may serve to mitigate the otherwise intense glare of their sunshine." ("Astronomy," *Cabinet Cyclopædia*, p. 279.)

Venus is sometimes seen to pass over the disc of the sun, presenting a phenomenon analogous to that of a solar eclipse by the moon. This phenomenon, which is called a *transit of Venus*, can only happen when the planet is at its inferior conjunction, and, at the same time, very near one of its nodes. It is therefore of rare occurrence; but very important, inasmuch as it affords the best means astronomers possess of determining the sun's parallax, and consequently the dimensions of the planetary system. (*See* PLANET.) Delambre

has given a list of all the transits occurring in a period of 2000 years. The following contains all that have happened since 1631, and that will happen before the end of the 21st century:—

1631, Dec. 6.	1874, Dec. 8.
1639, Dec. 4.	1882, Dec. 6.
1761, June 5.	2004, June 7.
1769, June 3.	2012, June 5.

(See *Baily's Astronomical Tables and Formulæ.*)

The first transit ever seen was that of 1639, which was observed in this country by Horrox and Crabtree. The importance of the phenomenon for determining the sun's parallax was first pointed out by James Gregory in his *Optica Promota*, 1663.

VE'NUS. In Zoology, a name applied by Linnæus to a genus of *Vermes Testacea*, including those which have a bivalve shell with the frontal margin flattened, with incumbent lips; the hinge with three teeth, all of them approximate, and the lateral ones divergent at the top.

The Bivalves thus characterized enter into the Cardiacean family of the Testaceous Acephala of Cuvier, and are subdivided into the genera *Venus* proper, Lam.; *Astarte*, Sowerby; *Cytherea*, Lam.; *Capsa*, Brug.; *Petricola*, Lam.

VENUS. The Latin name of the Grecian Aphrodite ('Αφροδίτη). This goddess is generally supposed to have been of eastern origin, and to have been the same as the Phœnician Astarte. By the Grecian poets she was called the daughter of Jupiter and Dione; or, according to some accounts, arose from the foam of the sea. She was worshipped as the goddess of beauty and love, her principal seats being the islands of Cyprus and Cythera. The Romans regarded her as the progenitress of their nation, which was fabled to have sprung from Æneas, the offspring of her union with the Trojan Anchises. She was married to Vulcan; but was not remarkable for fidelity to her husband. Her amour with Adonis is particularly celebrated in ancient poetry. (See, as to her worship, *Mém. de l'Ac. des Inscr.* vol. xvi.; *Bryant's Mythology*, i. 392. iii. 157.)

VENUS URANIA, or HEAVENLY, was distinguished from Pandemos, or Popular, rather by philosophers than the multitude. The most celebrated ancient statues of Venus now existing are the Anadyomene and Medicean, both at Florence.

VERA'TRIA. An alkaline principle found in the root of the *Veratrum album*, or white hellebore; in the seeds of the *Veratrum sabadilla;* and in the bulb and seed of the *Colchicum autumnale*, or meadow saffron. It is acrid and poisonous; difficultly soluble in water, readily soluble in alcohol, and less so in ether. It excites violent sneezing, and is probably the principle upon which the efficacy of colchicum in the cure of gout depends.

VERB. (Lat. verbum, *a word.*) In Grammar, a part of speech which consists of an affirmation and a property or attribute affirmed. Verbs are distinguished into transitive, intransitive, and passive. Besides these, there is the verb substantive, which expresses simple affirmation abstracted from any particular property affirmed. *See* GRAMMAR.

VERBAL. In Grammar, a noun derived from a verb. In English verbals are commonly known by the terminations *icn, ive*, which are derived from the Latin.

VERD ANTIQUE. A beautiful mottled green marble; it is an aggregate of marble and serpentine.

VE'RDICT. In Law, the answer of a jury given to the court concerning the matter of fact in any cause committed to their trial. A special verdict is a verdict not delivered generally in behalf of either plaintiff or defendant, but stating the facts, and referring the law arising upon them to the judgment of the court. *See* JURY.

VE'RDIGRIS. A blue green pigment, originally prepared in the south of France by covering copper plates with the refuse of the grape after the expression of the juice for wine. It appears to be a mixture of the subacetates of copper, and is now largely manufactured in this country by alternating copper plates and pieces of coarse woollen cloth previously soaked in crude pyroligneous acid.

VE'RDITER. A blue pigment, generally prepared by decomposing solution of nitrate of copper by the addition of chalk. It is a hydrated percarbonate of copper.

VE'RDURER, or VERDEROR. An officer in the royal forests, whose peculiar charge was the care of the *vert: i.e.* in forest language, the trees and underwood of the forest, all vegetation sufficient to cover a deer being included in the term; which was divided, in old language, into *over vert* and *nether vert*. The verderor is sworn to keep the assizes of the forest; to view, receive, and enrol attachments and presentments, &c.

VERGE OF THE COURT. The compass of the king's court, within which is bounded the jurisdiction of the lord steward of the household. It is said to be so called from the verge, or rod of office, borne by the marshal. *See* STEWARD.

VE'RJUICE. The expressed juice of unripe or green grapes. The term is applied also to a kind of vinegar made of the juice of unripe apples.

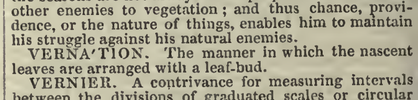
VER'MIFUGES. (Lat. vermis, *a worm*, and fugo, *I put to flight.*) Medicines used in effecting the expulsion of intestinal worms: these are sometimes merely purgatives, such as calomel, scammony, gamboge, jalap, &c. Some substances are supposed to have a specific action on the worm, such as male fern root; others act as mechanical irritants, such as the spiculæ of cowhage. The most effective vermifuge is a large dose of oil of turpentine. (*See* ANTHELMINTICS.)

VERMI'LION. Red sulphuret of mercury. *See* CINNABAR and MERCURY.

VE'RMIN. Quadrupeds, reptiles, worms, or insects, which are injurious to the cultivator. The number of these is great in every country, and calls into continual requisition the skill and vigilance of man to subdue them. In British agriculture the sheep and poultry are attacked by foxes, weasels, and other quadrupeds; the corn and other seeds and roots by rats and mice; and all plants, as well as seeds, by the weevil, the gnat, the turnip-fly, the Hessian-fly, the cockchafer, the wireworm, and numerous other insects. In gardening almost all plants are liable to the attacks of insects, seeds to those of rats and mice, and fruits to be eaten by birds. In general, the most efficient mode to subdue insects which attack plants is to invigorate their growth as much as possible by culture, because it is found that insects thrive best on plants which are in a state of incipient disease; and the next best mode to this, is the encouragement of such natural enemies to vermin as are not themselves more injurious than the creatures they prey upon. Thus birds of every kind, from the crow to the sparrow, are the natural enemies of insects; the crows seeking out and devouring the larva of the cockchafer, the beetle, and the wireworm, found at the roots of grasses; the blackbird and the thrush devouring snails, slugs, and worms; the turkey frogs, lizards, and small snakes; and the singing birds and sparrow destroying not only the larva of insects, but their eggs, and the insect in a winged state while flying through the atmosphere. Hedgehogs and weasels, while kept in outhouses and gardens, prey upon rats, mice, frogs, lizards, worms, snails, slugs, and beetles. There are some insects, such as the turnip-fly, the wheat or Hessian-fly, and the aphides or green fly, which propagate themselves very extensively, in consequence of the extensive propagation of the plants on which they feed; and these are the insects which are most injurious to the cultivator, because he cannot multiply their natural enemies in the same proportion as he multiplies the insects by cultivating on a large scale the plants on which they grow. The aphides he may destroy by the application of tobacco-water and other means; but he has little or no control over the turnip-fly or the wheat-fly. Happily for man the seasons are not always alike propitious to these and other enemies to vegetation; and thus chance, providence, or the nature of things, enables him to maintain his struggle against his natural enemies.

VERNA'TION. The manner in which the nascent leaves are arranged with a leaf-bud.

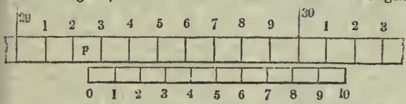
VERNIER. A contrivance for measuring intervals between the divisions of graduated scales or circular instruments. The name is given from that of the inventor, Peter Vernier, who published an account of the contrivance in a work printed at Brussels in 1631. It consists of a small moveable scale, which slides along the graduated scale; the divisions on the one scale being to those on the other in the proportion of two numbers which differ from each other by unity. The theory of the instrument, and the manner in which it is used, may be explained as follows:—Let A B $= a$ be a distance



on the scale containing n of its divisions. Let $v\,v$ be another scale equal in length to $n - 1$ of the divisions on A B; and let $v\,v$ be divided into n equal parts. Since the distance A B $= a$, and contains n equal parts, each division on the scale $= \frac{a}{n}$. Hence the length of the vernier $v\,v = a - \frac{a}{n}$; and, as it is divided into n equal parts, each division on the vernier $= \frac{1}{n}\left(a - \frac{a}{n}\right) = \frac{a}{n} - \frac{a}{n^2}$; and therefore the difference between a division on the scale and one on the vernier $= \frac{a}{n^2}$. Suppose the zero of the vernier to coincide with the division marked A

on the scale; then the first division on the vernier will not coincide with the first after A on the scale, but fall behind it by a quantity equal to their difference, or equal to $\frac{a}{n^2}$. In like manner, the next line on the vernier will fall behind the next on the scale by a quantity equal to twice the difference of the divisions, or equal to $\frac{2a}{n^2}$. The third on the vernier will fall behind the third on the scale by $\frac{3a}{n^2}$; and so on to the nth division on the vernier, which will fall behind the nth on the scale by $\frac{na}{n^2} = \frac{a}{n}$, that is, by a whole division; and therefore the nth on the vernier coincides with the division $n - 1$ on the scale. Conceive the scale to be a scale of inches, and suppose it divided into tenths; then $a = 1$ inch, $n = 10$, $\frac{a}{n} = \frac{1}{10}$th of an inch, and $\frac{a}{n^2}$ (the difference between a division on the scale and on the vernier) $= \frac{1}{100}$; so that the $\frac{1}{100}$th of an inch is exhibited on the scale, though its divisions are only to tenths.

The vernier is connected with the scale in such a way that it can be moved along it by means of a rack and pinion, or a tangent screw, or some similar contrivance, and its zero be brought to coincide with any point on the scale. If, when the vernier is thus adjusted, its zero coincides exactly with a division on the scale, the measure is read off at once; but if (as must generally happen) the zero falls between two of the divisions on the scale, then some one of the lines on the vernier will coincide, or very nearly coincide, with one of the divisions on the scale, and the distance of the zero beyond the last division on the scale, behind it is expressed in hundredths by the number of the division on the vernier which is coincident with a division on the scale. Suppose, for example, the position of the vernier with respect to the scale be as represented in the annexed figure, where the zero of the vernier is brought



to coincide with a certain point p on the scale. The point p is read on the scale 29 inches, 2-10ths, and a fraction which is to be measured by the vernier. Here the division 5 on the vernier coincides with that which is marked 7 on the scale; therefore the distance of the zero of the vernier from the last division (2) behind it on the scale is 5-100ths of an inch; for as 5 on the vernier coincides with 7 on the scale, the distance of 4 from 6 is 1-100th; of 3 from 5, 2-100ths; of 2 from 4, 3-100ths; of 1 from 3, 4-100ths; and of 0 from 2, 5-100ths. In like manner, if the vernier were pushed along till the division 8 coincided with 30 inches on the scale, then the reading of the zero point would be 29 inches 2-10ths and 8-100ths. If, when the zero is brought to coincide with p, none of the divisons on the vernier coincide exactly with a division on the scale,—for example, if the 5 on the vernier should be a little past the 7 on the scale, and the 6 not up to the 8,—the reading would be between 5-100ths and 6-100ths; but its precise amount could only be stated by estimation. If the line 5 appeared nearer 7 than 6 to 8, the distance measured would be greater than 5-100ths, or 10-200ths, but less than 11-200ths; and if the line 6 appeared nearer to 8 than 5 to 7, the distance would be greater than 11-200ths, but less than 12-200ths or 6-100ths. Thus in any case the limits of the uncertainty must be confined within a distance = 1-200th of an inch. In order that the coincidences may be observed with greater certainty, the divisions are usually read with a lens.

The vernier is equally applicable to circular scales as astronomical circles; it is then circular also, and must move concentric with the limb of the circle. Suppose the limb divided into intervals of $10'$; and let $n = 10$. We have then 10 divisions on the limb $= 100' = a$; and the length of the vernier $\left(= a - \frac{a}{n}\right) = 100' - 10' = 90'$; which, divided into 10 equal parts, gives $9'$ for the length of a division on the vernier, and consequently the difference of the length of a division on the scale and on the vernier $= 1'$. The arc, therefore, can be read to minutes. But the reading may be carried to much more minute quantities by increasing the length and the number of divisions on the vernier. Instead of embracing 9 intervals of $10'$ on the scale, let the vernier embrace 59 such intervals, and be divided into 60 equal parts. We have then $a = 10' \times 60 = 600'$, $n = 60$, $n^2 = 3600$; therefore, $\frac{a}{n^2} = \frac{600'}{3600} = \frac{1'}{6} = 10''$; that is to say, the arc may be read to $10''$.

In barometers, where a considerable degree of accuracy is required, the inch is divided into 20 equal parts; the vernier is made equal in length to 24 of these, and divided into 25 equal parts. In this case we have $a = \frac{25}{20} = 1{\cdot}25$ inch, $n = 25$; therefore $\frac{a}{n^2} = \frac{1{\cdot}25}{625} = 0{\cdot}002$; so that the vernier gives the reading to 1-500th of an inch.

Instead of making the vernier equal to $n - 1$ divisions of the scale, it is sometimes made equal to $n + 1$ divisions, and the object will still be accomplished in precisely the same manner. For in this case the length of a division on the scale being as before, $\frac{a}{n}$, and that of a division on the vernier $\frac{1}{n}\left(a + \frac{a}{n}\right) = \frac{a}{n} + \frac{a}{n^2}$, the difference is still $\frac{a}{n^2}$. The principle is the same in both cases.

The vernier is often called a *nonius*, but improperly, the contrivance invented by Nonius or Nunnez being on a quite different principle. See NONIUS.

VERRUCO'SE. (Lat. verruca, *a wart.*) In Zoology, when a surface presents several wart-like prominences.

VERSED SINE OF AN ARC, in Trigonometry, is the difference between the radius and the cosine.

VERT. (Fr. vert, *green.*) In Heraldry, one of the colours or tinctures employed in blazonry. It is equivalent to emerald among precious stones, to Venus among planets. In engraving it is represented by diagonal lines from the dexter to the sinister sides of the escutcheon.

VE'RTEBRÆ. The bones of the spine. They are divided into *true* and *false;* the former constituting the upper, and the latter the lower portion of the spinal column. The true vertebræ are further divided into those of the neck, back, and loins; or the *cervical, dorsal,* and *lumbar* vertebræ. There are seven cervical vertebræ; the first of which supports the head, and is called the *atlas;* the second is the *dentata:* it has a tooth-like process, forming a kind of pivot upon which the head rotates. The dorsal vertebræ are twelve in number, and the lumbar vertebræ five. In the neck the spine projects forwards; it is then curved backwards in the thorax, and in the loins again projects forwards. There is an elastic substance between the vertebræ, admitting of a certain degree of motion; small between the individual bones, but considerable as affects the whole column. The vertebræ, and their projections or processes, afford attachments for a number of muscles and ligaments; and the spinal marrow is lodged in the bony canal which their several perforations form.

VE'RTEBRATES, *Vertebrata.* (Lat. vertebra, *a bone of the spine.*) The name of a primary division of the animal kingdom, including those which have a cerebro-spinal nervous axis, protected by a bony cylinder composed of a succession of vertebræ, which are expanded into a cranium, where they inclose the enlarged anterior or upper portion of the nervous axis, called the brain. See ZOOLOGY.

VE'RTEX (Lat. *the top*), in Astronomy, is the point of the sphere directly over head, more frequently called the zenith. The vertex of an angle or a cone is the angular point, or that in which the sides of the angle or of the cone intersect. The vertex of a curve is the point in which the diameter meets the curve.

VE'RTICAL. Relating to vertex. *Vertical angles,* in Geometry, are the opposite angles formed by two straight lines which intersect each other. Euclid demonstrates that vertical or opposite angles are equal.

Vertical Circle, in Astronomy, a great circle of the sphere passing through the zenith and nadir. The meridian, and all azimuth circles, are vertical circles. The *prime vertical* is that particular vertical circle or azimuth which is perpendicular to the meridian, or which passes through the eastern and western points of the horizon.

Vertical Line, in Dialling, is a line perpendicular to the horizon; in the Conic Sections it signifies any line on a vertical plane which passes through the vertex of the cone.

Vertical Plane, in Conics, denotes a plane passing through the vertex, and parallel to the plane of the section.

VERTICE'LLUS, is a ring for organs of any kind placed round a stem upon the same plane. If the arrangement is not precisely so, and cannot be described by a line drawn horizontally round a stem, but consists of parts either above the line or below it, the verticellus is said to be broken. It is in English called *whorl.*

VERTI'GO. (Lat. verto, *I turn.*) Giddiness. This affection is a common symptom of fulness of the vessels of the head, and of nervous and general debility. In some it is produced by an overloaded stomach, and in others by emptiness of that organ. It is frequently symptomatic of fevers, inflammations, and other disorders, and requires peculiar treatment accordingly.

VERTIGO. In Zoology, a genus of marsh or land snails;

so named from the abrupt twist of the volutions of the shell. Several species of this genus are British; as *Vertigo secale*, *turton*, &c.

VERTU'MNUS. An Italian deity of rather obscure character. Some make him preside over merchandise, others over spring or the seasons in general.

VESA'NIÆ. (Lat. vesanus, *insane.*) A class of diseases in which the judgment is impaired without stupor or fever; it includes the various forms of insanity.

VE'SICANTS. (Lat. vesica, *a bladder.*) Substances which raise blisters upon the skin.

VE'SICLE. A small blister, or bladder-like tumour, formed by an elevation of the cuticle, and containing a serous fluid.

VESICULO'SANS, *Vesiculosa*. The name of a tribe of Tanystome Dipterous insects, comprehending those which have the abdomen in the form of a bladder.

VESPER, or HESPERUS. The evening star. A name given to the planet Venus when it is to the east of the sun, and consequently appears after sunset.

VESPERTILIO'NIDÆ. (Lat. vespertilio, *a bat.*) The name of a family of Cheiropterous Mammals, of which the genus *Vespertilio* is the type. It includes the insectivorous and bloodsucking species of the order.

VESPI'DÆ. (Lat. vespa, *a wasp.*) A family of aculeated hymenopterous insects characterized by their geniculate antennæ, composed in the males of thirteen joints, and sometimes, in this sex, hooked at the extremity. Mandibles strong and dentated; clypens large; ligula plumose or bilobed. The sting of the females and neuters long, powerful, and highly venomous. The larvæ of the wasp tribe are vermiform and without feet: those of the solitary species are inclosed separately in a cell, in which the mother deposits, with singular apparent foresight, at the same time with the egg, the bodies of insects, killed for the purpose, and upon which the larva feeds. The true wasps form large societies, composed of males, females, and neuters. A colony is commenced by a solitary female, which lays eggs that produce neuters or labourers. These proceed to enlarge the nest by detaching particles of old wood or bark, moistening and reducing them into a pultaceous mass resembling that of pasteboard, and constructing of this material a conical or subspherical comb, usually suspended by a stalk, and having on the under side ranges of vertical hexagonal cells. These are appropriated exclusively to the use of the larvæ, a cell to each, which the neuters enlarge in proportion to the growth of the occupant. The nest is generally surrounded by an envelope, pierced with a common central opening. The larvæ are nourished with the juices or pulp of fruit provided for them by the neuters; they are shut up, and spin for themselves a cocoon, when about to become nymphs.

VESTA. One of the four ultra-zodiacal planets which circulate between the orbits of Mars and Jupiter. Vesta was discovered by Dr. Olbers of Bremen, on the 29th of March, 1807. Its mean distance from the sun is 2·36787, the mean distance of the sun from the earth being unity; and its sidereal revolution is performed in 1325·7431 mean solar days. The orbit is inclined to the ecliptic in an angle of 7° 8′ 9″, and the eccentricity of its orbit is 0·08913. Vesta is supposed to be the smallest of all the celestial bodies with which we are acquainted, its volume being estimated to be only about a fifteen thousandth part of that of the earth, and its surface not to exceed that of the kingdom of Spain. On account of its smallness it is, however, difficult to determine its apparent diameter with any degree of certainty. It is distinguished from the other small planets by the vivacity of its light.

VESTA, the Hestia (Ἑστία) of the Greeks, in Classical Mythology, was a goddess about whom hangs considerable obscurity. She is called the daughter of Saturn and Rhea, and was worshipped as the patroness of the domestic and public hearth. At Rome she was attended by six virgins, called vestals, whose duty it was to preserve the sacred fire in her temple unextinguished; as the safety of the city was held to be connected with its preservation. (See *Mém. de l'Ac. des Inscr.* vol. xxvii. xxix.) According to Ovid (*Fast.* vi.),

> Vesta eadem est quæ Terra; subest vigil ignis utrique:
> Stat vi Terra suâ: vi stando Vesta vocatur.

(See Bryant, *Anc. Myth.* i. 77. 281.) The beautiful building popularly called the Temple of Vesta, at Rome, is not known to have been such.

VESTAL VIRGINS. This name was given to the six virgin priestesses of the goddess Vesta, who had charge of her temple at Rome, and the superintendence of the sacred fire, which was never to be suffered to go out. They had several privileges granted them; but the loss of their virginity was punished by burying the offender alive. Their institution is ascribed to Numa. Their abolition was one of the last victories of Christianity. (See Beugnot, *Destruction du Paganisme en Occident*, i. 164.)

VE'STIBULE. (Lat. vestibulum.) In Architecture, an area before the entrance of the Roman houses; said by some to have been so called because an altar to Vesta was placed therein. It was surrounded by a wall, and was the place in which the master of the house received his clients. It is used in modern architecture to signify an ante-hall, lobby, or porch.

VESTIBULE OF THE EAR. A small bony cavity of the internal ear, the opening of which into the cavity of the tympanum is closed by the small bone called the *stapes:* it is also connected with the cochlea and semicircular canals.

VE'STMENTS or VESTURES, ECCLESIASTICAL. Articles of dress or ornament worn by ministers in the celebration of divine service. The following were and are the principal known to the Western church, and many of them to the Eastern also:—1. The vestment properly so called, or chasuble, called in the Western churches *casula*, *planeta*, *pænula*, *amphibolum*, &c., and in the Eastern *φαινόλιον*, *phenolium*, was a garment extending from the neck nearly to the feet, closed all the way round, with only one aperture, through which the head passed. When the offices were performed, it was lifted up at the sides, while the front and back remained pendent. The Greeks retain this primitive form; the Latins have divided it at the sides. It admitted of various materials and colours. It is of very great antiquity, mentioned by Gregory of Tours, and appearing in a mosaic of A.D. 1540. 2. The cope (cappa, pallium, pluviale, &c.) similar in form to the vestment, but longer, and with a short division in the lower part of the front; and a cowl, which in modern times has given place to a sort of triangular ornament of the same shape, hanging over the shoulders. It is also of the highest antiquity in the Western church. 3. The tunicle, or dalmatica (in the East sticharion, used by deacons), received the addition of wide sleeves as early as the 4th century. 4. The alb (camisia, alba, linea; in the East poderis, from reaching the feet), a garment made of white linen. 5. The scarf, or stole, is worn by bishops with the rochet, and generally by dignitaries and prebendaries in cathedrals, and by chaplains. Its origin is obscure. It is called oradium by the Greeks. The pall (pallium, which see), generally worn by Western metropolitans, appears to have been a kind of stole, called ωμοφοριον in the East. 6. The rochet, a linen garment worn by bishops, much resembling the surplice; but in modern times, and in our church, with very wide sleeves. 7. The chimere, zimarra, cimar (probably from *χιμαρος*, *kid*), a sort of cape worn under the rochet by bishops; in modern England of black silk. 8. The pastoral staff (baculus pastoralis) was spoken of in the 4th council of Toledo, in the 7th century, as used by bishops. The form of the shepherd's crook is rather later. 9. The surplice (see that article), which only differs from the alb in having wider sleeves. 10. The hood was generally fastened to the back of the cape; called an "amice," "almatium" when lined with fur or wool. The square cap is thought to have been originally part of the amice.

Most of these vestments are noticed in the Act of Uniformity, passed in the 2d year of Ed. VI., which regulates the habits of the English church. But many of the directions are alternative; *e. g.* that a vestment or a cope, an alb or a surplice, may be used in particular instances. (See *Palmer's Origines Liturgicæ*, vol. ii. Appendix, from which this article is chiefly taken; and *Archæologia*, vol. xi.)

The extreme hostility conceived by the Calvinist and Zuinglian reformers, and the Puritan party in England, to vestments, and especially the surplice, is well known. The argument against them, as stated by Beza (*Tract. Theol.* iii. 29.), refers chiefly to the danger of wounding weak consciences, by retaining apparent relics of popery, &c. The defence by Hooker is in book v. ch. 29.

VE'STRY. (Lat. vestiarium.) The robing room attached to a church; and from hence applied to designate a meeting of parishioners for parochial purposes, the bishop and priests having in former times used these rooms when they met to consult together on similar affairs.

A *general vestry* is one to which every parishioner or outdweller assessed to or paying the church rates, or scot and lot, is admissible of common right. The minister, whether rector, vicar, or perpetual curate, is ex officio chairman of the meeting. The powers of the vestry extend to investigate and restrain the expenditure of parish funds; to determine on repairs, enlargements, ornaments, &c. of the church; and to elect certain parish officers.

Select vestries existed by custom in many large and populous parishes, especially in and round the metropolis. Originally these consisted of a number of householders annually elected by the rate-payers. But, by usage of long standing, these bodies were in many instances self-elected; *i. e.* the members of the vestry filled up by their own choice any vacancy occasioned by death or resignation.

Power has been given to parishes in which select vestries did not exist by custom to appoint such vestries

by the stat. 59 G. 3. c. 12.; and in many parishes the election of vestrymen, &c. has been regulated by local acts.

But in the first and second years of the last reign, an act was passed (1 & 2 W. 4. c. 60.) "for the better regulation of vestries, and for the appointment of auditors of accounts, in certain parishes of England and Wales." Every parish not already under a local act is empowered to decide, by a majority of the votes of its rate-payers, whether it will adopt the provisions of this statute. If adopted, a certain number of vestrymen, limited by the act according to the amount of the population, and five auditors, are to be annually elected by the rate-payers; the rector, district rectors, vicar, perpetual curate, and churchwardens, being always vestrymen ex officio. Vestrymen to be elected under this act must, in in any parish out of London and the metropolitan police district, be rated to the poor on a rental of 10*l.* a year within that district or city; if the resident householders amount to more than 3000, on a rental of not less than 40*l.* per annum. This act does not extend to parishes in which there are not more than 800 rate-payers, except in cities or towns.

VESU'VIAN. The volcanic garnet. The idocrase of Haüy.

VETCH. (Lat. vicia.) The name given to leguminous plants with herbaceous stems, often supporting themselves on surrounding objects by means of the tendrils with which their leaves are terminated. The common vetch or tare is extensively cultivated in Europe, and is considered a very valuable agricultural plant, being an excellent fodder for milch cows and working stock, &c.

VE'TERAN. (Lat. vetus, *old*.) Among the Romans, a soldier who had passed the legal age of military service, which extended from seventeen to forty-six, was termed veteranus; or, in the later times of the republic, one who had served a requisite number of campaigns, generally twenty-five.

VE'TO. (Lat. *I forbid*.) In Politics, the power enjoyed by a branch of the legislature, which cannot of itself originate or modify a law, to reject the propositions of the other branch or branches. In the Polish diet, every noble who was an independent member could prevent any resolution from passing by his simple dissent (expressed in the words "Nie pozwalam," *I do not permit*). The privilege of thus arresting the deliberations of the diet was termed the "liberum veto," and proved the fertile source of the disorders and anarchy of that country. In most constitutional monarchies the king has an absolute veto (as in France and England); in some it is only suspensive. Thus, in Norway, if three successive storthings (assemblies) repeat the same resolution, it becomes law against the will of the king. The president of the United States may return a bill, with his reasons for dissenting from it, to the house in which it originated; but if both houses pass it afterwards by a majority of two thirds in each, it is not in his power again to reject it.

VETO. An act passed by the General Assembly of the Church of Scotland, known by the name of the Veto Act. Lay-patronage, or the presentation by a lay-patron of a minister to a living in the church, has never been cordially recognised on the part of the people of Scotland. On the final establishment of Presbytery as the national church, in 1690, patronage was vested in the elders and heritors (landowners) of a parish. In 1711 (10 Anne, c. 12. s. 4.) that law was annulled, and patronage was transferred as a civil right to individuals as an accessory of land, or as a separate estate; and those patronages which had of old belonged to the pope, or to monasteries, or to archbishops, bishops, and chapters, were vested in the crown. The act of Queen Anne was never universally acceptable in Scotland. Two dissenting denominations (the United Associate Synod, and the Relief) owed their origin to the indiscreet exercise of lay-patronage; and though patrons were generally disposed, particularly within the last twenty years, to show due deference to the feelings of the people, yet hostility to this mode of nominating clergymen having gained greater force, the general assembly, in 1834, passed the Veto Act, whereby, if a majority of the male heads of families, in full communion with the church, appear before the presbytery and dissent, or lodge dissents at the meeting for "moderating in a call," the presentee was to be rejected. No specific objections were required to be made by the act, the dissentients being only required to declare, if asked, that they were actuated by no factious or malicious motive, but solely by a conscientious regard for the spiritual interests of themselves and the congregation; and if such declaration was made, their dissent was sustained; if not, it was rejected. Those entitled to dissent are ascertained from a roll annually made up. The Veto Act was first passed as an interim act; but, being referred to presbyteries, and having received the sanction of a majority of presbyteries, it was enacted into a standing law of the church by the General Assembly of 1835. (*Hill's Practice of the Judicatories of the Church*, p. 83.)

Against the provisions of this act, the minority of the assembly entered, and had recorded, both in 1834 and 1835, their solemn protest, on the ground that these provisions were not merely wrong in themselves, but also *ultra vires* on the part of the assembly, in violation of the statutes conferring on the church the privileges of an establishment, and calculated, therefore, on the first occasion on which a patron or presentee should determine to enforce his rights, to lead to a collision between the ecclesiastical and civil courts. Nor was this opinion without foundation. Immediately after the rising of the assembly of 1835, the Earl of Kinnoull, as patron of the church and parish of Auchterarder, and the Rev. Robert Young, whom his lordship had presented to that living, and whom the presbytery of Auchterarder had rejected in terms of the Veto Act, raised an action in the court of session to have it found and declared that the said presbytery had acted illegally, and to the hurt and prejudice of the pursuers, in having rejected Mr. Young; there being no other ground of such rejection, as admitted in the record of presbytery, than that a majority of the male heads of families, communicants, in the parish of Auchterarder, had dissented, without any reason assigned, from his admission as minister. In giving judgment in this action, the court of session (8th March, 1838) repelled the objections started against the jurisdiction of the civil court in the matter, and to the competency of the action, and found that the presbytery had acted illegally and to the hurt and prejudice of the pursuers, and in violation of their duty, and in particular contrary to the provisions of the statute of 10 Anne.

This decision of the court of session was appealed from by the defenders to the House of Lords; and this supreme court affirmed the judgment in question (3d May, 1839) without the alteration of a single word. Subsequently to this affirmation, when the case had been remitted to the court of session to apply the sentence, the latter tribunal pronounced in regard to it a further judgment, to the effect that the presbytery and the individual members thereof "are bound and astricted to make trial of the qualifications of the pursuer, the said Rev. Robert Young, as presentee to the church and parish of Auchterarder; and if, in their judgment, after trial and examination in common form, he is found qualified, to receive and admit him minister of the said church and parish, according to law."

The dominant party of the church had, meanwhile, come to the resolution not to obey or recognise the judgment of the court of session, though confirmed by the highest judicatory in the empire, to which themselves had made the appeal, but to declare the ecclesiastical law as supreme. Accordingly, the assembly of 1839 resolved, by a majority of forty-nine, to adhere to the Veto Act, notwithstanding the decision of the House of Lords. They maintained that the ecclesiastical and civil courts were endowed with co-ordinate powers; that their provinces were sufficiently distinct, each being supreme in its own department; and that the church courts were the sole and only judges of what was spiritual and what was civil. In short, they refused to induct Mr. Young as minister of the church and parish of Auchterarder. They regarded the parish as still vacant, and nominated a clergyman of their own sentiments to the parochial charge, *quoad spiritualia*, leaving the temporalities untouched. Thus the case still stands: but Mr. Young has raised an action of damages against the members of the presbytery of Auchterarder, both as a body and as individuals, for illegally and contumaciously depriving him of both his ecclesiastical and civil rights and privileges.

But the case of the parish of Marnoch, in the presbytery of Strathbogie, affords a still more striking illustration of the fruits of the collision that has taken place between the civil and ecclesiastical courts. The Rev. Mr. Edwards having been legally presented to that parish, and having been rejected by means of the Veto Act, a majority of the members of the said presbytery (seven in number) were disposed, in consequence of the decision in the Auchterarder case, and of the veto having been declared by the highest civil judicatory of the land as *ultra vires* of the church, to show due respect to the civil law, and to proceed with the settlement of Mr. Edwards, as if such a statute as the Veto had never existed. The majority, however, feeling the delicacy of the circumstances in which, both as clergymen, and as loyal subjects bound to obey the civil law, they were placed, did not proceed hastily to take steps towards the induction of Mr. Edwards. They remained inactive till a special decree, on the application of the presentee, had been obtained from the court of session, finding that they were bound to take him on trial, in common form, and that, if they found him qualified, to receive and admit him according to law. On their adopting the preliminary steps for the purpose, the commission of the General Assembly, 1839, suspended the seven ministers from the function of their sacred office, both judicial and ministerial. Against this proceeding the seven ministers applied to the court of session for protection; which

leugth; but the young are of such microscopic minuteness that Mr. Bauer, the naturalist, by whom this parasite has been successfully investigated, has calculated that 50,000 of them might be contained in one grain of wheat. The disease thus occasioned is commonly termed ear-cockles. Scalding water has been mentioned as the most obvious remedy for these creatures.

VIBRI'SSA (Lat. vibrissa, *a whisker*), in Mammalogy, are the stiff long-pointed bristles which grow from the upper lip and other parts of the head. In Ornithology, the term is also applied to hairs which stand forward, like feelers; or which in some birds, as the fly-catcher, point both upwards and downwards from both the upper and under sides of the mouth; or which spread out on each side like a comb from the upper sides of the mouth only, as in the goatsucker, when they are termed *vibrissæ pectinatæ*.

VI'CAR. (Lat. vicarius.) An ecclesiastical personage who has the care of a parish in the place of (vice) a lay or collegiate rector. *See* TITHES.

VICARS OF THE EMPIRE. In the German constitution, princes who had the right of representing the emperor in case of absence or interregnum. The king of the Romans, whenever there was one, was perpetual vicar. If there were none, the office was divided into two: the elector of Saxony exercised the vicariate in the two Saxon circles; the electors palatine, and of Bavaria, alternately in the remainder of the empire. They administered revenues, presented to benefices, received feudal homage, &c.

VICE-CHAMBERLAIN. An officer of the king's household immediately under the lord chamberlain.

VICEGE'RENT. (Lat. vicem gerens, *holding the place of any one*.) Any officer acting as deputy or lieutenant of another. In France the bishops appointed formerly vicegerents to the official in every ecclesiastical officiality.

VI'CEROY, or VICE-KING. A title often applied in common usage to any officer representing the supreme authority in a dependency; *e.g.* the lord lieutenant of Ireland. But it has seldom been officially given, except to the governors of certain dependencies of the old Spanish monarchy; such as Naples, Peru, and Mexico, each of whom bore the pompous title of "Alter Ego" of the sovereign.

VICTIM. (Lat. victima, of uncertain etymology; said to be from vinco, *I bind*.) The creature immolated at a sacrifice was so called among the Romans. (*See* SACRIFICE.) The well-known ceremonies of leading the victim, unbound, to the altar; pouring wine, oil, &c. on its forehead; the ceremonies of killing and burning it,—are all amply described in ancient writers. The general object of sacrifice, in all ancient religions, was expiation; but to this must be added another, peculiar to the Romans,—that of deducing auguries from the appearance of the entrails of the victim. Victims of different kinds had many designations: *bidentes*, according to some, all kinds of sheep; according to others, lambs only: *eximiæ*, animals chosen beforehand out of a flock or herd, for their beauty or other fitness, to serve for sacrifice: *prodigæ*, according to Festus, those which were entirely consumed, instead of leaving, as in the ordinary case, various parts which were consumed or sold by the priests: *succidaneæ*, those immolated in a sacred sacrifice to repair some error committed in a former one: *probatæ*, after they had been examined by the priest to ascertain their fitness. Various auguries were deduced from the demeanour of the victim: its resistance, its unusual cries, above all its flight, were unlucky. Artificial victims, made of flour, spices, &c., were sometimes sacrificed. Pythagoras seems to have introduced this custom among his disciples.

VI'CTORY. In Classical Mythology, a goddess, called by Varro the daughter of Heaven and Earth. Her altar was preserved in the curia or senate house of Rome; and its destruction was the subject of one of the latest contests between Christians and Pagans. (See Beugnot, *Destr. du Paganisme en Occident*, l. 410. 430.; *Mém. de l'Ac. des Inscr.* vol. xviii. 21.)

VIDA'ME. In French Feudal Jurisprudence, originally an officer who represented the bishop, as the viscount did the count (vice-dominus). In process of time these dignitaries erected their offices into fiefs, and became feudal nobles, such as the vidame of Chartres, Rheims, &c.; continuing to take their titles from the seat of the bishop whom they represented, although the lands held by virtue of their fiefs might be situated elsewhere.

VIDE'LICET. (More properly *scilicet*.) In Law. In pleading, it is usual to state any allegation which forms part of the facts set out, but which it is not intended to prove with precision, with the word "scilicet" (in English, "to wit") preceding it. Thus, numbers and dates, for instance, are frequently laid under a videlicet: as where any thing is alleged to have taken place heretofore, "to wit," on such a day; or where, in trespass, the plaintiff charges the defendant with carrying away or injuring divers, "to wit," so many articles, &c. The general rule on this subject is, that where an allegation is in itself material, so that the issue cannot be established without it, there the putting a videlicet before it will not dispense with the proof; but where an allegation is in itself immaterial, there (in general, but not always) the omission of a videlicet before it will render it material and make it necessary for the party so alleging it to prove it as stated. But the distinctions on this subject run, as may be supposed, into extreme minuteness.

VI'GIL. (Lat. vigilium, *watch*.) An ecclesaistical usage, the evening before a feast day, is so termed. The observation of vigils is said by some to be nearly the oldest of Christian ceremonies. According to Lactantius, Jerome, and other ancient authorities, the second advent of our Saviour was expected to take place on the vigil of Easter. They were originally celebrated by meeting together at night (as they are still on some occasions in the Eastern churches), and are said thus to preserve the memory of the nocturnal assemblies of Christians in times of persecution.

VIGNE'TTE. (Fr.) A small ornamental engraving used in printing for the illustration or decoration of a page of any work.

VIGORO'SO. (It. *vigorous*.) In Music, a term which, prefixed to a movement, denotes that it is to be performed with strength and firmness.

VI'LLA. In Roman Antiquities, originally any country dwelling, farm-house, &c., but in architectural language, the country residences of individuals of the wealthier classes were so called. Many descriptions of ancient villas are here and there scattered in the pages of classical writers; but the two most complete, undoubtedly (besides those contained in the work of Vitruvius,) are the accounts given by Pliny the younger of his Laurentine and Tuscan residences (Epist. ii. 17. and v. 6.): the first being the complete picture of a marine, and the second of an inland villa. The remains of the first are thought to have been discovered not far from Ostia, in the beginning of the last century. To these may be added the pleasing, though over ornamented poetical delineation of Statius, (*Silvæ*, lib. 3. entitled "Surrentinum Pollii," describing a magnificent residence overlooking the Bay of Naples. The most important parts of an ordinary villa were the porticoes, one or more, along the front or sides of the mansion; the triclinium or dining room: the wings forming suits of living apartments, commonly called, in the time of Pliny, diætæ; the baths, with their appurtenances, the hypocausta or vaulted heating rooms, apodyteria or dressing rooms, rooms for exercise (sphæristeria), &c. Adjacent to the main portico are generally the xystus (which see). There is a work by A. Castle on the villas of the ancients, with illustrative engravings. (fol. 1728.) The remains of several have been discovered in England. (See *Archæol.*vol. 8.; *Pictorial History of England*, i. 564.)

VI'LLAGE, or VILL. (Lat. villa, properly a *country house*.) In English Legal phraseology, a subdivision of a parish; sometimes a whole parish, and sometimes a manor. Most commonly it means the out part of a parish, consisting of a few houses separate from the rest. (See *Fleta*, l. 6.; and 1 *Inst.*) In countries where there are peasants attached to the glebe, or possessing distinct rights and obligations from other subjects, a village is properly a place inhabited by peasants only. From the Latin villa was derived the French ville, *city*, originally signifying any residence; and thence a collection of houses which gradually grew around a principal residence. Thus, especially in Normandy, ville is a common termination to the names of places, like *ton* or *by* in England; and consequently, also, of family names. The English "town" furnishes a parallel instance of the alteration of the meaning of a word produced by an increase of population, our original "towns" having been single residences or hamlets; and in Scotland, at this day, a house with its appurtenances in rural districts is sometimes called "the town."

VILLEIN, *Villenage*. In Anglo-Norman Feudal Jurisprudence, the villeins are thought to have been those who, under the Saxons, had held by the tenure known to the Saxons as "folk-land." Villeins were either "regardant," *i.e.* annexed to the manor, or "in gross," transferable from one owner to another. On the Continent, the rank of "villeins," "vilains," seems to have been from the beginning superior to that of serfs. (See Guizot, *Civilisation en France; Archæologia*, vol. ii.; The word villein is derived from the Latin villa; whence villani, *country people*. Besides the actual servile population of the Roman empire, there appears to have been a class of cultivators of the soil, who probably became greatly multiplied in the later period of the western division of that empire, known under the name of *coloni*, who were wholly or in part attached to the soil, and liable to certain fixed services to the proprietors of it, but not destitute of property or civil rights. Out of this class, augmented in process of time by the addition of numbers whom the vicissitudes of conquest, during the revolutions of the dark ages, subjected, with or without their consent, to the protection and control of masters, arose

the villein population of Europe in the middle ages. Among the causes which increased their numbers, Mr. Hallam also enumerates the fines and compositions so generally imposed in the barbarian codes of law, by default in payment of which many were reduced into this state; and the prevalent superstitions, which induced many to surrender their persons as well as their property to the control of churches and monasteries. The villeins are designated in these early codes under the general name of *lidi*, *leudcs*, &c. (leute, *people*); a name which, however, is also applied to the free vassals, or liegemen: some, who were attached to the soil of royal or church demesnes, are termed *fiscalini*, or *ecclesiastici;* and the condition of various classes appears to have been extremely different. (See Meyer, *Institutions Judiciaires*, liv. i. c. 7.) The general obligation common to all villeins was that of remaining on the lord's estate, and passing along with it by subinfeudation and alienation. The lord had also every where jurisdiction over the persons of his villeins. But in other respects there were several degrees of servitude. In England, at least from the reign of Henry II., only the inferior sort of villeins, or absolute serfs, seem to have existed. They were not only bound to the soil (*villeins regardant*), but they might also be severed from the soil and conveyed apart from it by the lord; and then became, in legal phraseology, *villeins in gross*. They were incapable of acquiring a full right to property, their *peculium* (as the Romans termed the possessions of a slave) being liable to be seized at any moment by the lord. Their tenure bound them to what were termed villein or ignoble services, indeterminate in degree. It must, however, be observed, that these villein tenures were rather attributes of the land than of the individual holding it, insomuch that lands held in villenage were frequently in the occupation of freemen; and thus, in process of time, our English copyhold tenures have been derived from those which prevailed in these lands of a villein equality. In France and Germany, where serfs of this description likewise existed, there were at the same time other classes whose servitude was of a less severe character, being bound only to fixed duties and payments in respect of their lands.

The abolition of villenage, in the greater part of Western Europe, was brought about by various causes. Among others, 1. Manumissions, which during some centuries were extremely common from religious principles, being strongly inculcated by the church; although that body is accused of not having added the force of example to its precepts, the villeins on church lands having been, in most parts, among the last emancipated. Redemption by the villein himself was also a common mode of acquiring freedom. 2. The influence of the towns, within which, when enfranchised, serfs by a certain period of residence frequently obtained their freedom. But, perhaps more generally, the process was gradual; the severest attributes of personal servitude being the first to disappear, while predial servitude, *i. e.* a liability to servile duties and payments in respect of land, existed down to a comparatively late period in most countries of Western Europe, and still exists, though much modified, in parts of Germany. In the 15th century there were, according to Machiavel, no villeins left in Italy. Predial servitude, in some rare instances, existed in England, it is believed, as late as the reign of Charles I. In France, it was not wholly abolished until the Revolution. In the greater part of the Prussian territories, the condition of the peasantry was still in some respects marked with the attributes of villenage until the reforms of Stein in the present reign. In those eastern parts of Europe in which the feudal system never prevailed (Russia and Poland), the condition of the great mass of the people is still servile, and, in some respects, lower perhaps than that of most feudal villeins. The Russian peasants are divided into those belonging to the crown, and those belonging to individuals; the former being rather more than half as many as the latter throughout the empire. The late emperor Alexander introduced some ameliorations in the condition of the crown peasants, with a view to their ultimate enfranchisement. He also planned measures for the prevention of the sale of serfs apart from the estates on which they reside. Under his superintendence, the nobility in the German provinces of Courland and Livonia abolished villenage altogether; but hitherto without much advantage in improving the state of the peasantry.

VILLO'SE. (Lat. villus, *wool*.) In Zoology, when a part is covered with soft flexible hairs thickly set.

VILLOUS. In Anatomy, this term is applied to vascular surfaces which, when minutely examined, look like the pile of velvet; as in the *villous* or internal coat of the intestinal canal.

VINA'LIA. According to Varro and Ovid (from vinum, *wine*), a festival in ancient Rome. There were two Vinalia: the first in April, sacred to Venus; the second in August, to Jupiter. The latter was considered as the beginning of the vintage season, before which new wine was not permitted to be conveyed into Rome. (See Ovid, *Fast.* l. iv.)

VI'NCULUM. (Lat. *a bond or tie.*) In Algebra, a mark or character which connects several letters or quantities, and indicates that they are to be treated as a single quantity. Vieta first used the bar or line over the quantities for a vinculum, thus, $a \times \overline{b + c}$; meaning that the quantity a is to be multiplied by the sum of the quantities b and c. This manner of connecting quantities was generally used by the early English writers on algebra; but it is now more common to make use of the parenthesis, which is a much more convenient mode of notation, especially when the expression is somewhat long. Thus, instead of writing $a \times \overline{b + c}$, or $\sqrt{x^2 + 2xy + y^2}$, it is more usual to write $a(b + c)$, $\sqrt{(x^2 + 2xy + y^2)}$. The parenthesis, which has generally been used by the foreign mathematicians, is said by Hutton to have been first used as a vinculum by Albert Girard.

VINE, in Horticulture, (*Vitis vinifera*, L.) the grape vine, is a ligneous climber, found wild in Syria and in various parts of Asia and in Greece, the fruit of which is in universal demand for the desert, either fresh, or dried as raisins, and its fermented juice forms wine, the noblest liquor that ever gladdened the heart of man. The best grapes for the table are grown under glass; but grapes are also grown of very good quality against walls and on cottages south of London, and on walls heated artificially as far north as Glasgow. Formerly the grape vine was grown in England without any protection, for the purpose of wine making; and Mr. Hoare in his interesting work on the *Cultivation of the Vine*, maintains, that with proper care, this might be done in some districts even at the present day. *See* VINEYARD.

VINE is often employed in a general sense to designate any stem which trails along the ground without rooting, or entangles itself with other plants, to which it adheres by means of its tendrils or by twining; as the cucumber and the hop.

VI'NEGAR. This term is applied to various modifications of the acetic acid. The simplest mode of obtaining vinegar is to excite a second or acetous fermentation in wine: in this case oxygen is absorbed, a variable proportion of carbonic acid is generally evolved, and the alcohol of the wine passes into acetic acid. Very good vinegar is also made from strong beer, or from a wort or infusion of malt prepared for the purpose, or from a decoction of common raisins, or from a mixture of about 1 part of brandy with 8 of water and some sugar and yeast.

When vinegar is distilled, various impurities which it contains remain in the still, and the liquid which passes over is the acetic acid, nearly pure, but largely diluted with water. In this state it is usually called *distilled vinegar*, and is used chiefly in pharmacy. But though a considerable quantity of vinegar is made in wine countries by the first-mentioned process, and here and elsewhere by the second, in which malt is employed; yet for all the purposes of the arts and manufactures, as well as for domestic consumption, the market is chiefly supplied from another source, which is the destructive distillation of wood. It has long been known that when certain kinds of dry wood, especially beech and such woods as are not resinous, instead of being burned in the open air, are converted into charcoal in close vessels, so as, in fact, to be submitted to distillation, that the vapours which pass off yield, when condensed, a large quantity of tar, and of very acid water. The latter is, in fact, an impure vinegar; that is, it owes its acidity to acetic acid, which is formed during the process out of the carbon, hydrogen, and oxygen of the wood, which elements are also those of acetic acid, and, what is remarkable, not in very different proportions. When this impure acetic acid is freed from the tar and empyreumatic oils with which it is mixed, it is called *crude pyroligneous acid*. To convert it into pure acetic acid, that is, to separate from it the empyreumatic products with which it is intimately combined, is a somewhat circuitous process, of which the following is an outline: — It is first distilled, by which *pyroxilic spirit* and *oil of tar* first pass over, and these are followed by a quantity of impure or rough acetic acid. This rough acid, which is used by dyers and calico-printers, and by makers of sugar of lead, is saturated with powdered slaked lime, and being filtered, yields a solution of impure acetate of lime, which is evaporated to dryness, and which, distilled with dilute sulphuric acid, yields a purer acetic acid than the former, but which still has a burned and disagreeable flavour; it is therefore again saturated by lime, and this liquid acetate of lime is mixed with a solution of sulphate of soda, which acting by double decomposition, yields a precipitate of sulphate of lime, and acetate of soda remains in solution. The latter salt is procured by evaporation, and purified by torrefaction and crystallization. The vinegar-makers, who purchase it, decompose it in retorts or proper stills, by means of sulphuric acid, by which a very pure and strong acetic acid passes over, sulphate of

soda remaining in the retort. The acetic acid thus obtained, which is in its most concentrated state, is extremely acrid, sour, and pungent, and is often called *radical vinegar*, or, when perfumed, *aromatic vinegar;* it is also occasionally termed *glacial* acetic acid, from its property of congealing at a low temperature, and remaining frozen at temperatures below 50°. In this state it is a compound of 1 atom of real acetic acid = 51, and 1 of water = 9; the real or anhydrous acid, as it exists in the dry acetates, being composed of—

	Atoms.	Equiv.	Per Cent.
Carbon - - -	4	24	47·06
Hydrogen - -	3	3	5·88
Oxygen - - -	3	24	47·06
	1	51	100·00

proportions which are equivalent to 4 atoms of carbon and 3 of water. When this strong acetic acid is diluted with water and slightly coloured, it forms a very pure and excellent substitute for common vinegar, and is cheaper than acid of the same strength prepared in any other way.

The combinations of acetic acid with various bases are called *acetates;* and of these salts some are importantly useful in the arts: such especially are the acetates of lead, copper, iron, and alumina, which are chiefly employed in dyeing and calico printing; the acetates of ammonia and of potash, which, as well as acetate of lead, are used in medicine; and the acetates of lime and of soda, which have been mentioned as steps in the preparation of strong acetic acid. The acetates are recognized by their solubility in water, and by the fumes of acetic acid which they evolve when acted upon by sulphuric acid. The specific gravity of the strongest liquid acetic acid is 10629; that of good malt vinegar is 10200; and that of distilled vinegar about 10023. The strength or value of vinegar, and of acetic acid, can only be learned by its saturating power.

A duty of 2*d*. per gallon is imposed upon vinegar; and the manufacture is consequently placed under the control of the excise. Previously to 1826 the duty was 4*d*. per gallon. The manufacture is chiefly confined to England, the quantity produced in Scotland and Ireland not amounting on the annual average to more than 100,000 gallons. The quantity of vinegar manufactured in England is nearly 2,700,000 gallons annually.

VINEYARD. A plantation of grape vines cultivated for the purpose of making wine. Though vineyards at present are chiefly confined to the warmer parts of the Continent, yet it appears that formerly they were occasionally to be met with in Britain, more particularly in the neighbourhood of religious establishments. Among the last vineyards which we have any account of, are one at Haffield, near Ledbury, which belonged to the celebrated Jacob Tonson; one in the Isle of Wight; another at Pain's Hill, in Surrey. The ground chosen in all these cases was a sloping surface of dry gravelly soil, with a southern aspect; and the vines were planted in rows at four feet apart every way, and trained to short stakes about four feet high. Every year the shoots were cut down to within a foot of the ground, and not more than three shoots were allowed to be matured by each plant. Each shoot produced two or three bunches of grapes, and the shoots were shortened in the course of the summer so as never to reach higher than the stakes, to which they were tied with rushes previously cut and dried for the purpose, or with twigs of willow. The kinds of grapes grown were chiefly the Burgundy or large black cluster, and the small black cluster or miller grape, so called from the white mealy appearance of the leaves. In fine seasons a tolerably good wine was produced. On the Continent, the vineyards which produce the best wine are invariably found on dry soils, more or less calcareous; and the most celebrated are on the dry sunny sides of granitic or calcareous hills, with the surface formed into terraces, like the steps of stairs on a large scale; each step or terrace being supported on the lower side by a stone wall, to which the vines planted at the base of the wall are sometimes attached, not by nails, as wall trees are in Britain, but by hooked sticks driven into the interstices between the stones, such walls being for the most part built without mortar. In France and the south of Germany, vines are seldom allowed to grow higher than four feet; and they are cut down every year, after the crop has been gathered and the leaves dropped, to within one or two feet of the ground. In the neighbourhood of Stuttgard, and between that city and Heidelberg, where the sides of the hills are covered with vineyards, the shoots are not cut down before winter; but those of each stool or plant are bent down to the ground, where they are tied together with a straw band, and retained in that position by laying a stone on the bundle. This is for the purpose of preserving the vines from the extreme cold of winter; the shoots, when so laid prostrate, being soon covered with snow. In spring, the shoots are raised up again, pruned, and tied to stakes. In the north of Italy, and chiefly in the plains of Lombardy, the vineyards are managed much in the same manner as they are in France; but in Tuscany, the Papal States, and Naples, the vineyards are interspersed with mulberry trees, which are kept pollarded; and to these the vines are attached, partly by ties of willow and partly by their tendrils, and they produce bunches of grapes to the height of six or eight feet from the ground. Sometimes the shoots are trained to elms, mulberry trees, or poplars, in which case they produce grapes to a much greater height. The only plantation of vines in the manner of a vineyard, which we know of in England at present, is a small one at White Knights, near Reading; where, however, the plants for several years past have been in a state of utter neglect, the leaves and young shoots being injured or totally destroyed by rabbits. The ground which was occupied by the vineyard at Pain's Hill is now covered with a plantation of pine trees, among which some of the vines still continue to spring up. The vineyard in the Isle of Wight has long since been laid down in pasture. In the early part of the last century there were several small vineyards in the neighbourhood of London: the situation of one at Hammersmith still bears the name of the Vineyard, and is now occupied as a nursery. But the most celebrated of the London vineyards appears to have been one cultivated by Richard Warner, at Rotherhithe, who is supposed to have introduced the Hamburg grape. There was a vineyard in the neighbourhood of Gloucester cathedral; one at St. Alban's; and one at Canterbury, the ground occupied by which is now cultivated as a nursery, by Mr. Masters of that city.

VIOL, or VOYOL. In Naval language, a purchase used occasionally in weighing the anchor.

VIOLA. (It.) In Music, a musical instrument of the same form and with the same number of strings as a violin, and, like it, played with a bow. The English call it the tenor violin.

VIOLA'CEÆ (*Viola*), are Polypetalous Exogens, well represented by the sweet violet of our woods, and distinguished by having five membranous anthers adhering to each other round a superior ovary, with parietal placentæ. The heartsease or pansy is a kind of violet, and there is a large number of other species in different parts of the world. An emetic property resides in their roots, and renders some of them useful medicinal agents as substitutes for ipecacuanha.

VIOLI'NO. (It.) In Music, a musical instrument, vulgarly called a fiddle, mounted with four strings, and played with a bow. It consists of three parts, — the neck, the table, and the sounding board; at the side are two apertures in the shape of *S s*. On it is a bridge, which bears the strings up from the belly, over which they pass from one extremity, called the tail-piece, to the other near the head, where they are received by turning pins, which tighten or loosen them at pleasure.

VIOLONCE'LLO. (It.) In Music, a bass violin with four strings, whose principles of construction are the same as those of that instrument.

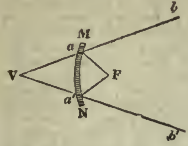
VIOLO'NE. (It.) In Music, a large bass violin, commonly called a *double bass;* seldom played with more than three strings, which lie an octave below the violoncello.

VI'PER. (Lat. a contraction of Vivipar; from vivus, *alive*, and paro, *I bring forth.*) The common name of a genus of venomous serpents which produce living young, and have a head broader than the neck, and no pits behind the nostrils. The true vipers (*Vipera*) are distinguished by the head being covered with scales, like those on the back, and by the nostrils being very large. The horned viper of North Africa and the puff adder of South Africa belong to this group. The adders (*Berus*) have the head covered with granular scales, with larger ones intermixed in some species, and have the nostrils of moderate size. The black adder and the common adder (*Berus chersea*), which are the only indigenous venomous reptiles of Great Britain, are examples of this group.

VIRGI'LIAN HUSBANDRY. That kind of agriculture which was practised by the Romans, and which is described in the *Georgics* of Virgil; or, in other words, the old mode of managing arable land throughout Europe. By this system two or three corn crops were taken in succession, and the land afterwards allowed to lie fallow for several years, when it was broken up again; being sometimes prepared by paring and burning. The Virgilian and Roman practice is fully described in *Dickson's Agriculture of the Ancients*. The first departure from this kind of husbandry in Britain was made by Jethro Tull in the middle of the last century, whose plan it was to keep arable land continually under crops cultivated in rows, and alternately growing corn and pulse, or plants cultivated for their leaves or roots.

VIRGO (the Virgin). In Astronomy, one of the twelve zodiacal constellations, or signs, being the sixth in order, beginning with Aries. Virgo is usually represented with an ear of corn in her hand, and is hence called *Signum Cereris*. The sun enters this sign about the 22d of August. The constellation Virgo contains one bright star of the first magnitude, called *Spica Virginis*.

VIRTUAL FOCUS, in Optics, is the point from which rays, having been rendered divergent by reflection or refraction, appear to issue. Thus, let M N be a metallic speculum, F a radiating point, F a, F a' rays falling on the speculum at a and a', and reflected into the directions $a\,b$ and $a'\,b'$; then the point V, in the concourse of the straight lines $a\,b$ and $a'\,b'$, is called the *virtual focus* of the reflected rays. *See* REFLEXION.

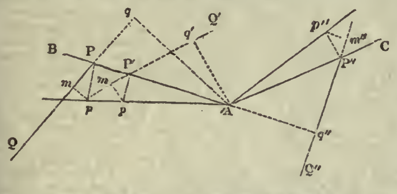


VIRTUAL VELOCITY, in Mechanics, is the velocity which a body in equilibrium would actually acquire during the first instant of its motion in case of the equilibrium being disturbed.

The general principles on which the laws of equilibrium in machines are established may be reduced to three; namely, the principle of the *lever*, the principle of the *composition of forces*, and the principle of *virtual velocities*. The last consists in this, that forces are in equilibrium when they are in the inverse ratio of the virtual velocities of the points to which they are applied, estimated in the direction in which they respectively act. Thus, let F and F' be two forces applied to the points p and p' of a body which is in equilibrium between their joint actions, and let s and s' be the spaces which the points p and p' would describe in the first instant of time, in case of the equilibrium being disturbed; then $F : F' :: s' : s$, or $Fs = F's'$. The principle is thus enunciated generally by Lagrange (*Mec. Analytique*, p. 22.): —

"If any system of bodies or material points, urged each by any forces whatever, be in equilibrium, and there be given to the system any small motion, by virtue of which each point describes an infinitely small space, which space will represent the virtual velocity of the point; then the sum of the forces, multiplied each by the space which the point to which it is applied describes in the direction of that force, will be always equal to zero or nothing, regarding as positive the small spaces described in the direction of the forces, and as negative those described in the opposite direction."

In order to illustrate this principle, we may take as an example the case of the bent lever. Let P, P′, P″ be



the points of application of the three forces F, F′, F″, acting on the lever B A C, in the directions P Q, P′ Q′, P″ Q″, which are all supposed to be comprised in the same plane. Suppose the lever to describe an infinitely small angle about the fulcrum A, so that the points P, P′, P″ come into the positions p, p', p''. According to the definition given above, the infinitely small arcs Pp, $P'p'$, $P''p''$, which may be considered as straight lines, will be the virtual velocities of the points of application P, P′, P″, of the three forces F, F′, F″. From the points p, p', p'', let there be drawn pm, $p'm'$, $p''m''$ respectively perpendicular to the lines P Q, P′ Q′, P″ Q″; then P m will be the virtual velocity of the point P reduced to the direction P Q of the force F, and P′ m', P″ m'' will in like manner represent the virtual velocities of the points P′ and P″ reduced to the directions in which the forces F′ and F″ respectively act. Let $Pm = s$, $P'm' = s'$, and $P''m'' = s''$; and as the force F acting in the direction P Q tends to turn the lever in the direction in which the motion has been supposed to take place, while F′ and F″ tend to turn it in the contrary direction, the space s must be regarded as positive, and s' and s'' as negative.

Now, according to the principle of virtual velocities, the sum of the given forces, each multiplied by the velocity of its point of application reduced to the direction of that force, is zero in the case of equilibrium; and, reciprocally, when this sum is zero the system is in equilibrium; hence the equation of the equilibrium of the lever is

$$Fs + F's' + F''s'' = 0.$$

It is easy to verify this equation by showing that it may be derived from the equation of equilibrium deduced from the principle of the lever. From A let A q, A q', A q'', be drawn respectively perpendicular to the directions P Q, P′ Q′, P″ Q″, and let the angle $PAp = \theta$; then, since the angle A P p may be regarded as a right angle, $m\,Pp = PA\,q$; whence the two triangles m P p q A P are similar, and $mP : Aq :: Pp : PA ::$ tan. $\theta : 1$; therefore $m\ P = A\,q$ tan. θ, that is, $s = A\,q$ tan. θ. In like manner we have $s' = A\,q'$ tan. θ, $s'' = A\,q''$ tan. θ; whence, by substituting in the above equation, and leaving out the common multiplier tan. θ, we find

$$F \cdot Aq + F' \cdot Aq' + F'' \cdot Aq'' = 0,$$

which is the well-known equation of equilibrium. *See* STATICS.

The equation $Fs + F's' + F''s'' = 0$ may be extended to a solid body of any form, or to any machine whatever. Let dm be an element of the body, F an accelerating force applied to dm, v the velocity of that element, z the angle comprised between the direction of the force F and that in which the element dm moves; then the moving force of the element will be $F\,dm$, and v cos. z its velocity estimated in the direction of this force; and consequently, by the principle of virtual velocities, the equation of equilibrium will be $\int F\,v \text{ cos. } z\,dm = 0$.

The principle of virtual velocities is easily verified by experiment with respect to all the simple machines; namely, the lever, the pulley, the wheel and axle, the inclined plane, and the screw. Its importance as a fundamental principle in rational mechanics was first recognized by John Bernoulli (see the *Nouvelle Mécanique* of Varignon, tom. ii.); and Lagrange has derived from it the whole theories of statics and dynamics in his celebrated work, the *Mécanique Analytique*. Fourier (*Journal de l'Ecole Polytechnique*, cahier v.) has demonstrated the principle from the property of the lever.

VIRTUE, in Moral Philosophy, is employed both in an abstract and comprehensive sense, to signify the law or laws in which right conduct consists, and also concretely for that quality of actions and persons which arises from their agreement with the rules of morality. By theories of virtue are understood the different explanations which have been given, both of that which distinguishes right from wrong, and of the nature of the feelings with which virtue and vice are contemplated by mankind. The distinction of these two questions, so frequently confounded by ethical writers, is due to Adam Smith, but has since been strongly insisted upon by Mackintosh and Hampden. The former question Mackintosh entitles "The Inquiry into the Criterion of Morality in Action," and the latter, "The Theory of Moral Sentiments;" whereas Smith and Hampden designate the former as "the Inquiry into the Nature of Virtue," and apply the term *criterion of virtue* to the principle of approbation. In the use of the phrase "Theory of Moral Sentiments," the last two writers again are at issue: Smith understands by it moral philosophy in general, while Hampden limits it to a division only of ethical inquiry. According to the latter, it comprises the two investigations already specified: that into the nature, and that into the criterion, of virtue. It constitutes the *subjective* branch of ethics, and arises from a consideration of man in himself as the *subject* of moral action, while the objective branch results from a regard to the end or object to which the moral nature of man has reference. This speculation into the final cause of man's capacity for virtue and happiness, Hampden considers to be the complement of ethics, and entitles it *the theory of natural religion*. Lastly, he defines ethics thus understood to be the science of *what ought to be*, as distinct from the science of *what is;* or of moral facts, as they are exhibited in life, or as they may be gleaned from the philosophy of history, and the study of the intellectual arts, which are based upon an appeal to the actual moral nature of man. These two together make up the whole domain of moral philosophy. (*Hampden's Lectures on Moral Philosophy.*)

The several theories of virtue are conveniently divided into ancient and modern. The distinction, however, is not founded on any essential difference of theory, but rather on the opposite points of view from which they respectively viewed the moral facts. While modern theories are permanently subjective, the objective question is the characteristic feature of ancient ethics. The leading speculation of the former is: what is the origin and nature of moral obligation? The first problem of the latter was to determine the object or end to which the moral constitution of man has reference, and this ultimate end of human activity they usually denominated the end or sovereign good (τελος, *finis bonorum, summum bonum*). And although the consideration of this question might tend in a few, as in Socrates and Plato, to carry the mind forward to some higher and ulterior existence, in which should be realised that entire satisfaction after which man aspires, still, as these promptings of natural religion were but vague and unauthoritative, the ethical writers of antiquity confined their views to this life alone, and the sovereign good which they proposed as the final cause of moral action was limited to the greatest good attainable in the present state of existence.

With Socrates, the first object of speculation was to

acquire a knowledge of man's true and proper nature; but this self-knowledge he held to be impossible so long as man continues ignorant of the universal principle. Now the nature of God can only be learned from his works, and these bespeak him to be good and intelligent. Moreover the consciousness of man attests his participation in the divine essence; consequently the ultimate destination of man is reason and goodness, and his moral end is the cognition and practice of good. Virtue, therefore, is the intelligent performance of duties, whose notions man may arrive at by a study both of his own nature and of the laws of an all-wise Creator discoverable in the system of the universe. In this pursuit happiness is inseparable from virtue. But if Socrates thus founded morality on a disinterested principle, he reconciled it with interest rightly understood; and on the other hand raised political science above the mere calculation of utility, by identifying it with justice as founded not on convention (*δογμα πολεως*), but on natural right, or the invention of what is (*του οντος εξευρεσις*).

Socrates having thus referred the laws of morality to the Deity as their author and upholder, Plato proceeded by a definition of the divine nature to guard against the objection of their arbitrary position by the will of God. He made the Deity to be the perfection of intelligence as resulting from an union of the good, the beautiful, and the true, which are in their nature eternal, necessary, and immutable. This perfection is also the term to which man spontaneously tends. For reason is the true principle of his nature, although in the present existence there is mingled with it a foreign element — *matter*, which, by obstructing its development, becomes the cause of his falling short of perfection. All, then, that is now possible for man is an approach to the divine excellence. This is virtue, and is effected by the harmony of the *rational*, *irascible*, and *concupiscible* parts of the soul. Although the two latter belong to the foreign element in man's nature, they are yet indispensable to the moral act: for the third affords a motive to action, inasmuch as beauty, being identical with the good and true, gives rise to desire or love (*ερως*), and thereby impels to virtuous action; while the second, disapproving what is base, and ugly, and false, furnishes the fortitude requisite for attaining to what is approved under every difficulty and every discouragement. To each of the three parts of the soul Plato assigns a special virtue, in a lower sense, and names them, respectively, *prudence*, *fortitude*, and *temperance* (*φρονησις, ανδρεια, σωφροσυνη*), while in a proper sense he declares virtue to be eminently one and the same with justice (*δικαιοσυνη*). These four are the so-called cardinal virtues. From the notion of justice he draws the connection of ethics and politics: the latter is but an application of the former to society. At the close of the republic he teaches that as an individual cannot be at peace with himself except by the harmonious adjustment of all his faculties, wherein each is allowed its due weight, so in the whole world happiness is proportionate to justice, and each individual derives the greater benefit from the community the more complete the harmony is in which he lives with all his fellow citizens.

Essentially agreeing, the ethical systems of Plato and Aristotle are chiefly distinguished by the relative value which they respectively ascribe to happiness; the former considering it as the natural fruit of virtue, while the latter rather viewed virtue as the means of attaining to happiness. Plato taught, that although the just man regulates his conduct by no reference to his own enjoyment, yet pleasure invariably attends him, since justice is good not only in itself, but also in its effects, and renders all things fitting and friendly to man. In Aristotle's opinion, the end of morality is to render individuals as useful as possible to society; the objects of whose institution is to procure in its members the highest moral perfection, as necessary to the attainment of the greatest possible felicity by the whole. Man, he teaches, is a free and rational agent, and therefore acts spontaneously and deliberately, invariably proposing to himself some end as the motive to action. All human arts and pursuits, then, have their appropriate ends; but among these there is a certain subordination, which implies a supreme end towards which they all converge; it being desirable not for its own sake, but the cause for which all else is sought. This supreme good is perfection: virtue is the approximation thereto, and consists in the habit of mediocrity according to right reason; in other words, it is self-control, which triumphs alike over the impetuosity of the passions and the weakness of the will, and thereby accomplishes a just mean. Every special virtue, in like manner, lies in a kind of middle between the two opposite vices of too much and too little: courage, for instance, being a mean between cowardice and rashness, of which the former offends by an excessive, the latter by a defective, regard to the proper objects of fear.

According to the Stoics, the supreme good which is the final cause of every special good is to act conformably to nature; *i. e.* in obedience to the immutable laws which reason discovers in the universe. This eternal and universal order, which they called *fate*, is an infinite enchainment of causes and effects, in virtue of which whatever happens is what ought to be: it embraces all living things, and man therefore has a principle within him which obliges him to seek that state of his nature which is the best and most perfect that it is capable of. This is reason. Wisdom, therefore, is man's chief good, and the pursuit of it is philosophy. Perfect wisdom, however, as modelled in the sage of the Stoics, they did not believe to be conceded to mortals, to whom nothing more is granted than to be in *the way to* perfection. Now, as they made reason to be the supreme arbiter in moral determinations, they naturally held vice to be but an error: yet this error, they taught, is the only evil; and, on the other hand, nothing is good but what is such in all times and all circumstances: all else is morally indifferent. But even indifferent things are, in a lower sense, agreeable to nature, and objects more or less of choice or aversion. That perfect rectitude of conduct, therefore, which constitutes the essence of virtue, consists in a just and accurate discernment of good, and in assigning to every object its due importance according to the place it holds in the natural scale of things. Lastly, although their first object was to emancipate the moral man from all dependence on external conditions and from the slavery of his passion, — and although, therefore, they removed all sensuous pleasures and pains from the catalogue of good and evil, — nevertheless the apathy which they taught was not, as commonly understood, an absolute insensibility, but rather the undisturbed supremacy of reason over the passions.

All the preceding theories agree in making reason the end of human activity, and are thereby distinguished from the Epicurean, which gave the first place to the sensuous element of humanity, and reduced science to the rank of a mean. According to Epicurus, pleasure alone is sought for its own sake, and philosophy and all else is but the pursuit of it. If, sometimes, it seems to be foregone, it is only with a view to some higher gratification, as pain also may occasionally be endured in the acquisition of a pleasure whose intensity will fully compensate for the intermediate suffering. The pleasures and pains that are primarily the objects of desire and aversion are corporeal, and from these the pleasures of the mind are ultimately derived, and consist merely in the anticipation of future and in the recollection of past states. This, however, constitutes the superiority of the secondary pleasures of the mind over their corporeal originals, for the latter do not extend beyond the present sensation. *Virtue*, therefore, is an enlightened pursuit of pleasure, which, although it is selfish in its principle, still allows free course to the social and benevolent affections, as being a part of man's nature and an additional source of gratification beyond the calculations of personal interest. For though they may expose a man to the chance of pain, as in the case of the death of a friend, still this is a less evil than apathy, and the deprivation of a natural enjoyment. Justice, lastly, has no other object than the general good; and right, properly understood, is but the sign of utility.

Modern ethics having taken their rise from a system greatly resembling the Epicurean, the inquiry into the nature of virtue became the first question that was proposed for solution. Accordingly this fact furnishes a general classification of the later theories of morals into selfish or disinterested, according as they found virtue on a selfish or on a benevolent principle.

The selfish theory has found its ablest advocates in Hobbes, Helvetius, Paley, and Bentham. Of these the first and last deserve a particular notice: Hobbes as the originator of the controversy into the nature of morality; Bentham as furnishing the most complete and elaborate exposition of the utilitarian scheme. According to Hobbes (born 1588, died 1679), the only motive that can induce men to any act is the pleasure which will follow from its execution. A preconception of pleasure is the necessary condition of every moral determination. Good and evil are simple tendencies to pleasure and pain, without which every object is indifferent. Self-love is the exclusive passion of man's nature. Other passions differ from it outwardly only, *i. e.* in the objects which excite them: pity, for example, is but the imagination of misfortunes which may happen to ourselves, suggested by the contemplation of another's sufferings; love, the conception of advantages to be derived from its object; and benevolence, nothing more than the consciousness of power sufficient to secure not only one's own happiness, but that of others also. The first law of nature is self-preservation: whatever tends, therefore, to this end is lawful and good, and all men have a natural right to appropriate by every means in their power whatever may contribute to their personal happiness. As this is the imprescriptible right of all, there are as many forms of natural right as there are separate and independent wills; and actions of the most opposite kinds are equally virtuous and legitimate. Now, as all possess an equal right to all things, and as there is no reason why one

should yield to another the objects which both may desire, the state of nature must be one of war; but as, in such a condition of things, the safety of every one is constantly endangered by the conflicting interests of all others, peace, at any price, becomes preferable to it. Peace, however, is the result of society alone; *i. e.* as defined by Hobbes, of the existence within a community of a sufficient force to control all individual wills and forces. But this is only practicable in two ways: either all are seized with a desire to terminate the state of hostility, and enter into a mutual compact, by which they engage to do no violence, nor to suffer it to be done to each other; or a single person succeeds by stratagem or force in establishing his own authority over the rest. The latter form of society is as legitimate as the former; and indeed, as the end of the institution is the suppression of warfare among its members, and as the more unlimited the power is the better calculated it must be to effect this object, an absolute monarchy is the very best polity that can be devised. Against the government in such a society, it is evident that subjects cannot consistently possess any rights; for these would impede its effectiveness: they have but one simple duty, and that is — implicit obedience. (*On Human Nature; Leviathan, &c.*)

Bentham (born 1748, died 1832), sets out from Hobbes' principle, that every object would be perfectly indifferent but for its fitness to produce pleasure or pain, which, he declares, are the sole motives of human determinations. This proposition he does not attempt to prove, but, asserting that it is one of those primary and self-evident truths which are the foundation of all reasoning, he proceeds to draw from it certain practical conclusions in the form of definitions. Thus he defines utility to be the fitness of actions and things to augment the happiness, or to diminish the misery, of individuals and communities; and maintains that this is the only true and intelligible interpretation of what is usually called the lawfulness, goodness, justice, and morality of an action. The principle of utility is next defined to be that which exclusively derives the quality of actions from their twofold property of augmenting the happiness or misery of one or many. This, he asserts, is the only valid principle of moral appreciation; and he reduces all opposing theories to two classes, which he designates by the principle of asceticism, and the principle of sympathy and antipathy. Under the latter head, Bentham comprises every theory of morals which draws the distinction of good and evil from any other principle than a consideration of consequences; whereas he explains the ascetical principle as agreeing with the utilitarian in drawing its qualification of objects from their tendency to produce pleasure or pain, but as differing from it in that it proceeds in an inverse manner, and calls pain good, but pleasure an evil. To forego the least pleasure, simply as pleasure, is to act on a principle of asceticism; but the true disciple of utility holds every pleasure to be in itself good. Even the abominable pleasure which the wretched criminal enjoys in gloating over his crime is good, so far as it is a pleasure; it is only evil so far forth as it entails the ill consequences of fear and punishment, which far transcend its guilty enjoyment. The practical conclusion, therefore, of the theory of utility is, that an action is only really good when it will give rise to more of pleasure than of pain; and evil, when its painful exceed its pleasurable consequences. It becomes, consequently, of the first importance to possess an accurate standard by which the amount of pleasure and pain likely to result from certain actions, and the relative value of the two quantities, may be measured. This desideratum Bentham has attempted to supply in a manner that constitutes the most original and characteristic feature of his theory and system. The first item of this moral arithmetic is what is intended for an exhaustive enumeration of all the pleasures and pains of which human nature is susceptible: in the next, he proceeds to furnish a method of determining their comparative value. For this purpose it is necessary to take into the account the following considerations: — I. What are the intrinsic circumstances of the pleasure itself which can augment or diminish its value: and these are, 1. intensity; 2. duration; 3. certainty; 4. proximity, or remoteness; 5. fecundity, or the probability of its immediate pleasures engendering others more remote; 6. purity, or whether its pleasures are mixed or not with more or less of pain. II. What circumstances are likely to affect the sensibility of the agents, and so to modify indirectly the result. These are of two kinds, individual and general: to the former belong temperament, constitution, habits, intellectual development, and other traits of personal character: those of the latter order are little more than generalizations of the first, and are — sex, age, education, profession, climate, national character, government, and religion. III. What are the consequences which, going beyond the immediate objects of the action, remotely affect others more or less numerous, and even the whole of society. By allowing their due weight to all these particulars, Bentham pretends that any ordinary capacity may form a correct estimate of the real tendency of actions, and thereby arrive at that general utility which it is the proper end of morality to secure. (*Treatise on Morals and Legislation.*)

The recognition of a principle of action independent of self-love will afford a general characteristic of the remaining theories. Some of these, however, place the origin of the disinterested determination in a perception of moral good and evil by the intellect or reason; while others explain the distinction by certain facts which take place within the sensibility or emotive part of man, so that the disinterested determinations which result proceed from an instinct or sentiment. These two classes may be conveniently designated the rational and the sentimental or instinctive. Of instinctive theories, however, while some are content with referring the moral principle to an original and admitted tendency of human nature, such as sympathy or benevolence, others have derived it from a new and peculiar faculty.

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acquire a knowledge of man's true and proper nature; but this self-knowledge he held to be impossible so long as man continues ignorant of the universal principle. Now the nature of God can only be learned from his works, and these bespeak him to be good and intelligent. Moreover the consciousness of man attests his participation in the divine essence; consequently the ultimate destination of man is reason and goodness, and his moral end is the cognition and practice of good. Virtue, therefore, is the intelligent performance of duties, whose notions man may arrive at by a study both of his own nature and of the laws of an all-wise Creator discoverable in the system of the universe. In this pursuit happiness is inseparable from virtue. But if Socrates thus founded morality on a disinterested principle, he reconciled it with interest rightly understood; and on the other hand raised political science above the mere calculation of utility, by identifying it with justice as founded not on convention (*δογμα πολεως*), but on natural right, or the invention of what is (*του οντος εξευρεσις*).

Socrates having thus referred the laws of morality to the Deity as their author and upholder, Plato proceeded by a definition of the divine nature to guard against the objection of their arbitrary position by the will of God. He made the Deity to be the perfection of intelligence as resulting from an union of the good, the beautiful, and the true, which are in their nature eternal, necessary, and immutable. This perfection is also the term to which man spontaneously tends. For reason is the true principle of his nature, although in the present existence there is mingled with it a foreign element — *matter*, which, by obstructing its development, becomes the cause of his falling short of perfection. All, then, that is now possible for man is an approach to the divine excellence. This is virtue, and is effected by the harmony of the *rational*, *irascible*, and *concupiscible* parts of the soul. Although the two latter belong to the foreign element in man's nature, they are yet indispensable to the moral act: for the third affords a motive to action, inasmuch as beauty, being identical with the good and true, gives rise to desire or love (*ερως*), and thereby impels to virtuous action; while the second, disapproving what is base, and ugly, and false, furnishes the fortitude requisite for attaining to what is approved under every difficulty and every discouragement. To each of the three parts of the soul Plato assigns a special virtue, in a lower sense, and names them, respectively, *prudence*, *fortitude*, and *temperance* (*φρονησις*, *ανδρεια*, *σωφροσυνη*), while in a proper sense he declares virtue to be eminently one and the same with justice (*δικαιοσυνη*). These four are the so-called cardinal virtues. From the notion of justice he draws the connection of ethics and politics: the latter is but an application of the former to society. At the close of the republic he teaches that as an individual cannot be at peace with himself except by the harmonious adjustment of all his faculties, wherein each is allowed its due weight, so in the whole world happiness is proportionate to justice, and each individual derives the greater benefit from the community the more complete the harmony is in which he lives with all his fellow citizens.

Essentially agreeing, the ethical systems of Plato and Aristotle are chiefly distinguished by the relative value which they respectively ascribe to happiness; the former considering it as the natural fruit of virtue, while the latter rather viewed virtue as the means of attaining to happiness. Plato taught, that although the just man regulates his conduct by no reference to his own enjoyment, yet pleasure invariably attends him, since justice is good not only in itself, but also in its effects, and renders all things fitting and friendly to man. In Aristotle's opinion, the end of morality is to render individuals as useful as possible to society; the objects of whose institution is to procure in its members the highest moral perfection, as necessary to the attainment of the greatest possible felicity by the whole. Man, he teaches, is a free and rational agent, and therefore acts spontaneously and deliberately, invariably proposing to himself some end as the motive to action. All human arts and pursuits, then, have their appropriate ends; but among these there is a certain subordination, which implies a supreme end towards which they all converge; it being desirable not for its own sake, but the cause for which all else is sought. This supreme good is perfection: virtue is the approximation thereto, and consists in the habit of mediocrity according to right reason; in other words, it is self-control, which triumphs alike over the impetuosity of the passions and the weakness of the will, and thereby accomplishes a just mean. Every special virtue, in like manner, lies in a kind of middle between the two opposite vices of too much and too little: courage, for instance, being a mean between cowardice and rashness, of which the former offends by an excessive, the latter by a defective, regard to the proper objects of fear.

According to the Stoics, the supreme good which is the final cause of every special good is to act conformably to nature; *i. e.* in obedience to the immutable laws which reason discovers in the universe. This eternal and universal order, which they called *fate*, is an infinite enchainment of causes and effects, in virtue of which whatever happens is what ought to be: it embraces all living things, and man therefore has a principle within him which obliges him to seek that state of his nature which is the best and most perfect that it is capable of. This is reason. Wisdom, therefore, is man's chief good, and the pursuit of it is philosophy. Perfect wisdom, however, as modelled in the sage of the Stoics, they did not believe to be conceded to mortals, to whom nothing more is granted than to be in *the way to* perfection. Now, as they made reason to be the supreme arbiter in moral determinations, they naturally held vice to be but an error: yet this error, they taught, is the only evil; and, on the other hand, nothing is good but what is such in all times and all circumstances: all else is morally indifferent. But even indifferent things are, in a lower sense, agreeable to nature, and objects more or less of choice or aversion. That perfect rectitude of conduct, therefore, which constitutes the essence of virtue, consists in a just and accurate discernment of good, and in assigning to every object its due importance according to the place it holds in the natural scale of things. Lastly, although their first object was to emancipate the moral man from all dependence on external conditions and from the slavery of his passion, — and although, therefore, they removed all sensuous pleasures and pains from the catalogue of good and evil, — nevertheless the apathy which they taught was not, as commonly understood, an absolute insensibility, but rather the undisturbed supremacy of reason over the passions.

All the preceding theories agree in making reason the end of human activity, and are thereby distinguished from the Epicurean, which gave the first place to the sensuous element of humanity, and reduced science to the rank of a mean. According to Epicurus, pleasure alone is sought for its own sake, and philosophy and all else is but the pursuit of it. If, sometimes, it seems to be foregone, it is only with a view to some higher gratification, as pain also may occasionally be endured in the acquisition of a pleasure whose intensity will fully compensate for the intermediate suffering. The pleasures and pains that are primarily the objects of desire and aversion are corporeal, and from these the pleasures of the mind are ultimately derived, and consist merely in the anticipation of future and in the recollection of past states. This, however, constitutes the superiority of the secondary pleasures of the mind over their corporeal originals, for the latter do not extend beyond the present sensation. *Virtue*, therefore, is an enlightened pursuit of pleasure, which, although it is selfish in its principle, still allows free course to the social and benevolent affections, as being a part of man's nature and an additional source of gratification beyond the calculations of personal interest. For though they may expose a man to the chance of pain, as in the case of the death of a friend, still this is a less evil than apathy, and the deprivation of a natural enjoyment. Justice, lastly, has no other object than the general good; and right, properly understood, is but the sign of utility.

Modern ethics having taken their rise from a system greatly resembling the Epicurean, the inquiry into the nature of virtue became the first question that was proposed for solution. Accordingly this fact furnishes a general classification of the later theories of morals into selfish or disinterested, according as they found virtue on a selfish or on a benevolent principle.

The selfish theory has found its ablest advocates in Hobbes, Helvetius, Paley, and Bentham. Of these the first and last deserve a particular notice: Hobbes as the originator of the controversy into the nature of morality; Bentham as furnishing the most complete and elaborate exposition of the utilitarian scheme. According to Hobbes (born 1588, died 1679), the only motive that can induce men to any act is the pleasure which will follow from its execution. A preconception of pleasure is the necessary condition of every moral determination. Good and evil are simple tendencies to pleasure and pain, without which every object is indifferent. Self-love is the exclusive passion of man's nature. Other passions differ from it outwardly only, *i. e.* in the objects which excite them: pity, for example, is but the imagination of misfortunes which may happen to ourselves, suggested by the contemplation of another's sufferings; love, the conception of advantages to be derived from its object; and benevolence, nothing more than the consciousness of power sufficient to secure not only one's own happiness, but that of others also. The first law of nature is self-preservation: whatever tends, therefore, to this end is lawful and good, and all men have a natural right to appropriate by every means in their power whatever may contribute to their personal happiness. As this is the imprescriptible right of all, there are as many forms of natural right as there are separate and independent wills; and actions of the most opposite kinds are equally virtuous and legitimate. Now, as all possess an equal right to all things, and as there is no reason why one

should yield to another the objects which both may desire, the state of nature must be one of war; but as, in such a condition of things, the safety of every one is constantly endangered by the conflicting interests of all others, peace, at any price, becomes preferable to it. Peace, however, is the result of society alone; *i. e.* as defined by Hobbes, of the existence within a community of a sufficient force to control all individual wills and forces. But this is only practicable in two ways: either all are seized with a desire to terminate the state of hostility, and enter into a mutual compact, by which they engage to do no violence, nor to suffer it to be done to each other; or a single person succeeds by stratagem or force in establishing his own authority over the rest. The latter form of society is as legitimate as the former; and indeed, as the end of the institution is the suppression of warfare among its members, and as the more unlimited the power is the better calculated it must be to effect this object, an absolute monarchy is the very best polity that can be devised. Against the government in such a society, it is evident that subjects cannot consistently possess any rights; for these would impede its effectiveness: they have but one simple duty, and that is — implicit obedience. (*On Human Nature; Leviathan, &c.*)

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and feelings in another. By virtue of this faculty we feel as it were a sympathy with ourselves when we have acted well, and are led to suppose that all other spectators would be similarly affected. This consciousness of unison between our own conduct and the sentiments of our fellows constitutes the pleasure of rectitude. And further, by aid of the same principle by which we judge of the actions of others, we feel that we have a right to pronounce our own also to be good. This is a source of inward tranquillity and satisfaction, while the least suspicion of the contrary gives rise to the pains of remorse. In manhood, indeed, when experience has drawn a system of general rules from the occasional judgments of sympathy, and established them in the mind, a new source of pleasure arises. We have now an intellectual perception also of the conformity of the act with the law of morality; and, independently of the instinctive approbation, the reason also awards to it its sanction. This rational perception is wanting in the infantine and uncultivated mind; but it is invariably found wherever education or experience has stored the mind with the general maxims of morality which are primarily founded on the instinctive emotions. The act of reason in approbation is simply a perception of the agreeableness of the act with the moral laws, and therefore implies them. Lastly, the act itself appears by its very nature to be part of a system of conduct fitted to establish a perfect agreement of sentiments among mankind; and this universal harmony being eminently beautiful in itself, we judge, in virtue of this perception, the act in question to be not only good but even beautiful. This is the principle of moral beauty, which is the origin of every other species of the beautiful. (*Theory of Moral Sentiments.*)

The doctrine of a moral sense owes its origin to Lord Shaftesbury (born 1671, died 1713). According to this writer, the human dispositions are of two kinds, — the social or benevolent, and the personal or selfish. The former lead us to desire the welfare of others simply for its own sake and without regard to our own interests. In the developments of these affections the soul takes part, and some are naturally agreeable and others disagreeable to it; of the former it approves, but disapproves the latter. As, then, these dispositions are a source of pleasure to the soul, there must be in it some faculty distinct from the dispositions themselves, by virtue of which they become agreeable or otherwise, and which performs the same office in their case as they do with respect to their immediate objects. This faculty Shaftesbury calls a sense which he characterises from its mode of operation as *reflex*, and from its object-matter as *moral*. The dispositions which this reflex sense approves or disapproves are morally good or evil: virtue consists in yielding to the former, but resisting the latter. Between goodness and virtue there is agreement, but not identity; the former being merely a constitutional predominance of the benevolent affections in the character and conduct, the latter being the same state produced by the operation of the conscience or moral sense, which, when the personal affections are of equal force with the social ones, interposes its authority, and inclines the balance in favour of the latter.

Butler (born 1692, died 1752), in the same manner divides the principles of action into those which lead directly to private good, and those which promote immediately the good of the community; but of both he shows with great originality that they are alike disinterested. The objects of both classes of passions are outward things, which are sought as ends in themselves and without any regard to their tendency to promote happiness, which is the proper end of self-love. This, again, is distinguished by Butler from selfishness, which consists in the weakness of the public affections and the undue strength of personal desires. Self-love, or an enlightened regard to our general happiness, is not a vice; whereas selfishness is utterly at variance with the happiness of him who harbours it, since without the gratification of the benevolent feelings it is impossible to attain to the greatest satisfaction of our nature, of which they are a part. But, besides these personal and social instincts and self-love, Butler discovers in man another faculty, which by its very nature is supreme over all others, and authoritatively approves or disapproves both the affections of our minds and the actions of our lives. This principle is conscience. Its perceptions are immediate, and its very idea implies that supremacy and authority are essential to it. (*Sermons at the Rolls Chapel.*)

The first object of Hutcheson (born 1694, died 1747,) is to show that the very frame of our nature which determines us to pursue happiness for ourselves, also determines us both to esteem and to benevolence on their proper occasions. But besides these original desires, he shows that there arise, in consequence of them, *secondary* desires of every thing useful to gratify the primary ones. But there is also in man an idea of moral good which can be explained by neither of the former. By a careful analysis, Hutcheson shows that by moral good we understand neither what gives pleasure by satisfying our benevolence, nor what is simply good to others; nor is it what is useful to others or agreeable to the spectators; nor, lastly, is it a conformity to the will of God, or to law, or truth, or order: it is simply what the word itself expresses, which is simple and original and inexplicable by any other. From this originality and simplicity of the term, Hutcheson argues that it must be perceived by a sense, because the senses alone are percipient of simple qualities; and by a special sense, since the quality apprehended by it differs from all other objects of sensation. Further he observes that this perception is attended with pleasure, which is the property of all sensuous perceptions; and that as moral good is an end and motive of action, it must be apprehended by a sense, since the understanding can neither propose the ends of human activity nor exercise any influence on the will. Again, the pleasure which accompanies the perception of good, being a consequence of the discovered quality, necessarily presupposes it; therefore it is impossible to resolve moral good, or the approbation which we award to it, into that pleasure; this would be to resolve the cause into the effect, and the consequence into the principle. As the qualities which it is the province of the moral sense to discover belong to the internal affections and emotions, it is internal, and not external, although, like the outward senses, it is capable of improvement by education and habit. This sense is designed to govern all the others, and we have an immediate consciousness of its authority. Reason is the servant of this sense, its only office being to discover and to combine the means necessary to the attainment of the objects which the moral sense approves of. The object of this approbation is benevolence alone: every action or measure which has in view our own advantage is, simply on that account, morally wrong; it may be innocent — it cannot be virtuous. (*Inquiry into Beauty and Virtue.*)

According to Hume, (born 1711, died 1776,) all the mental qualities and actions which are generally approved of by mankind agree in the circumstance of being useful to society. The fact that the different degrees of moral approbation correspond to the degrees of utility, affords an explanation of the greater merit ascribed to the benevolent passions: for these tend to the happiness of many, and indeed of all; whereas the personal affections tend to that of the agent alone. Yet even the latter are in a degree meritorious, inasmuch as they are useful to one, and they are only to be blamed when they are entertained at the sacrifice of the social feelings. The pursuit of self-interest is in the latter case culpable, although in itself it is not only innocent, but praiseworthy: for we admire in any character certain qualities, such as prudence, for instance, merely because they appear fitted to promote his personal welfare. In short, whatever is useful is morally good, and is only to be disapproved when it is preferred to what is more useful. That which judges of utility and the contrary is reason; but if we approve of one and disapprove of the other, and call the former good, but the latter evil, this is in virtue of a primary sentiment of our nature, which leads us to prefer the useful to the hurtful, as we prefer what is sweet to what is bitter. This instinct, however, is distinct from and frequently opposed to self-love; for this would lead us to love what is useful to ourselves, and not what is useful in itself absolutely and independently of any reference to our own advantage. This instinct is commonly called conscience, or the moral faculty, but more frequently designated by Hume as benevolence or humanity, inasmuch as its object is the good of mankind generally. As to the idea of moral obligation, it is simply a conception of the understanding. What is honoured by this name is, he says, nothing more than the undoubtedly correct view, that there is more happiness in obeying the impulses of the moral sense than in following the dictates of self-love. The reason is incapable of exercising any influence on the will. What determines us when we resolve to act rightly is merely the charm which utility exercises on the mind, and the force of certain dispositions which propel us to seek the good of ourselves and others, and are invariably seconding the promptings of conscience. (*Inquiry concerning the Principles of Morals.*)

Mackintosh (born 1765, died 1832,) agrees with all the writers of the instinctive school in denying conscience to be either a state or act of the understanding: but he differs from one form of the sentimental theory by denying that man has any special organization for moral perception, while he equally dissents from the other view, which would refer these perceptions to some one of the original and admitted sentiments of our nature. Butler and Stewart had shown that self-love is a secondary principle; and Hartley had exhibited the important part which association plays in the formation of our passions and affections, and even of our sentiments of virtue and duty. This view was further developed by Mackintosh, who declared conscience itself to be a similar derivative.

In the same manner he says that in the formation of self-love the desire which originally attaches to external objects is transferred to the pleasure which results from their attainment; so in the case of conscience the agreeable and disagreeable sensations which belong naturally to certain actions is transferred to the volitions which determine conduct, so that the latter become at last the immediate objects of love and repugnance. In this manner there is formed by association a number of secondary desires and aversions, whose proper object is volition, and which collectively form that interior principle called conscience, which judges, without regard to consequences, unerringly and authoritatively. As to the action of conscience on the will, this is composed both of the peculiar energy of the primary dispositions, which it causes to triumph, and of the pleasures naturally attached to them, as well as those which are produced by the gratification of the secondary affections. Accordingly, Mackintosh strongly insists upon the distinction between perception and emotion, and declares that the phrase *association* of ideas, as overlooking this distinction, conveys but a partial and incomplete view of the truth. He therefore proposes to substitute for it association of thoughts with emotions and with each other, but at the same time declares that the term "association" very inadequately indicates that perfect combination and fusion which occurs in these operations of the mind. For the moral faculty is properly and intelligibly spoken of as one. Now it is as common in mind as in matter for a compound to have properties not to be found in any of its constituent parts: the originally separate feelings are so completely blended together that they can no longer be disjoined from each other. Thus the sentiment of moral approbation, formed by association out of antecedent affections, may become so perfectly independent of them that we are no longer conscious of the process by which they were formed. It is in this mature and sound state of nature that our emotions at sight of right and wrong are ascribed to conscience. And although this supreme arbiter and judge of human conduct does not supersede the ordinary motives of virtuous feelings and habits, which are the ordinary motives to good actions, it yet exercises a lawful authority over them. Whatsoever actions and dispositions are approved by conscience acquire the names of virtues and duties; they are thereby pronounced to deserve commendation, and we are justly considered as under a moral *obligation* to practise the actions and cultivate the dispositions. The peculiar character of the moral sentiments is their exclusive reference to *states of the will*, and this is a character both of the private desires and social affections, and, indeed, among the many dissimilar elements that enter into the formation of conscience, this is the only common property that the mind can discover. Hence, however, the facility with which general terms, at first limited to relations between ourselves and others, are gradually applied to any voluntary acts and dispositions: it is thus that prudence and temperance, for instance, become objects of moral approbation. On the other hand, as the will is the sole means of gratifying any passion, the power of conscience is coextensive with the whole man. It is a universal principle, because will is the universal means. And as, when the mind is in a healthy state, nothing is interposed between it and the will, the dictate of conscience is immediately followed by a determination of will; conscience is thus at once universal, independent, and commanding. Lastly, as Mackintosh held that utility, as tending to promote the greatest happiness of the species, is the criterium of morality, he naturally felt himself called upon to explain the fact, that, while the moral approbation involves no perception of a beneficent tendency, there is nevertheless a striking coincidence between that principle and the moral sentiments. He replies that it is true that conscience itself rarely contemplates so distant an object as the welfare of all sentient beings, but that all its elements are invariably tending to this end. The social affections promote happiness, so far as their foresight and power extend; the rules of justice are conducive, if not necessary, to the well-being of society; even the angry passions, so far as they are ministers of morality, are employed in removing hindrances to the welfare of ourselves and others; and if the private passions terminate in the happiness of the individual, this is yet a part of the general happiness. And although this beneficent tendency be not one of the natural objects of conscience, because our voluntary acts are not felt to affect it, yet little is left to reason to perform; which is, to discover merely the truth, that the acts of those who labour to promote separate portions of happiness must increase the amount of the whole. (*Dissertation on the Progress of Ethical Philosophy.*)

The distinctive characteristic of the rational theory of morality is, that it considers the idea of good to be an *à priori* conception of reason, in which the idea of obligation is necessarily and essentially implied. As to the nature of the idea itself, two opinions have been held. While some moralists of this school pronounce it to be simple and immediate, others resolve it into some higher notion of the intellect, from which it derives at once its explanation and authority.

The most distinguished representatives of the latter opinion are Clarke and Wollaston; while the former has found able advocates in Cudworth, Price, and Stewart.

According to Clarke (born 1675, died 1729), the universe is an assemblage of objects held together by certain mutual relations which result from their respective natures; but as the nature or essence of things is immutable and real, and the essence is the principle of the relations, the latter must be equally real and immutable; and as they must have been always present to the Eternal Mind, they are also eternal. Now, as soon as reason conceives these relations as constituting the laws of individual things, and the order of the universe, they immediately appear to command the respect of every free and rational agent. Hence the obligation on every creature capable of thought to act conformably to those relations; and every act agreeable to them is judged to be good, and evil if opposed to them. Now, moral good being the conformity to the relations of objects, these, while they constitute, serve also to explain, all duties. Thus, the true nature of God and man, and their reciprocal relations, being known, the duties of man towards God are at once discoverable. In the same way the duties of man to his fellows similarly suggest themselves from a consideration of their relations as equally free and independent beings; and as the latter relation is one of equality, whereas that between God and man is one of inequality, the difference between the two classes of duties which those relations respectively engender is at once conceivable. In confirmation of this view of the moral principle, Clarke appeals to the historical fact of the gradual development of moral ideas among mankind: for the knowledge of the nature of things, and their consequent relations, is neither natural nor immediate to the mind, but is gradually unfolded by observation and science, which are more or less complete according to the degrees of its culture. The evolution of moral science, although subsequent to that of nature, nevertheless, being once awakened, is promoted by its progress, and keeps pace with the advancement of civilization. (*Being and Attributes of God; Evidence of Natural and Revealed Religion.*)

Wollaston (born 1659, died 1724,) makes morality to be conformity to truth. In support of this view he asserts that actions, equally with words, are but signs, and that consequently every true proposition, *i. e.* one which expresses things as they are, may be contradicted by deeds as well as by words. To violate a compact, for instance, is simply to deny by that act that there is any such compact subsisting. He then asserts that no act, whether word or deed, of any free and rational agent to whom moral good and evil are imputable, which interferes with any true proposition, or denies anything to be as it is, can be right. For, 1., if a false proposition be wrong, the act which implies, or is founded on it, cannot be right. 2. Whatever interferes with a true proposition, which expresses the relation between the subject and attribute as it is in nature, must, therefore, interfere with nature, and is consequently unnatural, or wrong in nature. 3. An act which contradicts a true proposition contradicts what is, and is, therefore, a revolt against God, the author of whatever is. 4. To deny things to be as they are, is a transgression of the great law of our nature — the law of reason. What is said of acts inconsistent with truth may be said of omissions to act, since by these, also, true propositions may be denied to be true. For instance, whoever having engaged to do some certain act, nevertheless voluntarily omits to do it, behaves himself as if there had been no such promise or engagement. Having thus established his theory, he proceeds, like Clarke, to show that it is agreeable to facts, and especially with that of the progressive development of morality. For morality being simply the truth expressed in action, it implies the knowledge of truth; and consequently the improvement of the moral perceptions must be proportional to the progress of science. It also affords an explanation of erroneous views in morality, and of the difference so universally drawn by the common sense of mankind between error and vice. If it is possible to err in morals, this is because the mind is liable to err in science, and not to see things as they actually are. To err in morals is but to affirm practically a false position: hence the act may be evil, but the agent is not culpable, since his error is involuntary. Lastly, Wollaston maintains that his theory, far from being inconsistent with the acknowledged characteristics of the idea of moral good, affords the only just explanation of them. The truth is immutable, because it expresses the unchangeable nature of things, and therefore the ideas of moral good are immutable. Hence, too, the same eternal distinction between moral good and evil as between truth and falsehood. Whatever, in short, may be predicated of truth, is applicable to the moral principle; and its foundations are as valid and

imperishable as those of science itself. (*The Religion of Nature.*)

The other form of the rational theory, which explains the idea of good to be an immediate conception of the intuitive reason, intelligible in itself, and incapable of definition, now remains for elucidation. According to Cudworth (born 1617, died 1688), certain universal and absolute ideas exist from all eternity in the Divine mind, from which the human intellect emanates; and, therefore, by its nature possesses these ideas antecedently to experience. They remain dormant, it is true, until outward objects call them forth; but when once awakened, they immediately apply themselves to things, and give them a significant character, which in themselves they do not possess. Cudworth's chief object in advancing this theory of intellection, was to exempt the ideas of right and wrong from the arbitrary and relative character with which the sensuous doctrines of Hobbes had invested them. Accordingly, he shows that no relation of human will or pleasure can constitute these ideas. Positive laws, he urges, do not oblige by their mere enactment, but by virtue of the natural ideas of justice and obligation which they imply. Neither is this idea the mere creature of man's reason, for this does but conceive it, and, by applying its unchangeable standard to actions and characters, appreciates and judges them. Lastly, this idea is simple and indefinable, and inseparably combined with that of obligation. Hence every virtue assumes the character of a duty, and is as unalterable as good itself. (*Eternal and Immutable Morality.*)

Price (born 1723, died 1791,) ascribes all simple ideas to two faculties — sense and understanding. The latter sees things as they are; the former perceives the effects only that they produce on the sensuous organization. The ideas of the understanding consequently express realities which are independent of man, whereas those of the latter are sensations which would be different if man's sensuous organs were changed. Now the question of the objective reality and immutability of the ideas of right and wrong reduces itself to the inquiry into their origin. According to Price, they belong to the understanding as a faculty of intuition or immediate power of perception, distinct from the understanding as a reasoning or deductive faculty. The doctrine which would assign them to sensation as their origin has its source in the fact that the moral perceptions are invariably attended with agreeable or disagreeable emotions, and the exclusive consideration of this circumstance. But when men declare gratitude to be a virtue, and ingratitude a vice, they intend to signify not merely that they produce emotions in their own minds, but that they are naturally virtuous and vicious in themselves. If by virtue and vice nothing more be meant than certain mental affections, then, in that case, our moral judgments would be infallible, and the same act might with equal truth be the subject of the most conflicting estimates, and all things would be indifferent in their own nature, since the understanding, which alone apprehends things as they are, could see in them neither good nor evil. Moreover, in this case, they would be without authority; for what obligation can there be to do what is pleasing, or to forbear what is displeasing? But these ideas are both immutable and imperative: they are immutable, since they are real qualities of actions, and every real quality is a part of the nature of things, which is immutable. God may destroy the things themselves, but he cannot cause them to be what they are not. After establishing the rational origin and immutable character of the moral perceptions, Price proceeds to explain the manner in which they are apprehended by the intuitive reason. As the sight of an event suggests the idea that it must have taken place in time, and thereby we arrive at the idea of duration, in the same way certain actions of free and rational agents are immediately apprehended to be good or evil, and the ideas of right and wrong arise in the consciousness. As to the notions of moral beauty and deformity, these we ascribe to good and evil actions in virtue of the pleasure and pain which accompany, but yet are distinct from the perception of right and wrong. In contemplating the actions and affections of moral agents, we have both a *perception of the understanding* and a *feeling of the heart;* the latter are the effects of the former, and partly depend on the positive constitution of our nature, and partly on the essential congruity of object and faculty. The former are wholly inexplicable, and the only account we can give of them is — such is our frame; so God has seen fit to make us. But there are some objects and ideas which have a natural fitness and unfitness to please our mind, and such is the nature of certain actions that when perceived by a rational being, there must result in him certain emotions and affections. These are at first of a purely intellectual kind; but, as such, they are too weak to govern and actuate mankind, and they are therefore combined with a stronger excitement, and we are endowed with certain special instincts which impel us to goodness, and by means of these we are effectually moved towards their proper objects. As to duty or obligation: this idea is so intimately allied to that of good, that one cannot appear without the other. Obligation to action and rightness to action are plainly coincident and identical. It is not plainer that figure implies something figured, than that rightness implies oughtness. Rewards and punishments suppose in their very idea moral obligation, and are founded upon it. They do not make it, but enforce it, or furnish additional motives to comply with it. They are the *sanctions* of virtue, but not its *efficients.* The ideas of good and ill desert are equally immediate; for they are really nothing less than a species of the ideas of right and wrong; although there is this difference in them, that while the latter are properly ascribed to actions, merit and demerit are applicable to agents or persons only. We have an immediate approbation of making the virtuous happy, and discouraging the vicious, apart from all consequences. The conception of virtue is totally distinct from the fact that virtue is a source of pleasure; for it is one thing to find by experience that the tendency of virtue is to the happiness of the world, and vice to its misery, and another to conceive that virtue is by a necessary truth deserving of happiness. Neither does it result from the view that virtue is of public utility; for, even though this consideration may incline us to wish good to the virtuous, yet are we antecedently moved to the same wish by the more immediate and more simple consideration that he is virtuous, and as such, without any other consideration, we pronounce him deserving of honour. Lastly, Price makes liberty and intelligence to be essentially necessary to the morality of the agent, and rightly distinguishes absolute virtue, which is to act voluntarily and consciously in conformity with the moral laws, from practical virtue, or acting on a belief of good in supposed conformity to good. (*View of Principal Questions and Difficulties in Morals.*)

Stewart (born 1753, died 1828,) distinguishes two questions in the fundamental problem of ethics — that of the nature of good, and that of the faculty which discerns and judges of it. With respect to the first, he teaches that upon observation of certain actions the idea of good arises in the mind. This idea represents a certain quality of the actions themselves, and inherent in them, like the primary qualities of bodies, and therefore independent of the sensuous percipient, and not, like the secondary qualities, mere relations between us and the actions. As to the nature of these qualities, they are, like the ideas which we have of them, perfectly original, simple, and irreducible, and consequently indefinable. He further shows, after Price, that it is impossible to explain the terms good and evil except by synonyms, or by substituting for the ideas which they represent some of the circumstances which accompany the perception of them. As to the second question, Stewart argues that good being a simple and real quality in actions, it is impossible to refer the idea of it to any faculty which is not a source of original ideas, and which does not apprehend the real and inherent qualities of objects. It is, therefore, impossible to refer it to a sense,—such as that of taste or smell, which do not reveal the real nature of objects, but only the effect which they produce in the perceiving subject; nor to reason, — if by this term we understand nothing more than the faculty which seizes the relations and deductions of ideas previously established, because the idea of good is simple and original, and not one of relation and consequence; but if by sense we understand a faculty analogous to that which perceives the primary qualities of bodies and their existence,—or if by reason we mean the intuitive understanding which furnishes the simple, primary, and original ideas of time, space, and causation,—then the ideas of good and evil may be referred to either. If Stewart inclines, nevertheless, to favour the claims of reason, he yet declares the question to be unimportant when once it has been admitted that good and evil are simple and indefinable. (*Philosophy of the Active and Moral Powers.*)

In this exposition, the first object has been to give a correct and impartial view of the several theories which have been proposed of the nature of virtue and of the moral perceptions. Their comparative merits have been left to the reader's judgment, unbiassed and undisturbed by any critical estimate by the writer himself, except so far as his arrangement of the subject-matter necessarily implies his own opinion. (Cf. Ritter, *History of Ancient Philosophy;* Mackintosh, *Dissertation on Ethical Philosophy;* Schleiermacher, *Kritik der Ethik;* Jouffroy, *Droit Naturel;* Cousin, *Cours de Philosophie Morale;* and the articles ETHICS and SCHELLING in this work.)

VIS (Lat. *force* or *power*), in Mechanics, is synonymous with *force.* The term is chiefly used by the older writers, and is applied by them to divers kinds of forces or powers. Thus, *vis acceleratrix*, accelerating force; *vis inertiæ*, resistance; *vis motrix*, moving force, &c. *Vis mortua*, and *vis viva*, are terms which were used by Leibnitz and his followers; the former signifying a pressure, and the latter the force of a body in motion estimated by the distance the body goes to.

About the beginning of the last century, a keen dispute arose among mathematicians with respect to the manner in which the forces indicated by those terms ought to be estimated. It began with a prize essay by John Bernoulli on the "Investigation of the Laws of the Communication of Motion," and was carried on for many years with great asperity. The question was, whether the force of a moving body is proportional to the square of the velocity, or to the simple power only of the velocity. No controversy, says Playfair, was ever carried on by more illustrious disputants: Maclaurin, Stirling, Desaguliers, Jurin, Clarke, Mairan, were all engaged on the one side; and on the opposite were Bernoulli, Herman, Poleni, S'Gravesande, Muschenbroek. The dispute was taken up as a point of national honour. Germany, Holland, and Italy declared for the *vis viva;* England stood firm for the old doctrine; and France was divided between the two opinions. (*Dissertation on the Progress of Math. and Phys. Science, Ency. Brit.*) The difference in this case, as in most other disputes of a similar kind, arose from the parties not understanding each other. When the effect of a body in motion is measured by the distance to which it goes, the effect is proportional to the square of the velocity; if measured by the time that elapses before the motion is destroyed by a resistance of uniform intensity, it is as the velocity simply. Both measures may be considered as correct, and they are not inconsistent when rightly understood. (*Playfair's Nat. Phil.* vol. i. p. 56.) The *vis viva*, considered as a power residing in a moving body, is otherwise called *impetus*. *See* FORCE.

VI'SCOUNT. A title of honour; in its original signification, the delegate of a count (vice-comes), and applied to governors of towns and districts under the authority of that officer. In England, the appellation of vice-comes, or viscounte, in Norman French, was long used to designate the sheriff of a county (the vicegerent of the earl) before it became a title of peerage. It is the most modern of English honours in the latter sense; and was first conferred by letters patent on John Lord Beaumont, and the heirs male of his body, by Henry VI. in 1440. For the rank of the viscount, see PRECEDENCY.

VISHNU. One of the three principal deities of the Hindoo mythology, the other two being Brahma and Siva. He is commonly called the Preserver, the other two being respectively the Creator and the Destroyer. The great objects of his providence are brought about by his successive incarnations or avatars, in which he appears and acts on earth. Nine of these have taken place. The last is said to have been the appearance of Buddha, which is supposed by some learned orientalists to have taken place about A. D. 1014; and hence the Buddhists reject the Vedas, which were compiled before that event. (*See* VEDAS.) The tenth avatar of Vishnu is yet to take place, when he will appear on a white horse, with a blazing scimitar, for the everlasting punishment of the wicked. One of the incarnations of Vishnu is the celebrated Juggernaut, whose temple and worship hold such a prominent place in Indian superstition. On the great annual festival in his honour, all distinctions of castes and classes are forgotten, and even on that occasion the Brahminical Hindoos and the followers of Buddha cease their religious hostilities. The word Juggernaut signifies literally *Lord of the Universe;* and it is said that on the day he expired, Buddha assumed this appellation, exclaiming, "*O Universe, I am thy Lord.*"

VI'SIBLE. Capable of being seen. Objects are visible or otherwise, according as they emit or reflect a sufficient quantity of light to make a sensible impression on the retina of the eye. According to Newton, colour is the proper object of sight; the visibility of an object must therefore depend on its transmitting to the eye rays of a different colour from those which proceed from the surrounding objects.

VI'SION. In Optics, the faculty of seeing. Philosophers have disputed much respecting the means of vision, and its seat in the eye. The Platonists and Stoics held vision to be effected by the emission of rays out of the eyes. The Epicureans supposed vision to be performed by the emanation of images or corporeal species from objects to the eye; and the Peripatetics differed in opinion from the Epicureans by supposing the species received by the eye to be incorporeal. Modern philosophers agree in referring the cause of vision to the impressions of light on the eye; but whether this impression is made by material particles emanating from a self-luminous body, and reflected from visible objects, or by the medium of a fluid of great elasticity exciting the eye by the vibrations communicated to it by the luminous body, is a question which is still undetermined. (*See* LIGHT.) In what manner the eye, or the particular part of it affected by the light, conveys to the brain the impressions it receives from the luminous rays, is a question which philosophy has not yet solved, and will probably never be able to solve.

Seat of Vision. — The retina of the eye, on which an inverted image of external objects is formed, has usually been regarded as the seat of vision; but this opinion was long ago brought into doubt by the accidental discovery of Mariotte, that the base of the optic nerve is insensible to the rays of light, and consequently incapable of conveying to the brain the impression of vision. But the retina, being only the extension or contraction of the optic nerve, Mariotte inferred that if the former were the true seat of vision, that part of it at the entrance of the nerve, and where it exists in the greatest quantity, and where precisely vision is wanted, ought to be at least as sensible to the rays of light as the other parts. Mariotte, therefore, concluded that the choroid coat which lies immediately below the retina, and lines the whole bottom of the eye excepting the place at which the optic nerve is inserted, is the real seat and cause of vision. (*Priestley on Vision, Light, and Colours*, p. 722.; or *Hutton's Dictionary*.) The opacity of the choroid coat, and the transparency of the retina, which render it an unfit ground for the reception of images, furnish arguments in support of this view; and an interesting fact was observed by Sir D. Brewster which points to the same conclusion. He observed that in young persons the choroid coat, which is generally supposed to be black, and to grow fainter by age, reflects a brilliant crimson colour, like that of dogs and other animals. Hence, if the retina is affected by rays which pass through it, this crimson light, which must necessarily be transmitted by it, ought to excite the sensation of crimson, which he found not to be the case. ("Optics," *Cab. Cycl.* p. 291.)

M. Lehot, a French writer, has recently attempted to prove that the seat of vision is in the vitreous humour; and that instead of seeing a flat picture of objects, we actually see an image of three dimensions. To produce this effect, he supposes that the retina sends out a number of small nervous filaments, which extend into the vitreous humour, and convey to the brain the impressions of all parts of the image. (Id. p. 292. For further information on this subject, see *Jurin's Essay on Distinct and Indistinct Vision*, in *Smith's Optics; Robins' Tracts*, vol. ii.; a paper *On Vision* by Dr. T. Young, *Phil. Trans.* 1793; *Horn on the Seat of Vision*, 8vo. 1813.) *See* OPTICS.

VISION, BEATI'FIC. In Theology. The doctors of the church distinguish three manners of seeing or knowing God: which they call, 1. *Abstractive vision;* i.e. through the consideration of his attributes. 2. *Beatific* or *intuitive vision;* that which the faithful enjoy in heaven. (1 Cor. xiii. 12.) The belief termed Catholic by the Romanists is, that this vision is accorded to the just, who die without leaving a sin unexpiated, immediately on their departure. The Greek church holds that they do not enjoy it until after the general resurrection. This is one of the opinions condemned by the Council of Florence in 1439; and its decision is confirmed by that of Trent. 3. The third kind of vision, or *comprehension*, is that which belongs to God, who alone can know Himself as He is. Prophetic vision is only the knowledge of future or distant events, given by inspiration.

VISITA'TION. In Ecclesiastical Law, the inspection by the bishop of the several parishes in his diocese; or by an archbishop of the dioceses in his province. By the ancient canon law visitations were to be held once a year, and by the personal repairing of the ordinary to each parish; but the modern practice, which appears to have come gradually into use, owing to the extent of dioceses, is to summon the clergy from several parts to one convenient place. The times of episcopal visitations are now usually fixed in this country about Easter and Michaelmas. By Can. 60. of the English Church, such visitations for the purpose of confirmation must be triennial at least. The care of the ancient parochial institutions has by degrees devolved on the archdeacons. They are bound to see that the offices of the church are duly administered; to keep account of the ornaments, vestments, &c. appertaining to the churches; to examine into the state of repair of parsonages, churchyards, &c.; and to receive presentments of excesses committed by ecclesiastical persons. Ecclesiastical corporations, such as conventual bodies, had usually their special visitors appointed by the founder; as is the case at present with colleges in our universities, hospitals, &c.

VISITATION. A festival of the Western Church, in honour of the visit of the Virgin Mary to Elizabeth; said to have been first instituted among the Franciscans by Saint Bonaventure, general of that order. It is celebrated on the 2d July. A female religious order was founded in Savoy in 1610 by St. Francis de Salis, in honour of the visitation.

VISUAL ANGLE, in Optics, is the angle under which an object is seen, or the angle formed at the eye by the rays of light coming from the extremities of the object. *Visual rays* are the lines of light coming from an object to the eye.

VI'TAL VESSELS. A name given by Schultz to certain vessels ramifying in all directions in plants, especially near the surface, and conveying latex, which that

physiologist calls a vital fluid. The milk-vessels of spurges are vital vessels.

VITE'LLUS. In Botany, a name given to the fleshy sac that is sometimes present in seeds; interposed between the albumen and the embryo, and enveloping the latter. It is the enlarged sac of the amnios.

VITILI'GO. (Lat. vitulus, *a calf.*) A disease of the skin, giving it a white appearance somewhat resembling that of calves.

VI'TIS (Celt. gwid, *a tree*), the grape vine, is doubtless a native of Asia Minor, although its universal cultivation renders it no longer possible to distinguish the wild from the domesticated kinds. It is the type of the Vitaceous order, which consists of plants climbing by tendrils, and producing small green flowers, succeeded by succulent fruit. None of the species are, however, to be compared with the true grape, *Vitis vinifera*, for quality; the best of the American species being disagreeable to the taste, and some of the order even acrid. The reputed varieties of grape are innumerable, if we are to believe the writers on the subject; 1400 being cultivated in the garden of the Luxembourg alone. There is no doubt, however, that many of these are repetitions of each other. When the pulp is fleshy and sweet, and the skin thick, raisins are prepared from the fruit; and when it is watery and less sweet, with a thin skin, grapes are best suited for wine. The currants of the grocers are the dried berries of a small variety of the grape cultivated at Zante.

VITREOUS HUMOUR, so called from its glassy appearance, is the third or interior humour of the eye, filling a large portion of the eyeball, and greatly exceeding in quantity the aqueous and crystalline humours together. According to Sir D. Brewster, the refractive power of the vitreous humour is 1·3394. *See* Optics.

VI'TRIFIED WALLS or FORTIFICATIONS. Ancient remains discovered in Scotland, constructed of stones piled rudely upon one another, and firmly cemented together by some matter which has been vitrified by means of fire. They generally surround the top of some steep conical hill. They have been discovered chiefly in the Highlands, but also in Galloway. The vitrification is mostly external, the interior of the walls being a mere heap of loose stones. Daines Barrington considered the vitrification to be accidental, but his explanation of how it took place is not very intelligible. (*Archæologia*, vol. vi.) It seems more reasonable to suppose that the art was derived from observation of the ease with which some kinds of earth containing much iron ore are vitrified by fire, and that the process was rendered easy by the quantities of wood which in early days covered the Highlands.

VITRI'NA. (Lat. vitrea, *glass.*) A genus of freshwater Gastropods; so called from the extreme thinness and fragility of the shell, and its watery green appearance. *Vitrina pellucida* and *Vitr. elongata* are natives of Great Britain.

VI'TRIOL. (Lat. vitrum, *glass;* from the glassy character of its crystals.) This term is applied by the old writers to crystallized sulphate of iron, or *green vitriol:* sulphate of copper and sulphate of zinc were afterwards called *blue vitriol* and *white vitriol. See* Iron, Copper, Zinc.

VITRIOL, OIL OF. The old name of sulphuric acid, which was originally obtained by distilling green vitriol. *See* Sulphur.

VIVA'CE. (It. *lively.*) In Music, a term which, affixed to a movement, denotes that it is to be executed by the performer in a lively manner. It is a mean between *largo* and *allegro;* but, if any thing, rather nearer the latter than the former.

VIVE'RRIDÆ. (Lat. viverra, *a ferret.*) Civet tribe. The name of a tribe of Carnivorous Mammals, of which the genus *Viverra* is the type. The characters are three premolars above, and four below; two tolerably large tuberculate molars above, one tuberculate and one sectorial molar below; the tongue beset with firm papillæ; claws more or less retracted; a large anal scent-gland and pouch.

VIVI'PAROUS, *Vivipara.* (Lat. vivus, *alive*, and pario, *I bring forth.*) Those animals are so called which bring forth their young developed and alive, and commonly extricated from the egg coverings; as all the Mammalia, which were hence called Zootoka by Aristotle; many reptiles, as the viper or "viviper;" some fishes, and numerous invertebrate animals. In its restricted sense, the term signifies that mode of generation in which the chorion, or external tunic of the ovum, contracts a vascular adhesion with the uterus; and hence only the Placental Mammalia are truly viviparous, the rest being termed ovi-viviparous.

VIZIR. (In Arabic *a porter;* and, by a singular metaphor, the title in various oriental countries of a minister and councillor of state.) The grand khalifs had their vizirs, who attained to the highest rank and consideration in their states, and were often more powerful than their masters; but after the creation of the new dignity of Emir-ul-omrah (commander of commanders), by Khalif Radhi, the older title lost much of its consideration. In Turkey, the councillors of state who sit in the divan, generally eight in number, are styled vizirs; and the chief among them vizir azem, rendered by us by grand vizir, which is the highest temporal dignity in the empire.

VOCA'TION. (Lat. voco, *I call.*) In Divinity, the grace vouchsafed by God to any man in calling him from death unto life, and putting him into the way of salvation. It is also used for the call of the Holy Spirit, by which persons are supposed to be initiated into the clerical order.

VOICE. The sound produced by the vibration of air emitted from the lungs of animals, which vibration is caused by an organ developed in the wind-pipe, called the "larynx." Mammals, birds, and reptiles, are the only animals, which, according to the above definition, possess a voice; but many species of other classes produce peculiar sounds, by which the individuals are attracted to each other, or express their wants and feelings. A true organ of voice includes the lungs, bronchi, trachea, larynx, and mouth. The most essential parts are two vibratile chords bounding a slit-shaped aperture, called the "glottis," and this may be situated at different parts of the air-tube in different animals; the portion of the tube between the glottis and the oral outlet being the true sonorous instrument. In mammals and reptiles the glottis is situated at the end of the wind-pipe, which communicates with the bronchial tubes, and consequently the whole trachea becomes, in this class, part of the vocal instrument. The organ of voice in reptiles consists of a simple larynx, without an epiglottis, and in which the glottis is merely membranous, not provided with fibrous vocal chords. Since neither fleshy moveable lips nor soft palate exist in this class, the voice cannot undergo any farther modification after its formation by the simple larynx. It consequently rarely rises beyond a hiss; and in the frog tribe, where the bones or gristles of the larynx are largest and most complicated, and the vibratile membrane of the glottis is best developed, the voice is only a more or less noisy croak.

In mammals, the air driven by the muscles of expiration from the lungs through the trachea strikes against the two vibratile "vocal chords," which bound the sides of the glottis; and a voice is produced, varying in different animals, according to the power of regulating the degree of tensions of the chords, and according to the size and shape, and various complications of the laryngeal sacculi of the pharynx, of the tongue, and of the mouth and lips.

The superior organization and mobility of the tongue and lips enables man to modify his vocal sounds so as to render them articulate, and adapted to express the ideas which it is his peculiar privilege to form. Although some quadrupeds possess the imitative faculty, and can be taught to do certain tricks, it would seem that the physical condition of their vocal organs is an insuperable impediment to their imitation of the human speech.

The sacculi or membranous pouches which communicate with the larynx in the chimpanzee, orang, and most other quadrumanous animals, together with their thicker and more confined tongues and less flexible lips, are assumed to constitute the impediments to speech in them; but it may be doubted whether they have the imitative faculty for sounds possessed by the parrot or starling; and in respect of their voluntary application of their vocal organs to speech, the absence of any such application is accounted for by presuming that they have nothing to say.

In birds, which possess the most diversified and complicated organ of voice, combined in some species with a high degree of imitativeness, instances are not uncommon, especially in the parrot and crow tribe, of an acquired power of forming articulate sounds superadded to the ordinary voice.

VOIRE DIRE. (Norm. Fr. a corruption of vrai dire, *to speak the truth.*) In Law, according to ancient practice, an objection to the competency of a witness, in a trial at common law, could only be taken on a preliminary examination, in which the witness was sworn *to speak the truth*, and then examined touching his interest in the subject matter. The same practice is still followed occasionally, although the objection may now be taken when it arises on the examination in chief.

VOLATILE ALKALI. *See* Ammonia.

VOLCA'NO. *See* Geology.

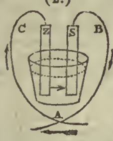
VOLTA-ELE'CTRIC INDUCTION. The term *induction*, as applied to common electricity (of tension), has been explained under the word Electricity. By volta-electric induction, we mean the electricity that is induced by a proximate electric *current*. The phenomena thus produced were discovered by Mr. Faraday in 1831 (*Philos. Trans.*), and were briefly as follows: — A long copper wire was wound in the form of a spiral round a cylinder of wood; a similar, but perfectly separate spiral, was then wound upon the same rod, the coils of each

being interposed and close to each other, but nowhere in contact; the extremes of one of the wires were then connected with the galvanometer, and those of the other with a voltaic battery. At the moment of making the contact with the battery, as well as of breaking it, the deflection of the galvanometer indicated a current of induced electricity in the proximate spiral; but in the interval, that is, whilst the current of electricity was continuing quietly to traverse, no deflection took place: the induced current was found to be in one direction upon making the contact, and in an opposite direction upon breaking it.

VOLTAIC ELECTRICITY. The phenomena resulting from the evolution of electricity by chemical action, as manifested by that important instrument of electro-chemical research called the *Voltaic Battery*, are usually included under the above term. Whenever substances act chemically upon each other, their electrical states are disturbed; but the electricity thus evolved is, in ordinary cases, so lost and dissipated as to escape observation. It may, however, be rendered manifest by the following simple arrangements:—When a plate of pure zinc (or of common zinc rubbed over or amalgamated with mercury) is dipped into a glass of very dilute sulphuric acid, little or no action is observed; nor does any thing happen when a similar plate of silver is placed in the same cup of acid, provided the metals be kept apart from each other. But if, as in the annexed figure, the zinc and silver be brought into contact, at their extremities out of the liquid, the water is decomposed; its oxygen combines with the zinc to form oxide of zinc, which is dissolved by the acid; and its hydrogen passes over to the surface of the silver, where it collects, and ultimately escapes in gaseous globules. These phenomena are further connected with the production of a continuous current of electricity passing *from* the zinc across the water *to* the silver, and again from the silver, by metallic contact, to the zinc, in the direction represented by the darts. It is not necessary that the metals should be connected exactly as represented in the above diagram; but it *is* necessary to the establishment of the continuous electric current that they should be somewhere in contact, or at least connected by what is usually termed a perfect conductor. By modifying (as represented in the margin by fig. 2) the preceding arrangement, so that the metallic contact between the plates be made *out* of the vessel, namely, at the point A, the electric current takes the same direction, travelling through the liquid *from* the zinc or generating plate Z *to* the conducting plate S, and through the wires B and C back again to Z, as shown by the darts. Here again Z is oxidized and dissolved, and hydrogen is liberated upon S; but the moment that the circuit is broken, by parting the wires at A, these actions cease, because the electric current ceases to flow. It is evident that various substances may be interposed between the wires at A, or they may be immersed into different liquids; and provided these are capable of transmitting electricity, the current will still pass, and its phenomena under a variety of circumstances may be studied. In this arrangement the end of the wire B is the *emitting*, and of C the *receiving* point or pole; hence these have been termed, in reference to the common electrical machine, the *positive* and *negative poles*. Mr. Faraday, with a view of avoiding certain misapprehensions to which these terms give rise, calls them the *electrodes;* the positive electrode he further terms the *anelectrode*, and the negative the *catelectrode*. See ANODE.

(1.)

(2.)



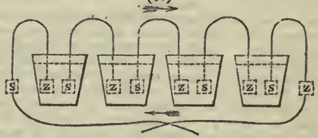
In the preceding paragraph it has been assumed that the generating metal is *zinc*, the conducting or conveying metal *silver*, and that the intermediate liquid is *dilute sulphuric acid*. A number of other metals may be substituted for the above; namely, for the zinc, cadmium for instance, or iron; and for the silver, platinum, gold, or copper. Many liquids may also be substituted for the dilute sulphuric acid; the requisite condition being that one of the metals shall be chemically acted on, whilst the other is indifferent, or at least not acted on by the liquid to the same extent. And the current is always in the direction above represented; that is to say, passes *from* the metal most attacked *to* that least attacked, whenever the communication is perfect or the circle closed. In the above cases also certain forms of charcoal, which are excellent conductors of electricity, may be substituted for the conveying metal, or passive element of the arrangement. Another requisite condition to the phenomena properly called *Voltaic* is, that the interposed fluid shall conduct; and further, that it shall be capable of that form of decomposition which Faraday has designated *electrolysis*, that is, resolvable into its elements by the electric current. See ELECTROLYTE.

Such, then, are the conditions requisite for this evolution of electricity. The existence of the electric current, and its direction, may be rendered manifest in various ways: the most striking is perhaps afforded by its magnetic effects, as exhibited by the galvanometer. See GALVANOMETER and ELECTRO-MAGNETISM.

The *quantity* of electricity generated in the above instances depends chiefly upon the superficial extent of the metals concerned, and upon the activity of the liquid acting upon the generating metal; and that it is considerable, even where small surfaces and weak acids are used, is manifest by the violence with which the magnetic needle of the galvanometer is deflected. But in the above described arrangements, the *intensity* of the electricity is very feeble; and in order to attain this, and to give the current that apparent impetus which it requires to traverse bad conductors, and easily to effect electro-chemical decompositions, it becomes necessary to repeat the metallic alternations; or, in other words, to employ a properly arranged succession of generating, conducting, and electrolytic substances. This leads to the grand discovery of Volta; namely, the construction of the *Voltaic Pile* or *Battery*.

In this arrangement, which, like the simple circles, admits of infinite varieties, the metals generally used are zinc on the one hand, and copper or silver or platinum on the other. The alternations originally adopted by Volta, and which are quite effectual, were zinc, silver, and flannel or pasteboard soaked in acid; and these were repeated according to the effects that were to be obtained. The inconvenience of arrangement led him, however, to various modifications of it; and, among them, to that represented in the following diagram (fig. 3.), which he called the *crown of cups* (couronne

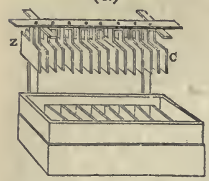
(3.)



des tasses), and which, slightly modified, has since been very generally adopted. The flannel is rejected, and in its place a cup of dilute acid, or other proper electrolyte, is substituted; so that each silver and zinc plate are in metallic communication, though in separate vessels: the arrangement being zinc, acid, silver; zinc, acid, silver, &c. Here the direction of the electric current is the same as in the simple circle, namely, from the zinc through the liquid to the silver; but in this form of the apparatus, for the mere convenience of carrying on the series, the conducting wire connected with the first zinc plate has a supernumerary silver one attached to it, and that with the last silver plate a supernumerary zinc plate; so that much confusion has arisen in regard to the direction of the current in these cases, in consequence of calling what is here the silver extreme the *negative pole*, and the zinc extreme the *positive pole;* whereas it is in fact the reverse, and the circulation of the current goes on through the electrodes precisely as in the simple circle. But though the *direction* of the current is the same, and the absolute *quantity* of travelling or circulating electricity not increased, the case as regards *intensity* is very different; and with numerous series arranged as above we obtain, on removing the electrodes (which in this experiment ought to consist of pointed pieces of well-burned boxwood charcoal) a little from each other, a most brilliant and continuous current of fire, luminous, so that the eye can scarcely endure it, and capable of overcoming obstacles and traversing conductors and electrolytes in a way essentially different from that of the simple circuit. Yet even with all these energetic phenomena, and with a quantity of circulating electricity far beyond any thing which the most powerful frictional machines can afford, the intensity is still insufficient to penetrate a thin layer of card or paper, or to make its way through non-conducting obstacles, as it does in the case of the discharge of the Leyden jar or battery. And now, if the hands be well moistened with salt and water, so as to overcome the non-conducting tendency of the cuticle, and the body be made part of the circuit, an extraordinary and unendurable sensation is perceived, which is in fact a *continuous shock*. By the same means wires may be ignited, metals burned, combustibles exploded, magnets made, and galvanometers affected, at any distance from the pile, provided the conducting communication is perfect. Thus it is that this power has been used to blast rocks, to explode gunpowder under water, and to communicate telegraphic signs, as in the arrangement of Professor Wheatstone.

The modification of Volta's couronne des tasses, and the form of voltaic apparatus in most general use, is the annexed (fig. 4.), in which the plates are attached, in proper order and connection, to a piece of dry wood, so that they may at once be plunged into the cells of the porcelain trough over which they are suspended. Sometimes also plates of zinc and copper soldered together are cemented into a wooden trough with intervening cells, which, when required for action, are filled with proper acid or saline solutions, as shown in fig. 5.

(4.)



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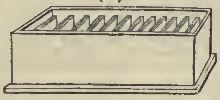
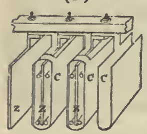


An important modification, as regards the arrangement of the plates of fig. 4., introduced by Dr. Wollaston, is represented in fig. 6.; in which the copper plate, instead of being single, is doubled over the zinc plate, actual contact being prevented by wooden cylinders placed between them. In this way much of the electricity lost in the preceding arrangements is brought into circulation.

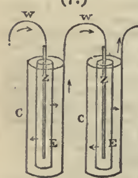
(6.)



But the most important modification of this instrument is that suggested by Mr. Daniell, and which he terms "a constant battery." In all the preceding arrangements the electrical power is liable to fluctuation; and after a time various causes induce such a falling off of its evolution as to render them inconvenient, or even useless, where continuous or regular action is required. In Wollaston's battery, for instance, which is the best of them, several circumstances combine to render it inconstant in its action: the adhesion of hydrogen to the copper plate, and the precipitation of zinc upon it, the saturation of the acid by oxide of zinc, and the ocal action which common zinc induces, are perhaps the principal sources of the above-mentioned irregularity and inconstancy. In Mr. Daniell's arrangement those inconveniences are to a great extent obviated; and although it is more complicated than the preceding, its constant and regular action, when it is properly constructed, amply repays the additional trouble and expense: there are, indeed, many investigations which can scarcely be carried on without it.

The annexed diagram, fig. 7., which is intended to represent two cells of the constant battery, may perhaps serve to illustrate the arrangement.

(7.)



C C are cylindrical vessels of copper; E E smaller cylinders or tubes of porous earthenware; Z Z are rods of amalgamated zinc, which are connected by the wires W W with the next copper cylinder, and so on in succession. The porous tubes are filled with dilute sulphuric acid (about 1 part of acid to 8 of water); and the copper cylinders are filled with a strong solution of sulphate of copper, also acidulated by sulphuric acid: so that the acid in the generating cells is separated from the solution of sulphate of copper; but the porosity of the tubes allows of their becoming so far imbued with the acid liquid as to admit of the passage of electricity, the current being in the direction of the darts. At the same time the sulphate of zinc is prevented mixing with the sulphate of copper, and thus all precipitation of zinc upon the copper prevented; while at the same time the hydrogen evolved in the copper cells or cylinders tends to reduce the oxide of copper, and continuously to throw down a film of metallic copper, with which they ultimately become lined. In proportion as the sulphate of copper is decomposed fresh portions of that salt are added, and the acid in the generating cells requires occasional renewal: for the former purpose there is a perforated receptacle or colander in the upper part of the copper cell, which is kept filled with crystals of sulphate of copper. (See *Daniell's Introduction to Chemical Philosophy*, p. 438.)

It has already been stated that, in all the ordinary forms of the voltaic battery, two metals and an acid dissolved in water are the essential elements. But it is by no means necessary that two metals should be employed to obtain an electric current; for if only one metal be used, different parts of which are differently acted on by an acid or other fluid, electricity will be evolved, according to the same law, the portion of the metal most acted on becoming the *generating* element. Thus, a current is established when a plate of clean zinc and one of oxidized or corroded zinc are used; or even when one of the plates is of cast and the other of rolled zinc. So also when a stick of copper, clean at one end and corroded at the other, is immersed in dilute nitric acid, an electric current is produced. In all these cases the surface most open to chemical action corresponds to the zinc, and that least so to the silver of the above described simple circles.

An electric current is also manifested when a single plate of metal of uniform surface is acted on by two fluids exerting distinct chemical actions upon it. If, for instance, a vessel be half filled with a strong solution of sulphate of copper, and then carefully filled up with dilute sulphuric acid, so that the latter may lie upon but not mix with it, a plate of iron immersed will be so acted on as to produce an electric current; the upper part becoming the equivalent of the zinc, and the lower that of the copper in the simple circle. A plate of copper immersed in the same way will produce a similar effect, and metallic copper will be deposited upon its lower end. (See *Faraday's Researches, Philosophical Transactions*, 1840.)

The chemical powers of the electric currents produced by and circulating under the circumstances above detailed are, to a certain extent, manifest by the phenomena of the pile itself; but they are more especially illustrated by interposing different substances between the electrodes in proper vessels, so that the changes which they suffer in the axis of the electric current may be more conveniently and distinctly observed. Under these circumstances, we find that all electrolytes must, to a certain extent, be conductors; and that the same body in different states may either be or not be an electrolyte, according as it has or has not a power of conduction. Thus *water* is a conductor and an electrolyte; but *ice* is a non-conductor, and therefore unsusceptible of electrolysis. So also nitre, chloride, iodide, and bromide of silver, and many other salts, require to be *fused* in order to become susceptible of electrolytic action. It would moreover appear probable, from Faraday's researches, that all bodies susceptible of true or primary electrolytic action (electric decomposition) must be compounds of single atoms, or equivalents of their components (*proto-compounds*): thus protochloride and protoiodide of tin are decomposed, but the bichloride and biniodide are not. Of this phenomenon the ultimate cause requires further investigation. The principal apparent exceptions to it have beeen ranked by Faraday among cases of *secondary decomposition*. Thus when common sulphuric acid, or oil of vitriol (which is a compound of 1 atom of sulphur, 3 of oxygen, and 1 of water, or the ultimate elements of which are 1 atom of sulphur, 1 of hydrogen, and 4 of oxygen), is subjected to the electric current, sulphur and hydrogen appear at the cathode (or negative electrode), and oxygen at the anode (or positive electrode). But in this case the sulphur is the result of the action of the hydrogen upon the acid; for in all cases of true or primary electrical decomposition of the sulphurets, the sulphur is evolved at the anode.

Not only, however, are the ultimate elements of binary compounds thus evolved in obedience to certain uniform laws, but *proximate* elements are also similarly separated. Thus when sulphate of soda, nitrate of potassa, and other neutral salts, are subjected in aqueous solution to the action of the current, the respective acids travel with the oxygen to the anode, and the alkalies, oxides, or bases, with the hydrogen to the cathode. Faraday terms substances susceptible of these transferences *ions*, and those which go to the anode *anions;* those to the cathode *cations:* thus doing away with the less definite terms of *electro-negative* and *electro-positive* bodies. And he has drawn up the following table of simple and compound anions.

Anions.

Oxygen.	Sulphuric acid.
Chlorine.	Phosphoric acid.
Iodine.	Carbonic acid.
Bromine.	Nitric acid.
Fluorine.	Selenic acid.
Sulphur.	Chloric acid.
Selenium.	Boracic acid.
Cyanogen.	Acetic acid.
Sulpho-cyanogen.	Tartaric acid.
	Citric acid.
	Oxalic acid.

Cations.

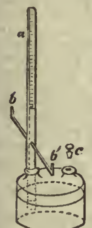
Hydrogen.	Nickel.
Potassium.	Antimony.
Sodium.	Bismuth.

Lithium.	Mercury.
Barium.	Silver.
Strontium.	Platinum.
Calcium.	Gold.
Magnesium.	Ammonia.
Manganese.	Potassa.
Zinc.	Soda.
Tin.	Lithia.
Lead.	Baryta.
Iron.	Strontia.
Copper.	Magnesia.
Cadmium.	Alumina.
Cerium.	Protoxides generally.
Cobalt.	Vegeto-alkalies generally.

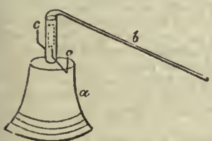
Analogy leads us to assume that all elementary bodies are *ions;* but this has not been experimentally proved in regard to carbon, phosphorus, nitrogen, silicon, boron, and aluminum.

VOLTA'METER. (Ital. volta, and Gr. μετρον, *a measure.*) An instrument contrived by Mr. Faraday for measuring the voltaic electricity passing through it, and which, being interposed in the course of the current used in any particular experiment, serves as a *comparative standard* of effect, or as a *positive measurer* of the electricity.

The indicating body used in this instrument is water acidulated by sulphuric acid. The electrodes are plates of platinum; and the quantity of electricity which has passed is indicated by the quantity of the mixed gases (oxygen and hydrogen, resulting from the decomposition of the water) evolved, or, in other words, by the weight of water decomposed. When the quantity of evolved gases is small, the voltameter represented in the margin is a good form: *a* is a graduated straight tube closed at the upper end, and including two platinum electrodes, connected with the external wires *b b*. This tube is fitted by grinding into one mouth of the double-necked bottle containing the acidulated water, and is filled by inclining it; so that when an electric current is passed through it the gases evolved collect in the upper part of the tube and displace the dilute acid, the stopper *c* being left open. When the graduated part of the tube is filled with the mixed gases the electric current may be broken by removing the wires connected with *b b*, the stopper *c* replaced, and the meter-tube refilled by inclining the instrument; a second measure of the gases is then collected on re-establishing the circuit, and so on.



When large quantities of the mixed gases are to be measured, as in cases where the current is left continuous for several hours or days, a voltameter in the form of a small retort may be used, set up in the block or foot *a*, and the evolved gases will then pass by the tube *b* into the common pneumatic trough, where they may be received into a graduated jar and measured: *c c* are the projecting wires by which communication is made with the platinum electrodes.



In using these and similar forms of apparatus for the electro-chemical decomposition of water, great care must be taken that the electrodes are kept continually covered by the water, and that their ends are never exposed to the mixed gases in the tube; for in that case they would be apt to become heated, and even incandescent, in consequence of the peculiar action of clean platinum on a mixture of hydrogen and oxygen, and in such a case an explosion might ensue. In these voltameters the contact of the electrodes is prevented by inserting between them a small piece of glass tube.

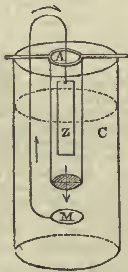
VO'LTATYPE, or ELECTROTYPE. It has been stated under the article on VOLTAIC ELECTRICITY, that when metallic solutions are subjected to the transmission of the electric current, the metallic oxides which they hold are in certain cases decomposed; so that the metal in its pure state is deposited upon the cathode, or upon what is usually termed the negative electrode. In these cases the metallic deposition is usually a secondary effect, arising out of the action of the hydrogen evolved at the cathode upon the oxide of the metal. A good illustrative experiment of this metallic precipitation consists in plunging two pieces of clean platinum into a solution of sulphate of copper: nothing happens. But if the electric current be transmitted through the solution, so that these platinum plates may form the electrodes, copper is immediately precipitated upon the catelectrode or negative surface, the positive surface or anelectrode remaining clean. If the current be now reversed, the copper will be removed from the platinum plate upon which it had just been deposited, and will be transmitted to the clean plate; and thus by reversing the direction of the electric current, the copper may be sent backwards and forwards, it always being deposited upon the negative pole, or, in other words, upon that surface by which the electric current leaves the electrolyte. A solution of sulphate of copper is particularly well adapted to this experiment, especially if it be slightly acidulated by sulphuric acid, inasmuch as it deposits the copper in a clean metallic state; and by a continuance of the electric current, and keeping up the strength of the solution by the occasional addition of fresh portions of the salt of copper, the metallic film upon the cathode may be obtained of any required thickness, and may afterwards be peeled off the platinum surface. The texture of the deposited copper varies with the power employed and with the temperature and strength of the solution; so that it may be obtained hard, brittle, and crystalline, or malleable and tough, or even pulverulent, according to the management of the operator. A low electric power, or rather a current of low intensity, a moderately strong acidulated solution of sulphate of copper, and a temperature not below 60° or 70°, are the circumstances under which the best deposit of copper is usually obtained for the purposes to which this process is commonly applied.

When the negative pole or cathode, instead of being, as above represented, a plane surface of platinum, is irregular, or worked into a pattern, or a medal or coin for instance, an exact impression of the irregularities of surface, or of the device upon the medal or coin, may be taken off on the precipitated copper; and to copies or plates of this kind the term *voltatype*, or *electrotype*, has been more particularly applied. Gold, silver, and other metals may, by proper management, be substituted for copper, and thus a variety of voltatypes may be obtained; or, if the precipitated metal be left upon the surface on which it is thrown down, gilding, silvering, and coppering may be extensively and beautifully effected. Thus it is that a new art of *plating* has arisen also out of these electro-chemical actions.

We shall now proceed briefly to point out the manipulation in a few of the principal applications of this new art, and to describe the apparatus commonly employed; illustrating the subject, in the first instance, by one of the simplest cases, in which we will suppose that an impression in copper is to be obtained from a copper medal, which, being in relief, will of course yield an impression in indent: the original being a cameo, the copy will be an intaglio.

The medal is first slung in a loop of annealed copper wire, so that it may be conveniently suspended and made electro-negative in the metallic solution; the following simple voltaic arrangements may then be used.

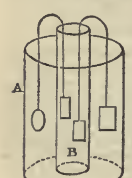
A is a glass cylinder (a common lamp-glass answers the purpose), closed at bottom with a piece of bladder, or with a plug of plaster of Paris, and filled with dilute sulphuric acid (1 of acid to 8 of water by measure); Z is a piece of zinc immersed in the acid, and connected by a copper wire with the medal M; C is a jar nearly filled with a strong solution of sulphate of copper, acidulated by the addition of about a tenth part of sulphuric acid. In this arrangement, the acid in the generating cell is prevented mixing with the solution in the jar by the diaphragm of bladder or plaster; which, however, when thoroughly wetted, suffers the electric current to pass from the zinc to the medal (or negative pole), and so through the wire, in the direction of the darts, back to the zinc. In this way a film of metallic copper is gradually thrown down upon M, which goes on increasing, and which, when it is sufficiently thick (perhaps in 24 or 30 hours), the wire with Z and M at its ends is lifted out; and by the point of a knife carefully applied, and aided, if necessary, by a file, the deposited copper is pulled off of M, of which it presents a faithful and minute copy or impression. To prevent the deposition of copper upon the edges, and upon the reverse of the medal, those parts should be covered with a varnish not acted upon by the solution; and the connecting wire should also be similarly varnished, to prevent its receiving an unnecessary incrustation of copper. In this way, by careful management, any number of impressions may be taken from either side of a medal without materially injuring the original; and for the medal any other metallic plate may be substituted, provided its dimensions and weight be not such as to render it inadmissible or inconvenient in this form of apparatus.



But it often happens that the article to be *voltatyped*,

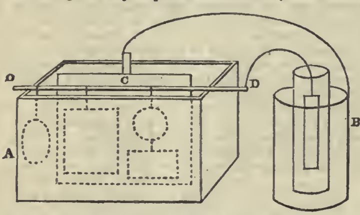
as this process is now called, is not a conductor of electricity; as, for instance, a seal, or sulphur or wax impression, or a plaster cast of a medal or coin. In these cases the surface is carefully covered by a film of the purest plumbago, or black lead, which is applied by a soft brush, and which, being a good conductor of electricity, renders the surface equivalent to that of a metal, care being at the same time taken that the conducting wire is in good contact with the plumbago, so that the electrical current may be nowhere intercepted by a non-conductor. Where the material of the cast is porous, or permeable to water, it must be imbued with melted wax or oil, or some kind of fatty matter; where plaster casts are used, melted spermaceti answers best: the surface to be voltatyped is then carefully blackleaded, and the process carried on as above. The use of black lead, so extremely convenient in these and a number of similar cases, was first suggested by Mr. Robert Murray, and communicated by him to the Society of Arts, who awarded a medal for the invention.

In the case of seals, coins, and other small articles, a number of them may be put in process at once by the following modification of the above described apparatus. A is a jar filled with a saturated and slightly acid solution of sulphate of copper; B is a porous earthenware cylinder, similar to those used in Daniell's constant battery, filled with dilute sulphuric acid. The articles to be coated with copper are prepared as above described, and attached to copper wires having a small piece of zinc at their other end; several of these may then so be suspended round the porous tube as that the zinc being in the acid, and the coin or seal in the cupreous solution, the process goes on until the voltatype is perfect.



When a number of articles of different sizes are to be voltatyped, the following is the preferable arrangement, and is that which is generally used where the process is employed upon a large scale; as in preparing voltatypes from wood-cuts, copper-plates, plaster casts, &c.

A is a trough of any required dimensions, made of slate



or wood, and filled with a proper solution of sulphate of copper; C is a copper-plate immersed in the trough, and forming the positive electrode of the constant battery B (of which one cell only is here represented, but of which two or more may be employed as required); D D is a copper rod forming the negative electrode, to which the articles to be coated with copper are suspended by copper wires. These several articles, previously properly prepared by the means above described, are retained in the circuit till adequately coated by copper. In this form of apparatus it is not necessary to provide against the impoverishment of the cupreous solution; for in proportion to the quantity of copper deposited upon the moulds is that which is taken up from the plate C, and when this plate is so far dissolved as no longer to form an effective electrode it must be replaced by another.

Where other metals are to be employed, proper solutions must be selected for the purpose, and the electric power modified accordingly: the weakest power, consistent with the precipitation of the metal and the non-evolution of hydrogen at the negative electrode, is that which is generally to be preferred. For gilding copper or silver, the solution which is generally employed is a double cyanide of gold and potassium: it is made by dissolving about 60 grains of sulphuret or of oxide of gold in a pint of a solution of cyanide of potassium containing 1 part of the cyanide to 10 of water. The sulphuret of gold is prepared by precipitating a solution of perchloride of gold by sulphuret of potassium, and washing the precipitate with hot water: the oxide of gold may be similarly prepared by precipitating the solution of the chloride by carbonate of potassa at a boiling heat. With this solution silver and copper may be effectively gilded, and the thickness of the coat of gold may be carried to any required extent. If it be desired to gild the inside of a silver vessel, the vessel may be filled with the gilding solution, and connected by its outside with the negative electrode, a plate of gold immersed into the centre of the solution in the vessel constituting the positive electrode.

For covering or plating articles with silver, a solution of 60 grains of chloride or of oxide of silver in a pint of the solution of cyanide of potassium of the strength above stated is to be used. In this case the article which is to receive the deposit is made the negative electrode, and a plate of silver may be used as the positive electrode. Here, as in the case of gold, the plating may be carried to any extent, and articles from which the silver has been abraded by wear may easily be replated.

In all cases where silver or gold is to be thus voltaically deposited so as to give a durable adhesive coating, the receiving surfaces must be perfectly clean; hence the necessity of dipping them in the first instance into warm aquafortis (or nitric acid diluted with three or four parts of water), and then washing them in a large quantity of pure water, previously to putting them into the solution: it is also generally right to make the connection with the battery, and immerse the positive pole, previous to putting the article into the depositing liquid. Messrs. Elkington of Birmingham, who have patented these operations, have produced a number of beautiful specimens both of gilding and silvering, and have largely applied them in numerous processes of the arts.

Mr. Palmer of London has made the most important applications of these precipitations to the purposes of the fine arts, in voltatyping the plates of engravings executed by the first artists. In these cases much care and dexterity are required in the manipulations, but the results are then beautifully perfect. The first impression of the etched or engraved plate is of course in relief, and serves as a *matrix*, from which any number of impressions in indent (or fac-similes of the original plate) may be obtained. Mr. Palmer has also invented various modifications of the process, full descriptions of which would be inconsistent with our present object, but which promise to render it much more extensively subservient to the purposes of the fine and useful arts. Messrs. De la Rue have also carried these processes to great perfection, and have extensively multiplied their applications to various purposes of ornamental printing. (See the article VOLTAIC ELECTRICITY in this Dictionary. Also Mr. Smee's *Elements of Electro-Metallurgy*, whose platinized silver battery is well adapted to most of the preceding operations.)

VO'LTI. (It. *turn*.) In Music, a term directing that the leaf is to be turned over.

VO'LUME. (Lat. volumen, from volvo, *I roll*.) A book. Thus a library is said to consist of so many thousand volumes, and a long work is divided for convenience into several volumes. Every single roll of paper or parchment, in an ancient library, was of course equivalent to a single book in one of our own; hence the name is derived. It should seem that the *books* (in the sense of divisions of the subject) of ancient works were originally actual volumes; so that the *History* of Herodotus or *Iliad* of Homer consisted of as many volumes, in ordinary writing, as books. The French word *tome* (signifying, properly, a single volume of a work containing more than one) is derived from the Greek *τεμνειν*, *to cut* or *divide*.

VOLU'TA. (Lat. voluta, *a wreath*.) A name applied by Linnæus to a genus of the *Vermes Testacea*, including those which have a univalve spiral shell, with an aperture without a beak, and somewhat effuse; and a columella twisted or plaited, generally without lips or perforation. The Mollusca thus characterized form a family in the Buccinoid tribe of the Pectinibranchiate Gastropods of Cuvier's system, and are distributed into the following subgenera:—*Oliva*, Brug.; *Volvaria*, Lam.; *Voluta* proper; *Cymbium*, Montf.; *Marginella*, Lam.; *Colombella*, Lam.; *Mitra*, Lam.; *Cancellaria*, Lam.

VO'LUTE. (Lat. volvo, *I roll*.) In Architecture, the spiral scroll appended on each side to the capital of the Ionic order. The Corinthian and Composite capitals are also decorated with volutes; but their character is different, their size smaller, and they are always diagonally placed. In the Corinthian order they are more numerous, and in the Composite they are larger than in the Corinthian.

VO'LVA, or WRAPPER. A term used in describing fungi to denote the involucrum-like base of the stipes of *Agaricus*. It was originally the bag enveloping the whole plant, but was left at the foot of the stipes when the plant elongated and burst through it.

VO'LVULUS. (Lat. volvere, *to roll up*, because it was supposed to arise from twisting of the intestines.) *See* ILIAC PASSION.

VO'MICA. (Lat. vomo, *I spit up*.) An abscess of the lungs.

VOMITO'RIA. (Lat. vomo.) In Architecture, the openings, gates, or doors, in the ancient theatres and amphitheatres, which gave ingress and egress to the public.

VO'RTEX. (Lat.) An eddy or whirlpool; a body of water running rapidly round and forming a cavity in the middle, into which floating bodies are drawn. The term is also applied to whirlwind. In the Cartesian philosophy, vortex signifies a collection of material particles, forming a fluid or ether, endowed with a rapid rotatory motion about an axis. By means of this hypothesis, and the received doctrine of centrifugal forces, a plausible explanation may be given of the motion of the planets, which move nearly in the same plane; but the motions of the comets which traverse the heavens in all directions are inexplicable, and in fact are inconsistent with the hypothesis. Descartes, nevertheless, had the merit of attempting to show how the universe might have assumed its present form and be preserved on mechanical principles. For an explanation of the system of vortices, see *Maclaurin's Account of Newton's Philosophical Discoveries.*

VO'RTICEL, *Vorticella.* (Lat. vortex, *a whirlpool.*) The generic name of certain pedicellate Wheel Animalcules, which are provided with vibratile organs at their anterior extremity, whose apparently rotatory actions produce little whirlpools in their vicinity, and thus attract the particles of food.

VO'TIVE. (Lat. votum, *vow.*) In Numismatics, votive medals are such as were struck in grateful commemoration of any auspicious event, such as the recovery from sickness of a prince, &c.; especially those of the Roman emperors, struck every five, ten, or twenty years, on which the public vows on their behalf are recorded. The custom is said to have originated in the repeated continuance of Augustus in his high offices at the prayers of the people. A votive tablet, picture, &c., is one dedicated in consequence of the vow of a worshipper; in classical Europe to some deity, in modern Roman Catholic countries to saints.

VOU'SSOIRS, in Bridges, are the stones which immediately form the arch, being of the shape of a truncated wedge. Their under sides form the intrados or soffitt. The length of the middle voussoir, or keystone, ought to be about 1-15th or 1-16th of the span, and the rest should increase all the way down to the imposts. Their joints should be cut perpendicular to the curve of the intrados; consequently the angle of the sides is determined by the curvature. (*Hutton's Tracts*, vol. i.)

VOW. (Lat. voveo, *I vow.*) A promise made to God of a thing which we believe to be agreeable to him, and which we are not on other grounds obliged to render to him. This is what the Theologians understand by it, when they say a vow is "promissio de meliore bono." To promise God to do what he commands, or to avoid what he forbids, is not a vow, because we are under an obligation so to act. (*Dict. de Theologie*, Toulouse 1817.) The use of vows is found in most religions. The Roman Catholics adduce numerous passages from the Old Testament to prove that vows are acceptable to God; the Protestants on the other hand reject the theory of vows as altogether untenable.

VOW'EL. In Grammar, a letter which can be pronounced alone, thus distinguished from consonants, which require to be sounded with the aid of a vowel. They are divided in ancient prosody into long, short, and common (ancipites), *i. e.* either long or short at pleasure. A diphthong consists of two vowels, of which the sounds run (or are supposed to run) into one another.

VU'LCAN. In Mythology, the Latin name for the divinity called by the Greeks Hephæstus, — the god who presided over the working of metals. He was also called Mulciber. He was the son of Jupiter who, incensed at his interference on the part of his mother Juno, cast him out of heaven: he fell in the isle of Lemnos, and broke his leg in the fall. His feats as the patron of armourers and workers in metal, his marriage with Venus, and her infidelities, form the subjects of many of the best known classical stories. (See Bryant, *Anc. Myth.* vi. 115.) There is about the character of Vulcan much of the usual confusion belonging to Greek mythology. Cicero mentions three Vulcans, besides the son of Jupiter: one, the child of Uranus; another, of Nilus, who reigned in Egypt; a third, of Mænalius. A peculiarity attending the worship of Vulcan was, that the victims were wholly consumed, in reference to his character as God of Fire. In sculpture, he is represented as bearded, with a hammer and pincers, and a pointed cap. He does not appear lame, as represented by the poets. Cicero, however, praises the sculptor Alcamenes for making his lameness observable without amounting to deformity. The description of his cavern in the Isle of Vulcan, or Hiera, in the 8th Book of the *Æneid*, is among the best known passages in classical poetry.

VU'LPES. (Lat. *a fox.*) This has been made a subgeneric term by those naturalists who so distinguish the foxes from the dogs, jackals, and wolves, to which they consequently restrict the term *Canis*. The grounds for the proposed distinction are chiefly the form of the pupil of the eye, which is vertical in the foxes, circular in the dogs; the lobes of the upper incisor teeth are less distinctly marked than in the dog; the tail of the fox is longer and more bushy; its head broader, and terminated by a narrower and more pointed muzzle; its gait and attitude crouching.

VU'LPINITE; so called from Vulpino, near Bergamo in Italy, where it is found. An anhydrous sulphate of lime, containing a little silica. It is sometimes employed by the Italian artists for small statues and other ornamental work, under the name of *marmo bardiglio.*

VU'LTUR. (Lat. *a vulture.*) The name of a Linnæan genus of diurnal Accipitrine birds, characterized by an elongated beak, curved only at the extremity, and by having a greater or less proportion of the head, and sometimes of the neck, denuded of feathers. To the brief Linnæan phrase descriptive of this genus it may be added, that the power of the claws does not correspond with the bulk of the body. The wings are so long that they are carried in the half-extended state when the vulture walks on the ground. In general, the birds of this group are of a cowardly nature, living on dead carcasses and offal; their gullet dilates into a considerable crop, which, when distended with garbage, projects above the furcular bone. When gorged with food a fœtid humour is discharged from the nostrils, and the bird is reduced to a state of stupidity. The vultures of Linnæus are divided into the subgenera *Vultur*, Cuv.; *Cathartes*, Cuv.; *Sarcoramphus*, Cuv.; *Percnopterus*, Cuv.; *Gypaëtus*, Storr.

W.

W. A letter found only in the alphabets of modern languages. In form, it resembles two Vs, and its English name is derived from the fact of the letter *v* being identical with *u* in the Latin, and in the more early form of the English language. In German, *w* is pronounced like the English *v*; the latter having the sound of *f*. When *w* commences a syllable, it is a consonant; but in all other positions a vowel.

WACKE. (German.) A modification of basalt.

WAD, or WADDING. In Gunnery, a bundle of paper, tow, old rope-yarn, or other loose matter, rolled up closely together, and rammed into a gun after the powder to keep it close in its chamber. From the experiments of Dr. Hutton it does not appear that the wadding has any effect in increasing the force of the charge.

WADD. A name occasionally given to plumbago, and also to an ore of manganese found in Derbyshire, which when mixed with linseed oil for the purpose of a paint is apt to take fire.

WA'DERS, WADING BIRDS, *Grallatores.* An order of birds, including those which have long legs naked from above the distal or lower extremity of the tibia downwards. *See* GRALLATORES.

WA'DSETT. In Scotch Law, a right by which goods are pledged for the recovery of a debt, answering to the English mortgage.

WA'GER OF BATTLE. The usage of deciding a civil suit by battle was common to the jurisprudence of many of the Teutonic tribes which established themselves in the provinces of the Roman empire. It was especially favoured among the Lombards; and there is a celebrated passage in the laws of their king Luitprand, in which, while he recognizes the impiety of the custom, he professes his inability to abolish it in consequence of the prejudices of his subjects. In England, battle trial is not mentioned in any Anglo-Saxon laws now extant; and its introduction is therefore attributed to William the Conqueror, although bearing in his laws the Saxon name of "orneste," probably *earnest.* (See *Sir F. Palgrave on the British Commonwealth*, chap. vii., who believes that the Conqueror did no more than confirm a usage already known to the inhabitants of England. He supposes that battle in civil suits was regularly joined in the Anglo-Saxon county courts.) Trial by battle, by the English common law, was used in civil cases only, where issue was joined upon a writ of right, in which the tenant pleaded the general issue, viz. that he had more right to hold than the demandant to recover, which he offered to prove by the body of his champion; for in civil actions the combat was not between the parties themselves. The champions were armed with batons and targets, and the combat took place before the judges and serjeants of the Court of Common Pleas. The combatants were bound to fight until the stars appeared in the evening; and if the champion of the tenant could either hold out so long, or obtain the victory, the tenant prevailed in his cause. Victory was obtained either by the death of the champion, or by his pronouncing the horrible word "craven," which caused his principal the loss of his land, and legal infamy to himself. The trial by battle was the only mode of deciding a writ of right, until Henry II. introduced the grand appeal or trial by inquest, and gave the tenant his choice between them. The last trial by battle in the Court of Common Pleas was in the 13th Elizabeth, 1571; but in the Court of the County Palatine of Durham

there was one in 1638. Trial by battle in criminal cases is explicitly noticed in the laws of the Conqueror. It took place on an *appeal*, when the appellee of felony pleaded not guilty, and declared he would defend the same with his body: as in *approvement*, when a party arraigned of treason or felony having become an approver by appealing, or accusing his accomplices, the latter might in the same manner demand trial by battle; in which case the combat was between the parties themselves. The last trial by battle awarded in this country was in the case of Lord Reay and Mr. Ramsay, in the 7th of Charles I.; but the king, after having appointed a constable to preside, revoked the commission. In 1818, William Ashford having brought an appeal against Abraham Thornton for the murder of his sister, the appellee waged his battle. Judgment was stayed, in consequence of a legal difficulty which arose in the case; and in the following year an act was passed, by which appeals of treason, felony, and other offences, and trial by battle on writs of right, were abolished.

WAGER. In Law, wagers are valid, and may be made subjects of action, unless they are on illegal matters. Illegal wagers are of two kinds: such as are rendered expressly void by statutes, and such as have an illegal or immoral tendency. To the first class belong wagers on the event of prohibited games; wagers on horse races, if the sum betted by either party be above 10*l*., or on any horse race not a bonâ fide race on the turf; of the latter class many instances might be given. Anything that incites to a breach of the peace or to immorality, or that has a tendency to annoy the feelings of another or cast ridicule on him, is not a legal subject of wagers. Wagers on merely speculative subjects, not arising out of circumstances in which the parties have an interest (for instance, on a point of law, or on the amount of a branch of the public revenue), are of too trivial characters to be enforced by legal proceedings. When a wager is illegal, both parties may recover back their deposits from a stakeholder.

WAGER OF LAW. *See* COMPURGATION.

WA'GES, in Political Economy, are the return made or compensation paid to those employed to perform any kind of labour or service by their employers.

In ordinary language, the term wages is usually employed to designate the sums paid to artizans or labourers employed in manufactures, in household services, and in agriculture, mines, and other manual occupations. Substantially and in fact, however, it has a much more extensive application: the salaries of public functionaries of all sorts, and the fees of lawyers, physicians, and other professional men, are as really wages as the sums paid by them to the menials in their service, and depend on the same laws and principles. "Every man," says Dr. Paley, "has his work. The kind of work varies, and that is all the difference there is. A great deal of labour exists besides that of the hands, many species of industry besides bodily operation, equally necessary, requiring equal assiduity, more attention, more anxiety. It is not true, therefore, that men of elevated stations are exempted from work; it is only true that there is assigned to them work of a different kind; whether more easy or more pleasant may be questioned; but certainly not less wanted, nor less essential to the common good." (*Assize Sermon*, July 29, 1795.)

Rates of Wages in different Employments. — The wages paid to the labourers engaged in different employments differ so very widely, that at first sight it may seem to be impossible to lay down any principles that should be generally applicable to them all. Such, however, is not the case. The differences in question are apparent rather than real; and when the various favourable and unfavourable circumstances connected with different employments are taken into account, it will be found that the wages or earnings of those engaged in them are very nearly the same.

If all employments were equally agreeable and healthy, if the labour to be performed in each was of the same intensity, and if each required the same degree of dexterity and skill on the part of those employed, it is evident, supposing industry to be quite free, that there could be no permanent or considerable difference in the wages of labour; for if those employed in a particular business were to earn either *more* or *less* than their neighbours, labourers would, in the former case, leave other businesses to engage in it; and in the latter, they would leave it to engage in others, until the increase or diminution of their numbers had lowered or elevated wages to the common level. In point of fact, however, the intensity of the labour to be performed in different employments, the degree of skill required to carry them on, their healthiness, and the estimation in which they are held, differ exceedingly; and these varying circumstances necessarily occasion proportional differences in the wages of the workmen engaged in them. Wages are the price paid to the labourer for the exertion of his physical powers, skill and ingenuity. They, therefore, necessarily vary according to the severity of the labour and the degree of skill and ingenuity required. A jeweller or engraver, for example, must be paid a higher rate of wages than a common farm-servant or a scavenger; for a long course of training being necessary to instruct a man in the business of jewelling and engraving, were he not indemnified for the cost of this training by a higher rate of wages, he would not think of learning so difficult an art, but would addict himself in preference to such employments as hardly require any instruction. Hence the discrepancies that actually obtain in the rate of wages are confined within certain limits, increasing or diminishing it only so far as may be necessary fully to countervail the unfavourable or favourable peculiarities attending any employment.

The following, according to Dr. Smith, are the principal circumstances which occasion the rate of wages, in some employments, to fall below or rise above the *general average* rate of wages: —

1st. The agreeableness and disagreeableness of the employments.

2d. The laziness or cheapness, or the difficulty and expense of learning them.

3d. The constancy or inconstancy of the employments.

4th. The small or great trust that must be reposed in those who carry them on.

5th. The probability or improbability of succeeding in them.

It would be useless even if our limits permitted to enter into any lengthened details with respect to the variations in the rates of wages arising out of the particular circumstances now enumerated. They have been fully illustrated by Smith in the 10th chapter of his first book. Every one must see that, *cæteris paribus*, those engaged in a disagreeable or disreputable employment must have greater wages than those engaged in such as are comparatively agreeable and respectable. Wherever a comparative disadvantage attaches to any branch of industry, it must be compensated to those engaged by higher wages or profits, or both, otherwise they would withdraw wholly from it. And on this principle it is plain that those engaged in a business or profession which it costs a great deal to learn must be more amply remunerated than those engaged in a business that may be learned with comparatively little trouble and expense. Inconstancy of employment must also, it is obvious, be indemnified by a higher rate of wages during the period of employment; and greater trust by requiring higher character must also be remunerated by higher wages. The probability or improbability of success in different employments applies mostly in the higher departments of industry. The instances are rare in which a person who is bound apprentice to a tailor, shoemaker, or other individual engaged in an ordinary business, fails of acquiring sufficient proficiency to enable him to live by it. But it is far otherwise in the higher departments; and supposing an individual is bound apprentice to a lawyer, physician, painter, sculptor, player, &c., the chances are more than twenty to one that he will not attain to distinction in his profession, and perhaps five to one that he will not be able to live by it. But, in professions where so many fail for one who succeeds, that fortunate one should gain not only what will indemnify him for the expenses of his education, but also all that has been laid out on the education of his unfortunate competitors. Hence the comparatively large earnings of successful lawyers, physicians, players, and so forth; though it be, after all, abundantly certain that they hardly compensate for the losses of the unsuccessful candidates for wealth and honours.

It will be found, therefore, taking all the circumstances into account, that the rates of wages in different employments approach pretty near an equality; and that the higher rate in some, and lower rate in others, is uniformly occasioned by certain contingent circumstances.

But without insisting farther on the causes of variation from the common standard, we shall now proceed shortly to inquire into the circumstances which determine this common standard, that is, into the circumstances which determine the rate of wages paid to labourers engaged in the common and ordinary departments of manufacturing and agricultural labour, or in such as require no peculiar skill or other superior quality, and have nothing peculiarly disagreeable about them.

To facilitate the acquisition of clear and correct views with respect to the circumstances which determine the price of ordinary labour, wages may be considered in a double point of view: viz. either (I.) as the sum which the labourers receive at any given period in return for their services, or (II.) as the sum which the habits of society render necessary to enable them to subsist and continue their race. Wages, considered in the first point of view, may be called market or actual wages; and considered in the second, they may be called natural or necessary wages.

I. Dr. Smith has said, (*Wealth of Nations*, p. 30, M'Culloch's edit.,) that the common or market rate of wages depends every where upon the terms of the contract

between the workmen and their employers. But we must not thence infer that these terms are adjusted on any arbitrary or capricious principle. In businesses of small extent, and placed under peculiar circumstances, this may occasionally be the case. But in the vast majority of cases, it is not possible for any combination, whether of the masters or the workmen, materially to affect the rate of wages. That must always depend on the amount of capital devoted to the payment of wages as compared with the number of labourers.

That portion of the capital, or wealth of a country, which the employers of labour lay out in the purchase of labour may be much larger at one time than at another; but whatever may be its absolute magnitude, it obviously forms the only source from which any portion of the wages of labour can be derived. No other fund is in existence from which the labourers, as such, can draw a single shilling. And hence it follows that the average rate of wages, or the share of the national capital appropriated to the employment of labour falling, at an average, to each labourer, must entirely depend on its amount as compared with the number of those amongst whom it has to be divided.

An increase of capital, or of the means of supporting and employing labourers, is not therefore, as is so generally supposed, always productive of an increased rate of wages. It has this effect when the number of labourers remains stationary or when it increases in a less proportion than capital; but not otherwise. Were capital and population to increase or diminish in the same proportion, the rate of wages, or the quantity of necessaries and conveniences falling to the share of the labourer, would undergo no change; but if the mass of capital be, on the one hand, augmented without a corresponding augmentation taking place in the population, a *larger* share of such capital will fall to each individual, or the rate of wages will be increased. And if, on the other hand, population be augmented faster than capital, a *less* share will be apportioned to each individual, or the rate of wages will be reduced. The well-being and comfort of the labouring classes are thus especially dependent on the proportion which their increase bears to the increase of capital. There are, in fact, no means whatever by which their command over the necessaries of life can be increased that do not, at bottom, resolve themselves into an increase of capital as compared with population; and every scheme for improving the condition of the labouring class, not bottomed on this principle, can hardly fail to prove nugatory and ineffectual.

It is needless to enter into any disquisition with respect to the circumstances which tend to increase capital. Suffice it to observe, that its increase is always of the greatest importance to the bulk of the population. It may not, indeed, occasion a corresponding increase in the demand for labour; but it is, notwithstanding, sure to increase it considerably, and consequently to improve the condition of the labourers. Their condition may also be improved by a greater prevalence of moral restraint or of foresight in the formation of matrimonial connections; for, by lessening the rate at which population was previously increasing, such increased restraint would tend to reduce the number of labourers as compared with the demand, and would contribute to improve their condition in the same way as an increase of capital. On this ground, it is believed, that the establishment of a proper system of education might be made to contribute, by enlightening the public as to the governing causes of the rate of wages, to increase their amount. It were right certainly that education should be made to embrace such subjects. The causes of national poverty should be explained to every one, that all may be made aware of their existence and enabled in some measure to provide against them. It should be impressed on the labouring classes that the means of increased comfort are, to a very great degree, in their own hands; that what others can do for them is but trivial compared with what they can do for themselves; that the best institutions, and the most tolerant and liberal system of government, cannot shield them from poverty and degradation, should their numbers become too great as compared with the means of subsistence; and that to obviate this, and to advance their individual and collective interests, they should exercise a reasonable degree of foresight in the formation of matrimonial engagements, and should, if possible, endeavour to make some previous provision against unfavourable contingencies. We have already seen (art. POPULATION in this work), that the native sagacity of the bulk of the people, and their laudable desire to preserve their present position or to rise to a higher are powerful enough to make the progress of population subordinate to the increase in the means of subsistence. And it seems reasonable to conclude, without overrating the power of education, that the prudential virtues would acquire greater strength were their importance and the influence they exercise over the condition of society explained to and enforced on the attention of every one.

The laws with respect to corporations, apprenticeships, combinations, &c., the effect of which on the market rate of wages has been ably pointed out by Dr. Smith, have of late years undergone very great modifications. The statute of the 5th of Elizabeth, regulating the duration of apprenticeships in most common trades in England and Wales, was repealed in 1814; the laws preventing voluntary combinations amongst workmen were repealed in 1824 (*see* COMBINATION), and the privileges of the different corporations have, in so far as matters of this sort are concerned, ceased to be oppressive. A similar change has been made in many of the continental states. The Revolution swept off all the vexatious enactments with respect to apprenticeships and corporations that formerly restricted the freedom of industry in France; and they have also disappeared in Prussia, the Netherlands, &c. The compulsory provision for the support of the able-bodied poor is the only institution now existing in England, that seems to have any very considerable influence over the rate of wages. *See* POOR.

II. But whatever fluctuations may take place in the rate of wages, there is in all countries a limit below which it is generally difficult to reduce wages for any considerable period; and below which they can never be permanently reduced, without a change taking place in the habits of the population. This limit forms what has been denominated the natural or necessary rate of wages, and consists of the various necessaries and accommodations, or the money sufficient for their purchase, required to enable the labourers to exist and continue their race according to the habits and customs prevailing in the countries to which they belong.

It is obvious from what has now been stated, that the natural or necessary rate of wages is susceptible of much variation. It varies in different countries according to the varying wants and necessities of the labourers; and it varies in the same country according to the perpetually occurring changes in their diet, dress, lodgings, and other accommodations.

The varieties in the climate of different countries occasion considerable variations in the necessary rate of wages. Humboldt states that there is a difference of about a third part between the wages of labour in the hot and temperate districts of Mexico. Nor is it difficult to see why this is the case. According as the severity of the climate increases, warmer, and for that reason, speaking generally, more expensive clothing, more substantially built houses, and a larger supply of fuel become necessary. The influence of these circumstances may, it is true, be either partially or wholly counteracted by others; such as the superior progress made by countries with a less genial climate in the arts of civilized life, the possession of unusually productive coal mines, &c. But abstracting from these circumstances, it is plain as a general proposition that the rate of necessary wages must vary with variations of climate; and that other things being equal, it will be highest in countries where the most expensive clothes and houses and the largest supplies of fuel are required.

The share of the wages of labour appropriated to the purchase of food necessarily differs in different countries. In all, however, it is very large; and even in Great Britain, where the labourers consider comfortable clothes and neat cottages as indispensable, it is commonly supposed that at an average from *two* to *three-fifths* of their earnings are laid out on food. It is obvious, therefore, that the necessary, and by consequence also the market rate of wages, must be especially dependent on the sort of food consumed by the inhabitants, and the cost at which it may be raised. Taking, for example, the present average rate of wages in agricultural employments in England at 25*l.* a year, and supposing three-fifths of this sum or 15*l.* to be expended on food, it is obvious that, if either by a reduction in the price of corn, or by substituting potatoes in its place, or any other means, the cost of food were reduced a half, the necessary rate of wages might be reduced in the same proportion, or from 25*l.* to 17*l.* 10*s.* Such a reduction in the price of corn, or such a change in the species of food as has been supposed, would lead to an increase in the means of subsistence; an additional stimulus would in consequence be given to population, and though the market rate of wages would not sink in the same degree that necessary wages are supposed to have sunk, it would sink to some extent; and were necessary wages to sink still more, market wages would also sustain a certain decline, which would be greater or less according to the habits and foresight of the people.

The state of the labouring classes in every country furnishes abundant proofs of what has now been stated. In Bengal, for example, where clothing, lodging, and fuel are of comparatively inferior importance, the necessary wages of labour are almost entirely determined by the cost of the food consumed by the labourer. And this food being the simplest and cheapest imaginable, consisting merely of boiled rice with split pulse, and salt to relieve its insipidity, a labourer is able to subsist on

the merest trifle; and in consequence the customary rate of wages in common employments is so low as $2\frac{1}{2}d$. a day. (Colebrooke, *On the Husbandry of Bengal*, pp. 20. 131.)

But it is not necessary to refer to distant countries or remote periods for an example of this principle. The contrast between the wages and the condition of the labouring classes in Great Britain, and the wages and condition of the same classes in Ireland, illustrates it in the most striking manner. In Great Britain the necessary rate of wages is principally determined by the cost of wheat and butcher's meat, and in a less degree by the rent of a comfortable cottage, the price of clothes, beer, tea, &c. In Ireland, on the contrary, the peasantry rarely taste butcher's meat; they do not even consider bread as necessary to their subsistence; they are generally without either beer or tea; and their hats, clothes, &c., are all of the most miserable description. The rate of necessary wages is there almost entirely determined by the price of potatoes; and as a quantity of these sufficient for the support of a family may be bought for a third part of the price of the bread and other articles required for that purpose, the necessary rate of wages is proportionally low. The market rate of wages, too, owing to the weakness in Ireland of moral restraint, and the nearly total non-existence of that prudent forethought and decent pride which distinguishes the labouring class in Great Britain, does not differ sensibly from the necessary rate. The principle of increase has filled up the population to the level of mere subsistence; so that while the wages of common labour may be taken on a rough average at 20*d*. a day in England, they are not supposed to exceed 6*d*. or at most 7*d*. a day in Ireland.

If we except the influence that would be exerted on the progress of population, and consequently also on the rate of wages, by the prevalence of a greater degree of moral restraint, an increased demand for labour, and a fall in the price of the articles consumed by the labourer, seem to be the only modes in which wages can be raised. From whatever causes an increased demand for labour may proceed, it must obviously raise the rate of wages; and it is hardly less obvious, that a fall in the cost of producing any article consumed by the labourer, or suitable for his consumption, must in so far improve his condition. The demand for labour is in most cases immediately increased, and it is never generally or permanently reduced, by a reduction in the cost of producing commodities. But supposing that the demand for labour continues the same after commodities fall in price, then, as the number of labourers in the market, and consequently the money wages paid them, must also be the same as before the fall, it is plain they will obtain a greater quantity of produce, and that their condition will be in so far improved. It is, no doubt, true, that were population to increase, as is sometimes alleged, proportionally to the increased demand for labour, or to the fall in the price of produce, the improvement in the condition of the labourer would only be temporary. But it is not improbable merely but next to impossible that population should increase in the same proportion. A period of about twenty years necessarily elapses before the stimulus which an increased demand for labour gives to population can occasion any increase in the number of labourers; and the labourers being accustomed, during this long interval, to an improved manner of living, the standard of natural or necessary wages becomes elevated; and the majority will be disinclined to do anything that might tend to sink themselves and their children below the new level to which they have attained.

The effects produced by a decreasing demand for labour, or by a rise in the price of the articles usually consumed by the labourer, are directly the reverse of those now stated. The number of labourers continuing for a while at least the same, the rate of wages is necessarily diminished when the demand for labour declines, and it necessarily continues at its old level when prices rise; so that in both cases the condition of the labourers is changed for the worse. In consequence, they are obliged to economise; and should the pressure continue for a considerable period, there is a risk lest their habits be degraded, or that they should learn to be satisfied with an inferior species of food, or a lower standard of comfort. Should this change unfortunately take place, the population would accommodate itself to the new state of things; and it would be difficult for the labourers to attain, at any subsequent period, to the elevation from which they had been cast down.

When the labourers are already subsisting, as in Ireland, on the lowest species of food, it is of course impossible for them to go to a lower in a period of scarcity; and should their wages, or the means of subsistence falling to their share, sustain any serious decline, an increase would necessarily take place in the rate of mortality. But in a country like England, where the inhabitants have been long accustomed to superior comforts, and enjoy various privileges, it is probable that they might pass through a pretty long period of privation, and that it would rather give new efficacy to the principle of moral restraint, and lessen the proportion of marriages and births, than induce them to submit to a lower scale of living or to relinquish comforts they have long possessed, and been taught to regard as indispensable. As the well-being of the labouring classes is essential to the tranquillity and happiness of the state, it is of the highest importance that this principle should be strengthened by every possible means. It is easy from this to see that a principal advantage of a compulsory provision for the support of the poor consists in the assistance it gives them in periods of adversity, and in its thereby contributing to prevent their tastes and habits or their standard of comfort from being lowered by the privations to which they might otherwise be compelled to submit.

WAHA'BEES or WAHA'BYS. A Mussulman sect, of which the founder was a learned Arabian, named Abd el Wahâb, who became persuaded of the corruption, both of doctrine and practice, prevalent among the professors of Islam, especially the Turks. His daughter married Mohammed Ibn Saoûd, the principal person of the town of Derayeh, who became his first convert and leader of the sect about 1760. Like the original prophet of their faith, Saoûd and his followers propagated their doctrines at once by persuasion and arms. Abd el Aziz and Ibn Saoûd, the son and grandson of the first Saoûd, carried their arms to the utmost extremities of Arabia, and, conformably with the old Mohammedan principle, established a spiritual and temporal leadership united in their persons. The Bedouins, or wandering tribes, formed the bulk of their converts. They acknowledged the Koran and the Sunne, or orthodox tradition, and they professed adherence to the liberal tenets of both; but they accused the other Mohammedans of an idolatrous veneration for the prophet and other saints, and denied the intercession of saints altogether. Like the early Protestants of Europe, their favourite taste was the destruction of the cupolas and tombs of saints. To this the mob of Wahabys added a strong aversion to the rich dress of the Turks, and to the practice of smoking tobacco, which had been prohibited by Abd el Wahâb much on the same bold principle which had induced Mohammed himself to condemn the use of wine. The province of Nedjd became the chief seat of the Wahaby power. Under the last Saoûd (a very handsome man, whom the Arabs called Abou Showareb, or the Father of Mustachios), it reached its greatest extent. Like the early Caliphs, he administered justice in person to great part of Arabia. The Wahabys, in the first twenty years of this century, extended their plundering expeditions to Syria, Irak, and Mesopotamia. In 1803 they took Mekka, and soon conquered the Hidjah. In 1809 Mehemet Ali began hostilities in Arabia; and in 1812 the Hidjah was restored, and the caravans of pilgrims once more arrived with their usual pomp at Mekka; but for some years afterwards the Wahabys maintained their superiority in the rest of Arabia. Saoûd died in 1814, and was succeeded in his political and religious authority by his son Abdallah, under whom the Wahabys were finally subdued by Mehemet Ali; but we possess no authentic account of their conquest, or their present condition. (See *Burkhardt's Travels in Arabia*; his *Notes for a History of the Bedouins and Wahabys*, 1830; and the *Travels of Ali Bey*; *Ed. Rev.*, vols. xxvii. xxxiv.)

WAIF. (From the Saxon wafian, *to abandon*.) In Law, goods stolen and abandoned by the felon were so termed, and were forfeited to the king, or lord of the manor having the franchise of waif; but if the owner made fresh pursuit after the felon, and sued an appeal of robbery, or gave evidence whereby he was concluded, within a year and a day, he was entitled to restitution.

WAINSCOT. In Architecture, the framed lining in panels wherewith a wall is faced. The wood originally used for this purpose being a species of foreign oak, that wood has acquired the name from the purpose to which it was thus applied.

WAIST. That part of the gun-deck between the fore and main masts.

WAITS, the popular name for the music played in our streets on the nights of the Christmas holidays, is thought to be only a corruption of "wake," the common name for a nocturnal solemnity. (See *Archæol.* vol. ii. p. 66.)

WAI'VER. In Law, a term used to signify a party's declining or refusing to accept to avail himself of something; as waiver of an estate, which may be made by infant or his heirs of an estate conveyed to him in his minority; waiver of tort, in some cases where action of tort and action of contract both lying, the aggrieved party declines the former and pursues the latter remedy.

WAKE. In Antiquities and popular usage, the word is of the same meaning as vigil; and the custom originated in the processions which took place early in the morning of feast days to the church, and were not uncommonly followed by revelling and drunkenness. At present most fast days are popularly called wakes by the English peasantry; but the peculiar "wake" or "revel"

of county parishes was, originally, the day of the week on which the church had been dedicated; afterwards, the day of the year. In 1536, an act of convocation appointed that the wake should be held in every parish on the same day, namely, the first Sunday in October; but it was disregarded. Wakes are expressly mentioned in Charles the First's *Book of Sports*, among the feasts which it was his majesty's pleasure should be observed. The wake appears to have been also held on the Sunday after the day of dedication; or, more usually, the day of the saint to whom the church was dedicated. In Ireland, it is called the "Patron Day." (*Brand's Popular Antiquities.*)

WAKE. The track of a ship which she leaves in the water. A vessel directly astern of another is said to be in her wake.

WALDE'NSES. In Ecclesiastical History, a remarkable religious sect, said to have derived their name from Peter Waldo, a merchant of Lyons, who preached what he regarded as the pure doctrine of the Scriptures about 1180. Historians have confounded them, on the one hand, with the Vaudois (see that article), who appear, although their history is involved in much obscurity, to be an older and separate people; and on the other (especially those of the Catholic party), with the Albigenses; and thus it has been endeavoured to throw on them the discredit of the Manichean tracts, which are commonly (but on very doubtful testimony) imputed to the latter. It seems clear, however, that the Waldenses were distinct from these, and probably from the Vaudois also. Their distinguishing character, it has been said, "seems to have consisted in a strict adherence to what they considered to be the doctrine originally delivered by Christ to his apostles." And out of their extremely literal interpretation of the Gospel appears to have arisen most of their peculiarities, whether good or evil. They seem to have rejected an established succession of the priesthood, and the distinguishing characteristics of the priestly office; the high Catholic doctrine of the sacraments, besides the common ecclesiastical abuses of their day; and are said in addition to have protested against oaths, warfare, lawsuits, and the accumulation of wealth. Their later history is obscure; and it may be said of them, as well as of other sects of the day, that they had little of the elements of permanence, the same opinions being continually promulgated afresh by new reformers, and then receiving new denominations. (*See* ALBIGENSES, PETROBRUSIANS, VAUDOIS.) The reader may consult *Milner's Ecclesiastical History* for the most favourable view of these and similar sectaries; and, among many other authorities, Faber, *On the Churches of the Waldenses and Albigenses. Mosheim*, cent. 12. vol. iii. There is a curious notice of an establishment of Waldenses in Kent in the *Archæologia*, vol. ix.

WALL. In Architecture, a body of stone, bricks, or other materials, serving to inclose a space, or carry superincumbent weights, or serving both these purposes.

WALL. In Horticulture, a fixed structure for the purpose of improving the climate of plants by shelter, by supplying heat, and by exposing them to the influence of the sun. Garden walls are formed either of brick, wood, or other materials; and are either solid, flued, or cellular, upright or sloping, straight or angular, according to the purpose intended by their erection. (See *Loudon's Encyc of Gardening*, p. 575, &c.)

WALL EYE. An opacity of the cornea of the eye. *See* GLAUCOMA.

WA'LLOWER. In Machinery, is used synonymously with lantern or trundle. *See* LANTERN WHEEL.

WALL PLATE. In Architecture, a piece of timber lying on a wall, on which girders, joists, and other timbers rest.

WALPU'RGIS NIGHT. The night of the 1st of May, a festival of St. Philip and St. James. Saint Walpurga was an English lady, sister of Boniface, the apostle of the Germans: her festival falls on the same day with that of the above-mentioned saints, and is a common day in Germany, like Lady-day in England, for the commencement of leases, &c. It is also known as the day on the eve of which, according to popular superstition, the great witch festival is held on the summit of the Brocken, in the Hartz mountains. This superstition is supposed to have originated in the rites performed by the pagan remnants of the Saxons to their gods, when their nation was forcibly converted to Christianity; which, being secretly celebrated in remote places, were supposed by the vulgar to be supernatural orgies.

WALTZ. (Germ. waltzer.) The name of the German national dance, and also of the species of music by which it is accompanied. Bohemia is said to be the original home of the waltz, whence it soon spread into other parts of Germany, and all over the Continent, and within the last few years it has become naturalised in England.

WA'PENTAKE. A territorial division in use among the Danish inhabitants of England: from wapen, *a weapon.* Yorkshire is subdivided into wapentakes instead of hundreds.

WAR, in International Law, is said to be "public," when it is a contest, by force, between independent sovereign states. A civil war is regarded by Grotius as "mixed" in its nature; being, according to him, public on the side of the established government, and private on that of the portion of the people resisting its authority. Public war is said to be perfect when one whole nation is at war with another, and all the members of each are authorized to commit hostilities mutually, subject only to the general laws of war. An imperfect war is limited as to persons, places, and things: to which class may be referred the hostilities of the United States against France in 1798; the hostilities between England, France, Russia, and Turkey, in 1827; and perhaps the recent proceedings against the Pacha of Egypt.

Formal declarations of war are now out of use: the latest example is said to be that by France against Spain, at Brussels, in 1635, which was announced by heralds. War is now usually preceded by the publication of what is termed a "manifesto" (see that word); and the permission of "reprisals" (which see) is usually the last step short of actual hostilities, and preceding them. The immediate effect of the commencement of hostilities would appear to be, on principle, the liability of all property belonging to subjects of one of the belligerent parties within the dominions of the other to seizure and confiscation; but many exceptions have been introduced by the practice of civilized states. (See Grotius, *De Jure B. & P.* lib. iii.; *Vattel*, lib. ii., &c.) In recent times, it has been the regular practice in Great Britain to seize and condemn, as droits of admiralty, property of the enemy found in our ports at the commencement of hostilities. Trade, and every species of contract between subjects of belligerent states, is in general unlawful, although often authorized for particular times and purposes. Subjects of hostile states, *domiciled* in the enemy's country, are held liable to reprisals; but not, it is said, mere travellers or temporary sojourners.

The "rights of war" are such as arise in times of hostilities,—1. Between enemies; 2. Between neutrals. As between enemies, it is a general law that subjects of a hostile state who are not in arms, or who have submitted, may not be slain. The killing of prisoners is only justifiable in very extreme cases. The usage of exchanging prisoners is now general, but was only firmly established in the 17th century; and it is not now considered obligatory. As to property, that belonging to the government of the vanquished nation belongs to the victorious state, wherever it is found; but private rights are unaffected by conquest, with the remarkable exception of private property when at sea, which is by general usage held lawful prize. Acts of hostility are only lawful, according to the modern usage, when committed by those authorized by the express or implied command of the state; such as the regularly commissioned military and naval forces of the nation, and all others called out by the government in its defence, as well as persons spontaneously defending themselves in case of necessity. Irregular bands of marauders are therefore denied the rights of war, and liable to be treated as banditti; and this distinction is generally only observed so far as suits the belligerent's purpose. For private citizens taking up arms, although in obedience to proclamations, are constantly liable to be treated as marauders; as by the French in the Peninsular war, and in numerous other cases. As to suspensions of hostilities, &c., see TRUCE, TREATY. As to the rights of war as to neutrals, see NEUTRALITY.

WARD. In Feudal Law, the heir of the king's tenant *in capite* during his nonage was so called; and, in general language, all infants under the power of guardians. (*See* GUARDIAN). The court of wards and liveries, for cognisance of various matters relating to the king's prerogative, was established by Henry VIII., and abolished at the Restoration. (See *Archæologia*, vol. ii.)

WARD-MOTE. A court in each ward of the city of London, which has power to present defaults in matters relating to the watch, police, &c.

WARDEN, LORD, OF THE CINQUE PORTS. (*See* CINQUE PORTS.) The constable of Dover Castle was created warden of the Cinque Ports, and guardian of the adjacent coast, by William the Conqueror: an office resembling that of the *comes littoris saxonici* in the decline of the Roman empire. The lord warden has the authority of admiral in the Cinque Ports and their dependencies, with power to hold a court of admiralty, and courts of law and equity: he is returning officer of all the ports. The salary is 3000*l.* a year. There is also a lord warden of the stannaries. *See* STANNARIES.

WARMTH. In Painting, a tone of colour arising from the use of colours expressive of heat.

WARP. In Weaving, the *longitudinal* threads of a woven fabric; they are crossed by the *transverse* threads, or *woof. Warp*, in Naval affairs, signifies a rope laid out for the purpose of moving the ship. *To warp* is to move a ship from one position to another by means of warps.

WA'RPING. (Fr. guerpier.) A mode of increasing the

fertility of tillage lands on the banks of rivers liable to be overflown by them. It appears to have been first practised in Britain on the banks of the Trent, Ouse, and other rivers which empty themselves into the estuary of the Humber. The water of these rivers, from passing through a great extent of alluvial country, are, after heavy rains, muddy to an excess; and they are in that state conducted over the adjoining surface in portions enclosed by banks, and there suffered to deposit their mud, which is technically called *warp*, and which being of the depth of an inch or two, adds greatly to the fertility of the soil, and ultimately to its quantity. The practice has existed on the banks of the Po, and other rivers in the north of Italy, from time immemorial.

Warping. In Architecture. *See* Casting.

WA'RRANT. In Law, a precept under hand and seal, directed to a proper officer, to arrest an offender.

WA'RRANT OF ATTORNEY, in Law, is a power given by a client to his attorney to appear and plead for him, or to suffer judgment to pass against him by confession. It authorizes a creditor to enter up judgment and levy execution, either instantly, or within a certain time specified in the instrument.

WARRANT OFFICERS, in the Navy, are the gunner, boatswain, and carpenter.

WA'RRANTY, in Law, as applied to lands, is a promise or covenant real annexed to lands or hereditaments, whereby the bargainor and his heirs are bound to warrant the same to the bargainee and his heirs against all men. But the ancient law of warranty of real property has been long obsolete in practice.

With regard to warranty of things personal, it is the general rule, that a purchaser of goods and chattels may have a satisfaction from the seller, if he sells them as his own, and the title proves deficient, without any express warranty for that purpose; but that with regard to the goodness of the things so purchased, the vendor is not bound to answer, unless he has expressly warranted them to be good, or unless he has in any way misrepresented them.

WA'RREN. (Fr. garenne; from the Teutonic wahren, *to protect or defend.*) In Law, a franchise or place privileged for the keeping of beasts and fowls of warren, which are said by some to be only hares and rabbits, partridges and pheasants; others add quails, woodcocks, waterfowl, &c. The franchise is from the crown by grant, or prescription which implies grant. It is often called *free warren*. In common language a warren is a surface of poor dry sandy soil on which rabbits are kept. In general, warrens may be described as the natural habitations of wild rabbits appropriated by man, and preserved for the breed of these animals; but they are occasionally formed in suitable situations. The rabbits are allowed to burrow in the soil at pleasure, and to crop the natural herbage which grows on the surface; but to render warrens profitable, the rabbits require to be supplied with clover, hay, corn, or other food, in the winter season.

WASH. The fermented liquor from which spirit is distilled.

WA'SHER. A circular piece of leather, or pasteboard, placed at the base of a screw, so as to prevent the metal surfaces from being injured when it is screwed home; it is also used to render screw and other junctions air-tight.

Washer. In Architecture, a flat piece of iron pierced with a hole for the passage of a screw, between whose nut and the timber it is placed to prevent compression on a small surface of the timber.

WA'SSAIL. (From the Ang. Sax. waes hael, *be in health.*) A common salutation used in drinking; whence the "wassel-bowl," which was anciently carried round on New Years' Eve. "A carol for a wakel bowl" will be found in *Ritson's Ancient Songs*, 1790, p. 304. (See *Brand's Popular Antiquities*, vol. i. p. 1.)

WASTE, in Law, is the destruction or material alteration of things forming an essential part of the inheritance; as houses, timber, &c. Neglect of repairs is termed *permissive* waste; active injury, *voluntary* waste. The action of waste, at common law, can only be brought by a person who has an estate of inheritance in immediate expectancy upon the devastator's estate.

WASTE LAND. Any tract of surface not in a state of cultivation, and producing little or no useful herbage, or wood. The quantity of this kind of land in Britain was estimated, about the end of the last century, at upwards of six millions of acres; four millions of which were considered capable of being brought under the plough, and the greater part of the remainder of growing wood.

WATCH. A well-known portable machine, moved by a spring, for measuring time. When executed in the most perfect manner, it is called a *chronometer*, and used in navigation for determining differences of longitude. *See* Longitude, Chronometer.

Watches are said to have been made at Nuremberg so early as 1477; but it is uncertain how far the watches then constructed resembled those which now go by that name. Some of the early ones were very small, in the shape of a pear, and sometimes sunk or fitted into th top of a walking-stick. As time-keepers, watches coul have very little value before the application of the spira spring as a regulator to the balance. The merit of thi excellent invention has been claimed by Hooke and Huygens; but it seems established by unquestionable evidence that the priority belonged to Hooke by at leas fifteen years. The date of the invention is about th year 1658. Hooke's first balance spring was straight, an acted on the balance in a very imperfect manner; bu he soon perceived its defects, and attempted to obviat them by adopting first the cylindrical, and afterwards th flat spiral. The latter appears to have been applied t watches before the publication of Huygens' claim in 1675 (*Encyc. Brit.* art. "Clock and Watch Work.") *See* Horology.

Watch. The portion of the ship's crew on duty a a time. This is usually half; and the watches are calle the *starboard* and *larboard* watches. Large crews ar put in three watches. The period of the time called a watch is four hours, the reckoning beginning at noon o midnight. Between 4 o'clock and 8 P.M., the time i divided into two short or *dog* watches, in order to break the constant recurrence of three watches at the sam hours.

WA'TER. (Germ. wasser.) The old chemists considered water as an element, and supposed it convertibl into earth, and into various organic products. This opinion was first questioned, and afterwards disproved, by th experiments of Watt and of Cavendish, in the years 1786 and 1787. (*Phil. Trans.*) And it has since been satisfactorily demonstrated that hydrogen and oxygen ar the elements of water, and that they are contained in it i the relative proportions by weight of 1 and 8, or by volum 2 and 1; the specific gravity of hydrogen being to that o oxygen as 1 to 16.

The electro-chemical decomposition of water is tha which affords the most satisfactory evidence of its nature. When made part of the volta-electric circuit, it i resolved into 2 measures of hydrogen and 1 of oxygen gas; the former evolved at the negative, and the latter at th positive surface; and if the gases thus obtained b mixed, and fired by the electric spark, they again combine and produce their weight of water. The analytic and synthetic evidence, therefore, of the composition of water i thus rendered complete.

But although perfectly pure water, such, for instance as has been boiled and very cautiously distilled, is in fact an *oxide of hydrogen*, and composed as above stated, all common water is more or less contaminated by foreign matters, which, if not in excess, or of an uncommon o injurious nature, render it, generally speaking, more fit for most of the ordinary uses to which it is applied. Of all water, *rain water* carefully and cleanly collected is most pure. But it absorbs air, and with it traces of carbonic acid; minute portions of certain ammoniacal salts are also found in it, and very near the sea it is seldom free from a trace of salt. During thunder-storms the rain which falls sometimes exhibits indications of nitric acid, formed, no doubt, by the passage of the lightning through the humid atmosphere. Next to rain water, *river water* is, generally speaking, most free from foreign matter. The water of the Thames, especially where it is not contaminated by drainage and manufactures, only contains about 2 grains of saline or soluble matter in each pint; and this is chiefly carbonate of lime, with a little sulphate of lime, chloride of sodium (common salt), and chloride of magnesium, and traces of organic matter. The saline contents of a gallon of Thames water, in its most impure state, do not exceed 24 grains; and when in its purest state, fall short of 16 grains. This statement refers only to matters *dissolved* in the water; for it is often loaded with substances *mechanically suspended* to a much greater extent, as is obvious from the muddy state in which it is often supplied to the houses of London and its vicinity by the water companies. These last impurities are separated either by subsidence or by filtration; hence the advantage of allowing the water to clarify itself in reservoirs before it is supplied for use, or of filtering it through fine sand, which imparts nothing to the water, and renders it clean and transparent. When water contaminated by animal or vegetable matter is kept for some time, it undergoes a spontaneous depuration, losing its odour and colour, and depositing more or less sediment. By this process, however, it becomes *hard*, in conquence of retaining certain indestructible saline matters in solution. The water for the supply of ships is well known to undergo this process of fermentation and purification, and the larger the quantity of destructible matter the more complete and rapid is the depuration: hence the preference given to Thames water for sea store, the purer river waters fermenting less rapidly, and remaining more or less foul and putrid for a much longer time. It is obvious, however, that for all ordinary purposes the purer the water the better; and it is quite clear that London ought to be supplied with Thames water from above Richmond, and out of the reach of the

tides, instead of from the heart of the metropolis, where it is loaded with the contents of the sewers, the offal of manufactures, and the mud stirred up by the steamers.

Spring water, as afforded by our common wells, may be considered as rain water modified by filtration through the superficial strata of the earth, and consequently containing more or less of the soluble substances which it meets with in its course. In and about London the purity of the water is very various at different depths from the surface. In the more superficial wells it is usually very hard, and abounds in sulphate of lime; in the deep wells, and especially the *artesian* and overflowing wells, the water is softer, and contains less foreign matter. These different states of purity may be judged of with a degree of accuracy sufficient for all common purposes by dropping into the water a solution of soap in spirit of wine: with pure water, such as rain or distilled water, it remains clear; but with river or spring water it becomes more or less turbid or milky, in proportion to the impurity. Water which is thus rendered decidedly opaque or milky is not fit for washing; but that which is only slightly troubled, or becomes merely opalescent, is usually called *soft water*. This simple experiment shows the cause of softness and hardness in water; for pure water perfectly dissolves soap, whereas in common spring water the salts are of such a nature as to form insoluble compounds with it, and these adhere to whatever is washed in it, and give that unpleasant sensation called *hardness* when we wash our hands. The application of a few other simple tests may be resorted to, to indicate more exactly the nature of the hardening impurities. The presence, for instance, of sulphate of lime is indicated by the production of a white cloud upon adding a few drops of a solution of *chloride of barium* (which shows the sulphuric acid), and of *oxalate of ammonia* (which detects lime). Such water generally leaves a white crust in the decanter in which it is kept, and incrusts boilers and kettles with a troublesome sediment; so that, unless frequently cleansed, they are soon destroyed by the action of the fire, in consequence of the sulphate of lime which coats their interior, and which prevents the transmission of heat. This impurity chiefly belongs to what are called *land springs*, and is derived from the blue clay upon which London is built, and which abounds in sulphate of lime. The deeper springs, especially those from the sandy deposits nearer to or upon the chalk, or those from the chalk itself, are more pure, especially where the land springs are excluded; and though they exhibit traces of sulphate of lime, common salt, carbonate of lime, and carbonate of soda, are yet pure enough for washing, brewing, &c. Traces of ammoniacal salts, and of nitrates, are also not uncommon in the waters from the deep wells of London and its vicinity.

Carbonate of lime, or chalk, is sometimes held in solution in spring water, by excess of carbonic acid; in this case the water becomes turbid upon the addition of oxalic acid, and slightly effervesces with muriatic acid; when boiled, the excess of carbonic acid which holds the carbonate in solution is expelled, and the water becomes more or less turbid. It is sometimes contained in such quantity as to be deposited upon substances thrown into the water, and upon the vessels containing it, as we see in the *petrifying* springs of Matlock in Derbyshire, and elsewhere; and the beautiful *stalactites* which line the caverns in limestone rocks are produced in the same way. Spring water which (*after having been boiled and filtered*) becomes turbid upon the addition of a few drops of nitrate of silver generally contains common salt, and the proportion may be judged of by the degree of milkiness thus occasioned. If water, after it has been evaporated to a small bulk, be tested by turmeric or violet paper, it often shows an alkaline reaction, and upon closer examination is found to contain carbonate of soda; and it occasionally evolves during its evaporation traces of carbonate of ammonia, and affords to delicate tests indications of organic matter. This is especially observed in the pump water from churchyards, in which most improper situation wells for the supply of the neighbourhood are often sunk.

Mineral springs or *waters* are of such a nature as to be unfit for common purposes, and often derive important medical efficacy from the substances which they hold dissolved. Those which have an inky and astringent flavour, and which become reddish brown and turbid by boiling, or by exposure, are usually called *chalybeate waters*, and contain carbonate or sulphate of iron: when examined as they flow from the spring, they blacken with a few drops of tincture of galls or of strong green tea. *Tunbridge water* is an instance of a chalybeate containing carbonate of iron, and the *Brighton chalybeate* contains sulphate of iron. There are some mineral waters which derive their efficacy from certain salts, and are called *saline waters*; such as *Cheltenham water*, *Leamington water*, &c. The salts which they contain are chiefly sulphate of soda and sulphate of magnesia; they have a bitterish salt taste, and are more or less aperient: when reduced to a small bulk by evaporation, and set aside for a few hours in a cool place, the salts generally crystallize. What are termed *sulphureous waters* are usually saline, and also contain *sulphuretted hydrogen*, which is presently recognized by its fetid smell, and by becoming black when a solution of sugar of lead is dropped into it; and turbid on the addition of a little muriatic acid, or by mere exposure to air, from the deposition of sulphur. *Harrogate* and *Aix-la-Chapelle* waters are instances. There are some waters which are occasionally resorted to medicinally, but which are only remarkable for extreme purity, such as *Malvern water*; and there are others which, exclusive of their chalybeate or saline qualities, are *effervescent* or sparkling, from the presence of carbonic acid, which gives them an agreeable and slightly pungent flavour: these qualities are entirely lost on boiling, in consequence of the escape of the gaseous acid; consequently they lose the power of reddening vegetable blues after they have been exposed to heat. In respect to *medical virtues*, the chalybeate springs are more or less tonic and astringent, and the saline springs aperient and alterative; and though they often contain their active ingredients in small relative proportions, they are perhaps on that very account more likely to be absorbed into the system, and to effect cures where larger doses of the same remedies fail. There are also some mineral waters which contain *iodine* and *bromine*, and which, though in very minute quantities, are powerful medicines; in others, baryta and strontia have been discovered. But a course of mineral water is often useful upon other principles: it generally is accompanied by strict attention to diet, by moderate bodily exercise, by mental relaxation, and by regular hours, all of which are powerfully curative resources; and with these aids the mere diluent effect of pure water (such as that of Malvern) may, in many instances, prove of eminent service: this is certainly often the case in the early stages of calculous complaints.

Sea Water.—The chemical history of sea water is extremely important, as involving that of sea salt (*see* SODIUM and CHLORINE), of *magnesia* and its most important combinations, and of those singular and powerful agents known to chemists under the names of *iodine* and *bromine*. It appears from the best authorities that the composition of sea water, when not influenced by adventitious or accidental causes, is nearly uniform in the vast extent of the ocean, which covers about two thirds of the globe, and probably has a mean depth of not less than half a mile (2640 feet). Its specific gravity varies from 10269 to 10285; and it contains rather more than three *per cent.* of solid matter, composed chiefly of common salt, muriate of magnesia, sulphate of magnesia, and sulphate of lime. These are the principal ingredients of sea water; besides which it contains traces of chloride of potassium, of muriate of ammonia, of carbonate of lime, of hydrobromate of magnesia, and often of hydriodate of magnesia. There is some difference of opinion as to the state of combination in which the acids and bases exist in sea water. The following tables show their proportions in a pint of sea water of the Frith of Forth, taken up near Leith, as obtained by evaporation, and as presumed to exist after and previous to evaporation:—

After Evaporation.		Before Evaporation.	
Common salt	180·5	Common salt	180·5
Muriate of magnesia	23·0	Muriate of magnesia	18·3
Sulphate of magnesia	15·5	Muriate of lime	5·7
Sulphate of lime	7·1	Sulphate of magnesia	21·6
	226·1		226·1

The other substances exist in such small quantities that they are omitted in this general statement. *See* OCEAN.

WATER BAILIFF. An officer in port towns, whose duties in general are with respect to the searching of ships: in London he has also the supervision of the fish market, gathering of tolls, &c.

WATER CLOCK. A contrivance for measuring time by the flow of water. *See* CLEPSYDRA.

WATER-COLOUR PAINTING. A species of painting, in which the medium of representation is colour levigated with water and gum, and which in our days has been carried to such extraordinary perfection as to rival oil painting in every thing but durability.

WATER DEVIL. A name given by some micrographers to the larva of a British species of *Hydrophilus*.

WATERLA'NDIANS. In Ecclesiastical History, a division of the Dutch Anabaptists, also called "Gross" (Grob), or "Moderate," in contradistinction to the "Fine," or "Rigid." They were so called from a district in North Holland denominated Waterland, and originated in the 16th century. John de Ries, in 1580, composed a confession of faith, which seems to have been pretty generally used among them. They still constitute (we believe) a portion of the general body of Mennonites. (See *Mosheim*, cent. 16., sec. 3., part ii.)

WATER LINE. The boundary of any horizontal section of the bottom of a ship. The uppermost one is called the load water line; the lowest the light water line.

WATER-LOGGED. A Nautical term, denoting the state of a ship when a quantity of water having been received into the hold by leaking, &c. she has in a great measure lost her buoyancy, and yields to the effect of every wave passing over the deck.

WATER MEADOWS. Meadows on low flat grounds, capable of being kept in a state of fertility by being overflown with water from some adjoining river or stream. The principal season at which this operation is performed is during winter, when the water is allowed to remain stagnant on the surface for some weeks; but meadows which can be watered are occasionally overflown during summer, especially after a crop of hay has been taken. The manner in which water so applied to grass lands is found beneficial has never been satisfactorily explained. By some it is attributed to the warmth retained in, or communicated to the soil, by the water during winter; by others to its effect in destroying insects, worms, &c.; and by some to the particles of manure deposited on the surface of the soil. During summer the effect is more readily accounted for, a supply of moisture being advantageous to all plants at that dry season. *See* IRRIGATION.

WATER OF CRYSTALLIZATION. Some crystallized salts contain more or less water, which, as it bears a definite proportion to the other components of the salt, may be considered as one of its essential constituents. Crystallized sulphate of lime, for instance, is a compound of 68 of dry sulphate and 18 water, or of one equivalent of anhydrous salt and two equivalents of water; one equivalent of crystallized sulphate of magnesia = 123, contains 7 of water = 63; and an equivalent of crystallized sulphate of soda = 162, contains 10 of water, = 90; the equivalent of water being 9. But it does not necessarily follow that a salt in crystals contains water, there being many crystals which are *anhydrous*, such as nitre, sulphate of potash, &c.

WATERSPOUT. A very remarkable meteorological phenomenon, observed for the most part at sea, but sometimes also on shore, though generally in the neighbourhood of water. Its general appearance may be described as follows: — from a dense cloud, a conical pillar, which appears to consist of condensed vapour, is seen to descend, with the apex downwards. When over the sea, there are usually two cones; one projecting from the cloud, and the other from the water below it. These sometimes unite, and the junction has been observed to be accompanied with a flash of lightning; but more frequently they disperse before the junction is effected. In calm weather the column maintains its vertical position while carried along the surface; but when acted on by the wind it becomes oblique to the horizon. The causes of this meteor are very imperfectly known. By some it is supposed to be formed by a whirlwind of extreme intensity, while others ascribe to it an electric origin. Dr. Young (*Nat. Phil.* vol. i.) thinks that some of the circumstances may be explained by considering the spout as a whirlwind, carrying up drops of water which it has separated from the waves, and that the remainder may perhaps be deduced from the co-operation of electricity already existing in a neighbouring cloud. (See also Pouillet, *Elémens de Physique*, tome ii.)

WATER TABLE. In Architecture, a projection or horizontal set-off in a wall, so placed as to throw off the water from the building.

WATER WAYS. Strong pieces of wood extending round the ship at the junction of the decks with the sides to carry off the water.

WATER WHEEL. In Hydraulics, an engine for raising water in large quantities. (*See* PERSIAN WHEEL.) Also a wheel turned by the force of running water. Of these there are two kinds: the *undershot wheel*, and the *overshot wheel*. In the case of the undershot wheel, the water strikes the float boards below the axle, and acts by the impulse due to its velocity; in the case of the overshot wheel, the water is brought over the top of the wheel, received in buckets, and acts solely by its weight.

WAVE. The alternate elevation and depression of parts of the surface of a liquid above and below the natural level.

When the surface of a liquid is unequally pressed, the columns which sustain the greatest pressure are shortened, and sink below the original level; and this pressure being communicated to the contiguous columns, these will be lengthened and rise above that level. But as the elevation is not sustained by a hydraulic pressure, the lengthened columns again fall, and acquiring in the fall a velocity due to the height, they descend below the original level, and communicate in their turn a pressure to those which are adjacent to them. In this manner a reciprocating motion is produced, the particles to which the primitive impulse was communicated being alternately the lowest and the highest; and a series of ridges and hollows is formed, which are called *waves* or *undulations*.

In passing from the columns which are shortened to those which are lengthened, and back again to those to which they originally belonged, the particles of the fluid acquire both a vertical and horizontal motion; but while the depth is sufficient to allow the oscillations to proceed unimpeded, no progressive motion takes place, each column being kept in its place by the pressure of the surrounding columns. If, however, free oscillation be prevented (by the shelving of the shore, or the interposition of a rock, for example), the columns in the deep water are not balanced by those in the shallower, and in consequence acquire a progressive motion towards the latter, or form *breakers*. Hence the reason why waves always break against the shore, whatever be the direction of the wind.

When waves are produced by the agitation of a small portion of the fluid, as for example by throwing a stone into stagnant water, they appear to advance from the disturbed point in expanding concentric circles, the height of the wave gradually diminishing as it recedes from the centre; but that there is no transference of any part of the mass from one place to another, is manifest from the motions of any light body floating on the surface. The appearance of progression is in fact an optical deception, produced by the form of the wave and the mode of oscillation. On attending closely to the phenomena it will be seen that the fore part is always in the act of rising, and the hinder part in the act of falling; and thus the whole system appears to roll onwards, while each particle of water in succession merely oscillates with a vertical ascent and descent.

If a second series of concentric waves take its origin from a different point at some distance from the first, the two sets will cross each other without the slightest interruption. Where a wave of the first series meets one of the second, and the two elevations correspond, the resulting elevation will be equal to the sum of the two; and the same is the case with the depressions. Where the elevation in the one series corresponds with a depression in the other, the surface will maintain its original level, at least if the waves of the two series have the same height. Thus, although different series of waves do not interfere with each others' propagation, they may nevertheless increase or neutralize each others' effects. The one series is in fact superposed on the other.

A series of waves meeting a vertical obstacle, as a wall or bank, is reflected; and the reflected waves are propagated in the same manner as those arising from the original impulse, but in an opposite direction. Waves proceeding in concentric circles are reflected in concentric circles, and in such a manner as to appear to diverge from a centre as far behind the obstacle as the original centre is in front of it, and in short appear to be subjected to all those laws which are usually noticed to belong to reflected light.

If the obstacle against which the waves strike have an opening in it of small horizontal breadth relatively to the breadth of the wave, the oscillating columns which reach it will act as an impulse originally exerted at that point, and a series of waves will diverge from the aperture as from a new centre; but when the aperture is considerably wider than the wave, the wave confines its motion in a great measure to its original direction, though with some small divergence, or the oscillation is continued principally in the direction of a sector, whose centre is at the point from which the original wave proceeded.

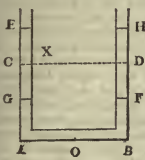
Waves which have been raised by the wind in the open sea proceed in parallel and nearly straight lines; and the original impulse being increased by the continued action of the wind, they will increase in height until the weight of the elevated column, together with the friction, becomes equal to the inciting cause. It has been inferred that the greatest height to which a single series of waves raised by the wind blowing constantly in one direction will attain does not exceed six feet. The force of the wind also tends to give a progressive motion to the mass of water raised above the general levél, and likewise to alter the shape of the wave by diminishing the acclivity of the side against which it strikes. In a strong gale this effect may be increased so far as to cause the top of the wave to project over the base, in which case it breaks and rolls over on the preceding wave. Hence, as is well known to sailors, a very strong wind will blow the sea down.

If the wind, after having given rise to a series of waves, suddenly veers about so as to strike the waves on the opposite side, it will produce a greater effect from its more direct impact; and hence the greatest waves are produced by sudden changes of wind, or by the wind blowing in an opposite direction to that in which the waves are propagated. In this manner the elevation of the waves may be greatly increased above the height to which they would be raised by winds of equal force blowing constantly in the same direction; and hence the ocean is comparatively smooth in regions where the winds are constant. And as it is by the friction of the wind on the water that the waves are raised and kept up, whatever diminishes the friction will tend to lessen the elevation. Hence the comparative tranquillity produced by

pouring oil on agitated water. The influence of the wind, which is exerted entirely at the surface, does not extend to a great depth, probably not more than 30 or 40 feet, below which the water suffers no agitation excepting that which arises from the motion of the tide wave.

Mathematical Theory of Waves. — In order to determine the time of an undulation and the velocity of the propagation of waves from the theory of hydrodynamics, Newton compares the undulatory motion of waves on the surface of water with the oscillations of the fluid in a siphon, with which they have a considerable, though not perfect analogy. Let the tube C A B D (fig. 1.), open and turned up at both ends, be filled with any liquid up to the level C D. Suppose the equilibrium to be disturbed, and that the liquid rises in consequence in the branch A C from C to E. The tube being supposed equally wide throughout, it is evident that the liquid will fall as much in the branch B D as it rises in A C; that is, making D F = C E, from D to F. Let C G = D F, then the difference of the height of the liquid in the two branches is E G;

(1.)



and according to the principle of D'Alembert, the accelerating force which acts on the fluid is the difference of the masses in the two columns divided by their sum, that is, proportional to E G divided by E A B F; or, bisecting A B in O, proportional to E C ÷ C A O. Now, C A O is constant; therefore the accelerating force is proportional to E C, or to the distance from the position of rest. Hence it may be inferred that when the fluid has been disturbed so as to rise from C to E, it will acquire, in falling to its level, a velocity which will carry it to an equal height H in the other branch, and that the oscillations, whether large or small, will be isochronous, or performed in equal times.

To prove this, and also to determine the time of the oscillation, let X be any point in C E, and make $EX = x$, $EC = a$, and $CAO = l$. Also let v = the velocity, and ϕ = the accelerating force when the liquid is at the point X, and g = the accelerating force of gravity. We have then, by what has been shown, $\phi = \frac{a - x}{l} g$. But from the theory of accelerating forces $\phi = \frac{dv}{dt}$, and $v = \frac{dx}{dt}$, (*see* FORCE), the substitution of which in the former equation gives

$$v\,dv = \frac{a - x}{l} g\,dx;$$

whence, by integrating and extracting the square root,

$$v = \frac{dx}{dt} = \sqrt{\left\{\frac{g}{l}(2ax - x^2)\right\}},$$

and consequently

$$dt = \sqrt{\frac{l}{g}} \cdot \frac{dx}{\sqrt{(2ax - x^2)}}.$$

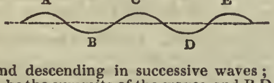
The general integral of the variable part of this expression is an arc whose cosine is equal to $(1 - \frac{x}{a})$; therefore between the limits $x = 0$ and $x = 2a$, the integral is

$$t = \pi\sqrt{\left(\frac{l}{g}\right)},$$

(π being the semi-circumference of a circle whose radius = 1). This gives the time which elapses during the passage of any particle of the water from the highest to the lowest point; and it is also the time in which a pendulum whose length is l, vibrating in an infinitely small arc, makes a single oscillation (*see* PENDULUM). Hence the time of passing from the highest to the highest again, or of a complete undulation, is the double of this, or equal to $2\pi\sqrt{(l \div g)}$, or to $\pi\sqrt{(4l \div g)}$, the time in which a pendulum whose length is $4l$ makes one oscillation.

To apply this solution to the undulatory motion of a fluid mass of indefinite extent, let A B C D E, &c. (fig. 2.) represent a superficies of stagnant water ascending and descending in successive waves; and let A C E, &c. be the summits of the waves, and B D, &c. the intermediate hollows. Now since the wave is produced by the alternate ascent and descent of the water, so that the particles at A C E, &c., which are at one instant the highest, become in their turn the lowest, and the moving

(2.)



power is the weight of the elevated water, the alternate rise and fall will be analogous to the reciprocating motion of water in a siphon, and will observe the same laws as to time; therefore if the distance between a summit A and the adjacent lowest point B be equal to $2l$, the highest points A C E, &c. will become the lowest in the time in which a pendulum whose length is equal to l makes one oscillation, and again become the highest in the time of the other oscillation. Hence the interval of time from the wave being the highest at any point to its being the highest at that point again will be equal to two oscillations, and the wave will describe its *breadth* (that is, the space between two successive summits or cavities, as from A to C or from B to D, which space is equal to $4l$) while the pendulum oscillates twice; or in the time to which a pendulum of quadruple the length, that is, equal to $4l$, or equal to the breadth of the wave, will oscillate once. (*Principia*, lib. ii. prop. 46.)

It must be admitted that the supposition on which this theory is founded, namely, that the vertical oscillations of waves are similar to that of water in a bent siphon, is a very precarious one; in fact, the theory itself is altogether insufficient for the explanation of the phenomena, as it gives no account whatever of the *form* of the wave. The subject is, however, one of great difficulty; and although it has been treated by the ablest mathematicians since the time of Newton, a complete theory is still a desideratum. Lagrange, in the *Mécanique Analytique*, has given an equation containing the general theory of waves formed by the successive and infinitely small elevations and depressions of stagnant water in a canal of small depth. Poisson (in the *Annales de Mathematique*, and *Mémoires de l'Acad.* tome i.) and Cauchy (*Mém. de l'Acad.*) have treated the subject more generally; and Professor Kelland (*Edin. Phil. Trans.* vols. xiv. and xv.) has endeavoured to obtain the equations of motion of a regular set of waves, without imposing any restriction whatever on the conditions. M. Kelland deduces from his analysis the following results, which apply to the motion of a wave in a canal whose depth is continually but slowly varying in the direction of its length: — 1. That the length of the wave is in direct proportion to the breadth. 2. That the velocity of transmission at any point varies as the square root of the depth. 3. That the elevation of the crest of the wave varies reciprocally as the total depth of the fluid. M. Kelland states that his endeavours to deduce a relation between the depth of the fluid and the length of the wave have been unavailing.

Experimental Researches on Waves. — In the *Reports of the British Association* for 1838, there is an account by Mr. Scott Russel of a series of observations on waves in the river Dee in Cheshire, and the Frith of the Clyde, and also in the open sea, which are interesting, as they establish the existence of waves of different kinds, following totally different laws. The most important results of these observations are the following: —

1. The progressive wave sent forward by a floating body in rapid motion (or generated in any other manner) differs entirely in its character and phenomena from the oscillatory waves of the sea, or those which ripple the surface of a lake, or are caused by the sudden elevation or depression of a small portion of the fluid. It is not necessarily followed either by a depression or elevation, but is a single elevation of a well-defined form, and transferred with a uniform velocity. This wave is called by Mr. Russel the *great primary wave of translation.* It is analogous to the tide wave of the ocean.

2. The velocity of the primary wave in channels of uniform depth is independent of the breadth of the fluid, and equal to the velocity acquired by a heavy body in falling freely through a height equal to half the depth of the fluid, reckoned from the top of the wave to the bottom of the channel. The velocity of the wave is accordingly proportional to the square root of the depth of the water, as the theory indicates, and it is not affected by the velocity of the impulse or the form of the body by which it is generated.

3. If waves be propagated in a channel whose depth diminishes uniformly, they will break when their height above the surface of the level fluid becomes equal to the depth below the surface. When waves of the sea approach the shore, or come into shallow water, they become waves of translation, and, in conformity with this law, always break when the depth of the water is not greater than the height of the wave above the level.

4. The great primary waves are reflected from surfaces at right angles to the direction of their motion, without suffering any other change but that of direction; and they cross each other without change of any kind, as the small oscillations on the surface of a pool.

5. In the primary wave of translation the displacement of the particles is uniform to the greatest depth; whereas in waves of the oscillatory kind the displacement of the particles of the fluid is greatest at the surfaces, and diminishes rapidly, and extends only to an inconsiderable depth.

6. The phenomenon called a *tidal bore* is produced in

two ways. First, if the water is so shallow that the first waves of the flood tide move with a velocity so much less than the succeeding ones that they are overtaken by them; and secondly, where the tide rises so rapidly, and the water on the shore or in the river is so shallow, that the height of the first wave is greater than the depth of the water.

The law by which the velocity of the primary wave varies according to the square root of the depth of the water gives rise to several other phenomena. Thus any change in the depth of rivers produces a corresponding change in the interval between the moon's transit and the hour of high water. A wave of high water of a spring tide travels faster than a wave of high water of a neap tide, &c.

The character and phenomena of the primary wave of transmission, and its importance as an element affecting the amount of the resistance of fluids on bodies moving through them, were first detected and examined by Mr. Russel in 1834. (*Transactions of the Royal Society of Edinburgh*, vol. xiv. part 1.). Its existence and laws are of great importance in reference to the construction and navigation of canals, and the improvement of tidal rivers. *See* HYDRODYNAMICS, TIDES.

WA'VELLITE. A mineral named after Dr. Wavell of Barnstaple, in which neighbourhood it was first found. It is a hydrated phosphate of alumina: it has also been called *hydrargillite*.

WAX. (Germ. wachs.) This is a common vegetable product, forming the varnish which coats the leaves of certain plants and trees. It is also found upon some berries, as of the *Myrica cerifera;* and it is an ingredient of the pollen of flowers. It was long supposed that bees merely collected the wax thus ready formed in plants; but Huber found that though excluded from all food except sugar, they still formed wax; and accordingly it has been found that the elementary composition of bees' wax and vegetable wax is slightly different. Bees' wax is prepared by draining and washing the honeycomb, which is then melted in boiling water, strained, and cast into cakes. English and foreign wax are found in the market; the latter being chiefly imported from the Baltic, the Levant, and the coast of Barbary. Fresh wax has a peculiar honey-like odour: its specific gravity is ·96. At about 150° it fuses, and at a high temperature volatilizes, and burns with a bright white flame. It is bleached by being exposed in thin slices or ribands to light, air, and moisture, or more rapidly by the action of chlorine; but in the latter case it does not answer for the manufacture of candles, which is one of its principal applications. Wax candles are made by suspending the wicks upon a hoop over the cauldron of melted wax, which is successively poured over them from a ladle till they have acquired the proper size,,so that the candle consists of a series of layers of wax; the upper end is then shaped, and the lower cut off. Attempts have been made to cast wax candles in moulds, but when thus made they burn irregularly. Bleached or white wax is generally adulterated with more or less spermaceti, and sold at different prices accordingly; in this case it has not the peculiar lustre of pure wax, and is softer and more fusible. It is also largely adulterated with stearine or stearic acid, which is detected by the odour of fat or tallow which it evolves when highly heated, and by its crumbly texture; it may also be separated to a certain extent by ether or alcohol. Wax is insoluble in water, and scarcely acted upon by the acids, so that it forms a good lute or cement: boiling alcohol and ether act partially upon it, and deposit the portion which they had dissolved on cooling. Some varieties of vegetable wax appear to contain two distinct principles, which Dr. John has termed *cerin* and *myricin;* the former soluble, and the latter insoluble, in alcohol. Heated with the fixed alkalies, wax forms a difficultly soluble soap.

WAY. The Sea term for progress. A ship in progress is said to have *way* upon her; when stationary, to have no *way*.

WEALDEN FORMATION and STRATA. *See* GEOLOGY.

WEAR. To put the ship on the other tack by turning her round, with her stern to the wind.

WEA'THER. (Germ. wetter.) The state or condition of the atmosphere with respect to heat, cold, dryness, moisture, wind, rain, snow, fogs, &c. The appreciation of the various causes which determine the state of the atmosphere, and produce those changes which are incessantly taking place in its condition, and which are popularly called the *weather*, forms the subjects of *Meteorology* and *Climate*. (See those terms; also ATMOSPHERE, BAROMETER, CLOUD, DEW, HAIL, RAIN, WIND, &c.)

In all ages of the world, mankind have attempted to explain and prognosticate the changes of the weather; but such is the complication of the subject, and the vast multitude of circumstances to be taken account of, that no theory can furnish rules for determining the order in which they succeed each other, or for predicting the state of the weather at a future time, with any approach to certainty. Nevertheless, all the different modifications of the atmosphere are the necessary results of principles, not only fixed and unalterable in their nature, but (many of them at least) well known in their separate and individual operation. The difficulty of tracing the results of their combined influences arises chiefly from their complexity and endless concatenation.

The principal cause of all the variations which take place in the state of the atmosphere is the heating action of the sun's rays; but in order to appreciate correctly its effect, it is necessary to know not only the extent of the atmosphere, but the properties of all the substances of which it is composed. Modern science has discovered that the atmosphere is composed of three different gaseous fluids, every where combined in the same proportions, and penetrated by an ever-varying quantity of elastic vapour. These two distinct envelopes of air and vapour mechanically mixed have different relations to heat; and therefore, in consequence of the unequal temperature of the surface of the earth, with which they are in contact, they cannot both be in a state of equilibrium at the same time. In consequence of the diurnal rotation, the different parts of the atmosphere are constantly receiving different quantities of heat, as the solar rays penetrate more or less obliquely. This inequality of temperature produces winds, which, if the surface of the earth were perfectly regular and homogeneous, would always blow in the same direction; but the surface of the earth being composed of materials of various kinds, and irregularly disposed, the distribution of heat over it is extremely irregular. The winds, sweeping along the surface, acquire its temperature; and hence the atmosphere also becomes irregularly heated. This produces an accumulation of air at one place, and a deficiency at another; and hence a subsequent rush to restore the equilibrium. As the air is cooled it becomes also incapable of holding the same quantity of aqueous vapour, a portion of which is therefore set free, and gives rise to clouds, mist, rain, dew, snow, &c. Besides all this, there is to be taken into account the development of electricity; the influences of light and galvanism; the agitation of the atmosphere produced by the rise and fall of the tides; and probably a variety of other circumstances with which we are entirely unacquainted. This very imperfect enumeration may serve to give an idea of the difficulties to be overcome in forming a theory of the weather. *See* CLIMATE.

It has always been a favourite prejudice that the weather is influenced in some mysterious manner by the moon. The moon can be supposed to act on the earth only in one of three ways; namely, by the light which it reflects; by its attraction; or by an emanation of some unknown kind. Now, the light of the moon does not amount to the 100,000th part of that of the sun; and the heat which it excites is so small as to b altogether inappreciable by the most delicate instruments, or the best devised experiments. No effect can be attributed, therefore, to the moon's light. With regard to the attraction of the moon, we see its influence on the tides of the ocean, and might therefore be disposed to allow it a similar influence on the atmosphere; but when we take into account the small specific gravity of atmospheric air in comparison with water, and the consequent smallness of the mass of matter to be acted upon, it will readily be perceived that this influence also must be extremely feeble. In fact, it has been demonstrated by Laplace that the joint action of the solar and lunar attraction is incapable of producing more than an atmospheric tide flowing westward at the rate of about four miles a day, and consequently scarcely, if at all, appreciable. As to the remaining supposition, that the moon may act on the atmosphere by some obscure emanation, it is sufficient to remark that no meteorological observations that have yet been made afford the slightest traces of any such connection between the earth and its satellite. The registers which are now kept in various observatories and other places also prove, contrary to the popular belief, that the changes of weather are in no way whatever dependent on the lunar phases. (See the *Annuaire du Bureau des Longitudes* for 1833; Kämptz, *Lehrbuch der Meteorologie;* Schubler, *Einfluss des Mondes auf die Veränderung unserer Atmosphare*, Leipzig, 1830.

WEATHER. The Sea term for that side on which the wind blows. *To weather*, to pass to windward of an object.

WEATHER BOARDING. In Architecture, feather-edged boarding nailed upright, whose boards lap over each other, so as to prevent the rain, &c. from penetrating them.

WEATHER GAGE. A ship to windward of another is said to have the weather gage.

WEATHER GLASS. A name commonly given to the barometer; but sometimes also applied to other instruments for ascertaining the state of the atmosphere, or measuring atmospheric changes. It is thus applied to the *thermometer*, the *hygrometer*, &c.

WE'AVERS, *Textoriæ*. The name of a tribe of spiders,

including those which fabricate webs in order to entrap their prey.

WEAVING, the art of forming cloth in a loom by the union or intertexture of threads. The art of weaving is of great antiquity: it has been practised in all ages and in all countries; but it would be impossible within our limits to give even a sketch of its history, progress, and successive improvements down to its present perfect state. We had intended to present the reader with a notice of the various improvements that have been made in the loom from its simplest construction, down to the elaborate invention of Jacquard; but it was found that this could not be effected without the introduction of numerous diagrams and details, which would have been foreign to the purpose of the work; and we must, therefore, content ourselves by referring to *Ure's Dictionary of Arts, &c.* for full particulars.

WEDGE. In Geometry, a solid having five sides or faces, three of which are rectangles, and the remaining two consequently triangles, and parallel to each other; hence the wedge, considered as a geometrical figure, is a prism with a triangular base. Its content is therefore equal to the area of the triangular base multiplied into the distance between the parallel planes.

WEDGE, in Mechanics, is one of the five simple engines or mechanical powers, and is used sometimes for raising bodies, but more frequently for dividing or splitting them. In the former case, if we suppose the wedge to be urged by pressure, the action of the wedge is precisely the same as that of the inclined plane; for it is evidently the same, in point of mechanical advantage, whether the wedge be pushed under the load, or the load be drawn over the plane. The power is therefore to the force to be overcome as the tangent of the angle of the penetrating sides to the radius, leaving the friction out of consideration: hence the thinner the wedge the greater is its effect. But when the wedge, as is generally the case, is driven forward by percussion, its power cannot be estimated with any degree of accuracy. The percussive tremor excited by the blow destroys for an instant the friction at the sides, and augments prodigiously the penetrating effect. Besides, when the wedge is used in rending wood or other substances, the parts of the block are generally separated to a considerable distance before the edge of the wedge, as in the annexed figure; in which case it acts besides as a lever, the power being applied at the end of the block or acting part of the wedge, and the resistance being at the point where the fibres begin to separate.

All the various kinds of cutting and piercing tools, as axes, knives, scissars, chisels, &c., nails, pins, awls, &c., are modifications of the wedge. The angle in these cases is more or less acute, according to the purpose to which it is applied. The mechanical advantage is increased by diminishing the angle of the wedge; but the strength of the tool is thereby also diminished. In tools for cutting wood the angle is generally about 30°; for iron it is from 50° to 60°; and for brass from 80° to 90°. In general, the softer the substance to be divided is, the more acute may the wedge be constructed.

WE'DNESDAY. (Sax. Woden's day; Lat. dies Mercurii.) The fourth day of the week, consecrated by our Scandinavian ancestors to Woden, the deity whose functions corresponded to those of Mercury in the Greek and Roman mythology.

WEEK. A period of seven days, of uncertain origin, but which has been used from time immemorial in eastern countries. The week did not enter into the calendar of the Greeks, who divided the civil month into three periods of ten days each; and it was not introduced at Rome till after the reign of Theodosius. By some writers the use of weeks is supposed to be a remnant of the tradition of the creation; by others, that it was suggested by the phases of the moon; while a third class, with more probability, refer its origin to the seven planets known in ancient times. This opinion explains the circumstance that the days of the week have been universally named after the planets, according to a particular order. In the ancient Egyptian astronomy, the order of the planets, in respect of distance from the earth, beginning with the most remote, is Saturn, Jupiter, Mars, the Sun, Venus, Mercury, the Moon. The day was divided into 24 hours, and each successive hour consecrated to a particular planet in the order now stated; so that one hour being consecrated to Saturn, the next fell to Jupiter, the third to Mars, and so on; and each day was named after the planet to which its first hour was consecrated. Now, suppose the first hour of a particular day to have been consecrated to Saturn, it is evident that Saturn would also have the 8th, the 15th, and the 22d hours. The 23d hour would therefore fall to Jupiter; the 24th to Mars; and the 25th, or the first hour of the following day, would belong to the Sun, from which it would take its name. By proceeding in the same manner, it is found that the first hour of the third day would fall to the Moon, the first of the fourth day to Mars, of the fifth to Mercury, of the sixth to Jupiter, and of the seventh to Venus. The cycle being completed, the first hour of the eighth day would return to Saturn, and all the others constantly succeed in the same order. According to Dio Cassius, the Egyptian week began with Saturday. The Jews, on their flight from Egypt, made Saturday the last day of the week. The Saxons seem to have borrowed the week from some eastern nation, substituting the names of their own divinities for those of the gods of Greece. In England, the Latin names of the days are still retained in legislative and judiciary acts. (See *Ency. Brit.*, "Calendar.")

WEE'PING CROSSES. In Ecclesiastical Antiquities, stone crosses, at which penances were commonly finished with weeping and signs of contrition, were so called. There was one close to the town of Stafford. (See Mr. Astle's "Observations on Stone Crosses," *Archæol.* vol. xiii.)

WEIGH. To take the anchor out of the ground.

WEIGHT. In Physics, that property of bodies in virtue of which they tend towards the centre of the earth. In this sense, weight is synonymous with gravity. *See* GRAVITY.

WEIGHT, in Mechanics, denotes the resistance to be overcome by a machine, whether in raising, or sustaining, or moving a heavy body. The force applied to the machine for this purpose is called the moving power; and where the equilibrium subsists, the difference between the weight and the moving power is the purchase of the machine. In all cases of equilibrium by the intervention of machinery, if the machine be put in motion by a small additional force, the space passed over by the moving power will be greater than that passed over by the weight, in proportion as the weight is greater than the moving power; or the product of the weight by its velocity will be equal to the product of the moving power by its velocity. *See* MOMENTUM, VIRTUAL VELOCITY.

WEIGHT, in Experimental Philosophy and Commerce, is the measure of the force by which any body, or a given portion of any substance, gravitates to the earth. The process by which this measure is obtained is called *weighing*; and when required, as in many philosophical experiments, to be performed with great accuracy, is a tedious and delicate operation. *See* BALANCE.

The measurement of weight, like that of extension, consists in the comparison of the thing to be measured with some conventional standard. But it is impossible to fix such a standard by written law or oral description; for it is impossible to communicate by words, and without reference to a sensible object, any adequate idea of a pound-weight, or foot-rule. Standards of linear measure, not accurately defined indeed, but having an average value sufficiently well known for the rude purposes of mankind in the early stages of society, were furnished by the different parts of the human body; hence the measures *foot, cubit, span, pace,* &c. (*See* MEASURES.) But the method of comparing the weights of bodies does not suggest itself so readily to the mind as the comparison of linear dimension, and is not so easily accomplished. A balance is necessary, the construction of which requires some degree of mechanical knowledge. Hence the art of weighing, though of great antiquity, (see Goguet, *Origine des Lois, &c.*) was probably practised at a later period, and in a still less accurate manner, than that of measuring. There has also been a much greater variety of standards of weight, still less definite than those of measure, as will be readily conceived by considering the origin and import of such terms as *stone, load, last,* &c. The term *pound* (pondus) implies only weight indefinitely. The *grain*, as a standard of small weight, being taken from the grains or corns of wheat, was perhaps the only denomination of weight that would universally convey any thing like a precise idea.

As there is a constant ratio between the volumes and weights of the same substances when placed in the same physical circumstances, it is obvious that standards of weight may be derived from those of measure. For example, a cubic foot or a cubic inch of distilled water, at the same temperature, and under the same atmospheric pressure, will always have the same weight. Advantage has been taken of this property of bodies to connect weights with measures in the metrical systems that have been adopted in this and other countries.

English Weights. — It was declared by the Great Charter that the weights should be the same all over England, but no ordinance, perhaps, was ever so ill observed; for the diversity that has prevailed, and which is still far from being remedied, has been so great as not only to produce confusion and inconvenience, but to render the system of weights adopted in one part of the country scarcely intelligible in another. The old English pound, which is said to have been the legal standard of weight from the time of William the Conqueror to that of Henry VII., was derived from the weight of grains of wheat: 32 grains

gathered from the middle of the ear and well dried made a pennyweight, 20 pennyweights an ounce, and 12 ounces a pound. Henry VII. altered this weight, and introduced the *troy* pound instead, which was 1-16th part, or 3-4ths of an ounce, heavier than the Saxon pound. The troy pound was divided in the same manner as the Saxon pound, into ounces, pennyweights, and grains; but the pennyweight contained only 24 grains, and consequently a grain troy became a much heavier weight than the grain of wheat. In fact the pound troy contains 5,760 grains, while the Saxon pound, which was divided into 7,680 grains, contained only 5,400 troy grains. Another weight, the *avoirdupois* pound, was introduced by a statute of 24 Henry VIII.; and though its first object was that of weighing butchers' meat in the market, it has gradually come to be used for all kinds of coarse goods or merchandize. Two legal measures of weight were thus established, and have continued to be used in the country ever since; the avoirdupois weight being used for common purposes, and the troy for the precious metals, and, with a different division, by apothecaries in compounding their drugs. The standard of these measures was at length definitely fixed by the act of parliament passed on the 17th June, 1824, cap. 74. George IV., entitled "An act for ascertaining and establishing Uniformity of Weights and Measures," which was partially amended by clause (A) of an act to prolong the time of the commencement of that act to January, 1826. The following are the terms in which the standard is defined by the act: — "That from and after the 1st day of May, 1825, the standard brass weight of 1 pound troy weight made in the year 1758, now in the custody of the clerk of the House of Commons, shall be, and the same is hereby declared to be, the original and genuine standard measure of weight; and that such brass weight shall be, and is hereby denominated, the Imperial standard troy pound; and shall be, and the same is hereby declared to be, the unit or only standard measure of weight, from which all other weights shall be derived, computed, and ascertained; and that 1-12th part of the said troy pound shall be an ounce, and that 1-20th part of such ounce shall be a pennyweight, and 1-24th part of such pennyweight shall be a grain, so that 5,760 such grains shall be a troy pound; and that 7,000 such grains shall be, and they are hereby declared to be, a pound avoirdupois, and that 1-16th part of the said pound avoirdupois shall be an ounce avoirdupois, and that 1-16th part of such ounce shall be a dram."

It follows from this that the weight of the pound troy to that of the pound avoirdupois, or common pound, is in the proportion of 5,760 to 7,000, or of 144 to 175. The retention of two different systems of weights was in compliance with the common usages of the country; and the motives which influenced the commissioners of weights and measures in recommending the system which has been adopted were thus explained by Mr. Davies Gilbert: — "The troy pound appeared to us to be the ancient weight of this kingdom, having, as we have reason to suppose, existed in the same state in the time of Edward the Confessor; and there are reasons, moreover, to believe that the word *troy* has no reference to any town in France, but rather to the monkish name given to London, of Troy Novant, founded on the legend of Brute. Troy weight, therefore, according to this etymology, is, in fact, London weight. We were induced, moreover, to preserve the troy weight, because all the coinage has uniformly been regulated by it; and all medical prescriptions and formulæ now are, and always have been, estimated by troy weight, under a peculiar subdivision which the College of Physicians have expressed themselves most anxious to preserve."

In the sixth clause of the act it is enacted, that if the standard troy pound should be lost or destroyed, it is to be restored by a reference to a cubic inch of distilled water, which has been found and is declared to be 252·458 troy grains, at the temperature of 62° of Fahrenheit, the barometer being at 30 inches. Hence the weight of a pennyweight troy is to that of a cubic inch of distilled water, in such circumstances, in the proportion of 24 to 252·458, or of 24,000 to 252,458; so that the weight of the cubic inch of distilled water must be conceived to be divided into 252,458 equal parts, and 24,000 of such parts will be the standard pennyweight; or 100 of such parts will be the standard pound. The restoration of the standard, however, in the manner prescribed by the act, is wholly impracticable.

Though the commissioners on this occasion probably acted wisely in accommodating their regulations to existing usages, it cannot be disputed that the circumstance of having different weights expressed by the same names, as the pound and ounce troy and avoirdupois, is a source of great inconvenience and confusion. Few persons, in fact, recollect the different standards and divisions well enough to have any clear or accurate ideas on the subject. The comparison of the weights is always a matter requiring care and calculation. The avoirdupois pound is greater than the troy pound, as has been already stated, in the ratio of 175 to 144; but in consequence of the different division, the ounce avoirdupois is *smaller* than the ounce troy, the former being equal to $437\frac{1}{2}$ grains while the latter contains 480 grains. The drachm in apothecaries' weight is 60 grains, while the dram avoirdupois is equal to only $27\frac{11}{32}$ grains.

For philosophical purposes and in delicate weighing troy weight only is used, and the weight is usually reckoned in grains. By this means fractional numbers are avoided, and no ambiguity can arise, as there are no other grains than troy grains. Dr. Kelly, in his *Universal Cambist*, an elaborate and useful work, states that the dram avoirdupois, like the drachm of the apothecaries, has sometimes been divided into 3 scruples and 60 grains; but as no such weight as an avoirdupois grain ever existed, the use of the expression is an instance of the confusion inseparable from having different systems of weights, in which the same names are applied to things totally distinct.

The irregular divisions which have been adopted and retained are also liable to much objection, on account of the great number of weights to be employed in practice. The most convenient system would probably be the decimal division, which requires weights of the following values: — 1, 2, 3, 4, &c. (grains for instance); 10, 20, 30, 40, &c.; 100, 200, 300, &c.; 1000, 2000, 3000, &c. up to 9000; and ·1, ·2, ·3, &c.; ·01, ·02, ·03, &c.; ·001, ·002, ·003, &c. By this means arithmetical calculations would be facilitated, and the number of weights in the scale would equal the digits in the number by which the grains or units of weight are expressed. Thus a load of 735·4 grains, would be counterpoised by weights of 700 grains, 30 grains, 5 grains, and 4-10ths of a grain. The composition according to the geometrical series, 1, 2, 4, 8, 16, &c. offers this advantage, that a smaller number of weights would be necessary than when any other system is adopted.

In consequence of the destruction of the parliamentary standards of weights and measures by the burning of the two houses of parliament in 1834, a commission (at the head of which was the Astronomer Royal) was appointed in 1838 to consider and report upon the steps to be taken for their restoration. The report of the commissioners, which is dated the 21st of December 1841, enters very fully into the subject, and recommends the adoption of considerable changes in the present system of weights and measures and coinage, chiefly with the view of introducing, at least partially, a decimal system. But as these recommendations may not be adopted by the legislature, or at all events will probably be considerably modified, it is unnecessary, in the present state of affairs, to state them in detail. With respect to weights in particular, the plan of the commissioners is briefly this: — that the troy pound be abolished, and that the use of the troy ounce and pennyweight be confined to gold, silver, and precious stones; that apothecaries' weight may continue to be used for the combination of drugs; that for all other purposes the only legal weights shall be derived from a pound, equal to the present avoirdupois pound, the distinctive term avoirdupois being abolished. The pound is to be divided into 16 ounces, and 7,000 grains, and no denomination is to be recognised lower than pound, except the ounce and the grain and the decimal parts of the pound. They also recommend that the weight of 14 pounds, or stone in common use, and its multiples 28 pounds, 56 pounds, 112 pounds, be abolished; and that the only legal weights above one pound be weights of multiples of 1 pound and not exceeding 10 pounds, and weights of 10 pounds and its multiples not exceeding 100 pounds. According to this plan there would only be decimal multiples of the standard; while, with respect to the submultiples, there would not only be a decimal system, but also a denomination of weight equal to a 16th and another equal to a 7-thousandth part of the standard. It is not easy to see what stronger reason there can be for retaining the ounce than the stone or the hundred-weight, which are so extensively used, particularly for purposes connected with agriculture. The quantity of iron weights of 14 lb. and its multiples in use in the country is estimated to be not less than 30,000 tons, and the expense of changing them for weights in the decimal scale to be between 100,000*l.* and 200,000*l.* With respect to the standard unit, the commissioners recommend that a platinum weight of 7,000 grains be constructed and declared to be the parliamentary standard of weight; but that it be not defined with reference to any natural standard, or to measures of length or capacity, as a cubic inch of distilled water.

Tables of British Weights.

1. *Imperial Troy Weight.* — Standard: One cubic inch of distilled water, at 62° Fahrenheit's thermometer, the barometer being 30 inches, weighs 252·458 troy grains.

grs.	dwts.	oz.	lb.
24 =	1		
480 =	20 =	1	
5760 =	240 =	12 =	1

Troy weight is used in weighing gold, silver, jewels, &c., and in philosophical experiments.

2. *Apothecaries' Weight.* — Standard: The same as in troy weight, with the ounce divided into 8 drachms and 24 scruples.

grs.	scrs. (℈)	drs. (ʒ)	oz. (℥)	lb. (℔)
20 =	1			
60 =	3 =	1		
480 =	24 =	8 =	1	
5760 =	288 =	96 =	12 =	1

Medicines are compounded by this weight; but drugs are usually bought and sold by avoirdupois weight.

3. *Imperial Avoirdupois Weight.* — Standard: The same as in troy weight; and one avoirdupois pound = 7000 troy grains.

drs.	oz.	lbs.	qrs.	cwts.	ton
16 =	1				
256 =	16 =	1			
7168 =	448 =	28 =	1		
28672 =	1792 =	112 =	4 =	1	
573440 =	35840 =	2240 =	80 =	20 =	1

This weight is used for the general purposes of commerce.

The preceding are the British statute weights; but numerous other discordant denominations of weight, generally multiples of the avoirdupois pound, are still used in different parts of the country for weighing particular kinds of merchandise. One of the most common of these is the *stone*, which has a great variety of different significations. In London, however, only two stones are generally understood; viz. the stone of 8 pounds for butchers' meat, and the stone of 14 pounds for other commodities. (For values of different local weights, see *Buchanan's Tables of Weights and Measures; General Paisley's work on the Measures, Weights, and Money used in this Country; M'Culloch's Commercial Dictionary; Kelly's Universal Cambist, &c.*)

A particular denomination of weight, a *carat*, is used for weighing diamonds. An ounce troy is equivalent to 151½ carats; whence a carat is nearly equal to 3⅙ grains. In expressing the fineness of gold by *carats*, the term rather denotes a proportion than a weight. Thus gold 22 carats fine signifies an alloy such that the proportion of the weight of pure gold to that of the whole weight is as 22 to 24; or such that it contains 22 parts by weight of pure gold, and 2 parts of some inferior metal.

French System of Weights.—The French denominations of weight occur so frequently in works connected with the physical sciences, that it is convenient to be acquainted with their values. The unit of weight is the *gramme*, which is the weight of the 100th part of a cubic mètre of distilled water at the temperature of melting ice. A gramme is equal to 15·434 troy grains; whence the following comparative table of French with troy weight: —

	grammes.	Troy grains.
Milligramme =	·001 =	·01543
Centigramme =	·01 =	·15434
Decigramme =	·1 =	1·5434
Gramme =	1 =	15·434
Decagramme =	10 =	154·34
Hectogramme =	100 =	1543·4
Kilogramme =	1000 =	15434
Myriagramme =	10000 =	154340

The kilogramme is equal to 2 lb. 3 oz. 4·428 drams avoirdupois weight. In the *Système Usuel* the standards are the same as the above, but the denominations are those which were anciently in use. It was found impossible to introduce the new terms. The divisions are binary. Half the kilogramme forms the *livre usuel*, which is divided into halves, quarters, eighths, &c., down to the *gros*, which is the eighth of the *once*, or the 1-128th of the *livre*. (For a comparative table of the weights and measures used in different countries of the world, see the *Encyc. Britannica*, art. "Weights.")

WELD. (*Reseda luteola*, Linn.) A plant cultivated for the use of the dyers. When the seeds are ripe, the plant is cut and dried: it yields a brownish yellow decoction, the colour of which is rendered paler by acids, and richer and deeper by alkalies. Alum throws down a yellow precipitate, and leaves the clear liquor of a fine lemon yellow; tartar also brightens its colour; and solutions of tin give it a dilute green tint. When a mixture of whiting and alum is added to a hot decoction of weld, a yellow precipitate is obtained, which, when collected, washed, and dried, is of a fine delicate colour, and much employed by paper-stainers.

WE'LDING. There are a very few of the metals which are susceptible of being united by pressure or hammering, or of being *welded* together. Two pieces of potassium may be welded at common temperatures (from 60° to 80°); but the term is generally applied to the junction of two pieces of iron at a white heat, or of iron and steel. Platinum, also, although infusible, may be welded at a white heat; and it is in this way that that valuable metal, when in the granular or pulverulent state, is worked into bars.

WELL. In Architecture, a deep pit sunk by digging, for the purpose of collecting and retaining the water of a spring or of a reservoir, by which it may be supplied. *See* WATER and ARTESIAN FOUNTAINS.

Before proceeding to dig a well, it ought first to be determined on, whether a mere reservoir for the water which oozes out of the surface soil is desired or obtainable, or a perpetual spring. If the former is the object in view, a depth of fifteen or twenty feet may probably suffice, though this cannot be expected to afford a constant supply, unless a watery vein or spring is hit on: if the latter, the depth may be various, there being instances of 300 and 500 feet having been cut through before a permanent supply of water was found.

The art of well-digging is generally carried on by persons who devote themselves exclusively to that department. The site being fixed on, the ground-plan is a circle, generally of not more than six or eight feet in diameter: the digger then works down by means of a small short-handled spade, and a small implement of the pick-axe kind; the earthy materials being drawn up in buckets by the hand or a windlass fixed over the opening for the purpose. Where persons conversant with this sort of business are employed, they usually manage the whole of the work, bricking round the sides with great facility and readiness; but in other cases it will be necessary to have a bricklayer to execute this part of the business.

There are two methods of building the stone or brick within the well, which is called the steining. In one of these a circular ring is formed, of the same diameter as the intended well; and the timber of which it is composed is of the size of the brick-courses with which the well is to be lined. The lower edge of this circle is made sharp, and shod with iron, so that it has a tendency to cut into the ground; this circular kirb is placed flat upon the ground, and the bricks are built upon it to a considerable height, like a circular wall. The well-digger gets within this circle, and digs away the earth at the bottom; the weight of the wall then forces the kirb and the brickwork with which it is loaded to descend into the earth, and as fast as the earth is removed it sinks deeper, the circular brick wall being increased or raised at top as fast as it sinks down; but when it gets very deep, it will sink no longer, particularly if it passes through soft strata: in this case, a second kirb of a smaller size is sometimes begun within the first. When a kirb will not sink from the softness of the strata, or when it is required to stop out water, the bricks or stones must be laid one by one at the bottom of the work, taking care that the work is not left unsupported in such a manner as to let the bricks fall as they are laid: this is called underpinning.

Well-diggers experience sometimes great difficulty from a noxious air which fills the well, and suffocates them if they breathe it. The usual mode of clearing wells of noxious air, is by means of a large pair of bellows, and a long leathern pipe, which is hung down into the well to the bottom and fresh air forced down by working the bellows.

The use of the auger is common in well-digging, both in ascertaining, before commencement, the nature of the strata to be dug into, and also in course of digging for the same purpose; and because, by boring in the bottom of a well to a considerable depth, the spring is sometimes hit upon, and digging rendered no longer necessary.

The use of the borer alone may procure an adequate supply of water in particular situations. This mode appears to have been long resorted to in this and other countries. From what we have already stated as to the disposition of strata, the conditions requisite for its success will be readily conceived; viz. watery strata connected with others on a higher level: the pressure of the water contained in the higher parts of such strata on that in the lower will readily force up the latter through any orifice, however small. All that is necessary, therefore, is to bore down to the stratum containing the water, and, having completed the bore, to insert a pipe, which may either be left to overflow into a cistern, or it may terminate in a pump. In many cases, water may be found in this way, and yet not in sufficient quantity and force to rise to the surface; in such cases a well may be sunk to a certain depth, and the auger-hole made, and the pipe inserted in it in the bottom of the well. From the bottom it may be pumped up to the surface by any of the usual modes.

As an example of well-digging combined with boring, we give that of a well dug at a brewery at Chelsea, Middlesex, in 1793. The situation was within 20 or 30 feet of the edge of the Thames, and the depth 394 feet, mostly through a blue clay or marl. At the depth of nearly fifty feet a quantity of loose coal, twelve inches in thickness, was discovered: and a little sand and gravel was found about the same depth. The well-digger usually bored about ten, fifteen, or twenty feet at a time lower than his

work as he went on; and on the last boring, when the rod was about fifteen feet below the bottom of the well, the man felt, as the first signal of water, a rolling motion, something like the gentle motion of a coach passing over pavement: upon his continuing to bore, the water presently pushed its way by the side of the auger with great force, scarcely allowing him time to withdraw the borer, put that and his other tools into the bucket, and be drawn up to the top of the well. The water soon rose to the height of 200 feet.

In a case which occurred in digging a well at Dr. Darwin's, near Derby, the water rose so much higher than the surface of the ground, that, by confining it in a tube, he raised it to the upper part of the house. (*Rees's Cyclopædia*, art. "Well;" and *Derbyshire Rep.*)

The process of boring the earth for spring-water has of late been practised with great success in various parts of England, chiefly by Mr. Goode of Huntingdon. In the neighbourhood of London, many fountains of pure spring-water have lately been obtained by these means. We may particularly name those at Tottenham, Middlesex, and Mitcham, Surrey, both of which afford a continuous and abundant flow of water, at one time equal to about eight gallons per minute; but now reduced to a much smaller quantity, in consequence of the great number of holes that have been bored into the supplying strata.

WELL. A small enclosed space near the mainmast, extending from the bottom of the ship to the principal gun deck, containing the pumps.

WE'REGILD. Among the Anglo-Saxons, the compensation paid by a delinquent to the party injured, or his relations, for offences against the person. This custom was common to all the Teutonic tribes, and to many Celtic. It is mentioned by Tacitus in his account of the ancient Germans. The great distinction between Saxon freemen was that between the "eorls," or nobility, and "ceorls," or commonalty; and the *were* of the former was usually rated at six times the amount of that of the latter.

WE'RNERITE. A mineral named after Werner. It is a silicate of alumina, lime, and oxide of iron; of a green or grey colour; and forms eight-sided prismatic crystals. It has been found in Norway and Sweden, and also in Switzerland.

WE'SLEYANS. The chief denomination of the Methodists; so called from John Wesley, their founder. *See* METHODISTS.

WE'STERN EMPIRE. The name given by historians to the western division of the Roman empire, when divided, by the will of Theodosius the Great, between his sons Honorius and Arcadius, A. D. 395. After the deposition of the emperor Augustulus by Odoacer, A. D. 476, the Western empire was definitively at an end. But when Charlemagne, in the year 800, assumed the imperial crown, it was with the view of reassuming the ancient dignity of the Cæsars in Western Europe; and after him the German emperors were considered by the jurists of their own country, and of their party in Italy, as representing the majesty of ancient Rome, the Italian states being looked on as feudatories of the empire.

WHALE. *See* BALÆNA.

WHEAT. (*Triticum*, L.; *Triandria Digynia*, L.; *Gramineæ*, Juss. Inflorescence spiked. Glume two-valved, many-flowered, shorter than the spikelet; the valves nearly equal, beardless, or with one beard enclosing the florets. Paleæ two, one of them bearded from the end. Seed enclosed in the paleæ, rarely otherwise.)

Wheat is by far the most important and most extensively cultivated species of bread-corn raised in England. It is sown after fallow, turnips, cabbages, potatoes, beans, &c. In light soils it follows clover and the cultivated grasses; but it never, at least in the best farmed districts, follows any other white crop. Wheat may be raised on all sorts of soils; but those of a clayey nature are the most suitable. So peculiarly, indeed, is wheat adapted to heavy stiff lands, that they are usually termed "wheat soils." The lighter the soil, the less is it suited to this species of grain; and it is an error in practice to force the cultivation of wheat on soils, and under circumstances, better suited to the production of other grain. In this country it does not admit of being raised at a great elevation. As it is a crop on which the farmer mainly depends, the preparation for it, in whatever rotation it comes, should be an object of great care and attention. If it be intended to sow wheat after fallow, the land is repeatedly ploughed, harrowed, and well manured; if after clover, only one ploughing is given, and seldom more after beans; where tares have been previously sown, they are got off the land in sufficient time to plough it more than once; when wheat follows turnips or cabbages, it must, unless they be stored or eaten, be sown in the spring months.

The kinds of wheat grown in England seem mostly all to be varieties of two species — the *Triticum hybernum*, or winter wheat, and the *Triticum turgidum*, or turgid wheat. The culture of the latter is mostly confined to clays; the cone or bearded wheat, being the most esteemed of its varieties: it enjoys this pre-eminence, not because it yields the finest flour, but because it is comparatively productive, and not subject to disease on wet soils.

The varieties of wheat are perpetually changing, in consequence of variations of culture, climate, and soil. Those most in use are distinguished by different local terms. They may, however, be divided into the two great classes of *red* and *white*, — the latter being superior as respects quality of produce, and the former of hardiness. In general, the thin and smooth-chaffed varieties are preferred to those that are woolly and thick-chaffed. Wheat sown in the spring is called *spring wheat;* but the species is quite the same as that sown before winter; though, by being sown in the spring, its period of ripening is changed. It is always sown before winter when the ground can be got ready; but when it follows turnips, cabbages, and such like crops, it has frequently to be deferred to the spring. (*Low on Agriculture*, pp. 222—228.)

Winter wheat is seldom sown in any part of England before the beginning or middle of September, or later than the end of November. Spring wheat is generally sown between the middle of March and the middle of April. The seed is invariably pickled or steeped; a process intended to prevent *smut*. The quantity of seed allowed to an acre, when sown broad-cast, usually varies from 2½ to 3, and even 4 Winchester bushels.

The drill husbandry, as applied to wheat, is practised to a considerable extent in many parts of England; and in some places it is not unfrequently planted with the dibble; but by far the greater portion is sown broad-cast. While growing, but little attention or labour is bestowed upon it. When drilled, it is generally hoed; and when sown broad-cast, it is sometimes hand-weeded, and occasionally, though rarely, harrowed and rolled in the spring. But these operations are generally, perhaps, prosecuted as much in the view of covering the clover and grass seeds that are then frequently sown in the wheat fields, as of improving the wheat crop.

Wheat harvest generally commences, in the south of England, about the 25th of July, or the beginning of August; in the midland counties it is about ten days, and in the northern counties from a fortnight to three weeks later. There is a striking difference in the harvest field operations, with respect to this as well as other kinds of grain, between the north and south of England; in the former, during harvest, the corn-field exhibits a large number of reapers, perhaps 50, 60, or even 100, all working together, and presenting an interesting and animating spectacle. In the south of England, on the other hand, and over the greater part of the midland counties, wheat is reaped by small sets of individuals, who contract to cut a field or a certain number of acres; so that, in general, the field merely exhibits one or two men, with, perhaps, their wives, working in different parts of it. Wheat is seldom or never cut down with the scythe, but is either reaped with the common sickle, or, as is the practice in some of the counties near the metropolis, as well as in some of the south western counties, it is *bagged*, that is, struck down near the ground with a large and heavy hook. It is universally bound in sheaves, which are set up in *shocks* or *stooks*, each containing twelve or fourteen sheaves. Perhaps no circumstance marks the difference of climate in the south and north of England more strongly than the difference in point of time during which it is necessary to keep wheat and other grain in the field before it is carried home. In the southern counties it is generally ready in a week or ten days; whereas in the north it is necessary to let it stand out for two or three weeks. In the southern, eastern, and midland counties, it is frequently put into barns: in the north, it is almost universally stacked.

As this grain is so extensively cultivated, frequently on very inferior soils, and after very imperfect preparation, the produce per acre varies materially in different counties and districts; it is also very liable to injury from a bad seed time, a wet winter, or a blight during the period of its flowering (which last is the most common cause of the failure or deficiency of our wheat crops); so that its produce varies as much in different seasons on the same farms, and under the same management, as it does during the same season on different farms. The lowest quantity of produce, except where an absolute deficiency from blight occurs, may, perhaps, be rated at from 10 to 12 bushels an acre; and the highest at from 48 to 56 or 64 bushels. Occasionally, indeed, even more than this has been reaped on the deep loams near Chichester, in Sussex, on the calcareous loams near Epsom, and in some of the more favoured and highly cultivated parts of Kent, Essex, Lincoln, Somerset, &c.

The wheat counties are Kent, Essex, Suffolk, Rutland, Hertford, Berks, Hants, and Hereford; that is, these are the counties most distinguished for the quality as well as the quantity of their wheat. In the north, this

grain is sometimes raised of a very fine quality; but generally it is inferior; being colder to the feel, darker coloured, thicker skinned, and yielding less flour. In the best wheat counties, and in good years, the weight of a Winchester bushel of wheat varies from 60 to 62 lbs. In the Isle of Sheppey, in Kent (where, perhaps, the best samples are produced), it sometimes weighs, in favourable seasons, 64 lbs. a bushel. Where the climate is naturally colder, wetter, and more backward, or in bad seasons, the weight of the bushel does not exceed 56 or 57 lbs. It is calculated that, at an average, a bushel of good English wheat weighs 58½ lbs.; and that the average yield of flour is 12½ lbs. of flour to 14 lbs. of grain. The weight of the straw is supposed to be about double that of the grain; so that an acre yielding 30 bushels of wheat, at 58½ lbs. per Winchester bushel, would yield 3,510 lbs. of straw. (*Statistics of British Empire*, i. 464.)

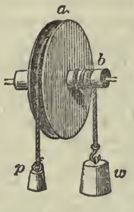
The increase of population, and the extraordinary extension and improvement of cultivation during the ten years ending with 1840, coupled with the inquiries we have made, have satisfied us that in average seasons the quantity of wheat raised in the United Kingdom for food cannot at present (1842) be less than 15,000,000 quarters, and adding to this ⅛th part for seed, the total produce will be 17,500,000 quarters; worth, at the low average price of 52*s*. a quarter, 45,500,000*l*. But notwithstanding its magnitude, the supply is, speaking generally, inadequate to meet the demand, and whenever the crops are below an average there is a large importation.

We incline to think that of the total produce of wheat in the United Kingdom, at least 15,000,000 quarters are furnished by England. The climate of Scotland and Ireland, especially of the latter, is, speaking generally, too cold and moist for the profitable culture of wheat. Along the east coast of Scotland, indeed, in Berwickshire, East Lothian, Fife, Perth, and Forfar, there are extensive tracts where the soil and climate are comparatively good, and the culture excellent, and where very good wheat is raised. But with these exceptions, the rest of Scotland, and the whole of Ireland, is more suitable for the growth of oats and barley than for that of wheat. Indeed its culture in Ireland has recently been declining. The following table gives a comprehensive view of the most important circumstances connected with the British trade in wheat from 1799 down to 1841, both inclusive: —

Account of the Total Quantities of Wheat and Wheat-Flour imported into and exported from Great Britain; distinguishing between the Quantities imported from Ireland and Foreign Parts, in each Year from 1799 to 1841, both inclusive, with the Average Prices of Wheat per Imperial Quarter, in England and Wales, during the same Period.

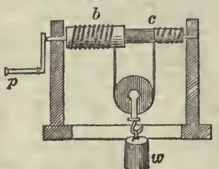
Years.	Imports from Ireland.	Imports from Foreign Parts.	Total Imports.	Exports.	Average Prices.	
	Qrs.	Qrs.	Qrs.	Qrs.	s.	d.
1799	- -	- -	463,185	39,362	69	0
1800	749	1,263,771	1,264,520	22,013	113	10
1801	150	1,424,615	1,424,765	28,406	119	6
1802	108,751	538,912	647,663	149,304	69	10
1803	61,267	312,458	373,725	76,580	58	10
1804	70,071	391,069	461,140	63,073	62	3
1805	84,087	836,747	920,834	77,955	89	9
1806	102,276	208,066	310,342	29,566	79	1
1807	44,900	360,046	404,946	25,113	75	4
1808	43,497	41,392	84,889	98,005	81	4
1809	66,944	389,043	455,987	31,278	97	4
1810	126,388	1,440,738	1,567,126	75,785	106	5
1811	147,245	188,886	336,131	97,765	95	3
1812	158,352	132,358	290,710	46,325	126	6
1813	217,154	341,846	559,000	Records destroyed	109	9
1814	225,478	627,089	852,567	111,477	74	4
1815	189,544	194,931	384,475	227,947	65	7
1816	121,631	210,860	332,491	121,611	78	6
1817	55,481	1,034,374	1,089,855	317,524	96	11
1818	105,179	1,589,082	1,694,261	58,668	86	3
1819	153,850	471,788	625,638	44,689	74	6
1820	403,407	593,072	996,479	94,657	67	10
1821	569,700	137,684	707,384	199,846	56	1
1822	463,004	47,598	510,602	160,499	44	7
1823	400,068	23,951	424,019	145,951	53	4
1824	356,384	85,207	441,591	61,680	63	11
1825	396,018	391,588	787,606	38,796	68	6
1826	314,851	582,276	897,127	20,054	58	8
1827	405,255	306,613	711,868	57,323	58	6
1828	652,584	757,716	1,410,300	76,489	60	5
1829	519,017	1,671,078	2,190,095	75,097	66	3
1830	529,717	1,676,034	2,205,751	37,149	64	3
1831	557,498	2,310,362	2,867,860	65,875	66	4
1832	790,293	464,058	1,254,351	289,558	58	8
1833	844,211	322,246	1,166,457	96,212	52	11
1834	779,505	201,981	981,486	159,482	46	2
1835	661,776	99,032	750,808	134,076	39	4
1836	598,757	262,399	861,156	256,978	48	6
1837	534,465	575,027	1,109,492	308,420	55	10
1838	542,583	1,380,817	1,923,400	158,621	64	7
1839	258,331	2,852,398	3,110,729	42,512	70	8
1840	174,439	2,352,206	2,526,645	87,242	66	4
1841	218,708	2,704,481	2,923,189	30,390	64	4

WHEEL AND AXLE. In Mechanics, one of the simple mechanical powers or machines, consisting of a wheel having a cylindrical axis passing through its centre, resting on pivots at its extremities, or supported in gudgeons, and capable of revolving. The power is applied to the circumference of the wheel, and the weight or force to be overcome to the circumference of the axle; and equilibrium takes place when the power and weight are to each other inversely as the radii of the circles to which they are applied. In the annexed figure, a is the wheel, b the axle, p the power, and w the weight. The power is applied by a rope passing round the wheel, and the weight attached to another rope coiled round the axle in a contrary direction. As the wheel and axle turn together, the wheel takes up or throws off as much more rope than the axle as its circumference is greater than that of the axle; or the space through which p descends is as much greater than that through which w is lifted up as the circumference or radius of the wheel is greater than the circumference or radius of the axle. Hence if a denote the radius of the wheel, and b that of the axle, we have, by the principle of virtual velocities, $p : w :: b : a$, or $p\,a = w\,b$.



The wheel and axle is a perpetual lever, so contrived as to have a continued motion about a fulcrum. When the thickness of the rope is taken into consideration, the force must be conceived as acting at the centre of the rope, and therefore the thickness of the rope which supports the weight must be added to the diameter of the axle, and the thickness of that which supports the power to the diameter of the wheel. But the manner in which the power is applied is very various, and frequently otherwise than by means of a rope. If the power acts not at the circumference of the wheel, but at the extremity of a handspike or projecting pins inserted in the wheel, the distance of that extremity from the centre of the axis is to be accounted the radius of the wheel. The common winch with which a grindstone is turned or a crane worked, the capstan, the windlass, the crank, and other contrivances of a similar kind, are only different modifications of the wheel and axle.

A form of the wheel and axle is represented in the subjoined figure, by which a great mechanical advantage is obtained. The axle consists of two parts having different thicknesses; and the rope after being coiled round one of the parts is carried round a pulley attached to the weight, and coiled round the other in the opposite direction. The power p is applied at the handle of the winch, which here takes the place of the wheel. In order to compute the advantage gained by this machine, let a denote the circumference described by the handle of the winch, b the circumference of the thicker part of the axle, and c that of the thinner part; then, while the winch makes one revolution in the direction which raises the weight, the part of the rope which passes from the one part of the axle to the other round the pulley will be shortened by the quantity $b-c$, and consequently the weight w will be raised through the height $\frac{1}{2}(b-c)$. But the space described in the same time by the power p is equal to that through which the handle of the winch passes, or equal to a; therefore, by the principle of virtual velocities, $p : w :: \frac{1}{2}(b-c) : a$, or $p\,a = \frac{1}{2} w\,(b-c)$. As the circumferences of circles are to their radii in a constant ratio, it is evident that the formula will equally apply if the letters a, b, c be taken to represent the respective radii.



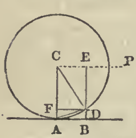
WHEEL. In a Ship, the wheel and axle by which the tiller is moved.

WHEEL ANIMAL, or WHEEL ANIMALCULE. *See* Rotifers.

WHEEL, BREAKING ON THE. A mode of capital punishment, said to have been first employed in Germany; according to some writers, on the murderers of Leopold, duke of Austria, in the 14th century. According to the German method of this savage execution, the criminal was laid on a cart-wheel with his arms and legs extended, and his limbs in that posture fractured with an iron bar. But in France (where it was restricted to cases of assassination, or other murders of an atrocious description, highway robbery, parricide, and rape), the criminal was laid on a frame of wood in the form of a St. Andrew's cross, with grooves cut transversely in it above and below the knees and elbows; and the executioner struck eight blows with an iron bar, so as to break the limbs in those places, sometimes finishing the criminal by two or three blows on the chest or stomach: thence

called *coups de grace*. He was then unbound and laid on a small carriage wheel, with his face upwards, and his arms and legs doubled under him; there to expire, if still alive. Sometimes the sentence contained a *retentum*, by which the executioner was directed to strangle the criminal, either before the first, or after one, two, or three blows. This punishment was abolished in France at the Revolution; but it is still resorted to in Germany as the punishment for parricide, the last instance of which took place in 1827 near Gottingen. The assassin of the bishop of Ermeland in Prussia, in 1841, was sentenced to the wheel.

WHEELS OF CARRIAGES. Wheels applied to carriages serve a twofold purpose. In the first place, they greatly diminish the friction on the ground by transferring it from the circumference to the nave and axle; and in the second place, they serve to raise the carriage more easily over obstacles and asperities met with on the roads. The friction is diminished in the proportion of the circumference of the axle to that of the wheel; and hence the larger the wheel, and the smaller the axle, the less is the friction. The mechanical advantage of the wheel in surmounting an obstacle may be computed from the principle of the lever. Let the wheel touch the horizontal line of traction in the point A, and meet a protuberance B D. Suppose the line of draft C P to be parallel to A B, join C D, and draw the perpendiculars D E and D F. We may suppose the power to be applied at E, and the weight at F, and the action is then the same as the bent lever E D F turning round the fulcrum at D.



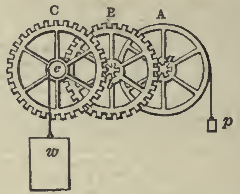
Hence P : W : : F D : D E. But F D : D E : : tan. F C D : 1; and tan. F C D = tan. 2 (D A B); therefore P = W tan. 2 (D A B). Now, it is obvious that the angle D A B increases as the radius of the circle diminishes; and therefore the weight W being constant, the power required to overcome an obstacle of a given height is diminished when the diameter is increased. Large wheels are therefore best adapted for surmounting inequalities of the road. There are, however, circumstances which prescribe limits to the height of the wheels of carriages. If the radius A C exceeds the height of that part of the horse to which the traces are attached, the line of traction C P will be inclined to the horizon, and part of the power will be exerted in pressing the wheel against the ground. The best average size of wheels is considered to be about 6 feet in diameter. The fore wheels of carriages and waggons in this country are usually much too small.

Cylindrical wheels are best adapted for level roads; and the breadth of the rim should be considerable (not less than three inches), to prevent their sinking into the ground. In hilly and uneven roads a slight inclination of the spokes, called *dishing*, tends to give strength to the wheel; but it is very frequently carried to excess.

WHEEL WORK, in Machinery, consists of a combination of wheels communicating motion to one another. Such combinations may be formed in various ways; but they are generally reducible to the principle of the wheel and axle, though the wheel which turns the other is not usually on the same axis with it. The motion in such cases is communicated from the one wheel to the other, either by belts or straps passing over the circumferences of both, or by teeth cut in those circumferences, and working in one another. In either of these ways the velocities of points in their circumferences are equal; and consequently their angular velocities, or the number of revolutions which they make in the same time, are inversely as their radii. When one wheel drives another by teeth, they necessarily turn in opposite directions; if united by a cord or belt, they will turn in the same direction, if the belt does not cross itself between the two wheels; but if the belt crosses itself, they will turn in opposite directions. The chief advantage of transmitting motion by cords or belts is, that the wheels may be placed at any convenient distance from each other, and be made to turn either in the same or in opposite directions.

Wheels may act on one another so as to communicate motion in various ways. When the resistance of the work is not great, the object may be accomplished by the mere friction of their circumferences. In order to increase the friction, the surfaces of the rims are faced with buff leather (caoutchouc might answer the purpose better), or wood cut against the grain, and pressed together with a certain degree of force. This method is sometimes used in spinning machinery, and has even been applied successfully to the saw mill; but is seldom adopted in works on a great scale. Motion communicated in this manner proceeds smoothly and evenly, and is accompanied with little noise.

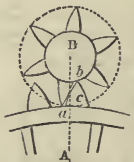
When motion is to be transmitted through a train of wheel work, toothed wheels are generally employed. It is usual to call a small wheel acted on by a large one a *pinion*, and its teeth the *leaves* of the pinion. Wheels and pinions are combined in the manner represented in the annexed figure. On the axle of the wheel A, which bears the power, is a pinion *a*, which drives the wheel B. The axle of this wheel carries a pinion *b*, which drives the wheel C. In the figure, the axle *c* of this wheel carries the weight; but the combination may be continued at pleasure.



When motion is communicated in this manner, the angular velocity of the first wheel is to that of the last pinion as the product formed by multiplying together the radii of all the wheels to the product formed by multiplying together the radii of all the pinions. Consequently, if R, R′, R″, &c. denote respectively the radii of the wheels, and r, r', r'', &c. the radii of the pinions, we shall have, by the principle of virtual velocities, $p\ (R \times R' \times R'', \&c.) = w\ (r \times r' \times r'', \&c.)$. As the size of the teeth of any wheel and the opinion into which it works must be equal, we may substitute for the radii the number of teeth in the wheels and pinions respectively.

Toothed wheels, as distinguished by the position of the teeth relatively to the axis, are of three kinds: *spur wheels*, *crown wheels*, and *bevelled wheels*. When the teeth are raised upon the edge of the wheel, or are perpendicular to the axis (as in the above figure), the wheel is a spur wheel; when they are raised parallel to the axis, or perpendicular to the plane of the wheel, it is a crown wheel; and when they are raised on a surface inclined to the plane of the wheel, it is called a bevelled wheel. The combination of a crown wheel with a spur wheel as pinion is used when it is required to communicate motion round one axis to another at right angles to it. Two bevelled wheels are employed to transmit motion from one axis to another inclined to it at any proposed angle. Wheels have also different names, according to their mode of action, as *heart wheel*, *sun-and-planet wheel*.

Form of the Teeth of Wheels. — In the construction of machinery, it is of the utmost importance that the several parts act on one another with a uniform force, and with the smallest possible amount of friction. When wheels act by teeth working into each other, every point of the side *a b* of the tooth which is in action comes successively into contact with the tooth of the pinion as the wheel turns round, and the force is necessarily exerted at the points *c*, which are in contact.



Hence the lengths and positions of A *c* (A being supposed the centre of the wheel) and B *c*, the levers by which they act, are constantly changing; and in order, therefore, that the force of the one tooth upon the other may be constant, it is necessary that the line drawn perpendicular to the surfaces of both teeth, at the point of contact *c*, always intersect the line A B of the centres in the same point. There are many different curves according to which the teeth might be formed so as to answer this condition; but that which has been most generally adopted, and which appears the most convenient, is the epicycloid generated by the revolution of a circle whose radius is equal to half the radius of the pinion on the circumference of a circle equal to the wheel. This was first proposed by Roemer, the celebrated Danish astronomer. The evolute of the circle was proposed, with other curves, by Euler. *See* TEETH OF WHEELS.

When the teeth are constructed according to the theoretical rules, the action is not only uniform, but there is little friction; for the teeth roll on one another, and neither slide nor rub. But as it is impossible to attain perfect accuracy in practice, the surfaces of the teeth will always present some inequalities, and there will consequently be some friction. In order, therefore, to equalize the wear, it is necessary that every leaf of the pinion should work in succession through every tooth of the wheel, and not always through the same set of teeth; and hence the number of teeth in a wheel and in a pinion which work into each other should be prime to one another. This precaution is more especially necessary in mill work, and where considerable force is used (*Willis's Principles of Mechanism*; *Buchanan on Mill Work*, by Rennie; *Lardner's Mechanics*, *Cab. Cyclop.*; *Gregory's Mechanics*, &c.)

WHELPS. Short upright pieces placed round the barrel of the capstan, to afford resting points for the messenger or hawsers.

WHE'TSTONE. A talcy slate containing silica, used for hones. *See* NOVACULITE.

WHEY. The limpid part of milk which remains after the separation of the curd and butter: it consists chiefly of water holding between 3 and 4 per cent. of sugar of milk in solution. *See* MILK.

WHIGS. The well-known designation of a political party in English history. It was first used in the reign of Charles II. The term, which is of Scottish origin (*vide infrà*), was first assumed as a party name by that body of politicians who were most active in placing William III. on the throne of England. Since that time it has been borne by successive generations of those who, by hereditary inclination, or by education, or party connection, have followed in the same political line. Generally speaking, the principles of the Whigs have been popular, and their measures, when in power, tending to increase the democratic influence in the constitution. It may not be out of place to subjoin a few of the various accounts of the origin of the term *Whig*, now incorporated indelibly in the political vocabulary of this country. It was introduced immediately after the failure of Hamilton's expedition into England, in the year 1648, for the rescue of Charles I. from the hands of the English levellers and fanatics. After Hamilton's defeat at Preston, the Westland Whigs raised an insurrection, which is thus alluded to: —

"The party appellation of *Whigamores*, or, briefly, *Whigs*, had its origin at this period; and the insurrection referred to was called the 'Whigamores' raid,' or incursion, that term being the common one for the predatory expeditions of the Borderers. This nickname being still preserved in the vocabulary of party, although there is truly none now existing that can be in any degree assimilated to the original faction, it seems proper to explain how the distinction originated. Mr. Laing, in his History (vol. i. p. 381. 2d ed. 1804), informs us that 'the expedition was termed the Whigamores' inroad, from a word employed by these western peasants in driving horses; and the name transferred, in the succeeding reign, to the opponents of the court, is still preserved and cherished by the Whigs as the genuine descendants of the Covenanting Scots.' And in a footnote he adds, 'According to others from whig or whey, the customary food of those peasants.'"

Sir Walter Scott, in his *Tales of a Grandfather* (*Prose Works*, vol. xxiv.), says, "This insurrection was called the Whigamores' raid, from the words *whig, whig*, — that is, get on, get on, — which is used by the western peasants in driving their horses; a name destined to become the distinction of a powerful party in British history."

In Daniel Defoe's *Memoirs of the Church of Scotland*, printed 1717, p. 173., speaking of the Covenanters, he says, "This is the first time that the name of a Whigg was used in the world,—I mean as applied to a man or to a party of men; and these were the original primitive Whiggs, the name for many years being given to no other people. The word is said to be taken from a mixed drink the poor men drank in their wanderings, composed of water and sour milk."

And Bishop Burnet, who lived nearer to the time in which the nickname was invented, gives the following explanation of it in the *History of his Own Times* (p. 26. imperial ed. 1837): — "The south-west counties of Scotland have seldom corn enough to serve them round the year; and the northern parts producing more than they need, those in the west come in the summer to buy at Leith the stores that come from the north; and from a word *whiggam*, used in driving their horses, all that drove were called Whiggamores, and, shorter, the Whiggs. Now, in that year, after the news came down of Duke Hamilton's defeat, the ministers animated their people to rise and march to Edinburgh, and they came up marching on the head of their parishes with an unheard-of fury, praying and preaching all the way as they came. The Marquis of Argyle and his party came and headed them, they being about six thousand. This was called the Whiggamores' inroad, and ever after that all that opposed the court came, in contempt, to be called Whiggs; and from Scotland the word was brought into England, where it is now one of our unhappy terms of distinction."

WHI'NSTONE. A species of basalt. *See* GEOLOGY.

WHIP. In sea language, a rope passed through a single block or pulley.

WHI'RLING TABLE. A machine contrived for representing several phenomena of centrifugal force, by giving bodies a rapid rotation. Mr. Robins invented a whirling machine for the purpose of determining the resistance of the air, which is described in the 1st vol. of his *Tracts*; and also in *Hutton's Tracts*, vol. iii., where the results of a series of experiments with it are detailed.

WHI'RLPOOL. A vortex, eddy, or gulf, where the water has a circular motion. Whirlpools are produced by the meeting of currents which run in different directions. Their danger to navigation is well known, but is perhaps not equal to the dread which sailors entertain of them. Some of the most celebrated are the Euripus, near the coast of Negropont; the Charybdis, in the straits of Sicily; and the Maelstrom, on the northern coast of Norway. (*Murray's Geography*, Introd.)

WHI'RLWIND. A revolving column or mass of air, supposed with most probability to be produced by the meeting of two currents of air blowing in opposite directions, but ascribed by some to electricity. It is analogous to the *whirlpool*. When the opposite currents have the same velocity, the circulation will be maintained at the same spot; but if the motion of one of them is more rapid than that of the other, it will transport the whirling motion with its excess of celerity, and a progressive and rotatory motion are thus maintained at the same time. Whirlwinds generally occur in summer, and are most violent in tropical countries, where they frequently produce most destructive effects. The diminution of atmospheric pressure arising from the centrifugal force of the revolving column is thus computed by Professor Leslie: — "If r denote in feet the radius of the extreme circle described by the whirlwind, and t the time of circumvolution in seconds, the elasticity, or pressure of the column at the verge, will suffer a diminution corresponding to the fraction $\frac{5\,r}{4\,t^2}$. The amount of this diminution over the whole base would be reduced to three fourths; and consequently, h expressing the height of the revolving column of air, $\frac{15\,r\,h}{16\,t^2}$ would represent the mean effect of centrifugal action. Suppose the whirlwind to have an elevation of 200 feet, and a radius of 50, and to circulate in 3 seconds, the diminished pressure would be equal to the weight of a column of $\frac{15 \times 50 \times 200}{16 \times 9} = 1040$ feet. This example, assuming a celerity of sixty-five miles an hour, might be reckoned an extreme case; but it would occasion the mercury to sink in the barometer more than an inch, or 1·12." (*Ency. Brit.*, "Meteorology.") *See* STORM; WINDS.

WHI'SKEY. (A corruption of the Gaelic word *usquebaugh*.) A species of corn spirit. *See* DISTILLATION.

WHI'SPERING DOMES, or GALLERIES, are places in which whispers or feeble sounds are communicated to a greater distance than under any ordinary circumstances. In order to produce this effect, the form of the roof or walls of the building must be such that sound proceeding from one part is transmitted by reflection or repeated reflections to another. The dome of St. Paul's church in London furnishes an instance. *See* SOUND.

WHITE. In Painting, a negative colour (if such definition may be allowed), whose opposite or antagonist is *black*, which may best serve as its explanation; because black is void of all colour, properly so called.

WHITE. The colour produced by the combination of all the prismatic colours mixed in the same proportions as they exist in the solar rays. This is proved both by decomposing white light by means of a prism, and by recompounding the primitive colours in due proportions. *See* COLOUR, LIGHT, REFRACTION.

WHITE ARSENIC. Oxide of arsenic, or arsenious acid. *See* ARSENIC.

WHITE BAIT. The name of a small and peculiar species of *Clupea*; confounded, until studied by Mr. Yarrel, with the young of the shad (*Clupea alosa*). The young fish of the white bait (*Clupea alba*, Yarrell) begin to ascend the Thames at the beginning of April, and continue in that part of the river where there is a mixture of salt with fresh water until September, when young fish of the year four or five inches long are not uncommon, though accompanied by others of smaller size; but the parent fish are believed not to ascend beyond the estuary. The young of the shad are not two inches and a half long till November, when the white bait season is over; and they are distinguished by a spotted appearance behind the edge of the upper part of the operculum, which the white bait never exhibits. Mr. Yarrel suggests that if a net sufficiently small in the mesh were used, the white bait might be taken in other rivers besides the Thames; but he states that the Hamble, which runs into the Southampton Water, is the only other river from which he has received this justly estimated fish.

WHITE COPPER. An alloy used by the Chinese, and called by them Packfong or Pakfong; it is composed, according to the analysis of Dr. Fife, of 40·4 parts of copper, 25·4 of zinc, 31·6 of nickel, and 2·6 of iron. *German silver* is a modification of this alloy.

WHITE EAGLE, ORDER OF THE. An order of knighthood in Poland, instituted by Uladislaus V. in 1325; revived by Frederic Augustus I. in 1705.

WHITE LEAD. Carbonate of lead. *See* LEAD. Thi

important compound, of which from 16,000 to 17,000 tons are annually manufactured in England, is chiefly used as the basis of white oil paint; it is also employed to a small extent in the manufacture of cements. It is chiefly made in two ways: either by precipitation, as when carbonic acid or a carbonate is used to decompose a soluble salt, or a subsalt of lead; or by exposing plates of cast lead to the joint action of the vapour of acetic acid, air, and carbonic acid: it is by the latter process only that the resulting carbonate of lead is obtained of that degree of density and opacity, and perfect freedom from crystalline texture, which fits it for paint. This last, commonly called the *Dutch process*, was introduced into England about the year 1780. It is described, together with the other processes, in *Brande's Manual of Chemistry*, fifth ed. p. 844. White lead is often largely adulterated with sulphate of baryta, which is detected by insolubility in dilute nitric acid, whereas pure white lead is entirely dissolved by it.

WHITE LEG. A disease which generally occurs in women soon after delivery, and which has been erroneously supposed to arise from redundancy of milk. It comes on with stiffness and pain of the limb, which afterwards becomes tumid and tense from the effusion of serum, and in some instances goes on to suppuration. Leeches, fomentations, friction, and gently stimulating liniments, with the internal use of mild aperients and remedies calculated to allay the febrile symptoms that attend it, are the principal points of treatment. Those women who during pregnancy have suffered very much from swellings of the lower extremities are generally most liable to its attacks.

WHITE PRECIPITATE. The white powder which falls on adding ammonia to a solution of corrosive sublimate: it is a compound of peroxide and bichloride of mercury with ammonia: it is virulently poisonous, and is chiefly used in ointments and for killing vermin.

WHITE STONE. A granite abounding in white felspar.

WHITE SWELLING. A term vulgarly applied to indolent tumours in scrophulous habits.

WHITE VITRIOL. The old name of sulphate of zinc. *See* ZINC.

WHI'TEWASH. A mixture of whiting, size, and water, for whitening ceilings, walls, &c.

WHITFIE'LDIAN ME'THODISTS. The name given to the most numerous body of the Methodists after the Wesleyans; so called from Whitfield, whose early connection with the Methodists will be found noticed under that term. Soon after the return of Mr. Whitfield from America in 1741, he withdrew connection with Wesley on account of religious tenets; the former holding the high doctrine of Calvinism, and differing from the latter chiefly on the subjects of election and general redemption. But though they differed in sentiments, these good men lived and died united in heart. Whitfield devoted his life to itinerant preaching, and was, if possible, more popular as an energetic and eloquent pulpit orator than his former coadjutor. He did not confine his labours to Great Britain and Ireland, but visited North America no fewer than seven different times; and died there at Boston, in 1770, in the fifty-sixth year of his age. But he can scarcely be said to be the founder of a sect: his chief object was itinerating. At several places, indeed, he erected chapels, or *tabernacles*, as he called them; but these he invariably left to the care of any orthodox clergyman, whether in the establishment or among the dissenters, who was prepared to occupy them. Since his death the members of these congregations have been nominally, but only nominally, classed together as a distinct body, under the title of the *Tabernacle Connection*. They are not governed by a general conference, nor is their cause supported by a common stock; but each congregation is virtually independent in itself, and provides for its own expenses. The lay-preachers are few, most of their ministers being ordained among themselves; but, like the Wesleyans, they have a periodical change of pastors. (*Dr. Gillies's Life of Whitfield*.)

Among the most zealous of Whitfield's followers was Selina, Countess of Huntingdon, in whose family he had at one time officiated as chaplain. She devoted her ample funds to the erection of chapels in different parts of England, and invited clergymen of the established church to occupy them; but finding the supply of pastors from that source deficient, she founded a college at Trevecca, in South Wales, for the education of pious young men for the ministry. She thus became the foundress of a distinct sect, under the name of *Lady Huntingdon's Connection*. The college has, since her death, which took place in 1791, been transferred to Cheshunt, in Hertfordshire. In her chapels, about sixty in number, the service is performed according to the ritual of the church of England. (*Dr. Haweis's Hist. of the Church*, vol. iii.; *Adam's Religious World*, vol. iii. 146-56.)

Another sect of Methodists, whose name is frequently found in connection with that of Whitfield, are the Welsh Calvinistic Methodists. This body, which, though not founded by Whitfield, received much countenance and support from him in its earlier stages, had its origin so early as 1735, but was not finally organized till 1785. Its founder was Mr. Howell Harris of Trevecca. The field of the operations of this sect is chiefly Wales; and there is scarcely a village in the principality in which one of their chapels is not to be found.

WHI'TING. The name of a species of the Cod tribe (*Merlangus vulgaris*, Cuv.), and the type of a subgenus, distinguished from the true cod by the absence of the barbules at the chin. It is esteemed for the delicacy of its flavour and its easiness of digestion.

WHITING. Chalk carefully cleared of all stony matter, ground, levigated, and made up into small oblong cakes. As it is often used as a polishing material, it should be very carefully freed from all particles of flint or sand.

WHI'TLOW. (Sax.) A painful inflammation, tending to suppuration, at the ends of the fingers.

WHI'TSUNDAY, in the Calendar, is the seventh Sunday, or 49th day after Easter. *Whitsuntide* corresponds with *Pentecost*. This Sunday was called in the ancient church *Dominica Alba*, White Sunday; or *Dominica in Albis*, the Sunday in which *white garments were worn*, it having been formerly a custom with those who were baptized on this day to dress in white for the occasion. The term, however, has been differently derived from the Saxon "utas," octave, the eighth from Easter. (*Hamon l'Estrange*. See *Riddle's Christian Antiquities*.)

WI'CKLIFFITES. In Ecclesiastical History, the followers of the reformer Wickliff, who are better known by their popular name of Lollards (which see). The memory and opinions of Wickliff were solemnly condemned by the council of Constance in 1415. His bones were dug up and publicly burned in 1428, an event finely commemorated in one of the sonnets of Wordsworth.

WILL, or TESTAMENT, is, in Law, the legal declaration of a man's intentions as to what he wills to be performed after his death. In strictness of language, the term *will* is limited to land; *testament*, to personal estate.

Wills, according to the law up to a recent period, were either nuncupative or written. A nuncupative will could not revoke one that is written; it must be proved by the oaths of three witnesses present at the making of it, must have been made in the last sickness of the testator, and at his house; and was subject to various other restrictions. A written will to dispose of personal property was good, if sufficient proof could be obtained of the writing of the testator, even without his signature or the attestation of any witnesses. A will of real property must, by 29 C. 2. c. 3., be in writing, signed by the testator, or by some other person in his presence, and by his express direction; and witnessed or subscribed, in the presence of the testator, by three or four credible witnesses. This state of the law gave rise to considerable inconvenience. Much litigation was occasioned by the uncertainty as to what was, or was not, a paper sufficient to convey personal property as a will: much fraud was supposed to have been caused by the facility with which such testaments might be forged, or surreptitiously obtained; while, on the other hand, the rules respecting the publicity of wills of real property were thought more stringent than the case required. These considerations induced the legislature to pass the statute 7 W. 4. & 1 Vict. c. 26. (in 1837), by which the making of wills is now regulated. All wills (except those of seamen and soldiers on service), whether of real or personal property, must be in writing, and signed at the foot by the testator or some other person in his presence and by his direction; and such signature must be made and acknowledged by the testator in the presence of two or more witnesses present at the same time; and such witnesses must attest and subscribe the will in the presence of the testator; but no form of attestation is necessary. All appointments by will, whatever formalities may have been required by the creator of the power, must now be made according to the provisions of this statute, and require no further form.

The same statute enacts that no will of a minor shall be valid. All devises and gifts by will to an attesting witness are void. To put an end to the various questions which had arisen respecting the revocation of wills, it is provided that they shall be revoked only by the marriage of the party, or by another will duly executed, or some writing declaring an intention to revoke, and executed with similar formalities, or by burning, tearing, or otherwise destroying, with intention to revoke. All wills now speak from the death of the testator, unless they show on the face a contrary intention, that is, they act upon the property which he possesses at his death. And various important alterations are introduced in the effect of the ordinary language used in devises and bequests.

A married woman cannot make a will of lands or tenements; nor, without the consent of her husband, of personalty.

A disposition by will of real property is termed a *devise;* of personal property, a *bequest* or *legacy*. *See* DEVISE, EXECUTOR.

WI'LLOW. *See* SALIX.

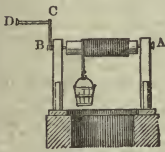
WINCH. In Mechanics, a bent handle or rectangular lever, for turning a wheel, grindstone, &c. The term *winch* is also popularly applied to the *windlass*. *See* WINDLASS.

WIND. *See* WINDS.

WINDAGE OF A GUN. The difference between the diameter of the bore of a gun and the diameter of the ball. Formerly it was usual in the English service to allow a very considerable windage, 1-20th of the diameter of the bore; but it has been found that the shot will go much truer, and that a smaller quantity of powder is required, when the above allowance is considerably diminished. (*Hutton's Tracts*, vols. ii. iii.) *See* GUNNERY.

WIND GAGE. An instrument for measuring the force or velocity of the wind. *See* ANEMOMETER.

WI'NDLASS. A machine used for many common purposes. It is a particular modification of the wheel and axle, the power being applied by means of a rectangular lever or *winch*. The arm B C of the winch represents the radius of the wheel; and the power is applied to C D at right angles to B C. The windlass is frequently used in merchant ships or small trading vessels instead of a *capstan* for heaving the anchors, &c. In this case it consists of a large cylindrical piece of timber laid in a horizontal position, and supported at its two ends by two pieces of wood called *knight-heads* placed on opposite sides of the deck near the foremast. This axle is pierced with holes directed towards the centre, in which long levers are inserted, called handspikes. It is furnished with strong *pauls* to prevent it from turning backwards when the pressure on the handspikes is intermitted.

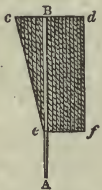


WI'NDMILL. In Mechanics, a mill which receives its motion from the impulse of the wind. The general appearance of the windmill is familiar to every one. The building containing the machinery is usually circular. To the extremity of the principal axis, or wind-shaft, are attached rectangular frames (generally five), on which cloth is usually stretched to form the sails. The surfaces of the sails are not perpendicular to the axis, but inclined to it at a certain angle, about 72° at the extremities nearest the axle, and 83° at the farther extremities; so that their form is in some degree twisted, and different from a plane surface. Suppose the axis to be placed in the direction of the wind; the wind will then strike the sails obliquely, and the force may therefore be resolved into two parts, one of which, acting in the direction perpendicular to the axis, gives a motion of rotation to the sails, and consequently to the wind-shaft, from which it is communicated to the machinery. The wind-shaft is inclined to the horizon in an angle of from 8° to 15°, principally with a view to allow room for the action of the wind at the lower part, where it would be weakened if the sails came too nearly in contact with the building.

As the direction of the wind is constantly changing, some apparatus is required for bringing the axle and sails into their proper position. This is sometimes effected by supporting the machinery on a strong vertical axis, the pivot of which moves in a socket firmly fixed in the ground; so that the whole structure may be turned round by a lever. But it is now usual to construct the building with a moveable roof, which revolves upon friction rollers; and the shaft being fixed in the roof is brought round along with it. The roof is brought into the required position by means of a small vane wheel furnished with wind sails, which turns round when the wind strikes on either side of it, and drives a pinion which works into the teeth of a large crown wheel connected with and surrounding the moveable roof.

Of the Form and Position of the Sails.— From the investigations of Parent and Belidor, it appears that the maximum effect of the wind on the sails is produced when their inclination to the axis of rotation is about $54\frac{3}{4}$ degrees; or when the *angle of weather*, that is to say, the angle formed by the plane of the sail and the plane of its revolution, is $35\frac{1}{4}$ degrees. But this result, being obtained from considering the effect of the wind on the sails when at rest, does not agree with that which is found by experiment. In fact, as the velocity of the sail tends to withdraw it from the action of the wind, it is necessary to counteract the diminution of force by diminishing the angle of weather, or to bring the sail into such a position that the wind strikes its surface more directly; and since the velocity of the different parts of the sail is in proportion to their distance from the axis, it follows that in order to produce the greatest effect every elementary portion of it ought to have a different angle of weather, diminishing from the centre to the extremity of the sail. Euler has given a theorem which determines the law of variation. Let a be the velocity of the wind, and b the velocity of any given part of the sail; then the action of the wind upon that part of the sail will be a maximum when the tangent of its inclination to the axis, or the cotangent of the angle of weather, $= \sqrt{2 + \left(\frac{3b}{2a}\right)^2} + \frac{3b}{2a}$. Suppose that at a given part of the sail the velocity of the sail is equal to the velocity of the wind, we have then $a = b$; and the formula becomes $\sqrt{2+\frac{9}{4}} + \frac{3}{2} = 3{\cdot}561 =$ tangent of 74° 19′, which gives 15° 41′ for the angle of weather.

This subject was investigated experimentally by Smeaton (*Philosophical Trans.* vol. li.), who found that the common practice of inclining the sails from 72° to 75° to the axis is much more efficacious than the angle assigned by Parent, the effect being as 45 to 31. When the sails were weathered in the Dutch manner, or with their surface concave to the wind, and the angle of inclination greater towards the extremities, the effect was greater than when weathered either in the common way or according to Euler's theorem. But the effect was greatest of all when they were enlarged at their extremities, and had the form $c\,d\,f\,e$, represented in the annexed figure; so that $c\,d$ was one third of the radius A B, and c B to B d as 5 to 3. If the sails be farther enlarged, the effect is not increased in proportion to the surface; and besides, when the quantity of cloth is great the machine is much exposed to injury from sudden squalls. In Smeaton's experiments the angle of weather varied with the distance from the axis; and it appeared from several trials that the most efficacious angles at the different parts of the sail were those in the following table:—



Parts of A B, which is divided into Six equal Parts.	Angle with the Axis.	Angle of Weather.
1	72°	18°
2	71	19
3	72	18
4	74	16
5	$77\frac{1}{2}$	$12\frac{1}{2}$
6	83	7

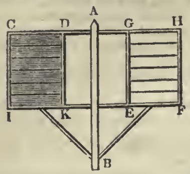
If the radius A B of the sail be 30 feet, then the sail will commence at 1-6th of A B, or 5 feet from the axis, where the angle of inclination will be 72°. At 10 feet from the axis, the angle will be 71°; and so on, as in the table.

Of the Effect of Windmill Sails.—The following maxims relative to the effect of the sails were deduced by Smeaton from his experiments:—

1. The velocity of windmill sails, whether loaded or unloaded, so as to produce a maximum effect, is nearly as the velocity of the wind, their shape and position being the same. 2. The load at the maximum is nearly, but somewhat less, as the square of the velocity of the wind, the shape and position of the sails being the same. 3. The effects of the same sails at a maximum are nearly, but somewhat less, as the cubes of the velocity of the wind. 4. The load of the same sails at the maximum is nearly as the squares, and their effects as the cubes of their number of turns in a given time. 5. When the sails are loaded so as to produce a maximum effect at a given velocity, and the velocity of the wind increases, the load continuing the same, then the increase of effect, when the increase of the velocity of the wind is small, will be nearly as the square of those velocities; when the velocity of the wind is doubled, the effect is nearly as 10 to $27\frac{1}{2}$. When the velocities compared are more than double of that where the given load produces a maximum, the effects compared increase nearly in the simple ratio of the velocity of the wind. 6. In sails where the positions and figures are similar and the velocity of the wind the same, the number of turns in a given time will be reciprocally as the radius or length of the sail. 7. The load at a maximum that sails of a similar figure and position will overcome at a given distance from the centre of motion will be as the cube of the radius. 8. The effects of sails of similar figure and position are as the square of the radius. 9. The velocity of the extremities of Dutch sails, as well as of the enlarged sails in all their usual positions, when unloaded, or even loaded to a maximum, is considerably quicker than the velocity of the wind.

Horizontal Windmills.—Windmills are sometimes constructed in such a manner that the planes of the sails intersect each other in the wind-shaft, in which case they are called *horizontal windmills;* because the wind-shaft being usually vertical, the sails have a horizontal motion. The wind-shaft, however, might be placed with equal advan-

tage in the horizontal position. In this construction



A B is the wind-shaft or arbor, which moves upon pivots. Cross bars are fixed in this arbor, which carry the frames C D E F and G H I K. The sails C E and G I are stretched on these frames, and are carried round the axis A B by the perpendicular impulse of the wind; and a toothed wheel fixed upon the arbor gives motion to the machinery. Two sails only are represented in this figure, but there are always other two at right angles to these. When the wind impels the two sails C E and G I equally, it is obvious that no motion can ensue. In order, then, that motion may be communicated to the machine, the impulse of the wind on the returning sail must be removed by screening it from the wind, or at least diminished by making it present a less surface when returning against the wind. The first of these methods is said to be practised in Tartary, and some provinces in Spain; it is the simplest, and probably the best. The other method requires the sail to be formed of several flaps moveable on hinges, and so adjusted that on one side of the axis they present their surfaces to the wind, and when returning on the other only their edges. Other contrivances have been proposed; but horizontal windmills are greatly inferior, in point of effect, to those which have vertical sails, and are accordingly seldom met with.

On account of the irregularity of the moving force, and the interruption from calm weather, machines impelled by the wind can only be used advantageously for purposes which are not urgent, and where regularity is not indispensable. The chief purposes to which they are applied are grinding corn, expressing oil from seeds, bruising oak bark for tanning, sawing wood, raising water, &c. Windmills were brought into Europe from the East about the time of the Crusades. (*Phil. Trans.* vol. li.; *Smeaton's Miscellaneous Papers; Ferguson's Lectures*. by Brewster; *Gregory's Mechanics*.)

WI'NDOW. (Quasi wind-door.) In Architecture, an aperture in a wall for the admission of light and air to the interior. In distributing windows so that there be had a sufficiency of light, it is usual to make the piers or intervals between them never less than the width of the window, and never more than two widths of the same. Where it is required to ascertain the total area of light necessary for a room, the following empirical rule is frequently used:— Multiply together the length, breadth, and height, and extract the square root of the product, which will be the area of light required.

WINDS. Currents in the atmosphere, conveying the air, with more or less velocity, from one part to another. Notwithstanding all that has been written on the subject of the winds, their theory is still involved in considerable obscurity. The subject is exceedingly complicated; and no attempt that has yet been made to derive a general law from the observations has been attended with much success. Nevertheless we can discern, clearly enough, certain prevailing causes of the disturbances which are constantly taking place in the equilibrium of the elastic fluid which envelopes the earth, though their influence is modified, and sometimes altogether concealed, by disturbing causes, the effects of which we have no means of adequately appreciating.

The principal cause of wind may be ascribed to the unequal and variable distribution of heat through the atmosphere, the temperature of which is mainly determined by that of the surface of the earth. The distribution of heat at the surface is determined by the manner in which it is received from the sun, and radiated from the earth to the celestial spaces. If we consider the whole earth, or the state of any given portion of it through a long series of time, the quantity of heat received from the sun and the quantity lost by radiation exactly balance each other, and the mean temperature remains an invariable quantity. But, on considering any particular portion of the earth, it is easy to see that though a balance is effected in the long run between the heat received and parted with, the two quantities are never precisely equal at the same time, or only so for very short intervals, the one alternately exceeding and falling short of the other. The radiation goes on continually, though not uniformly; but the supply of heat from the sun, on a given surface, is interrupted entirely while the sun is below the horizon, and during the day varies with the sun's altitude. It varies also at the different seasons of the year, in consequence of the unequal lengths of the days and nights, and the greater or less obliquity with which the rays strike against the surface.

But the effect of the solar rays depends not only on the obliquity with which they fall upon the surface, but also in a great degree on the nature of the surface. The daily illumination of the sun warms the land to a very small depth, scarcely exceeding, perhaps, an inch. The heat is therefore accumulated at the surface, the temperature of which is rapidly increased when the heat received exceeds that which is radiated away, and as rapidly cooled in the reverse circumstance. In water, however, the calorific rays penetrate to a considerable depth, twenty or thirty feet. If we suppose a tenth part of the incident light to be intercepted by a stratum of water one foot in thickness, while it is totally intercepted by 1·2 inch of dry land, it would follow that the sun's rays communicate every day a hundred times less heat to the surface of a body of water than to an equal expanse of level ground. Now the effect of the two surfaces in heating the superincumbent atmosphere will be in proportion to their respective temperatures; but in the present instance the general conclusion is modified by two circumstances. In the first place, a portion of the solar light, perhaps a fiftieth of the whole, is intercepted in its passage through the atmosphere, and converted into heat; and it is obvious that the increase of temperature caused by this portion is independent of the nature of the surface. In the second place, a small portion of the light which falls upon water is reflected from the surface into the atmosphere, and converted into heat. On the whole, it may be concluded that the change of temperature in the air caused by the succession of day and night is about thirty times less over water than over land. Hence, if the whole surface of the globe had been covered by the ocean, the effect of the alternation of day and night in producing atmospheric currents would have been scarcely sensible. Hence, also, over a great part of the surface of the ocean, the winds are reducible to fixed and determinate laws; while on continents, and also on the ocean in high latitudes, the order and periods of their recurrence are irregular and anomalous.

Besides the effects arising from the disturbance of the equilibrium of temperature, we have also to consider the mechanical effect of the earth's rotation about its axis. If the earth were a sphere of uniform temperature, and at rest in space, the atmosphere would also be at rest; its height would be constant over every point of the earth's surface, and its density and elasticity at equal altitudes every where the same. But if the temperature of the motionless sphere, instead of being equal at every point, were greatest at the equator, and decreased towards the poles, though the pressure on every point of the surface would still continue the same, the altitude of the atmospheric column would become greatest at the equator, and consequently its specific gravity less there than at the poles. The heavier fluid at the poles would then, by virtue of its greater weight, pass beneath and displace the lighter, and a current be established in the lower part of the atmosphere from the poles towards the equator. In the higher regions of the atmosphere the effect would be reversed. The lower stratum of air in the equatorial regions being heated by its contact with the earth, becomes rarified and ascends, and thus produces an accumulation, and causes a counter current in the higher regions from the equator towards the poles. The height at which this change in the direction of the motion takes place under certain circumstances may be computed. Professor Daniell (*Meteorological Essays*) computes that the lower current, from the poles to the equator, extends to the height of 2¼ miles, diminishing in velocity from the surface upwards.

If we now suppose the sphere to revolve about its polar axis, an apparent modification will take place in the directions of the currents. The lower current, coming from a zone where the velocity of rotation is less than that of the parallel at which it arrives, will appear to be affected with a motion contrary to that of the diurnal rotation; while the upper current, flowing from the equator to the poles, would be apparently affected in an opposite manner. On this theory it is usual to explain the *trade winds*, which prevail within and to a considerable distance beyond the tropics in both hemispheres. These easterly currents, however, receive important modifications, both as to their direction and the distance to which they extend from the equator on either side, from the annual variations of the sun's declination and the configuration of the land. They prevail in the open ocean, in the Atlantic and Pacific, between the latitudes of 30° N. and 27° S. On entering these from either side, the deviation arising from the rotation of the earth, towards the east is greatest; and this deviation becomes less and less as the equatorial zone is approached. In the immediate vicinity of this zone, the wind is nearly due N. on the northern side of the equator, and nearly due S. on the southern side. *See* TRADE WINDS.

In the Indian Ocean the trade winds receive a curious modification from the position of the surrounding land, and the effect of the solar heat on it. During one half of the year, from November to April, the winds blow in the ordinary direction of the trades, that is to say, from the north-east; but from April to November they blow

in the directly opposite direction. These periodical winds are called the *Monsoons*. (*See* MONSOONS.) Between the equator and 10° south latitude, north-west winds prevail from October to April, and south-west the rest of the year. In other parts of the tropics, the regular trade winds are also modified by the configuration of the land. On the coast of Guinea the wind almost constantly blows from the south-west, in the opposite direction to the trades. Near the Cape Verd Islands calms and variable winds are usually experienced.

Between the parallels of 30° and 40°, in both the North and South Pacific Oceans, westerly winds blow almost constantly, excepting only for a short time after each equinox. In the North Atlantic Ocean the prevalence of westerly winds between those parallels is less constant, in consequence of the comparative narrowness of that ocean, and the consequent influence of the opposite continents; they are still, however, the prevailing winds, except in the months of April and October, when a north-east wind is more frequent. In consequence of these winds, the voyage from Europe to America is much more tedious than the opposite one.

Upon the continents the diurnal and annual changes of temperature are much more rapid and extensive than over the ocean; hence there is little constancy in the direction or intensity of the winds, even in equatorial countries. In high latitudes the inequalities are still greater, and extend even to the open seas. Beyond the latitude of 40°, the winds do not seem to be reducible to any fixed laws.

The different manner in which land and water are affected by radiation and the direct heat of the sun gives rise to the *land* and *sea breezes* which prevail on the coasts, particularly in tropical countries, though they are not confined to any particular latitude, and are perceptible sometimes as far north as Norway. During the day the surface of the land becomes more heated than that of the adjacent ocean, and the air over the land, in consequence of its greater rarefaction, is displaced by the denser air rushing from the sea. Hence a current, or *sea breeze*, beginning at some hour in the morning, and continuing till the sun is near setting, will flow from the water towards the land. At night the water remains warm, while the surface of the land cools rapidly; and hence the current sets from the land towards the water, and forms the *land breeze*. Winds of this sort are more frequent about islands and small peninsulas than in other situations.

A variety of *local winds* are observed, the circumstances occasioning which are either too complicated or too imperfectly known to admit of their being satisfactorily explained. The *Etesian* is a northerly or north-easterly wind, which prevails very much in summer all over Europe. The *Sirocco* is a hot, moist, and relaxing wind, which visits Naples and the south of Italy from the opposite shores of the Mediterranean. The *Samiel* or *Simoom* of Arabia is a hot, arid, pestilential blast, generally coming from the south. The *Kamsin* of Egypt is of the same kind. The *Harmattan* is a dry east wind, also of an unwholesome description, occurring in Guinea and some other countries.

In the preceding remarks the winds have been considered as produced by the unequal distribution of temperature in the atmosphere, combined with the earth's diurnal rotation. Other causes, however, depending on the physical constitution of the atmosphere, must be assigned for those sudden and irregular blasts which occasionally spring up, and rage for some time with tremendous fury. Among these causes, one of the most powerful is, doubtless, the rapid condensation of vapours in the bosom of the atmosphere. An inch of rain has sometimes been observed to fall within the space of an hour over a great extent of country, particularly in the equinoctial regions. Suppose the superficial extent over which rain has fallen to the depth of an inch to be only 100 square leagues; if the vapour necessary to produce this quantity of rain existed in the atmosphere at the temperature of 50° of Fahrenheit, it would occupy a space 100,000 times greater than in the liquid state; that is to say, it would occupy a space equal to a column of which the base is 100 square leagues, and the altitude 100,000 inches, or nearly 10,000 feet, and such would be the dimensions of the vacuum created by the condensation. Some abatement must be made from this estimate, inasmuch as the vapour existing in the atmosphere is in the vesicular, and not the elastic state; but in any case its condensation into drops and precipitation must create an immense void, the filling up of which must necessarily occasion violent atmospherical concussions. On this principle may be explained a fact, the observation of which is often of great importance at sea, that an unusual fall of the barometer is generally followed by a gale of wind. *See* STORM.

The velocity of wind varies from nothing to upwards of a hundred miles an hour; but the maximum is variously stated by different experimenters, and, in fact, it is not easy to see by what means its velocity can be ascertained within moderate limits of accuracy. The best method seems to be that of deducing its velocity from its force, observed by means of an anemometer. In vol. li. of the *Philosophical Transactions* a table is given of the different forces and velocities of winds, drawn up by Smeaton from a considerable number of facts and experiments. The following extract from it will give the reader a general idea of the velocity of the wind in different circumstances:—

Velocity of the Wind.	Perp. Force on 1 Sq. Foot, in lb. Avoirdupois.	Common Appellation of the Force of such Winds.
Miles in an Hour.		
1 -	·005	Hardly perceptible.
4 -	·079	Gentle pleasant wind.
5 -	·123	
10 -	·492	Pleasant brisk gale.
15 -	1·107	
20 -	1·968	Very brisk.
25 -	3·075	
30 -	4·429	High wind.
35 -	6·027	
40 -	7·873	Very high.
50 -	12·300	A storm.
60 -	17·715	A great storm.
80 -	31·490	A hurricane.
100 -	49·200	A violent hurricane.

Of late years the theory of winds (in common with other meteorological phenomena) has received much attention; and through the recommendation of the British Association, self-registering anemometers have been erected at the principal observatories and other places, with a view to obtain systematic series of observations. The principal points to be determined are the mean duration of the different winds, the law of their succession, and their connection with the state of the barometer, thermometer, and hygrometer. (See *Prof. Forbes' Reports on Meteorology* to the Brit. Association for 1831 and 1840; Experiments by Col. Beaufoy in the *Annals of Philosophy*, vol. viii. p. 94.; *Daniell's Meteorological Essays; Murray's Geography*, Introd.; Pouillet, *Elemens de Physique*.)

WIND SAIL. A tube or funnel of canvass, employed to convey a stream of fresh air down into the lower part of a ship.

WINE. (Germ. wein.) All spirituous products of fermentation are occasionally denominated *wines*. The term, however, is more generally limited to fermented grape juice, or *must;* and the theory of the process has been noticed under the word FERMENTATION. There are many circumstances which influence the general characters or quality of wine; among which are principally climate, soil, and aspect, the nature and maturity of the grape, and the mode of fermentation. In regard to climate, for instance, it may be observed that that which is best suited to the culture of the vine extends from the 35th to the 50th degrees north latitude; in more northerly situations the grape seldom ripens perfectly, and the wines that it yields are of a less generous character than those produced in more congenial districts. In warmer climates, on the other hand, the juice becomes too rich and saccharine. It often happens, however, that a very luscious grape transplanted to a colder climate yields a good wine, and that vines carried from a cold to a warmer climate, within the latitudes mentioned, afford excellent liquors; it is said, indeed, that we are indebted for some of our most choice wines to such judicious transplantations. Chaptal has stated that the *must* obtained from grapes grown in the south of France was richer than that from the northern departments. With respect to soil, it may be observed that no fruit is more remarkably influenced by its qualities than the grape. Light and porous soils are best suited to it; and although the plant will grow vigorously in rich and moist ground, the fruit is by no means excellent in proportion to its luxuriance. Dr. Henderson states (*History of Wines*), that strong argillaceous soil not only checks the extension of the roots, but keeps them too moist, and often imparts to the wines a peculiar earthy taste, such as we perceive in Cape wine. A stony or gravelly soil is preferable to all others; it allows of the free growth of the roots, and is sufficiently retentive of moisture. Volcanic soils are also favourable to the growth of the vine, as shown in the island of Madeira, Italy, Sicily, and the south of France. The quality of the grape is also greatly influenced by differences in the exposure and inclination of the ground. Hills are preferable to plains, especially where the aspect is such as to be duly exposed to the sun and sheltered from cold winds; hence the advantage of a south-eastern aspect. The influence of season, so important in regard to the ripening and perfection of all fruits, is especially so with respect to that of the vine, its consequences going beyond the mere temporary perfection of the grape as fitting it for the table, and extending in a very striking manner to the qualities of the wine; hence the notoriety and high character of the vintages of particular seasons, as, for instance, that of the comet in 1811. In a cold year the wine is weak and

acescent. "When the season is rainy," observes Dr. Henderson, "the produce will be increased; but it will be poor and insipid, and generally found to contain a large portion of malic acid, which gives to it a peculiar flavour, always most perceptible in those wines which are most devoid of spirit. A moderate degree of humidity, however, is essential to the welfare of the vine. In those climates, accordingly, where great droughts prevail, as in Persia, and in the neighbourhood of Malaga, the earth is formed into a dish around the plant, in order to collect and retain the rain which falls during the spring. High winds and fogs are always very injurious to the vine." Manures are generally regarded as prejudicial in warm climates; but in colder aspects, as upon the Rhine, they are often not only useful, but necessary. Different methods of planting and training the vine are adopted in different countries; but it is generally found advantageous to keep the plant as low as possible, for the same vine yields fruit of very different qualities, depending upon the mode in which it is trained and trimmed. But there are no circumstances by which the quality of the wine is more affected than those dependent upon the state of maturity of the grape. When grapes are fully ripe they generally yield the most perfect wine as to strength and flavour: if suffered to shrivel to a greater or less extent, the wine will be more saccharine; and if they are not fully mature, it will be brisk, and often tart. "In general, dry and clear weather ought to be chosen for the vintage; but when a slow and imperfect fermentation is required, as in the case of the brisk champagne wines, the grapes that are collected during a fog, or before the dew that has settled on the vines is dispersed, are found to answer best, and to yield the largest quantity of *must.*" The few facts which have now been stated will show how many minute circumstances must be attended to in the selection and cultivation of the vine; and it is astonishing how much the character and excellence of the produce depend upon causes which often appear so trifling as to be beneath notice. But the ultimate production of good wine involves a variety of other considerations connected with the process of fermentation, in the due management of which much practical skill is often requisite, and the utmost cleanliness always indispensable. The component parts of *must*, and the changes which they undergo in the fermenting vats, have already been noticed (*see* FERMENTATION); so that it only remains here to add a few remarks upon the general characters and composition of the principal varieties of wine. The colour of the wine almost always depends upon the husks of the grape; for the pulp, even of the blackest fruit, is, with very few exceptions, equally colourless with that of the green grape. The seeds of the grape, and more especially the stalks, containing tan and extractive matter, also modify the taste of the wine; hence they are added to Port wine, but generally excluded from the delicate wines of Bourdeaux and of the Rhine. The peculiar aroma or perfume is sometimes dependent upon very recondite causes, as in the fine wines of Burgundy. In some cases it is acquired by age, and appears to depend upon some chemical change, perhaps connected with the formation of something like a variety of ether; but it also depends upon the quality of the grape, as in the Muscadine and Frontignac wines. The leading character, however, of wine must be referred to the *alcohol* which it contains, and upon which its intoxicating powers principally depend: not exclusively, however; for some of the lighter wines, if brisk and effervescent, seem to derive from the admixture of carbonic acid a peculiar exhilarating power not directly proportional to their alcoholic contents. And again, we find other wines, among which certain Burgundies stand foremost, which are eminently heating, though not very strong. The following table shows the quantity of alcohol (of the specific gravity of 825 at 60°), by measure, contained in 100 parts by measure of the respective wines. Some other vinous and spirituous liquors have been added, for the purpose of showing the relation which they bear to wine in the proportion of alcohol which they contain.

	Proportion of Spirit per Cent. by Measure.	Averages.
1. Lissa	26·47	
Ditto	24·35	
Ditto	15·90	25·41
2. Raisin wine	26·40	
Ditto	25·77	
Ditto	23·20	25·12
3. Marsala	26·03	
Ditto	25·05	
Ditto	18·40	25·09
4. Port	25·83	
Ditto	24·29	
Ditto	23·71	
Ditto	23·39	
Ditto	22·30	
Ditto	21·40	
Ditto	19·00	22·96
5. Madeira	24·42	
Ditto	23·93	
Ditto (Sercial)	21·40	
Ditto	19·24	22·27
6. Currant wine	20·55	
7. Sherry	19·81	
Ditto	19·83	
Ditto	18·79	
Ditto	18·25	
Ditto (very old)	23·80	19·17
8. Teneriffe	19·79	
9. Colares	19·75	
10. Lachryma Christi	19·70	
11. Constantia (white)	19·75	
Ditto	14·50	
12. Ditto (red)	18·92	
13. Lisbon	18·94	
14. Malaga (1666)	18·94	
15. Bucellas	18·49	
16. Red Madeira	22·30	
Ditto	18·40	
17. Cape Muschat	18·25	
18. Cape Madeira	22·94	
Ditto	20·50	
Ditto	18·11	
19. Stein wine	10·60	
20. Grape wine	18·11	
21. Calcavella	19·20	
Ditto	18·10	
22. Vidonia	19.25	
23. Alba Flora	17·26	
24. Malaga	17·26	
25. White Hermitage	17·43	
26. Rousillon	19·00	
Ditto	17·26	
27. Alcatico	16·20	
28. Ætna	30·00	
29. Claret	17·11	
Ditto	16·32	
Ditto	14·08	
Ditto	12·91	15·20
30. Malmsey Madeira	16·40	
31. Lunel	15·52	
32. Sheraaz (red)	15·52	
Ditto (white)	19·80	
33. Syracuse	15·28	
34. Sauterne	14·22	
35. Grenache	21·24	
36. Burgundy	16·60	
Ditto	15·22	
Ditto	14·53	
Ditto	11·95	
Ditto (20 years in bottle)	12·16	17·84
37. Hock	14·37	
Ditto	13·00	
Ditto (old in cask)	8·88	12·08
38. Johannisberger (1788)	8·71	
39. Rudisheimer (1811)	10·72	
40. Rhenish	7·36	
41. Nice	14·36	
42. Barsac	13·86	
43. Tent	13·30	
44. Champagne (still)	13·80	
Ditto (sparkling)	12·80	
Ditto (red)	12·56	
Ditto (ditto)	11·30	12·01
45. Red Hermitage	12·32	
46. Vin de Grave	13·94	
Ditto	12·80	
47. Frontignac	12·79	
48. Cote Rotie	12·32	
49. Gooseberry wine	11·84	
50. Orange wine (average of six samples made by a London manufacturer)	11·26	
51. Tokay	9·88	
52. Elder wine	8·79	
53. Cyder (highest average)	9·87	
Ditto (lowest ditto)	5·21	
54. Perry (average of four samples)	7·26	
55. Mead	7·32	
56. Ale (Burton)	8·88	
Ditto (Edinburgh)	6·20	
Ditto (Dorchester)	5·56	
57. Brown stout	6·80	
58. London porter (average)	4·20	
59. Ditto small beer (ditto)	1·28	
60. Brandy	53·39	
61. Rum	53·68	
62. Gin	51·60	
63. Scotch whiskey	54·32	
64. Irish ditto	53·90	

It is necessary, however, to observe that the proportion of alcohol in the same wine varies materially according to the age of the wine and other circumstances, and that wines having the same quantities of alcohol in each, may, notwithstanding, differ essentially in every other respect. Practically wines are distinguished by their colour, hardness or softness on the palate, their aroma, and their being still or effervescing. In many cases, too, the same variety of wine may be distinguished into a number of sub-varieties, differing more or less in one or more of these particulars. Thus, in the case of champagne, some varieties are red, and others white or straw-coloured; some are dry and others sweet; the aroma of one variety differs from that of another; and, while some are still, others have every different degree of effervescing power.

The same variety exists in the case of clarets, and, indeed, of almost every description of wine.

The differences in the quality of wines depend partly on differences in the vines, but more on the differences of the soils in which they are planted, in the exposure of the vineyards, and in the treatment of the grapes, and the mode of manufacturing the wine. Though the vine grows in every sort of soil, a rising ground, or gently-sloping hill facing the south, with a loose, gravelly, or rather volcanic soil, is by far the best situation for a vineyard: —

"——— apertos
Bacchus amat colles."

It is in such situations that all the finest wines are produced.

It would be useless in a work of this kind to attempt characterizing the different sorts of wine used in Great Britain. Port and sherry have long enjoyed a decided preponderance in our markets; and it must be admitted that, when of good quality and sparingly used, they are very unexceptionable wines. But they are often harsh, and have the disadvantage of being strong and heating, so that they cannot be taken, to anything like excess, by most persons with impunity. They are well enough for a glass or two, but they are not wines for conversation or society. It is not probable, indeed, had it not been for the high differential duties with which French wines were so long burdened, that the use of port and sherry would ever have been so general in England; and since the abolition of the differential duty in 1831, French wines have begun gradually, though slowly, to make their way from the highest, to which they have hitherto been mostly confined, amongst the middle classes. They are, indeed, superior, in almost all respects, to every other variety. The best growths of claret, champagne, and Burgundy, seem to unite all the qualities required to constitute perfect wines. Had they been known in antiquity we apprehend they would have engrossed most part of the praise so profusely lavished on the Pramnian, Cecuban, Falernian, and other renowned wines of Greece and Rome. We subjoin

An Account of the Quantities of the different sorts of Wine imported into and exported from the United Kingdom; the Quantities entered and retained for Home Consumption; and the Rates of Duty in 1840.

Wine.	Quantities imported.	Quantities upon which Duty has been paid.	Quantities exported.	Quantities retained for Consumption, deducting export after Payment of Duty.	Rates of Duty per Gallon.
	Gallons.	*Gallons.*	*Gallons.*	*Gallons.*	*s. d.*
Cape - -	460,024	457,062	5,467	456,773	2 9
French - -	570,195	362,712	155,375	341,841	5 6
Portugal -	2,980,383	2,773,404	391,581	2,668,534	do.
Spanish -	4,022,315	2,641,171	1,238,878	2,500,760	do.
Madeira -	279,157	122,010	143,829	112,555	do.
Rhenish -	75,611	62,381	14,760	60,056	do.
Canary -	250,804	30,149	280,607	29,298	do.
Fayal - -	1,241	191	277	191	do.
Sicilian and other sorts -	671,517	394,124	189,789	383,914	do.
Mixed, in bond - -	- -	- -	16,515	- -	do.
Total -	9,311,217	6,843,204	2,437,078	6,553,922	

WINGS. In Naval matters. Passages along the sides of the ship between the fore and after cockpit.

WINGS, in Plants, are membranous expansions of different parts. The two lateral oblong petals of a Papilionaceous corolla, the two lateral sepals of a Polygam, the expansion from the back of the fruit of the ash tree, from the sides of the seed of a Bignonia, and from the surface of many Umbelliferous fruits, are all called *wings*.

WINGS. In Architecture. *See* ALÆ.

WI'NTER. One of the four seasons of the year. Winter is usually understood to begin with the shortest day, and to end when the sun returns to the vernal equinox.

WI'PERS, in some kinds of machinery, as oil-mills, powder-mills, fulling-mills, are pieces projecting generally from horizontal axles, for the purpose of raising stampers, pounders, or heavy pistons, in vertical directions, and then leaving them to fall by their own weight. The principal object to be attended to in the construction of wipers is to give them such a form that the weight shall be raised with a uniform force and velocity. (*Gregory's Mechanics; Appendix to Ferguson's Lectures*, by Brewster; *Willis's Principles of Mechanism.*)

WIRE-DRAWING. The art of extending the ductile metals into wire. The operation is performed by casting or hammering the metal into a bar, which is then successively drawn through holes in a steel plate, each being smaller than the other, until the requisite fineness is attained. The holes through which extremely fine wires of platinum, gold, or silver are occasionally drawn, are sometimes made in a diamond or ruby. *See* GOLD, &c.

WIT (Germ. witz), has been defined briefly to be the unexpected combination of distant resemblances. The term *wit* has in the course of two centuries passed through more significations than most others in the English language. Without going further back than the reign of James I., wit is used by Sir J. Davies as the most general name for the intellectual faculties, of which reason, judgment, wisdom, &c. are subdivisions. In the time of Cowley and Hobbes, it came to denote a superior degree of understanding, and more particularly a quick and brilliant reason. By Dryden it is used as very nearly synonymous with talent or ability; but after his time, and more particularly by Addison in his papers on Wit, we find a gradual approximation to the modern signification of the term.

The forms of wit are so various that it would be impossible to include them all within the circle of a precise definition; but the following comprehensive enumeration of these forms by the celebrated Dr. Barrow may be interesting to the reader. "Sometimes it lieth in pat allusion to a known story, or in seasonable application of a trivial saying, or in forging an apposite tale; sometimes it playeth in words and phrases, taking advantage from the ambiguity of their sense, or the affinity of their sound; sometimes it is wrapped in a dress of humorous expression; sometimes it lurketh under an odd similitude; sometimes it is lodged in a sly question, in a smart answer, in a quirkish reason, in a shrewd intimation, in cunningly diverting, or cleverly retorting an objection; sometimes it is couched in a bold scheme of speech, in a tart irony, in a lusty hyperbole, in a startling metaphor, in a plausible reconciling of contradictions, or in acute nonsense; sometimes a scenical representation of persons or things, a counterfeit speech, a mimical look or gesture, passeth for it; sometimes an affected simplicity, sometimes a presumptuous bluntness giveth it being; sometimes it riseth only from a lucky hitting upon what is strange; sometimes from a crafty wresting obvious matter to the purpose. Often it consisteth in one knows not what, and springeth up one can hardly tell how. Its ways are unaccountable and inexplicable, being answerable to the numberless rovings of fancy and windings of language." (See, as to the difference of meaning between *wit* and *bulls*, *Edin. Rev.* vol. iii. p. 399.)

WITCH, WITCHCRAFT. It has been a subject of much controversy whether the verse, "Thou shalt not suffer a witch to live," in the 22d chapter of Exodus, is correctly rendered in modern versions. The Septuagint render it by φάρμακος, *a poisoner*. It is, however, generally held, that the latter interpretation is not the true one, and that the practice here condemned was that of pretended divination by means of supernatural agency. This was, by the Jewish law, an act of rebellion against the Almighty Ruler of the Jewish nation, and punished as such. (See also Deuteronomy, xviii. 10, 11.) The only detailed and particular narrative of witchcraft in the Old Testament is that of the evocation of Samuel by the witch of Endor. (See on this subject *Sir W. Scott's Second Letter on Demonology and Witchcraft.*)

Among the Greeks, a general belief prevailed in magical practices and incantations, especially by women; and Thessaly was the region most celebrated for the pursuit of these arts by its inhabitants. The same superstition was equally prevalent among the Romans. But, in the sense in which the word is used in modern times, a witch is supposed to derive her power from a peculiar compact with evil spirits; and this species of witchcraft is of course posterior to the rise of Christianity, although the belief in demoniacal possession was common from the first ages of the Christian church, and a particular class of the clergy was early set apart for the purpose of conjuring devils, with the name of exorcists. The first traces of the modern superstition respecting witchcraft are perhaps to be found in *Augustine*, who speaks of magicians as living in society with devils, and having a compact with them. The ancient witchcraft of the classical times became easily connected in vulgar belief with the superstitions arising out of Christian theology. As early as the Council of Ancyra (308), the belief in transformations by magical art (of which we find so remarkable an instance in the romance of Apuleius) is condemned as heretical. The gods of the ancient mythology, by the zealous preaching of the Christian clergy, acquired in popular imagination the attributes of demons; and there is little doubt that many of the supposed assemblies of witches and devil-worshippers, which terrified the imaginations of the chroniclers and historians of saints in the early part of the dark ages, originated in the secret meetings of the proscribed worshippers of Pagan deities, who endeavoured to secure their privacy by terrifying their orthodox neighbours. (See a poem of Goëthe's on this subject.) From all these causes combined, the belief in witchcraft grew, as has been observed, side by side with the prevailing worship of saints and relics. About the time of Charlemagne

and his successors, we find one species of imaginary witchcraft peculiarly prevalent. Storms and tempests were attributed to certain magicians (defensores), who were believed, as in the classical mythology, to have acquired a power of controlling the elements; but this belief was condemned by the church as superstitious. The very general superstition (which also is mentioned by Augustine) of assemblies of females riding through the air with the demon Diana, Minerva, or Herodias (from which, in later days, the notions of the witch festival on the Brocken in Germany, the French sabbat, &c., were all derived), is also reprobated by the divines of this period. It has been supposed by some that the sudden spread of intelligence, and the cast of noble and more liberal sentiment which prevailed in Europe about the time of the Crusades, checked for a time, at least among the higher orders, the spread of debasing superstitions; but if this was really the case, the effect was but temporary. Up to this time we have found the church generally condemning most of the popular fancies respecting demoniac agency as superstitious; but from the end of the 12th century we find them gradually gaining ground, so as to become articles of religious credence. At the coronation of Richard I., Cœur de Lion, Jews and women were forbidden to attend: the latter because so many of them were suspected of witchcraft. The works of Gervase of Tilbury (at the beginning of the 13th century) give perhaps the best picture of the extent to which similar opinions prevailed about that epoch. In the same century, witches and heretics were first connected in the eye of the church: the commissioners who tried the various sectaries of the time were equally directed to inquire into and punish magical practices. In the 14th century the persecution of witches assumed a more regular and severe character. The well-known accusations against the Templars (1309), in which all the common charges of compacts with the devil, witch-assemblies, &c., were mingled with those of atheism and heresy, were but the prelude to a long series of similar proceedings. About this time the south of France, north of Italy, and some parts of Germany seem to have been most infested with demoniacal agency. The female sex seems from the earliest times to have been most implicated in the public horror of witchcraft; and from the commencement of the 15th century we find this common notion become a confirmed doctrine: almost all the decrees of councils, &c., which speak of witchcraft, and the prosecutions which are carried on, henceforward are directed against women only. From this time, therefore, we may date (as far as accuracy is practicable on such subjects) the separation in popular belief of the higher magic practised by learned and distinguished men, from the petty witchcraft of which the great performers were poor, old, and ignorant women. Many of the great magicians were believed to operate their wonders by the control which they had acquired over inferior spiritual agents, without any express compact with the devil; and although such practices were often condemned by the church, always liable to suspicion, and sometimes brought those who indulged in them (together with alchemists and astrologers) under the cognizance of criminal tribunals, yet they were always considered as of a different order altogether from the feats of common witches. In 1484 appeared the famous bull of Innocent VIII., "Summis desiderantes affectibus." In this remarkable instrument all the absurdities of the popular superstition are formally recapitulated, and a commission directed to three individuals (Institor, Sprenger, and Gremper) to examine and punish witches in the German empire. Although immediately relating to Germany only, this bull is rightly considered by Herzog (the author of the article on witchcraft in *Ersch and Gruber's Encyclopædia*, from whom we have borrowed largely on the present subject) as forming a period in the history of this superstition. Although much cruelty had been committed before in the pursuit of this imaginary crime, it is from this solemn confirmation of the vulgar superstition that we must date the continuous course of legal persecution which lasted for two centuries over the greater part of Europe.

The details of these legal proceedings bear a striking similarity in all the countries in which this baleful superstition so long prevailed. It has been seen that by the bull of Innocent VIII. witchcraft was rendered a crime peculiarly cognizable by ecclesiastical authorities: so it remained for the most part in Catholic countries, especially where the Inquisition was established; and this constituted the chief difference between the procedure in those regions and that which prevailed in Protestant districts, where the civil magistrate took cognizance of the offence. Thus the various forms of religious observance which were interwoven with the judicial proceeding in the former, exorcisms and so forth, were for the most part disused by Protestants. In other respects, the mode of investigation and punishment was much the same. Every where they exhibited a singular mixture of legal refinement with popular violence. Thus the various ordeals by which suspected witches purged themselves (one of the most vulgar superstitions connected with witchcraft) were conducted with gravity and regularity under the eye of the law. The best known in England was that of water: if the accused swam when thrown in, it was held as a proof of guilt. On the Continent a favourite mode, among many others, was by weighing. In the scales set apart for this purpose a true witch was always found to weigh more than her previously ascertained weight. There was in the 17th century a weighing beam at Budewater in Holland, of such celebrity that persons accused of witchcraft in many neighbouring provinces used to appeal to it. When, however, the suspected person was in the hands of the tribunal, there was in general one only mode of procedure, — by torture. This was carried to the most horrible and unheard-of excesses; and as it was generally recognized that witchcraft was a crime entirely out of ordinary rules, the various provisions of the civil or municipal laws by which that dreadful practice was mitigated were wholly neglected, and the accused abandoned to all the cruelty with which fear or fanaticism might inspire the judges. In England, which forms in this respect a solitary exception, torture was not judicially practised; but the various severities to which the unfortunate prisoners were subject had probably nearly equal effect. And thus every where the witch persecutions produced the same result — confessions, namely, of all the strange and monstrous crimes with which the accused lay charged. These appear to have grown more voluminous and more utterly incredible in every generation; and this may be naturally accounted for: for when a witch had made up her mind to confess, it cost her nothing to promulgate the most extravagant inventions; and these being regarded as undoubted truths, formed the basis of interrogatories to be administered to other unhappy beings who might be brought under the same accusation. The punishment was uniformly death, usually at the stake.

Much has been said concerning the connection between religious fanaticism and the superstition of witchcraft. It has already been seen that the cruelties and absurdities of witch persecution had reached a great height even before the Reformation; but it can scarcely be denied that the strong religious excitement which produced and accompanied that event was in some way connected with the rapid spread and development of that atrocious system. The more intense the belief in the overruling providence of God, and his immediate interference in the course of ordinary events (which especially characterized the revival of religion), the more does the parallel belief in the agency of evil spirits, and their dealings with man, appear to take root in the imagination. Sir W. Scott observes that, among Protestant sects, the Calvinists (whose views of religion were at once the most gloomy and the most engrossing) seem to have afforded the most terrible examples of this prevailing mania.. There seems also to have been a constantly recurring tendency to treat witchcraft and heresy as allied offences. It appears, upon the whole, that the persecutions during the 16th and 17th centuries were most violent in those countries which were the scene of much strife between the two religions, or in which the Calvinist opinions were pushed to an extreme,—France, the Netherlands, Northern and Western Germany, Switzerland, Scotland, England under the Commonwealth, and at a still later period New England. A singular example of the contagion of fanaticism suddenly spreading with extraordinary violence, and subsiding again after one terrible outbreak, is to be found in the history of the witch persecutions in Sweden, in the end of the 17th century. In Italy, with the exception of one or two northern districts, the superstition was generally less prevalent, or at least less distressing in its effects; and the same may be said of Spain, after the first period of the history of the Inquisition.

Among many and voluminous authors who wrote disquisitions on witchcraft with a full conviction of its reality, we may cite, as some of the most remarkable, Sprenger, one of Pope Innocent's three inquisitors, whose celebrated *Malleus Maleficarum* (Hammer of Witches) contains a complete code of precedents for inquisitors, which was adopted, varied, and extended through succeeding generations; Delrio the Jesuit, the author of *Magical Disquisitions*; Bodinus; and Remigius, a judge in the duchy of Lorraine, who put to death eight hundred witches in sixteen years, and was at last himself burnt as a conjuror. In England, King James I. has acquired an unenviable celebrity by his literary zeal against witchcraft. Even from the earliest times, there were not wanting here and there bold and enlightened individuals, who ventured to publish their sentiments against the vulgar delusion. Ulric Molitor, a distinguished divine at the period of the Council of Constance, avowed his doubts of the very existence of the crime of witchcraft. In 1556 appeared the book of Wier (a native of Brabant), *De Præstigiis Dæmonum*, in which he exposes the cruelty

and absurdity of the judicial proceedings; but either from caution, or from his own imperfect enlightenment, he ascribes the confessions of the witches to their own melancholy, or the delusion of the devil so working on them as to make them believe they had seen and done what they avowed. In England, Reginald Scot, in the reign of Elizabeth, was still more advanced beyond his age. Even at the end of the 17th century, Balthazar Bekker, a Dutch Jesuit, for having ventured to assail the prevalent superstition in his *Monde Enchanté*, was persecuted, and died in want. The writings of Thomasius, about 1700, had much effect in Germany, and prepared the way for the abolition of witch persecutions in all her Protestant states. But the public mind was at that period rapidly changing. Louis XIV. had already put an end to them by edict in France. The last execution on account of witchcraft in England was probably in 1682; although the statute against it was not repealed until the 9th of Geo. 2. In Scotland, a woman was executed in Sutherlandshire in 1722. But the practice lingered on later in some Continental districts, as in Catholic Germany, Spain, and Switzerland. The subprioress of a convent was burnt at Wurtzberg in 1749. And the last, probably, of all the victims of this superstition, was burnt at Glarus in Switzerland in 1783. It now exists only as a vulgar delusion, which it will probably require some centuries more wholly to extirpate. It is prevalent to a degree little suspected among the English peasantry in remote districts. The writer of this article has seen a horse-shoe suspended inside over the door of a gaol in a Cornish borough, as a protection against the "ill wishes" to which the guardians of such an establishment naturally considered themselves exposed. The most pains-taking collection of learning on this strange subject will be found in *Horst's Zauber-Bibliothek*. An amusing essay on it is contained in the *Quarterly Review*, vol. xlviii. See also *Grimm's Deutsche Mythologie*, passim.

WI'TENA GEMO'TE, or MEETING OF THE WISE MEN. The great national council of the Anglo-Saxon kings; also termed the "Mycel-getheaht," or Great Thought. Who composed the "witan" cannot now be ascertained: bishops, abbots, earls, aldermen, thanes of the Danish burghs, &c. attended. It seems that in East Anglia the possession of forty hides of land was necessary to entitle a person to rank among those termed in the Latin of the age "proceres," who appear to have been members of the great council. The powers and character of the witena gemote passed to the great council of the early Norman kings, which are called by the same name by Saxon writers. The subject has been abundantly discussed by older and more recent antiquarians; the reader may consult an article in the *Ed. Rev.* vol. xxxiv.

WI'THERITE. In Mineralogy, a name applied to carbonate of baryta, in honour of Dr. Withering, who first discovered it at Anglesark in Lancashire.

WI'TNESS. In Law, one who gives evidence in a judicial proceeding. In civil cases, witnesses are compelled to attend by the process called *subpœna ad testificandum* (which see), and punishable if they neglect to do so by attachment or action. In criminal cases, by subpœna or by recognizance taken by the magistrate before whom the information is given.

By the law as it at present stands, witnesses are disqualified or rendered "incompetent" by reason, 1. of want of reason or understanding; 2. Want of religious principle; that is, their want of belief in a God and a future state of rewards and punishments; 3. Infamy; that is, conviction of an infamous crime, and judgment thereupon; the crimes which fall within this class being treason, felony, and other offences which involve the charge of falsehood. The suffering of the punishment, if so provided by statute, restores the witness to competency, as does also pardon; the only exception being the case of convictions for perjury or subornation of perjury, which disqualify for ever unless reversed; 4. Interest; on which grounds the heads of exclusion are numerous, and the distinctions very refined; the general principle being, in civil causes, in courts of common law, that every one interested in the event and in the verdict is excluded. *See* EVIDENCE.

The policy of these exclusions has been matter of much debate; and perhaps the only practical reason which can really be given for this is, that the time of courts of justice being limited, it is advisable to exclude at once from consideration all those classes of evidence which, from their peculiar deficiency, must be of less weight than the testimony of witnesses at once upright and disinterested. This year (1842) Lord Chief Justice Denman has brought in a bill for the abolition of all incompetency by reason of infamy or interest, except in the case of parties to the suit, and one or two other special exceptions.

WI'ZARD. (Seems to be from the old verb witan, *to know*, and of the same derivation with *wise* and *witch*: Glanvile, *Sadduismus Triumphatus*.) The popular name in England for a sorcerer. *See* SORCERY, WITCHCRAFT.

WO'DEN, or WUOTAN. An Anglo-Saxon divinity, considered to correspond with the Mercury of the ancient Greeks and Romans; from whom Wednesday derives its name. (See *Mém. de l'Ac. des Inscr.* vol. xxiv.) He is sometimes also, though erroneously, considered as identical with Odin. *See* ODIN.

WOLF FISH. The name of a species of fish (*Anarrhichas lupus*, Linn.), which subsists on whelks and other shell-fish, which it seizes by means of strong conical slightly curved anterior teeth, set in the jaws like grappling hooks, and bruises by the action of very powerful posterior molar teeth. The flavour of this forbidding-looking fish is much superior to what might be supposed from the general low estimation in which it is held.

WO'LFRAM. A native tungstate of iron and manganese.

WO'LLASTONITE. A name applied by some mineralogists to a species of prismatic augite, in honour of Dr. Wollaston.

WOOD, in Plants, physiologically considered, is the support of all the deciduous organs of respiration, digestion, and impregnation; the deposit of the secretions peculiar to the individual species; and also the reservoir from which the newly forming parts derive their sustenance until they can establish a communication with the soil. It consists organically of woody tissue, and various kinds of vessels surrounded by cellular matter, and more or less carefully arranged. In the youngest state it is succulent and brittle, and is of nearly the same quality in all plants; but as it gains age the sides of the woody tissue become hardened and thickened by the deposit within them of matter of solidification, and wood then assumes the colours and appearances peculiar to different species. In the young state it is called *sapwood* or *alburnum*, when hardened and coloured it becomes *duramen* or *heartwood*. It abounds in nitrogen, which may be removed by simple washing; and it is supposed that the perishable quality of wood is owing to the presence of this element. It is believed that the preserving power of certain agents employed to render wood durable depends upon their rendering the azotized matter insoluble.

WOOD, or TI'MBER. The trunks or main stems of ligneous plants, which attain such dimensions as to be fit for use in architectural construction. In general, every country has its appropriate timber, which is produced by its indigenous trees; but there are some kinds of timber, such as that of the oak and that of the pine, which, in consequence of their durability and of commercial intercourse, are used in all countries. The most useful timbers of Europe are the oak, the ash, the Scotch pine, the larch, and the spruce fir; those of North America are the hiccory, the different species of pine, and some species of oak; those of tropical countries are the teak tree, the different species of bamboo, and the palm. The oak, the teak, and the larch are throughout the whole world found the most suitable timbers for shipbuilding; and the pine, and fir, and the bamboo those most conveniently adapted for civil architecture.

WOOD COAL. A synonym of brown coal.

WOOD-ENGRAVING. *See* ENGRAVING.

WOOD-OPAL. An opalized quartz occurring in various vegetable forms.

WOO'DSTONE. Petrified wood.

WOOD-TIN. An opaque, fibrous, and nodular variety of oxide of tin of a brown colour, hitherto only found in Cornwall.

WOODY FIBRE. Very slender transparent membranous tubes, tapering acutely to each end, lying in bundles in the tissue of plants, and having no direct communication with each other. They are of extreme tenuity, and form the substances called hemp and flax.

WOOL. (Germ. wolle.) A term used very indefinitely, being applied both to the fine hair of animals, as sheep, rabbits, some species of goats, &c., and to fine vegetable fibres as cotton (called in German baumwolle, or *tree-wool*); but when used without restriction it is generally confined to the wool of sheep — a substance which, from the remotest period of history, has been of primary importance to mankind. In reference to textile fabrics, sheep's wool is of two different sorts, the short and the long stapled; each of which requires different modes of manufacture in the preparation and spinning processes, as also in the treatment of the cloth after it is woven, to fit it for the market. Each of these is, moreover, distinguished in commerce by the names of fleece wools and dead wools, according as they have been shorn at the usual annual period from the living animal, or are cut from its skin after death. The latter are comparatively harsh, weak, and incapable of imbibing the dyeing principles, more especially if the sheep has died of some malignant distemper. The annular pores, leading into the tubular cavities of the filaments, seem, in this case, to have shrunk and become obstructed. The time of year for sheep-shearing most favourable to the quality of

the wool, and the comfort of the animal, is towards the end of June and beginning of July—the period when Lord Leicester holds his celebrated rural fête for that interesting purpose.

The wool of the sheep has been surprisingly improved, by its domestic culture. The *mouflon* (*Ovis aries*), the parent stock from which our sheep is undoubtedly derived, and which is still found in a wild state upon the mountains of Sardinia, Corsica, Barbary, Greece, and Asia Minor, has a very short and coarse fleece, more like hair than wool. When this animal is brought under the fostering care of man, the rank fibres gradually disappear; while the soft wool round their roots, little conspicuous in the wild animal, becomes singularly developed. The male most speedily undergoes this change, and continues ever afterwards to possess far more power in modifying the fleece of the offspring, than the female parent. The produce of a breed from a coarse-woollcd ewe and a fine-woolled ram, is not of a mean quality between the two, but half-way nearer that of the sire. By coupling the female thus generated, with such a male as the former, another improvement of one-half will be obtained, affording a staple three-fourths finer than that of the grandam. By proceeding inversely, the wool would be as rapidly deteriorated. It is, therefore, a matter of the first consequence in wool husbandry, to exclude from the flock all coarse-fleeced rams.

Long wool is the produce of a peculiar variety of sheep, and varies in the length of its fibres from 3 to 8 inches. Such wool is not carded like cotton, but combed like flax, either by hand or appropriate machinery. Short wool is seldom longer than 3 or 4 inches; it is susceptible of carding and felting, by which processes the filaments become first convoluted, and then densely matted together. The shorter sorts of the combing wool are used principally for hosiery, though of late years the finer kinds have been extensively worked up into merino and mousseline-de-laine fabrics. The longer wools of the Leicestershire breed are manufactured into hard yarns, for worsted pieces, such as waistcoats, carpets, bombasines, poplins, crapes, &c.

The wool of which good broad cloth is made should be not only shorter, but, generally speaking, finer and softer than the worsted wools, in order to fit them for the fulling process. Some wool-sorters and wool-staplers acquire by practice great nicety of discernment in judging of wools by the touch and traction of the fingers. Two years ago I made a series of observations upon different wools, and published the results. The filaments of the finer qualities varied in thickness from $\frac{1}{1100}$ to $\frac{1}{1500}$ of an inch; their structure is very curious, exhibiting, in a good achromatic microscope, at intervals of about $\frac{1}{300}$ of an inch, a series of serrated rings, imbricated towards each other, like the joints of *Equisetum*, or rather like the scaly zones of a serpent's skin. (See *Philosophy of Manufactures*, *figs*. 11, 12., p. 91. 2d ed.)

There are four distinct qualities of wool upon every sheep; the finest being upon the spine, from the neck to within six inches of the tail, including one-third of the breadth of the back; the second covers the flanks between the thighs and the shoulders; the third clothes the neck and the rump; and the fourth extends upon the lower part of the neck and breast down to the feet, as also upon a part of the shoulders and the thighs, to the bottom of the hind quarter. These should be torn asunder, and sorted, immediately after the shearing.

The harshness of wools is dependent not solely upon the breed of the animal, or the climate, but is owing to certain peculiarities in the pasture, derived from the soil. It is known, that in sheep fed upon chalky districts, wool is apt to get coarse; but in those upon a rich loamy soil, it becomes soft and silky. The ardent sun of Spain renders the fleece of the Merino breed harsher than it is in the milder climate of Saxony. Smearing sheep with a mixture of tar and butter, is deemed favourable to the softness of their wool.

All wool, in its natural state, contains a quantity of a peculiar potash-soap, secreted by the animal, called in this country the *yolk;* which may be washed out by water alone, with which it forms a sort of lather. It constitutes from 25 to 50 per cent. of the wool, being most abundant in the Merino breed of sheep; and however favourable to the growth of the wool on the living animal, should be taken out soon after it is shorn, lest it injure the fibres by fermentation, and cause them to become hard and brittle. After being washed in water, somewhat more than lukewarm, the wool should be well pressed, and carefully dried. England grows annually about 1,000,000 packs of wool, and imports 100,000 bags. (*Ure's Dict of Arts.*)

The woollen manufacture was the early staple of England. The first impulse towards the improvement of the woollen manufacture was given in the 14th century, by Edward III., who invited a number of Flemish manufacturers to settle in England. But the manufacture laboured, down almost to our own day, under a number of vexatious and oppressive restrictions; and it did not begin to make any very rapid progress, or to participate in the wonderful improvements made in the cotton trade, till the introduction of the gig-machine, &c., in 1802, and the repeal of the prohibitory acts of Edward VI. and Mary, in 1807. The total value of the exports of woollen goods in 1839 amounted to 6,271,645*l.*, of which the exports to the U. States made 2,142,352*l.* The woollen factories of England and Wales employed, in 1838, 30,115 males, and 18,387 females.

WOOLSACK. The seat of the Lord Chancellor of England, in the House of Lords, is so called, from its being a large square bag of wool without back or arms, covered with red cloth.

WOOTZ. A species of steel imported from Bengal, peculiarly excellent for some cutting instruments. It appears to contain minute portions of silicium and aluminum.

WO'RMING. An operation performed on puppies, consisting in the removal of a vermiform ligament from under the tongue; it is sometimes supposed to prevent madness, but, in fact, merely breaks them of their habit of gnawing.

WOULFE'S APPARATUS. A series of two or three-necked bottles, connected by intermediate tubes, used in the chemical laboratory for impregnating water and other liquids with various gases or vapours.

WRA'NGLER. At Cambridge, those who attain the highest honours in the public mathematical examinations for the degree of bachelor of arts are so called. At the close of the last day of examination, those who have most distinguished themselves (to the number of thirty at least) are arranged in order of merit by the examiners, and divided into three classes: wranglers, senior optimes, and junior optimes. The first or senior wrangler is the most distinguished mathematician of his year. The name is probably derived from the public disputations in which candidates for degrees were formerly required to exhibit their powers; of which the "exercises" still held at Cambridge retain the form.

WRECKS. Goods cast up by the sea after a shipwreck, and left on land within the limits of some county. The goods so brought to land belong at common law to the king, or to the lord of the manor enjoying the franchise of wreck. It was ordained by Henry I. and II. that such forfeiture should not take place if any man or beast escaped alive from the wreck; and we find in Bracton (Henry III.) that in his time if the goods could be known by marks to appertain to any owner, it was no wreck, even if no living creature escaped. The limitation of claims by the owner, by stat. Westm. 1. (3 E. 1.), was within a year and a day. By 7 & 8 G. 4. plundering wrecked vessels or goods stranded is felony. Goods cast overboard at sea, and not stranded, are divided into *jetsam*, *i. e.* things sunk to the bottom; *flotsam*, things found floating; and *ligsam*, things sunk, but fastened to a buoy or cork in order to be found again. These are all the king's, if no owner appears to claim them; and they do not pass by the ordinary grant of wreck.

WRIT. In Law, a precept in writing under seal, in the name of the king, judge, or other person having jurisdiction in the particular subject matter, and directed to some public officer or private person, requiring him to do something in relation to a suit or action. Writs, though still very multifarious, have been within the last few years much reduced in number. The original writ issuing out of Chancery for the commencement of actions in the three courts of common law is now superseded by three judicial writs, which issue in the name of the chief justices of the respective courts; namely, the writ of *summons*, the writ of *capias ad respondendum*, and the writ of *detainer*. The first of these is the one in ordinary use; the second is only used when it is intended to arrest the defendant, and the last when he is already in prison for some other cause.

WRITERS TO THE SIGNET. A numerous society of lawyers in Scotland, equivalent to the highest class of attorneys in England. They possess several privileges. *See* SIGNET.

WROUGHT. In Architecture, a term applied to any material to denote that it is brought to a fair surface.

WUOTAN. *See* WODEN.

X.

X. A letter borrowed from the Greek, and used chiefly in words derived from that language. Numerically it signifies 10; and as an abbreviation it is used for Christ: Xmas for Christmas, &c.

XA'NTHIC. (Gr. ξανθος, *yellow*.) Tending towards a yellow colour, or some colour not green of which yellow forms a part; as orange, which is a mixture of yellow and red; scarlet, which is another mixture of the same colours, &c.

XA'NTHIC ACID. (Gr. ξανθος, *yellow*, and γεννάω,

I generate.) An acid composed of sulphur, carbon, hydrogen, and oxygen, obtained in combination with potassa by agitating sulphuret of carbon mixed with solution of pure potassa in strong alcohol. Its compounds are mostly of a yellow colour, whence its name. The relative proportions of its component parts have not as yet been satisfactorily obtained.

XA'NTHIC OXIDE. (Gr. ξανθος, *yellow.*) A yellow substance found by Dr. Marcet, composing a urinary calculus; its solution in nitric acid, when evaporated to dryness, left a bright lemon-coloured residue.

XE'BEC, a small three-masted vessel, constructed for conveying merchandize or stores: it is chiefly found in the Mediterranean and on the coasts of Spain and Portugal.

XENELA'SIA. (Gr. *the expulsion of strangers.*) A Spartan institution which prohibited strangers from dwelling in Sparta beyond a certain time, and also from entering the city except on stated days. The object of this institution was to preserve the simplicity of manners of the nation, and prevent foreigners from prying into their measures; but it acquired for Lacedæmon the reputation of great inhospitality.

XE'NIA. (Gr. ξενος.) In Classical Antiquities, the presents given by friends connected by the rites of hospitality as pledges of that singular relation. In the *Iliad*, the mutual gifts which pass between Glaucus and Diomede are so called.

XEROPHA'GIA. (Gr. ξηρος, *dry*; φαγω, *I eat.*) In Ecclesiastical Antiquities, a name given to the rigorous practice of certain fasts, during which nothing was consumed but bread with salt, and water. It was particularly observed in Holy Week.

XIPHIRHY'NCHS, *Xiphirhynchi.* (Gr. ξιφος, *a sword*, 'ρυγχος, *a beak.*) The name given by Latreille to a family of Acanthopterygious fishes, of which the swordfish (*Xiphias*) is the type.

XI'PHOSURES, *Xiphosura.* (Gr. ξιφος, and ουρα, *a tail.*) A name of a tribe of Crustaceans, comprehending those in which the body terminates posteriorly in a long, hard, sword-shaped appendage.

XYLO'GRAPHY. (Gr. ξυλον, *wood*, and γραφω, *I draw.*) The same as wood-engraving. *See* ENGRAVING.

XYLO'PHAGANS, *Xylophaga.* (Gr. ξυλον, and φαγω, *I eat.*) The name of a tribe of Coleopterous insects, comprehending those of which the larvæ devour the wood of trees in which they are developed; also applied to a family of Dipterous insects, the larvæ of which have similarly destructive habits.

XYLO'PHILANS, *Xilophili.* (Gr. ξυλον, and φιλεω, *I love.*) The name of a tribe of beetles, consisting of those which live on decayed wood.

XYLO'TROGES, *Xylotrogi.* (Gr. ξυλον, and τρωγω, *I gnaw.*) The name of a tribe of Serricorn beetles, comprehending those which perforate timber.

XYNO'ECIA. In Classical Antiquities, an Athenian festival in commemoration of the union by Theseus of the little townships of Attica into one commonwealth: whence the name, derived from ξυνος, *common*; and 'οικεω, *I inhabit.*

XYST, or XY'STOS. (Gr. ξυστος, from ξυω, *I polish.*) In ancient Architecture, an open, or sometimes covered court, of great length in proportion to its width, with porticoes on three sides, for the performances of the athletic exercises of wrestling, running, &c.

Y.

Y. A letter borrowed from the Greek υ, is considered a consonant at the beginning, and a vowel in every other place, in English words. As a vowel, it has exactly the sound of *i*, being short or long, according to its position.

YACHT. A vessel of state or pleasure.

YA'GERS, or JAGERS. (Germ. *hunters.*) Light infantry armed with rifles (*chasseurs, riflemen*). In the Prussian service, the Yagers form a distinct corps with peculiar discipline; in that of Austria, light infantry generally from the mountain districts. In Germany the term *jager* is applied to a peculiar species of higher servant attached to the families of the aristocracy.

YA'NKEE, the popular name for the New Englanders in America, and among English people pretty indiscriminately applied to all inhabitants of the United States, a word for which many ridiculous etymologies have been assigned, is, according to *Dr. Welsh's Dictionary*, "a corruption of the word English by the Indians of North America."

YA'NOLITE. A mineralogical synonym of AXINITE, which see.

YARD. The British standard measure of length. *See* MEASURES.

YARD. A beam or rod suspended by a rope called the halliards, for the purpose of extending a sail, signals, &c. A yard is called a *square yard* when hung horizontally by the middle: such a yard is turned round by braces.

YARD-ARM. In Naval language, the extremity of the yard. *Yard-arm and yard-arm* is a term descriptive of two ships engaging each other as close as possible.

YAW. The Sea term for temporary deviation from a direct course.

YAWL. A particular kind of carvel-built boat, rather narrow, and not carrying many oars.

YAWS. A disease in which eruptions form upon the skin, somewhat resembling a raspberry. *See* FRAMBŒSIA.

YEAR. A period of time determined by the revolution of the earth in its orbit, and embracing the four seasons. The year is either *astronomical* or *civil*.

The astronomical year is determined by astronomical observations, and is of different kinds, according to the celestial body or the point of the heavens to which the earth's revolution is referred. When the earth's motion in its orbit is referred to an immoveable point in the heavens, to a fixed star, for example, the time of revolution is that which elapses from the instant at which the star, the sun, and the earth are in a straight line, till the earth returns again into the same straight line with the sun and the star. This interval is called the *sidereal year*. But when the earth's motion is referred to a point of the ecliptic, as one of the equinoctial points, or the tropics, the time of revolution is that in which the earth returns to that point, and is called the *equinoctial*, or *tropical*, or *solar year*. On account of the precession of the equinoxes (*see* PRECESSION) the equinoctial and solstitial points, in reference to the fixed stars, have a retrograde motion on the ecliptic, in consequence of which the earth returns to one of these points in a shorter time than it returns to the same fixed star.

The length of the *sidereal year* is 365·2563612 mean solar days; or 365 d. 6 h. 9 m. 9·6 sec.

The length of the *equinoctial* or *tropical* year is 365·2422414 mean solar days, or 365 d. 5 h. 48 m. 49·7 sec. (*Baily's Tables*, p. 16.)

The difference is 19 minutes 19·9 seconds of mean solar time, being the time in which the earth describes in its orbit an arc of 50·1″, the annual precession of the equinoxes. *See* EARTH.

The earth's motion may also be reckoned by the time in which a revolution is completed with respect to the line of the *apsides* or the line of the *nodes*. In these cases the times of revolution may be called respectively the *anomalistic year* and the *nodical year*: the former term is sometimes met with.

The *civil year* is the year of the calendar. As it is always supposed to begin with the beginning of a day, the civil year contains a whole number of days; and hence, in order that the seasons may always correspond with the same parts of the year, it is necessary from time to time to vary the length of the year, or to intercalate a day when the fractional parts neglected have accumulated to a whole day. The ancient Egyptian year consisted invariably of 365 days, and hence was called a *vague* or *erratic* year, because the first day of the year in the course of 1460 years *wandered* as it were over all the seasons.

The *Julian year*, which is frequently employed in chronological reckoning, consists of 365¼ days. Julius Cæsar ordered that the civil year should consist of 365 days for three successive years, and that the fourth year should contain 366 days. This practice of intercalating a day every fourth year has been adopted in all European countries, with the modification introduced by the Gregorian calendar. The mean Julian year is longer than the true tropical year by 11 m. 10·3 sec., a difference which amounts to a whole day in about 120 years. The years which contain 365 days are called *common* years; those which contain 366 days are called *leap years*. *See* LEAP YEAR.

According to the regulations of the Gregorian calendar the intercalations are omitted on years in which centuries end, excepting when the number of the year is divisible by 4, after leaving out the two zeros. Thus the years 1700, 1800, 1900, which would be leap years in the Julian calendar, are common years in the Gregorian; but 1600 and 2000 are leap years in both calendars. (*See* CALENDAR.) The mean length of the Gregorian year is 365 d. 5 h. 49 m. 12 sec., exceeding the true tropical year by 22·38 sec., which amounts to a whole day only in about 3866 years.

The civil or legal year, in England, formerly commenced on the 25th of March, the day of the Annunciation, though the historical year began on the 1st of January, the day of the Circumcision. Between these two epochs it was usual to date the year both ways, as 1745-6, or $174\frac{5}{6}$. By the act of parliament for the alteration of the style in 1751, the beginning of the year was transferred to the 1st of January. It is frequently necessary to keep this circumstance in mind in referring to old dates.

The fraction by which the tropical years exceed 365

days is ·2422414; and the series of approximating vulgar fractions alternately greater and less than this quantity is,

$$\frac{1}{4}, \frac{7}{29}, \frac{8}{33}, \frac{39}{161}, \frac{281}{1160}, \text{\&c.}$$

The fractions in this series indicate the intercalations by which the coincidence between the civil and solar year may be restored to any degree of exactness. The third, $\frac{8}{33}$, offers a very convenient mode of intercalation which would preserve the coincidence with great accuracy. It requires eight intercalations to be made in thirty-three years; that is to say, one at the end of four years seven times in succession, and the eighth at the end of the fifth year. The mean length of the civil year would by this arrangement differ in excess from the solar year only by 15·38 seconds, while the Gregorian year is too long by 22·38 seconds. In a period of thirty-three years, it therefore produces a nearer coincidence between the civil and solar years than the Gregorian method does in 400 years; and by reason of its shortness it also confines the evagations of the mean equinox from the astronomical within much narrower limits. The modern Persians are said, but not on very good authority, to intercalate in this manner. (Delambre, *Astronomie Moderne*, tom. 1.) *See* CALENDAR.

Lunar Year. — Though the return of the seasons obviously depends on the motion of the sun, or rather of the earth in its orbit, some nations have chosen to regulate their civil year by the motions of the moon; and many others have formed luni-solar years, by combining periods determined by the revolutions of both bodies. The proper lunar year consists of twelve lunar months or lunations, and consequently contains only 354 days: its commencement, therefore, anticipates that of the solar year by upwards of eleven days, and passes through the whole circle of the seasons in about 34 lunar years. The inconvenience attending this circumstance has been so universally perceived that, excepting the modern Jews and Mohammedans, almost all nations which have regulated their months by the moon have employed some method of intercalation for the purpose of retaining the beginning of the year at nearly the same place in the seasons. These methods are founded on certain luni-solar periods or cycles, which were established in the most ancient times, and which, with other relics of a barbarous age, are still preserved in our ecclesiastical calendars. *See* CHRONOLOGY, CALENDAR, CYCLE.

YEAST. The substance produced during the vinous fermentation of vegetable juices and decoctions, rising partly to the surface in the form of a frothy, flocculent, and somewhat viscid matter, insoluble in water and alcohol, and gradually putrefying in a warm atmosphere. It excites fermentation, and accelerates the process when added to saccharine and mucilaginous liquors. It appears closely allied to *gluten;* and, like that vegetable principle, it contains nitrogen as one of its ultimate elements.

YE'LLOW. In Painting, a colour of golden hue, and of many varieties. It is one of the seven primary colours. *See* COLOUR, LIGHT.

YE'LLOW FEVER. A bilious remittent fever. *See* FEVER.

YE'NITE. A ferruginous silicate of lime, from Elba; named by Lelièvre, its discoverer, in honour of the battle of Jena.

YEO'MAN. (From the Anglo-Saxon gemen; Germ. gemein, *common*.) Camden ranks yeomen as the next class to the gentlemen; and calls them "ingenuos." The name seems to have been generally appropriated in the middle ages to small freeholders. In the king's household, the yeomen of the different departments have a middle place between the sergeant and the groom.

YEOMAN. A seaman appointed to certain duties, as to attend to the storerooms.

YEO'MANRY CAVALRY. A denomination given to those troops of horse, which were embodied during the Revolutionary wars of France and afterwards among the gentlemen and yeomen of this country. They were called out annually, and disciplined for three weeks; and as they consisted entirely of volunteers, and were not called upon to leave their homes, or to quit their ordinary employments, except for the short period they were in quarters, the duty was not found to entail any serious privation. Several troops of yeomanry are still kept up, though most of them have been disbanded. The infantry troops that voluntarily enrolled themselves for similar purposes to the yeomanry, were called *volunteers*. These were all disbanded at the peace.

YEOMEN OF THE GUARD. *See* GUARD, YEOMANRY OF THE.

YOKE. A piece of wood or light frame of two arms, placed over the head of a boat's rudder instead of a tiller, and having two lines (*yoke lines*), by pulling on which the boat is steered.

Y'TTRIUM. The metallic base of an earth, discovered in 1794 by Professor Gadolin in a mineral found at *Ytterby* in Sweden, whence it was called *Yttria*. The metal was first obtained by Wöhler in 1828: it is of a dark grey colour, and brittle. The salts of Yttria have a sweetish taste, and some of them a pale purple colour. Yttria is distinguished from glucina by the amethystine colour of its sulphate, by its insolubility in pure potassa, and by yielding a precipitate with ferrocyanate of potassa. According to Berzelius, the equivalent of Yttrium is about 32; and that of Yttria, which is probably a protoxide, 40.

YTTROTA'NTALITE. A mineral from Ytterby in Sweden, containing Yttria and oxide of columbium.

YU. (Chinese.) Nephrite or jade (which see).

YULE. The common Scottish name for Christmas. It appears to be a very ancient Celtic word. In Welsh, wyl or gywl signifies a holyday; whence also the old phrase "Gule of August," the first day of August, or fast of St. Peter and Vincula, for which various absurd etymologies have been found. Perhaps the old French word "Noel," for Christmas (used also generally as a popular cry of rejoicing), has the same original. (See *Archæol.* vol. ii.) Count de Gebelin, however, derives yule from a supposed primitive word, connected with the idea of revolution or "wheel." (See *Brand's Popular Antiq.* vol. i. p. 364.)

Z.

Z. The last letter in the alphabets of all the modern languages, usually regarded as a double consonant, from its having the sound in some languages of *ts* or *ds*. Like the letter *x*, it begins no word originally English; and Dr. Johnson has remarked, that although it is found in the Saxon alphabets, set down by grammarians, it is read in no word originally Teutonic.

ZA'FFRE. An impure oxide of *cobalt*, obtained by exposing the native arseniuret of cobalt broken into small pieces to the action of heat and air in a reverberating furnace, by which its elements are oxidized, and the greater part of the arsenic driven off.

ZA'MITE. Fossil zamia.

ZA'NTHOPI'CRIN. A bitter principle, obtained from the bark of the *Zanthoxylon caribæum*. It forms yellow acicular crystals, insoluble in ether, but readily soluble in alcohol, and sparingly in water.

ZAX. In Architecture, a tool for cutting slates.

ZE'CHSTEIN. (Germ.) A magnesian limestone, lying under the red sandstone.

ZE'IN. A substance of a tough elastic nature, resembling gluten, but said to be destitute of nitrogen, contained in Indian wheat; the produce of the *Zea mays*.

ZEMINDA'R. (From the Persian zemin, *land*.) A title introduced into India by its Mohammedan conquerors, conferred in Bengal, and generally throughout the Mogul empire, on the agent employed to collect that share of the produce of the soil which belongs to it. The zemindars were the great landholders of the Mogul empire; but the nature of their tenure has given rise to much dispute. Whether they were hereditary absolute owners of the soil, or only tenants of the sovereign at a fixed rent by way of land-tax for which they were personally responsible, was a question much agitated by writers on Indian subjects at the period of the "Permanent Settlement" in 1793. By that settlement the rent was to be fixed in the first instance by custom, and the zemindar was then to give the ryot a lease restricted to himself and his assignees on performance of its conditions; his own share being fixed as before at 10 per cent. of the assessment, and his hereditary right secured. A zemindary, *i. e.* the district of a zemindar, is liable to be sold by government for arrears of revenue, and existing leases with the ryots to be set aside. At present the land-tax of India is levied in three methods, which prevail in different districts: — the "zemindar settlement," by which the zemindar is responsible to government; the "mouzawar" or village settlement, by which the collector contracts with the head man of the village; and the "ryotwar" or cultivator settlement, by which the tax is collected immediately from the peasantry. (See, as to the effects of the zemindary settlement, *Mill's History of British India*, vol. v.; M'Culloch's Edition of *Smith's Wealth of Nations*, note 19.; *Ed. Rev.* vols. xxxi. lxxi.) *See* RYOTS.

ZE'ND-AVE'STA. (Pers. *Living Word*.) The sacred books of the Parsees in India, and Guebers in Persia, who profess the religion of the ancient Persians. According to the popular belief among them, these books are attributed to the famous Zoroaster. Their real history is much disputed; but it is generally supposed that they are not of great antiquity, and that the belief of the modern Guebers is for the most part a compound of legendary notions drawn from various religions. (*See* MAGIANS.) Sir William Jones thought the *Zendavesta* a forgery of the learned adventurer Anquetil du Perron. (See *Mém. de l'Ac. des Inscr.* vol. xxxi.; *Milman's Hist. of Christianity*, vol. i. p. 68., for the arguments for and against its authenticity; and the *Conv. Lex.*, article "Per-

sian Religion." See also *Bryant's Mythology*, vol. ii. p. 390. 401.) It is certain, at all events, that the Zend language, in which it is written, is of great antiquity, and radically allied to the Sanscrit. *See* Sanscrit, Parsees.

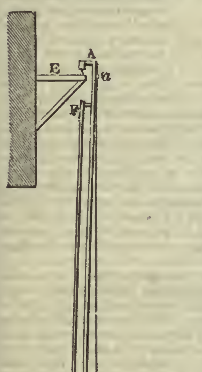
ZE'NDIK. In Arabic, a name given to those who are charged with atheism, or, rather, disbelief of any revealed religion; or with magical heresies. The sect of Zendiks opposed the progress of Mohammedanism in Arabia with great obstinacy. It appears to have had many features in common with Sadduceeism among the Jews.

ZE'NITH. (From the Arabic.) In Astronomy, the top of the heaven, or vertical point; the point directly overhead. The zenith is that point of the celestial sphere which would be intersected by the plumb line, supposed to be indefinitely extended. It may also be defined as the pole of the horizon, from which it is 90° distant. All vertical circles or azimuths necessarily pass through the zenith.

ZE'NITH DISTANCE. The distance of any celestial object from the zenith; or the complement of the altitude of the object above the horizon.

ZE'NITH SECTOR. An astronomical instrument, contrived for the purpose of measuring with great accuracy the zenith distances of stars which pass near the zenith. It was by means of a zenith sector that Bradley discovered the existence and magnitude of two most important astronomical elements,—the aberration of light, and the nutation of the earth's axis. The instrument has also been generally used (in this country at least) in trigonometrical surveys for determining the difference of latitude of two stations, a purpose for which it is very convenient; for the difference of the zenith distances of the same star, observed at its meridional passages at two places, gives the difference of the astronomical latitudes of the places without any regard to the star's declination. The general description of the zenith sector has been given by the present Astronomer Royal as follows (*Ency. Metr.*, art. "Figure of the Earth"): —

"In the annexed figure A B is a bar of iron with a cross piece C D, the whole in one piece. The top A is formed in such a way that the instrument can be turned half round in azimuth when suspended at the top, and that the bottom can be moved freely in the directions D C or C D. The bracket or other support E, on which it rests, is attached to some firm part of the building. To the bar A B is firmly attached a telescope F G. At a point *a*, near A, is attached a plumb line *a* H; sometimes it is fastened at a point of attachment which is moveable, in order that by moving the point of suspension the plumb line may be made to pass over a fine dot at *a*. The limb C D is graduated, sometimes on a circular arc of which *a* is the centre, and sometimes on a straight line. L D is a screw passing through a block strongly connected with the floor, and acting with its point against the end D of the piece C D; and M N O are a string and weight pressing the sector against the point of the screw."



The method of observing with the zenith sector is this: — A clock being regulated by transits or equal altitudes, the direction of the meridian is found, and guides fixed to compel the sector to move in the meridian. When a star is to be observed, the screw L D is turned till the plumb line falls exactly on some point K of the graduated arc, such that the telescope is very nearly directed to the point through which the star will pass when it comes to the meridian. When the star enters the field of view, the screw is again turned till the star appears to glide exactly along the wire fixed in the focus of the eye-glass; and the motion of the screw being ascertained, and the value of the division known, the apparent zenith distance of the star is found. But it is evident that this is not the true zenith distance, unless the zero point of the division on the scale be quite accurate; that is to say, so placed that when the plumb line falls on it the optical axis of the telescope is exactly vertical. It is impossible to insure this accuracy; but it is easy to see that if the instrument be turned half round in azimuth, and the same observation made, the apparent zenith distance will be just as much greater than the true as in the former determination it was less. The mean of the two will therefore be the true zenith distance of the star.

The advantages of the zenith sector are these: — The stars observed being very near the zenith, the tremor and dancing which generally affect stars in other positions are seldom seen; there is no uncertainty about the effects of refraction; the telescope and the whole instrument are not subject to flexure; and the variation of temperature produces no sensible effect.

(For a detailed account of Ramsden's zenith sector used in the measurement of the English arcs of the meridian, see the second volume of the *Trigonometrical Survey of England and Wales*, or *Phil. Trans.* for 1803. This superb instrument was unfortunately burnt in the great fire which took place in the Tower of London in October, 1841. Another sector, on a different plan from that above described (the zenith point being determined by levels instead of a plumb line) has recently been constructed for the use of the survey by Troughton and Simms, under the directions of the Astronomer Royal. A description of the new instrument is given in the *Monthly Notices of the Royal Astronomical Society* for May, 1842.)

ZE'OLITE. (Gr. ζεω, *I boil*, and λιθος, *stone*.) A name given to a family of minerals, which, when heated before the blowpipe, melt with considerable ebullition. They mostly consist of silica, alumina, lime, and water.

Natrolite. A species of zeolite containing soda: from *natron*, or soda.

ZE'PHYRUS. (Gr. ζεφυρος.) The west wind, a mythological divinity, child of Astræus and Aurora, according to Hesiod; to whom Anchises sacrifices a ram. It is said to be the same wind with the Latin Favonius; but Vegetius distinguishes between the two.

ZERI'NTHIA. (Gr. Ζερινθια, one of the names of the goddess of love.) The name of a subgenus of butterflies in Treitschke's system, where it is erroneously written *Zerynthia*.

ZE'RO. (Ital. ?) A term generally used in reference to the thermometer, implying the point at which the graduation commences. The zero of Reaumur's and of the centigrade thermometer is the freezing point of water. The zero of Fahrenheit's scale is 32° below the point at which water congeals, being about the temperature of a mixture of salt and snow. *See* Thermometer.

ZE'THES. In Classical Mythology, Zethes and Calais were the sons of Boreas, king of Thrace, and Orithyia. They accompanied the Argonauts, and were afterwards slain by Hercules.

ZEU'GMA. (Gr. ζευγμα, *yoke*.) A figure in grammar, by which an adjective or verb which agrees with a nearer word is referred also, by way of supplement, to one more remote.

ZI'MOME. (Gr. ζυμωμα, *a ferment*.) That part of the gluten of wheat which is insoluble in alcohol. When rubbed in a mortar with powdered guaiacum, it produces a fine blue colour.

ZINC. A metal, first mentioned by Paracelsus; but its ores were known at a much earlier period. In commerce it is often called *spelter;* and is obtained either from the native carbonate of zinc, called *calamine*, or from the native sulphuret or *blende* of mineralogists. These ores are roasted and mixed with charcoal or carbonaceous flux: the mixture is put into a kind of crucible closed at top, and perforated at bottom by an iron tube, which passes through the grate of the furnace into water; the vapour of the zinc distils downwards through this tube, and is condensed in the water. The first portions are impure, containing arsenic, and often cadmium, in which case the vapour burns with what the workmen call a *brown blaze;* when the *blue blaze* appears the zinc is collected. The zinc of commerce (which is not quite pure) has a peculiar blueish colour and lustre, a lamellar and crystalline texture, and its specific gravity is about 7. At common temperatures it is tough and intractable under the hammer; and when heated to above 500° it becomes brittle, and fuses at about 770°. But at temperatures between 220° and 320° it becomes malleable and ductile; so that it may be beaten out under the hammer, and rolled into sheets and leaves, and drawn into wire, in a manner extremely remarkable when its highly crystalline texture is considered. Being a cheap and light metal, and one which, after having been superficially oxidized, long resists the further action of air and water, it has lately been much employed as a substitute for lead in lining water cisterns and covering buildings; it has also been lately employed in the curious operation of transferring printing (under the name of *zincography*). It is a very inflammable metal, burning in the flame of a spirit lamp with a brilliant white light; but the oxide which forms interferes with its continuous combustion,

which can only be carried on at a high red heat, when the vapour of the metal burns with an intensely bright flame, and yields at the same time a quantity of flocculent oxide, which floats about in the surrounding air, and was formerly called *philosopher's wool*, *pompholix*, and *nihil album*. The equivalent of zinc is 32, and that of its oxide 40. Though zinc is apparently without action upon water, yet it is a most oxidable metal; but the insolubility of its oxide protects it from further action, so that when a film is once formed upon it, it resists further change; but when a little acid is present in the water, and the zinc not quite pure, it is rapidly acted upon, and oxidized at the expense of the water, which evolves abundance of hydrogen (when dilute sulphuric acid is used), and the oxide of zinc is removed and dissolved by the acid. It is this action which renders zinc so powerful a generator of electricity in the voltaic pile. The salts of zinc are mostly soluble, and have a nauseous, astringent, and metallic taste. The *sulphate of zinc*, or *white vitriol*, is employed in medicine as an emetic and tonic, and the oxide and carbonate are externally used in the form of ointment. The *chloride of zinc* is a colourless compound, fusible at a heat a little above 212°, and known to the older chemists under the name of *butter of zinc*. Brass is an alloy of zinc and copper.

ZINGIBERA'CEÆ (Zingiber, one of the genera), or SCITAMINEÆ. A natural order of Herbaceous Monandrous Endogens, inhabiting the tropics. It is distinguished from the Musaceous order in the latter having five or six stamens, with a calyx and corolla of the same texture; and from *Iridaceæ*, by two of the stamens being either deformed or abortive; and from *Marantaceæ*, by the single stamen being placed opposite to the labellum or anterior division of the inner series of the corolla, and proceeding from the base of the posterior outer division. Cardamoms are the seeds of several plants of this order, which are, however, principally valued for the aromatic stimulating properties of the root or rhizoma; such are found in ginger (*Zingiber officinale*), galangale (*Alpinia racemosa* and *galanga*), and zedoary (*Curcuma zedoaria* and *zerumbet*). Turmeric, a substance half dye and half condiment, is the powder of the rhizoma of *Curcuma longa*.

ZI'RCON. A mineral chiefly composed of zirconia and silica, found in the sand of the rivers of Ceylon, and occasionally imbedded in primitive rocks. It is of various colours, and when transparent is sometimes used in jewellery.

ZIRCO'NIUM. The metallic base of *zirconia*, an earth discovered in 1789 by Klaproth in the jargon or zircon of Ceylon. Zirconium has only been obtained in the form of a black powder, which when heated in the air burns into the oxide. The salts of zirconia are distinguished from those of alumina and glucina by being precipitated by all the pure alkalies, and by being insoluble when they are added in excess.

ZOA'NTHUS. (Gr. ζωον, *an animal*, and ανθος, *a flower*.) The name of a genus of Polypes, comprehending those which possess the complex structure of the *Actiniæ*, but consist of different individuals adhering to a common fleshy basis.

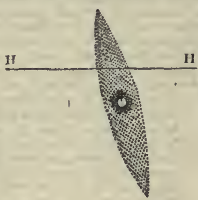
ZO'CLE, or ZOCCOLO. (It. zoccolo, *a wooden shoe*.) In Architecture, the same as *socle*; which see.

ZO'DIAC. (Gr. ζωδιον, dim. of ζωον, *animal*; because the constellations of the ecliptic are for the most part represented in celestial charts by the figures of animals.) An imaginary zone or belt in the heavens, extending to about 8° or 9° on each side of the ecliptic, which divides it in the middle. No use is made of the zodiac in astronomy; the name only indicates that region of the heavens within which the apparent motions of the sun, moon, and all the greater planets are confined. Three of the new planets, Juno, Ceres, and Pallas, have inclinations which exceed the limits of the ancient zodiac, and are therefore sometimes called *extra-zodiacal* planets; but Vesta is also sometimes included in the same description. *See* PLANET.

The zodiac is divided into twelve equal parts, called *signs*; which are designated by the names of the constellations with the places of which the signs anciently corresponded. They are Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricornus, Aquarius, and Pisces. The signs are counted from the vernal equinox, one of the points in which the equator intersects the ecliptic; whence, in consequence of the regression of the equinoctial points, their position with respect to the constellations or fixed stars is greatly different from what it was in remote ages. Some time prior to Hipparchus, the first points of the constellations Aries and Libra corresponded to the vernal and autumnal equinoxes; those of Cancer and Capricorn to the summer and winter solstices: at present, the difference is about 30°. The vernal equinox now happens in the constellation Pisces, the summer solstice in Gemini, the autumnal equinox in Virgo, and the winter solstice in Sagittarius; but the vernal equinox always corresponds to the first point of the sign Aries, the summer solstice to the first of Cancer, and so on. On this account it is necessary to distinguish between the *signs* of the zodiac, which follow the motions of the equinoctial points, and the *constellations* of the zodiac, which are immoveable in the celestial sphere.

It has been supposed that the constellations of the zodiac were invented in Egypt in a very remote age, and that they had a reference to the divisions of the seasons and the agriculture of that country at the time of their invention. If we go back to a period about 2500 before Christ, the constellations Aquarius and Pisces, at the season of the overflow of the Nile, would be diametrically opposite to the sun, and would consequently rise at sunset. Virgo, usually represented as a woman with an ear of corn in her hand, would be the constellation rising at sunset in the time of the harvest in Egypt. Such conjectures, however, it is easy to conceive, are at best extremely uncertain. Representations of the zodiac have been found in several Egyptian temples, and also in other eastern countries, which have given rise to much discussion. (See Dupuis, *Mémoire sur l'Origine du Zodiaque*; Biot, *Récherches sur l'Astronomie Egyptienne*; Montucla, *Histoire des Math.* tom. i.; Bailly, *Histoire de l'Astr. Ancienne*.)

ZODIACAL LIGHT. In Astronomy, a faint nebulous aurora which accompanies the sun. This curious phenomenon was observed by Kepler, who supposed it to be the solar atmosphere; but it was first accurately described by Dominic Cassini, who gave it the name by which it is now known. It is visible immediately before sunrise or after sunset, in the place where the sun is about to appear or has just quitted in the horizon. It has a flat lenticular form, as represented in the annexed figure, extending from the horizon H H obliquely upwards, and following the course of the ecliptic, or rather of the sun's equator. For this reason it is scarcely visible in our latitudes, excepting in those seasons when the plane of the sun's equator is most nearly perpendicular to the horizon. The most favourable times for observing it are in the months of April or May, in the evening, or at the opposite season of the year before sunrise. At other times, the plane of the solar equator being more oblique, and the luminous pyramid inclined in the same degree, it rises so little above the horizon that its light is effaced by the atmosphere of the earth. The apparent angular distance of its vertex form the sun varies, according to circumstances, from 40° to 90° or 100°, and the breadth of its base perpendicular to its axis from 8° to 30°. It is extremely faint and ill-defined, at least in this climate; though it is better seen in tropical countries.



Numerous opinions have been entertained respecting the nature and cause of this singular phenomenon. Cassini thought it might proceed from the blended light of an innumerable multitude of little planets circulating about the sun, as the milky way owes its appearance to the light of agglomerated myriads of stars. Euler endeavoured to prove that it proceeds from the same causes as the tails of comets. Kepler had ascribed its appearance to the solar atmosphere; and the same hypothesis was adopted by Mairan and others, till it was shown by Laplace to be untenable for the following reasons:— In the first place, the solar atmosphere cannot extend beyond the distance at which the centrifugal force would be balanced by the attraction; but this point lies far within the orbit of Mercury, the greatest elongation of which is 28°, whereas the zodiacal light has been observed to extend to 100° from the sun. In the second place, in order that the spheroid of the solar atmosphere may be in equilibrium, the ratio of the equatorial to the polar axis cannot exceed that of 3 to 2; whence its form would not correspond with the lenticular appearance of the zodiacal light. Sir John Herschel remarks, that "it may be conjectured to be no other than the denser part of that medium, which, as we have reason to believe, resists the motion of comets; loaded, perhaps, with the actual materials of the tails of millions of those bodies, of which they have been stripped in their successive perihelion passages, and which may be slowly subsiding into the sun."—*Astronomy*, *Cab. Cyc.* p. 407. (Biot, *Astronomie Physique*; Mairan, *Traité Physique et Historique de l'Aurore Boreale*; Euler, *Mém. de Berlin*, 1746; Lalande, *Astronomie*, tom. i.; Hooke, *Opera Posth.*)

ZO'HAR. (Heb. *splendour*.) A Jewish book, highly esteemed by the rabbis, and supposed to be of great, though altogether unascertained, antiquity. It consists of cabalistical commentaries on Scripture, especially the

books of Moses. It has been translated into Latin (ed. 1680).

ZOI'SITE. A variety of epidote, named after its discoverer Baron von Zois.

ZONE (Gr. ζωνη, *a girdle* or *belt*), in Astronomy, denotes a portion of the celestial sphere included between two parallel circles. In Geography, the terrestrial zones are the five broad spaces or belts into which the surface of the earth is divided by the two tropics and the two polar circles. The space included between the tropics is called the *torrid zone;* its breadth is equal to 47°, or twice the sun's greatest declination, and it is divided into two equal parts by the equator. That included between the tropic of Cancer and the arctic circle is called the *north temperate zone;* and that between the tropic of Capricorn and the antarctic circle the *south temperate zone.* The breadth of each of these is 43°. The space between the arctic circle and the north pole is the *north frigid zone;* and that between the antarctic circle and the south pole is the *south frigid zone. See* GEOGRAPHY, EARTH.

ZOO'GRAPHY. (Gr. ζωον, and γραφω, *I write.*) The description of animals.

ZOO'LATRY. (Gr. ζωον, *an animal*, and λατρευω, *I worship.*) The worship of animals; which was the characteristic of the ancient Egyptian religion most remarked upon by foreigners.

ZOO'LOGY. (Gr. ζωον, *an animal;* λογος, *a discourse.*) The science of animals. It teaches their nature and properties, their classification, and their order of succession upon and their distribution over the earth.

A knowledge of the nature of animals, as it implies that of their organization, and of the functions and interdependencies of their component parts, constitutes the two great branches of zoology, called *Zootomy*, or comparative anatomy, and *Physiology*. The doctrine of the succession of species of animals upon the earth, as it relates principally to such as no longer exist, is included in a third branch of the science of animals, called *Palæontology*, with which is closely connected that which treats of the geographical distribution of existing species. The term *Zoology* is practically restricted to the science of the outward characters, habits, properties, and classification of animals.

As the forms of living animals, the parts they play in the theatre of nature, their good and evil relations to man, cannot be profitably treated of in the space assigned to this article, it will be limited to the exposition of the principles of the classification of animals, and of the characters and relative value of those groups which have not been already treated of in the present work.

A classification is essentially based on the ideas of likeness, unlikeness, and proportion in its subjects. When it is purposed to define, in a classification of animals, their different degrees of resemblance, a natural system is aimed at. When a classification is restricted to the enunciation of a few likenesses which may be most readily detected and most easily retained in the memory, it becomes an artificial system. A likeness extends as far as a character is common; and the more extended or common the property or structure on which such character is founded, the more important and essential it becomes as an element of the classification.

Zoologists having ascertained as many of the characters common to all animals as served to form their complex idea of an animal, have, in the next place, endeavoured to discover the difference, which, added to the idea or definition of the animal, would form the most extended species of that genus, logically speaking.

Such a difference or character is not to be detected by a superficial examination. Aristotle thought he had found it in the blood, recognizing as blood only the red-coloured nutrient fluid, like that which flows in the arteries and veins of man. His primary division of animals was therefore into Sanguineous and Exsanguineous animals; the *Enaima* and the *Anaima*. The Enaima were the beasts, birds, reptiles, and fishes; and the Anaima, or bloodless animals, included all the lower species.

Nothing, perhaps, can show more forcibly the nature and amount of observation required to frame a good classification, and the value of the information concentrated in its exposition, than the great and long-continued deference paid to this early step in the classificatory branch of zoology, and the minute and extended researches required for the elimination of its erroneous element. First, it was found that many of the Exsanguineous animals of Aristotle did actually possess blood, differing only in colour from that of the so-called Sanguineous species. This discovery, however, led only to a nominal improvement in the primary division of animals; the Enaima being "red-blooded," and the Anaima "white-blooded" animals. It was reserved for Cuvier, in the course of his minute dissections of the lower animals, to discover that an extensive class of worms had red blood circulating in a closed system of arteries and veins; and this discovery first materially affected the value of the character adopted by Aristotle for the primary groups of the animal kingdom.

Now, if scientific classification were really based on the idea of likeness alone, and the grouping together of individuals into kinds in forming a natural system were regulated by a consideration of their resemblances only, then the modification of the Aristotelian system involved in Cuvier's discovery would be merely an extension of the group Enaima at the expense of the group Anaima; and the Anellides, or red-blooded worms, must have been united with birds, fishes, and other Sanguineous animals. But the zoologist, in the formation of a natural system, has to be governed at every step by the idea of difference as well as by that of likeness. Coincident with the discovery above mentioned was the perception that if the Anellides resembled beasts in the colour of their blood, they differed from them in most other essential points; and thus the circulating fluid was rejected as a ground for the primary groups of the animal kingdom, and other characters were eagerly sought for.

Lamarck conceived that he had discovered the best substitute for the Aristotelian primary character in the vertebral column; this structure being present in all the Enaima of Aristotle, and absent in all the Anaima. He proposed, therefore, the name of *Vertebrata* for the one class, and *Invertebrata* for the other. The defect of this primary division of the animal kingdom was soon perceived to arise from the neglect of a third fundamental idea in a classificatory science, viz. that of proportion, or relative value, in the primary groups; and in the attempt to remedy this defect the important discovery was made, that the vertebral column was a modification of structure subordinately related to a particular condition of an organic system of much higher importance in the animal body than the skeleton, viz. the nervous system. A knowledge of the anatomy of this system hence became essential to the zoologist; and the result of a long series of minute and elaborate dissections was the detection of at least three modifications of the nervous system of equal importance with that in regard to which a skull and vertebral column are dependent and subordinate. Hence arose the proposition by Cuvier to divide the animal kingdom primarily into four provinces or subkingdoms: viz. *Vertebrata, Mollusca, Articulata*, and *Radiata;* or, as they have been termed, in accordance with the modifications of the nervous system respectively characterizing them, *Myelencephala, Heterogangliata, Homogangliata*, and *Acrita*.

All previous primary divisions of the animal kingdom*, having been proposed in ignorance of the true characters by which such groups exist in nature, are now abandoned by the common consent of naturalists, and nothing would be gained by quoting them in this place. Herein the Linnæan method is inferior to the Aristotelian system: the class *Vermes* of the *Systema Naturæ*, as it included the *Ostracoderma* and *Malakia* of Aristotle, afterwards the *Mollusca* of Cuvier, with the true *Vermes*, was a retrograde step in this branch of zoological science.

The subkingdom *Vertebrata*, or *Myelencephala*, is subdivided into classes, according to the modifications of the respiratory and circulating organs. These modifications are essentially four in number, which may be thus expressed:—

1. Lungs suspended freely in a thoracic cavity; subdivided into minute air-cells. Heart divided into four cavities; pulmonic and systemic circulations distinct.

2. Lungs adherent to the walls of a thoracic cavity, communicating with large air-cells in other cavities of the body. Heart with four cavities; pulmonic and systemic circulations distinct.

3. Lungs suspended freely in, or attached to the parietes of a thoracic-abdominal cavity; not divided into minute air-cells. Heart with four or three cavities; pulmonic and systemic blood mixed in the general circulation.

4. Gills for respiration, with or without lungs. Heart with two cavities, transmitting all the blood to the breathing organs.

The first condition of the respiratory and circulating organs coexists with a viviparous generation, and lacteal organs for the nourishment of the new-born young; whence the class was termed *Zootoca* † by Aristotle, and *Mammalia* by Linnæus; and the latter term is retained, because it expresses a character which is truly peculiar to the class. The total or partial clothing of hair, and the other organic coexistences which proclaim the naturalness of the group in question, are mentioned under the term MAMMALIA.

The second condition of the respiratory and circulating organs characterizes the class of Birds. It is associated in this class with an oviparous generation, a covering of feathers, and those other modifications of the vertebrate type of structure which are detailed under the

* If we except some of the schemes of classification of the animal kingdom by John Hunter, found among his manuscripts after his death. (See Preface to Palmer's edition of his *Animal Economy.*)

† The term *Zootoca* has been degraded by a modern naturalist to designate a subgenus of lizards, distinguished by their viviparous generation.

head of Aves. This is the most natural and circumscribed of all the groups of animals of corresponding value. Both mammals and birds differ from all other classes of animals in being warm-blooded; whence they have been combined to form a group called *Hematherms*.

The condition of the circulating and breathing organs which characterizes the third class of vertebrate animals, called Reptiles, is associated with cold blood, and a covering of scales, bony plates, or a naked skin. The generation is oviparous or ovoviviparous: the other characters are given under the head Reptilia.

Fishes, besides breathing by gills, and having a heart composed of a single auricle and ventricle, have the skin defended by scales, or by bony plates, or are naked. They are likewise oviparous, or ovoviviparous; and, with a few exceptions, as the tunny, the temperature of their blood corresponds with that of the surrounding medium. They are exclusively aquatic; and their general characters and classification are given under the heads Pisces and Ichthyology.

The subkingdom *Mollusca*, or *Heterogangliata*, is characterized by a ring of nervous matter surrounding the gullet, whence the nerves radiate, often unsymmetrically, to different parts of the body. There is a ganglion or little brain below the gullet, and sometimes also above that tube: the nerves of the body are generally connected with one or more detached ganglions. The form of the body corresponds with the disposition of the nervous system, and is often unsymmetrical; it is generally soft, covered with a mucous skin, and destitute of jointed limbs. In one class (*Cephalopoda*), in which the supra-œsophageal nervous mass is large, it is protected by a cartilaginous cranium; but this is absent in other Mollusca, and a vertebral column exists in none. Many species have for their skeleton a calcareous plate or plates, called *shells*, secreted by the skin. (*See* Conchology.) The animal functions are feebly enjoyed in the *Heterogangliate* subkingdom. Distinct organs of hearing and smell have as yet been found only in the highest class (*Cephalopoda*); the eyes are reduced to mere rudiments in the group next in subordination (*Gasteropoda*); and the head is altogether wanting in the three lower classes, thence collectively called *Acephala*. The machinery of the organic functions, on the other hand, is largely and completely developed. Every mollusk has a heart, and a closed system of arteries and veins: in the higher Cephalopods the circulating system is physiologically as perfect as in the highest Vertebrates, and the heart is anatomically more complicated. An organ of respiration is never wanting; but it presents this character, that whereas in the *Vertebrata* it communicates with the mouth, in the *Mollusca* it is connected with the opposite termination of the alimentary canal. The *Mollusca* are either Diœcious or Hermaphrodite.

The primary division of *Mollusca* is, according to the presence or absence of a head, into the *Encephala* and *Acephala*.

The Encephalous Mollusks are divided, according to their locomotive organs, into the classes *Cephalopoda*, *Gasteropoda*, and *Pteropoda;* the Acephalous Mollusks, according to their respiratory organs, into *Lamellibranchiata*, *Palliobranchiata*, and *Heterobranchiata:* the two latter classes are more commonly called *Brachiopoda* and *Tunicata*. See those names of classes, and Malacology.

The third primary division of the animal kingdom, viz. the *Articulata*, is as well characterized, Cuvier states, as that of the *Vertebrata*. "The skeleton is not internal, as in the latter; neither is it annihilated, as in the *Mollusca*. The articulated rings which encircle the body, and frequently the limbs, supply the place of it; and as they are usually hard, they furnish to the powers of motion all requisite points of support; so that we have here as many kinds of locomotion as among the *Vertebrata*. This external position of the hard parts, and internal one of the muscles, reduce each articulation to the form of a sheath, and allow it but two kinds of motion, unless the limbs be united by flexible membranes, or fit into one another; and then their motions are more various, but have not the same force.

"The system of organs in which the *Articulata* resemble each other the most is that of the nerves. Their brain, which is placed above the œsophagus, and furnishes nerves to the parts adhering to the head, is very small. Two cords, which embrace the œsophagus, are extended along the abdomen, and united at certain distances by double knots or ganglia, whence arise the nerves of the body and limbs. Each of these ganglia seems to fulfil the functions of a brain to the surrounding parts, and to preserve their sensibility for a certain length of time when the animal has been divided. If to this we add that the jaws of these animals, when they have any, are always lateral, and move from without inwardly, and not from above downwards, and that no distinct organ of smell has hitherto been discovered in them, we shall have expressed all that can be said of them in general." The existence, however, of the organs of hearing, the presence, number, and form of those of sight, the kind of respiration, the condition of the organs of circulation, and the colour of the blood, present great differences, which characterize the subdivisions or classes of the Articulate or Homogangliate subkingdom.

These classes are, *Crustacea*, *Arachnida*, *Insecta*, *Anellata*, and *Cirripedia*. See those words.

The first three are combined by Latreille into a large group, called *Condylopoda*, in reference to their possessing articulated members; but these are likewise possessed by the *Cirripedia*, which, although placed by Cuvier in the Molluscous subkingdom, are proved by their nervous system and metamorphoses to be essentially *Articulata*, nearly allied to the Crustaceans.

The Radiated, or fourth primary division of animals in the system of Cuvier, is so called because the low-organized animals composing it agree, Cuvier says, in having their parts arranged round an axis, and on one or several radii, or on one or several lines extending from one pole to the other. "Even the *Entozoa* have at least two tendinous lines, or two nervous threads, proceeding from a collar round the mouth; and several of them have four suckers situated round a proboscidiform elevation! The nervous system, when traces of it have been visible, is also arranged in radii." This cannot, however, be affirmed with propriety of the nerves of the *Entozoa* or *Rotifera;* but these classes agree with all the other *Radiata* (*Holothuria* excepted) in the absence of distinct respiratory organs. It has been proposed to divide the Radiated animals, or Zoophytes of Cuvier, into two subkingdoms: the *Nematoneura*, presenting conspicuous nervous filaments; and the *Acrita*, in which such filaments are rarely distinguishable. The *Nematoneura* are more definitely and readily characterized by having the alimentary canal in the form of a distinct tube, with proper parietes, floating in an abdominal cavity, and provided with a separate inlet and outlet; while in the *Acrita* the digestive cavity is excavated in the parenchyma of the body, is devoid of distinct parietes, and has no anal outlet. The *Nematoneura* never propagate by germination or spontaneous fission, but these modes of reproduction are common in the *Acrita*. The latter division has been termed *Oozoa*, from their analogy to the ova or germs of the higher classes; but I have elsewhere observed * that as the changes of the embryo succeed each other with a rapidity proportionate to its proximity with the commencement of its development, so, also, in each class of *Acrita*, there are genera which closely approximate or merge into some one or other of the higher or Nematoneurous classes, and their characters are consequently less definite and fixed. If, therefore, guided by their natural affinities, we arrange the *Radiata* into their primary groups, it will be found that one part of each of these groups presents the characters of the *Nematoneura*, and another those of the *Acrita*. This will be exemplified in the disposition of the Radiated classes in the following table of the primary groups and classes of the animal kingdom.

Kingdom Animalia.

Subkingdom *Vertebrata*.

Class Mammalia.
Aves.
Reptilia.
Pisces.

Subkingdom *Articulata*.	Subkingdom *Mollusca*.
Class Crustacea.	Class Cephalopoda.
Arachnida.	Gasteropoda.
Insecta.	Pteropoda.
Anellata.	Lamellibranchiata.
Cirripedia.	Brachiopoda.
	Tunicata.

Subkingdom Radiata.

Nematoneura.	*Acrita*.

Class Radiaria, Lamarck.

Echinoderma, Cuv.	Acalepha, Cuv.

Class Entozoa, Rudolphi.

Cœlelmintha, Owen.	Sterelmintha, Owen.

Class Polypi, Cuvier.

Ciliobrachiata, Farre.	Nudibrachiata†, Farre.

Class Infusoria, Cuvier.

Rotifera, Ehrenb.	Polygastria, Ehrenb.

ZOO'NOMY. (Gr. ζωον, and νομος.) The branch of science treating of the laws of animal life.

ZOO'PHAGANS. (Gr. ζωον, and φαγω, *I devour*.) The term applied to the order of Unguiculate Mammals

* *Cycl. of Anat. and Physiol.*, art. "Acrita."

† This may be again subdivided into the *Anthozoa* and *Nudibrachiata* proper, which lead to the doubtful class of *Spongiæ*.

which live on animal food, and corresponding to the French term *Carnassiers;* also the corresponding group of the Marsupial Quadrupeds.

ZOO'PHORUS. (Gr. ζωον, *an animal*, and φερω, *I bear.*) In Architecture, the same as frieze; which see.

ZO'OPHYTES, *Zoophyta.* (Gr. ζωον, and φυτον, *a plant.*) The name given by Cuvier to his fourth and last primary division or subkingdom of animals. By Linné it was applied in a more restricted sense to an order of *Vermes*, comprehending those beings which he supposed to participate of the natures of both animal and plant. Mr. Hatchett's dissertation upon these subjects, in the *Philosophical Transactions* for 1800, contains nearly all the chemical information which we have respecting them. In respect to their composition they may be arranged into four classes: — 1. Those which consist almost entirely of carbonate of lime and gelatine. They are perfectly soluble, with effervescence, in muriatic acid, and the solution yields slight traces only of animal matter: when heated red-hot they evolve but little smoke or odour, and leave quicklime. Common white coral (*Madrepora virginea*) is an instance of this variety. 2. Those which, like the former, have carbonate as their hardening principle, but which when steeped in muriatic acid are less rapidly acted on, and leave membranous or cartilaginous films, and which, when heated, exhale smoke and the odour of burned bone; these, therefore, consist of carbonate of lime, gelatine, and albumen. Such are the *Madrepora zamea* and the *Madrepora fascicularis.* The *Isis hippuris* is a curious variety of this class, in which separate portions of var. 1. are united by cartilaginous joints. 3. This class includes the *Gorgonia nobilis*, or red coral, the *Tubipora musica*, and some other varieties; the earthy part of which is not merely carbonate of lime, but contains a portion of phosphate of lime, whilst the animal part resembles class 2. 4. This class includes the various sponges. Some of these consist almost exclusively of what may be called animal matter, that is, of a peculiarly organized albumen, with a trace of gelatine; others are hardened by abundant siliceous or calcareous spiculæ. Mr. Hatchett has pointed out the resemblance which exists among the three first classes to porcellaneous shell, mother-of-pearl shell, and the crustaceous coverings of the crab and lobsters.

ZOO'TOMY. (Gr. ζωον, and τεμνω, *I dissect.*) The branch of anatomical science which relates to the structure of the lower animals. *See* ANATOMY, COMPARATIVE.

ZOTHE'CA (Gr.) In ancient Architecture, a small apartment or alcove, capable of being separated from or added to a larger one by means of curtains.

ZU'MIC ACID. (Gr. ζυμη, *leaven.*) A compound formed in sour bread, and in vegetable substances which have undergone acetous fermentation.

ZUMO'LOGY. (Gr. ζυμη, and λογος, *a discourse.*) The doctrine of fermentation.

ZUMO'METER, or ZUMOSI'METER. (Gr. ζυμη, and μετρον, *a measure.*) An instrument intended to show the degree to which fermentation has proceeded in different fermenting liquors. *See* SACCHAROMETER.

ZU'RLITE. A name given to a recently discovered Vesuvian mineral.

ZYGODA'CTYLES. (Gr. ζυγον, *a yoke;* δακτυλος, *a finger.*) The name given by M. Temminck to an order of Climbing Birds, including those which have the toes arranged in pairs, two before and two behind; corresponding to the *Scansores* of Cuvier.

ZYGŒ'NA. (Gr. Ζυγαίνα; the name of a fish in Aristotle.) A genus of Cartilaginous fishes of the Squaloid or Shark tribe, remarkably characterized by the extreme breadth and flatness of the head, the sides of which extend outwards at right angles with and far beyond the body, just as the head of a hammer is placed on the handle: the eyes are placed at the lateral margins of the head. The term *Zygæna* has also been applied by Tchsenheimer to a genus of *Lepidoptera.*

ZYGO'MA. (Gr. ζυγον, *a yoke;* because it transmits the tendon of the temporal muscle like a yoke.) The cavity under the *zygomatic* process of the temporal bone. Hence, also, the term *zygomatic muscles.*

ZYGOPHYLLA'CEÆ. (Zygophillum, one of the genera.) A natural order of arborescent, shrubby, or herbaceous Exogens, inhabiting the hotter parts of the world. Are nearly allied to *Oxalidaceæ*, from which they differ in many characters; with *Simarubaceæ* they accord in the stamens springing from the back of an hypogynous scale; and are distinguished from *Rutaceæ* in the leaves being constantly opposite, with lateral or intermediate stipules, and in being generally compound, and always destitute of pellucid dots. The ligneous plants of this order are remarkable for their hardness. Guaiacum, or *Lignum Vitæ*, is one of them.

THE END.

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SUPPLEMENT.

ABSI'NTHINE. (Gr. *α, priv.*; *ψινθος, sweetness.*) A peculiar bitter principle extracted from wormwood (*Artemisia Absinthium*).

ACE'TAL. (Lat. acetum, *vinegar.*) A colourless inflammable liquid, obtained by the action of spongy platinum upon the vapour of alcohol: it is convertible by slow combustion into *acetic acid*.

ACETO'METER (Lat. acetum and Gr. *μετρον, measure.*) An instrument in the form of an hydrometer, for determining the strength of vinegar and other forms of acetic acid: it was invented by Messrs. J. and P. Taylor, and is described in the *Quarterly Journal of Science and the Arts*, vol. vi.

ACE'TONE. (Lat. acetum.) When acetate of lime, baryta, or lead, is subjected to dry distillation, a limpid colourless liquid is obtained, to which the above name has been given: it has a penetrating aromatic odour, and is highly inflammable: its ultimate components are 3 atoms of carbon, 3 of hydrogen, and 1 of oxygen.

A'CETYLE. The hypothetical radical of the acetic compounds: it is composed of 4 atoms of carbon and 3 of hydrogen. Its symbol therefore is $C_4 H_3$, and that of the acetic acid $C_4 H_3 O_3$.

ACHILLEI'NE. A peculiar bitter principle procured from the *Achillea millefolia*.

ACH'MITE. (Gr. *αχμη, the point of a sword.* Named from the pointed form of its crystals). A mineral found near Kongsberg in Norway: it is a double silicate of soda and iron.

ACIDI'METER. (Lat. acidus, *acid*, Gr. *μετρον, measure.*) An instrument for determining the strength of an acid by its saturating power: it usually consists of a glass tube graduated into 100 equal parts, and containing an alkaline liquor of known strength, the proportion of which, requisite to saturate a given quantity of any acid, is the equivalent of that acid. *See* ALKALIMETER.

A'CINI. (Gr. *ακινος, a grape.*) A number of vesicles arranged in clusters usually round the ends or by the sides of the smallest branches of the ducts of aggregated glands. Each acinus seems to be formed by the fusion of the walls of several vesicles which combine to form one cavity lined or filled with secreting cells. The various modes of grouping of the *acini* afford characters for the different aggregated or conglomerate glands.

ACRO'LEINE. (Gr. *ακρος, extreme; ελαιον, oil.*) An acrid volatile product, formed during the destructive distillation of the fat oils: it appears to arise from the decomposition of glycerine, inasmuch as it is not obtained from the pure fat acids.

ACTI'NOGRAPH (*ακτιν, a sunbeam; γραφω, I write*). An instrument for the purpose of registering the variations of chemical influence in the solar rays, the intensity of which has been found to bear no direct relation to the quantity of light, but to vary at different periods of the day and year. The instrument, as contrived by Mr. Hunt, and described to the British Association, "consists of a fixed cylinder, on which is placed a prepared photographic paper. This is covered by another metal cylinder which revolves once in twenty-four hours. Through this there is a triangular opening divided by fifty bars, through which the paper is exposed to the sunshine. As the time during which the smallest part of the opening allows the paper to be exposed is one hundred times less than the time during which it is exposed by the largest opening, different effects are produced on the paper, and consequently a register for every hour of the day may be numerically kept of the actinic radiation associated with light." — *British Association Reports* for 1845 and 1846.

ACTINO'METER (Gr. *ακτιν, a sunbeam*, and *μετρον, measure*), an instrument invented by Sir John Herschel for measuring the force of solar radiation. It consists of a hollow cylinder of glass soldered at one end to a thermometer tube terminating at the upper end in a hollow ball drawn out to a point, and broken off so as to leave the end open. The other end of the cylinder is closed by a silver, or silver-plated, cap cemented on it, through which a screw, working in a collar of leather, passes into the interior of the cylinder, and gives the means of increasing or diminishing the hollow capacity of the cylinder to a small extent at pleasure. The cylinder is filled with a deep-blue fluid (the ammonio-sulphate of copper); a graduated scale is applied to the stem, or thermometer tube, and the instrument is defended from currents of air by being enclosed in a case having the interiors of three of its sides blackened, and the fourth, or face, composed of a thick plate of glass.

Before using the instrument for observation any air-bubbles in the cylinder must be carefully expelled. This is easily effected by means of the screw and the ball at the top of the stem, which serves as a reservoir and contains a small portion of superfluous liquid. When the ball and stem are both filled and no air bubble is left, the fluid is brought down to the zero of the scale by turning the screw.

The general object is to determine the expansion of the liquid produced by the exposure of a given area of the cylinder to the direct rays of the sun during a given interval of time. But as the expansion of the liquid depends, not only on the heating power of the sun, but also on the rapidity with which the heat received is radiated away, and on every other circumstance exerting a thermometrical influence, it is necessary to eliminate those influences. For this purpose the observations are made with the instrument alternately exposed to and screened from the solar rays for intervals of one minute.

On exposure to the sun, the liquid in the stem rises rapidly, and the difference of the readings of the scale at the beginning and end of the interval of exposure shows the combined effect of all the heating and cooling influences. The instrument is then placed in the shade during an equal interval. If during this second interval the liquid remains stationary, then it may be inferred that the rise in the first interval was due to the solar action alone. If the liquid *falls* during the shade observation, then it is manifest that the solar action is opposed or counteracted by the cooling influences, and the number of divisions through which the liquid falls must be *added* to the number through which it rose in the interval of exposure, in order to have the measure of the solar action. But if the liquid continues to *rise* during the shade observation, then it is plain that the action of the solar rays is assisted by other heating influences, and the number of divisions through which the liquid rises in the second interval must be *subtracted* from the number through which it rose during the first.

The observations are made in triplets: that is to say, the instrument is held in the sun's rays one minute, then one minute in the shade, and again one minute in the sun, an interval of 20 or 30 seconds being interposed at each change for the purpose of noting the readings. The difference of the readings at the beginning and end

of each minute interval is taken, and the difference in respect of the second interval is added to or subtracted from the mean of the two differences in respect of the first and third. A complete actinometer observation, however, cannot consist of less than three sun observations and two shade observations intermediate; but the more there are taken the better.

It will be readily seen that the results obtained, as above described, are only relative; some positive determination must therefore be had recourse to before the indications given by any two instruments are comparable. This is a matter of much difficulty. No doubt it is possible to determine for every instrument both the area of the section of the sunbeam which falls on the bulb, and is effective in raising the temperature, and also the absolute quantity of liquid in the capillary tube, corresponding to any length on the scale; or, which comes to the same thing, to determine the value of the parts of the scale in water grains, or some other absolute measure; but even this would not be sufficient, for, in so delicate an experiment, the slightest difference in the thickness or composition of the glass would produce discrepancies, and no two plates of glass are ever found to be precisely the same in respect of the proportion of calorific rays they stop or absorb. Hence, the only means of discovering the relation between the results given by two instruments is to make a series of experiments with both together, and under precisely the same circumstances. Sir John Herschel proposes to adopt as the *actine*, or unit, that intensity of solar radiation which, at a vertical incidence, and supposing it to be wholly absorbed, would suffice to melt one-millionth part of a *metre* in thickness from the surface of a sheet of ice horizontally exposed to its action in one minute of mean solar time.

In the Philosophical Transactions for 1842 Professor Forbes, of Edinburgh, has given an account of some interesting experiments with the Actinometer, made by him on the Faulhorn (in Switzerland), for the purpose of ascertaining the difference of solar radiation at the bottom and top of the mountain, and thence the proportional quantity of calorific rays absorbed in passing through a stratum of the atmosphere of a given thickness. This is one of the most useful purposes to which the instrument can be applied. It may also be used for measuring the defalcation of heat in an eclipse of the sun.

The Actinometer was first described in the *Edinburgh Journal of Science*, vol. iii. for 1825. For a full description of the instrument, and of the method of using it, see the *Report of the President and Council of the Royal Society on the Objects of scientific Inquiry in Physics and Meteorology*, 1840.

AD′JUTAGE, or AJUTAGE. (French.) In Hydraulics the name given to a short tube or pipe applied to a vessel containing a liquid for the purpose of facilitating the discharge. *See* HYDRAULICS, in DICT.

ADRIANO′PLE RED. A term applied by dyers to the red obtained from madder: it is also called *Turkey red*.

AE′RIAL IMAGES. In Optics, the name given to images of objects produced by reflection or refraction when they appear suspended in the air. For example, a spectator standing before a concave mirror, at a somewhat greater distance from it than its radius of curvature, sees an inverted image of himself, hanging as it were between himself and the mirror. For examples of aerial images produced by refraction, see FATA MORGANA, MIRAGE, in DICT.

ÆS′CULINE. A peculiar substance contained in the bark of the horse-chestnut tree (*Æsculus hippocastanum*): it appears in the form of a white crystalline powder, and when dissolved in very minute quantities in water, communicates a blue opalescence to it.

Æ′THOGEN. (Gr. *αιθων*, *brilliant*, *γιγνομαι*, *I become*.) A compound of nitrogen with boron, remarkable for the intense luminosity which it exhibits in the flame of the blowpipe.

ÆTI′TES. (Gr. *αιτος*, *an eagle*.) A mineralogical term applied to globular masses of clay iron-stone. The name is derived from its being supposed to form one of the component parts of an eagle's nest.

AF′FERENT. The term, in Anatomy, applied to those lymphatic vessels which enter the lymphatic glands, subdivide, and form tortuous plexuses therein, whence other vessels proceed, converge, and unite into two or more efferent vessels which are larger than the afferent ones, and proceed towards the main trunk called "thoracic duct." The term *afferent* has also been applied to those nerves which convey impressions to the central axis, and which Hartley called "sensory" nerves, in contradistinction to the efferent or "motory" nerves.

AG′GREGATED GLANDS. Those secreting organs in which a number of compound vesicles or *acini* are arranged in groups, forming lobules. (*See* CONGLOMERATE.) Such are the so-called mucous glands of the mouth, trachea, and vagina; the tonsils, salivary, pancreatic, and mammary glands; the lachrymal and Brunnian glands; Cowper's glands and prostate.

AG′MINATE GLANDS. (Lat. agmen.) The glands of Peyer, in the small intestines, where they are aggregated in groups, are so called: these groups are of various sizes, and usually of an oval form.

A′LCOHOL. The following is Fownes' table of the specific gravities of mixtures of alcohol and water.

Sp. Gr. at 60°.	Per centage of real Alcohol.	Sp. Gr. at 60°.	Per centage of real Alcohol.	Sp. Gr. at 60°.	Per centage of real Alcohol.
·9991	0·5	·9511	34	·8769	68
·9981	1	·9490	35	·8745	69
·9965	2	·9470	36	·8721	70
·9947	3	·9452	37	·8696	71
·9930	4	·9434	38	·8672	72
·9914	5	·9416	39	·8649	73
·9898	6	·9396	40	·8625	74
·9884	7	·9376	41	·8603	75
·9869	8	·9356	42	·8581	76
·9855	9	·9335	43	·8557	77
·9841	10	·9314	44	·8533	78
·9828	11	·9292	45	·8508	79
·9815	12	·9270	46	·8483	80
·9802	13	·9249	47	·8459	81
·9789	14	·9228	48	·8434	82
·9778	15	·9206	49	·8408	83
·9766	16	·9184	50	·8382	84
·9753	17	·9160	51	·8357	85
·9741	18	·9135	52	·8331	86
·9728	19	·9113	53	·8305	87
·9716	20	·9090	54	·8279	88
·9704	21	·9069	55	·8254	89
·9691	22	·9047	56	·8228	90
·9678	23	·9025	57	·8199	91
·9665	24	·9001	58	·8172	92
·9652	25	·8979	59	·8145	93
·9638	26	·8956	60	·8118	94
·9623	27	·8932	61	·8089	95
·9609	28	·8908	62	·8061	96
·9593	29	·8886	63	·8031	97
·9578	30	·8863	64	·8001	98
·9560	31	·8840	65	·7969	99
·9544	32	·8816	66	·7938	100
·9528	33	·8793	67		

ALCOHO′LMETER. An instrument by which the quantity of alcohol contained in wines and other spirituous liquors is determined by reference to their respective boiling points at given pressures.

AL′CORNINE. A crystallisable substance contained in the alcornoque bark of America.

AL′DEHYDE. (From *alcohol dehydrogenatus*.) A chemical term applied to a pungent volatile liquid, obtained by distilling alcohol with oxide of manganese and sulphuric acid. Alcohol is a compound of 4 atoms of carbon, 6 of hydrogen, and 2 of oxygen; whereas aldehyde consists of 4 of carbon, 4 of hydrogen, and 2 of oxygen.

ALKA′RSINE. A compound of carbon, hydrogen, oxygen, and arsenic; it was formerly called *Cadet's fuming liquor of arsenic:* it is the *oxide of kakodyle* of modern chemistry. *See* KAKODYLE.

ALLANTO′INE. The substance originally termed *Allantoic acid*. It has been produced artificially by the action of peroxide of lead on uric acid: its formula is $C_4\,H_3\,O_3\,N_2$.

ALLO′PATHY. (Gr. *αλλος*, *different*, and *παθος*, *disease*.) A term recently invented to describe the ordinary system of medical practice in opposition to *Homœopathy*, which see.

ALLOPHA′NIC ACID. (Gr. *αλλος*, *different*, and *φαινομαι*, *I appear*.) An acid body discovered by Wöhler and Liebig, and formed by passing the vapour of cyanic acid into alcohol: its chemical formula is $C_4\,H_3\,O_5\,N_2$.

ALLO′TROPY. (Gr. *αλλοτροπος*, *of a different character*.) A term used by Berzelius to designate the property belonging to certain substances of exhibiting variable characters at different temperatures, especially as relates to *colour*, *texture*, *solubility*, &c.: thus sulphur is usually yellow and brittle; but if fused at a high temperature, and poured into water, it becomes brown and viscid. The characters of phosphorus may also be remarkably changed by temperature, though its nature, as well as that of sulphur, remains the same.

ALLO′XAN. One of the products of the action of nitric acid on uric acid: it is a colourless crystalline substance, the aqueous solution of which tinges the cuticle purple: its chemical formula is $C_8\,H_4\,O_{10}\,N_2$.

AL′LYLE. (Lat. allium, *garlic*.) A hydro-carbon ($C_6\,H_5$) supposed to constitute the basis of the volatile oil of garlic.

ALTE′RNATE GENERATION. In Physiology, that modification of generation in which the young do not resemble the parent but the grand-parent; so that the successive series of individuals seem to represent two species alternately reproduced. The *salpa*, a floating gelatinous molluscous animal, is an example: it may be found as a solitary individual, pregnant with numer-

ous minute salpæ, of a more simple structure, which continue after birth to be united together in the form of a long chain floating on the sea. In each individual of this chain there is generally developed an egg, from which is hatched a solitary salpa, of the form and organisation of the parent of the chain of aggregate salpæ: thus the species is represented by an alternation of simple and aggregate salpæ. *See* PARTHENOGENESIS.

AMANI'TA MUSCARIA. (*Fly Mushroom.*) One of the most poisonous of the fungi of this country: it renders water in which it is boiled so poisonous that animals are killed by it, whilst the boiled fungus itself is nearly harmless. The liquid procured from it is used as a *fly-poison*, whence the name of the mushroom is derived. It is known by its rich orange-red colour.

AMI'DOGEN. (The generator of *amides.*) A compound of 1 atom of nitrogen and 2 atoms of hydrogen: this compound has not been isolated, but may be traced in combination with other substances, constituting compounds called *amides:* thus *potassiamide* is a compound of the metal potassium with amidogen; and, in reference to the same view, ammonia (which see) is an amide of hydrogen. Amidogen is thus represented by the symbol $N\,H_2$, and ammonia as $= N\,H_2 + H$, or $N\,H_3$.

AMPHIO'XUS. (Gr. *αμφι, both*, and *οξυς, sharp.*) The name of a genus of fishes, so called because the animal is sharp at both ends. It has not, in fact, any proper head, brain, or heart; and is recognised as a vertebrate animal only by its gelatinous dorsal chord, which supports a medullary spinal chord or nervous axis, and gives attachment to segmental partitions.

AMPU'LLA. (Lat.) In Anatomy, that end of each of the three semicircular canals of the internal organ of hearing which is more dilated than the other.

AMY'GDALINE. (Gr. *αμυγδαλον, an almond.*) A crystalline principle contained in the bitter almond, which, under the influence of *emulsine* and water, yields hydrocyanic acid, and the volatile oil of bitter almonds. By the action of certain bases amygdaline yields ammonia, and amygdalic acid. The composition of amygdaline is $C_{40}\,H_{27}\,O_{22}$.

AMY'LE or AMYLENE. (Gr. *αμυλον, starch.*) This term implies in chemistry the hydrocarbon which is the basis of the so-called *Amylic alcohol*, or hydrated oxide of amyle. Amyle contains 10 atoms of carbon and 11 of hydrogen, and is represented, therefore, by the symbol $C_{10}\,H_{11}$. The volatile oil of potatoes, or the *Fousel oil* of the Germans, includes this compound.

ANACA'RDIC ACID. An acrid fatty substance, found in the fruit of the *Anacardium occidentale*, or Cashew nut.

A'NALOGUE. (Gr. *ανα* and *λογος, method.*) In Comparative Anatomy, an organ which resembles another in its functional relations; as the wing of a bird is analogous to the wing of the flying lizard (*Draco volans*) and to the wing of an insect, though it be not in its structural relations the corresponding organ of the body.

ANAMO'RPHOSIS. (Gr.) In Natural History, expresses the change of form which may be traced throughout the species or higher members of a natural group of animals or plants, either in the actual series, or, as they have succeeded each other in the course of time on this planet; which change is usually ascensive, or indicative of a progression towards a higher series of species. It has been conjectured that the succeeding or supplanting species may be actually the species supplanted, but changed, *i. e.* otherwise and commonly more highly developed, but of this there is no proof; and the term "anamorphosis" must be understood as expressive of an *ideal* change, in contradistinction to the real or bodily change observed in the development of the individual, and which is called "metamorphosis."

ANAPO'PHYSIS. (Gr. *ανα, backward; αποφυσις, a process.*) That process of a vertebra which, arising in the dorsal region from above the diapophysis or transverse process, recedes to the side of the centrum, as the vertebræ approach the sacrum, and projects more or less backwards. It usually supports and strengthens the joint of the anterior zygapophysis of the succeeding vertebra. It is well developed in the hare and most rodents.

A'NATASE. (Gr. *ανατασις, extension.*) A mineralogical name of the *oxide of titanium.*

ANCHUSINE. The colouring principle of alkanet root (*Anchusa tinctoria*).

ANEMO'METER. Dr. Lind's Anemometer, described in the DICTIONARY OF SCIENCE, gives the means of determining at any particular instant the force of the wind by its pressure against a column of water directly opposed to it. For meterological purposes it is, however, very important that instruments should be *self-registering*, because the changes proposed to be measured often take place very suddenly, and may therefore escape notice altogether when observations are taken at intervals. The anemometer now generally introduced into the principal observatories was contrived by Mr. Osler of Birmingham, and registers the direction as well as the force of the wind at every successive instant. It is described as follows in the *Report of the President and Council of the Royal Society on the Objects of Scientific Inquiry in Physics and Meteorology*, 1840.

"In this instrument the direction of the wind is obtained by means of the vane attached to the rod, or rather tube, that carries it, and consequently causes the latter to move with itself. At the lower extremity of this tube is a small pinion working in a rack, which slides backwards and forwards as the wind moves the vane; and to this rack a pencil is attached, which marks the direction of the wind on a paper ruled with the cardinal points, and so adjusted as to progress at the rate of one inch per hour by means of a clock; the force is at the same time ascertained by a plate one foot square, placed at right angles to the vane, supported by two light bars running on friction rollers, and communicating with three spiral springs in such a way that the plate cannot be affected by the wind's pressure without instantly acting on the springs, and communicating the quantum of its action by a wire passing down the centre of the tube, to another pencil below, which thus registers its degree of force."

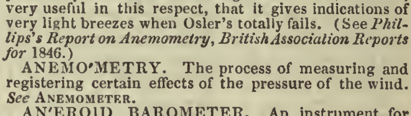
Another self-registering anemometer, proposed by the Rev. Dr. Whewell, is described in the same Report. "In it a small set of windmill vanes, something like the ventilators of windows, are presented to the wind by a common vane, in whatever direction it may blow. The current, as it passes, sets these vanes in rapid motion, and a train of wheels and pinions reduces the motion, which is thence communicated to a pencil traversing vertically, and pressing against an upright cylinder, which forms the support of the instrument: 1000 revolutions of the fly only cause the pencil to descend 1-20th of an inch. The surface of the cylinder is covered with white paper, and the pencil, as the vane wavers, keeps tracing a thick irregular line like the shadings on the coast of a map. The middle of the line may be easily traced, and it gives the mean direction of the wind, while the length of the line is proportional to the velocity of the wind, and the length of time during which it blows in each direction." This instrument consequently records both the direction and integral effect of the wind. Being more complex in its construction than Osler's, it is practically more liable to derangement. It is, however, very useful in this respect, that it gives indications of very light breezes when Osler's totally fails. (See *Phillips's Report on Anemometry, British Association Reports for* 1846.)

ANEMO'METRY. The process of measuring and registering certain effects of the pressure of the wind. *See* ANEMOMETER.

AN'EROID BAROMETER. An instrument for indicating the variations of atmospheric pressure, recently brought into use, and said to be the invention of M. Vidi, of Paris, for whom a patent was taken out in this country by M. Fontainemoreau in 1844.

In the ordinary barometer the pressure of the atmosphere is measured by the height of the column of mercury which it supports; in the aneroid the differences of pressure are measured by the effect produced on a metallic spring, no fluid being employed. Hence the composition of the terms from the Greek *α, without, υγρος, watery*, and *ειδος, form.*

The instrument may be described as consisting of three essential parts: first, an air-tight box or vase formed of thin metallic plates, so that the sides yield to the pressure, and collapse when the air is withdrawn from the interior; secondly, a spiral spring resisting the compression of the sides of the box; and thirdly, a system of levers connected with the box and spring, and giving motion to an index by which the amount of pressure is exhibited on a scale. The arrangement is represented in the annexed diagram, in which A represents the vacuum-vase, B B the main lever, C the fulcrum or support, and S the spring; the direction of the forces being indicated by the arrows. If, at a certain pressure, the lever has the direction indicated in the figure, then, supposing an increase of pressure to take place, the upper side of the box will be pressed downwards, carrying the lever, with which it is shown to be in connexion, along with it, and consequently compressing the spring against which it acts. The lever, it will be observed, is of the second order, and, as usually constructed, the distance of the spring from the fulcrum is to that of the box from the fulcrum in the ratio of six to one.



The box is of a cylindrical form, about $2\frac{3}{4}$ inches in diameter, and 5-16ths of an inch deep, partially exhausted of air, and hermetically sealed. It is composed of thin corrugated copper plates. The spring is formed of steel wire, about 1-20th of an inch in thickness, and the helix or coil is about an inch in height, and 5-8ths of an inch in diameter. A system of levers is employed to multiply the movement of the main lever, and to the ultimate lever is attached a piece of fine watch-chain pressing round a small roller, on the axis of which the index is placed, which exhibits the variations of pressure on a graduated dial. The index is kept in its place, and the chain in a state of tension, by means of a delicate spiral spring attached to the same axis. The whole is placed within a cylindrical box, about five inches in diameter, and the general form of the instrument resembles that of a watch.

The principal difficulty to be overcome, in the construction of the aneroid, is to eliminate the influence of changes of temperature; and the manner in which this is done, or, perhaps it should be said, *attempted* to be done, is sufficiently ingenious. It has been stated above that the air-tight box is only partially exhausted of air; indeed, it would scarcely be possible to effect a perfect vacuum. A small portion, however, is purposely allowed to remain, and elastic fluids, as is well known, expand about 1-480th part of their volume by an increase of temperature corresponding to a degree of Fahrenheit's thermometer. Now the range of temperature in our climate may be considered to be about 50 degrees, and consequently the expansion of unconfined air will vary to more than one-tenth of its volume. But as the capacity of the vase remains sensibly the same (for the small increase arising from expansion of the metal of which the box is formed may be disregarded), the portion of air confined within it cannot vary in volume; its elastic force is therefore increased with the increase of temperature, and the action of this force being in opposition to the external pressure on the sides of the box, the effect on the lever is the same as would be produced by an increase of the elastic force of the spring. But the effect of an increase of temperature on the spring itself is to diminish its elastic force. Hence it is easy to see that, in order to effect a perfect compensation, the parts of the instrument must be so adjusted to each other that, upon an increase of temperature taking place, the loss of elastic force sustained by the spring shall be just equal (allowing for the leverage) to that which is gained by the air confined within the vase, and the lever consequently remain in equilibrio. It is manifest that a perfect adjustment must be attended with great practical difficulty, if indeed it be possible.

From comparisons that have been made, it appears that, within a certain range of barometric pressure (and a variation corresponding to two or three inches of mercury is all that is necessary to provide against), the indications of the aneroid agree sufficiently well (for ordinary purposes) with those of the mercurial barometer, the greatest differences of reading through the ordinary range of the barometer and thermometer having been found, in the case of certain instruments, not to exceed six or seven hundredths of an inch. It possesses great advantages in its small bulk, its portability, and also its extreme sensibility, which is such that the variation of pressure corresponding to an ascent or descent of a few feet is distinctly indicated. On the other hand, it is liable to move by jerks; the spring can hardly be expected to preserve the same elasticity for any considerable time; and it has been found that the zero point has been altered by a journey. For philosophical purposes it can never supersede the mercurial barometer; but there are cases in which it may be used with great advantage: for example, by sailors employed in the coast trade, or the fisheries, as it may be carried even in an open boat.

Though the aneroid has been brought forward as a new invention, Mr. Weld, in a communication to the Athenæum (December 30, 1848), has shown that the principle was developed so long ago as 1798 by M. Conté, who describes an instrument similarly constructed, and resembling a watch in appearance, in the *Bulletin des Sciences Naturelles*, tom. i. No. xiii. p. 106. (See *Dent on the Aneroid Barometer; Frodsham's Few Remarks upon the Construction and Principles of the Aneroid*, &c.; *Belville's Manual of the Barometer; Mechanics' Magazine*, No. 1307.)

A'NGLEME'TER. This name has been specially given to an instrument used by geologists for measuring the dip of strata, the angles of joint-planes, &c. (*British Association Reports*, 1847.)

ANHARMO'NIC RATIO. In Geometry, if four points A, B, C, D, be taken in a straight line in any order, the ratio which is compounded of the ratio of A B to B C and of C D to D A, or (A B : B C) × (C D : D A) has been styled by Chasles *anharmonic ratio*. In the particular case in which this compounded ratio is one of equality, or 1 : 1, we have A B : B C = A D : C D; and when this property holds the line A D is said to be *harmonically* divided in B and C. The term *harmonical* applied in this sense, first occurs, we believe, in Lahire's Conic Sections. The characteristic property of the anharmonic ratio is the following:— If from any point out of the given straight line four straight lines a, b, c, d, be drawn through the four points respectively, and if sin $(a\,b)$ denote the sine of the angle included between a and b (and so with the others), then the double or anharmonic ratio is equal to [sin $(a\,b)$: sin $(b\,c)$] × (A B : B C) × (C D : D A) × [sin $(c\,d)$: sin $(d\,a)$]. These angles being entirely independent of the position of the straight line in which the four points A, B, C, D are taken, it follows that if any straight line whatever be drawn to intersect the four straight lines a, b, c, d respectively in the points A′, B′, C′, D′, then the anharmonic ratio (A′ B′ : B′ C′) × (C′ D′ : D′ A′) will be the same as (A B : B C) × (C D : D A). From this general property some very remarkable relations of geometrical figures have been deduced. (Steiner, *Systematische Entwickelung der Abhangigkeit geometrischer Gestalten von einander;* Berlin, 1832; Chasles, *Aperçu Historique des Méthodes en Géométrie* (*Mémoires de Bruxelles*), 1837.)

A'NILINE. (Anil, the Indigo plant.) A colourless oil-like liquid of a strong odour and hot aromatic flavour, remarkable for its tendency to form crystallisable compounds with the acids, so that it was originally termed *crystalline;* it is a product of the distillation of certain organic substances, and among others it has been derived from *indigo*. It is a compound of carbon, hydrogen, and nitrogen, $= C_{12}\,H_7\,N$.

ANO'RTHOSCOPE. (Gr. ανορθος, and σκοπεω, *I view*.) The name given by M. Plateau, of Brussels, to an instrument invented by him, and intended to produce a peculiar kind of anamorphoses by means of two discs rotating rapidly one before the other, the hind one of which is transparent, and bears distorted figures, while the front one is opaque, and pierced with a small number of narrow slits. As in other toys of a similar kind, the *Phenakistoscope*, for example, the effect depends on the persistence of impressions on the retina. The instrument is described at length in the *London, Edinburgh, and Dublin Philosophical Magazine*, Third Series, No. 245. — June, 1850.

ANTAGONI'STICS. In Anatomy, those muscles are so termed which are opposed to others in their action, as the extensors to the flexors, the pronators to the supinators, the abductors to the adductors, &c.

ANTH'ELIA. (Gr. αντι, *opposite;* ἥλιος, *the sun.*) Luminous coloured rings, or glories, observed under certain conditions round the shadow of the spectator's own head. The conditions of the phenomenon are two; first, that the sun be near the horizon, and secondly, that the shadow be projected on a surface covered with dew drops, as a field of grass or stubble, or on a dense cloud or fog-bank, distant about 50 or 60 yards. Generally the luminous appearance is very faint, and only one or two rings can be traced; but sometimes, in favourable circumstances, it is strikingly vivid, and two or three small concentric circles appear, surrounded by a much larger one, of whitish light, the head of the observer's shadow being at the common centre. Such brilliant Anthelia were observed by Bouguer and his companions on the clouds of the Andes (*Figure de la Terre*, p. 43.), and by Scoresby on the fog-banks in the Arctic seas. Scoresby gives the following dimensions of the rings as measured by him on one occasion: radius of the first or innermost ring 2°; of the second $4^{\circ}\,45'$; of the third $6^{\circ}\,30'$; and of the outermost $38^{\circ}\,50'$. The cause of interior rings is thus explained by Fraunhofer. Light falling directly from the sun on the anterior side of an aqueous globule undergoes a refraction, and a portion of this refracted and consequently coloured light on falling on the interior surface of the opposite side of the globule is reflected back to the eye of the spectator. The large surrounding circle is supposed to be formed by a double reflection, as in the case of the ordinary rainbow. *See* HALO, in DICT.

ANTI'ARINE. The poisonous principle contained in the milky juice of the *Antiaris Toxicaria*, a large forest tree growing in Java. This poison acts upon the brain and spinal marrow, and paralyses the heart.

ANTIGU'GGLER. A siphon, so inserted into casks or carboys as to admit air over the liquor contained in them, and to allow of its being poured out without agitation.

A'NTIPERISTA'LTIC. (Gr. αντι, and περιστελλω, *I wrap up.*) That movement of the intestinal tube which is retrograde or contrary to the proper course impressed upon the contents by the ordinary vermicular or peristaltic action.

A'PIINE. A gelatinous substance (distinguished by affording a blood-red colour with solution of sulphate of iron), obtained from parsley (*Apium petroselinum*).

APLANA'TIC LENS. (Gr. α, *without;* πλανη, *de-*

viation.) In Optics, a lens such that rays parallel to its axis, or rays diverging from a point in its axis, after passing through it and suffering refraction at its surfaces, converge to a single point, or the true focus. In order, therefore, to be aplanatic, the lens must not only have the true geometrical figure necessary to destroy aberration, but must also be constructed of different media, so as correct the effects of the unequal refrangibility of the different rays, that is to say, it must be achromatic. Neither of these conditions can be accurately fulfilled in practice; the object aimed at is therefore to give the lens such a form that, with a given index of refraction, the aberration shall be the least possible. *See* ABERRATION, ACHROMATISM, in DICT.

APOPHY'LLITE. (Gr. ἀπο, and φυλλον, a leaf: from its lamellar structure). In Mineralogy, a lamellar zeolite.

A'POTHEME. (Gr. ἀποτιθημι, I deposit.) A term applied by the old chemists to some of the varieties of *extractive matter*.

A'QUA VITÆ. (in Fr. *Eau de vie*.) The name absurdly given to brandy and other intoxicating liquors.

AQUÆDU'CTUS. In Anatomy, the term is applied to certain canals leading from the labyrinth or internal ear to the outside of its bony capsule or os petrosum: one of these, which extends from the hinder part of the vestibule to the posterior margin of the petrosal, is called "aquæductus vestibuli;" a second canal leading from the cochlea to the jugular fossa of the petrosal is called "aquæductus cochleaæ:" the function of the "aqueducts" is unknown.

A'QUEOUS HUMOUR. A thin watery fluid holding in solution a small quantity of chloride of sodium and extractive matter, situated in a space behind the cornea of the eye-ball, which is divided into an anterior and posterior chamber by a musculo-membranous partition called "iris," perforated by the aperture called "pupil:" the chief use of the aqueous humour is to maintain the convexity of the cornea and support and facilitate the movements of the iris.

ARCH. In Anatomy, a structure commonly composed of bone or other hard material disposed in a bow-like form, and constituting the chief part of the primary segment of the skeleton: that which rests upon the body of the vertebra (projects backward in man), and spans across the neural axis or trunk of the nervous system, is called the "neural arch;" that which is suspended in an inverted position (extends forward in man), and incloses the hæmal axis (heart and vascular trunks), is called the "hæmal arch." Those in the segments composing the head are called, with their surrounding soft parts in the embryo, "visceral arches." Curved portions of the great arterial and intestinal tubes are called "arches," as the "arch of the aorta," the "arch of the colon."

A'RCHETYPE. (Gr. ἀρχη, *beginning*, and τυπος, *a type*.) In Anatomy, is that ideal original or fundamental pattern on which a natural group of animals or system of organs has been constructed, and to modifications of which the various forms of such animals or organs may be referred. The archetypal figure has been most clearly recognised in the study of the modifications of the skeleton of the vertebrate animals.

A'RCOGRAPH. (Lat. arcus, *a bow; γραφω, I write.*) A drawing instrument for describing arcs of circles, or other curves, without centres.

ARDENT SPIRIT. *See* ALCOHOL.

A'REA. (Lat.) In Embryology, certain definite spaces which successively arise in the germinal membrane are so called: thus the opaque spot produced by an accumulation of cells and cell-nuclei is called "area germinativa," or germinal area; the clear space which subsequently appears in its centre is called "area pellucida;" and the outer part of this space, where the blood-vessels are first formed, is called "area vasculosa."

A'REOLAR TISSUE. In Anatomy, a term synonymous with CELLULAR TISSUE, which see.

ARGAND LAMP. The application of a circular wick to oil lamps, so contrived as to allow of a current of air both inside and outside, was originally patented by a person of the name of Argand: the contrivance constitutes an important epoch in the history of the improvement of lamps; by it the amount of light derivable from a given quantity of oil was enormously increased. The same principle is also applied to gas burners. *See* LAMP.

A'RMATURE. A piece of soft iron applied to a loadstone, or connecting the poles of a horse-shoe magnet.

A'RNICINE. A bitter principle contained in the flowers of the *Arnica montana*.

A'RRAGONITE. A peculiar variety of carbonate of lime originally found in Arragon in Spain: it is harder than the common variety, and is prismatic instead of rhomboidal. Some specimens contain about 3 per cent. of carbonate of strontia.

ARTE'SIAN WELLS. Numerous works of this kind have been executed of late years. One of the most remarkable of them is that of Grenelle, a suburb at the south-west of Paris, where there was formerly a great scarcity of water. The strata which were penetrated were, 1. the tertiary strata above the chalk; 2. chalk; 3. green sand and clay; 4. oolite or Jura limestone. The sheet of water flows in a stratum of gravel under the limestone. On account of the great depth of the boring the work was attended with much difficulty, and retarded by various accidents. At length, in February, 1841, after eight years of exertion, the engineer (M. Mulot) had the satisfaction of seeing the water he was in search of burst forth from a depth of about 600 English yards, and the jet yielded no less than 4,000,000 litres, or in round numbers 880,000 imperial gallons in the 24 hours. The temperature is 81° of Fahrenheit, corresponding to an increase of 1° for each 20·4 yards of descent. The bore is protected by a metal tube divided into four unequal lengths, and successively decreasing in diameter. The dimensions are as follows: — From the surface of the ground to the commencement of the first tube, 2·5 yards; length of first tube, 162 yards; of second tube, 227 yards; of third, 75 yards; of fourth, 124 yards; from extremity of last tube to bottom of bore, 7·5 yards; total, 598 yards. The diameter of the first or highest tube is about a foot, and of the lowest about six inches, English. The expense was about 12,000*l.* sterling. For a description of the boring apparatus, and methods of conducting such works usually followed in this country, see Ure's *Dictionary of Arts, Manufactures, and Mines;* and for details respecting some Artesian wells in England, the *Reports of the British Association.*

ASAFŒTIDA. *See* ASSAFŒTIDA.

A'SBOLINE. (Gr. ἀσβολη, *soot.*) A resinous pitchy matter obtained from wood-soot.

ASSOCIATION. In Physiology, a name given to that combination of motions which arises from the voluntary impulse to one motion exciting other motions contrary to or independently of the will; as, for example, whenever the eye is voluntarily turned inwards the iris contracts: these are termed associate or consensual movements.

ASTA'TIC NEEDLE. A term applied to the magnetic needle when it is withdrawn from the action of the earth's magnetism, and has no longer the *statical* position in which it is in equilibrio with the influence of this force. A needle is rendered astatic by placing the axis about which it is moveable in the direction in which terrestrial magnetism acts, because it cannot then receive any motion from this force, and will rest in any position. The same effect will be accomplished by neutralising the action of the earth by means of an equal and opposite magnetic action. (*Brewster's Treatise on Magnetism.*)

ASTI'GMATISM. (Gr. α, *without;* στιγμα, *a mark.*) In Optics, the name given to a peculiar defect in the eye, which consists in its refracting the rays of light differently in different planes. The defect may be detected by looking at a small pin-hole in a card, held up against the sky or any bright object, and moved to different distances from the eye. In the case of ordinary eyes the image of the hole remains circular at all distances, but to an eye having the peculiar defect in question the image of the hole, as the card is moved away from the eye, becomes elongated in a particular direction, and at a certain distance passes into a straight line. On moving the card still farther from the eye it becomes elongated in a direction perpendicular to the former, and again at a certain distance (the second limit of distinct vision) it passes into a straight line. This imperfection may be corrected by means of a cylindrical, or spherico-cylindrical, lens, the distances of the card from the eye when the two focal lines are formed, giving the means of calculating the required curvature of the cylindrical surface. (See *Transactions of the Cambridge Philosophical Society for* 1829, *Reports of the British Association for* 1849.)

ASTRÆ'A. One of the recently discovered small planets circulating between the orbits of Mars and Jupiter. Astræa was discovered on the 8th of December, 1845, by Hencke of Driessen, in Prussia, who had for several years previously been engaged in astronomical observations directed to the discovery of such a body. The announcement of his success excited great interest among astronomers, no other addition having been made to the planetary system since the discovery of Vesta by Olbers in 1807; but nine others belonging to the same group have since been added to the number. Astræa appears as a small star of the ninth magnitude. Its mean distance from the sun is 2·577 times that of the earth, and it completes its revolution in 1511·095 mean solar days. Unlike the four others previously discovered in the same region, the inclination of its orbit was found to be only 5° 19′ 22·7″, which is less than the inclination of Mercury, and consequently the term *ultra-zodiacal* is no longer applicable to the whole group. This distinction also belongs to three of the others since detected, viz. Flora, Iris, and Metis. Hebe, also

discovered by Hencke, has an inclination of nearly 15°. *See* PLANET.

ASTRO'METER (Gr. *αστρον, a star; μετρον, measure*), the name given by Sir John Herschel to an instrument invented and employed by him for comparing the intensities of light of the stars one with another by the intervention of the moon, or the planet Jupiter, or some other *natural* standard, no invariable standard of artificial light having yet been discovered. It is necessary that the intermediate standard of comparison be brighter than any of the stars to be compared, so as to allow of being equalised with them by a reduction of its light optically effected, and at the same time either invariable, or at least variable in such a manner that its changes can be calculated and reduced to numerical estimation. Jupiter being brighter than any of the stars, subject to no phases, and variable in its light only by the variation of its distance from the sun, may be considered as best fulfilling all the conditions. "The process," says Sir John, "consists in deflecting the light of the moon by total internal reflexion at the base of a prism, so as to emerge in a direction exactly coincident with that of the undeflected light of one of the stars to be compared. It is then received upon a lens of short focus, by which the image of the moon is formed, which, viewed at a considerable distance by an observer placed in or near the axis of the lens, will appear to him as a star. This artificial star is then to be approached to or removed from the eye until its light is judged to be exactly equal to that of the real star, which, lying in nearly the same direction from the observer, will be seen side by side with the artificial one by the same eye, or with both eyes at once, without the aid of a telescope, in the ordinary mode of natural vision. The distance of the eye from the focus of the lens being then measured, the prism and lens are to be placed so as to form another similar artificial star in a direction nearly coincident with that of the other star under comparison; and another equalisation being made and distance measured, it is obvious that the intensities of the lights of the two stars, or at least their effects on the retina under the circumstances of comparison, will be to each other in the inverse ratio of the distances so measured respectively." (*Results of Astronomical Observations*, &c., p. 353; also *Outlines of Astronomy*, Art. 783.)

Sir John remarks that the use of a prism to deflect the light of a standard luminary by total reflexion at its base, is common to the astrometer described by him and an instrument which had been previously described by Steinheil in a paper printed in the Memoirs of the Göttingen Academy in 1836, though he had no knowledge of the existence of Steinheil's memoir until his return to Europe from the Cape (where he had used the astrometer) in 1838.

It may be noticed that the name *Astrometer* was given by Bouguer to the Heliometer, or object-glass micrometer. It was also given by Jeaurat to an instrument for finding the rising and setting of the stars and their position, which he has described in the *Memoirs* of the Academy of Sciences of Paris. An improved instrument for the same purpose is described in the *Edinburgh Encyclopædia*, art. SCIENCE.

ASTRO'NOMY. During the few years that have elapsed since the publication of the DICTIONARY, the progress of this science has been very remarkable. A brief outline of the principal discoveries and improvements which have been made in it in the decade 1840—1850 is, therefore, necessary, in order to bring down its history to the present date.

Among the recent discoveries in astronomy, the most prominent, and in certain respects the most remarkable ever made in the science, is that of the new planet, to which the name of Neptune has been given, beyond the orbit of Uranus. In all previous instances of the discovery of a new planet, the discovery was accidental, in so far as the existence of the body was not foreknown, or even suspected, until its true nature became revealed by the observation of its relative motion. In the present case, not only had the existence of the planet been made known through the effects of its attraction, but the precise spot which it occupied in the heavens had been indicated by the results of a profound theoretical investigation, and the planet was immediately recognised on directing a telescope upon the spot so indicated. The researches which led to this notable result were directed by the following considerations.

For several years it had been remarked that the motions of the planet Uranus were not in accordance with theory. On comparing the observations with the tables of Bouvard, it appeared that the true longitudes of Uranus began to be in advance of the computed longitudes from about the year 1795, and more notably from 1804, the difference continuing gradually to increase till about 1822, when the excess attained its maximum. After that year the difference began to diminish rapidly, and in 1830 the tabular and true longitudes agreed. But the planet still continued to fall behind, as if hindered or retarded by some opposing force. The attractions of the other known planets afforded no explanation of these irregularities; and in searching for a cause, the idea of disturbance from a more remote planet did not fail to present itself, and in fact afforded the only probable explanation of the phenomena. It was no easy matter, however, to test this hypothesis; for, unless the place of the supposed planet could be assigned within moderate limits, so as to direct the observations, any attempt to find it must be undertaken at random, and insufficient to prove its non-existence as a visible object. The problem, therefore, which presented itself for solution (and it had never before occurred in physical astronomy) was this: Given the disturbances to find the orbit and the place in that orbit of the disturbing planet. By a singular coincidence, though not without example in the history of discovery, the problem was undertaken about the same time by two distinguished mathematicians, Mr. Adams in England, and M. Leverrier in France, neither having the slightest knowledge of the other's attempt; and both arrived at a correct conclusion. Mr. Adams's results, however, though communicated to two or three astronomers, were not published or generally known until some time after the actual discovery of the planet, and, as it happened, did not contribute in any way to that discovery. Those of M. Leverrier were given to the Academy of Sciences at Paris, and published in the *Comptes Rendus*; and by their means the planet was found by Dr. Galle, of Berlin, on the very day on which his attention was directed to them, within less than a degree of its predicted place. This memorable discovery took place on the 23rd of September, 1846, and was hailed by every astronomer of Europe as the most signal triumph of theory which had ever been achieved.

Soon after the planet had been found and regularly observed, it was perceived that, notwithstanding the agreement between its actual and predicted position, the elements of its orbit differed very considerably from those which had been assigned by the two mathematicians. In order to render the computations possible, it had been necessary to assume a certain mean distance of the hypothetical planet from the sun; and both M. Leverrier and Mr. Adams had assumed, as a first approximation, the law of Bode (*see* PLANET), which, though purely empirical, had a great probability in its favour, in consequence of its being observed to hold good in the case of the other planets. According to this law, the mean distance of the planet from the sun should be double that of Uranus, or 38·34 radii of the earth's orbit, in which case the periodic time would be 237·4 years. M. Leverrier had concluded the distance to be 36·15, and Mr. Adams 37·25, radii of the terrestrial orbit; the former corresponding to a period of 217·4 years, and the latter to one of 227·3 years. On computing the real orbit from the observed motions of the planet, the mean distance was found to be only 30·036 radii, and the period 164·6 years, differing widely from both predictions, and still more from the law of Bode, which fails entirely in this single instance. On considering all the circumstances of the case, the disagreement between the elements of the real and theoretical planet will not appear in any way remarkable; the latter, in fact, representing the perturbations which were to be accounted for with all the accuracy that could possibly be expected in such a research.

Neptune is attended by at least one satellite, probably two, and is suspected to resemble Saturn, in having also a ring. Its position in the ecliptic, since the date of its discovery, has been unfavourable to its being distinctly seen.

The next most remarkable feature in the recent progress of astronomy is the discovery of six new planets belonging to the group which circulate between the orbits of Mars and Jupiter. It has been stated, under the term PLANET, that the first of these small bodies, or asteroids, as they have been called, was discovered by Piazzi, at Naples, on the first day of the present century; and the discovery was regarded with great interest by the astronomers of that time, more especially as it had been surmised that a planet probably existed whose orbit, lying between those of Mars and Jupiter, would preserve the continuity of Bode's law of the distances; and the orbit of the new planet was found to be in conformity with that law. The discovery of a second, in the following year, was entirely unexpected, but it led to a more careful observation of the small stars in and near the zodiac than had previously been attempted, in the hope of detecting others. The result was the discovery of a third, in 1804, and of a fourth in 1807; but for nearly forty years the number was not increased. About the end of 1845, however, a fifth, belonging to the same group, was discovered by M. Hencke, of Driessen, in Prussia, and since that time ten more have been found, so that at the present time (January, 1852) no fewer than fifteen small bodies are known, all circulating at nearly the same mean distance from the sun, and consequently

in nearly the same period of time. Their names, with those of their discoverers, and the dates of their respective discoveries, are as under: —

Ceres,	discovered by	Piazzi	1801, Jan. 1.
Pallas	-	Olbers	1802, March 28.
Juno	-	Harding	1804, Sept. 2.
Vesta	-	Olbers	1807, March 29.
Astræa	-	Hencke	1845, Dec. 8.
Hebe	-	Hencke	1847, July 1.
Iris	-	Hind	1847, August 13.
Flora	-	Hind	1847, Oct. 18.
Metis	-	Graham	1848, April 25.
Hygeia	-	De Gasparis	1849, April 12.
Parthenope	-	De Gasparis	1850, May 11.
Victoria	-	Hind	1850, Sept. 13.
Egeria	-	De Gasparis	1850, Nov. 2.
Irene	-	Hind	1851, May 19.
Eunomia	-	De Gasparis	1851, July 29.

In reference to the eleven recently discovered planets it is proper to remark, that although none of them was previously known to exist, their discovery was in every instance the result of a "careful and minute examination and mapping down of the smaller stars in and near the zodiac, undertaken with that express object." The singular circumstance of so many planets moving in orbits of nearly the same dimensions, and all so insignificant (in comparison of the other planets) in size, gives considerable probability to the hypothesis proposed by Olbers on the discovery of Pallas, that a large planet originally occupied that region of space, and was shattered into fragments by an internal convulsion. But the hypothesis of Laplace, that they have their origin in a ring or zone of nebulous matter, thrown off from the sun's atmosphere in the gradual process of cooling, and broken up into small masses, no one being of sufficient magnitude to attract the others to its centre (as has happened in the case of all the other planets), will equally account for the phenomena. But whatever hypothesis may be formed respecting their origin, the number of them already known makes it extremely probable that many more exist, though by reason of their excessive smallness they may long, or for ever, elude observation. Those already known appear in the telescope as stars of the ninth or tenth magnitude, but such is their minuteness, that it is impossible, with the existing means of observation, to measure their apparent diameters, and thence to deduce their real dimensions, with any degree of accuracy.

Another recent discovery, affording evidence at the same time both of the excellence of the instrumental means now applied to astronomy and of the attention bestowed on the careful and accurate examination of the heavens, is that of an eighth satellite of Saturn; and it is not a little remarkable that the discovery was made both in England and America at the same time — even on the same day. In England the body was first observed by Mr. Lassell, of Liverpool, with a two-foot reflecting telescope, on the 18th of September, 1848, and taken for a faint star. On the 19th it seemed to have changed its place, following the motion of Saturn, and was accordingly suspected to be a satellite; and on the 21st, when it was next observed, its true nature was satisfactorily made out. The same object was observed in America by Mr. G. P. Bond at the Cambridge Observatory, Massachusetts, on the 16th of September, and then supposed to be a small star. On the 18th it was again noticed, but still without suspicion of its nature. On the 19th it was suspected to be in motion, and its position was therefore accurately determined. On the 20th it could not be seen, but on the 21st it was proved by its relative motion to be an attendant of Saturn The new satellite is very faint, and can only be seen in a powerful telescope. Reckoning from the outermost satellite inwards towards the planet, it is the second in the order of distance.

Cometary Astronomy has also been cultivated of late years with great assiduity, and in a manner which promises to lead to important results. Formerly the computation of an orbit was a task which not many observers were competent to undertake. At present the methods of performing such computations are far more generally known; and, indeed, no sooner does a comet make its appearance than elements of its orbit proceed from many quarters with a sort of rivalry. The first approximate calculations are carefully corrected by means of subsequent observations till the path of the body is determined with great accuracy, and in this manner the means are prepared of identifying it if it should make its appearance at any future time. Only a small number have yet been satisfactorily proved to move in elliptic orbits, and consequently to return at definite intervals; by far the greater numbers move in orbits which cannot be distinguished from parabolas, and after passing their perihelia shoot off to indefinite distances, and may possibly enter within the sphere of attraction of other systems. Their physical constitution still remains a profound mystery. One of the most remarkable on record appeared in 1843. It was visible within four degrees of the sun and in full day. No other comet has been known to approach so near to the sun. At the perihelion its distance from the luminous surface of the sun was computed to be less than a seventh part of the sun's radius, and the whole segment of its orbit cut off by the plane of the ecliptic was passed through in the short space of two hours, its actual velocity being then no less than 366 miles per second. It has been supposed to be identical with a comet which appeared in 1668.

In sidereal astronomy, a great accession to our knowledge has been recently made through the publication of the results of Sir John F. W. Herschel's observations at the Cape of Good Hope. This distinguished astronomer, after devoting some years to the examination and description of the nebulæ and double stars in the northern hemisphere, with the view of completing the work begun by his father Sir William Herschel (who may be regarded as the founder of this interesting branch of astronomy), conceived the idea of extending his survey to the southern hemisphere, in order to place on record a description of the principal nebulæ and double stars over the whole heavens, as observed with the same telescope and by the same observer, whereby the astronomers of future time would be enabled to detect changes in their physical appearances or relative positions, should any such take place. For this purpose he removed his Observatory to the Cape of Good Hope, where he passed four years (1834—1838), assiduously employed in carrying out the objects of his great undertaking; and after completing the still more laborious task of reducing his observations, the results were given to the world in 1847. Though the main purpose of his voyage was the observation of nebulæ and double stars, of which objects he has given reduced catalogues, accompanied with minute description and interesting remarks; the work also embraces a great variety of observations and disquisitions on other matters connected with astronomy, — the constitution of the galaxy, the Magellanic clouds, Halley's comet, the satellites of Saturn, the solar spots, &c. It is right to add, that this noble enterprise, which has conferred so much honour on his country, and been productive of so much benefit to astronomy, was undertaken and carried through by Sir John Herschel at his own private charges. He held no public appointment, and received no public assistance; and for the means of rendering his labours available to astronomers by the publication of the results, he professes his obligations to the Duke of Northumberland.

Among the circumstances which have most contributed to the general advance of astronomy in late years, one is the increased dimensions now given to telescopes, in consequence of which the objects of observation are not only greatly multiplied, but the observations are made with far greater distinctness and precision. Refracting object-glasses, of a foot or upwards in diameter, can now scarcely be considered as rare. But greatly exceeding these in optical power is the reflecting telescope made and erected by the Earl of Rosse, at his lordship's seat, in Ireland. The mirror of this gigantic instrument is six feet in diameter, and weighs about four tons. For a short account of the ingenious contrivances and apparatus made use of for the casting, grinding, polishing, and placing in its position this enormous mass of metal, we would refer to article *Telescope*, in this Supplement; they are all due to Lord Rosse himself, and could only have been produced by the combined exercise of extraordinary ingenuity, patience, and mechanical skill. Nor has the performance of the instrument disappointed the expectations that were formed of it. Nebulæ which, in other telescopes, gave no indication of resolvability, are by this easily resolved into stars; and in fact it already seems probable that it will be the means of upsetting the whole nebular theory. The appearance of some of the nebulæ or clusters in this telescope is extremely remarkable. Some are observed of a spiral form, perfectly regular; others exhibit streaks, sometimes straight, and sometimes curved; and generally they give evidence of systematic arrangement. Telescopes on the same principle have also been brought to great perfection by Mr. Lassell, and though of far inferior dimensions to those of Lord Rosse, have already rendered good service to astronomy in the discovery of a satellite of Neptune, two new satellites of Saturn, and two of Uranus.

Concurrently with the increase of optical powers, the art of observing, and the science of reducing the observations, have undergone corresponding improvements. The probable errors are consequently now confined within much narrower limits, and the consequence is, that astronomers are enabled to recognise and measure minute changes in the places of stars which formerly eluded observation. It is to this extreme practical accuracy that we are indebted for the present perfection of the planetary theories, and that astronomers look for the solution of many problems still beyond their reach; such

as the parallaxes and proper motions of the stars, and their systematic connexion with one another and with our own sun. Already the point in the heavens towards which the sun, with all his planets, appears to be moving, has been indicated with considerable probability; and a German astronomer (Mädler) has ventured to assign a star in the Pleiades as the centre about which not only the sun, but the whole stratum of stars among which it is placed, is revolving.

The measurement of two additional arcs of the terrestrial meridian in India by Colonel Everest, under the auspices of the East India Company, is a work of sufficient importance, in an astronomical point of view, to deserve notice in this rapid retrospect. Under the term *Degree of Latitude*, in the *Dictionary*, a short reference has been made to the principal geodetical operations for determining the magnitude and form of our globe,— an element of great importance in physical astronomy, and by which the magnitudes of all the planets are estimated, — and among these operations some which had been effected in India occupied a prominent place. With instruments of a much superior kind to any which had previously been used in that country, and with all the appliances of modern science, Colonel Everest has added two arcs of meridian to the former measurements, one of 6° 3′ 56″, and the other of 5° 23′ 37″; which, taken in connexion with Lambton's operations, gives a continuous meridianal arc of 21° 21′ 13″, extending from Cape Comorin to the foot of the Himalayas. The details of the measurement were published in 1847. It may also be noticed, that the trigonometrical measurement of the British arc, of 10° 7′ 55″, from Dunnose, in the Isle of Wight, to Balta, in Shetland, is understood to be completed, and, it may be hoped, the details will shortly be given to the public. For the purpose of verification, a new base was measured in 1849, on Salisbury Plain, with the same apparatus as was used in measuring the Irish base; and it may be presumed, that all the distances will be given in terms of this new measurement, the results being much more trustworthy than those which were obtained by the older methods. Another interesting operation of the same kind, extending to about 4½°, and including a repetition of Lacaille's arc, has been completed at the Cape of Good Hope, but the results are not yet published.

Physical astronomy has now been carried to a state of such perfection, and the disturbing forces resulting from the reciprocal attractions of the different planets on each other so completely represented by mathematical formulæ, that the improvements which remain to be made must consist chiefly in giving greater accuracy to the numerical coefficients, which depend on data furnished by observation. For this purpose, the most important work which has been executed in recent times is the reduction of the planetary and lunar observations made at Greenwich, from 1750 to 1830, under the superintendence of the Astronomer Royal; a work of immense labour and utility, which puts the theoretical astronomer in possession of the results, in their most available shape, for perfecting the elements of the solar system, by means of the longest, and probably the most accurate, series of continuous observations which the world can furnish.

ATA′CAMITE. The native muriate of copper of the desert of Atacama in South America.

ATHAMA′NTINE. A crystallisable substance contained in the root of the *Athamanta oreoselinum*.

ATHA′NOR. A term applied by the alchemists to a furnace so constructed as to supply itself with fuel.

ATHE′RMANOUS. (Gr. α, *priv.* and θερμος, *heat.*) Transparent or translucent substances which resist the passage of radiant heat.

ATMOSPHE′RIC TIDES. Diurnal oscillations of the atmosphere, produced by the attractions of the sun and moon, and similar to the tides of the ocean. The attractions of the sun and moon tend continually to cause a variation in the figure of the atmosphere relatively to the meridian of any place, and consequently to produce a change in the amount of barometric pressure; but the change is so small in comparison to those produced by many of the other causes which disturb the equilibrium of the atmosphere, that a long series of accurate observations is necessary to render it sensible, even within the tropics where the influence of solar and lunar attraction is greatest, and the other causes of atmospheric disturbance act with least effect. In the *Philosophical Transactions* for 1847, Colonel Sabine gives an account of a series of observations of the barometer made at St. Helena, *hourly*, during a period of three years, for the purpose of determining the moon's influence. The result of the first year's observations, which were reduced at St. Helena, showed an average excess of barometric pressure of ·0014 parts of an inch at the hour when the moon is on the meridian (above or below the pole), and an average defect of ·00115 when six hours distant from the meridian, making together an average difference of ·00255 in. when the moon is on the meridian, and when 90° from it. The observations of the other two years were reduced at Woolwich, under the superintendence of Colonel Sabine, and the result was still more decided, the average difference exceeding ·00365 in., or nearly four-thousandths of an inch. These differences are, no doubt, exceedingly minute; but as the observations were made with great care, and on being broken up into periods of six months were still found to give consistent results, it may be reasonably presumed that they represent with considerable accuracy the amount of the lunar influence on the atmosphere. The effect of the sun's attraction being not only much smaller than that of the moon, but also masked in the diurnal barometric oscillation by the much greater and variable influence of the solar heat, probably cannot be satisfactorily determined.

ATOLL, or LAGOON ISLAND. In Physical Geography, the name given to a particular kind of coral island. The Atoll consists of a chaplet or ring of coral, enclosing a lagoon or portion of the ocean in its centre. The average breadth of the part of the ring which rises above the surface of the sea is nearly a quarter of a mile, and it seldom rises higher than from six to ten or twelve feet above the surface. On the outer side the ring gradually shelves down to the distance of 100 or 200 yards from its edge, so that the sea deepens to about 25 fathoms, beyond which the sides plunge almost perpendicularly into the unfathomable depths of the ocean. On the lagoon side, where the water is calm, the bounding ring or reef shelves into it by a succession of ledges, also of living coral, but of a different species from those which build the exterior wall, and the foundation of the whole ring. The size varies from two to ninety miles in diameter. The lagoon islands are widely spread, but chiefly in the Pacific Ocean. Most frequently they occur in elongated archipelagos, extending in groups over a large surface; the Carolina Islands, for example, extend to 1000 miles. Sometimes the lagoons have islands within them: Otaheite, the largest of the Society group, is a remarkable instance of this formation. The lagoon which encompasses it is thirty fathoms deep, and hemmed in from the ocean by a coral band of the usual kind, at a distance varying from half a mile to three miles. (*Somerville's Physical Geography*.)

AU′GITE. (Gr. αυγη, *splendor*.) A crystalline mineral common in volcanic and basaltic rocks. It is the *pyroxene* of Hauy.

AU′RIC ACID. (Lat. aurum, *gold*.) A term now frequently applied by chemists to the *peroxide of gold*.

AU′RIPIGME′NTUM. (Lat.) Yellow sulphuret of arsenic.

AU′ROCYA′NIDES. Compounds of the cyanide of gold with basic oxides. The aurocyanide of potassium is used in the art of electro-gilding.

AUTO′MALITE. (Gr. αυτομαλος, *a deserter*.) Named from the presence of zinc in a mineral not resembling a metallic ore.) A crystalline mineral consisting chiefly of oxide of zinc and alumina. It is the zinc-spinelle of some mineralogists.

AUTOMA′TIC. In Physiology, applied to those muscular actions which are not dependent on the will or other act of the mind: such are the successive contractions of the hollow viscera of organic life, *e. g.* the heart, the intestines, the ureters, urinary bladder, the uterus; the involuntary movements of respiration; the motions of the muscles of the eye during sleep; the persistent contraction of the sphincters.

AVA′NTURINE. (Deriv. unknown.) A beautifully iridescent variety of rock crystal.

AXIS-CYLINDER. In Anatomy, the name applied to the central substance of the primitive nerve-fibre.

A′ZOLI′TMINE. A dark red substance forming a great part of the colouring material of litmus: its chemical formula is, according to Kane, $C_{18} H_{10} O_8 N$.

AZOTI′SED PRINCIPLES. (Gr. α, *without*, and ζωη, *life*.) In Anatomy, the two chief classes of substances of animal bodies, — viz. the gelatinous and albuminous. In Chemistry, the term is chiefly applied to substances containing nitrogen, and used as aliments: many of them are common to animals and vegetables.

B.

BA′BLAH. An astringent dye-stuff imported from the East Indies and from Senegal: it has been used for dyeing drabs, as a substitute for more expensive materials. It is the shell of the fruit of the *Mimosa cineraria*.

BACK. A reservoir or cistern. The *liquor back* in a brewery is the water reservoir.

BAGA′SSE. (Fr.) The sugar-cane in its dry crushed state, as used for fuel in the colonial sugar-houses.

BALEE′N. (Fr. baleine.) The term in common use among whale fishers for whalebone.

BALSA. (Spanish.) A species of float or raft, chiefly used on the coasts of South America, for landing goods

through a heavy surf. The balsa is formed of two seal skins sewed up so as to form two large bags, which are covered with pitch to render them perfectly air-tight, and secured by ligatures. The bags or bladders thus prepared are inflated with air passed through a flexible tube, which is left of sufficient length to reach the mouth of the conductor, who is thus enabled to replenish them with air, should any have escaped. The two bags are fastened together at one end, which forms the prow of the vessel, the other ends being kept about four feet apart by means of a small plank; and the raft is completed with small sticks covered over with matting, having thus the shape of a wedge or triangle. It is propelled by a double-bladed paddle, and the conductor, on approaching the shore, contrives to keep the balsa on the top of the highest wave till it is thrown on the beach to the greatest extent the surf reaches, where it is immediately secured. The balsa will carry three passengers besides the person who conducts it, and by this means cargoes are landed from merchant vessels where the violence of the surf prevents ordinary boats from passing through it without great danger. Floats of a still ruder kind, usually formed of the hides of bullocks simply stretched on a frame, are used for crossing rivers in South America, and go by the name of balsa. (*Penny Magazine*, vol. iii. p. 150.)

BANDA'NNA. A style of calico-printing in which white spots are produced upon a red ground. The term is of Indian origin, and the art has been extensively adopted and improved upon in this country. (See a detailed account of Messrs. Monteith's manufactory at Glasgow, in Brande's *Quarterly Journal of Science and the Arts*, June, 1823, and in Ure's *Dictionary of Arts*, &c.)

BARBA'DOES NUTS. The fruit of the *Jatropha Curcas*, a native of South America and Asia. They are sometimes called *physic nuts*, and are virulently purgative.

BARBA'DOES TAR. Petroleum. A bituminous liquid of the consistence of tar: it oozes from the soil along with water, from which it is skimmed off and preserved in earthen jars. By distillation it yields *naphtha*. It is used in medicine as an internal remedy in certain chronic pulmonary affections, in obstinate diseases of the skin, and against tape-worm. As an external agent it is sometimes applied to ill-conditioned ulcers, and to chilblains. These stimulating bituminous oils have been recommended as effectual in cholera: the dose is from 30 drops upwards.

BARM. The yeast which collects upon the surface of fermenting beer. The term is of Welsh origin.

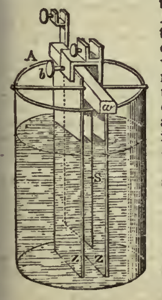
BA'ROSE'LENITE. A mineralogical name applied to *sulphate of baryta*, or heavy spar.

BASTARD SUGAR. *Bastards* is a term applied by the sugar refiners to an impure sugar chiefly produced by the action of heat and various substances used in the refining, and which cannot be remuneratively purified. They are also called *pieces*.

BAT'TERY, ELECTRICAL. A series of Leyden jars so arranged that they may all be discharged at once. *See* ELECTRICITY, in DICT.

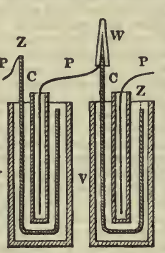
BATTERY, GALVANIC. Several forms of this apparatus have already been described (*see* VOLTAIC ELECTRICITY); many others have lately been invented, two of which, namely, SMEE'S BATTERY, and GROVE'S BATTERY, deserve particular notice. In Smee's battery, of which a detailed description will be found in his *Elements of Electro-metallurgy*, the positive or generating plates are composed of amalgamated zinc, and the negative plates of platinised silver, which, on account of its rough surface, favours the escape of the hydrogen gas evolved upon it, the adhesion of which to platinum or silver in their ordinary state is a serious impediment to the action of the battery.

One form of Smee's battery "consists of a piece of silver S, on the top of which is fixed a beam of wood *w* to prevent contact with the silver. A binding screw is soldered on to the silver to connect it to any required object. A strip of zinc Z, varying, at the fancy of the operator, from one half to the entire width of the silver, is placed on each side of the wood, and both are held in their place by a binding-screw *b*, sufficiently wide to embrace the zincs and wood. These batteries vary from the size of a tumbler to a ten or twelve gallon vessel."



A single cell of this battery is represented in the annexed cut. A is an earthenware or glass vessel containing dilute sulphuric acid (composed of 1 part of oil of vitriol to 6 or 7 of water). *w* is a bar of wood to which the platinum, or platinised silver plate is attached. Z Z are two plates of amalgamated zinc, connected and secured to the bar by a binding screw; and a separate binding screw is soldered to the platinised plate; these are for the convenience of making connections by wires. When a series of these cells are required they are connected together in the usual way.

Grove's battery, called also *the nitric acid battery*, is an extremely valuable instrument both to the lecturer and experimentalist; it combines great power both of quantity and intensity; it is free from the inconveniences of local action, and, therefore, so far, a *constant battery*; it occupies little space, and is upon the whole more economical than any other form of battery possessing the same advantages. The sections of two cells of this battery are represented in the annexed cut. The outer vessel V is a flat cell of glazed porcelain, containing within it another similarly shaped, but smaller and thinner cell C, of *porous* earthenware. A flat plate of amalgamated zinc Z is bent so as to receive the porous cell; a plate of thick platinum foil P being contained within the latter cell, and long enough to extend to the projecting end of the zinc plate of the next cell, perfect contact being there preserved by the cleft piece of wood W. The inner porous cell is charged with strong nitric acid; the outer porcelain cell is filled with a mixture of 1 part of oil of vitriol and 6 of water. The zinc being amalgamated, there is in this apparatus, as in Daniell's, and Smee's, no chemical action till the electrical current passes, and then the evolved hydrogen is suppressed by the nitric acid, which it converts, by deoxydizement, into nitrous acid. Twenty of these cells form a very powerful combination. Many years ago Mr. Cooper proposed to substitute coke for platinum in these batteries, and a similar plan has been more recently adopted by Bunsen, but so much inconvenience has attended the use of this material that it has not been generally adopted.



BE'BEARINE. A bitter basic principle contained in the bebearu plant or *Greenheart* of British Guiana.

BEISTINGS, or *Colostrum*. The first milk yielded by the cow immediately upon the birth of the calf.

BELU'GA. The species of whale (*Delphinus leucas*, Pallas) which, from its colour, is commonly called by the whalers "white-fish." It is confined to northern latitudes.

BENGAL STRIPES. Cotton cloth woven with coloured stripes. Ginghams.

BENJAMIN. *See* BENZOIN, in DICT.

BENZO'LE. A compound of carbon and hydrogen, originally discovered by Faraday amongst the products of the destructive distillation of whale oil. The same compound was produced by Mitscherlich from *Benzoic acid*. It consists of 12 atoms of carbon, combined with 6 of hydrogen, its formula being $C_{12} H_6$. It has a peculiar aromatic odour: it boils at 176°, and concretes into a crystalline solid at 32°, a property which enables it to be separated from other hydrocarbons, which remain liquid at low temperatures. Benzole has lately acquired much interest from having been discovered by Mansfield (*Journal of the Chemical Society of London*) amongst the products of the distillation of coal tar: it promises to form a valuable article for the manufacture of varnishes, and as a source of light.

BERLIN BLUE. *See* PRUSSIAN BLUE.

BERM (Fr.) in Fortification, a narrow level space, two or three feet wide along the exterior slope of a parapet to prevent the mass of earth and other materials of which it is composed from falling into the ditch.

BERRIES OF AVIGNON. (*Graines d'Avignon.*) The fruit of the *Rhamnus infectorius*, generally known under the name of *Persian Berries*. They are grown in Provence, Languedoc, and Dauphiné, and another variety comes from Persia. They contain a peculiar principle which has been termed *Rhamnine*, and which acquires a yellow colour by exposure to air.

BEZO'AR MINERAL. Peroxide of antimony. It is also called *diaphoretic antimony*.

BICU'SPID. (Lat. bis, cuspis, *a point*.) In Anatomy, when a part has two cusps, or pointed portions, as the bicuspid valve between the left auricle and ventricle.

BIO'LOGY. (Gr. *βιος, life; λογος, discourse*.) A branch of statistics having for its object the determination of the average duration of human life from the comparison of recorded observations. The term, MORTALITY, or *doctrine of* MORTALITY, is more generally applied to the same inquiry.

BITTER APPLE. The fruit of the *Cucumis colocynthis*.

BLACK ASH. Impure carbonate of soda.

BLACK DROP. A preparation of opium, known also under the name of *Lancaster*, or *Quakers' black drops*. It is said to be a solution of opium in verjuice.

BLAS. A term applied by Van Helmont to certain supposed emanations of the heavenly bodies.

BLISTERED STEEL. *See* STEEL.

BLOCK MACHINERY. A system or assemblage of machines for manufacturing the shells and sheaves of blocks required for ship tackle. The term is specially applied to the ingenious machinery invented by Sir M. I. Brunel, and set up in the woodmills in the dockyard at Portsmouth between 1802 and 1808, and also at Chatham about 1807, for the supply of the royal navy. By these machines every operation connected with the construction of blocks, from the cutting up of the timber to the polishing of the iron pinion which the sheave turns, is performed with astonishing celerity and precision; and when it is known that a single ship of war of 74 guns requires about 1430 blocks for her equipment, the advantage and even the necessity of abridging the labour of construction by appropriate machinery will be understood. Although it would scarcely be possible, without entering into long details and the aid of drawings to give any idea of the peculiar mechanism employed, the principal operations may be easily indicated. In the first place the rough timber (which is generally elm) is squared by an upright saw; it is then cross cut into pieces of the proper length by a circular saw. These pieces are then brought under the *boring machine*, when one centre bit bores a hole for the centre pin of the sheave, and another bores another hole at right angles to the former at one extremity of the mortise (or two or more such holes are bored when the block is to hold two or more sheaves) to admit the first stroke of the chisel. The next operation is performed by the *mortising machine*, which consists of a set of cutting chisels attached to a moveable frame, and making from 100 to 130 perpendicular strokes in a minute, the block being placed on a carriage which at every ascent of the chisels advances forward a little until the proper length has been mortised out. The block is then removed from the mortising machine, and the four corners are taken off by a circular saw, after which it is placed under the *shaping machine*, when, by tens at a time, the proper curvature is given by means of a tool moving in a direction curved towards the line of the axis. Lastly, the *scoring machine* scoops out a groove round the longer diameter of the block to receive the hempen or iron strap which goes round the block, and by which it is suspended when in use, and the *shell* is thus completed. The *sheaves* of the block are made of lignum vitæ, a log of which wood is first cut into plates of the proper thickness by a circular saw. The plates are then carried to the *crown saw*, which at once bores the centre hole through which the pin is to pass, and gives an exact circular form. They are next brought to the *coaking machine*, for the purpose of having grooves cut in them, on both sides, for the insertion of the *coak* or bush, which is of gun metal and of a peculiar shape (to prevent them from turning in the sheaves) the section being bounded by three semicircles, the diameters of which form the sides of an equilateral triangle. This part of the machinery is exceedingly curious, and so accurately is the operation performed that the coaks are fixed in the sheaves by the tap of a hammer. The two coaks (one on each side of the sheave) are secured by copper rivets passing through them and the sheave—an operation also performed by the machine. The sheave is then completed by turning a groove round its periphery for the rope to run in, and by smoothing its sides, both operations being performed on the same lathe. The iron pin only now remains, and this is also turned and polished by engines for the purpose. The whole of the machinery is put in motion by straps passing over drumheads, and is driven by a single steam engine. It is found that by means of this machinery ten men can with ease finish in one year from 130,000 to 140,000 blocks of different sizes.

BLOWING MACHINES. Instruments for producing a current or blast of air, chiefly for the purpose of exciting the combustion of fuel, and producing a great heat. The common bellows is an instrument of this kind, but for certain processes of metallurgy, as in smelting and refining ores, the intermittent blast produced by the single bellows is prejudicial, and even in the double form of the machine, as used generally by blacksmiths, the defect is not altogether remedied. Various contrivances have been had recourse to for the purpose of producing a continuous and equable blast, though depending generally on the principle of forcing air into large cylinders or air-chests, by means of a force air-pump, and allowing it to escape by eduction pipes under a regulated pressure. For the regulation of the pressure the air may be forced into a vessel inverted in a reservoir of water; but as the air is chilled by its contact with the water, the water regulator is found to be objectionable for large blast furnaces, and a weight is employed. Machines on this principle, frequently on a large scale, are in use at every foundry and great engine manufactory; and they have this advantage, that a number of forges may be supplied from the same air-chest. (See Ure's *Dictionary of Arts, Manufactures, and Mines*, Art. *Metallurgy*.)

BLUE PILL. The *pilula hydrargyri* of the Pharmacopœia. It consists of mercury triturated with conserve of roses and the powder of liquorice root till the globules disappear, and a homogeneous bluish-grey pill-mass is obtained: it contains one-third of its weight of mercury.

BLUE STONE. *Blue vitriol.* Sulphate of copper.

BO'CCIUS LIGHT. A form of gas-burner invented by Boccius, in which two concentric metal cylinders are so placed over the flame, and within the usual lamp glass, as to modify the combustion and increase the proportion of light.

BOLO'GNA PHIALS. Small flasks or phials of unannealed glass which fly into pieces when their surface is scratched by a hard body, as by dropping into them a fragment of flint; whereas a bullet may be dropped into them without injury.

BONE BLACK. The black carbonaceous substance obtained by heating bones to redness in a retort or other close vessel. When deprived by the action of hydrochloric acid of the phosphate of lime with which it is blended, it yields one of the most valuable forms of *animal charcoal*, and is highly prized by chemists as a decolouring and deodorising material.

BORNEO CAMPHOR. The camphor of the *Driabalanops aromatica*, or camphor tree of Sumatra.

BOUGIE. (French.) A slender flexible tube, intended for introduction into the urethra, œsophagus, or rectum, when those passages are obstructed by stricture or other disease.

BOULDERS. In geology, detached masses or fragments of rocks detached from their native locality, and scattered about upon the actual surface of the earth. They are also called "erratics" and "greyheads."

BOXINGS. A term applied by millers to an inferior or second flour.

BOYLE'S FUMING LIQUOR. This term was applied to the *hydrosulphuret of ammonia*, originally obtained by distilling a mixture of sulphur, sal ammoniac, and quick lime. When recently prepared it exhales dense fumes on exposure to air.

BOYLE'S HELL. A piece of chemical apparatus contrived by Boyle, resembling a flattened flask with a very long neck. It was principally used for the preparation of oxide of mercury (*precipitatum per se*).

BRAZING. The soldering of metals with an alloy of brass and zinc, to which small portions of tin are occasionally added.

BREAST-WHEEL. In hydraulics, the name given to a water-wheel so placed as to be struck by the stream of water nearly on a level with the axle, the lower quadrant of the circumference on the side opposed to the stream being placed in a *race* or channel concentric with the wheel, through which the water is conducted in its descent from the higher to the lower level, and in falling on the float boards within the channel acts both by its momentum and weight.

BRIGHT'S DISEASE. A morbid condition of the kidney, occasioning the secretion of urine loaded with albumen: the disease has hence been termed *Albuminuria:* it was originally described by Dr. Richard Bright.

BRITANNIA METAL. An alloy of tin with a little copper and antimony, used for tea-pots and similar purposes.

BRONZE POWDER. Copper or brass reduced to the state of a fine powder.

BRONZING LIQUID. A solution containing chloride of antimony and sulphate of copper, used for bronzing iron gun-barrels. Brass is sometimes bronzed by washing it over with a solution of chloride of platinum.

BRUNNER'S GLANDS. These glands, so called after their discoverer, are minutely lobulated bodies, situated beneath the mucous membrane in the submucous tissue of the duodenum: they are provided with permanent gland-ducts, which pass through the mucous membrane and open on the internal surface of that intestine. They resemble the pancreas in intimate structure.

BRYO'ZOA. (Gr. *βρυον, moss; ζωον, animal.*) An order of compound polypes, including the *Flustra* or sea-mat, which encrusts foreign bodies like moss. The organisation of the individual polypes resembles that of the Ascidian molluscs.

BUDE LIGHT. This term has been applied to various forms of oil and gas burners contrived by Mr. Gurney, of Bude, in Cornwall. The original proposal was to maintain the combustion by means of a supply of

oxygen gas to the burner, by which, with oil, or naphthalised gas, an intense light may be commanded, but at an inconvenience and expenditure quite incompatible with its economical adoption. Large gas burners with variously formed reflectors and refractors have since been erected in different parts of London under the name of *Bude Lights*, but they have nothing in common with the original proposal.

BUFF LEATHER. A leather prepared by imbuing the prepared skin with an aluminous compound, and afterwards some oily matter, such as yolk of egg.

BUFFERS. Elastic cushions attached to railway carriages for the purpose of breaking the shock when one carriage is pushed against another. They are usually formed of horsehair covered with leather; but may consist of strong iron springs, or of vulcanised caoutchouc.

BUFFY-COAT. When the coagulation of blood is retarded so as to allow the red particles to sink, and the lighter white corpuscles to rise towards the surface, the supernatant opaline plasma coagulates without the red particles, but includes the white ones, and forms a light-coloured clot of fibrine and white corpuscles resting upon the main body of the coagulum which has included the red corpuscles, and constitutes what is called the "buffy-coat." It is indicative of inflammatory disease, during which the coagulation of the blood is retarded beyond the ordinary time.

BULBUS ARTERIOSUS. In Embryology, the third cavity developed upon the primitive arterial trunk; the first being the auricle, the second the ventricle. The trunks of the aorta and pulmonary artery are developed out of the bulbus arteriosus in the warm-blooded vertebrata. In Comparative Anatomy the muscular basis of the branchial artery in fishes is so called, which may be regarded as a retention of the embryonic structure by arrested development.

BUMBE'LO. A glass flask or mattrass of flattened ovoid shape, in which camphor is sublimed.

BURSÆ MUCOSÆ. In Anatomy, synovial serous sacs, either subcutaneous or situated beneath tendons that glide over bones.

BUTY'RIC ACID. One of the fatty acids contained in butter: it is also formed in certain cases in which sugar undergoes fermentation in contact with curd, and hence termed *butyric fermentation*. This acid is a volatile, colourless, and very mobile liquid, of a pungent sour odour, resembling that of a mixture of acetic acid and rancid butter; its taste is first pungent and sour, then sweetish and ethereal. The chemical formula of this acid is $C_8 H_7 O_3 + H O$; that is, the anhydrous butyric acid consists of 8 atoms of carbon, 7 of hydrogen, and 3 of oxygen; which in the ordinary acid are combined with an atom of water: in the *butyrates* this atom of water is replaced by an atom of base.

C.

CA'CODYLE. *See* KAKODYLE.

CACO'THELINE. A substance formed by the action of nitric acid upon brucia.

CALO'RIFA'CIENT. (Lat. calor, *heat;* facio, *I make.*) The term is applied in Physiology to those non-azotised materials of food, in the form of fat, starch, sugar, gum, which are believed to be employed in the production of heat.

CA'LOTYPE, or KALOTYPE. (Gr. καλος, and τυπος.) A term applied to the photogenic drawings obtained by the action of light upon certain salts of silver. See PHOTOGRAPHY.

CA'LYX. In Anatomy, is applied to that branch of the pelvis of the kidney which receives the apex of the cone or bundle of the uriniferous tubules: in man there are several "calyces" in the kidney.

CAM or CAMB. In Machinery, a contrivance for converting a uniform rotatory motion into a varied rectilinear motion. The end of a rod which is free to move only in the direction of its length is held in contact, by the action of a spring, or weight, with the edge of an irregularly shaped mass which revolves uniformly upon an axis. A varied motion is thus communicated to the rod, which carries with it the machinery by which the motion is to be applied. This contrivance is much used in the machinery for lace-making. *See* ROSE ENGINE, in DICT.

CAM WOOD. The wood of *Baphia nitida:* the tree which yields it grows in Sierra Leone and the interior of Africa. It is used in dyeing instead of Brazil wood, and gives a finer and more durable red.

CANNA STARCH. The fecula of the *Canna coccinea*, sold in the shops under the name of *Tous les mois.* It is imported from St. Kitt's, and is a good substitute for arrow-root. Its granules are comparatively large, and form an excellent microscopic object.

CA'PRIC ACID. One of the volatile acids of butter obtained by saponifying it with soda, adding excess of sulphuric acid, and distilling: it passes over mixed with butyric acid, and with two other acids, namely, the *caproic* and the *caprylic* acid. Capric acid has a mixed odour of acetic acid and the smell of a goat. The odour of caproic acid is less goaty, and that of caprylic acid strongly resembles perspiration. A curious relation exists between the formulæ of these several acids, the carbon and hydrogen successively increasing by the addition of 4 equivalents, as shown in the following table:—

Butyric acid - -	$C_8\ H_7\ O_3$, HO
Caproic - - -	$C_{12}\ H_{11}\ O_3$, HO
Caprylic - - -	$C_{16}\ H_{15}\ O_3$, HO
Capric - - -	$C_{20}\ H_{19}\ O_3$, HO.

CA'PSICINE. An acrid soft resin found in the fruit or seed pods of the *Capsicum annuum;* it appears to be the acrid principle of Cayenne pepper.

CA'PSULAR LIGAMENTS. Those ligaments which surround moveable articulations, and retain the synovia, as in a bag.

CA'PSULE. (Dimin. of *Capsa*, a box or case.) In Anatomy, a membranous sac investing an organ; as the capsule of the liver, the spleen, &c.: those flask-shaped sacculi from which the uriniferous tubes commence are called "capsules of Malpighi:" they surround the capillary glomerules or plexuses, called "corpuscles of Malpighi."

CARAGHE'EN MOSS. The *Chondrus crispus:* called also Irish moss. It is very common on rocks and stones on the sea coast: it appears to contain a peculiar mucilage, which has been called *Caragenine.* It is a popular remedy for pulmonary complaints, and is sometimes used in soups and jellies.

CA'RAITES. A sect among the Jews who adhere closely to the text and letter of the Scriptures, rejecting the rabbinical interpretations and the Cabbala.

CA'RAMEL. *See* CAROMEL.

CA'RAPACE. The upper shield or plate of the armour or shell of the tortoise and crab.

CA'RBAMIDE. A compound of carbonic oxide and amidogen, contained, according to Regnault, in chlorocarbonate of ammonia: its chemical formula is CO, NH_2.

CARBO'LIC ACID. A substance obtained by the distillation of coal tar: it crystallises in prismatic needles, which fuse at 95° and boil at 270°: it has a penetrating odour and burning taste, and in many respects resembles kreasote: its specific gravity is 1·06. It appears to be identical with the substance called *hydrate of Phenyle.* Its formula is $C_{12}\ H_5\ O$, HO.

CARI'NTHINE. In Mineralogy, a sub-species of *Augite* from Carinthia.

CARMI'NIC ACID. This, according to De la Rue, is the colouring principle of *cochineal.* Its formula is $C_{28}\ H_{14}\ O_6$. When in powder it is of a brilliant crimson. It appears to be the substance described by Pelletier and by Preisser under the names *Coccinelline* and *Carmeine.*

CAROLI'TIC COLUMNS. Architecture. Columns with foliated shafts.

CA'ROTINE. A deep red crystallisable substance contained in carrots.

CARPO'LOGY. (Gr. καρπος, *fruit*, and λογος, *discourse.*) That branch of botany which treats of the structure of fruits.

CAR'PUS. In Anatomy, the segment of the skeleton of the upper or fore-limb, answering to the wrist: it consists of eight small bones in the human subject.

CA'RTHAMINE. The colouring matter of the *safflower.*

CA'RYOPHY'LLINE. (Gr. καρυα, *a walnut tree*, and φυλλον, *a leaf.*) A crystalline substance (called also *Clove camphor*) deposited by a strong alcoholic tincture of *Cloves.* In composition it resembles common camphor: $C_{10}\ H_8\ O$.

CA'SCALHO. The name given to the alluvial deposit in which the diamond is found in Brazil.

CASE HARDENING. The superficial conversion of iron into steel.

CA'SEINE. *See* CASEUM.

CASKET. A small rope used to fasten the sail to the rope in furling.

CASSELL YELLOW. A compound of oxide and chloride of lead: it is also known in commerce under the name of *patent yellow* and *Turner's yellow.*

CA'STOR OIL. The expressed oil of the seed of the *Ricinus communis*, or *Palma Christi.* It is a mild aperient.

CATA'LYSIS. (Gr. κατα, and λυω, *I dissolve.*) That process in which a substance excites by its mere presence (and without itself undergoing change) some chemical action in the substances with which it is in contact.

CATECHU'IC ACID. A substance in the form of white silky filaments contained in *Catechu.* Its formula is $C_{14}\ H_6\ O_6$. It has also been termed *Catechine* and *Tanningenic acid.*

CAT SILVER. A species of mica.

CAUDA EQUINA. (Lat.) In Anatomy, the roots of the terminal spinal nerves which are contained in the neural canal of the vertebræ, and surround the "filum terminale" of the myelon.

CAU'DATE. (Lat. cauda, *a tail.*) In *Anatomy*, when the apex of a pyramidal part or organ is prolonged into a long slender point: certain microscopic bodies found in ganglia are termed especially "caudate" nerve-corpuscles. In *Zoology*, an animal provided with a tail.

CAUK or CAWK. The term applied by miners to massive sulphate of baryta or heavy spar.

CAU'SALTY. A miner's term for the light parts of ores which are carried away by washing.

CAU'ZERANITE. A crystallised mineral found at Cauzeran in the Pyrenees, of a black or dark blue colour: it is a silicate of lime and alumina, with potassa and soda.

CAVA VENA. *See* VENA CAVA.

CA'VENDISH EXPERIMENT. An important mechanical experiment for the purpose of ascertaining the mean density of the earth; the method employed being a comparison of the force of terrestrial attraction with that of the attraction of leaden masses of known magnitude and density, determined by means of the balance of torsion.

The idea of rendering sensible and measuring the attractive force of a dense body upon another body in its immediate vicinity by means of the torsion balance, appears to have been suggested by the Rev. John Michell; but the experiment was first actually made by the celebrated Henry Cavendish, whose report is published in the *Philosophical Transactions* for 1798. It was subsequently repeated by Reich, Professor of Physics at Freiberg in Saxony, who published his results in 1838; and again by the late Francis Baily with far greater precision, and by a far more varied and extensive series of observations, the details of which are given in a paper of great value published in the *Memoirs of the Royal Astronomical Society*, vol. xiv. 1843.

In the mode of proceeding adopted by Cavendish, and followed by Baily, the data for determining the earth's mean density were obtained in the following manner:— A slender deal rod of six feet in length, having a leaden ball of about two inches in diameter attached to each of its ends, is suspended horizontally from a beam by a fine metallic wire, about 40 inches in length. This forms the torsion balance. Immediately under the balance is placed a strong horizontal plank about 8 feet in length, supported by and turning upon an axle, the central line of which is in the same vertical with the suspension wire. On this plank, near its extremities, are placed two equal spheres of lead (12 inches in diameter, and each weighing about 380lbs.), cast with great care, in order that the density may be uniform throughout the mass, and accurately turned. The apparatus is so arranged that the centres of the two balls at the extremities of the arm of the torsion balance, and the centres of the two leaden spheres, or *masses*, are in the same horizontal plane, and equally distant from the vertical axis of motion. Suppose now the torsion balance to be at rest in a certain direction, and the plank which supports the masses to be at right angles to the direction of the balance; in this position the attraction of the two masses will have no tendency to give motion to the balance. But let the beam be turned round till the two masses approach near to the balls, then the attraction of each mass, acting most powerfully on the nearest ball, tends to bring the masses and balls still closer together. A motion is thus given to the arm of the torsion balance, and in consequence of the elasticity of the suspension wire, the balance performs a series of isochronous oscillations, and ultimately comes to rest in a position in which the attraction of the two masses on the balls is exactly counterbalanced by the torsion of the wire.

The force developed by the leaden masses being exceedingly minute, not more than a 50-millionth part of their weight, a very small disturbing force will prevent the success of the experiment, and accordingly many precautions are requisite. In Baily's experiments the torsion rod was enclosed in a mahogany case, gilt in the inside, wrapt round with thick flannel, and covered over with gilt paper, to prevent the radiation of heat, and consequent derangement from the currents of air thereby produced. The balls were also gilt and burnished, and the whole apparatus was surrounded by a close wooden frame or case, having glazed openings, through which the motions of the torsion rod were observed by means of a telescope from a distant part of the room.

In order to deduce the mean density of the earth from the data furnished by the experiments, it is necessary to find expressions for the torsion developed in the wire, and for the attractive force of the masses on the balls, in that position of the arm of the balance at which it comes to rest under the action of the two forces, which th counterbalance each other. The theory is as follows.

Let F denote the force (measured by the weight grains) which, being applied horizontally and perpe dicularly to the arm of the balance at the unit of distan (one inch) from the suspension wire, causes the arm pass through a unit of angular space, or describe an a equal to the radius. Also, let F′ denote the torsi actually developed by the attraction of the masses, the distance of the suspension wire from the centre the ball, and θ the angle of deviation of the arm fro its first position. By the nature of the lever, the for required to produce a given effect is inversely as t distance of its point of application from the fulcru which is here the suspension wire; and according to t law determined by Coulomb, the force of torsion is rectly proportional to the angle of torsion; therefore

$$F' = F\frac{\theta}{a}.$$

The measure of this force F′ is deduced from the tir in which the oscillations of the balance are perform The general formula (see TORSION, in DICT.) for t torsion force is,

$$F = \frac{\pi^2}{n^2} \times \text{moment of inertia},$$

where $\pi = 3{\cdot}14159$, and n is the number of seconds in t time of an oscillation. In the present case the whole the matter in each ball may be regarded as accumulat at its centre, and the matter in the rod may be neglecte hence in respect of each ball the moment of inertia expressed by the mass (m) multiplied into the square the distance of its centre (a) from the suspension wi that is, by a^2m, consequently the inertia in respect both balls is $2a^2m$, and the above formula becomes

$$F = \frac{2\pi^2}{n^2} a^2 m.$$

Let w denote the weight in grains of each ball, g t accelerating force of gravity, and l the length of t seconds' pendulum; then $w = gm$, and $g = \pi^2 l$, whence substitution $F = \frac{2a^2w}{ln^2}$, and consequently, since $F' = F\frac{\theta}{a}$

$$F' = \frac{2aw\theta}{ln^2}.$$

Having obtained an expression for the torsion for we have next to find the force of the attraction of t leaden masses. In respect of each mass let g' denote t force of attraction, r the radius, v the volume, and d t density; and in respect of the earth (assumed to be sphere) let the same elements be respectively denot by g, R, V, and D; also, let k denote the distance of t centre of the mass from the centre of the ball at t middle of the oscillation, and assume f to be the c efficient of gravity. Now, because the attraction o sphere on a point without it is directly as its mass, that as its volume multiplied into its density, and invers as the square of the distance of the attracted point fr its centre, we have $g' = \frac{fvd}{k^2}$, and $g = \frac{fVD}{R^2}$; when $\frac{g'}{g} = \frac{vdR^2}{VDk^2}$. But $\frac{v}{V} = \frac{r^3}{R^3}$, therefore $\frac{g'}{g} = \frac{r^3d}{RDk^2}$; con quently, since the attraction of the earth upon the b is the same thing as the weight of the ball, or $g = w$, have $g' = \frac{r^3dw}{RDk^2}$, and therefore

$$\text{attraction of both masses} = \frac{2r^3dw}{RDk^2}.$$

By the conditions of the problem this attraction equal to, or balances, the torsion force F′; therefo putting the two expressions equal to each other, we ha $\frac{a\theta}{ln^2} = \frac{r^3d}{RDk^2}$; whence, finally,

$$D = \frac{r^3ld}{aRk^2} \cdot \frac{n^2}{\theta}.$$

In this expression for D, the mean density of earth, all the quantities are supposed known excepti n and θ, and the object of the experiment is to determ their values. The angle θ is determined by observi the number of divisions, on a known scale, passed over an index or pointer attached to the extremity of the a of the balance, so that if β denote the value of one divis of the scale in parts of an inch, λ the distance in inc between the suspension wire and the extremity of index, and h the number of divisions passed over by index when the arm of the balance moves from its sition of rest *before* the mass is approximated to ball, to its position of rest *after* the approximation, t $\theta = \frac{h\beta}{\lambda}$.

Cavendish gives the numerical values of the consta which enter into the expression for D as follows: r= $l = 39{\cdot}14$, $a = 36{\cdot}65$, $k = 8{\cdot}85$, $R = 250800000$, all in inch

and d (the density of the leaden mass as compared with water)=10·64. He also had $\beta=\frac{1}{20}$, $\lambda=38{\cdot}3$, whence $\theta=1\div766$; and the substitution of these numbers in the formula gives $D=\frac{n^2}{10683h}$. There are, however, several corrections to be made, on account of the attraction of the matter in the plank and mahogany case, and other parts of the apparatus, as also for the inertia of the arm of the balance, and for the variation of the masses on the balls according to the position of the arm, for the details of which we must refer to the memoir of Baily already cited. It may be noticed that the motion of the arm is very slow, the average time of a complete vibration in Cavendish's experiments having been from six to seven minutes.

The result obtained by Cavendish gave the mean density of the earth, as deduced from 17 sets of experiments, equal to 5·45, that of water being unity. Reich, from 57 experiments, found it to be 5·44. Baily's experiments were far more numerous and varied than those of his two predecessors. The torsion rod was suspended in different ways: by a single copper wire, as had been practised by Cavendish and Reich; and by double lines, as proposed by Gauss; and in the latter case the substances used were silk fibres, brass wire, and iron wire. In order to ascertain whether the results would be affected in any way by varying the substance of the attracted body, the experiment was made not only with leaden balls attached to the ends of the torsion balance, but also with balls of platina, zinc, glass, ivory, and hollow brass, and with a torsion rod of brass without balls. The actual number of experiments recorded in the memoir is no fewer than 2153; and nearly as many more, which had been made before the anomalies of the balance had been entirely got rid of, were rejected. The mean result from all the recorded experiments, without exception, gave the mean density of the earth equal to 5·675, with a probable error of ·0038.

CE'LANDINE, the poisonous irritant principle of the *Chelidonium majus*.

CELE'STINE. (Lat cœlum.) The blue variety of sulphate of strontia.

CELL. In Anatomy, a primary microscopic vesicle, of larger average size than the nucleus, composed of membranous cell-walls, with usually liquid contents, round or oval, and sometimes flattened like a scale. With a few exceptions—*e. g.* the mammalian blood discs and old cells of the epidermal or adipose systems — the primary cell contains a nucleus.

CENTRAL SUN. In sidereal astronomy, the name given to the body about which the sun, and all the stars in the great cluster or nebula to which the sun belongs, is assumed to be revolving. M. Mädler, of Dorpat, has recently published a paper under this title, in which he attempts to assign the real motions of the stars, and consequently the position of the central point, in reference to a dynamical theory. He thinks there is no reason for supposing that there exists anywhere a star of such magnitude as to dominate the motions of others as the sun does the motions of the planets; but if we suppose the stars of our stellar cluster to be pretty uniformly distributed, and the form of the limit of the cluster to be nearly spherical, or a surface compressed between two planes, as is supposed to be the case of the milky way, then, whatever the law of attraction may be, the stars near the centre will move with much smaller linear velocity than the distant one; and this difference of real velocity will give rise to apparent motions by comparison of which the relative distances from the centre may be assigned. Applying these considerations to the apparent motions actually observed, and assuming the direction of the sun's motion in the heavens to be that which has been determined by Argelander and others, Mädler shows that a point somewhere in the group of the Pleiades, and probably not far from the star *η Tauri*, possesses the characteristics of the central point. Having thus obtained, approximately, the position of the central body, Mädler proceeds to discuss its probable distance from our sun, and the velocity of the sun's orbital motion about the centre. Assuming the star 61 *Cygni* to be at the same distance from the central body as the sun is, and the distance of 61 *Cygni* from the sun to be known from the parallax found by Bessel, he finds from these assumptions, and from the observed proper motions of 61 *Cygni* and *η Tauri*, that the parallax of *η Tauri* is 0′′·0061, or that its distance is thirty-four millions of times as great as the distance of the earth from the sun. The proper motion of *η Tauri* gives for the periodic time of our sun round the centre 18,200,000 years; and the velocity of our sun in its orbit round the central sun is about thirty English miles in a second of time. (*Monthly Notices of the Royal Astronomical Society*, vol. vii. No. 12. February, 1847.)

CERAU'NIA. (Gr. *κεραυνος*, *lightning*.) Thunderstones of the old mineralogists.

CERE'BRIC ACID. (Lat. cerebrum, *the brain.*) A fatty acid, containing nitrogen and phosphorus, forming one of the components of brain.

CE'RINE. (Lat. cera, *wax.*) A name given by some chemists to that portion of bees' wax which is soluble in boiling alcohol: the insoluble portion has been termed Myricine.

CE'ROSINE. (Lat. cera, *wax.*) A waxy substance which exudes from the sugar-cane.

CERVI'DÆ. *See* Deer, in Dict.

CHALCOLITE. (Gr. *χαλκος*, *copper*, and *λιθος*, *a stone.*) A green crystalline mineral found in several of the Cornish mines, and supposed to contain copper, till it was shown by R. Phillips to be a *hydrated phosphate of uranium.*

CHA'LILITE. A mineral found in the Donegore mountains in the county of Antrim. It is a hydrated silicate of alumina, lime, and oxide of iron: its name is derived from its *flinty* appearance — *χαλιξ*, *a flint.*

CHA'MOISITE. A mineral from Chamoisin in the Valais; it is of a dark greenish grey colour, and appears to be a hydrated silicate of protoxide of iron.

CHA'RTISTS, the name assumed by a certain political party in England, composed chiefly of the working classes, who have embodied their principles in a document called the "People's Charter," the leading points of which are universal suffrage, vote by ballot, annual parliaments, electoral districts, abolition of property qualification, and payment of members of parliament.

CHARY'BDIS. *See* Scylla, in Dict.

CHA'SCHISCH. The term applied by the Indians to the inspissated juice of the Cannabis sativa, or Indian hemp: it has been used as a substitute for opium. It is also known under the name of *Churrus*. It is a powerful narcotic poison.

CHE'LMSFORDITE. A crystallised greyish-white mineral composed of silicate of alumina and silicate of lime. It appears to have the same composition as Meionite and Scapolite.

CHEILO'GNATHA. (Gr. *χειλος*, *a lip; γναθος*, *a jaw.*) An order of myriapods or centipedes, of which the lower lip is formed by the tongue and two mandibles.

CHEILO'PODA. (Gr. *χειλος*, and *πους*, *a foot.*) A family of myriapods, in which a pair of feet form the lower lip.

CHEROPHY'LLA. The poisonous principle of the *Cherophyllum silvestre*, or Wild chervil.

CHIA'STOLITE. Hollow-spar. A mineral found imbedded in clay-slate: it occurs in the slate of Cumberland, and of Antrim in Ireland: in rhomboidal prisms, exteriorly greyish-white, and interiorly black. Some of the sections of the crystals have the form of an X, hence the term from *χιαζω*, to mark with that letter.

CHINA INK. A finely divided carbon, probably lamp-black of some kind, mixed with gelatine, and formed into cakes or sticks. It is sometimes stated to be the desiccated ink of the cuttle-fish.

CHINO'LEINE, or CHINO'ILINE. An oily liquid obtained by distilling quinine with caustic potassa.

CHINO'NE. A substance obtained by distilling certain salts containing kinic (cinchonic) acid, as for instance the kinate of lime, with oxide of manganese and sulphuric acid. Chinone sublimes in the form of golden-coloured crystals, soluble in water, very volatile, and of a very peculiar and distinctive odour. Their formula is said to be $C_{25}\ H_8\ O_8$.

CHI'TINE. (Gr. *χιτων*, *a coat of mail.*) The hard insoluble matter forming the shells and elytra of insects.

CHLORACE'TIC ACID. A crystalline acid obtained by the action of the solar rays upon a mixture of chlorine with the vapour of acetic acid. Its formula is $C_4\ Cl_3\ O_3$, $H\ O$; in it, therefore, the hydrogen of the acetic acid is replaced by chlorine.

CHLORHYDRIC ACID. *See* Hydrochloric.

CHLO'RIC ACID. A compound of 1 atom of chlorine with 5 of oxygen, represented therefore by the formula $Cl\ O_5$. Its most important salt is the chlorate of potassa, formerly called oxymuriate of potash.

CHLO'ROFORM. (Gr. *χλωρος*, *pale*, and Lat. formica, *an ant.*) A compound represented by the formula $C_2\ H\ Cl_3$, and obtained by distilling a mixture of chloride of lime with diluted alcohol. It is a heavy liquid, its sp. gr. being 1·48; it boils at 140°. Its name has reference to the constitution of *formic acid*, which is represented by $C_2\ H\ O_3$, and is therefore the teroxide of a hydrocarbon $= C_2\ H$, to which the term *formyle* has been applied; so that, in reference to this view of its composition, chloroform has also been denominated *terchloride* of formyle. When the vapour of pure chloroform is respired it soon induces insensibility, in the same way as ether vapour; and hence has been similarly used, in the performance of surgical operations and in child-birth. Much prudence and caution are requisite in its administration.

CHLORO'PAL. A mineral of a greenish yellow colour, associated with the opal of Hungary. It is a hydrated silicate of iron.

CHLO'ROUS POLE. The voltaic pole or electrode at which chlorine is evolved in cases of the electrolysis of chloric compounds.

CHOLE'IC and CHOLIC ACID. Choleic acid is a fatty acid, which, in combination with soda, constitutes a principal ingredient in *bile*. By the protracted action of caustic potassa it evolves ammonia, and is converted into *Cholic* acid. The elements of choleic acid are carbon, hydrogen, oxygen, nitrogen, and sulphur, the following being its formula: $C_{44}\ H_{40}\ O_9\ N\ S$.

CHO'NDRINE. (Gr. χονδρος, *cartilage.*) That form of gelatine which is obtained from cartilage, and which differs from ordinary gelatine in being precipitable by acetic and the mineral acids, and by sulphate of alumina and potash, persulphate of iron, and acetate of lead.

CHO'NDRODITE. (Gr. χονδρος, *a grain.*) A mineral found in Finland, and also in N. America. It is yellow, and of a vitreous fracture: it is a *fluosilicate of magnesia.*

CHO'RDA DORSALIS. *See* NOTOCHORD.

CHO'RDA TYMPANI. (Lat.) A branch of the facial nerve or portio dura, which crosses the tympanum, and supplies the lingualis and some other muscular fibres of the tongue.

CHOR'DÆ VOCA'LES. (Lat.) In Anatomy, are the ligaments which extend from the thyroid to the cricoid cartilages, and bound the glottis. They contain much elastic tissue, and can be made to vibrate under various degrees of tension by the action of the muscles upon the cartilaginous parts of the larynx to which they are attached: they are the proper organs of voice.

CHO'ROGRAPH. (Gr. χωρος, *a region;* γραφω, *I describe.*) The name given by the late Professor Wallace, of Edinburgh, to an instrument contrived by him for the mechanical construction of this geodetical problem, viz. "To determine the position of a station, having given the angles made by lines drawn from it to three other stations in the same plane, whose positions are known." The problem, which is important by reason of its frequent application in maritime surveying, was reduced by Professor Wallace to another very simple one, viz. "To construct two similar triangles on two given straight lines, having given their angles." The triangles may be constructed by any of the ordinary methods; but inasmuch as they are similar, the construction is much facilitated in practice by means of the *chorograph*, a particular kind of protractor, having two moveable indices or arms. "The circle from which the two arms project is of brass, and is divided into 180 equal parts, each serving as the measure of an angle of two degrees at the centre, or one at the circumference. Each of the equal parts is subdivided into half degrees. [By means of a vernier the degrees are subdivided into single minutes.] The graduations on the scale are numbered quite round from 0 to 180° both ways. One of the three arms has a fixed position on the circle, and is placed against zero and 180°; the others turn on a common centre. There is a steel pin terminating in a point at the extremity of each arm, at equal distances from its centre, and perpendicular to its plane. By the graduated circle the moveable arms may be placed in such positions that lines joining the steel points at the extremities of the arms may form a triangle similar to any given triangle." (*Geometrical Theorems and Analytical Formulæ, &c.* By W. Wallace, L. L. D. Edinburgh, 1839.)

CHROMA'TIC THERMOMETER. When the edge of a rectangular plate of glass is applied to a piece of heated metal, or other substance having a temperature different from that of the glass, and exposed to a beam of polarized light, coloured fringes are developed; and as the particular tints depend on the difference between the temperature of the glass (which is supposed to be known) and that of the substance to which it is applied, the colour of the central fringe affords a means of inferring the temperature of the substance. Hence the term *Chromatic Thermometer*. The phenomena in question were discovered and first studied by Sir David Brewster.

CHROME-ALUM. The potassa-sulphate of chromium; a salt isomorphous with alum, in which alumina is replaced by oxide of chromium.

CHROME YELLOW. The yellow chromate of lead.

CHRO'MULE. (Gr. χρωμα, *colour.*) The green colouring matter of the leaves of plants; more commonly and properly termed chlorophylle.

CHRYSA'MMIC ACID. (Gr. χρυσος, *gold;* αμμος, *sand.*) A substance in the form of a brilliant golden-coloured powder, obtained by the action of nitric acid on aloes.

CHRY'SENE. (Gr χρυσος, *gold.*) One of the numerous products of the destructive distillation of woods.

CHRYSOLE'PIC ACID. (Gr. χρυσος, and λεπος, *a scale.*) A peculiar acid formed along with chrysammic acid by digesting aloes in nitric acid.

CHUCK. In Mechanics, the name given to that part of the turning-machine by which the *work* is connected with the lathe. There are various kinds of chucks, as the *screw*-chuck, the hollow-chuck, the drill chuck, &c., for ordinary turning; the excentric chuck, the geometric chuck, for ornamental turning.

CHYLE-CORPUSCLES. Cells developed in chyl of a subspherical form, greyish-white colour, abou $\frac{1}{2500}$ of an inch in diameter: often tuberculated on thei surfaces. When found in the blood they are calle "white corpuscles."

CHYMISTRY. *See* CHEMISTRY. Those who deriv the word from χυω, *I melt* or *dissolve*, adopt the forme mode of spelling.

CINCHO'NIC ACID, or *Kinic Acid.* An acid foun in combination with the alkaloids in the varieties o Peruvian Bark, or *Cinchona:* it is crystallisable, an represented by the formula $C_{14}\ H_{11}\ O_{11}$, H O.

CINNA'MIC ACID. When the essential oil of cin namon is exposed to air, it gradually absorbs oxyge and deposits crystals of cinnamic acid $= C_{18}\ H_7\ O_8$, H O It much resembles *benzoic acid*, into which it is con verted when mixed with bichromate of potassa and sul phuric acid. This acid is found, together with benzoi acid, in Peruvian and in Tolu balsam, from the latte of which it is readily obtained.

CIN'NAMYLE. The supposed *radical* of oil of cin namon and of cinnamic acid, and of which oil of cinna mon is the *hydruret*. The formula of Cinnamyle $C_{18}\ H_7\ O_2$, and that of oil of cinnamon, $C_{18}\ H_7\ O_2 + H$

CIRCI'NNUS. The Compasses: — a constellatio of four stars near the South Pole.

CIRCULATION OF THE BLOOD. *See* BLOOD

CIRROCU'MULUS. The *sonder cloud.* (Lat. cirru *a curled lock of hair*, and cumulus, *a heap.*) A cloud in termediate between the Cirrus and Cumulus. *Se* CLOUD.

CIRRO'STRATUS. (Lat. cirrus, and stratus, *a be or covering.*) The *wane cloud*, intermediate between th Cirrus and Stratus. The *mackereled sky* of a summe evening, which is regarded as foreboding rain, is a mod fication of this cloud. *See* CLOUD.

CIRRUS. The *curl-cloud*, or *mare's-tail.*

CITRACO'NIC ACID. One of the acids resultin from the action of heat on citric and on itaconic acid.

CITRI'BIC ACID, CITRICIC ACID, CITRIDI ACID. Acids derived from the *Citric acid*, and iden tical with the *Citraconic, Itaconic*, and *Aconitic* acids.

CI'TRINE OINTMENT. An ointment containin nitrate of mercury; it has a lemon yellow colour. Th *unguentum hydrargyri nitratis* of the Pharmacopœia.

CLEA'VAGE. In Mineralogy, the direction which the structure of a crystal enables it to be spli the resulting smooth surfaces are called *cleavage plane*

CLEA'VELANDITE. A variety of felspar: it h also been called *Albite.*

CLEDGE. A miner's term, applied to thin strata clay or fuller's earth.

CLEPSA'MMIA. (Gr. κλεπτω, *I hide*, and αμμ *sand.*) An antient instrument for measuring time by th running of sand, like the modern hour-glass.

CLEW LINES. CLEW GARNETS. Tackle which the sails of a ship are trussed up to the yard.

CLI'CHY WHITE. A pure carbonate of lead, white-lead, manufactured at Clichy in France.

CLOT. In Physiology, the coagulum of blood.

CLU'TCHES, or GLANDS. In machinery, couplin which have no coupling boxes are denominated *clutch* or *glands*. A coupling of this kind consists of tw crosses, one fixed to the end of each of the shafts to b connected. One of the crosses, having its end bent fo ward, lays hold of, or *clutches*, the other, and by doi so turns round the other shaft. Instead of cross piec two round cast-iron plates are sometimes used, ea having a part cut out, and a corresponding projectio The projection of the one plate is inserted in the ope ing of the other, and thus serves to engage the shaf (*Buchanan on Mill Work.*)

COA'GULUM. (Lat.) The part of the blood whi changes from the fluid to the solid state, when dra from the body and left at rest, or subjected to heat certain chemical reagents. It consists of the fibri with the blood-discs.

COA'GULABLE LYMPH. A term given in so surgical works to the fibrine of the blood, which is t only part that has the power of spontaneously coagulati

CO'CHLEA. (Lat. *shell.*) In Anatomy, a port of the internal ear, which in mammals is shaped like t common snail-shell, with its base resting on the bott of the internal meatus, and perforated to receive so filaments of the acoustic nerve. It is traversed by a co cal column, called "modiolus," around which a "spi canal" makes two turns and a half. This canal divided into two ramps or "scalæ," by a partition of b called the "lamina spiralis." At the base of the coch one scala communicates with the vestibule, the oth with the tympanum; they communicate with each ot at the apex of the cochlea.

COCI′NIC ACID. When the solid fatty matter of cocoa-nut oil is saponified, the crystalline fatty acid into which it is converted has been called *cocinic* or *cocostearic* acid.

COCOA. The fruit of the *Theobroma Cacao*, which is about the size of a kidney-bean, and inclosed in a thin shell.

COD LIVER OIL. This oil, expressed from the liver of the cod-fish, has lately acquired much reputation for its remedial powers. It has been used in the dose of a table-spoonful three or four times a day, in pulmonary phthisis, in various scrofulous affections, in chronic gout and rheumatism, and in some obstinate skin diseases. It is supposed to contain iodine or bromine, to which its efficacy has been ascribed: but, on the other hand, it is asserted that it cures those forms of scrofula and other diseases which do not yield to the usual forms of iodine.

COGS. In mill work the term *cogs* is given to the teeth of wheels when they are not of the same piece with the body of the wheel, but are each of a particular piece.

COIN WEIGHING MACHINE. A machine for this purpose was constructed by Mr. Napier for the Bank of England in 1844, and has since been more extensively applied at the Mint.

It consists of a square brass box, on the top of which is placed a hopper to hold the sovereigns to be weighed, and in front of it are two small apertures fitted with receivers, one for the sovereigns of full weight, and the other for light sovereigns. The balance for weighing the sovereigns is placed inside the box near the upper plate vibrating upon a knife edge, and receiving the sovereigns upon a small platform at one end of the beam and above it. The platform is kept in its place by means of a small pendulum, on which, at about an inch below the platform, there is an oblong perforation, about half an inch in length, technically called a *slot*, in which a small ivory rod works freely up and down, without touching the sides.

Between the slot and the platform a pair of forceps is placed. From a knife-edge at the other end of the beam a small round polished plate is suspended, to which a pendulum is fixed, and at its lower part the scale is placed to receive the weight. Above the small round plate, under the top of the box, is fixed an agate with a blunt point. When the machine is in motion the small ivory rod is depressed; this, on touching the bottom of the slot, or opening in the pendulum in which it works, brings down the beam on that side, and raises it of course on the other, the weight side, until the small round plate on that side touches the agate point. The beam is then in a horizontal position. As soon as this is effected the forceps catch hold of the pendulum between the platform and the slot, and hold it firmly. The balance is then in a condition to receive the sovereign, which is shifted from the bottom of the pile in the hopper, and brought by means of a slide along a channel, just large enough for a sovereign of the proper standard gold to pass, but not large enough to admit a counterfeit, and deposited upon the platform. The forceps then let go their hold, the ivory rod is gently raised, and, if the sovereign happens to be light, that end of the beam rises, and the other end leaves the agate point; but, if the sovereign be of full weight, the beam remains stationary, and the small plate on the weight end is in contact with the agate point.

When the sovereign is weighed, the operation of its removal is very ingenious, and is as follows:—Two bolts are placed at right angles to each other, and on each side of the platform or scale there is a part cut away to admit of the bolts striking so far into the area of the platform as to remove anything that would nearly fill it. These bolts are made to strike at different elevations, the lower one striking (as to time) a little before the other. If the sovereign be of full weight the scale remains down, and the lower bolt knocks it off into the full-weight box. If the sovereign, on the other hand, be light, it rises up, and the first bolt strikes under and misses it, and the higher bolt then strikes and knocks it off into the light box. The machine weighs about thirty-three sovereigns in one minute. The weights used are of glass, and are adjusted to within the ten-thousandth part of a grain.

COLCHI′CIA. An alkaloid obtained from, and probably constituting the active principle of the *Colchicum autumnale*. It was formerly confounded with *Veratria*.

COLD-BLOODED. In Zoology, those animals are so called which have a range of temperature from a little above the freezing-point to 90° Fahr. and upwards, and which follow the changes of the surrounding medium through that range. Almost all invertebrate animals, and fishes and reptiles, amongst vertebrates, are "cold-blooded" in this sense.

COLISEUM. *See* AMPHITHEATRE.

COLLA′TERAL CIRCULATION. In Physiology, the passage of the blood from one part to another of the same system of vessels by collateral communicating channels: it is much more frequent in the veins than in the arteries.

COLLO′DION.* (Gr. κολλα, *glue*.) A term applied, in consequence of its adhesive properties, to a solution of gun-cotton in ether.

COLOBO′MA. (Gr. κολοβοω, *I contract*.) The adhesion of the eyelids. Congenital fissures of the upper eyelid.

COLOGNE EARTH. A deep brown pigment, or species of umber. It is supposed to be of vegetable origin.

COLUMN. In Anatomy, the term is applied to longitudinal portions or tracts of the myelon, of which there are three in each lateral moiety, called from their situation in the upright posture of man, "anterior," "middle," and "posterior," columns.

COLU′MNÆ CARNEÆ. (Lat.) In Anatomy, the fleshy prominences from the inner surface of the ventricles of the heart. Some are conical, with free apices giving attachment to the threads "chordæ tendineæ" attached to the valves; others extend from one part of the walls of the ventricle to another, and are sometimes called "trabeculæ."

COMBU′STION-HEAT. A term given by Liebig to the animal heat generated by the union of the oxygen absorbed into the blood from the atmosphere with the carbon and hydrogen taken into the system as food.

COMBUSTION, SPONTANEOUS. *See* IGNITION, in DICT.

COME′NIC ACID. When a solution of *meconic* acid in water, or in dilute sulphuric acid, is long boiled, or when dry meconic acid is heated to 400°, it is converted into a modified bibasic acid, water and carbonic acid being at the same time evolved. The formula of comenic acid is $C_{12}\ H_2\ O_8 + 2\ H\ O$.

COMMUNISM. *See* RIGHT OF PROPERTY and SAINT SIMONIANS, in DICT.

COMPASS OF THE VOICE. In Physiology is the number of notes of the musical scale comprehended in the voice of a singer: it usually extends from two to three octaves.

COMPENSATION PENDULUM. *See* PENDULUM.

COMPOST, vulgarly called COMPO. *See* CEMENT.

COMPLEMENTARY COLOURS. In Optics, two colours are said to be complementary to each other which are such that the blending together of the two gives rise to the perception of whiteness. According to the Newtonian theory, a beam of white light is resolved by the prism into rays of seven primary colours: if, therefore, the rays of one colour be intercepted, the composition of the remainder will give the complementary colour. Or, adopting the simpler supposition of Mayer, that all colours are produced by the mixture of three primitive colours—*red*, *yellow*, and *blue*—in certain proportions, then, on intercepting the red rays in a beam of white light, the remaining yellow and blue rays will give the colour arising from the mixture of yellow and blue, namely green, so that red and green are complementary colours. In like manner as a mixture of red and yellow gives orange, and a mixture of red and blue gives violet, orange is the colour complementary to blue, and violet to yellow. *See* CHROMATICS, in DICT.

CONDUCTION OF IMPRESSIONS. In Physiology, is the propagation of that state or action of a nerve-fibre, which is produced by the application of a stimulus, through the whole length of the fibre; it takes place with immeasurable rapidity, in the same way as electricity is said to be conducted along a wire.

CONSE′NSUAL MOVEMENTS. In Physiology, when one motion gives rise to the production of other motions contrary to or independent of the will, they are so called: as, e. g., the contraction of the iris when the eye is voluntarily directed inwards.

CONTRACTI′LITY. In Physiology, is the power which certain tissues have, during life, of shortening themselves in a peculiar manner: it is usually observed in muscular and some kinds of fibro-cellular tissue; but is also exercised by series of cells, as in the *Hydra* polype.

CONVOLU′TIONS. (Lat.) In Anatomy, the winding folds of the superficial layer of the brain; and also the coils and turns of the intestinal tube.

COPYRIGHT, INTERNATIONAL. A literary treaty of vital importance to the interests of authors, translators, composers, painters, sculptors, or engravers, was agreed to between France and England in 1851. The French enactment contains fourteen separate articles, and by the fourteenth it is stipulated that, after its legislative sanction by the British parliament, a day shall be fixed on which the following important privileges shall be granted to all works published subsequent to its date. The authors of literature or of art of either nation are to exercise the same rights with respect to their productions in the country in which they were not originally published as are granted to authors of similar works when first produced in that country. Authors of either nation will be entitled in both coun-

tries to the protection of the laws which are or may hereafter be in force in England or France for the suppression of piracy. Translators, under certain conditions, are to enjoy the same privileges as original authors. Nevertheless it is only in the case in which an author chooses to reserve to himself the exclusive right of translating his own original work that the law prohibits independent translations of the same work. To reserve to himself this exclusive right of translation for five years in either country, the author must have registered and deposited his original work within three months from the day of its publication in the other country; he must have declared in the title-page his intention of reserving this right; the translation must appear in part at least within three years from the date of the deposit, and when eventually published in either country must be legally registered.

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CO'RIUM. (Lat.) In Anatomy, is the basis of the skin, or "true skin," and consists of a vascular and fibro-cellular tissue, of interlaced dense, but elastic, filaments. It rests on the subcutaneous cellular tissue, and is covered by the cuticle or "scarf-skin."

CORPUS CALLO'SUM. (Lat.) In Anatomy, the great commissure, or band of transverse fibres, connecting the hemispheres of the cerebrum.

CORPUS LU'TEUM. (Lat.) In Anatomy, a yellowish mass which is formed in a Graafian vesicle subsequent to the escape of an ovum. It is largest, most conspicuous, and lasting, after the escape of an impregnated ovum in the human subject.

COU'PLING. In Machinery, this term is applied to any contrivance for connecting or disconnecting the different parts of a machine, and particularly for effecting the longitudinal connexion of shafts. *Hook's Joint* (Dict. of Science) is one of the most ingenious of the contrivances of this kind. (See Buchanan's *Practical Essays on Mill Work, &c., with Additions*, by Tredgold and Rennie.)

COU'NTERPOISE. In Mechanics, a mass of metal connected with an instrument or machine, either for the purpose of giving steadiness, or diminishing the pressure on some particular point, as, for example, the pressure of the pivots of a transit-instrument on its supports.

CRAB. A machine for raising weights, consisting of a horizontal barrel, usually turned by a winch handle, and having a rope wound round it, which, when the weight is to be raised to a greater height than the machine, passes over a pulley fixed on the scaffolding. *See* Windlass.

CRE'ATINE. *See* Kreatine.

CRE'NIC ACID, or KRENIC ACID. (Gr. *κρηνη, a fountain.*) A term applied by Berzelius to a species of extractive matter occurring in spring-water.

CRI'SPITE. A mineralogical name of the *titanite.*

CROCO'NIC ACID. (Gr. *κροκος, saffron.*) A yellow substance resulting from the action of potassium on carbonic oxide. It is difficulty soluble, and of a sour astringent taste. Its composition is $C_5\ O_4$, H O.

CRO'NSTEDITE. A hydrated silicate of iron from Pritzbram, in Bohemia. It was originally regarded as a species of tourmaline.

CROSS FLOOKANS. A name applied by the miners of Cornwall to veins of stony matter running North and South.

CROWN GLASS. The glass usually employed for windows: it differs from *flint glass* in containing no oxide of lead.

CRU'OR. (Lat.) In Anatomy, the substance contained in the red discs or corpuscles of the blood.

CRU'RA. (Lat. *crus*, the leg.) In Anatomy, are the bundles of nervous fibres which expand into the hemispheres of the cerebrum (crura cerebri), or of the cerebellum (crura cerebelli).

CUBE ORE. A hydrated arseniate of iron, crystallising in cubes.

CUBE SPAR. A synonym of the *anhydrite* or anhydrous sulphate of lime.

CU'BIZITE. A mineralogical synonym of the *cubic zeolite* or *analcime.*

CURVOGRAPH. *See* Arcograph.

CYCADEOI'DEA. A name given by Buckland to a genus of fossil dicotyledonous plants: the genus *Mantellia* of Brongniart.

CY'CADITES. A genus of dicotyledonous fossil plants.

CYCLOGRAPH. *See* Arcograph.

CY'PRINE. A variety of the green garnet, or *grossularia.*

CYSTINE. A term applied by some chemists to the *cystic oxide*, a constituent of certain urinary calculi.

CY'TISINE. A purgative bitter principle, extracted from the *Cytisus alpinus.*

CY'TOBLAST. (Gr. *κυω, I hold; βλαστη, a sprout or growth.*) In Physiology, the nucleus, cellule, or centre of assimilative force, from which the organic cell is developed.

CY'TOBLASTE'MA. (See above.) The structureless substance in which the elementary nuclei, cellules, or cytoblasts, are imbedded.

D.

DA'NAIDE. In *Hydronamics*, a machine put in motion by the power obtained from a fall of water applied in a particular manner. A cylindrical trough of tin-plate is fixed to a vertical axis of iron, which passes through the middle of a hole in the bottom of the cylinder, the diameter of the hole being somewhat greater than that of the axis, so as to allow the water to escape. A drum of tin-plate, close above and below, is also fixed upon the axis, and placed within the trough; its diameter being so much less than that of the trough that a clear cylindrical space of about an inch and a half in thickness is left between the outer circumference of the drum and the inner circumference of the trough; and the bottom of the drum is also about an inch and a half from the bottom of the trough. This space between the two bottoms is divided into compartments, by diaphragms radiating from the axis to the circumference of the drum. Into the space between the two cylinders water is made to fall from a reservoir above, through one or more pipes, the ends of which are bent into a horizontal direction, so that the water escapes in the direction of a tangent to a horizontal section of the cylinders, and, impinging on the interior surface of the trough, communicates a circular motion to the machine. The water between the cylinders thus acquires a centrifugal force, in consequence of which it presses against the interior surface of the trough and the diaphragms on the bottom; while, on the other hand, the action of gravity constantly tends to make it run out at the hole in the bottom. The moving power is measured by the weight of water escaping from the supply pipes multiplied into the height of the reservoir, and the useful effect by the same product diminished by half the force which the water retains when it issues from the hole in the bottom of the cylinder. (*Encyc. Brit.* art. *Hydrodynamics.*)

DA'TISCINE. A name given by Braconnot to a substance having the appearance of grape sugar, which he extracted from the *Datisca Cannabina.*

DAU'RITE. A variety of Tourmalin.

DA'VIDSONITE. A mineral discovered by Dr. Davidson in the granite quarry of Rubislaw, near Aberdeen: it is a *Silicate of Alumina.*

DECI'DUA. (Lat.) In Anatomy, a product or an alteration of the mucous membrane of the uterus, preparatory to the reception of the impregnated ovum, which is discharged at parturition. When the ovum enters the womb it becomes imbedded in the decidua, which yields and is protruded inwards, and becoming more and more inverted as the ovum grows, it is called the "decidua reflexa," while the other part of the membrane is called the "decidua vera."

DECLINO'METER. An apparatus for measuring the declination of the magnetic needle, or the force of terrestrial magnetism in the plane of the horizon. *See* Magnetometer.

DEGREES OF LATITUDE AND LONGITUDE. The most important operation executed of late years in connexion with the measurement of terrestrial degrees, of which the results have been published, is the prolongation of the great meridional arc of India, described by Colonel Everest in his Account of the Measurement of two Sections of the Meridional Arc of India, bounded by the parallels 18° 3′ 15″, 24° 7′ 11″, and 29° 30′ 48″, published in 1847. Of these two sections, the southern one, extending from Damargida to Kalianpur, had been previously measured, and the result is referred to under the article Degree (Dict. of Science); but on account of the state of the instruments the result was not considered as altogether satisfactory; and accordingly, when a new measuring apparatus and astronomical instruments of a better description had been provided for the purpose of extend

ing the arc to the northward, the Directors of the East India Company sanctioned the repetition of the whole operation. The northern section, from Kalianpur to Kaliana, embraces an arc of rather more than 5° 23′. Adding both sections to the arcs formerly measured by Colonel Lambton, the result is the "Great Meridional Arc of India," extending from Punnæ, near Cape Comorin (lat. 8° 9′ 31″) to Kaliana, near the base of the Himalayas (lat. 29° 30′ 48″), and including 21° 21′ 17″ of the meridian—the longest continuous line which has been measured on the surface of the earth.

Colonel Everest's measurement was executed with extraordinary care, and with instruments sufficient to ensure the utmost attainable accuracy. Three base lines, each exceeding seven miles in length, were measured with a compensating apparatus similar to that invented and used by General Colby for the measurement of the base of the trigonometrical survey of Ireland. The terrestrial angles were observed with theodolites of three feet in diameter, and the two celestial arcs were determined by observations of stars made simultaneously at both extremities of each arc with altitude and azimuth circles, having vertical circles also of three feet in diameter. The final results were as follows: the amplitude of the celestial arc corresponding to the northern section, Kaliana to Kalianpur, was found by the mean of all the observations to be 5° 23′ 37″·051; and that of the southern, Kalianpur to Damargida, 6° 3′ 55″·973. The terrestrial distances on the meridian, computed from the mean of the two bases (near the extremities of each section), and reduced to the level of the sea, were 1961157·117 feet, and 2202926·196 feet respectively. Hence the length of the meridional degree, as found from the northern section, is 363606 feet, or 68·865 miles, at the middle latitude 26° 49′, and as found from the southern section is 363187 feet, or 68·785 miles, at the mean latitude 21° 5′. The comparison of the two arcs, without reference to other measures, gives an ellipticity to the terrestrial spheroid of 1÷192, considerably greater than the ellipticity deduced from the results (properly combined) of all the principal operations of the same kind executed in different countries, namely 1÷300, and consequently indicating some irregularity either in the curvature of the earth at that locality, or in the density of the superficial strata, giving rise to local attraction at the terminal stations.

The long-protracted operations connected with the trigonometrical survey of the British Islands are now, it is understood, approaching completion, and one of the results will be the prolongation of the arc of meridian, which was measured about the beginning of the century between Dunnose in the Isle of Wight and Burleigh Moor in Yorkshire, to Balta in Shetland, the amplitude or difference of latitude of the extreme stations being 10° 7′ 55″·28. The astronomical observations made at the extreme and several intermediate stations were published in 1842; and as the principal triangles of the southern sections have been observed anew, and the distances have been computed from the base measured in Ireland, the result will be entirely independent of the previous work. A base of verification was measured on Salisbury Plain in the summer of 1849, and it is understood that the calculations are now completed and ready for publication.

Degrees of the meridian have now been measured under so many latitudes in the northern hemisphere that it is not probable the general elements of the terrestrial spheroid, as already determined, will be much disturbed by any future operations. The distance between the parallels of Kaliana, Col. Everest's northern station, and Formentera, the southern extremity of the French arc, is only about nine degrees; and with the exception of this interval, and another of about five and a half degrees between the parallels of the northern extremity of the Russian arc and the southern extremity of the Swedish, the whole distance (though in different meridians) has been measured between the parallels of Punnæ (lat. 8° 9′ 31″) and Pahtavara (lat. 67° 8′ 49″), being nearly two-thirds of the distance from the Equator to the Pole. In the southern hemisphere an arc of about four degrees has been recently measured by Mr. Maclear, near the Cape of Good Hope, the details of which have not yet been published; but the operation is of peculiar interest on account of the anomalous result obtained by Lacaille in the same locality about the middle of the last century, which led to the inference that the two hemispheres are dissimilar. Mr. Maclear has, however, made it known that the anomaly in Lacaille's result was caused by local attraction, and that the extended measure proves the length of the meridional degree at the Cape to be the same as in the northern hemisphere under the corresponding latitude.

In the year 1841 the astronomical arc of longitude between the Royal Observatory at Greenwich and the island of Valentia on the west coast of Ireland was determined by means of pocket chronometers carried forwards and backwards repeatedly between the two places (or rather between Greenwich and Kingston (Dublin) and Kingston and Valentia, the operation being divided into distinct parts), under the superintendence of the Astronomer Royal. The number of chronometers employed was thirty, and the number of journeys eight or ten. By this means the difference of apparent time was ascertained probably with greater certainty than could be done by the method of fire signals, hitherto chiefly relied on for this purpose, but scarcely available for so long an arc. The geodetical distance on the parallel of latitude being computed from data furnished by the trigonometrical survey and assumed elements of the earth's figure, and the result converted into time, it was found that the difference between the computed arc and the chronometrical arc amounted only to a small fraction of a second. The inference from this agreement is, that the assumed elements of the spheroid represent the curvature of the earth at this locality so accurately as to require no correction. As a definite result they give the length of 1″ in the arc perpendicular to the meridian in latitude 51° 40′ equal to 101·6499 feet.

The conveyance of local time from one place to another, by means of chronometers, has also been adopted for determining the differences of longitude between Greenwich and some of the principal observatories on the continent. A still better means is now becoming available, in the use of the electric telegraph, which has already been applied to this purpose in America, and by which instantaneous signals may be transmitted to any distance, however remote. The preparations are nearly completed for connecting Greenwich immediately with all the great continental observatories, by means of wires communicating with the terminus of the Dover railway.

The following elements of the spheroid of rotation, deduced by Bessel from the principal measures of meridional arcs, may be considered as representing, with the most probable accuracy, the present state of our knowledge on this subject:—

Equatorial radius 20923600·00 feet,
Half the polar axis 20853657·16 feet,
Ratio of equatorial to polar axis 299·1528 : 298·1528,
Ellipticity$=1\div299{\cdot}1528={\cdot}003342773$.

Let l denote the latitude, m the length in feet of a degree of the meridian between two parallels whose latitudes are respectively $l-\frac{1}{2}$ and $l+\frac{1}{2}$, and p the length of a degree of the parallel circle at latitude l; then

$$m=364575{\cdot}6-1831{\cdot}0 \cos. 2\,l+3{\cdot}9 \cos. 4\,l-\&c.$$
$$p=365491{\cdot}2 \cos. l-305{\cdot}8 \cos. 3\,l+0{\cdot}4 \cos. 5l-\&c.$$

from which formulæ the degrees of the meridian and parallel at any latitude are readily computed.

DELPHI′NIC ACID. A fat-acid obtained by saponification from the oil of the *Delphinus* or porpoise: it has also been termed *phocenic* acid. It exists in the vegetable kingdom in the berries of *Viburnum Opulus*.

DE′LPHINITE. A variety of *Epidote* from Dauphiny.

DE LUC'S COLUMN. An alternation of different substances, such as silver, zinc, and thin paper; which produce an electric arrangement. It is sometimes called the *dry pile*.

DE′NTINAL TUBES. (Lat. dens, *a tooth*.) The subparallel branching tubes which radiate from the pulp-cavity of a tooth at or nearly at right angles with the periphery of the dentine: they have a diameter of $\frac{1}{10000}$ th of an inch, at their origin, in the human teeth, and consequently admit only the plasma, or colourless liquor of the blood.

DE′NTINE. (Lat. dens, *a tooth*.) The fundamental and most constant substance or tissue of which a tooth is composed. It consists of an organised animal basis disposed in the form of extremely minute tubes and cells, and of earthy particles, which have a two-fold arrangement, being either blended with the animal matter of the interspaces and parietes of the tubes and cells, or contained in a minutely granular state in their cavities.

DEO′DORIZERS. A term applied to a class of disinfectants especially characterised by their power of destroying fetid effluvia: chlorine and several of its compounds come under this class: chloride of zinc and nitrate of lead, which are active in decomposing sulphuretted hydrogen, are also *deodorizers*. Some kinds of charcoal, and especially that obtained from peat, when mixed with manure or excrement, not only destroys the odour, but forms an excellent compost for agricultural purposes.

DEOXYDI′ZEMENT, or DEOXYDATION. The chemical process of the abstraction of oxygen: these terms are synonymous with *reduction*. A compound of a metal with oxygen may for instance in many cases be reduced or deoxydized by heating it with carbon, or in a stream of hydrogen gas, in which case it is subjected to the process of *deoxydation*, and the metal set free.

DE′SMINE. (Gr. δεσμη, *a bundle*.) A variety of foliated *Zeolite*.

DESMO'LOGY. (Gr. δεσμος, *a chain*, and λογος, *description*.) That part of anatomy which relates to tendons and ligaments.

DEVE'LOPMENT. In Physiology, is the process by which each tissue and organ of the body is formed, and subsequently transmuted, so as to be adapted to the actions of the most perfect state of the individual.

DEVO'NIAN SYSTEM. In geology, comprises the *Old Red Sandstone*. *See* GEOLOGY, in DICT.

DE'VONITE. A mineralogical synonym of the *Wavellite* or *Hydrargyllite* of Barnstaple in Devonshire.

DIALU'RIC ACID. A crystalline acid having the formula $C_8\ H_3\ O_7\ N_2, + HO$, obtained by the action of sulphuretted hydrogen on a boiling solution of alloxan.

DIAMAGNE'TIC. A term applied to bodies which appear to be *repelled* by either pole of a magnet; as opposed to the term *magnetic* bodies, the particles of which are *attracted* by either pole.

DIAPHORE'TIC ANTIMONY. In old pharmacy this term has been applied to the peroxide of antimony, and also to the antimoniate of potassa, obtained by deflagrating a mixture of antimony and nitre.

DIAPO'PHYSIS (Gr. δια, *through*; αποφυσις, *process*). In Anatomy, the upper of the two transverse processes which project from the sides of the cervical and anterior dorsal vertebræ of the crocodile, and which is usually anchylosed with a rudimental rib in the cervical vertebræ of birds and mammals; in these it forms the sole "transverse process" of the succeeding vertebræ, and is usually developed from the neural arch.

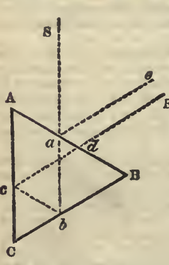
DIATO'NIC SCALE *of Colours*. Newton found, or supposed, that the spaces occupied by the seven primary colours in the solar spectrum are exactly proportional to the lengths of chords that sound the seven notes in the diatonic scale of music. On this assumption the spaces occupied by the different colours are as the intervals of the numbers $1, \frac{8}{9}, \frac{5}{6}, \frac{3}{4}, \frac{2}{3}, \frac{3}{5}, \frac{9}{16}, \frac{1}{2}$, which form the diatonic scale. It is now known, however, that the relative lengths of the spaces occupied by the different colours in the spectrum depend on the nature of the substance of which the refracting prism is formed. *See* CHROMATICS, in DICT.

DICTIOPHY'LLUM. A name given by Lindley and Hutton to a fossil leaf first described by Phillips, from the upper sandstone, shale, and coal of the Yorkshire oolite. The term *Dictiophyllum* is employed to designate all fossil leaves of a common reticulated structure, while the term *phyllite* is applied to leaves whose principal veins converge both at the base and apex.

DIE'DRAL or DIHE'DRAL. In *Geometry*, a diedral angle is the angle or corner formed by the intersection of two planes.

DIPLEI'DOSCOPE. (Lat. duplex, *double*, Gr. σκοπεω, *I view*.) An optical instrument for indicating the passage of the sun, or a star, over the meridian, by the coincidence of two images formed by a single and double reflexion.

The instrument is constructed as follows: A B, A C, and B C are three reflecting planes, one of which, A B, is transparent, and the other two of silvered glass, the three forming an equiangular prism. Suppose the side A C to be placed exactly in the plane of the meridian, and a pencil of light proceeding from the sun, S, to fall upon the transparent plane A B at *a*, in the direction S *a* parallel to A C. A portion of this light will be reflected from *a* in the direction *a e*, which is such that the angle *e a* B is equal to S *a* A. Another portion of it will pass through the transparent plane A B, and, proceeding in the same direction, will fall on the silvered mirror at *b*, where it will suffer a total reflexion in the direction *b c*, and, falling on the second silvered mirror at *c*, will be again reflected in the direction *c d*, and will pass through the transparent plane A B, and continue its course in the same direction *c d* E. Now, the angles of incidence and reflexion being equal, when S *a* is parallel to A C, then *b c* is parallel to A B, and *c d* to C B, and the direction *d* E to *a e*, so that an eye at E or *e* will see only a single image of the sun S. But if S *a* be not parallel to A C, then *d* E will not be parallel to *a e*, and a double image will appear. Suppose, for instance, the sun's course to be in the direction from A towards B; then, before the sun comes to the meridian, the pencil of light S *a* will make with A B an angle S *a* A less than 60°. Consequently, the reflected ray *a e* will make the angle *e a* B less than 60°. But in this case the angle E *d* B will be greater than 60°, and therefore two images will be seen by the eye at E, one in the direction *e a*, and the other in the direction E *d*. The first of these will appear to move with the sun in the direction A B, and the second in the opposite direction B A; they will approach each other until S *a* becomes exactly parallel to A C, when they will coincide; after this, as the angle S *a* A becomes greater than 60°, they will separate, and gradually pass off the field, one at B, and the other at A. Hence it is evident that if A C be in the plane of the meridian, the instant of the coincidence of the two images will be that of apparent noon.



When used as a meridian instrument, the dipleidoscope must be fixed so that one of the reflecting planes, A C, is exactly vertical, and also in the meridian. The latter adjustment may be made by any of the means which suffice for fixing a sun-dial, or for drawing a meridian line; the former, by suspending a fine plumb-line a few feet before the transparent glass, and moving the instrument slowly about the edge A C till the two images of the line become exactly parallel. These are the only essential adjustments; but it is convenient also to fix the instrument so that the lines of intersection of the three planes may be parallel to the axis of the earth's rotation, in order that the sun's greatest altitude above the plane of the instrument at midsummer may be equal to his greatest depression below it at midwinter. On account of the intense light of the sun, the eye must be protected by a coloured glass; and the field of view may be magnified by a small telescope. Three observations should be made; the first, of the instant at which the two images come into contact; the second, of the instant at which they exactly coincide; and the third, of the instant at which they separate. The instrument, if accurately made and fixed, is capable of giving true time within a fraction of a second.

The dipleidoscope is a patent instrument, the property of Mr. Dent, chronometer maker, of the Strand, who has published a popular description of it in a small pamphlet, in which he states that the idea was first suggested by Mr. Bloxam, but that the original form has been much improved and simplified. From its small size, and the facility of the observation, it may be conveniently employed for the regulation of time-keepers in circumstances under which recourse cannot be had to a transit instrument.

DI'STHENE. One of the varieties of *Cyanite*.

DITHIO'NIC ACID. (Gr. δις, *twice*, and θειον, *sulphur*.) Berzelius applies this term to the *hyposulphuric acid;* and he calls the hyposulphurous acid, *dithionous*. The term implies the existence of *two* atoms of sulphur in each of these acids.

DOBEREI'NER'S LAMP. A small instrument for obtaining instantaneous light, in which a jet of hydrogen gas is inflamed by coming into contact with spongy platinum.

DO'MITE. A white mineral found in the Puy de Dome, in Auvergne.

DRU'MMOND'S LIGHT. The name given to the light produced by directing a stream of oxygen gas passing through the flame of alcohol upon a small ball of quick lime. The light produced by burning lime in this manner is of extreme intensity, and Mr. Drummond, of the Engineers, while engaged in the trigonometrical survey of Ireland, suggested its use as a signal for the observation of distant stations. For this purpose the ball of lime, about a quarter of an inch in diameter, was placed in the focus of a parabolic mirror, the axis of which was directed to the point from which the observation was to be made; and such was the brilliancy of the light that it was sometimes distinctly seen, even in hazy weather, at a distance of upwards of sixty miles, when argand burners and other modes of illumination previously used were altogether ineffectual. But the use of this signal is found to be attended with some inconveniences, and the heliostat is now generally preferred in geodetical operations. (See Lieut. Drummond's paper in the *Philosophical Transactions* for 1826.)

DU'MASINE. An oily liquid obtained among other products, by distilling acetate of lime: its formula is $C_{10}\ H_8\ O$. It is named in compliment to the celebrated French chemist, Dumas.

DYNACTINO'METER. (Gr. δυναμις, *power;* ακτιν, *a sunbeam;* μετρον, *measure*.) An instrument for measuring the intensity of the photogenic (light-producing) rays, and computing the power of object glasses. It is described by Mr. Claudet in the *Philosophical Magazine* for June, 1851.

DYNAM, or DYNAMICAL UNIT. For the purpose of measuring or comparing the moving power of machines, or the useful effect procured by the exertion of animal force applied in different ways, it is necessary to adopt some standard, or unit of force, and for convenience of explanation it is desirable the unit should be designated by an appropriate name. When the steam-engine came into use, the work accomplished by it in a given time was naturally compared with that of the

moving power which it most frequently superseded; hence the term *Horse-power*, which was originally used by Watt to denote, in a rough way, the force developed by a horse of average strength drawing a load during twenty-four hours without intermission. Watt subsequently gave a definite signification to the term, by defining it to be the force which suffices to raise a weight of 32,000 lbs. avoirdupoise to the height of one foot in one second of time. C. Dupin, in his *Géometrie des Arts et Métiers et des Beaux-Arts*, proposed the term *Dyname* to denote the unit of moving force, represented by one cubic metre of distilled water at its maximum density raised to the height of one metre in an astronomical day. Dr. Whewell, in his *Mechanics of Engineering*, recommended the adoption of the English synonyme, *Dynam*, to represent the effect equivalent to a weight of one pound raised to the height of one foot in a second. The terms *efficiency*, and *duty*, are frequently applied in a similar sense.

DYNA'METER. In Optics, an instrument for measuring the magnifying power of a telescope. The magnifying power is the ratio of the solar focal distance of the object glass to the focal distance of the eyepiece considered as a single lens; and this ratio being the same as the ratio of the diameter of the aperture of the telescope to the diameter of its image or disc formed at the solar focus, and seen through the eyepiece, the object of the instrument is to measure the exact diameter of this image, which, not being projected on any solid body, can only be measured by optical means. Ramsden proposed for this purpose the double image micrometer (Micrometer, in Dict.), an instrument formed by dividing the eye lens of a positive eye-piece into two equal parts, and mounting them so that the divided edges are made, by means of a fine screw-apparatus, to slide along each other. Each semilens thus gives a separate image, and the distance of the two centres, measured by the revolutions of the screw, when the borders of the two images are brought exactly into contact, gives the distance of the centres of the images, or the diameter of one of them. The construction of this dynameter has been improved by Dollond. (Pearson's *Practical Astronomy*, vol. ii.)

E.

EAR TRUMPET, or HEARING TRUMPET. An instrument for aiding defective hearing. The ordinary ear trumpet consists of a metal tube, usually of a conical shape, the wide end being turned towards the speaker to collect the waves of sound, and the narrow end terminating in a small tube, and bent sideways so as to enter the ear of the deaf person. Various other instruments besides the *trumpet* are used for the same purpose. The *Auricle* is a small scroll-shaped instrument which is worn in the ear, the expanded mouth only being visible. *Ear-cornets* are applied outside the ear, and held in their place by a slender steel spring, a bent tube entering the ear in this case, as in that of the common trumpet. Flexible tubes, made of India rubber covered with silk, and kept open by a spiral spring of wire, terminating at one end in a tube, which enters the ear, and in a cup or hollow hemisphere at the other, into which the speaker speaks, are found to be of great efficiency. *Sonifers* are large bell-shaped instruments of metal, which are placed on a table, and turned towards the part of the room whence the sound proceeds, and the sound being collected at the bottom of the instrument is conveyed to the ear by a flexible tube. With respect to acoustic instruments in general, it does not appear that mathematical accuracy of figure is of much importance. Whatever prevents the dispersion of the undulating air, and directs it upon the tympanum, will partially assist hearing, though, of course, it is advantageous that as much as possible of the sound which enters the instrument should be reflected forward to the ear.

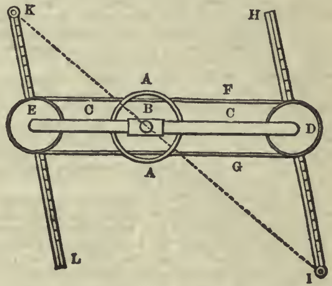
ECDY'SIS. (Gr. εκδυσις.) The act of stripping. The moulting of the skin.

EGE'RIA. One of the small planets between Mars and Jupiter. It was discovered at Naples on the 2nd of November, 1850, by Dr. De Gasparis (who had previously discovered Hygeia and Parthenope), and is the 13th of the group in the order of discovery. *See* Planet.

EI'DOGRAPH. (Gr. ειδος, *form;* γραφω, *I describe.*) A copying instrument invented by Professor Wallace, of Edinburgh, by which copies of drawings are made, reduced, or enlarged in any proportion within certain limits. It answers the same purposes as the ordinary pentagraph, but is more convenient and accurate.

The geometrical theory of this ingenious instrument is contained in the following proposition: "If two lines which contain a given angle turn in a plane about a fixed point at their intersection and have to each other a constant ratio, and the moving extremity of one of them trace a line of any kind, the extremity of the other will trace a similar corresponding line, and these two lines will have to each other the constant ratio of their distances from the centre of angular motion." To apply this property mechanically it was necessary to connect two material points moving on a plane (the tracer and the pencil) in such a way that straight lines drawn from them to a fixed centre should contain a given angle, and have to each other a given ratio. It is convenient to take the given angle equal to 180°, in which case the two moving points are in the same straight line with the centre, and on opposite sides of it.

The instrument is represented in the annexed figure.



A beam, C C, about 30 inches in length (formed of a hollow rectangular prism of brass, in order to combine strength with lightness), passes horizontally through a socket B B, attached to the top of a strong steel conical axis, which turns in a tube rising perpendicularly from the centre of a mass of metal, A A, forming the base of the instrument, and heavy enough to afford a steady support. The beam thus turns freely about the steel axis, and may be clamped at any point. Two wheels, D, E, of exactly the same size, are attached to the beam, at its extremities, by means of steel axes screwed to the wheels and entering upright sockets fixed to the beam. The wheels are connected by a metallic band, F G, part of which (as much as is applied on the wheels in making about half a revolution) is formed of thin and narrow watch spring; and they are crossed by two arms, H I and L K, about 27 inches in length, which slide through sockets placed under the centres of the wheels, and must be placed truly parallel. Both the beam and the arms have a scale of equal parts engraved on them for the purpose of adjustment.

Suppose the beam and the two arms respectively clamped in their sockets in such wise that the beam is divided at the axis b in any given ratio, and D I is equal to D b, and E K to E b; then, on turning the beam about its axis, the two arms will manifestly retain their parallelism, and the three points, I, b, K, will be always in the same straight line; consequently, in virtue of the geometrical theorem above enunciated, the two points, I and K, will have similar corresponding motions, and the lines traced by them will always be in the ratio of D I to E K. It only remains, therefore, to attach a tracing point at I, and a copying point (a pencil) at K, in order to complete the construction. These are placed in vertical tubes, and carefully adjusted to the centres of the tubes. The tracer is guided by the right hand over the contour of the figure to be copied, and the pencil accurately follows its motions, describing a similar but reversed figure on a sheet of paper placed under it. The pencil is pressed down by a small weight, and is raised from the paper, when required, by means of a rectangular lever, one end of which is connected with the pencil-carrier, and the other moved by a string which passes over a pulley, and is held by the operator in his left hand. In order to facilitate this motion the pencil is kept steadily in its place, and at the same time prevented from pressing against the tube, by small friction-wheels fixed in the tube. The motion is extremely free, and with a little practice the outlines of even the most complicated figures, anatomical drawings for example, are copied with great facility and perfect precision.

By combining two instruments adjusted to make reduced copies the reduction may be carried by a single operation to a much greater extent than could be done by one instrument. For obvious reasons, the power of enlarging a figure is more limited. Professor Wallace, likewise, proposed a form of the instrument, by which a copy of any subject is produced so reversed as to have the appearance of the image of the subject as seen reflected from a plane mirror The Eidograph was

invented about 1821, and was first described in the *Transactions of the Royal Society of Edinburgh*, vol. xiii.; it is also described in Wallace's *Geometrical Theorems and Analytical Formulæ*, 1839.

ELAIO'METER. (Gr. ελαιον, *oil*, and μετρον, *measure.*) An instrument for detecting the adulteration of olive oil.

ELAO'PTENE. (Gr. ελαιον, *oil*, and πτημι, *I fly.*) The *liquid* portion of the volatile oils, when separated from the concrete, or crystallisable portion, which had been called *Stearoptene*.

ELE'CTRIC COLUMN. An electric instrument invented by Deduc, consisting of numerous alternating discs of silver leaf, zinc leaf, and paper. *See* ELECTRICITY, in DICT.

ELE'CTRO-MAGNE'TIC CLOCK. The discovery of the mutual relations of electricity and magnetism by Oersted in 1819, necessarily led to the construction of the *electro-magnet*, and amongst its numerous applications, that to *timekeepers* was perhaps one of the most obvious. By referring to the description which we have elsewhere given of the electro-magnet, it will be seen, that a bar of iron of any required form may have any amount of magnetism conferred upon it by proper adjustments of an electric current; and inasmuch as the magnetic power ceases the moment that the electric current is discontinued, so we are enabled to render an iron bar, or horse-shoe, a strong magnet at one moment, and at the next to withdraw all such force. It will be further obvious, that these magnets may be made and unmade at any distance, by an adequate extent of metal wire; so that at one and the same moment a magnet may be made and unmade at London and at Liverpool, and simultaneously, if we please, with the vibrations of the magnetic needle which announce the signals of the electric telegraph. And, of course, the magnet may be made alternately to lift and drop a weight, or to bend and release a spring, or to raise and depress a lever. Bearing these matters in mind, the *principle* of electric clocks will be intelligible, without entering into minute details respecting their varied mechanism.

There are several ways in which electro-magnetism has been applied to these purposes; one of the first consisted in fixing upon the arbor or axis of the seconds wheel of a clock a wheel or disc of metal, the circumference or edge of which was divided into sixty alternating divisions of metal and of ivory or wood, the metal being a conductor, and the ivory or wood a nonconductor of electricity. A small platinum peg, or point, was kept in contact with this divided edge, so as, by the revolution of the wheel, to be alternately in contact with the conducting and nonconducting surfaces, and so connected with a voltaic series, as alternately to admit and resist the passage of an electric current. In this way, supposing the clock in question to be keeping accurate time, one or more electro-magnets placed any where in the circuit of the conducting wire would be made and unmade at each succeeding second. Now it is easy so to connect an electro-magnet with a lever, as to give motion to a wheel and axle, and to cause it to revolve so as to indicate seconds, and when in communication with a proper train of wheels, to move the minute and hour hands of a clock; and this secondary, or *electro-magnetic clock*, would of course be regulated in its movements by the alternating electric current derived in the way we have mentioned, from the original time-keeper. Every clock, therefore, upon the circuit, would show the same time as that shown by the regulator; and in this way, one good regulator may be made to preside as it were over any number of electro-magnetic movements, each of which will indicate the same time.

Another form of the electro-magnetic clock is that in which the pendulum is itself kept in action by electro-magnetism, and through it the other movements of the clock are sustained; and this is effected either *directly*, as in Bain's clock, or *indirectly*, as in Shepherd's clock. In Bain's clock, the pendulum, at each vibration, moves a light slide by which the electric current is alternately completed and broken, and by which magnetism is alternately conferred upon, and abstracted from a coil enclosed in a heavy hollow brass case or tube, which constitutes as it were the bob of the pendulum, and on either side of which are the poles of two common, or permanent bar magnets, which alternately attract and repel the coil of the bob, as it is magnetised and demagnetised by the alternate presence and absence of the electric current. These clocks have been kept in motion by electric currents derived from a zinc plate buried in damp earth, and so far, therefore, independent of the usual forms of voltaic battery, in which the electricity is derived from the action of dilute sulphuric acid upon zinc.

The most recent form of electric clock is that invented and patented by Mr. Shepherd; the large clock at the Great Exhibition of 1851, in Hyde Park, was of this description, and it appears to possess several advantages. In this clock, electro-magnetism is the sole moving power, its force being employed, not only to give impulse to the pendulum and to propel the ordinary movement of the clock, but also to perform the striking of the hour, no auxiliary weights or springs being employed. The pendulum is so arranged as to make and break the electric circuit, and make and unmake a horseshoe magnet at each vibration. Each time that the magnet is made, it attracts its armature, which lifts certain levers; one of these is concerned in raising a weighted lever, and causing it to be held up by a latch or detent; the magnet is then unmade in consequence of the pendulum breaking the circuit, and its armature is released, when the pendulum lifts the latch and allows the weighted lever to fall, which, in falling, strikes the pendulum, so as to give it a certain adequate impulse; then the circuit is again completed, the armature attracted, the levers moved, the weight raised and held by the detent; another vibration breaks the circuit and then releases the armature; the pendulum then raises the detent, the weight falls, and in falling its arm strikes the pendulum and gives it its impulse, and so on.

But the pendulum at each vibration not only makes and breaks the electric circuit which maintains its own action, but also, and simultaneously, that of another battery, of which the duty is to make and unmake the electro-magnets belonging exclusively to the clock or clocks which are upon this circuit. These electro-magnets act upon the extremes of one or more horizontal bar magnets so as alternately to attract and repel their opposed poles, and which carry upon their axes the pallets, by the alternating motion of which to the right and left, the ratchet-wheel is propelled onwards at the rate of a tooth each second; and the axis of this ratchet-wheel carries the pinion which moves the other wheels of the clock.

The circuit of the battery connected with the *striking* part of the clock, is only completed once in each hour, and is connected with an electro-magnet so arranged as by means of a proper lever to pull the ratchet-wheel attached to the notched striking-wheel one tooth forward every two seconds, and each tooth is accompanied by a blow on an electro-magnetic bell. The number of blows depends upon the notched wheel, the spaces in the circumference of which are adapted to the number to be struck; and when this is complete, a lever falls into the notch, and in so doing cuts off the electric current, which is not re-established through the striking electro-magnet, till the completion of the next hour, when a peg upon the hour-wheel pushes the striking lever forward so as to cause it to be depressed by a similar peg on the minute wheel.

Electro-magnetic clocks are peculiarly fitted for all large establishments where many dials, each indicating the same time, are required; the pendulum by which the whole series is controlled is placed in some safe and quiet place, and the only requisite precaution for maintaining them in order consists in careful attention to the conditions and functions of the voltaic apparatus, or source of the electric current. Smee's batteries, as they are called, consisting of amalgamated plates of zinc in proper connexion with plates of platinum, or platinised silver, and immersed in dilute sulphuric acid, or in sand moistened with that acid, are generally used; the number and dimensions of the plates or cells depending upon the extent of wire which the electrical current is required to traverse, and care being taken that the chemical action of the acid upon the plates is as small and feeble as is consistent with the object in view. These clocks also promise to become importantly useful upon lines of railway, and for a variety of other purposes, more especially when some few difficulties attending their management and maintenance are overcome.

ELECTRIC TELEGRAPH. *See* TELEGRAPH, ELECTRIC.

ELECTRICAL EEL. *See* GYMNOTUS, in DICT.

ELECTRO'LYSIS, or ELECTRO-CHEMICAL DECOMPOSITION. (Gr. ηλεκτρον and λυω, *I dissolve.*) The separation of the elements of a compound by the transmission of electricity.

ELE'CTRO-BIO'LOGY. (Gr. ηλεκτρον; βιος, *life*, and λογος, *description.*) A term that has recently been applied to certain mental phenomena produced by various applications of Mesmerism to the human body.

ELE'CTROMETA'LLURGY. The electro-chemical precipitation of the metals, as applied to various purposes in the arts.

ELECTROMO'TOR, or ELECTROMOTIVE FORCE. Terms applied to the development of electricity in Voltaic arrangements.

ELE'CTRONE'GATIVES. Those substances which in electro-chemical decompositions make their appearance at the *anode* or electropositive pole. The term has reference to the mutual attraction of bodies dissimilarly electrical, and hence those which appeared to be attracted by the positive pole in the Voltaic circuit were presumed to have an inherent *Electronegative* state.

ELE'CTROPO'SITIVES. Bodies appearing in electrochemical decompositions at the *cathode* or electronegative pole.

ELE'CTROTYPE. An impression of a medal, or bas-relief, obtained by electric precipitation. *See* VOLTATYPE, in DICT.

ELE'CTROVI'TAL CURRENTS. Two electric currents are supposed by some physiologists to move in the nerves of animals: the one external and cutaneous, moving from the extremities to the *cerebro-spinal* axis; the other internal, and proceeding from that axis.

ELLIPTIC FUNCTIONS. In the higher mathematics the term *Elliptic Function* is used to designate any integral comprised in the formula $\int \frac{P\,d\,x}{R}$, in which P is a rational function of x, and R is a radical of the form $\sqrt{(\alpha+\beta\,x+\gamma\,x^2+\delta\,x^3+\varepsilon\,x^4)}$; $\alpha, \beta, \gamma, \delta, \varepsilon$, being constant quantities. Such integrals are called elliptic functions because they either contain, or are closely connected with expressions for the arc of an ellipse. The principal works on the subject are the following: *Exercises de Calcul Integral*, 3 vols. 4to. 1811; and *Théorie des Fonctions Elliptiques*, 3 vols. 4to. 1825—1828, by Legendre; *Œuvres de* N. H. Abel, 2 vols. 4to. 1839; and Jacobi's *Fundamenta Nova Theoriæ Functionum Ellipticarum*, 4to. 1829.

ELLIPTIC POLARIZATION. *See* POLARIZATION OF LIGHT.

ELVAN COURSES. In Mining, the term *Elvan* is applied by the Cornish miners to the porphyritic and other veins and masses which occasionally traverse granite and clayslate, deranging the direction of the metallic veins.

ENCKE'S COMET. *See* COMET, in DICT.

ENDE'LLIONITE. The triple sulphuret of antimony, lead and copper found in the mine Huel Boys, in the parish of Endellion, Cornwall.

ENDLESS SCREW. A piece of mechanism formed by combining the screw with a cog-wheel, or by making a screw act on the threads of a female screw sunk in the edge of the wheel. The axis of the screw may be either in the plane of the wheel, or at right angles to it; in the latter case it is called the American endless screw. In its mechanical principle the endless screw is a combination of the inclined plane and the lever.

ENDOSMO'METER. (Gr. ενδοσμωσις, and μετρον, *measure.*) In Physiology, an instrument invented by M. Dutrochet, to measure or demonstrate the rapidity with which one or other of two mixing fluids, of different densities, will pass into each other: and by which the less dense fluids are shown to pass with greater rapidity into the more dense fluids, than *vice versâ*; in other words, that "endosmosis" is more rapid than "exosmosis." A simple form of the instrument is a graduated tube, expanded into a bell at one end, over which a portion of membrane may be tied. If the bell be filled with a fluid of much density, such as a strong solution of salt, and be immersed in one of less density, as water, the water will endosmose, or pass into the solution more rapidly than the solution will exosmose or pass out. But if the water were put into the bell and the saline solution outside, the directions of the currents would be reversed. In both cases, however, the currents would continue until the two fluids were equally mixed on both sides of the membrane.

ENTHELMI'NTHA. *See* INTESTINALIA, in DICT.

ENTO'MOLINE. (Gr. εντομα, *insects*, and λινον, *thread.*) A chemical principle called also *Chitine*, found in the elytra and wings of insects.

E'NTROCHITE. (Gr. εν, *in*; τροχος, *a wheel*). A genus of fossils constituted of the petrified arms of the sea starfish.

EPENCEPHA'LIC ARCH. (Gr. επι, *upon* or *near*; εγκεφαλον, *the brain.*) The bony arch which encompasses and protects the epencephalon: it is composed of the basioccipital, exoccipitals and superoccipitals, and, in general anatomy, forms the neural arch of the occipital vertebra.

EPENCE'PHALON. (See above.) In Anatomy, the hindmost of the four primary divisions or segments of the brain, including the medulla oblongata, pons varolii, cerebellum, and fourth ventricle.

EPIDI'DYMIS. (Gr. επι, *upon*; διδυμοι, *turns*, or *the testicles.*) In Anatomy, a body formed by convolutions of the commencement of the sperm-duct or *vas deferens*, lying upon the testicle, and more or less closely attached to that gland. In anthropotomy the epididymis is divided into a *caput minor*, *corpus* and *caput major*.

EPIME'RAL. (Gr. επι, *upon*; μηρος, *a limb.*) In Zoology, the part of the segment of an articulate animal which is above the joint of the limb.

EPITHE'LIUM. (Gr. επι, *upon*; θηλη, *a teat.*) In Anatomy, a thin and delicate kind of cuticle, like that which covers the nipple. The term is now confined to the innermost layer of the internal cavities and canals of the body, which is analogous to the cuticle of the outer surface. The epithelia of the mucous membranes consist of the secreting cells of those surfaces, and are either "tesselated," "cylindroid," or "ciliated." The tesselated, or "*pavement epithelium*," is composed of flat, roundish, or polygonal cells, arranged in one or more layers, and is spread over the mouth, pharynx, and œsophagus, the conjunctiva, and the vagina; it is the kind of epithelium which most nearly resembles the external cuticle. A tesselated epithelium also lines most of the serous and synovial membranes, the vascular system, and the secerning tubuli and ducts of many glands. The *cylindroid* epithelium is composed of close-set cells of a conical or cylindrical form, and extends from the cardiac end of the stomach along the intestinal tract to the anus, and lines the principal gland-ducts which open upon this surface. It lines the ureters and urinary bladder, and the sperm-ducts.

The cells of the ciliated epithelium support at their free extremities fine pliant hair-like appendages called "cilia," which are in constant and rapid vibration: this kind of epithelium lines the whole respiratory tract, the interior of the cerebral ventricles, the uterus and oviducts, and the Malpighian capsules of the kidneys of the Batrachia.

EPIZOO'TIC DISEASES. (Gr. επι, *upon*, and ζωον, *an animal*). When diseases prevail among inferior animals, they are said to be *Epizootic*, corresponding to *Endemics* among men.

EQUA'TION, PERSONAL. The term *Personal Equation* has of late been introduced into Astronomy to denote the interval of time by which an observer, on the average of a number of observations, notes a phenomenon before or after the instant assumed to be that of its actual occurrence. If it were possible to determine the true instant of the occurrence of any phenomenon with absolute certainty, the personal equation of an observer would be the amount of error he is in the habit of making, or the probable error of a single observation made by him; but as the true instant of the occurrence can only be assumed by taking the mean of a number of observations, the term has only a relative signification. For instance, if, on comparing a number of observations of the same phenomenon by A and B, it be found that A notes the phenomenon, on the average, half a second sooner than B, then half a second is the *difference* of their personal equations; but this does not enable us to form any judgment with respect to the amount of error due to either, and it is only by a further comparison of observations made by A and B with those of other observers, that we are enabled to assume that the true instant at which the event occurred lies between the times noted by them respectively, or before or after both. If, however, it be assumed that either A or B observes correctly, then the personal equation of the other is half a second.

Generally speaking, the personal equation of an observer is a minute quantity, seldom exceeding a few tenths of a second, but it is sometimes found even in the case of experienced observers to amount to, or even exceed, a whole second. It is found to vary with the age of the observer, and may possibly at all times depend in some measure on the state of his health. The subject is treated at length in a *Memoir on the Difference of Longitude of Greenwich and Brussels*, by Prof. Quetelet and Mr. Sheepshanks, *Mémoires de l'Academie Royale de Bruxelles*, tom. xvi. See also Introductions to the volumes of the Greenwich Observations.

ERY'THRINE. (Gr. ερυθρος, *red.*) One of a series of substances obtained from the *Roccella tinctoria*, a lichen which furnishes the blue dye-stuff called *litmus*.

ERYTHROPHY'LLINE. (Gr. ερυθρος, *red*, and φυλλον, *a leaf.*) The *red* colouring matter formed in certain leaves, when they change into their autumnal tints.

ESMA'RKITE. A species of Datholite or Borosilicate of lime, discovered by Esmark at Arendal.

ESO'CIDÆ. (Lat. esox, *the pike.*) The *Pike tribe*, a family of *Malacopterygious*, or soft-spined fishes, having the ventral fins placed under the abdomen, and including most of the voracious fresh-water fishes, as well as several marine species.

ES'SONITE. A mineralogical synonym of the *Cinnamon Stone* of Ceylon: it is a silicate of lime, alumina, and oxide of iron.

ETHIO'NIC ACID. (Gr. αιθηρ, and θειον, *sulphur.*) An acid formed by the action of the vapour of anhydrous sulphuric acid on alcohol.

EUCHRO'NIC ACID. (Gr. ευχροος, *of a fine colour.*) An acid formed by the action of heat on the mellitate of ammonia.

EUCHYSI'DERITE. (Gr. ευχυειν, *to melt easily*; σιδηρος, *iron.*) A silicate of lime, magnesia, and protoxide of iron. A species of *pyroxene*.

EUDE'MONISM. (Gr. ευδαιμονια, *happiness.*) A term applied by some German philosophers to a system of moral philosophy which makes morality to depend on the production of happiness.

EU'DI'ALITE. (Gr. ευ, *easily*, and διαλυω, *I dissolve*;

from the facility with which it is gelatinised by the action of hydrochloric acid.) A mineral from Greenland, of a red colour, and in dodecaedral crystals: it contains silica, zirconia, lime, soda, and the oxides of iron and manganese.

EUGE'NIA. A genus of plants so named by Micheli in honour of Prince Eugene of Savoy, an eminent patron of Botany. It embraces the Eugenia caryophyllata, or Clove Tree, and the E. Jambos, or Malabar plum, the ripe fruit of which has the odour of the rose.

EUGE'NINE. A crystalline substance extracted by alcohol from cloves.

EUKAI'RITE. (Gr. ευκαιρος, *seasonable.*) A native seleniuret of silver and copper from Sweden.

EU'LYTINE. (Gr. ἐυ, *easily*, and λυω, *I dissolve.*) A mineral found at Freiberg, composed of silica, oxide of bismuth, and alumina.

EUNO'MIA. One of the small planets belonging to the group between Mars and Jupiter. It was discovered by M. De Gasparis at Naples on the 29th of July, 1851, and is the fifteenth in order of discovery. At its discovery it appeared like a star of the ninth magnitude. Four sets of elements of the orbit have been computed, but they exhibit greater differences than usual, the extreme values of the mean daily motion being 824″ and 955″. (*Monthly Notices of the Royal Astronomical Society*, vol. xi. No. 9.) See PLANET.

EUPATO'RIUM. (Eupator being the discoverer of its virtues.) The herb *Agrimony*, in common use in Holland as an alterative.

EUPE'PSIA. (Gr. ευ, *well*, and πεπτειν, *to concoct.*) Good digestion.

EU'PHOTIDE. (Gr. ευ and φως, *light.*) A rock consisting of felspar and diallage. It is the *gabbro* of the Italian artists.

EUPHRA'SIA. (Corrupted from *Euphrosyne:* from ευφρων, *merry*, because it exhilarates.) The name of a genus of plants: it includes the *E. officinalis* or *Eyebright*, much esteemed as a popular remedy for diseases of the eyes: it is also an ingredient in British herb tobacco.

EUPY'RION. (Gr. ευ, *easily*, and πυρ, *fire*). A term applied to several contrivances for obtaining instantaneous light; such as lucifer matches, &c.

EURITE or WHITE STONE. (Gr. ευρυς, *broad.*) A fine-grained granite, in which felspar predominates.

EUXA'NTHINE. (Gr. ευ, and ξανθος, *yellow.*) A substance obtained from India under the name of *Purree*, or *Indian yellow*. It is supposed to be derived from the bile of the camel, or of the elephant: it forms small pale yellow crystals.

EU'XENITE. (Gr. ευξενος, *welcome.*) A mineral containing columbium, yttria, and uranium, found at Arendal in Norway.

EVERLASTING FLOWERS. Certain flowers, whose hard tissue and deficient moisture renders them little liable to change, and enables them to retain their colour for several months after having been gathered.

EVIDENCE, LAW OF. An important enactment was passed in the 14 and 15 Vict. chap. 99, by virtue of which parties to suits, actions, or other proceedings in any court of justice are admitted witnesses. It provides that on the trial of any issue joined, or of any matter or question, or on any inquiry arising in any suit, action, or other proceeding in any court of justice, or before any person having by law, or the consent of parties, authority to hear, receive, and examine evidence, the parties thereto, and the persons in whose behalf any such suit, action, or other proceeding may be brought or defended, shall be competent and compellable to give evidence either *viva voce* or by deposition, according to the practice of the court, on behalf of either or any of the parties to the suit, action, or other proceeding. By this clause, in addition to the parties offering themselves to give evidence in their own behalf, their opponents can compel them to give evidence in the cause. Nothing in the act is to compel persons charged with criminal offences to give evidence, nor is the act to apply to proceedings in consequence of adultery. Further, the new law authorises the common law courts to compel an inspection of documents whenever equity would grant a discovery. Foreign and colonial acts, judgments, &c., are to be received in evidence, without proof of the seal or signature; so, also, are apothecaries' certificates. Documents are to be admitted in England or Ireland from either place, and the colonies, without proof of seal. Persons forging the seal or signature to be guilty of felony, and punished accordingly. This act, which extends to all parts of the united kingdom except Scotland, came into force on the 1st of November, 1851.

EXA'NGIA. (Gr. εξ, and αγγειον, *a vessel.*) A term applied by some medical writers to diseases in which large blood vessels are broken or perforated, or enlarged, without any external opening: it includes *aneurism*, *varix*, and *cyanea*.

EXA'NTHALOSE. (Gr. εξανθεω, *to effloresce.*) A name given by Beudant to native *sulphate of soda*, occurring as an *efflorescence* on certain lavas, and elsewhere.

EXAN'THESIS. (Gr. εξανθεω, *to effloresce.*) An efflorescent eruption on the skin.

EXCE'NTRIC. In machinery, a wheel in which the axis is removed from the centre of the figure, or of which the periphery is not circular. Excentrics are used for converting circular motion into alternating, rectilinear, or intermitting motion, and are usually driven by bands or straps.

EXCI'TANTS. (Lat.) Medicines which excite the actions of the system: they are either *general*, such as alcoholic liquors, &c., or *local*, such as diuretics, diaphoretics, &c.

EXCITO-MOTORY ACTS. In Physiology, the term has recently been applied to the first class of nervous actions defined by Hartley as "those sensory vibrations which are excited in the external organs and ascend towards the brain, when they arrive in their ascent, at the origins of motory nerves, as they arise from the same common trunk, plexus, or ganglion, with the sensory ones affected, detach a part of themselves at each of those origins down the motory nerves; which part by agitating the small particles of the muscular fibres excites them to contraction" (*On Man*, i. p. 92). "The actions of sneezing, swallowing, coughing, hiccoughing, vomiting, and expelling the fœces and urine, with others of a like nature, are to be deduced from the first and fourth classes of motory vibrations; i. e. either from those vibrations which first ascend up the sensory nerves, and then are detached down the motory nerves, which communicate by some common trunk, plexus or ganglion; or else from those vibrations that run along the surfaces of uniform membranes, and so affect all the muscles which lie contiguous to any part of the membranes" (*Ib.* p. 97). "The yawnings and stretchings of persons disposed to sleep, the convulsive respiration of those that are just fallen asleep, and the convulsive motions which attend the extinction of the senses in epileptic fits, and the near approach of death, may be derived, perhaps, in part, from this source" (*Ib.* p. 93).

EXCRE'TORIES. The ducts which convey the secreted fluids from the glands.

EXCU'RTRICES. (Lat. excurro, *I rush hastily.*) An order of birds intermediate between the flying and walking tribes, and belonging to the *Insessores*.

EXI'NTINE. A membrane situated between the extine and intine in the pollen of yew, juniper, cypress, &c.

EXOCHNA'TA. (Gr. εξοχος, *prominent.*) A designation of the long-tailed *Crustaceæ;* as the lobster and shrimp.

EXPECTORA'TION. (Lat.) The act of ejecting matters from the chest. The term is sometimes applied to the matter ejected, which is, however, more properly termed *sputum.*

EXPERIME'NTUM CRU'CIS. (Lat.) Bacon's *Crucial*, or *decisive* experiment; so called from the *crosses*, or finger-posts on roads, as at once determining between two or more possible conclusions.

EXPIRA'TION. (Lat.) In Physiology, the movements by which the air that has been changed by the respiratory process, is expelled from the lungs: they are chiefly due to the elastic contraction of the lungs and the walls of the chest, after they have been dilated in the act of inspiration.

EXSE'RTED. (Lat. exsertus, *thrust out.*) A term applied to such stamens of plants as are longer than the corolla.

EXTE'NSOR MUSCLES. As opposed to *flexor muscles*, are those which extend any limb or part; the muscle in the fore-arm which extends the joints of the fingers, called the *extensor digitorum*, is an instance.

E'XTINE. The external membrane of the pollen-grain of plants.

EXTROVE'RSION. (Lat.) A term applied by surgical writers to those malformations of the body in which a part is, as it were, turned wrong side outwards. Such cases are congenital; thus cases are on record of *extroversion of the bladder*, in which there is a congenital defect of its anterior part, and of the corresponding portion of the parietes of the abdomen, so that the internal surface of the bladder projects and forms a tumour.

EYEBRIGHT. See EUPHRASIA.

EYE-PIECE (SOLID). The *solid eye-piece* is an invention of the Rev. J. B. Reade, of Stowe, near Aylesbury. It consists of three lenses, the anterior and posterior of which are double convex of crown glass, and the intermediate one a concave lens of flint. The contact surfaces are cemented together, and consequently the action of the rays of light is similar to that of a single lens. The advantages of this construction are that it gives a large and flat field of view, and that the defects of spherical and chromatic aberration are got rid of. These advantages arise from the great thicknest

of the flat lens, which is a perfectly new feature in the construction of eye-pieces.

EYE-PIECE (PERSONAL BINOCULAR). An eye-piece recently invented by Mr. Thomas Jones, a well-known optician of London, for enabling two persons to observe the image of the same star with the same telescope. It consists of two 3-glass eye-pieces having the first lens common to both. This first lens is contained in a tube adapted in the usual way to the telescope, and, branching off at angles of 120° from it, are two other tubes, each containing other two lenses, fixed in smaller tubes sliding in them. At the junction of the tubes is an equilateral prism, by which the pencil of rays passing perpendicularly through its first surface, is divided into equal parts at the opposite angle, and is reflected in two equal parts into the two branch tubes. All the light received on one half of the object-glass is reflected into one tube, and that received on the other half into the other tube, and thus two distinct images of the star, as well as of the wires in the focus of the object-glass, are formed.

By the use of this eye-piece, two persons may, under precisely the same circumstances, observe transits of stars, and thus obtain, much more certainly than it has been effected by other means, their *personal equation*, that is, the difference of average estimation of the time of a star's transit across the wires of a transit-instrument. In this respect the invention of Mr. Jones is likely to be of inestimable service to astronomy, since the uncertainty attending the observation of time, and the different estimations of this element by different observers, have been the greatest obstacles to a perfect system of observation since the construction of large instruments and the great improvements introduced during the present century into the systems of the great observatories of Europe.

F.

FA'CET. (Fr. façette.) In Anatomy, a small but well-defined surface of a bone or other part; as, e. g. the hexagonal divisions of the surface of the cornea of the compound eye of the insect and crustacean.

FACTO'RIALS. In Analysis, the name given by Arbogast to certain symbolical expressions representing the continued product of a series of factors such that each is greater or less than the immediately preceding one in the series by a constant quantity. For example, the expression x^{n+a} denotes the continued product

$$x\,(x+a)\,(x+2a)\,(x+3a)\;.\;.\;.\;.\;(x+\overline{n-1}\,a).$$

FÆ'CES. (Lat.) The excrements; usually confined, in Physiology, to the solid matter evacuated from the alimentary canal. According to the analysis of Berzelius, human fæces of consistence sufficient to form a coherent mass are composed of

Water			75·3
Matters soluble in water.	Bile	0·9	5·7
	Albumen	0·9	
	Peculiar extractive	2·7	
	Salts	1·2	
Insoluble residue of the food			7·0
Insoluble matters which are added in the intestinal canal, — mucus, biliary resin, fat, and a peculiar animal matter			14·0
			102·0

This term is also applied to sediments, especially in vegetable infusions, tinctures, and fermented liquors.

FAU'JASITE. A hydrated silicate of alumina, lime, and soda, from Baden; named after Faujas St. Fond.

FAVO'SE. (Lat. favus, *a honeycomb.*) In Botany, honey-combed: cellular.

FAY'ALITE. A native silicate of iron from the island of Fayal.

FE'BRIFUGE. (Lat. febris, *fever*; and fugo, *I drive away.*) A remedy which cures or relieves fever: the term is commonly applied to medicines used in the treatment of agues.

FELLIC and FELLI'NIC ACID. (Lat. fel, *gall.*) Products obtained from bile.

FENESTRA. (Lat. *a window.*) In Anatomy, the term is applied to certain holes in the osseous or petrous capsule of the internal organ of hearing; one on the outer wall of the labyrinth, which is filled by the base of the "stapes," is called the "fenestra ovalis;" a second, at the base of the cochlea, is called the "fenestra rotunda," and is separated by a membrane from the cavity of the tympanum.

FER'RIC ACID. A compound of 1 atom of iron with 3 atoms of oxygen; Fe O_3. It is very unstable, and has not been isolated.

FE'RRIDCYA'NOGEN. A compound of 2 atoms of iron and 6 of cyanogen and which, in combination with 3 atoms of potassium, forms the *Ferridcyanide of potassium*, or *red prussiate of potash.*

FE'RROCYA'NOGEN. A compound of 1 atom of iron and 3 atoms of cyanogen; or 1 of iron, 6 of carbon, and 3 of nitrogen; and which, in combination with 2 atoms of potassium, constitutes *anhydrous ferrocyanide of potassium*, the crystals of which include 3 atoms of water. This crystallized ferrocyanide of potassium is generally known under the name of *yellow prussiate of potash.*

FI'CHTELITE. A white crystalline substance found in a peat moss in Bavaria: it is a hydrocarbon.

FI'MBRIÆ. (Lat. fimbria, *a fringe.*) In Anatomy, the jagged processes of the abdominal opening of the oviduct, or "Fallopian tube," are so called.

FIRE-SHIP. A vessel filled with combustible materials for the purpose of being sent in a burning state among the ships of an enemy, in order to set them on fire, and thereby effect their destruction. As the destruction of the vessel itself is a necessary consequence, it must be abandoned by the men, and therefore cannot be steered. Hence fire-ships are formidable only to vessels which cannot be manœuvred, either by reason of their having been disabled, or on account of their occupying a confined space, as a harbour, where there is not room for escape.

FIS'CHERITE. One of the native hydrated phosphates of alumina, so called from its discoverer, Fischer.

FLABE'LLIFORM. (Lat. flabellum, *a fan.*) Fan-shaped — as the plaited leaves of some palms.

FLAGE'LLIFORM. (Lat. flagellum, *a whip.*) Whip-shaped. A term applied to a long, pliant, whip-like stem.

FLEAM. An instrument used by farriers to bleed horses and cattle: it includes a small pointed blade, which is projected from a sheath by means of a spring.

FLE'XOR MU'SCLES. Muscles, the office of which is to *bend* the joints.

FLOOD-GATE. A sluice, or gate, for drawing off the superfluous water from a canal or reservoir liable to be flooded by falls of rain.

FLORA. One of the recently discovered small planets belonging to the group between Mars and Jupiter. Flora was discovered at Mr. Bishop's Observatory in the Regent's Park, on the 18th of October, 1847, by Mr. Hind, while comparing the fourth hour of the map of Professor Knorre with the Heavens. It had then the appearance of a star of the ninth magnitude, but shortly after the discovery the brightness increased, and became equal to that of a star of the eighth magnitude. At Mr. Bishop's request, Sir John Herschel named the planet *Flora*, with a rose for the symbol. It is the eighth of the group. The period of revolution of this planet appears to be somewhat shorter than that of any other of the group, being 1193·25 days. (*Monthly Notices of the Royal Astronomical Society*, vol. viii.) See PLANET.

FLUCE'RINE or FLUOCE'RINE. The native fluoride of cerium, occurring near Fahlun, in Sweden.

FLUEL'LITE. Native fluoride of aluminum, occurring at Stennagwyn, in Cornwall.

FOG-RINGS. Banks of fog arranged in a circular or ring form; a meteorological phenomenon not unusual on the coast of Newfoundland. (See *British Association Report for* 1846.)

FO'LLICLE. (Lat.) In anatomy this term is applied to a simple gland, consisting merely of a hollow vascular membrane, and an excretory duct: hence the term *mucous* and *sebaceous follicles.*

FOMES. In medical language this term is applied to porous substances capable of absorbing and retaining contagious effluvia. Wool and woollen clothes are said to be active *fomites.*

FONT *of Type.* See FOUNT, in DICT.

FORENSIC MEDICINE. (Lat. forum, *the bar.*) The application of medical science to the elucidation or solution of judicial questions.

FOREST MARBLE. A portion of the series of the lower oolite formation, consisting of a coarse laminated shelly oolite, interposed between beds of clay and grit. See GEOLOGY.

FORESTS, SUBMARINE. The inroads of the sea have in many places submerged forests of considerable extent. A submarine forest on the coast of Lincolnshire was described in 1799 by Correa de Serra. (*Phil. Trans.*) Another was discovered in 1832 in Cardigan Bay: it is said to have been submerged in the year 520. The remains of the trees are covered by peat. A similar fir wood, beneath the mean level of the sea, exists at Bournemouth, in Hampshire. These forests are sometimes also found in inland situations, of which there is a good example about four miles west of Newcastle-on-Tyne, near the river, consisting of an immense number of trees lying a few feet beneath the surface. At the bottom of the moss of Kincardine, under a bed of peat

from 8 to 12 feet thick, are a number of trees which have been cut down, and hatchets are occasionally found in the moss. It is supposed that these are the relics of the Caledonian forest cut down by Agricola. (Lyell's *Geology*. Thomson's *Geology*, &c.)

FO'RMULA. (Lat.) In Chemistry, a concise mode of exhibiting by symbols the results of chemical changes, and dependent upon the theory of atomic equivalents. These formulæ are employed either to represent the actual results of experiment, or to indicate the different theoretical or hypothetical views which may be taken in reference to the composition of certain products. Formulæ, therefore, are either empyrical or rational. As an instance of the first-mentioned application of formulæ we may give those of water, of sugar, of carbonic acid, of alcohol, and of ether. Water is a compound of an atom of hydrogen=1, and an atom of oxygen=8; the formula, therefore, of *water* is $H\,O$. The formula of grape-sugar is $C_{12}\,H_{12}\,O_{12}$; that is, it consists of 12 atoms of carbon, 12 of hydrogen, and 12 of oxygen. Carbonic acid consists of 1 atom of carbon =6, and 2 atoms of oxygen=16; its formula, therefore, is $C\,O_2$. Alcohol is a compound of 4 atoms of carbon, 6 of hydrogen, and 2 of oxygen, its formula being $C_4\,H_6\,O_2$; and lastly, ether is a compound of 4 atoms of carbon, 5 of hydrogen, and 1 of oxygen, and is represented by the formula $C_4\,H_5\,O$. All these are *empyrical formulæ;* that is, simple statements of the composition of the several bodies.

In the act of fermentation sugar is resolved into alcohol and carbonic acid, and this change may be concisely represented by the following arrangement of formulæ:

$$C_{12}\,H_{12}\,O_{12} = 4\,(C\,O_2) + 2\,(C_4\,H_6\,O_2)$$

that is, 1 atom, or *equivalent* (for we use these terms synonymously) of grape-sugar, is equal to 4 atoms of carbonic acid, and 2 atoms of alcohol.

Now, in reference to the use of *rational* formulæ it may be remarked, that sugar may be hypothetically represented as a compound of 12 atoms of carbon, and 12 of *water;* and in that case its formula would be $C_{12} + 12\,(H\,O)$.

Again, alcohol is resolvable into ether and water; for $C_4\,H_6\,O_2$ is $= C_4\,H_5\,O + H\,O$: and lastly, ether may be regarded as an oxide of a hydrocarbon, composed of 4 atoms of carbon and 5 of hydrogen, and which has been termed *Ethyle;* in which case its formula might be written $C_4\,H_5 + O$; or ether may contain a hydrocarbon composed of 4 atoms of carbon and 4 of hydrogen, in combination with an atom of water; in which case its rational formula would be $C_4\,H_4 + H\,O$.

FO'RMYLE. The basic hydrocarbon of the formic acid $= C_2\,H$.

FO'RSTERITE. A crystalline mineral accompanying the pyroxene of Vesuvius.

FOU'SEL OIL or FUSEL OIL. (Gr. φυω, *I produce.*) An oil contained in corn-spirit and potato-spirit, and which gives to those liquors a disagreeable taste and smell. When purified it constitutes the *amylic alcohol*, or hydrate of oxide of amyle, of modern chemists; its formula is $C_{10}\,H_{11}\,O + H\,O$.

FOW'LERITE. A silicate of manganese and iron, from New Jersey.

FOWLER'S MINERAL SOLUTION. A solution of *arsenite of potassa* introduced into medicine by Dr. Fowler of Stafford, as a substitute for a similar preparation, sold as a quack medicine, under the name of *Tasteless Ague Drops*. The *Liquor Arsenicalis* of the Pharmacopœia is for the same purpose.

FRA'GARIA. (Lat. fragro, *I smell sweet.*) A genus of plants, including the *Strawberry*.

FRAGMENTARY ROCKS. A geological term applied to rocks apparently composed of the agglutinated fragments of other rocks. *Brecciæ* and *Conglomerates* are of this class.

FRA'NKLINITE. A ferriferous oxide of zinc occurring in New Jersey, N. America, so called in honour of Dr. Franklin.

FRA'XINUS. (Lat.) The ash. A genus of plants, in which the common ash, *Fraxinus excelsior*, and the manna tree, *Fraxinus ornus*, are included.

FREE CHURCH OF SCOTLAND. The name assumed by the large body of Presbyterians in Scotland that seceded from the established church in 1843. Under the head VETO in the DICT., we have detailed at some length the causes that led to this important movement, and their results; and it remains for us here only to say that, as might be expected, the Free Church embraces a large body of lay adherents. In 1851, no fewer than 570 churches had been built for the accommodation of its members; 70 more were, at the same time, in the course of being built; and others were projected. It had then, also, 613 ordained clergymen, and 197 congregations without ministers. Very conflicting estimates have been formed of the total numbers of those within the pale of the Free Church; these being exaggerated by its friends, and underrated by its opponents. On the whole, however, they may perhaps be safely estimated at about 600,000.

Nothing, perhaps, has been so extraordinary, in connexion with the history of this secession, as the zeal and liberality displayed by the public in subscribing funds for the building of churches and the support of the clergy. These amounted, in May, 1845, to no less than 776,453*l*., of which not 10 per cent. was unpaid. Large additional subscriptions have since been received. During the year ended 30th March, 1850, the sum of 306,622*l*. was received by the Free Church for its various objects. A handsome college in connexion with the Free Church has been opened in Edinburgh; and houses (manses) for the accommodation of the clergymen have been built in most parts of the country.

FRENCH CHALK. Talc, or silicate of magnesia.

FRENCH POLISH. A solution of shell-lac in spirit of wine is the basis of this compound; a small quantity of linseed oil is added to it at the time of its application, and it is laid on by a ball of cotton-wool and rapidly rubbed in the direction of the fibres of the wood; when dry it is finished off by friction with tripoli and oil.

FRENCH WHITE. Finely pulverised talc.

FRIABI'LITY. (Lat. frio, *to crumble.*) The property by which substances admit of being crumbled into powder by gentle friction.

FRIAR'S BALSAM. The *compound tincture of Benzoin* of the London Pharmacopœia. It is an alcoholic solution of benzoin, styrax, tolu balsam, and aloes; it is used as a stimulating application to wounds and ulcers.

FRIE'SLAND GREEN. *Brunswick Green.* An oxichloride, or an ammonio-chloride of copper.

FRITILLA'RIA. In Botany, a genus of *liliaceous* plants, including the *F. Imperialis* or *Crown Imperial.*

FRONTAL SINUS. A cavity in the frontal bone, placed over the orbit, on each side.

FRU'GORDITE. A silicate of alumina, lime, and magnesia, from Finnland.

FU'LGURITE. The fused or vitrified tube which is produced by the passage of lightning through a sandy soil.

FUMA'RIC ACID. An acid existing in the *fumaria officinalis*, or common fumitory: it may be produced by the action of heat on malic acid.

FU'MING LIQUORS. Certain chemical compounds which exhale visible fumes, or in common language *smoke*, when exposed to air: *Boyle's fuming liquor* is sulphuret of ammonium: *Cadet's fuming liquor* is an arsenical compound, now termed *oxide of kakodyle:* the *fuming liquor of Libavius* is the anhydrous bichloride of tin.

FUNDUS. (Lat. fundus, *a basis.*) In Anatomy, the base of any cone-shaped organ: the term is usually restricted to that part of the womb, the urinary bladder and the gall bladder.

FUNGUS HÆMATODES, *Spongoid inflammation, Soft cancer*. A species of malignant tumor, called also *medullary sarcoma.*

FU'SCIN. (Lat. fuscus, *tawny.*) A brown colouring matter obtained from empyreumatic oils.

FU'SCITE. (Lat. fuscus, *tawny.*) A yellowish variety of compact scapolite from Norway: it has also been termed gabronite.

FUSEL OIL. *See* FOUSEL OIL.

FU'SIBLE CALCULUS. That species of urinary calculus which consists of a mixture of ammonio-magnesian phosphate, and phosphate of lime, and which is characterised by the facility with which it enters into fusion before the blow-pipe.

FU'SIFORM. (Lat. fusus, *a spindle.*) Spindle-shaped; thickest at the middle and tapering towards the ends.

FU'SINÆ, in Conchology, a term used for spindle shells.

G.

GA'BIAN OIL. A petroleum or mineral naphtha exuding from the strata at Gabian, a village in Languedoc.

GA'BRONITE. (Gabbro, the Italian name of a rock composed of diallage and felspar.) A mineral found in a vein of titaniferous iron near Arendal, in Norway. It is a silicate of alumina, soda, and potassa. It has also been termed *Fuscite* and *compact scapolite*.

GA'DUS. In Ichthyology, the name of a Linnæan genus of fishes, including the haddock, cod, whiting, and many other species of the cod tribe.

GA'HNITE. A native aluminate of zinc, called also *automalite*. Named from Gahn, who first described it.

GALA'CTIC CIRCLE. (Gr. γαλα, *milk.*) A term first used by Sir John Herschel to denote that great circle of the heavens to which the course of the Milky

Way, as traced by the unaided eye, most nearly conforms. It is inclined, at an angle of about 63°, to the equator, and cuts that circle in two points, whose right ascensions are respectively about 0 h. 47 m. and 12 h. 47 m., so that its northern and southern poles respectively are situated in R. A. 12 h. 47 m., N. P. D. 63°, and R. A. 0 h. 47 m., N. P. D. 117°. This circle, Sir John Herschel observes, is to sidereal what the invariable ecliptic is to planetary astronomy — a plane of ultimate reference, the ground-plane of the sidereal system. (*Outlines of Astronomy.*) See GALAXY.

GALA'CTIC POLES. (Gr. γαλα, *milk.*) The two opposite points of the heavens, situated at 90° from the Galactic Circle.

GA'LACTINE. (Gr. γαλα, *milk.*) An ingredient in the sap of the *Galactodendron utile*, or Cow tree of S. America.

GALACTODEN'DRON. (Gr. γαλα, *milk;* δενδρον, *a tree.*) The *Palo di Vaca*, or *cow tree* of S. America: when tapped it yields a white, palatable, and nutritious liquid, much resembling milk.

GA'LAXY. (Gr. γαλαξια, from γαλα, *milk.*) The *Via Lactea* or Milky Way. This luminous zone, so remarkable in a clear night, must have attracted the notice of the first observers of the heavens, and its true nature seems to have been surmised at an early period. Manilius, in his Astronomicon, after alluding to the well-known mythological fable of its origin, asks

> Anne magis densâ stellarum turba coronâ
> Contexit flammas, et crasso lumine candet,
> Et fulgore nitet collato clarior orbis?

The explanation of the phenomenon here suggested, namely, the condensed light of countless multitudes of small stars so crowded together as to be individually undistinguishable, is ascribed to Democritus, and its truth was confirmed, or at least rendered greatly more probable, immediately on the discovery of the telescope, Galileo himself enumerating among the advantages resulting from his instrument, that of putting an end to the disputes about the nature of the milky way. About the middle of the last century, Wright of Durham, and Kant and Lambert in Germany, speculated on the connexion of the phenomenon with the general arrangement of the stars in space; but the first who undertook a systematic examination of the galaxy with telescopes of adequate power was Sir William Herschel, and it is to the indefatigable labours of this great astronomer, and to those of Sir John F. W. Herschel, who, during his memorable residence at the Cape, with the same telescope as had been used by his father, and by a similar process of examination, explored the regions of the sky which are invisible in our latitudes, that astronomers are mainly indebted for the facts upon which any sound speculation respecting the constitution of the heavens can as yet be founded.

The Milky Way, as seen by the naked eye, presents the appearance of a succession of luminous patches of varying intensity. Its breadth is very unequal, in some parts hardly exceeding 5 degrees, in others extending to 16 degrees; and there is a part between Serpentarius and Antinous where the two branches into which it is there divided occupy together a breadth of 22 degrees. Its course through the heavens is nearly that of a great circle inclined at an angle of about 63 degrees to the equator, and cutting that circle in two points whose right ascensions are, respectively, 0 h. 47 m., and 12 h. 47 m. Struve remarks that the most condensed stratum does not lie exactly in one plane but appears rather to be contained in two different planes inclined at an angle of 10 degrees, and intersecting in the plane of the celestial equator, the sun being at a little distance from the line of intersection. This slight deviation from a great circle had been remarked at an earlier period, and Lambert supposed it might be occasioned by the place of the sun being not exactly in the middle of the zone, but a little on one side. It is convenient, however, in speaking generally of the system of the galaxy, to refer it to a great circle of the sphere; and the great circle to which it most nearly conforms has been named by Sir John Herschel the *Galactic Circle.*

At several parts of its course the Milky Way throws off streams or branches. In Perseus a branch is sent off which is traceable to a considerable distance. Another proceeds from a point near the star *m Puppis*, nearly on the southern tropic. In Argus it opens out into a wide fan-like shaped expanse, nearly 20° in breadth, which terminates abruptly, and at this part its continuity is interrupted by a wide gap. At *α Centauri* it again subdivides. At *γ Sagittarii* it suddenly collects into a vivid oval mass, about 6° in length and 4° in breadth, so exceedingly rich in stars that a moderate calculation gives upwards of 100,000. On the other hand, spaces occur in the very middle of its course, which appear, to the naked eye, entirely devoid of stars, and perfectly black. The most remarkable of these is situated in the Southern Cross, where the Milky Way approaches the nearest to the south pole, and so striking is its appearance that the early navigators designated it by the name of the *coal sack.* This space is of an irregular pear-shaped form; it is about 8° in length and 5° in breadth, and was described and figured by the Abbé Feuillée in 1710. Lacuille correctly attributed its striking blackness to the effect of contrast with the vivacity of the Milky Way which surrounds it on all sides, and which in this region is remarkably brilliant.

At first view it might seem a hopeless attempt to determine the form or boundaries of the agglomeration of stars forming the galaxy, insomuch as we see only its projection on the surface of the celestial sphere, and that, too, from a position within it. If, however, the two following hypotheses be admitted: 1st, that the stars are so distributed through space as to be, on the average, at nearly equal distances from each other, and 2d, that the telescope penetrates so far as to reach the extreme limits of the agglomerated mass, — then the relative distances of the remotest stars in every direction, and consequently the shape of the mass, may be estimated by counting the number of stars in the field of view of one and the same telescope in a great number of different directions; for, granting the above hypothesis, it is obvious that the distances of the remotest stars will be proportional to the cube root of the whole number visible in the field. This was the process followed by Sir William Herschel, in his celebrated *gauges of the heavens.* The telescope he made use of was a reflector of 20 ft. focal length, having an aperture of 18 inches in diameter, and the magnifying power was 180. With this instrument he made upwards of 3400 gauges, and thereby ascertained the number of stars visible in the field of the telescope in so many different directions.

The general fact established by this process of counting was the rapid diminution of the number of stars in the field of view on increasing the angle between the direction of the telescope and the plane of the galactic circle. From a careful analysis of the gauges of Sir William Herschel, Struve deduced a formula which expresses the number of stars in a field of view of 15 minutes in diameter in terms of the angular distance from the galactic equator. At the distances of,

0°	15°	30°	45°	60°	75°	90°

the numbers (representing the average of the gauges) are, respectively,

122·00	30·30	17·68	10·36	6·52	4·68	4·15

whence it appears that the average density of the stars in the plane of the galactic circle is nearly thirty times greater than in the direction of its poles. The researches of Sir John Herschel have established the fact that a similar law of diminution is observed in the southern galactic hemisphere, the average number of stars in a field in both hemispheres being very nearly the same at equal angular distances from the galactic equator.

It is to be remarked that the great increase in the number of stars which is observed in the neighbourhood of the galaxy is occasioned chiefly by the greater abundance of telescopic stars, that is to say, of those beyond the 6th order of magnitude. Stars of the first magnitude are distributed over the sphere with tolerable uniformity. Taking, however, the whole number visible to the naked eye, a rapid increase is perceptible as we approach the limits of the galaxy; but, with respect to those of the smaller magnitudes, and particularly beyond the 11th, the accumulation along that circle and its branches almost exceeds imagination. The vast predominance of the small stars must be held to indicate the immense distances at which they are situated.

From the relatively greater abundance of stars in the plane of the galactic circle, than in the regions on either side of it, and from the indication of some preponderance on the southern side, Sir W. Herschel drew the conclusion that the galaxy is composed of a stratum of stars of which the thickness is inconsiderable in comparison of its length and breadth, and that the sun is placed not far from the middle of the stratum, but somewhat nearer to its northern than to its southern side. He was also enabled to draw a further conclusion. Assuming the real magnitudes of stars to be the same, on the average, through the whole sidereal system, he determined by a series of photometrical experiments that stars of the 6th magnitude (the least visible to the naked eye) are 12 times more remote than those of the first (Sirius, for example), and that the penetrating power of his 20-foot telescope (with the front view) was 75 times greater than that of the naked eye, so that the smallest stars visible in the telescope are at a distance equal to 900 times the distance of Sirius. Now the average apparent breadth of the Milky Way is about five degrees; consequently its linear breadth at that great distance must be 900 × sin. 5°, or equal to 78 times the distance of Sirius, or more than six times the distance of the stars of the 6th magnitude. Therefore the Milky Way, even in the direction of its poles, extends to three

times the distance of the smallest stars visible to the unaided eye, the sun being supposed at the centre of the stratum. Hence it follows that not only our solar system, but all the stars in the firmament visible to the naked eye, are plunged to a great depth in the stratum of stars forming the galaxy, and form an integral part of it.

It must be kept in mind that the above conclusions are based on two hypotheses which are, at best, very precarious; and in fact both of them appear to have been abandoned by Sir W. Herschel himself in his later years. With respect to the first, namely, the distribution of the stars in space at nearly equal distances from each other, he remarks in a paper published in 1817, that although a greater number of stars in the field of view may be taken in general as an indication of their extension to a greater distance, yet the gauges have in reality more direct reference to the condensation than to the distance, and hence a greater number in the field of view may be explained as well by a greater condensation of the nebula as by a greater extension of its figure in the direction in which the stars appear most numerous. The other hypothesis, namely, that the telescope penetrates to the extreme boundaries of the galaxy, is subject to much doubt, and cannot be easily established or disproved. Sir W. Herschel, speaking in 1818 of his 40-foot telescope, the penetrating power of which he estimated to reach to 2300 times the distance of Sirius, states, as his opinion, that even at this enormous distance the limit of the stratum was not attained, inasmuch as the telescope failed to resolve the nebulous appearance into stars, and he therefore concluded the stratum to be fathomless. Sir John Herschel thinks the limit has been attained only in certain directions, "Throughout by far the largest portion of the extent of the Milky Way in both hemispheres the general blackness of the ground of the heavens on which its stars are projected, and the absence of that innumerable multitude and excessive crowding of the smallest visible magnitudes, and of the glare produced by the aggregate of multitudes too small to affect the eye singly, which the contrary supposition would appear to necessitate, must, we think, be considered unequivocal indications that its dimensions, *in directions where these conditions obtain*, are not only not infinite, but that the space penetrating power of our telescopes suffice fairly to pierce through it and beyond it." But, on the other hand, there are parts where not the slightest indication of a limit is discernible. "Such is, in effect, the spectacle afforded by a very large portion of the Milky Way in that interesting region near the point of its bifurcation in Scorpio, where, through the hollows and deep recesses of its complicated structure, we behold what has all the appearance of a wide and indefinitely prolonged area, strewed over with discontinuous masses and clouds of stars, which the telescope at last refuses to analyse." (*Outlines of Astronomy*, 1849.)

It thus appears that the amount of knowledge which has yet been obtained respecting the constitution of the galaxy, is extremely small. The only conclusions, in fact, which can be safely drawn are the following:—

1. That the whole light of the Milky Way is nothing but the light of innumerable stars of all magnitudes down to the faintest point perceptible in the best telescopes.

2. That the phenomena, on the whole, agree with the supposition that the stars of our firmament, instead of being scattered through space indifferently in all directions, form a stratum of which the thickness is small in comparison of its length and breadth, and that the sun occupies a place near the middle of the thickness, and near the point where the stratum is subdivided into two principal laminæ.

3. That if all the fixed stars in the firmament be regarded as forming one great system — that of the galaxy — we are still in complete ignorance of its extent, and without the least idea of its external form.

GALE'GA. (Gr. γαλα, *milk*, because it is supposed to increase the milk of animals, especially of goats.) The name of a genus of plants, including G. officinalis, or *goat's rue*, a plant of little taste, and eaten in Italy in salads.

GA'LIPOT. A white resin derived from the *Pinus maritima*.

GALLI'ZENITE. A mineralogical synonym of *Titanite*.

GALT. A provincial term applied to certain beds of chalk-marl, found in the east of England, between the upper and lower greensand.

GANGUE. The mineral substances which accompany metallic ores in the veins of rocks.

GARA'NCINE. One of the colouring matters derived from *madder*.

GARCINIA. (From Dr. Garcin.) A genus of plants including the celebrated *Mangasteen tree*, the fruit of which, about the size of an orange, is said to excel in flavour and salubrity.

GASHO'LDER. A hollow cylindrical vessel open a bottom and closed at top, suspended by counterpoises i a tank of water, so that it may be filled with gas intro duced by a central pipe, and the gas afterwards distri buted by proper pressure through the mains which con vey it for service. Some of these magazines of coal-ga are of an enormous size, holding half a million cubi feet and upwards.

GASO'METER. This term is often applied to th gasholders of coal-gas works; but it should rather b limited to a smaller instrument constructed upon mor delicate principles, and capable of accurately measurin the quantity of gas of any kind which passes into an out of it. These instruments are sometimes constructe upon a much smaller scale in glass and iron, for th purpose of containing mercury, so as to be used for gase which are absorbable by water.

GASTRO'TOMY. (Gr. γαστηρ, and τεμνω, *I cut.* The operation of cutting into the abdomen.

GAYLUSSITE. A mineral named after Ga Lussac, found at Lagunilla, near Merida; it is com posed of nearly equal weights of carbonate of soda, car bonate of lime, and water.

GAZOLYTES. *See* AEROLITES, in DICT.

GEAR, or GEER. A term applied in Mill-work t wheels, or wheels and pinions, acting into each other *Spur gear* signifies wheels acting together in th same plane, with their axes parallel; for example, th wheel and trundle. *Bevel gear* is applied to wheel acting together whose axes are inclined to each other.

GE'INE. (Gr. γη, *the earth.*) The soluble brow matter which may be extracted from soils by the actio of water. *See* HUMIC ACID.

GELO'SCOPY. (Gr. γελαω, *I laugh*, and σκοπε *I view.*) A divination founded upon laughter, whenc the qualities and characters of persons might, it wa presumed, be deduced.

GEMITRI'CES. (Lat. gemo, *to moan* or *coo.*) I Ornithology, an order of birds comprising the *Columbin* or pigeons.

GENE'TTE. (Fr.) A small variety of horse. Also a animal of the weasel kind (*Viverridæ*), having a musk odour.

GE'NIOGLO'SSI. (Gr. γενειον, *the chin*, and γλωσσ *the tongue.*) In Anatomy, a pair of muscles by whic the tongue is protruded.

GENI'STA. (Lat. genu, *a knee*, so named from th inflection and angularity of the twigs.) A genus o plants including the *G. tinctoria* or *Dyer's Broom*, *&c*

GEORA'MA. (Gr. γη, *the earth*, and ὁραω, *I see.* The name given to a large concave globe, or spherica chamber, having the features of the earth delineated o the concave surface. A spectator in the interior o such a globe sees a much larger portion of the surfac at once than if he occupied an exterior position, and i has accordingly been suggested as a theatre for geo graphical lectures. (*Address to the Anniversar Meeting of the Royal Geographical Society*, 1850, b the President, Captain W. H. Smyth, R. N.)

GE'OTHERMO'METER. (Gr. γη, *the earth*, an thermometer.) An instrument for measuring th earth's heat at different places, as in wells and mine and for determining its rate of increase with the dept The temperature rises about one degree of Fahre heit's scale for every 70 or 80 feet of descent; hence th inference that at the depth of a few miles the earth mu be incandescent.

GERMAN SILVER A silver-like alloy generall composed of nickel, copper, and zinc; various propo tions are given, amongst which the following are said t be the best: 1 nickel, 1 zinc, 2 copper; and 8 nicke $3\frac{1}{2}$ zinc, 8 copper. It resembles the tutenag of th Chinese.

GERM-CELL. In Physiology, the cell which r sults from the union of the spermatozoon, or spermat matter conveyed by it, with the germinal vesicle, or i nucleus. The germ-cell assimilates the surroundi yolk and propagates its kind by spontaneous fissio whence the first or parent-cell has been termed t "primary germ-cell," and its progeny the "derivati germ-cells."

GE'RMINAL AREA. In Physiology, the circular oval space formed by liquefaction and metamorphosis a peripheral portion of the germ-mass: preparatory the appearance of the first trace of the proper embry It is divided into a central clear part called "area p lucida," and a peripheral part called "area opaca;" t portion of the latter, in which blood and blood-vess are developed, is called the "area vasaclosa."

GE'RMINAL MEMBRANE. In Physiology, t strata of cells and nuclei of cells originally formi and afterwards extending from, the germinal area: t external stratum is the "vertebral" layer, also call the "serous" and "animal" layer; the internal st tum is the "visceral" layer, also called the "mucou and "vegetal" layer.

GE'RMINAL SPOT. In Physiology, the nucleus

he germinal vesicle: it consists of a finely granulated ubstance, strongly refracting the rays of light.

GE'RMINAL VESICLE. In Physiology, a clear ucleated cell, which is the first formed and most essenial part of the ovum: it is surrounded by the yolk, and asses to the periphery of that part prior to impregnation, after which the germinal vesicle becomes opake, r disappears. It is sometimes called, after its disoverer, the "Purkingian vesicle."

GERM-MASS. In Physiology, the materials preared for the future formation of the embryo, consistng of the derivative germ-cells and the yolk which hey have assimilated.

GERM-YOLK. In Physiology, that portion of the rimary yolk of the egg which is to be assimilated by he derivative germ-cells in the formation of the germnass. In some animals the whole yolk is so assimiated; in others, as e. g. the bird, only a very small ortion; that, viz. which is included in the germ-mass r "cicatricula."

GIANT'S CAUSEWAY. See GEOLOGY, in DICT.

GIB'BSITE. The native hydrated alumina of Massachusetts, named after Col. Gibbs.

GI'LBERTITE. A white talcy mineral composed hiefly of silica, alumina, and lime, from St. Austle, in Cornwall, named by Dr. Thomson, from Mr. Davis Gilbert, late President of the Royal Society.

GILL. A measure of capacity equal to the fourth art of a pint. Miners apply the term to a pint. Physiologists to the breathing-organ in fishes and other aquatic nimals.

GI'MBERNAT'S LIGAMENT. The tendinous exansion of the lower portion of the oblique muscle of he abdomen, by some defined as the third insertion of *Poupart's Ligament.*

GI'NGLYMUS. GINGLYMOID. (Gr. *γιγγλυμος, a hinge; ειδος, like.*) Hinge-like. An anatomical term pplied to joints formed for motion in one plane.

GIROUE'TTE. (Fr. *a weathercock.*) Public characters who turn with every political breeze. The French published a *Dictionnaire des Girouettes*, conaining the names of the most celebrated revolutionary characters, with a number of weathercocks against each, corresponding to the number of his political changes.

GISMO'NDIN. A native silicate of lime, first noticed by Gismondi at Capo di Bove, near Rome. It occurs n octohedral crystals.

GIZZARD. The proper stomach of birds; its texure differs remarkably in granivorous and carnivorous birds, being thick in the one and thin in the other.

GLA'CIES MARIÆ. (Lat.) One of the old mineralogical terms applied to the large foliated *mica*.

GLANDERS. A disease in horses characterised by mucous discharge from the nostrils.

GLASS-GALL. The saline scum which rises to the urface of fused glass in the glass pots; it is also called *andiver.*

GLASS SOAP. A term sometimes applied in the lasshouse to certain substances which take away colour rom glass; thus oxide of manganese destroys the green int derived from iron.

GLASS FOR TELESCOPES. Till lately, English rtists had failed in producing large disks of glass for the ormation of object-glasses for telescopes, all the large bject-glasses in the public and private observatories eing of foreign manufacture. Since the duty has been aken off from glass, considerable energy has been shown n England with respect to this branch of manufacture; nd Messrs. Chance & Co. of Birmingham have suceeded in manufacturing a disk of pure glass 29 inches in iameter, whose thickness was 2½ inches, and weight 00 lbs. This disk was produced at the Great Exhiition of 1851, and was subjected to a very severe exmination for the purpose of detecting defects arising rom striæ, tension arising from imperfect annealing, ubbles, &c. The only serious defect which was deected after a very lengthened examination, was the xistence of a group of striæ occupying a space of about ½ inches in length, and 2½ inches in breadth, beginning t about 1½ inches from the edge, and having its longer imension directed towards the centre. It was found hat if it were ultimately thought necessary to sacrifice he defective portion, a disk of absolutely pure glass of t least 22 inches, or probably even of 25 inches in iameter, would still be left, being almost double the iameter of the largest object-glasses mounted in any bservatory at present.

GLAU'BERITE. A double sulphate of lime and oda, occasionally associated with rock salt.

GLAUBER'S SECRET SAL-AMMONIAC. Sulhate of ammonia.

GLAU'COLITE. (Gr. *γλαυκος, azure*, and *λιθος, a tone.*) A blue-green mineral from near Lake Baikal, Siberia: it is a silicate of alumina, lime, and potassa.

GLAU'CONITE. (Gr. *γλαυκος, azure.*) A constituent of the *green-sand* formation; it is also sometimes found in the cavities of certain trap-rocks. Under the name of *green-earth* it is used as a pigment. It is a hydrated silicate of iron, alumina, and magnesia.

GLAZING. The vitrified surface of pottery; it often contains oxide of lead. See POTTERY, in DICT.

GLECHO'MA. A genus of plants including the *G. Hederacea* or *Ground Ivy*, a favourite popular remedy for the cure of obstinate coughs.

GLE'NOID. (Gr. *γληνη, a cavity; ειδος, like.*) A term applied in anatomy to certain articular surfaces of bones: thus the surface of the scapula which articulates with the head of the humerus is called the *glenoid cavity* of the scapula or blade-bone.

GLI'ADINE. (Gr. *γλια, glue.*) A chemical term applied to one of the constituents of the gluten of wheat.

GLO'CHIS. (Gr. *γλωχις, a projecting point.*) A form of hair occurring in plants, forked at the apex: a *barb*.

GLO'SSOPE'TRÆ. (Gr. *γλωσσα, tongue*, and *πετρα, rock.*) The fossil teeth of certain fishes.

GLO'TTALITE. (From *Glotta*, the river Clyde.) A white mineral from the vicinity of Glasgow. It is a hydrated silicate of lime and magnesia.

GLUCO'SE. (Gr. *γλυκυς, sweet.*) A distinctive chemical term applied to the sugar of grapes, and to starch sugar, &c. See GRAPE SUGAR.

GLUME. In Botany, the *husk*, or peculiar calyx of grasses.

GLUTE'AL. (Gr. *γλουτος, the buttock.*) Of or belonging to the buttocks: as gluteal *muscles, arteries, &c.*

GLYPHO'GRAPHY. (Gr. *γλυφω, I engrave; γραφειν, to draw.*) An art by which an engraving is produced by the simple mode of drawing: in other words, an art by which the operations of drawing and engraving, which were formerly distinct, are here combined in one. Various admirable specimens of this art were displayed at the Great Exhibition. The process is as follows:— a drawing having been made through the ordinary etching-ground, the plate is then etched, and rolled up with a mixture of various substances, a copper-plate being made over the whole.

GME'LINITE. A hydrated silicate of alumina, potassa, and peroxide of iron; named after Gmelin, the mineralogist. It has also been called *hydrolite*, from the quantity of water which it includes.

GNAPHA'LIUM. (Gr. *γναφαλον, the wool of the teasel.*) The name of a genus of plants including the *G. dioïcum* or *Cotton Weed.*

GO'DBOLD'S VEGETABLE BALSAM. A quack remedy composed chiefly of honey and vinegar.

GO'DFREY'S CORDIAL. A quack medicine made by infusing 9 ounces of sassafras shavings, and of bruised caraway, coriander, and anise seeds each 1 ounce, in 6 pints of water, simmering the mixture till reduced to 4 pints, then adding 6 pounds of treacle, boiling for a few minutes, straining, and adding lastly 3 ounces of tincture of opium.

GOLD. The auriferous deposits in California were discovered so late as 1848; and the accounts of their extraordinary productiveness occasioned an unparalleled influx into the country of adventurers from the U. States and all parts of the world. For a while the accounts in question were pretty generally regarded by the less sanguine portion of the public as being in the highest degree exaggerated. But the result has shown that such had not been the case; and the produce obtained from the washings and the mines has exceeded even the most extravagant *à priori* estimates of its magnitude. It is believed, on good grounds, to have amounted in 1849, 1850, and 1851, to from 8,000,000*l.* to 10,000,000*l.* a year; and it is increasing with every increase in the numbers and skill of the diggers and miners. Whether it will continue at this rate for any considerable time it is impossible to say. But if it does, it cannot fail to exercise a powerful influence over the value of gold.

But it is not alone from California that new supplies of gold are beginning to be thrown upon the market. An auriferous region has very recently been discovered in Australia, about 160 m. W. Sydney. And though it be, at present, impossible to form any estimate of its probable productiveness, its appearances are most flattering. Some very large masses of native gold have been discovered; and the locality in which it is found bears, it is said, a striking resemblance to that of the most productive of the auriferous regions of California.

GOLDBEATER'S SKIN. The membrane used by goldbeaters, and interposed between the leaves of gold when they have attained considerable tenuity: the intestinal membrane of the rectum of the ox is generally used.

GOLDEN SULPHURET OF ANTIMONY. A preparation of antimony consisting of a mixture of the sulphuret and oxide of that metal.

GOLD LEAF. See GOLD, in DICT.

GO'LHITE. One of the mineralogical synonyms of

the *hydrated peroxide of iron*, or brown fibrous hematite or ochre.

GO'MPHOLITE. (Gr. *γομφος, a nail; λιθος, a stone.*) A term applied by Brongniart to the conglomerate rocks of the tertiary series, called by the Swiss *Nägelfloh*.

GO'RDIUS. (Lat.) The hair worm, or *seta equina*, found in stagnant water in Lapland and elsewhere.

GORGO'NIA NOBILIS. (Lat.) An old synonym of *Corallium rubrum*, or red coral.

GOSSY'PIUM. (Lat.) Cotton. The systematic name of the cotton plant is *Gossypium herbaceum*.

GRAIN. The integer of our system of weights. *See* WEIGHTS, in DICT. The troy pound contains 7000 grains, and the avoirdupois pound 5760 grains. The French decigramme is about 1·5 English grains, the gramme being =15·434 English grains.

GRAIN TIN. The purest kind of tin. The term was formerly applied to the metal obtained from the rounded pebbles of tin stone, called *stream tin*. The peculiar columnar fracture which pure tin exhibits when broken, is given by heating the ingot till it becomes brittle, and then letting it fall from a height upon a hard pavement.

GRAINS OF PARADISE. The seeds of a species of *amomum:* they are acrid, and said to be the *malagueta pepper* of Africa.

GRAMMATITE. The name originally given by Haüy to the mineral usually called *Actinolite* or *Amphibole*.

GRAMME. The French integer of weight = 15·434 English grains. *See* WEIGHTS, in DICT.

GRAMMITE. A mineralogical synonym of the variety of bisilicate of lime, commonly called *Tablespar*.

GRAPE SUGAR or GLUCOSE. The peculiar form of sugar existing in grapes, and in fruits generally: it differs from cane sugar in having much less sweetening power, and in being very imperfectly crystallisable: its chemical formula in its crystallised state is C_{12} H_{14} O_{14}; that of crystallised cane sugar being C_{12} H_{11} O_{11}.

GRASS-OIL. Some of the *grasses* yield odorous volatile oils, as the *Anthoxanthum odoratum*; the *Andropogon Schœnanthos* yields the oil of *lemon-grass;* and the *grass-oil of Namur* is distilled from the *Andropogon calamus aromaticus* or *nardoides*.

GREEK FIRE. A highly inflammable compound, supposed to have been invented by the Greeks, and to have consisted of bitumen, or asphaltum, nitre, and sulphur.

GREEN EARTH. *See* GLAUCONITE.

GREENLANDITE. A variety of the precious garnet.

GREEN LEAD ORE. The native phosphate of lead.

GRE'GORITE. The *menachanite* of Cornwall, discovered by Mr. Gregor, whose name it bears. An ore of titanium.

GRIFFITHS' MIXTURE. The Mistura Ferri Composita of the London Pharmacopœia; it is a useful ferruginous tonic, deriving its efficacy from the protocarbonate of iron.

GROUND GRU. Ice formed under peculiar circumstances at the bottom of running water. *Gru* is the name given by the people of Lincolnshire to snow swimming in or mixed with water; and the ground ice, a phenomenon of not unfrequent occurrence in that part of the country, having a considerable resemblance to this, goes by the same name.

The theory of the formation of ground ice is attended with some difficulty. Dr. Farquharson, who has carefully investigated the facts, and given the results of his observations on the ground gru of the rivers Don and Leschal in Lincolnshire, in two papers printed in the *Philosophical Transactions* for 1835 and 1841, is of opinion, that the ice is formed when the water has gone down to the temperature of the freezing-point in consequence of the bottom being cooled to a still lower temperature through the effect of radiation, in the same manner as dry land, under a clear sky, is cooled below the temperature of the air; and in corroboration of this opinion he states, that the formation never occurs excepting under a clear sky, and does not take place where the stream is shaded by bridges or high banks. It has been objected to this theory, that ground ice has been observed in the Neva under a thickness of three feet of surface ice, and an additional covering of three feet of snow, circumstances under which radiation could not take place; but Dr. Farquharson rightly remarks, that this fact can form no valid objection to his explanation, unless it were ascertained that the ground ice was formed *after* the surface ice and fall of snow, and not before. M. Arago, in the *Annuaire du Bureau des Longitudes* for 1833, after stating the observations which had then been collected on the subject, attributes the formation to three circumstances: 1. In a body of water in motion, the temperature of which is below 39° of Fahrenheit (under which water becomes specifically lighter by a further diminution of temperature), the eddies of the current throw down the coldest parts which, in still water, would remain at the surface, so that the whole stream from the surface to the bottom acquires the same temperature through this mechanical action. 2. The aptitude to the formation of crystals on the stones and asperities at the bottom. 3. Less impediment to the formation of crystals at the bottom, in consequence of the comparatively greater stillness of the water. Probably all these circumstances may concur; but as it frequently happens that they are all present when surface ice only is formed, some other conditions appear to be necessary, and Dr. Farquharson's theory, or radiation, seems the most probable which has been yet suggested. On this subject see, in addition to the works above referred to, Colonel Jackson's paper on the Congelation of the Neva, in the *Journal of the Royal Geographical Society;* Mr. Eisdale's, in the *Edinburgh New Philosophical Journal*, vol. xvii.; and Mr. Weitz's, on the Ground Gru of the Siberian rivers, in the *London Geographical Journal*.

GROUND SWELL. An undulation of the ocean caused by the continuance of a heavy gale of wind. Ground swells are rapidly transmitted through the water, sometimes to great distances, and even in direct opposition to the wind, until they break against a shore, or gradually subside in consequence of the friction of the water. They indicate, by the direction of their movement, the quarter in which a storm has raged; and occasionally they are observed to come from various points of the compass at the same time.

GUN COTTON. *Pyroxyline.* A highly inflammable and explosive substance, discovered by Schönbein, obtained by steeping clean cotton wool for a few minutes in a mixture of the strongest sulphuric and nitric acids in equal proportions; it is then thoroughly washed, and cautiously dried at a temperature of 212°. The original appearance of the cotton is little changed, but it has now become explosively inflammable, and when kindled by a spark it very suddenly flashes off with greater rapidity and energy than gunpowder, for which it has been proposed as a substitute, but the sad accidents which have occurred in the attempts to manufacture it upon a large scale have hitherto prevented its employment. When used in a gun it is much more energetic, weight for weight, than gunpowder; but, like fulminating mercury, it is apt, from the extreme suddenness of its explosion, to burst the gun. It appears to be pre-eminently fitted for blasting rocks.

The composition of gun cotton has not been very satisfactorily determined; by some it has been considered as a *nitrate of lignine;* that is, as a direct atomic combination of lignine and nitric acid, represented by the formula C_{24} H_{16} $O_{16} + 5\,NO_5$. Porret thinks that the cotton acquires oxygen from the nitric acid, and forms a new basic compound which he calls *lignea*, and he regards gun cotton as a *hyponitrite of lignea*.

Gun cotton is soluble in ether, and furnishes a glutinous liquor which has been used as an adhesive application in surgery, and even as a substitute for common sticking plaister, or goldbeater's skin. This solution has been called *Collodion*. When spread upon a surface the ether evaporates and leaves the gun cotton in the form of a transparent film, still very inflammable and explosive, and like the gun cotton itself, becoming highly electric on friction.

GU'RHOFITE. A compact magnesian carbonate of lime, from Gurhoff in Lower Austria.

GUTTA PERCHA. This important article, the uses of which in arts and manufactures are on the rapid increase, is the produce of a large forest tree (*Isonandra Gutta*. Nat. Ord. *Sapotaceæ*) growing in the mountains of Singapore, and in the forests of Johore at the extremity of the Malayan Peninsula, and in Borneo; it is plentiful at Sarawak, where it is called *Niato;* it is also supposed to abound on the clusters of islands to the south of Singapore. The gutta percha appears to separate from the juice or sap of the tree in the same way as India rubber, and its general properties in regard to solvents and to the products of destructive distillation resemble those of caoutchouc. At common temperature gutta percha is somewhat hard and very tough and unyielding, but when immersed in boiling water it softens so as to admit of being beaten into a mass and moulded into any requisite shape, and on cooling it resumes its hardness. In very thin films it has a pale yellow or pinkish tinge, but generally occurs in brown or blackish lumps or masses, of a somewhat mottled appearance upon the cut surface, and translucent at the edges. When softened it may be stretched into slips which do not recover their former shape when the force is withdrawn, but retain a kind of leathery pliability on cooling. When heated to about 350° gutta percha undergoes a kind of fusion, and remains viscid when cold. It burns with a strong yellow smoky flame. It is said to be obtainable in very large quantities, but that from the destructive mode hitherto pursued by the natives in obtaining it, there is a risk of its scarcity. It was first

made known in England in 1843 by a communication from Dr. Montgomery to the Society of Arts.

Gutta percha has been applied to the manufacture of cements, architectural and other ornaments, bookbinding, tubes, water-pipes, engine-hose, picture-frames, bottles, and drinking-cups, and to the soles of boots and shoes, &c. &c.; and when blended with caoutchouc it is used for driving machinery, for saddles, cushions, walking-sticks, &c.

GYNÆCO'NOMI. Athenian magistrates superintending the conduct of women, and having the power of inflicting punishment in cases of misdemeanour. They differed, therefore, from the *Gynæcosmi*, who were inspectors of dress.

GYRASOL. *See* GIRASOL, in DICT.

GYRATION, CIRCLE OF. If a body revolve round an axis, a point can be found in it at a certain distance from the axis at which, if the whole body were compressed, the moment of inertia would remain the same. This point is called the *centre of gyration*, and the radius of the *circle of gyration* is its distance from the axis. Thus, if M be the mass of a body and k the radius of gyration, then $k^2 \times M =$ the moment of inertia; and if r be the distance of any particle m of the body from the axis, we have the equation $k^2 M = \Sigma (r^2 m)$, where the quantity on the right-hand side of the equation will be found by integration for the particular body under consideration.

GY'RINUS. (Lat.) The water flea.

GY'ROSCOPE. (Lat. gyrus, *a circle*; Gr. σκοπεω, *I view*.) An instrument for exhibiting the effects of revolution or rotation, or both together.

H.

HABERGEON. (Fr.) A coat of mail composed of chain-work for the defence of the neck and breast.

HÆ'MACHROME (Gr. αἱμα, *blood*, and χρωμα, *colour*.) The colouring matter of the blood: called also *hæmatosyn*.

HÆMAL ARCH. (Gr. αἱμα, *the blood*.) That part of the vertebra or primary segment of the skeleton which encompasses the main axis, or its prolongations, of the vascular system. It is situated opposite the neural arch, and, except in man, is inverted and beneath the centrum.

HÆMAPOPHY'SIS. (Gr. αἱμα and αποφυσις, *process*.) The autogenous vertebral elements which close or form the hæmal arch. In the human thorax they close the arch, as "cartilages of the ribs," with the aid of a hæmal spine or "sternal bone;" in the Saurian tail they form, with the spine, the entire hæmal arch.

HÆ'MATINE. (Gr. αἱμα, *blood*.) The colouring principle of logwood.

HÆMATO'LOGY. (Gr. αἱμα, *the blood*, and λογος, *description*.) The doctrine of the blood.

HAI'DINGERITE. A double sulphuret of antimony and iron, named after Haidinger.

HAIR PENCILS. A term applied by artists to the small brushes used in painting, and often termed *camel's hair* pencils: they are composed of fine hairs, especially of the marten, badger, minever, polecat, &c., and are mounted, when small, in quills; but when larger, in tinned iron tubes.

HAIR SALT. Efflorescent sulphate of magnesia.

HAIR'S BREADTH. The forty-eighth part of an inch is sometimes so called.

HALISPO'NGIA. (Gr. ἁλς, *the sea*; and Lat. spongia.) The generic type of a group of sponges distinguished by the presence of *silicious* spiculæ.

HA'LITUS (Lat. *vapour*.) In Physiology, the term is applied to the watery vapour which rises from newly-drawn blood: the peculiar odour of blood is conveyed by this exhalation.

HALLITE. The subsulphate of alumina found at Halle.

HAL'LOYLITE. A mineral named after M. d'Halloy. It is a hydrated silicate of alumina.

HA'LOSCOPE. An instrument for the exhibition of all the phenomena connected with halos, parhelia, &c. One, invented by Bravais, was shown at the Great Exhibition of London in 1851. The instrument consists mainly of the following parts, all connected with and revolving on a vertical axis by means of a clock-movement:—Two triangular glass prisms and one quadrangular, the first of which is hollow for the reception of water; a small mirror carried by a short arm; two opaque plates of glass for the purpose of observing one or two sides of the prisms, as may be found necessary; and, finally, a plate of glass.

To produce a representation of the parhelion, it is necessary to place a candle in a darkened chamber, on a level with and from 10 to 12 ft. distant from the glass-prism on its axis of rotation, the prism having two sides covered. On looking in a horizontal direction, the parhelion circle becomes visible. By observing one side of the prism, only three horizontal lines are seen; two being found by external and one by internal reflexion.

To produce an imitation of the white parhelion, the candle is placed in the same position, and two sides of the prism are again darkened; when, on looking at the parhelion circle at a distance of 120° from the candle, the white one will be perceived.

Coloured parhelia may be exhibited by means of the prism of water, viewed at an angle of 20° or 25°. One side of the prism being obscured, the coloured parhelion, red on the side next the candle, with a white train prolonged to 15° or 20°, will be seen.

To imitate coloured parhelia, formed at a distance of 98° from the sun, the arrangements are the same. By observing the prism and looking at the distance of 98° from the candle, a coloured spot will be observed, red to the side opposite to the candle, and less bright than the parhelion.

The circumzenithal tangent of the arc may be imitated by means of the prism of water, the candle being lowered from its original position, and two sides of the prism darkened; on placing the eye in a proper position, the image will then be reflected upon the ceiling. Several changes may be produced by simply turning the prism. The circumzenithal arc may be produced by the above arrangement, the position of the eye only being altered.

To imitate the anthelion it is necessary to make use of the quadrangular prism; its large transparent surface is turned towards the observer, and the candle placed a little above the prism at the distance of six or eight feet from it. A small circular mirror is then so placed that its centre is on a level with the top of the prism. The eye being situated behind the prism will perceive a luminous circle described beneath its edge. If a little slip of paper be placed beneath, it will be perceived more distinctly without moving. By moving the position of the eye several distinct phenomena will become visible. There are means of adjusting the apparatus to render the image for a time permanently fixed. Other phenomena besides those detailed can be shown by this instrument, and great merit is due to M. Bravais, the inventor.

HAND. A measure of four inches, by which the height of a horse is computed: also the parts of a horse — as *forehand*, for the head, neck, and fore quarters; and *hindhand*, which includes the rest. It also designates the hand of the rider; the *spur-hand* being the right hand, and the *bridle-hand* the left.

HARMALI'NE. A crystallisable alkaloid contained in the seeds of the *Peganum Harmala*.

HARMA'TTAN. The dry parching wind prevailing on the coast of Africa, between Cape Verd and Cape Lopez, in the months of December, January, and February.

HARMO'NIC RATIO. In Geometry a straight line is said to be divided harmonically, or in harmonic ratio, when it consists of three segments such that the whole line is to one extreme as the other extreme is to the middle part. *See* ANHARMONIC RATIO.

HARRIER. A small hound trained for hunting the hare, remarkable for the acuteness of the sense of smell.

HA'RRINGTONITE. A mineral compound of silica, alumina, lime, soda, and water, from the North of Ireland.

HARUSPICES. *See* ARUSPICES, in DICT.

HAU'SMANNITE. Native oxide of manganese; so called in honour of Prof. Hausmann.

HAVERSACK. A strong coarse linen bag for carrying provisions on a march.

HAY'TORITE. A variety of calcedony.

HEADSTOCK. In machinery, the framing used for supporting the gudgeons of a wheel.

HEBE. One of the recently discovered small planets belonging to the group whose orbits lie between Mars and Jupiter. Hebe was discovered on the 1st of July 1847, by Hencke, of Driessen, the discoverer of Astræa, while examining the stars in Bremiker's chart. It had then the appearance of a star of the ninth magnitude, but soon after became fainter, and appeared as one of the tenth. The new planet was named *Hebe*, with a cup for its symbol, by Professor Gauss. Its periodic time is about 1380 days. (*Monthly Notices of the Royal Astronomical Society*, vol. viii.) *See* PLANET.

HECATE'SIA. In Grecian antiquity, an entertainment given every new moon in honour of Hecate.

HE'CTOGRAMME. A French measure of weight =100 grammes, or 1543·4 English grains.

HECTOLI'TRE. A French measure of volume =100 litres, or 6102·8 English cubic inches.

HECTOME'TRE. A French measure of length =100 metres, or 3937 English inches.

HEDENBE'RGITE. A silicate of lime and iron, first described and analysed by Hedenberg, in Sweden.

HE'DYPHAN. An arsenio-phosphate of lead and lime from Sweden.

HE'LENINE. *Elecampane Camphor.* A crystalline camphor-like substance, found in the root of *Muta Helenium*, or Elecampane. Its vapour has a peculiar odour somewhat resembling that of *patchouli*. Its chemical formula appears from the analyses of Dumas and Gerhardt, to be C_{21} H_{14} O_3.

HELIO'GRAPHY. (Gr. ἡλιος, *the sun*, and γραφω, *I describe.*) A general name given to the art of fixing images of objects by means of *Photography*, which see.

HE'LVINE. A mineral occurring in small crystals at Schwartzenberg, in Saxony; it is composed of the silicates of manganese, glucina, and iron.

HEMERALO'PIA. (Gr. ἡμερα, *the day*, and ωψ, *the eye.*) A peculiarity in the sight, in which persons see in broad day light but not in the evening: it is said to be endemic in some parts of Europe, and of the West Indies. The pupil is generally more dilated and less sensible than in healthy eyes.

HEMIPI'NIC ACID. Semi-opianic acid. An acid obtained by the oxidizement of the *opianic acid*.

HEMIPLE'GIA. (Gr. ἡμισυς, *half*, and πληττω, *I strike.*) Paralysis of one side of the body.

HE'MISPHERES. In Anatomy, the two moieties of which the cerebrum is chiefly composed: in man and mammalia they approach the hemispheric form; but in most of the lower vertebrata, where the cranial cavity affords more room for the small brain, both moieties are spherical.

HE'MITROPE. (Gr. ἡμισυς, and τρεπω, *I turn.*) A term applied by some crystallographers to what are usually called *twin crystals*, from their being generally conceived to result from the cutting, as it were, a crystal in half, and then turning one of the halves half round upon the other. The plane common to the two portions of the crystal is called the *twin plane*. These crystals are often distinguished by the presence of notches or *re-entering angles*.

HEPA'TIC AIR. (Gr. ἡπαρ, *the liver.*) Sulphuretted hydrogen of modern chemistry.

HE'PATITE. (Gr. ἡπαρ, *the liver.*) A mineralogical name of some of the varieties of sulphate of baryta which have a liver colour.

HERO'S FOUNTAIN. *See* FOUNTAIN, in DICT.

HE'RSCHELITE. A prismatic mineral from Catania, in Sicily, containing silica, alumina, and potassa; so called in honour of Sir J. F. Herschel.

HESPE'RIDINE. An insipid white crystalline substance obtained from the soft spongy part of orange and lemon rind. It has also been called Aurantine.

HE'TERO. (Gr. ἑτερος, *the other, one of two.*) As a prefix, or in composition, this term usually indicates *difference*; in opposition to the prefix *homo*, which indicates resemblance.

HETO'PYLITE. (Derivation unknown.) A native phosphate of iron and manganese.

HEU'LANDITE. A mineral formerly classed with the zeolites found in the basalt of the Giants' Causeway and elsewhere: it is a silicate of alumina and lime.

HIBERNATION. *See* HYBERNATION, in DICT.

HIERO'S FOUNTAIN. *See* FOUNTAIN, in DICT.

HILUM. The point by which a seed is attached to the seed vessel.

HI'PPOCRAS. Spiced wine. The following is one of the most approved recipes for its preparation: 2 ounces of cinnamon, half an ounce of canella alba, and of cloves, mace, nutmeg, ginger, cardamoms, each 1 drachm: these are to be finely bruised and digested for three or four days, in a warm place, in a mixture of 12 quarts of canary and Lisbon wines: the liquor is then to be filtered, and 3 pounds of refined sugar added.

HIPPO'CRATES' SLEEVE. *Manica Hippocratis.* An old pharmaceutical term signifying a conical bag or strainer made of flannel or linen, in the shape of a jelly-bag.

HIPPUS. (Lat.) A spasmodic affection of the iris, occasioning repeated dilatations and contractions of the pupil of the eye.

HI'SINGERITE. A hydrated silicate of peroxide of iron, found in Sweden and Germany; occurring in rounded nodules.

HISTO'LOGY. (Gr. ιστος, *a tissue;* λογος, *a discourse.*) The doctrine of the animal tissues.

HOCK DAY. HOKE DAY. A festival formerly observed in England on the second Tuesday after Easter, in commemoration of the destruction of the Danes in the time of Ethelred.

HO'GAUITE. A mineralogical synonym of a species of *natrolite* from Högau, near the lake of Constance.

HO'LMITE. A species of carbonate of lime, named after Holme, who analysed it.

HOMBERG'S PHOSPHORUS. Fused chloride of calcium.

HOMBERG'S PYROPHORUS. *See* PYROPHORUS, in DICT.

HOMBERG'S SEDATIVE SALT. Boracic ac to which Homberg erroneously assigned sedative powe

HO'MO. (Gr. ὁμος, *one and the same.*) A pre used in composition to denote *resemblance*, and th opposed to *hetero*, which indicates *difference*.

HOMŒO'PATHY. (Gr ὁμοιος, *similar;* παθος, *fection.*) A medical hypothesis promulgated at the co mencement of the present century by the late I Hahnemann, of Leipsig, according to which every me cine has a specific power of inducing a certain diseas state of the system; and if such medicine be given t person suffering under the disease which it has a te dency to induce, such disease disappears because t similar diseased actions cannot simultaneously subs in the same organ. Medicines, therefore, are adn nistered in doses sufficient to induce an action som what superior to that of the disease, and the doses whi answer this purpose are *infinitesimal*, as it is called : millionth of a grain is often an excessive quantit "With respect to the homœopathic theory of the op ration of medicines," observes a good medical authori "all that can be said is, that it is a mere whim, u supported either by reason or by facts. With respect the practice, it evidently amounts to doing nothing b regulating the diet and habits of the patient." No all judicious practitioners have long been agreed th there are many cases which are best treated in t manner just mentioned, and in which physic does mo harm than good; in which, in short, a sensible phys cian endeavours to amuse the patient, while nature cur the disorder: so that the frequent success of homœ pathic treatment may be explained, without admitti the principles upon which it is presumed to be founde

HOMO'LOGY. (Gr. ὁμος, *the same*, and λογος, *d scription.*) In Anatomy, that department of the scien which teaches the essential correspondence or answe ableness of the parts, either in different animals, or in di ferent segments of the same animal, or in the same se ment, also the correspondence of the parts of an anim with the ideal archetype which has governed the plan its organisation. Thus, firstly, the wing of a bird is, h mologically, the same limb as the arm of a man or t fore-foot of a horse: and the "os quadratum" of bird is shown to be the same bone as the "os tym panicum" of the tortoise, and as the "auditory pr cess of the temporal bone" of a man. They a said to be "homologous" parts, and the propositio are examples of what has been called "special hom logy." Secondly, the wing of a bird is the same correlative part in its segment of the body, as the leg in a more posterior segment: just as the frontal bone the correlative element in its segment, with the supe occipital bone in its segment. The wing of the rig side is also the answerable part of the wing of the l side; in the same way that the right neurapophysis any given segment answers to the left neurapophysis the same segment. Propositions of this kind are e amples of what is termed "serial homology;" and t parts so corresponding are said to be "homotypal thus the arm is the homotype of the leg, the humer of the femur, the radius of the tibia, the ulna of t fibula, &c. Thirdly, in relation to the archetype of t vertebrate skeleton, the arm is the "diverging appen age" of its segment; the superoccipital bone is the "ne ral spine;" the exoccipital bone or "condyloid part the occipital bone" in "Anthropotomy" is the "neu apophysis;" the basioccipital bone or "basilar process the occipital bone" is the "centrum" or "body" of segment: these propositions are instances of what termed "general homology," as being expressive of t highest generalisations in that philosophical departme of anatomical science. — See Owen *On the Archety and Homologies of the Vertebrate Skeleton.*

HOMO'NYMOUS. (Gr. ὁμος, *the same*, and ονυμ *a name.*) In Anatomy, syn. of Homotypal. " those of the right side arise from the left part of t brain, and *vice versâ*, which seems to be the opinion the best anatomists, then one would imagine that t homonymous nerves of the right and left side must, crossing over, lie somewhere contiguous to each oth and so impart vibrations to each other." — *Hartley.*

HO'MOTYPE. (Gr. ὁμὸς and τυπος.) In Anato the correlative in one segment with any given part another segment, or in the same segment, of one a the same animal. Thus the frontal bone is the ho type of the superoccipital bone; the humerus is t homotype of the femur; the parts on the right side homotypes of those which are repeated on the l side. It is the object of "serial homology" to de mine "homotypal" parts. *See* HOMOLOGY.

HO'NEY DEW. A sweetish substance ejected u the leaves of plants by certain *aphides*.

HO'PEITE. A mineral named after Dr. Hope, l Professor of Chemistry at Edinburgh; it is said to b hydrous phosphate of zinc and cadmium.

HOOPOO. The vernacular name of the *Up Epops*, in Ornithology.

HORSE POWER. A dynamical unit employed for expressing the power or magnitude of a steam engine.

When Mr. Watt first employed his improved steam engine in turning mills, many of which had previously been driven by horses, it became desirable to possess some measure of power whereby the size of engine proper for the supercession of any given number of horses might be approximately determined. Mr. Watt consequently made several experiments to ascertain the amount of power exerted by a horse in a given time, and he found that the strongest class of dray horses would on an average raise a weight of 33,000 lbs. through one foot in the minute, by the intervention of appropriate mechanism. This dynamic effort, therefore, he designated a *horse power*, and when he had to introduce an engine which should be capable of performing the work of any given number of horses, he had only to take care that it would be able to raise 33,000 lbs. one foot high in the minute for every horse power that it was intended to supersede. The dimensions of engine which should be capable of raising any multiple of 33,000 lbs. one foot high in the minute were at the same time determined, and that multiple expressed the number of horses power the engine was able to exert. Thus if the engine were of such dimensions as to be able to raise 5 times 33,000 lbs. one foot high in the minute, it would be 5 horses power; if it were able to raise 10 times 33,000 lbs. one foot high in a minute, it would be of 10 horses power, and so of any other number. The effective pressure on the piston of these engines, or the pressure considered available for imparting motion to any body, after deducting the power consumed by the engine itself, was reckoned to be about 7 lbs. on the square inch. The area of the piston, therefore, in square inches multiplied by 7 represented the effective moving pressure, and the space travelled through by the piston in the minute gave the distance through which the pressure or weight operated. The total effective weight or pressure upon the piston, therefore, multiplied by the space through which it passes, and divided by 33,000, would in all cases give the number of horses power that the engine was capable of exerting, and as the effective pressure upon the piston was limited to about 7 lbs. on the square inch, and as the speed of the piston was limited to about 220 feet in the minute, a certain dimension of engine was necessary to realise any prescribed power, and came to be considered as tantamount to that power. In this way, therefore, engines of certain dimensions came to be considered as of a certain power, and engines were bought and sold by the horse power in the same way that cloth is bought or sold by the yard measure, and the engine would in all cases exert just about the power at which it was nominally rated.

In process of time, however, a different state of things supervened. When Watt's patent expired, numerous other manufacturers of engines sprang into existence. By degrees the pressure upon the piston came to be increased: the velocity of its motion was also increased, and a dimension of engine answerable to a horse power became capable of raising much more than 33,000 lbs. one foot high in the minute. Engines continued, however, to be bought and sold by the horse power, just as if there had been no increase in their efficiency, and the same dimension of engine was reckoned equal to a horse power that was accepted before. There came, consequently, to be two kinds of horse power,— the one a *dynamical unit*, which measures the number of times 33,000 lbs. can be lifted one foot high per minute by the engine; and the other a *commercial unit*, which measures the dimension of the engine. The dynamical horse power is what is termed *actual horse power;* the commercial or conventional unit is what is termed *nominal horse power*. In speaking of engines great misapprehension and confusion have been caused from the want of a distinct idea of the difference between actual and nominal power.

The actual power of any engine cannot be determined except approximately, before the engine is made; but it is ascertained, when the engine is at work, by means of an instrument called the indicator. An engine sometimes exerts more actual power than at other times, although its nominal power remains unaltered. For example, when a steam vessel in entering a harbour lowers her speed, the steam is partially excluded from the cylinder, and there is consequently less pressure upon the piston than before. A similar result will follow if the coals be bad, or there be an inadequate proportion of boiler; and the efficiency with which an engine works is in all cases ascertainable by determining by means of the indicator the actual power. (See INDICATOR, in the SUPPLEMENT.) In modern engines the actual power is from 2 to 4 times greater than the nominal power. In other words, an engine purchased or popularly spoken of as 1000 horses power, will be able to lift from 2000 to 4000 times 33,000 lbs. one foot high in the minute. Such an engine, therefore, though nominally of 1000 horses power, will exert actually from 2000 to 4000 horses power; the exact amount of power exerted being determinable only by the application of the indicator to the engine. For the mode of determining the actual power of an engine see the article INDICATOR. The nominal power may be determined by the following rule: — Multiply the square of the diameter of the cylinder in inches by the cube root of the stroke in feet and divide by 47. The result is the nominal power of the engine in horses. The reader will find in the *Artizan Club's Treatise on the Steam Engine*, p. 96., a table of the nominal horse power of low pressure or condensing engines.

HU'MORAL PATHOLOGY. The doctrine which refers disease to a morbid condition of the humours or fluids of the body, as opposed to *nervous pathology*, which refers them to the nervous energy resident in the solids.

HUMBOLDTITE. So called in honour of Humboldt. A crystalline mineral found in the lava of Vesuvius; it is a silicate of lime and magnesia.

HU'MIC ACID. HUMINE. (Lat. humus, *the ground.*) The peculiar brown matter which may be obtained from bog-earth, peat, and turf, and which may also be extracted from most soils, where it is derived from the slow decay of plants; it is also contained in brown decayed wood, and in the brown exudations of the bark of certain trees, more especially in that of the elm, or *ulmine*. By the action of several chemical agents on different organic bodies, the same substance is frequently produced. It is a substance which contributes to the fertility of soil, chiefly, perhaps, in consequence of its absorptive power in regard to ammonia.

HUMMOCK. A level sheet of *ice*. A circular mound appearing at a distance is also so called.

HU'NGER. (Germ.) The sensation in the region of the stomach arising from the want of solid food: in intensity it varies considerably in different individuals, and is sometimes attended by pain and windy rumblings in the epigastrium. When severe, hunger is attended by slow respiration and circulation, and diminution of the heat of the body and of the secretions. The return of hunger is accelerated by exercise and fatigue, and by a low temperature. In debilitated constitutions excessive hunger should be carefully avoided, and in any case, the effects of fasting may prove prejudicial to the functions of the stomach.

HU'RAULITE. A phosphate of iron and manganese found at Huraux, in the Haute Vienne.

HU'RONITE. A mineral from the vicinity of Lake Huron; it is imbedded in a species of hornblende: it is a hydrated silicate of alumina, and contains also lime, magnesia, and oxide of iron.

HY'ALOSI'DERITE. (Gr. ὑαλος, *glass;* σιδηρος, *iron.*) A mineral consisting essentially of the silicates of magnesia and iron, from Sasbach, in Brisgau. It is of a glassy lustre.

HY'DROLITE. (Gr. ὑδωρ, *water;* λιθος, *a stone.*) A silicate of alumina, iron, and potassa, containing nearly 30 per cent. of water: it has principally been found in the amygdaloidan rocks of Antrim in Ireland.

HYDRO'PATHY. (Gr. ὑδωρ and παθος, *disease.*) This term is applied to a treatment of disease generally called the *cold water cure;* it was suggested in 1828, by Vincent Priessnitz of Graefenberg in Silesia, and consists in the internal and external administration of cold water, accompanied by air and exercise, early hours, and strict attention to diet; there are, therefore, many cases in which such a plan rationally pursued must be obviously useful, more especially to overphysicked individuals, residing in populous towns, eating and drinking too much, and keeping bad hours. At the same time, some parts of the treatment "are of so outrageous a character, as frequently to aggravate the disease which they are intended to cure, and occasionally to endanger or even destroy the life of the patient." (The term *hydropathy* is considered to be a corruption from *hydro-therapeutics.*)

HYDROTHIO'NIC ACID. (Gr. ὑδωρ and θειον, *sulphur.*) Hydrosulphuric acid, or sulphuretted hydrogen.

HY'DRURET, or HYDROGURET. A term applied in chemistry to some of the compounds of hydrogen, more especially with the metals.

HYGE'IA. One of the group of small planets between Mars and Jupiter. Hygeia was discovered by Dr. Annibal De Gasparis, of the Observatory at Naples, while comparing Steinheil's map with the heavens, on the 12th of April, 1849. It had then the brightness of a star between the ninth and tenth magnitudes. De Gasparis referred the naming of the planet to Capocci, who called it *Hygeia*, and selected for its symbol a serpent crowned with a star. It was the tenth in the order of discovery. See PLANET.

HYGRO'MA. (Gr. ὑγρος, *moist.*) A tumour containing serum or other nonpurulent fluid.

HYGRO'METRY. (Gr. ὑγρος, *moist*, and μετρον, *measure.*) Of the various methods which have been proposed for ascertaining the hygrometric condition of the atmosphere that which consists in deducing

the tension of the aqueous vapour contained in it from the temperatures indicated by two contiguous thermometers, one having its bulb kept wet, while that of the other is dry, is, perhaps, the most generally convenient, and is accordingly that which is usually adopted in meteorological observations. The apparatus has been called a *Psychrometer*, and is described under that name in the DICTIONARY OF SCIENCE, though the term, from its etymology, might be applied with equal propriety to any other hygrometer or instrument for measuring the quantity of vapour existing in air. On account of the importance of this instrument in meteorology, we propose, here, to state the theory upon which its application depends.

It may be proper to premise that the relation between the tension, or the elastic force of aqueous vapour, and the temperature (a relation which is the subject of experiment) is supposed to be known for all temperatures under consideration, and exhibited in a table. Hence, to determine the elastic force of the vapour existing in the atmosphere at a given temperature, is the same problem as to determine the degree of temperature to which, if the air were cooled down, it would be saturated with the same quantity of vapour as it actually contains, and begin to deposit moisture; and, reciprocally, if this temperature, which is that of the *dew point*, be determined, the tension of the vapour existing in the air becomes known from the previously ascertained relation between the tension and the temperature of aqueous vapour. Tables of the numerical expression of this relation were constructed by Dalton, and are given in most works which treat of the subject. *See* VAPOUR, in DICT.

Theory of the Psychrometer.—When water or any wetted surface is exposed to air not saturated with moisture, vapour is formed; and, in the formation of vapour, heat is absorbed or becomes latent. The heat thus absorbed being taken from the body from whose surface the evaporation takes place the body becomes colder, and the thin shell or stratum of air in immediate contact with it is cooled down to the same temperature. Now, the theory of the psychrometer is founded on this hypothesis, namely, that the quantity of heat abandoned by the thin shells of air which successively come into contact with the wetted bulb of the thermometer is precisely equal to the heat absorbed in the formation of the vapour.

From this hypothesis an equation is obtained which gives the tension corresponding to the temperature of the dew point in terms of the tension corresponding to the temperature of the wet bulb (that of evaporation), the difference of the readings of the wet bulb and dry bulb thermometers, and the height of the barometer, in the following manner: Let t denote the temperature, in Fahrenheit degrees, indicated by the dry bulb thermometer, and t' the temperature indicated by the wet bulb thermometer. The thin shell of air in immediate contact at any instant with the wet bulb, which previous to the contact had the temperature t, is cooled down to t', and consequently abandons a certain quantity of heat. But the shell is composed partly of dry air, and partly of aqueous vapour. If, therefore, we assume

A=the heat abandoned by the dry air in the shell,
B=the heat abandoned by the vapour originally existing in the portion of air forming the shell,
C=the heat absorbed by the vapour formed and taken up by the shell;

then by the hypothesis

$$A+B=C. \qquad (1.)$$

To express these portions of heat universally, we have

A=weight of dry air in shell × specific heat of dry air × $(t-t')$,
B=weight of vapour in shell × specific heat of vapour × $(t-t')$,
C=weight of vapour formed × latent heat of vapour at temperatures between t and t'.

Now let

w=weight of shell of dry air, at 32°, under a pressure equal to 30 inches of mercury,
α=coefficient of expansion of air for 1° Fahrenheit =1-480th,
δ=ratio of density of vapour to density of dry air,
h=height of the barometer in inches,
f'=elastic force of aqueous vapour, in saturated air, at temperature t', measured in inches of mercury,
x=elastic force of the vapour actually existing in the air at temperature t, or the tension of vapour at the dew point;

then, in respect of the thin shell of air surrounding the wet bulb, we have the following expressions for the several weights, viz.

Weight of dry air in shell $=w\dfrac{1}{1+\alpha t'}\cdot\dfrac{h-f'}{30}$,

Weight of vapour in shell previously to contact with wet bulb $=w\delta\dfrac{1}{1+\alpha t'}\cdot\dfrac{x}{30}$,

Weight of vapour formed $=w\delta\dfrac{1}{1+\alpha t'}\cdot\dfrac{f'-x}{30}$.

Now putting

γ=specific heat of dry air,
k=specific heat of vapour,
λ=latent heat of vapour between t and t';

and substituting these and the above expressions for the weights in A, B, and C, the equation (1.) becomes

$$\gamma(h-f')(t-t')+k\delta x(t-t')=\lambda\delta(f'-x),$$

from which we obtain

$$x=\frac{\lambda f'-\frac{\gamma}{\delta}(t-t')(h-f')}{\lambda+k(t-t')}. \qquad (2.)$$

Of the quantities which enter into this equation t, t', and h are given by direct observation, and f' is given when t' is known from the table of tensions above referred to. The remaining quantities are supposed to have been determined experimentally, and their values are as follows:—

1. From the experiments of Laroche and Berard the specific heat of dry air, γ, was found to be 0·2669, that of water being unity.

2. The specific heat of aqueous vapour, k, is less certainly determined. August assumes it to be equal to that of dry air. Laroche and Berard found it to be 3·136 times that of dry air. In the present case its accurate value is not important, for the term which it multiplies is so small in comparison of λ that it may be rejected without sensible error.

3. The density of aqueous vapour, δ, referred to that of dry air at the same temperature, was found by Gay Lussac to be 0·6235, or nearly 5-8ths. Regnault assumes δ=0·622.

4. With respect to the latent heat of vapour, λ, its value at any temperature is deduced from its known or assumed value at 212° by means of the hypothesis (confirmed by experiment) that the sum of the latent and sensible heat is constant for all temperatures. At 212° the latent heat of vapour is usually assumed, according to the determination of Lavoisier, to be 1000; that is to say, as much heat is absorbed in the formation of a certain weight of vapour as would raise the temperature of 1000 times the same weight of water one degree of Fahrenheit's scale. Hence at 32° it is 1180. Regnault ascertained by direct experiment that the formula for the psychrometer would be more accurate by taking λ equal to 610° on the centigrade scale, at the temperature of freezing; this corresponds to 1098° of Fahrenheit, and, consequently, at 0° Fahrenheit the latent heat is 1130°. For any other temperature, t', we have, therefore, $\lambda=1130-t'$.

Substituting these values of γ, k, δ, and λ, in the formula (2.), and rejecting $k(t-t')$ in the denominator, it becomes

$$x=f'-\frac{0{\cdot}429(t-t')(h-f')}{1130-t'}. \qquad (3.)$$

For $t'=50°$, this gives $x=f'-{\cdot}000397(t-t')(h-f')$.

If the temperature of the wet bulb fall below the freezing point the water surrounding the bulb is frozen, so that it is ice which is evaporated. And as 140° of heat are expended in converting ice into water the formula becomes, for this case,

$$x=f'-\frac{0{\cdot}429(t-t')(h-f')}{1270}. \qquad (4.)$$

The value of x being computed from this formula the corresponding temperature in the table is that of the dew point.

Objections of various kinds, theoretical and practical have been raised to the results obtained by this method The fundamental principle adopted by August is, tha the whole of the air which supplies heat to the wet bul falls to the temperature of that bulb, and becomes com pletely saturated with moisture. But it seems mor probable that the air coming into contact with the bul does not quite take the temperature of the bulb, an that the saturation is not complete. Regnault remark that the ratio of the quantity of heat which the air take from the bulb by the vaporisation of the water to th quantity which it loses in being cooled is probably no constant, but so much the greater as the air is drie because dry air absorbs moisture with greater avidit than when it is nearly saturated. Another objection i that the heat which is absorbed in converting the wate on the wet bulb into vapour is not supplied exclusivel by the surrounding air, but in some measure by th radiation from objects around (for example, the fram to which the thermometers are attached, or the dr bulb itself if too near), the influence of which it is perha impossible altogether to eliminate. Other objection are founded on the considerable uncertainty as to th numerical values of some of the elements which ent

into the formula, and especially with respect to the heat absorbed by water when vaporised in air. Regnault, therefore, considers that the safest course is to determine the coefficients of the formula by direct experiments under determinate conditions. One means of accomplishing this is to compare the results of a large number of observations with the temperatures of the dew point ascertained directly by simultaneous observations with a Daniell's hygrometer; but as this instrument itself cannot be relied on with certainty, the only sure method would seem to be that of separating the moisture from the air and determining their proportions by actually weighing them.

It is important to determine the influence of the wind on the results obtained by this instrument. According to theory, when the difference of the temperatures indicated by the two thermometers has become stationary, the agitation of the air should have no effect on them; for as the degree of cold ultimately produced depends on the *intensity*, and not on the *velocity*, of evaporation, the effect of wind on the wet bulb might be expected to be only that of depressing its temperature more speedily, but not to a lower point. Regnault made numerous experiments on this subject, and arrived at the conclusion that wind certainly does influence the observation, but when the instrument is exposed to free air the influence is not perceptible so long as the velocity of the wind does not exceed five or six *metres* per second (16 or 20 English feet, or from 11 to 14 miles per hour). When the wind blows strongly, another disturbance may arise from the circumstance that the masses of air successively brought into contact with the wet bulb may have very different degrees of humidity. On the other hand, when the air is perfectly calm it is not improbable that an atmosphere of saturated air may be formed and remain about the wet bulb, extending to some sensible distance; for it is known that vapour diffuses itself through air in this state slowly and with difficulty. It is scarcely necessary to add, that when the air is nearly saturated with vapour, and there is consequently little difference between the temperatures indicated by the two thermometers, the results obtained must be liable to considerable uncertainty.

The formula for computing the temperature of the dew point, from observations of a dry and wet bulb thermometer, was first investigated by Professor August, of Berlin, and is given in his work *Ueber die Fortschritte der Hygrometrie* (Berlin, 1830), the same in form as the above, but with slightly different constants. There is also an investigation on the same principle, and leading to the same results, by Dr. Apjohn, in the Dublin *Transactions* for 1834 and 1835, and tables have been constructed by Col. Boileau for facilitating the computation of the formula. But the fullest and best information on the subject is contained in a paper by Regnault, published in the *Annales de Chimie et de Physique* (3me series, tome xv., Paris, 1845). In this paper Regnault describes a new hygrometer, invented by him, for determining the dew point by direct observation, the cold being produced, as in Daniell's hygrometer, by the evaporation of ether; but in Regnault's instrument the ether, instead of being poured over the wet bulb, and much consequently wasted, is confined within a glass tube, or cylinder, of about an inch in diameter, and agitated by blowing a stream of air into it through a flexible tube. A rapid evaporation consequently takes place within the cylinder, and the cold thereby produced causes a deposition of dew on the outside. A delicate thermometer placed inside the cylinder, immediately over the ether, indicates the temperature, which must be noted at the instant the deposition commences, and should be again noted at the instant it disappears. A portion of the cylinder over the ether is blackened for the purpose of intercepting the passage of light, whereby the deposition is rendered more easily visible. Of the various hygrometers which have been proposed on the principle of condensing the vapour existing in the air, or as modifications of Daniell's, this appears to be the most satisfactory.

HYOI'DES. (From the Greek letter υ, and ειδος, *like.*) A bone situated between the root of the tongue and the larynx is called the Os Hyoides, or hyoid bone, from its supposed resemblance in shape to the letter U or upsilon.

HYPAPO'PHYSIS (Gr. υπο, and αποφυσις, *a process.*) In Anatomy, the usually exogenous process which descends from the lower part of the centrum or vertebral body: it is sometimes single, as in the cervical vertebræ of the lizard; sometimes perforated, as in certain cervical vertebræ of birds; sometimes double, in a transverse pair, as in the caudal vertebræ of certain mammals, where they support the hæmal arch.

HY'PER. (Gr. υπερ, *over, above.*) In chemical nomenclature this prefix is sometimes used to denote acids containing more oxygen than those to which the term *per* is prefixed.

HYPERÆ'MIA. (Gr. υπερ, and αιμα, *blood.*) Congestion of blood in any part.

HY'PERCATHA'RSIS. (Gr. υπερ, and καθαιρω, *I purify.*) Excessive purging.

HYPERI'CUM. (Gr. υπερ, and εικων, *an image*, so called from a supposed power of expelling evil spirits.) The *Hypericum perforatum*, or St. John's Wort, was much esteemed by the ancients as an anodyne.

HY'PO. (υπο, *under.*) In chemical nomenclature this prefix indicates the presence of a smaller quantity of oxygen than that contained in the acid or compound to which it is prefixed, thus the *hyposulphurous acid* contains less oxygen than the sulphurous, and the *hyposulphuric acid* less oxygen than the sulphuric; and the *hyponitrous* acid less oxygen than the nitrous, etc.

HY'POCYST. A pharmaceutical name of the inspissated juice of the *Cytisus hypocistis*, a parasitical plant on the roots of several species of *cystus* in the S. of Europe.

HYPOGÆ'UM. (Gr. υπω, and γη, *the earth.*) A term applied by ancient architects to the cellars and other underground parts of a building.

HYPOGA'STRIUM. (Gr. υπο, and γαστηρ, *the stomach.*) The middle part of the lower region of the belly.

HYPO'GLOSSAL NERVES. (Gr. υπο, and γλωσσα, *the tongue.*) The lingual nerves.

HYPO'PHYSIS (Gr. υπο, and φυσις, *nature* or *origin.*) In Anatomy, the gland-like body and sac which originate from the under surface of the third ventricle of the brain, and are lodged in the "sella turcica." *See* PITUITARY GLAND.

HYPSO'METRY. (Gr. υψος, *height*, and μετρον, *measure.*) The art of measuring heights either relative or absolute, by trigonometry or the barometer.

HYSON. A commercial name of one of the varieties of *green tea. See* TEA, in DICT.

HYSSOP. The name of a genus of plants including the common hyssop (*Hyssopus officinalis*), formerly used in medicine as a stimulant and expectorant.

HYSTERO'TOMY. (Gr. υστερα, *the womb;* τεμνειν, *to cut.*) The extraction of the fœtus from the uterus. The *Cæsarean operation.*

I.

IA'TRALEI'PTES. (Gr. ιατρος, *a physician;* αλειφω, *I anoint.*) A physician who cured diseases by external remedies only, as by friction, inunction, &c. There was among the Greeks a sect of Ιατραλειπται founded by Prodicus, a disciple of Esculapius.

IA'TROMATHEMA'TICI. (Gr. ιατρος, and μανθανω, *I learn.*) Physicians who explain the functions of the body, and the action of remedies on mechanical principles. These doctrines seem to have originated with Asclepiades, and in modern times were promulgated by Borelli as founded on the atomic philosophy of Descartes.

ICE. (Ger. eis.) Frozen water. At the temperature of 32°, water, in its ordinary condition, crystallises into ice, which if slowly produced forms prisms crossing each other at angles of 60° and 120°; the primitive figure has not been ascertained, though it is probably rhomboidal. The arrangement of the acicular prisms in flakes of snow is very various, but in the same snow storm the same forms of arrangement generally prevail. The specific gravity of ice in its densest form is about ·950. It is a nonconductor of electricity, and becomes electric by friction. The expansion of water in the act of freezing, takes place with irresistible force, and the frequent rupture of thick iron and leaden pipes from this cause is a familiar instance of this. Exposed to air ice loses considerably by evaporation. In the act of freezing water parts with all soluble matter, so that coloured water becomes colourless ice; saline solutions become pure water; and spirituous liquors part with their alcohol. To effect this purification perfectly, the ice must be formed under circumstances which prevent the accumulation of blebs and air bubbles, and the entanglement in the ice of any of the unfrozen or ejected liquor, for the foreign matters held previously in solution in the water, are, in the act of freezing, transferred to the portion which remains unfrozen, when the whole of the water becomes a mass of porous ice the impurities are retained in the pores; but those brilliant and perfectly transparent and dense masses of ice which we find in the American and Norway ice as imported into this country, yield, when thawed, water equal in purity to that which has been distilled; and nearly free from air.

ICHTHYO'PHAGIST. (Gr. ιχθυς, and φαγω, *I eat.*) A fish eater: some savage tribes who live almost entirely on fish were called by the ancients *Ichthyophagi.*

I'GLOITE. A mineralogical synonym of one of the varieties of carbonate of lime, or *Arragonite.*

ILLU'DERITE. A mineralogical synonym of *Epidote*.

I'LMENITE. The titaniferous iron ore from Ilmensea, near Minst.

I'LVAITE. A mineral from *Elba*, in black prismatic crystals: it is a silicate of iron and lime.

IMBIBI'TION. (Lat. in, and bibo, *I drink*.) The absorption of a liquid into the pores of a solid: much importance has been attributed to this property as belonging to the organic tissues and as affecting their functions.

IMPE'RIAL. A beverage formed by dissolving one drachm or one drachm and a half of cream of tartar in a pint of boiling water, and flavouring with lemon peel and sugar. When cold, it may be taken *ad libitum*.

INCLINO'METER. An apparatus for determining the vertical element of the magnetic force. The difficulty of determining this element by a direct method is considerable, on account of the delicacy of the apparatus which is requisite. Various indirect methods have been proposed. Dr. Lloyd, in the *Account of the Magnetical Observatory at Dublin*, describes an Inductive Inclinometer, "the principle of which is the measurement of the intensity induced on a vertical bar of soft iron by the deviation it is capable of causing in a horizontal bar suspended near it." Weber, of Gottingen, proposed a method, in which "the deflexion of the horizontal magnet is produced by the earth's magnetism, induced not on a vertical bar of soft iron at rest, but on a ring, sphere, or plate of copper made to revolve about a vertical axis." Dr. Lamont, of Munich, proposed a third and less simple method: "As in Dr. Lloyd's process, a bar of soft iron is used as a temporary magnet. The bar so temporarily magnetised is made to act unequally on the two bars of an astatic magnetic couple, thereby tending to draw them aside from a given position in which they would otherwise be held by a fixed magnet of a given power. This tendency is, however, destroyed by another magnet placed in a given position at a given distance. A series of reversals and changes of distance in the soft iron bar and the neutralising bar is then operated, which furnishes equations by means of which every quantity excepting the intensity sought and known quantities can be eliminated." — (*British Association Report*, 1842.) See MAGNETOMETER.

INDIAN RUBBER. *See* CAOUTCHOUC, in DICT. A curious and important modification of this article has been discovered by Mr. Thos. Hancock; it is generally known under the name of *Vulcanised India-rubber*, and is, in fact, caoutchouc combined with a very small proportion of sulphur: the several modes of effecting this are fully described in the specification of his patent. Vulcanised India-rubber, does not, like the ordinary article, become hard and rigid by cold, and it bears a very high temperature without change of properties. It is much more perfectly elastic than the common rubber, so that when stretched it does not acquire a set, but returns, when released, to its former dimensions. This discovery has rendered caoutchouc applicable to an infinity of purposes, for which, in its ordinary state, it is either unfit or objectionable. Among the most remarkable properties of Vulcanised caoutchouc, is the resistance which it affords to naphtha, oil of turpentine, ether, oils, and a variety of other substances which are comparatively without action upon it, whereas they either soften, or dissolve common rubber.

INDIAN YELLOW. *See* EUXANTHINE.

I'NDICATOR. (Lat. indico, *I point out*.) An instrument for determining the power exerted by a steam engine. This instrument consists of a small cylinder and piston, which is placed in connexion with the cylinder of the engine by means of a pipe and stop-cock fitted into the cylinder cover. The cylinder of the indicator is open at the top, so as to permit the access of the atmosphere, and its piston is kept at about the middle of its stroke by means of a spring, when the instrument is out of connexion with the engine; but when the stop-cock is opened so that the space beneath the piston of the indicator is put in connexion with the cylinder of the engine, the piston of the indicator is pressed up and down every stroke by the alternate steam pressure and vacuum existing within the cylinder of the engine. The extent to which it is pressed up and down indicates the amount of pressure urging the piston of the engine; and a scale is attached to the side of the indicator, graduated with pounds pressure, upon which a pointer in connexion with the indicator piston shows the number of pounds pressure above the atmosphere that is exerted by the steam, and also the number of pounds pressure below the atmosphere that is exerted by the vacuum.

I'NDIGOGE'NE. *Indigo white*. *See* INDIGO, in DICT.

I'NDIGOTI'NE. The sublimate obtained by heating indigo. *See* INDIGO, in DICT.

INFUNDIBU'LIFORM. A botanical and anatomical term, signifying *funnel shaped*. The *Infundibulum* of the brain is a canal proceeding from the lower and anterior part of the third ventricle of the brain to the pituitary gland.

I'NGUINAL. (Lat. inguen, *the groin*.) Appertaining to or situated in or near the groin: as *inguinal artery*, *inguinal hernia*, etc.

INHALA'TION. (Lat.) The drawing of air, gases, or vapours, into the lungs. Many substances are medicinally applied in this form, by means of an *inhaler*, an instrument so contrived as to admit of the inhalation of a variety of vapours mixed more or less with atmospheric air. The steam of hot water, the vapour of tar, of ether, of chloroform, of iodine, chlorine, &c. are often thus administered.

INJE'CTION. A liquid thrown into a cavity of the body by means of a bladder, syringe, or elastic bottle. Injections thrown into the rectum are called *enemata*, or *clysters* (from κλυζω, *I wash*).

I'NOLITE. (Gr. ινεω, *I cleanse*, and λιθος, *a stone*.) A variety of carbonate of lime.

INOSI'NIC ACID. (Gr. ινοω, *I absorb*.) An acid said by Liebig to exist in the juices of the flesh of animals.

INTERCO'STAL. (Lat. inter, and costa, *a rib*.) In anatomy, a designation of certain bloodvessels, nerves, and muscles, situated between the ribs.

INVERMINA'TION. (Lat. in, and vermis, *a worm*.) The morbid state of the intestinal canal occasioned by the presence of entozoary animals. *See* INTESTINALIA, and ENTOZOA, in DICT.

I'ODATES. Salts of the iodic acid.

IRE'NE. One of the small planets belonging to the group whose orbits lie between those of Mars and Jupiter, and the fourteenth in the order of discovery. Irene was discovered by Mr. Hind, at Mr. Bishop's observatory in the Regent's Park, on the 19th of May, 1851. When first observed, its brightness rather exceeded that of a star of the ninth magnitude; its light is very blue, and it appears to be surrounded with a faint nebulous envelope, not perceptible about the stars in its vicinity. Its period is about 1519 days. (*Monthly Notices of the Royal Astronomical Society*, vol. xi.) *See* PLANET.

IRIDE'SCENT FILMS. Iridescent films are produced by dropping a little oil or spirit of varnish upon the surface of water contained in a vessel. When the water becomes tranquil, the varnish spreads in all directions, becoming exceedingly attenuated, and reflects the most vivid colours of the spectrum. If any objects that require ornamenting, such as insects, shells, birds, bronzes, paper-hangings, &c., are previously immersed in the water and slowly raised to the surface after the film has been formed, the latter will adhere to their surfaces, and when they are completely dried, it will be found firmly attached to them, and perfectly iridescent, having lost nothing of its brilliancy of colouring. This is a beautiful illustration of the production of colours on a thin transparent surface, by the agency of light, such as is commonly seen in an ordinary soap bubble.

I'RIS. (Lat. *the rainbow*.) One of the newly discovered planets of the group between Mars and Jupiter. Iris was discovered by Mr. Hind, at Mr. Bishop's Observatory, on the evening of August 13. 1847, while engaged in a systematic comparison of the Berlin charts with the heavens, which soon after rewarded him with the discovery of a second planet, *Flora*. Iris, when discovered, had the appearance of a star between the eighth and ninth magnitudes. The symbol adopted for its designation is a semicircle, to represent the rainbow, with an interior star and a bare line, for the horizon. Its period is about 1342 days. Iris is the seventh of the group in the order of discovery. (*Monthly Notices of the Royal Astronomical Society*, vol. vii.) *See* PLANET.

I'RISCOPE. (Lat. iris, *the rainbow*; and Gr. σκοπεω, *I view*.) An instrument proposed by Dr. Joseph Reade for exhibiting the prismatic colours, thus described by Sir David Brewster, in the *Philosophical Transactions* for 1841: — "This instrument consists mainly of a plate of highly polished black glass, having its surface smeared with a solution of fine soap, and subsequently dried by rubbing it clean with a piece of chamois leather. If we breathe upon the glass surface, thus prepared, through a glass tube, the vapour is deposited in brilliant coloured rings, the outermost of which is black, while the innermost has various colours, or no colour at all, in proportion to the quantity of vapour deposited. The colours in these rings, when seen by common light, correspond with Newton's *reflected* rings, or those which have *black centres*, the only difference being, that in the plate of vapour, which is thickest in the middle, the rings in the Iriscope have black circumferences."

IRISH MOSS. The *Chondrus Crispus*. *See* CARRAGEEN MOSS.

I'SCHIOCE'LE. (Gr. ισχιον, *the hip*; and κηλη, *tumour*.) A hernial tumour at the foramen of the ischium.

I'SERINE. *Titaniate of iron*, from the Iser in Bohemia.

I'SINGLASS. The term Isinglass is sometimes said to be derived from *ice* and *glass* in consequence of the transparent and vitreous appearance of the concrete jelly which may be obtained from it; but the word is more evidently a corruption of the German *hausenblase*, "sturgeon's bladder."

ISOCHROMA'TIC. (Gr. ισος, *equal;* χρωμα, *colour.*) A term in Optics, applied to two or more bodies of which the colours are identical, or undistinguishable.

ISOGO'NIC LINES. (Gr. ισος, *equal;* γωνια, *angle.*) In Terrestrial Magnetism, are the lines passing through all places on the surface of the earth at which the horizontal magnetic needle makes the same angle with the meridian, or at which the *declination* is the same. *See* MAGNETISM, TERRESTRIAL.

I'SOPYRE. (Gr. ισος, *equal;* πυρ, *fire;* because the effect produced upon it by the blowpipe is the same as that produced on several other minerals!) A silicate of alumina, iron, and lime, found imbedded in granite from Cornwall.

ITACO'NIC ACID. An acid formed by the action of heat on *aconitic acid.*

ITA'LIAN JUICE. The extract of liquorice prepared in *Calabria.* That grown on the estates of the Marchioness of Solazzi, and known in commerce under the name of *Solazzi juice*, being so stamped, is the most esteemed. The *Spanish juice* is prepared in *Catalonia.*

J.

JA'LAPINE. The purgative principle of jalap root: it is a basic resin.

JAMES'S POWDER. (*Pulvis Jacobi.*) A mixture of bone-earth, or phosphate of lime, and oxide of antimony: it is often called *fever powder*, and acts as a diaphoretic, and also on the bowels, and sometimes nauseates or vomits, according to the dose in which it is exhibited. It is an uncertain remedy, and may be properly replaced by emetic tartar mixed with a little chalk or magnesia. The *pulvis antimonialis*, or *antimonial powder* of the London Pharmacopœia is intended as a substitute for James's preparation, but it also is open to the objection of uncertain activity, dependent upon the state of oxidizement of the antimony, the protoxide of that metal being virulently active, while the peroxide is nearly inert. The usual dose of James's powder is from one to five grains.

JE'RVIA. (from *Jerva*, the Spanish name of a poison obtained from white hellebore.) A basic crystalline substance, contained, together with *veratria*, in the root of *veratrum album*, or white hellebore.

JE'SUITS' DROPS. The *compound tincture of benzoin* of the Pharmacopœia: called also *Friar's balsam.*

JE'SUITS' POWDER. Powdered Cinchona bark.

JEWS' PITCH. *Asphaltum.*

JU'NKERITE. A native crystalline proto-carbonate of iron from Pullouen.

JU'RINITE. A mineral from Dauphiny, containing *titanium.*

K.

KA'KODYLE. (Gr. κακος, *bad;* and οζειν, *smell.*) A compound hydrocarbon and arsenic, having the formula $C_4 H_6$ As. It is a clear liquid which takes fire when dropped through the air, burning with a blue flame, and forming water, carbonic acid, and arsenious acid; the latter rises as a white smoke. *Cadet's fuming liquor*, called also *Alkarsine*, is an oxide of Kakodyle=$C_4 H_6$ As O.

KA'RSTENITE. Anhydrous sulphate of lime: *Anhydrite.*

KE'RATOPHY'LLITE. (Gr. κερας, *a horn;* and φυλλον, *a leaf.*) A mineralogical synonym of Amphibole or Actinolite.

KEY'SER'S PILLS. A once celebrated mercurial preparation, the active ingredient in which is the *acetate of mercury.*

KIKEKUNE'MALO, a resin, much resembling copal, brought from America, where it is said to be used medicinally. It forms excellent varnishes.

KILKENNY COAL. *Anthracite.*

KI'MMERIDGE CLAY. The clay formation of Kimmeridge, on tho coast of the Isle of Purbeck; it contains beds of bituminous shale, used as fuel, and called *Kimmeridge coal.* In the neighbourhood are found the pieces called *coal money;* they are about 3 inches diameter, flat on one side, and convex on the other, and on the flat side are two or four small holes. They are supposed to have been either money or amulets. In the same neighbourhood there has been found a shallow bowl of Kimmeridge coal containing coal money.

KINEMA'TICS, or KINE'TICS. (Gr. κινεω, *I move.*) A term used by some writers to denote the doctrine which treats of the effects of motion without reference to its causes, and in contradistinction to dynamics. Curves produced by combined movements, or by machinery, are called kinematic curves, of which many beautiful specimens are given in Mr. Henry Perigal's work on the subject. The term is used chiefly by German writers, and applies to the same subjects as are usually treated of in analytical mechanics.

KI'RWANITE. A silicate of lime, iron, and alumina, from the basalt of the North East coast of Ireland, named after Kirwan the mineralogist.

KISH. A substance occasionally produced in iron smelting furnaces: in appearance it resembles plumbago, but is said to consist chiefly of carbon and manganese.

KNE'BELITE. A silicate of iron and manganese.

KOME'NIC ACID. A substance resulting from the action of heat on *meconic acid*, and formed when a solution of the latter acid is boiled. It has also been called *parameconic acid.*

KO'REITE. A mineralogical synonym of the Chinese *figure stone*, called also *Agalmatolite.*

KRE'ATINE. (Gr. κρεας, *flesh.*) A crystallisable organic substance contained in the juice of the muscular fibre of animals.

KREMNITZ WHITE. A pure variety of *White Lead.*

KROKI'DOLITE. (Gr. κροκις, *woof.*) A mineral of a fibrous asbestiform texture; it is a hydrated silicate of iron and soda: there is also a compact variety; it is occurs near the Cape of Good Hope.

L.

LAGGING OF THE TIDES. In Terrestrial Physics, a phenomenon of the tides, consisting in the irregularity of the lengths of the successive tide-days or intervals of the occurrence of high water at any particular place, and caused by the combined action of the sun and moon on the ocean. If the tides were caused by the moon's attraction only, the intervals between two successive arrivals at the same place of the same vertex of the tide-wave would be the lunar day, that is, the interval between two successive arrivals of the moon at the same meridian. In like manner, if the tides were caused by the sun's attraction only, the tide-day would be of the same length as the solar day. In consequence of the moon's revolution about the earth in the same direction as the diurnal rotation, the lunar day is longer than the solar; and the actual or lunisolar tide being the result of the superposition of the two tides caused by the sun and moon respectively, it follows, that from the time of a coincidence of these two tides the actual tide-day (reckoned in mean solar time) will become longer and longer, until the moon has completed a quarter of a revolution, after which the lunar wave will fall back on the next following solar wave, and the tide-day will become shorter and shorter during the next quarter of the moon's revolution, and the coincidence will again take place when a semi-revolution is completed. This alternate acceleration and retardation of the tidal intervals is called the *priming and lagging of the tides*, and is most remarkable about the time of new and full moon. *See* TIDES, in DICT.

LAGOPHTHA'LMIA. (Gr. λαγωος, *a hare;* and οφθαλμος, *an eye.*) A disease in which the eye cannot be closed. Sometimes it is a paralytic affection, and sometimes depends upon enlargement of the eye; it is also occasionally connate. The term has reference to the notion that hares sleep with their eyes open.

LA'PIS DIVI'NUS. (Lat.) A compound of nitre, alum, and verdigris, melted together; camphor is sometimes added, and white vitriol substituted for verdigris. A portion of this fused compound dissolved in water formed a celebrated eye lotion; it was hence also called *Lapis Ophthalmicus.*

LA'PIS LY'DIUS. (Lat.) Lydian stone. A silicious slate, used as a *touchstone* for trying the quality of gold and silver by the colour of the streak.

LA'PIS SPECULA'RIS. (Lat.) Selenite or spathose gypsum: formerly used as a remedy for fits.

LA'RDITE. A mineralogical synonym of the Chinese *figure-stone*, or Agalmatolite.

LA'SIONITE. A mineralogical synonym of Wav-

ellite or hydrargylite: the hydrated phosphate of alumina.

LECA'NORINE. *Lecanoric Acid.* A crystallisable substance obtained from several species of *Lecanora*, and some other *lichens*.

LECCA GUM. The gum of the olive tree, which is abundantly collected at Lecca in Calabria.

LEHU'NTITE. A compact *zeolite* found in Antrim by Captain Lehunt.

LE'MANITE. A synonym of felspar, so called from Lake Leman, where it is found.

LEPIDO'KROKITE. (Gr. λεπις, *a rind*, and κρο-κος, *saffron*.) Fibrous brown hematite.

LEVA'NT NUT. One of the commercial names of the berries of *Cocculus Indicus*.

LIBE'THENITE. The native phosphate of copper from Libethen, in Hungary.

LI'CHANUS. (Gr. λειχω, *I lick*.) The fore-finger, used in tasting a small quantity of anything.

LI'CHTENBERG'S FIGURES. When the knob of a charged Leyden phial is drawn over a flat surface of lac or resin, as, for instance, the plate of an electrophorus, it leaves a charge in its track, positive or negative, as we choose; and if, after this, a mixture of certain powders be sifted upon the plate, as, for instance, of powdered sulphur and red lead, the sulphur will adhere to the one, and the red lead to the other electrified surface, and with a little management, groups of figures resembling flowers may be thus brought out, as Lichtenberg first observed.

LIEBERKU'HNIAN GLANDS. In Anatomy, are simple secerning cavities, having the form of blind tubular depressions of the intestinal mucous membrane, thickly distributed over the whole surface of the large and small intestines. They are so called after their discoverer Lieberkühn, who observed them in the small intestines, where they are visible only with the aid of a lens, their orifices appearing as minute dots scattered between the villi. They are larger in the large intestine.

LI'ENTERY. (Gr. λειος, *the spleen :* soft or smooth.) A medical term formerly applied to a form of diarrhœa in which the food passes rapidly through the bowels in an apparently undigested state. Lubricity of the intestines.

LIE'VRITE. A crystallised mineral discovered by Le Liévre. It is a silicate of iron and lime; it has also been called *Jenite*, in commemoration of the battle of Jena in 1806, and specimens from Elba have been termed *Ilvaite*.

LIFT-TENTER. The name given in some parts of England to a sort of regulator or governor applied to wind-mills to counteract the irregular action of the wind. In a wind-mill for grinding corn, the distance between the upper and lower millstones is regulated according to the velocity; and if, when the mill is at work, the velocity should receive any considerable increase, the corn is forced rapidly through the mill without being sufficiently ground. To prevent this is the object of the lift-tenter. Like the governor of a steam-engine, it acts by the centrifugal force of one or more balls which fly out when the velocity is augmented, and as they rise in the arc of a circle, allow the end of a lever to rise with them, while the other end descends with the upper millstone, and brings it a little nearer to the under one.

LI'GATURE. (Lat. ligo, *I bind.*) In surgery, a waxed thread of silk used in tying arteries or veins.

LIGHTHOUSE. The Light Tower recently erected on the small island or rock of Skerryvore, on the west coast of Scotland, is one of the most remarkable works of this class, both by reason of its magnitude and the difficulties encountered in its construction. The following particulars are extracted from the very able and interesting account of it, drawn up by the engineer, Mr. Alan Stevenson, and published under the authority of the Commissioners of the Northern Lighthouses.

Skerryvore is the largest of a group of rocks lying in the channel between the western isles of Scotland and the north coast of Ireland, and in the track of the larger vessels proceeding round the north of Ireland from the Clyde or the Mersey. It is of inconsiderable extent, the surface of the solid rock being only about forty square yards, and consequently the stones had to be quarried, and the greater part of the works carried on in the island of Tyree, the nearest land, situated about eleven nautical miles to the north east. Much of the difficulty attending the operation arose from the distance of this latter island from the site of the works, from its being destitute of any shelter for shipping, and from the exposed and stormy situation, which frequently rendered communication impossible.

The dimensions of the tower were determined with reference to the situation and circumstances. The great distance of the outlying rocks, some of them not less than three miles right seaward of the rock, made it desirable that the light should command an extensive range, and consequently that the tower should be of considerable height; and the great difficulty of landing on the rock, and the consequent uncertainty of keeping up the supplies, demanded a large internal space for the accommodation of the light keepers and the stowage of stores. It was accordingly determined that the light should be elevated 150 ft. above the level of high-water at spring tides, so as to illuminate a visible horizon of not less than eighteen miles radius; and that the void space within the pillar should be about 13,000 cubic feet.

In determining the form of the tower the object is to obtain the greatest strength with the smallest consumption of materials, having regard to the necessary conditions of height and internal accommodation. The shaft of the Skerryvore pillar is a solid generated by the revolution of a rectangular hyperbola about its asymptote as a vertical axis. Its exact height is 120·25 feet; its diameter at the base 42 feet, and at the top 16 feet. The first 26 feet of height is a solid frustrum, containing about 27,110 cubic feet. Immediately above this level the walls are 9·58 feet in thickness, whence they gradually decrease through the whole height of the shaft until, at the top, they are reduced to two feet in thickness. Above the shaft is a cylindrical belt 18 inches deep, which is surmounted by a cavetto 6 feet high and having 3 feet of projection. The cavetto supports an abacus 3 feet deep, the upper surface of which forms the balcony of the tower, and above it rest the parapet wall and lantern. The whole masonry of the tower contains 58,580 cubic feet, weighing about 4308 tons.

The general arrangement in the interior of the tower is as follows: "The ascent to the outside door is by a ladder or trap of gun metal 26 feet high. The first apartment on the level of the entrance door is chiefly appropriated to the reception of iron water tanks, capable of holding a supply of 1251 gallons. The next story is set aside for coals, which are stored in large iron boxes. The third apartment is a workshop, the fourth is a provision store, and the fifth is the kitchen. Above are two stories, each divided into two sleeping apartments for the four light keepers. Over them is the room for the visiting officers; then follows the oil store, and lastly comes the light room, making in all 12 apartments."

In its general arrangement the illuminating apparatus is identical with that of the tower of Corduan. (*See* DICT. OF SCIENCE.) It consists of eight annular lenses (of the first order in the system of Auguste Fresnel) of 36·22 inches focal distance, revolving round a lamp with four concentric wicks, and producing a bright blaze as each lens passes before the lamp. Above these principal lenses there are placed eight pyramidal lenses of 19·68 inches focal distance, inclined at an angle of 50°, with the horizon, and combined with eight plane mirrors inclined in the opposite direction under the same angle of 50°, by means of which the rays which would pass upwards are turned into the horizontal direction. The light appears in its brightest state at intervals of one minute, and is well seen as far as the curvature of the earth permits.

The works were begun in 1838, and the tower was finished in 1842, but considerable time was required for completing the internal fittings, and the light was not exhibited as a sea light till February 1844. The expense of the lighthouse, including the opening of quarries and forming wharfs for shipping the stone both in Mull and Tyree, amounted to 90,268*l*. 12*s*. 1*d*. (*Account of the Skerryvore Lighthouse with Notes on the Illumination of Lighthouses; by Alan Stevenson, LL.B. etc., Engineer to the Northern Lighthouse Board*, 4to. *Edinburgh*, 1848.)

LIGHTHOUSES. A plan of the arrangement of the reflectors for lighthouses was produced by Messrs. Chance at the Great Exhibition of 1851, which combines the principles of Fresnel's fixed and revolving lights with an improved method of reflexion; and does away with the use of metal reflectors.

The system of reflectors and refractors may be divided into three compartments, the upper and lower of which are composed respectively of thirteen and six catadioptric zones, which produce a vertical strip of light extending the whole length of the apparatus, similar to Fresnel's fixed dioptric light. The central compartment consists of eight lenses of three feet focal length, each of which is the centre of a series of eleven concentric prismatic rings, designed to produce the same effect as a solid lens of equal size. These compound lenses are mounted upon a revolving frame, and transmit horizontal flashes of light as they rotate. Motion is communicated by clock-work, and one revolution is performed in the space of four minutes, and, consequently, a flash of light is transmitted every thirty seconds to the horizon by each of the lenses in succession. The apparatus is lighted by an Argand lamp, with four concentric wicks; it is provided with four burners, the

largest of which is $3\frac{1}{4}$ inches and the smallest $1\frac{6}{10}$ inches in diameter.

LIGNO'NE. (Lat. lignum, *wood.*) A liquid which may be separated by distillation from commercial wood spirit. It has also been called *Xylite.*

LI'GNOSULPHU'RIC ACID. A peculiar acid resulting from the action of sulphuric acid upon lignine. It is more properly termed *Sulpholignic acid.*

LIGNUM VITÆ. (Lat.) The wood of the guaiacum tree.

LI'LACINE. A bitter crystallisable principle contained in the leaves of the *Syringa vulgaris.* It has also been termed *Syringine.*

LI'MBILITE. A granular mineral found in the volcanic formation of Limbourg.

LI'MONITE. (Gr. λειμων, *a meadow.*) In Mineralogy, brown iron ore.

LIMO'SIS. (Gr. λιμος, *hunger.*) A genus of diseases distinguished by excessive or defective appetite.

LI'NARITE. In Mineralogy, the cupreous sulphate of lead from Linares, in Spain. It also occurs in Cumberland, and at Leadhills in Scotland.

LINCTUS. (Lat. lingo, *I lick.*) A medicinal preparation of the consistence of thick syrup, or honey, which requires to be licked off the spoon.

LINDEN TREE. The Lime tree, *Tilia Europœa.*

LI'NINE. A bitter principle obtained from the *Linum catharticum*, or purging flax.

LINNE'ITE. In Mineralogy, native sulphuret of cobalt; first noticed in Sweden by the celebrated Linnæus.

LINNÆAN SYSTEM. *See* BOTANY, in DICT.

LI'NSENERZ. In Mineralogy, octohedral arseniate of copper.

LINT. A soft woolly material made by scraping old linen by hand: it is also made by machinery. It is used in surgery for dressing wounds and ulcers, either alone, or spread with some ointment.

LIPAROCE'LE. (Gr. λιπαρος, *fat;* κηλη, *a tumour.*) A fatty tumour.

LI'PIC ACID. (Gr. λιπος, *fat.*) An acid formed by acting upon stearic and oleic acid, by means of nitric acid.

LIPO'MA. (Gr. λιπος, *fat.*) An encysted fatty tumour.

LIQUA'TION. *See* ELIQUATION, in DICT.

LI'QUIDA'MBER. A balsam procured in Mexico and Louisiana from the stem of *Liquidamber styraciflua.* It is, probably, identical with the so called *White Balsam of Peru.*

LI'QUORICE. The extract of the root of the *Glycyrrhiza glabra*, or officinal liquorice: it is often called Spanish liquorice or Spanish juice, of which that stamped with the name Solazza, and imported in sticks or bars six or eight inches long, is considered the best. It is in common use as an emollient in catarrh and cough. The so-called *refined liquorice*, rolled into pipes or quills, is often much adulterated.

LIQUOR SANGUINIS. *See* PLASMA.

LI'RIODE'NDRINE. (Gr. λιριον, *a lily*, and δενδρον, *a root.*) A bitter crystallisable principle obtained from the bark of the root of the *Liriodendron tulipifera.*

LI'THAGOGUE. (Gr. λιθος, *a stone*, and αγω, *I drive away.*) Medicines supposed to have the power of expelling calculous matter from the kidney or bladder.

LI'THOCHROMA'TICS. (Gr. λιθος, *a stone*, and χρωμα, *colour.*) A term applied to a recent invention, which consists in painting in oil upon stone, and taking impressions upon canvass.

LITHOCO'LLA. (Gr. λιθος, *a stone*, and κολλα, *glue.*) A cement for stone-work.

LI'THOFE'LLIC ACID. (Gr. λιθος, *a stone;* and Lat. fel, *gall.*) A substance obtained by Göbel from a Bezoar stone. In 1844, Taylor made the curious discovery of the identity of the substance constituting the so-called *Oriental Bezoars*, which are probably the intestinal concretions of a species of antelope, with the acid called *Ellagic acid*, contained, along with tannic and gallic acids, in the gall nut.

LITHO'PHAGI. (Gr. λιθος, and φαγω, *I eat.*) *See* LITHODOMES, in DICT. Molluscous animals which bore into stones.

LI'THOPHYTES. (Gr. λιθος, and φυτον, *a plant.*) Polypes which have a stony axis; as distinguished from the Keratophytes, or horny polypes.

LIVER ORE OF MERCURY. *Hepatic ore.* A bituminous cinnabar, or sulphuret of mercury, from Idria.

LO'BELINE. A peculiar acrid oil contained, along with *Lobelic acid*, in the leaves of the *Lobelia inflata.*

LO'BOITE. In Mineralogy, a magnesian idocrase from Norway.

LONDON CLAY. A very extensive tertiary geological deposit of a bluish clay, superficially brown, and abounding in Middlesex, Essex, Suffolk, and part of Norfolk. *See* GEOLOGY, in DICT.

LO'PEZ. *Radix Lopeziana.* The name of the root of an unknown tree, supposed to grow at Goa: it is said to be remarkably effective in checking diarrhœa.

LO'RIMER. A name formerly given to the makers of bits, spurs, and other articles of iron used for horses.

LOVE APPLE. The Tomata. The fruit of *Solanum lycopersicum.* An excellent ingredient in soups and sauces, in especial use in Spain and Portugal.

LU'PIA. (Gr. λυπεω, *I molest.*) An encysted tumour.

LUSTRE. Several varieties of *Lustre* are referred to in descriptive mineralogy, such as splendent, glistening, glimmering, shining, dull, &c.

LU'TEOLINE and LUTEOLE'INE. Peculiar colouring principles, said by Preisser to be obtained from *weld.*

LUZ. The name of a bone in the human body, celebrated in Rabbinical writings, and supposed to be indestructible: according to some it was a vertebra; others regard it as having been the sesamoid bone of the great toe, and others one of the triangular bones near the lambdoidal suture of the cranium.

M.

M. In medical prescriptions M stands for *misce*, or mix: also for *manipulus*, a handful.

MA'CER. The bark of the root of a tree growing in Malabar. It is astringent, and celebrated for the cure of diarrhœa.

MACQUERS SALT. A pharmaceutical designation of the binarseniate of potassa.

MA'CROCOSM. (Gr. μακρος, *large;* κοσμος, *world.*) A term applied to the world at large, or *universe*, as opposed to *microcosm*, having reference to man.

MADARO'SIS. (Gr. μαδαρος, *bald.*) A falling off of hair, especially of the eyelashes.

MAGDEBURGH EXPERIMENT or HEMISPHERES. A hollow sphere composed of two hemispheres which fit air-tight, intended to show the amount of the air's pressure, by the amount of force with which they are so held together after the interior air has been removed by the air-pump. This apparatus was first suggested by Otto Guericke of Magdeburgh, the inventor of the air-pump.

MAGELLA'NIC CLOUDS. These singular objects were carefully examined by Sir John Herschel during his residence at the Cape of Good Hope, from 1834 to 1838, and are minutely described in his "Results of Astronomical Observations," &c. The greater nebula, or *Nubecula major*, is situated between the meridians of 4 h. 40 m. and 6 h. 0 m., and the parallels of 156° and 162° of North Polar Distance, occupying an area of about 42 square degrees. The lesser is situated between the meridians 0 h. 28 m. and 1 h. 15 m., and the parallels of 162° and 165° N. P. D., and covers about ten square degrees; their general shape is round, or somewhat oval; and the larger, which deviates most from the circular form, exhibits the appearance of an axis of light very ill defined, and by no means strongly distinguished from the general mass which seems to open out at its extremities into somewhat oval sweeps. "When examined through powerful telescopes," Sir John observes, "the constitution of the nubeculæ, and especially of the Nubecula major, is found to be of astonishing complexity. The general ground of both consists of large tracts and patches of nebulosity in every stage of resolution, from light irresolvable with 18 inches of reflecting aperture, up to perfectly separated stars, like the Milky Way, and clustering groups sufficiently insulated and condensed to come under the designation of irregular, and in some cases pretty rich clusters. But besides those, there are also nebulæ in abundance, both regular and irregular; globular clusters in every state of condensation; and objects of a nebulous character quite peculiar, and which have no analogue in any other region of the heavens. Such is the concentration of the objects, that in the area occupied by the Nubecula major not fewer than 278 nebulæ and clusters have been enumerated, besides 50 or 60 outliers, which (considering the general barrenness of such objects in the immediate neighbourhood) ought certainly to be reckoned as its appendages, being about six and a half per square degree, which very far exceeds the average of any other, even the most crowded parts of the nebulous heavens. In the Nubecula minor the concentration of such objects is less, though still very striking, 37 having been observed within its area, and 6 adjacent but outlying. The nubeculæ, then, combine, each within its own area, characters which, in the rest of the heavens, are no less strikingly separated, — viz. those of the galactic and the nebular system. Globular clusters (except in one region of small extent) and nebulæ of regular elliptic forms are comparatively rare in the Milky Way, and are found congregated in the greatest abundance in a part of the

heavens the most remote possible from that circle; whereas, in the nubeculæ, they are indiscriminately mixed with the general starry ground, and with irregular though small nebulæ." (*Outlines of Astronomy*, p. 613.)

MAGNETISM, TERRESTRIAL. During the last quarter of a century immense efforts have been made to determine the phenomena and laws of terrestrial magnetism. The impulse given to the study of this department of science is mainly due to the celebrated Humboldt, who, in 1828, formed an association at Berlin for the purpose of verifying an inference which had been drawn from the comparison of corresponding observations made at London and Upsala by Graham and Celsius in the last century, and recently at Paris and Kazan by Arago and Kupffer, namely, that the irregular movements of the needle take place simultaneously at places very distant from each other. At first the operations were on a very limited scale, being confined to hourly observations on some particular days, previously agreed on, at Berlin and Freyberg; but in the following year the plan received an immense extension in consequence of the establishment by the Russian government of magnetical observatories, acting in co-operation with those of Germany, at St. Petersburg, Kazan, Nicolaieff, and Sitka (on the north-west coast of America); that is to say, across the whole continent of Europe and Asia. A second association was soon after formed at Gottingen by Professor Gauss, through which very important improvements were effected both in the instruments of observation and the methods of observing, which have been since generally adopted. In 1836 the indefatigable Humboldt addressed a letter to the late Duke of Sussex, then President of the Royal Society, on the best means of perfecting the knowledge of terrestrial magnetism; and, his suggestions being approved by the Council of the Society, the government was induced, through the representations of that body, to sanction the establishment, in several of the British colonies, of observatories, equipped with appropriate instruments, and superintended by military or naval officers, with sufficient assistance at their disposal for making continuous *hourly* or *two-hourly* observations of the different magnetic elements. The places selected were Toronto, St. Helena, the Cape of Good Hope, and Hobarton, in Van Diemen's Island; and, as it was considered important to obtain observations in high southern latitudes, the expedition to the Antarctic seas, under the command of Sir James Clarke Ross, was projected and ordered at the same time. The East India Company likewise promised its co-operation by providing for the establishment and maintenance of observatories at Bombay, Madras, Lucknow, Singapore, and Simla. At home, a magnetical and meteorological department was added to the Royal Observatory at Greenwich, and another is kept on foot at Dublin. It was originally proposed that the colonial observatories at the four stations above named should be continued for three years only; but the grant of the requisite funds has been renewed from time to time, and they are still (1852) in operation. The observations have been made systematically, according to rules drawn up by a Committee of the Royal Society, and are reduced under the superintendence of Colonel Sabine, at an establishment also maintained by the government, at Woolwich. Several volumes of observations have been published, containing a regular series, since 1841, made at Toronto, Hobarton, and St. Helena; and including those made in 1841 and 1842 by the officers of the Antarctic expedition. In addition to these official volumes, Colonel Sabine has also contributed a series of interesting papers to the *Philosophical Transactions*, and the *Reports of the British Association*, containing the results deduced from a comparison of the observations at the different places. The observations made at Greenwich are reduced at the observatory, and the whole were for some years (till 1847) published annually; at present only a portion of those made continuously by a photographic process are published in an Appendix to the volumes containing the astronomical observations. By all these means a very large collection of well observed facts has been accumulated, but it cannot be said that the theory has yet made corresponding advances.

A magnetical observation is complete when three elements are determined, — the *declination* of the magnetic needle, its *inclination*, and the intensity of the force. The two latter, however, are not usually observed directly, but in lieu of them the horizontal and vertical components of the intensity are observed, and, from the variations of the two components, those of the inclination and of the force itself, are computed. The declination and inclination indicate the direction in reference to the horizontal and vertical planes which a freely suspended needle would assume, so that, in fact, the direction of the magnetic force and its intensity are the two elements sought to be determined. The instruments employed are called by the general name of *Magnetometers*. (*See* the term.)

In order to obtain a knowledge of the laws of terrestrial magnetism, it is necessary that the mean values of the three elements, and the variations of those elements, should be determined at a great number of points taken all over the earth's surface. For the purpose of comparison, the points or stations at which the observations have been made are projected on maps, and lines being drawn through those points at which the mean values are the same in respect of each element, a series of curved lines is obtained, which indicate the values of the elements at the intermediate points with more or less accuracy, according to the proximity of the stations at which observations are made. The curves thus traced through the points of equal declination are called *Isogonal;* those through the points of equal inclination, *Isoclinal;* and those connecting the points of equal force, *Isodynamic*.

Declination, or *Variation*. Although the general direction of the horizontal needle is nearly north and south, there are few places at which it points exactly in the direction of the meridian. At London, and over the greater part of Europe, the north end of the needle declines to the west, while in Siberia and some parts of the North American continent it declines to the east. In the northern hemisphere the isogonal lines, though extremely irregular, appear to converge towards two separate points or poles, whence it has been inferred that there are four magnetic poles, two in each hemisphere. Supposing this to be the case, the declination of the needle will be east or west, according as the place of observation is to the west or east of the meridian passing through the nearest or most powerful pole, and there will be in each hemisphere two isogonal lines of no declination, or in which the direction of the needle coincides with the meridian. These lines, accompanied by others passing through the series of points at which the declination is respectively 5°, 10°, 15°, &c. were first laid down by Halley, in 1700, in a *Sea Chart* or *Variation Chart;* and since that time similar charts have been published by various persons, — Hansteen, Barlow, Erman, and others. Halley supposed they would be useful as a means of finding the longitude at sea; but, on account of the changes which the declination is undergoing at almost every place where correct observations have been made, they are not only useless for this purpose, but do not long continue to represent the actual declinations.

The changes which take place in the declination are of three kinds, — secular, annual, and diurnal. The laws and period of the secular change are very imperfectly known. At London, in 1550, the declination was 11° 17′ E.: about 1660 it was 0°. Soon after that year the needle began to deviate to the west; and the westerly declination continued to increase till 1815, when it seems to have attained its maximum of 24° 27′ 18″, inasmuch as it has gradually decreased since that time. The mean declination deduced from the observations at the Greenwich Observatory in 1846 was 22° 49′ 35″. At Paris, the observations give a similar increase up to the same period. But this agreement is by no means general: in Jamaica, for example, the declination seems to have remained nearly constant. The explanation of these phenomena forms one of the greatest difficulties in the theory of terrestrial magnetism.

The annual variation of the declination was first remarked at Paris by Cassini. From a comparison of observations made at Paris from 1784 to 1788, and at London from 1793 to 1805, Arago found a minimum of declination towards the vernal equinox, and a maximum towards the summer solstice. But it may be doubted whether these ancient observations were sufficiently accurate to determine this question, more especially as the result is not confirmed by the recent observations in the colonial observatories. At St. Helena and Toronto no variation of the rate of the secular change in the different seasons is perceptible. At Hobarton the east declination appears to be, on the average, somewhat greater in the summer months than in the winter months, but the differences are extremely small.

Diurnal Variation. The declination is also subject to a diurnal change, which was first remarked by Graham, at London, in 1722. The remark was confirmed by the observations of Celsius, and by Hiorter in Sweden (1740—1746), and subsequently by those of Wargentin, who found that the needle declined towards the west from the hours of 8 or 9 before noon till 1 or 2 after noon, and then towards the east till 8 or 9 in the evening. The same observers also remarked that the needle was affected by Aurora, or polar light, and that in the presence of this phenomenon the change in its mean direction was sometimes as much as 5° in the course of a day. In the *Philosophical Transactions* for 1759 there is a paper by Canton, giving the results of observations on the daily variation during 603 days. On 574 of those days the deviations were regular, and nearly the same as those found by Celsius; on the remaining days they were irregular, and on those days there were displays

of Aurora. Canton ascribed the diurnal change to the effect of the sun's rays in heating the earth, and thereby diminishing the magnetic force; so that in the morning, when the earth is heated on the eastern side of the meridian, the magnetic force on that side is weakened, and the needle consequently declines to the west; and in the afternoon, as the earth becomes heated on the western side of the meridian, the needle begins to move in the opposite direction, and declines to the eastward of its mean place. The amount of the diurnal change is different at different places, and at different seasons of the year. At London, for the years 1817—1819, it was found by Col. Beaufoy to be from 4′ to 5′ in December and January, and above 11′ in June and August. At the Royal Observatory the mean diurnal range for the year 1846 was, in summer, 15′ 14″; in winter, 11′ 53″; and the mean for the whole year, 13′ 34″. At Toronto and Hobarton the diurnal range is also greatest in the summer months and least in the winter months, and the changes take place at nearly the same hours of local time.

Inclination, or *Dip*. The inclination has a general dependence on the latitude, but it varies considerably at different places under the same latitude. A line drawn through all those places where the dipping needle becomes horizontal (usually, though perhaps improperly, called the magnetic equator) appears to intersect the equator of the earth in four points. In the Atlantic Ocean, between Africa and America, it lies wholly to the south of the terrestrial equator, its greatest south latitude being about 25°. According to Hansteen the nodes or points intersective with the equator of the earth are on the meridians 22° E., 187° E., 120° W., and 108° W.; but these determinations must be taken as subject to considerable uncertainty, the observations being by no means accordant. The other isoclinal lines follow, with more or less irregularity, the direction of the magnetic equator until a high latitude is attained. In Boothia Felix, in latitude 70° 5′ 17″ N., and longitude 96° 45′ 48″ W., Sir James Clarke Ross found the dip to be 89° 59′, within a minute of the vertical; and the needle had there altogether lost its directive power. In the southern hemisphere, on board the Erebus, in 1841, Sir J. C. Ross observed an inclination of 88° 36′ in latitude 75° 22′ S., and longitude 161° 48′ E. (Sabine, *Phil. Trans.* 1843). The places at which the dipping needle becomes exactly vertical, and to which the above most nearly approach, are usually styled the *magnetic poles;* but, as will be seen presently, they not only do not coincide with, but are at a great distance from, the places at which the intensity of the magnetic force is a maximum,—a circumstance which it is necessary to keep in mind, as the term *pole* is also frequently applied to the points of greatest force. Like the declination, the dip is subject to secular, annual, and diurnal changes. At London it was observed by Graham, in 1720, to be 74° 42′; and by Captain Kater, in 1830, to be 69° 38′. The mean of the Greenwich observations for 1846 is 68° 58′·1; whence it appears that the dip at London is diminishing. The annual variation is scarcely perceptible. At Toronto and Hobarton the range of the diurnal variation of the dip is about 1′·25; at Greenwich, for 1846, the difference of the means of the daily observations at 9 A. M. and 3 P. M. was 1′.

Intensity. The absolute intensity of the magnetic force, like the declination and dip, varies at different places, and probably at different times. It is compared at different stations by observing the number of oscillations made in a given time by a magnetic bar suspended horizontally by a fine wire or silk fibre. If F denote the force, D the inclination of the dipping needle, and N the number of oscillations made by the suspended bar in a given time at any station, and F′, D′, N′, denote the same things at a second station, then the following proportion holds, which gives the relative value of the two forces, *viz.*

$$F : F' :: N^2 \cos^2 D : N'^2 \cos^2 D'.$$

From the large table of results given by Hansteen, it appears that if the intensity at the magnetic equator in Peru (where it was supposed by Humboldt to be a minimum) be unity, then the intensity at Naples is 1·275, at Marseilles 1·294, at Madrid 1·394, at Paris 1·348, at London 1·370, at Christiania 1·420, in Baffin's Bay (lat. 76° 45′ N., long. 58° 20′ W.) 1·705. The maximum intensity hitherto observed is 2·052, and the minimum 0·706. Both observations were made at places in the southern hemisphere, the former by Sir James Clarke Ross, in lat. 73° 47′ S., long. 171° 50′ E. (of London), where the dip was observed to be 87° 4′; and the latter by Erman, in lat. 19° 59′ S., and long. 35° 4′ W., off the eastern coast of Brazil, where the dip is 7° 55′: the two extreme intensities are therefore in the ratio of 1 : 2·906. In both hemispheres there are two points, or rather regions, of maximum intensity, which may be regarded as centres of separate magnetic action. The position of the principal or strongest northern maximum intensity was ascertained by Captain Lefroy, in 1842 and 1843, to be in lat. 52° 19′ N., long. 268° E. (Sabine, *Phil. Trans.* 1846); that of the minor maximum was determined in 1828 and 1829 by Hansteen, and Erman, in the Russian expedition, to be in the meridian of 111° 27′ E. The interval between the two meridians is consequently 270°—111°=159°, so that they are not directly opposite. Both points appear to have undergone progressive changes from west to east, though not at the same rate. In the southern hemisphere the two centres of maximum force are still nearer each other in respect of geographical longitude, and the intensity is greater than in the northern hemisphere (Sabine, *Phil. Trans.* 1850). The isodynamic lines are in general nearly parallel to each other, and also to the isoclinal lines, though at some particular places the two sets of lines are nearly at right angles. The intensity does not appear to be affected by elevation above the surface.

Simultaneous Perturbations. In the volume of Hobarton Observations, 1841 to 1848, Col. Sabine gives an interesting comparison of the simultaneous affections of the three elements at Hobarton and Toronto, on one of Gauss's term days, April 21, 1842, these two stations being specially selected for comparison as being geographically situated at nearly opposite points of the globe. The result showed that the amount of disturbance on this day was nearly the same at both stations, and that the instants of extreme disturbance are not unfrequently as nearly identical at both as the nature of the observations enables us to determine. The inference is that many of the perturbations or particular disturbances observed, must be regarded as general affections of the whole globe, manifesting themselves at stations the most remote from each other.

Theory. On considering all the phenomena, and particularly those of the diurnal and annual variations (which obviously depend on solar heat), as well as the disturbances accompanying displays of polar light, it must appear extremely improbable that the magnetic force on which these phenomena depend is deeply seated in the earth. If it belongs to the earth it must be supposed to be near to or at the surface, in order to account for the correspondence of the phenomena with the diurnal variations of temperature. Accordingly it has been suggested that the cause must be looked for in the atmosphere. Sir D. Brewster (*Treatise on Magnetism*, 1837) adopts this view, and considers it to be proved, by certain experiments of Fusinieri, that iron is diffused through the atmosphere in a state of vapour. But a new light has very recently been thrown on this subject by Faraday, who has demonstrated that the oxygen of the atmosphere is magnetic, and that the intensity of its magnetism, like that of iron, is diminished by an increase of temperature. This fact renders the hypothesis of a diffusion of ferruginous vapour through the atmosphere unnecessary; and as the constituent gases of the atmosphere are every where in the same proportion, the phenomena depending on the magnetic properties of its oxygen must be precisely the same as if the whole atmosphere were magnetic. In a paper published in the *Philosophical Transactions* (Part I. 1851), Professor Faraday has shown how these properties may be applied to explain the variations of the terrestrial magnetic force. The earth, he remarks, is a great magnet: its power, according to Gauss, being equal to that which would be conferred if every cubic yard of it contained six one-pound magnets. The disposition of this magnetic force is not regular, nor are there any points on the surface which can properly be called *poles;* still the regions of polarity are in high north and south latitudes. These regions are connected by lines of magnetic force, which, generally speaking, rise out of the earth in one (magnetic) hemisphere, and, passing in varied directions over the equatorial regions into the other hemisphere, then enter into the earth to complete the known circuit of power. A free needle shows the presence and directions of these lines, which invest the globe with a system of forces like that about an ordinary magnet, and wherever they pass through the atmosphere the forces are subject to the changing action of the magnetic oxygen. There is every reason to suppose that these lines are *held* in the earth, just as the lines which originate in a magnet are held by it; and that any disturbance from above will cause a greater change in their place and direction in the atmosphere than in the earth. When space, traversed by uniform lines of magnetic force, is occupied by a uniform body, as air, the disposition of the lines is not altered; but if a better conducting substance is introduced, the lines are concentrated or drawn closer together in it; and if a worse conducting substance is introduced, they are opened out, and stand at greater distances from each other. Now, supposing the whole atmosphere to have a mean temperature, the lines of force would have the direction determined by the arrangement of the power within the earth. Then the sun's presence in the east would make all the atmosphere in that region a worse conductor, and the lines of force

would be opened out; and as the sun came up to and passed the meridian, similar changes in the directions of the lines of force would there take place, so that in the morning a needle would be deflected towards the west, and in the afternoon towards the east. As the night came on, and with it a lower temperature than the mean, the lines of force would be concentrated, and a reverse variation of the needle would take place. The magnetic properties of oxygen and its daily variations of temperature, manifestly produce effects similar to those which actually take place; but whether they cause the whole of the observed variations, or are competent to do so, is a question that can only be decided after a very careful inquiry. Professor Faraday states that the hypothesis has been compared with the mean daily variation for all the months in the year at north and south stations, as Toronto and Hobarton, and at many others near to and far from the equator, and the agreement is very remarkable. Thus, according to the hypothesis, the paths described by the upper ends of free needles in the north and south hemispheres should be closed curves with the motion in opposite and certain directions, and so they are;—the curves should be larger in summer and smaller in winter, and so they are;—the northern hemisphere ought to have a certain preponderance over the southern, because of its superior temperature, and that is so; — the disposition of land and water ought to have an influence, and the observations indicate one in the right direction. What still remains to be done, to verify this ingenious theory, is to ascertain the amount of change in the conducting power of the air for given changes of temperature, in order that it may be seen whether the effect on the magnetic instruments thereby produced corresponds with that which actually takes place.

MA'GNETITE. In Mineralogy, magnetic ore of iron.

MAGNETO'METER. An instrument or apparatus for determining the elements of terrestrial magnetism, in direction and force. When adapted to the purpose of determining the declination of the needle, it is called a *Declinometer*; for the inclination and vertical force, it becomes an *Inclinometer* (*see* the terms). From the experience obtained in the British colonial observatories, it appears that these instruments, at least in the form recommended in the *Instructions* drawn up by the Committee of the Royal Society, are liable to certain sources of irregularity; one depending on the liability of the magnetised bar to lose a portion of its magnetism, and others on causes not perfectly understood. (Sabine, *Phil. Trans.* 1850.) The instruments used at the Greenwich Observatory, and the modes of using them, are described in detail in the Introductions to *Greenwich Magnetical Observations*, which were published annually from 1841 to 1847.

MALABA'THRUM. The leaf of the Cassia laurel, from Malabar.

MALACO'STEON. (Gr. μαλακος, *soft*, and οστεον, *a bone*.) A diseased softening of the bones: *mollities ossium*.

MAL DE LA ROSA. A disease endemic in the Asturias, attended by redness of the skin.

MALPI'GHIAN. In Anatomy, this term is applied to certain parts, especially of the kidney, in allusion to the anatomist Malpighi, by whom they were discovered or first definitely described. Thus the numerous secreting tubes (*tubuli uriniferi*), where they are collected into conical bundles, form the "Malpighian" cones or pyramids; the more tortuous parts of the tubes which pass towards the surface of the kidney, terminate in or bear on small pedicles appended to their walls, flask-shaped sacculi, named "Malpighian capsules." The arteries of the kidney, before dividing into capillaries, form, by tortuous convolutions, little balls, called "Malpighian corpuscles or glomerules."

MA'LTHAZITE. A white tallow-like mineral from Lobau.

MANDE'LIC ACID. (Germ. mandeln, *almonds*.) A white crystalline acid obtained by the action of hydrochloric acid on bitter-almond oil. Its chemical formula is $C_{16} H_7 O_5 + H O$. It has also been called *Formobenzoilic acid*, inasmuch as it contains the elements of formic acid and hydruret of benzoyle.

MA'NDRIL. The part of a turning lathe which carries the chuck upon which the *work* (that is, the material to be turned) is fixed. It consists of a pulley, fixed upon an axle, which is supported in the headstock, and receives its motion from the foot wheel (or the treadle, in the case of the pole-lathe), by means of a catgut band passing over the mandril pulley, into which grooves are cut for receiving the band. Mandril, also, is the name given to the iron rod upon which a gun barrel is welded. In Zoology, a species of baboon is so called.

MA'NGANITE. In Mineralogy, grey ore of manganese.

MA'NNACROUP. A granular preparation of wheat deprived of bran, used as an article of food for children and invalids.

MARASCHI'NO. A liquor prepared from a peculiar cherry growing in Dalmatia; it is bruised, fermented, and then distilled, and afterwards sweetened with sugar. It is stated by some, that maraschino is the alcoholic liquor distilled from the fermented juice of the liquorice root.

MA'RCASITE. In Mineralogy, white iron pyrites. A sulphuret of iron.

MA'RIOTTE'S LAW. This important relation between the elastic force and the density of gaseous matter, ought, in justice to the first discoverer, to be called *Boyle's Law*. In a tract published at Oxford in 1668, under the title of "New Experiments touching the Spring and Weight of the Air," the Hon. Mr. Boyle announced that the spring — that is to say, the elastic force — of air is directly proportional to its compression; which is equivalent to saying, that the elastic force is directly as the density, or inversely as the volume, under the same temperature. Boyle's experiments were made on atmospheric air confined in the closed end of a U-shaped glass tube, and compressed by the weight of a column of mercury. It does not appear that he took the precaution to expel the moisture from the air, and the greatest pressure he applied was only equal to four atmospheres, so that it may, perhaps, be said that his experiments were neither sufficiently accurate nor extensive to establish the general law, even in respect of atmospheric air, without mentioning the other gases. Mariotte's experiments were described in the Memoirs of the Paris Academy of Sciences, published about eleven years later, namely in 1679, without any reference to Boyle's announcement, which was possibly unknown to him; and as it was through this channel that the law became known to the continental philosophers, who were the first to perceive its importance, they naturally distinguished it by the name of the person whom they supposed to be its discoverer.

The relation in question has recently been investigated by M. Regnault of Paris, in a series of experiments, conducted with the utmost attention to every circumstance affecting their accuracy; and the results are interesting. If v denote the volume of a gas under the pressure p, and v' its volume under pressure p', then the law gives $vp=v'p'$, whatever the pressures may be, if the temperature remains unaltered. But, on comparing the results of his experiments, M. Regnault has found that the above equation is not strictly true for any gas; and that, assuming $vp=v'p'(1+q)$ (where q is a small correction), the value of q increases with the pressure. In respect of atmospheric air, the elastic force, under a pressure of twenty-five atmospheres, is less by a quantity somewhat exceeding the seventh part of an atmosphere than it would be if the law were strictly true. With respect to carbonic acid the deviation is considerably greater. In the case of hydrogen the correction q becomes negative, so that while air and the other gases experimented upon were more compressed than they would be if the law were exactly followed, hydrogen was less compressed, and its compressibility was found to diminish as the pressure increased. But temperature has a considerable influence on these results; and as it was found that the deviation from the law diminishes as the temperature is increased, M. Regnault concludes that the law is only rigorously true when the gases are infinitely dilated, and that it becomes less and less exact in proportion as they are in a state of greater condensation. (*Mémoires de l'Institut*, tome xxi.)

MA'RTIAL ETHIOPS. An old pharmaceutical name of black oxide of iron.

MA'RTIAL REGULUS. Metallic antimony, obtained by decomposing sulphuret of antimony by means of iron.

MA'STICIN. That part of mastic which is insoluble in alcohol: it has some of the characters of caoutchouc. The part of mastic soluble in alcohol, has been termed *Masticic acid*.

MATE'RIA HERMAPHRODITA. A term applied by Boerhaave to a peculiar substance soluble both in alcohol and water, and contained in vegetable extracts. Scheele called it *Materia saponacea*. It is the *extractive* of later chemists.

MA'TICO. The leaves of a Peruvian plant, said to be a species of pepper, have been brought under this name to England, and much extolled for their medical virtues.

MAULSTICK. (Germ. *Mahlstock*.) A painter's stick on which he rests his hand whilst painting.

MECCA BALSAM. The produce of the *Balsamodendron Gileadense*, growing at Gilead, in Judæa. It is also called *Opobalsamum*.

MEDU'LLA OBLO'NGATA. (Lat. *the oblong pith*.) In Anatomy, is the name given to the mass of grey and

white neurine contained in the occipital segment of the cranium, and forming the medium of connection between the spinal marrow (myelon) and the brain (encephalon): it is sometimes described as the cephalic prolongation of the myelon; but it has distinct and higher functions, and constitutes the chief part of the epencephalic division of the brain.

MEDU'LLA SPINALIS. (Lat. *the spinal pith.*) In Anatomy, the part of the nervous axis which is contained in the vertebræ of the trunk. *See* MYELON.

MELA'MPYRINE. (Gr. μελας, *black*, and πυρ, *fire.*) A crystallisable substance, soluble in water and nearly insipid, contained in the *Melampyrum nemorosum.*

MELANO'CHROITE. (Gr. μελας, *black*, and χροα, *colour.*) A mineralogical variety of chromate of lead.

ME'LANOGA'LLIC ACID. A synonym of *Metagallic acid.*

ME'LANOTA'NNIC ACID. (Gr. μελας, *black.*) The black substance formed by the action of excess of potassa upon tannic or gallic acid.

MELASSES. *See* MOLASSES, in DICT.

ME'NDIPITE. A native oxychloride of lead from the Mendip Hills, Somersetshire.

MENINGI'TIS. (Gr. μηνιγξ, *a membrane of the brain.*) Inflammation of the membranes of the brain.

MENSIS PHILOSOPHICUS. (Lat.) A chemical or philosophical month; its duration is variously stated; it is generally considered as including three days and nights.

MENTHENE. A liquid hydrocarbon obtained by distilling the crystallisable portion of peppermint oil, or *peppermint camphor*, with anhydrous phosphoric acid. Its formula is $C_{20}\ H_{18}$.

MESENCE'PHALON. (Gr. μεσος, and εγκεφαλον, *brain.*) The natural primary division of the brain, which is usually encompassed by the parietal segment of the cranium, and consists of the lobe of the third ventricle, the optic lobes, with the appendages called the "conarium," "hypophysis," and in fishes the "hypoaria." Chaussier gave the term "mesocephale" to an artificial combination of the pons varolii with the optic lobes, dissociating the one from the medulla oblongata and cerebellum, and the other from the lobe of the third ventricle. By some Anthropotomists the term "mesocephalon" is used synonymously with that of "pons varolii."

ME'SITE. (Gr. μεσος, *middle.*) A liquid existing in pyroligneous spirit, the formula of which appears to be $C_6\ H_6\ O_2$: it is, therefore, the hydrocarbon mesylilene $(C_6\ H_4)+2\ H\ O$.

MESOXA'LIC ACID. An acid obtained by boiling a saturated solution of alloxanate of baryta, which is thus resolved into *mesoxalate of baryta*, and other products. This acid is crystallisable, and very sour and soluble. Its formula is $C_3\ O_4+2\ H\ O$.

MESLIN. (Fr. mesler.) A mixture of various kinds of grain.

META'CETONE. (Gr. μετα, indicating *change*, and acetone.) A product formed during the distillation of a mixture of 1 part of starch with 8 of quick lime: it is a colourless liquid, insoluble in water, but soluble in alcohol and ether, and of an agreeable odour. Its formula is $C_6\ H_5\ O$. It is converted by oxidising agents into *Metacetonic (metacetylic)* acid $= C_6\ H_5\ O_3+H\ O$.

METAGE'NESIS. (Gr. μετα, indicating *change*; γιγνομαι, *I produce.*) The changes of form which the representative of a species undergoes in passing, by a series of successively generated individuals, from the egg to the perfect or imago state. It is contradistinguished from "metamorphosis," in which those changes are undergone by the same individuals. The following is an example of Metagenesis: — The egg of the Medusa is developed into a polype, which, assuming a form called *Strobila*, separates into numerous individual young Medusæ. The larval polype propagates other similar polypes by gemmation, each of which becomes a *Strobila*, and is resolved into numerous Medusæ. Thus there is a successive production of procreating individuals from a single impregnated ovum of a Medusa, according to the law of Parthenogenesis.

META'LLIC TRACTORS. Towards the end of the last century Dr. Elisha Perkins, of Norwich, in Connecticut, introduced a method of treating diseases by drawing over the affected part two small metallic rods made of different metals, which he called *metallic tractors*, and the operation was called *tractoration.* The use of tractors has been called *Perkinism*, as that of animal magnetism has been called *Mesmerism.* It is almost needless to say that metallic tractors only operate in the fancy of the patient. (Hooper's *Medical Dictionary.*)

METALLOCHRO'MES. (Gr. μεταλλον, *metal*, and χρωμα, *colour.*) When very thin films of peroxide of lead are deposited by electrolytic action upon polished steel plates they give rise to those beautiful prismatic tints which Nobili first described under the above name.

For the method of their production, see *Brande's Manual of Chemistry*, p. 1518.

METAME'RIC. (Gr. μετα, indicating *change*, and μερος, *part.*) A term applied in Chemistry to bodies having one and the same composition, and atomic weight, but yet differing remarkably in certain of their properties, probably in consequence of dissimilar molecular constitution. Thus, formiate of oxide of ethyle (formic ether), and acetate of oxide of methyle (methylo-acetic ether), may both be correctly represented by $C_6\ H_6\ O_4$, but the elements in each are no doubt dissimilarly grouped, as represented in the following formulæ:

$$\left.\begin{array}{l}\text{Formiate of oxide of ethyle } C_4\ H_5\ O+\\ C_2\ H\ O_3\ \ -\ \ -\ \ -\ \ -\ \ -\\ \text{Acetate of oxide of methyle } C_2\ H_3\ O+\\ C_4\ H_3\ O_3\ \ -\ \ -\ \ -\ \ -\ \ -\end{array}\right\}=C_6\ H_6\ O_4.$$

METAPOPHY'SIS. (Gr. μετα, *between*, αποφυσις, *a process.*) In Anatomy, the exogenous process commonly situated between the diapophysis and anterior zygapophyses: in the human skeleton it is best developed in the last dorsal and first lumbar vertebræ; the metapophyses are developed more, and from more numerous vertebræ, in most of the inferior mammalia, arriving at their maximum of length in the armadillos, in which they equal the neural spines in length in the posterior dorsal and the lumbar vertebræ; they relate in these singular quadrupeds to the support of the carapace, the neural spines representing the "king-posts," and the metapophyses the "tie beams," in the architecture of a roof.

ME'TEOROLITE. *See* AEROLITE, in DICT.

METHIO'NIC ACID. (Gr. μετα, indicating *change*, and θειον, *sulphur.*) An acid obtained by the action of anhydrous sulphuric acid on ether; althionic acid is at the same time formed.

METHO'DIC MEDICINE. Medicine as practised by the methodic sect of physicians, of which Themison was the head. They endeavoured to reduce medicine to exact rules, and assumed that all diseases arose from constricted fibre.

METHYLE. *See* METHYLENE, in DICT.

ME'TIS. One of the small planets belonging to the group between Mars and Jupiter. Metis was discovered by Mr. A. Graham, at Mr. Cooper's observatory, Markree Castle, on the 25th of April, 1848, and is the ninth of the group in the order of discovery. Its brightness was equal to that of a star between the 9th and 10th magnitudes. The symbol chosen to designate it is an eye and star. Its period of revolution appears to be about 1346 days, nearly the same with that of Iris. *See* PLANET.

METO'PION. (Gr.) An ancient ointment containing galbanum, which was formerly called *Metopium.*

METRE. The French standard measure of length. *See* MEASURE, in DICT. The metre is $= 39{\cdot}371$ or nearly $39\frac{3}{8}$ English inches.

MICROCO'SMIC SALT. (Gr. μικρος, *small*, and κοσμος, *the world.*) The ammonio-phosphate of soda; it is obtained among the products of the evaporation of urine, and was formerly used as a blowpipe flux.

MI'DDLETONITE. A fatty substance found in the coal strata at Middleton, near Leeds.

MI'LLIPEDES. Several insects formerly used in medicine were included under this name: amongst them, the *Armadillo vulgaris*, or *pill millipede*; the *Porcellio scaber*, or *Sclater* of the Scotch: the *Oniscus asellus*, or common *Woodlouse.*

MIMOTA'NNIC ACID. The astringent acid of *catechu*, called also *tanningenic* acid.

MIRA'GE. From observations of this phenomenon made by Mr. T. Hopkins on the sea coast of Lancashire, it appears that mirage is produced by vapour when the atmosphere is loaded nearly to saturation, at which time there is consequently little or no evaporation as indicated by the difference of temperature of a dry and wet bulb thermometer. He found, that when the sky was cloudy and apparently threatening rain, evaporation in the air near the surface of the earth was very active, and there was no mirage; but at other times, when the sun was shining brightly, evaporation was checked, and at such times mirage might be seen. Mr. Hopkins supposes that in strong sunshine the direct rays raise the temperature of the ground considerably, when energetic evaporation from the wet sand takes place, and sends much vapour into the adjacent strata of the atmosphere, the presence of which checks the evaporation from the wet bulb. It is not improbable that some of the vapour thus formed is condensed by the comparatively cool air at a small distance from the surface of the sand, and a stratum of cloud formed, from the surface of which light is reflected, and the phenomenon of mirage produced. But, however this may be, the presence of vapour in sufficient quantity to saturate, or nearly saturate, the air at the place where the mirage appeared, always accompanied its appearance. (*Reports of the British Association*, 1849.)

MOH'SITE. In Mineralogy, crystallised titaniate of

iron from Dauphiny; so named, in honour of Mohs, the crystallographer.

MOLE. Different productions of and excretions from the uterus are so called by medical writers. Small soft excrescences of the cuticle are also termed moles.

MONGO'LFIER BALLOON. A balloon filled with atmospheric air considerably dilated by heat, so called from its inventor. A fire-balloon.

MONI'LIFORM. (Lat. monile, *a necklace.*) A botanical term: it is applied to the pod of the *Hedysarum moniliferum*, from its necklace-like appearance.

MONOPHY'ODONTS. (Gr. μονος, *one;* φυω, *I generate;* οδους, *tooth.*) In Zoology, those mammals which generate one set of teeth, as, *e.g.* the Sloths, Armadillos, Cape ant-eater, Ornithorhynchus, and the true Cetacea: all other mammals that have teeth generate two sets, called "deciduous" and "permanent." *See* DIPHYODONTS.

MO'RINE. The colouring principle of the wood of *Morus tinctoria*, or *fustic*.

MORMONS. The name assumed by a religious sect in the United States of North America, which derives its origin from a person called Joseph Smith, whose account of his own mission is as follows:—He all at once found himself labouring in a state of great darkness and wretchedness of mind—in the first stage, in fact, of what is ordinarily known among Methodists as "receiving a call." He was bewildered among the conflicting doctrines of the Christian world, and could find no comfort or mental rest. In this state he resorted to earnest and "vocal" prayer, kneeling in the woods and fields, and after long perseverance in this course, his prayers were answered by the appearance of a bright light in heaven, which gradually descended until it enveloped the worshipper, who found himself standing face to face with two supernatural beings. Of these he inquired which was the right and true religion of the world? The reply was, that all religions were equally erroneous, but that the true doctrine and the crowning dispensation of Christianity should at a future period be miraculously revealed to himself. Several similar visitations ensued, and at length he was informed that the North American Indians were a remnant of Israel; that when they first entered America they were a great, enlightened, and favoured people; that their priests and rulers kept the records of their history and their doctrines; but that, having fallen off from the true faith and worship, the great body of the nation were supernaturally destroyed—not, however, until after a priest and prophet named Mormon had, by celestial direction, drawn up an abstract of their national record and religious opinions. This abstract, Joseph Smith was told, still existed, buried in the earth, and he it was whom God had selected for the instrument of its recovery and its manifestation to all nations. The record, he was told, contained many prophecies as to "these latter days," and would give instructions for the "gathering of the saints" into a temporal and spiritual kingdom, preparatory to the second coming of the Messiah, which was at hand. After several of these preliminary visions, the spot in which the book lay buried was at length indicated. Joseph Smith went there, and after digging, discovered a sort of box formed of upright and horizontal flags, within which lay a number of plates "resembling gold," and about the thickness of common tin. These plates were bound together by a wire, and were engraved with "Egyptian characters." Beside them lay two transparent stones, "called by the ancients Urim and Thummim," which were evidently divining crystals, and the angels informed Joseph Smith that by using them he would be enabled to decipher the characters on the plates. What ultimately became of the plates in question—if such things existed at all—does not appear. They were said to have been seen and handled by eleven witnesses. But, it should be noticed, that with the exception of three persons, these witnesses were either members of Smith's family, or of a neighbouring family of the name of Whitmer. Professor Anthon described a document submitted to him as having been a sort of *pot pourri* of ancient marks and alphabets. "It had evidently been prepared by some person who had before him a book containing various alphabets; Greek and Hebrew letters, crosses and flourishes, Roman letters, inverted or placed sideways, were arranged in perpendicular columns, and the whole ended in a rude delineation of a circle, divided into various compartments, decked with various strange marks, and evidently copied after the Mexican Calendar given by Humboldt, but copied in such a way as not to betray the source whence it was derived."

The result of these facts is startling. In spite of two bitter persecutions accompanied by murder, robbery, and arson, and two expulsions from flourishing settlements, in the course of twenty years the number of firm adherents to this faith has increased to upwards of 300,000 persons, of which a large number are now settled as an independent state, having a regular charter and organised local government, on a territory of which they possess not only the sovereignty, but the *fee simple*—a beautiful and exceedingly fertile tract as large as England, and situated upon the best "trail" from Eastern America to California and the Pacific. This state is called Deseret, or Utah, and will probably soon be added to the group of the American Union. Its capital is Salt Lake City, a large and flourishing town, which has sprung up like magic in the wilderness. Such being their head-quarters, the Latter-day Saints have agencies and missions in every capital in Europe, and in every large town in the United Kingdom. The great object of these undertakings is to make converts and to "gather the saints" to Deseret. From Great Britain, since 1840, upwards of 14,000 persons have inclined to the doctrines of Mormon, and have gone forth to join the settlement. The Mormon emigration, in 1849, passing through Liverpool, amounted to 2,500 persons, all of the better class of emigrants; and it is calculated that 30,000 Latter-day Saints then remained behind. In June, 1850, there were in England and Scotland 27,863 Mormonites, of whom London contributed 2,529; Manchester, 2,787; Liverpool, 1,018; Glasgow, 1,846; Sheffield, 1,920; Edinburgh, 1,331; Birmingham, 1,909; and Wales—South Wales principally—4,342. And the Mormonite census was taken in last January, giving the entire number in the British Isles as 30,747 "Saints." During the last fourteen years more than 50,000 had been baptised in England, of which nearly 17,000 had emigrated from her shores "to Zion." (The above details are borrowed from an interesting little work called "The Mormons, or Latter-Day Saints," published by the proprietors of the "Illustrated London News.")

MO'TORY, or MOTO'RIAL. (Lat. moveo, *I move.*) In Physiology, this term was applied by Hartley, in 1749, to the nerves conveying the stimulus to the muscles in contradistinction to the nerves conveying the impressions to the neural axis, which he called "sensory;" but he distinguished those actions which result from the conveyance of impressions to the brain, producing sensation and exciting volition, from those actions that are now called "reflex;" as where he states that "the actions of sneezing, swallowing, coughing, hiccoughing, vomiting, and expelling the fœces and urine, with others of a like nature, are to be deduced from those vibrations which first ascend up the 'sensory' nerves, and then are detached down the 'motory' nerves which communicate with these by some common trunk, plexus, or ganglion."

MOUNTAIN BLUE and GREEN. The blue and green carbonates of copper.

MOUNTAIN CORK. MOUNTAIN LEATHER. In Mineralogy, varieties of asbestos.

MULE. A machine for spinning cotton. This very ingenious piece of mechanism was invented, about the year 1777, by Samuel Crompton, formerly of Hall-in-the-Wood, Lancashire. For many years the machine was worked by hand only, the variety of its movements rendering it difficult to accomplish the moving of it by the power of water or of steam, so simply as to be of common use. One form of the mule was in use in Manchester in the year 1797. (Buchanan's *Essays on Mill-Work*, 1841.)

MUM. A malt liquor made chiefly at Brunswick of the malt of wheat, with the addition of a little oat and bean meal.

MU'MIA MINERALIS. (Lat.) A bituminous substance resembling brown asphalt.

MUNJEET. Indian madder.

MU'REXAN. The *Purpuric acid* of Dr. Prout. Its formula is $C_6\ H_4\ O_5\ N_2$.

MURE'XIDE. (Lat. *Murex*, a molluscous animal giving a purple dye.) The *Purpurate of ammonia* of Dr. Prout. It is best obtained by adding 4 grains of alloxan, and 7 of alloxantine, dissolved in half an ounce of boiling water, to one-sixth of an ounce of a saturated solution of carbonate of ammonia. The liquor acquires a magnificent purple colour, and deposits small crystals of murexide, which are green, and iridescent by reflected light, but deep red by transmitted light: they form a beautiful microscopic object. The chemical formula of murexide is $C_{12}\ H_6\ O_8\ N_5$.

MUSCADI'NE. MUSKATEL. A rich sweet wine made of Muscadine grapes in the South of France.

MUSCOVY GLASS. Mica. It is used in Siberia as a substitute for window-glass.

MUSK, ARTIFICIAL. A substance obtained by the action of nitric acid upon oil of amber, and having an odour which some have thought to resemble that of musk.

MY'ELON. (Gr. μυελος, *marrow.*) The single-worded equivalent of "spinal marrow" and "spinal cord."

MY'KOMELI NIC ACID. An acid resulting from the mutual action of alloxan and ammonia. It forms a yellow powder $= C_8\ H_5\ O_5\ N_4$.

MYRIORA'MA. (Gr. μυριας, *a myriad*, and ὁραω, *I view*.) A picture made up of fragments of buildings, landscapes, &c., so as to admit of an infinity of combinations.

MYRI'STIC ACID. (Gr. μυρον, *an odorous oil*.) One of the fatty acids contained in the expressed oil of nutmeg.

MYRO'NIC ACID. (Gr. μυρον, *an odorous oil*.) A substance existing in black mustard seed.

MYROXY'LIC ACID. (Gr. μυρον, *an odorous oil*, and οξυς, *sharp*.) A substance obtained from the Peruvian balsam, the produce of the *Myroxylon Peruiferum*.

MYRRHIC ACID. A substance obtained by heating the resin of myrrh.

N.

NARCOGENI'NE. (Gr. ναρκη, *stupor*, and γιγνομαι, *I produce*.) A basic substance resulting from the oxidation of narcotina.

NATURAL SCIENCE. The term has been applied, arbitrarily, to signify the science of organic bodies, in contradistinction to *Physical Science*, by which is meant the science of inorganic matter.

NAVI'CULAR. (Lat. navicula, *a little boat*.) Boat-shaped. The *navicular* bone is one of the bones of the tarsus. The termed is also used in botany.

NE'BULÆ. In the *Philosophical Transactions* for 1850 (Part II.), the Earl of Rosse has given a description of several remarkable nebulæ, as seen in the great reflecting telescope erected at his Lordship's seat in Ireland. This noble instrument has a mirror of six feet in clear aperture, with a focal length of 53 feet, and by reason of the great extent of reflecting surface it gives a better means of observing faint objects of this class than any other which has ever been applied to the heavens.

Among the new features which Lord Rosse's telescope has brought out, the most remarkable, perhaps, is the spiral arrangement of the nebulous matter, or what appears to be so, observed in various cases. The most strongly developed instance is the 51st nebula of Messier's catalogue, one of the first known, and which has been often described. Messier describes it as a double nebula without stars, Sir W. Herschel as a bright round nebula with a halo or glory surrounding it, and attended by a companion; and Sir John Herschel observed the subdivision of the ring, through about two-fifths of its circumference, as if into two laminæ, one of which has the appearance of being turned up towards the eye out of the plane of the other portion. Viewed through Lord Rosse's telescope, this upturned portion of the ring assumes the aspect of a nebulous coil tending in a spiral form towards the centre, and a general tendency to a spiroid arrangement of the streaks of nebulæ becomes apparent. The companion is also seen to be connected with the general nebula. The number of nebulæ in which the spiral arrangement had been observed to prevail was fourteen at the time the paper was communicated to the Royal Society, but some have been detected since. They are in general difficult to be seen, and the full powers of the instrument are required to bring out the details.

When the catalogue of Sir John Herschel was published only two *annular nebulæ* were known to exist in the northern hemisphere. Now there are seven; five of the planetary nebulæ having been found to be annular. One of them has two perforations; but it is remarked, in reference to this class of objects, that in no instance is the central opening entirely dark. Lenticular or long elliptic nebulæ are very numerous.

With respect to the structure of these strange objects it is very difficult to form any satisfactory opinion. Lord Rosse in speaking of the spiral nebula, Messier 51, observes, that "with each successive increase of optical power the structure has become more complicated, and more unlike any thing which we could picture to ourselves as the result of any dynamical law of which we find a counterpart in our own system." All that can be safely inferred seems to amount merely to this, that the distant parts of the nebulous object are held in connexion by some dynamical law which gives rise to the symmetrical forms which prevail, though those forms, particularly in the case of the spiral nebulæ, are very different from those which we should expect to result from the operation of any laws with which we are acquainted. It is to be kept in mind, however, that, on account of the great difficulty of tracing the outlines, we are by no means certain that we yet know what the forms really are. Frequently, says Lord Rosse, "there is a gradual fading away at the edge, the last trace of which is rather a luminous mist, becoming rarer until imperceptible; a gauze-like tissue of the faintish imaginary flocculi or hairy filaments which become finer and more scattered till they cease to be visible, showing that the real boundary has not been seen, and that the form of the object would alter if additional optical power could be brought to bear upon it."

The considerable number of nebulæ which have been resolved by Lord Rosse's telescope into separate stars must be considered as strengthening the probability that they have all a similar constitution; for since every increase of optical power has multiplied the number of resolvable nebulæ, it seems reasonable to suppose that a further increase would accomplish the same result in those cases in which they have not yet been resolved. But since there are still many with respect to which the large telescope does not give the slightest idea of separate stars, the question of the existence of nebulous matter in contradistinction to stars, cannot be said to be decided.

NEPHRA'LGIA. (Gr. νεφρος, *the kidney*; αλγος, *pain*.) Pain in the kidney.

NE'PTUNE. In astronomy, one of the principal planets of the solar system, and the remotest at present known. The mean distance of Neptune from the sun is 30·0368 times the sun's distance from the earth, or about 2800 millions of miles. Its mean sidereal period is about 60,127 mean solar days, or 164⅔ years. The orbit is nearly circular, the eccentricity in parts of the semi-axis being only 0·00872, and is inclined to the ecliptic in an angle of $1^{\circ}\ 46'\ 59''$. Its apparent diameter is about $2''\cdot8$, and its real diameter 41,500 miles, a little more than half that of Saturn. Its density is about one-seventh of that of the earth, and its mass has been computed to be $1 \div 19840$ of the sun's mass. The time of its rotation about its axis is not known. It is attended by one satellite certainly, and the existence of a second has been suspected. Some observers have also suspected the existence of a ring. On account of the distance of the planet, the difficulty of observing satellites, or any circumstances connected with its physical constitution, is very great even in the most powerful telescopes.

Neptune was first observed as a planet on the 23rd of September, 1846; and the circumstances attending its discovery are extremely remarkable. For a number of years it had been remarked that the observed motions of Uranus were not in accordance with theory. About 1795 the true longitude began to be in advance of the computed longitude, and this acceleration continued till about 1822, after which the true motion began to be slower than the computed, and has continued to be so till the present time. Various hypotheses were formed to account for the phenomena, all of which were found, upon examination, to be untenable, with the exception of one, namely, the existence of an exterior and unknown planet disturbing the motion of Uranus according to the known laws of gravitation. This hypothesis acquired greater probability as the irregular motions of the disturbed planet were more fully developed, and at length a systematic examination of the question was undertaken by Le Verrier, an astronomer attached to the observatory of Paris, and already distinguished by an admirable investigation of the orbit of Mercury. Le Verrier first applied himself to the revision of the tables of Uranus, and the result showed that the observed irregularities could not be explained by the perturbations of Jupiter and Saturn, the only planets then known which exert any sensible action on Uranus. This result was published in the *Compte Rendu* of the Paris Academy of Sciences for Nov. 10. 1845. Le Verrier next proceeded to inquire whether the irregularities were explicable on the hypothesis of disturbance by an exterior planet, and in the *Compte Rendu* for June 1. 1846, he announced that such was the case, and that, assuming the mean distance of the disturbing planet according to Bode's law, its true longitude for the beginning of 1847 must be about 325° — an important determination, inasmuch as it was sufficient for the guidance of any observer who might wish to undertake a search for the planet. In a third memoir, which appeared in the *Compte Rendu* for August 31. 1846, Le Verrier gave the final results of his investigation, containing elements of the orbit of the hypothetical planet, namely, its distance from the sun, periodic time, eccentricity, and longitude of the perihelion; and, in order that nothing might be wanting, he likewise computed the limits within which the deduced place of the planet would be varied by any supposable amount of error in the observations made use of, thus indicating the precise portion of the heavens within which it was necessary to institute a search; and he also assigned the limits of its mass, and in addition pointed out that the planet would probably have a disc of about three seconds, and be visible in ordinary telescopes.

Having completed the theoretical investigation, Le Verrier next proceeded to consider the best means to be adopted for the discovery of the planet, and for this purpose addressed a letter to Dr. Galle of Berlin, one of the best observers of the day, calling his attention to the memoir of August 31, and requesting him to search for the planet according to the indications therein given. The letter was received at Berlin on the 23rd of

September (1846); and so well had the determination been made, that the planet was actually discovered by Dr. Galle on the evening of the same day, and within 52 minutes of a degree of the place assigned by the mathematician. An announcement of the discovery was immediately published, and the astronomers of all countries concurred in regarding it as the most remarkable triumph of the theory of gravitation which had ever been achieved.

Soon after the existence of the planet had been verified by Dr. Galle, it began to be rumoured that Le Verrier was not the only claimant of the honour of the discovery, but that he had even been anticipated in some of his principal conclusions. Nothing, however, was generally known of the circumstances till the publication of the *Monthly Notice* of the Royal Astronomical Society of London for November, 1846, which contained a detailed statement of them drawn up by the Astronomer Royal, about the accuracy of which there could consequently not be a question. From this statement it appeared that so early as February, 1844, the Astronomer Royal was requested to furnish Mr. Adams, of St. John's College, Cambridge, with some observations of Uranus from the records of the observatory, as data for investigations in which he was engaged respecting the theory of Uranus; and that in the month of October in the following year (1845) Mr. Adams, having completed his calculations of the perturbations of that planet on the assumption of their being caused by the attraction of an exterior planet, left at the Royal Observatory a paper containing a complete set of elements of the orbit of the hypothetical planet, a value of its mass, and a table of differences of mean longitudes of Uranus as deduced from the theory, and as determined by actual observation. It further appears that the Astronomer Royal having only results before him, and being well aware of the difficulty of the investigation, requested from Mr. Adams some explanations to enable him to form a better opinion as to the sufficiency of the hypothesis made to explain the observed discrepancies; that, from some unexplained reason, no answer was given to this request; that the matter rested in this state from the end of October, 1845, till the appearance of Le Verrier's second paper in June, 1846, which contained, as above stated, a determination of the longitude of the hypothetical planet; and that on comparing the two results they were found, when reduced to the same epoch, to differ only by 3° 19′.

The parties acquainted with Mr. Adams' results had now far stronger reasons than other astronomers for believing in the existence of the hypothetical planet as well as in the accuracy of its computed place. In so intricate an investigation, founded on data liable to more or less uncertainty, the risks of error were sufficiently numerous to justify hesitation even on the part of those best acquainted with the subject; but when the same result had been arrived at by two different computors independently of each other, the chances of error were almost annihilated. There could then hardly be a doubt as to the accuracy of the conclusion; and if Mr. Adams and his friends had immediately published the fact, it is not improbable that other observers would have been led to look out for the planet. They did not, however, adopt this course, nor does it appear that they acquainted Le Verrier with the remarkable confirmation of his results, but they resolved to institute a search for the planet themselves with the great equatorial of the Cambridge Observatory. The plan adopted was one which, though it virtually ignored the accuracy of the calculations, could scarcely fail of being successful in time. It consisted, simply, in making a close examination of a part of the heavens 30° long, in the direction of the ecliptic, and 10° broad, having its centre at the place indicated by Le Verrier and Adams, and observing all the stars to the 11th magnitude inclusive, from time to time, so as to detect the planet by its change of place. Observations in pursuance of this plan were actually begun on the 29th of July, 1846, and continued during two months. On the 29th of September, Mr. Challis, the director of the observatory, read Le Verrier's paper of August 31, in which the possibility of detecting the planet by its disc was suggested. Concurring in this idea Mr. Challis at once abandoned the plan he had been following, and on the evening of the same day began to observe within the limits indicated by Le Verrier. The planet, however, though observed as a star, was not recognised; on the next night observations could not be made, and on the following day information was received of Dr. Galle's discovery on the 23d of September.

It is to be remarked that Dr. Galle had an advantage over Mr. Challis in the possession of a star-map, then recently published at Berlin, of the part of the heavens to which his search was directed. A star appeared in the field of the telescope which was not laid down in the map, and his attention was consequently directed to it till its true nature became evident by its proper motion.

A circumstance deserving of notice is, that notwithstanding the near coincidence of the predicted place with that at which the planet was actually found, the elements of the hypothetical orbits determined both by Le Verrier and Adams were very wide of the truth. The mean distance they gave was rather more than 36 times the mean distance of the earth from the sun (Le Verrier 36·1539, Adams 37·2474), and the period of revolution about 220 years. It is now known, however, that the periodic time is less than 165 years, and the mean distance only about 30 times that of the earth from the sun, the error in this respect being greater than the radius of Jupiter's orbit. It seemed difficult at first to conceive how elements so faulty should give so close an approximation to the true place of the planet, but the reason has been satisfactorily explained.

NERVE. *See* NERVOUS SYSTEM, in DICT.

NEURAL ARCH. (Gr. *νευρον*, *a nerve.*) In Anatomy, the arch of the vertebra or primary segment of the skeleton which protects a corresponding segment of the neural axis: it is posterior in Man, superior in other Vertebrates, and is formed by the "centrum," "neurapophyses," and "neural spine."

NEURAL AXIS. (Gr. *νευρον*, *a nerve.*) In Anatomy, the central trunk of the nervous system, consisting of brain and myelon: it is sometimes called "cerebro-spinal axis."

NEURAPOPHY'SIS. (Gr. *νευρον*, and *ἀποφυσις*, *a process.*) In Anatomy, the autogenous vertebral element which forms the side or wall of the arch protecting the neural axis or central trunk of the nervous system: it has been called the "vertebral lamina," and by Soemmerring the "radix arcus posterioris vertebræ."

NINIVEH MARBLES. The name given to the collection of Assyrian Antiquities, recently procured by the researches of Mr. Layard at Niniveh, and deposited in the British Museum.

NODAL POINTS. NODAL LINES. Under the term VIBRATION (DICT. OF SCIENCE) it is stated that a vibrating chord may spontaneously divide itself into any number of aliquot parts, each of which will vibrate separately as if it were fixed at its two extremities and formed a separate chord. The points of separation between two such contiguous parts, which participate neither in the vibration of the one nor the other, but remain at rest, are called *Nodal Points*. And in like manner, when elastic plates are put into a state of vibration, the molecules separate themselves into parcels which vibrate independently of each other, and the lines of separation thus formed, or lines of repose in which no vibration takes place, are called *Nodal Lines*. *See* VIBRATION.

NO'NTRONITE. A nodular silicate of iron from Nontron, in France.

NOPAL. The cactus upon which the cochineal insects breed.

NORDHAU'SEN ACID. A peculiar sulphuric acid, intermediate between the anhydrous, and monohydrated acid, or oil of vitriol, so called from the place of its manufacture.

NU'SSIERITE. In Mineralogy, a species of *phosphate of lead* from Nussières, near Beaujeu.

O.

O. A contraction for *Octarium*, a pint.

O'CTROIS. (A corruption of Lat. auctoritas.) The name given in France to the taxes levied on objects of consumption at the gates of many towns and cities, and applied partly to the general uses of the state, and partly to local purposes. There are nearly 1500 communes subjected to this tax, which amounts in some years to nearly 100,000,000 of francs. The revenue of Paris from this source alone is upwards of 30,000,000 of francs.

ŒNANTHIC ETHER. (Gr. *οινος*, *wine*; *ανθος*, *a flower.*) A peculiar compound, upon which the fragrancy and persistent odour of certain wines depends.

ŒNANTHY'LIC ACID. (See above.) An acid of a peculiar aromatic odour, obtained by the action of nitric acid on castor oil.

OE'RSTEDITE. In Mineralogy (in honour of Oersted), a silico-titaniate of zirconia, from Arendal in Sweden.

ŒSOPHAGI'TIS. (Gr.) Inflammation of the œsophagus.

ŒSOPHAGO'TOMY. (Gr. *οισοφαγος*, *the gullet*, and *τεμνω*, *I cut.*) The operation of cutting into the œsophagus, or gullet, for the purpose of removing some foreign substance.

O'KENITE. In Mineralogy (in honour of Oken), a hydrated silicate of lime.

O'LANIN. (Gr. *ολειον*, *oil.*) One of the ingredients

of the fetid empyreumatic oil, obtained by distilling bone and other animal matters.

O'LEOSA'CCHARUM. (Gr. ολεον, and Lat. saccharum, *sugar.*) In Pharmacy, powdered sugar mixed or imbued with certain essential oils; called also *Elæosaccharum.*

O'LIGISTE. (Fr.) In Mineralogy, the *fer oligiste* of Haüy. A variety of hæmatite or specular iron.

O'LIGOCLASE. (Gr. ολιγος, *few*, and κλαω, *I break.*) In Mineralogy, a silicate of alumina and soda.

ONO'NINE. A sweet crystalline principle contained in the root of the *Ononis spinosa.*

OPERA'METER. A piece of machinery for registering the number of revolutions made by the shafts or wheels of mill-work.

O'PHITE. (Gr. οφις, *a serpent.*) In Mineralogy, serpentine. Green speckled porphyry.

OPHTHA'LMODY'NIA. (Gr. οφθαλμος, *the eye*, and οδυνη, *pain.*) A violent pain in the eye without apparent inflammation; it is sometimes of a gouty character.

OPHTHALMOPTO'SIS. (Gr. οφθαλμος, *the eye;* πτωσις, *a fall.*) A protrusion of the whole globe of the eye.

OPIA'NIC ACID. A crystallisable acid formed by the action of peroxide of manganese on a solution of narcotine in dilute sulphuric acid. Its formula appears to be $C_{20} H_9 O_9 + HO$.

OPTO'METER. (Gr οπτομαι, *I see;* μετρον, *measure.*) An instrument for measuring the focal distance of the eye, or the distance at which a minute object is distinctly seen. As the distance varies in respect of different individuals, the instrument is applicable to the purpose of determining the focal lengths of spectacles required for myopic or presbyopic eyes.

The principle upon which the optometer is constructed appears to have been first established experimentally by Scheiner, and subsequently by Dr. Motte of Dantzic, and by Dr. Porterfield. If we look at any minute object through two pin holes, or two parallel slits made in a card or any opaque thin body, the distance between the holes or slits being less than the diameter of the pupil of the eye, then, if the object be at the point of perfect vision, the image on the retina will be single, but in every other case it will be double; and, on varying the distance of the object from the eye, the two images will be seen to approach to or recede from each other. As a consequence of this, if the object looked at be a line pointed nearly towards the eye, it will appear as two lines crossing each other in the point of perfect vision at a very acute angle.

The practical application of this principle is extremely simple. As proposed by Dr. Thomas Young, the optometer may be made of a slip of card paper, or ivory unpolished, about eight inches in length (this being the distance of distinct vision for most eyes) and one in breadth, divided longitudinally by a black line which must not be too strong. The end of the card is bent into a position nearly perpendicular to its length, or a detached piece may be applied in the same inclined position. In this part (which is applied to the eye) a hole of about half an inch square must be made, the side being so cut as to receive a slide of thick paper, with slits of different sizes from a fortieth to a tenth of an inch in breadth, divided by spaces somewhat broader, so that each observer may choose that which best suits the aperture of his pupil. The slide is then brought close to the eye, and the black line viewed through two adjacent slits: it appears as two lines intersecting each other; the point of intersection is marked, and distance of this point from the slide is the focal length of the eye. (Young's *Lectures on Natural Philosophy*, vol. ii. p. 576, or p. 354. of Kelland's Edition; Priestley's *History of Discoveries relating to Vision*, etc., p. 641.)

O'RCINE. A crystallisable substance obtained from certain *lichens*, which, when exposed to air, gradually reddens. By ammonia it is converted into a purple substance called orcéine or orceic acid, which forms the beautiful blue or purple colours yielded by lichens.

ORE'LLINE. A colouring principle obtained from annotta (*Bixa orellana*).

ORGAN. The plan of Mr. Willis's instrument, which attracted great attention at the Exhibition in 1851, was as follows: Three complete rows of keys from C C C C to G, with two octaves and a fifth of pedals.

Great Organ.

Stops.		Feet
1. Double diapason (metal) largest pipe		16
2. Bourdon, closed	(wood)	16
3. Trumpet		16
4. Open diapason		8
5. Open diapason		8
6. Stopped diapason with claribella		8
7. Trumpet		8
8. Principal		4
9. Principal		4
10. Flute, open	(wood)	4
11. Clarion		4
12. Twelfth		4
13. Fifteenth		2
14. Fifteenth		2
15. Piccolo		2
16. Octave clarion		2
17. Doublette		1
18. Sesquialtera	3 ranks	
19. Mixture	3 ranks	
20. Fourniture	3 ranks	

Swell Organ C C to G.

Stops.		Feet
1. Double diapason, lower octave	(wood)	16
2. Double dulciana		16
3. Open diapason		8
4. Open diapason		8
5. Dulciana		8
6. Viol de Gamba		8
7. Stopped diapason		8
8. Trumpet		8
9. Trombone		8
10. Oboe		8
11. Cremona		8
12. Principal		4
13. Principal dulciana		4
14. Flute, open	(wood)	4
15. Clarion		4
16. Twelfth		3
17. Fifteenth dulciana		2
18. Fifteenth		2
19. Dulciana	3 ranks	
20. Sesquialtera	3 ranks	
21. Mixture	3 ranks	
22. Fourniture	3 ranks	

Pedal Organ C C C C to G.

Stops.		Feet
1. Double diapason, open	(wood)	32
2. Open diapason do.	(do.)	16
3. Open diapason	(metal)	16
4. Violin	(do.)	16
5. Bourdon	(do.)	16
6. Tromba		16
7. Trumpet		8
8. Octave	(metal)	8
9. Octave	(wood)	8
10. Quint		6
11. Super-octave	(metal)	4
12. Clarion		4
13. Sesquialtera	3 ranks	
14. Mixture	3 ranks	

Choir Organ.

Stops.		Feet
1. Bourdon		16
2. Open diapason		8
3. Dulciana		8
4. Viol di Gamba		8
5. Stopped diapason		8
6. Corno di bassetto		8
7. Viola		4
8. Principal		4
9. Flute	(wood)	4
10. Flute, closed	(metal)	4
11. Octave cremona		4
12. Fifteenth		2
13. Piccolo		2
14. Orchestral oboe (the only half-stop)		8

Copular.

1. Great organ to swell.
2. Swell to great organ.
3. Choir to great organ.
4. Swell to choir organ.
5. Swell to pedals.
6. Great organ to pedals.
7. Choir organ to pedals.

being in all 77 stops.

Of the above stops, all except the Orchestral Oboe were of the same compass as the various Claviers, a circumstance, we believe, without parallel in any large English organ.

ORGEAT. (Fr.) A sweetened emulsion of almonds usually flavoured by a few bitter almonds and a little orange-flower water. Mucilage of gum arabic is also sometimes added.

ORSEDEW. Brass leaf. Dutch, or Manheim gold.

O'RTHOCLASE. (Gr. ορθος, *straight*, and κλαω, *I break.*) A mineralogical synonym of *Felspar.*

ORTHOPÆ'DIA. (Gr. ορθος, *straight*, and παιδεια, *the bringing up of children.*) That department of medicine and surgery which relates to the prevention and cure of deformity.

O'STEODE'NTINE. (Gr. οστεον, *a bone;* and Lat. dens, *a tooth.*) That modification of dentine in which the tissue is traversed by irregularly disposed and ramified vascular or medullary canals, and in which some of the branches of the dentinal tubes communicate with cells, like the radiated cells of true bone: this modification of dentine is found in the central part of the tooth of the Cachalot and some other cetaceans; also in the teeth of the Cestracion, Acrodus, Lepidosiren, and many other existing and extinct fishes.

O'XALYLE. (Gr. οξυς, *sharp*, and υλη, *principle.*) The hypothetical radical of the oxalic acid $= C_2 O_2$.

OXA'MIC ACID. (Gr. οξυς, *sharp*, and ἁμα, *together.*) One of the products of the destructive distillation of binoxalate of ammonia. Its composition is represented by the formula $C_2 H_4 O_5 N + HO$.

OZO'KERITE. (Gr. οζειν, *to smell*, and κηρος, *wax.*) A species of *mineral tallow.*

OZO'NE. (Gr. οζειν, *to smell.*) A substance occasionally existing in the atmosphere, and having a peculiar odour resembling that produced when repeated electric sparks, or the electric discharge from a point, is passed through the air. It is supposed to be a peculiar modification of oxygen. It is also formed in certain cases of the slow action of air upon phosphorus.

P.

P. In some medical formulæ is used as the abbreviation of *Pugillus*, the eighth part of a handful.

P. Æ. The abbreviation of *partes æquales*, or equal parts.

PACI'NIAN CORPUSCLES. Small oval bodies situated on some of the cerebro-spinal and sympathetic nerves, especially the cutaneous nerves of the hands and feet, are so called, after their discoverer, Pacini.

PACKWAX. The ligaments of the neck of ruminants. It differs from common ligament in resisting the action of boiling water.

PADDING-MACHINE. An apparatus used by calico-printers for uniformly imbuing a piece of cotton cloth with any mordant.

PALÆOSAURUS. (Gr. παλαιος, *ancient*, and σαυρος, *a lizard,*) A genus of extinct lizards, characteristic of the magnesian conglomerate.

PALA'GONITE. A mineral found in the tufa of Palagonia, in the Val di Noto, Sicily. It is a hydrated silicate of alumina, iron, and lime.

PA'LPEBRÆ, (Lat., a palpitando, from their fre-

quent motion.) The eyelids; the upper and under uniting at each end to form the *canthi.*

PALPITA'TION. A throbbing; the term is especially applied to irregularities of the heart's action, which are frequently the result of indigestion, of nervous excitement, or mental agitation.

PA'LMIC ACID. The acid resulting from the saponification of the *palmine* of castor oil. (*Palma Christi.*)

PALMI'TIC ACID. The acid formed during the saponification of *palm oil.*

PANA'DA. (Ital. pane, *bread.*) Bread or biscuit steeped or boiled in water so as to acquire a soft consistence.

PANDICULA'TION. (Lat. pandiculo, *I gape.*) The gaping, yawning, and stretching that characterises some diseases. It sometimes occurs in the cold fit of an ague.

PANOPHO'BIA. (Eng. panic, from Lat. Pan, and Gr. φοβεω, *I frighten.*) That form of hypochondriasis or melancholy which is chiefly characterised by groundless apprehensions.

PANTOCRA'TIC MICROSCOPE. (Gr. παν, *all;* κρατος, *power.*) The name given by Professor A. Fisher, of Moscow, to a microscope so arranged that the observer is enabled by simple movements to vary the magnifying power from 270 to 550, without in any degree obscuring the object; thus avoiding the inconvenience of having to shift the different parts of the microscope when he desires to observe the same object under different magnifying powers.

PAPI'LLÆ. (Lat. papilla.) In Anatomy, are minute conical or cylindriform elevations, usually well supplied with vessels and nerves: they are close-set, and prominent on the palmar surface of the fingers and the plantar surface of the toes, where they are disposed in double rows, along parallel curved lines. They are very numerous, and of different kinds; *e. g.* "conical," "fungiform," "calyciform," on the upper surface of the tongue.

PA'RA. A very small Turkish coin, equal to the fortieth part of a piastre.

PARABA'NIC ACID. One of the acids resulting from the action of nitric acid upon uric acid: it forms colourless and transparent six-sided prisms, very soluble and sour. Its composition is represented by the formula $C_6\,O_4\,N_2+2\,HO$.

PARABOLE. *See* PARABLE.

PA'RALLAX. In 1846, Mr. Peters, of the Pulkova Observatory, presented to the Imperial Academy of Sciences of St. Petersburg, a very important memoir on the Parallax of the Fixed Stars, of which an analysis has been given by Struve in his *Etudes d'Astronomie Stellaire*, 1847. Among the results obtained by Mr. Peters are the parallaxes of eight stars, determined by observations of zenith distances made at Pulkova in 1842 and 1843 with the great vertical circle of Ertel. The divided circle of the instrument is 43 inches in diameter, and the object glass of the telescope nearly six inches; the magnifying power employed was 215; and the whole number of observations was 711, of which 289 were of Polaris alone. The names of the stars, their resulting parallaxes, and the probable errors of the respective results, are as follows:—

Star's name.	Parallax.	Prob. Error.
61 Cygni	+0″·349	0″ 080
Groombridge, 1830	+0 ·226	0 ·141
ι Ursæ Majoris	+0 ·133	0 ·106
Arcturus	+0 ·127	0 ·073
α Lyræ	+0 ·103	0 ·053
Polaris	+0 ·067	0 ·012
Capella	+0 ·046	0 ·200
α Cygni	—0 ·082	0 ·043

The parallax of 61 Cygni was determined by Bessel from a series of observations with the Konigsberg heliometer, and found to be 0″·348 (*see* DICT. OF SCIENCE); and the confirmation thus given by Peters may be considered as not only placing the fact of a measurable parallax of this star beyond all doubt, but as proving that its amount cannot differ more than a small fraction from the above value. With respect to the next star in the list (Groombridge, 1830), Mr. Faye, of the Paris Observatory, had announced that he had detected a parallax exceeding 1″, a result which Mr. Peters' observations prove to be erroneous. Struve found the parallax of α Lyræ to be 0″·261. The negative value found in the case of α Cygni must be considered as indicating merely the absence of any sensible parallax. In fact, the relative magnitudes of the probable errors in respect of the four stars Capella, ι Ursæ Majoris, Arcturus, and α Cygni, show that very little reliance can be placed on the numerical results in any of those cases.

Another conclusion deduced by Peters is, that the mean parallax of stars of the second magnitude is +0″·116, with a probable error of 0″·014. This result is obtained from 33 stars, of which the absolute or relative parallaxes have been determined with a degree of certainty presumed to be sufficient to establish the conclusion. Assuming the scale of relative distance adopted by Struve for stars of the different orders o magnitude (*see* GALAXY), he thence concludes that th mean parallax of the stars of the first magnitude 0″·209, and that the mean parallax of those of the thir is 0″·076. On this it is to be remarked that, althoug the hypothesis that the stars which have the greates apparent magnitude are those which are nearest th earth, and consequently those which have the larges parallax, is very probable in itself, it is not established b any conclusive facts; on the contrary, there does no appear, in the case of those stars whose parallaxes ar supposed to have been determined by direct observation to be any relation between the parallax and the apparen magnitude.

In the *Memoirs of the Royal Astronomical Society* vol. xix., the parallax of the double stars α^1 and α^2 Cen tauri is determined by Mr. Maclear from a series of ob servations with the mural circle, made at the Cape i the years 1842, 1843, 1844, and 1848. The final result i given as follows:—

Parallax of α Centauri = 0″·9187, Prob. error = 0·034
Constant of aberration = 20″·53 , Prob. error = 0·038

This result scarcely differs from that which was de duced in 1842, by M. Henderson (who first discovere the parallax of this remarkable star), from observation made at the same place, namely, parallax = 0″·913. I must be remembered, however, that both results are de duced from observations made with the same instru ment, and the agreement therefore may perhaps b considered as not so conclusive as in the case of 6 Cygni.

PARAPOPHY'SIS. (Gr. παρα, *across;* αποφυσις, *a process.*) In Anatomy, the process which extends outwards, or outwards and downwards, from the body o the vertebra in Fishes, and from the same part in th cervical and anterior dorsal vertebræ of the Crocodile where it has been called the "inferior transverse process." It is sometimes ossified from an independen centre.

PARI'LLINE. The supposed active principle of sarsaparilla. It has also been called Smilacine. It appears to be identical with the Parillic acid of Batke.

PA'RISITE. A crystallised mineral containing cerium, found in the mines of the Musso Valley, in New Granada.

PA'RTHENOGE'NESIS. (Gr. παρθενος, *a virgin*; γιγνομαι, *to be born.*) In Physiology, the procreatio of offspring by a plant or animal independently of th immediate stimulus of the male principle. The impregnated seed of a plant produces a "phyton" of the prope species, usually in the form of a leaf, with a stem an root; from this a succession of "phytons" may be developed by gemmation, most of them having the form of leaves; but, in the higher species of plants, some may take on the form of petals; others of stamens, developing the male principle, or "pollen;" others o pistils, forming the female principle, or "seed." By th union of these two principles the seed is impregnated, and may germinate; but the series of individuals successively developed from the first individual from th seed are procreated by "parthenogenesis." The different individuals being organically connected, accordin to a definite pattern for each species, form a compoun whole, which is commonly regarded as the individua "tree" or "shrub."

In the compound Polypes the first individual polyp from the impregnated ovum develops a succession o individuals, by gemmation, most of which may resembl the first-formed polype; but others are modified so a to reproduce the male principle, or the ova: thes generative polypes are also, sometimes, as in *Coryn* and *Campanularia*, set free. For other instances o this alternating kind of generation, see Steenstrup, *O Alternate Generation*, and Owen, *On Parthenogenesis.*

PARTHE'NOPE. One of the small planets belonging to the group between Mars and Jupiter, and th eleventh in the order of discovery. It was detecte at Naples on the 11th of May, 1850, by Dr. De Gasparis who, in announcing its discovery, remarked that he ha used his utmost endeavours to realise a Parthenope i the heavens; this name having been suggested by Si John Herschel upon the occasion of the discovery o Hygeia (also by De Gasparis) in 1849. The symbol i a fish crowned with a star. *See* PLANET.

PAU'LITE. A variety of hypersthene or prismati schiller-spar, from Paul's Island and the coast of La brador.

PEACHWOOD. A dye-wood extensively used i calico printing. It is the produce of a species of *Cæsal pinia.*

PE'ARLWHITE. The subnitrate of bismuth; fo merly used as a cosmetic under the above name.

PE'CTOLITE. (Gr. πηκτος, *bound together*, an λιθος, *a stone.*) A species of zeolite, which, after havin been heated, forms a gelatinous solution with muri atic acid.

PE'GANITE. A species of wavellite, or hydrated phosphate of alumina, from Strigis in Saxony.

PE'GMATITE. (Gr. πηγμα, Lat. aliquod compactum.) A granular mixture of quartz and felspar, found chiefly in granite veins, and closely resembling the so-called *graphic granite*, having the appearance of laminar compression.

PELIO'MA. (Gr. πελιος, *black*.) A mineralogical synonym of iolite or allochroite.

PE'LOKONITE. (Gr. πηλος, *mud*, and κονια, *clay*.) In Mineralogy, a native phosphate of manganese, iron, and copper.

PELOSI'NE. (Gr. πελος, *black*.) A bitter extractive matter obtained from the root of the *Cissampelos Pareira*, or *Pareira Brava*.

PENDULUM EXPERIMENT. An experiment proposed by M. Foucault of Paris, which, in 1851, excited great interest both in this country and in France; its object being to afford a visible proof of the rotation of the earth. It is this: By the theory of dynamics, if a simple pendulum be made to oscillate in a plane, the plane of oscillation, in reference to the meridian of the place, will not remain fixed, but will appear to rotate uniformly about the vertical passing through the point of suspension, and the time of rotation will be twenty-four hours increased in the ratio of the cosecant of the latitude to radius. This is easily understood in respect of a pendulum supposed to be suspended directly over the pole, where the terrestrial meridians would successively pass under it, and the earth's rotation would have no tendency to alter the direction in space of the plane of oscillation; but for any place between the pole and the equator the conception of the phenomenon is more difficult. Upon trial, the experiment is liable to failure from various causes, but principally from the great difficulty of adjusting the suspension so accurately that the vibrations shall continue to be made in a plane; for if the pendulum acquires an elliptic motion, however slight, the greater axis of the ellipse, or line of apsides, immediately begins to revolve from a cause entirely independent of the rotation of the earth, and the two motions cannot easily be distinguished. (See *Notices of the Royal Ast. Soc.* vol. xi. p. 199.; and *Memoirs of R. A. S.* vol. xx.)

PE'PSINE. (Gr. πεψις, *digestion*.) A peculiar animal principle contained in the gastric juice, and which, in conjunction with acid matter, also present in that secretion, confers upon it its solvent or digestive powers in regard to certain components of the food.

PERCU'SSION. (Lat. percutio, *I strike*.) In medical language, signifies the striking or tapping upon any part of the surface of the body, with a view of ascertaining the condition of the subjacent parts by the sound so produced. It is a valuable mode of exploration in some diseases of the chest. Attention was first called to this mode of diagnosis in 1761, by Dr. Avenbrugger, of Vienna: his work was translated into French in 1808, by Corvisart, and the subject was further illustrated in 1816, by the celebrated work of Laennec on *Auscultation*.

PE'RICLASE. (Gr. περι, and κλαω, *I break*.) A crystalline mineral, composed of magnesia with about 7 per cent. of protoxide of iron, found at Monte Somma, near Naples.

PE'RICLINE. (Gr. περι, and κλινειν, *to lie*.) A variety of felspar.

PE'RILYMPH. (Gr. περι, and Lat. lympha, *water*.) The fluid between the membranous and osseous labyrinth of the ear, or that in which the membranous labyrinth is suspended.

PE'RMANENT WHITE. Sulphate of baryta, when used as a pigment, it not being liable to discolouration, as is the case with white lead.

PERMANGA'NIC ACID, called also *Hypermanganic* acid. A compound of 2 atoms of manganese with 7 atoms of oxygen. It has been obtained in carmine-red acicular crystals. Its salts are of a fine red or purple hue.

PERONE'AL MUSCLES. (Gr. περονη, *the fibula*.) Muscles arising from the fibula and concerned in the movements of the foot.

PE'ROWSKITE. A crystallised titaniate of lime found in the chlorite slate of Slatoust in the Ural.

PE'RSIAN BERRIES. The berries of the *Rhamnus infectoria*, called in France *grains d'Avignon*. They are used by calico-printers and dyers, as a source of a yellow colouring matter, which has been called Rhamnine.

PE'RTHITE. A variety of felspar, from Perth in Upper Canada.

PERU'VINE. One of the products of the distillation of Peruvian balsam. Its formula is $C_{18}\ H_{12}\ O_2$. It is a light oily fluid.

PE'TZITE. An ore of silver with from 30 to 40 per cent. of tellurium, analysed by Petz, and found in the mines of Nagyag.

PEUCEDA'NINE. A crystallisable principle existing in the root of *Peucedanum officinale*, hog's fennel or sulphur-wort.

PEU'CILE. (Gr. πευκη, *a fir tree*.) A liquid obtained by the action of lime upon the hydrochlorate of oil of turpentine, of which oil it appears to be an isomeric modification. Its formula is $C_{10}\ H_8$.

PEYER'S GLANDS. Small glandular sacculi peculiar to the mucous membrane of the small intestines, and either scattered singly, when they are called "glandulæ solitariæ," or aggregated into groups, when they are termed "glandulæ agminatæ," or "Peyer's patches," from the anatomist who first described them.

PHA'COLITE. (Gr. φακος, *a wart*, and λιθος, *a stone*.) A silicate of alumina, lime, and soda (zeolite), from Leipa in Bohemia.

PHA'NTASCOPE. The name given by Prof. Locke, of the United States, to an apparatus for enabling persons to converge the optical axis of the eyes, or to look "cross-eyed," and thereby observe certain phenomena of binocular vision. It consists of a flat base-board, with an upright rod at one end bearing two sliding sockets which may be clamped at any height, like those of a retort stand. The upper socket supports a small screen or card having a slit or aperture a quarter of an inch wide and about three inches long, so that both eyes may be applied to it at once, the middle of the aperture being directly over the centre of the base-board. The lower socket bears a moveable screen of pasteboard or thin wood, having an opening of about three inches long, and an inch wide, and so adjusted that its centre is in the same straight line with the centre of the set in the upper card and the centre of the base-board. This screen has an index marked across its middle. In experimenting with the apparatus the observer places an object on the base-board, looks downward through the slit in the upper screen, and slides the lower up or down till the required adjustment is attained. For example, let the letter A be written twice on the base-board, about two and a half inches (the width between the eyes) apart, and in the line of the axis of the apertures of the screens; and suppose the lower screen to be close down to the base-board. On gradually raising this screen, and keeping the eyes directed to the index and not to the letters, each letter will separate and appear double, so that four letters will be seen. As the screen is raised the two internal images gradually approach, and become optically superimposed, or coalesce into one, so that there are only three letters visible, and the middle or superimposed figure is the *phantom* or *image* where there is really no object. On ceasing to look at the index, and directing the eyes on the base-board itself, the phantom figure instantly vanishes. The experiment may be varied so as to produce various amusing illusions; and the author thinks the apparatus will illustrate many important points in optics, and especially the physiological point of single vision by two eyes. (*London, Edinburgh and Dublin Philosophical Magazine*, June, 1850. It may be remarked that whether the apparatus be new or not, the phenomena have long been well known, and are fully explained in *Smith's Optics*, 1738.)

PHA'RMACOSI'DERITE. (Gr. φαρμακον, *poison*, and σιδηρος, *iron*.) Native arseniate of iron.

PHENAKI'STOSCOPE. (Gr. φενακισμος, *illusion*; σκοπεω, *I view*.) A philosophical toy, which illustrates the principle of the *persistence* of impressions on the retina of the eye in a very ingenious manner. It is thus described by Sir D. Brewster (*Ency. Brit.* art. OPTICS). "This instrument was, we believe, originally invented by Dr. Roget, and improved by M. Plateau, at Brussels, and by Mr. Faraday. It consists of a circular disc from six to twelve inches in diameter, with rectilinear apertures on its margin in the direction of its radii. A series of figures, of a rider, for example, leaping a fence is drawn on the circumference of a circle, parallel to the rim of the disc. The *first* figure represents the rider and horse standing *before* the fence; and the last figure represents them standing *over* the fence, when the leap is completed. Between these two figures there are several others, representing the rider and the horse in various parts of the leap. The observer then stands in front of a looking glass, with the disc in his left hand, attached to a handle, and by a piece of simple mechanism he whirls it rapidly round, looking at its image in the glass through the notches in its margin. He is then surprised to see the horse and his rider actually leaping the fence, as if they were alive, and returning and leaping again as the disc revolves. If we look over the margin of the disc at the reflected picture on the face of the disc, all the figures are effaced, and entirely invisible; but when we look through the notches, we only see the figure of the horse and rider at the instant the notch or aperture passes the eye, so that the picture instantaneously formed on the retina is not obliterated by preceding or subsequent impressions. Hence the eye receives in succession the pictures of the horse and rider in all the attitudes of the leap, which are blended as it

were into one action. The apparent velocity with which the horse and rider advance (supposing the disc always to have the same velocity) depends on the proportion between the number of apertures in the margin of the disc, and the number of figures of the horse and rider."

PHE'NAKITE. (Gr. φεναχιζειν, *to deceive.*) A rare mineral, containing glucina. The Rhomboedral Emerald of Mohs.

PHE'NE. (Gr. *an eagle.*) One of the chemical synonyms of the hydrocarbon usually called benzole, C_{12} H_6. It is isomeric with bicarburet of hydrogen. It has also been called *Hydruret of Phenyle*, and is in that case represented by the formula C_{12} H_5 + H.

PHENIKO'CHROITE. (Gr. φηνη, and χςοα, *colour.*) A native chromate of lead from Beresow in Siberia.

PHE'NYLE. (Gr. φηνη, and υλη, *matter.*) A radical hydrocarbon = C_{12} H_5.

PHI'LLIPSITE. A variety of zeolite. So called in honour of Phillips the geologist.

PHILOSO'PHIC CANDLE. An inflamed jet of hydrogen gas.

PHILOSO'PHIC WOOL. Oxide of zinc formed during the combustion of the metal, when it floats about in white flocks in the air. It has also been called *nihil album.*

PHLEBI'TIS. (Gr. φλεψ, *a vein.*) Inflammation of a vein.

PHLE'BOLITE. (Gr. φλεψ, and λιθος, *a stone.*) A venous calculus, commonly called "vein-stones." Very small concretions have sometimes been found in certain veins, varying in size from a pin's head to that of a pea. They consist chiefly of carbonate and phosphate of lime and animal matter.

PHLEGMA'SIÆ. (Gr. φλεγω, *I burn.*) Inflammatory diseases. The term *phlegmasia dolens* has been applied to a peculiar inflammatory condition of the leg, which sometimes occurs in females soon after delivery.

PHLORI'DZINE, or PHLORIZINE. (Gr. φλοιος, *bark*; ῥιζα, *root.*) A white crystalline substance obtained from the bark of the roots of apple, pear, cherry, and plum trees, giving to it its bitter astringency. Its composition is represented as C_{21} H_{15} O_{12}. Acids, aided by heat, resolve it into sugar, and *Phloretine*. By the joint action of oxygen and ammonia it is converted into a gum-like substance which has been called *Phloridzéine.*

PHŒ'NICIN. (Gr. φοινιξ, *purple.*) A purple substance obtained by the action of sulphuric acid on indigo.

PHO'LARITE. (Gr. φολις, *a scale.*) A mineralogical name applied to a hydrated silicate of alumina, occurring in pearly scales.

PHO'SGENITE. Native chlorocarbonate of lead, occurring in transparent yellowish crystals at Matlock. It is a very rare mineral.

PHO'SPHORIC ACID. *See* PHOSPHORUS.

PHO'SPHURET. Compounds of Phosphorus with the metals have been termed *Phosphurets* or *Phosphides.*

PHO'SPHOROCHA'LCITE. The native hydrated phosphate of copper found near Rheinbreitenbach, and also in the Ural.

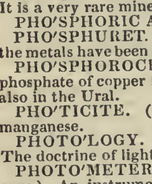
PHO'TICITE. (Gr. φως, *light.*) A native silicate of manganese.

PHOTO'LOGY. (Gr. φως, *light*; λογος, *discourse.*) The doctrine of light. *See* LIGHT.

PHOTO'METER. (Gr. φως, *light*, and μετρον, *measure.*) An instrument for measuring the intensity of light, or of illuminations.

The most elegant instrument which goes under this name is the photometer invented by the late Sir John Leslie. It is merely the differential thermometer of the same ingenious philosopher, having one of its balls diaphanous, and the other coated with China ink, or blown of deep black enamel; and the whole covered by a case of thin transparent glass, to defend the balls from the disturbing influence of currents of air. The photometer has two general forms; the one *portable* (fig. 1.) in which the black ball is about an inch higher than the other, and bent forward to the same vertical line, or the axis of the translucent cylindrical case; and the other *stationary* (fig. 2.), having both its balls of the same height, and reclining in opposite ways; the case being composed of a wide cylinder surmounted by the larger segment of a hollow glass sphere. The latter form of the instrument, though less commodious, is better adapted for nice observations; since, besides receiving the light more regularly, its balls, from being on the same level, are not liable to be disturbed by different strata of unequally heated air.

(1.) (2.)



The theory of this photometer depends on the assumed principle that the intensity of light is proportional to the heat excited by its incidence on the black ball. When the instrument is exposed to light, the rays which fall on the clear ball pass through it, without suffering obstruction; but those which strike the dark ball are stopt and absorbed at its surface, where, assuming a latent form, they act as heat, which, by expanding the air within the ball, causes the liquid in the stem to descend. This heat will continue to accumulate till its farther increase comes to be counteracted by an opposite dispersion, caused by the rise of temperature which the ball has acquired. But, in still air, the rate of cooling is, within moderate limits, proportional to the excess of the temperature of a given surface above that of the surrounding medium. Hence the space through which the coloured liquid sinks in the stem will measure the momentary impressions of light, or its actual intensity. (*Leslie on the Relations of Air to Heat and Moisture.*)

The graduation is entirely arbitrary, and may be regulated according to fancy or convenience. Leslie adopted the same scale of divisions as in the differential thermometer, ten degrees of which correspond to one of the centigrade thermometer. When the temperature of both balls is exactly the same, that is, when the instrument is excluded from light, the liquid in the stem next the coloured ball stands at zero. In this country the direct impression of the sun at noon, about the summer solstice, forces the liquid down to 90° or 100°. The greatest force of the solar beams, in the depth of winter measures only about 25°. At the altitude of 3° above the horizon, the whole effect of the sun's rays does not exceed one degree. The indirect light from the sky at noon in summer is from 30° to 40°; in winter from 10° to 15°. Comparing the illuminating power of the solar rays with that of artificial lights, Leslie found the light emitted by the sun 12,000 times more powerful than that of a wax candle; that is to say, if a portion of the luminous solar matter, rather less than half an inch in diameter, were transmitted to our planet, it would throw forth a light equal to the effect of 12,000 candles.

It has been objected that the instrument now described is only a species of thermometer, and not strictly a photometer; since it measures heat, and not light. To this objection Sir J. Leslie replies by asking, "What does the thermometer itself indicate except *expansion?* As heat is measured by the expansion it occasions, so light is determined by the intensity of the heat which in every supposition invariably accompanies it. What other mode, after all, could be imagined for detecting the presence of light? How can an unknown quantity be expounded but in terms of one already known?" (*Ency. Brit.*, art. CLIMATE.)

It must be admitted, however, that the same quantity of light emitted by terrestrial bodies of different kinds is not always accompanied with the same degree of heat. Thus, phosphorus burns in oxygen gas with intense splendour, and yet gives out far less heat than the comparatively dull combustion of hydrogen in the same gas; and the unfitness of this instrument for comparing the intensities of lights from different sources has been pointed out by Arago, who proved that it rises when exposed to the light of the sun, falls when exposed to the light of a common fire, and under the light of an Argand lamp remains stationary. (*Humboldt's Kosmos*, vol. iii. 1851.) See *Leslie's Experimental Inquiry into the Nature and Propagation of Heat*, 1804.

PHRA'GMOCONE. (Gr. φςαγμος, *a partition*; κωνος, *a cone.*) The essential part of the complex-shell of the Belemnite, consisting of a straight cone divided by numerous transverse partitions perforated by a marginal siphon. From the time of Llwyd conchologists have called this part the "alveolus," a term which is now more properly restricted to the socket of the sheath lodging the "phragmocone." Belemnites are chiefly distinguished by modifications of the "sheath" or "dart;" but the phragmocone is the constant and true characteristic of this extinct group of Cephalopods, which chiefly flourished from the epoch of the Muschelkalk to that of the Maestricht chalk.

PHTHORE. (Gr. φθοςος, *pernicious.*) A name given by some of the French chemists to *Fluorine.*

PHYLLIRE'INE. A bitter crystalline principle contained in the *Phyllirea latifolia.*

PHY'MA. (Gr. φυω, *I produce.*) A term applied by the ancient physicians to scrofulous tumours. In modern medical language it signifies a tubercle on any external part of the body.

PHYSE'TER. (Gr. φυσητης, *a blow-pipe.*) The generic name of the cachalot, or sperm whale.

PHY'SICAL SCIENCE. This term has been applied, arbitrarily, to signify the Science of Inorganic Bodies, as contradistinguished from that of Organised Beings. In this sense it includes the study of the external appearances and elementary principles, as well as the properties of inorganic matter.

PHYTE'LEPHAS. Vegetable Ivory. (Gr. φυτον, *a plant*; ελεφας, *an elephant.*) A genus of plants inhabiting America. Its fruit is of great size, and contains a milk which hardens into a substance resembling ivory.

Of this hardened albumen, buttons, boxes, and other articles are turned. It is the *Caleza de Negro*, or *Taqua plant*.

PHYTO'TOMY. (Gr. φυτον, *a plant;* τεμνω, *I cut.*) Vegetable anatomy.

PIAU'ZITE. A fusible resin-like substance found in the brown-coal at Piauze, near Neustadt in Carniola.

PI'CKERINGITE. A magnesian alum occurring in white silky fibres at Iquique in Peru.

PICRAMY'LE. (Gr. πικρος, *bitter;* υλη, *principle.*) A radical hydrocarbon = $C_{14}H_6$. The name has reference to the composition of bitter almond oil, which is $C_{14}H_6O_2$, and therefore a *binoxide of Picramyle.*

PICROGLY'CION. (Gr. πικρος, *bitter*, and γλυκυς, *sweet.*) An extractive matter of a bitter and sweet taste, obtained from the stalks of the *Solanum dulcamara*.

PI'CROLITE. (Gr. πικρος, and λιθος, *a stone.*) A name given by some mineralogists to fibrous serpentine.

PI'CROPHA'RMACOLITE. (Gr. πικρος, φαρμακον, *poison*, and λιθος, *a stone.*) A native arseniate of lime and magnesia from Riechelsdorf in Hessia.

PICROPHYLLITE. (Gr. πικρος, and φυλλον, *a leaf.*) A species of serpentine in dark green foliated masses.

PI'CROSMINE. (Gr. πικρος, and οζειν, *to smell.*) A species of steatite said to yield a *bitter odour* when breathed upon.

PILE, GALVANIC. *See* Voltaic Electricity.

PILLOWS. In Machinery, are the bearings on which gudgeons and journals rest. They are usually fixed in blocks of cast iron, whence the term *Pillow Block*, and sometimes, corruptly, *Plumber Block*.

PIMA'RIC ACID. The purified resin of the *Pinus maritima*: it forms a white crystalline mass. When subjected to dry distillation it yields an oil which has been called *Pimarone*.

PIME'LIC ACID. (Gr. πιμελη, *fat.*) One of the products of the action of nitric acid on fatty bodies.

PI'NGUITE. (Lat. pinguis, *fat.*) A greasy feeling silicate of iron, of a dark green colour, found at Wolkenstein in Saxony, and in the Harz.

PI'NIC ACID. (Lat. pinus, *the fir tree.*) The principal resinous constituent of common resin or colophony.

PIPEFISH. The vernacular name of the fishes of the genus *Syngnathus*.

PI'SSOPHANE. (Gr. πισσα, *pitch.*) A substance chiefly composed of sulphate of alumina and iron, found in the decomposing alum slate of Saalfeld and Reichenbach in Saxony. It resembles pitch in fracture and colour.

PI'STACITE. A green silicate of alumina, lime, and iron. It is a variety of epidote, and occurs embedded in many crystalline rocks. The finest crystals are from Arendahl, and from several parts of the Alps.

PISTO'MESITE. A crystallised carbonate of iron and magnesia from Saltzburg.

PITCH. In wheel work, signifies the distance between the centres of two contiguous teeth. *Pitch Line* is the circle, concentric with the circumference, which passes through all the centres of the teeth.

PITTIZITE. In Mineralogy, a variety of bog iron ore found near Limoges in France.

PLA'GIONITE. A sulphuret of lead and antimony from Wolfsberg in the Harz.

PLA'KODINE. (Gr. πλαξ, *a tabular surface.*) A native arsenuret of nickel found near Müsen in Siegen in tabular crystals.

PLA'SMA. (Gr.) The fluid of the blood in which the red particles are suspended, to which its colour is due: it consists of serum, holding fibrine in solution. It is sometimes called "Liquor sanguinis."

PLA'TTNERITE. A native oxide of lead from Leadhills in Scotland.

PLE'XUS. (Lat. *woven.*) In Anatomy, the term is substantively applied to those portions of nerves which interweave and interchange fasciculi, appearing to anastomose with each other, as, *e. g.*, in the arm-pit, forming the "axillary" or "brachial plexus," and in the loins, forming the "lumbar plexus." As nerves approach their final distribution in the several tissues, the minute fibres commonly form delicate plexuses, called the "terminal plexuses."

PLICIDE'NTINE. (Lat. plica, *a fold;* dens, *a tooth.*) That modification of dentine in which the substance is folded, as it were, on a series of vertical vascular plates, which radiate from the central axis of the pulp, and which is accompanied by a fluted character of the exterior of the tooth: the basal part of the teeth of the wolf-fish, of the *Lepidosteus oxyurus*, and of the *Ichthyosaurus*, affords examples of plicidentine.

PLI'NTHITE. A hydrated silicate of alumina and iron from Antrim in Ireland.

PLU'MBIC ACID. The *Peroxide of lead* = PbO_2. It combines with certain bases, forming compounds which have been called *plumbates*.

PLUMBOCA'LCITE. (Lat. plumbum, *lead*, and calx, *chalk.*) A mixed carbonate of lime and lead from Wanlock Head, in Scotland.

PLU'MBUM CORNEUM. (Lat.) Horn lead. The old chemical name of fused chloride of lead.

PLUMOSE ALUM. (Lat. pluma, *a feather.*) A name formerly given to the silky amianthine crystals occasionally observed on alumslate. It is a *sulphate of alumina and iron*.

PLU'MOSITE. (Lat. pluma, *a feather.*) Capillary or plumose sulphuret of antimony, chiefly found in the Harz and Hungarian mines.

PNEUMATO'METER. (Gr. πνευμα, *air*, and μετρον, *measure.*) A gasometer constructed for the purpose of measuring the quantity of air taken into the lungs and again given out, at each inspiration and expiration.

PNIGA'LIUM. (Gr. πνιγω, *I suffocate.*) A name given by some medical authors to the *Nightmare*, from the sense of suffocation which it induces.

POE'NAMU. A variety of jade or nephrite used in New Zealand for the manufacture of axes and other weapons.

PO'LAR CLOCK. An optical apparatus invented by Professor Wheatstone, whereby the hour of the day is found from the polarization of solar light.

Light reflected from the atmosphere, like other reflected light, is polarized in a certain plane; and it is found that the light reflected from any particular point of the sky is polarized in the plane passing through that point, through the sun, and the eye of the observer. Suppose the point of the sky under observation to be the pole, then the plane in question is one which passes (sensibly) through the axis of the earth's rotation, and consequently the angle which it makes with the meridian is an hour angle; if, then, the situation of this plane be determined, the hour of the day, or time from true noon, is determined also.

Mr. Wheatstone's method of determining the plane of polarization consists in attaching to the top of an upright pillar a glass plate, held by a brass ring, and directed perpendicularly to the earth's axis, the lower half of the ring being divided into twelve equal parts (which may be again subdivided) to represent the hours. A conical tube is fitted into the brass ring, so that its axis is parallel to that of the earth. The upper and wide end of the tube is closed by a plate of glass having a star of selenite on it, and a Nichol's prism is attached to the lower end. The principal sections of the thin plates of selenite which form the star are all parallel, and inclined at an angle of 45° to the plane of polarization of the prism, and so placed that the lamellæ simultaneously appear colourless. In order to make the observation the tube is turned till the central portion of the star exhibits the maximum of red colour, when a black line drawn on the glass plate in the direction of a principal section of the lamellæ and serving as an index, gives the position of the plane of polarization of the reflected light, and consequently indicates the hour. Instead of this apparatus, Soleil proposed to use a polariscope containing two plates of quartz of opposite rotation, in which case the situation of the plane of polarization becomes known by the equality of colour.

The polariscope has some advantages over the sun dial, inasmuch as it may be used some time before sunrise and after sunset, and even when the sky is in some measure clouded, but the practical use of the instrument appears to be subject to many considerable difficulties. (*Annual Report on the Progress of Chemistry, &c.* vol. iii. part 1.)

POLA'RISCOPE. Any apparatus or instrument by means of which it can be ascertained whether light is in its ordinary state, or has been polarized. This may be done in various ways. The polariscope proposed by Arago is formed of a tube closed at one extremity by a plate of rock crystal cut perpendicularly to the optical axis, and about five millimetres (or a fifth of an inch) in thickness, and having at the other end, where the eye is applied, a prism possessing the property of double refraction placed transversely to the axis of the tube. A beam of polarized light, after passing through the plate, is decomposed by the prism into two others which are polarized at right angles to each other, and exhibit the complementary colours, varying with the position of the prism. *See* Polarization of Light, in Dict.

POLA'RIZATION OF LIGHT. The phenomena of polarization are arranged under the heads *plane polarization*, *circular polarization*, and *elliptic polarization*. For the first, see Polarization, in Dict.

Circular Polarization is produced when light is twice totally reflected from the second surfaces of bodies at their angle of maximum polarization. It may also be produced, as was discovered by Arago, by the passage of light through rock crystal; or, as discovered by Biot and Seebeck, through certain fluids, as oil of turpentine, oil of laurel, solution of sugar, &c.

Elliptic Polarization, is produced by reflexion from the polished surfaces of metals at angles included between 70° 45′ and 78° 30′; gold having the least and tin the

greatest polarizing angles. This property was discovered by Sir David Brewster.

PO'LIANITE. A crystallised peroxide of manganese from Bohemia.

PO'LISHING SLATE. *Polierschiefer* of the German mineralogists. A light slaty substance occurring abundantly at Bilin in Bohemia: it consists of the siliceous bucklers of microscopic animals.

POLLUX. Among the abundant absurdities of mineralogical nomenclature, is the application of the names Castor and Pollux to two varieties of felspar found in the granite of Elba.

POLY'BASITE. (Gr. πολυς, *many*, and βασις, *support.*) A native sulphuret of silver, copper, arsenic, and antimony, found in the mines of Saxony, Hungary, and Mexico.

POLYCHROMA'TIC ACID. (Gr. πολυς, and χρωμα, *colour.*) A compound resulting from the action of nitric acid upon aloes. When used as a dye-stuff it yields a great variety of colours.

POLYDI'PSIA. (Gr. πολυς, and διψη, *thirst.*) Excessive thirst.

POLYHY'DRITE. (Gr. πολυς, and ὑδωρ, *water.*) A hydrated silicate of iron from Breitenbrun, in Saxony. It seems to be the same as the *Hisingerite* of Berzelius found in Sweden.

PO'LYKRASE. (Gr. πολυς, and κρασις, *combination.*) A rare mineral occurring in black six-sided tables: it contains titanic and tantalic acids, zirconia, yttria, alumina, magnesia, lime, and the oxides of iron, cerium, and uranium. It is found at Hitterö, in Norway.

POLYSPHÆ'RITE. A reniform variety of chlorophosphate of lead from Freiberg, containing also phosphate of lime.

POLY'XENE. (Gr. πολυς, and ξενος, *stranger.*) A name given by Hausmann to the ore of platinum, as indicating the many new metals associated with it.

POO'NAHLITE. A species of zoolite from Poonah, in Hindostan.

PO'RTAL. (Lat. porto, *I carry.*) In Anatomy, is applied to a system of veins that ramify like arteries, and send the blood from trunks to branches in the substance of the liver. The portal system is derived in mammals from the veins of the abdominal organs of digestion, which form a common trunk, called "Vena portæ." This subordinate kind of circulation in the liver is called the "portal circulation," and the blood it transmits is called the "portal blood." The blood of the portal vein differs from other venous blood in being of less specific gravity, darker, and incapable of being rendered bright by the contact of salt or oxygen; in containing only about half the ordinary quantity of fibrine, and in containing less albumen, but more red globules, and nearly twice the usual amount of fatty matter.

POSO'LOGY. (Gr. ποσον, *quantity*, and λογος, *description.*) In Medicine, that which relates to the doses or quantities in which medicines should be administered.

POST MORTEM. (Lat. *after death.*) In Anatomy, the technical phrase signifying the inspection and examination of the dead body, in order to determine the cause of death: it is also applied to the appearances presented, and more especially to some phenomena which are constantly noticed shortly after death. Thus, the muscles retain their property of contracting under the influence of stimuli applied to them, or to their nerves, for some time after death; and when they have lost this irritability, they spontaneously pass into a state of contraction, producing a general stiffening of the body, which is called "post-mortem rigidity," or "rigor mortis."

POT-METAL. An alloy of copper and lead.

POUDRE'TTE. (Fr.) A manure composed of night-soil mixed up with clay, and formed into cakes.

PRA'SEOLITE. A species of tourmalin from Norway.

PREDA'ZZITE. A magnesian marble, or dolomite, which forms mountain masses at Predazzo, in the Tyrol.

PREMO'LAR. (Lat. præ, *before*, molaris, *grinding tooth.*) In Anatomy, the name of those permanent teeth in the Diphyodont mammals that displace and succeed the deciduous teeth vertically: they are situated before the molars; and, being in many cases of more simple structure, they have been termed "false molars," and in Human Anatomy "bicuspides." The premolars never exceed four in number on each side of both jaws.

PRIMING AND LAGGING. The alternate acceleration and retardation of the times of high water, caused by the combined action of the sun and moon. *See* LAGGING.

PRINCE'S METAL. Prince Rupert's metal. The same as pinchbeck. An alloy of copper and zinc.

PROCŒ'LIAN. (Gr. προ, *before;* κοιλος, *hollow.*) In Anatomy, those vertebræ are so called which have a cavity or cup at the fore part of the body, and a ball at the back part. The term is also applied to the group of animals—a certain family of Reptiles, *e. g.*, which manifest this vertebral character. It is found in most existing Saurians, but not in any extinct species of earlier date than the cretaceous period.

PROLETAI'RE. (Lat. proles, *offspring.*) A term that has come into common use in the social discussions of late years, signifying that class of the community whose labour is their only capital. As its origin indicates, it was applied to those members of a community whose social duties were limited to furnishing children to defend the state, and whose social rights were necessarily small. The word plays a considerable part in all the writings of the communists and socialists both of France and Germany.

PROSY'LLOGISM. In Logic, a word sometimes used to signify a second syllogism, proving a former one; at other times in the same sense as Enthymeme, viz. a syllogism of which one premise is suppressed.

PRO'TEINE. (Gr. πρωτειον, *the chief place.*) The azotised substance which forms the basis of albumen, fibrine, and caseine, in which proximate principles it is combined with small proportions of sulphur and phosphorus. Different formulæ have been assigned to proteine: that of Mulder is $C_{40}\ H_{30}\ O_{12}\ N_5$.

PRO'TEOLITE. (Gr. πρωτος, *first*, and λιθος, *a stone.*) The slaty rock immediately recumbent upon granite.

PRO'TOZENE. (Gr. πρωτος, and ξενος, *a stranger.*) Talcose granite. A mixture of felspar, quartz, and talc, or chlorite. It decomposes into china clay or porcelain earth.

PSELLI'SMUS. (Gr. ψελλιζω, *I stammer.*) An imperfect articulation. Stuttering.

PSEU'DÆSTHE'SIA. (Gr. ψευδης, *false*, and αισθανομαι, *I feel.*) Imaginary or false feeling.

PSEU'DOMA'LACHITE. (Gr. ψευδος, and μαλακος, *soft.*) Native phosphate of copper.

PSEUDOMO'RPHOUS CRYSTALS. (Gr. ψευδος, and μορφη, *form.*) Substances found in crystalline forms not belonging to them, and being, as it were, casts of other crystals.

PSEUDOSCOPE. (Gr. ψευδος, and σκοπεω, *I view.*) A name given by Professor Wheatstone to the stereoscope when employed to produce what he calls "conversions of relief." These conversions may be produced in three different ways:—1st, by transposing the pictures from one to the other; 2ndly, by reflecting each picture separately, without transposition; and, 3rdly, by inverting the pictures to each eye separately. The converse figure differs from the normal figure in this circumstance, that those points which appear most distant in the latter are the nearest in the former, and vice versâ. The *pseudoscope* consists of two reflecting prisms placed in a frame, with adjustments, so that when applied to the eyes, each eye may separately see the reflected image of the projection which usually falls on that eye. The instrument being directed to an object, and adjusted so that the object shall appear of its proper size, and at its usual distance, the distances of all other objects are inverted; all nearer objects appear more distant, and all more distant objects nearer, and this constitutes the "conversion of relief." The inside of a teacup appears a solid convex body. A china vase ornamented with coloured flowers in relief, appears to be a vertical section of the interior of the vase, with painted hollow impressions of the flowers. A small terrestrial globe appears a concave hemisphere; when the globe is turned on its axis, the appearance and disappearance of different portions of the map on its concave surface has a very singular effect. A bust regarded in front becomes a deep hollow mask. When regarded in profile the appearance is equally striking. A framed picture hung against a wall appears as if imbedded in a cavity made in the wall. (See *Athenæum* for 1852, Jan. 24, and STEREOSCOPE in SUPP.)

PSILA'NTHROPISTS. (Gr. ψιλος, *mere*, and ανθρωπος, *man.*) A name given to a peculiar sect of Unitarians who believe that Jesus was the son of Joseph, and in whose creed the resurrection holds a higher place than the crucifixion.

PSILOME'LAN. (Gr. ψιλος, *mere*, and μελας, *black.*) In Mineralogy, black hæmatitic ore of iron.

PSOROPHTHA'LMIA. (Gr. ψωρα, *the itch;* οφθαλμος, *the eye.*) An inflammation and ulceration of the eyelids attended by an itching sensation.

PTYALI'NE. (Gr. πτυαλον, *saliva.*) A supposed peculiar animal matter obtained from saliva. It is insoluble in alcohol, and is said to be analogous to the vegetable substance termed diastase.

PULSE GLASS. A tube of about a quarter of an inch diameter and five or six inches long, with a bulb at each end, and about half filled with spirit of wine or water, care having been taken to expel the whole of the air previously to sealing the tube. When held in an inclined position, one of the bulbs being grasped

in the hand, the expansion of the included vapour causes the liquid to rise and fall in the tube, or to *pulsate*.

PU'NCTUM CÆCUM. (Lat.) That part of the retina of the eye immediately about the spot at which the optic nerve unites with it is found experimentally to be totally insensible to the stimulus of light, and hence it has been called by writers on Optics the *Punctum Cæcum*.

PURREE, or INDIAN YELLOW. A yellow colouring matter imported from India and China. Its origin has not been accurately ascertained, but it is supposed to be a vegetable juice mixed with magnesia.

PUSCHKINITE. A variety of Epidote from Siberia.

PUZZOLA'NO. A volcanic rock, which yields an excellent water-cement. It occurs at Puzzuoli, near Naples.

PYRARGI'LLITE. (Gr. πυρ, *fire*, and αργιλλος, *pure clay*.) A hydrated silicate of alumina, found in the granite of Finnland.

PYRA'RGYRITE. (Gr. πυρ, and αργυρος, *silver*.) The red or ruby silver ore; it is either a sulphuret of silver and antimony, or a sulphuret of silver and arsenic. The finest specimens are from Andreasberg, in the Harz, and from Joachimsthal in Bohemia.

PYRE'NEITE. A species of garnet found in the limestone of the Pic d'Erselids near Barége, in the Pyrenees.

PYROPHI'LLITE. A hydrated silicate of alumina and magnesia which exfoliates before the blowpipe, found in the Ural, and formerly considered as *talc*.

PYROPHY'SALITE. (Gr. πυρ, *fire*, and φυσαλος, *a toad*.) A mineralogical synonym of the common topaz, found in veins and blocks near Fahlun. A crystal in the College of Mines at Stockholm weighs 80 lbs.

PYRO'SKLERITE. (Gr. πυρ, and σκληρος, *hard*.) A green hydrated silicate of magnesia and alumina coloured by iron and chromium, from Elba.

PYRRHOSI'DERITE. (Gr. πυῤῥος, *brown*, and σιδηρος, *iron*.) A brown hydrous peroxide of iron.

PY'RRHOTINE. (Gr. πυῤῥος, *brown*.) Magnetic iron ore.

PYRU'VIC ACID. (Gr. πυρ, *fire*, and Lat. uva, *a grape*.) An acid discovered by Berzelius amongst the products of the destructive distillation of racemic and of tartaric acid. It had been before observed by Pelouze, who mistook it for acetic acid.

Q.

QUAS. A fermented liquor used in Russia, and prepared from a mixture of meal and malt.

QUI'NCEITE. A hydrated silicate of magnesia tinged red by oxide of iron, found near Quincey, in France.

QUI'NOIDINE. (From Quinin.) An alkaloid said to accompany cinchonia and quinia in certain varieties of *cinchona*.

R.

RAPHA'NIA. (Lat. Raphanus, *the radish*.) A disease said to be produced by eating the seeds of a species of raphanus; it is attended by convulsive motions of the limbs, vomiting, and diarrhœa.

RA'PHELITE. A species of hornblende from Perth, in Upper Canada.

RATAFI'A. A term applied to certain liqueurs or drams, derived like the word *ratify* from *ratum* and *fio*, to make firm, or *confirm*. By ratafia, therefore, was originally meant a liquid drank at the *ratification* of an agreement. (PEREIRA, *on Food and Diet*.)

RE'AGENT. In Chemistry, bodies which serve to detect the presence of others; tests.

RECE'IVER. In Chemistry, generally means a globular vessel applied to a retort in which the *distillate* or product of distillation is collected or received. The bell-glass placed upon the plate of an air-pump is also called a receiver. *See* RETORT, in DICT.

RED FIRE. A pyrotechnical compound which burns with a beautiful red or pink flame. It consists of nitrate of strontia, mixed with charcoal and a little sulphur and chlorate of potassa.

RE'DRUTHITE. The vitreous sulphuret of copper, magnificent crystallised specimens of which have been obtained from the mines near Redruth in Cornwall.

REFLEX FUNCTION, in Physiology. *See* AUTOMATIC, MOTORY, SENSORY.

REFLEX ZENITH TUBE. An instrument recently invented by the Astronomer Royal, and erected at the Greenwich Observatory, for measuring the zenith distances of stars very near the zenith. It consists mainly of an object-glass of 5 inches diameter and 10 ft. focal length; of a micrometer firmly attached to the cell of the object-glass; and of a trough of mercury placed beneath the object-glass at a distance of nearly half its focal length. The cell of the object-glass is fixed in a tube sliding in another tube fastened to the flooring of the small chamber in which the instrument is erected, the mercury being a short distance beneath the flooring. By this apparatus the parallel rays proceeding from a star very near the zenith are, while in a converging state, reflected from the mercury, so as actually to converge to a focus and form an image at a short distance above the object-glass; and it is ingeniously contrived that the point of convergence shall be in the same line (measured parallel to the diameter of the object-glass) as its focal centre. By this means any inaccuracy which would arise from a small error of level of the plane of the micrometer is avoided. A micrometer is mounted upon the cell which carries the object-glass, which has a series of wires stretched across its side bars, and whose screw acts against the standards carrying the bars, the wires being placed at intervals nearly equivalent to double the distance of γ Draconis from the zenith of Greenwich. For viewing the images of the star and the wires together, a compound 4-glass eye-piece is used, consisting of two distinct parts, the first part consisting of a first lens for receiving the rays from the object-glass, and a glass reflecting prism for turning them into a horizontal direction, the prism having one side ground to a spherical surface, so as to produce the effect of the second glass of the eye-piece, and to avoid unnecessary loss of light. This part is fixed in a tube carried between the bars of the micrometer. The second part consists of the third and fourth glasses of the eye-piece mounted in a tube carried horizontally by a fixed support, so as to allow the head of the observer to avoid interference with the rays after passing through the object-glass. The cell of the object-glass is made to revolve, carrying with it the micrometer, for the purpose of making observations in reversed positions. The micrometer is also double, carrying screws and divided heads on each side of the object-glass, and it is so arranged that by the action of one of the screws the micrometer wires are carried without disturbance of the reading of the head attached to the other screw.

REMI'SSION. In Medicine, the abatement of a disorder, or regular mitigation of symptoms, as opposed to *intermission*, in which the symptoms of disease for a time entirely disappear. *See* REMITTENT FEVER, in DICT.

RE'SINITE, or RETINITE. A substance intermediate between resin and asphalt. *See* RETINASPHALTUM, in DICT.

RE'STIFORM. (Lat. restis, *a rope*, and forma.) In Anatomy the term is applied to certain rope-like columns or tracts, behind the "lateral tracts" of the medulla oblongata. The "restiform tract" is continuous below with the posterior columns of the myelon, while above, its fibres may be traced transversely through the pores into the cerebellum. If the restiform tracts be irritated the most acute suffering is produced.

REVE'RBERATORY FURNACE. A furnace in which the flame is made to pass over a bridge, and then beat down again upon a hearth or surface, on which the materials to be heated are placed.

RHABA'RBARINE. The colouring principle of rhubarb.

RHÆ'TIZITE. A mineralogical synonym of the cyanite of the Tyrol.

RHEO'METER. (Gr. ῥεω, *I flow*; μετρον, *measure*.) A term proposed by Peclet as a synonym for *galvanometer*, and generally adopted by the French writers on physics. Professor Wheatstone, in an ingenious paper entitled "An Account of several new Instruments and Processes for determining the Constants of a Voltaic Circuit," published in the *Philosophical Transactions* for 1843, uses the term, in a general sense, to designate any instrument for measuring the force of an electric current, without reference to its particular construction. Mr. Wheatstone also uses the following similar terms in describing apparatus employed in investigations on the same subject:—

Rheomotor (Lat. moveo, *I move*), any apparatus which originates an electric current.

Rheoscope (Gr. σκοπεω, *I view*), an instrument for ascertaining merely the existence of a current.

Rheostat (Gr. ιστημι, *I place*), an instrument for adjusting or regulating the circuit, so that any constant degree of force may be obtained.

Rheotome (Gr. τεμνω, *I cut*), an instrument which periodically interrupts an electric current.

Rheotrope (Gr. τρεπω, *I turn*), an instrument which alternately inverts the current.

RHEOPHORE. (Gr. ῥεω, *I flow*, and φορεω, *I carry*.) A term employed by Ampere to designate the connecting wire of a voltaic apparatus, as being the carrier or transmitter of the current.

RHODA'NIC ACID. (Gr. ῥοδον, *a rose*.) A chemical synonym of sulphocyanic acid. It produces a red colour with persalts of iron.

RHODIZO'NIC ACID. A substance formed by

passing dry carbonic oxide over highly heated potassium, and acting on the product by water. A red powder separates which is rhodizonate of potassa, from which rhodizonic acid may be separated by a mixture of sulphuric acid and alcohol. Its formula is said to be $C_7 O_7$, 3 HO.

RHO'DIZITE. (Gr. ῥοδον, *a rose.*) A species of boracite, which, when heated before the blowpipe, colours the flame first green, but afterwards red.

RHO'DOCHROME. (Gr. ῥοδον, *a rose*, and χρωμα, *colour.*) A hydrated silicate of magnesia and alumina, containing a little chromic oxide, and of a red colour when in fine splinters. It has been found in Siberia, also near Baltimore, and in Tino in Greece.

RHO'DONITE. (Gr. ῥοδον, *a rose.*) A silicate of manganese.

RHYTHM. (Gr. ῥυθμος. *rhyme.*) In Physiology, the more or less regular succession of the contractions of certain automatic muscles. In the heart the motion commences in the venæ cavæ, and proceeds through the auricles and ventricles, and then, after an interval, is resumed in the venæ cavæ. In the intestine the movement travels in a vermicular manner from above downwards; and a second movement, beginning at the upper part of the intestine before the first has completed its course, affects the parts in the same order. These movements are called "rhythmic;" those of the intestinal tube are also called "peristaltic."

RI'CINOSTE'ARIC ACID. One of the acids resulting from the saponification of castor oil.

RIFACIMENTO. (Ital. *re-establishment.*) A term in common literary use applied to any work or treatise, the materials of which have neither been derived from original research, nor have been collected for the first time.

RIGOR MORTIS. (Lat.) In Physiology, the general stiffening of the body produced by the simultaneous contraction of all the muscles of the trunk after death. The muscular coat of the arteries also contracts after death on division and mechanical irritation, on the application of cold, and under the stimulus of electricity.

RIPIDOLITE. A mineral resembling Chlorite.

RISUS SARDONICUS. (Lat. *sardonic laugh.*) So called as having been produced by eating a species of ranunculus growing about certain springs in Sardinia. A convulsive grin, giving a peculiarly horrible expression to the countenance, chiefly observed in cases of tetanus and inflammation of the diaphragm.

ROCHE ALUM. Alum deprived of part of its water of crystallisation by heat. The term is also sometimes applied to the so-called *Roman Alum*, made from the alum ore of the Solfaterra, near Naples.

ROCKSOAP. An earthy silicate of alumina. It is used for crayons, and also for washing cloth.

ROCKWOOD. The common name for ligniform asbestus.

ROME'ITE. A native antimoniate of lime found in the manganese mines of St. Marcel, in Piedmont, and named in honour of the celebrated crystallographer Romé de l'Isle.

RO'SENITE. A sulphuret of lead and antimony from Wolfsberg in the Harz. Named in honour of H. Rose, the analytical mineralogist.

RO'SITE. (Eng. *rose.*) A mineral of a red colour in small grains embedded in limestone, from Sweden; it appears to be silicate of alumina tinged red by manganese. It has also been called *Rosellanite.*

RUBI'NIC ACID. An acid formed by exposing a solution of catechuic acid in carbonate of potassa to the action of air.

RU'FINE. (Lat. rufus, *red*) A red substance formed by the action of sulphuric acid on salicine.

RUTHE'NIUM. A metal closely resembling iridium, with which it is associated in the residue from crude platinum insoluble in aqua regia. Its properties require further investigation. (CLAUS. *Annalen der Chem. und Pharm.*, lix. 234.)

RUTI'NIC ACID. An acid contained in the leaves of rue.

S.

SA'CCHARITE. (Lat. saccharum.) A mineral of the felspar family, found in veins in serpentine, in the chrysoprasm mines near Frankenstein, in Silesia.

SACCHARO'METER. (Lat. saccharum, Gr. μετρον.) An improved construction of the saccharometer was exhibited at the London Exposition of Industry by M. Duboscq-Soleil. A double gauge is formed by a rotating polarising plate of quartz and Iceland spar, of which two semicircles, placed in juxtaposition, and viewed through a telescope of low magnifying power, are brought into exact coincidence of colour, by turning the spar. In this situation the images are viewed through an empty tube, closed at both ends with glass. The saccharine juice is poured in and the quality of colour is disturbed; the semicircles, which no longer match, are readjusted, by sliding upon each other two achromatised prisms of Iceland spar, so as to leave a variable difference of thickness estimated in parts of a finely divided scale, which gives numerical evidence of the quantity of saccharine matter present.

SAL ALEMBROTH. The hydrargo-chloride of ammonium. A compound of sal ammoniac and corrosive sublimate.

SA'LAMSTONE. The common name of the oriental sapphire.

SAL DE DUOBUS. (Lat.) An ancient chemical name applied to sulphate of potassa.

SALICY'LIC ACID. An acid obtained by the action of fused potassa on salicine: it may also be obtained from various other sources. The formula of the salicylic acid is $C_{14} H_5 O_5 + HO$.

SAL MIRABILE. (Lat.) Glauber's salt. Sulphate of soda.

SAL PERLATUM. (Lat.) A term applied by old chemical writers to the rhombic phosphate of soda.

SAL PRUNE'LLA. Nitrate of potassa fused into cakes or balls. The latter were sometimes coloured blue.

SA'MARSKITE. A granular mineral found in the Ilmen mountains near Miask. It contains uranium and tungstic acid.

SA'NDERS WOOD. The wood of the *Pterocarpus Santalinus*, a large tree growing upon the Coromandel coast and in other parts of India, especially Ceylon. It furnishes a deep red resinous colouring matter.

SANDYX. (Gr. Σανδυξ.) An old alchemical term applied to red lead prepared by calcining carbonate of lead.

SA'NTONINE. A crystalline principle contained in the *Artemisia Santonica*, the buds or broken peduncles of which plant are used in pharmacy under the name of *worm seed: Semen Cinæ*, or *Contra.* The composition assigned to santonine is $C_{30} H_{18} O_5$.

SA'RCOSINE. (Gr. σαρξ, *flesh.*) A basic substance obtained by boiling kreatine with hydrate of baryta. Its formula is $C_6 H_7 O_4 N$.

SARGA'SSO. *Fucus natans* or Gulf Weed, spread over a large part of the Atlantic. Its abundance has led to the Portuguese expression *Mar de Sargasso*, or Weedy Sea.

SA'TELLITE. The recent discovery of an eighth satellite in the system of Saturn may be regarded as the natural consequence of the increased optical power of the instruments now applied to astronomical observations, but it was by a singular chance that the discovery was made both in England and America on the very same day, — the 19th of September, 1848.

In order to avoid the confusion which has arisen from the practice of designating the satellites of Saturn by numbers, applied sometimes with reference to the order of discovery and sometimes to the order of distance, Sir John Herschel proposed to distinguish the individuals of this system by names, and in conformity with the nomenclature adopted by him (the names of the Titanian divinities), both discoverers of the new satellite gave it the name of Hyperion. Commencing with the one nearest the planet, and taking them in the order of distance, the names of the eight satellites at present known are as follows.—

Mimas, Enceladus, Tethys, Dione,
Rhea, Titan, Hyperion, Iapetus.

Of these bodies Titan is by far the largest, and supposed to be nearly equal in size to the planet Mars. Mimas and Enceladus are the two discovered by Sir W. Herschel, interior to the ring, and so small that they can be seen with great difficulty even in the best telescopes. Hyperion is probably not greater than Mimas, but more easily seen on account of its greater distance from the planet. Prior to its discovery the interval between Titan and Iapetus was so great as to destroy the analogy which seemed to prevail in the other cases, and to leave, as it were, a large gap in the system, similar to that in the solar system between Mars and Jupiter before the discovery of the small planets. From this circumstance, and also from the smallness of Hyperion, Sir J. Herschel has surmised the probability of other minute satellites revolving at the same mean distance.

Of the six satellites of Uranus seen or suspected by Sir William Herschel, the existence of two only has been confirmed by the observations of other astronomers. Some others have been seen by Lassell and by Otto Struve; but none of them appear to be identical with those observed by Sir W. Herschel. The remaining two are still doubtful.

One satellite of Neptune has been repeatedly observed, both by Lassell and O. Struve. The existence of a second, suspected by Lassell, has not yet been verified.

SATURA'TION. In Chemistry, a fluid is said to be saturated with a substance when it holds as much of it in solution as it can take up and retain: we thus speak

of *saturated solutions* of saline, and other bodies. The term *saturation* is also especially applied to the combination of acids and alkaline or other basic bodies, in such definite proportions as neutralise each other; thus we say that sulphuric acid is saturated by potassa, when neither acid nor alkaline properties are predominant: hence, also, the resulting sulphate of potassa is called a *neutral salt*. An excess of acid would be termed *supersaturation*.

SATURATION, FRACTION OF. The term *Fraction of Saturation* is used to denote the ratio of the elastic force of the vapour actually existing in the atmosphere, to the elastic force of as much vapour as atmospheric air is capable of containing in an equal volume and at the same temperature, or as would *saturate* the air.

SCA'LPRIFORM. (Lat. scalprum, *a knife*.) Certain teeth are so called, which have a cutting edge, preserved by a partial deposition of the enamel on one side: such scalpriform teeth are large, long, and curved, and are well exemplified in the incisors of the Rodent order.

SCA'RBROITE. Hydrated silicate of alumina from the vicinity of Scarborough.

SCE'LOTYRBE. (Gr. σκελος, *the leg*, and τυρβη, *disturbance*.) A disease described by Galen, in which a man is incapable of walking straight forward, and drags the foot: it is generally regarded as a species of Chorea, or St. Vitus's dance.

SCHE'RERITE. A mineral hydrocarbon found in beds of brown coal in Switzerland.

SCHRO'TTERITE. A hydrated silicate of alumina from Freienstein in Styria.

SCHU'LZITE. An antimonial sulphuret of lead from Gallicia in Spain.

SCHWEINFURTH GREEN. A compound of arsenious acid and oxide of copper, much resembling Scheele's Green.

SCLE'ROGEN. The ligneous matter deposited in the cells of plants.

SCO'LEZITE. A species of zeolite.

SCOU'RING DROPS. The essential oils of lemon and of bergamotte are sold under this name, for the purpose of removing grease stains from silk dresses. They are generally adulterated with oil of turpentine.

SCREW PROPELLER. An instrument for the propulsion of vessels, consisting of two or more twisted blades, like the vanes of a windmill, set on an axis running parallel with the keel, and revolving beneath the water at the stern. The screw propeller is driven by a steam engine situated within the vessel, and by its revolution in the water it carries the vessel forward in the manner a cork-screw is drawn forward when penetrating a cork, or a bolt when turned round in a stationary nut. The water in which the vessel floats forms the nut of the screw propeller; and when the propeller is turned round, therefore, the vessel is screwed on. To enable the water to act as the nut of the screw, the thread traced in the water requires to be very much deeper than if it were traced in metal or wood, and the pressing surface of the screw requires to be large, to prevent the thread from being stripped or broken by the reacting force. Accordingly, screw propellers are made with a small central body and deep thread; they are also made as large in diameter as possible, reaching, usually, from the keel to near the surface of the water.

History of the Screw Propeller. — It appears probable that the screw propeller is as old as the windmill; and a windmill of the construction now usually employed is represented in the 77th proposition of Hero's Spiritalia, a work written 130 years before the Christian era. In China screw propellers are said to have been employed from a very early date as an arrangement for sculling vessels; and a screw is a continuous sculling machine, in which the necessity of a reciprocating motion is superseded by giving a complete revolution to the propelling blade. Captain Basil Hall, in his account of his voyage to Loo Choo, states that the Coreans scull their ships instead of rowing them; and, from what he saw of the operation, he is inclined to give the preference to that mode of propulsion. The galleys of the Greeks and Romans were also propelled by an action of the oars more nearly resembling sculling than rowing, as was first pointed out by Robert Hooke in 1684; and Hooke also showed that this mode of action would be exceedingly efficient. In a work entitled *Philosophical Collections*, printed for Richard Chiswell, printer to the Royal Society, 1681, there is a paper by Hooke on Horizontal Windmills, containing various suggestions of great originality and importance. Hooke says that he does not consider horizontal windmills to be as efficient as vertical windmills; but if they are in any case employed, it will be advisable, he says, to make them on a certain construction, of which he gives a representation, and which is almost identical in its main features with the most improved species of feathering paddle wheel now employed in steam ships. Hooke adds, that wheels of this kind may be set to work advantageously, as water wheels in a river where no dam can be made, as may also the common vertical windmill with twisted arms. In this cursory suggestion we have the germ both of the screw propeller and feathering paddle wheel. Robertson Buchanan admits having taken the idea of his feathering wheel from the mechanism of orreries which was invented by Hooke; and the same considerations which make the screw and feathering wheel eligible instruments when driven by the water equally hold when the water is driven by them.

On the 14th of October, 1683, Hooke showed to the Royal Society an instrument he had invented for measuring the velocity of the wind. It consisted of four vanes, like the vanes of a windmill, set upon an axis, and the vanes were so constructed that they could be set at any angle that was desired. On the 28th of November, in the same year, Hooke showed to the Royal Society an instrument he had contrived, and had shown to some of the members twenty years before, for measuring the way of a ship through the water. The prime mover of this instrument was a screw turned by the water, and the instrument not merely took cognizance of the progress of the vessel through the water, but also of the lee way. The plan of making gearing in steps, as is now usually done in such screw vessels as make use of gearing, is also an invention of Hooke's. Wheels made upon this principle are divided in the direction of their breadth into a number of parallel wheels, which are set a little in advance of one another, so that the teeth of each do not come in the same line. The benefit of this practice is that the teeth, though necessarily very thick to give adequate strength, work as smoothly as if they were thin and small, or as if the space between the teeth were only a fractional part of its actual amount.

In the *Recueil de Machines approuvées par l'Academie, depuis* 1727 *jusqu'au* 1731, there is a machine described, which was invented by M. Du Quet, for dragging up barges against a current in a river by the aid of a screw driven by the water, and by the screw thus driven a rope, dragging the barges, is to be wound up. This screw, which is a helical blade wound upon an axis, is only partially immerged in the water, and it would be a much less effectual instrument than the screw of a windmill form previously recommended by Hooke. In Bouguer's *Traité du Navire*, published in Paris in 1746, an arrangement of revolving oars, resembling the vanes of a windmill, is mentioned as having been proposed for the propulsion of vessels; but this expedient, it is stated, had not been found to possess sufficient force. In 1752 Daniel Bernouilli obtained the prize offered by the French Academy of Sciences for the communication of the best project for impelling vessels without the aid of the wind. Bernouilli's apparatus consisted of an iron axle, 14 feet long and 2 inches thick, set upon each side of the vessel beneath the water. Each axle was to carry eight wheels, six feet diameter, set at equal distances from one another, and each wheel was to have eight arms or spokes, to the extremity of each of which a sheet-iron plane 16 inches square, and inclined so as to form an angle of 60° with the axle or keel of the vessel, was to be affixed. Bernouilli's plan appears to have been contrived to meet Bouguer's objection, and it would probably answer for towing, but the revolution of such a large number of wheels in the water would in all cases of considerable speed occasion a serious loss of power from friction and other analogous causes.

In Emerson's *Principles of Mechanics*, published in 1754, we have an explanation of the mode of constructing screws with an expanding or increasing pitch. Emerson describes an arrangement of screw set vertically in a well or stationary cylinder, as an instrument for rendering available a fall of water in giving motion to mills. The water is admitted at the top of the cylinder and escapes at its base, and in its descent it turns round the screw by which the cylinder is filled up. Emerson explains, that at the top of the cylinder the blade of the screw must have very little inclination with the axis, but at the bottom of the cylinder the blade of the screw must have a considerable inclination with the axis. Blades set in a conical pit or vessel, and driven round by the gravity of water, have long been in use in France, under the name of Danaïdes, or *roues à poires*; and in some cases the blades were merely plane surfaces suitably inclined, while in other cases they were spiral or screw-formed. Instruments of this kind are described by Belidor in his *Architecture Hydraulique*.

In 1768 a work on the Archimedean screw was published at Paris by M. Paucton; and it is suggested that a ptérophore, composed of the circumvolution of the thread of a screw round a cylinder, should be placed on each side of a vessel to propel her through the water, or one only may be used at the fore part. These screws, it is stated, may be either wholly or partially immersed. In 1776 a submarine vessel was invented by D. Bushnell, an American, which was to be raised upward or

sunk downward in the water by means of an inclined blade or oar affixed to the top and operating in the manner of a screw, and forced forward or backward in the water by another similar blade affixed to the bow. This vessel was to carry a powder magazine, which was to be screwed to the bottom of an enemy's ship to blow her up. It was the original of Fulton's torpedo.

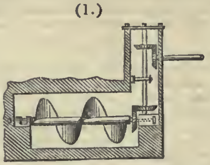
In 1784 Joseph Bramah, of London, engineer, obtained a patent for propelling vessels by means of a wheel with inclined fans or wings, similar to the fly of a smoke-jack or the vertical sails of a windmill. This wheel was to be fixed to an axis passing out at the stern of the vessel, and was to revolve beneath the water with a stuffing box, or proper packing surrounding the shaft, where it pierces the vessel, to prevent the water from entering. In 1794 William Lyttleton, a merchant of London, obtained a patent for an instrument which he called an "aquatic propeller," and which consisted of a single convolution of a three-threaded screw. The thread of a screw is the projecting part of it, and a screw may have one, two, three, or any other number of threads. A string wound round a cylinder represents the thread of a screw: and if one string only be wound round it, the screw will be a screw of one thread; if two strings be wound round it, so as equally to divide the space, the screw will be a screw of two threads; and so of any number. If, instead of a string, a thin ribbon of iron be wound edgeways upon the cylinder, and be soldered thereto, then a slice cut off the end of this screw will have two projecting arms or portions of this ribbon, if the screw be one of two threads; three projecting arms, if of three threads; and so of any other number. In any screw propeller, therefore, the number of threads is the same as the number of arms. The pitch of the screw is the distance from one thread of the screw to the next thread measured on the axis, supposing the screw to be continued through a whole convolution. A spiral stair is virtually a screw; and the pitch is the vertical distance from any one step of the stair to the step immediately over head.

In 1799 Edward Shorter, of London, mechanic, obtained a patent for propelling vessels, and among the expedients he employed is one termed a "perpetual sculling machine," consisting of a screw immerged in the water at the stern of the vessel. The shaft, which gives motion to the screw, passes through the stern of the vessel above the level of the water, and is armed at its extremity with one of Hooke's universal joints, from whence a pole extends obliquely into the water with the screw attached to its extremity. The end of the pole is prevented from sinking too deeply in the water by a buoy which supports it at the proper elevation, and guy ropes are applied, by means of which the pole and screw may be moved to the one side or the other, so that the vessel may be steered, or assisted in her steerage, thereby. Between 1800 and 1836 various arrangements of screw propellers were proposed by Dallery, Stevens, O'Reilly, James, Trevithick, Boswell, Millington, Scott, Whytock, Delisle, Bourdon, Dollman, Perkins, Brown, Tredgold, Maceroni, Cummerow, Smith, Church, Copley, Ovinel, Peltier, Salichon, Poole, Woodcroft, Sauvage, Emerson, Burke, Theal, Smith, and Fitzpatrick. The forms of these screws are very various, but in most cases they consist of helical blades, like the vanes of a windmill, revolving beneath the water at the stern, or of a helical feather coiled round an axis, in the manner of an Archimedean screw. In some cases the pitch of the screw is intended to be uniform, and in other cases increasing, the uniform pitch being a straight line wound upon a cylinder, and the increasing pitch being a curved line wound upon a cylinder, or a straight line wound upon a cone or spire. Bourdon, in 1824, formed his screw with an increasing pitch, and placed it in the dead wood of the vessel. Tredgold, in his work upon the Steam Engine, published in 1827, recommended that screws should be made with an increasing pitch. Peltier, in 1830, proposed to make his screw with an increasing pitch, and Woodcroft proposed the same thing in 1832. Marestier, in 1824, in a work published by direction of the French government, giving an account of steam navigation in America, described various arrangements of screw propellers which had been tried in that country, but none of those expedients had come into practical operation. Lyttleton in 1794, Shorter in 1802, Stevens in 1804, Bourdon in 1824, and several others at different times, had practically tried the effect of propelling vessels by means of a screw. But these experiments led to no useful result, and in 1836 there was no vessel propelled by a screw in existence. In that year patents for propelling vessels by a screw were taken out by F. P. Smith and Captain John Ericsson; and to these two persons the successful introduction of the screw as a propeller must be attributed. Ericsson, not meeting with the encouragement in this country that he expected, went to America, where he soon after constructed the war steamer Princeton, and about two hundred screw vessels have since been built in America. Smith, as soon as his early trials had demonstrated the efficacy of the screw as a propeller, built the Archimedes, and soon afterwards his propeller was applied to the war steamer Rattler. It has subsequently been applied to about fifty war steamers and a very large number of merchant steamers. In by far the greater proportion of these vessels the screw is only applied as an auxiliary to the sails, and at present this appears to be its most valuable application.

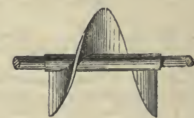
It would swell these remarks beyond the limits to which they must be restricted to attempt any enumeration of the various modifications in the form of the screw, and in the mode of its application, which have been made or proposed since the time it has been practically introduced as an available propeller. In this country vessels are, for the most part, fitted with Smith's screw of two or three threads. In America, and in France, vessels are mostly fitted with Ericsson's screw of four or six threads. The average efficiency of both is about the same, but screws of few threads appear to be best adapted for sharp and swift vessels, or which are much immersed in the water; whereas in the case of heavy vessels of shallow draught screws of many threads appear to be the most suitable. For vessels with auxiliary power, of good form and considerable immersion, a screw with three blades appears to be, upon the whole, the best propeller that can be employed.

In Smith's earlier experiments upon the screw propeller he employed a single-threaded screw of two convolutions, such as that represented in *fig.* 1. During one of his trials, however, the screw having come in contact with some object in the water, about half of it was broken away, and the vessel was found in consequence to realise a higher speed than before. The Archimedes was originally fitted with a single-threaded screw of one convolution, such as that represented in *fig.* 2.; and it

(1.)



(2.)



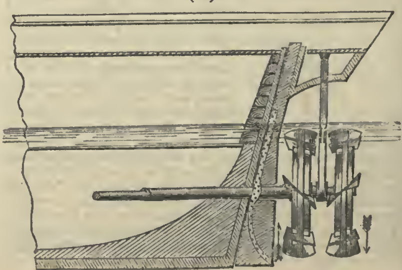
was with a screw of this kind that the efficiency of the screw as a propeller was originally demonstrated. She was subsequently fitted with a double-threaded screw of half a convolution, which gave the same amount of propelling surface, and diminished the uneasy motion at the stern. This screw is represented in *fig.* 3. The Rattler was fitted with a screw of this kind, but its length was subsequently reduced to one-sixth of a convolution, which made its length just one-third of its original length, and the best results were obtained with this proportion. This amended screw of the Rattler is shown in perspective in *fig.* 4.

(3.)

(4.)

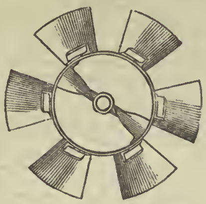
Ericsson, in his original form of propeller, employed two wheels armed with helical blades and revolving in opposite directions. The object of this arrangement was to neutralise any tendency which one wheel might have to turn the vessel from her appointed course. The second wheel, however, was soon discarded, as it was found that it was not required. *Fig.* 5. represents Ericsson's original arrange-

(5.)



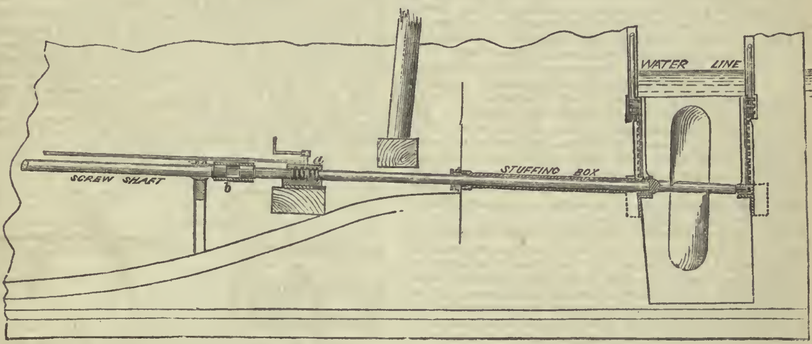
ment of screw propeller, and *fig.* 6. is the propeller of the Princeton, which is the form he now usually employs.

(6.)



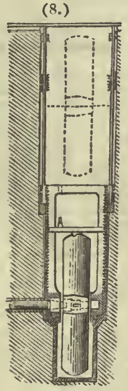
Description of the mode of applying the Screw Propeller. — The most approved method of introducing the screw propeller into a vessel will be seen by a reference to *fig.* 7., which is a section of the stern portion of H. M. S. Wasp. The screw is set in a hole or opening in the dead wood behind the stern post, and before the rudder post. It is hung upon a short shaft, which is carried by a metal frame with a rack on each side, and in these racks endless screws work, which, being put into revolution, raise the frame, lifting the propeller out of the water, so as to enable the screw to be repaired if required, or a new one introduced without putting the vessel into dock. Before, however, the frame can be raised, the shaft, passing through the ship, and which communicates with the engine, has to be pulled on end, so as to disengage it from the boss of the short shaft, which supports the screw. This is accomplished by the handle *a*, by means of which an end motion is given to an adjoining bearing, in which work a number of collars formed on the shaft, the brass of the bearing being suitably grooved to receive these collars. At *b* a vacant space is left between the end of the shaft which communicates with the engine, and the end of the shaft which communicates with the screw, so as to enable the shaft communicating with the screw to be drawn on end without disturbing the other shaft; and a short pipe fixed to the one shaft, but sliding on

(7.)



the other, is so applied that, notwithstanding the end play, the force of torsion will be communicated from the one shaft to the other. *Figs.* 8. and 9. represent the screw propeller and the apparatus for raising it out of the water, as applied in Her Majesty's steam frigate Ajax. By a reference to these figures the configuration of the screw usually employed for the service of the navy, and the mode of raising it out of the water, will be readily understood. A catch represented as engaging the centre of the screw is put down only when the screw requires to be raised out of the water, and its use is to retain the blades in a vertical position during that operation.

(8.)

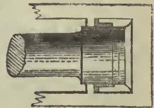


(9.)

The screw shaft at the point where it passes through the stern of the vessel is kept tight by means of a stuffing-box, consisting of a long pipe fitted tightly into the hull of the vessel. Through this pipe the screw shaft passes, and the space between the shaft and the pipe is kept tight by means of a plaited rope of soft hemp forced tightly into a recess provided for the purpose by means of screws. It is very desirable that the shaft should fit so accurately into this pipe as to be exempt from all side play, which, if it exists, will have the effect of communicating a disagreeable motion to the stern of the vessel. In wooden vessels the pipe should be made of brass; and it has been found advantageous in such cases to cover with brass that part of the shaft which revolves within the pipe, so as to obviate corrosion from the sea-water. In all cases the extremity of the vessel in advance of the screw should be brought to as fine a line as possible, and the hole in the dead wood in which the screw revolves should be considerably larger than the screw itself. The screw in its revolution carries with it a coating of water, and if this coating be partially stripped off at every revolution from the too near proximity of the stern part of the vessel, a shock will be communicated at every revolution, from the impact of the water against the side of the dead wood, and a part of the engine power will be also dissipated without effect.

Modes of receiving the Thrust of the Screw. — As the screw by its revolution is forced forward in the water, carrying the vessel with it, the screw shaft, it is clear, must have to sustain a forward thrust, and it is this thrust in fact which propels the vessel. The severity of this forward thrust, combined with the velocity of rotation which the screw shaft requires to maintain, was the occasion, in the earlier screw vessels, of considerable inconvenience, in consequence of the friction produced; and several cases have occurred where the end of the shaft became white hot, and actually welded itself to the steel plate against which it pressed, although a stream of water was all the while running upon the surfaces in contact. Various expedients have since that time been proposed for receiving the thrust, of which one was to let the end of the shaft enter, in the manner of a piston, a tight cylinder of oil, so that it would be against a liquid only that the end of the shaft would press. Another expedient was to place a large collar upon the shaft, which should press against a number of balls or small rollers resembling the rollers of a swivelling bridge. Neither of these plans, however, have come into practical use; but one of two other modes is now generally followed. Either the thrust is received upon a number of collars, as represented in *fig.* 7., before described, or else it is received upon a series of discs applied to the end of the shaft, and resting in a cistern of oil, as represented in *fig.* 10. The cistern is usually cast upon the base plate or some other solid part of the engine, and its end is sufficiently strong to bear the thrust of the screw. Interposed, however, between the end of the cistern and the end of the shaft are two, three, or more discs of metal, usually about two inches thick, and of the same diameter as the shaft itself. A bolt passes through their centres to keep them in a line, but they

(10.)



are each free to revolve upon this bolt; and where the shaft passes out of the cistern a collar of leather is applied, to prevent the oil from escaping. It will be obvious from such an arrangement that if the end of the shaft where it presses upon the discs begins to heat from undue friction, it will revolve with somewhat more difficulty, and will consequently carry the first disc round with it. The rubbing surfaces, therefore, are no longer the end of the shaft and the first disc, but the first disc and the second disc. In fact, the rubbing surface, instead of being confined to one disc, is distributed over several. Those surfaces which begin to heat, and consequently to stick, will cease to rub, whereby they will speedily become cool again, and their efficiency will thereby be speedily restored.

Best Proportions of Screw. — For mercantile purposes screws with three blades are, on the whole, to be preferred. The diameter of the screw should be as large as it can be conveniently got, and when the area of the screw's disc — that is, the area of the circle described by the extremity of the arms of the screw — has one square foot of area for every $2\frac{1}{2}$ square feet in the area of the immerged midship section of the vessel, a very efficient performance is obtained. The pitch of the screw should be equal to the diameter of the screw, or a little more, and the length of the screw fore and aft should be that answering to one-sixth of a convolution. Thus in the case of a screw twelve feet in diameter, the pitch would be twelve or fourteen feet, and the length of the screw measured along the axis would be about two feet.

Best Forms of Screw. — Screws are commonly made with a uniform pitch, and with the blades standing at right angles with the axis. A slightly progressive increase in the pitch, however, say to the extent of 5 per cent., appears to be advisable — that is, the pitch of the screw at its leading end should be 5 per cent. less than at its following end. The pitch at the centre should also be 10 per cent. less than the pitch at the circumference, for the centre should merely screw through the water without seeking to produce any reacting force, which, from the great obliquity of the blades at the centre, could not be done with advantage. Finally, the blades of the screw should be bent a little astern, so as to produce a tendency in the particles of water they force backwards to converge to a point. This tendency will balance the divergent tendency produced by the centrifugal action of the screw in its revolution, and the two forces, by balancing one another, will cause the water to be projected backwards from the screw in a cylindrical column. With the ordinary screw the water projected backwards assumes the figure of the frustum of a cone, and some portion of the power is lost thereby.

Positive and negative Slip of the Screw. — When a vessel is propelled by oars, paddles, or any other instrument which acts upon the water, it is obvious, that since the water is not a solid body which can resist without disturbance the application of force, there will be a certain amount of recession in the water, or, in other words, the water will be moved to a certain extent backwards, while the vessel is forced to a certain extent forwards. This backward movement of the water is what is termed *Slip*, and in its results it is analogous to the loss of power and speed which a locomotive experiences when the wheels slip upon the rails. This slip exists in the case of the screw as well as in the case of the paddle or other species of propeller; and when the engines of a steam vessel are set in motion while the vessel is at anchor or moored in a river, the whole power of the engines is wasted in slip, or in moving the water without moving the vessel. The ordinary amount of slip in paddle vessels is about one-third of the whole distance travelled, or, in other words, the vessel would go one-third faster with the same number of revolutions if the wheels geared into an iron rack instead of gearing into water. In well-constructed paddle vessels the slip is only 10 per cent., or, in other words, the vessel would only go one-tenth faster with the same number of revolutions if the screw worked in an iron nut instead of working in water. Since, therefore, all the power expended in producing slip is lost, and since there is less slip with the screw than the paddle, there is an apparent superiority in the screw from this cause. In some screw vessels, however, the apparent slip is nothing at all, and in others it is less than nothing, or, in other words, the vessel is propelled through the water by the screw alone at a greater velocity than if the screw worked in a solid nut with the same number of revolutions. In the early history of the screw propeller this apparent paradox provoked much incredulity, but the phenomenon is now understood, and is not difficult of explanation.

When a vessel passes through the water, the friction of the bottom and the sides puts a column of water in motion which proceeds in the direction of the vessel. Sea-weeds and other light objects adhering to a vessel have been observed to stand out straight from her side when the vessel was moving through the water with a considerable velocity, whereby it is clear that a film of water must be moving with the vessel. The vacuity also which the motion of the vessel through the water tends to produce at the stern causes a flow of water towards the stern in order to fill it up. It follows, therefore, that a vessel, in passing through the water, puts in motion a stream or current which follows in her track; and that this is no hypothetical supposition is proved by the fact that a boat will often follow a vessel without being towed by a rope, and that when a slow steamer gets into a swift one's wake the slow steamer will not fall into the distance, but will be towed by the current which the leading steamer creates. Now in a screw vessel the screw works in this current; and if from the form of the stern or other causes the current runs at a considerable velocity, and if from the large dimensions of the screw or otherwise the actual slip of the screw be small, then it will often follow that the slip of the screw will *appear* to be less than nothing, or negative, if the comparison be made not with the current, but with the stationary water at the ship's side. The screw must at all times have slip *relatively with the water in which it works;* but if that water is itself in motion, it is not surprising that the vessel should travel through a greater distance than what answers to the pitch and revolutions of the screw, any more than that a paddle vessel in descending a river with a strong current should pass through a greater distance than what answers to the diameter and revolutions of the wheel, if the distance travelled be measured on the river bank. A log placed where the screw revolves will always show that the screw advances with a greater velocity than the vessel as measured at that point, or, in other words, that the screw passes through the current with a greater velocity than the vessel passes through the current, though of course the speed of the vessel and of the current together may be greater than the speed of the screw alone.

Measure of the Thrust upon the Screw Shaft, and Amount of Power lost by Slip. — In some vessels a dynamometer has been applied to the end of the screw shaft, whereby it has become possible to measure accurately the amount of forward pressure exerted by the screw. In the Rattler, a vessel of 888 tons burden, this pressure amounted, on an average, to about four tons. This pressure, multiplied by the space passed through by the vessel per minute, and divided by 33,000, will manifestly give the force in actual horse power that is instrumental in the propulsion of the vessel, and the power thus computed amounts, on an average, to about half or two-thirds the power developed in the cylinders. It hence appears, that in screw vessels such as the Rattler from one-third to one-half of the engine power is wasted in slip and in the friction or other resistances caused by the revolution of the screw in the water. With the paddle wheel the loss from these causes is nearly the same, and the screw and paddle consequently produce about the same speed by the application of the same amount of power.

Relative Efficiency of the Screw and Paddles. — To determine the relative efficiency of the screw and paddle as a propeller, two vessels, the Rattler and the Alecto, were constructed of about the same power, 200 horses, and of nearly the same size and form; but the Rattler was a screw vessel, and the Alecto a paddle vessel. The Rattler, it was found, had, in nearly all cases, somewhat the advantage in point of speed, but the engines of the Rattler also exerted somewhat more power. Subsequently two other vessels, the Niger and Basilisk, were constructed of 1072 tons, and 400 horse power, the Niger being a screw vessel, and the Basilisk a paddle vessel, and the following were the results obtained: — In deep immersions the screw vessel had an advantage of $1\frac{1}{2}$ per cent. over the paddle vessel, but with medium immersions the paddle vessel had an advantage of $1\frac{3}{4}$ per cent. over the screw vessel, and in light immersions the paddle vessel had an advantage of $4\frac{3}{4}$ per cent. over the screw vessel. The slip of the screw was 24 per cent. Upon the whole, therefore, the screw seems to have somewhat the advantage when the vessel is deep, and the paddle seems to have somewhat the advantage when the vessel is at a light or medium immersion.

Screw Vessels not adapted to go Head to Wind. — The experiments with the Rattler and Alecto established one important fact in connection with screw vessels, viz. that they are ill-adapted to advance against a head wind. For, although both vessels attained the same speed of 4 knots against a strong head wind, yet, in the case of the Alecto, this performance was attained with a velocity of the engine of 12 strokes per minute; whereas, in the Rattler, it was only attained with a velocity of the engine of 22 strokes per minute. It follows, therefore, that a screw vessel in proceeding head to wind will require 1·8 times, or nearly twice the quantity of fuel to do the same amount of work. The screw, in fact, revolves at nearly the same velocity whether the wind is adverse or favourable, or whether the vessel

is lying at anchor; and this is a serious defect in the case of vessels intended to encounter adverse winds. In the case of vessels, however, which use the screw only as a resource in calms, or as an auxiliary to the sails, this disadvantage will not be experienced, since such vessels have no pretensions to the capability of proceeding in direct opposition to a strong head wind.

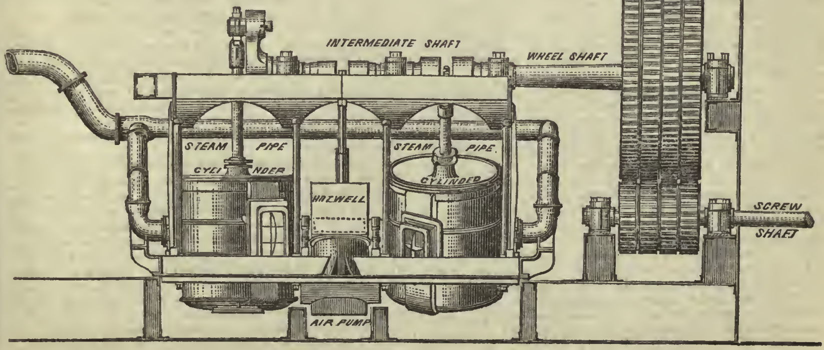
Paddle and Screw Vessels tied Stern to Stern.—In all cases where screw and paddle vessels of equal power and size have been tied stern to stern, the screw vessel has preponderated, and towed the paddle vessel so soon as the engines were set on. When the Rattler and Alecto were tied together in this manner, the Alecto's engines were set on first, and she was allowed to tow the Rattler at the rate of 2 knots an hour. The Rattler's engines were then set on. In five minutes the two vessels became completely stationary. The Rattler then began to move ahead, and towed the Alecto against the whole force of her engines, at the rate of 2·8 knots per hour. In like manner the Niger towed the Basilisk astern, in opposition to the force of her engines, at the rate of 1·1 knots per hour. The natural inference from this experiment would be that the screw is more suitable for towing than the paddle; yet this inference is not confirmed by experiment. For, when the Niger and Basilisk were each set to tow the other alternately, in the usual manner in which a steamer tows a ship, it was found that the Niger towed the Basilisk at a speed of 5·63 knots, with 593·9 horse power, and that the Basilisk towed the Niger at the rate of 6 knots, with 572·3 horse power. The paddle vessel, therefore, accomplished in towing the largest speed with the least power. It has also been found that when a paddle and screw vessel set stern to stern push one another instead of pulling one another, the paddle vessel preponderates, whereas, if they pull, the screw vessel preponderates. These circumstances seem to show that the power of a screw vessel to tow a paddle vessel astern, when the two are tied together, does not arise from any superior tractive efficacy of the screw itself, but is due to the centrifugal action of the screw, which raises the level of the water at the stern, so that the vessel gravitates down an inclined plane.

Cause of the serrated Outline of the Dynamometer Diagram.—In those screw vessels which have had a dynamometer applied to the end of the shaft the thrust of the screw was made to act upon a spring, and a pencil in connexion with the shaft marked a line upon a revolving cylinder, which line was either high up on the cylinder, or low down, as the thrust of the screw increased or diminished. The line thus traced, instead of being tolerably uniform and straight, was found to be serrated, like the teeth of a saw; and, on further investigation, it was discovered that every time the screw, in its revolution, brought the blades into the vertical position, and therefore into a line with the stern post, at that moment the thrust was increased. This phenomenon appears to be due to the circumstance of the water immediately behind the stern post being carried forward with nearly the same velocity as the vessel itself; and when the screw comes into that dead water, as it is termed, it is no longer a reaction answering to the *difference* of speed of the screw and vessel that it has to encounter, but a reaction answering to nearly the *whole* speed of the vessel. If such a reaction had to be encountered through the whole revolution of the screw, the velocity of its rotation would be necessarily diminished until the reacting pressure produced was balanced by the pressure on the pistons of the engine. But the momentum of the machinery and of the screw itself momentarily carries up the thrust to a higher point than that due to the pressure on the pistons. If a screw vessel be reversed until she attains full speed astern, and be then suddenly changed to full speed ahead, it will be found that a dynamometer diagram taken at that point at which the vessel is stationary in the water, from the effort to overcome her own momentum, will have a straight, and not a serrated line.

Importance of making the Stern of Screw Vessels very sharp and fine.—The preceding remarks will have very clearly indicated the importance of making screw vessels as sharp as possible at the stern; but the following facts may be stated in corroboration of the propriety of such a configuration:—In 1846 the Dwarf, a screw steam vessel, with a fine run, was filled out in the stern by the application of three successive layers of planking, so as to alter the shape to that of a vessel with a full run. Prior to the alteration the speed of the vessel was 9·1 knots per hour, the engines making 32 revolutions per minute. The effect of the filling was to reduce the speed to 3·25 knots per hour, with a speed of the engine of 24 revolutions per minute. One layer of filling was then taken off, and the speed rose to 5·75 knots per hour, the engines making 26·5 revolutions per minute. When the whole of the filling was removed the speed rose to 9 knots, as before. Care was of course taken in this experiment to bring the filling into conformity with the lines of the vessel, so that there should be no roughness or abruptness to aggravate the evils of a full run. Again, the Sharpshooter and Rifleman were sister vessels of 486 tons, and 200 horse power, but the Rifleman was made with a full run, and the Sharpshooter with a fine run. The speed of the Rifleman was found on trial to be 7·9 knots, and of the Sharpshooter 9·9 knots. The Minx and Teazer were sister vessels of about 300 tons and 100 horse power, but the Teazer was made with a full run, and the Minx with a fine run. The speed of the Teazer was found to be 6·3 knots, and of the Minx 7·8 knots. The sterns of both the Rifleman and Teazer were sharpened subsequently to these trials, and the 100 horse engines of the Teazer were at the same time put into the Rifleman, while new engines of 40 horse power were put into the Teazer. Both vessels went faster than before. The Rifleman, when sharpened at the stern, attained a speed of 8 knots with engines of 100 horse power, whereas she had before only attained a speed of 7·8 knots with engines of 200 horse power. The Teazer, when sharpened at the stern, attained a speed of 7·685 knots with engines of 40 horse power, whereas she had before only attained a speed of 6·3 knots with engines of 100 horse power. The engines of the Teazer when transferred to the Rifleman drove that vessel nearly 2 knots an hour faster than they had previously driven the smaller vessel, an amelioration consequent altogether upon the sharpened form of the stern.

Engines for driving the Screw.—It will be obvious, on looking to the pitch of an ordinary screw, and the speed with which the vessel passes through the water, that the screw must revolve with a considerable velocity. For example, if a vessel be driven 10 miles an hour, or 880 feet per minute, by a screw of 12 feet pitch, then the screw must make somewhere more than the twelfth part of 880, or 73 revolutions in the minute. This is a much higher speed than marine engines have been heretofore accustomed to travel at, and two methods of obtaining the necessary velocity of rotation have been adopted. In the one the construction and

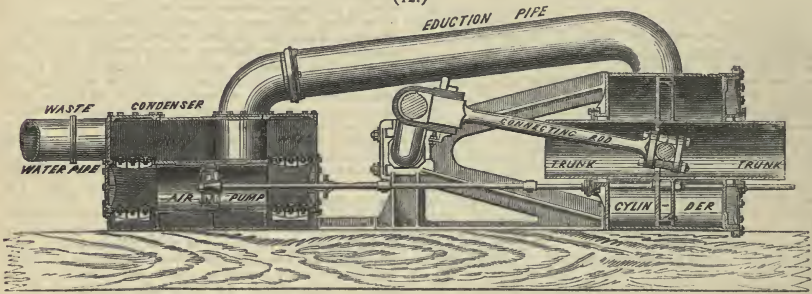
(11.)



speed of the ordinary engine have been retained without material alteration, and the required velocity of revolution has been given to the screw shaft by means of intervening gearing. In the other case a new arrangement of engine has been introduced which is capable of moving with a much greater velocity than ordinary engines, and the engine and screw shaft are directly connected with one another. *Fig.* 11. represents a pair of geared screw engines, being the engines constructed by Messrs. John Penn and Son for the Great Britain. These engines are on the oscillating principle, which Messrs. Penn have rendered so celebrated, and they are almost identical in construction with the paddle engines made by Messrs. Penn for the Sphinx and other vessels. The Great Britain is of 3500 tons burthen, and her displacement, at 16 feet draught of water, is 2970 tons. The diameter of cylinder is 82½ inches, length of stroke 6 feet, nominal power 500 horses, diameter of screw 15½ feet, pitch of screw 19 feet, length of screw 3 feet 2 inches. The screw has three arms or blades. The multiple of the gearing is 3 to 1, and there are 17½ square feet of heating surface in the boiler for each nominal horse power of the engine. The crank shaft, being put in motion by the engine, carries round the great cog wheel or aggregation of cog wheels affixed to its extremity, and these wheels acting on suitable pinions on the screw shaft cause the screw to make three revolutions for every revolution performed by the engine.

Fig. 12. is a representation of a pair of direct-action screw engines, being the engines constructed by Messrs.

(12.)



John Penn and Son for H. M.'s screw frigates Arrogant and Encounter. Here the cylinders lie in a horizontal position, and are traversed through the centre by a pipe or trunk, upon which the piston is cast. The central trunk is circular, and it projects through both the top and bottom of the cylinder, the points of penetration being made tight by suitable packing. One end of the connecting rod is attached to the centre of the trunk, while the other end engages the crank, which turns round the screw shaft. The air-pump, which also lies in a horizontal position, is double-acting, and is situated within the condenser. A large pipe, called the eduction pipe, leads the steam from the cylinder to the condenser, where it is condensed by a jet of cold water, and the hot water thence resulting is ejected by the air-pump through the waste water pipe, and passes overboard. In the figure only one cylinder and one air-pump is represented, but it will be understood that there are two cylinders and two air-pumps. The valves by which the water is admitted to the air-pump from the condenser, and passes again from the air-pump into the hot well and waste pipe, consist of several discs of indian-rubber, kept down by a central bolt so as to cover radial slits or orifices in a perforated plate. These valves are found to operate without noise or shock, notwithstanding the high speed at which the engine must work in order to give motion to the screw without intervening gearing. The diameter of the cylinder in the Arrogant and Encounter is 60 inches, and the diameter of the trunk 24 inches, which, being deducted, leaves an available area of piston equal to that of a piston 55 inches in diameter. In the Arrogant the length of stroke is 3 feet, and in the Encounter 2 feet 3 inches. The nominal power of both engines is 360 horse. The diameter of the screw of the Arrogant is 15 feet 6 inches, and the diameter of the screw of the Encounter is 12 feet. The pitch of both is 15 feet, and the length 2 feet 6 inches. The Arrogant is a vessel of 1872 tons burden, and the Encounter of 953 tons. Both the engines and boilers are kept below the water-line, so as to be out of the reach of shot.

The forms of engine, both geared and direct-acting, for giving motion to the screw, are too numerous to be here described. But in most war vessels the cylinders are placed upon their sides, so as to keep the engines below the water-line. In merchant vessels a form of engine like the land beam engine, with the cylinder at the one end of a beam and the connecting rod at the other — the connecting rod extending downwards from the end of the beam to give motion to the crank — is frequently employed. In other cases the cylinder is inverted, and a connecting rod proceeds from the end of the piston rod to turn the crank, the end of the piston rod being, of course, steadied by suitable guides. Upon the whole, a construction of engine resembling that of the Arrogant and Encounter appears to be the best for driving the screw, but perhaps it might be preferable if the trunk were put into the air pump instead of into the cylinder. The condenser also might be dispensed with, and the condensation be performed in the air pump, — the flow of water *to* which and *from* which might be governed by a slide valve of a construction similar to that employed to regulate the admission and escape of the steam from the cylinder. It appears probable that slide valves will come into use for regulating the flow of water to and from pumps of every kind; but in the case of ordinary pumps for raising water those valves need not be like common slide valves, — which, in fact, do not seem well adapted to give sufficient area for such purposes, but they may consist of short wide cylinders with gridiron orifices revolving slowly at the top and bottom of the pump.

Screw Vessels with Auxiliary Power. — We have already stated that screw vessels, intended to go head to wind and to contend against head seas, are not so efficient as paddle vessels, inasmuch as they require more coal to do the same work. Under the conjoint influence of sails and steam, however, they are under most circumstances as efficient, and, if deeply laden, are more efficient. A screw vessel, being divested of paddle boxes, partakes more of the character of a sailing ship; nevertheless, from the experiments with the Niger and Basilisk, it does not appear that a screw vessel is more efficient under sails than a paddle vessel, although such a result might naturally be expected. The advantages incident, therefore, to the use of screw vessels with auxiliary power do not result from any superiority of the screw as a propeller, nor from the increased facilities which it presents for the application of sails, but are to be ascribed to the large employment in screw vessels of wind power, which costs nothing, instead of steam power, which costs much, and also to the maintenance of lower rates of speed than are thought necessary in paddle vessels. The screw, indeed, is a less cumbrous propeller than the paddle, and, in consequence of the high speed of engine which it permits, a very considerable engine power will go into a small compass. Upon the whole, therefore, the screw for all purposes of auxiliary propulsion is much to be preferred; nevertheless, it is right to understand that its superior eligibility is not due to any greater efficiency than the paddle as a propeller, either in a calm or under sail, but only to the greater convenience in the application of auxiliary steam power which its employment affords.

Comparative Expense of conveying Merchandize in a Paddle Vessel of full Power, and in a Screw Vessel of auxiliary Power. — For the purposes of this comparison, we may take a paddle vessel of 1000 tons burden and 350 horses power, and a screw vessel of 300 tons (old measurement) and 50 horses power—each performing a voyage of 500 miles. The paddle vessel would perform the voyage in about 45½ hours, carrying 400 tons of cargo, exclusive of her machinery and coals. The screw vessel would perform the voyage in about 62 hours, carrying 400 tons of cargo, exclusive of her machinery and coals. Each vessel would make one double trip weekly, or 104 single trips per annum. The first cost of the paddle vessel

would be about 40,000*l.*; the first cost of the screw vessel would be about 10,000*l.* In the paddle vessel the wages and the scale of the expenses altogether would be larger than in the screw vessel, which would partake more of the nature of a coasting ship. The following is an approximate estimate of the expense of each:—

PADDLE VESSEL.

	Per Annum. £	Per Trip. £ s.
Wear and tear 10 per cent. on 40,000*l.*	4,000	96 3
Depreciation 5 per cent.	2,000	
Insurance 5 per cent.	2,000	
Interest 5 per cent.	2,000	
	10,000	

	Per Month. £ s.	Per Trip. £ s.
Commander 25*l.* per month, and 6*s.* per day victualling	33 8	26 11
Two mates, first 7*l.* and second 4*l.* per month, and 3*s.* 4*d.* per day	22 4	
Two quarter-masters 3*l* per month, and 1*s.* 6*d.* per day victualling	10 4	
Ten seamen 2*l.* 10*s.* per month, and 1*s.* 6*d.* per day victualling	46 0	
Carpenter 5*l.* per month, and 1*s.* 6*d.* per day victualling	7 2	
Three apprentices 16*s.* per month each, and 1*s.* 6*d.* per day	8 14	
Eleven firemen and trimmers 3*l.* per month, and 1*s.* 6*d.* per day	56 2	
Two engineers, first 12*l.* per month, second 8*l.*, and 3*s.* 6*d.* per day	28 16	
Wages and victualling per month	212 10	

SCREW VESSEL.

	Per Annum. £	Per Trip. £ s. d.
Wear and tear 10 per cent. on 10,000*l.*	1,000	24 0 9¼
Depreciation 5 per cent.	500	
Insurance 5 per cent.	500	
Interest 5 per cent.	500	
	2,500	

	Per Month. £ s. d.	Per Trip. £ s. d.
Captain 16*l.* per month, and 5*s.* per day victualling	23 0 0	11 6 9
Mate 4*l.* per month, and 3*s.* 6*d.* per day	8 18 6	
Six seamen 2*l.* 10*s.* per month, and 1*s.* 6*d.* per day	27 12 0	
One apprentice 16*s.* per month, and 1*s.* 6*d.* per day	2 18 0	
One engineer 8*l.* per month, and 3*s.* 6*d.* per day	12 18 6	
Three firemen and coal trimmers 3*l.* per month and 1*s.* 6*d.* per day	15 6 0	
Wages and victualling per month	90 13 0	

PADDLE VESSEL.

	Per Trip £ s. d.
Wear and tear, depreciation, &c.	96 3 0
Wages and victualling	26 11 3
Coal, 60 tons at 15*s.*	45 0 0
Oil and tallow	5 0 0
Port charges, light dues, &c.	19 0 0
Sundry ships stores	7 0 0
Expense per trip of paddle vessel	198 14 3

SCREW VESSEL.

	Per Trip. £ s. d.
Wear and tear, depreciation, &c.	24 0 9¼
Wages and victualling	11 6 9
Coal, 15 tons at 15*s.*	11 5 0
Oil and tallow	1 0 0
Port charges, light dues, &c.	8 0 0
Sundry ships stores	5 0 0
Expense per trip of screw vessel	60 12 6¼

Thus it appears that it will cost 198*l.* 14*s.* 3*d.* to transport 400 tons of merchandize through a distance of 500 miles with a full-powered paddle vessel, and that it will cost only 60*l.* 12*s.* 6½*d.* to transport the same merchandize through the same distance with a screw vessel of auxiliary power. The average speed of the paddle vessel would be 11 miles per hour, and the average speed of the screw vessel would be 8 miles per hour.

Comparative Cost of carrying Merchandize in Screw Vessels and in Sailing Ships.— By carrying an investigation similar to the foregoing into the case of sailing ships, so as to determine the cost of conveying a given quantity of merchandize per annum through any given voyage by their instrumentality, as compared with the cost of carrying the same merchandize through the same voyage by the instrumentality of screw vessels, it will be found that the screw vessels will do the work at the least expense, or, in other words, that a given sum of money, if invested in screw vessels, will yield larger returns than the same sum of money invested in sailing ships, and this irrespective altogether of any benefit or preference which may fairly be expected from the increased speed. Mr. Laming states, in his evidence before the committee of the House of Lords on the slave trade, that he had had the management of a line of sailing vessels between London and Rotterdam which were at length superseded by screw vessels, after having been in existence for 25 years; that, taking the three sailing vessels, the Hope, the London, and the Alkmaar, by which, before the establishment of the screw vessels, the communication had been maintained, the average cost of carrying a ton of merchandize, from one terminus to the other, was 1*l.* 12*s.* 5½*d.* With the screw vessels, however, the City of London and the City of Rotterdam, the average cost of conveying the same quantity of merchandize through the same distance was, on an average of ten voyages, only 19*s.* 6*d.*; so that the screw vessels not merely maintained a superior speed, but did the same work at about one-third less expense.

Conditions to be observed in the Construction of Screw Vessels.— The whole of the superior eligibility of screw vessels for the conveyance of merchandize, whether compared with paddle vessels or sailing ships, is not due to the action of the screw itself or to the use of steam power. Much, probably most, of it arises from the superior form of vessel which has been simultaneously introduced, and by which the sails have been rendered much more efficient than heretofore in urging the vessel through the water. And the main conditions necessary to the satisfactory performance of screw vessels lie in making the form of the vessel sharp and fine, in applying a large amount of sail power, and in keeping the screw well immersed in the water. Screw vessels should be broad at the water line, so as to enable them to bear the pressure of a large amount of sail and the sails should be as flat as possible, and be laced to the spars, so as to enable the vessel to go as near as possible to the wind. The rigging of all vessels is still in a most defective state. It is without any provision whatever for using up the power of the wind in an effectual manner, and a large proportion of that power is consequently lost. Under suitable arrangements vessels would be able to sail directly against the wind, instead of having to tack, as is at present the practice; and there is every reason to believe that before many years, expedients for this purpose, and for obtaining from a given force of wind and area of sail a much larger propelling effect, will be practically applied.

For further information respecting the screw propeller, see a *Treatise on the Screw Propeller*, by John Bourne, C. E., from which the engravings and most of the information given in this article have been extracted.

SEED LAC. The substance called Gum Lac in a granulated form. *See* LAC, in DICT.

SELBITE. A name given to native carbonate of silver.

SE'NSORY. The term appears to have been first applied by Hartley to those nerves which convey a stimulus to the neural axis or nervous centres with which they are connected, in contradistinction to the nerves that convey a stimulus from the neural axis to the muscles. "The actions of sneezing, swallowing, coughing, hiccoughing, vomiting, and expelling the fæces and urine" are to be deduced "from those vibrations which first ascend up the sensory nerves and then are detached down the motory nerves, which communicate with these by some common trunk, plexus, or ganglion." — *On Man*, vol. i. p. 97. This class of motions or vibrations, now called "reflex," Hartley distinguishes from those produced by the transmission of the sensory vibrations to the brain, where they produce "sensation," and excite "volition;" and the nerves producing the "first and fourth classes of motory vibrations of Hartley's system" have been recently asserted to be anatomically distinct from those that produce sensational and volitional vibrations. The distinction has not been recognised, and anatomists apply the term "sensory" to those parts of the neural axis with which the sensory nerves are connected, as, *e.g.* the posterior columns of the myelon, the optic lobes, the thalami and the corpora striata, which are termed "sensory ganglions."

SE'RUM. (Lat. *whey.*) In Anatomy the constituent of the plasma, or liquor sanguinis, which remains after the separation and coagulation of the fibrin. Serum contains a quantity of albumen, and coagulates at a temperature of from 150° to 170°.

SE'THITES or SETHIANS. In Ecclesiastical History, a branch of the Ophites, a sect of the family of the Gnostics. They are said to have believed that Seth, the son of Adam, appeared again in the person of the Messiah. (*Mosh.* vol. i. cent. 2.)

SE'VERITE. A hydrated silicate of alumina found in nodules in the gravel of St. Sever in France.

SHA'LLOT. The *Allium Ascalonicum* of Linnæus. It possesses the flavour of garlic, but less pungent.

SHEAR STEEL. A kind of steel made by welding several bars together, and again drawing them out. It

is used for clothiers' *shears*, and many other cutting instruments. *See* STEEL, in DICT.

SHELL LIMESTONE. *See* GEOLOGY.

SHOEMAKERS' BLACK. *Atramentum sutorium.* A name given by Pliny to sulphate of iron, or green vitriol, from the circumstance of its being used to rub over tanned leather, to which it communicates a black dye.

SI'BBENS. A disease endemic in some of the western parts of Scotland, somewhat resembling the yaws, and propagated by direct application of the contagious matter.

SI'DERITE. (Gr. σιδηρος, *iron.*) Sparry iron ore. Native carbonate of iron.

SIDE'ROSCOPE. (Gr. σιδηρος, *iron*; σκοπεω, *I view.*) An instrument for detecting minute degrees of magnetism in substances usually supposed to be non-magnetic, — the name having reference to the hypothesis that the traces of magnetism so detected are due to the presence of atoms of iron. The apparatus proposed by Lebaillif, in which the object is accomplished by means of a very delicate combination of magnetic needles, is described by Pouillet, *Elemens de Physique*, and by Sir D. Brewster, *Treatise on Magnetism*, in the *Encyclopedia Britannica*.

SIGAU'LTIAN OPERATION. The division of the *symphysis pubis*, for the purpose of increasing the capacity of the pelvis in cases of impracticable labour. It was first performed by a French surgeon of the name of Sigault, but is now discarded.

SIGNATURE. In Printing, a letter or letters of the alphabet placed at the bottom of the first page of each sheet of a book, to denote the order of the sheets, and to guide the bookbinder in folding and arranging them. Sometimes figures are used, but seldom, except in America.

SILICATES. (Lat. silex.) Compounds of silica with certain bases: thus we have silicates of lime, magnesia, oxide of iron, &c. amongst minerals; and silicate of *lead* is an important ingredient in flint glass.

SI'LICITE. (Lat. silex.) A silicate of alumina and lime from Antrim in Ireland.

SI'LVANITE. Auriferous and argentiferous ore of Tellurium.

SILVER GLANCE. A mineralogical synonym of the vitreous sulphuret of silver.

SI'LVIC ACID. A name applied to that portion of common rosin or colophony, which is most readily soluble in cold alcohol. Its combinations with salifiable bases have been termed *silvates*. It is crystallisable, and its alcoholic solution reddens litmus.

SI'NOPITE. The *Sinopian earth* of the ancients. A hydrated silicate of alumina and iron from Asia Minor.

SITO'LOGY. (Gr. σιτος, *aliment*; λογος, *a discourse.*) *Dietetics*, or the doctrine of aliments.

SKU'TTERUDITE. The arsenuret of cobalt found in mica slate at Skutterud, near Modum in Norway.

SLATE SPAR. A variety of calcareous spar of a shining white pearly lustre and greasy feel, found at Wicklow in Ireland, in Glentilt in Scotland, and in Norway.

SLEET. Rain mixed with hail or snow in small particles. It falls during gales or in squally weather, and chiefly in spring and autumn, when the temperature of the air at a small height above the earth is below the freezing point. M. Kaemptz considers gusts of wind to be a necessary condition for the formation of sleet.

SLIDE-REST. An apparatus adapted to a turning-lathe for carrying the tool, and which by means of screws is made to move or *slide* along the frame of the lathe so as to bring the tool successively to the different parts of the work. The advantages obtained by the slide-rest are extremely important, particularly in reference to the construction of machinery, where extreme accuracy is requisite, both in respect of the size and form of the work. The tool being fixed to the rest, and adjusted by screws, its distance from the axis about which the work revolves can be regulated with the utmost precision, while a degree of steadiness is secured which is altogether unattainable when the tool is simply held in the hand.

SLO'TTING MACHINE. A machine for grooving metal surfaces.

SMALL WARES. A commercial term applied to tape, bindings, braid, and other textile articles of that kind.

SMA'RAGDITE. (Gr. σμαραγδος, *emerald.*) A variety of hornblende.

SMILA'CINE. (Lat. smilax.) A crystallisable principle obtained from Sarsaparilla root.

SMI'THSONITE. A variety of calamine, or native carbonate of zinc, from Somersetshire and Derbyshire, analysed by Smithson.

SNAKE WEED. The great Bistort, *Polygonum bistorta.* The root is *twice bent* on itself, hence the name. This root contains starch, which renders it nutritive; hence, in Siberia, it is roasted and eaten.

SO'CIALISM. The science of reconstructing society on entirely new bases, or the substitution of the principle of association for that of competition in every branch of human industry. *See* RIGHT OF PROPERTY and SAINT SIMONIANS in DICT. The best account of the innumerable modifications of which this principle has been made susceptible, from Rousseau down to Proudhon, will be found in Karl Grün's work entitled "Soziale Bewegung."

SOLA'NO. A hot wind, or species of sirocco, prevailing at certain seasons, in Spain and Portugal.

SOLAR PHOSPHORI. Substances which are seen to be luminous in a dark place after having been exposed to light.

SO'LVENT. In Chemistry, the liquid in which a solid is dissolved. The substance dissolved is sometimes distinguished as the *solvend*.

SO'MERVILLITE. A mineral found in the ejected blocks on Vesuvius, named after Mrs. Somerville.

SORDAWA'LITE. A mineral of the hornblende family, being a silicate of alumina, iron, and magnesia, with about 3 per cent. of phosphoric acid. It occurs in thin veins in the trap rocks of Sordawala in Finland.

SOU'JEE. A species of Semolina; it is a granular preparation of wheat deprived of bran.

SOURKROUT, or SAUERKRAUT. Fermented cabbage. The plants are collected in autumn, divided, the stalks removed, and the leaves cut into slices, a layer of which is placed in a vat alternating with a layer of salt till the vessel is full, when it is subjected to the action of heavy weights placed on the whole. At the end of about six weeks, when the acetous fermentation is complete, it is considered fit for use. The method of cooking it in Germany is simply to stew it in its own juice with bacon, pork, or other fat meat: dill, caraway seed, and other carminatives, are occasionally added. Sauerkraut is not fitted for persons troubled with acidity of stomach; it has a slight relaxing effect on the bowels. As an antiscorbutic it has long been celebrated, and was highly spoken of by Captain Cook. (PEREIRA *on Diet.*)

SOWANS, or SOWINS. The husk and some adhering starch separated from oats in the manufacture of oatmeal are sold, says Dr. Christison, under the inconsistent name of *seeds*; these, if infused in hot water and allowed to become sourish, yield, on expression, a mucilaginous liquid, which, on being sufficiently concentrated, forms a firm jelly, known by the name of Sowins. A similar preparation from groats or oatmeal is called *flummery*.

SPANISH CHALK. A variety of steatite or silicate of magnesia. It is also called *French chalk*.

SPECIFIC HEAT. In Physics, denotes the ratio of the quantity of heat entering into or passing out of a given weight of any substance, to the change of temperature thereby produced. For instance, if the unit of heat be assumed to be that quantity of heat which is necessary to melt a pound of ice at the temperature of 32° of Fahrenheit, then assuming n to denote the number of pounds of ice necessary to cool down a body whose weight is one pound from t to t', the specific heat of the body is $n \div (t-t')$. Hence if $t-t'=1°$, the specific heat is denoted simply by n.

It is found by experiment that, provided a body does not change its state (as from solid to liquid), the above ratio remains constant, or nearly so, through a considerable range of temperature; but it varies greatly in respect of different substances. Thus a pound of water absorbs thirty times more heat than a pound of mercury in being heated the same number of degrees, and consequently, the specific heat of water is thirty times greater than that of mercury. It is usual to express the specific heats of different substances in terms of that of water assumed equal to 1000; the specific heat of mercury thus becomes 33.

SPEISS. An impure arsenuret of nickel, obtained from the ores of cobalt and nickel in smalt-works.

SPELDINGS. A Scotch term for dried and salted whitings.

SPERMATO'A. (Gr. σπερμα, *seed*; ωον, *egg*). The cells which stand in the relation of nuclei to the sperm cells, and of developmental cells to the spermatozoa. Sometimes the sperm-cell contains a single spermatoon, sometimes several spermatoa, in which case the resulting spermatozoa often unite together and form a fasciculus, as, *e.g.* in the sparrow.

SPERMATO'PHORA. (Gr. σπερμα, and φερω, *to carry.*) In Anatomy, cases of albuminous matter, in which the bundles of spermatozoa are packed: they are largest and most complex in the Cephalopods.

SPERMATOZO'A. (Gr. σπερμα, and ζωον, *animal.*) The filamentary bodies developed in the semen, and consisting of an enlarged extremity called "body," and a vibratile filamentary appendage, called "tail." Spermatozoa consist of an amber-coloured, highly refracting homogeneous substance, like the hyaline nucleus of cells, and are formal modifications of the nucleus of the spermatoon. They are essential to impregnation.

SPERM-CELL. In Anatomy, the cells contained in the liquor seminis, in which are formed the spermatoa, or cells of development of the spermatozoa.

SPHE'ROSIDE'RITE. (Gr. σφαιρα, *a globe*, and σιδηρος, *iron.*) A name given by Hausmann to a granular variety of spathose carbonate of iron.

SPIKENARD. The spikenard of the ancients appears to have been the *Nardostachys satamansi*, the root of which is highly esteemed at the present day throughout the East as a perfume, and as a stimulant medicine. The plant is a native of the mountainous parts of the north of India.

SPINAL CHORD or CORD. *See* MYELON.

SPINAL MARROW. The division of the neural axis lodged in the vertebral column of the trunk. *See* MYELON.

SPIRÆ'A ULMARIA. (Lat.) Meadow Sweet. The essential oil of this plant has been produced artificially by the oxidizement of salicine, and has been termed *spiroylous acid*. Its chemical formula is $C_{14}\ H_5\ O_3 + H\ O$.

SPUNK. A species of Agaric or fungus; the *Polyporus*, or *Boletus igniarius;* called also Touchwood. Cut into thin slices and beaten till soft, it has been used as a styptic to check hæmorrhage; it is also used, when soaked in a solution of nitre, for kindling matches and tobacco, under the name of *amadou*, or *German tinder*.

SPURGE, or SPURGE OLIVE. The *Daphne Mezereon*. All parts of this plant, but especially the fruit and the bark, are very acrid and poisonous; it is used as a sudorific and alterative in medicine, and is sometimes applied externally as an irritant.

SQUA'LUS. (Lat.) In Ichthyology, the Linnæan generic designation of the shark tribe.

SQUIRTING CUCUMBER. The *Momordica elaterium.* When the fruit or *pepo* is ripe it separates from the stalk and expels its seeds and a thin mucous juice with considerable violence through the remaining aperture. The acrid purgative, known in pharmacy under the name of *elaterium*, is deposited by this juice.

STANDARD MEASURES OF LENGTH. A standard-bar measurer of very refined construction was produced by Messrs. Whitworth and Co. at the Great Exhibition of 1851. The machine consists of a metal frame, at each end of which is placed a micrometer. These micrometers, by means of a combination of screws and wheels, will measure small differences of length corresponding respectively to the one-millionth and the one-five-thousandth part of an inch. The bar to be measured is carried in a steel groove on the upper part of the frame, a parallel-sided piece of metal at the right-hand end forming a perfectly flat contact for measurement, and the other end abutting against the left-hand micrometer.

The determination of the exact contact for the measure of length can be made either by a *gravitation test* or a *galvanic test*. In the former the experimenter moves the end of the screw of the right-hand micrometer through one division of the head, corresponding to one-millionth of an inch, and, carefully raising the contact-piece, lets it fall by its own gravity; and he repeats this operation till the approach of the screw prevents the contact-piece from descending. In the galvanic test, a small battery composed of a piece of copper and zinc soldered together and immersed in rain water, is connected with the micrometer, and also with a delicate galvanometer by means of covered wires, the bar to be measured being insulated from the machine. The contact is in this case indicated on completing the circuit by the deflexion of the needle of the galvanometer.

STAR. The recent researches of Sir J. Herschel, Argelander, Struve, Peters, and others, have led to some very remarkable views relative to the distances, magnitudes and number of the stars, and their distribution in space.

Distance.—Although it is a very improbable supposition that all the stars are of the same size, it is equally improbable that their real magnitudes are in any way dependent on their distance from the sun; but unless this latter supposition be made, we must conclude that *on the average* (putting individual cases out of view), the most distant will be those which have the smallest apparent magnitude.

Argelander, of Bonn, has given a catalogue of the stars visible to the naked eye, in which they are divided into six orders of magnitude; the faintest stars, or those just perceptible by the naked eye, being considered as the smallest of the sixth magnitude. If we suppose six concentric spheres to be described about the sun, with radii such that the first contains all the stars of the first magnitude, the second all those of the first and second magnitude, the third all those of the three first magnitudes, and so on; and if we also suppose the *mean* distance of the stars of the first magnitude to be unity, then, according to the computation of Struve (founded necessarily on certain hypothetical assumptions respecting the distribution of the stars in space), the mean distance of the stars of the different orders of magnitude, and the radii of the spheres circumscribing them, as above supposed, are as follows: —

Magnitudes.	Mean Distance.	Radius of Sphere.
1	1·0000	1·2638
2	1·8031	2·1408
3	2·7639	3·1961
4	3·9057	4·4374
5	5·4545	6·2093
6	7·7258	8·8726

For stars of the three next magnitudes, the data for computing the relative distances have been furnished by Bessel's zone observations. Struve finds the radii of the circumscribing spheres to be as follows: For those of the seventh magnitude 14·4365 units; for those of the eighth 24·8445; of the ninth 37·7364; and lastly, he concludes that the smallest stars observed by Sir William Herschel with his twenty-foot reflector are at an average distance of 227·8 units, or 25·67 times more distant than the smallest stars visible to the naked eye. (*E'tudes d'Astronomie Stellaire*, p. 81.)

It is usual to express these almost inconceivable distances in terms of the time which light—propagated at the rate of 192,000 miles in a second—takes to traverse them. The average parallax of stars of the first magnitude has been computed by Peters to be 0″·209. (*See* PARALLAX, in SUPPL.) Now if a star has a parallax of 1″, its distance is 206,265 times the distance of the sun from the earth (for radius : sin. 1″=206265 : 1), and the time which light takes to traverse this distance is about 3 years and 83 days, or $3\frac{1}{4}$ years; therefore the time which light takes to come from a star whose parallax is 0″·209,—that is, to traverse a distance equal to the average mean distance of a star of the first magnitude, which has been assumed as the unit of the above scale,—is 15·4 years; to come from the remotest star of the sixth magnitude, 137 years; from the remotest of the ninth magnitude, 580 years; and from the remotest star visible in Herschel's twenty-foot reflector, 3500 years. (*E'tudes*, p. 106.)

Number of visible Stars.—As no limit can be set to the distance to which the stars may extend in space, the number of visible stars is limited only by the powers of the telescope. But the direct enumeration is beyond human power, and in order to obtain an approximation, it is necessary to have recourse to hypothetical considerations. By a very ingenious investigation, founded on the numbers ascertained by Sir W. Herschel to exist within certain limited spaces, Struve has attempted to compute the whole number in the heavens within the range of the twenty-foot reflector, which, as stated above, is 227·8 times that of the distance of stars of the first magnitude. He first establishes a law of diminution depending on the angular distance from the plane of the galactic circle (*see* GALAXY), and having ascertained the mean number visible in a field of the telescope in that plane, he finds, by a process of integration, the whole number in the celestial vault to be 20,374,034, or upwards of twenty millions. Whether this number be near or far from the truth, it must be taken as the most probable estimate yet made. (*E'tudes*, p. 72.)

If we confine our attention to stars visible to the naked eye, the number may be estimated with greater precision. The number of stars of the several magnitudes, in the northern hemisphere, contained in Argelander's catalogue, is as under: —

Magnitudes	1	2	3	4	5	6
Stars in each	9	34	96	214	550	1439
Sums	9	43	139	353	903	2342

Assuming the *density* to be the same in the southern hemisphere as in the northern, the catalogue should contain 4684 stars. It is estimated by Struve, that the number entered in the catalogue is to the whole number existing (and visible to the naked eye) within a given space, in the ratio of 8136 to 10,000. Hence the whole number of stars which can be seen with the naked eye is 5757, or less than 6000. Sir J. Herschel remarks that the whole number of stars already registered, down to the *seventh* magnitude inclusive, amounts to from 12,000 to 15,000.

Apparent Magnitudes.—The method of estimating the apparent magnitudes usually adopted is by a scale of brightnesses decreasing in geometrical progression, each term being half of the preceding, or at least having a fixed ratio to it. Sir J. Herschel proposes and recommends the adoption of a scale decreasing as the squares of the terms of an harmonic progression, namely, the series 1, $\frac{1}{4}$, $\frac{1}{9}$, $\frac{1}{16}$, $\frac{1}{25}$, &c. This scale is not a purely photometric one, like the former, but involves the physical idea of supposing the scale of magnitudes to correspond to the appearance of a first magnitude star removed successively to twice, three times, four times, &c. its original or standard distance; so that upon the supposition of an equality among the real lights of the stars, the nominal magnitude would be a sort of index to the presumable distance.

Real Magnitudes.—The only means we have of obtaining any indication respecting the real magnitudes of the

stars is by means of the quantity of light received from them. Sir J. Herschel compared the light of α *Centauri* directly with the moon, and from several experiments, made with attention to all the circumstances required to be taken account of, found that the mean quantity of light sent to the earth by a full moon exceeds that sent by α *Centauri* in the proportion of 27,408 to 1. Dr. Wollaston (*Phil. Trans.* 1829) found the proportion of the sun's light to that of the full moon to be that of 801,072 to 1. Combining these results, it appears that the light sent to us by the sun is to that sent by α *Centauri* as 21,955,000,000, or about twenty-two thousand millions to one. Hence, and from the parallax assigned to that star (0″·913), it is easy to conclude that its intrinsic splendour, as compared with that of the sun, is in the proportion of 2·3247 to 1. The light of Sirius is four times that of α *Centauri*, and its parallax is only 0″·230, if so much; its intrinsic splendour, therefore, according to these determinations, must be above sixty-three times (63·02) that of our sun. (Herschel, *Outlines of Astronomy*, p. 553.)

STAR ANISE. The fruit of *Illicium anisatum*, an evergreen growing in Japan and Cochin China: the seeds have the odour of common anise, and yield, when distilled with water, an oil sometimes called *Oleum badiani*, which is used by liqueur makers.

STA'VESACRE. The *Delphinium staphysagria.* The seeds of this plant are emetic and purgative, in consequence of the presence of *Delphinia*, a very acrid bitter principle, which, in the dose of a few grains, excites a sense of heat and tingling in various parts of the body. The disease in which it has been chiefly successful is neuralgia, in which it has been applied externally in the form of ointment.

STEAM HAMMER, for pile-driving. An ingenious machine invented by Mr. Nasmyth, now in general use in government and other large works. "It consists of a steam cylinder, closed at the bottom, but with openings in the top to allow the passage of air; a piston works in it, having its rod passing through a steam-tight aperture in the bottom. To the piston the monkey or driver, which weighs 2½ tons, is attached, and is thus suspended. The machine is worked by high-pressure steam, which being admitted at the bottom of the cylinder by the induction-pipe, raises the piston, and, with it, the monkey attached to it. The instant it arrives at the height required, it closes the induction-pipe, and, opening the eduction-pipe (also at the bottom of the cylinder), the steam escapes, and the piston, with the monkey attached to its rod, falls freely on the head of the pile. A large heavy cap of iron, with a hole to allow the head of the pile to pass through, slides between the upright standards, and guides the direction of the pile. The monkey and cylinder also follow the course of the pile, guided by the same uprights, between which they slide."

The saving of labour effected by this contrivance is very great. A stage, which carries the machine, boiler, workmen, and every thing necessary, moves along a railway. Having driven one pile, the machine moves onward the regulated distance; it then picks the next pile out of the water, hoists it high in the air, drops it into its exact place, then covers it with the great cap; the monkey immediately acts, giving at the rate of seventy-five blows in a minute. The whole operation of raising a pile from the raft, putting it in its place, and driving it to the required depth, occupies generally from two to four minutes. By the old method of pile driving, a comparatively light weight (about 12 cwt.) is made to fall from a great height, and the blows succeed at intervals of about five minutes. By the new machine a very heavy weight (about 50 cwt.) falls through a height of only three feet, and the blows are repeated seventy-five times in a minute.

The principle of this invention may be said to consist in the employment of a heavy weight moved with a small velocity, instead of a light weight moved with a great velocity. In a paper communicated to the British Association for 1841, Dr. Greene gave the following instance of the state of the heads of two piles, as driven by the two methods:—

"One was 56 feet long, driven by a monkey of 12 cwt. falling from a great height, and making only one blow in five minutes, and requiring twenty hours to drive it; this, though protected by a hoop of iron, was so split and shattered on the head, that it would require to be re-headed, to drive it any further. The other, though 60 feet long, was not even supported by an iron hoop, and the head is as smooth as if it were dressed off with a new plane. It was driven with a hammer of 50 cwt., and only three feet fall, making seventy-five blows in a minute, and was put into its place and finished in four and a half minutes."

STEI'NMANNITE. One of the mineralogical synonyms of the double sulphuret of lead and antimony.

STE'LLITE. A variety of zeolite crystallised in delicate rhombic prisms grouped in concentric stars, from Kilsyth, Scotland.

STEPHANITE. A mineralogical synonym of one of the varieties of brittle sulphuret of silver.

STEREO-ELECTRIC CURRENT. (Gr. στερεος, *solid.*) A term applied to the *thermo-electric* current which ensues when certain metals are brought into contact at different temperatures; it implies the production of a current of electricity in *solid bodies*, as opposed to the voltaic or *hydro-electric* current, in which fluids are essential.

STE'REOSCOPE. (Gr. στερεος, *solid;* σκοπεω, *I view.*) The name given by Professor Wheatstone to an instrument or apparatus proposed by him, and described in a paper on the Physiology of Vision, published in the *Philosophical Transactions* for 1838, for the purpose of exhibiting the effect of simultaneously presenting to each eye the projection of a solid body on a plane surface as it appears to that eye. To render this clear, it may be necessary to observe, that when a body of three dimensions is placed so near the eyes that, on looking at it, the optic axes must converge, a different perspective representation of it is seen by each eye; the body being, in fact, thus seen from two points of sight, at a distance from each other equal to the distance between the centres of the pupils, and the pictures of it projected on the two retinæ being consequently dissimilar. Supposing, then, two perspective drawings, on a plane surface, to have been made of an object as it is seen by each eye respectively; in order to try the experiment, it is necessary that the pictures be placed so that each can be seen by one eye only, and that the rays of light from the corresponding points of the two pictures fall on similar points of both retinæ, or enter the eyes in the same directions as the rays from the corresponding points of the original object. By reason of the small distance between the two eyes, this, manifestly, cannot be done without altering the direction of the rays. For this purpose Professor Wheatstone employed two small plane mirrors, about four inches square, adjusted at right angles to each other, so as to form two adjacent sides of a cube, the faces being outwards. The edge where the two planes meet being brought close to the face of the observer, and the mirrors being placed symmetrically with respect to the direction of the visual rays, it is evident that if the two pictures be respectively placed before the mirrors symmetrically, and at equal distances, rays of light proceeding from them in opposite directions, and falling on the mirrors, will be reflected at right angles to their former directions, and become parallel. The right eye will see only the reflexion of the picture on the right hand side, and the left eye that on the left hand side; but on regarding both simultaneously, the mind readily unites the two images, and instead of the two plane pictures, an object of three dimensions makes its appearance, the exact counterpart of that from which the pictures were drawn, standing out, as it were, in relief between the planes of the two mirrors.

In the Report of the British Association for the Advancement of Science, for 1849, Sir David Brewster states, that having had occasion to make numerous experiments on this subject, he was led to construct the stereoscope in several new forms. Of these forms, the most generally useful is the *Lenticular Stereoscope.* This instrument consists of two semilenses placed at such a distance that each eye sees the picture of a drawing opposite to it, through the margin of the semilens, or through points of it equidistant from the margin. The distance of the two portions of the lens through which we look must be equal to the distance of the centres of the pupils, which, at an average, is two and a half inches. By this method the images are not only united, but magnified at the same time, which is in many cases advantageous.

STERNBERGITE. The flexible sulphuret of silver and iron, named by Haidinger in honour of Count Sternberg. It occurs in Bohemia and Hungary.

STILBENE. (στιλβω, *I shine.*) A peculiar hydrocarbon, which crystallises in scales of a pearly lustre.

STILBITE. A pearly variety of zeolite.

STILPNOSIDERITE. (στιλπνος, *lucens;* σιδηρος, *iron.*) A native oxide of iron.

STIMMI. An ancient name of the sulphuret of antimony.

STIR-ABOUT. A moderately consistent mixture of oatmeal and water boiled, and generally eaten with cold milk, called Porridge in Scotland. When mixed with the thin liquor of boiled meat, or the water in which cabbage or kale has been boiled, it is called *beef brose*, or *kale brose*. (PEREIRA *on Diet.*)

STONE BLUE. A compound the basis of which is usually an impure starch, or mixture of starch and gluten, being the starchmakers' refuse, coloured either by indigo or Prussian blue. It is used in the laundry to cover the yellow tint of linen.

STRAWBERRY. The fruit of *Fragaria vesca.* Strawberries contain a very small quantity of nutritive matter. The grains or seed-like pericarps are not digestible, and sometimes excite intestinal irritation; so

that some physicians have directed their patients to suck strawberries through muslin.

STRETCHING MACHINE. Calicoes, and other similar textile fabrics, are prepared for the market by being stretched in a proper machine, which lays all their warp and woof yarns in parallel positions, and extends their width after the shrinkage occasioned by bleaching, dyeing, &c.

STROGA'NOWITE. (Named after Count Stroganoff.) A mineral found in loose blocks in the Slüdänka, a river of Dauria, of a greyish white colour, and slightly effervescent with acids; it is a silicate of alumina, soda, and lime, combined apparently with carbonate of lime.

STROMEY'ERITE. A mineral so named by Haidinger, after the Hanoverian chemist Stromeyer, who analysed it; it is a double sulphuret of silver and copper.

STRO'MNITE. A sulphate of baryta and carbonate of strontia: probably a mixture merely of the sulphate and carbonate, found at Stromness in Orkney. It occurs in yellowish-white translucent masses, with a slight pearly lustre, and crystalline cleavage.

STRU'THEINE. (Gr. στρουθος, *a kind of herb.*) A bitter acrid principle obtained from the root of *Gypsophila struthium.* It appears to be identical with *saponine*, obtained from the *Saponaria officinalis*, or soapwort.

STRU'VITE. A name (in honour of Struve) given to the crystallised ammonio-magnesian phosphate, found in peat earth, in digging the foundation of a church at Hamburgh.

STY'PHNIC ACID. (Gr. στυφνος, *astringent.*) An astringent acid compound obtained by the action of nitric acid upon certain gum resins. It is also called *Nitrostyphnic acid.*

STYRO'LE. (Gr. στυραξ.) An oily hydro-carbon obtained by distilling liquid storax. It is perfectly liquid, but has the curious property of becoming a soft viscid transparent solid when heated. In this state it has been called *metastyrole.* The formula of styrole is $C_{16}\ H_8$.

SUBSTITU'TION. In Chemistry, this term is applied to such results of affinity as are dependent upon the substitution of one or more atoms or equivalents of a simple or compound body, for the same number of atoms of another body. Thus, in the decomposition of water, which ensues when zinc is made to act upon dilute sulphuric acid, an atom of zinc is *substituted for* (or replaces) an atom of hydrogen, the latter being expelled. These changes are clearly shown by the aid of formulæ. Thus, in the above case,

$$H + S\,O_4 \text{ becomes } Zn + S\,O_4.$$

Another illustrative case of substitution occurs in the conversion of acetic into chloracetic acid, in which the 3 atoms of hydrogen belonging to the acetic acid are substituted by 3 atoms of chlorine:

$$\underbrace{C_4\ \ H_3\ \ O_3}_{\text{Acetic acid}} \text{ becoming } \underbrace{C_4\ \ \ Cl_3\ \ \ O_3}_{\text{Chloracetic acid.}}$$

In the same way in the formation of nitric ether, an atom of nitric acid is substituted for an atom of water:

$$\underbrace{C_4\,H_5\,O + H\,O}_{\text{Alcohol.}} \text{ becoming } \underbrace{C_4\,H_5\,O + N\,O_5}_{\text{Nitric ether.}}$$

SU'CCORY. Called also *Chicory*. The *Chicorium intibus* (*wild endive*). The root of this plant, which resembles a carrot, when cut into slices, dried, roasted, and ground into powder, is used for the adulteration of ground coffee. It has a somewhat burned flavour, a very little resembling that of coffee, but it yields a large quantity of a rich brown infusion, or decoction, with water. To detect the adulteration, sprinkle the suspected article upon the surface of some water in a jar or tumbler: if genuine coffee, it remains for a long time floating, scarcely tinging the water, and appearing greasy, or not easily wetted; whereas, if succory powder be present, it communicates a deep reddish-brown tint to the water, and portions of it soon sink to the bottom.

SUDORI'PAROUS GLANDS. (Lat. sudor, *sweat;* pario, *I produce.*) In Anatomy, the secreting organs of the sweat, which consist of a slender elongated blind glandular tube, coiled into a lobular form and imbedded in the subcutaneous fat, and continued thence in a spiral course to the cuticle, where it opens by an oblique pore.

SU'LFAMIDE. A crystallised compound obtained by the action of anhydrous sulphuric acid on ammonia. The compound resulting from the analogous combination of dry sulphurous acid on ammonia has been termed *Sulfimide.*

SULPHURA'TION. The process by which certain silk, cotton, and woollen goods are subjected to the fumes of burning sulphur, or sulphurous acid, for the purpose of decolouring or bleaching. The rooms or chambers in which the operation is conducted are often of considerable dimensions, and fitted with poles and frames, on which the blankets, shawls, and similar articles may be suspended. The straw used in the manufacture of hats is similarly bleached or sulphured.

SU'NSTONE. A resplendent variety of felspar, found in Norway and elsewhere. The play of colour which it exhibits arises from minute lamellar crystals of iron-glance which are embedded in it.

SUPRARE'NAL BODIES. (Lat. supra, and ren, *a kidney.*) In Anatomy, the flattened bodies situated on the upper part of the kidneys in man, and at the forepart in brutes: they are well supplied with blood-vessels and nerves, and are composed principally of simple or closed vesicles, resembling the secreting glands, except that they have no ducts. They are of disproportionately large size and the fœtal state in man and quadrumana.

SU'RINAMINE. A crystallisable principle obtained from the bark of the *Geoffroya Surinamensis*, or *Surinam bark.*

SWEETBREAD. The thymus gland of the calf is employed as food, under this name; it contains about 70 parts of water, and 30 of nutritious matter, chiefly of an albuminous character. "A fresh sweetbread when plainly cooked (by boiling) and moderately seasoned, forms a very agreeable and suitable dish, for the convalescent; but, when highly dressed, is improper both for dyspeptics and invalids." (PEREIRA *on Diet.*)

SYE'POORITE. A sulphuret of cobalt, found in primary rocks at Syepoor, near Rajpootanah, in North-west India. It is said that the Indian jewellers use it to give a rose colour to gold.

SYMBOLS, CHEMICAL. A chemical symbol is the representation of one atom or equivalent of each elementary substance by the capital initial letter or letters of its Latin name, it being necessary where the names of two or more elements begin with the same letter to add a second, in a smaller character, for the purpose of distinguishing between them. Thus, C, Cl, Ca, Cd, Co, Cu, Ce, Cr, are the symbols of Carbon, Chlorine, Calcium, Cadmium, Cobalt, Copper (Cuprum), Cerium, and Chromium, H and Hg are the symbols of Hydrogen and of Mercury (Hydrargyrum), O and Os of Oxygen and of Osmium, and so on. The following table enumerates, in alphabetical order, the simple or elementary substances, with their annexed symbols, and equivalents or atomic weights; that is, the respective *weights* of each of the elementary bodies which each symbol is assumed to represent upon the *hydrogen* scale, or in reference to hydrogen as unity:

	Atomic Weight.	Symbol.
Aluminum	14	Al.
Antimony (Stibium)	129	Sb.
Arsenic	75	As.
Barium	69	Ba.
Bismuth	106	Bi.
Boron	11	B.
Bromine	78	Br.
Cadmium	56	Cd.
Calcium	20	Ca.
Carbon	6	C.
Cerium	46	Ce.
Chlorine	36	Cl.
Chromium	28	Cr.
Cobalt	30	Co.
Copper (Cuprum)	32	Cu.
Didymium ?		Di.
Fluorine	19	F.
Glucinum	17	G.
Gold	200	Au.
Hydrogen	1	H.
Iodine	126	I.
Iridium	99	Ir.
Iron (Ferrum)	28	Fe.
Lanthanum	36	Ln.
Lead (Plumbum)	104	Pb.
Lithium	7	Li.
Magnesium	12	Mg.
Manganese	28	Mn.
Mercury (Hydrargyrum)	100	Hg.
Molybdenum	48	Mo.
Nickel	29	Ni.
Niobium ?		Nb.
Nitrogen	14	N.
Osmium	100	Os.
Oxygen	8	O.
Palladium	54	Pd.
Pelopium ?		Pe.
Phosphorus	32	P.
Platinum	99	Pt.
Potassium (Kalium)	40	K.
Rhodium	52	R.
Ruthenium	52	Ru.
Selenium	40	Se.
Silicium	15	Si.
Silver (Argentum)	108	Ag.
Sodium (Natrium)	24	Na.
Strontium	44	Sr.

	Atomic Weight.	Symbol.
Sulphur - - -	16	S.
Tantalum (or Columbium) -	185	Ta.
Tellurium - - -	64	Te.
Thorium - - -	60	Th.
Tin (Stannum) - -	59	Sn.
Titanium - - -	24	Ti.
Uranium - - -	60	U.
Vanadium - - -	68	V.
Wolframium (or Tungston) -	95	W.
Yttrium - - -	32	Y.
Zinc - - - -	32	Zn.
Zirconium - - -	23	Zr.

It will be understood that the above symbols represent a single atom or equivalent of each of the simple bodies, in reference to Hydrogen as *unity*. Thus, H represents 1 part by weight of Hydrogen; O, 8 parts by weight of Oxygen; S 16 of Sulphur; Hg, 100 of Mercury, and so on. It is evident, however, that, as far as the equivalents are concerned, other numbers or weights, bearing the same relations to each other, might be adopted: thus, upon the *oxygen* scale, oxygen is represented as = 100; in which case hydrogen is 12·50, sulphur 200, mercury 1250, and so on. But we shall confine ourselves exclusively to the hydrogen scale, which is now in most general use, and in all respects preferable to the more complicated numbers which the oxygen scale necessarily involves.

When two or more equivalents of one elementary substance are to be indicated, figures are placed either before or after the symbol. Thus, 2 equivalents (or *atoms*, for we use the terms synonymously) of iron may be represented by 2 Fe, or by Fe 2; in the former case a large, in the latter a small numeral being generally adopted. It is often customary to place this small numeral somewhat above or below the symbol, as Fe^2 or Fe_2, but there are inconveniences and no advantages attending this arrangement; and they give to these chemical symbols something of the character of algebraic symbols, with which they have little in common. Some writers have expressed two atoms of an element by drawing a line through its symbol; thus, 2 atoms of hydrogen are represented by $\not{H}$; 2 of sulphur, by $\not{S}$, &c.; but such abbreviations are inconvenient.

By a proper collocation of symbols, the *formulæ of compounds* are easily represented; thus, Cu O represents an atom of copper and an atom of oxygen in combination, that is, *protoxide of copper;* Fe O, protoxide of iron, &c. Sulphuric acid, which is a compound of 1 atom of sulphur with 3 atoms of oxygen, is represented by $S\ O_3$, and sulphate of protoxide of iron by $Fe\ O + S\ O_3$; or, more commonly, the symbol + is omitted in such cases, and a comma substituted, as $Fe\ O, S\ O_3$. It will be observed that this formula has reference to the assumed *proximate* constituents of the salt in question, and that if its ultimate elements only were intended to be indicated, the formula would stand thus, $Fe\ S\ O_4$. In many instances the plus sign and the comma are conveniently available in the same formula; thus, the double sulphate of potassa and oxide of iron may be written as follows: $K\ O, S\ O_3 + Fe\ O, S\ O_3$. Here the comma may be assumed as indicating a more intimate or higher order of combination than the plus sign, namely, that of the oxide and acid in each salt, while the union of the salts with each other is represented by the sign +.

In the preceding formulæ the figures only affect the symbol to which they are immediately appended. When they are intended to apply to the *entire compound*, they precede the symbol of the compound, and it is in such cases clearer to use large figures: thus, $3\ S\ O_3$ represents three atoms or equivalents of sulphuric acid, and 2 Cu O, two atoms of protoxide of copper. A salt containing *two* atoms of oxide of copper and *one* of sulphuric acid would be written as follows: $2\ Cu\ O, S\ O_3$, or $2\ Cu\ O, + S\ O_3$: in these cases the intervening comma or *plus* sign prevents the extension of the influence of the figure 2 beyond the oxide of copper, and if our object were to imply *two atoms of sulphate of copper*, we should inclose all that is to be affected by the figure 2 within brackets, and write it thus: $2\ [Cu\ O, S\ O_3]$. To give one other instance: $Pb\ O, Cr\ O_3$ is the neutral chromate of lead; and $3\ [Pb\ O, Cr\ O_3]$ is *three* atoms of the same neutral chromate; but $2\ Pb\ O, Cr\ O_3$ is the *dichromate* or subchromate of lead, and $3\ [2\ Pb\ O, Cr\ O_3]$ is three atoms of the same dichromate. $K\ O, 2\ Cr\ O_3$ is the *bichromate* of potassa, and $4\ [K\ O, 2\ Cr\ O_3]$ four atoms of the same, &c.

The following are more complicated illustrations of the application of these symbolic notations: $K\ O, S\ O_3 + Al_2\ O_3, 3\ S\ O_3 + 24\ H\ O$ represents the constitution of crystals of common alum; they include an atom of sulphate of potassa, an atom of sulphate of alumina, and 24 atoms of water of crystallisation: an atom of alumina includes 2 atoms of *aluminum* and 3 of oxygen, and its *sulphate*, as it exists in alum, is constituted of 1 atom of alumina and 3 of sulphuric acid. In *iron alum* the alumina is replaced by its *isomorphous substitute*, peroxide of iron; and the formula of this salt is

$$K\ O, S\ O_3 + Fe_2\ O_3, 3\ S\ O_3 + 24\ H\ O.$$

It is obvious that the atomic or equivalent weights of compounds are in all cases to be deduced from their symbols. Thus, the symbol of potassa K O indicates its equivalent to be 48, for the equivalent of K is 40, and that of oxygen 8. And again; $S\ O_3$, the symbol of sulphuric acid, is equal to 40 of that acid; for S is = 16 sulphur, and O_3, $8 \times 3 = 24$ of oxygen; and $16 + 24 = 40$. Hence also, $K\ O, S\ O_3$, is one atom, or equivalent of sulphate of potassa, or 88 parts by weight.

In the construction of chemical formulæ the arrangement of the symbols should not be arbitrary, but such that the *basic* or electro-positive elements should precede the *acid* or the electro-negative elements: hence sulphate of potassa is written $K\ O, S\ O_3$, and not $S\ O_3, K\ O$; and chloride of sodium is represented by Na Cl, and not Cl Na. In this way, also, much useful information respecting the real or theoretical constitution of compounds may be expressed in the due arrangement of their formulæ: thus, $H\ O, S\ O_3$ represents hydrated sulphuric acid of the specific gravity of 1·84, or common oil of vitriol, which may be called a *sulphate of water:* the acid of the specific gravity of 1·78 contains 2 atoms of water to 1 of anhydrous sulphuric acid, and might therefore be represented as $2\ H\ O, S\ O_3$; but if we give to it the formula $H\ O, S\ O_3 + H\ O$, we indicate that 1 atom of water only is combined as a *base*, with the anhydrous acid, and that the second atom of water is in combination with the sulphate of water, constituting, as it were, water of crystallisation.

In cases where complicated formulæ are to be expressed, and more especially in the combinations with which the mineralogist has to deal, the above symbolic notation may become inconveniently long, and, accordingly, various abbreviations have been suggested, but the evil of them is their frequent indistinctness, and the confusion which results from slight and almost unavoidable typographical errors. The equivalent of oxygen in oxides and acids is thus frequently represented by a point placed over the symbol of the element with which the oxygen is combined. The following, for instance, are the several combinations of nitrogen with oxygen, represented in ordinary and in abbreviated notation:—

Nitrous oxide - -	N O	$\dot{N}$
Nitric acid - - -	$N\ O_2$	$\ddot{N}$
Hyponitrous acid - -	$N\ O_3$	$\dddot{N}$
Nitrous acid - -	$N\ O_4$	$\ddddot{N}$
Nitric acid - - -	$N\ O_5$	$\overset{\cdot\cdot\cdot\cdot\cdot}{N}$.

Mineralogists also sometimes represent the atom of sulphur by substituting a dash over the symbol of the element with which it is combined, in place of using the letter S in the usual way; thus they indicate the three sulphurets of arsenic:—

$As\ S_2$	by	$\overset{\prime\prime}{As}$
$As\ S_3$	„	$\overset{\prime\prime\prime}{As}$
$As\ S_5$	„	$\overset{\prime\prime\prime\prime\prime}{As}$.

Certain compound bodies, more especially where they perform the part of elementary substances, are sometimes conveniently represented by their initial letter or letters, as if they were simple bodies. For instance, Cyanogen, which is a compound of 2 atoms of carbon with 1 of nitrogen, is indicated by Cy, instead of $C_2\ N$; and Ethyle, which is a compound of 4 atoms of carbon and 5 of hydrogen, by E instead of $C_4\ H_5$. And, lastly, certain organic bases and organic acids are similarly expressed by one or more initial letters, with the plus or minus sign attached; thus, instead of giving the composition of Morphia, Cinchonia, &c. at length, they are represented by $\underline{\overset{+}{\text{Mor}}}$, $\underline{\overset{+}{\text{Cin}}}$, &c., and Acetic, Tartaric, and other acids, by $\overline{\text{A}}$, $\overline{\text{Tar}}$, &c. But these and similar abbreviations are only admissible where a frequent repetition of the extended symbol is required, and where the indication of the elementary components is immaterial.

SYNAPTA'SE. (Gr. συναπτω, *to be present.*) A term applied by Robiquet to the *emulsine* or *vegetable caseine* of the almond, in consequence of its necessary *presence* in the conversion of *amygdaline* into hydrocyanic acid and bitter almond oil.

SYRINGI'NE. A crystallisable bitter principle obtained from the leaves of the lilac tree (*Syringa vulgaris*). It has also been called *lilacine.*

SYSTE'MIC. In Physiology, is applied to designate the circulation of the general system, beginning at the left ventricle and aorta, and ending at the venæ cavæ and right auricle, as contradistinguished from the circulation through the lungs, which is called "pulmonic." They have also been termed the greater and lesser circulations. The parts concerned in these circulations have also received the same names: thus the left ventricle is called the "systemic" one.

T.

TABOO. A word used by the South Sea islanders to denote something sacred, or set aside for particular uses or persons.

TA'CHYLITE. (Gr. *ταχυς*, *rapid*.) A very fusible alumino-silicate of protoxide of iron, occurring in certain basaltic rocks. Its name has reference to its rapid fusibility.

TAFFO. A manure made in China, composed of night soil mixed up with clay and formed into cakes which are dried in the sun.

TA'GILITE. A native phosphate of copper from Nischne-Tagilsk, in Siberia.

TA'LBOT. A hunting dog, between the hound and beagle.

TA'LBOTYPE. A name given certain photographic pictures in honour of the inventor of the process, Mr. W. A. Fox Talbot. *See* PHOTOGRAPHY, in DICT.

TANGHICI'NE. A crystallisable neutral principle said to possess narcotic properties, extracted from the kernel or seed of the *Tanghinia venenifera*, a native of Madagascar. This seed, which is said to be a deadly poison, was formerly used in Madagascar to ascertain the guilt of suspected persons, as a kind of ordeal, those who withstood it being deemed innocent. The extract of the seed has been called *Tanginine*.

TANSY. *Tanacetum vulgare*. The herb and flowers of this plant, used sometimes as a kind of medicinal pot-herb, have a disagreeable though somewhat aromatic odour, and a strong nauseous bitter taste. A small portion is sometimes added to omelets, and we have heard of *Tansy puddings*.

TARA'XACINE. A crystallisable bitter principle contained in the juice of the root of dandelion (*Leontodon taraxacum*).

TA'RNOWITZITE. A carbonate of lime, or species of arragonite, containing a small proportion of carbonate of lead, found at Tarnowitz, in Upper Silesia.

TAU'RINE. A crystalline substance containing a large proportion of sulphur, and obtained from bile. Its formula is $C_4\ H_7\ O_6\ S_2\ N$.

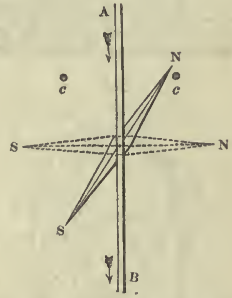
TE'BETH. The tenth month of the Jewish ecclesiastical year, and fourth of the civil year. It corresponds to December.

TE'KORETINE. A crystalline resinous product obtained from turf.

TELEGRAPH. The Electric, or, as it ought more properly to be called, the ELECTROMAGNETIC TELEGRAPH, has now superseded all other means of telegraphic communication. We purpose, therefore, here briefly to describe the *principle* upon which these instruments are constructed, referring for minute details to the various works which have been published, and to the specifications of the many patents which have been issued upon the subject. The mutual relation of electric and magnetic currents will be evident from what has been stated elsewhere under the heads ELECTROMAGNETISM and GALVANOMETER, so that it will only be necessary to recapitulate such circumstances as have especial relation to telegraphic purposes.

When a current of voltaic electricity is traversing a metallic wire, a magnetic current is at the same time established, at right angles to, and as it were revolving about the electric current, as its axis; and if the pole of a magnet be supposed capable of freely moving in any direction, the tendency of such pole would be to revolve about the wire in question, or rather, about the electric current which that wire carries. If a common magnetic needle, turning horizontally upon a point or pivot, be brought near the voltaic current, or to the wire conveying that current, the magnet will accordingly be deflected from its meridian. Supposing, for instance, the magnetic needle in its natural position, and pointing therefore north and south, to be approached by a wire transmitting the volta-electric current, held above, and parallel to the needle, the deflection of the needle will take place either to the right or left, or to the north or south, the direction of the deflection depending upon that of the electric current; and accordingly the tendency of the magnetic needle will be to place itself at *right angles* to the wire conveying the electric current. It is obvious, therefore, that the electric and magnetic forces may so far be said *to deflect each other*, and upon this principle the various forms of the galvanometer are constructed. Now, in reference to the application of such principle to telegraphic purposes, another form of apparatus must be adopted, in which the magnetic needle and deflecting current, instead of being placed horizontally, as in the galvanometer, are placed *vertically*, or perpendicularly, as in the annexed diagram, where A B represents a wire having a magnetised steel needle placed immediately behind it, and so adjusted as to hang vertically when at rest. If an electric current be now made to descend from A to B through such wire, the needle will be deflected into the position N S; that is, its north

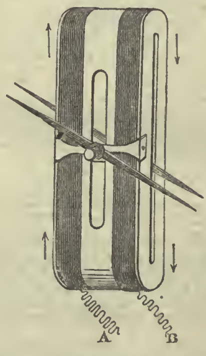
(1.)



pole will turn to the right as you stand before it; and on increasing the force of the electric current, the deflection of the needle might be so far increased as to cause it to place itself at *right angles* to the electric current, as shown by the dotted figure; but this may be prevented by the small studs *c c*, by which such extreme deflection is limited. If we now suppose the wire to be continued on, and bent into the shape of the letter U, the current still passing onwards, that is, down the limb A B and up B C (as indicated by the darts), then the portion of the current B C would also act upon the needle, and proportionately increase the deflection. If we now change the direction of the electric current, so as to send it down C and up A, then also will the direction of the deviation of the magnetic needle be changed, and its north pole, instead of pointing to the right, will point to the left. And if, by repeated convolutions of the wire, the electric current be made to pass many times around the magnetic needle, the deflection would be still further increased, so that, by the adoption of this latter expedient, or the use of a *coil* instead of a single wire, the effect of the electric current may be so *multiplied* as to produce a considerable deflection by a comparatively feeble current. This is, in fact, the principle of the *galvanometric multiplier*, and is the form of apparatus used in the electric telegraph, as now most commonly constructed. The construction of this *coil* is shown in the annexed wood-cut It consists of a polished wooden

(2.)

(3.)

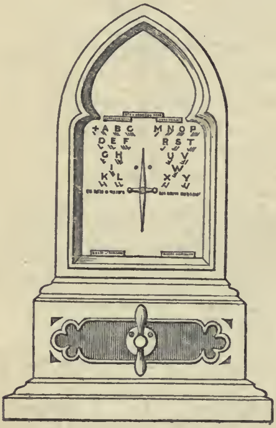


or ivory frame, round which are bound some hundred feet of fine copper wire, covered with silk, which, being a nonconductor, prevents the lateral passage or transfer of electricity from wire to wire, so that the current, entering at A, passes through the whole length of the coil, and goes out at B. Two magnetic needles are fixed

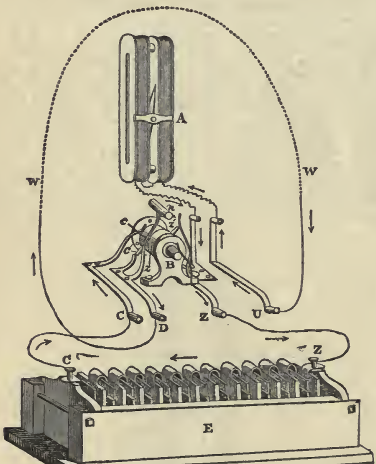
upon an axis which passes through the frame, one within, and the other without the coil, the poles of which needles are in opposition to each other, by which they are rendered *astatic*, that is, they are not affected by the magnetism of the earth. This coil is so placed at the back of the dial plate of the telegraph, shown in the next diagrams, as to allow the outer needle to traverse right and left upon the dial plate.

Having said thus much of the *principle* upon which the usual form of the electro-magnetic telegraph is constructed, we may now further explain the details of its simplest form, in which *one* indicating needle only is employed, and which therefore is usually called the *Single needle instrument*. A front and back view of this telegraph is given in the following cuts, the battery being represented annexed to the latter, and the circuit through

(4.)



(5.)



the galvanometric coil A being completed by the wire W W. The following description of the *working* of the instrument is abridged from Mr. C. V. Walker's "Electric Telegraph Manipulation," to which we may here refer the reader for a variety of details respecting its construction and uses, which would have been irrelevant in this article.

The instrument has a twofold character: it is either *passive*, or ready for *receiving* signals *from* another instrument; or it is *active*, or ready for *transmitting* signals *to* another instrument. By describing first how it is fitted for *receiving* signals, and then how it is arranged for *transmitting* them, we shall be better able to analyse it, and comprehend its structure. The frame of the coil A is screwed upon the face of the instrument, which face is a brass plate varnished on the inner side. Looking at the coil, a short wire from its *right-hand end* comes to a screw terminal, which, by a slip of brass, is connected with another terminal U. The *left-hand end* of the coil comes also to a terminal, from which a slip of brass descends to a brass plate, here partly hidden; but its form may be seen from a similar plate, visible on the left side. These twin plates are in metallic connection by means of the two upright *springs*, shown in the cut. The *springs* are of steel, and press strongly on two points in a short insulated brass rod *n*, which is screwed into the framework of the instrument. The left-hand plate is connected with the terminal D, also by a slip of brass. If, now, the two terminals U and D are connected by a wire W W, the circuit will be complete, as follows: from the terminal U into the coil at the right-hand side; out of the coil, at the left side, downwards to the right-hand plate; up the right-hand steel spring, across the brass rod *n*, to the left-hand steel spring; downward, by this spring, to the left-hand plate, thence by the slip of brass to the terminal D, and thence by the wire W W to the terminal U, whence we started. If, now, the wire from U went up the line of railway, and the wire from D down the line, and the circuit were in some way kept complete on the large scale, as it has been here described on the small scale, any electric current passing along the wire from a distant station would traverse this coil in its course, and would *deflect the needle*, and so make a signal.

So far for receiving a signal; now for sending one. Were we to go out on the open railway, taking with us a battery, and to cut any one of the wires, and place its two ends, thus obtained, upon the two terminal ends of the battery, a current would pass along the line, and the needles on that line would be deflected; and if we changed hands, so as to reverse the connections, and consequently to reverse also the direction of the electric current, the deflections of the needles would be reversed. The same would happen were we to cut a wire inside the office, or inside the telegraph, and to treat it in a similar way. Now, in every apparatus contrived for transmitting signals, we have a *place corresponding to such a cut wire;* and, near this place, are the poles of the battery, mounted and moveable, so that they may be readily applied in the breach, one way or the other as required. The place here (*fig.* 5.) is the *top of the springs*. They are not *joined* to the brass rod *n*, but *press hard* upon it, and can readily be raised; and when either of them is raised, the circuit is broken. Now near this place is a contrivance, by which the poles of the battery may make a breach in the circuit, and be applied in the breach in either direction. The drum B is of box-wood, the ends *c* and *z* being capped with brass, and insulated from each other by the wood left between them. The drum is moveable by a handle in front of the instrument, visible in *fig.* 4. A stout steel wire, *c′*, is screwed beneath into the *c* end of the drum; and a similar wire, *z′*, is screwed above into the *z* end. These two wires are the poles of the battery, *z′* being connected with the zinc end, and *c′* with the copper, thus: — from the copper end of the battery a wire is led to the terminal C; thence a slip of brass leads to a curved brass spring which presses on the drum at *c;* from the zinc end of the battery a wire goes to the terminal Z, and thence a slip of brass leads to a similar curved spring, pressing on the continuation of the *z* end of the drum, as shown in the figure. Whenever, therefore, the drum is moved, the steel wire *z′* will lift up one or other of the upright steel springs; it is now lifting up the right-hand one, and so breaks the circuit; but, by a little further motion of the drum, the wire *c′* will press upon the boss below, as shown in the figure, and thus there will be a battery-pole on each side of the breach, and a signal will be made on this, and on all instruments connected with it. And, from the peculiar arrangement of the drum, the motion can be changed as rapidly as the hand can move. I have shown the battery connections exactly as they occur in practice; and the connections are such that if the right-hand spring is moved off, the needle moves to the right, and if the left to the left. The needle on the face of the instrument always has its north end upward, and the needle within the coil its north end downward, so that, by the law elsewhere stated (*fig.* 1.), if we look at the face of an instrument, and see the top end of the needle move to the right, we may be sure that in the half of the coil nearest to us the current is *ascending*.

Now, as regards the *front* of the instrument, upon which the alphabet is engraved right and left of the needle, it will be obvious, from what has been said above, that the manipulator has it in his power to cause the dial-needle to vibrate or deflect to the right or left, as he directs the electric current one way or other through the coil, and this direction of the electric current is commanded in the way above described, by turning the handle at the lower part of the instrument to the right or left;

when this handle is *vertical*, the current is altogether cut off.

The letters of the alphabet, and a few other signals, are indicated by the number of *beats* made by the needle, some of these beats being to the left and some to the right, the general rule being, that in the letters placed to the *left* of the needle the *last* beat to make any given letter is a *left-hand* beat, whatever other beats may enter into the production of the letter; thus, L requires four beats, and they are right, left, right, *left*, finishing with the *left;* so, again, the letters placed on the *right* of the needle finish with a *right-hand* beat, as, for instance, W, which is composed of four beats, three to the *left*, and the *fourth* to the *right*. The system upon which this single instrument alphabet is formed is sufficiently simple. The symbol of each letter is placed underneath it, and consists of one or more diagonal lines sloping either to the right or left, some of which are full length, and others half length; the direction of the diagonal is the direction of the deflection or beat, a deflection being made for each diagonal, the deflection corresponding to the *half length* being made *first*. D, for instance, is thus represented \/, and is made by a beat to the right, followed by a beat to the left; R is represented by √, and is made by a beat to the left, followed by a beat to the right; H is \\/, two to the right and two to the left, W is ///, three beats to the left and one to the right, and so on. The scheme of the code is, one, two, three, and four left-hand beats for the first four signals; then one right-hand and one, two, and three left-hand beats for the next in order; then two right-hand and one and two left for the next; then three right-hand and one left; then a left, a right, and a left; and lastly, right and left, right and left, \/\/, which reaches L, and comprises the first half of the series. The other half are the counterparts, with the beats reversed. To render this description more intelligible, we annex a separate representation of the dial alphabet, and a separate alphabet, in which the direction and number of beats for each letter is shown separately.

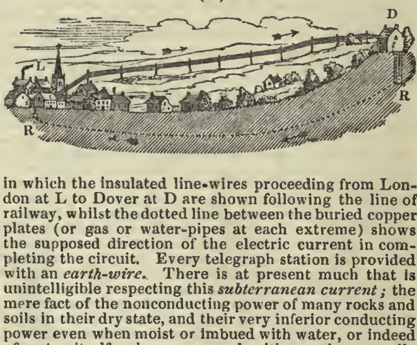
(6.)

In the preceding diagrams, the symbol like the Maltese cross ✠, indicated by one beat to the *left*, and which is termed *stop*, is used by the *sender* of a message, *at the end of every word*, and by the *reader* or receiver of the message, when he does *not understand* the previous word. On the other hand, a single beat to the *right* (indicating the letter M upon this form of the instrument) implies that he *does understand*. When, in this or other form of the needle-telegraph, *numbers* are to be transmitted, which, however, is very rarely necessary in the form of *numerals*, conventional letters and signals are settled upon for the purpose.

Our object here is, merely to render the principle of this form of the electric telegraph intelligible, and therefore we have selected the simplest instrument; but at all the principal stations a DOUBLE-NEEDLE INSTRUMENT is employed, and which may in fact be regarded as two single instruments capable of being worked separately or together. With this double telegraph the reading of the signals is much more rapid, but it has the inconvenience of requiring a separate line-wire for each needle; the signals also are different from those of the single instrument, but the *principle* is in both the same.

It is obvious, from the laws which govern the transmission of what we call the *electric current*, that when, by its means, a message is to be sent to any distant station, as, for instance, from London to Dover, there must be a means by which the current may return from Dover to London, and this was formerly effected by a separate wire; so that each single telegraph required two wires, one down the line to Dover, and one up the line to London, and a double-needle instrument could only be worked by four wires, by which much expense and occasional inconvenience was incurred. But, about the year 1837, it was discovered that the circuit might be completed, or at least that the return-wire might be superseded, by what has been called the *earth circuit*, so that, instead of using *two* lengths of wire, one only is employed for each needle, and the terminal or return-wire of the Dover instrument is connected with the gas and water-pipes of Dover, while the other terminal of the London instrument is similarly connected with the gas and water-mains of London, and, strange to say, it is found that this transit by the earth is more perfect, that is, presents less resistance to the passage of the electricity than if a return-wire had been used. In cases where there are no large subterranean metallic communications at hand, a hole is dug, in which a copper plate connected with the return-wire is buried, at a sufficient depth to be always in moist earth. The annexed cut will perhaps render this statement more intelligible,

(7.)



in which the insulated line-wires proceeding from London at L to Dover at D are shown following the line of railway, whilst the dotted line between the buried copper plates (or gas or water-pipes at each extreme) shows the supposed direction of the electric current in completing the circuit. Every telegraph station is provided with an *earth-wire*. There is at present much that is unintelligible respecting this *subterranean current;* the mere fact of the nonconducting power of many rocks and soils in their dry state, and their very inferior conducting power even when moist or imbued with water, or indeed of water itself, when compared with metal, are well-known facts, and yet, in the communication we have described, the circuit appears to be quite as complete as if a continuous wire had been used, or even more so. To get over this difficulty, some have discarded altogether the notion of *conduction* in these cases, and have regarded the earth as a reservoir in which positive and negative electricity are equally and indifferently lost, absorbed, or neutralised; the positive end of the battery freely giving off positive electricity to the earth at London, and the negative end giving off negative electricity to the earth at Dover, or *vice versâ*, as the case may be.

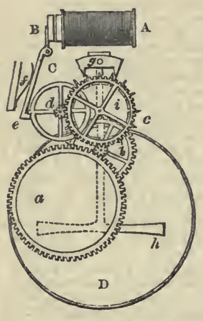
We have now endeavoured to render the principle upon which signals are communicable between distant stations by electromagnetic means intelligible, and have only noticed a few of the appendages, as they may be termed, to the talking part of the apparatus.

One of them, and an important one, is the *Alarum*, or *Bell-signal*, by which *audible* notice is given from station to station of their desire to talk to each other through the telegraph. These bell-signals may be either altogether independent of the telegraph, and rung by a separate wire, or they may be rung by the same wire which actuates the telegraph, and which in that case is so arranged that the electric current may be diverted through the bell-magnet, or through the telegraph, as occasion may require; and in this case, if we suppose the bell to be in the circuit, its *ringing* announces the wish of the distant station, say of Dover, to communicate with London; then London, on hearing the bell, turns on the current, to the bell at Dover, to announce that the signal has been successful; the current is then turned off the bells on to the needle-coils, and the message transmitted in the usual way. When sepa-

rate and independent wires and bells are employed, they are always in the circuit, and may be rung whenever required; for particular purposes the bells may serve as special signals, and when rung once, twice, thrice, and so on, may thus serve to announce something that has happened at the distant station.

These *alarums* are rung by means of an *electro-magnet*, that is, a short rod or core of *soft iron*, wound round with a sufficient length of silk-covered copper wire; this core becoming a powerful magnet whilst an electric current is traversing its copper coil, and returning again to its indifferent or normal state the moment that the electricity ceases to circulate. A side view of an *alarum* is given in the annexed diagram. A is the elec-

(8.)

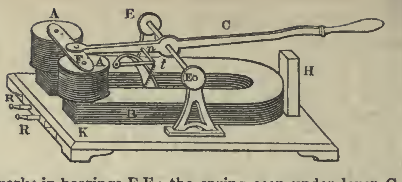


tro-magnet; in front of it is a soft iron keeper B. This keeper is attracted by the poles of the electro-magnet *every time* a current is made to circulate around it, and *as long* as it is in circulation; and attraction ceases the moment the current ceases. To prevent the keeper remaining attracted, which sometimes happens, even after the force ceases to circulate, it is prevented *actually touching* the pole of the magnet by two ivory studs, or sometimes merely by the intervention of a piece of paper; but it is so adjusted that, when in its state of rest, it shall be as near as convenient to the poles of the magnet. The rest of the figure represents the mechanism by which the bell is rung. The keeper B is mounted on the shorter arm of a lever C; the other end of the lever terminates in a catch *e*, which catches a pin in the circumference of the wheel *d*, and prevents it moving; *f* is a slender spring pressing against the long arm of the lever C, and by means of which the keeper is restored to its normal position when attraction ceases, and the catch *e* is made to act; *a* is a box containing the mainspring; *b*, a toothed-wheel connected with *a* by a pinion; *c*, a toothed-wheel having a pinion working in *b*; *d*, the wheel that carries the stop, and connected by its pinion with *c*; *g* is an escapement, working in pallets on the wheel *i*, which is on the same axis with the wheel *c*; *h* is the bell hammer: it is virtually a short pendulum, its connections and action being quite similar. When the voltaic current is made to pass along the wire of the coils A, the soft iron core is magnetised, and the keeper B is attracted; this raises the catch *e*, and so allows the wheel *d* to move. The machinery being thus liberated, the mainspring in the box *a*, which is kept wound up, sets it in motion, and the pendulum hammer *h* vibrates rapidly and strikes the bell D, which is shown also in section. When the magnetisation ceases, with the cessation of the current, the catch *e* is pressed into its place again by the reacting spring *f*, and the ringing terminates.

It will be seen, from this description, that the alarum is sounded by ordinary mechanism, and that the office of the voltaic force is merely to move a lever and liberate the machinery; whence it is obvious that there is little limit to the amount of noise which may be produced.

In some other forms of telegraph, the bell, instead of being sounded by the detachment of a common ringing scapement, is rung by the direct blows of a hammer attached to the keeper of the magnet itself; and there are several modifications of this contrivance, by which a single blow or a continuous ringing may be effected. For ringing bells at short distances, and in cases where a voltaic battery would be inconvenient, a current of magneto-electricity is substituted, which is most simply obtained by the following form of apparatus: — A A are coils (similar to the coils described); the two bars of iron which pass through the coils are connected by their upper ends to a strip of iron F, the lower ends rest on the magnet B; thus they form what is commonly termed a keeper, by connecting the two poles of the magnet; F is joined to a lever C, which is attached to a shaft that

(9.)



works in bearings E E; the spring seen under lever C is for forming a short circuit; N, a small ivory pin for insulating the wire *t*; R R, two terminals, where the wires coming from the coils terminate; H, a block for stopping the entire descent of lever; K is the stand, to which the whole apparatus is firmly fixed. As long as the iron bar remains on the magnet, no effect is produced; but sharply depressing the lever whereby the iron bars are detached from the magnet, a current of electricity is produced, passing through the coils and along the line to the bell.

TELESCOPE. In addition to the explanation of the general theory and mechanism of telescopes given in the body of the work, it is thought desirable to give specific accounts of some of those gigantic instruments whose establishment has done so much in the last few years to revolutionise certain preconceived notions in astronomy, and to supply information concerning the nature and existence of celestial objects which were before invisible. We propose then to confine ourselves to four of the largest telescopes now in existence, our space not admitting of much detail even for these. These telescopes are: the large reflecting telescope erected by Lord Rosse in the grounds of his residence at Birr Castle in Ireland; and the three large refracting telescopes at the Observatories of Pulkova near St. Petersburg; of Cambridge, Massachusetts, near Boston, U. S.; and of Cambridge in England.

Lord Rosse's 50 *ft. Reflecting Telescope.* — This enormous telescope, which has two object mirrors of 6 ft. diameter, and is 53 feet in focal length, was begun in 1842. The metal used for the specula is an alloy of tin and copper in atomic proportions, the weight of the copper being something more than double that of the tin. The weight of metal in one of the specula is $3\frac{1}{2}$ tons, and that of the other 4 tons. For fusing these immense masses of metal it was placed in three iron crucibles cast expressly for the purpose, each crucible weighing of itself about $1\frac{1}{2}$ tons. The crucibles were placed in as many furnaces, whose mouths were level with the ground, and with flues opening into one common stack or chimney. The metal for its complete fusion required to be kept in the furnace about twelve hours, and when it was in the state proper for casting, the crucibles were withdrawn from the furnaces by means of a powerful crane to the iron cradles of pouring frames arranged round the mould at intervals of ninety degrees.

The mould had for its base a framework of hoop iron six inches in depth, placed edgewise, packed in a strong frame, and supported by strong transverse bars beneath. The upper edges of these were ground into a slightly convex surface of about 108 feet radius, and thus formed the base of the mould; allowing the air to escape through the interstices, though, from the viscosity of the amalgam, no particle of *it* could escape through them. The metal also by being poured upon the iron became chilled immediately into a dense sheet of about half an inch thick, and thus secured one of the conditions which have been found to be most important, if not indispensable, in the casting of speculum metal. After becoming tolerably solid, the speculum was withdrawn to the annealing furnaces, where it remained for about sixteen weeks, when it was considered to be ready for the process of grinding and polishing.

A full account given by Lord Rosse of the polishing machinery will be found by those interested in this inquiry, in the *Phil. Trans.* for 1840. It is sufficient to state that the beam carrying the polisher is moved by a small steam engine, by which a rotatory motion round a vertical spindle is given to a crank, which by a connecting rod acts upon a sliding rod that moves the grinder or polisher backwards and forwards. By such means the polishers make strokes backwards and forwards very nearly in the manner in which the hand would make them, if the polishing were performed by hand, and at the same time another part of the machinery causes the frame carrying the speculum, and therefore the speculum itself, to revolve with a slow motion. We must remark further in connexion with this part of the subject, that it was necessary that the speculum should be cast and polished upon the same fixed frame (distinct from the rotatory frame before mentioned) that would support it when in the telescope. For this purpose the fixed frames are provided

with small wheels, by which, after being conveyed in a carriage to a railroad running into the lower part of the tube of the telescope, the speculum is deposited in its proper position for use.

For the support of the mirror in such a way as to avoid strain and flexure, a very ingenious system of levers is employed. This consists of a combination of three similar systems, resting on three points under the centres of gravity of the three equal sectors into which the speculum may be supposed to be divided. Each system consists of one triangle with its point of support directly under its centre of gravity, upon which it freely oscillates. This triangle carries at its angles three similar points of support for three other triangles, under their centres of gravity, and they again at their angles carry in a similar way cast-iron platforms formed of three ribs so as to make a kind of irregular open-work grating, supported under their centres of gravity. There are thus twenty-seven platforms, which are coated with greased cloth, and upon these the speculum is supported, each bearing $\frac{1}{27}$th part of the weight.

The above is the construction first adopted by Lord Rosse. But, as the surface of the speculum by the pressure on its edge at different elevations was found to be distorted, instead of the platforms in contact with the back before mentioned, there were adopted eighty-one brass balls capable of revolving freely, that is, three at the corners of each triangle, occupying the place of the platform in the former construction.

We now come to the mounting of this immense speculum. The tube of the telescope is made of wood, and is at the middle about 7 ft. in diameter; the interior exceeding 6 ft. in every part. This is fixed to a cube of 10 feet, which has folding doors in one of its sides for admission of the speculum, and which carries the fixed frame supporting the mirror on that side which is opposite to the mouth of the telescope. To this side of the cube is attached a universal joint by which the lower end of the telescope is connected with a fixed support, the joint being a few feet below the general surface of the ground.

On the east and west sides of the telescope are immense piers about 70 feet long and nearly 50 feet high, of which the eastern carries a large iron arc of a circle, in which moves a slider attached to a racked bar working by means of a pinion carried by the telescope tube, and the other carries the stairs and galleries necessary for the observers. Near the tops of the piers in the east and west plane passing through the universal joint are two cranes with pulleys, over which pass chains attached to the telescope, and to the ends of these chains, after they have passed through fixed pulleys in the walls, are attached the counterpoises, weighing about four tons each. There is also a contrivance connected with the chains for equalising the action of the counterpoise-weights in different positions of the telescope.

By means of the rack and pinion before mentioned, the observer is enabled, standing near the eye-end of the tube, to give a motion in hour angle of about half an hour on each side of the meridian position.

At the south end of the piers there are strong ladders, and upon these (assisted by counterpoises) there slides a stage upon which a small observing gallery travels backwards and forwards. For great elevations curved galleries are mounted upon the curved slope of the upper part of the western pier, carried by beams that run above and below pulleys fixed to the top of the pier; they are run out by rack and pinion work to approach the side of the telescope.

A quick motion in declination is given by the windlass below, and a slow motion is given by hand above for measurements: the quick motion in right ascension is given also below by a wheel turned by a workman, and the slow motion by hand above. The tube is slung by chains and is perfectly steady in a gale of wind.

The tube carries at the upper extremity the apparatus for the Newtonian small mirror, which is itself of considerable size and weight, the minor axis of its ellipse being about 6 inches; but Lord Rosse has made provision in the construction of his observing galleries for using it as a Herschelian telescope, if it is found necessary or desirable to obtain an increase of light.

In the use of this wonderful instrument Lord Rosse has hitherto chiefly confined himself to the observations of nebulæ. Many of these objects previously supposed to be unresolvable have been resolved by the powers of the telescope, and a great deal of most interesting information has been already gained respecting their structure. The figures of many of these are of a spiral form, something like the convolutions of some species of shells. 51 Messier and 99 Messier, of which drawings are given in the] *Phil. Trans.* for 1850, are very remarkable specimens of this class. The first, which is thickly studded with stars, has a large condensed mass in the centre with spiral curves of variable condensation radiating from it upon the general illuminated mass of the nebula. A large condensed mass exists at its right hand boundary. Messier 51, whose spiral formation was detected early in 1845, is of a different character, with but few detached stars, but the sweep of its spirals is exceedingly bold and interesting. Another class of nebulæ is the *annular*, of which several additional specimens have been detected. This class consists of nebulæ in the shape of a ring, and the most remarkable of them is that in Lyra, which the telescope has partially resolved.

For drawings of several other beautiful specimens, the reader may consult Lord Rosse's papers in the *Phil. Trans.* before quoted: enough has been said to show in some measure the powers of the telescope, and the grand future which it seems to open for astronomy.

Of *refracting* telescopes we give the first place to that at *Pulkova*. Its object-glass has a clear aperture of very nearly 15 inches, and its focal length is 22·5 feet. The length of that part of the tube between the object-glass and the declination axis is 13·7 feet, and that of the part between the eye-piece and the declination-axis is 9·2 feet. The tube is of wood; it is of a conical shape, and the exterior diameter at the extremities are 17·0 inches and 11·8 inches. The telescope is furnished with six eye-pieces, whose powers vary from 152 to 1218, and with other eye-pieces, twenty-one in number, belonging to the micrometrical apparatus, with powers as high as 2000.

The mounting is that known by the name of the Frauenhofer mounting, having the telescope on one side of the polar axis. The polar axis is nearly 4 feet in length and the diameter of the horary circle is 18 inches, and is divided to 40″ of time. Sidereal motion is given to the telescope by clock-work.

The instrument was constructed by Messrs. Merz and Mahler, and is in most respects similar to that erected at Cambridge, Massachusetts, near Boston, U. S., which we now proceed to describe.

The *Cambridge* telescope belongs to the observatory in connexion with the Harvard university. It has not been erected many years, but it has already earned considerable fame by the discovery of some comets, of the third ring and eighth satellite of Saturn, and by micrometrical observations of nebulæ of great excellence and importance.

The telescope and its equatorial mounting are the work of Messrs. Merz and Mahler of Munich. The extreme diameter of the object-glass is 15¾ English inches, the effective aperture barely 15 inches, and the focal length 22 ft. 6 in. The mounting, like the preceding telescope, is that known as Frauenhofer's, that is, the telescope is not in the plane of the polar axis, but on one side of it, supported near its centre at one extremity of the declination-axis, and counterpoised by a weight beyond the other extremity of the declination-axis. The declination-circle is 26 inches in diameter, and is read by four verniers to 4″ of arc; the hour circle is 18 inches in diameter, and is read by verniers to single seconds of time.

Sidereal motion is communicated to the telescope by clock-work, regulated by the friction of centrifugal balls.

It is furnished with nine eye-pieces, whose powers vary from 103 to 1118, and with a wire-micrometer eye-piece and position circle. The screw of the micrometer has been severely tested and found to be of sensibly equal value throughout its length.

The usual inconvenience attending the reversing of the telescope when an object arrives at the meridian is experienced, and the arrangement of the divisions of the hour circle and declination circle is complained of as awkward; the clock-work machinery is also disproportionate to the other parts of the instrument, and requires adjustment frequently; but the optical power of the telescope has excited universal admiration.

The whole aperture can be used without injury to the definition, and the disks of stars are remarkably small. In measuring double stars powers from 700 to 1200 have been habitually employed. On rare occasions, a power of 2000 has shown well the disks of Neptune and of the satellites of Jupiter.

With powers of 700 and 800, stars have been separated whose measured distance has proved to be 0″·3. The satellites of Neptune and the inner and eighth satellite of Saturn are seen steadily, as well as the edge of the ring at what is called its disappearance. — (*Description of the Observatory at Cambridge, Massachusetts, by William Cranch Bond.*)

The last telescope we propose to describe is that called the *Northumberland Telescope*, at the Observatory connected with our own university at Cambridge.

It was the gift of the late Duke of Northumberland when Chancellor of the University, and has acquired considerable fame from the successful search after the planet disturbing Uranus. Before the discovery of Neptune, at Berlin, it had been observed twice during

the sweep instituted for it, though it was not recognised till afterwards.

The object-glass, by Cauchoix of Paris, is of 11½ inches effective aperture, and the focal length is 19¼ feet. The mounting is that generally adopted with English equatorials, that is, the telescope is in the plane of the polar axis, and this prevents the disagreeable necessity of reversing the instrument when an object comes to the meridian.

The hour circle is 5½ feet in diameter, and is not permanently attached to the polar axis, but can be clamped to or released from the lower iron frame at pleasure. There is no declination circle, but its place is supplied by a declination sector, that is, a graduated arc carried by a flat brass bar nearly 6 feet in length, turning about a pin fixed in the telescope tube at the distance of rather more than 2½ feet from the axis of revolution of the telescope. This serves to measure small differences of declination. The instrument is provided with clockwork.

The whole of the mounting was performed under the direction of the Astronomer Royal, Mr. Airy. — (*Cambridge Observations; Airy's Description; Weale's London Exhibited in* 1851.)

TERA'TOLITE. (Gr. τερας, *a wonder*.) A species of clay found in the coal formation of Planitz, in Saxony. It is the *terra miraculosa* and *terra sigillata* of old pharmaceutical authors, and was celebrated for its supposed medical virtues.

TERCE-MAJOR. In Card-playing, a sequence of the three best cards.

TE'REBINE. A modified oil of turpentine.

TE'SSELITE. A species of *zeolite*, of a peculiar tesselated or mosaic-like structure, from Faroe.

TE'TANINE. The poisonous alkaloid *Strychnia* is sometimes described under this name.

THEBAI'A. A crystalline alkaloid contained in opium. It has also been termed *Paramorphia*. It exists in very small proportion.

THE'NARDITE. A native anhydrous sulphate of soda, found near Madrid, so named in honour of Thenard, the French chemist.

THENARD'S BLUE. A compound of a splendid blue colour, obtained by heating a mixture of phosphate of cobalt with pure alumina.

THEOBRO'MINE. A white bitter substance, contained in the chocolate nut (the fruit of the *Theobroma cacao*).

THERMONA'TRITE. A peculiar species of carbonate of soda, found in the Natron lakes at Lagunilla, in Columbia, in the Macarius desert in Lower Egypt, and in the steppes between the Ural and Altai, and is deposited from their water in the warm season. According to Haidinger, a saturated solution of carbonate of soda at a temperature between 80° and 100°, forms, on slow cooling, crystals of thermonatrite, which differ in form from those of the common carbonate, and contain less water of crystallisation.

THIEVES' VINEGAR. Called also Marseilles vinegar, and *Vinaigre des quatre voleurs*, is made by digesting rosemary tops, sage leaves, lavender flowers, and cloves, in vinegar: this useless preparation was once regarded as an effective antidote against the plague and other contagious diseases.

THRAU'LITE. (Gr. θραυω, *I break*.) A hydrated silicate of iron, which occurs, with magnetic pyrites, at Bodenmais, in Bavaria; it has a resinous fracture and is very brittle.

THRI'DACE. (Gr. θριδαξ, *lettuce*.) *Lettuce opium*, called also *Lactucarium*. It is the inspissated juice of the common lettuce, which is slightly sedative.

TIDE GAUGE. The chief improvements recently introduced into tide gauges are exhibited in that constructed by Hewitson, to which reference is made in the Dictionary. Great pains have been taken in every part of its construction to diminish friction as much as possible. The teeth of the wheels are carefully made, so that should the rise or fall of the tide amount to the fraction of an inch only, a simultaneous movement of the machine follows to that amount. It is furnished with a brass cylinder turning on axes of bell-metal revolving in Y's. The traversing bar carrying the registering pencil moves on steel friction rollers, concealed in the capitals of the brass supporting pillars. The machine is connected with an astronomical clock, which needs winding only once in 16 days, or in rather more than half a lunation, and thus produces, without any attention in this interval, a complete chart of tidal curves.

TI'KOR. A name applied in India to the fecula or starch of certain species of *Curcuma*.

TILE ORE. An impure oxide of copper of a brick-red colour.

TISSUE. In animals, the substance of which systems of organs are composed, as, *e. g.* bone, or "osseous tissue," in the osseous system; flesh, or "muscular tissue," in the muscular system; "neurine," or nervous tissue, in the nervous system; "dentine," or tooth-bone, in the dental system. The branch of Anatomy which treats of the tissues is termed "Histology."

TODDY. The sap or juice of the cocoa nut palm, which is collected in India by wounding the flower-stalk or spadix. Five or six pints are sometimes daily obtained from each tree, and it is in much request as a beverage, especially by European troops; but it requires to be drunk early in the day, and quite fresh, for it rapidly ferments, and acquires intoxicating powers.

TOLU'IDINE. An organic base obtained by the action of sulphuret of ammonium upon nitro-toluide: it is a yellow oil composed of $C_{14}\ H_9\ N$.

TOLUO'LE. An oily hydrocarbon obtained by distillation from Tolu balsam. Its composition is $C_{14}\ H_8$.

TO'MBAZITE. A mineralogical synonym of one of the native arsenurets of nickel.

TONE. In Physiology, a degree of firmness and tension in certain soft tissues, as contradistinguished from flabbiness: it is commonly applied to the muscles, in which the "tone" depends on a state of passive contraction, dependent on the connexion of their nerves with the myelon, and which is lost when that connexion, or the myelon itself, is destroyed.

TONKA, or TONQUIN BEAN. The fruit of the *Coumarouna*, or *Dipterix odorata*. It is used as a perfume, especially for snuff; its odour, resembling that of new hay, is derived from a concrete volatile oil which chemists have termed *Coumarin*, or *Tonka-Camphor*. A similar substance may also be extracted from the flowers of Melilot (*Melilotus officinalis*).

TOUCHWOOD. A term sometimes applied to the agaric of the oak (*Polyporus igniarius*).

TOUS LES MOIS. An article under this name is sold in London, as a substitute for *arrow root;* it is the starch of the *Canna coccinea*. Its particles are admirably suited as objects for the microscope, on account of their large size: in other respects they resemble the granules of potato-starch.

TRANSCENDENTAL. In Anatomy, the term has been applied to that branch which treats of the essential nature and homologies of the parts of the body, and the results of which study seem to be different from, or beyond, what would be suggested by the ideas of the parts derived from the outward senses; as when the human blade-bone, which to the eye is very different from a human rib, and which is quite distinct from the skull, is seen by the mind to be the rib of the occiput.

TRANSIT CIRCLE. A meridian instrument which combines the properties of the Transit Instrument and the Mural circle, that is, which can be employed for determining at the same transit of a celestial object, both its R. A. and its zenith distance. A remarkable instrument of this class was erected at Greenwich, by the Astronomer Royal, Mr. Airy, in the year 1850; and, from the beginning of the year 1851, all the meridian observations have been made with it. It consists mainly of a telescope of 12 feet focal length with an object-glass of 8 inches clear aperture, carrying on each side of its centre a circle of 6 feet diameter. The tube of the telescope is of iron cast in four pieces, viz. two immense cones at its eye end and object end, and a large central cube in two pieces, having attached to them in the same casts the pivots on which the telescope revolves. The cones weigh each about 1¾ cwt., and the central cube with its pivots weighs nearly 8 cwt. The two parts of the cube are bolted together on flanges with planed surfaces, as also are the cones to the central cube. The surfaces of the pivots were hardened after the casting, by chilling them, to a depth of about a quarter of an inch, and were afterwards ground and polished to a true cylindrical form after a great expenditure of time and labour. The circles are carried on cylindrical rims on the east and west sides of the central cube. The western circle has a *dished* surface of about 3 inches in breadth with its concavity westward, and carries two bands, one on its eastern and one on its western surface, the latter being divided to 5′ of space. The eastern divisions are merely given for the convenience of setting the instrument accurately to given objects by means of a pointer; but the western divisions are for the observations of zenith distance. For the reading of the circle six long microscopes or lunettes are fixed in the solid stone of the western pier, having their object-glasses arranged in a circle of about 5½ feet diameter on the inner or eastern surface, and their eye-pieces in a circle of about 2 feet in diameter at the back of the piers. The centres of these circles are in the same horizontal line with the centre of the telescope, and at the height of 5 feet from the floor. The microscopes, whose axes lie in a conical surface, are each 45 inches in length, and their axes are not quite perpendicular to the portions of the surface of the circle opposite to them, but are inclined in such a way that the light thrown through corresponding illuminating holes (cut in the pier) from a central gas lamp shall be reflected truly into them without the aid of specula. The error of collimation of the telescope is found by means of two 5 ft. telescopes, one to the north and the other to the

south of it, and the error of level is found by the observation of the reflected image of the central wire by means of Bohnenberger's eye-piece; by which means also, together with observations of stars by reflexion, the zenith point is found. An apparatus is provided by which the instrument can be lifted at pleasure out of its Y's, so as to be in the same state of strain when elevated as when resting in its Y's. The apparatus for carrying the mercury trough, which usually contains about 60 lbs. of mercury, is ingenious, and motions are readily given to it either in a north and south, or in an east and west direction.

For illumination of the wires with a dark field eight prisms are employed. Four of these are arranged symmetrically on the reflector, which is placed at the centre of the telescope as usual, but which is movable round an axis and can be acted upon by a rod passing through the tube of the telescope and having its end near the eye-piece; and four are arranged symmetrically in the plane of the wires in the eye-piece. By this means, when the field is dark, or the reflector is at right angles to the tube, the light after reflexion by the two sets of prisms is thrown across the field in the plane of the wires, and illuminates them abundantly for observation.

The casting and the engineering generally for this instrument was performed by Messrs. Ransomes and May of Ipswich, but the dividing of the circles, and all the optical part of it, was performed by Mr. Simms. The object-glass is also of his manufacture.

TRANSIT INSTRUMENT. Several improvements, both in application and in construction, have been within a few years made with regard to this admirable instrument. The principal new application of it is that by which it is made to determine the latitude of the place of observation, or the zenith distances of stars, by being placed at right angles to its ordinary position, that is, with its line of collimation lying in the plane of the prime vertical. A large instrument of this class has been recently erected at the observatory of Pulkova, and it serves to determine with admirable precision the zenith distances of stars which pass near the zenith of that observatory; and M. Struve considers its use to be of extreme importance in the ulterior investigations connected with aberration, precession, and nutation.

Mr. Simms produced at the Great Exhibition of 1851, a specimen of a *double transit instrument*, that is, of an instrument which might be used with equal facility when placed in the meridian and in the prime-vertical. This is effected by making the axis of the telescope itself convertible into a telescope by having an object-glass fitted into one of the pivots, and a sliding-tube carrying an adjustible cross of delicate spider-lines with a positive eye-piece at the other pivot. The adjustment of the axis-telescope is effected by a small collimator placed in a line with the axis. The axis is turned round, and the position of the wire-frame is shifted till the centre wire coincides with the mark equally well before and after reversion. If the meridian telescope be previously adjusted, it can be made use of for readily placing the axis telescope in its proper position for the determination of latitude by means of the transits of stars which pass the meridian near the zenith.

Another kind of transit instrument lately brought into use is the *diagonal* or *chamber transit*. The peculiarity of this instrument is, that the rays tending to form an image of a star after passing through the object-glass, do not proceed in a straight line through the tube in the usual way, but, being received upon a speculum or prism placed in the axis, are turned aside through one of the axes, which is perforated and provided with an eye-piece and a system of wires. By this means the inconvenience of placing the body in awkward positions for the observations of stars, so much felt in the use of small transits, is avoided, and the observer has no occasion to shift his position, whatever be the altitude of the star to be observed. Mr. Simms has succeeded in providing convenient means for the illumination of the field of view of the diagonal transit by the following method:— The back pivot being also perforated has a small convex lens set within it, and a larger convex lens is fixed within the axis at the back of the reflector, of such a size that one or more segments near the edges project beyond the edge of the reflector. The light of a lamp placed outside the pivot is condensed by the small lens, and the rays after crossing diverge upon the large lens at the back of the reflector, whose outer segments again condense it upon the field of view in sufficient quantity to produce a well illuminated field.

The last improvement we shall mention is the *prism illumination* of the field of view of transit instruments. It has always been a difficult problem for practical astronomers to provide for the observation of very faint objects, for which it is necessary to have the field of view dark and the wires illuminated. Various means, attended with only partial success, have been devised in different observatories, the most successful of which was till recently the application of the galvanic current. Mr. Airy applied for the first time the *prism-illumination* to the great transit-circle at Greenwich, in the year 1850, and this method, which is equally remarkable for its simplicity and facility of application, is now applied to small instruments, and will probably supersede all other methods. A pierced reflector is placed as usual in the central part of the axis of the telescope, but this, instead of being fixed, has a motion round an axis, so that it can be placed at any angle of inclination to the tube, being acted on by means of a rod projecting through the eye-end of the telescope-tube near the observer's hand. If the rod be pulled out to its full length, the reflector stands at its usual angle of 45°, and the field is *fully illuminated* by the lamp placed at the axis. By pushing the rod the reflector is made to stand more nearly at right angles to the tube, and less light is thrown down the tube, and by this means the light is *moderated*. Finally, when the reflector is at right angles to the tube, no light passes down it to the eye, but in this case the prism-application comes into play. Four right-angled glass prisms are placed symmetrically round the ring of the reflector, one of the sides of each receiving the rays from the axis-lamp perpendicularly. The light, reflected from their hypothenusal sides, and passing perpendicularly through their remaining sides, is made to proceed parallel to the sides of the tube. It is then finally received upon other four prisms placed properly in the plane of the wires of the telescope, so as to be transmitted entirely in that plane, and to illuminate perfectly both sides of the vertical wires, and the upper and under sides of the horizontal wires. This process has been used with perfect success for a considerable time for the illumination of the wires of the Transit Circle at Greenwich.

TRI'CLA'SITE. (Gr. τρεις, *three*, and κλαω, *I break*.) A mineral found in the talc and chlorite slate of Fahlum, regarded as a species of *Iolite*: it has a *three-fold* cleavage.

TRIPE. The stomachs of ruminants, when properly prepared, constitute *Tripe*. Dr. Thomson, in his *Domestic Management of the Sick Room*, says, "few things are more readily digested than tripe, when properly cooked." It should be slowly boiled, with an onion and some salt.

TRI'PLITE. (Lat. triplex, *three-fold*.) A mineral composed of phosphoric acid in combination with the oxides of iron and manganese, which occurs with beryl in the granite of Limoges, in France.

TRI'PTOTE. (Gr. τρεις, *three*, and πτωσις, *a case*.) In Grammar, a noun that has only three cases.

TRO'MBOLITE. Native phosphate of copper.

TU'BULAR BRIDGE. A bridge formed of a great tube or hollow beam, through the centre of which a roadway or railway passes. The most remarkable bridge of this kind is that designed by Mr. Robert Stephenson for carrying the Chester and Holyhead railway over the Menai Straits. This bridge consists of two rectangular tubes of wrought-iron plates riveted together; one tube being for the accommodation of the up line of rails, and the other for the accommodation of the down line of rails. A pier erected upon a rock in the middle of the straits divides each tube into two spans of 462 feet each, and there is also at each end a smaller tube of 230 feet span to serve as approaches to the bridge. These several tubes are joined together so as to form one long tube for each line of rails of the total length of 1524 feet.

The thickness of the central pier is 45 feet, of the side piers 32 feet each, and the tube projects 17 feet 6 inches over the masonry at each end. The bridge contains 9480 tons of wrought iron, 1988 tons of cast iron, and 1,500,000 cubic feet of masonry The total expense of its construction was 601,860*l.*, of which the iron work cost 443,160*l.* and the masonry 158,700*l.* It was commenced on the 10th of August, 1847, was finished on the 5th of March, 1850, and was opened for traffic on the 18th of March, 1850. A similar bridge of one length of tube and of a somewhat smaller span had been previously erected, under Mr. Stephenson's direction, over the river Conway on the same line of railway. This bridge was opened for traffic in 1848.

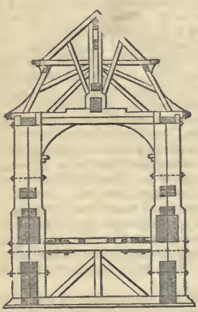
History of Tubular Bridges.— On the occasion of an entertainment given at the opening of the Conway bridge in 1848, Mr. Stephenson gave an account of the circumstances which had led to the conception of the plan of carrying a railway over a river or chasm by employing as a bridge a hollow beam or tunnel constructed of iron plates. About six or seven years before he had been called upon to construct a bridge on the Northern and Eastern Railway at Ware under certain limitations imposed by act of parliament which rendered bridges of the ordinary forms inapplicable; and he thereupon resolved to employ malleable iron beams, by the aid of which a cellular platform was made which answered the exigencies of the occasion. In this cellular platform however there does not appear to have been much novelty of conception, for it was merely an arrangement of beams of the ordinary form of railway girders, and the

(1.)

only peculiarity of these beams was that they were made of wrought iron instead of cast iron as had been the previous practice. They were proportioned moreover in the same manner as cast-iron beams, as will be seen by *fig.* 1., whereas malleable iron beams it is now known should have the top and bottom flanges of about the same dimensions. However, from the suggestions of this structure, the idea of a tubular bridge first arose in Mr. Stephenson's mind, and in his original conception he appears to have contemplated the use of elliptical or cylindrical tubes supported by chains. Mr. Stephenson's engagements did not permit him to work out this idea or to put it into such a practical form that he would have himself had confidence in carrying it into execution. He therefore called in the aid of Mr. Fairbairn to accomplish this task, and Mr. Fairbairn taking up the idea where Mr. Stephenson had left it, pursued the inquiry with great ardour and sagacity until he finally brought the idea into the form in which it was carried into practical effect.

Long before this time, however, a form of bridge much more nearly resembling that finally adopted for crossing the Menai Straits than Mr. Stephenson's cellular platform at Ware, or even than his subsequent conception of an oval or cylindrical tube supported by chains, had been successfully introduced in Switzerland; but the bridges which had been erected upon this plan, instead of being made of wrought iron, were constructed of timber. The first of these bridges appears to have been erected over the Rhine at Schaffhausen by Jean Ulrich Grubenmann in 1757. It consisted of two spans — the one of 170 feet, and the other of 193 feet. In 1778 another bridge of a similar construction was built by the same person over the Limmat at Wettingen. The span of this bridge was 390 feet. *Fig.* 2. is a section of this bridge at the ends, and

(2.)



(3.)

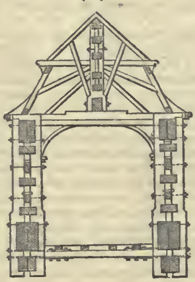


Fig. 3. is a section at the centre. It will be apparent from these figures that this bridge is composed of a platform for the roadway, two side frames of carpentry, and a roof, so that it in fact constitutes a great hollow timber beam of a nearly rectangular form. These bridges were both burnt by the French in 1799, after having remained in constant use, the one for forty-two years and the other for twenty-one years. Armies, artillery, and heavy weights, had passed over them in safety, and they appear to have perfectly fulfilled the purpose for which they were designed. Each of the side frames was raised into its place in a piece by means of powerful screw jacks resting on piles.

Subsequently to this time lattice bridges came into considerable use in America. These bridges consist of two or more great frames of carpentry formed of planks or timbers crossing one another diagonally and bolted at top and bottom to shelf pieces. The lower shelf piece carries a platform which forms the roadway, and in some cases the top is also covered with lattice work so as to convert the bridge into a hollow lattice beam. In a few cases these lattice bridges were formed of iron, and in Boston there is an elliptical tubular lattice bridge of iron of 120 feet span. This bridge had been in use a few years before the construction of that cellular platform at Ware which Mr. Stephenson says first suggested to his mind the idea of a tubular bridge. Lattice bridges formed of bars of iron have of late years come into use in this country. A singular phenomenon has been observed in some of these bridges. The centre of the bridge, instead of sinking, has actually risen up when the bridge has been put into its place.

In entering upon the consideration of the best mode of carrying out Mr. Stephenson's idea, it occurred to Mr. Fairbairn, upon whom this responsibility now devolved, that the most judicious course would be to institute a series of experiments to determine the breaking weight of beams or tubes of different forms, with the view of ascertaining what form of tube would reconcile the greatest amount of strength with the least quantity of material, and also what load a tube of a given form and of given dimensions could with safety sustain: these experiments were accordingly instituted, and they speedily furnished information of great practical importance. It was very soon found that oval and cylindrical tubes were not of so eligible a form as rectangular ones; and it was further found that in rectangular tubes the strength should be chiefly concentrated at the top and bottom, and in nearly equal proportions. It also occurred to Mr. Fairbairn that it would be advisable to make the top and bottom of the tube of a cellular form, which would obviate the necessity of using plates of such a thickness as could not be so securely riveted; and this construction, it was anticipated, would also impart greater stiffness to the structure, and render the top less liable to buckle up when a heavy strain was applied. The determination of the rectangular form of these bridges, the rejection of the chains, the introduction of the cellular structure of the top and bottom, and the settlement of all the details of the iron work, was unquestionably the work of Mr. Fairbairn; but it does not follow that Mr. Stephenson was unequal to the determination of these particulars, or that, if his other engagements had enabled him to perform the experiments which were judged necessary, instead of delegating them to other hands, a result equally satisfactory would not have been attained. However, the existing form of tubular bridge, as carried into execution for crossing the Conway river and the Menai Straits, is certainly quite as much Mr. Fairbairn's creation as it is Mr. Stephenson's, since Mr. Fairbairn settled the form, established the proportions, arranged all the details of construction, and set the first tube in its place.

Experiments to determine the best Form of Tube. — The first experiments were made upon cylindrical tubes formed of iron plates, riveted together like the chimney of a steamboat. The tube experimented upon was laid horizontally between two supports, and a small hole was cut in the centre of its lower side to enable a rod of iron to pass through; from this rod of iron the weights employed to ascertain the strength were suspended; around the hole a collar was riveted so as to impart as much strength to that part of the tube as before the perforation had been made, and a cushion of hard wood 8 inches square was fitted to the interior of the tube above the perforation. Through this piece of wood the rod which carried the weights ascended, and a cutter passing through the end of the rod rested on a square plate of iron superimposed upon the wood, so that from the wooden cushion the whole weights depended. Many of the tubes gave way by tearing at the riveting of the plates; but some also broke from the compression at the top. The more important results of these experiments are exhibited in the following tables: —

STRENGTH OF CYLINDRICAL TUBES USED AS BEAMS.

Number of Experiment.	1.	2.	3.	4.	5.	6.	7.	8.	9.
External diameter -	12·18 in.	12 in.	12·4 in.	18·26 in.	17·68 in.	18·18 in.	24 in.	24·3 in.	24·2 in.
Length between supports - - -	17 ft.	17 ft.	15 ft. 7½ in.	23 ft. 5 in.	23 ft. 5 in.	23 ft. 5 in.	31 ft. 3¼ in.	31 ft. 3¼ in.	31 ft. 3¼ in.
Thickness of plates -	0·0408 in.	0·037 in.	0·131 in.	0·0582 in.	0·0631 in.	0·1190 in.	0·954 in.	0·119 in.	0·98 in.
Weight of tube - -	102 lbs.	107 lbs.	392 lbs.	334 lbs.	346 lbs.	777 lbs.	1,007 lbs.	1,385 lbs.	1,005 lbs.
Greatest deflection -	0·39 in.	0·65 in.	1·29 in.	0·56 in.	0·74 in.	1·19 in.	0·63 in.	0·93 in.	0·72 in.
Breaking weight -	3,040 lbs.	2,704 lbs.	11,440 lbs.	6,400 lbs.	6,400 lbs.	14,240 lbs.	9,760 lbs.	14,240 lbs.	10,880 lbs.
Broke by compression or extension - -	Compression.	Compression	Extension	Extension at rivets	Extension at rivets	Extension at rivets	Extension at rivets	Extension at rivets	Extension at rivets

The thickness of the plates in these experiments was ascertained by cutting a portion of the plate into small pieces and screwing these pieces together in a vice. The collective thickness was then accurately measured, which divided by the number of pieces gave the thickness of each. It appears probable that the whole of the tubes would have been broken by compression, but for the weakening of the bottom caused by the rivet holes and which generally produced fracture by extension in that part.

The ends of the tubes where they rested upon the supports had to be kept in shape by circular pieces of wood inserted into them. When these pieces of wood were withdrawn, the ends were flattened horizontally. At the same time the centre of the tube was flattened vertically by the action of the weight hanging at the under side, and in looking endways at the tube the two sections made a species of cross; the ends forming the horizontal part of the cross, and the centre the vertical part.

The following are the results of the experiments made with elliptical tubes: —

Strength of Elliptical Tubes used as Beams.

Number of Experiment.	1.	2.	3.	4.	5.	6.
Major axis - - - -	14·625 in.	21·66 in.	21·25 in.	15 in.	12 in.	13 in.
Minor axis - - - -	9·25 in.	13·50 in.	14·125 in.	9·75 in.	7·5 in.	8 in.
Length between supports - -	17 ft.	24 ft.	24 ft.	17 ft. 6 in.	18 ft. 6 in.	18 ft. 6 in.
Thickness of plates - - -	0·0416 in.	0·1310 in.	0·0688 in.	0·143 in.	0·0733 in.	0·061 in.
Weight of tube - - -	109 lbs.	708 lbs.	357 lbs.	374 lbs.	232 lbs.	267 lbs.
Greatest deflection - - -	0·62 in.	1·35 in.	0·45 in.	1·45 in.	0·95 in.	1·14 in.
Breaking weight - - -	2,100 lbs.	17,076 lbs.	7,714 lbs.	15,490 lbs.	6,867 lbs.	8,812 lbs.
Broke by compression or extension ! -	Both.	Extension.	Compression.	Extension.	Compression.	Compression.

(4.)

(5.)

Numbers 5. and 6. of the foregoing experiments were not made with simple elliptical tubes, but the tube employed in number 5. was an elliptical tube with a fin at the top (*fig.* 4.), and the tube employed in number 6. was more of a rectangular form with a fin at the top (*fig.* 5.). These top fins were not found to operate advantageously, as they were thrown into compression before the strain came on the top of the tube itself, and the strength was thus overcome in detail.

The most important of the experiments, however, are those upon rectangular tubes, the results of which are as follows: —

Strength of Rectangular Tubes used as Beams.

No. of Experiment	1.	2.	3.	4.	5.	6.	7.	8.
Form of Cross Section.								
Top flange, inches	12 by ·075	12 by ·757	12 by ·142	12 by ·149	12 by ·269	6 by ·260	10 by ·260	2plates·115each
Bottom flange, in.	12 by ·0743	12 by ·142	12 by ·0757	12 by ·269	12 by ·149	10 by ·260	6 by ·2[illegible]	·180
Sides, inches -	9·6 by ·0743	9·6 by ·0757	9·6 by ·0757	18·25 by ·0594	18·25 by ·0594	15 by ·131	15 by [illegible]	15·40 by ·070
Length between supports -	17 ft. 6 in.	17 ft. 6 in.	17 ft. 6 in.	17 ft. 6 in.	17 ft. 6 in.	24 ft.	24 ft.	19 ft.
Weight of tube -	202 lbs.	255 lbs.	255 lbs.	317 lbs.	317 lbs.	788 lbs.	788 lbs.	500 lbs.
Greatest deflection	1·12 in.	0·94 in.	1·88 in.	1·03 in.	1·13 in.	2·66 in.	2·58 in.	1·59 in.
Breaking weight -	3,738 lbs.	3,788 lbs.	7,148 lbs.	6,812 lbs.	12,188 lbs.	17,600 lbs.	15,920 lbs.	22,469 lbs.
Broke by compression or extension	Compression.	Compression.	Extension at rivets.	Compression.	Compression.	Compression.	- -	Compression.

These experiments having been concluded and a few others of a similar character, which it would be needless to recapitulate, Mr. Fairbairn directed his attention to the determination of the proportions which it would be proper to adopt for the tubular bridges which it was proposed to construct. It was made very clear from the experiments, that the rectangular form was the best, and that the strength should be chiefly concentrated at the top and bottom of the tube, where the extending and compressing forces would act with greatest energy, and where they must be met. The proportion of the sectional area of the top to that of the bottom to give the maximum strength, was also found to be as 5 to 3 in the case of thin rectangular tubes. It was also made clear that the strength of a tubular beam would be increased if the buckling or crumpling up of the top side could be prevented, and it was known from previous experiments of Mr. Hodgkinson upon cast-iron pillars, that a given quantity of metal would better resist compression if disposed in a tubular form than if disposed in any other form. Hence it occurred to Mr. Fairbairn, that the compressing strain upon the top of the tube would be more effectually counteracted by disposing the metal in the form of longitudinal tubes than by disposing it in the form of a flat plate. The tube with the corrugated top, tested in the eighth experiment upon rectangular tubes, was made in pursuance of this idea, but eventually it was determined to form the top of the bridge of a series of parallel rectangular tubes or cells, chiefly because that form was more convenient in construction and better admitted of painting and repairs. The bottom of the tube it was considered advisable to make in the same fashion, and these points being settled, a model tube was constructed, which was nearly identical with one of the tubes of the intended bridge in every thing but size. The model tube was 78 feet long, and 75 feet between the supports; 4 feet 6¾ inches deep at the middle, and 4 feet 0¾ inches deep at the ends. It was 2 feet 8 inches wide in the body; but the cellular top was somewhat wider, being 2 feet 11½ inches wide, and the bottom, which was not cellular but consisted of a flat plate, was of the same width as the top. The cellular top was composed of six longitudinal channels formed by seven vertical plates 6½ inches deep running longitudinally from end to end of the tube and having a plate above and another below them extending through the whole length and breadth of the top. The thickness of the plate of the bottom of the model tube was ·156 inches, of the sides ·099 inches, and of the top ·147 inches. The sectional area of the top was 24·024 square inches, of the sides 9 square inches, and of the bottom 8·8 square inches. The weight of the tube was 4·86 tons. Its ultimate deflection was 4·375 inches, and its breaking weight 35½ tons. The tube gave way by tearing asunder at the bottom.

The top plates of the tube having been made a little thicker than was intended, two strips of plate 20 feet long, 6½ inches wide, $\frac{5}{16}$ths of an inch thick, and weighing about 4 cwt., were riveted along the bottom of the tube at the centre part. The ultimate deflection then became 4·11 inches, and the breaking weight 43·3 tons. In this experiment the tube got out of shape and collapsed. To obviate this evil for the future, vertical ribs of angle iron were riveted along the sides of the tubes internally at distances of 2 feet apart, and the tube having been repaired, was again subjected to experiment. The ultimate deflection was now found to be 5·68 inches, and the breaking weight 56·3 tons. As, however, in this experiment the fracture occurred, not at the centre of the tube, but at some distance to one side, where the plates were weak, a final experiment was made with the plates decreasing in thickness from the middle according to the proper law. The tube then broke by compression of the cellular top with a weight of 86¼ tons.

Mode of Determining the Dimensions proper for the Menai and Conway Bridges. — The strength of any beam larger or smaller than a beam of any given size, but which is increased or diminished proportionally, varies as the square of the alteration of its linear dimensions, or more nearly as the 1·9th power in the case of tubular beams, whereas the weight varies as the cube of any linear dimension. A beam, therefore, of twice the length, depth, and thickness of any given beam, will be about four times as strong and eight times as heavy. Taking the weight of the model tube upon which the

foregoing experiments were made at 6 tons, the distance between the supports at 75 feet, and the breaking weight of the tube at 60 tons, Mr. Fairbairn calculated that a tube of 400 span, such as was intended to carry the railway over the Conway river, would bear a load of 1704 tons exclusive of its own weight. For since the span of 400 feet is 5·33 times greater than that of the model tube, then $5{\cdot}33^2 \times 60 = 1704$ tons, and the weight of the tube will be $5{\cdot}33^3 \times 6 = 906$ tons. Now a given load distributed equally over a beam produces nearly the same strain upon it as half the load applied at its centre, or more correctly the ratio is as 5 to 8. Taking the half of 906 or 453 from 1704 we have 1251 tons as the actual load which Mr. Fairbairn considered that the tube would bear exclusive of its own weight.

Mode of Computation by Hodgkinson's Formula for Cast-iron Beams. — Some years before the formation of the Britannia and Conway bridges, Mr. Hodgkinson had ascertained the form of cast-iron beams which gave the greatest strength with the least material, and by the formula derived by Mr. Hodgkinson from these experiments, Mr. Fairbairn found that the model tube would bear about 20 tons if it were of cast-iron. But it actually bore 56·3 tons in one of the experiments of which the result was not the best, and introducing this correction into the formula, it appeared that a tube six times larger than the model tube, and therefore of 450 feet span, 27 feet deep, and with 460·8 square inches of sectional area of iron at the bottom, would bear 2018 tons exclusive of the weight of the tube itself. The results obtained by calculating the strengths as the squares and the weights as the cubes of the dimensions do not differ materially from the foregoing, and Mr. Fairbairn calculated that a tube of 462 feet span 31 feet deep and 460 square inches of area at the bottom would bear 2469 tons; and supposing the tube to weigh 1200 tons the breaking weight, when the load was applied at the middle, would be 1869 tons, exclusive of the weight of the tube itself. Now a tube which will carry 1869 tons at the centre, exclusive of its own weight, will he reckoned carry about twice this amount, or 3738 tons, equally distributed over it exclusive of its own weight; and taking the maximum load to which the bridge would be subjected at one ton per lineal foot, it followed that the bridge, when thus proportioned, would bear eight times the load that could ever be put upon it. One of the tubes of the Conway bridge when completed was tested in the same manner as the model tube by placing weights upon it and observing the deflections. The result was found to confirm the accuracy of the deductions derived from the experiments upon the model tube. The law followed by the deflections appeared to show that the tube would sustain a load of 2200 tons equally distributed over it, and exclusive of its own weight, before it broke, and that the ultimate deflection would be 30 inches.

Mr. Hodgkinson's Experiments. — Besides the experiments made by Mr. Fairbairn, a number of experiments upon tubular beams was made by Mr. Hodgkinson at Mr. Stephenson's desire, and from these experiments results were obtained of great interest in a scientific point of view. Mr. Hodgkinson found that the strength of tubes to resist compression varied greatly with the thickness of the metal of which they were composed. Thus, when the plates composing a tube, compressed in the manner of a pillar, were ·525, ·272, and ·124 inch, the resistances per square inch of section were 19·17, 14·47, and 7·47 tons respectively. Mr. Hodgkinson also found that the power of plates to resist compression varied as the cube, or, more nearly, as the 2·878 power of their thickness. He further found that long continued impact upon a tubular beam of small size, producing a deflection of less than one-fifth of what would be required to injure the tube by pressure, was completely destructive of the riveting. In large bridges, however, the inertia of the mass will, by resisting the effect of impact, prevent any such injurious effect from taking place. He also determined, experimentally, that the strength of similar tubular beams was as the 1·9th power of their linear dimensions. Mr. Hodgkinson further made a series of experiments to ascertain if the thickness of the plates of a tubular bridge might be diminished towards the ends, as indicated by theory, and he found that such was the case. The thickness of the plates of the top, bottom, and sides, at any point, was therefore made in the proportion of the rectangle of the segments into which the distance between the supports of the tube was divided at that point, the tube itself being of uniform dimensions throughout; but at and near the supports the thickness was half that of the middle. A further experiment was made to ascertain how far the effect would be advantageous to stiffen tubular beams with cast-iron applied at the top, and it was found that 10 square inches area of cross section of cast-iron at the top of the beam balanced 21 square inches of cross section of malleable iron at the bottom of the beam, proving that the cast-iron would resist compression more efficiently than the wrought. These investigations, howeve[r] though highly important, did not materially influen[ce] the configuration of the Conway and Menai bridges, th[e] proportions of which were mainly settled by Mr. Fai[r]bairn from his experiments upon the model tube alread[y] described. Experiments were also made both by M[r.] Fairbairn and Mr. Hodgkinson to determine the strengt[h] of tubular beams when laid upon their sides. The pu[r]pose of this investigation was to determine the later[al] strength to resist storms blowing on the side of the tub[e] and it was found that the proportions and strength proper for resisting the vertical strains would also give lateral strength more than sufficient to withstand an[y] storm to which the tube could be exposed.

Comparative Strains caused by Stationary and Movin[g] Loads.— In proportioning iron beams or girders to be[ar] any given load the prevailing practice among engineer[s] has heretofore been to give a strength adequate to carr[y] three times the load if the load be stationary, and twic[e] that strength, or a strength adequate to carry six time[s] the load, if the load be a moving one. At the time th[e] Conway and Menai bridges were constructed the precis[e] effect upon iron bridges of shifting pressures, vibration[s] and concussions consequent upon the passage of a rai[l]way train, was by no means accurately known; but sinc[e] that time those relations have been investigated by [a] commission appointed for the purpose, and it was one [of] their functions to ascertain what increase of the statica[l] pressure upon an iron beam or bridge would occasio[n] the same strain as a given velocity of the load. It [is] clear that this relation once determined the statical pres[]sure is all that has thenceforth to be considered, and th[e] question of the strength proper for all kinds of construc[]tions is consequently narrowed to the determination [of] the strength necessary to withstand a certain statica[l] strain, which is greater in an ascertained proportion tha[n] that due to the intended maximum load.

Effect of Momentum on the Deflection of a Beam.— If a load be placed upon any long or slender beam proppe[d] up in the middle, and the prop be suddenly withdraw[n] so as to allow deflection to take place, it is clear that th[e] deflection must be greater than if the load had bee[n] gradually applied. For the momentum of the weigh[t] and also of the beam itself, falling through the spac[e] through which it has been deflected, has necessarily t[o] be counteracted by the elasticity of the beam; and th[e] beam will therefore be bent momentarily to a greate[r] extent than what is due to the load, and after a few vi[]brations up and down it will finally settle at that poin[t] of deflection which the load properly occasions. It [is] obvious that such a beam must be strong enough no[t] merely to sustain the pressure due to the load, but als[o] that accession of pressure due to the counteracted mo[]mentum of the load, and of the beam itself; and this in[]creased strain is produced in the case of all beams t[o] which a deflecting weight is applied, but is most materia[l] in those in which a large and rapid deflection takes plac[e]. A rapid deflection increases the amount of the deflectio[n] as well as the amount of the strain, as is seen in th[e] cylinder cover of a Cornish pumping-engine, into whic[h] the steam is suddenly admitted, and in which the mo[]mentum of the particles of the metal put into motio[n] increases the deflection to an extent which the mer[e] pressure of the steam could not produce.

Effect of Deflection on the Amount and Position of th[e] Strain.— If a railway train moving at a high rate of spee[d] be made to descend a steep declivity, the pressure of th[e] wheels upon the rails will obviously be diminished; an[d] if the motion of the train be supposed to be very rapi[d] and the declivity very great, the wheels will leave th[e] rails altogether, and the train will advance after th[e] fashion of a projectile. In like manner, if a rapid trai[n] ascends a steep acclivity, the pressure of the wheels upo[n] the rails will be increased. Now a beam bent by a pass[]ing train forms both a falling and rising plane, and o[n] the first half of the beam the strain will be less tha[n] what is due to the load, and on the second half of th[e] beam the strain will be greater than what is due to th[e] load. The maximum strain therefore, and consequentl[y] the maximum deflection, will not be at the centre of th[e] beam, but at a point somewhere between the middle an[d] one end. In order to remedy this inconvenience th[e] beams of a railway bridge should be made with a sligh[t] rise in the centre, so as to form a straight line when de[]flected by a passing train.

Law of the increased Strain consequent upon Deflec[]tion.— The momentum of any moving body being pro[]portional to the square of its velocity, it follows that i[n] the case of a railway train deflected either sideways o[r] upwards by a curve or incline, the strain will be pro[]portioned to the square of the amount of motion in [a] new direction given in any specified time; or with an[y] given velocity of the train the strain will be proportiona[l] to the square of the amount of the deflection whic[h] takes place from a perpendicular or horizontal plane i[n] any given distance along the line.

Effect of the Inertia of Beams. — The mass of matte[r]

in a beam first resists deflection by its inertia, and then promotes deflection by its momentum; but whether in practical cases increased mass without reference to strength or weight will, upon the whole, increase or diminish deflection, will very much depend upon the magnitude of the mass, relatively with the magnitude of the deflecting pressure, and the rapidity with which that pressure is applied and removed. Thus, if a force or weight be very suddenly applied to the middle of a ponderous beam, and be as suddenly withdrawn, the inertia of the beam will, as in the case of a collision of bodies, tend to resist the force, and thus obviate deflection to a considerable extent; but if the pressure be so long continued as to produce the amount of deflection due to the force, the effect of the inertia in that case will be to increase the deflection. The mass must, under such circumstances, move through a space equal to the deflection, whereby a momentum will have been acquired that will afterwards expend itself in increasing the deflection. By far the severest strains, however, to which railway structures are habitually exposed arise from the jerks and concussions caused by the imperfect juncture of the rails at the ends, or other similar irregularities of surface, and a large amount of inertia in a beam will enable it to withstand such shocks much better than it could otherwise do. A large inertia compels the train to deviate from the horizontal plane to an extent answerable to the difference of weight of the striking and stricken bodies, so that if the bridge be heavy it will, under such circumstances, be less deflected, and consequently will suffer a less serious strain.

Law of the Elasticity of Iron Beams. — A bar of iron is usually regarded as a very stiff spiral spring, and it is supposed that it will be compressed or extended equally by equal increments of pressure. This law, however, though nearly true for malleable iron, is not true for cast-iron. The compressions and extensions of a bar of cast-iron one inch square, and of any length, were found by Mr. Hodgkinson to be represented by the following formulæ: —

For the extension, $w = 13934040\frac{e}{l} - 290743200\frac{e^2}{l}$.

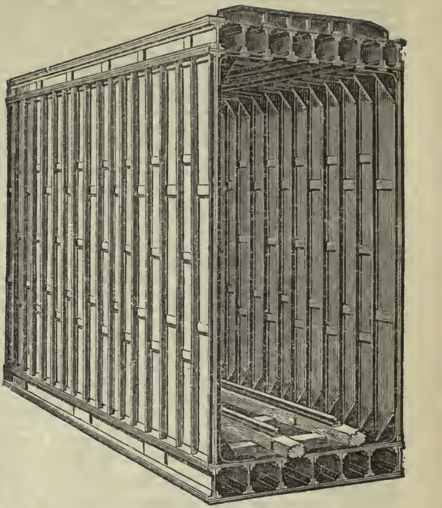
For the compression, $w = 12931560\frac{d}{l} - 522979200\frac{d^2}{l^2}$.

Here w is the weight in pounds acting upon the bar, e the extension, and d the compression in inches, and l the length of the bar in inches. Iron beams alternately deflected and released will be broken in time with a much less strain than that necessary to produce speedy fracture. Thus it has been found experimentally, that cast-iron beams deflected by a revolving cam to only half the extent due to their breaking weight will, in no case, withstand 4000 successive deflections; but 4000 successive deflections through one-third of the distance due to their breaking weight may be incurred without visible injury. Looking, however, to the various jolts, vibrations, and concussions to which railway structures are exposed, it does not appear that even a strength answering to six times the breaking weight gives an adequate margin for safety in the case of cast-iron beams.

Proportions to be observed in the Construction of Tubular Bridges. — The sectional area of the bottom of a tubular bridge of wrought iron plates should be to the sectional area of the top, as 11 to 12. The breaking weight is then found by multiplying the total area by the depth, by a constant (80), and dividing by the length. The depth of tubular beams of 150 feet span should be about $\frac{1}{13}$th of the span, and the depth of tubular beams of 300 feet span should be about $\frac{1}{15}$th of the span. These rules are empirical, but they are a near approximation to the most approved practice of the present time.

Description of the Britannia and Conway Tubular Bridges. — Having now indicated the manner in which the proportions and configuration of these bridges were arrived at, and having further pointed out the considerations which should influence the design of all railway bridges composed of iron beams, whatever be the subordinate features of their construction, it will be proper to describe briefly the more important features of the Britannia and Conway bridges as they at present stand. The annexed figure represents a portion of one of the tubes seen in perspective. There are two tubes in each bridge, one for the accommodation of the up line, and the other for the accommodation of the down-line. Each tube is rectangular, formed of plates of iron riveted together, and with ribs to support the sides, like the ribs of a ship. The most remarkable feature of the construction, however, is the cellular top and bottom. In all beams which have to be loaded in the centre, it is proper to concentrate the strength as much as possible upon the edges of the beam, or at the top and bottom; and in the case of these bridges this is done by building upon the top and bottom a number of square pipes or pillars joined laterally together, and running from end

(5.)



to end of the bridge. The upper pipes sustain a force of compression, the lower of extension; and the function of the sides of the tube is merely to keep these combinations for meeting compression and extension in their proper places. The sectional area of the top and bottom of the tubes may easily be computed by taking the width of each tube, which is 14 feet 8 inches, and the thickness of the plates; but in the model tube, which gave the best results, the sectional area of the top was to that of the bottom as 24 to 22, and this is the proportion commonly employed. There are eight cells or pipes composing the cellular top, each 1 foot 9 inches square. The plates composing the top of the Britannia bridge are, $\frac{12}{16}$ths at the middle of the bridge, and $\frac{10}{16}$ths at the ends of the bridge. The ends of the plates are carefully abutted together, and strips of iron are riveted over the joints. The bottom is composed of six cells or pipes, each 2 feet 4 inches by 1 foot 9 inches; and the upper and lower platforms, by the introduction of partitions between which the cells are constituted, consist each of a double thickness of plates so arranged that the end of each plate comes to the centre of the other, as shown in the accompanying figure. A small plate covers each joint, and as it was important not to weaken the bottom of the tube by the rivet holes running across it, the rivets are arranged in longitudinal rows, each a considerable distance from the other, and they act as cogs or steady-pins in keeping the plates together. By this expedient the longitudinal cohesion of the bottom is better maintained; and the strength of each tube approximates to what it would be if formed out of a solid piece of iron, instead of being built up of riveted plates. The thickness of the plates forming the upper and lower platforms of the bottom is $\frac{9}{16}$ths at the middle of the tube, and $\frac{7}{16}$ths at the ends. The vertical plates are, $\frac{9}{16}$ths at the middle, and $\frac{8}{16}$ths at the ends. The sides of the tube are, $\frac{8}{16}$ths at the middle of the bridge, increasing to $\frac{10}{16}$ths where the bridge rests upon the piers; for as the ends of the tube have to sustain the whole weight, they require to be made very strong and stiff to retain them in shape. To impart increased stiffness at the ends of the tubes strong cast-iron frames are introduced within them, and an arrangement of rollers is put beneath the ends of the tubes to enable the metal of the tubes to expand or contract with changes of temperature.

(6.)

The tubes of each bridge were built in the same manner as an iron ship, adjacent to the place where they had to be erected. A wooden platform or quay was erected upon the shore, upon which a tube was built, and stone supports were subsequently erected at the ends, upon which the tube when completed was made to rest. The

timber platform was then cleared away, so as to enable a number of boats or pontoons to be floated beneath the tube, and these rising with the tide lifted the tube. The floating mass was then drawn by ropes across the stream, and the ends of the tubes were rested in shelves left in the masonry of the piers, by which the tube had to be sustained. On the tops of the piers hydraulic presses were set, from which chains descended to the ends of the tube, and by putting these hydraulic presses into operation the tube was raised up a small distance, and so soon as it was raised sufficiently above the shelf the intervening space was built up. Another lift was then taken, and so on, the masonry following up the tube as it ascended, until it reached the level of the top of the piers. In the Britannia bridge there are four spans; and the tubes of each span are joined together at the ends, so as to form one long tube for each line of railway. The effect of thus joining the ends of the tubes is virtually to diminish the span, for the tube takes a contrary flexure where it passes over the piers, and if a line be drawn down the side of the tube where these contrary flexures meet, it will be found that the tube might be cut through that line without weakening it at all.

Chepstow Tubular Bridge.—A tubular bridge of a construction very different from that of the Conway and Britannia bridges has been designed by Mr. Brunel, for carrying the South Wales railway over the river Wye, at Chepstow. This bridge has a nearer resemblance to a suspension bridge than to a hollow beam; but instead of the heads of the towers being tied back by chains, as is usual in suspension bridges, they are kept asunder by cylindrical struts of wrought iron, and rods descend from the tops of the towers, which are also of iron, to support the platform of the bridge. The limits of this article, however, prevent any detailed description being given of this bridge and of other tubular bridges which have been constructed since the Conway and Menai bridges were projected. (For further information on the subject, see Mr. Fairbairn's *Account of the Construction of the Britannia and Conway Tubular Bridges*, and the *Report of the Commission appointed to inquire into the Application of Iron in Railway Structures*.)

TURGITE. A compact reddish brown mineral composed chiefly of oxide of iron, found in the Turginsk copper mines in the Ural.

TURNBULL'S BLUE. A modification of *Prussian Blue*. It is a *Ferridcyanide of Iron:* its ultimate components are 5 atoms of iron, 12 of carbon, and 6 of nitrogen.

TURNER'S CERATE. This is the *calamine ointment* of the Pharmacopœia. The modern zinc ointment prepared with oxide of zinc and hogs' lard is a good substitute for it; it is a mild drying ointment.

TURNER'S YELLOW. The fused oxichloride of lead, in fine powder: it is the basis of a good yellow oil colour formerly much used in coach-painting: it is also called *patent yellow*, and *Cassel yellow*.

TURPETH MINERAL. The yellow subsulphate of mercury, so called from its yellow colour, which resembles that of the root of the *Ipomœa* or *Convolvulus Turpethum*.

TYMPAN. (Lat.) A part of a printing-press on which the blank sheets are placed.

TY'ROLITE. A native arseniate of copper found at Falkenstein in the Tyrol.

TY'ROSINE. A crystalline substance obtained from cochineal.

U.

U'LLMANNITE. A sulphuret of nickel, antimony, and arsenic, from Siegen, analysed by Ullman.

UMBILI'CAL CORD. In Anatomy, the cordlike prolongation of the teguments of the abdomen, including the vessels which pass from the fœtus to the placenta in placental mammals; or to the allantois and vitellicle in implacental mammals, birds and reptiles; or to the vitellicle alone in plagiostomous fishes. In other fishes, in batrachians, and in most invertebrates, the vitellicle is sessile, and there is consequently no umbilical cord.

UMBILI'CAL VESICLE. The name given to the proportionately small vitellicle, or yolk bag, in man and most mammalia.

U'SNINE. A substance extracted from different lichens of the genus *Usnea*. It forms yellow and very difficultly soluble crystals, fusing like a resin. It has slightly acid characters, and forms crystallisable compounds with the alkalies: hence it has also been called *Usnic acid.* Its ultimate composition is represented by the formula C_{38} H_{17} O_{14}.

U'TERINE. (Lat. uterus.) In Anatomy, that which appertains to the womb, as the uterine arteries, veins, nerves, and the uterine portions of the placenta or cotyledon.

UTERUS. (Lat.) The womb, or the muscular and vascular part of the efferent canal or tract in the female viviparous or ovo-viviparous animal, in which the fœtus is developed. In the human subject and quadrumana it is single; in many quadrupeds it is bifid; in some, it is completely divided into two symmetrical uteri.

UTRI'CULUS. (Lat.) In Anatomy, the term is applied to the upper and larger of the two divisions of the vestibular portion of the membranous labyrinth of the internal organ of hearing.

UVIC ACID. (Lat. uva, *the grape*.) A synonym of the *Racemic* or *Paratartaric acid*, an acid isomeric with the tartaric, but differing from it in certain respects, more especially in its relations to polarised light.

V.

VACCI'NIC ACID. A name given by Lerch to a peculiar volatile acid which occasionally replaces the butyric and caproic acid in butter.

VALERIA'NIC, or VALE'RIC ACID. This acid constitutes the leading ingredient of the volatile oil obtained by distilling valerian root with water. It may also be obtained from the root of *Angelica*, so that it has been called *Angelicic acid;* and it is contained in the bark of the *Viburnum opulus*. Lastly, valerianic acid is artificially formed by the action of a mixture of quick lime and caustic potassa, on the oil of potato spirit, the *fusel oil* of the Germans, the *hydrated oxide of Amyle* of modern chemists. The formula of this acid is C_{10} H_9 O_3+HO. It is an oily colourless liquid, smelling intensely of valerian, and of a sour, pungent, and nauseous taste, leaving a sense of sweetness, and a white spot upon the tongue.

VALO'NIA. The cup of a large species of acorn imported from the Levant and the Morea, and largely used by tanners.

VAREC. The impure carbonate of soda, made in Brittany: it is also sometimes called *Blanquette:* it corresponds to our *Kelp*.

VASODE'NTINE. (Lat. vas, *a vessel*, dens, *a tooth.*) In Anatomy, that modification of dentine in which capillary tracts of the primitive vascular pulp remain uncalcified, and carry red blood into the substance of the tissue. They form the so-called vascular or medullary canals, and are usually more or less parallel in their course. A large proportion of the central part of the tooth of the sloth and megatherium consists of vasodentine, and a smaller proportion of the same part of the tusks of the elephant and of the scalpriform incisors of the rodents.

VAU'QUELINITE. The native double chromate of lead and copper: named in honour of Vauquelin, the late celebrated French chemist.

VEDETTE or VIDETTE. (Fr. from Lat. video, *I see.*) A sentry placed on an outpost or elevated point, so as to be able to observe advantageously the approach of an enemy, and to give early notice of his movements.

VE'GETAL. (Lat. vegeo, *to flourish;* vegetus, *lively.*) In Physiology, that class of vital phenomena common to plants and animals: viz. digestion and nutritive assimilation, growth, absorption, secretion, excretion, circulation, respiration, generation; as contradistinguished from a second class of vital phenomena, viz. sensation and volition, peculiar to animals: the first are called the "vegetal functions," the second "the animal functions;" and the powers or forces on which they depend have been termed respectively the "vegetal life" and the "animal life."

VE'NA PORTÆ. (Lat.) In Anatomy, the great trunk formed by the union of the veins from the abdominal organs of digestion, which trunk ramifies, after the manner of an artery, in the substance of the liver, and transmits its blood by capillaries to the hepatic veins.

VE'NICE WHITE. A pigment consisting of carbonate of lead mixed with sulphate of baryta. *Dutch White* and *Hamburgh White* are similar mixtures.

VE'NTRAL. (Lat. venter.) In Anatomy, the parts or the aspect of the region of the belly: the plates of the vertebral or serous layer of the embryo that are extended towards that region are called "the ventral laminæ."

VERA'NDAH. A term of Eastern origin applied to a light gallery external to a house, supported on pillars, and frequently inclosed in front with lattice work. In England verandahs are frequently met in villas and cottage residences attached to sitting rooms on the ground floor, where they afford a good substitute for a colonnade, and provide shelter against rain and sun.

VERA'TRIC ACID. An acid contained in the seeds

of *Veratrum sabadilla*, hence also called *sabadillic acid.* Its formula is $C_{18} H_9 O_7 + HO$.

VERGERS. Officers of the courts of law who carry white wands before the judges. There are also vergers attached to cathedrals and collegiate churches, who carry a small mace or rod tipped with silver before the clergy.

VERGE'TTE. In Heraldry, a pallet, or small pale. A shield divided by pallets is termed *Vergette.*

VERMICE'LLI. (Ital.) A paste of wheat flour in the form of wormlike cylinders of various diameters: the smallest or thread-like being termed *vermicelli*, and the larger *macaroni.* It is also cut into ribbands and other forms, and is then called *Italian paste.* It is made by forcing the paste through small apertures in an iron plate, which is done by a powerful screw press. The most glutinous varieties of wheat are those which yield the fittest flour for this manufacture.

VERMI'CULITE. (Lat. vermis, *a worm.*) A fine scaly talc composed of micaceous plates cemented together by a whitish matter; it is a hydrated bisilicate of magnesia, oxide of iron, and alumina. When heated to redness it projects out with a vermicular motion as if it were a mass of small worms. Hence the name.

VE'RMIFORM. (Lat. vermis, and forma, *shape.*) In Anatomy, certain parts that are convoluted and shaped like a worm are so called, as, *e.g.* a hollow process or prolongation of the intestinum cæcum; a part along the middle of the upper and under surfaces of the cerebellum.

VERST. A Russian measure of length containing 3500 feet; about three-fourths of an English mile.

VE'RTEBRA. (Lat. verto, *I turn.*) The term, restricted, in Anthropotomy, to certain moveable portions of the segments of the skeleton of the trunk, is now applied, in Anatomy, to the entire segment; which consists, in its typical state, of a "centrum," "two neurapophyses" and a "neural spine," two "hæmapophyses" and a "hæmal spine," and two "pleurapophyses." The principal processes of a vertebra, which are usually exogenous, are, the "parapophyses," the "metapophyses," the "hypapophyses," the "diapophyses," the "anapophyses," and the "zygapophyses." The endoskeleton of the vertebrate animals consists of a series of such segments or vertebræ, some of which may support a pair of "diverging appendages," and two pairs of such are usually developed into limbs.

VESICA'TORIN. *Cantharidin.* The blistering principle of *Cantharides*, *Lytta*, *Mylabris*, and other blistering beetles. *See* CANTHARIDES, in DICT.

VE'SPERS. (Lat. vesper.) Evening service in the Roman Catholic church.

VICTO'RIA. The name given to one of the small planets between the orbits of Mars and Jupiter. It was discovered by Mr. Hind, at Mr. Bishop's observatory, in the Regent's Park, on the evening of the 13th of September, 1850, in the constellation *Pegasus*, and is the twelfth of the group in the order of discovery. Its brightness is somewhat greater than that of some of the others, being equal to that of stars of the eighth magnitude. Mr. Hind selected as the symbol of the new planet a star and laurel leaf, emblematical of the Goddess of Victory. (*Monthly Notices of the Royal Astronomical Society*, vol. xi.) *See* PLANET.

VI'LLARSITE. A mineralogical name of one of the hydrated silicates of magnesia.

VILLI. (Lat. villus, *wool.*) In Anatomy, the name given to minute vascular processes covering, in the proportion of about twenty-five to every square line, the surface of the mucous membrane of the small intestine, and giving it a velvety or fleecy appearance. They promote the absorption of chyle from the completely digested food. Similar minute vascular processes of the chorion and other membranes are called "villi."

VI'OLINE. An emetic principle contained in the root of the *Viola odorata*, or common violet.

VIRGI'NEIC ACID. A name applied by Querenne to one of the acids contained in the rattlesnake root of America (*Polygala Senega*). It is a volatile fatty acid, of a strong disagreeable odour and taste.

VI'SCERA. (Lat. viscus, *a bowel.*) The contents of the three great cavities of the body: the brain, *e.g.* is the viscus of the cranium, the heart one of the viscera of the thorax, and the stomach one of the abdominal viscera. The term is usually restricted to the organs of the thorax and abdomen; for the myelon is as much entitled to be called a viscus of the spinal canal, as the encephalon a viscus of the cranium. The hæmal arches of the cranial vertebræ have been called "visceral" in the embryo, and their interspaces the "visceral clefts."

VITE'LLICLE. (Lat. vitellus, *yolk.*) The bag which is developed around the food-yolk, or that part of the yolk which has not been converted into the germ-mass and embryo: it is chiefly formed by a development of the inner layer of the germinal membrane; the constricted part at which it is continued into the wall of the intestinal canal is called the "vitelline duct." In man and mammalia the vitellicle is called the "umbilical vesicle."

VI'TTIE VAYR. The Tamool name under which perfumers sell the fibrous roots of the *Andropogon muricatum*: they contain an agreeable odorous oil. The *oil of lemon-grass*, and the *grass oil of Namur*, are obtained from other species of *Andropogon.*

VI'VIANITE. A native hydrated phosphate of iron which occurs in beautiful crystals at St. Agnes, in Cornwall.

VOL'TAITE. A species of *iron alum*, which occurs in black octaedral crystals in the Solfaterra of Puzzuoli. Named in honour of Volta.

VO'LTZITE. A native oxisulphuret of zinc, found at Rosiers, in the department of Puy de Dome: named after Voltz, the engineer of the mines.

VOMICI'NA. A name given by some pharmaceutical chemists to the alkaloid more usually termed *Brucia*, obtained from the bark and seeds of the *Nux vomica* and from *St. Ignatius' bean*; it is usually associated with *Strychnia.*

VO'RAULITE. A mineralogical name of the ferromagnesian phosphate of alumina, found near Vorau, in Styria. It appears to be a species of *blue-spar*, or *lazulite.*

VU'LCANITE. A mineralogical synonym of the pyroxene, or volcanic garnet.

VU'LGATE. (Lat. vulgatum, *made public.*) The Latin translation of the Old Testament, which is as highly reverenced in the Roman Catholic church as the original itself, and from which the texts and other portions of Scripture used in the liturgy are taken. The translation earliest in use was commonly called "Itala," and made from the Septuagint. Saint Jerome composed a new one from the original Hebrew. These two translations were, in after times, intermingled, and the Vulgate is composed partly of each: *e.g.* the Psalms are in the old or Italic translation. The Vulgate is declared authentic, and appropriated to the use of the church, by the Council of Trent.

W.

WAFERS. Adhesive discs for securing letters or sticking papers together. Common wafers are punched out of a paste made of very fine flour which is pressed between two heated plates of smooth iron. Transparent wafers are made of films of isinglass or gelatine, dried upon plate glass, and punched out of various forms and sizes. Wafers are coloured with various materials, but care should be taken that these are not, as is often the case, of a poisonous nature. The wafer makers are very unwilling to show the process.

WAGNERITE. The native fluo-phosphate of magnesia, from Herpen, in Salzburg.

WARD'S PASTE. A quack medicine, of which *pepper* is the active ingredient, and which has obtained some celebrity as a remedy for piles, and for fistulæ and abscesses about the rectum. Its efficacy is said to depend upon the gentle stimulus which it gives to the affected parts, and severe cases of piles are sometimes relieved by it. The *Confection of black pepper* of the *London Pharmacopœia*, which is a mixture of powdered black pepper, elecampane root, fennel seeds, honey, and sugar, is intended as a substitute for this remedy.

WART. A thickening and induration of the cuticle, which is elevated in different forms. They frequently wear away by abrasion, and may be removed by caustic applications, amongst which nitrate of silver, and acetic or nitric acid, are most commonly employed.

WASP. *See* VESPIDÆ in DICT.

WATERING OF STUFFS. This is a process to which silk and some other woven fabrics are subjected, with a view of giving a peculiar appearance to their surface, as seen by reflected light: it is generally done by passing the goods, in a damped state, between rollers, some of which are variously indented or engraved: sometimes the appearance depends upon the pressure of one fold of the stuff laid transversely or diagonally upon another, and powerfully pressed between plain revolving cylinders.

WATERPROOFING. The process by which textile fabrics are rendered impervious to water. This is most perfectly effected by means of caoutchouc, which is applied in various ways, but there are other substances, and among them some of the earthy soaps, which are more or less effective, such, for instance, as a mixed solution of soap and alum, to which some gelatinous material is occasionally added.

WE'BSTERITE. The native subsulphate of alumina, from Newhaven on the coast of Sussex: named in memory of Webster, the geologist.

WEN. A term commonly applied to fleshy and other tumours, more especially when they affect the face or neck.

WHOOPING COUGH. *Chincough*, or *Kincough*. A disease characterised by a convulsive cough, accompanied by a peculiar sonorous or whooping inspiration, and returning by paroxysms which are usually terminated by vomiting. It is infectious, and most commonly attacks children, seeming to depend upon a specific infectious or contagious matter, and affects the same individual once only. It usually comes on with slight febrile symptoms, hoarseness, and common cough, and in about a fortnight the spasmodic attacks ensue. The fit is terminated by expectoration of mucus, or vomiting of the contents of the stomach, after which the patient returns to his usual pursuits, and generally expresses a desire for food, except in very severe cases, where lassitude and fainting ensue, and often bleeding from the nose and headache. The disease is of very variable duration, but generally goes off gradually after having lasted for some weeks. The dangerous cases are those in which the head is much affected, or which are accompanied by bronchitis. The treatment consists in obviating irritation, keeping bowels open, giving nauseating medicines, and perhaps an occasional emetic, and in full habits blisters and leeches may be resorted to. Sedatives or narcotics, carefully administered, are often of the utmost service, especially hemlock, henbane, or even opium, in conjunction with squills and ipecacuanha. Opiate and stimulating liniments applied to the chest and to the region of the spine are also frequently resorted to. A mixture of cochineal and carbonate of potash has by some been considered as almost a specific in the treatment of this disorder. The relics of the cough, which are often very tedious and obstinate, are best removed by change of air.

WI'LLIAMSITE. A mineralogical synonym of the native silicate of zinc.

WI'NCING MACHINE. The reel by which the dyer winds various articles through the dyeing vat or copper.

WINTER-GREEN. The *Chimophila umbellata*. This plant, under the name of *Pipsisseiva*, was first used medicinally by the aborigines of America. The infusion of the dried leaves is tonic and diuretic. It has been found useful in some chronic affections of the urinary organs.

WINTER'S BARK. The bark of the *Drimys Winteri*, or *Wintera aromatica*, a large forest tree growing in Chili, Peru, and New Granada, and which was first brought to England by Captain Winter, who accompanied Sir Francis Drake, in 1578, to the Straits of Magellan, where he obtained his specimens. It is found in the market in large quills or rolled pieces of a dull yellowish grey colour, an aromatic odour, and warm pungent flavour. It was at first confounded with *Canella bark*, which it much resembles in appearance and flavour, but its inner surface is reddish brown, whereas that of canella is much paler, and solution of sulphate of iron gives a precipitate in its infusion, but not in that of canella. Canella is the bark of the *Canella alba*, a large tree growing in the West Indies and America.

WITCH MEAL. A popular name given to the pollen or powder sold in the shops under the name of *Lycopodium*, procured from the *Lycopodium clavatum*, or *Club moss*. It contains a large quantity of oily inflammable matter, and when thrown into the flame of a candle produces a sudden flash or blaze, whence it is theatrically used for imitating lightning. It has also, from its yellow colour, been called *Vegetable sulphur*. In pharmacy it is used for enveloping pills to prevent their adhesion, and for which, being tasteless and inert, it answers well, and better than magnesia, which is usually employed for that purpose.

WI'THAMITE. A mineral discovered by Witham in minute red crystals in the porphyry of Glencoe. It appears to be a ferro-silicate of alumina.

WOAD. The *Isatis tinctoria*, or *Woad plant*, yields by the fermentation of its leaves a blue colouring matter resembling indigo. It is the *Pastel* of the French.

WO'HLERITE. A crystallised mineral containing tantalic acid, zirconia, and silica, found embedded in the zircon-sienite, near Brevig, in Norway. Analysed by Scherer, and named in honour of Wöhler, the eminent chemist.

WO'LCHITE. An arsenio-sulphuret of lead, copper, and antimony found in rhombic crystals in the iron mines at Wölch, in the Lavant valley, in Carinthia.

WO'LFSBANE. The popular name of the *Aconite*, called also *Monkshood* from the shape of its flowers. In sufficient doses it is virulently poisonous, its most characteristic effects being the production of tingling and numbness, vomiting, contracted pupil, failure of the circulation, and occasional convulsion. The root has sometimes been mistaken for horseradish, and has led to fatal results. It has been medicinally used with great success in some obstinate cases of *tic doloureux*, or *neuralgia*. Its powers are ascribed to the presence of the alkaloid *Aconita*.

WORM BARK. The bark of the *Andita inermis*, or *Cabbage bark tree*, of the West Indies. It is cathartic, emetic, and narcotic, in doses of from 20 to 30 grains. It is usually given in the form of decoction.

WORMSEED. The substance sold under this name consists of broken peduncles, mixed with the calyx and flower buds of some species of Artemisia, and is not the seed of *Artemisia Santonica*, as usually represented. Wormseed is imported from the Levant, and used as a vermifuge in doses of from 10 to 30 grains.

WORM TEA. A preparation kept in the shops of the United States, and much used: it consists of spigelia root, savine, senna, and manna.

WORMWOOD. The *Artemisia Absynthium*. It contains a peculiar, bitter principle, to which its medica virtues may be ascribed, called *Absynthine*. Its infusion was formerly a favourite popular remedy for worms, but it is now in disuse.

WOUND BALSAM. The compound tincture of *Benzoin* of the Pharmacopœia, known also as *Friars balsam*.

WOURARA or WOURALI. *Ourari*. A powerful poison used in Guiana: it is obtained from a species of *Strychnos*. *See Waterton's Essays on Natural History*.

WRY'NECK. A permanent inclination of the head towards one of the shoulders, not connected with distorted vertebræ, and arising often from a contraction of the integuments from burns, or other causes, or from a contraction of the fibres of the sterno-mastoid muscle.

WU'LFENITE. A mineralogical synonym of the native molybdate of lead.

WY'VERN. In Heraldry, an imaginary animal resembling a flying serpent.

X.

XA'NTHINE. (Gr. ξανθος, *yellow*.) The yellow colouring principle of madder.

XA'NTHITE. (Gr. ξανθος.) A mineral found in small grains and crystals of a yellow colour, at Amity, Orange county, New York: its principal constituents are silicate of lime and silicate of alumina.

XANTHOPHYLLINE. (Gr. ξανθος, *yellow*; φυλλον, *a leaf*.) The yellow colouring matter formed in autumnal leaves.

XA'NTHOPHY'LLITE. (See above.) A yellow foliated crystalline mineral, found in the talc slate in the Ural: it is a ferrosilicate of alumina, lime, and magnesia.

XA'NTHOPI'CRITE. (Gr. ξανθος, and πικρος, *bitter*.) A crystalline bitter principle contained in the bark of the *Xanthoxylum Caribæum*, which is used in the Antiles as a febrifuge.

XA'NTHOPRO'TEINE. (Gr. ξανθος, and πρωτειον, *the chief rank*.) A yellow acid substance formed by the action of nitric acid upon fibrine.

XA'NTHORHA'MNINE. (Gr. ξανθος, and ῥαμνος, *a kind of shrub*.) A yellow substance extracted from the berries of *Rhamnus tinctoria*, the *Persian berries* of commerce.

XE'NOLITE. (Gr. ξενος, *foreign*, and λιθος, *a stone*.) A silicate of alumina, from Peterhoff, in Finland: it appears to be a species of cyanite.

XESTA. (Gr.) An Athenian measure of capacity, answering to the Roman sextarius.

XY'LITE. (Gr. ξυλον, *wood*.) A ligniform asbestus, from the Ural.

XY'LOIDINE. (Gr. ξυλον, *wood*.) A white granular substance, formed by the action of nitric acid upon starch, and upon certain modifications of lignine: it is related to Schönbein's *Gun cotton*.

XYLO'RETINE. (ξυλον, *wood*, and ῥητινη, *resin*.) A crystalline resinous substance found in certain varieties of turf.

Y.

YELLOW EARTH. A mixture of hydrated silicate of alumina and peroxide of iron, found in Scotland, Bavaria, the Harz, and elsewhere: it is sometimes used as a coarse yellow pigment.

Z.

ZEA MAYS. See MAIZE, in DICT.

ZEDOARY ROOT. The sliced tuber of *Curcuma Zedoaria*, a warm aromatic bitter. *Zerumbet root* is a similar product.

ZEIL'ANITE. A species of spinel or corundum from Ceylon. It has also been called *Candite*.

ZEUXITE. (Gr. ζεῦξις, *connection*, because found in the *United Mines*, Cornwall.) A mineral, composed of fibrous crystalline aggregates of a greenish brown colour, and having the appearance of asbestous actinolite. It is a hydrated ferro-silicate of alumina.

ZIE'GA, or SERAI. After rennet has ceased to produce the coagulation of milk, the addition of acetic acid occasions a further separation of curd, to which the above names are applied.

ZI'NCITE. Native ferriferous oxide of zinc, found with Francklinite and calcareous spar, at Franklin and Stirling, in New Jersey.

ZI'NCKENITE. A native sulphuret of antimony and lead, found near Stolberg, in the Harz, named after its discoverer Zinken.

ZOLLVEREIN. (Germ. *Customs Union*.) A name given to the German Commercial Union, of which Prussia is the head, by which it was determined that there should be perfect freedom of commerce between all the states that joined it: that the duties on importation, exportation, and transit, should be identical in all such states: that these duties should be charged along the frontier of the dominions of the contracting parties, and that each should participate in the produce of such duties in proportion to its population. The basis of this league was first laid in 1818: since which period it has been gradually joined by nearly every German state, except Austria; and there is reason to believe that this last power will soon be included in its arrangements. (See *Com. Dict.* art. PRUSSIAN COMMERCIAL UNION.)

ZOMIDINE. (Gr. ζωμος, *broth*.) The aqueous extract of flesh: one of the substances giving the odour to meat-broth, and probably the same as OSMAZOME.

ZONA PELLUCIDA. (Lat.) In Embryology, the external investment of the ovarian ovum in mammalia, which consists of a thick transparent membrane, and appears, under the microscope, as a bright zone or ring.

ZWIE'SELITE. A fluophosphate of iron and manganese, found at Zwiesel, in Bavaria.

ZYGA'NTRUM. (Gr. ζυγον, *a yoke*.) The articular cavity at the back part of the neural arch of the vertebræ of serpents and some lizards which receives the zygosphene.

ZY'GAPOPHY'SIS. (Gr. ζυγον, *a yoke; αποφυσις, a process*). The articular or oblique process of the vertebra, by which it is connected to the adjoining vertebræ.

ZY'GOSPHENE. (Gr. ζυγον, and σφην, *a wedge*.) The wedge-shaped process from the fore part of the neural arch of the vertebræ of serpents and some lizards, superadded to the ordinary anterior zygapophyses, and articulated to a cavity in the antecedent vertebra.

ZYMO'TIC. (Gr. ζυμη, *leaven*.) In Medicine, diseases caused apparently by the reception into the system of a virus or poison, which is diffused through the frame, and operates upon it like a ferment or leaven. In the Registrar-general's Report, the following diseases are grouped together as "zymotic:" — small pox, measles, scarlatina, hooping cough, croup, thrush, diarrhœa, dysentery, cholera, influenza, purpura and scurvy, ague, remittent fever, infantile fever, typhus, metria or puerperal fever, rheumatic fever, erysipelas, syphilis, noma or canker, hydrophobia.

THE END.

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